

IMPORTANT NEW SERIES By Sir OLIVER LODGE.



THE OFFICIAL ORGAN OF THE B. B. C.

Vol. 6. No. 71.

[Registered at the G.P.O. as a Newspaper.]

EVERY FRIDAY.

Two Pence.

OFFICIAL
PROGRAMMES
OF
THE BRITISH
BROADCASTING
COMPANY.

For the week commencing
SUNDAY, February 1st.

MAIN STATIONS.

LONDON, CARDIFF, ABERDEEN, GLASGOW, BIRMINGHAM, MANCHESTER, BOURNEMOUTH, NEWCASTLE, BELFAST

HIGH-POWER STATION.
(Chelmsford).

RELAY STATIONS.

SHEFFIELD, PLYMOUTH, EDINBURGH, LIVERPOOL, LEEDS — BRADFORD, HULL, NOTTINGHAM, STOKE-ON-TRENT, DUNDEE, SWANSEA

SPECIAL CONTENTS:

A FATHER LECTURES THE "UNCLES."
By S. R. Littlewood.

WIRELESS FOR THE BLIND.
By Captain Ian Fraser, C.B.E., M.P.

LONDON'S WIRELESS ORCHESTRA.
By Rex F. Palmer.

OFFICIAL NEWS AND VIEWS.

LISTENERS' LETTERS.

CONTINENTAL BROADCASTING.

The Mystery of the Ether.

By Sir OLIVER LODGE.

[Sir Oliver Lodge is broadcasting from London a course of lectures on "Ether and Reality." These lectures are of remarkable general interest in that they challenge many popular and some scientific theories. "The Radio Times" has acquired the exclusive serial rights and will publish four of Sir Oliver's lectures in their broadcast form. The first appears below. Subsequently all seven lectures will be published as one of the volumes of Messrs. Hodder and Stoughton's "Broadcast Library."]

WHAT fills empty space? What is there between the worlds? Not air; the atmosphere soon stops, and beyond there seems nothing—nothing appreciable, only intense cold.

"The wind that blows between the worlds, it cut him like a knife,"

says Rudyard Kipling, concerning one Tomlinson. Well, that is the ether; it is absolutely cold. We on the comfortable earth are five hundred Fahrenheit degrees warmer. Five hundred degrees hotter would be red-hot: five hundred degrees colder is the temperature of space.

Space is full, not of matter, but of ether. The ether is other than matter; and it fills all space in the most thorough manner: there is nothing so omnipresent and so efficient in the physical universe.

We employ the ether every day and every minute of our lives; it is the very breath of our material existence; but it escapes what are called our five senses, and so we usually know little about it. Some few even deny its existence. This is ungrateful and should be remedied.

The first thing to realize about the ether is its absolute continuity. Let me explain. Matter is discontinuous; it consists of portions with gaps between. You see this clearly enough in the stars; they are bodies separated by wide, empty spaces, they are not massed together. There must be a reason for this; the

reason is partly known, but is not easy: we will be satisfied with the fact that it is so.

Matter is full of discontinuity. The universe consists mostly of empty space: the portions of matter in space are all well separated from each other in proportion to their size. Fire an infinitely long-range projectile into the sky, and the chances are it will not hit anything. Lord Kelvin reckoned that the chance of hitting anything by such a projectile was about the same as the chance of hitting a bird if you fired a gun at random. That is one of the first things to realize about matter: there are great gaps between its particles.

You may say that is all very well for the sky and the stars and planets; but what about the earth? What about a piece of rock, or furniture, or any solid object? Do you mean to say that the particles of a body like that are widely separated, with great spaces between them in proportion to their size, and that a straight line might penetrate them deeply without encountering a particle?

Yes, I do: that is what I mean by the discontinuity of matter. It is discontinuous on a small scale as well as on a large scale. It does not appear so, but that is only because our senses are not fine enough to tell us about things on a small scale: we can only see things on a big scale.

A microscope is of some assistance, but nothing like sufficient: no microscope, however powerful, can show us an atom, still less can it show us how an atom is composed and how far apart its ultimate particles are: we know this otherwise and indirectly. It is, however, common knowledge, now, that matter is built up of minute electric charges, both negative and positive, which are called electrons and protons. It is also known that these electric units are so extremely minute that they are separated from

(Continued overleaf.)

The Mystery of the Ether.

(Continued from the previous page.)

one another like the planets in the solar system: the greater part of the atom is empty space, just like the sky on a small scale. Or, more clearly, if we could take a solid body and magnify it sufficiently (which is impossible), we should see it something like the night sky.

Since the particles of matter are thus separated from each other and never in contact, it would seem to follow that they were all independent of each other, disconnected, nothing uniting them—the particles completely separated by empty space. If there were nothing existent but matter, that would be so; there would be no unification, no binding force, no family relationship, nothing but separate, independent particles: that is what would happen if Space were really empty, and the universe would not be a cosmos, but a chaos.

The Force Between the Stars.

We know better than that; we know that the stars are not independent of each other; they are bound together into systems: there is a unifying and connecting force between them which is called Gravitation, though it is not understood. Hence the space between them cannot be really empty; the interspaces must be filled up somehow: there must be something which is without gaps, something really continuous, something which combines the whole together, welding all the separate bodies into a cosmos.

The same thing is true inside any solid body: the separated particles cohere, they are not independent of each other; there is no chaos to be found anywhere. The solid has a definite size and shape; and if it is a crystal, its shape may be beautiful and very definite.

There is evidently law and order reigning among the particles: however great the interstices between them, they must be full of something; space is not really empty, though it is empty of matter. Matter exists as separate particles, here one, there another. But the uniting "something" is not composed of particles at all; it is continuous: it unites the particles with a force which is known as Cohesion.

An Addition to the Elements.

What you choose to call this unifying "something" is of no consequence. The Ancients sometimes spoke of the "Ether," possibly as an addition to the usual four elements, and Sir Isaac Newton adopted this term for the officially connecting medium. The optical medium connects the particles together into a solid or a liquid, and the same medium connects the Heavenly Bodies together into systems and clusters and constellations and nebulae and the Milky Way.

All pieces of matter and all particles are connected together by the ether and by nothing else. In it they move freely, and of it they may be composed. We must study the kind of connection between matter and ether.

An Unsolved Problem.

The particles embedded in the ether are not independent of it, they are closely connected with it, it is probable that they are formed out of it: they are not like grains of sand suspended in water; they seem more like minute crystals in a mother liquor. The mode of connection between the particles and the ether is not known; it is earnestly being sought; but the fact that there is a connection has been known a long time. We know it, because a particle cannot quiver, or move, without disturbing the medium in which it is. A boat cannot oscillate on the surface of water without sending off waves or ripples; a bell cannot vibrate in air without sending out waves of sound; a particle cannot vibrate in ether without sending off waves of light.

So the second thing to learn about the ether is its property of conveying light. It seems curious to call it a "second" property, because historically it was the first—the first discovered, and the first on which attempts were made at elaboration. The Physics of the early part of the nineteenth century was almost wholly occupied with it: the highest genius was devoted to the theory of ether waves, and the climax was reached by Clerk Maxwell. The whole of the immense Science of Optics is involved, and grew out of it; but as with everything else it is difficult completely to understand and to realize clearly what is happening; certain things can be stated with apparent simplicity, but the full explanation is not yet attained.

The first and most definite fact, on which there is complete agreement, is the rate at which ether waves travel, the thing ordinarily called "the velocity of light." This speed is the most fundamental and absolute thing in the physical universe, and it is evidently related to some fundamental or constitutional velocity, the full meaning of which has still to be discovered. Meanwhile we can make elementary statements about what has been observed in connection with it.

The speed is measured by timing the interval required by light to travel a certain measured distance, whether it be a distance measured on the earth or a greater distance measured in the heavens. The results all agree; and there is no doubt that all ether waves, however else they differ, all travel at the same pace. The speed of light is not only the speed of that by which we see things, but it is the speed with which every disturbance travels in the ether of space.

Such disturbances may be the great waves (akin, as it were, to Atlantic rollers) which we employ in radio telegraphy; or they may be the small ripples which, when they break upon the shore of matter, excite heat; or they may be the minuter tremors which in enormous numbers enter the eye and operate the curious receiving mechanism there, so as to disturb the nerves and give us the sense of sight, or, by rearranging the chemicals on a glass plate or film, can reproduce the likeness of the objects which have emitted them; or they may be the still minuter tremors—small almost beyond imagination, and beyond the power of any microscope to utilize—fearfully rapid tremors or other vibrations which can be excited electrically, in a form which we know as X-rays. But whether big or small, they all travel at the same pace, with a speed far beyond anything in our experience, a speed which it seems impossible even for the ether to over-top.

Imagine a thread wrapped round the equator of the world, crossing all the continents and oceans and going right round the earth; stretch such a thread out into a straight line, that is the distance which light can travel in the seventh part of a second. To get the distance traversed by light in one second, the thread would have to be wrapped round the world seven times and then stretched out; such a thread would reach nearly to the moon.

The light of the moon takes a second and a quarter to reach the earth; from the sun it takes eight minutes; from the stars, even the bright

stars, it takes years or even centuries; while some of the dim and distant objects revealed in a large telescope we see only as they were a hundred thousand years ago. So immense is the scale of the Universe!

All this is well and even popularly known: the difficulties do not lie here; they lie in determining the exact nature of the waves and the way in which they are produced. We have to work by analogies for the most part. As a vibrating bell or string or tuning-fork excites waves in the air, so a vibrating electron excites waves in the ether. The processes are analogous, not identical, and if we tried to enter into more detail, we should get beyond our depth.

The Vehicle of Light.

Meanwhile, if ripples are travelling from distant objects, there must be something which is rippling. You cannot imagine space being thrown into vibration; there must be something in space which vibrates, and that "something" extends to the furthest visible object. This was our first idea of the ether of space: it is more than a century old, and the argument was as valid in 1825 as it is to-day. The ether was therefore called "the luminiferous ether," the light-carrier, the vehicle of light. Not of light only, but of every other link between the worlds and between the atoms; the vehicle of Gravitation, as Sir Isaac Newton suspected; the vehicle of Cohesion too, as we now know; the unifying and connecting mechanism which welds together the disconnected atoms of matter and makes cosmos out of chaos.

However evasive the ether is to our senses, it is a great reality, and we already know something definite about it.

These waves that we are now using will get to the Antipodes, say, New Zealand, in the 1-14th part of a second. How far will sound waves travel in the same time? Sound in air takes five seconds to go a mile. Consequently, in the 1-14th part of a second they go the 1-70th part of a mile, which is 25 yards—that is, to the back of the hall in which I might be speaking.

Appalling Magnitudes.

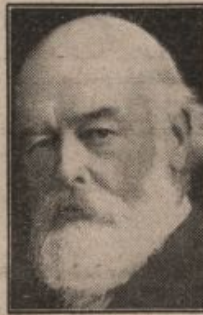
Ether waves travel just about a million times as quickly as sound waves; consequently, if the waves are of the same length, the vibrations would be a million times as rapid. But the ether waves by which we see are not of the same length: sound waves are a few feet in length, whereas, a row of ten thousand light waves is only an inch long. Consequently, the rate of vibration which the eye perceives is 500 million million per second—a quite incredible number!

But in dealing with the Universe we must not be afraid of large numbers: the magnitudes we deal with are many of them appalling, some of them appalling for size, others for smallness, some for rapidity, others for unknown and mysterious properties. We have as yet but little acquaintance with the Universe; sometimes we seem to know a great deal, at other times we realize that we hardly know anything.

The Mystery Which Surrounds Us.

Meanwhile, we grope along as best we can, and he is wisest who denies least of the mystery which surrounds us and the possibilities ahead.

To assert, requires knowledge; to deny, requires much more knowledge. Let us be satisfied with positive knowledge, so far as it has been vouchsafed to us, and leave negations to the self-sufficing and the omniscient. We can deny the self-contradictory and the absurd, but in the unknown and the mysterious, denials have no legitimate place; our business is carefully and cautiously to ascertain what is. We are surrounded by infinity, and the wealth of existence is such as to justify a faith in our highest conceptions, a hope in the possibilities which lie before us, and a charity which enables us to do our daily work and to love our fellow-men.



SIR OLIVER LODGE.