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ESSAY

ON

THE ORIGIN AND PROSPECTS

OF

MAN.

BY THOMAS HOPE.

IN THREE VOLUMES.

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ESSAY

ON THE

ORIGIN AND PROSPECTS OF MAN.

CHAPTER I.

INTRODUCTION.

I HAVE, in common with every other human being who has thought, wished my life here to be prolonged to a happier existence hereafter. Revelation has in me to mere hope added faith. Still have I sought to found my belief, not merely on the promises made through the medium of other men, who, like myself, might be deceived, or deceive, but on the unerring course of that nature which, when rightly viewed, admits of no deceit. The following pages are the result of my inquiry.

I advance in them nothing as an absolute certainty. That of which man may be actually certain amounts to very little. It amounts, at most, only to a few actually present sensations, called, some, of the sense, others, of the mind; and each, unto the minutest, detached and disconnected even from the nearest neighbouring sensations;—such as sensations of mere time and space—of quantity and number—of touch, taste, smell, hearing, sight,—some in their intrinsic nature, and in their disposition relative to others resembling, others different from certain of the remainder;—some prior to, some following, certain others.

We assert certain facts which we cannot prove, and which we nevertheless regard as more undoubted even than others susceptible of proof. Such is the truism, that a whole is singly larger than are separately any of its lesser component parts. But, in so doing, we only yet use the word whole as already directly expressing the idea of a something greater than that other thing, which we only express by the word part. Consequently in advancing this position we only yet describe a mere peculiar mode of feeling or thinking itself. We draw not yet, from that peculiar mode of feeling or thinking, any later inference or conclusion. We state not yet any belief, in the mind only produced by taking of a peculiar idea a part, spontaneously connected with the rest, and connecting it equally with other ideas different from the former one, with which it was not immediately connected, in view only of the resemblance which in other respects these other ideas already bear to that former one.

All demonstration, even the most purely and strictly mathematical, on the contrary, already is only a later statement, founded on two or more prior different and distinct enunciations of feelings or ideas entertained, each separately yet admitting of no demonstration, but to one of which we again, in view of the resemblance it already presents with the other, in our mind add other resemblances to that former one, only inferred from that former resemblance itself. In proportion as a demonstration only becomes founded on later inferences from such prior axioms or enunciations of positive primitive feelings or thoughts, distinct from each other, more numerous, more diverging, more distantly drawn, it must, from the character of an absolute, intrinsic, and self-evident certainty, in a greater measure pass over and degenerate into that of a mere surmise only of a something else, prior or posterior to itself.

Of many things at first sight appearing most evident we can in reality only entertain mere suppositions. That I am not, in this world, the only entity rational, or sentient, or tangible, or occupying a peculiar definite portion of space and time: that there exist around me myriads of other entities, sentient and tangible, distinct from myself: that of those other surrounding entities some resemble me more, and, like myself, feel, and think, and act in consequence of a will of their own, separate from mine, while others do not: that besides other human beings, separate from, though similar to myself, there are brutes, vegetables, and bodies entirely inorganic and lifeless, on some of which the living ones tarry and move: that, of the various entities around me, many continue to exist even when I cease to feel or to perceive them: that many entities existed long before I felt or saw any, and that many others will only begin to exist after I have no longer the faculty to feel or to see them: that, besides those from which I can derive sensations, there are many others which exist, though I can derive from them no sensations: that, of the entities and modifications which I occasionally feel, and even of those which I never feel, some are nearer to, others more distant from the sensations and thoughts I derive from them than others: that of the modifications which precede and surround my sensations of them, and which through these sensations are known to me, some have with these sensations of them a connexion sufficiently close, permanent, and distinct from other modifications surrounding me at a greater distance, to be more peculiarly called component parts of my own individual aggregate and person; while of these modifications again others, not having with that person of mine a connexion equally distinct and close, can only be regarded as parts of other different surrounding entities and aggregates: that of these latter entities and modifications, some nevertheless receive sensations and thoughts which, though separate from, and not directly perceived by my individual person, yet resemble my own sensations and thoughts in a greater or a less degree, and constitute the entities that receive them as more or less resembling myself; while of these latter entities and modifications others again receive no such sensations and thoughts at all, and thus only remain what are called mere inanimate beings, in certain respects more dissimilar from myself: that of the modifications which preceded my existence, my forms, my faculties, my sensations and my thoughts, some themselves produced certain of the others, even including certain of those of my own person; and that, of those subsequent to my formation, my birth, my sensations and my thoughts, which surround these, certain others again are themselves through the medium of these produced: that some are the causes, the parents; some again are the effects, the offspring of myself or of others from which they differ: that all relationship of cause and effect follows certain invariable rules: that there has been a past which is no longer, and that there will be a future which is not yet: that certain portions of time, of space, of quantity and of other modifications contained in these, are in reality contiguous to each other; while certain others of these are situated at a distance in time and place smaller or greater from each other, and only through the medium of other intervening ones are connected together: that any external object, on which as I think I actually continue, during a certain portion of time, uninterruptedly to fix my eye, really, during that aggregate of different lesser portions of time, remains the same object: that the sun which I see rising this morning is the same sun which I saw setting yesterday evening: that it will again to-morrow rise and set: that my thoughts, my sensations—as well those which I call later internal recollections of former sensations from without, as those which I call actual present perceptions of external objects—do not this instant all arise for the first time: that my present being had a prior commencement, and may have a later sequel: that the ideas I entertain of an infancy, a childhood, and a youth which preceded my present mature age—the thoughts I still cherish of the many days I have seen, the many events I have witnessed, the many persons I have known and loved or loathed—of the parents I have wept for, of the wife I have worshipped, of the children I have lost or left—are not the mere fancies of the present moment, but the recollections of what once externally was, or the representations of what still externally is—are all so many different suppositions, none of which any longer amount to positive certainties, and all of which can only, strictly speaking, be considered as mere beliefs, at the very best only founded on a presumed recurrence of certain successive combinations of sensations and ideas, representing certain external objects more frequently, and minutely, and connectedly, than do certain other sensations and ideas, in the external reality of the objects represented by which I thence do not equally believe;—and so many beliefs, during certain periods, and under certain circumstances of my life, not only while I slept, in my dreams, but while I was awake, and in a state of the utmost watchfulness, by me most firmly entertained, have at later times, and under different circumstances, again by me been so completely rejected, as the effects of mere illusions, errors, hallucinations, and deliria, only arisen within the precincts of my own individual mind, and without immediate external cause for them whatever, or without any other direct external cause for them besides the false reports of credulity, fraud, or fanaticism, or the false impressions, by juggling, phantasmagoria, ventriloquism, or other modes of deceit produced around me;—to my very face the entities I thought I had continued to fix—within my own hand the card which I fancied I had continued to grasp—have so often been, and in a manner so imperceptible to my utmost attention and vigilance, withdrawn or exchanged for some other, in reality wholly different; of a limb already amputated men have so often imagined they still endured the agony; of so many facts, like the diurnal motion of the sun round the earth, by millions, during many ages most implicitly, on the evidence of their senses, believed, later ages have again brought forth a disbelief so firm and so general;—what I first, at a certain distance, and in a certain light, took to be a living, breathing person, has so often, on nearer inspection, and with a stronger light thrown upon it, proved to be a mere forgery in stone or on canvas, or a still more unsubstantial shadow; what, on first hearing it, I fancied to be a sound, by a person I beheld directly addressed to me, on minuter inspection has been so often so clearly proved to be a voice from some other different quarter, by one of those contrivances of art called ventriloquism, imperceptibly conveyed to my ears,—that I no longer presume to draw the line between what are direct impressions by entities or modifications existing withoutside my person made on my own sense and mind, and what are only later ideas and beliefs concerning such entities, in that very mind conceived: that I cannot feel any absolute mathematical certainty of any thing save the actual present sensations and thoughts I experience themselves: that I cannot be assured of the convictions which still cling to my mind, having, withoutside that mind, a foundation more secure than those others once entertained, which since again have fallen away —have vanished: that I dare not trust that, like the beliefs once most firmly entertained, and since as unhesitatingly rejected, all those still most tenaciously retained will not some day, here or hereafter, also, like unsubstantial visions, be withdrawn from the mind.

Like images of external objects, during my sleep of a few minutes often most intensely believed to be perceptions of external realities, and producing the desires or aversions which such external realities alone can justify, but which, on my again awaking are, merely from their want of connexion with the sensations prior and posterior to that sleep more vivid and more connected, thence judged to be perceptions of external objects, subsequently presumed to have been only mere intervening creations of the mind, or dreams, why may not the sensations more vivid, more connected and more permanent, which return when I am roused from my nightly slumbers,—which during the whole course of my present sublunary existence continue to cling to me, and to pass in my mind for impressions of external objects, after I have lapsed into, and again have resurged from, the deeper torpor of death, in their whole, from first to last, equally turn out to have been mere phantasms and dreams, only somewhat more congruous and durable than those which, arisen during the sleep of a single night, are the very next morning already detected in their fallacy, but still as little founded as these on external realities?

From what I thus far call the realities of life, as from its dreams, I may at last awake to other later realities, or to other dreams more extensively and durably connected, of an entire different sort. I have no absolute certainty that any of the pictures, which at this moment present themselves to my mind, as internal recollections or representations of earlier sensations, first only derived from the impressions by external objects made on my sense and mind, really are the effects of such earlier and more distant impressions from without, already gone by, or that they really give a foretaste of other sensations and ideas which other impressions from external objects may, in periods still future and unexisting, here or hereafter, produce in us: I have no certainty that I have existed, felt, thought, willed, and acted during a certain measure of successive time; that I do not, in fact, at this present passing instant, only first begin to be, to feel, to think, to will, and to act; that all the days which I now fancy I have already seen, all the events which I imagine I have witnessed, all the relations and friends of which I think I retain a recollection, may not themselves be parts of a mere illusion or dream, only just beginning to take place, and to glide over my mind. In his fits of insanity many a youth has, even while broad awake, fancied himself an old man, the relict of many successive centuries; many a beggar, a king, elevated to the throne by the acclamation of millions: I myself, during my sleep, have imagined myself in deep conversation with men, which, on awaking, I found never to have existed.

Perhaps when from the sleep of death, in which I expect to lapse on this globe, I again, in another different globe reawake to a new life, I may for the first time, in the vastness of space, discover a wonderful new machinery, of which my present grosser faculties of sense and of mind give me not the smallest foretaste or idea. From a new point of view, less indirect, less oblique —more central, more uninterrupted than any from which I at present can take a survey of the surrounding universe,—perhaps I may at a future period see new surrounding objects much more extended and varied than those I yet behold; or see the very same objects I already in part behold, in a way infinitely more minute, more explicit, more distinct and more connected than I at present do:—I may from a new and more internal situation in space, through new and more varied intervening media, for the first time in the surrounding world recognize modifications more early, more simple and more elementary than any as yet perceptible to my present senses :—I may find the whole of space itself only to be a modification already later, more partial, and more complex of the modification of time :—I may recognise an earlier and more universal primitive material of both, of which certain remodifications, later and more partial, alone produce the difference of the perceptions I receive from the one and those I receive from the other :—I may then possibly, instead of believing, as I now do, that the future in its progress never leads back to the past—that this future ever impels us to a greater distance from each peculiar portion of the past—that there never can be, in the collective mass of time, as there constantly may be in that of space, a return to the points whence we first set out—a retrograde as well as an advancing movement—on the contrary find that in time, as we already do that in space, there exists with an advancing a retrograde movement; that through dint of a circle of a prodigious extent, of which on this present globe, in this present existence, we only describe a segment so minute as not to perceive its curve, and as only to make us fancy we still merely advance while we also in part again retrograde, we already by degrees again revert to the point whence the creation first started.

People are sometimes heard to exclaim, "Can I entirely disbelieve the evidence of my senses?" I answer, "Certainly not." If this is never believed, nothing else can be so. But of how little do these senses, left to themselves, actually give direct evidence? How much is there, in our simplest and most familiar reasoning, which, though still only passing for arguments directly founded on the positive evidence of the sense, is already, in fact, an inference and conclusion only drawn from that evidence by the later operation of the mind? Only of a few detached sensations of feel, taste, smell, hearing and sight —whether they only pass for immediate effects of earlier impressions from more external objects, or whether they already pass for later and more internal mental recollections of such former sensations from without, and which in neither case give any intrinsic security for the external existence of the objects whence they are supposed to derive—do we, only while these actually last, receive direct evidence: and if, of the external facts which we deduce from the peculiar combination of certain of these sensations or ideas with certain others—from the order which certain of these hold in time and place relative to certain others—we cannot directly receive any such positive assurance, still less can we from any other different quarter derive any such;— still less can we from elsewhere derive a certainty of the existence of entities, more external or early than the sensations and ideas arising in our sense and mind, which cause, and which are represented by these; or of the connexion of certain of these entities with certain of the others. Only of the external existence of certain of these entities and modifications, and of the connexion more proximate or more remote of certain of them with certain others, the sensation or thought, within the sensations and ideas more elementary and fundamental of mere time and space less or more frequently recurring in a similar order, occasions the belief less or more intense and rooted. By thinking that we have frequently experienced the arising of these different sensations and thoughts in the same peculiar relative disposition in time and place, we at last also come to think that they, or at least the external causes to which we attribute them, have a certain corresponding connexion with each other—a certain contiguity, out of which that of the sensations and thoughts itself proceeds.

When we think we actually feel, or hear, or see, outside the impression of our own person, that of some other positive person, distinct and separate from ourselves, we may in reality only outside ourselves see a partial imitation of the mere exterior of human forms and movements—a mere puppet, or picture, or shadow. Nay, we may, even when this puppet itself is already gone by,—when our own external sense already assures us that it no longer in reality stands before our eyes,—in our mind, through our recollections, still continue to view its impression so distinctly and forcibly as still to fancy it in sight. People, while broad awake, and still more when dreaming, often, from their mind, view outward even such objects for which they never beheld any external precedent whatever—which represent, to their knowledge, no external realities, past or present, of any sort. Often, even after a time, they mistake the very phantasms of their own mind, first conjured up intentionally as different from any sensations of external objects, for later recollections of sensations, previously by real external objects produced. They fancy that what had only first been put together in a certain way by the mere volition of that mind within, has previously been actually perceived by the sense without; and often, again, at a period still later, and when they begin to reflect more deeply, they again recognize the groundlessness of this belief; and again, by the mere effort of reason, and the palpable want of connexion between certain of their ideas, find out that if of these ideas some are the result of prior perceptions, received through the external sense, others, at first equally believed to be such, can, in reality, only have been internal visions of the mind. Often a jealous man has, for a time, fancied he saw in the arms of his wife the stranger, who at the time was in reality crossing the main; and sometimes he has afterwards again inferred, that the person he first took for a stranger could only have been a relation legitimately embraced.

Descartes said, "Cogito, ergo sum." He might as well first have said, "Sentio, ergo sum;" but leaving out this minor criticism, if by the word "sum" he meant to express any thing more than that there is a certain series of thoughts, lasting a certain limited period of time:—if by that word "sum" he meant to signify that there moreover is, besides those actual more transient thoughts, the certainty of an entity more lasting than these thoughts themselves, in which inheres more permanently the faculty of receiving such thoughts, and which continues to exist for some time, as well when that faculty is not exerted, and when such thoughts do not actually arise, as when they do,—he certainly already transgressed the limits of positive certainty. Of these latter additional circumstances he could at most only entertain a strong belief, not receive an undeniable assurance. I have already shown that we do not know for certain whether we existed before we had any sensations or thoughts, or exist while these are suspended: that what we take for internal recollections of prior sensations from without, may be only present perceptions peculiarly modified. In strict logic Descartes was only warranted to say, "Cogito, ergo cogitationes sunt." I think; and consequently there exist thoughts;—there exists a faculty of thinking, no matter whence derived, and by what entity, different from those actual thoughts themselves, this faculty be possessed.

D'Alembert, on the contrary, however, again went as much too far in the opposite extreme, when, in a letter to Frederic the great of Prussia, he asked, "Y a-t-il quelque chose?" and calls that a "terrible question." "Oui, sans doute il y a quelque chose, et cela d'averé, de certain." If there is nothing else, there are sensations, and there are thoughts; these are felt, and in so far at least they intrinsically exist, whether, and by whatever else, different from themselves, they may from without be produced, and from within be felt, and whether they represent any thing, outside themselves, or not.

Independent of our having, for the existence and for the connexion of external modifications, in their capacity as causing our sensations and thoughts, no other pledges than those sensations and thoughts themselves—than the belief in that existence which those sensations and thoughts themselves gradually produce,—the very beliefs in peculiar external modifications, which they produce, do not invariably at one time, and in one place, offer to our mind the same intensity and strength, which at another different time, and in another different place, they offer to that mind; or which, at the same time, they seem to offer to other different beings, even which we fancy to possess an organization similar to our own.

While we have yet only experienced sensations few and slight;—while we yet only remain very young in this world,—we believe most implicitly in the external reality of certain events and entities, represented by our waking thoughts, or even dreams, which, at a later period, and when further experience and observation have made us believe more intensely certain other circumstances, which appear to us incompatible with these former ones, and of a nature, when credited, to overturn and to render proportionably incredible their prior testimony, we again as firmly and strenuously disbelieve. Nay, while the mind, still young, yielding, and unfortified against beliefs only conceived on slight grounds by other beliefs resting on foundations more firm and solid, and which, if inculcated first and in good time, would, by the depth and spread of their roots, themselves utterly have repelled and excluded the penetration of those that happened to precede them, is already pre-occupied by those weaker ones, before those fitted to acquire more strength can win their way, they will themselves, on the contrary, prevent those susceptible of taking stronger hold on the mind from striking root in the same; they will employ that very faculty called reason,—which may be rendered conducible equally, according as it is directed in the right way or the wrong, to the establishment of truth, or to that of falsehood,—to build round the latter a niche protecting it from disclosure by the former, instead of wresting from its face the veil by which its fallacies are hidden: and not only such men as are ignorant and ill-judging on all subjects alike, but even such other men as, on topics not directly interfering with certain prejudices imbibed most early, and rooted most deeply, on which they have only later turned the whole strength of their more matured mind, evince the utmost penetration, and display the utmost sagacity, will, on certain other topics, respecting which early in life, and before their reason began to ripen, they have been accustomed to view one side of the question only, and have never had their eyes opened to the arguments offered on the opposite side, reason most feebly and falsely. How often are the beliefs which we ourselves at a peculiar period, and under peculiar circumstances, entertained on a peculiar subject, wholly at variance with, and again rooted out by those which, on the same subject, we adopt at another different period, and under other different circumstances!

It is no uncommon thing to see the same person, when taken by surprise, and before he has had leisure to reflect, by his words and actions indicate a fear of certain things, of which, with more opportunity to consult his reason, he would have rejected the possibility. How often we behold a man in his infancy, and before his judgment is formed, imbued with ideas of ghosts and hobgoblins, and at more advanced age, in the day-time, and when surrounded by other entities, alive and breathing like himself, proof against a belief in beings immaterial, and yet producing in others impressions similar to those produced by matter, at night, and when alone and in the dark, relapsing in his former fears, and by any sudden sound or vision made to fancy he beholds a spectre! How many individuals have we heard of, who, in perfect health and full possession of all their mental faculties, only give credence to the suggestions of a reason sound, sober, and judicious; and who, at the point of death, and with an intellect enfeebled by disease, become a prey to the grossest or most puerile superstition, submit to the most absurd mummeries and practices, and, after living like philosophers, die like mere capuchins!

While, on the one hand, we believe certain assertions on the slightest grounds, as long as we have not, for withholding from them our credence, reasons more cogent than we have for giving the same; on the other hand, we, even with motives very weighty for yielding to other opinions our belief, suspend, or refuse, or even again withdraw the faith by them demanded, when we are made to discover other new circumstances, still more weighty than the former ones, which invalidate their evidence.

Thus the diurnal motion of the sun round our earth, for which, as long as we continue tenants of this smaller globe, itself revolving round that sun, we possess what may be considered as the fullest evidence of the mere external sense, we nevertheless no longer believe; but, on the contrary, from an accumulation of inferences more deep and far-fetched of the mind, which controvert that single impression of the sense, and indicate the very reverse of what it at first sight announces, as fully and firmly disbelieve. As a man who first undertakes to prove a peculiar assertion, only tries to do so by producing later inferences deduced from former direct impressions on the sense, so a man who afterwards again undertakes to disprove the peculiar assertion maintained by the former, again only tries to do so by adducing for the existence of other and different phenomena, with the existence of which that of the former phenomena appears incompatible, other proofs, other inferences, still more weighty, and more substantial, which again exclude or subvert those tenets that, as long as unattacked, stood their ground, and were admitted as tenable.

We should thus, if we resolved never to admit in our mind the least faith respecting aught but absolute certainties, never think. We should, if we had no hopes of persuading others to a belief in any thing, save such as we ourselves had a certainty of, never converse with other men. If they have senses and minds constituted like our own, they must already, without any communication with our sense and mind, be sufficiently certain of all the things of which we ourselves can obtain a positive assurance, to render that communication superfluous; and cannot, through any medium of ours, acquire a certainty of what we ourselves only surmise. If, on the contrary, they have senses and minds differently constituted from ours, we cannot understand each other at all—cannot reason together on any topic whatsoever. All reasoning only consists in causing actual detached sensations from without to produce inferences and to cause combinations within; of which, only because those formed in certain minds may be made to subdue or to yield to those formed in other different minds, the communication between those different minds, may have its use. If we were determined only to act on positive certainties, we should never address any surrounding entities with the intention to render them, by our arguments, amenable to our interests, or by our actions, subservient to our views; for, as I observed before, we can have no certainty even of the existence of such entities, or the accomplishment of such views. We should not even act or move for the mere direct solace or convenience of our own persons, uncertain as we are whether we possess any permanent bodies, or any bodies at all. We should, by our own choice only, like Indian idols, remain seated immoveably where we happen to be placed, unassured as we must remain whether any change of position will afford an improvement in our condition; and let unforeseen and involuntary impulses alone determine our future fate and circumstances.

But unpossessed as I must content myself with remaining of a certainty, my sensations and thoughts nevertheless inspire me with the strong belief that there exist around me other entities and modifications distinct from myself; that of these other entities and modifications some resemble me more, and themselves receive from without sensations and thoughts like those which I receive, while others resemble me less, and receive no sensations or thoughts similar to those which I receive; that of these entities and modifications withoutside my sensations and thoughts, some themselves produce others, and produce these according to invariable rules; that I can communicate certain of my thoughts to other men, and can in my turn receive communication of the thoughts arising in other men; that through the communication of those thoughts, given and received, certain men may influence the thoughts and actions of other men;

that as these thoughts are representations, less or more true and faithful, of external objects, they influence men less or more to the advantage of their own individuals and of society at large; that by a sedulous study and an increasing cognizance of the invariable course of nature we become more able to discriminate what are actions of a salutary tendency, from what are actions of a detrimental sort; more inclined to prefer those of the latter to those of the former species, and thereby—imperfect as must, to the last, remain all information on a globe from which we cannot yet embrace the whole of the rules which guide the universe—more likely to advance our own individual welfare, and that of other distinct surrounding individuals with which we are connected.

With the view of acquiring this knowledge in as far as I could, I have long exerted my utmost powers of observation, of thought, of digesting the facts I collected; and with the view of disseminating to my own advantage and that of others,—for the increase of my own felicity and that of my fellow-creatures,—the fruits of my study, I now write.

Such being my motives for committing my ideas to paper, the consequences must evidently be twofold: firstly, that the opinions I profess are sincere; and next, that they are the result only of a long and severe scrutiny. Whatever system I might already, through dint of much labour, have reared (for whoever writes, and confines not his theme to mere insulated facts, without drawing from them any inferences, rears or confirms a system), has again been unhesitatingly sacrificed to the love of truth, the moment that truth seemed to lean on the side of another system, opposite to the former, more probable and better founded. Even when I had, as I thought, attained the very conclusion of my arduous task, if some new light arose and was reflected back on the parts more early and more fundamental of my theory, so as to give them a new and a different aspect, I have retraced all my steps, retrograded till I again reached the doubtful point, pulled asunder piece by piece the whole superstructed fabric, and, with the new materials added or substituted to the former, remodelled my entire work anew. Thus I have, more than once, drawn ultimate conclusions wholly opposite to those which I had previously expected to establish.

Vast and far apart as are the outermost opposite limits of my theme, nowhere have I, in treating its intermediate details, to my knowledge, taken a bold leap in order more rapidly to compass its end ; nowhere have I, intentionally, skipped over any intervening difficulties, in order the sooner and the more surely to arrive at a conclusion settled beforehand. I have cut asunder no knots which with greater patience I might have hoped to untie. A slow and shortsighted mole, creeping underground in the dark, as is each human being, when engaged in the contemplation of objects so high and distant as those here submitted to the reader, I have been content with groping my way, as I was fitted to do, earth to earth. From each truth which I fancied I had mastered, I have advanced the next step only with the utmost caution. When I found myself inextricably arrested in my progress in one direction, I have wriggled round, or turned back, till I found, in another different direction, more to the right or left, another path more circuitous, but more wide, through which I could perceive and pursue the light.

Ever continuing, in common with all other things created, to move on in space with that intangible point in time called the present, from a past already gone by, to a future not yet come; ever only able from the fleeting perceptions of that fugitive and unfixable present, to infer the past, and from that past, in its turn, to conjecture the future, I have yet dared, from the small number of events simultaneously and successively experienced by my diminutive self, to draw inferences respecting surrounding things, as remote, one way, as the first creation of matter, and the other, as the final destination of man. If I have dared too much, my work itself will condemn me.

With respect to the details of the physical phenomena of which I have occasion to speak, I may frequently advance erroneous statements. I am not myself much of what is called an experimentalist. I can call myself a natural historian no further than every man who, without the help of alembics and crucibles, electric batteries and Voltaic piles, telescopes and magnifiers, by his mere unassisted senses and mind, athwart the later and more partial phenomena of matter searches for its earlier and simpler principles, is entitled to that denomination. Indeed, apprehensive lest an investigation too minute and too protracted of certain branches of what is called natural science, might render my eye both external and internal,—both bodily and mental,—too microscopic and too intent on penetrating the earliest stages of modifications merely physical, to retain leisure, means, and long-sightedness sufficient for spanning at the same time their later mental developments in such a way as to compass the whole aggregate of created matter, I have even studiously resisted the temptation to enter deeply into mere mathematical and physical researches, and have chiefly borrowed my account of such from the experiments made by others, which seemed to be best founded, and most consistent with each other and with the results of my own observations.

With regard to the internal faculties and phenomena called, collectively, of the mind, contained in that later laboratory of sensation and thought yclept the brain, of which each human being well constituted carries about with him a complete specimen—though no man can, of any of its parts, immediately with the peculiar form and structure identify the peculiar faculties and movements, because the former can only be laid open to the light by operations which destroy the latter,—I have, for the opinion I enounce of their mode of existence and development, entirely and solely trusted to my own observations and inductions. I have endeavoured to understand the nature of the mind, not by turning my outward senses on objects still further outward, but by turning the later and more internal faculties and impressions of my mind outward upon the earlier and simpler faculties and phenomena of that mind itself; by watching its earlier and more external processes through its later and more inward operations. I have, perhaps vainly, said, "I want not from elsewhere: I possess within myself all the materials necessary for studying all the faculties and movements of the mind."

Of the things which I describe, many may, each singly and separately, already have been described before much more fully and circumstantially than I durst think of attempting; others, on the contrary, have not yet, as far as I know, been touched upon at all; or, at least, have not yet been placed in that intimate connexion with the former ones in which their external prototypes really stand, and in which I have endeavoured to collocate, relative to each other, their descriptions. My chief aim has been, while only pointing out more slightly the peculiarities of a more late and superficial sort, in which certain modifications of matter and of mind differed from certain others, to dwell more sedulously on those attributes more elementary, and fundamental, and primitive, in which those very things that in certain conditions more partial and more superstructed, again present greater differences from certain others, at bottom, and in their earlier shape still more resembled those others, and remained of the same genus with them; to fix the eye more on the unbroken connexion between the different parts of the universe of matter and of mind, than on the distinction of certain of these parts from others; and, by diving one way somewhat deeper than I think has yet been done into the origin of things created, and, by penetrating the other way somewhat further than has yet been attempted into their furthest yet unborn consequences and developments, to display somewhat more extensively than has yet been attempted the relationships that really exist between all the different external objects more proximate or more remote of our feelings and of our thoughts; between those productions of the great primitive cause of all known effects that are earlier and those that are later; between those that are nearer to and those that become more distant from that first cause itself; between the past, the present, and the future, unto their furthest limits.

For this endeavour alone I claim some credit. Of whatever subject the history is first traced to its earliest source in time past, and thence is carried forward, in most unbroken continuation, through all its successive ramifications, to its utmost probable issue in time to come, the account, however slight, but resting on just and well-founded inductions, may singly, in science, cause greater advances than will do thousands of descriptions of different things, each individually most minute—most laborious,—but each desultory—each devoid of that connexion with the rest which their external subjects in reality bear to each other. What then must, in good hands, be even a connected sketch only of the general concatenation of cause and effect, both in the physical and intellectual world?

I may be thought presumptuous in attempting to give even a mere approximation to such—may be laughed at for hoping to succeed: but no one can succeed in any thing who does not try; and in my case, where nothing more urgent can be sacrificed in the attempt, the probability of success may be made to preponderate over the chance of failure, and the fear of ridicule. Nothing great is undertaken where that fear predominates;—where we dread a weapon formidable only when fled from, and falling innoxious when boldly faced.

A work in which all the leading conditions both of matter and of mind, as yet known, are necessarily, in some degree, made successively to pass in review, must needs contain much which as yet only is an approximation to the full and exact truth. Many of the less important assertions, which in themselves, as far as they go, are just, must still from other assertions, with which their subjects are in reality connected, remain separated by intervening chasms of thus far insuperable ignorance, or only with these others be connected by false and erroneous statements. Innumerable must be the omissions of essential points of information, and the intermixture of errors with truths. But if of the few new facts upon which I cannot help thinking I have alighted, or even of the few new connexions between facts long established, which I imagine I have discovered, any be thought of the least importance, and serve to give additional perspicuity to our ideas or confirmation of the external realities they represent,—and still more, if they serve to increase our disposition to what is good, and our aversion to what is evil, by increasing our confidence in the rewards attendant on the former, and the penalties arising out of the latter,—let not any errors, however palpable to others, which still may have clung to my essay, in the eyes of the reader acquire a magnitude so exaggerated as to render them indifferent to the adoption or rejection of my theory.

If we wish to extend our knowledge, we cannot confine ourselves to the investigation of the things that fall immediately under the cognizance of the sense: we must conjecture; we must abstract; we must generalise;—and in generalising we must always, from what we know for certain, launch into what we only believe,—what thus remains liable to error. But should certain of my conclusions be of a nature calculated to combat and to overturn certain other even of my own inductions, in a manner more triumphant than has yet been done, even this would already be a new step advanced in science.

Many men have complained, that the deeper they dived in the depths of metaphysics, the more they became, instead of enlightened and made to see their way before them, on the contrary only bewildered—only involved in a mass of darkness, confusion and contradiction deeper and more dense. This cannot have arisen from the intrinsic nature of the modifications themselves to which they sought the clue. Nature has followed in her developments not only of matter but of mind fixed and invariable rules: nay, where she has permitted us first to begin perceiving their series, she has allowed us to go on unfolding their later combinations in a regular progression. The first attributes of matter are already phenomena only appreciated by the faculties of the mind, as the last combinations of the mind only rest on the first conditions of matter. Of the uncertainties so often incidental to—of the errors so often mixed with—metaphysical pursuits, the fault must thus have lain, not in the subject itself, but in the wrong method of conducting the inquiry; in a predetermination at the very outset of this latter to establish certain preconceived opinions, where the later conclusions drawn ought only have been left to flow naturally out of earlier premises spontaneously occurring;—in a manifest partiality felt for collecting only such observations as seem to favour and to support a peculiar doctrine, rather than a disposition cherished to investigate with equal eagerness and zeal whatever circumstances may make for or against our peculiar belief.

Instead of pursuing this latter fallacious mode of discovering the truth, most inimical to its real detection, men should first only seek to lay down just principles, and then let the later conclusions fit on to these spontaneously in the best way they could.

This is what I have at least strived to do. I have tried to discard all preconceived opinions. I have cleared away right and left all later, more partial and more superstructed attributes not only of mind but even of matter, till athwart these latter I penetrated to the earliest, simplest, and most general positive conditions which I could find; and after I had alighted on these, I have on their deep and broad base replaced my later and more partial materials, both corporeal only and intellectual, according as on all sides and in all directions they seemed to tally with these more perfectly. Thus I have at last, by insensible degrees and transitions both analytical and synthetical, arrived at the conclusions which I here present.

I thus cannot join in the general charge brought against metaphysical pursuits, that they only retain those unfortunate beings, allured by them, in an inextricable maze or circle;—that they lead to no final result, or at least to none that is useful in practice. The earlier and simpler phenomena of a purely physical sort have themselves pointed out to me the way to the later ones of an intellectual nature, and these latter have in their turn thrown fresh light over the former.

At a period when, if the study of the phenomena which appertain to the moral world are generally neglected, those, on the contrary, that set forth the mere physical properties of matter are pursued with the utmost activity;—when while with regard to the former there seems to reign the utmost indifference, with regard to the latter every day teems with fresh discoveries, I might, no doubt, by delaying the publication of my work, contribute greatly to the further improvement at least of its earlier and more elementary parts; but science is long and life is short. I have already during the best period of my existence, not only sacrificed social enjoyment to recluse studies, but, moreover, in doing so, greatly impaired my health, and thus lessened my chance of a prolonged existence. I may thus with reason apprehend that by trying to do much better than I have thus far done—by delaying for that purpose much longer to communicate the fruits of my labours—my days may come to an end before my task is completed. I therefore prefer publishing what still remains full of flaws and imperfections, to what, more elaborately finished, might only be doomed to follow me to the grave. Others, beginning from where I have been forced to leave off may, partly supported by the very scaffolding I have helped to raise, complete and beautify the monument of which I set out the rude beginnings. They will with less intellectual labour be able to correct my errors, to supply my omissions, to cement my disunited assertions, to smooth my asperities, and to make my statements glide into each other with more ease and more perspicuity. Thus giving the finishing touch to what I have only vaguely sketched out, they will reap the praise bestowed on the edifice of which I have collected the materials and conceived the plan. So be it! My object is the further dissemination of knowledge and of happiness; and whether I myself, or others, gain the applause merited by pointing out a speedier or surer way to its attainment, seems, so the end be attained, a matter of indifference. I must equally be the gainer by the result.

Whenever I have, in my way to the elucidation of what I deemed valuable truths, met with such errors as seemed calculated to impede their establishment, I have always made the exposure of these errors, by showing their incompatibility with truths already acknowledged, the first part of my double task; and made the announcement of the new truths intended to be inculcated, the second. Errors, where they exist in the mind, must be removed, ere sufficient room can be cleared out to rear in their stead the new and more extensive truths, of which they hindered the admission.

Great names I have always mentioned with due respect, even where I questioned the doctrines ushered in, or maintained, under their sanction. Wherever, as must frequently be the case, I myself mistake the wrong for the right, I shall ever be ready to acknowledge the trouble taken to expose the fallacy of my reasoning as an obligation, provided the task be undertaken from the same motive from which I wrote: the love of that truth, whose empire must equally be extended, whether I inlist others, or whether others inlist me, under its legitimate banners.

Even where I owe most to prior authors, I have seldom indulged in the pleasure of quoting their works: not that I wished to appropriate to myself any of their discoveries. Those, in whose minds have originated great advances in science, are generally too well known to hazard the attempt, even if I had been inclined to boast of borrowed feathers: and to have, at every step of my progress, repeated their illustrious names, could only have increased the bulk of my work, without adequately increasing its utility. Moreover I must have been prevented by the very mechanism of my essay. The facts I have borrowed from different preceding authors are so intimately interwoven and blended with each other and with my own conjectures, that, to have given each man his separate due would have been as impracticable as it was unnecessary to my purpose. The different origin of different lights, from different quarters diffused over a subject, can only be pointed out while they remain distinct and partial: its trace must cease to be visible where they merge in an universal glare; and the time perhaps may come, when all men will have to renounce individual and separate merit.

As the title of my work indicates, its main object is to trace the origin, the vicissitudes, and the final destination of man; but the very globe on which man first arises, is not a distinct and separate whole. It is only a late, a small, a remote part of an universe of things created, comprehending millions of other globes earlier and larger than our mole-hill, to many of which it is only a mite, and to some of which it owes its own later existence, and that of all the entities of which it becomes gradually composed; nay, to all of which it remains to a certain degree subservient; in so much that we can only of the origin and prospects of the entities that arise on its surface form a sound judgment, by casting our glance constantly both forward and backward on all the other globes by which we are surrounded.

Whoever has attempted to write, even only on later and more partial objects of the creation separately, and has wished to describe their appearance from their first beginning, must already have experienced the difficulty not merely of saying all that essentially pertained to the subject, but of saying only that, and of saying of it every lesser part precisely in that peculiar stage of his progress—in that peculiar order with regard to the remainder—where it was best calculated to prepare one for all the assertions that were to follow, and to confirm all those that preceded; where with the least repetition and redundance might be combined the greatest precision, perspicuity and connexion. How absolutely impossible then must necessarily be this most seasonable timing of every different detail, where the whole aims at embracing a description of all the most essential attributes both of matter and of mind, each, from their earliest known beginnings carried on to their utmost ramifications yet discovered by us.

All descriptions given by man must, from the very essence of the materials of which they must be composed, and of the means by which they must be communicated—namely, by words addressed to the ear or eye—necessarily be liable to certain defects, or, at least, discrepancies from the originals described, which no human ingenuity can avoid, and for which the reader should be prepared, in order when they occur to make allowance.

In didactic works, professing to describe many external entities and modifications which, in reality, begin to exist simultaneously, or, at most, at short distances from each other, and go on being developed together, the descriptions can only be presented successively, so that of each different modification in particular the account, as it is intrinsically given with greater precision and accuracy, must be farther removed from, and placed at a greater distance before or after that of the other modifications different from itself, to which its original lies closest.

Thus while of an entity called animated, the parts termed vital in reality have their commencement soon followed by that of their parts named sensitive, and these again, soon followed by that of their organs termed cerebral or intellectual, each superstructed on the former ones, man, in proportion as he wishes of each of those parts individually to render the description more explicit, is obliged, however small be the period of real successive time which the commencement of these different developments occupies, and however simultaneously they all go on, to stretch out that description to a greater successive length, and more in that description to separate the account of each part individually from that of every other part really nearest to it in time and place: and the greater the number and the difference of external objects described, the greater becomes this discrepancy between the originals and the representation.

This is a defect inherent in the very nature of all description, even the best; and becomes more obvious, as the description is, in other respects, rendered more accurate and more detailed. Infinite are the other faults which result only from the individual capacities and means of the describer,—from want of sufficient materials on which to found his observations, or time allowed him to digest these thoroughly. Had I only been able to command all the leisure, required for that purpose in a work like mine, how many errors that subsist might have been removed!

The imitative order and connexion of the different parts of my description, such as it may be, is however, I flatter myself, sufficiently analogous to the real concatenation of the object described, to enable such as should have no taste or leisure for tracing step by step each peculiar branch of my long and manifold investigation, to skip over those parts by which they are less attracted, and proceed at once to those which more excite their curiosity; provided only that they consent to take for granted the conclusions I draw from earlier inferences which they have not taken the trouble to investigate.

Desirous of giving to the long chain of arguments which I sometimes string together the utmost perspicuity, I have been obliged to waive in my style all attempt at elegance, without having dared to seek conciseness. My diction is necessarily always monotonous, often trailing, and sometimes, I fear, even pedantic. For these faults the uniformity and simplicity of the principles on which my work rests must account, and the importance of the result must atone. Eloquence is produced by presenting contrasts; my aim has been to render similarities more evident.

Often indeed will my style incur very serious blame. Often, from the number of thoughts so connected together as scarcely to bear being presented in sentences wholly separate from each other, it will seem so involved as to require in the reader the most unremitting attention not to lose the thread of the subject; but whoever undertakes to describe not only what attributes a number of different things intrinsically possess, but moreover, and in the same breath, what other attributes of other objects, earlier or later and more distant than their own, these are, in their turn, again connected with;—to present to the mind of the reader not only the picture of what each object singly is, but, at the same time, the constant image of what else it is superstructed upon, and what else it produces—will often be unable to avoid this circumstance, which only to intellects limited and able to retain very little without reposing from their labours, like those of man, is a positive defect. In an essay of the nature of mine, the understanding of the reader must necessarily on its side make some effort and advance a few steps, so as to meet the ideas of the author half way, instead of remaining quiet and unexerted, while the unfortunate writer alone is required to perform the whole of the strides necessary to reach the reader's capacity. This mutual advance the very nature of the subject renders indispensable.

Words are but arbitrary and conventional signs, framed by man to represent the objects of external nature, or the ideas by these objects in man produced: and as my chief purpose is, to mark the many still unheeded connexions that exist between certain of the more important modifications of matter and of mind which themselves intrinsically have already long been rendered familiar topics of discourse, rather than for the first time to describe lesser and more partial objects and modifications, thus far still remaining wholly unnoticed and undescribed, I shall seldom want words wholly new, even to represent what may be new in my mode of combining ideas already frequently expressed. This will be accomplished by connecting certain already familiar expressions together in a new way, more than by creating thus far uninvented and unheard-of new terms.

When I have trod on entire new ground, I have boldly created new words. I have never displaced any expression, already received and in use, from the meaning to which it had been generally attached, in order to transfer it to a new signification, even where in its former sense it already had a sufficient number of synonymes, to appear a piece of superfluous wealth. The contrary practice I have ever thought conducive only to unsettle both our ideas and our language. Little mischief can arise only from overabundance of expressions, much from ambiguity. Of any word, by abusive application again become vague and uncertain in its meaning, I have always given a definition ere I hazarded the use.

Among words of this sort are those which, like that of immensity, of incomprehensibility, of infinity, of indivisibility, of immutability and of innumerability, express the absence or negation of certain positive attributes so radically inherent in all modifications alike of matter and of mind such as our faculties of sense and of intellect can discern, that where we deny them in an absolute and unconditional manner, we must at the same time imply the absolute absence of all modifications of matter and mind, such as we know, whatever; and therefore can, where we deny them in such an absolute and unconditional matter, and yet speak as of any thing that is, only be understood to speak of the sole entity which must be independent of them, and yet be, namely, their own first cause and creator: that God, whom we believe to exist, and yet cannot comprehend.

These negative words, however, we generally, even when in reality we only use them in a relative sense, and in order to indicate that certain positive entities are beyond being measured, comprehended, bounded, divided and changed by certain other peculiar limited entities, use in this unconditional and unqualified manner so inconsiderately, as often to risk leading our hearers into a wrong understanding of our meaning.

The word eternal seems only in its origin to have been employed to express, not the absence or cessation of time, that first and most essential ingredient of all things created, and of all sensations and thoughts by which such things are represented in the sense and mind—which absence cannot be comprehended when applied to any thing we can understand or think of—but only, on the contrary, to express a constant replacement of portions of time already gone by, by new portions of time again succeeding them. In this sense alone we can to the word eternity attach an intelligible meaning, or rather, any meaning at all. By degrees, however, the word eternity has been understood as signifying, instead of the unceasing duration of time, its sudden and total cessation, again following, as its non-commencement first preceded its intervening and thus limited existence and flow; and eternity has thus been rendered a nondescript positive attribute, opposed to that other positive attribute time. We talk of a period when eternity shall begin, because time shall have had an end, instead of saying that eternity shall take place, because time, once having begun to flow, shall never cease to exist. Do as we please however, we cannot conceive such a state of things ever to take place: we cannot connect the idea thereof with that of any modification of matter or of mind of which we can form a conception. Of all those entities and modifications of which we can have any idea at all, we can have an idea only as existing within the precincts both of time and of space, and as themselves throughout partly composed of certain portions of both these essential conditions as well of mind as of matter. To us the cessation of time is the cessation of all else that constitutes matter and mind intrinsically and that constitutes our sensations and thoughts relative to matter and to mind. If we wish for a hereafter in which to feel, to think and to enjoy eternal happiness, we must also wish in that hereafter to be conscious of the continuation of that time, through the medium of which we can alone conceive any felicity to exist, to be felt, and to be enjoyed.

Even when by the word eternal we only wish to express that which is destined to be ever prolonged in time, we become, in using that word in a present sense—in saying that a thing actually is eternal—guilty of a vicious locution. Nothing can be intrinsically actually eternal, since eternity, applied to what alone it can justly be applied to,—to the unceasing duration of time,—comprehends in addition to that time past which is no longer, that time future which is not yet, which never can actually exist, never can actually be present: and since time itself is only the constantly shifting point of transition from its earlier to its later portions.

We use a locution equally vague, equally vicious with the former, and that, in more senses than one, when, in order to express that the modification which we call matter, however minutely it already is divided and subdivided, still remains liable to further subdivision more minute than the former, we describe that matter as, in the present tense, dividable ad infinitum.

The word matter must either be taken as a word synonymous with the word space, and as expressing that modification which, together with that expressed by the word time, is one of the most essential and primary ingredients of all matter more late, and partial and complex, or it must be taken as only, within more general space, expressing certain lesser portions of that matter, presenting a cohesion, a solidity so much greater than others, as to require a greater effort to produce their separation; and as thus only being a word synonymous with the word substance.

Now it is evident that, if we take the word matter in a sense synonymous with that of space itself, no portion of matter can by any entity situated in another different portion of matter, be divided at all, since mere space is undividable in parts separate from each other;—since objects changing their place, only glide in the space before unoccupied by them, and leave to other objects their own former portion of space;—since all that which objects more partial can effect in space in general, is to render its different lesser portions to the sense more distinct from each other;—and it is equally evident that, if we take the word matter in a sense synonymous with that of more partial solid substance, floating in more general space, and of which certain portions can be divided and removed from others, and in that general space occupy a distance from each other greater than they occupied before, this can still only be affected by gradual extension and movement,—by the assistance of further time as well as more extended space;—and can consequently leave no matter unconditionally, in its present tense, and without any fresh modification not actually present, thus dividable.

And this leads me to observe, that the word matter is, in general, used in such a way as only to present a meaning very vague and indefinite. In order to bear a signification liable to no mistake, it ought to be considered as comprehending the first and most essential conditions of all that may be entitled to the appellation: those conditions without a certain quantity of which no portions of matter, whether only merely physical or liable also to experience sensation and thought, known to us, can exist; namely, those of time and space. Most people, however, exclude these former attributes from among the number of those which matter of a mere physical sort always embraces, and again, are greatly tempted to discard them from among those on which all intellectual phenomena necessarily rest. Most people restrict the application of the word matter to such modifications as come within the special cognizance only of one or more of those five senses, to which is intrusted the task of receiving certain sensations in part different from those experienced by the others; or, even to such as only to the sense of touch give sensations of palpability, solidity, and cohesion. Thus they render the word matter, instead of applicable to corporeal attributes already much more early, extensive and elementary than those expressed by the word substance, synonymous only with the word substance itself; leave us in possession of no word singly comprehensive enough to embrace of physical entities all the conditions more early and fundamental, namely, those of mere time, space, force and movement; and encumber us uselessly with two words totally different, for the attributes of a more partial and restricted sort which the word substance alone suffices to express.

This consideration will make me deviate from the usual practice. I shall use the word matter in that more extended and comprehensive sense in which it may, from that entity which we must suppose to exist, namely God, but which we can neither perceive nor conceive, precisely because we must suppose God to be the first creator of all that is perceptible and conceivable, on the one hand already distinguish the very first conditions of that matter, namely those of mere time, space, force, and movement, and on the other still distinguish the last and highest developments of that matter, namely those of the most transcendent intellect; and in which it may moreover again, from the modifications of matter more early, general, intangible, and invisible, not yet called substance, leave us the means of distinguishing those other attributes again more late and partial of cohesion and solidity, peculiarly pertaining to that portion of matter, especially marked by the more restricted appellation of substance. Thus only I can make the two distinct words of matter and of substance designate two modifications themselves already in part different from each other.

A confusion, very similar to that which is often made between the meaning of the word matter in general and that of the word only signifying a smaller and more partial portion of that matter peculiarly denominated substance, is frequently made between the different words mind and soul.

The word mind—and those others, really synonymous with the same, of intellect or understanding—mean the whole collective aggregate of the faculties and phenomena, founded as we shall show on material organs, by which, after an individual entity has received from without actual impressions, the sensations produced by these impressions are capable of being again revived and recombined in the shape of other sensations later and more internal, called thoughts or ideas: and of the modification thus called of mind there may be as many specimens or individuals separate from each other, as there are different and distinct corporeal thinking individualities.

The word soul can either be used as only synonymous with that of mind,—in which sense it is at best only useless and superfluous,—or it can only be made to receive a meaning again somewhat different from, and more general than the former, by the former being restricted to such portions of the faculty of thinking as are actually extant in peculiar individuals distinct and different from other individuals, while the latter is alone extended to the faculty, by the author of all matter, instilled in all its modifications alike, namely that of being destined at certain later periods, in certain of its later and more partial subdivisions and developments, to receive certain sensations, thoughts, and modes of consciousness of other more distant surrounding entities and modifications; no matter whether this faculty is already fully matured and in actual exertion, or whether it still is unripe and capable only of being by more distant future maturity fitted for actual exertion; whether, as the scholastics would have expressed themselves, it already is "in actual *esse*, or still only is in mere *posse*;" whether it already in its later developments be divided among a number of different individuals distinct from each other, or whether, in an earlier and less developed state of created matter, it still be, in its mere embryo condition, collected in a single undivided mass. In order to avoid ambiguity of expression I think we should make it a rule only to use the word mind in the former sense, and to reserve the word soul for the latter, in which we shall only have occasion to use it more rarely.

To the first incomprehensible author and cause of all that we can in any degree perceive, or think on, or conceive either of mere matter only or also of intellect—itself nowhere bounded by time or space, or any other of the positive attributes of that matter or that intellect, precisely because each of these latter is only a later and more partial emanation of this same first cause itself,—I have not dared, I have not been able to ascend, or to attribute any condition in common with any positive modifications which we do perceive or know, whether they already be among those simpler ones only of mere time, space, quantity, force and others, already belonging to mere body as well as to mind, or whether they only be among those more partial modifications, such as those pictures of entities and events retrospective or prospective traced by the memory or the foresight, which only arise more gradually within certain more partial subdivisions of the modifications of matter called of mind; because, firstly, all the attributes whatever which we do know—those of intellect as well as those of mere unthinking matter—are alike only among God's later and more partial creations, and thus are not intrinsically parts of that God himself before he created them; and moreover, because, secondly, though we are more accustomed to regard the modifications of intellect in particular as qualities more directly inherent in the very essence and nature of God than those earlier and more external ones of mere unthinking matter, they precisely are those which, as only arising at later periods, in smaller and more internal portions of that matter emanated from the first cause, only more remotely, and through a greater number of intervening media or secondary causes, arise from the first cause itself—only called infinite, precisely because it is not yet liable to be confined or bounded even by the earliest, and simplest and most external, any more than by any of the later and more internal modifications of time or space themselves, which emanate from its bosom.

When I happen to say that of a certain peculiar entity or event of which in my mind I fancy the internal representation or picture, the external reality cannot take place or be presented to my sense, let me only be understood to add, according to the rules to which omnipotence itself seems to have restricted the course of nature; not to imply that the Almighty could not have laid down other different rules, or could not again change those which it seems to have laid down.

Above all, let not, I pray, from any part of my theory taken separately and out of its connexion with the remainder, be drawn any argument against the duty—nay, what with many might have greater weight,—the policy, the expediency of always doing, of the different things alike in our power, those that are considered best and most righteous. Any argument for not consulting the general good in preference to partial interests, pretended to be drawn from my work, can only be founded on a misunderstanding of certain of its principles, and this fault it is often the easiest thing in the world to fall into, since the very same words will frequently, by a slight transposition, effect this, and make what signified white, mean black.

Viewed in the real connexion in which I intend to offer the different parts of my system, they will present the wisdom and policy of virtue even with regard to the general concerns of this present world, and still more, with regard to those of that world to come, to which all we see around us makes us expect to be ultimately transferred, in a clearer light, I hope, than any in which it has yet, according to my ideas, been shown.

When the customary forms and dispositions of any peculiar idiom cause of a peculiar sentence certain parts to be placed relative to each other in an order different from that in which the different external attributes represented, or the different ideas we entertain of these, themselves arise, hearers are apt, from the discrepancy between the thing represented and the order of the representation, to derive a sort at least of temporary perplexity and doubt. An inconvenience of this sort is often in the English and in other languages of Teutonic origin produced and prolonged by the illogical custom of making the noun substantive, used for the purpose of marking the peculiar genus to which belongs a peculiar condition expressed by a peculiar adjective, not precede the adjective which again defines the later and more partial attribute by which the later and more partial subdivision of the genus particularly described is again distinguished from other different subdivisions of the same genus, as is done in other languages allied to the Greek and Latin—like the French, for instance, in which, when it is intended to express that of the human genus an individual is of a colour darker than usual, he is called *un homme basané*, but, on the contrary, of making the noun substantive only follow the adjective, and only after the word dark, which thus far may apply to the situation of a room as well as to the complexion of a man, adding that word man which limits the darkness to the colour of an individual of the human species.

In familiar conversation, and where the subject is obvious, this mode of collocating with regard to each other the nouns substantive and adjective, however illogical, is sufficiently understood: in close philosophical reasoning, and especially where a number of different attributes may have to be connected by a single link, and to be represented as belonging to a single genus, I have often found it—by causing the principal object in discussion, and which ought to have been presented first and foremost to the mind, to be kept in the back ground to the last, and then only to be placed where it most interrupted the connexion between the sentence concluded and a new one commencing—render most difficult the comprehension of ideas that ought to present themselves with the greatest ease. I have therefore tried to avoid it, where-ever I could, consistent with the genius of the language in which I write, by dint of such circumlocutions as were calculated to make the substantive, representing the genus, stand first, and the adjective, which only restricted the discourse to a certain lesser subdivision of that genus, follow later. Instead of saying, as is usually done, "a young, and healthy, and handsome, and active, and intelligent"—"what," it may be asked—"man," I have rather said, "a man young, and healthy, and handsome, and active, and intelligent:" and this I have often, on trial, found to be of more consequence to the general clearness of my reasoning than at first sight would appear.

Many things, however, I am conscious of having expressed in a manner much less clear, less terse than, merely by considering more sedulously the natural order of the different subjects to be described, I might have done; but to do this I must have employed more time, and this additional time I was not sure of being allowed.

Having said thus much in explanation of my views, and in extenuation of my defects: having stated—what, indeed, the sequel of my work will confirm—that the object of my labours has only been to diffuse more generally the cardinal virtues of faith, hope and charity, as rationally understood,—as distinct from credulity, from presumption, and from weakness,—I now take leave of the long egotism in which I thus far have dealt, some may say indulged. I shall first proceed to settle the signification which I wish to be attached to a few more doubtful words, on the right understanding of which depends much of that of my reasoning; and then, without further delay, plunge in *medias res.*

CHAPTER II.

Legitimate sense of the words liberty, power, subjection, faculty, fact, immutability, contiguity, connexion, good, evil, happiness, unhappiness, beauty, ugliness, wisdom, folly, utility, noxiousness, sameness, similarity, and some others.

A TIME may come when, in another world, more perfect than this, of each separate individual the mind shall lay so open to—the inmost thoughts and wishes shall remain so little concealed from—the outer eye of every other individual, that words will no longer be wanted to express those thoughts and wishes, and to communicate them from one person to another; that each individual separately shall, by mere intuition, know what thoughts, what wishes arise in the breast of every other individual, near or distant.

In this present imperfect world, where every wish and propensity of every person individually would not yet always be sure to find a welcome in the breast of every other different person, this notoriety of every mental movement does not, fortunately for man's comfort, yet take place.

To express his thoughts, and to communicate his wishes, man here below still wants the use of words,—but, like every thing else produced on this globe, these words still only answer their purpose imperfectly. They often only express thoughts, in themselves already obscure and limited, in a way still more obscure and doubtful. We are often puzzled to understand what our neighbour means in addressing us.

I shall, therefore, in addition to the definition of the few terms of dubious import already mentioned, of a few more such endeavour to mark the origin and to point out the just application; as being highly important to the right understanding of this work.

To those modifications and entities created, —from the first materials still merely radiant of later solid globes to the latest bodies arising on this peculiar globe, which, even while living and growing still are called inanimate, and, only in their growth and movements blindly following an impulse first given them from without, still are not yet possessed of any internal sensation or will of their own,—no one yet thinks of attributing any degree of liberty whatsoever.

Even of those entities more late and complex in which, at a certain period of their progress, the impressions of certain external surrounding objects are made to produce certain sensations, thoughts, desires, wills and actions of a voluntary sort,—and which thus already are distinguished by the name of animals,—that inferior subdivision which still remains unendowed with the peculiar powers of intellect called powers of abstraction or reason, is not yet supposed to possess any freedom either of will or action.

The reason thereof seems to be this, that whatever sensations or later thoughts, always first aroused from without, and producing a will, which again from within tends to produce an inclination to such actions outward as are called voluntary, in the mind or brain of brutes does not yet find, before they actually produce outward any corresponding voluntary action, room sufficient for letting other later sensations and thoughts from without produce other different wills, in their tendency again different from and often incompatible with that of the peculiar wills by the former sensations and thoughts from without produced, and which again balance and check the impulse outward of these former wills, suspend their impulse, prevent their immediate action, and thus, before that action can have its ultimate result, leave leisure for a choice and option between resolves different from each other, and often make an inclination or will, later than another, gain over that other so great a preponderance, as to pass it by, and to produce a preference for some positive action, wholly different from that which the former will suggested,—circumstances which all, after a time, take place in the roomier mind of man, and, in this latter, at last produce that faculty of option denied to brutes.

But as little as, where an entity, from sensations and thoughts first only produced prior to and without the concurrence of any will whatever of his own, subsequently only derives a single will, only impelling him to a single mode of acting, that entity can be said to acquire freedom of will and action, so little can an entity, in which after a certain period a certain number of sensations and thoughts different from former ones and tending to produce wills and inclinations to actions outward at variance with each other, are left to struggle and to fight it out, before any of them by a preponderating impetus finally overpowers the others and leads to the accomplishment of the action to which it tends, be said from these circumstances—from that struggle between different impulses—that ultimate yielding of the weaker to the stronger—to derive that freedom of action which the former entities, to whom the power of option is denied, are said to want.

The movements and wills that, after having been first by involuntary sensations and thoughts from without produced, are left unimpeded to pursue their course till they are vented outwards in corresponding actions, and those that, after having from prior involuntary sensations and thoughts first arisen, in their progress,—before they have had time to advance outward, till they vent themselves in corresponding actions,—are again by others from within more powerful and producing a rush more potent overtaken and made to give way to their superior impetus, as well as those which in their way outward, by some impulse from without opposing their further progress and exit are again met and stemmed in their course, and prevented from finding their ultimate vent in corresponding actions, all alike derive their origin and impulse from some prior more external cause, arising and acting before these impressions, movements, thoughts and wills themselves are born.

And if we so seldom complain of having been obliged to perform those actions which arise directly out of and coincide with our own previous will,—however noxious their later results may prove to us,—and on the contrary, so often complain of certain others, prompted by our own will itself, being by some external cause prevented from being executed, or others again being in defiance of our own inclination by some external impulse forced upon us; this is only because, in the former case, the fluids left to convey the impulse of the will from the brain outwards to the organs of action, when there vented, there immediately produce a sensation of pleasure, which, even where again the consequences of the action at a later period produced pain, only caused that sensation of pain to be too far removed from the first cause of the will itself to have its idea connected with that of the said prior will; whereas in the latter case, the fluids carrying the impulse of the will from within outward, in the very act of flowing out, and before they are vented, and have had time to give that prior pleasure, by some external impediment arrested, repelled and forced back into the body, produce a sensation of pain more immediately following the impulse outward.

All will, all thought, all sensation which precedes and causes these thoughts and volitions, thus being, even in man himself, in their origin alike involuntary, must, by the links of a chain of prior causes that ascend in unbroken connexion till they originate in the first Ruler and Creator of things created and cognizable, give to that Ruler, that Creator—to God alone—ruled by nothing prior, nothing more external which we know of, on every side that real unbounded liberty of which nothing created can boast but by self-deception.

The noun substantive power derives from the Latin verb potere—to can: the noun substantive faculty derives from the Latin verb facere—to do. Both imply alike the possession of all the means, physical only or also intellectual, necessary to bring a thing about; since we cannot fancy any thing being actually effected, without also fancying the possession of all the means necessary to effect it. In common parlance, however, the word power is often applied more generally and indefinitely to entities and modifications which possess these means unconsciously as well as to those which possess them consciously; while the word faculty is applied more definitely and pointedly to entities which only possess those means consciously.

Power unbounded, faculty unlimited, ability at the same time, from the same place, to act backward and forward; to impel all round, without being previously from any side and in any direction by any prior or different power impelled,—power, faculty, thus liable to no prior subjection, and by no power more early and external acted upon and produced,—cannot be conceived to exist in any entity, created by a prior being different from itself. The simple fact of an entity having been created by another entity different from itself, implies its having received its powers and faculties from that other different being, to which it consequently remains subject. We can only suppose a power derived from no prior subjection, impulse, force—if by the name of power it can be called—to exist in the first cause, itself uncreated, unproduced, of all later and more partial entities perceivable and conceivable, that have been created by it.

In things created, from the very first, most simple and most general,—such as time, space and quantity,—we cannot conceive the existence of any power, any faculty, any force, any action manifested in any particular direction, which proceeds not from a particular subjection and passiveness, by a peculiar prior power, force, impulse first from without in that direction produced. All things created, more partial than mere time and space, seem only to be in time and space by some other force earlier and more external than time and space themselves driven on in the peculiar direction in which they move and advance. It is only in the bosom of Omnipotence alone, which has been able to bring forth all things created and subject to prior power, that this power to create and rule all things perceptible seems first to originate. That Omnipotence alone, which has had the power first to bring them forth, has that later power of moving, of modifying, of modelling and of ruling them all alike. Only in virtue and through dint of their entire subjection to God can any of his productions, his creatures, acquire and exert, immediately or mediately, over other entities created by him any later secondary more partial and delegated power, itself only arising out of their prior subjection to his fiat. Nay, every entity and modification, later and more partial than mere time and space, and withinside these two most early and general modifications of matter, by God created, unto those that by degrees acquire, with regard to certain other entities and modifications created, the secondary delegated powers and faculties most complex and varied, remain to the last not only subject to and ruled more primarily by God himself, but by God's earlier intervening creations,—from those of time and space themselves,—through the medium of which they were at second hand previously more proximately produced.

In common parlance we generally distinguish from the mere power or faculty of doing a thing the actual present deed: we often maintain the former to exist long before the latter arises out of it, or even where it never produces the latter. We say that certain modifications have the power of killing, where there is no one yet on whom death can be inflicted; that certain entities have the faculty to make us laugh, while we still are more inclined to cry, and the like. All this only proceeds from a certain laxity in our ideas, which causes them not to comprehend all the different external conditions, of which the actual concurrence and meeting is necessary to produce the entire fulness and presence of the power of performing the thing in question; which, provided of the conditions all alike indispensable to the performance of that thing a certain number only of the more obvious are present, omits the consideration of the others less tangible, such as those of time, place and circumstances and deems the faculty, while it still only is probable and proximate, already to be present, and entire, and certain.

But in order for a faculty to be actually complete, and certain, and present, it is necessary that all the conditions of time, space, quantity, proportion, force, impulse, movement, substance and others, whether only physical or also intellectual, necessary to produce and to complete it, should not only all be in existence, but actually all, without any exception, be present, and joined, and concurring; and the proof that this condition is necessary for the completion of the faculty lies in this, that, however proximate they all be, as long as of them a single one, however trifling, yet remains in time, space, or quantity at a distance from any of the others—as long as any of them co-operates not yet on the spot with all the rest in the actual production of the event expected,—the faculty of producing that event may again, before it take place, be further removed in time and space, or be entirely annihilated and destroyed in its very roots.

Take a man of whom we say, that he has the power—the faculty—to buy bread, only because he has the money necessary to buy that bread, and because he is in communication with a person who has that bread to sell. While he does not actually buy that bread, how many things may still happen to prevent his ever attaining the complete faculty of doing so? He may be struck dead; the person who had the bread to sell may fall in a fit; the very bread be destroyed, and the faculty of purchasing it never come to maturity.

Indeed there are certain things of which the conditions, depending on further increase of time and on further extension of space, can never be said actually at any single moment to exist and be present. Such is what we call the divisibility of space ad infinitum. However much any particles of matter, already divided, may again be subdivided, it is plain that every further subdivision, depending on further time and further space, still can never be called present, and that whenever this subdivision happens it moreover still must, as before, leave the particles of matter bounded in time and space.

Nor are these to be deemed mere verbal objections and sophisms, as at first sight they might appear. They arise from the very simplest and most fundamental attributes of the very earliest and most elementary materials of all other modifications physical and intellectual—from the very intrinsic nature of time and of space.

As evident as it is on the one hand that, while of the conditions necessary for a faculty to be complete and to ripen into a positive and present fact any one, however trifling it may appear, is not yet present, not yet concurring with the rest, there can as yet only be a probability of—an approximation to that faculty; there cannot yet be the certainty, the fulness, the presence of it, as evident it is on the other hand that, when of the conditions necessary to that faculty the whole is complete,—when none any longer lag behind, or remain separated from the rest,—when all concur—the faculty can no longer remain only probable, or distant, or dormant, but must immediately at the very instant, and on the very spot, produce the action; so that in their fullest extent the faculty of doing a thing, and the deed, must be synonymous.

The only entity which we can suppose to remain the same during different successive portions of time, and in different simultaneous portions of space, is that imperceptible, inconceivable first cause of time and space themselves—that God, who must be wholly different from, and beyond, and unlimited by the partial limits of each different portion of time and space, because he himself caused every portion of time and space, from the earliest and outermost, first to be, and next to be connected with all the remaining ones.

Nothing which by man can be perceived or conceived can be so as remaining intrinsically, during the smallest perceptible portion of time, or in the smallest perceptible portion of space, the same that was before; since of time and of space themselves every portion, however minute, however contiguous to another portion different from itself, can only be perceived as no longer the same with—as different from that other; and since all else of body or mind that can be perceived or conceived, can only be so in certain portions of time and space.

Every one allows at first sight that of time every new instant or portion, added to a former portion, is already only perceived as a change from that former portion from which it is already again allowed to differ; and every one must, on the least reflection, equally admit that of space—though on the first view it appears the most unchangeable of attributes—the smallest particle that already can be discerned as different from another—as being at all,—can only, like every measurable portion of time, be perceived or conceived as being a mere aggregate of differences.

Now, all else physical or intellectual which can be perceived, only perceptible as in part and fundamentally formed of portions of time and space, must necessarily partake of the most essential requisites of time and place themselves; and must, in all its lesser component parts successive and simultaneous, alike constantly offer change and difference.

The most permanent rock can already only be considered as throughout a mere aggregate of constant change and difference; and man himself, the most mutable of beings, can only be regarded as an aggregate of changes and differences more rapid, more numerous and more varied. Already while we behold the rock, it no longer is the same in time on which we first cast our eyes; and if we contemplate its different parts, there is not one, however small and contiguous it be to another, which does not in space as in time differ from that other.

We can thus only call certain modifications, situated in certain portions of time and of space different from others, however minute and contiguous to the first those others be, the same with those others—we can only call an entity which was yesterday the same that is to-day—we can only call a man who was at Paris last week the same man that is at present in London—by abstracting from the idea of that man the image of the changes it must have undergone in time, and of the differences it must present in space since his trip to Paris; and by thus only taking the word sameness as synonymous with that of similarity. We must not heed the real changes of time, and the real differences of space which, though every where constantly taking place in the different parts of all entities physical and intellectual perceptible to us, still in reality only leave them similar to what they were, in order to assume the privilege of calling even those parts of them different from each other which in time or space still are contiguous, and together only form a single individual, during the smallest portion of successive time or of collective space, positively the same.—To call the full grown tree the same even with the earlier plant; the full formed man the same even with the earlier infant, out of which the latter continuously arose. In other words, we must in our mind from the idea of two objects different from each other,—from the external reality of which can never, as far as we know, be detached the attributes of change in time and difference in place,—abstract the idea of that difference, that change, ere we can call these entities, in reality different from each other, the same.

But while nothing that in time or space is different from another thing can be called wholly the same with that other, nothing that in time and space still is the very same can yet be called similar only. A thing must already in time and space offer certain differences from another thing, or from its former self;—of what is collectively still called the same genus, must already be discerned individuals or parts in time or at least in space different from each other,—before they can become liable to a comparison with, and be found not only different from, but even again similar to other individuals or parts of the same genus different from or earlier than themselves. A man at a certain age can only appear either already different from, or still like a man of an earlier age, with which we still call him identically the same, because he only proceeds from and is only a continuation of that former man, and thus already in so far is in reality different from that former man.

While the imperceptible first cause, God, alone, as not being liable to any of the conditions of time and space which he himself first created and contains, still ever continues the same, all things created by him perceptible to us, whether merely physical or also intellectual, however different they be from each other in the portions of time and space they each occupy, still each, in necessarily occupying certain portions of time and space, already resemble each other; and as by later developments they acquire further differences from each other, with these further differences from, also again acquire new similarities with each other.

We only call certain portions of time, of place, and of other attributes corporeal only or also intellectual of the same or of different sorts, contained in portions of time and place, whether they be small or large, few or many, while they are unto the last in time and space contiguous to each other, collectively, single individuals. When they no longer are thus in time and space contiguous to each other, we no longer call them single individuals, though we still may call them parts of the same genus.

Of time, of space or of other attributes corporeal or intellectual, contained in time or space, we call the parts, which, whether continuous or distinct, resemble each other, in as far as they resemble each other, parts of the same single genus.

Parts may be of the same genus and belong to different individuals: parts may belong to the same individual and to different genera.

Contiguity begins before connexion. Of time and of space alone lesser component parts may already be contiguous, but seem yet incapable of being connected with each other, unless they be, by the assistance of some other attribute, different from themselves, thus connected. Continuity is positive, and has no degrees. Connexion begins in smaller degrees, and thence extends to others more extensive and more forcible.

The very same external objects which, compared with certain others, offer attributes and make impressions of a peculiar sort, when compared with other things again different from the former, again offer attributes and make impressions wholly different from, and often contrary to, these former ones.

The very same mouse which, compared with a flea, shall appear of colossal dimensions, compared with an elephant will appear most diminutive. The same event which with regard to the first creation of the globe will appear late, with respect to the occurrences of the present day will bear an early date. The food which to a man in health is wholesome, useful, pleasant, to an invalid is injurious and disagreeable. Those features which in a monkey are handsome, in a human being are hideous. Those measures which in a man possessed of money may be wise, good, capable of producing pleasure, profit and happiness, in a poor man will only be foolish, injurious, and capable of causing loss, pain, and misery. What to a sensualist gives delight, to a man whose mind alone is expanded may occasion mere ennui.

The honied poison may begin by affording pleasure to the same person on whom it ends by inflicting torture. The toothdrawer often gives present torture with the view of producing future solace. That which in a man young, healthy and likely to enjoy a long life is wise, prudent and useful, in a man old, infirm and on the verge of the grave, may be the height of imprudence or folly. That which in the mind of one who entertains no hope of a future existence may be a sound calculation, in the idea of one convinced of the immortality of the soul may be a silly conduct. What in one respect is good, pleasant, beautiful, in another may be bad, irksome, ugly.

External objects are, with reference to their capacity of immediately affecting the sense or mind agreeably or disagreeably, called pleasant or unpleasant, handsome or ugly. With regard to their capacity of affecting the sense or mind more remotely, and at a more distant future period only, with such feelings of pleasure or of pain, they are called good, useful, wise, virtuous, or bad, injurious, foolish, vicious.

But things may often only, through the means of prior intervening effects called irksome, like those of labour or of medicine, produce more distant pleasures, like those derivable from health or plenty; or they may, through the means of prior intervening effects called pleasant, such as those attending on excessive indulgence, produce future pains, like those of illness or privation. And thus the same things which, with reference to their immediate results are called good, palatable, pleasant, beautiful, with regard to their more distant consequences often deserve the name of bad, disagreeable, detrimental, ugly; and the same things which, with regard to their immediate effects are called bad, nauseous, disagreeable, irksome, ugly, with regard to their more distant consequences often deserve the name of good, useful, and praiseworthy.

CHAPTER III.

Causation, or relationship of cause and effect. Primary cause, itself imperceptible, inconceivable, of all other causes and effects later and more perceptible of a secondary sort emanating from it, called Jehovah, God. Immediate effects of that first cause, in their turn called the secondary causes and media of other causes and effects again later than themselves.

When the sensation of an entity or event of a peculiar sort is frequently in time and space immediately followed by the sensation of another entity or event of a peculiar sort still in part similar to, though in part again different from the former, we gradually begin to believe that the external modifications which produce the former species of sensation, are in part the cause of the external modifications which produce the latter species of sensation—or, in other words—that the external modifications that produce the latter species of sensation, are in part the effect of the external modifications which produce the former species of sensation: and this peculiar relationship of cause and effect which we suppose to exist between the causes of certain sensations and of certain others, has of late years received the peculiar name of causation.

There are people who have denied that in things perceptible there is any real relationship of cause and effect; who have said, and justly: " while we see not yet in time and space two entities or events, in their intrinsic modifications at all different from each other, we cannot behold one as the cause of the other, and another as the effect of the former; and as soon as we see two entities or events at all in time and space different from each other—a thing which can only take place by the one occupying a portion of time or of space, which though still contiguous to, is already different from that occupied by the other—there no longer is any proof positive that the one ever in part contained the other—that the other ever in part arose out of the former. Their contiguity may only arise from later coincidence or juxta-position.

If on a tree, on which we first only beheld a white blossom, we afterwards see on this white blossom superstructed a hard green fruit; and afterwards again see this hard green fruit gradually replaced by a juicy red pulp, how are we to obtain a proof positive, that the former appearances are themselves in part the cause—the foundation of the latter phenomena; that the latter in part arise out of the former; that what in the latter is different from the former, is, and can be superstructed only on what in this latter still is similar to the former. Why may not, in some mode concealed from our observation, the former substances and shapes and colours have been replaced by the later ones, without these later ones having with the prior ones any direct or necessary connexion; without their being partly produced by and arising out of these former ones themselves?

And the people that thus denied all connexion of cause and effect even more late and partial between things perceptible, have of course also denied all connexion between later and more partial modifications perceptible to our sense, and an earlier cause of these modifications itself still imperceptible and inconceivable.

Strictly speaking, we cannot controvert their assertions by proving positively that there is a prior cause still imperceptible of all effects perceived.

But the want of mathematical proof that a peculiar thing is, can never alone, and independent of the proof positive—the evidence—of the existence of another and a different thing with which that of the former is incompatible,—which leaves no room in time or place for that of the former,—be construed into a proof positive that the former does not exist. I may still, even without such proof positive of the existence of that former thing on just grounds believe it to exist. And the more I feel, and experience, and observe, and think, the more I infer and believe that causation exists: that certain things only can contribute to the production of certain other things, in part still like them, though in part again different from them: that certain things can only, more proximately or remotely, in part arise out of certain other prior things which they in part still resemble, though they in part again differ from them.

Nay, by degrees I have been, like many others before me, led by my sensations, my experience, my thoughts, most firmly to believe that all modifications of an intellectual nature which we behold, arise partly out of prior modifications still merely physical; and all modifications merely physical later and less comprehensive than and included in those of space and time, in part out of those of space and time themselves, which, though the earliest and the most comprehensive that we can behold or conceive, must, by further analogy, in their turn, together with all the other modifications later, and less, and more partial physical and intellectual yet perceptible, comprehended in time and space, again arise out of other modifications, again in part different from each of these perceptible modifications singly, which though themselves still imperceptible, nevertheless already are; and of which I call the first cause and author Jehovah, God, the Deity.

All that we can feel, or think, or know, no longer being this first cause, this Deity in its undivided whole—only being of this first cause—this God—some of the later and more partial emanations; only being certain of the media more proximate or more remote, already different from the Deity itself taken in its whole, through which that Deity again produces other entities and media still later, more partial, more different from that whole than themselves, we can of this whole—of this first cause—of this Deity, as such, not know the intrinsic attributes; or through any of the conditions either merely physical or intellectual which we do know, describe these attributes.

Perhaps, however, it may not be improper or wholly inapposite to say that all the media which the Deity first brings forth, and through which it creates other things perceptible; and all the impressions it gives these things, and all the consciousness certain of these things or entities receive of these impressions of prior things must, in their capacity as emanations from the Deity, alike be integrant parts of that Deity itself, which thus chooses, under the different peculiar forms it successively assumes, not only to make, but, in our name and under our appearance to receive, the peculiar sensations, and even for a time to experience the peculiar ignorance or lack of sensation to which we creatures are liable. Perhaps when we feel or recollect any peculiar modification, from the simplest of matter to the highest of mind, it is the Deity itself which we feel in that shape,—as Mallebranche has already vaguely thought and said; and if so, we should ourselves unconsciously still all be parts of the Deity; which in fact as emanations, as creatures, as children of that Deity—for such we are even in Scripture called—and as thus still partaking of the nature of our common father, we are justified in thinking ourselves.

Ignorant as we are of the intrinsic nature of the first cause of our being, of our sensations and of our thoughts; ignorant as we are of our own intrinsic nature; ignorant as we are of the intrinsic nature of the very media emanated from the first cause, through which it has lighted up in us consciousness, sensations, and thoughts; able only to say that a first cause must exist, and that secondary causes must flow from it—since I have sensations of such, all I can do is to give of these secondary causes or media, and of the order in time and space in which they arise relative to each other, the most faithful account which the sensations received of them suggest.

But before I begin to do so, I shall first observe that we must have the sensation or idea of two events or entities each different from the other, before we can conceive the idea, or draw the inference, or entertain the belief that the one is in part the cause, the author, the parent of the other—that the other is in part the effect, the production, the offspring of the former; nay, that we must believe a thing, in part the effect of another different thing from which it in part again differs, to be in that other part in which it again differs from that prior thing, the effect of another prior thing, again different not only from the later collective effect itself, but from the prior cause of the other part of that collective effect, and which that other part again in its turn resembles,—since it is only from the resemblance of certain things to other prior things that we infer their being the effects, the offspring of these former things; that consequently each later effect must singly present itself as derived from the union of more than one prior cause, each already intrinsically different not only from the collective result of that union, but from each of the other different prior causes of that union, taken separately.

CHAPTER IV.

All descriptions, from the very nature of their materials, offer certain difficulties and defects: description of time.

I HAVE already hinted, that if of a mere history or series of successive events, presenting few parts simultaneous in proportion to those that are only successive, and resembling a stream of great length, but throughout of narrow and equal width, the narration can, in the order of its different successive parts, to the real order of the original represented, retain a similitude sufficiently close to allow the easy representation of those events to the imagination of the reader, of the general developements of nature, like the stem of a tree at first very close and compact, but rapidly on all sides shooting forth into ramifications different from each other, all spreading simultaneously, the description in words, which can only represent what itself takes place simultaneously, in slow succession, presents difficulties very great; and the greater, as of each simultaneous developement different from others the partial description, more explicit and detailed, makes that of the whole advance more slowly. These difficulties are still increased by that of the things in reality most closely connected still having their descriptions necessarily divided by the words in which these are conveyed.

Often this defect has been in part obviated by descriptive tables, in which of different objects the simultaneous ramifications are first represented more rapidly to the eye, before they are afterwards more in detail repeated through the channel of the ear. But this very repetition of the more essential parts of a subject becomes tiresome to the reader, and causes either the tables or the explanation to be soon neglected. I shall therefore trust to the more mobile mind of that reader himself for forming, of the developements which I can only describe in slower succession, a picture more rapid and more simultaneous.

It would perhaps be going too far to say with Berkeley, that between God, the first cause of our sensations, and between those sensations themselves, there exists no intervening medium—no intermediate external world; that those sensations are all that exist outside God; and that only, because we know nothing of such a world, save what those sensations give us room to conjecture respecting the same; though it may not be too much to say that we do not see any indispensable necessity for such an external world, merely to secure our happiness, or to afford a clue by which our will may be led in the path of that happiness, and deterred from the road to suffering; as long as the sensations we receive themselves follow a certain regular order simultaneous and successive relative to each other, through the knowledge of which that will of ours may be more immediately or mediately made to attain such of these sensations as tend to enjoyment, and to avoid others of them that lead to pain.

And this order simultaneous and successive these sensations do follow; and as they are the only things of whose intrinsic nature and whose order relative to each other we can have any knowledge, and through which we can attain any idea of the existence or nature of the more external objects which they are supposed to represent and to arise from, we shall make the account of them stand for that of the external objects themselves; begin with that of the most early, most comprehensive and most elementary of them, and from these gradually, as they produce others more late and partial more proximately or more distantly, pass over to the description of those others more late and partial, which through their medium God is pleased to bring forth.

Of the first great cause, itself still imperceptible,—itself still liable to no definite quantity, limits, division—of all things possessing quantity, and liable to limits and to division, the partial effect, medium and modification, already in some degree perceptible to us, liable to limits and to division, and, through itself transmitting these attributes to whatever else it contributes to compose, which seems the first to arise, and the first also in sentient entities to arouse a consciousness of its existence, is that which causes the sensation of time.

Sensations of time can be experienced without those of any other modifications either of mere matter or of mind; but no other modifications whatever can be known except as included in certain portions of those of time. It already takes some successive portions of what is called time or duration even to perceive what are called different simultaneous portions of space, and as of any objects merely corporeal more partial than modifications of mere space the sensations still occupy certain portions more partial of the sensations of time, so of these later sensations of time itself the still later mental thoughts again occupy other still later portions of the same sensations of time.

Omnipotence seems, of the time poured out of its bosom, to cause the portions already perceptible to be constantly followed by fresh portions flowing out after and driving on before them the former ones, till they again vanish from the sight. Of time, always continuing to roll on in one single straightforward direction, each individual portion seems already gone by or not yet arrived. Still, as new time starts up on one side, former time seems to steal away on the other. No portion of time appears ever stationary, present, able to be grasped, retained, dwelt upon, or, after it has once gone by, again able to be recallable, so as to be re-experienced, re-tasted. Even former time, already felt by the sense, can only by actual fresh later time be represented in the mind; and if we call any sensible length of time, collectively taken, in its whole or in any of its lesser perceptible parts actually present, it is only because we take not the trouble of distinguishing any of its lesser component portions, partly already gone by, and partly yet unexperienced, from each other.

As time only advances in one direction, it can only be said to have perceptible length, not width; to be composed of parts distinguishable from each other such as are successive and coming before or after certain others, not such as are simultaneous and at the same instant appear to the right or left of others different from them. As time is always passing by, and leaves of its former existence no relics, and as new time has no permanence, old time is only a figure of speech. Time, not able intrinsically to last, is not able to grow old. Time existing is ever new, young, and fresh. The very hour of its birth is that of its demise. Time is only said to grow, or even to continue, while it drops away at one end and makes room for new time to replace it from the other; whereas space, as we shall see, may be made to grow equally by new parts added on externally to former parts still subsisting, and by the former parts themselves being again internally divided into lesser new parts.

As time is ever fleeting, it ever eludes actual measurement. Of that which is gone by we cannot know the intrinsic length. We only infer its duration from the extent of the space over which it has run; from the number of changes it has successively brought forth. Only through the division of and comparison between portions of space different from each other, over which different objects are made to run simultaneously, have we of the comparative duration of their movement the means of forming an estimate. Where successive rounds and repetitions of what we regard as similar movements take place one after another in the same space, we have no means of directly ascertaining the different duration they successively present, or whether they do employ a duration at all different.

We have no means of ascertaining whether of time the successive portions which we experience succeed each other with equal or with different speed; whether by degrees the succession becomes accelerated or slackened, expanded or condensed; whether year after year the planets continue to revolve round the sun in lesser or in greater portions of duration than they did before, or thus of calculating through the peculiar rapidity with which flowed prior time, that which is presented by the flow of time more recent.

As the Omnipotent seems constantly to be pouring forth fresh time, and as fresh time is required for every other different new developement of matter, God can only be said to have rested from the labours of the creation—if labours they can be called—figuratively, not really. New creations of time must ever be going on, because new appearances of other modifications which only through dint of time are brought about and matured, are ever continuing. Indeed, as time is in part the foundation of all else of matter and of mind perceptible to us, any stoppage of time must imply a stoppage, a stagnation, a ceasing of all else that is perceptible. If such an entire stoppage could ever take place, it could not be perceived. We could not any longer by the partial advancement of some things, estimate the lagging behind of others. At the conclusion of this general stoppage things perceptible could only again, from where it first began, go on in what must seem uninterrupted continuation.

Of an aggregate of time the successive portions are not perceived, or only perceived faintly, as long as in it arise not, or are not presented to the sense other changes more partial but more palpable, through the medium of which we are made more distinctly to mark and distinguish the different successive periods of time itself in which they take place.

Of time the longest aggregate, undivided, unmarked by partial changes, would only seem an instant; and only as changes more rapid take place in time does that time itself, the recipient of these changes more numerous, appear longer.

A portion of time is necessary to the production, the existence, the perception of all else we know. Without a portion of time on which to rest, nothing else perceptible can be conceived to exist or to be perceived. Even space, in order to be perceived, requires a portion of time; and as time itself ever changes, ever loses its identity, ever makes way for new time, every thing else perceptible, founded on and included in time, must ever fare the same; must ever change—ever be different from what it was before.

There is thus more truth, less sophistry than we think, in the saying of Protagoras of Abdera, when he maintained that since every thing must, in its most fundamental conditions of mere time and space, ever change, nothing which we perceive has any intrinsic permanent existence;—in maintaining that nothing which we perceive, strictly speaking, is.

CHAPTER V.

Space, extension.

It is not a little singular that while time—duration—of which no portion is perceived to be permanent, or to last even a single instant; of which every part is ever new and different from every prior portion, has nevertheless been pronounced —and justly—as being in itself a positive attribute, space, extension, on the contrary, of which each part once produced seems to remain unceasingly; of which no part that has once appeared seems ever again to disappear; of which, as well as of time, certain portions are found necessary to the existence of all other different attributes of matter and of mind more partial than itself perceptible to us; which, like time, is in part the indispensable material of all these attributes; without certain portions of which, added to certain portions of that of time as their foundation and their materials, no other attributes can find room to exist or to be perceived, has nevertheless been pronounced intrinsically a mere nonentity, and has only been called the room in which other attributes more positive might be produced and placed;—as if that room, which itself is indispensable to the appearance of these other attributes; which may exist or not exist, and which may in some places be more capacious than in others, were in itself nothing: as if the very difference between where such room does not exist and where it does, and between certain portions of it and certain others, did not already prove it to be in itself a something positive.

Far from adopting this idea, space, like time, to me appears actually to be in itself a something positive, a something created, a something of which the being or the not being makes a prodigious difference, independent of that of the attributes more late and partial again made to appear within it: a something of which, as of time, in a dreamless sleep, we may have no perception, while when awake and receiving sensations, we may of it have a positive consciousness, even though we actually have not yet a consciousness of any thing else more definite and distinct contained in it; since of space as of time we may perceive portions different from and larger or smaller than others, and since whatever may be compared with something else, and have of a peculiar condition a greater or a less quantity, must in so far needs exist and be perceptible.

The first cause, itself imperceptible, of all effects perceptible, seems to have endowed every individual portion of space, as well as of time, which we can fix and distinguish from others, with its distinct and definite limits; and however contiguous a peculiar portion of space still be to another different portion of space from which we can already distinguish it, to have rendered it incapable of presenting with that other portion any identity in place—to have already situated it to the right or the left of, over or under, above or below, that other different portion of the same attribute.

It seems doubtful to me whether the conditions of space proceed directly and without intervening medium from the first cause, and only are in part again subsequently joined to those of time, or whether only through the prior medium of certain portions of time themselves have been formed those of space. This alone seems certain, that only through the intervention and medium of successive portions of time we can recognise, survey, and be sensible of what we call even simultaneous portions of space different from each other. Viewed through the medium of time, as all space must be by us, it however presents conditions very different from those which time itself, void of accompanying space, presents.

While of fleeting time, taken singly, the different portions seem only each to appear in succession and in a single forward direction, of stationary space the different portions seem in great measure from first to last to remain simultaneous, and to stand by the side of each other, so as to stretch out in every direction, right, left, upwards, downwards, forward, and backward.

While of time, of which every individual portion vanishes as soon as it appears, the general mass alone seems to increase or rather to continue existing—and that only through dint of constant new portions replacing the former ones gone by—of space, ever remaining, the aggregate seems to increase in reality, partly by its former external boundaries having new and more external boundaries ever added to them, and partly also, at least in appearance, by having its internal divisions and recesses ever further subdivided and multiplied.

While of time there only seem to be portions which differ from others in being prior or subsequent to those others, of space there exist portions, simultaneous with others and yet different from them, in being either withinside or withoutside those others.

While of time the portions seem each constantly themselves to change, to become new and different from prior ones, of space the portions seem each intrinsically constantly to remain unchanged,—the same that in time from their beginning were, and to their end shall be; and each, wherever they can be individually fixed as distinct from others simultaneous with them, seem only to differ from these others in the place which, relative to these others, they permanently occupy.

While evanescing time only collectively continues to flow on by ever presenting new portions replacing the portions preceding them already elapsed, sturdy space, maintaining its ground, only every further instant of duration grows older. If such imperfect similitudes were admissible, I should say that while time resembles the rolling of an immense cylinder, space resembles the form of a stationary globe.

While of time no portion whatever admits of being grasped, laid hold of, retained, and when gone by, again resumed, or by sentient entities themselves again reverted to and retasted;—while of time the portions only resemble the waters of a rapid stream, that soon disappear and plunge into a fathomless ocean, of space every portion, unto the most minute, like the contents of a tranquil lake, seems ever capable of being fixed, dwelt upon, seen through deeper and deeper, and, however often quitted or looked away from, again from the greatest distance able to be returned to and revisited.

While of future time certain subdivisions can only by the subdivisions in space over which an object is to move, by anticipation be made measurable, of space past and still present, certain subdivisions can have their capacity through others, situated within or withoutside them, directly estimated.

Of time the lesser portions present not any peculiar order, relative to each other, in space, by no parts of which latter condition they can be bounded. Of space the lesser portions present not any peculiar order, relative to each other, in time, by no parts of which earlier attribute they can be limited.

While time, only passive with regard to the first cause alone whence it first emanates, seems to be of that first cause the effect, or secondary cause, most active with regard to all other later effects, space seems to be of that first cause a later effect, only through the medium of time itself at second hand produced, which, by time again impregnated with, and rendered the womb of all other attributes later and more partial than that space itself,—from those of mere force, impulse and movement, to every other of mere unsentient matter or of mind arising in space—is from beginning to end wholly passive.

Time is always moving: space seems wholly immoveable. Space can only by time and by other objects formed in time be invaded, be occupied, be tenanted; not be moved, be displaced, be annihilated. All mere change without motion only requires new time. All motion is through change of time performed in difference of space.

In the same way as we are destitute of means to know whether of time the portions can be intrinsically more condensed, and run more rapidly at one period than they do at another, we are destitute of means to find out whether of space the portions can intrinsically be more condensed in one place than they are in another. This only we can say with certainty, that as of time so of space the lesser portion only through dint of other attributes more numerous, varied, distinct and partial, perceptible in and occupying lesser portions of them, become ever more marked and more distinct; and that as of time, whatever be its length, the utmost duration would only seem a single instant, so of space, whatever be its surface, the extension would only seem a single point, while no other attributes, distinct and different from each other, rose within its different portions to show their capacity.

As of time and of space the attributes are the simplest and most comprehensive which can be perceived, it follows that when these fail to be felt, nothing else whatever remains perceived; and that, if these should happen not to be continuous, but to have a gap, that gap, filled by nothing else perceivable by us, could not itself be perceived.

Even in sleep, though time runs on, and space continues to surround us, while we receive not in dreams any perceptions of these attributes, we can receive, even in the shape of dreams, the perception of nothing else.

To us the whole extent of successive time and of simultaneous space which we can perceive and conceive seems continuous—seems only to be one single undivided aggregate. When geometricians think they can separate from each other certain portions of space, before continuous, by intervening lines, they separate not these portions of space in reality from each other. They only cause certain of the portions of space, intervening between other portions of space more distant, to contain attributes of a visible sort more marked and distinct than those others. When such intervening lines are employed for that purpose, their own extent ought always to be kept in mind, and be expressly added to, or positively deducted from, that of the intervening space on both sides of them, in order fairly to estimate the dimensions of this latter.

Of certain portions of space, the general extent and quantity, relative to that of their own lesser component parts, or relative to that of other different portions of space, is called their size. The direction relative to each other, in which these different portions of space are situated, is called their shape. The situation in which they stand relative to other surrounding space, is called their place.

As of the perceptions of time and of space the outskirts are immediately next to the absence of all perception, they are, while yet wholly unoccupied by the perceptions of any other attributes that serve to distinguish certain of their lesser component parts from others, the least marked and distinct yet of any perceptions whatsoever. Only when other attributes, perceptible to certain senses in particular, such as the senses called of touch, or taste, or smell, or hearing, or sight, again subdivide aggregates of time and space in lesser portions, do in respect to these secondary attributes different from each other these more partial limits of these lesser portions become more distinct, and the capacity of the whole which contains them more evident and striking.

Mathematicians have puzzled their brains to define an unextended or intrinsically immeasurable point of space—and no wonder! We can only define what we can conceive—what we can measure—what positively differs from something else. Time is in all its perceptible portions measurable: so is space; and a point of space that is not intrinsically measurable—that is, properly speaking, immense—is not. Such a point, if it existed, could not, by aggregation with other similar points, be capable of acquiring greater extent than it possessed singly. Of such points no number could collectively present a greater mass than a single one can do. No quantity of such can form a measurable line, or surface, or extension in any sense. All extension, all surface, all size, only depends upon, only consists of, an aggregate of lesser portions of space, which, though smaller, are themselves already through time dividable in others still less than themselves, and thus are through such still measurable. The difficulty of the definition lies in the thing to be defined not existing—not being possible:—in the terms through which it is expressed intrinsically presenting contradiction.

What is by the courtesy of language called an immeasurable point of extent is not any extent at all, or is only the beginning of an extent actually measurable. It is only the place in surrounding space where two or more portions of positive measurable extension meet and come in immediate contact—where they thus leave no room for other intervening points of space, either immeasurable or measurable. An intrinsically immeasurable point is the limit from whence measurability first on all sides begins, or where it again ends.

There are not, in reality, in space, points destitute of extension, lines destitute of width, and surfaçes destitute of depth. We only fancy such to be, by leaving the representation of the latter attributes of the modifications possessing them indefinite in our mind,—by confounding the mere sensation of a surface only, which of an aggregate of extension or space is all that we can perceive of it, with the reality of that aggregate, such as alone, outside our sensation of it, we can conceive to exist. Space, in reality, where it exists at all, ever extends, as we can conceive it, to a certain degree alike in every direction.

Each later attribute than those of mere time and mere space, which becomes perceptible to us, can only arise, or at least, can only become perceptible to us, in certain portions of the perception of time and of the perception of space. Of the rudest modifications of external matter, every portion perceived by us occupies, together with some positive portion of mere time some positive portion of space; and of the finest and most volatile phenomena of mind, by which that external modification of matter is represented, each portion still, in the brain of man, occupies a certain portion of time and a certain portion of space dividable into lesser portions, in which the modifications of that external matter are depicted.

CHAPTER VI.

Quantity, number, proportion, and their effects.

Of different attributes or of different parts of such, no matter whether these be continuous or separate, united or divided, an aggregate, collectively taken, forms what is called quantity. A quantity of any such attributes or parts is deemed great or small, relative to any other quantity of the same or of other different attributes or parts. Of quantity, as of mere time and space, each portion is intrinsically definite, limited, and incapable of offering identity with any other portion of quantity different from itself. It is only capable of existing in those portions of time and place where a different quantity of the same attribute is not: it is incapable of being where any such other different quantity of the same or other attributes or parts is found. If an entity at the same time and in the same place offer quantities different from each other, it is only of attributes already different from each other. Thus the same orange may at the same time and in the same place offer a very great quantity of what is called savour, and a very small quantity of what is called sap. Quantity, except where it is of time and space themselves, is not always measured by time and space. Similar measures of time may, of similar modes of movement, according as these movements are slower or quicker, contain quantities very different: similar measures of space may, of the same sort of colour, according as this colour is lighter or deeper, contain quantities very dissimilar: and often the smaller measure of time or of space may contain the greater quantity of movement, or of colour. This constitutes it a poverty in language only to have the same word greatness or smallness for expressing the relative superiority or inferiority in quantity and in size. It feels grating to say that the minuteness of a mite is very great compared with that of a mammoth.

As of time and of space, so of quantity or of any other attribute different from those of time and of space, no portion appears great or small while uncompared with and unmeasured through some other portion of the same attribute. It is only when compared with and measured through some such that it appears either the one or the other. As from the Almighty bosom, of time ever advancing and of space ever growing, new portions must continually be poured forth, so likewise must from the first cause, of quantity and of every other modification, through the medium of time and space created or made to appear, new portions continually be made to flow.

Where of time, or of space, or of any other attribute or modification included in those of time or space, certain portions, before still united in a single continuous mass, collectively still called one and the same, by degrees become perceptibly distinguishable from each other, they form together number, increasing as often and as much as in the whole aggregate there arise new divisions into lesser portions, each again distinguishable from the others. Of numbers some may be subtracted from others; and to numbers other numbers again different from them may be added.

Numbers may be increased without the quantities which supply them being increased, by those quantities being divided into smaller quantities separate from each other: they may be increased by the former quantities having new separate quantities added to them.

Of certain modifications, whether of duration, or extension, or number, or force or other, the quantity, compared with and measured through another different quantity either of the same, or of any other modification different from itself, and equal to or larger or smaller than itself, is called its proportion relative to that other.

The same aggregate which offers, compared with a certain other aggregate different from itself, a considerable excess in quantity, may again, compared with a certain other aggregate again different both from itself and from that former different aggregate, present in quantity a considerable inferiority or falling short.

The apple which is large or capacious in proportion to the pips it contains, is small in proportion to the tree which bears thousands of similar apples.

It is a trite but a true observation that between all the modifications physical and mental perceptible to us, different from and opposite to each other, a certain proportion, such as causes the force, impetus, movement and action of each respecting that of the other to be by those of the other respecting itself balanced, is necessary in order to produce in each modification a power of resisting the further advancement of the other; a liability of becoming itself, through the check which the other offers to its own further advancement, equally arrested and stationary with that other; a means of each thus becoming united with the other, and being through dint of that union with the other made to offer new forms and to present new faculties, different from and more complex than those which each singly and separately possessed. Nay it is equally evident that where such balances already have existed and such unions been formed, the addition on both sides of new modifications balancing each other, will externally enlarge the mass, or internally increase the condensation and vigour of the modifications already united.

It consequently is equally true that if modifications, physical or mental, perceptible to us, different from each other, are, in proportions relative to each other between which this balance does not exist made to approach each other, instead of the two opposite modifications being made to unite into a third, different from either of the former separately, and possessing, with a substance and a form, faculties different from and more complex than those which either of the two prior modifications separately possessed, the one of these two opposite modifications which in quantity, or impetus, or strength, exceeds the other, will not only by the other, less in quantity or weaker in impetus than itself, not be arrested, but on the contrary will drive that other backward before it, and continue pursuing that other, until by the accession of some other force from before, or by some diminution of its own force from behind, the proportions of the opposite modifications relative to each other be altered.

Nay it is equally evident that if, after between two opposite modifications a prior balance have already produced a prior union, on one side later accessions or later losses, not similarly taking place on the opposite side, again disturb that balance, the union by the former balance produced will again cease; the faculties that arose out of this union will again be annihilated, the forms be destroyed, and the modifications that are weakest be by those that are strongest again driven away and put to flight.

This circumstance already takes place with the opposite quantities of modifications still the most purely physical—with those of mere material force and impulse, which, if equal on both sides, arrest each other and become stationary, or only, instead of each continuing to act as before in a forward direction, each unite with the other and turn aside into a new direction, different from that former one, and intermediate between and transverse to both the former ones.

This circumstance also of substances and bodies first causes the composition, cohesion and solidification, and the again later subsequent decomposition, decombination and dissolution; and this circumstance again holds good with the opposite quantities of modifications even the most complex of mind. If from one side a will of ours is strongly impelled to the performance of a particular action, and if from another side another will of ours, different from the former, is as strongly impelled to another peculiar action, incompatible with the former, it causes these two opposite wills each to arrest the impetus and to mar the tendency of the other, and to remain ineffective and stationary; whereas, when one preponderates, it again drives away the other, and exclusively ripens into corresponding action.

But of this circumstance neither the earliest instances in mere matter, nor the latest in mind, have yet been attended to sufficiently to draw from the observation of them a principle universally applicable.

CHAPTER VII.

Genera—individuals.

Some people have thought themselves peculiarly acute and logical in maintaining that in the external world—I mean in that world which we suppose to exist outside the sensations and ideas which are all that we perceive of it—there existed no genera, but only mere individuals; that what we call genera are the mere creations of our own mind,—exist only in that mind and nowhere else.

They have confounded with real external genera, such as we suppose to exist on this globe, outside the human mind, the peculiar later pictures and representations of these genera, which we only form in that mind when we abstract and generalise.

If by the word genus we mean the whole collective aggregate of all the portions of a peculiar attribute of matter or of mind, different from those of any other peculiar attribute of matter or of mind again different from the former, which may exist,—no matter whether these portions be all collected together in time and space in a single continuous undivided body and mass, or whether of these portions some are, by intervening portions of time and space only, or even by portions of other attributes included in certain of those of mere time and space, separated from others; whether the whole genus be collected in a single uninterrupted individual, or whether it be divided among a number of different lesser individuals simultaneous or successive, again distinct and separate from each other; whether, for instance, a plant of a certain description be an unique and singly form both the genus and an individual of that genus, or whether millions of different similar individuals be spread over the globe; continue to appear on it from age to age, and only collectively form the whole genus, —assuredly there are real genera existing in the external world, just as much as there are ideas and pictures of such genera existing in the mind.

And this is the way in which the word genus is meant to be, and is actually, in general by the custom of language understood, when applied to real external modifications; and of these modifications there are some, such as that of finiteness, of limits, of quantity, of proportion and others which, belonging essentially to all matter alike, are every where found to exist in a continuous aggregate, as well in the external world as in the mind of man. But there are others which, like powers of vitality, of sensation, of thought, and of reason,—only belonging to certain lesser or later genera or individuals,—have on this globe certain of their component parts separated by wide intervening portions of time and space unoccupied by any portion of them, from other portions of time and space possessing other different individual portions of them.

Even of these genera, more restricted however, of which different portions may, on this globe, in reality be divided from other portions of the same genus, and belong to other individuals different in time and place from those to which belong the former portions of the same genus, there may, in the mind of man, by means of abstractions and generalisations, be formed ideas, representations, pictures, in which all that is in the external reality thus separated and divided between different individuals simultaneous and successive distinct from each other, shall, in that mind, be united in a single continuous intellectual whole; which mental whole however, while it is a representation of the external world more concise, and representing more of it in less space and time than any ideas only called concrete can give, only represents those objects more numerous of which it is the image less definitely and detailedly. But this difference between external genera, and the mental representations of certain of them, does not diminish or destroy the reality of the former any more than it does that of the latter.

We shall later see that of the different portions simultaneous and successive of higher genera on this globe in reality separated, and forming individuals distinct from each other, the union in a single continuous whole, of which we can here only form in our mind an abstract idea and representation, a world higher and better organized will probably hereafter present the external reality; that the generalizations formed here will probably only prove anticipations of the state of things we may really expect to experience hereafter; and that thus all the evils which on this globe result from minor individualities, simultaneous and successive, distinct and separate from and interfering with each other, will, in another world, be corrected and removed.

As long as of any genus of modifications all the different portions still remain in time and space so united as only to form a single continuous mass and body, void of interruptions and gaps only filled by intervening portions of mere time and space, or of other attributes different from those belonging to the same genus with the former, that genus is said only to be composed of a single individual; the individual and the genus are said to be one and the same.

But as soon as of a genus certain portions become by certain intervening portions of time and space, not occupied by attributes of the same genus, or occupied by attributes of some other different genus, separated from other portions of the same genus, that genus becomes singly divided in a number of individuals different from each other.

Of time only and of space alone, the whole aggregate still presents itself to us as a single continuous mass, of which different lesser portions, though in appearance by different later and more partial attributes, resting on these, distinguishable from other portions of the same, and thus far already regarded as different individuals, cannot yet in reality be separated from these others so as to form different individuals distinct from each other, except by means of other different intervening portions of the same attributes of mere time and space.

Of the different globes of our planetary system, by the force of gravitation united in one single body, that gravitation thus already composes a single individual, in its various intrinsic parts united more strongly than are united with these other globes, belonging to other different planetary systems. An aggregate of entire globes may thus, through certain connecting links, form together a single individual as well as an aggregate of the minutest particles of matter; and an aggregate of the most intangible ideas may, through certain connecting links, form a single individual as well as an aggregate of the most solid and cohering substances.

Of a genus, more early and simple and general, lesser component parts may each separately contribute their share to other genera more late and complex and partial; but in order to do this they must be added to a portion of some other genus again different from the former. The conditions belonging to and completing a genus earlier and simpler, must be united with the conditions belonging to another genus, different from the former, ere the two can by combination form the conditions of a third genus, again later and more complex than either of the two former ones singly.

We shall hereafter see that, according as of different attributes, forces and materials from opposite sides, only smaller portions are yet made to meet in relative proportions so balanced as to combine together in a new single individual entity, these portions still leave behind them other larger portions yet liable, by a later approach from either side, unbalanced on the other, again to impair the faculties, forms, combinations and existence acquired by that entity, and that only according as of different attributes, forces, and materials from opposite sides greater proportions have met and combined, and only leave smaller quantities still behind, liable again, by approaching from opposite sides in unbalanced proportions, to expose this combination to injury and destruction, the entity becomes more permanently secure from all danger.

CHAPTER VIII.

Power exerted, force displayed, impulse given and received, movement produced.

I HAVE observed before that of powers and faculties already fully possessed, and yet not immediately leading to their manifestation, there can only exist in the mind mere abstract and indefinite ideas; that of such there cannot exist an external reality: that in reality we can only conceive powers, while they remain unexerted, to remain incomplete; that we must conceive faculties, as soon as complete in all their parts, to grow immediately into corresponding actions. I shall therefore, in discussing the origin of powers and faculties, here consider their actual full existence as identical with their positive present exertion.

It has been generally maintained that a power, a faculty, cannot be exerted, a force act, an impulse be given, a movement be produced, except where the modification which produces it is actually present in the very spot where it is produced.

I maintain the contrary.

A power possessed, a force exerted, an impulse given and received, a movement produced, an impression made, imply two objects different from each other, the one active and giving that impression, and the other passive and from the former receiving that impression. These two objects must needs be different from each other in point of place. Force exerted moreover implies movement, and movement implies time in which to perform it. Thence force and movement can only be conceived to exist in portions of time successive, and consequently, like those of space, different from each other. They can only take place in change of time as well as in change of space.

Such power, such faculty, such force cannot originally in its whole derive only from space or time themselves, of which every portion is in itself different from and unconnected with every other portion. It must first derive from something beyond space and time, and able itself, of these attributes of time and space, to embrace and connect different portions together. It must originally derive directly from the very first cause itself of time and space. From that first cause alone can originally emanate, like time and space, that force which, of the portions of time and space before separate and distinct, causes some to act or be acted upon by others, and through the medium of these others.

From the first cause seem constantly to emanate fresh portions not only of time and of space, but also of force, impulse and thus movement, which through time are made to chase these former portions of the same attributes of force, impulse and movement further before them, and more inward in space.

If on the one hand I cannot believe that force can first only originate in later and more internal points of time and space; if I find myself obliged to ascend for the origin of that force to the most external points of space—to the first beginning of time—to the very first cause of space and time itself—I cannot on the other hand conceive of this force the further impulse and propagation to be any where in points of space more late and in points of space more internal stopped or suspended, so as only athwart intervening periods of time or portions of space unoccupied or untraversed by these, and distant from those that are thus traversed, again to be as per saltum revived, propagated and transmitted to other points of time and space still more late and distant.

I can only conceive force to be, through the medium of earlier intervening portions of time contiguous with later portions of time, and through intervening portions of space more external contiguous with portions of space more internal, insensibly from these former transmitted to these latter; or to be, when in its progress by the resistance of an opposite force stopped and rendered incapable of advancing farther, by fresh pressure from behind made to accumulate on the spot, or by pressure from before made to retrograde backward, till it again approaches the boundaries of space. I can within the boundaries of space conceive force to be concentrated, or diffused, not lost.

When force from stoppage by opposite force, and from consequent stationariness and accumulation, is again at a later period in time released and left to advance, it again from the very identical point in space where it had been arrested, and where until its liberation it had pressed upon the opposite force unsuccessfully, starts and rushes forwards.

I can only conceive force as first on all sides by the Almighty, through successive portions of time, from the more external circumference of space pressed inward into internal portions of space more contracted, and there by its condensation gaining in strength and impetus what it loses in extension. Nay, I can only imagine all force, all impetus, all movement, in the first state in which it is from the first cause through time emanated in space, to be emanated in a more radiant shape; that is to say, in a straight direction in less time advancing to a greater distance. Indeed all force, as from a wider external circumference in space it more approaches its centre, also through greater condensation is made to show greater intensity, and in less time to take greater strides.

I can only see force, as on every side from behind through space more external and capacious it is pressed forward and inward into space more narrow and confined, ever moving on with greater impetus and rapidity, till by some other force, from another side impelled in space, it is so met that each portion from the opposite side resists the further progress of the other opposite portion.

When this circumstance happens, the peculiar direction in which the opposite forces are made to approach, and the peculiar quantity and proportion in which each meets the other, will cause further consequences very different.

If they meet in a straight line and in equal quantities face to face, each will by its progress forward entirely arrest the other, and be by the progress of that other itself arrested and rendered stationary. If they meet in a straight line, but in unequal quantities, the one whose impetus preponderates will cause the other, whose strength is less, only to be deflected from its straightforward course, and made to turn sideways in a certain greater degree, while itself is on its part by its opponent also made to give way in some degree; or the one whose impetus is strongest will force the other wholly again to retrograde, and to retrace its former steps backward, while itself continues to advance in its original course.

Thus radiating forces, by other forces radiating or more condensed and stationary met, are refracted or reflected.

If opposite forces meet in quantities and proportions equal, but at an angle, and in an oblique direction, the oblique pressure of each on the other will become blended with the oblique pressure of the other on itself, in an united pressure forward, different from and intermediate between that of either of the former separate pressures; moving in a direction from whence the resistance from without is less than that which each pressure singly intrinsically presented to the other. As the pressure from either side preponderates less or more over that from the opposite side, the angle which the two jointly on meeting describe, and the prolongation of the direction produced by that angle, will deviate less or more from the direction in which the opposite forces first advanced and met.

In the same way as forces, from the outskirts of space impelled further inward to its centre, by greater condensation in less time and space acquire more intensity, they will, when from the centre of space they are, by other opposite forces there meeting them, again made to recoil and to be repelled outward and backward towards the circumference of space, again by greater diffusion in time and space diminish in strength, and become more weak and slow. It is, however, probable that forces, once poured into space, are ever, through dint of new forces, by the first cause continued to be poured in after them, prevented from again entirely escaping from space.

As forces must each singly occupy a certain portion not only of time but of space, and thus can only each individually in the same portion of time exist in a portion of space where the other exists not, where two or more radiant forces are from opposite points of space so impelled as to cross each other, they must necessarily each in its turn advance athwart, and give way to the other, and consequently with that other produce an oscillation, a pulsation, a see-saw of arrestation and of progress.

That force which is strongest will pass on, and in its passage arrest the weaker one, which, while the former, pushed on, gathers by no accumulation any increase of strength, on the contrary itself by stoppage and accumulation from behind gains additional strength, till it again in its turn preponderates over, and arrests, and passes athwart the former. But in forces still radiant, these alternations are still performed in divisions too minute, and with a rapidity too great, to become perceptible to us otherwise than through the pulsations which they cause in time and space.

I believe that time and space being the first and most general of created modifications perceptible to us, it was only through the medium of portions of time and of space combined in certain relative proportions, that the first cause composed or rendered perceptible modifications of force, impulse and movement, which, in fact, as in more or less time they pervade less or more space, remain less or become greater.

I believe that of the forces, by the first cause in time and space produced, that called of gravitation—not, as we shall see, a force of attraction but of propulsion—to have been the earliest, because it seems to be the most extensive and universal: and thus to have preceded, not only that force and impulse from opposite sides which causes the feel of cohesion, of solidity and of substance, but even that force which, causing the feel of electricity, is after the force causing the feel of mere gravitation itself, the radiant force still most early and most general which we can perceive; and because I do not see how, within the earliest modifications of mere time, and within the most external modifications of mere space, could arise modifications of electricity; and how within modifications of electricity again could arise modifications of positive cohesion, solidity, and substance; and how, in time and space, these modifications of electricity and of substance could be made to perform movements more partial than those of mere gravitation, otherwise than through the medium of gravitation itself,—as we shall explain in the following chapter.

CHAPTER IX.

Gravitation, the earliest and most universal of forces known; a force not of attraction, but of propulsion.

The force of gravitation is generally described as a force of attraction; or a force which, first proceeding from a peculiar object, draws another different object from a distance to that first.

This I do not believe to be the case, and for several reasons: because, if it were the case, firstly, the force of gravitation, originally issuing from a peculiar body which draws another different body to it, would, whenever in its course forward or backward it crossed the course forward or backward of another different force of gravitation, issuing from another different body and drawing another different body to it, interfere with this other force; an inconvenience to which the movements of the different heavenly bodies, made by agencies of different gravitations to tend to each other, seem not to be liable.

Secondly: the force of gravitation, first issuing from a peculiar body, and next attracting another distant body to that first, must singly act in two directions opposite to each other; first in one direction from the object distant from another, which was to attract that other, till it had reached the same, and next, from that other distant from the former, when reached, again back towards that former, in order to bring the second back to the first; and must act in these opposite directions, not successively, and by pulses, syncopes, see-saws and movements alternately advancing one way and the other, but simultaneously, and so that the opposite movements should at the very same time, in the very same place, advance in these two opposite directions—a thing absolutely contrary to the simplest perceptions and evidence of the sense.

Thirdly: the force of gravitation, if this was the way in which it made one body approach another, would not, after it had produced that approximation between two opposite bodies with ever-increasing celerity up to a certain point, again, beyond that point, before the two opposite bodies had been brought in positive contact, somewhere cease to act; whereas, on the contrary, after it has made the two bodies approximate to a certain point, it not only leaves them, as by magic, again to stand still, but even again to fly away from each other.

Fourthly: the force of gravitation, if it proceeded from a mass attracting another mass towards it, must in each mass be strongest at that part of the surface nearest the other mass where it had the greatest quantity of its own substance in its rear to be backed by; and must thence go on diminishing across the diameter of that mass till it reached the opposite side of its surface, where, the substance again ceasing, the attraction exerted by it must likewise entirely cease; whereas on the contrary, in each globe to which any other globe tends, the force of gravitation is made from every side alike to increase and to compress substances with an increasing intensity, as from the surface we advance nearer to the centre, till at that centre the intensity and pressure is greatest.

Fifthly: the force of gravitation must, instead of leaving on each globe the substances nearest its surface to cling round its centre,—thereby rendering each globe a body distinct and separate from other globes, and making the tendency of each globe to another globe appear first to begin as it does from the centre of each,—in this case, on the contrary, first begin to show itself by acting from the very surface of each different globe, and where it is nearest to the other next globe; and make of that very surface every minutest particle detach itself from the remaining mass behind it, in order to rise, to advance, and to meet half way the particles of substance, from the other opposite globe equally drawn and made to rise; so that each separate body should, by the attraction of the others, be finally destroyed, and that gravitation, instead of being made to form masses and globes distinct from each other, should only of distinct globes, in the intermediate space between them, cause the substances again to be confounded and made to return to their original state of chaos.

Sixthly: because it is only, as we shall further more explicitly show, where between different particles of substance is previously found to subsist that cohesion which is only the later and more partial effect of opposite pressures, not only of the force of gravitation, but moreover, within the force of gravitation, of that of electricity, that, through the medium of this cohesion, objects themselves previously moved forward can really and literally drag other objects, in the way of attraction, after them; and because even all the movements arising in the mind that are called effects of attraction, are only in reality the effects of a prior impression which the entity attracting makes by propulsion, and which impression, again, from within the object attracted, by its recoil, produces an impulse outward to the object attracting;—and because thus real attraction only is of matter one of the latest and most partial and most internal modifications, whereas mere gravitation, in its earlier forms, acting from the earliest periods of time and the most distant points of space, already seems to be of that matter one of the earliest and most general attributes.

Seventhly: because wherever between certain objects situated at a distance from each other we find produced in a certain direction this cohesion just mentioned,—the only medium of real positive ascertained attraction,—it must interfere with and prevent any other attraction acting in a different direction from crossing it; whereas the tendency by one portion of gravitation to one object given is not by a tendency, by another gravitation to another object given across the former, ever annihilated and destroyed.

And, eighthly and lastly: because, if the force of gravitation were a force only first found to inhere in masses of substance, when forming a distinct body, and not already existing before such bodies were formed, and itself first forming such, it could not account, in a satisfactory way, for substances previously incohering and diffused in space being first by it made to conglomerate, and next to grow, before they were lastly by it driven and made to wind round others; nor could this phenomenon, thus left unaccounted for by gravitation, be accounted for satisfactorily by any other power; whereas, on the contrary, if we suppose the force of gravitation, instead of being at best a force of attraction, which, only after globes were formed and finished, first from their general mass began to act outwardly in an incomprehensible manner on other globes, on the contrary to be a force of propulsion which in time and space, long even before globes were first commenced, already from without, of the materials of such future globes thus far still diffused throughout space, caused certain portions to be first separated, gathered up, propelled toward, collected and conglomerated round distinct centres in distinct bodies, and there by the force of gravitation first made to appear as minute points, next to grow, and lastly, from the same gravitation, to receive the impulse that causes them to move forward and to wind round other globes, all the difficulties of the subject, from that of the first origin in space of substance still unconglomerated, next of the first conglomeration of these substances in globes distinct from each other, and next of the movements by these globes performed relative to each other, to—last of all—those of the very development on this globe of ours of substances merely inorganic into substances organized, sensitive, and intellectual, alike vanish at once, the veil of nature is withdrawn, and each of these different successive phenomena only appears a natural consequence of the original conditions of gravitation.

Nor is it at all indifferent, but of the highest importance to science, to secure to gravitation the acknowledgment of this its legitimate character, which transfers it from the rank of an attribute of matter, only showing itself subsequent to the aggregation of substances into solid globes, to the rank of a condition coeval with the beginning of time and space themselves; and the medium, in time and space, of the first formation of all substance, all cohesion, all conglomeration of substances into solid bodies and globes, and into all else that on those globes to inorganic matter adds entities organized, living, breathing, feeling, and thinking.

CHAPTER X.

The force of gravitation in reality a force of propulsion.

Gravitation, thus wholly unable, as we have in the former chapter seen, to be a force of attraction, can only be a force of propulsion, originating immediately in the first cause, and by that first cause through the medium of time poured into space.

Had the Almighty through the medium of time only propelled portions of gravitation forward in space in a desultory manner, confusion would have been the only consequence. Even had the Almighty through time propelled gravitation forward in space in a more regular mode, but only in parallel directions, earlier portions of gravitation could only have fled before later ones, and later ones could only have pursued earlier ones through space, without any material result whatever deriving from the chase,—without any rays from opposite sides meeting, and by their mutual pressure producing later condensation, distinct form, &c.

But the Almighty, from the outskirts of space first on all sides causing rays of gravitation to advance to the centre of that space, and causing former rays emanated ever to be by new rays poured out after them driven on, the rays of gravitation, as from the outskirts of space they were driven to its centre, would first in equal quantities become in lesser portions of time and space so much more condensed, as to acquire, relative to the extent and duration they occupied, greater impetus and velocity.

Had rays of gravitation, when from the opposite outskirts of space they were near its centre made to meet, there all met so regularly that those coming from each side were completely arrested by those coming from the opposite side, they could only, while constantly accumulating from behind and arrested from before, have formed a single ever-increasing mass, condemned to be stationary and quiescent during the remainder of time.

But it seems this was not to be the case.

Of rays of gravitation on one side from the outskirts of space propelled inward, many at the centre of space by the rays propelled from the opposite side not arrested, were allowed to traverse that centre, and from converging inward till they reached it, were again beyond it allowed to diverge outward; so that of rays from the outskirts of space converging to its centre, and, as they approached the same, acquiring greater condensation, intensity, and rapidity, many would, after crossing that centre, and beginning to diverge outward to the opposite portion of the circumference of space, again in more room become more diffused, slower and weaker.

Of rays of gravitation, on one side from the outskirts of space propelled inward, others would at its centre, by rays coming from the opposite outskirts of that space, be met in such equal quantities as there to be arrested by these others and to arrest them, so as with them to form an aggregate of opposite forces becoming quiescent and stationary, which would ever from behind, by fresh forces pouring in, and joining, and accumulating round the former, be increased and extended.

Finally, of rays of gravitation, on one side from the outskirts of space propelled inward, others again would, nearer to its centre, or at distances smaller or greater from that centre, by rays from the opposite side poured into space be met in such unequal quantities and with such unequal strength, that a part of these would again by another part be made to recoil and retrograde in directions more or less approaching those from which they first had come, and would, in these backward movements, by those that had repelled them, be pursued.

So that out of the rays of gravitation first from the outskirts of space converging to its centre would in more than one way be made to grow rays of gravitation again from the centre of space diverging to its outskirts. Gravitation impelled in a centripetal direction would in more than one way produce gravitation propelled in a centrifugal direction.

But the rays of gravitation from within diverging outward, ever by fresh rays of gravitation from without poured into the same track met and opposed, would partly again, by the pressure of these latter upon them in their retrograde course, be from their first direction outward so deflected as, from being first from the general centre of space made to diverge outward to its general circumference, at a further distance from the same centre again to be made to converge inward to some secondary lesser centre, situated at a distance beyond the first, and between that first and the circumference of space, where, by fresh gravitation from without radiating inward met, they would with the same produce a secondary focus of gravitation, first centripetal, and next again by recoil from opposite sides also becoming centrifugal.

And wherever, between the general circumference of space and its general centre, of the rays of gravitation from that circumference propelled to that centre, certain portions met portions of the gravitation from the centre of space again radiating outward, the two would mutually so arrest each other as together to produce one of these secondary smaller nuclei of gravitation, first converging and next also diverging, here described; so that, while the first and more central nucleus itself was still, by fresh converging gravitation from the circumference of space, made to grow and to increase, partly from the continuation of that same converging gravitation, and partly from the later gravitation from that central mass again made to diverge, there would arise round it, in different points of space situated nearer to the circumference of space, other lesser and later nuclei of gravitation centripetal and centrifugal in numbers beyond all calculation.

From these secondary nuclei the radiations outward, again catching and deflecting and arresting still further radiations from the general circumference of space first propelled to its general centre, there would again arise between that general centre and the secondary nuclei, and between the secondary nuclei and the circumference of space, other nuclei of a third order, and others still later and less, so that we can conceive no limits to the creation of heavenly bodies out of others earlier and more central, as long as the Almighty power continues to show, by the continued impulse of gravitation, that it pours forth fresh portions of that force into space.

Of gravitation both converging and diverging the first great central nucleus, experiencing from all sides around a pressure even and balanced, would retain a situation fixed, motionless, and stationary; but of the other later and lesser nuclei formed round it, each receiving both from the circumference of space and from its centre opposite pressures indirect and oblique relative to each other, would have their more external parts driven and made to wind round their more internal parts, in the direction in which the pressure preponderated: and this oblique pressure preponderating on the side next the circumference of space, and being nevertheless, by the resistance of the centrifugal force from within, prevented from causing the later nuclei to collapse on the earlier ones, would only make these later ones to their rotation round their own centre, or rather, round an axis of their own, add a progressive motion such as would make them wind round all the prior nuclei in which they partly originated, unto the earliest, innermost, and largest of them.

Should, however, on the one hand, by the cessation of further gravitation converging from without, the gravitation from within diverging outward for a time predominate, it would push all the secondary nuclei themselves outward, till they were again from situations nearer the centre of space made to reach its outermost circumference; and should, on the other hand, by the cessation of diverging gravitation, the converging gravitation alone acquire paramount sway, all the different secondary nuclei would be made to collapse on the first and most central one.

At the peculiar point in space where later gravitation from without converging, with gravitation from a prior nucleus within diverging, first met in quantities so preponderating over those of the latter, as to begin causing in the new nucleus it produced a rotation round the former nucleus, that preponderance would probably ever after continue so much greater than the preponderance of the gravitation of a converging sort influencing the remaining portion of the orbit of the secondary nucleus round the more primary one, that whenever, in its successive rotations, the secondary nucleus approached that point, it would be pressed nearer the former nucleus, and more overcome the diverging pressure it experienced from that former, than it did during the remainder and the opposite extreme of its rotation; and would thus in that rotation more from a perfect circle deviate into an ellipsis.

New converging gravitation ever poured into space, and ever producing new later diverging gravitation, would ever press the later secondary nuclei outward to a greater distance from the first and from each other; so that while each nucleus singly increased in individual extension, the whole collective mass of nuclei would do so likewise.

Of the gravitation from the secondary nuclei nearer the circumference of space diverging, a part would find its way inward into the first and most central nucleus, and by its uneven pressure from different sides on the same, produce in it some oscillation and movement, though small compared with that by these later and more partial nuclei themselves experienced.

Where nuclei of gravitation converging and diverging produced round them other nuclei, made to wind round their parents, but not afterwards to kindle up with, and emanate from them that light with which again shone the lesser and later nuclei in their turn formed around them, they would themselves from a distance remain invisible, and their later offspring alone, lit up and visible, would appear destitute of a common link and centre.

Nor is this all. From the general circumference of space certain rays of converging gravitation would fall or stray into what we should call the lost corners, intervening between the circumferences from whence spring the converging gravitations of a secondary sort, co-operating in the production of the secondary nuclei; and these rays would, with rays of gravitation from these secondary nuclei again diverging outward and made to penetrate into these lost corners, form a third order of nuclei of gravitation converging and diverging, less regular, less condensed and less evenly resisting further pressure from without than any former ones. Thus showing with less condensation less regularity of form, the latter nuclei would also display round other nuclei more regular, movements and rotations more eccentric, more uneven, less steady and less regulated; and while the former nuclei were only driven round others to which they owed allegiance, in ellipses little deviating from the perfect circle, and less deviating from a course in the same direction, these latter nuclei would be driven round those on which they depended in parabolas so elongated as often to appear at one time quite to fly away from the very same nuclei which at others they threatened with positive contact and collision, and would round these ruling nuclei be driven in directions wholly opposite to those of others.

The force of gravitation—the first force which out of the union of portions of time with portions of space arises, and which from first being merely converging in part again becomes diverging—seems, after time and space themselves, the first medium, agent, material and mover of all other combinations and decombinations later and more partial; from those of electricity—both that called positive, and that foolishly enough called negative—and those of cold and of heat, to all other forces and substances, combinations and decombinations, perceptible to us, by these prior forces again in their turn produced and influenced.

After later gravitation has, by its combinations, produced entities possessed of instruments and powers of sensation, that gravitation, when from points in space without situated above these organs, it directly or through other media falls on and presses them downwards in a centrifugal direction, produces in them a sensation of gravity or weight; and when, on the contrary, from points in space without situated underneath those organs, it rises and presses them upwards in a centripetal direction, produces in them the opposite sensation of lightness or buoyancy.

CHAPTER XI.

Of some of the attributes and conditions belonging to the earliest and most universal force—that called of gravitation,—proofs à posteriori.

THAT the force of gravitation already may, without the medium of any intervening solid body in immediate contact with another solid body, impel that other solid body forward, is seen in a billiard ball, which merely by its motion may accumulate gravitation before it in sufficient quantities already to begin propelling another billiard ball situated at a further distance, and thus far stationary, before it in the same direction with that in which it is itself impelled; and is again seen in a ball which, propelled from one side to a solid wall, impeding the further advance of the gravitation driven before that ball, may, even before that ball reaches that wall, by that gravitation again pressed and dilating from the other side, be made to recoil and rebound backwards.

That the force of gravitation is elastic; that when a portion of it advancing from one side is from the opposite side by another portion of it more powerful, pressed upon, its quantity is by that pressure condensed in less space; and that, when from the opposite side that other portion is removed, the same quantity again spreads over a wider space, appears, since firstly, when of gravitation the lateral pressure outward is on one side by the intervention of high mountains stopped from extending farther, that gravitation existing on the other side of and beyond these mountains, is left to dilate towards them so much more than it does in points of space where it meets with resistance and counteraction, as to make the plummet, instead of being from all sides pressed down to the globe in a sense alike perpendicular to it, from the side where interfere these mountains visibly incline towards their mass; and since secondly, where the force of gravitation drives a detached solid object either from on high downwards to the solid earth, or from one side forward to another solid surface, so that the gravitation intervening between this detached solid body and the solid surface beyond, itself unable to retreat farther backward, is by the movement of that detached mass forward and by its own resistance and stationariness, compressed in less space, it acquires by this greater condensation so much greater force as, when the detached and moving solid body has reached, or nearly so, the stationary solid surface, again to make that gravitation by the resistance of the surface from behind dilate in front and towards the body moved, till its dilatation make that moveable body rebound backward to a certain distance, and allow the recoiling gravitation room to escape sideways from between the stationary solid surface and itself, before that body, even where by its weight falling a second time, is thenceforward made to lie still where it alights.

That the force of gravitation, as from space more extended it is in equal quantities compressed into space more contracted acquires, by compression and condensation, greater intensity and velocity; and that again, as from space more contracted it is in equal quantities left in greater space more to dilate, it loses by that dilatation more of its strength and velocity, appears, since on the one hand the gravitation from a wider and more distant circumference falling on this globe, the nearer it approaches its centre, the more also, from greater condensation it increases in rapidity and pressure; and since the opposite gravitation from a more contracted focus rising to a wider circumference, the higher it rises, the more likewise, from greater diffusion, it loses of its strength and rapidity.

That of two opposite portions of gravitation, from two opposite extremities made to meet, each, by the degrees of extent, quantity, force and impetus which it possesses and exerts relative to the other, has its further movements in conjunction with those of the other ruled, appears, since according as the proportions in which each presents these conditions relative to the other, one of the two is by the other repelled and pursued; or each joins that other in a new direction, intermediate between and at angles greater or less relative to its former direction and that of the other.

That gravitation of a centripetal sort, from a wider external circumference converging to a more confined internal focus, when by an opposite converging gravitation arrested, repelled, and made to recoil, with that other produces a later gravitation of a centripetal sort, from a narrower internal focus again diverging outward to a wider and more external circumference, appears, since, after converging gravitation has from on high made vapours descend till round the earth they collect and condense in clouds, the centripetal gravitation again from the earth recoiling, keeps these clouds at a certain distance from its body suspended or rather supported over the same, without approaching nearer; and since, even after converging gravitation has from on high driven fluids down till they be in their further lapse by the solid earth arrested, they will, by later gravitation from that earth recoiling, again be made to rise to a certain height above its surface, as we see in jets d'eaux; and since, where centrifugal gravitation from on high driving fluids down is by solid bodies interposed between this gravitation and the earth, so arrested as only to make these fluids reach the upper side of these bodies and there remain, the centrifugal gravitation, from underneath recoiling upward, is by this arrestation of the converging force from on high left at liberty to act with so much more power than before, as to drive other fluids from the earth upwards, till they are arrested by and made to cling to the undermost surface of those very intervening solid bodies, of which the upper surface arrested the fluids from on high; and since gravitation, from the outside of a hoop by its rapid circular motion so drawn in, as by recoil from its prior converging and centripetal direction to be within that very hoop again driven outward in a centrifugal direction, will drive and press a glass filled with water outward till it reach the inside surface of the hoop, and during all the later successive circular motions of that hoop, sufficiently rapid to keep up this pressure from within, while from without the further divergence of the glass of water is stopped, continues pressing the cup and making it cling to the inner surface of the hoop; and since a solid body, by centripetal gravitation from on high driven to the solid surface of the earth with such impetus and velocity as not to let the force of gravitation, intervening between itself and the earth, escape sideways before it be greatly compressed, will again, by the subsequent dilatation of that intervening portion of gravitation, be made to rebound to a certain height before that intervening gravitation, by making its escape laterally, leaves the body a second time to fall to the ground without again rebounding; and since a solid body, by side-long gravitation cast forward laterally in the same way till the gravitation intervening between that body and a solid wall be compressed in a very small space, will equally, by the subsequent dilatation of that compressed gravitation, increasing in proportion as the pressure from behind on the moving body by dilatation becomes weaker, again makes that body rebound. And since where gravitation of a centripetal sort has by narrow tubes its further descent and pressure downwards so interfered with, as to leave gravitation of a centrifugal sort ascending from the earth, when ascending through these tubes, more unobstructed play, this gravitation of a centrifugal sort forces liquids through these tubes upward, by what is erroneously called capillary attraction, in a direction opposite to that of centripetal gravitation; and since, where of tubes even wider than those already calculated to disturb the straightforward movement of converging gravitation, the aperture from above is by a solid body protected from the influx of that gravitation, the centrifugal gravitation from underneath attains in these tubes an unimpeded power so much greater still, as even to force up in them large columns of fluid;

as we see in pumps; and since heavenly bodies, from great distances by gravitation driven towards others, when approaching nearer to these others, are again by opposite gravitations from them proceeding outward, repelled and made to retrograde; and finally, since round Saturn we see a solid ring detached from its body, which yet during the movements of the planet is constantly, by the gravitation from its nucleus radiating outwards, on all sides equally repelled, and on all sides kept at an equal distance from its surface.

We shall now proceed to see how the force of gravitation, thus by the first cause out of combinations of time and space first formed, in its turn became the medium of the later and more partial force of electricity.

CHAPTER XII.

Cold not a mere negative attribute,—not the mere absence or subtraction of a certain portion of the positive attribute of heat, but itself a positive attribute distinct from, and contrary to, and often growing simultaneously with, and by the very side of, and positively conflicting with the positive attribute of heat itself.

I THINK I have exposed one error, which, if left unmolested, would have impeded my progress toward truth,—namely, that the force of gravitation is a force of attraction. I have shown it to be a force of propulsion. I shall now pass over to exposing another error, which will otherwise also soon stand in my way,—namely, that cold is a mere negative attribute: the mere absence or subtraction of a certain portion of the positive attribute of heat.

Cold, that force which at a certain degree of intensity causes substances, from thus far being merely radiant to become gaseous, liquid and solid, and which, when acting on substances and bodies of a sentient sort, produces in these, while increasing their solidity, a peculiar sensation, according to its degrees, pleasant or painful, has long been considered as the mere diminution or absence of the positive modification of heat; only because, in general, when heat any where increases cold diminishes.

But this circumstance is no proof whatever in support of the idea in question. Two forces, two attributes, two substances, nay, two bodies, may be so incompatible with each other in the very same portions of space, that in that identical portion of space a certain quantity of the one necessarily excludes the smallest quantity of the other, and yet both may be equally positive; nay, each equally thrive in the nearest vicinity to the other.

Who will assert for instance that two colours wholly different, such as red and blue, though they may be intermixed so closely that the impression of each singly on the eye cannot be distinguished from that of the other,—that they shall jointly produce on the eye the mixed impression only of purple—are not each separately as positive as the other, and yet who shall not at the same time deny, in consequence of that very positiveness of both, that either can possibly at the very same time be in the very same place with the other?

And is it not the same with every other portion of every other positive attribute of substances and bodies?

It has been asserted that cold is the mere absence of heat, in the same way as darkness is the mere absence of light.

But the two cases are not parallel; and here precisely lies the difference, that what we call darkness is the mere absence of the attribute of light, or what we might call a mere negative attribute; and, while removing the impressions produced by light, substitutes immediately no other positive different impressions in their stead: whereas what we call cold is not the mere absence of the attribute of heat, or what we might call a mere negative attribute; but, while removing the impressions of the positive attribute of heat, substitutes other different impressions, as positive as those of heat themselves, in their stead.

If during darkness there arise ideas and feelings not apt to visit us while there is light,—such for instance as fears of ghosts and hobgoblins,—these are not the direct offspring of darkness itself, but of the room this darkness leaves in the mind for visions which the light of day, and the more cohering objects it shows, exclude. Darkness directly produces no sensation whatever, whereas cold does.

The idea, erroneous and unfounded, of cold being a mere negative attribute—a mere diminution or absence of heat,—can only be reconcilable, and seems connected with, the other idea equally erroneous that the primitive state of all created matter, in the earliest periods of time, and in the most external as well as more internal points of space, was a state of entire cohesion and solidity; that only at later periods, through dint of a supervening positive force called of heat, of that matter, before solid throughout, certain parts were released from their original state of cohesion and solidity, and rendered more separate and more expanded; that thus, as the mere force of heat, by subsequently supervening, had caused matter from solid to become fluid, gaseous and radiant, the mere removal of that heat again sufficed to leave matter to relapse in its original state of cohesion and solidity.

Were cold a mere negative, not a positive attribute;—were cold, and the condensation of matter resulting from it, by the mere extinction of heat carried to its maximum,—that maximum must not only again take place afresh wherever heat again totally disappears; it must have existed universally in matter, before in that matter arose any particle of the positive attribute of heat whatever. In the first periods of the creation it must have enveloped, have torpified all. It must have rendered all that is perceptible a mass of unmixed solidity, impenetrability and cohesion. Only by degrees would there in space, with the arising of heat, by the melting and dissolution of some portion of this solid mass, have arisen some portion of partial fluidity, gaseousness and radiance—some open space, some void, some breathing-holes: and it even remains inconceivable how in such a solid mass any heat could penetrate and make its way, and produce these intervening vacua.

But in the beginning of time and space we can as little suppose any cold, any condensation and solidity, as any heat, any dissolution and fluidity, to have existed. The more we look around us the more we are convinced to the contrary; the more we are led to infer that in the beginning of space and time all was universal diffusion, looseness, absence of pressure, of resistance, of gravity, solidity and cohesion; that there was not yet that medium which produces the effects and feelings of cold, as there was not yet that other medium which produces the effects and feelings of heat; that only in certain portions of time less remote, and in certain portions of space more internal, through forces first radiant of gravitation, of electricity and of cold, other forces, first likewise radiant, were first condensed in gases, liquids and solids.

And to this very day, of space how many portions, even more inward and more partial, seem still to remain in a state of pure radiance, and destitute alike of positive cold and of positive heat.

Moreover, if cold were a mere negative attribute—if cold and the condensations it causes were the mere effects of the absence of heat, and of the dilatations by heat produced, it would only, as heat increased and extended, quietly and without bustle diminish and disappear, and leave the field to heat; and when that heat itself again in its turn retired, cold would again spontaneously resume its former possession but, like mere gravitation, leave substance, by the former heat distended, again quietly to collapse in incohering matter. It could not erect its crest in opposition to that of heat itself; present itself to heat as an equal in might; struggle with it for victory, dispute with it the ground, and at the same time with heat, in portions of space often very small and very numerous, situated next to and intermixed with those occupied by heat, possess its own beginning, growth, extent, duration, locality, limits, pressure, resistance, movements, radiations and other properties, as positive as those of heat itself; and yet different and distinct from, and often contrary to and conflicting with those of heat. Each could not in turns contend for mastery with the other: each could not in turns by superior power drive away from, or compress within it the other, so as to render that other for a time quiescent, without yet causing its annihilation.

Cold could not, if it were a mere negative attribute, a mere absence of heat, where it rose to that degree as to produce frost, and the congelation of substances, compress and condense that heat itself so much more than it did before, as to make a fire burn brighter during frost than it does during thaw. It could not in a body weakened by disease, and having within it little heat wherewith to resist the invasion of cold from without, penetrate so much more freely and copiously and deeply than it does in a body in health, and having more internal warmth to protect it, as in that weakened body to produce the cold fit of an ague, lasting while warmth remains within more compressed, and until that warmth, left torpid within, is by new additions of heat penetrating from without anew so reinforced, as again to dilate, in its turn to drive out the cold before it, and by its own renewed expansion to produce a copious perspiration.

Cold could not, instead of only suffering molecules of substance to collapse in an irregular and desultory way, by the peculiarities of a positive pressure of its own, drive these molecules forward, and compress those molecules that come from opposite sides together in such peculiar relative directions, as when in their tendency to each other meeting with obstructions from other bodies already solid, again to cause these other bodies to burst and to be driven asunder, in order to make way for them, and as themselves, when by that cold their meeting is effected, and their cohesion completed, to be enabled to resist other pressures and shocks from without very considerable, without being by these again separated.

It could not, after a lump of ice had been plunged in hot water, when by degrees from that water the heat in part penetrates within the ice so as to make it distend and liquesce, make the cold, instead of from the first in the ice entirely disappearing, cause it at first only to be driven to a greater distance and a wider circumference in the surrounding water, itself becoming less hot as the heat has more been left from that water without to penetrate the ice within; and thus, by only making that cold exchange places with that heat, make it form, round where the lump of ice melted, a new ring or zone of ice, less compact and dense than that former lump, before, by the subsequent melting of this zone itself, the cold was gradually suffered from the water entirely to escape in circumambient air.

Cold could not, by its own peculiar movements and pressures on substances, by that pressure condensed and congealed, produce those symmetric and beautiful arrangements of parts, not producible by the mere collapsion caused either by mere gravitation, or by melting of solids, which we already find in congelations by mere cold: those stars seen in snow-spangles, and those ramifications, those arborescences by hoar frost displayed in rind.

Above all, cold could not, instead of only leaving in the organs of sense the feel of heat diminished or annihilated, as would have been the case were cold only the mere diminution or cessation of heat, itself cause, even sometimes before the feel of heat has entirely subsided, and intermixed with that very feel of heat itself, a feel as positive as that of heat, but wholly different from it, and like that of heat, while in moderation pleasant, only when immoderate becoming irksome and painful.

Now all this, which cold, were it the mere negation or diminution of heat, could not effect, it does effect in direct opposition to heat.

Rays of cold and of heat may each be made so to radiate across the track of the other that neither rays shall be destroyed by their antagonists, but that while those of heat shall across those of cold dissolve ice into fluids, those of cold shall across those of heat congeal liquids into ice.

Often when in muggy weather the opposite radiations of heat and of cold from on high, alike penetrating our dense atmosphere with difficulty, are alike very weak and very diffused, we find in the air, mixed with little heat, little cold; and again, in an atmosphere most clear and sunshiny, and when from on high the radiations of heat reach the earth most copiously, we again feel rays of cold side by side and intermixed with rays of heat, both reach the earth so closely, that while those of heat drive the perspiration from the inside of the body, those of cold again, at the very exit of the fluids through the pores of the skin, and on the very threshold, arrest and condense these fluids into solids; and that, while rays of heat extract vapours from the ground, those of heat again congeal these vapours at the surface of the waters.

In India, we find ice skimmed from the surface of tanks in a temperature where in England such a thing would be unheard of.

When our body has from surrounding air imbibed a great quantity of cold in a way so gradual as to be, while it remains quiescent in the body, little felt, the sudden approach to a large fire, throwing out a great heat, may of that heat make the streams flow into the body so rapidly and copiously, as, by again setting in motion and driving out the former rays of cold as rapidly, at their exit to produce a chill, a shivering and a trepidation, not felt while that cold retained quiet and undisturbed possession of the body.

And every day we experience some other of those positive effects and sensations of cold, produced so very palpably in the very teeth of heat itself, as to prove that, like heat, cold is a positive attribute, having its beginning, increase, and limits independent of those of heat, but able to exist and to grow simultaneously with heat itself, and to have with that heat struggles, sometimes ending in victory, and at others in flight.

CHAPTER XIII.

The modification productive of the effects and sensations of cold not only is a peculiar modification as positive as that productive of the effects and sensations of heat; and a modification totally distinct from and contrary to the modification productive of heat, but is even in its earliest appearance and origin out of other prior conditions a modification anterior to and more general than the modification productive of heat itself.

In the former chapter I have shown that I consider the effects and the feel of cold as not proceeding from the mere absence of the attributes and effects of heat, but as proceeding from an attribute, a secondary cause as positive as that from which proceed the effects of heat themselves; from an attribute as independent of heat, as heat is independent of cold; from an attribute distinct and different from, and even contrary to that from which proceed the effects and feel of heat; from an attribute of which the increase at the same time with, though in places different from those occupied by that of heat, is compatible with that of heat itself; though, according as cold preponderates over, or is preponderated over by heat, from a peculiar spot it expel or be expelled by heat.

I shall now go a step farther: I shall show that I consider the effects and sensations of cold to proceed from an attribute which, in its first birth and existence, I regard as prior to the attribute whence arose the effects and sensations of heat.

I shall maintain that since time and space, the two first, most universal and most elementary of perceptible modifications, were first wholly destitute of cohesion, of solidity and of substance; since even of later forces the most universal—that of gravitation—was still at first wholly radiant and unconnected in its parts, before any of its portions were in their radiance stopped, fixed, and rendered cohering and solid: since only by a force of combination a part of these radiant elements and forces must, from that state of universal radiance, first have been reduced to a state of connexion, combination, cohesion and solidity, before it could, from that state of connexion, combination, cohesion and solidity, again have been restored to a state of decombination, dissolution, diffusion and radiance; and since of all forces of decombination and dissolution that of heat is the earliest and most universal, the action of heat, which decombines, must to a certain degree have been preceded by that of cold, which combines,—must only have succeeded that of cold.

And that this was the case not only induction shows, but experience confirms; for after we have, out of a substance, through means of an air-pump drawn, with all the air it could contain, all the heat it could harbour, we still find the cold, before in that substance by that heat counteracted and modified, now again remaining unmodified and uncontrolled, now also again over that substance exert an exclusive and uncontrolled sway.

At the same time I believe cold itself, like gravitation and like heat, in its primitive state, only yet to be, not only a mere radiance, but a mere force, which, after being itself from certain other radiations and forces first separated, can by these others again be made to grasp, and weave itself round, and compass, and compress and condense certain other radiant forces, and from their being radiant, moveable, yielding, and imponderable to us, render these more dense, and fixed, and resisting, and ponderable, and palpable, and visible; because I have never seen cold become intrinsically so condensed as to become directly, in itself, and independent of some substance on which it acted, palpable, ponderable, weighty or visible; because I have only found the substance itself on which cold acted to become thus gradually palpable, ponderable, weighty, and visible; and because even the sensation of cold only arises in the body, where in the same that cold meets, and condenses, and torpifies the peculiar fluid which flows in the nerves susceptible of that sensation.

CHAPTER XIV.

The modification productive of cold is not only a peculiar modification of a positive sort, prior to that productive of heat, but is the first modification produced by, and in which shows itself the force called of electricity.

I BELIEVE the radiant force called cold, which, when itself still comparatively weak, diffused and yielding, lets other radiations pass unarrested athwart its mass, and remain imponderable, impalpable, and fleeting, and when itself becoming more strong, dense and resisting, is able to arrest and condense certain of these other radiations, so as to render them ponderable and palpable, stationary, cohering and solid, to be the first and simplest modification or form assumed by electricity—to be electricity itself in its simplest shape; because, firstly, in those upper regions of space, the most roomy that intervene between different globes or worlds,—those in which electricity, from less interference of and remixture with other forces and substances even still radiant, like those of heat and light, only left to make through their expanse from globe to globe a hasty transit, itself still remains most pure, primitive and unalloyed,—cold still reigns most generally, constantly and powerfully; and in those lower regions where electricity finds substances on which to act, cold moreover acts on these substances most generally and permanently, —witness the snow there produced and thence unceasingly cast on the highest summits of the highest mountains; the hail thence often in the hottest regions of the globe in the hottest seasons of the year dropped on the lower plains; and the intense frost there at all times experienced by those whom a balloon carries thus high: because, secondly, even in the hottest regions of the earth, after we have out of a Leyden jar with the air also pumped all the heat contained in that air, we find the cold that still remains behind, accompanied and supported by the signs of an electricity more powerful and more uncontrolled than before; because, thirdly, only as we approach nearer the poles, where even at the surface of the earth more cold is collected, we see higher up in surrounding air more of those coruscations of electricity which thence are called aurora borealis and australis; and because, fourthly, where the opposite electricities, which we shall presently describe, are best balanced, and produce the atmosphere clearest, brightest and most elastic, there are found in that atmosphere, mixed with the rays of heat that pervade it, rays of cold more dense and copious; while, on the contrary, when by the preponderance of one of those opposite electricities over the other, they so lose their balance that they separate, and that the relaxing and decombining sort, productive of heat, lapses unmixed to the lower strata of the atmosphere, and there breaks out in lightning and rain, the bracing and combining sort, productive of cold, again ascends unmixed to the upper strata of the air, and there condenses the humidity it finds into sleet and hailstones; because, fifthly, where substances mineral, vegetable and animal show themselves to be from a state of radiance, gas and liquidity through cold combined into congelations, the movements, the radiations, the shootings, and dilatations, and contractions, and pulses, and vibrations, and crossings in different directions, to which during their transformation these substances show themselves liable, accuse the presence and the agency of electricity; and because, sixthly, when the operation of freezing is concluded, and the substances, before gaseous or liquid, become stationary, cohering, and solid, whether they be solidified, like mere aqueous vapours, in the mere spangles of snow, the mere cubes of hail, the mere ramifications of rind, and the mere sheets of ice, or whether, like substances more complex, they be congealed in forms more varied, mineral, vegetable or animal, they all alike show their component solid molecules intrinsically so shaped, and extrinsically so disposed relative to each other, and exhibiting such facettes and such angularity—such laminarity and such follicles—as evidently refer their formation and arrangement to the agency of that same radiant force of electricity. Nay, I believe all other combinations of substances, before radiant, gaseous or liquid, into cohering solids more complex, more late and more partial than those produced by mere rapid congelation—called combinations and forms mineral, vegetable and animal—still only to be produced by later developments and remodifications of the movements of that very same force of electricity of a combining sort, productive of cold and congelation, because these combinations later, more partial and more complex only differ from that of mere congelation in their degrees: because they are always, like mere congelations, while going forward, accompanied by a certain degree of cold, and, like those combinations by cold more evidently formed, when achieved, offer their more elementary and fundamental component forms still only consisting of those alternations of solid parietes and intervening voids, and producing that cellularity, which in its turn by further aggregation composes strata, laminæ or follicles, such as already in mere congelations arise from the mere movement of the electricity by which these congelations are produced.

Of electricity in its first and most elementary shape,—in that of the force productive of cold, of congelation, and of the sensations resulting from these effects and productions, I shall now show the immediate cause and parent in its turn to be certain modifications of mere gravitation.

CHAPTER XV.

I believe that directly out of certain modifications of gravitation arise the earliest modifications of electricity; namely, those which produce the force of cold, combination, and substance. I believe that sort of electricity which produces cold to be the connecting link between mere force and positive substance.

I CANNOT any where in time and space, outside gravitation, find a modification which is capable of being the secondary cause, or medium or material of that modification more partial which arises in time and space under the name of substance. And were gravitation, as it has been generally supposed, a force of attraction, first from within acting outwards, I could not even in gravitation itself find the connecting link between mere force and substance. I could not find in gravitation those modifications arising out of the former which produce the latter. I could not find in gravitation the qualities requisite to render it the parent of that force which in the present state of science we still only collectively call electricity: thus still making the same term of electricity apply to two forces wholly opposite to each other;—the one more pointedly called of cold, which first condenses forces into substances, and the other more peculiarly called of heat, which again, after forces have been condensed into substances, dilates and dissolves these substances into mere forces.

But as I have, I hope, proved gravitation to be a force of propulsion from without, I find in certain modifications of gravitation itself the materials of the earliest modifications of electricity; —of the link which, through the medium of electricity, connects gravitation with substance; —of the secondary cause or agent which in space, through gravitation, produces electricity and substance.

I believe within time and space, and within those earliest forces rising within mere time and space, which, whether they still only offer propulsion inward to a common centre, and thus near that centre still occasion a feel of pressure downward to the same, called weight or gravity, or whether they already, through recoil and propulsion outward from that centre, produce from the same a feel of pressure upward called of buoyancy and lightness, alike still may be called forces of gravitation, the force of electricity which produces the effects and sensations of cold to be the offspring most early and universal; because it seems after these modifications of mere time, space and gravitation, within the forces of gravitation to manifest itself first and most extensively, and to precede, and surround, and embrace the earliest modifications of substance still merely radiant, which afterwards become converted in the shape of the gases, liquids and solids, even the most primitive, general and simple, such as light, colours, and others, thus far in their uncombined state still imperceptible, and only by later combination first becoming perceptible: because all these substances seem only through the medium of electricity first after and within gravitation to arise; and because, after of the gravitation converging and centripetal falling perpendicularly on certain centres, certain portions had again by recoil been converted into rays of gravitation from those centres again diverging and rising vertically on high, when these portions of centrifugal gravitation, in their flight upward, again met with fresh gravitation from on high converging downwards, the portion of each sort, met by a portion of the other, would arrest and be arrested by that other, till by mutual pressure and counter pressure both became alike deflected in their course, and, from each separately moving in a straightforward line, the one ascending and the other descending, would both thenceforth be made jointly to move to the right and left in a lateral line, intermediate between and horizontal to the two former ones, and which, by the superior strength derived from this union of two before separate and opposite rays, would force its way across the neighbouring ones thus far still only separately ascending and descending; and because that force of electricity, productive of cold and condensation, which seems the most early and general of forces of electricity, possesses all the conditions arising out of these premises—out of this modification of gravitation,—inasmuch as it is a force no longer on this globe, like the earlier and simpler modifications of mere gravitation, only yet moving downwards and upwards, and only directly presenting a strong pressure in these two opposite vertical directions, and not yet presenting any pressure in a lateral and horizontal direction, but is a force which across the opposite pressures of gravitation, descending and ascending themselves, strikes and drives objects forward sideways and in a lateral direction; and often by its superior strength conquers the mere pressure of gravitation from above and from underneath; and as moreover it is a force, no longer, like the earlier and simpler modifications of mere gravitation, only from vast surrounding circumferences moving forward to vast common centres, but, on the contrary, a force from an infinite number of smaller points in space beginning separately to spread outward,—a thing which that electricity, as arising at the same time in points of contact between rays of gravitation converging and diverging very numerous, would naturally be supposed to do; and as in fact forces of gravitation descending and ascending in a mode very forcible and very complex, and where there arise between them points of contact and mutual resistance very complex and very diversified, actually themselves already produce effects partaking of the nature of those of electricity, as we see in the heat and light which arise out of rotatory motions very rapid.

CHAPTER XVI.

In what respect do, from mere forces, such as gravitation centripetal and centrifugal, and electricity combining and decombining, otherwise called cold and heat, again differ what are called substances.

In general people thus far seem to consider substances as intrinsically wholly distinct from mere forces; nay, as earlier than forces; as the very womb out of which alone forces can first arise,—as the matrix from which alone forces can first come forth.

This idea seems to me to arise from people not sufficiently analysing the nature of force and of substance unto their very first origin,—from their only being struck with the attributes more late and complex which force assumes, after it again later issues forth from substances in a shape more condensed, more distinct and more palpable; and of their not yet being impressed with those conditions still more vague, less definite, which it already possesses, before it has, through the medium of these conditions, round certain lesser portions of itself first wove and compressed that very substance, through which those portions of force are again transmitted and made to issue forth beyond it, in that shape more condensed, more complex, more distinct and more palpable, which they there assume.

But we have already, I think, seen that, as well as of mere time and space, so likewise of force and of movement the modifications most early and extensive, those called of gravitation, already seem first to arise directly out of the bosom of what is, or what to us still appears, the yet imperceptible first cause of all the attributes which we can perceive; and that, in its first and simplest perceptible state, force thus as yet intrinsically presents to us no conditions which should prevent its being one of the prior secondary causes or media of the attributes of substance, instead of only being a later and more partial effect of substance. We have seen that later than and within this modification of force called gravitation; and not only later than and withinside gravitation alone, but even after and withinside the modifications of electricity the most early and extensive, already again later and more internal,—those productive of cold, condensation, and congelation,—first appear to have arisen the attributes of elements gaseous, liquid and solid constituting substance, on which those forces of gravitation and of electricity, after first composing them, again acted, and through the medium of which they first in part again acquired a shape and direction more compressed, distinct and palpable.

What in fact is substance? It is that modification of matter later, more partial and more internal only than portions of mere time, space, and the forces of gravitation and of electricity, from which we again receive, in addition to the sensations we receive from these former conditions only, other sensations of fixity, stationaryness, resistance and pressure more definite, more lasting than those which we receive from time, and space, and gravitation, and even electricity, while they still only act unenveloped in and unmodified by attributes of substance.

Examine every thing pointedly called a substance, and it will be found to derive its name of substance only from its being capable of giving, in addition to certain sensations of time and space, and weight or buoyancy, and cold or heat, certain sensations of fixity, of cohesion, of form more distinct and permanent, of resistance to pressure, of pressure on surrounding space condensed in a smaller compass, and consequently, of condensation in the same compass greater than any that can arise from mere unsubstantial force.

But these sensations of substance themselves arise insensibly and gradually out of the sensations of mere unsubstantial force. Substance only presents itself as an attribute of which the most elementary component conditions consist of portions of time, space, force and movement, and which, if rendered more fixed, more stationary, more resisting displacement from each other than those of mere radiance, still begin in mere radiance, and only derive the conditions in which they again differ from mere radiance, in the radiance which from one side advances being by another radiance from the opposite side advancing, pressed, condensed, arrested, fixed, rendered stationary, and made to cohere with that former; made less liable than that former singly is to yield to pressure even in directions opposite to those from which came their first pressure and arrestation; more capable of, in its turn, making other surrounding points of space yield to its own force and penetration; and more consequently become, what is no longer called merely radiant, but gaseous, liquid, and solid,—what is deemed to possess the full conditions of substance.

And that these sensations of the peculiar conditions of substance, and these peculiar intrinsic conditions of substance themselves from which these sensations arise, at least in part more remotely proceed from modifications of gravitation, after these modifications of gravitation have by mutual resistance, pressure and condensation produced the first modifications of electricity,—namely, those modifications of electricity productive of cold and combination,—and arise more proximately and immediately out of those later modifications of electricity itself, appears, since that electricity, by conflicting gravitation first produced, would in its turn, when its rays from opposite sides advancing caused fresh rays of gravitation, still going on converging till by each other met and arrested, to be between them caught and compressed, cause these rays from the opposite pressure upon them to derive that increasing condensation, and slowness, and arrestation, and fixity, and cohesion, which from mere radiance distinguishes what are more positively called substances, whether still only gaseous, or already in a greater degree liquid or solid.

Thus it appears that of the opposite forces of gravitation centripetal and centrifugal portions more restricted, internal, and partial, jointly converted into the conditions of electricity combining and productive of cold, through the medium of these intervening attributes of cold again convert other still later portions of the forces of gravitation centripetal and centrifugal, into the aggregates or masses still more condensed and fixed that occasion the feel of substance; and that electricity of a combining sort and productive of cold, is the more immediate secondary cause and agent, through the medium of which, within modifications more early and extensive of time and space and force and movement, by certain portions of these prior conditions, is produced what we call substance.

And that electricity of a condensing sort, and productive of cold, though in itself at first only a mere force—and of a radiant description—is the more proximate parent of all positive substance, appears, since all the sensations which we generally derive in a more definite and palpable shape from positive substances, we already in a certain degree receive from the mere radiating force of electricity, where this force is from peculiar circumstances more than usually condensed and confined.

Mere radiant electricity already, when greatly accumulated, gives to the sense of touch not only feels of pressure, of weight, of penetration, and of buoyancy, more distinct and forcible than those which mere gravitation gives while still unassisted by posisive substance; but, moreover, gives sensations of cold, and, when differently directed, as we shall see, of heat, which gravitation, in its more primitive modifications, gives not yet in any degree: it already to the sense of taste gives certain sensations of flavour alkalescent and acid; to the sense of smell certain sensations of odours sulfurous and others; to the sense of hearing certain sensations of sounds, either continuous or crackling; and to the sense of sight certain sensations of light and of colours—such as high in the heavens above, near the poles, in cold weather and at night are seen in those coruscations, those vibrations, those pulses of light and colour, called aurora borealis and australis; and nearer the earth are beheld in the shape of lightning, shooting stars, and other meteors descending and ascending; and even in a room darkened on purpose are, in electric experiments, witnessed in the form of sparks and streams of light and colours the most vivid; even where there are not any previous positive substances, through the medium of which these phenomena or feelings can be produced in a shape more permanent and lasting.

The force of heat is, as we shall later more explicitly show, a force of electricity still radiant, of which the very beginning—though arising later than the first beginning of that of cold—still out of the radiance producing cold, by the recoil and the contrary direction given to certain portions of that radiance of cold, arises in its incipient degrees almost immediately after the radiation of cold itself has arisen out of that of mere gravitation.

But, as only after cold has by increase produced combinations very forcible, and has, through these combinations produced by it, itself become to us very perceptible, the later decombinations again produced by heat can themselves also become very perceptible, I shall first describe those combinations that on this globe are the effects of the first electric force—

that of cold; and only next describe the decombinations that out of the secondary form of electricity, called that of heat, again in their turn arise, and counteract the effects of the former; not minding that in reality already from some of the more incipient modifications of cold arise some of the incipient degrees of heat, long before of cold combinations later and more complex give opportunities for decombinations by heat more late and complex, more distinctly by us in themselves or in their effects becoming perceptible.

CHAPTER XVII.

Like those modifications that intrinsically to the last remain mere radiant forces, all those other modifications that, by degrees, become more stationary and cohering substances and bodies, gaseous, liquid, and solid, begin by being mere radiant forces; and it is through the medium of the radiant forces of electricity, producing cold, condensation and combination—itself the later offspring of gravitation—that the materials of bodies first supplied by that same gravitation, and themselves merely radiant, are by degrees combined into the later substances more condensed, stationary and cohering, gaseous, liquid, and solid.

People that deal in natural history generally begin by describing objects mineral, vegetable, and animal, in their solid form.

This perhaps may be a method sufficient for the purposes they have in view, but it is not sufficient to give of the origin of these objects a very extended knowledge. It is contenting oneself with only describing, in their last and concluding state and modifications, things which have many other prior and more elementary forms, on which these last are only subsequently superstructed, instead of beginning by describing these things in the more elementary forms, which are the necessary foundations and preliminaries on which their later shapes are raised. It even leads to the egregious error of considering solids as being in entities the bases and support of their fluids; and of considering particularly, in entities of an organized and living sort, the vessels as the first parts destined to be the receptacles and conductors of those saps, out of the prior composition and course of which, wholly independent of vessels, the very composition and course of these vessels themselves on the contrary first arose.

The fact is, as we shall show, that throughout nature the solids are, in their peculiar direction, form and cohesion, only later and more partial effects of the combination and condensation of liquids and fluids arising prior to them; and that these liquids and fluids again are the later effects only of still prior radiances—as we may partly see in a seed or an egg, in which all the parts are liquid or fluid, before any of them become solid and cohering.

Having already in the preceding chapter shown that mere radiances may be combined into substances more stationary and cohering, gaseous, liquid and solid, we shall now show that all substances, gaseous, liquid and solid whatever, without any exception, must have begun in mere radiance.

This assertion may, on the first glance of it, appear bold.

What!—will it be said—maintain that, like the modifications which still surround the most distant outskirts of our atmosphere, the materials of the most early and internal and dense and weighty nuclei of our globe—the metals and rocks which, during ages unnumbered have formed its hard, heavy, fixed and motionless core, —have once been pure radiance, capable of traversing in the shortest periods of time, with the greatest rapidity, the farthest regions of space; of spreading in the twinkling of an eye from one extremity of the hemisphere to the other, without being able to resist the slightest touch of organs like our present ones, or of making on such organs the smallest impression of weight, density, ponderability, palpability and penetration, at all perceptible?

This has in it a something at first sight truly startling.

For even admitting that the numerous productions, not only organic and living, but even lifeless and inorganic which every day still, from beginnings imperceptible to our senses, gradually arise in the atmosphere, at the surface and in the recesses of our globe, and grow and become more and more perceptible, the materials may at first in part have from higher and more distant regions been driven to our atmosphere —a thing which no person of the least observation can doubt, in as far as, on the one hand, these entities on first combining from above gradually increase, and grow, and acquire palpability and ponderability and weight and substance, in greater proportions than the earth underneath loses these; and, as on the other hand, these entities again in decombining lose more of these conditions than again reverts to the body of the earth underneath; and thus must of these conditions first receive and next return to the regions above a great proportion in the shape of mere imperceptible radiance—still is it plain that of most of the latest and most superficial creations and substances some portion proceeds from and again returns to the earth underneath, and must for ages without number have lain deposited in the bosom of that earth, out of all reach of surrounding radiance.

But millions of centuries are of little moment in the formation and changes of the universe; in the manufacture of the globes that fill its vastness.

We are forced to admit that even those substances, those modifications most hard, heavy, and cohering, which we can bring up from the deepest recesses of the earth accessible to us, are all, unto the furthest and innermost, able again to decombine, till by decombination they lose whatever rendered them solid substances; and, in thus decombining, all again resolve themselves in mere imponderable, impalpable, unfixed radiance; and therefore—unless we suppose that of the body of this globe the substances at the beginning of time and at the outermost boundaries of space were very different from what they became since —a supposition scarcely admissible, scarcely analogous to the gradual progress of all we perceive —we must also suppose that of these substances every part began by being what we call radiant, and what we often still find to be, to senses like our present ones, wholly imperceptible; we must suppose that all globes which now have solid nuclei, at some earlier period only were composed of mere matter wholly gaseous, like those nebulæ which still appear in distant parts of the heavens, and of which some already appear to contain the kernels of more solid incipient worlds; and at some period still more remote were formed only out of mere aggregates of radiance somewhat more condensed than what pervades the sky in general, by being first by gravitation of a centripetal sort driven to certain of its foci; and were round these foci, by the later offspring of gravitation called electricity of a condensing and combining sort more pointedly denominated cold, so collected and concentrated, as there to acquire a, to us, more sensible ponderability, palpability, and cohesion.

We must suppose that every particle of solid substance of every globe, however near its centre, however distant from its circumference, however remote from all radiance—from light, from colours, from cold, from heat and others—however quiescent, torpid and unchanging it now may be, first arose out of, and for some time continued to remain exposed to, further radiance; and that only after later supervening radiances had over the prior radiances in which began solid bodies, superstructed new and more external solid strata, these former ones began to be by the stoppage of further influxes of light and heat &c. from without, doomed to that unceasing obscurity, and immutability and torpor, into which the interior of our globe has since lapsed and remained.

In fact, how constantly do we not, to this very day, under our very eye, still on all sides from the most distant surrounding realms of space, where their excessive tenuity and diffusion does not yet allow our senses to discern the radiances which our mind tells us must there already in every sense and direction cross each other, find rays of gravitation, electricity, light, colours, cold and heat, as they approach nearer to our earth, by becoming more condensed, already, even in their still radiant state, also in some degree become more capable of impressing our senses with sensations of ponderability, or palpability, or pressure, or penetration, or visibility; and by degrees assume the shape more compact, more definite and more durable of gas, of vapours, of fluids, of liquids, and of solids—of atmospheric air, of clouds, of hail, of snow, and of ice.

And though from the regions of pure radiance, and from the gaseous atmosphere within it, such substances liquid and solid as mere water and ice, formed out of the combination of elements more simple, are seen in the shape of rain, hail, sleet, snow, and the like, to fall more copiously and constantly than other substances liquid and solid even still only mineral, but formed of elements more multifarious and complex, how often are not iron, silex, salts, chrome, nickel, alumina, lime and other mineral substances themselves, first so diffused as not to have gravity sufficient to overcome the resistance and to divide the density of the more general gases of the atmosphere, by degrees through electricity made in air to agglomerate in substances and solid bodies so dense and weighty as to fall to the earth in the shape of atmospheric stones,—and as then to present, with the weight of lead, the hardness of diamond and the cohesion of hair and wool.

Nay, though, whether this arise from their being formed in space less generally than the materials of the substances thus far named, or from their being more diverted than in former periods they were from their propulsion to this third or fourth rate globe, we actually, of those substances oily, fatty, gelatinous and others, more necessary to the composition of bodies organic and living vegetable and animal, detect less on its actual road from the sky and the atmosphere downward to the surface of our earth, how often do we not, even of these latter sort of substances still at the surface of the globe discover enough, lying in its crude uncombined state, to infer that the whole of that which now contributes to the composition of its vegetables and animals originally came to it from higher regions in a radiant state.

In the beds of the clearest brooks, when long exposed to the influx of electricity, light, colours, and other radiances from on high, are still made to appear,—assuredly not as having come from underneath,—sediments of a mucous nature sufficient to make the very pebbles become slippery. At the bottom of the clearest vessels, long exposed to similar radiant influxes,—even at the surface of the brightest panes of glass long left unwiped in the face of day,—are seen to accumulate deposits which gradually grow into positive microscopic vegetables and animals. Some vegetables indeed, like the air-plant of China, without ever wanting any further contact with the solid substances of the earth than is merely necessary to support their weight, from mere air have their solid limbs daily grow and increase, till they at last attain a considerable size; nay, after certain gaseous elements of the atmosphere, first balancing and supporting each other, so as to let through the radiant light and to be left transparent, have by some subsequent disproportion experienced those partial collapsions and accumulations called a blight, which cause them to become opaque and visible to the eye, the air itself becomes for miles suddenly filled with myriads of animalcules, unseen before, and unproduced by parents of the same sort, which must, out of certain of these elements, first radiant and next gaseous, liquid and solid, collapsing and condensing, suddenly and spontaneously have been formed and combined.

It cannot be denied that there is no substance so hard, so dense, so fixed, so solid, so cohering, so difficult to penetrate, to change and to dissolve, which cannot, by the agency of certain forces, be by degrees released from the cohesion, the combination, the solidity of its component parts, and made to return to a full state of liquidity, fluidity, vapour, gas, and ultimately radiance; and consequently, since all things created and perceptible seem to have begun by being in a state more diffused and more simple, before they became more condensed and combined, we must also believe that they first floated in space in that state of radiance and absence of combination to which they are again able subsequently to return.

Substances must, even in that state of radiance in which gravitation does not yet from one side press on them sufficiently to make them on the other side offer to our senses a perceptible weight, already have a degree of diffusion or condensation greater or smaller. Nay, those substances which afterwards in their shape no longer of radiance, but of greater fixity, offer to our senses effects and impressions different from those offered by other substances, must already intrinsically, even in their earlier radiant state, and before these differences can yet be perceived by us, possess the seeds of them.

And that all those substances which afterwards become more stationary, more palpable, more ponderable, more cohering, more resisting and more pressing, in their radiant state already did possess such differences from each other as afterwards became more distinctly perceptible to such sense as ours, is a circumstance which may from those substances that even in that radiant state, when sufficiently condensed, become occasionally perceptible, be collected: rays of mere light and of different colours,—whether they be composed in part of different condensations of rays of gravitation, effected through different actions of the force of electricity upon them, as I suppose to be the case, since I see them preceded and surrounded by such rays of electricity, and by nothing else perceptible more early and general to which I can assign this effect; or whether they be composed entirely of some other modifications still unknown to us,—already each in their radiant state generically offering an intrinsic degree of dilatability and contractibility,—a polarity, a pressure, a leaning, and a quantity of cold and of heat, different from others.

Were our senses sufficiently fine to perceive unto the most distant circumference of space, the most incipient beginnings of all the forces and movements, combinations and decombinations, of which the later and nearer results, in the shape of entities, events, substances, and bodies more condensed and stationary, alone are as yet perceptible to our grosser organs of perception, what an extent, number, complexity and diversity of cords, and pullies, beginning in the largest collective masses and ending in the finest distinct filaments—what an apparatus, what a bustle, taking its origin from the very commencement of duration and from outermost outskirts of extension—should we behold, pervading every portion of time and of space at present still to our dim eyes a complete void, and, like concentric ropes, in uninterrupted continuation tending to the most distant future points of that time, and the innermost future recesses of that space; and from time and space past, present, and future, again by recoil made to travel outward in every sense and direction! How at every point in time and space these connecting forces would be seen to cross each other; to precede, to surround, to weave, to form and to increase millions of globes; to arrest, to suspend and to move them, and on each of them again to produce millions of entities and modifications mineral, vegetable, and animal, radiant, gaseous and solid, more minute and more finished! How filled would appear every smallest portion of that time and space, in which we only at present at distant intervals and in small spaces behold floating a few comparatively rare aggregates of perceptible substances and bodies, separately wandering in the tenantless surrounding regions!

Let us hope that some day or other, in a globe more central and more perfect than this, and, from that situation more central, itself endowing us with organs of sense more fine and better situated, this glorious spectacle, at present withheld from our sight, will display itself to our astonished eyes, and in the contemplation of it furnish us with means of never-ending enjoyment and felicity.

I shall now, in as far as I can perceive them, describe the various lesser and later modifications which out of the materials, by certain portions of the radiant forces of gravitation first supplied, and by certain of the forces of electricity, out of certain of these very forces of gravitation themselves arising next again remodified, gradually proceed; and from the state of mere radiant forces gradually pass over into that of different more solid substances—beginning with the most early and general of these modifications perceptible by us.

CHAPTER XVIII.

Of the modifications by electricity of a combining sort, first, I believe, out of a portion of the rays of gravitation formed, and by degrees from the state of mere radiant forces condensed into that of substances, the sort most early and general and elementary seems to be that called light.

Electricity of a combining sort seems itself, within that gravitation whence it first originated, to have of portions of that very gravitation itself formed the first cradle of more solid substances and bodies, before in this cradle were deposited the materials and were woven the forms even of light, after mere electricity that first immediate element of all bodies more connected, distinct and solid, from the largest of heavenly globes itself, to the smallest that on this earthly mass again subsequently springs forth; since at first of these bodies even light itself seems to impede the formation and growth: since at first they seem to shun the garish eye of day: since their first developement seems only to take place in darkness; though soon the more substantial food of light becomes requisite for their further extension and consolidation.

While and where light existed not yet, time and space, gravitation and electricity, and whatever else of modifications created might already exist, and even exist perceptibly to certain senses such as ours, could still only exist in total darkness,—this word expressing only the absence of light.

People have frequently thought light to be immediately connected with heat—but it is not so. Light is neither the offspring, the necessary companion, nor the parent of heat. It has with heat no direct nor indispensable connexion. Metals often give out intense heat, while they give out no light whatever. Snow and other phosphorescent substances often give out intense light without any symptoms of heat. On the contrary cold is often accompanied, as in aurora borealis and australis, by sensible light: but, because the electricity of a decombining sort which produces the feel of heat, or the bodies and substances combined by cold, on dissolving, let out with the cold that combined them, the light that was incorporated in them; and occasion this light, before fixed and dormant, again to disengage itself, to move, to distend and to strike the eye, the sensation of heat and that of the light it disengages are often so closely allied, as to have caused the supposition of there being between them a closer connexion—the supposition of light deriving directly from heat itself.

We have already seen that in reality light seems in part from gravitation, from which are derived its materials, and in part from electricity of a combining sort, from which are derived its form and visibility, to take its origin : since mere electricity in aurora borealis and australis, in sheet and other lightning, in natural meteors and in artificial electric experiments produces light, even where solar light cannot penetrate; and where light, already incorporated in solid substances of the earth, is not again emitted: since the very light by the sun itself, our great luminary, and by the other fixed stars and planets emitted, seem the later effects only of the materials of that light, first by these bodies from surrounding space in a shape less perceptible, and not yet lighting up their darkness, imbibed; and which materials thus can only be supposed to have proceeded from combining electricity itself.

Probably after gravitation converging and centripetal had first formed those distinct foci, the cradles and seats of future worlds; and had on its return outward from these seats in a centrifugal direction, with fresh gravitation centripetal, in the vast surrounding regions of space formed the stores of electricity—the first materials of light,—further gravitation of a converging sort hying to these foci, of this electricity and this light thus far diffused in an imperceptible state in the regions of space, from all sides drove portions to and compressed them round these foci in those denser masses which first lit up these sites of future globes, rendered them visible, and, when from these again emanating outward, caused them to become perceptible to distant beholders, as soon as any such beholders arose to contemplate them.

Of these foci of gravitation and seats of future globes, the earliest and largest first received all the materials of the light which first kindled them up, from surrounding electricity, in a state so diffused as to remain to us invisible: and thus received in a covert and a concealed manner that which, in them more becoming condensed, was again subsequently on all sides issued forth from their precincts in a way more open and undisguised; because this mode of these foci being constantly by surrounding electricity, as constantly from surrounding gravitation and from the first cause of that gravitation, emanating, supplied with light, is the only way to account for their constantly letting out light, without being by that constant emanation wasted or consumed; and yet, without being with the materials necessary for its formation, kept as constantly supplied in a perceptible, open and avowed way.

Thus however these primary globes obtained the credit of shining with a light of their own, not derived from any thing else anterior to itself, and outside itself in time or space:—as if such a circumstance could, conformably with analogy, within the limits and short of the most external yet unknown cause of time and space, and of whatever other modifications are from this unknown source poured into these limits, be supposed to exist.

The seats and foci of the converging gravitation of a mere secondary sort, subsequently out of the recoil of the more primary gravitation, again diverging outward in part, formed, would likewise from general gravitation and electricity receive and again radiate outward some light; and in fact in the moon we observe a strong phosphorescence: but they would comparatively remain immersed in obscurity, until from more primary globes, with the gravitation radiated outwards, was also radiated outward, and at second hand driven to these secondary foci, more of the light already in these primary foci more condensed and rendered more capable of impressing the sense. These latter foci thus received light from a twofold source, first from general surrounding electricity, and next, from the central body of their system, and while this body has been called a sun, or, most erroneously, a fixed star, the others have been called planets, satellites, comets, &c.

When from those heavenly bodies in which the light, originating in surrounding electricity, first acquires a more permanently visible shape, that light again radiates outward, it again by degrees, as when first it was out of electricity formed, becomes so diffused and so rarified as by the rapidity of its motion to elude and baffle all attempts to fix it; to prevent its making on senses, still so obtuse as ours, any impressions, and again to leave surrounding space and objects in utter darkness. Only the distant stars, from which this light first departs in a more condensed state, appear athwart the general surrounding obscurity to twinkle like diamond spangles studded on a dark veil.

When, again approaching and made from different sides to be deflected toward, and to converge and condense round later secondary centres of gravitation, these rays of light again become anew more condensed, they also again become anew more capable of immediately impressing the eye.

When afterwards round these foci of secondary gravitation prior light more condensed, had formed an atmosphere more substantial and more cohering, itself made to follow the movements by gravitation impressed on these foci themselves, this atmosphere would by its resistance and movement, in the fresh rays of light by distant bodies cast upon it, cause a curve: and these rays of light being the only medium through means of which the distant bodies from which it came could make an impression on the eye, this curve would cause the impression of celestial objects not to appear to us in a line straight with that of their real situation in the heavens, but in a line so deviating from that former one as to make them appear to rise above our horizon before they really did.

Light, in the first and simplest and most diffused state in which it springs forth from mere electricity, and becomes perceptible to our sense, seems still only to possess the conditions of a more radiating force, a little more complex only than that of mere gravitation and mere electricity themselves, whence it proceeds.

It has velocity of motion, straightness of direction, continuity of form. It has elasticity, dilatability and contractility to a prodigious degree. It offers, according to the direction in which it is propelled, convergence towards or divergence from other rays. It is liable to be by other portions of the same or of other forces and substances, themselves still only radiant or already more solid, when meeting it in a straight line, resisted, arrested and made to accumulate; and when meeting it at an angle, liable to be divided, deflected, let through obliquely, refracted, or reflected and made to retrograde. When alternately made to cross or to be crossed by the rays of another force or substance, it displays pulses or alternate periods of advancement and of arrestation; and finally it may by other forces and substances be so arrested, accumulated, compressed and condensed, as from being very rapid in its motions and very rarified in its quantity, to become very dense, fixed and stationary; from being in small quantities diffused over a wide extent, to become in large quantities compressed in a small space; from yielding to the smallest pressure, to become capable of resisting a pressure very great; as by degrees from radiant to become gaseous, liquid and solid; and from only, while in its radiant state able to strike the finer organs of sight, in its later state of greater compression, condensation, arrestation, combination and incorporation in different species of gases, liquids and solids, by its greater resistance, pressure, weight, ponderability, and palpability, also to be able to impress with its dimensions, form and movements, the coarser sense of feel more distinctly.

After gravitation and electricity of a combining sort, the prior parents of light, light itself appears in its turn, either still imperceptibly or already perceptibly, one of the chief component elements of most other substances radiant, gaseous, liquid and solid, mineral, vegetable, and animal, merely vital, sensitive, or moreover intellectual, in as far as most of these substances, again later and more partial than mere light, in their earliest and most general state even only of mere radiance imperceptible or already perceptible, such as that of different mere colours;—and thenceforward in whatever other shape and under whatever other denomination again more late and partial of gases, such as of oxygen, hydrogen, nitrogen, carbon and others; or of minerals, such as sulphur, metals, alkalis, acids, earths and others, or of a vegetable description, such as albumen, gelatine, or others, or of an animal sort, such as lymph or chyle or blood, or bile, or nervous fluid, or others—they again appear, already seem in part composed of the earlier elements of light, and of later particles of light itself; and when, whether by gradual exhalation and evaporation, or by more sudden and entire detonation or explosion, or by effervescence, or slow combustion, or putrefaction, or otherwise, from a more solid state they are again decombined and made to return to a state of radiance, again emit, next to mere gravitation and electricity of a combining sort, portions of light first combined in their substance in a way less or more perceptible:—certain bodies like the moon, the aurora borealis and australis, sheet and other lightning, certain clouds, vapours, water, minerals, vegetables and animals,—snow, sulphate of barytes, bologna stone, oyster shells, fire flies, glow worms, and other entities, called phosphorescent, already again visibly letting out part of the light combined in them, even previous to and without general decombination; and inasmuch as when in their formation and composition and growth substances have not of light received a sufficient quantity, they attain not that perfection to which their genus seems to entitle them, and remain in their texture more loose, lax, feeble, inelastic, pale and deficient in form and faculties than they ought by their nature to be.

The places and modifications in which directly from electricity arises light, such as those occupied by fixed stars, by suns and by lightning, are called self-luminous. Those whence, after light has in them in a mode still imperceptible or already perceptible to us, penetrated, it again spontaneously and without effort or general decombination, in part visibly again issues, are called phosphorescent. The bodies which after having let light in at one side, suffer it to pass entirely through, so as again to be let out at the other, are called transparent; and when their solid component parts, and the intervening interstices, are so disposed as to cause the rays of light in their way athwart them to be from their straightforward direction deflected, and only to go out at an angle from their prior entrance, they are called refracting. Bodies in which the light from one side falling on them remains engulphed and buried, so as not to pass through them, and again to issue at the side opposite to that at which it entered, are called opaque. While bodies of a transparent sort give through the medium of light no impression of themselves, because the light from more distant quarters reaching them, passes entirely through, bodies that entirely absorb, engulph, and render quiescent in them the light they receive, also send not of their existence through any intervening medium an impression to the eye. They leave surrounding space in darkness, but this darkness caused, not by their receiving no light, but by their concealing the light which they receive, is called blackness.

Other objects cause the light falling upon them to be from their surface again reflected backwards, and they then give the eye on which that light falls, through its medium, an impression of their existence.

The rays of light reflected by an object in consequence of the lesser or greater distance to which they travel before they reach the eye, cause, by their less or greater concentration, the impression of that object before it reaches that eye to occupy in the same a smaller space compared with that of the object itself by which the rays are reflected: nay if these rays, in their journey from the object from which they are reflected, are again deflected before they reach the eye, they will in that eye present the image of that object in a place different from that which in reality it occupies.

From the way in which substances are solidified, most of them, in solidifying, become so porous, and acquire between their solid parts intervening interstices so numerous and wide, that while only forming thin plates, they let through all the later light that falls upon them, and by not stopping any part thereof on either side, themselves still remain invisible to the eye; even where they already with their powers of resistance and pressure affect the sense of feel. Some of these substances, like crystal and glass, from the regularity of their pores, even remain transparent in large masses, except when by friction or otherwise the regularity of their pores and interstices is so disturbed as to stop the transit of the light; when they become opaque.

Other substances which in thin plates are transparent, in thicker bodies spontaneously arrest the light and become opaque: and though of gases, less closely knit together than cohering solids, a greater number still remain transparent, even of gases a few, whose interstices fit not regularly on to each other, already become less or more opaque.

Substances which, like most stuffs and like paper, from the irregular form of their wider interstices, already of the light admitted in them bewilder and arrest so great a quantity, and let so little pass through them, as to become in part opaque, often, where their density is increased, but by such a new substance as, like wax, water or oil, through its more uniform interstices to make the light pass more regularly, have through that more regular transmission of the light, a greater transparency again given them.

It is by certain substances having interstices and parietes so disposed that, instead of receiving and transmitting the light equally in all directions, they in some directions transmit, and cast the light forth falling upon them more powerfully than they do in others, that they shew what is called polarization of light; but it is evident that this circumstance depends not so much and so primarily on the primitive nature of the light itself, in its radiant state, as on the form of the molecules of the peculiar substance, already solidified, on which this light happens to fall.

Where from objects self-luminous, or reflecting light, that light falls on other objects opaque, so dense and smooth that, like mercury, they retain and absorb none of its rays, but, again, at second hand reflect the whole of them to the eye so completely as to give that eye circuitously an impression of the visible form and movements of the object whence it first departed, that light, thus at second hand and circuitously propelled to the eye, depicts on the organ the image of the first object whence it departed alone; and the intervening substances or media which reflect it, themselves imperceptible, are only called specula or mirrors.

Objects which, while externally offering a surface rough and uneven, of the rays of light falling upon them bewilder a great many, cause the few they reflect to the eye to make little impression on that organ, and to appear faint and vague. When of these objects the surface is, by polishing away a part, or by filling in the interstices between the molecules with varnish, rendered more even and smooth, it renders, by reflecting the rays of light more evenly and closely, the impression on the eye more vivid and distinct; as cabinet-makers and picture-cleaners know: but sometimes these latter persons overshoot the mark. They give their pictures so high a polish, that none of the rays of light falling upon the surface of these objects take any hold on or penetrate them at all; that all are so immediately reflected as to transmit no impressions of their internal modifications, and only to render them specular and capable of transmitting circuitously and at second hand the images, first from some more distant objects falling on themselves.

Mere light, divested of the admixture of colours, only makes on the eye an impression of whiteness. The light emanated or reflected from the moon is white; that emanated from the sun, coming from that body mixed with rays of various colours, no longer is a pure white.

Different stars and planets, probably from the different way in which electricity combines in or acts upon them, emit their light mixed with different colours.

The light coming directly from electricity, or from the first laboratories to which electricity naturally imparts that light, and from which it is again naturally and spontaneously let out, is called natural light: all such light as is by man from substances intentionally through decombination again extracted is called artificial light. Such is that given by a lamp and candle when ignited.

If the light coming directly from the sun is supposed to have powers which the light drawn by combustion from earthly objects has not: if the former seems to give flowers a hue, an odour, —fruits a maturity and savour,—vegetables and animals a brilliancy, and human faces a vividness of complexion and a vivacity of expression which the latter sort of light imparts not to these, this probably arises less from any difference in the nature of the light itself, than from the light which comes straight from the sun, coming accompanied by a great many other species of elements and substances, in their radiant state not yet distinctly perceptible, which are by different earthly bodies again separated from that light, and absorbed; and of which the light embodied in a coal fire, a lamp fed with train oil, or a tallow candle, is consequently already divested, before it enters these bodies and substances.

Of light a certain quantity seems directly to be from electricity supplied not only to suns and stars of the first order, but, though less copiously, in some degree also to planets and satellites. These latter, however, receiving less light all round directly from electricity, are more dependant on what they receive at second hand ready formed from their sun: but when these bodies become opaque, the latter species of light can only fall on one side of them at a time, and can only fall successively on opposite sides as these are successively turned towards that sun.

While from some bodies a slight pressure suffices to cause the light absorbed by them again in part to issue, from other bodies, the strongest and most accumulated decombining force alone can again drive out that light, and reduce them to a state of combustion.

Light, when from the shape of radiance it is sufficiently arrested and condensed in the shape of gas to become endowed with a peculiar more distinct and more permanent form, is called flame; but when from a state of mere radiance light is first condensed, it does seldom remain long enough in the closer transient state of mere gas, to become in that state perceptible in the shape of flame, before it assumes a shape still more cohering, liquid or solid. It is only when, after having been condensed in other bodies gaseous, liquid or solid more complex, it is again by decombination of such bodies let out in little time and space in great quantities, that, nearer to these bodies it preserves its gaseous state of flame in greater quantities long enough to be distinctly visible, before at a greater distance from these bodies it again is more entirely unravelled and made to return to a state of mere radiance, in which it again diffuses itself through space more rapidly and imperceptibly, and only again shows the more distant objects from which it is reflected.

CHAPTER XIX.

Colours.

Because from the sun, the chief source of the light received by this earth, that light comes mixed with the rays of different colours, and because from the rays of light and from those of each colour singly we may again separate those of each other different colour, rays of light are supposed to be singly composed of the union of the rays of all the different colours, combined together in a fasciculus; and to be singly later and more complex than the rays of any peculiar colour taken separately.

This I find some difficulty in believing; since from different objects light can be so emanated as to impress the eye with a mere sensation of whiteness, unmixed with that of any peculiar colour, whereas no peculiar colour can impress the eye without a certain degree of light; and since all objects that, from first letting the light through so as to remain transparent, by degrees become opaque, first acquire mere whiteness before they acquire any particular colour; since, while the light of the sun, accompanied by other radiances, is coloured, that of the moon, divested of those other radiances which accompany that of the sun, is white; since, after heat has again caused substances to decombine to a certain degree, so as to make them lose the colours they displayed, they still show a residue of white light before they disappear in total radiance; and since, when the different colours are intermixed so closely in such equal quantities, that the impression of each separately disappears and merges in a joint impression of all united together, that impression does not become that of white, but of gray.

I therefore believe that though electricity produces not only white light, but the different colours, it is through the medium of prior white light only that electricity more lately and partially produces the different colours; and that only through the different new peculiarities of form and movement electricity gives to white light, it endows this light before white with each peculiar colour: since the rays of each colour singly have a movement, a direction, a dilatability and a contractility, different from those displayed by those of each of the other colours.

Of the primitive colours, none entirely different from mere light, because they must each in part be founded on and composed of the materials of mere light, but each singly entirely independent of the other different primitive colours, there are three, namely, blue, red and yellow. Of each of these colours certain portions may again, with portions of either or of both the others, be so minutely intermixed, that the impression of each shall no longer be separately discernible, and that they shall together produce a joint impression intermediate between the former. The impression of red and yellow mixed being called orange, that of red and blue mixed being called purple, and that of blue and yellow mixed being called green; while that of all the three mixed, according as that of one or the other prevails in lesser or greater proportions to the remainder, is called gray or brown.

With the pure light that only produces whiteness, each colour may be mixed in different degrees, so as to produce deviations from pure whiteness and shades of peculiar colours offering different degrees of depth; until at last each peculiar colour may become mixed with pure light in quantities so great as quite to overload that light; and as to prevent its any longer remaining able to serve to that colour as a vehicle, capable of carrying it to the eye, but on the contrary to leave that colour where it alights entirely to drop and be absorbed; so that the eye shall only with regard to the peculiar spot where the colour is engulphed remain in that state of absence of impression called, when more general, obscurity—when more partial, blackness.

Like mere light, the various colours, originating in electricity, but only originating in remodifications of that electricity somewhat more complex and partial than mere light, are first from electricity by converging gravitation carried to and made to accumulate in its first and most central foci; and there further condensed and elaborated.

And from general surrounding electricity not only light, but various colours, may also already in a certain degree be directly supplied to other foci of gravitation more late and partial.

Still will the earlier and more central foci of gravitation, which in part supplied the secondary gravitation of the later and lesser foci, to these later and lesser worlds also at second-hand dispense, as well as mere light, the various colours ready made in greater plenty; and according as these secondary worlds again, of the colours elaborated in themselves or reflected from their suns, retain or again reflect certain sorts in greater quantities, they will shine with different hues. Saturn shines red, Jupiter green, the moon white.

Like electricity and mere light, the various colours are in their primitive state still entirely radiant, contractible and dilatable; liable to divergence and convergence, to transmission, refraction and reflexion,—to being, from different points, by alternate intervals of arrestation and advancement, or pulsations, made to cross each other,—to being arrested and accumulated and condensed, and from their state of radiance, in which to us they still are imponderable and impalpable, by condensation converted into gases, liquids and solids more dense, more ponderable, and more cohering,—and again, to being from a state more solid and condensed decombined into a more diffused and radiant state: but in all these different states they each still seem to show from each of the others, and from mere white light, the fundamental differences which already from the first distinguished them from that mere white light.

Like mere white light, they are, when gaseous, collected in the form of a flame, preserving the hue of the peculiar radiance of which it is composed.

Different objects, of the different colours which form their surface are reflected, transmit the impression to the eye. Of those colours of which they absorb the whole, and reflect no portion whatever, the eye becomes not aware. When objects are lighted up from behind, the light passing through them conveys along with it the colour with which it is loaded; nay, it even again detaches and conveys along with it part of the colours by the substance before taken in, which in them were become quiescent. Gold, which, when only seen by reflected light appears yellow, when viewed by a light passing through it, appears green.

Solid objects cohering in very thin plates let the different colours through their pores so as not to reflect any. Those objects which are in masses sufficiently thick no longer to let colours entirely through, but of the colours hovering in air to reflect some, and from the shape of their component molecules to reflect certain colours at an angle different from that at which they reflect other colours, where seen in different aspects, will show different colours; as do the scales of certain fishes, and the feathers of certain birds. Substances still denser, and absorbing certain colours entirely, will only show those colours which they do not absorb, but reflect.

Of the rays of different colours proceeding from the sun, the more yielding rays of blue, being alone in the day-time reflected from the sky, while the more sturdy rays of red and yellow pass on unresisted, in the day-time make that sky look blue. The rays of red and yellow proceeding from the sun, having at nightfall to perform athwart the denser vapours of the atmosphere a longer journey, are there at that time also reflected in so much greater quantities than before, as then to make the clouds appear fringed with purple and gold.

Objects so smooth as already to reflect the mere light falling upon them sufficiently to become specular, will in the same way reflect the various colours cast upon them.

Different substances, according to the different forms of their component molecules and interstices, and according to the different way in which the rays of different colours fall upon them, will of these colours transmit, retain, or reflect different sorts: and chemical combinations, which change the internal form and composition of substances, will also produce changes in the colours they transmit, absorb, or reflect. Blue appears the least tenacious of colours, and to be made to quit substances soonest. Red seems to enter later, and to leave them less readily.

In certain substances and bodies, mineral, vegetable and animal, not only a certain portion of light but of colours is poured so loosely, that of those which during the day-time the pressure from the sun caused to flow in, at night, when that pressure ceases, a part is again suffered to escape; as we see in the glow-worm and the fire-fly.

In other substances and entities, not only light but colours are imbodied so much more forcibly, that they can only again by the strongest heat and most general decombination be expelled.

From some bodies, in which radiance of colour from the sun produces various hues, radiance of heat and others from that sun again drive out these hues, and cause the objects again to fade.

Certain bodies, first sufficiently porous to let light and colours through and to remain transparent, when their surfaces are, through corrosion or otherwise become so rough as to have the interstices between their solid molecules disturbed and rendered irregular, will retain, absorb, and reflect not only light but colour in such a way as to appear opaque, and not only white but opalescent.

Some substances, in which colours different in tenacity have successively been combined, will also through different degrees of decombination let out these different colours successively. Thus foliage, first, while formed in obscurity, still white, by degrees, as it developes further, appears yellow and green; and as it again decays, again turns yellow and brown; and other bodies, while decomposing more rapidly by combustion, as their colours are successively discharged, first let out a blue, next a red or yellow, next, in their last stage of decombination, a white flame.

Not only light but peculiar colours seem, by condensing in bodies mineral, vegetable and animal, to contribute so powerfully to their completion, that those bodies of each sort not sufficiently exposed to the radiance of the sun—that great source of light and colour to the surrounding planets—remain in their external hues faint and indistinct, and in their internal texture lax and feeble; in their forms unfinished, and in their faculties short of the tone and vigour which the perfection of the genus seems to require. This we see in plants, which, reared in obscurity, remain etiolated; in animals, which, kept in darkness, want strength and spirits; and in human beings, which, left to pine in dungeons, in cloisters, and in harems, become feeble in body and depressed in spirits.

The light and colours, formed in the sun, and again emanating from its surface, seem first over its more solid nuclei to form a gaseous atmosphere or canopy of flame, which, where it is more rarefied, leaves the appearance of dark spots, or gaps seen through at a certain height from its body. This envelope, still visible, further unravels, entirely loses its cohesion, its perceptibility, and, becoming radiant, again plunges into the unfathomable realms of surrounding space; in which on all sides it advances unimpeded, till, again approaching the converging gravitation of other surrounding worlds, it again is by that gravitation drawn in and made to contribute, first in its state of radiance, and next in that of gases, of fluids and of solids, to the atmospheres and kernels of those secondary bodies.

The circumstance which of light, and of the colours mixed with it, when they first originate in electricity, or when, after having been condensed in solid bodies, they again from these bodies are liberated and left to return to radiance, proves the tenuity, is that from a candle with its light filling a whole room, when, by that candle being extinguished, that light seems on one side to cease being supplied from its source, and on the other side seems to have its further diffusion and propagation arrested by the walls of that room, on those walls, of that light which has long travelled from the one to the other, nothing visible or tangible, palpable or ponderable, is left to collapse, to accumulate and to remain; except it be by slow degrees that dust so fine as hardly to be perceptible, which yet on every stationary object to which light has long penetrated, and by which light has been long arrested, seems at last in certain quantities to collect.

CHAPTER XX.

Savours—Odours.

We have seen how out of modifications of time and space, and out of forces of gravitation and of electricity of a combining sort, arose most of the modifications that cause impressions of feel and of sight:—those of duration, extension, pressure, resistance, weight, buoyancy, cold, substance, light, colours, forms and movements tangible and visible, radiant, gaseous, liquid and solid.

We have still to see how out of these modifications arose those that cause impressions of taste, smell, and hearing.

I have already observed that like light and colours, savours and odours,—though arising more remotely out of time, space and gravitation, which are the earlier materials of electricity itself,—more proximately arise out of that electricity, inasmuch as the mere force of electricity, when strongly condensed, already, without the intervention of solar influence, immediately produces peculiar flavours and odours; nay, since certain flavours and odours are accompanied by a peculiar sensation of coolness or heat, pungency or penetration, which we already know only to proceed from electricity.

Like the modifications of light and colour, those of savour and odour first probably arose out of the force of radiant electricity, in a state of such diffusion as still to be imperceptible to senses such as ours. These modifications of savour and odour likewise appear first from surrounding electricity to have been poured in the greatest quantity in those foci of gravitation of the first order, in which gradually arose and kindled up suns and fixed stars.

Partly from this same general surrounding electricity in a manner more direct, and partly from these primary globes in a more circuitous and second-hand way,—but in a shape already more condensed and elaborated, and in company with rays of gravitation, of electricity, of light, and of colour,—rays of savour and of odour were transmitted to the more secondary globes, called planets, satellites, &c. Since on our earth certain substances and bodies seem to acquire these attributes of savour and odour even without exposure to solar radiance, though many of them seem to attain these in a greater measure only by being longer exposed to the influence of the sun.

Like light and colours, later savours and odours, first radiant, seem by degrees to be by certain substances arrested, accumulated, fixed and rendered gaseous, liquid and solid. By the pressure of electricity they seem with peculiar substances formed by light and colour, whether still only gaseous, or whether liquid or solid,—in consequence of the shapes of their solid molecules taking a proper hold of those of these savours or odours,—to become incorporated; and by decombination they seem again from these bodies to be liberated, and, when in sufficient quantities conveyed to the sense, able to produce in the organs of sensation the peculiar impressions we receive of savours and odours.

Savours and odours, affecting organs of sense different from each other, must not only be different intrinsically, but originate in modifications of electricity as differently disposed. It is however true that in their origin these modifications, though already different from each other, must still be nearly related, since the senses of taste and of smell always arise close to each other, and in such relative situations as only to render the sense of smell apparently a further development of that of taste; since the same external causes that sharpen or blunt the faculties of the one also sharpen or blunt those of the other; and since very often there even is a strong resemblance between the different impressions which the same external objects make on these different senses.

Like light and colours, different flavours and odours, often in their radiant state imperceptibly poured into bodies, there accumulate, condense and become fixed so imperceptibly, that it is not till they are again from them made to emanate more rapidly in greater quantities, that they first perceptibly affect the sense.

Flavours more dense, after having been incorporated in bodies, can in general only by liquids be from these detached, set afloat and conveyed elsewhere: odours can often by mere air be extracted and carried to the organs of sense: they can often by mere heat again be rendered volatile.

The odours first from the sun sent forth in a radiant state to the earth, next on that earth again condensed and in more solid objects imbodied, and more lately from these bodies by heat again detached and made to issue forth, when they meet a clear atmosphere and immediately again become volatilised, and return to a state of radiance, diffuse themselves in that state more quickly, and give the sense less leisure to collect and to be impressed by them. When encountering after their liberation a denser atmosphere, they are more arrested in their flight, tarry longer on the road, and give the sense an opportunity of inhaling them longer, and in a less volatilised form. A bed of flowers, often nearly scentless in the day-time, under the influence of a hot sun often at nightfall strongly perfumes the air.

Among the different flavours and odours by electricity directly on this globe produced, or more circuitously through the medium of the sun in a radiant state transmitted to this globe, those alkalescent, acid, salt and sulphureous seem among the first produced, condensed, fixed and rendered perceptible. The finer and more volatile sorts seem only by objects later and more complex first arrested and fixed; and, like many colours, many flavours and odours seem singly composed of the union and mixture of many others more simple.

It seems almost needless to observe that no substances in nature can in any of their successive states of combination, from radiant to gaseous, liquid and solid, be intrinsically poisonous; that is to say, such as by decombination to destroy or impair bodies by former combinations of similar or other different substances formed. It is only after certain substances have in certain quantities and proportions been combined in certain bodies posesssing certain faculties, that substances of the same or of other sorts, in such quantities or proportions as are calculated again to impair or destroy those combinations, may thereby, relative to these peculiar bodies, become detrimental or poisonous. But the same substances which at certain times and in certain proportions relative to certain bodies, in which they are calculated to increase and to invigorate these bodies, may be salutary, at other times and in other proportions relative to these same bodies, in which they are calculated to decombine and destroy them, may become deleterious and poisonous.

The last species of modifications giving peculiar sensations, again different from those thus far described, which yet remain unnoticed, seem to be those that give to the sense called of hearing the impressions of sound: but as these proceed from mere electricity, or from substances still remaining in their first radiant state, less directly than the former ones—as they only from substances when later condensed in a state of gas or solid materials, and next again put in motion, in consequence of the resistance and shock these molecules offer to each other, seem first immediately to proceed:—as consequently they pervade space even in an imperceptible form less generally than the former modifications described; and as they took their origin at a later period and from a smaller distance, I shall defer the description of them till I have given that of the changes of substance from a mere radiant to a more solid state, in which they first more immediately produce sounds.

CHAPTER XXI.

Substances first by combining electricity out of gravitation formed in a radiant shape, are next by that electricity moulded in a gaseous form.

We have seen that substances of different sorts were by combining electricity, itself first out of gravitation formed, again within that gravitation produced, in a shape thus far still only continuous, volatile, yielding, and generally imperceptible or at least imponderable to senses so obtuse as our present ones, which is called merely radiant.

But there exist substances in another different state more dense, more fixed, more capable of offering sensible pressure and resistance, more ponderable and palpable, called gaseous.

That of these latter substances the aggregates no longer, like those of the former, are continuous, but are divided in molecules very small, separate and distinct from each other, appears, since these aggregates are more elastic—more by pressure upon them contracted, and by removal of that pressure again dilated; a circumstance which can only arise from there being between their component parts vacua filled by forces which, as they are more or less by pressure dilated or contracted, leave the intervening molecules more to extend, or cause them more to be condensed; and also appears from other later symptoms, which cannot be accounted for unless we suppose the masses of gas to be divided in very minute distinct molecules.

That notwithstanding this greater separation from each other than is offered by any portions of mere radiance, which is offered by molecules of gas, these latter are more powerfully connected together than are the component parts of mere radiance, appears, since molecules of gas offer a greater collective resistance to pressure from without, and a greater collective pressure outward; as we see in wind, which, though only composed of an accumulation of mere invisible gases, by its pressure already may fell trees and lay prostrate men; and moreover see in the general atmosphere, in which gases heavier than others, instead of falling through the lighter ones, are nevertheless often kept supported by or intermixed with these lighter gases; a thing which we can only explain by the molecules of each sort of gas, though divided and distinct from each other, being connected together by some intermediate network of intervening radiant forces, which permits other heavier ones to penetrate between, but prevents them from falling through, these former ones.

That these substances thus gaseous derive their intrinsic materials from earlier substances still radiant appears, since, though later, more internal and more partial than these radiant ones, they still in their nature resemble them; only are combined in forms more complex, and when decombined again resolve themselves in the same—in mere radiant light, colours, savours, odours, &c.

That they derive their new gaseous form, their division in separate molecules, and the greater connexion of these molecules together, as well as the greater condensation, fixity, resistance to pressure and weight from without which they show, from forces of combining electricity penetrating from without in them, dividing their before continuous mass in separate molecules, and pressing upon, and confining, and steadying and connecting these molecules together, is a circumstance which we infer from their immediately preceding and surrounding them.

That, as must *à priori* be expected, those radiating forces of combining electricity, in penetrating between masses of substances which, though all alike thus far still radiant, continuous and rapidly advancing, still already each had powers of resistance to pressure in directions different from those of others, actually divided and moulded the masses of each sort of substance in molecules always in the same substance offering the same shapes, and in different substances offering shapes as different, appears, since of some substances different from each other the molecules cannot at all be made to cohere; of other substances the molecules can only in certain relative proportions be made immediately to cohere; and of others again they can only be made through the medium of a third intervening sort, also in certain definite proportions relative to the former interposed between them, be made more mediately to cohere: circumstances which indicate that their cohesion depends on their being through the peculiarities of their different forms, in certain senses so approximated, and in certain others kept so far asunder, that the pressure of electricity intervening from the latter side so preponderates over the counter pressure of electricity that finds room to act from the former side, as to keep them in the former direction close pressed and cohering relative to each other: a thing which combining electricity and cold must have the faculty of effecting, since decombining electricity and heat have the power of again destroying that cohesion;—and since from the masses of peculiar substances, whether still in the state of mere gas, as well as when in a state of more cohering and more fixed solids, each other different peculiar sort of substance itself still in a state of radiance, is radiated, or refracted, or reflected in a peculiar direction and at a peculiar angle, always similar in the same and different in different substances, which shows that of each substance in a state of gas, as well as of later cohesion, the mass is composed of molecules and interstices always in their shapes and outlines uniform ;—and since when of peculiar substances the mass before gaseous becomes cohering in solid bodies, so thin that like a chord they can by force and pressure be twisted in peculiar directions, they will, when the constraint and pressure upon them are removed, again of their own accord untwist themselves; which shows that in thus twisting them a violence has been done to the natural form of their component molecules ;—and since when masses, formed by the union of molecules of peculiar substances, are increased by accessions of new masses formed of similar molecules, those accessions always are in a form similar to that of the former nuclei, and different from these exhibited by accessions to other nuclei formed of the union of other different substances ;—and since when these larger masses again are by spontaneous fracture reduced to a number of smaller ones, all these smaller ones separately retain the shape of the larger one; and similar in the same, and different in different substances; and since even when these fractures are reduced to an impalpable powder, but of which the component substances still retain their cohesion and remain dry, these fragments again by frequent and short vibrations become disposed in peculiar symmetric lines and dispositions; the same in the same, and different in different substances; —all circumstances which indicate these masses having been originally composed of molecules whose arrangement and combination together were owing to the peculiarities of their individual relative forms.

Most substances in their gaseous state still have their molecules sufficiently wide asunder to let radiance of light and others through, instead of reflecting these, and thus, to remain transparent, insapid, and odourless. Some, when their molecules are in their relative situation disturbed, or with other gases so intermixed that the interstices of each fit ill on to those of the other, from transparent and reflecting neither light, colour, savour nor scent, become opaque and endowed with scent and savour.

It is by radiations of electricity which divide substances, before still continuous, in radiant molecules naturally moving in a direction transverse and horizontal to that of gravitation, that of gaseous aggregates the masses seem generally divided in lesser horizontal strata, such as we already observe in the gaseous atmosphere that first formed and still surrounds our earth, and such as in the electricity which from higher regions pierces athwart them in the shape of thunderbolts, by their resistance to it alternately in opposite directions, causes the zigzag route in which those thunderbolts advance; and as, when these strata of gas are afterwards again condensed in masses of a more solid sort, mineral, vegetable and animal, still produces that shape of follicles heaped one upon the other which, from snow-spangles upwards, all naturally thick bodies are fond of affecting.

The radiant substances first and most copiously by electricity formed, such as those called light, colour, &c. would first and most copiously by that electricity be partly divided, compressed, combined and moulded into the shape of gaseous aggregates, and of these gases a portion would first again by converging gravitation be driven to and collected round its various foci, and there lay the foundation of bodies no longer composed of matter merely radiant. At least all the gases most early and copious in the atmosphere of our globe perceptible, when by detonation decombined into radiance, by resolving themselves in great measure in radiant light and colours, show that they were in great measure part composed of radiant light and colours.

Of the various gases of this description, first in great measure out of radiant light again variously modified, by electricity round the focus of this globe composed, and of which the innermost part is by later and greater condensation from without by degrees again transformed in vapours, liquids and solids, the sorts most simple, most elementary and most copious are, firstly, that called hydrogen, which, when its decombination is not by other intervening gases retarded, is highly inflammable, and in decomposing lets out much light; secondly, that called carbon, partly at a later period imbodied in sea-coal, in diamond, and in the more combustible part of other minerals, vegetables and animals; thirdly, that called nitrogen, again different from the two former gases in the proportion and combination of its component parts, and contributing in less quantities than carbon to the composition of mere vegetables, and more to that of animals; and fourthly, that gas called oxygen, so formed that by its transit through bodies already gaseous, liquid or solid, it favours the dilatation of their component molecules, the penetration into them of decombining electricity and heat from without, and thus, if this penetration and passage of oxygen is left to go too far, and to become too copious, the entire separation of the particles of these bodies by it, according as they were previously less or more firmly knit together, in the way of detonation, explosion, effervescence, oxidation, combustion or putrescence; or even by such an expulsion of some of these gases as is followed by the closer condensation and calcination of the others that remain connected.

These four gases every where round this globe intermixed in the same relative proportions, every where round it form alike the bulk of its atmospheric air; so that travelling from one country to another for change of air can only answer in as far as you find more or less of other secondary gases mixed with these primitive ones; and as by a more rapid motion air is in the body renovated more rapidly: but to these primary gases have successively in different parts of the globe been more partially added others more or less complex, which, from their number and their partiality it is more difficult to describe.

What quantity of gravitation or weight these gases can already arrest and accumulate is proved by the pressure they exert on the two hemispheres of a hollow globe, from the inside of which the gases, whose counter pressure outward balanced the pressure inward of the former, have been extracted; and which hemispheres, though loosely applied to each other, can in that state only be drawn asunder by the strength of a team of horses.

Of the gases thus from radiances formed, some already have their molecules separated from each other, and made to enter the pores of the skin separately, with so much ease, as already to produce in some degree that feel of unctuosity and greasiness, sometimes observable in the very air, but becoming in certain other substances liquid and solid more palpable.

When from among the molecules of certain gases, single or mixed, is expelled or drawn out the combining electricity that kept them apart and fixed, they collapse into liquids, denser and heavier, but of which the parts are less fixed than those of gas in their situation with regard to each other. When this collapsion takes place in a mixture of oxygen and hydrogen, it produces the liquid called water, which again becomes mixed with many other gases more partial.

Of gaseous molecules a part often collapses in liquids between another part still remaining gaseous. In this state they are said to become vapours; and in this state, while by centripetal gravitation made more to converge toward the earth, they are again by centrifugal gravitation held supported at a certain distance over that earth, till by fresh incoming electricity again wholly resolved in gas or radiance, or by mere gravitation entirely condensed in liquids, they either again ascend higher, or descend lower.

CHAPTER XXII.

Liquidity.

Besides substances in a state of gas, we see substances in a state of liquidity, in which they present on the one hand a density, a pressure toward the earth, a weight on the side next that earth greater, and on the other hand a fixity, a pressure toward each other, a cohesion of particles less than they present in a state of gas.

I believe that these substances, thus liquid, arise most proximately from substances in a state of vapour, more remotely from substances in a state of gas, and thus more remotely still from substances wholly radiant: because they only arise after and withinside those substances vaporous, gaseous and radiant; still have intrinsically the same nature with these; only differ from them in their internal form; and again more or less gradually decombine in each of these.

I believe they only in their form differ from substances merely vaporous in having attained in their whole that change, that transition from pure gas to entire liquidity, which vapour has only attained in part, and so as still to have their liquid particles run together, surrounded, supported, buoyed up, and prevented from being by their increasing weight pressed down to the earth; or rather, in spite of that weight and tendency to earth, by the centrifugal force from earth still kept uplifted in air.

I believe that liquids in their form only differ from gases in this, that while of gas the distinct molecules are still by the intervening force of that electricity, which from continuous radiance converted them into such distinct molecules, kept in their peculiar situations relative to each other, supported and fixed at a certain distance from each other, of liquidity the particles, first by electricity separated and condensed, are, by the subsequent withdrawing of that electricity from among them, again from their fixed situations and cohesion with regard to each other released, and left more at liberty to follow the mere impulse and pressure of gravitation.

This latter circumstance I believe in gases and vapours to produce liquidity, because in that state of liquidity masses or aggregates of substance no longer have that elasticity which they had in a state of gas, and which in that state of gas only arises from the interstices between their component particles being still only filled by intervening radiance more easily extended or contracted; but on the contrary collectively offering a greater density, resistance to gravitation from on high, accumulation of that gravitation over them, and consequent pressure by it downward and weight underneath: and with greater pressure to the earth, offering less of that cohesion with each other which can only arise from their being each in a state of gas more, by intervening links, fixed in their relative situations, than are aggregates merely gaseous.

I believe this radiating force of electricity, which, by penetrating between the masses of substance themselves before radiating and continuous, caused these to become divided in separate mólecules more dense, fixed and cohering, was afterwards again, in the more dense state of these molecules, driven away from between them, so as to allow them in that condensed state to collapse; by being prevented from passing athwart them in opposite directions, so as to enable that coming from each side to arrest and keep in balance that coming from the opposite side; since air first by the transit of radiance from opposite sides kept in balance, suspended and transparent, where its further progress is by high mountains, and sometimes by mere high towers, on one side stopped, on approaching from the other side these lofty solid apices, becomes vaporous and cloudy so much more frequently and constantly than elsewhere, as to give rise to the belief that these eminences attract from elsewhere the clouds which they first form and collect.

The masses of substance, half collapsed and condensed in a state of vapour, are either in a state of transition from gaseousness to liquidity, and thus descending, or in a state of transition from liquidity to gaseousness, and thus ascending.

A mass of substance very small in a state wholly liquid and incohering, which is insulated from all larger solid, is, in that state, from all surrounding space by gravitation of a converging sort so equally compressed and moulded, as to assume the form of a round drop.

When an aggregate of substance is, in a state of liquidity, supported by a solid body which on all sides extends beyond it, the gravitation only pressing upon the liquid plash more partially only moulds it in a curve or fraction of a drop more partial; but when the liquid mass spreads very wide, of its surface any small part, though in reality a curve, from the slightness of that curve, is not perceptible as such, and to the eye assumes the appearance of a straight line. Thus water does *not* in reality every where find its level.

When by gravitation from on high the liquid is pressed down till in earth it reaches that point where, from underneath that gravitation again recoiling in a centrifugal direction, again drives the liquid upward, it again from underground rises in the shape of springs to the surface of the earth, where general converging gravitation stops it from rising further, except when, by tubes from the pressure of converging gravitation screened to a greater height, it is made by menns of these tubes to conquer and pierce athwart that converging gravitation to a greater elevation.

When a mass of liquid is, by decombining electricity or heat from underneath, so penetrated as partly to distend in vapour, that vapour becoming lighter than the surrounding liquid remaining, is driven out from amongst it upward, and the surrounding liquid, not yet reduced to vapour, is now by its superior gravity made to fall in the place of that already reduced to steam, till the whole, reduced to vapour, is made to rise and escape; and it is by the distending force of decombining electricity penetrating the water, which it reduces to a state of vapour, that this vapour acquires the power of driving other objects more solid and cohering collectively outward and upward with such great force.

The peculiar feel of liquidity, different alike from that of gas and that of solidity, only proceeds from liquids, though heavier and denser than gas, still by the want of cohesion in their molecules being made to press in the pores of the body so much further than cohering solids, without either by their collective weight bruising, or by their penetrating mass dissevering and lacerating this body.

Substances whose component molecules already have forms somewhat different, though still in a liquid and uncohering state, may be left to be by their weight pressed forward by the side of each other, so as to flow separately, though by no intervening partition kept asunder, as we see in the waters of different rivers when united without mixing; and in the different saps of vegetables, and fluids of animals, while in that embryo state in which between these different streams have not yet been consolidated the parietes of those vessels that increase their separation.

Substances still liquid, but denser and heavier, and with fewer interstices than certain more cohering solids, may not only yield to a pressure to which these solids, more cohering but more porous are not liable, but may even support, and, when pressed forward, carry along with them those solids, as we see in the solid molecules carried forward by the blood, and the vessels wafted along on the water.

As of some substances the particles may themselves acquire greater cohesion, or contain other particles more cohering, in greater quantities than other substances, liquidity or yieldingness to pressure, and solidity, cohesion, and power of collectively resisting that pressure are relative terms. Compared with water, oil, which in the midst of that water conglomerates in flakes more tenacious, already is a solid: so is relative to pure water that water which a mixture of soap enables to rise in bubbles able to resist the pressure of the surrounding atmosphere at a degree of tenuity in which pure water would have yielded to the same. Silex, which by combining electricity and cold is compressed into a cohering solid, by decombining electricity and heat is again distended into an uncohering liquid.

Of all substances first still radiant and next gaseous, but which in their gaseous state probably have electricities so opposite that when mixed they neutralize and arrest each other, and make the molecules, before distended, collapse in liquids, those in their gaseous state called hydrogen and oxygen, being the most early and copious, are those which, on mixing and collapsing, compose that liquid most elementary and copious called water.

Oxygen and hydrogen may already, high up in the atmosphere, in quantities very small and diffused, mix in the shape of water. This water may even there already again be mixed with other gases, as all rain-water already at a great elevation is with a certain portion of nitric acid, which it derives from nitrogen, and as nearer earth it is with other gases, when it becomes mineral.

Like oxygen and hydrogen, other gases may by the removal of combining electricity be left to collapse in other liquids more dense and heavy than mere water, which, like mere water, may again, by the penetration of combining electricity and cold, in greater quantities than that which is sufficient to reduce common water into the solid called ice, be reduced like liquid mercury into a solid block.

Between the opposite electricities, which, while high up in the atmosphere, balancing each other, first kept oxygen and hydrogen, in their gaseous state, suspended separate from each other, the loss of that balance first leaves particles to collapse in water, in quantities so small and so diffused as thus far still to let through all the light falling from on high, and itself to remain invisible. As this loss of balance becomes greater and more sensible, it leaves these particles of water to collapse still further, to increase in density and gravity, and to form those aggregates called clouds, pressed nearer to the earth, but, in their approximation to that earth, so arresting the recoil of gravitation from the earth centrifugally ascending as to make it accumulate and support these very clouds, during a certain period, in air at a distance from that earth, till, from remaining semi-transparent and letting through the light, they become by still increasing collapsion and density wholly opaque, able only to absorb that light, and to present from the earth a dark and heavy appearance. Sometimes the light accumulates in these clouds till it rends them in twain, and athwart their dissevered body breaks forth in streams called of lightning, which, by the concussion they cause around them, produce the noise of thunder; and, of the clouds thus dissevered, cause the aqueous particles, thus far still suspended, to collect and to descend in large drops; and not unfrequently, by the separation taking place between the electricity of a combining sort, productive of cold, and the electricity of a decombining sort, productive of heat, the former acts on these drops so powerfully as in their fall to condense them into hail.

At other times, before opposite electricities each come, by their conflict, to the extremity of that complete separation productive of thunder-storms, they cause the aqueous particles, first transparent and invisible in the sky, to collapse in clouds, still by centrifugal gravitation supported in the atmosphere, till by further collapsion, these particles transformed into rain-drops are made to descend to the earth, and to penetrate its core. At last, nearer the centre of that earth, by the recoil of centripetal into centrifugal gravitation arrested, the water is again, in the shape of springs, driven up to the surface of the globe, where it again meets with a converging gravitation, by diverging gravitation from underneath less counteracted, and is by the latter driven forward in streams, which run on in a sidelong direction till their contents collect and subside in the deepest cavities at the surface of the globe, in the form of seas. Thence, by the penetration of decombining electricity and heat from on high, the particles of that water, again separated and reduced to a state of lightness similar to what they presented before they descended from the sky, again in the shape of vapour reascend in the atmosphere; and either again by degrees through the intermediate state of gas return to that of radiance, or through fresh separations between opposite electricities revert to a state of aqueousness and collapsion.

Composed in great measure of hydrogen, itself previously composed of condensed light, water still retains the inflammability of its component elements to such a degree, that it even again communicates the same to its later combination by electricity, in the solid state of ice, which, when forcibly struck or compressed, will emit sparks of light.

Even when on substances already converted in solid bodies water is again poured in a liquid shape, it will add to their combustibility, make them burn brighter, and emit a fire more intense; as long as not poured upon them in such quantities as by its want of cohesion to choke and fill up their pores, and thus to prevent through them that transit of oxygen which is the instrument of their decombination.

Like the substances first radiant and next gaseous, called hydrogen and oxygen, of which the collapsion produces the liquid called water, there are other substances, first radiant, next gaseous, of which the collapsion produces other liquids still mineral only, such as mercury, petroleum, naphtha; or vegetable, such as the saps of plants; or animal, such as lymph and chyle and blood, before these liquids are again by further consolidation rendered cohering and solid: others are often, like iron, silex, and other minerals, without even reaching the earth or being visible naturally in an intermediate liquid state, already in the very atmosphere, by mixture and by the retreat of that electricity which kept them suspended, from that state of gas immediately converted into that of solidity and cohesion, under the name of atmospheric stones; which, by the density and gravity they acquire, are made to collapse to the earth.

Indeed it is probable that most of the substances, from the state of radiance by the force of combining electricity and cold made to pass into the state of gas, were by the force of decombining electricity and heat again made to lose the separation and fixity of their particles in that state, and to return to that of liquidity, before they assumed that of positive cohering solids; since the present general globular form of this earth, in its cohering state, seems such as it could only from the pressure of converging gravitation have received while in a state of liquidity; and since the highest and most primitive mountains raised above the general surface of the globe in their present solid state still retain those indentations, and that shape of lengthened ridges of waves, sharp at the summit, more slanting towards the side from which they were pressed upwards, and more precipitous toward that opposite side on which they were again left to collapse, which they could only have derived from a pressure upon them from one side and in one direction while in a prior fluid state; and since the highest summits of those mountains are still found to retain the exuviæ of such animals as could only have lived in their bosoms while their materials were fluid; and since the numerous successive deluges which this globe has experienced prove that, after its kernel was solidified, water still continued to cover a great part of its surface; and, buoyed up on the highest solid apices, only gradually broke through the barriers which there for a time retained it; and thence fell back into the lower reservoirs where it at last subsided.

CHAPTER XXIII.

Of substances first radiant, and next condensed in the form of gas, the further consolidation in forms cohering and solid.

We have seen substances not only from a state of radiance, continuity, rapid volatility, and yielding to the smallest pressure perceptible to us, by the intervening force of combining electricity first reduced to a state of molecules separate from each other, and yet at a certain reciprocal distance remaining so fixed and stationary, as, while by their diffusion still remaining individually imperceptible to the sense, already in collective aggregates to offer to that sense a certain resistance and pressure, such as is presented by wind.

We have seen aggregates of substance from this state, called of gas, in which their portions, by intervening electricity divided, compressed and condensed, remained fixed and stationary at a certain distance from each other, by the withdrawing of this intervening electricity from between their molecules, next collapse into a state on the one hand of still greater collective density and weight, but on the other hand again of less fixity and stationariness, called liquidity.

But we also again see, of aggregates of substance, either immediately from a state of gas, or more mediately through an intervening state of liquidity, certain particles acquire a fixity, a cohesion with regard to their immediate neighbours, so much greater even than that which they already presented in the state of gas, that even when joined and stretched out horizontally to the earth, and in a direction alike transverse to the gravitation centripetal and centrifugal, in flakes or follicles very spreading and very thin, and receiving the pressures of both these gravitations over a very extended surface, they nevertheless remain able to resist the pressure of both; and to preserve their continuity in a degree much exceeding that in which either of the two pressures of mere gravitation alone enables them to resist the other; and which power of resistance to pressure, so much greater than that derived from mere gravitation, is called the power of cohesion.

This power of cohesion, for instance, the particles of these substances forming water show, when immediately from the state of gas, or through the intermediate state of liquidity, they are converted into the state of spangles of snow, or of sheets of ice; and this power of cohesion the particles of other gases acquire, when they are combined into the solid bodies of other minerals, of vegetables and of animals.

Some people have explained the power of cohesion by a peculiar hooked form pertaining to the component molecules of all substances, which made those that in a gaseous state still remained separate from each other so to hitch or hook on to each other as to become cohering. They have forgotten that this very circumstance, of their being able to hook on to each other in that way, already presupposes a prior cohesion in the lesser component parts of each individual molecule, which must have existed in them from the first creation of the universe.

Besides, if the component molecules of all kinds of substances invariably and unalterably possessed and preserved this uniform hooked shape, any number of molecules, large or small, first cohering, and next, by subsequent violence again torn asunder or otherwise separated, might again afresh, by mere approximation, be immediately made to cohere as before; which however in general they cannot do, until by a more general dissolution at least a certain number of molecules, as well more distant from as nearer to those first separated, are first from their cohesion released, and restored to a prior state of liberty, liquidity or gas; a circumstance which shows cohesion first to proceed from an action more general and collective than merely that of each molecule singly on its next neighbour.

Other persons, allowing that it is not any attraction from within certain molecules of substance acting on others, which can make these others cohere with them,—that a pressure from opposite quarters, situated all alike outside the molecules made to cohere, is necessary to keep them in a state of cohesion able to resist a pressure tending to separate them,—will perhaps think the compression of opposite gravitations alone adequate to that purpose: but that sort of pressure deriving from gravitation, wherever it acts, is always perceived to act from a great distance, and can moreover from opposite sides only act in a vertical direction, and can only huddle molecules of matter together in round masses or drops; and, coming from a great distance, often has its action by some preponderating interference interrupted; and can, as soon as that interruption ceases, immediately have that action resume its continuance; as we see when the pressure of centripetal gravitation from on high is, by a beam placed horizontally over the surface of the earth, so interrupted as to enable the opposite centrifugal gravitation from the earth upwards by its increased play, to make rain-drops cling to the under side of that beam; and as we again see when that pressure from on high, the moment the beam is removed, again continues as before to drive all the rain on to the surface of the earth—and that sort of pressure moreover derived from gravitation can only act on molecules of matter collectively, and so as to huddle them together in a lumpish mass; and as soon as, by some external cause, this pressure is made with regard to molecules still liquid and uncohering to change its direction, it makes in its turn these molecules themselves change their situation with regard to each other; whereas none of these circumstances any longer are found to apply to particles of substance, when positively made to cohere; substances only being made positively to cohere by the pressure of a force acting on them perceptibly only from so short a distance that we cannot any where outside these molecules detect it; and yet acting on these molecules so forcibly as to resist a very strong pressure of gravitation tending to separate them; and acting on these molecules, not like the pressure of gravitation, only in a vertical sense, corresponding with that of gravitation itself, but equally in a horizontal sense, contrary to that of gravitation; and while gravitation, by its collective pressure only huddles a certain number of molecules together in the lump, and as soon as it changes its own direction also changes the relative situation of the different molecules pressed together by it, on the contrary pressing each molecule so directly to its immediate neighbours that the pressure may to a great distance, even in a horizontal direction, keep molecules cohering together in very defiance of a strong pressure of gravitation upon them; nay, that when, by violence, neighbouring molecules have their cohesion broken, the cohesion and the situation relative to each other of the more distant molecules will not thereby be altered.

The force, thus different in its mode of action and pressure from that of mere gravitation, producing mere weight and buoyancy proportionate to the pressure, which produces fixity and cohesion of molecules before unfixed and uncohering, whether in small or large aggregates, can only be a later increase and condensation of that same force of electricity, which, first arising out of the force of gravitation itself, first causes substances thus far still only radiant, continuous and volatile, to be, by its penetration, divided and compressed in the separate molecules more dense and more stationary of a gaseous aggregate.

This force of electricity, after it has thus divided substances of different sorts, and moulded them, according to the different sorts of resistance they offered to its compressing force, into molecules of different sizes and shapes, by still further increase and pressure on these molecules, brings them in certain directions in contact so close and complete, that, offering on those sides no proportionate balance or counteraction to the pressure exerted from opposite sides, where, by the peculiarity of their relative shapes, they cannot be brought in similar contact, the pressure, entirely accumulated on these latter sides, and unbalanced by any similar pressure on the former sides, suffices to keep them in their peculiar situation with regard to their neighbours, thenceforth fixed, permanent, and cohering, even in spite of efforts, very strenuous and considerable, used to destroy their union, and to drive them away from their neighbours.

And that this circumstance alone forms the spring and secret of all cohesion of molecules of substances in large collective masses,—that all cohesion only arises from the peculiar form of molecules when in a gaseous and liquid state, being such as to admit their being, by the force of combining electricity on certain sides approximated so closely, and to forbid their approximation on other opposite sides to such a degree, as to prevent the pressure on certain sides from being balanced and counteracted by that on the opposite sides, appears since, firstly, any force acting exclusively from one side, without being opposed, balanced, and counteracted by a force acting from the opposite side, even where we do not yet perceive its action, already acts so powerfully, that that of mere gravitation centripetal from without pressing on a ball or globe, from whose inside has been pumped out with air that gravitation centrifugal which might have balanced and counteracted the former, already presses the two hemispheres of that globe, though uncohering with each other so closely together as to require the strength of a team of horses to overcome this pressure and to produce their separation: Secondly, only in portions of space accessible from without to the force of combining electricity, of substances before entirely radiant or gaseous or liquid, a portion is made to cohere and to solidify: Thirdly, all cohesion and solidification always begins in the portion of each substance nearest the surface often penetrates to no sensible depth within that surface; and when it does, only does so later and more gradually—as we see from the earliest and simplest solidification of mere water into ice, unto the latest and most complex consolidation of saps and fluids vegetable and animal into solid organs. Fourthly, the detached molecules of substances do not seem to cohere in solid bodies the moment they are any how brought in contact; but seem only to be so solidified by a slow and deliberate process, requiring in the electric force much previous adjustment of the molecules to each other, in order to bring them in contact on that side where their forms may fit on to each other closest, before cohesion can take place. Fifthly, when, from a state of liquidity and huddling together in a still yielding mass substances are solidified in a cohering body, they are to a certain degree made in certain directions to separate and to extend so as to render their aggregate, proportionately to its size, less dense, less heavy, more elastic and lighter than it was before; and when from a state of liquidity, within the pores of a prior substance already solidified, this new substance, before liquid, is made to solidify, the force which causes this expansion and solidification often by its action causes the former solids to burst asunder, as we see in stones in which water becomes congealed; circumstances which can only arise from substances, when solidifying, again being driven further asunder. Sixthly, in proportion as cohering bodies, by being composed of substances more varied and complex, may be supposed to be composed of molecules more different in size, shape, pores and parietes, they offer, with greater elasticity, greater cohesion; as we can see in comparing these attributes in a flake of ice, with the same attributes in a hair; which circumstances can both only arise from the greater number and variety of interstices in the substance of the latter when solidified. Seventhly, the cohesion in a smaller space and number of molecules dissevered can often only by the intervening dissolution of a larger mass of molecules beyond those dissevered, again be restored; a circumstance which can only arise from the first particles dissevered having suffered so much of the force contained between them to escape, as to render it necessary to draw out part of that still imprisoned in the parts as yet remaining in a state of cohesion, in order to re-establish that force of cohesion between the others. Eighthly, of certain substances the molecules cannot be made immediately to cohere at all, and can only through the means of other different substances interposed be made to cohere; and of the substances that can be made immediately to cohere, some cohere less firmly than others; circumstances which must depend on the peculiar forms of the molecules of different substances affording the electric force which cements them together less or more means of so making them fit together, that its pressure from one side shall more preponderate over that from the opposite side. Ninthly, of most substances still only gaseous, and thus presenting their molecules still only on all sides fixed further asunder, the dissolution into radiance takes place by sudden detonation, while only of a few substances already in state of more cohering solidity the unravelling continues to take place by rapid explosion, and of the greatest number the decombination is only effected by more gradual combustion or putridity; a circumstance denoting that of the combining force of electricity which kept these molecules fast wedged together, the unravelling and exit, which again liberates them from their confinement and leaves them to be driven asunder, has different degrees of tenaciousness and leaves different degrees of facility to be counteracted or defeated.

If, however, the causes here alleged for the cohesion of the molecules of substances in solid bodies should not be deemed sufficient for the effect produced, I frankly own I can find none other,—must leave the precise way in which this cohesion takes place among the arcana of nature still undiscovered, and must content myself with only in general asserting, that cohesion appears an effect of combining electricity, since on every side it is preceded and surrounded by that electricity.

But in whatever way combining electricity, of substances, in the first instance purely radiant, causes certain portions to be first divided from others, and next combined with certain of these others in aggregates so far still only gaseous, and ultimately to cohere with these others in more extended solid bodies: and whether, while these consolidations of substances are going on more rapidly, they emit, under the name of congelations, a cold very intense; or whether under the name of other formations mineral, vegetable or animal, more slow, they emit a cold less intense, or even totally imperceptible to senses such as ours: whether they end in forming solid bodies of mere ice, or others more complex still merely mineral, or, in fine, bodies organized vegetable and animal, I equally believe it to be the same force of combining electricity, productive of cold, and in bodies endowed with sensation, of a feel more or less intense of that cold, which alone causes these combinations and consolidations;

—which alone converts these substances, first merely radiant, not only into ice and other mere congelation, but into every other form of a cohering sort more complex mineral, vegetable and animal; because many consolidations even animal are still accompanied by a strong emission of cold—witness that which takes place in a human body in vigorous health, when, after a good digestion, the food taken into the stomach is reconverted into the substances of the body; and because in the liquids in which these consolidations are more easily watched,—such as that of water, of milk, and of blood,—they are accompanied by those vibrations, those pulses, those radiations, those retractions (*tiraillemens*) in opposite senses, which betray the agency of electricity; and because in all consolidations mineral, vegetable and animal, from the simplest in mere ice to every later sort, the solid form most early and elementary and simple displayed —that of the recombination of which all solid forms later and more complex and more partial are composed—is that form of a cellular description, showing alternate solid particles and intervening interstices, only again later by their aggregation composing follicular masses, and by their still later compression and convolution vascular tubes, which only arise out of the agency of radiating electricity.

And I believe that it is only because that combining electricity, when it still only finds gases so early and so coarse as simple hydrogen and oxygen to act upon and to connect together in a cohering mass, is itself required to be collected and condensed very powerfully, before it can so act as to become directly perceptible even to senses such as ours, that the combinations of those solids are accompanied by a sensible cold, and are called congelations; whereas when that electricity finds gases more numerous, more varied and more fine to act upon, and lay hold of, and combine in later solid bodies mineral, vegetable and animal, it is able on these to act in subdivisions so much finer and more diffused, as no longer to remain in the shape of cold perceptible to our present senses; but to suffer the agent to remain concealed, while his work alone becomes perceptible.

I believe the circumstance of combining electricity being in this, and probably in other secondary globes by a gravitation more oblique and unbalanced made in its turn to press upon substances in a manner so uneven, oblique and partial, as by degrees to prevent their further circulation, and to cause them to be in certain places so wedged together as to remain for a time fixed, cohering, stationary, torpid and unyielding to pressure, in their turn to impede the circulation of light and of other elements still radiant, and by their arrestation to produce partial obscurity and suspension of life, is only an effect of the oblique situation of this, and of those other secondary globes, with regard to the centre of the first and most general and central gravitation. That this arrestation and torpor of component elements thus is a circumstance which only exists in globes of a later secondary sort, only situated more obliquely in general space; and that in globes formed by a gravitation of a converging sort more equally from all sides pressing on their centre, it cannot exist;—an opinion confirmed, on the one hand, by our sun appearing composed of substances less dense, less stationary, more replete with light and life; and on the other hand, by our moon appearing more solid, more stationary, more lifeless, than our own globe.

Be this as it may, the degree of condensation at which on this globe electricity of a combining sort is capable of causing substances still radiant, gaseous or liquid, to be congealed with such an emission of cold as to us are perceptible, is called the freezing point; but it must be evident that that degree must vary according as the substances are of a nature to be by electricity congealed with more ease or more difficulty. Some substances, like gold and silver, are already found in a solid, and we may say frozen state, to which they were probably reduced from a prior state of gas, at a degree of cold so small as to be to us still imperceptible; while others, like mercury, can only by a condensation of cold so strong as to be most sensibly frozen and reduced to a cohering mass. The gases that by their union form water seem in their state of water to preserve the medium between these two extremes.

After electricity productive of cold has already, in substances before fluid, penetrated in sufficient quantities to congeal and solidify them to a certain degree, it may still continue to rush into them in so much greater quantities as to render their cohesion and consolidation more powerful, tenacious and firm; and consequently to enable them, while congealed, again to give out a great quantity of cold, and yet themselves to retain a sufficient quantity to remain cohering—as we see in a lump of ice which, dropped in a pail of water, may cause of that water a part to freeze around it, without itself wholly dissolving.

Electricity, when it penetrates within and solidifies substances, may become in these so concealed as to remain in them imperceptible till they are again entirely dissolved,—as we see in salt which, when conglomerated into large crystals, may again be pounded into mere dust, before from that dust the cold be again so emitted as to leave it to dissolve and to melt. From substances by electricity congealed, as water is into ice, that cold may again be emitted and made to pass into and congeal other neighbouring substances; and from the quantity of cold absorbed by salt when consolidating, the addition of salt to water will of that water hasten the congelation, and the later communication of cold and congelation to other more distant substances in contact with that water.

Electricity productive of cold and combination will, while through an atmosphere fine and dry it passes more rapidly and with less obstruction, by so doing be left to fall and accumulate on solid substances which arrest it so much more rapidly and copiously, as, while less felt in its transit, to congeal those substances on which it falls faster and more firmly; on the contrary, while through an atmosphere more dense and damp it is made to travel in less quantities more slowly, it will in its transit be more sensibly felt, and in the substances gaseous or liquid, by which it is finally arrested, cause a congelation less rapid and less forcible.

Where from certain substances, as from iron, cold is emitted rapidly in great quantities at once, its emission will for a time be more felt, but sooner by exhaustion cease: where from certain substances, as from wool, cold is emitted slowly and in small quantities at a time, its emission will, in equal quantities, be less sensibly felt, but last longer, before it again ceases.

CHAPTER XXIV.

Properties of Solids.

Of substances of different sorts, molecules, not throughout mixed and added to in proportions and situations relative to each other such as are similar, may already by combining electricity be made to cohere in solid bodies, resisting the forces employed to detach their component particles from each other; but in this case these bodies cannot yet, when solidified, throughout present substances, forms and faculties homogeneous and similar, such as we call regular crystallizations.

Only when of different substances the particles are throughout intermixed and combined in proportions definite and similar, can the bodies they collectively compose throughout present substances, forms, and faculties of that homogeneous sort, which constitute regular crystallizations.

Only when of substances the molecules, made thus to cohere in homogeneously crystallized masses, are not yet so varied and fine as to require forces of electricity very complex, and frequently crossing each other, to tie them together in cohering bodies, do these bodies, though increased to any size and thickness, continue to let through all the light that falls upon them, and to remain themselves transparent: but while thus of substances the molecules are still made, by forces of electricity more simple and less crossing each other, to cohere in dispositions such as easily to let through the light, do they also still remain more easily dissevered, more brittle.

When, on the contrary, molecules more varied are, by electrical forces more variously and closely crossing each other, so firmly interknit as more to resist and reflect the light that falls upon them, they become, even in smaller and thinner plates, more opaque and more coloured; and, being tied together by forces of electricity more able to yield and to extend in any sense without suffering total disruption, they become at the same time more malleable and more susceptible of being, by pressure from without, extended without losing their cohesion: as we see on comparing transparent spars with opaque metals.

Substances solidified into cohering bodies may, by the different forms in which their collective mass may be moulded, the different pressures it may be made to exert over, and the different resistances it may be made to experience from other different and distinct cohering bodies, be made to show the different forces and faculties called mechanical; such as those of the hammer, the wedge, the lever, the peg, the plug, the beam, the arch, the pendulum, the pivot, the wheel, the screw and others partly of propulsion and partly of attraction, and among these latter, where, of the bodies cohering and solid some are very pliant and others very inflexible, and where the former are made to circulate round the latter, those of the pulley.

Substances solidified and cohering may be made, by their parietes, so to screen their intervening pores from the pressure of the centripetal gravitation from on high descending, as to give to the centrifugal gravitation from underneath ascending, within these channels a more unobstructed play; and to make this latter gravitation from within the body of the earth drive to its surface, and even from its surface into detached bodies situated over the same, fluids and liquids; which thus are made to rise in a mode wrongly called of capillary attraction, till they become exposed to and resisted by the full pressure of centripetal gravitation; as we see in the springs rising from the earth, and in a sponge held over a body of water.

Where through the pores of a solid body is made to rise above its surface a new fluid, this fluid may, above the former solid, either alone, or with some other new fluid from on high descending, be, by the pressure of combining electricity, consolidated into a new solid, cohering with the former, which shall in its own substance, forms, faculties and crystallizations be homogeneous throughout, but at the same time wholly different from those of the former body on which it is superstructed.

While of the properties of mere gases acting on each other, on liquids, or on solids, the science is called that of pneumatics, and while of the properties of mere liquids acting on each other and on solids the science is called that of hydraulics, of solids acting on each other the science is called that of mechanics.

As the gases called oxygen and hydrogen are on this globe among the earliest, the most copious, and the first, by electricity so combined as to lapse in a state of liquidity, under the name of water, and to be compressed into a state of solidity, under the denominations of hail, snow, sleet and ice, we must suppose that, of solids, snow and ice have on this globe been the first. The whole of the solid body first within the atmosphere of this globe composed must have been a snowball, before this snow-ball afterwards became covered by strata of other solid masses more dense, more complex and more durable.

And this opinion seems confirmed by the

later and more superficial component strata since formed nearer the surface of the globe themselves. These strata present fractures and obliquities of position, which prove that, after having first been formed in a horizontal direction, and supported by the prior ones formed under them, they have only by the subsequent melting of these more internal masses of ice or snow been made again to give way, and frequently to collapse, till their fragments stood on edge.

CHAPTER XXV.

Of the forces of electricity certain modifications more partial than those thus far described, which show themselves in certain substances when solidified, and are called magnetic and galvanic.

I SUPPOSE the magnetic force only to be a later, lesser, and more partial offspring of the electric force, acting on certain substances, after these have been, by an earlier and more general modification of that electric force, condensed and combined; inasmuch, as the general attractions, or rather propulsions of the magnetic needle towards the poles seem connected with the peculiar lights at those poles by electricity produced, and as the magnetic pressure seems sensibly influenced by the partial accumulations of that decombining electricity, which elsewhere produce thunder-storms, earthquakes, and other electric phenomena.

As I disbelieve that any solid bodies can really attract or draw other solid bodies after them, otherwise than through the medium of intervening solids, I believe that where a magnetised body has the appearance of doing so, it is in reality only by repelling and dispelling other forces which previously prevented the body seemingly attracted from obeying the force that impelled it in the track of the former body.

The force of magnetism often, by exerting on solids a pressure, not direct but oblique, causes in small bodies a rotation similar to that which centripetal gravitation produces in the largest globes.

In certain substances and bodies the magnetic poles that existed at first are frequently, by the partial influx of fresh electricity and lightning, again subsequently changed. A combination of zinc and silver often affects the magnetic needle, and different streams of magnetism are often each by the other so alternately arrested and broken through, as to cause certain objects to be alternately driven forward and backward.

Like the magnetic forces, I suppose the galvanic forces only to be an offspring of electricity; or in other words, only to be electricity, through the medium of certain substances of a solid sort more partial and complex so remodified, as to be made on certain other substances to act in a new way. It seems to be the force of electricity so directed as to be manifested in peculiar substances, which in certain entities contribute to the composition of those organs called nerves, the instruments which of external objects and events receive and transmit sensations, and the thoughts and volitions which these sensations in their turn produce.

Even after the death of an entity that has felt, thought and willed, the galvanic fluid, without being any longer conducted through the organs of sense, thought and voluntary action—without passing through the brain, and causing actual sensations, ideas and wills,—on only being, directly from without, poured into the muscles of the face, body or limbs with which the nerves from within communicate, may in these muscles still produce, though less perfectly, some of those very movements and contractions, which, when that fluid passes, while the body is alive, through the peculiar organs adapted for the purpose, and causes in these organs actual sensations, thoughts and wills, are only of those sensations, thoughts and wills the later effects and manifestations.

Of the origin and composition of the magnetic and galvanic fluids, and of their movements and influence on bodies, the science is still in its infancy.

CHAPTER XXVI.

Sound.

Though I have already described the radiances which cause in us the sensations of sight, of feeling, nay, of taste and smell, because I conceive of those radiances the first origin already to precede even that of the most primary globes, and thus from gravitation and from electricity in unbroken continuation to descend to these primary globes, and from these again to our secondary globe, so as to precede in the formation of the latter that of the very substances more solid, even still merely gaseous, which we recognise around this globe, I have not yet touched upon the radiances which cause in us the sensations of sound, because I consider these peculiar radiances as only arising out of, and following the prior formation of substances at least gaseous; and thus consider that even, if the immediate causes of sensations of sound might already exist in primary globes, they must again die away entirely in the intervals of space separating these primary globes from more secondary ones, in which substances emanating from the former again diffuse themselves into a state of mere radiance, and which they traverse in that state of mere radiance, before around secondary globes they again become more condensed; because I consequently consider the music of the spheres, such as might be heard from one globe to another, to be one of those poetic fictions of the ancients which, inasmuch as impressions made on mere radiant forces cannot yet in those latter forces produce any vibrations perceptible to human ears, cannot yet have any reality in nature.

In our sun, in fact, one of those more primary globes, which, from the greater centrality of their situation with regard to surrounding space, can only from that surrounding space receive pressure of gravitation, of electricity and of other forces more even, more balanced and more direct, substances cannot probably yet through pressures more oblique, more partial and more preponderating be compressed so as to offer condensations, and to experience shocks and vibrations, such as are necessary to produce sounds.

Nor in such globes as our sun can the production, the propagation and the sensation of sounds yet be required for the information, the guidance, the welfare, the happiness of any even of their most sentient tenants.

The same centrality, and security from any partial pressure, which there must prevent in substances the arising of sounds, must there also prevent the different substances themselves produced from being so partially collected, as to be divided among genera, and in each separate genus, among individuals, distinct from each other; and among individuals no longer all alike throughout to every radiance so pervious as to render through the mere movement of light —through the mere impression of sight—every entity instantaneously aware of what happens in every other entity near or far. It must there prevent in certain individuals partial obscurities and ignorances of the impressions, sensations, thoughts and designs by other different individuals harboured against them; the effects of which they can only through the vehicle of sound be made to guard against and to obviate.

In such primary globes no sounds of distant thunder can be necessary to warn any of their tenants of the approach of those storms, which there cannot exist: no howling of beasts of prey can be required to apprise any of their inmates of the vicinity of those beasts, which there cannot take place: no cries or language of man can be wanted to inform other men of the desires of the former, to the accomplishment or prevention of the effects of which the concurrence of others is necessary for mutual advantage.

Every thing that is to be sought, or to be dreaded—if any things of the latter sort still exist on such globes—must there, by mere intuition, and without the assistance of sound, be directly known.

But not so in a secondary globe like ours. On this globe, where the more uneven and unbalanced pressure of elements still causes the arising of numberless genera and individuals simultaneous and successive, wholly distinct and separate from each other, and by intervening obstructions prevented from each knowing by intuition what passes in the body or mind of others, the vibrations of sound are constantly required to give others notice of events that produce no direct impression on their senses of feel and sight, and that should nevertheless be communicated from one entity to the other, for the well-being of both. In this globe those vibrations of sound alone can, of many movements, wants, desires and intentions that arise in the bosom of one individual, give timely notice to another individual, interested in promoting or preventing their effects.

And on such a globe as this, the very causes that must produce the necessity, the want of sounds, would also produce in certain entities the capacity of emitting, and in others that of hearing such sounds.

While forces and substances still merely continuous and radiant have not yet in themselves even here intrinsically sufficient condensation, and extrinsically and around them sufficient room to give and to receive from other substances pressures, shocks and vibrations sufficiently strong, dense and abrupt yet to produce and to propagate sounds, as soon on the contrary as forces and substances already by electricity are divided into molecules more condensed, separate from each other, though still only gaseous, when of these molecules a certain mass, by that electricity further pressed, is made to come in sudden contact with and to press upon and to produce a shock in another mass, it may already in this other mass produce those vibrations more abrupt, more dense and more close, which are called sounds, and which produce sensations of such.

These vibrations, productive of the sensation of sound, we already perceive high up in the atmosphere, when electricity produces on it the more diffused glare of aurora borealis or australis, accompanied by an abrupt and crackling noise; or when the same electricity produces lower down the more condensed streams of lightning, accompanied by the more continuous roar of thunder; or when that same electricity again, by distending and moving certain masses of air, causes the howlings of the wind.

Even liquids, notwithstanding the greater collapsion, density and yielding of their component molecules, may still, to a certain degree, receive, continue and transmit these vibrations; but it is especially where molecules are more closely interwoven in cohering substances, of which the solid parietes alternate more densely and regularly with the intervening interstices, that these vibrations of sound are produced and transmitted with so much less interruption,—so much greater equality, rapidity and closeness,—as to acquire infinitely greater loudness and distinctness.

From the spot where, by certain pressures and shocks, those vibrations are first produced, they are on all sides around propagated and extended to further distances in radiating directions. Already when to mere inanimate solids they are so communicated as to make the dust lying on these jump about, they cause this dust gradually to accumulate in distinct ridges, wider or narrower, according as the vibrations are of a nature to produce in the organs of hearing sounds more deep or more acute. They make houses shake and windows rattle.

These vibrations, even when through the medium of fluids or solids only yet communicated to the sense of feel, are by this sense already perceived, as we may see in an oyster, already by the vibrations of thunder made to gasp and to open its shell, though it be yet unpossessed of any organs of hearing; and as we may see still more forcibly in ourselves, when we experience the vibrations of thunder, or those which a gun fired, or an organ or harmonica played upon, communicate to surrounding air, and through this air to the human frame.

Finally, these vibrations, when reaching in entities those organs of sense more complex and fine, capable of receiving from peculiar movements the impressions more condensed, distinct and diversified which are the media of sound, produce in those organs the peculiar sensations called of sound.

As the various substances existing in nature, when by electricity divided and compressed in distinct molecules, are moulded in molecules of size and of forms very different from each other, these substances, when sufficiently compressed to receive from the pressure of electricity or of other substances the vibrations of sound, receive vibrations in their nature, their dimensions, their direction, so different from each other as to become very different in their impression on the organs of hearing. This we may already perceive in those produced by mere wind or by water, by mineral, by vegetable, or by animal substances; by strings of metal, or cords of catgut; by the external limbs of lower animals, and by the internal organs of voice of higher brutes and of human beings.

And, according as by other substances moulded into peculiar forms, the rays in which these vibrations are formed and propagated, again are made to become more diverging or converging, diffused or condensed, refracted, reflected, conducted, or made to cross or to be crossed by other rays, or ultimately are so attenuated or absorbed as again to become imperceptible, they are heard in different degrees, or in different directions; as we find in the vibrations of sound, by speaking trumpets, by whispering galleries, by echoes, by ventriloquists, and even by musical instruments in unison with other musical instruments situated at a distance from them, received, collected and reverberated.

However, while light and colours, being substances, may in their radiant state be arrested; and, though becoming stationary and quiescent, and consequently latent and unfelt, still remain existing and ready to be again directly diffused, rendered volatile and able to reach and to re-impress the sense, sounds, only the effects of forces, of movements, cannot become latent and still continue to exist. As soon as the movement which is necessary to render sounds audible ceases to exist, the sounds must cease with it, and cannot without fresh movements be revived.

Sounds, however, having, as such, to perform between the molecules of substances that form and condense them sufficiently to be audible, a vibratory motion, before they perform a radiant and forward movement, are in their progress so much slower than radiating substances, such as light and colours, that when both depart at the same time from the same point, the light soon gets the start of the sound, which presently lags so far behind, that of a distant clap of thunder, or a distant explosion of gunpowder, only long after the light has ceased striking the eye the noise first reaches the ear.

As I have already observed that only when substances become, by combining electricity, so compressed as from a state of radiance to pass into a state of gas, they first become able to experience and to propagate the vibrations of sound, it can only be that electricity of a combining sort, causing the effects and the feel of cold, and the combination by it of substances before radiant into a more condensed and solid state, which can be called the immediate parent of all the primitive sounds that arise out of such combinations, from the simplest crackling of aurora borealis, and peals of thunder, and rustlings of wind and roar of waves, to every most sonorous and dulcet production of the human voice and of music. The same decombining electricity, as we shall see, being the parent of all decombination of substances, whether in the way of detonation, explosion, effervescence or combustion, can only be the parent of all the vibrations of sound that arise out of these latter.

According as molecules of substance are connected more distantly and loosely, or more closely and firmly, the vibrations which when pressed they receive, and which in their turn produce sounds, will be more wide, more lax, more obtuse, more slow in time and space, and produce sounds more deep and blunt and sluggish, or they will be more short and rapid, and produce sounds more sharp, more acute, more numerous and more piercing: and while, in the former case, if forcible, they will only by their pressure from without compress, and stun the organs of hearing, and deprive them of the power of moving, in the latter case they will penetrate them so as from within to lacerate, to dissever, and to destroy them.

In the same way as certain modifications of substance, said to be peculiarly dry to the feel, or certain modifications of flavour, said to be very astringent to the palate, only become irksome to the sense by drawing out of their organs the fluids already poured into them, so likewise certain vibrations of sound, such as that produced by cutting a dry cork, or by pressing a dry spunge, only become painful to the ear by the contractions they cause in the organs of hearing.

As electricity productive of combination and cold is the first modification which immediately converts substances from a state of continuity and radiance to that state of distinct molecules necessary to receive and to transmit the vibrations of sound—as electricity productive of decombination and heat can only at second-hand produce in these molecules, while again decombining, vibrations of sound more loose and lax, the countries and climates in which combining electricity most prevails, and the seasons in which it reigns most exclusively, are those in which an atmosphere most elastic and dry is productive of sounds more clear and distinct. Those climates and seasons, on the contrary, in which electricity of a decombining sort and heat are most experienced, and produce most relaxation, humidity, and dissolution, must in objects weaken and destroy the capacity of producing sounds clear and distinct; must render them able only to emit sounds hoarse and deep.

In regions at once very hot and very humid, the very cries of beasts, the notes of birds, and the voice of man are less silvery and sonorous, more hoarse and croaking, than they are in those where the air is more elastic and dry. No nightingale pipes in the swamps of Berbice: no Catalani sings on the banks of the Niger: the substances of nature are less sonorous, and the instruments of art sooner out of tune.

As, however, we already have seen that radiations of heat and radiations of cold, both very intense, are very compatible with each other, there are places very hot, where cold may produce objects capable of emitting sounds very clear and very diversified.

CHAPTER XXVII.

Forces of electricity of a decombining sort, or of heat.

I HAVE said that though forces of combination must, in their effects, precede forces of decombination, yet the earliest and simplest actions and effects of the former might already be followed by the earliest and simplest actions and effects of the latter, even before these former themselves had evinced actions and produced effects more late and complex: that thus, even before the forces of combining electricity or cold had yet converted any substances from a state of radiance into a state of gas or solidity, forces of decombining electricity or heat might already decombine these substances from a state of radiance more dense and close into a state of radiance more loose and diffused.

But I have, nevertheless, deferred the description of the origin and action and effects of decombining electricity or heat, till I had carried the account of the origin, action and effects of combining electricity or cold somewhat further than its first commencement, in order to render between the two modifications, having a common source, the later difference somewhat more marked and distinguishable. I now proceed to the account of the latter force, which, though it arises out of the former, arises out of it somewhat later.

Though of the force of decombining electricity or heat the effects and the feelings be entirely opposite to those that proceed from the force of combining electricity or cold; and though I believe them in their first origin to have even been later and more internal than those of cold, yet I believe them to have, like the forces of combination and cold themselves, originated more proximately out of forces of electricity, and thus to have originated more remotely and mediately out of forces of gravitation; because, even in the depth of winter, and at night, when no actual rays of heat more condensed from the sun can reach that portion of our earth turned away from it,—while, consequently, electricity alone seems to pervade the atmosphere, after a degree of cold so severe as under the name of frost to cause all surrounding matter thus far fluid and gaseous to become solid and dry, there often suddenly arises in that very atmosphere a degree of heat so great as again to thaw and dissolve those substances, by that cold erst combined and congealed; and again, from a state of congelation and solidity to make them return to a state of liquidity, vapour, gas and even radiance; a phenomenon which, under those circumstances, can only be attributed to a sudden change in the electric state of the atmosphere itself:—and because, even at night, a thunder storm only arises from the modification of electricity causing cold and condensation, first throughout by the modification of electricity causing heat and dissolution so balanced that each retains its place intermixed with the other, subsequently being by the latter so overpowered that they separate; and that while the electricity causing cold and condensation, again driven up to and made to accumulate in the higher regions of the sky, there congeals the aqueous particles into hail and snow, the other electricity, causing heat and collapsion, descends to the lower strata of the atmosphere, and there makes the particles of humidity, before diffused, collapse in vapours, clouds and rain.

Nay, I believe the forces of electricity productive of decombination and heat to have more immediately arisen out of the forces of electricity productive of cold and combination themselves: I believe the forces of electricity which, while from more distant points without approaching, and pressing substances enclosed withinside them to each other, produced withinside themselves, and upon these substances, the effects of cold and combination, when met, and again by the shock of meeting made to recoil outwards, and to drive substances situated outside them from each other, to have themselves on these substances situated outside them produced the later effects of heat and decombination. I believe the ignition and inflammation by heat caused, only to arise from the evolution and return to volatility, to radiance and to transient visibility, again by the expansion of heat produced in those very particles of light, which by prior cold had, from a state of volatility and radiance and visibility, been reduced to a state of solidity, cohesion, quiescence and invisibility, because the march and progress and effect of the electricity causing heat and decombination, though directly opposite to the march, progress and effects of the electricity causing cold and combination, seem to arise immediately after and out of those of the former electricity, and to become more striking, as more striking effects of the former electricity have preceded them.

Thence rays of heat, arising out of the clashing of rays of cold, and their recoil outward from a common centre, may, even in the sun, only after a time begin to be connected with later rays of cold, and may, from all points of space do what we have already seen them do; namely, cross and be crossed by rays of cold; and in certain points of time and place contend with and conquer or be conquered, by those of cold, and either displace them, or be displaced by them.

On our globe, sometimes both heat and cold alternately experience such excessive and preponderating condensation, that in India, while in the day-time the heat from the sun is quite unbearable, at night the cold freezes the water in the tanks; and any where cold and heat may be made from opposite quarters to radiate to peculiar spots in such quantities, that after crossing each other, the former shall congeal a plash of water into ice, and the latter liquefy a block of ice into water, side by side.

But when rays of cold and rays of heat fall, whether it be in small or in great quantities, at the same time, on the same spot, the preponderance of either will drive the other away.

Some substances by little cold from without made to solidify and to cohere, but in solids and bodies of which the component parts are little tenacious, will again by little heat be made to dissolve and to return to a state of gas or radiance. Mere percussion will in some bodies drive sufficient decombining electricity and heat for that purpose. Other substances, requiring more cold to make them solidify and cohere, will also require, when solid and cohering, more heat to drive out the cold and make them dissolve. While most gases are made by little decombining electricity and heat to rebecome radiant most rapidly, most metals are by decombining electricity and heat only when most condensed, most slowly again from a state of solidity and cohesion first made to experience the more partial decombination of melting; and only fresh oxygen poured in among their particles can facilitate their more gradual but complete dissolution into mere radiance.

Where substances very different have by the converging pressure of combining electricity and cold been first from radiant combined together in bodies gaseous, liquid and solid, the diverging pressure of decombining electricity and heat sufficient to cause some again to separate and from solid to rebecome fluid, may not yet be strong enough to produce the same effect on others; and in that case, while the former, when returning to a state of vapour, will rise and escape in on high, the latter will only collapse and fall to the ground in ashes. As substances, before by cold combined and consolidated in gases, liquids or solids more loosely or firmly, are by heat again decombined more rapidly or more slowly, the decombination is said to take place in the various ways called of detonation, explosion, combustion, effervescence, fermentation or putrefaction. As their distension and dissolution is more rapid and forcible, or more slow and gradual, it causes in the particles of air around a vibration and a displacement productive of a noise more stunning or more subdued.

Liquids are by heat dissolved and separated less easily than either gases or solids; because their molecules being less fixed and stationary, the first that are dissolved have the voids they leave so immediately filled up by others still undissolved, which gravitation impels to take their place, as every where to obstruct the progress of heat, and to prevent the passage of the force of decombination,—every where of this latter to impede the thorough draft.

Substances gaseous and cohering, presenting between their solid molecules interstices disposed in peculiar orders and directions, will through these interstices conduct the electricity productive of heat in peculiar ways. Thus it is, that through different strata of air, piled one upon the other, we see decombining electricity and heat chase the light it causes to decombine and to be evolved, before it, in the shape of thunderbolts, or, of what is called forked lightning, alternately in one direction and in another opposite direction. Thus it is again, that on board of a vessel the electric fluid will be made unaccountably to dart by certain substances and objects, without singeing them, while it wholly destroys certain others,—that it will spare a man's integuments, while it reduces to ashes his vitals,—that it will sometimes in his nervous ducts, before pervious, cause such derangements as in these to obstruct all power of sensation or or movement, and at other times will again in these ducts already deranged remove the obstructions produced; and cause a man, become deaf or blind, to be again restored to sight and hearing; a man disabled by palsy again to recover his power of movement.

It is from the radiance of electricity and heat travelling most readily in the direction in which it meets with least impediment, that it travels easier from the body of the globe outward and upward into the atmosphere, than from the surrounding atmosphere it travels downward and inward into the globe; and that fuel is easier kindled from underneath than from above.

I have already observed that heat, made from underneath to penetrate into liquids, by first expanding their lower molecules, and causing these by their increasing lightness to rise, while others from above, remaining proportionably heavier, sink in their place, in these liquids causes eddies.

The first degree of heat, beyond that which only from within so uplifts part of a mass of liquids, as to make it bubble up and overflow its bounds, makes these bubbles burst and separate in vapours; and it is only because vapours still have cohesion enough to keep heat to a certain degree imprisoned within them, without being permitted entirely to escape and to be dissipated in surrounding space, that that heat, by its own distension causes the vapour to distend, and to drive other surrounding bodies before it with a force which, when it is itself entirely dissolved in gas or radiance, and suffers heat entirely to escape, it again loses.

The expanding power of heat which drives gases on all sides and in all directions before it, when it causes these gases to be in their flight greatly accumulated, causes them to exhibit in peculiar directions that increased pressure called wind; which, from where the penetration of heat first produces it, blows alike in opposite directions, but which at a further distance from its origin appears only to blow in a single direction; and often from accumulating, with gases, the cold these contain, increases that cold, though sometimes, from conveying along more heat, it also increases the feel of heat.

Often in different strata of air arise at different points different foci of wind, which at different distances from their first source are seen to blow in different and opposite directions.

Where, from peculiar causes, at peculiar periods, and in peculiar regions, electricity and heat are made to drive the atmosphere more constantly in peculiar directions, they cause what are called trade winds.

Where a wind in its progress in a peculiar direction is, by a contrary wind coming from the opposite side, so resisted as to be made with it to move in an eddy of its own, it is called a whirlwind.

When in an atmosphere charged with vapour, heat from different quarters makes that vapour so distend as in other quarters again to collapse, and by its own weight to fall to the ground, it forms what are called heat drops.

Where in bodies, partly liquid and partly solid, heat penetrates sufficiently to drive the liquids out in the shape of vapours, without penetrating sufficiently to decombine the solids, it causes, by the escape of the former, the latter to increase in solidity and dryness so greatly, as to render them less liable than they were before to be by fermentation or putrescence entirely dissolved; as we see in mummies.

After both cold and heat have, to a certain degree, penetrated into substances, the heat imprisoned in them may, with a certain portion of their other component elements, be so pumped out as to leave the cold more to prevail, and to congeal what remains more strongly; as we see in a Leyden jar.

Where of a mass or mixture of different substances, reduced to a liquid state, by the removal or evaporation of part of the force of combining electricity, or by the penetration of fresh forces of decombining electricity, certain sorts are again made, from that state of liquidity, to pass into a state of gas, this conversion, according as it takes place more rapidly or more slowly, presents the conditions of effervescence or of fermentation. Sometimes, after of compounds certain substances are by effervescence or fermentation thrown off, the remaining ones, instead of being left to subside, again from without take in new gases, which again of the compound change the nature and the faculties.

Of lime, in its dry and solid state, when water is poured upon it, the hydrogen, or heat and light contained in that water, again causes a decombination, in which of that lime, thus far called quick, the acrid and corrosive parts are again made to evaporate, and the others remaining to collapse and subside in the milder, more quiescent, and less corrosive form of slackened lime.

As solid bodies have surfaces more rough and more uneven, these surfaces, leaving heat more room to escape at, leave it from within to escape faster. From a solid body in immediate contact with an expanse of colder external air of indefinite extent, heat will escape faster than it will from a body from which it only is left to travel a short distance, before it again meets with another solid body or envelope, from which it is in part again reflected backward to the body whence it first emanated.

The heat directly, and at first hand, radiating from the sun, seems, on a superficial view, to have more power of giving plants savour and odour, than that which has already been incorporated in, and is again, by combustion, let out of earthly substances; but this, probably, only arises from the heat directly emanated from the sun coming to the earth accompanied by rays of savour and odour more abundant, and which in their diffused and imperceptible state incorporate themselves with different earthly productions more copiously, than do the rays of heat only at second-hand again emanated by such earthly bodies as those serving for fuel.

Of the heat in the day-time from the sun radiated to the earth, at night, when, of this radiance from without the pressure ceases, a certain portion is from the earth and from its productions again radiated into outer space.

It is because the radiations from the sun, which in the day-time cause particles of humidity to remain detached and suspended in the atmosphere in the state of gas, at nightfall leave those same particles to collapse and to descend in vapours to the surface of the earth, that they then appear condensed in the shape of dew; and it is because thick clouds hovering over the earth intercept and arrest even at night the radiations of heat from the earth upwards, that murky weather, which causes those radiations in that state of the atmosphere still to remain more accumulated near the surface of the earth, causes in that weather before the morning the dispersion of that dew, which, in serene weather, the more rapid escape of that radiation upwards in the atmosphere leaves condensed near the surface of the earth.

When, within portions of substances, already by electricity of a combining sort and cold combined in solid bodies of a peculiar definite form internal and external, other fresh substances still radiant, fluid or liquid, are from without poured and made to penetrate in such a manner, as within these former solid forms and bodies to consolidate in new solid forms and bodies, attached to these former ones, the substance or body is said to be living. As we shall presently more amply see, no boundary line can be drawn between things lifeless and living.

When, from those new portions of substances before fluid being made to consolidate within, and to cohere with those already solid and cohering, these former solid aggregates derive additional size and extension, they are said to grow. When, the new substances flowing in, while with a part of those already consolidated and cohering they are again made to cohere in solids more extensive, they are at the same time made on another part thereof so to press as again to loosen that other part, to detach it from the former, to drive it out and to make it evaporate, the solid aggregates are said to experience change and renovation, which already implies partial decombination and decay. When, from the increasing pressure of the new elements from without on those already consolidated within, these latter again, in their turn, loosen and drive more of these substances from within out than are allowed from without to come in and replace them, the decombination, the decay and the waste, become more general; and when, finally, the substances consolidated within are, by the very pressure of former ones from without, disabled from taking in more such, and when, from first being by such renovated, they at last lose their faculties of life and further combination entirely, they are said to die.

People are mistaken when, in substances gaseous, liquid or solid, and decomposing, whether in the mode of detonation, explosion, slow combustion or other, they regard the fire they show and the flame they emit as the instruments of that decomposition; because fire and flame are used to communicate combustion from one object to another.

Many bodies apparently composed of less light than others are by heat again dissolved without emitting any visible flame. In all bodies, the decomposition, by decombining electricity caused, precedes the flame. It is only after this decombining electricity has first loosened and detached some of the portions of the body first formed out of condensed light, that these portions, again escaping, show themselves in the shape of flame; and flame thus is not the cause but only the effect—the later symptom—of prior decombination. Flame is only the state of transition, or gas, intervening in light between a state of consolidation and a state of radiance. It is, moreover, the vehicle in which the decombining electricity issuing from it, may more easily from one body be conveyed and communicated to another.

Of light and colours, the portions by combining electricity incorporated in solid bodies, and by decombining electricity again driven out of those bodies, while still near to those bodies, retain around them the shape somewhat cohering and distinct of a gas, itself still visible to the eye, called flame. At a further distance from those bodies this flame again becomes unravelled in the shape more diffused of radiance, becoming entirely invisible. When combustion later comes to a close, the intermediate state of gas or flame itself again becomes imperceptible; and objects seem, at once, from a state of a red hot coal to be reduced to a state of radiance.

In vast decombinations of substances, especially in the rapid mode of detonation and explosion, and even in that of more gradual combustion, the particles driven out create such a rush and pressure on the surrounding substances of air, as in these to produce vibrations and radiations of noise very loud, which we perceive in the clatter of thunder, in the report of a gun, and even in the rustling of wind, and the roar of a violent conflagration.

When electricity and heat, first imprisoned in clouds, break forth from these, and, in their condensed state, strike a body, this circumstance is independent of the lightning by which this thunderbolt is accompanied. This lightning is only the condensed light which the current of electricity again distends and drives before it. The same is the case in the detonation of earthly gases made to decombine. Solids, when by oxidation their decomposition is facilitated, also, whether they decombine in the shape of rapid explosion or of slower combustion, are made to emit, in the form of a flame more transitory or more lambent, the light that was imbodied in them.

The sun—the first great receptacle of the radiance of cold, of heat, of light, of colour, of flavour, of odour and of other forces and substances, within the precincts of our system first formed—is, by the pressure of these elements from within again recoiling outward, of them again at all times made to emanate a great deal. By the coloured canopy of fluids which surrounds the body of this sun, that body seems first from its interior to pour out these substances in the shape of flames, and only at a further distance from its surface again to unravel them in pure radiance, before, in the latter state, they are made to hie on to surrounding planets. While traversing, in their diffused and radiant state, the unbounded regions of intermediate space, only the rays of cold seem perceptible to such senses as ours: the others appear imperceptible; and only as they approach nearer to, and are again condensed round inferior planets, do they in part again become more perceptible, prior to their absorption by and incorporation in the bodies of these planets.

From the body of this planet, and of the substances produced by the same, especially when and where the pressure of the sun upon these substances seems for a time, during the night, to subside, of the light and other elements taken in a portion seems again to flow out in the shape of phosphorescence; as we see in minerals, vegetables and animals, even while they still remain, upon the whole, in their state of combination: and when these substances again are by decomposing electricity more entirely decombined, that light is again poured out of them in quantities greater and more perceptible.

In many substances, from which mere repletion of heat and light suffices not alone and without assistance to make these elements sensibly emanate, the smallest pressure or friction from without will increase the quantity of that heat made to penetrate within them to such a degree, as to make it again exude from and decombine the body, and drive its light out, and cause the body to dissolve by detonation, explosion, or combustion. Even ice may be struck so as to emit not only electricity and heat, but light, in the shape of sparks of fire; before certain of its particles, by liquefying, again obstruct the passage of the fire, in some of them kindled, to other particles more distant.

While certain electric phenomena, such as aurora borealis and australis, only appear to proceed from electricity of a combining and compressing sort, productive of cold; and only to arise from this electricity when, compressing certain portions of light and other fluids into solid bodies, it again of these fluids drives other portions from between these former ones outward;—because these phenomena are chiefly seen in polar regions, in winter, and high up in the atmosphere, where cold is most intense,—other electric phenomena, such as bolides or fire-balls, falling-stars, or those more condensed effects of the same cause, the ærolithes formed of atmospheric gases collapsed and fixed in solid masses, which by their density and gravity are driven to the earth, appear effects only of electricity decombining and productive of heat; because they are mostly seen in tropical climates, in summer, and nearer the earth, where heat is more condensed and more powerful in its action; and because of the atmospheric vortex and pressure the diameter, lessening as it approaches nearer to the nucleus of the earth, makes them in their way to that earth describe a line oblique and diagonal, before they either reach its surface or again evaporate.

Where substances and bodies are originally composed, not only of white light, but of different colours, of those colours the sorts imbodied last and most superficially will by electricity and heat again be driven out first. Thus some substances and bodies, on being ignited, emit a flame first blue, next red and next yellow, before colour being all burnt out, only leaves a flame entirely white; which, when likewise ceasing, reduces what remains of the body to decombine immediately in radiance no longer perceptible to the sight, but only to the feel: and those bodies in which radiant substances calculated to affect the taste and smell have first been incorporated so gradually and imperceptibly as in them to remain quiescent, and for a time not to strike the sense, when suddenly by decombining electricity put in motion and made again from them to emanate, so as to reach the sense in greater quantities, will then again affect this sense with a perception of their exit.

As the radiations of combining electricity and cold, when reaching the sense of feel occasion in the same a peculiar sensation, so the radiations of decombining electricity and heat, when reaching this sense occasion in the same a peculiar sensation again different from the former, which while in moderation, and benefiting the organs, is agreeable; but when excessive, and injuring those organs, becomes irksome and painful.

And, as from substances by cold combined that cold issues morê rapidly into the organs of sense, that cold is by these organs felt more forcibly, so likewise, as from substances by heat decombined that heat issues more rapidly into those organs, that heat is by these organs felt more forcibly. Objects containing a certain quantity both of heat and of cold will to the hand feel cold, when from them that hand, hotter than themselves, extracts more radiations of cold than of heat;. and will to the hand on the contrary feel warm, when from them that hand, colder than themselves, extracts more radiations of heat than of cold.

CHAPTER XXVIII.

Effects of gravitation continued.

As we have already seen, earlier centripetal gravitation, from without through time poured into space, and made on all sides from the outskirts of that space to advance inwards to its centre, and from that centre again to recoil or to advance outwards in a centrifugal direction, and to form, by its meeting with further centripetal gravitation from without, the modifications of electricity and of substance ; and through the electricity it forms, to consolidate part of that substance, and to impel that part first again in a centripetal, and next in a centrifugal direction, must ever be followed from without by fresh gravitation first centripetal pressing earlier centripetal gravitation forward, and pursuing the same course.

Gravitation must thus continue to this day to exert the same power which it exerted from the beginning of time over all that it first created and ruled ; and to this day, if any where of that force of gravitation the usual direction be by any unusual accumulation and resistance reversed—if in any place at which it usually preponderates in a centripetal direction it is made to acquire a greater force in a centrifugal direction, all the effects usually arising out of its former direction will also be reversed.

The stone before from the heavens dropped on the earth, is then from the earth again made to rise on high; the plant to shoot up its roots into air; the very animal has the course of its fluids so altered, that instead of contributing to the support of its life, they cause its speedy death. A man need only stand on his head for a few minutes to be suffocated.

Now in that spot where, from all sides of the circumference of space, all the later forces, elements and substances within its precincts by gravitation formed, ever continued to be by that gravitation propelled inward in a converging and centripetal direction unto its very centre, in the way most equal and most balanced, they would, from the pressure and influx mixed in this manner most even and balanced, at that centre form and increase a globe, from its earliest and inmost core to its latest and outermost circumference growing, and again by recoil from within outward pouring forth and emanating forces, pressures, elements and substances, diverging and centrifugal, in the mode most even and balanced.

The forces, elements, pressures and substances of gravitation, electricity, cold, heat, light, colours and others of later date, from without pressing upon earlier forces and elements already situated withinside them, would there press upon these in a mode on all sides so direct, even, balanced and free from obliqueness and partiality—from excess, deficiency and disproportion to each other—as there to form and to increase a globe, from its innermost core to its outermost circumference, and from its first commencement to its latest continuation, only presenting, and by every new accession of materials only increasing, one single genus of formations, homogeneous in all their lesser component parts near or distant; and in that single genus one single individual, every where in all its component parts equally connected, equally from within growing in extent, in faculties, in light, in movement, in life, in sensations, in thoughts, in will and in action outward; without any where in any of its attributes experiencing the least deficiency, arrestation, interruption, stationariness, and still less, retrogradation, decrease, death, or dissolution.

These forces, elements and substances would there form a globe, from its innermost core to its outermost circumference, and from its first commencement to its latest continuation, wholly exempt from being, by gravitation and electricity, cold and heat, light and colours and other forces and elements, from without pressing on earlier ones already within, in a mode oblique, indirect, partial, uneven, unbalanced, disproportionate, and in some portions of time and space too strong or too weak relative to those penetrating into others, in different times and places made to show, here accumulations and stationariness, there attenuation and volatility,—here pressures and there resistances,—so excessive or so inadequate to those shown elsewhere, as to produce genera, and in these genera individuals simultaneous and successive, formed and made to grow separately from and independent of each other; some stopped in their individual growth, extension, and development by that of others, and others by their individual growth and extension and development again interposing between and preventing that of the former; and all liable to have of the materials of further gravitation, electricity, cold, heat, light, colours, life, sensation and thought, the further entrance in, and movement, circulation, and transit through them so stopped, as to be again partially doomed to immobility, obscurity, insensibility, ignorance, error, even injury corporeal and mental, and finally, decay, death and dissolution.

But in proportion as from that globe most primary and most central, we passed more over to other surrounding globes more late and partial, partly only by the forces, elements and substances again from that first and most central globe issuing outward in a centrifugal direction, and partly by fresh forces and elements directly from without to that central globe converging, till further from the same and nearer to the circumference of space, the two opposite forces met and arrested each other, formed and increased, we would more, by the manner oblique, indirect, uneven, and partial, in which from opposite sides these opposite forces were made in these secondary globes to meet, find them by opposite pressures uneven, oblique and partial forming in one period and place accumulations and condensations, cohesions and consolidations, and in another period and place again forming gaps and lacunæ, diffusions and separations, so disproportionate to each other, as to compose genera, and in these genera individuals in time and space only partial and divided from each other; and many of these individuals again ceasing of gravitation, of electricity, of light and of other elements to receive any further influx, and circulation and transit, even before they attained any faculties of life, and sensation, and thought, and will and voluntary action at all; and all those even that by further development attained such faculties, alike liable to have their extension, by other genera and individuals, from other centres developing in a sense opposite to their development, so interfered with, as soon again to be by this interference subjected to injury, suffering, decay, death and dissolution.

Thus while the earliest and most central globe—the abode of immortality, and of ever increasing perfections, powers, faculties, sensations, thoughts and happiness—exempt from imperfections, from injuries, from sufferings and from death,—would constitute what we call heaven, the later and more partial surrounding globes, necessarily offering different degrees of imperfection, of injury, of suffering and of death, intermixed with and alloying life and happiness, would present the various approximations to, or stages of what we call hell: from whence their tenants look up to that heaven to which their emanations will probably at last return, as to their ultimate prospect and hope.

And as far as we can trust to our faint perceptions of the systems of globes situated beyond our own, and to the more distant parts of our own system, our observations on the same already confirm this theory.

Already, when compared with what our reason tells us to be the condition of the first and most central globe of all—that globe which from the remote corner of the universe occupied by us our sight cannot yet reach, even those stars called fixed—those suns of other systems most immediately after and through the channel of this primary globe formed,—already, by their progressive movement in space, show that the pressure of gravitation from opposite sides falls upon them in a mode somewhat uneven, oblique and unbalanced; and give the assurance that from their movements, uneven and unbalanced, they must derive other further pressures and influxes equally uneven and unbalanced, causing in their internal constitution a considerable inferiority to the first and most central globe, as well as difference from each other; circumstances which the peculiarity of the colours they shine with and emanate, and the difference of the hues of some from those of others, fully confirm.

In the atmosphere that envelopes our own sun, the gaps and fissures called spots, visible from the earth, and constantly changing in number and in size, show the changes and inequalities constantly going forward in the exhalations rising from within.

But in the planets that surround our sun, the effects of the unevenness, obliquity and partiality of the pressure from opposite sides that first composed and still continue and increase them, seem more evident and more striking. These planets, all again less stationary, less fixed in their places, —more tossed about, more dependent in their movements on the influence of higher bodies—even than our sun itself, again at different distances winding round that sun, are subject to all the vicissitudes arising from their more complicated movements.

And even among these planets how great must be the difference!

Perhaps in the globes of our system most distant from its centre, of the cold and the heat there from gravitation and from electricity arising, a less quantity made to reach the sun, and a greater proportion immediately diverted to these secondary planets, might leave a dependence on the returns from that sun, for supplies, less urgent than exists in planets formed nearer to that central orb.

But be this as it may, where even nearer that sun the pressure of gravitation from opposite sides on a planet, still of that planet, as it does of Jupiter, left the axis of rotation round its own centre to coincide with the diameter of its orbit round the sun, as long as from that sun itself emanations on all sides issued in equal quantities, they would necessarily in the planet fall on each part of the same zone in equal proportions. Each zone would still, throughout every successive period of the continuation of the planet, have alternate days and nights of equal length—an equal alternate degree of heat and cold. There would in the planet be no alternate vicissitudes of distinct prolonged summer and winter, each separately continuing during a certain series of days and nights. There would not be days and nights more distinct at the equator, more blended at the poles. Vegetation must in each zone continually go on at the same rate, and with the same rapidity: though even here certain zones receiving from the sun rays of heat more vertically, and others more obliquely, might from these rays receive developments at all times very different.

But where, as on our globe, to other irregularities of situation and movement still is, by a pressure of gravitation from opposite sides uneven and ill-balanced, added the irregularity of a rotation on its own axis oblique to, and acting at an angle with, the diameter of its orbit round the sun, that second irregularity produces in each of the different zones of the planet individually, at different seasons of the year, a difference in the quantities of light and other forces and substances received from the sun, which must again infinitely increase its other irregularities and vicissitudes, in their turn arising out of these same circumstances.

Yet can even the irregularities, the unevenness, the vicissitudes of too great pressure and too great yielding, too much speed and too much torpor, too great condensation and too great diffusion—the distinctness, and partiality and interference of genera and individuals, distinct and different in time and place from each other, and from different centres extending in opposite directions, and conflicting with, and subduing or subdued by others, and causing in each individual alternate vicissitudes of growth, development, welfare and injury, happiness and misery, advancement and retrogradation, life and death, combination and dissolution, which, on this globe, are every day experienced, only again be trifling compared with those which mark the globes again appearing in the characters of later satellites to planets themselves.

In many of these satellites no combinations perhaps ever reach that degree of development in which to mere sensation of the present is added recollection of the past, or anticipation of the future; or where to mere insentient vitality is added sensation; or even to mere mineral consolidation are added organization and life. The extremes, the vicissitudes of cold and of heat are perhaps, in these satellites, too great yet to produce any life, any sensation whatever. They may yet only present the solid forms of mere metals and stones, mere ice and snow—may, perhaps, only to the forms and substances add the vicissitudes and movements of mere hurricanes and deluges, earthquakes and volcanoes. Such, at least, seems to be the condition of our own moon.

What shall I say to those congregations of substances; those bodies by a gravitation again more uneven, more unbalanced even than that which formed and moved satellites, in their turn composed, which under the name of comets still are compressed, moulded and moved in a manner so irregular, as yet to know no peculiar parent, to pay allegiance to no peculiar ruler; to be attached to no peculiar principal; as, like entities, unavowed by all, and erring unclaimed through space, at one period to be driven to the furthest extremities, and at another to be brought close to the innermost recesses of our system.

Many of these seem not yet in any of their parts to present any of that permanent solidification, cohesion and form, which is the result of mere cold and congelation. If at one time pushed to the utmost outskirts of our system, where, perhaps, cold and condensation preponderate most, they seem to assume the solidity and torpor of ice, at another time, and when again driven to the inmost centre of that system, where the sun reigns with least control, they are made to experience the distention and diffusion of mere vapour, gas and radiance. If any of them may, during the transient periods intervening between their alternate approach to either extreme of their elongated orbit, produce any hasty vegetables or animals, these must at one period have their vitality, by the extremes of cold which torpifies every fluid, again arrested; and at another period have that vitality by the extremes of heat, which again dissolves every solid, annihilated and destroyed.

And in proportion as by their situation these bodies acquire less internal capacity for stability and for repose, they seem, in a greater degree, to possess the unenviable privilege of disturbing the security of other bodies better gifted. The comet of 1680, during its period of density, gave Jupiter a shock and a deflection from its former course, from which even the later rushings in of gravitating force and pressure have never yet permitted it to recover: while the subsequent comet of 1778, in a state of greater diffusion, passed several times across the satellites of the same planet, without causing in their general movements the least derangement perceptible to us; whatever deluges or other injuries of a more partial description it might, imperceptibly to us, have produced at their surface.

Wherever took place, and by whatever circumstance was caused, on this peculiar globe of ours, the pressure of gravitation so uneven as to produce in its motions round its own axis the deviations from its orbit round the sun,—the obliquity, the tilting over, the inclination—which it now presents, this irregularity in its situation, and in its aspect relative to the sun, must account for many of the other irregularities which we at present witness on its surface.

CHAPTER XXIX.

Of substances all alike first radiant, gaseous or liquid, all subsequent combinations and consolidations again later and more complex than those called mere congelations, whether they still only be in bodies merely mineral, inorganic and lifeless, or whether they be in bodies organic and living, vegetable, sensitive or also intellectual, and whether they only be in forms merely cellular, or also in forms vascular, are still produced by remodifications of the same force of combining electricity and of cold, by which already are produced the earliest and simplest crystallizations called mere congelations; and like these simpler consolidations are made to commence in forms merely crystalline.

I BELIEVE electricity productive of combination and cold to have in substances produced not only the sort of combination and consolidation ending in cohering solids called mere congelations or ice, but also every other sort of combination and consolidation into solids more late, partial, complex and cohering, which we know, whether still only called merely mineral, or whether vegetable and animal, vital, sensitive and intellectual; whether only remaining cellular, or whether also in part becoming vascular.

I believe that not on any difference in the force combining, but only on a difference in the substances combined—on the number and the proportions relative to each other of the latter,—depends whether these substances be only combined in solid bodies called mere congelations, or in other different bodies still merely mineral, vegetable or animal, of a later, more partial and more complex description—whether in bodies merely cellular, or also in bodies of a vascular sort:

Because, firstly, like mere congelations by electricity of a combining sort and cold into mere ice, all other consolidations later and more partial into solids more complex and fine, mineral, vegetable and animal, unto the very last and highest into human organs vital, sensitive and cerebral, first from a more external space take their beginning, and only more gradually act upon and penetrate into the substances thus far still fluid, more inward, which they combine; and in these produce their consolidation further inward by such progressive degrees, as still only to have the inside of their mass fluid, after the outside envelope already is consolidated—witness all organs, vegetable and animal not yet solid throughout, but still within their integuments containing saps and fluids:

Because, secondly, in the same way as in the consolidations by electricity of a combining sort and cold into mere ice, in every other consolidation and crystallization later, more partial and more complex, whether in bodies cohering and solid still merely mineral, or already vegetable, animal, vital, sensitive or intellectual; whether in forms still remaining wholly cellular, or whether in forms already also partly becoming vascular, we still retrace, while the process is going on, the same effects of forces shooting, radiating, resisting, crossing each other, vibrating, oscillating and alternately dilating and contracting, already perceived in mere water, when by combining electricity and cold only still made to congeal into mere ice; or, if we no longer perceive them, do not cease doing so from their internally ceasing to be, but, on the contrary, from their becoming so numerous, so rapid and so minute, that our sense can no longer continue to receive of them a distinct perception:

Because, thirdly, some substances, first still radiant, gaseous or liquid, even more complex in their component elements than mere water, such as certain metals, salts, &c. themselves still evidently are by mere combining electricity productive of cold, from a state of fluidity consolidated into the solid and cohering forms they display;—because in their solid and cohering state they still only remain congelations somewhat more complex, more permanent and more resisting the decombining power of the electricity causing heat, than do the congelations of mere water into mere common ice; because like them they ultimately are by mere heat again liquefied and dissolved in gas and radiance—witness gold, silver, brass, and iron, all by a certain degree of cold alone still rendered solid, since by a certain degree of heat alone again dissolved:

Because, fourthly, like the mere congelations by electricity of a combining sort and cold of water into ice, all other consolidations later and more partial of substances more varied than mere water, into solid forms, mineral, vegetable and animal more complex than mere ice, while they are going on, still are accompanied by a peculiar influx and absorption, in the substance consolidating, of cold; evidently felt not only in the congelations of water into ice, but in the consolidations of certain minerals of a more complex sort, such as of liquid mercury into a solid mass, and of liquid salts into solid cubes; which again, when dissolving, as evidently let out that cold which in consolidating they evidently took in: because if in certain sorts of consolidations more fine and minute, mineral, vegetable and animal, going forward outside our bodies, we no longer perceive the cold rushing into the substances solidifying, this arises merely from the quantity of cold entering into them, no longer making in the quantity of that drawn out of our frames any perceptible difference; and because in the consolidations and assimilations after a hearty meal going forward in our own bodies, a sensible chill again pervades these bodies themselves:

Because, fifthly, like the first crystallizations by electricity combining and productive of cold formed under the name of congelations in pure water, when transformed into hailstones, snow-spangles, flakes of ice, and ramifications of rime, all other later consolidation, whether merely mineral, vegetable, or animal, vital, sensitive, or intellectual, merely cellular, or in part also vascular, alike first and fundamentally still show those forms composed of alternate parietes and intervening pores, that cellularity, those alternate facettes and angles, still called crystallizations, always similar in bodies composed of the same sorts of substances, and united in the same sorts of proportions, and always different in bodies composed of molecules of different sorts of substances, or united in different relative proportions, which necessarily arise from the combination by electricity and cold of molecules, already having singly peculiar forms always the same in the same, and different in different substances; before, by further continuation of this same combining force of electricity and cold, of these cells aggregates more extensive are again spread out and made to cohere into collective forms still thin and flat, but more laminar and follicular, themselves again in their turn by later reduplication of the laminæ made to form solid bodies more thick and dense; which in part again subsequently, by later weights pressing upon the centres of those bodies till they make their sides curl up and their edges rejoin over their more fundamental parts underneath, are more partially converted into the shape of those cylinders or tubes called vessels:—as we perceive in the crystallized strata of mineral bodies, the leaves of vegetables, and the laminæ of animal muscle and membranes, only by degrees from fluids changing to solids, and from solids merely crystalline and cellular, again partly made to become vascular:

Because, sixthly, in all substances consolidated in a form later and more complex than that of mere congelation, from that of the fixed star most distant from us to that of the mite within our grasp, we still find that elasticity—that dilatability and contractility—still to remain evident to the sense of sight, even when it no longer is perceptible to that of feel, in the scintillations of the stars, which already to a certain degree is a characteristic feature of congelations into mere ice; and denotes that the consolidations of these stars, like those of lesser bodies, only proceed from molecules of certain shapes having been, by the force of combining electricity, so approximated as still to remain susceptible of greater alternate contractions and dilatations:

Because, seventhly, all substances, already solid, whether still only aerial or already terrestrial; whether still merely mineral or already vital, sensitive and intellectual; whether still only cellular or already vascular, only appear in external size and in internal vigour—in developement, tone and buoyancy,—to increase faster, in proportion as the electricity productive ot combination and cold seems to exist, and embrace, and affect them in quantities more intermixed with that of the electricity productive of decombination and heat; and because peculiar forms and faculties can only be subsequently increased by the very same agents and media, by which they have been first produced:

Because, like the mere congelations into ice, all other consolidations, more late and partial, not only into bodies still inorganic, but even into bodies organic and living, unto the last and highest forms vital, sensitive and intellectual, still remain liable to be by the same power of electricity, of a decombining sort, productive of heat, by which already mere congelations again are decombined, also again decombined, dissolved and made to return to a state of mere radiance.

Because all bodies thus combined, unto the last and highest, in again decombining let out, mixed with electricity of a decombining sort or heat, a great deal of electricity of a combining sort or cold; not to advert to the very unusual quantities of decombining electricity let out by peculiar animals, such as the electric eel or gymnotis, the torpedo, and the professor Halman of Francfort on Oder; who can at all times let out at pleasure, from certain receptacles, certain explosions of electricity very copious; and because entities can only again let out what they first took in:

Because even where the functions, vital, sensitive and intellectual, are by too much electricity of a decombining, distending and relaxing sort, productive of heat, or by the later effect of such decombining electricity again weakened, reduced, obstructed and impeded, they can, by an artificial supply of electricity of a combining sort productive of cold, again be restored to their former tone, bracing, invigoration and permeability.

Because no line of demarcation can any where be drawn between consolidation effected by mere congelation, and between any of the other sorts of consolidation more fine, more tenacious, and more lasting here named: because the one insensibly passes over into the other; inasmuch as the congelations of plain water into ice, and those of saline fluids into solid salt crystals, and those of metallic fluids, such as mercury, into solid malleable metal, and those of molten iron into a hard and resisting lump, all alike present an insensible transition from mere congelations to consolidations more complex, and only depend for their permanence in either shape, on the quantity of cold or of heat made to penetrate into them:

And because, finally, if substances more complex than mere water are, by a force of electricity combining and productive of cold less sensible than that which is required to congeal mere water, already reduced to a state of solidity more lasting than that to which is capable of being reduced mere water, this is only owing to the molecules of those substances, more varied and more complex, presenting forms and dimensions which from their variety are enabled to be, by a cement of cold lest forcible, made to experience a degree of cohesion more intense.

So small a quantity of cold suffices to condense and cause cohesion between the molecules, probably very various and complex, which together form the compound called iron, compared with that which is required to produce cohesion in mercury, that even in latitudes on this globe which naturally accumulate most heat, iron still remains congealed in a solid mass; whereas in those latitudes in which accumulate least heat, while many other liquids remain condensed and congealed, mercury already again is rendered fluid; so that while iron is perhaps only constantly found in a fluid state in planets so near the sun as Venus, quicksilver is, perhaps, only found permanently hard and cohering in planets so distant from the sun as Saturn.

That electricity of a combining sort, productive of cold, can only, when in small degrees, cause molecules of substances, in their nature, form and dimensions more varied than those already combinable in mere congelations, to be combined in the shape of solids, mineral, vegetable and animal more permanent, appears, since water, which singly cannot yet be consolidated in a cohering shape more permanent and more closely knit than that of mere ice, already by the simplest heat again dissolvable, when again mixed with mercury and sulphur, already immediately consolidates into a solid body wholly dry and cohering, no longer by the degree of heat, which again reduces mere common ice into water, fusible; and when added to sulphuric acid and burnt clay, in the very midst of its effervescence, suddenly turns into a solid artificial stone.

And that the smallest quantity of positive cold already suffices to congeal and render cohering certain substances, which the smallest quantity of positive heat again suffices to dissolve, we may see in that potassium, which, when congealed, may even on a sheet of ice again, by the mere penetration of heat from the surrounding atmosphere, be made to kindle up, and with a bright flame to return to a state of radiance.

If, on the one hand, certain substances, like pure water, already capable of being singly, by electricity of a combining sort and cold, consolidated in the crystalline forms of mere congelations and ice, are not yet singly capable of being, by that combining electricity and cold, combined into the crystalline forms more durable, more resisting heat, in which even substances more late and complex, still only mineral, and, above all vegetable and animal, are by the same or even by a less degree of electricity of a combining sort and cold, consolidated:—if water requires the admixture of other substances, in order to be combined into these modes more cohering and tenacious than that of mere congelation, mineral, vegetable and animal; while substances more complex are already capable of being by electricity of a combining sort, when accumulated in great quantities, more hastily combined into mere congelations and ice, as well as when diffused in smaller quantities, more slowly, and leisurely and gradually combined into forms, mineral, vegetable and animal, more complex and tenacious;—this, probably, only arises from these molecules of mere water singly not yet possessing that variety of forms relative to each other, necessary to render a small degree of the pressure of combining electricity able to give them that cohesion more strong, intimate, lasting, and impenetrable to the decombining force of heat, which the forms more varied of the molecules composing the latter bodies already suffice to give them; while the more varied forms of the molecules composing the latter bodies, at the same time that they enable these to be, by a degree of electricity and cold less condensed, and perceptible, combined into these forms, mineral, vegetable, and animal more firm and cohering, do not prevent them from being already, by a cold more intense and accumulated, congealable more hastily into mere ice: and what confirms this supposition is, that, in fact, the cold which condenses substances in the way of mere congelation is always very perceptible to our senses, while that which consolidates substances in these latter modes is so diffused as often to become wholly imperceptible to those same senses.

Though molecules of substances can only be made to cohere by having their solid parietes divided by intervening interstices or voids; and thus can only first be combined, in the way of crystallization, it is not essential to their cohering to a certain extent, that these substances, and thus, the form and disposition of their solids and parietes, should, to that full extent, be homogeneous and similar. Substances and crystallizations of one sort may cohere with substances and crystallizations of another different sort; and often, on this globe, the uneven, irregular, and confused mixtures of substances have produced cohesion of molecules so varied, as to render it impossible any where in a solid mass to detect a peculiar mode of crystallization, or to distinguish it from another again different. But such is the tendency which molecules of different substances, from their peculiar form, receive, to a peculiar mode of crystallization, that as soon as in a fluid aggregate any peculiar species of substances and molecules preponderates, these preponderating substances generally are, by the pressure of electricity, made to extricate themselves from the rest, and to form crystallizations more distinct, protruding from the more mixed mass, which then is called their matrix.

That the light and the colours, which already were the chief component materials of mere water and ice, are still the chief component materials of all substances capable of receiving solidifications more complex and tenacious called mineral, vegetable, or animal, appears, since all mineral bodies, from that fulminating silver which on the least contact with air, and with the oxygen and heat contained and compressed in that air, unravels, inflames, explodes and disperses in gas and radiance, to that iron, which day after day, in the shape of a kitchen-grate, resists the hottest fire, and assists the combustion of the hardest materials, itself unignited and undissolved; and all bodies vegetable and animal, least readily inflammable, when heat is presented to them in certain proportions and under certain circumstances which favour its penetration into the same, are thereby made to decombine, ignite, inflame, and dissolve in the form of light and colours: iron itself, when reduced to minute filings, and mixed with sufficient oxygen to begin its dissolution, being by degrees seen to inflame, to burn, and to let out the light and colour contained in it; till the aggregate be entirely consumed and made to return to radiance.

I have already observed that all substances consolidated, whether in the form merely of congelation, or in other forms later and more complex, mineral, vegetable and animal, even when aggregated to the greatest thickness, as long as they retain between their solid molecules,—between their parietes,—pores and interstices sufficiently regular to let through the light falling upon them, and not to bewilder and retain it in their mazes, remain transparent; but that other substances in which this was not the case, only in very thin plates remain transparent, and as soon as conglomerated in thicker bodies, so arrest the light they receive from one side, as instead of letting it through in a straight line to the other side, to refract it at angles, or even to become entirely opaque, and entirely to reflect whatever light and colours they do not retain. The different relations which the forms of the molecules of substances consolidated bear to the different movements of the colours that fall upon them, determine, of the peculiar colours floating in air, those which they retain, and those which they again reflect. Sulphur, while solid, receives and retains the blue and reflects the yellow rays; whence, on being ignited, it again emits the blue colour. Gold with the blue retains part of the yellow hue; whence, reduced into lamina so thin as to let some light through, it shows a green transparency. Iron is supposed to retain invisibly that red which, emitted with rust, is reflected in carmine, gives to the rose its blush, and colours the blood of the higher animals.

Some substances, like water, and even minerals more complex, are already by cold made to cohere easily enough, already from a certain degree of cold in the very atmosphere to receive that cohesion which we find in hail, in snow, and in atmospheric stones: other substances mineral, vegetable and animal require the resistance and counter pressure of the earlier solid bodies of the earth to serve them as a mould, before they can be brought to a state of distinct, perceptible and permanent form and cohesion.

Some substances, especially of the mineral sort, after being solidified, still are by gravitation centripetal or centrifugal from the atmosphere overhead or from the globe underneath, in their interstices made to receive new fluids and gases which, from one side poured into, circulate through their mass, till at the opposite side they be again expelled. Sometimes in their way through these prior bodies these fluids detach from them and drive along in their passage part of the solids already embodied; and thus render and leave what substance remains solid, more porous and brittle: of this description is the red or brown rust of iron, and the green oxidation of copper. Frequently these rusts, on issuing from certain substances and bodies, again, with fresh fluids and gases from air combine in new consolidations and substances, again different from the prior nuclei and strata over which they are formed; and thus arise acids, alkalis, salts, sulphurs, earths and other later mineral formations.

Round the nucleus of centrifugal gravitation, which lay the first foundation of this globe; and within the mass of different gases, from substances first radiant round that nucleus congregated, and after the solidification of part of these gases first in the shape of mere congelations—of seas of mere water, and of continents of mere ice, still entirely transparent or merely white, which sketched out its earliest and inmost solid kernel—would first again with these bodies still merely congealed become intermixed other solids yet merely crystalline, inorganic and lifeless, but already, like metals, oxydes, earths, &c.

displaying, with greater cohesion and powers of resistance to the decombining force of heat, all the various hues of the rainbow; and which in time, by their further combinations and decombinations, again become ready to receive and to mould the substances still more varied that fall upon them, into forms still more complex, called organic and living.

Of this supposed progress of solid forms we find the confirmation in the mean density of this globe, calculated altogether as eight times that of mere water:—in the masses of rock salt which must line the bottoms of the most extended seas, and which in many places even protrude from among the later substances of the land; and in those metals of which the greater solid aggregates are every where only found, as we dig deeper into the primeval substructures and foundations of this globe; and of which only the later ramifications are beheld in those veins which ascend to the very surface of our earth.

Of this fancied progress of solid forms—of these successive creations of cohering bodies, beginning from the earliest and innermost kernel of the globe—while the mind suggests the idea, the sense can no longer obtain the evidence. The nature of the innermost kernel of the earth must evermore, while its external envelopes remain sound and intact, remain concealed from those entities that crawl over these latter. After the many later successive strata of various substances which have oppressed and hidden the earlier strata of the earth from our view, the very deepest expectorations of nature herself, through the channel and orifices of volcanoes, can no longer give samples of their internal composition; and still less can the puny efforts of man penetrate to their main body. These efforts, however great, can as little enable us to advance downward to the most internal solid strata of our globe, as upwards to the most external gaseous envelope of our atmosphere. The greatest depths in the bosom of our earth to which our tools can reach, amount not to the eight thousandth part of our ball's diameter. What lies further inward, hidden from our eye, can only be inferred by our mind. Any revolution in our planet, sufficient to expose its inmost bowels, must first sweep from its surface the last wreck of every entity capable of taking of their construction the least cognizance.

It has lately by some been supposed that all the molecules of substances mineral, vegetable and animal, before they are combined in larger aggregates, individually possess life: that of their faculties of life the exertion and the display are, by their combination in these larger masses, rather trammelled than assisted and increased; because of some substances which appear inert and motionless when seen in large masses, the molecules, when detached from each other, and reduced to dust, often are found to oscillate rapidly, to wind on their axis, and to perform other movements supposed to arise from internal powers of life.

To me this conclusion seems unfounded. To me it appears that the mere forces of gravitation centripetal and centrifugal, where from opposite sides meeting at such angles as to press unequally on different parts of intervening molecules, are sufficient to produce in these molecules movements similar to the rotations produced in the largest cohering globes ; when not rendered abortive by the cohesion of their mass or by other incidental circumstances: at any rate, that we are not warranted to attribute to individual molecules, singly and in their detached state, faculties which only seem to result from their very combination, their circulation, their change.

Among the substances evidently shown to begin in radiance, since already found among the highest and lightest atmospheric gases which by later compression of electricity enter into vapours, clouds, rain, water, snow and ice, but which on the earth are also found pure in greater masses merely mineral and unorganized, before they be found to form a component part of other bodies organized and living, vegetable and animal, is that called silica.

This silica has generally been supposed to have been combined neither out of the substance called light, nor by the pressure of the force called of combining electricity; because the substances in their turn in great measure composed of light, and by forces of combining electricity,—such as flint, spar, glass, rosin and silk—powerfully resist the decombining powers of electricity; and because when at last they yield to these powers, they are generally calcined without perceptible combustion, emission of light, or reduction to a state of radiance.

However, that silica is in part composed of light, and thus, in a solid state, contains light, is proved by a flint, when forcibly struck, emitting light in the shape of sparks; and since flint, when reduced to dust, may by decombining electricity powerfully condensed be dissolved.

So greatly however does silex resist more moderate powers of decombination, that it is considered as an ægis against such; and that, mixed with the other substances which enter in the composition of bodies vegetable and animal, whose component substances remain in constant circulation, it is by the centrifugal pressure from their insides again driven to their surface, and there by centripetal pressure from without stopped, condensed and accumulated in the shape of a pellicle called epidermis, which envelopes them. This pellicle screens these bodies to a certain degree from the general and forcible inrush of decombining electricity, and of other forces and substances; and only permits these so partially to penetrate athwart the interstices and pores left in this integument, as to permit its continuing to cohere, even when by that influx the parts more internal are again made to separate and to dissolve, —a phenomenon we may frequently witness, since an electric stream from without, sufficient to melt the metal case of a man's watch in his pocket, or to decompose the internal pulp of a pear, or to dissolve the internal muscle of a man's body, though covered by the epidermis, leaves of that epidermis itself the cohesion undisturbed, or only produces in the latter those partial lacerations—like those produced by a sharp instrument—which indicate a partial accumulation of pressure: and since the gastric juice, in which enters much electricity, though it easily decomposes in the stomach vegetable and animal bodies, of which the epidermis has been previously broken, leaves those of which the epidermis has escaped entire from the tooth, however soft and pliant, to pass through the bowels uninjured.

Silica, taken into the composition of bodies vegetable and animal, and from within these bodies again by degrees driven out, till again by later pressure from without at their surface accumulated and made to form a pellicle more dense and close, does on this globe both good and harm.

On this globe, where often, on objects and entities from without first formed and moulded, from without later pressures, penetrations and frictions become so excessive as, instead of only leading to their further combination, again to lead to their later decombination, this silex, by gradually from their different parts internal and external again exuding so as to form round them an additional external integument, envelope and partition, dividing each of the internal organs from the next internal organs of the same individual, and the whole of these organs of that individual from external surrounding space—by only letting pressures and penetrations from without through the pores of these pellicles into the body in moderate quantities, and excluding excessive pressures and influxes—gives the bodies thus enveloped additional means of resisting the excess of that pressure and influx from without. It helps to keep each of those inflowing elements within its proper bounds; prevents any of them from being by sudden shocks or by frictions confounded with other neighbouring ones; and serves them as an ægis—a shield.

On the other hand, on this globe, where already, in consequence of prior imperfections, substances are partially distributed and divided; where they are made to compose many genera, and in these genera, many individuals simultaneous and successive, again distinct from each other, and themselves again become the cause of other later imperfections, these integuments still increase this distinctness, this separate individuality; and often, by becoming obstructed and clogged, prevent even of elements from without that more moderate influx in the body, necessary to keep up from one side its circulations, its assimilations, its nutriment, and the other attributes of life and growth, which again are calculated on the other side, by supplying its losses and deperditions, to prevent or to defer its decay, death and dissolution.

CHAPTER XXX.

As gravitation centripetal, electricity combining, and cold, of substances first radiant produce the later congregations, combinations, and consolidations, not only in the form of congelations, but in all other forms more late, partial and complex, unto the last and highest of an intellectual sort—those of the cerebral system of man; so gravitation centrifugal, electricity of a decombining sort and heat, of substances reduced to any sort of consolidation, from the first and simplest into mere congelations and ice, unto the last and highest into organs vital, sensitive and intellectual, also alone again causes the later re-dissolution, even through the medium of putrescence, into forms of a simpler sort solid and fluid, unto that of mere radiance.

We have seen that of substances first radiant, all later combinations from that state of mere radiance into a state of greater solidity, cohesion and combination, effected not only in the mode of mere congelation, but in every mode later and more partial, mineral, vegetable and animal, unto that in the shape of the highest organs of the human brain, was effected more proximately or more remotely by the same electricity productive of cold and combination, by which the combination of these substances, in the mode of mere congelation, was already produced; and was thus still only a somewhat more distant offspring of the mere force of gravitation, from which both the substances by combining electricity and cold combined, and the electricity and cold combining them, already themselves arose.

We shall now see that, in the same way, of all substances, from a state of radiance reduced to a state of greater combination, solidity and cohesion, whether only yet that called of congelation, or whether any other sort more late and complex, mineral, vegetable or animal, merely vital, sensitive, or also intellectual, all later decombination again, whether more partial or more entire—whether still only produced by partial pressure or bruising, which still leaves many molecules to cohere together, or by more general melting, which again separates each individual molecule from the rest; whether by putridity, fermentation, effervescence, slow combustion, rapid explosion, or still more rapid detonation, by which even the still solid molecules of gas again return to mere radiance, proceeds either from that same force of decombining electricity and heat, from which already proceed the earliest modes of decombination, called melting, thaw, conflagration, explosion and detonation, and thus again proceeds more distantly and mediately from that power of decombining gravitation, from which electricity of a decombining sort itself, in its turn, more immediately proceeds; or themselves even from that decombining gravitation more directly and immediately proceed.

That, where from more distant opposite points in space, forces of gravitation, of electricity or others, or the substances by such forces formed, aggregated and moved, have been driven to each other by a pressure and propulsion no longer on both sides so even and balanced that, when in contact, the force or substance from each side advancing equally resists the pressure and progress of the force or substance from the other side advancing, so as to render and be rendered by that other stationary, quiet and cohering with it in a single aggregate and mass, but, on the contrary, by a pressure and propulsion so uneven and unbalanced, that, where in contact, the one preponderating divides the other, and breaks athwart that other, or forces that other to retrograde, while itself continues unimpeded to advance, the mode of decombination thence resulting proceeds directly from peculiar modifications of the force of gravitation, is a thing too plain to need any proof.

That when bodies solid and cohering, organic or inorganic, are thus, whether by tearing, breaking or bruising—dissevered in lesser parts or fragments;—whether these fragments still remain large and few, or whether they become so numerous and small as only to assume the shape of an impalpable powder,—while the distinct particles still preserve in their component molecules a sufficient cohesion to give a feel of dryness, this decombination is still produced more immediately by gravitation pressing on certain parts of this mass more than on others, no one can doubt.

Nor can any one doubt that even, when of bodies solid and cohering, organic or inorganic, more late, more complex and more tenacious than mere common ice, but still fusible, the decombination is so much more general than that just described, as to render the molecules of substances all again distinct and separate from each other, and again from dry to make them, by the process of dissolution and melting, become liquid, this decombination, evidently more proximately the effect of that same power of decombining electricity and of heat, from which already arises the decombination of ice, and snow, and other congelations into mere water, is thus more remotely and mediately also again the effect of that earlier and more general power of gravitation, which is the parent of all electricity, both combining and decombining.

This then being thus far self-evident, I have only to prove that all other species of decombination, by what is called putrescence, fermentation, effervescence, slow combustion, or more rapid explosion or detonation ; or in any other way more general and entire, that can, in solids which have possessed organization and life, or even in solids of a mere mineral sort more complex and cohering than mere congelations, take place, is still only an effect of the same power of decombining electricity and heat, from which already the decombinations of former combinations in the shape of mere congelation arise.

That all these decombinations of solids more complex, organic or only inorganic, likewise only arise from the distending powers of mere decombining electricity and heat, I believe, because, firstly, all the substances, by electricity of a combining sort and cold combined, not only in the mode simpler and less tenacious of congelation, but in every other later mode of combination more tenacious, mineral, vegetable and animal, can again have their combination by mere electricity of a decombining sort, productive of heat, when carried to a certain degree of intensity, stopped in its career, counteracted, and again in the mode of putrescence, or fermentation, or effervescence, or melting, or combustion, or explosion, or detonation, unravelled and decombined, in a manner more gradual or more rapid, more partial or more general : as we see, when the mere influx of decombining electricity in the shape of lightning causes milk, wine and beer to ferment and turn sour—prevents blood from coagulating; and makes meat corrupt and dissolve: and because, secondly, when in substances solid and cohering, even of an organized description as well as of an inorganic sort, the dissolution in the shape of putridity, or fermentation, or effervescence becomes sufficiently advanced to cause the elements combined again to separate, to be driven out, and to return to a state of volatility and radiance, it causes the emission not only of the light, but also of the heat and decombining electricity, before poured into them; as we know in hay which, when got up in a damp state, is by the heat and decombining electricity that penetrated in it, so made to putrefy and to dissolve, as at last not only to ignite, to burst out into flame, but during combustion, to have that heat and electricity before taken into it again driven out: and see in all other substances, in which putrefaction, fermentation, effervescence and combustion is always accompanied by a considerable emission, not only of light, but of the electricity and heat, which expel that light before them.

And if, while that electricity of a decombining sort, and productive of heat, can only decombine bodies inorganic and lifeless, in the way of effervescence, or ignition, or explosion, or detonation, unaccompanied by fermentation or putrescence, and can only decombine bodies organic and living alone in the way more slow and gradual of fermentation and putrescence in which it cannot decombine simpler inorganic combinations, this only arises from bodies of an organized sort alone being previously composed of molecules of substances so varied that, when attacked by electricity of decombining sort, they are liable to that decombination more slow and gradual which is called putrescence.

Nay, if moreover electricity of a decombining sort, when it decombines those bodies called organic in the slow and gradual mode of putrescence and fermentation, causes them to emit a taste and a smell nauseous and fetid, this only arises from the same particles which, while from these bodies, in a healthy state exhaling in proportions so moderate as only to benefit the organs of taste and smell, when from these same bodies in a decaying state they exhale in proportions different from the former, and excessive, on the contrary injure and decompose those organs.

Naturally in a body, or aggregate of substances, electricity of a combining sort and cold prevent electricity of a combining sort and heat, from penetrating and gaining ground; and as long as the former electricity prevails, it will obstruct the progress, and arrest the effects of the latter: as we see in all bodies liable to putrefaction, which, while they remain congealed, remain exempt from putridity.

Nay, those very substances which from others again extract that humidity that to them attracts and in them accumulates electricity of a decombining sort, and thereby renders them dry, and capable, instead of confining and accumulating that electricity, of passing it through them unrested and unconfined, prove the most powerful antiseptics, and preventives of putrescence.

Even of bodies composed partly of cohering solids and partly of intervening fluids, a heat so strong as to make the liquid part of their substance again turn to vapour, and disengage itself entirely from the solid part, before either have time to ferment, will, instead of hastening the more entire dissolution, stop and prevent this latter: as we see in grass when left to turn to hay, and in animal bodies when transformed to mummies.

Bodies solid and cohering may, according to the different nature of their composition, be made to return to a state of gas and radiance, in a way more gradual as well as more sudden; in a way more partial as well as more entire.

The slowest way, and that in which only bodies organized and living can return to a state of decombination, is that called of putrefaction: the next and somewhat less gradual way in which only solid bodies composed of particles strongly cohering may be made to decombine, is by slow combustion ; the next way in which solid bodies less firmly cohering may be made more rapidly to decombine is by explosion ; and the last way in which bodies or aggregates still only gaseous can more rapidly be decombined is that by detonation.

Bodies solid, cohering and dry may only be partially decombined and separated in a greater number of lesser bodies, each still solid, cohering and dry, and each still composed of molecules still fixed in their situation relative to their neighbours, by the more summary but incomplete processes of tearing, cutting, breaking or bruising them.

They may be decombined so much more generally in their component molecules separately, as to make them entirely lose their fixity and cohesion with regard to their neighbours, and as from being dry to collapse in a liquid mass, in which the pressure of gravitation shall take a greater hold of each molecule separately, in the way of dissolution, melting and thaw.

When bodies solid or liquid are so decombined that their component molecules are again driven to a great distance from each other, they are said to evaporate, or to return to a state of vapour and gas.

Finally, when the molecules of substance, thus far still by electricity of a combining sort kept separate and divided, are by the entire removal of that force pressing upon and dividing them into distinct molecules, again left to run together, and to diffuse themselves on all sides in the most unconstrained manner, they return to a state of radiance.

When of substances partly still solidified and cohering, or entirely liquid, some of the component molecules, by their peculiar form, more homogeneous, giving combining electricity more hold upon them than those others do, are made to combine more closely, and in doing so to separate from them and to expel those others more heterogeneous, they are said to ferment; and in consequence of this fermentation the substances more homogeneous that remain become more clear and transparent.

When of liquids, while some of the component substances retain their density, their weight and their collapsion, others are made to return to a state of gas, and to escape in air, the liquids are said to effervesce; and their more volatile parts thus disengaging themselves from the others, and making their escape, leave those others to become more quiescent and more flat.

It however seems that substances more compounded, after they have been made by fermentation to throw off certain of their component elements, less firmly cohering with each other than those that remain, again become, in their more homogeneous state, capable of absorbing from the atmosphere new substances, which cause in them a new sort of fermentation; since many compounds, not content with showing a single sort of fermentation, after this has ceased, by degrees show in succession different other later sorts, such as the saccharine, the venous and the acetous, each separated from the former by such intervals of apparent quiescence as indicate that in each substance the period during which it throws off certain elements perceptibly, is followed by a period during which it again from the atmosphere takes in other new elements imperceptibly, before it is again ready for a fresh and later sort of fermentation.

Those substances—and they are the greatest number—that in their combined state had imbodied in them a certain quantity of light and colours, when made again to decombine into mere radiance, again let out that light and those colours.

Nay, from certain substances and bodies mineral, vegetable and animal, in which, after being solidified, later light and colour are still by new pressure from without very slight made to enter and to penetrate very loosely, this light and these colours will again, by removal of that pressure from without, be suffered to exhale, without these substances being suffered to decombine more deeply, and to lose the more essential and fundamental of their component elements; as we see in those stones, plants and insects which, in the dark throwing out light, are what is called phosphorescent.

Bodies and substances by putrescence or by fermentation made to decombine more deeply but more gradually, let out the light imbodied in them less quickly and less perceptibly: those again, by combustion, by explosion, or by detonation decombining more rapidly in less time, emit a greater quantity; and as bodies in decombining let out their substances with less or more rapidity, they produce, as I have already observed, in surrounding gas, during a longer or a shorter period, with less or more violence, those vibrations which in their turn cause in our ears the impressions of sound.

Of some solid bodies the molecules, though made to cohere by a force of combining electricity greater than that which occasions the cohesion of water into ice, are yet made to cohere by a force of combining electricity so weak that their aggregates still, like those of crystal and of glass, have little flexibility; and are by the least excess of partial pressure, tending to throw any of their component molecules out of the peculiar position relative to their neighbours in which they were made to cohere with these, again so detached from these as entirely to lose their cohesion with them, and to snap asunder. Other solid bodies, even of mineral formation, such as gold, silver, asbestos, and most vegetable and animal productions—flax, hemp, cotton, silk, wool, and hair—composed of molecules more fine, and varied, and admitting in various directions of an approximation of interweaving electricity of a combining sort and of cold, so much more close, dense and intricate as to have its partial pressure much more easily shifted in its situation without being destroyed—still in their thinnest laminæ, with the utmost pliability preserve the utmost cohesion. The utmost bending does not destroy their cohesion and allow their being broken. When flax, cotton, silk, wool or hair only at first sight appear by heat more easily decombined than mere congelations in ice or in mineral solids, this can only arise from the excessive tenuity of their largest aggregates, compared with those in which are seen the former bodies. A hair as thick as an ordinary piece of ice or crystal could only be torn asunder by a force fifty times greater than that which suffices to divide in twain the latter; or could only be decombined by a heat much more intense: breathing upon a snow-spangle suffices to melt it.

Though I have shown cold to be the first cause of combination, yet cold, when so intense as greatly to hasten combination, and to cause substances to condense very rapidly in the simplest and earliest mode of cohesion,—that by mere congelation,—thereby prevents other modes of combination later, slower, and higher even in forms merely mineral, and especially, in forms vegetable and animal, which when heat is more mixed with cold, and retards its effects, and leaves these to be brought about more leisurely, take place. Thence it is that, while in very cold climates, nothing is seen but ice and snow, in hot climates, when these climates supply sufficient fluids and liquids for combination, vegetables and animals show a much greater degree of luxuriance.

We have thus in gravitation, as it is centripetal or centrifugal, seen the first principle of all aggregation and combination, from the first in the largest bodies to the latest in the minutest particles; as well as of all later separation and decombination from the last and highest and most long-winded to the first, most simple and most general. We have in electricity, the later and more partial offspring of gravitation, as it is of that sort called cold, seen the instrument of combination more partial and more forcible; and as it again is of that sort called heat, seen the instrument of decombination more late and more evident: but we have not yet seen in detail how mere combining electricity and cold could cause substances, first only combined in solids inorganic and lifeless, to become by degrees recombined in solids organic and living, vegetable and animal.

People in general, not yet seeing by what secondary media, already existing in inorganic matter, this could be effected, have denied that it could at all by any such be done: have supposed that the first cause, after creating that inorganic matter, stood in need of a second and separate condition or process in order to infuse in part of the former the principles of life. I shall show that, according to my opinion, this mode of proceeding, generally credited, which makes the author of the perceptible universe do piecemeal, by fits and starts, and in a disconnected way, what he might in his omnipotence have done by a single act of his will and power, is wronging his attributes and his works. I shall, I hope, prove that in the very conditions of lifeless matter itself—nay in those of mere time and space—in the very first act of the creation, already were laid the seeds of its last and highest developments, not only vital, but sensitive and intellectual: and that it was impossible that when the former arose, the latter should not, in their turn, have out of them arisen.

END OF VOL. I.

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