THE LIGHT OF THE WORLD

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COMPILED BY WORKERS OF THE WRITERS' PROGRAM OF THE WORK PROJECTS ADMINISTRATION IN THE COMMONWEALTH OF PENNSYLVANIA

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FOREWORD

The Light of the World is the twelfth of thirty booklets in the Children's Science Series. It was prepared by the Philadelphia Unit of the Pennsylvania Writers' Project, sponsored by the Pennsylvania Department of Public Instruction.

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C. C. LESLEY
State Supervisor

THE LIGHT OF THE WORLD

Once upon a time, so an old story says, the wind and the sun had a quarrel. Each one boasted that he was more powerful than the other. The quarrel became so bitter that they felt they must settle it by a test of strength.

On the earth far below, they saw a man walking, his coat buttoned about his neck. "Look," said the wind, "the one that can make that man down there take off his coat first is the stronger!" And with a great howl, he swept down upon the traveler, blowing a blast that was fierce and strong and cold. He tore

at the traveler's coat with stinging fingers. But the traveler shivered and clutched it closer. Harder and harder puffed the wind. Louder and louder he howled. But the traveler only bent his head and hugged his coat more tightly.

Then the sun brushed the wind aside and shone down upon the earth with all his power. The air grew warmer and warmer, the clouds melted away. Soon the traveler opened his coat. As the heat kept pouring down, wheat stalks in the fields drooped their heads, leaves shriveled, and ponds dried up. The traveler tore off his coat and flung himself under a shady tree. Now the victorious sun dropped behind the hills, and the earth became cool and pleasant. Then the wind knew he was beaten, and fled away to hide in the cracks of a mountain cave.

WHAT DOES THE SUN DO FOR US?

This is not a true story, of course, but it shows the great power of the sun. Though we may not think much about it, the sun is the most important thing in our lives. If it were taken away, the earth would have no light or heat. Everything would be black, darker than any darkness we know. Soon the whole earth would be covered with a heavy crust of ice and snow.

Every flower, fish, bird, and animal would freeze and die. For living things must get heat and strength from the sun if they are to live and to grow. Plants drink in the heat of the sun and store it as energy inside their leaves and stems and roots. Then when people or animals eat the plants, they take that energy and strength into their own bodies.

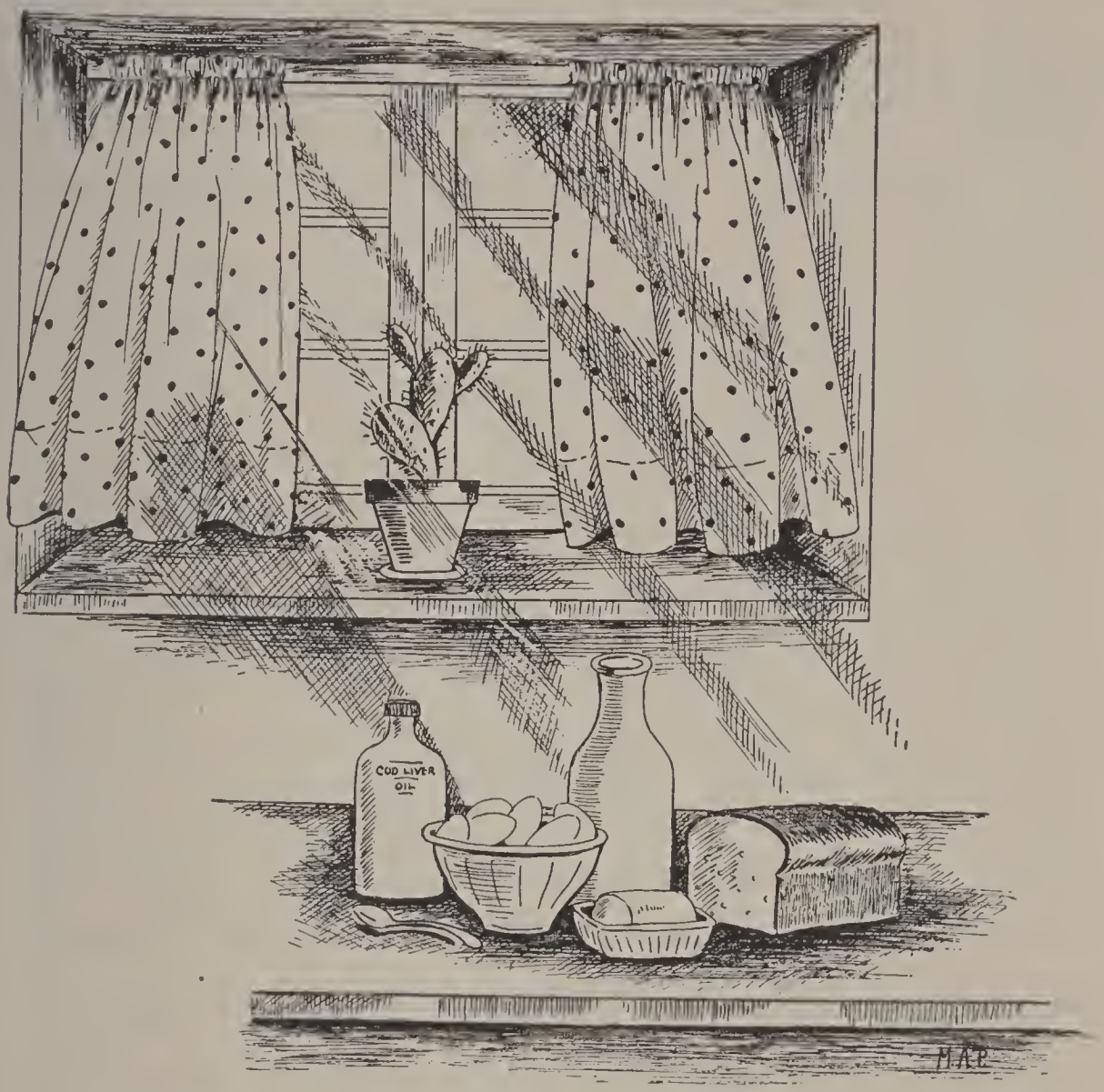
Even the heat in the coal men burn is heat from the sun. For coal is made of

the leaves and stalks of giant plants that grew in the sunlight upon the earth long, long ago. These plants died and were buried under rock and then pressed into the hard black coal that is used today. Coal has a great deal of stored heat. But if all the coal in the world could be burned at once, it would not give us so much heat as the sun does.

Certainly if there were no sun everything on earth would be completely different from what it is today.

HOW BIG IS THE SUN?

We may think there is nothing in the heavens at all like our sun. But there are other suns, billions of suns, and some of them are many times bigger than our own. The earth does not get much light or heat from these other suns because all of them are so far away that they are seen only as pinpoints of light at night. Yes, they are the stars! Our



ALL THESE FOODS COME FROM LIVING THINGS THAT GREW IN THE SUNSHINE. THE SUN'S HEAT IS STORED UP IN THEM AS ENERGY.

sun and the stars are brothers. All of them are great, hot, glowing bodies, floating through space.

But none of the stars is so important to the earth as the sun. The earth is

much nearer to the sun than to other stars. It moves with the sun through the heavens. It is part of the sun's family.

Because the sun is nearer than other stars, it seems larger to us. Still, it does not appear very large. We can find out how small it seems by trying a little trick. Let us ask a friend to stand six feet away from us and hold up a dime between our eyes and the sun. When our friend holds the dime in the right position, it covers the whole face of the sun. So if we believe our eyes, we must think the sun is as large as a dime. Can something as large as a dime give out enough heat and light to keep the whole earth bright and warm?

The answer is that we must not believe our eyes. The sun is very much larger than it seems. There are men who spend a great deal of time studying the sun and the stars. These men, called astron-

omers, have found the sun's real size by very careful measuring. They say that the distance straight through the sun, from one side to the other, is 864,000 miles! It would take 108 balls as big as the earth, placed side by side, to stretch that far.

Suppose we think of the sun as the size of a large pumpkin. The earth beside it is now only the size of a very small pea, so small that it is scarcely seen beside the big pumpkin. About one and one-third million balls the size of the earth would have to be pressed together to make one ball as big as the sun. The sun may not be so large as some stars, but it is still a giant. No wonder it is able to shed so much light and heat upon the earth.

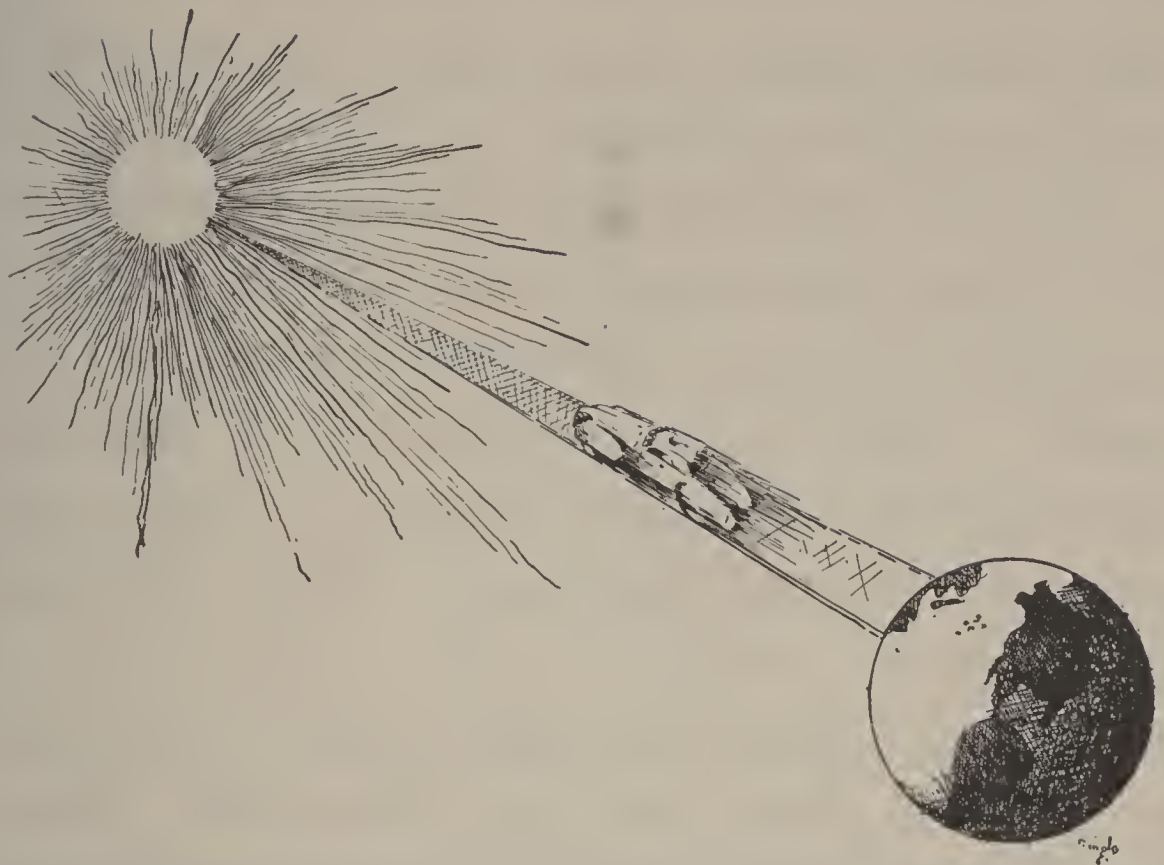
HOW FAR AWAY IS THE SUN?

We can see only the outside, or surface, of the sun. Yet this surface alone is so

bright that we cannot look at it without blinking our eyes. Of course, a very strong electric bulb can make us blink too. But the bulb is close to our eyes. Its light does not have to travel far. We can realize how strong the light of the sun must be when we think that it must travel to the earth through ninety-three million miles of space.

Ninety-three million miles! That's as far as going around the world about 3,720 times. It makes our heads swim. If an explosion took place on the sun and the sound could travel to earth, it would not be heard here until 15 years after the explosion had happened!

Just suppose it were possible for an automobile to travel to the sun. Suppose the automobile traveled night and day without stopping, at 50 miles an hour. It would take 210 years to reach the sun.



AN AUTOMOBILE TRAVELING 50 MILES AN HOUR WOULD REACH THE SUN IN 210 YEARS.

WHY DOES THE SUN SHINE?

Of course, no automobile could travel to the sun. But if it could, it would melt. For the sun is hotter than we can possibly imagine. It is hotter than the hottest fire that could be made here on earth, hotter than the furnaces in which iron and gold and other metals are melted. We are lucky that we do not come close to the sun, and that it does

not come close to us. If it did, it would burn up the earth.

The sun itself is not burning, however. If it were burning like an ordinary fire, it would burn to dust and ashes in 1,500 years. But it has been giving off heat and light for millions of years, and it will go on doing so for many more millions of years.

It may seem strange that the sun is so bright if it is not burning. Some people think things have to burn to give light. But, let's look at an electric bulb. We press a button, and the light flashes on. Yet the bulb is not burning. What happens is that the wire in the bulb gets so hot that it shines brightly. The sun shines for the same reason. The materials of which it is made are so hot that they glow.

If heat makes the materials of the sun shine, it must do something else to them too. Even though they are not burning, certainly in that terrible heat they can-

not be the same as they would be if they were cold. All of us have seen some of the changes that heat can make in things. Butter, or even iron, melts if it gets hot enough. When water is heated enough, it turns to steam, or gas. These changes take place in all things, even the hardest stone or metal, if they become hot enough. At a certain point, they melt. And if they are heated more and more, they will at last turn to gas.

Some things, of course, need much less heat than others in order to melt or turn to gas. Ice and snow, for instance, melt while they are very cold. Our earth is not hot enough to melt most things. If it did become hot enough, even our tall stone buildings would melt like ice castles. But of course it is not possible for the earth to become so hot.

The sun, however, has enough heat to turn to gas all the materials of which it is made. And that is exactly what has happened. Although the sun has iron,

nickel, copper, tin, oxygen, and probably all the other materials that the earth has, these materials are much different there. On earth most of them are solid. On the sun all of them are gases, each shining brightly.

HOW MUCH HEAT DOES THE SUN GIVE US?

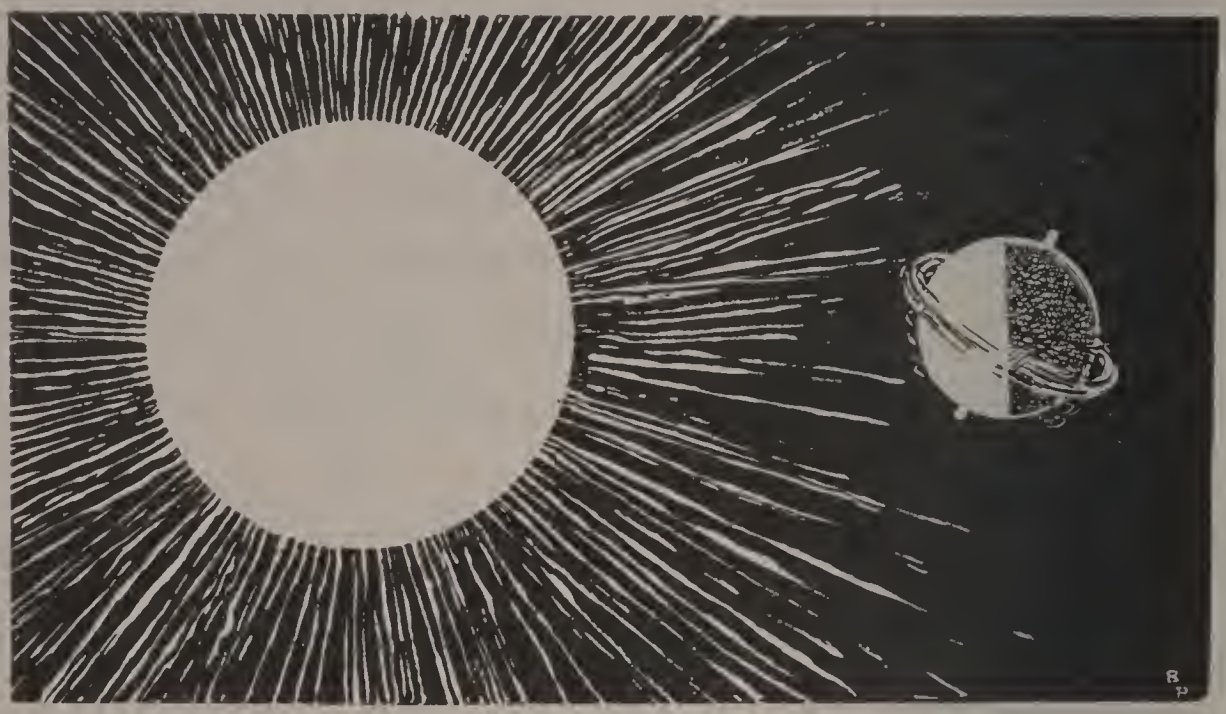
All of us have seen pictures of tne sun with rays shooting out like spokes from the center of a wheel. The sun does not really look like this, of course, but the pictures want to show how the light and heat pour from the sun in all directions through space. Only a few of those rays travel in the direction of the earth. But suppose all the sun's rays could be turned in our direction. There would be enough heat to melt in one second a bridge of ice two and one-half miles thick reaching all the way from the sun to the earth.

Some of the heat that does flow toward

us does not reach the earth's surface. For there is a blanket of air stretching for many miles all around the earth. This is the air we breathe. This air keeps some of the sun's heat for itself, and turns some of it back into space.

So only a small part of all the sun's heat ever reaches us. Yet even that small part is a great deal. The earth does not seem to be getting much heat on a winter day when we shiver in woolen clothes. But if the heat of all our winter days were added together, the total would surprise us. In one year we get enough heat to melt a crust of ice 114 feet thick, covering all the world. If one half of the earth were turned to the sun all the time, that half would be baked hard as brick. The other side would be cold and dark.

Luckily that does not happen. Every part of the earth has both day and night. Every part gets heat and light from the sun regularly.



THE HALF OF THE EARTH ON WHICH THE SUN SHINES IS BRIGHT. THE OTHER HALF IS IN DARKNESS.

NIGHT AND DAY

If we get up very early some morning, we can see the sun come up over the fields or hills or houses in the eastern part of the sky. At night it goes down below the land in the west. It seems to travel right across the sky.

People long ago used to think that the sun really did move overhead like this every day. And they believed that the

earth was flat. After a while, they found out that the earth was round, much like a ball. Then they thought that the sun went around the earth, taking twenty-four hours to make the trip.

Today people know that the sun is not moving around the earth. It is the earth that is turning. Sometimes when we ride on a train the trees outside seem to be skimming quickly past us. But we know that it is really the train that is rushing past the trees. And we know too that though the sun seems to be moving, it is really the earth that is turning.

Our earth is spinning like a top. It takes about twenty-four hours to make one turn, and that is one whole day. Because of this turning, all parts of the earth have both darkness and light. The parts that the sun's rays reach are bright. Those parts turned away from the sun are in shadow or darkness.

But every part of the earth does not have just the same amount of darkness and of light every day. Only at the middle of the earth, called the Equator, does this happen. There the night is always twelve hours long, and the day is the same.

In other parts of the earth, the hours of daytime and nighttime change from day to day. In winter, nights are long and days are short. In summer, the sun goes down so late that we have to go to bed sometimes while it is still light. And if we lived at the North Pole, the sun would be shining all summer, even while we slept! For there darkness does not come every day as it does here. There is only one night, and it lasts for months, all during our autumn and winter. Then the sun comes up over the snow-covered land, and it can be seen at all hours during our summer and spring. At the South Pole, it is the other way around. The sun is shining

down there while the trees in our country are bare and the ground is covered with snow.

All these differences in day and night happen because the sun is shining on the earth differently at different times of the year. During our spring and summer, the northern half of the earth is tilted more toward the sun. So it receives the sun's rays for a longer time each day. During our autumn and winter, the southern half of the earth is tilted toward the sun, and receives the sun's rays for a longer time each day.

TELLING THE TIME

People learned a very long time ago that they could tell time by the sun. They learned where the sun would be in the sky on each day, and at each hour of the day. Then they could squint up at the sky, with hand shielding their eyes, and judge the time. After a while they made something which helped them

to measure the position of the sun, and so tell time more exactly. This was a sundial. Sundials were first used more than 2500 years ago.

One of the best types of sundials had two parts. It had a round face, or dial, which looked straight up to the sky. Set on the face, in the same way we hold a pencil on a paper to write, was a strip of metal, stone, or wood. This pointed, like a finger, directly to the north.

The face of the sundial was first divided into quarters, by a line running east and west, and one running north and south. Then each quarter was marked by hour spaces. The strip of metal cast a shadow on the dial, and the edge of the shadow marked the hour. As the sun moved across the sky, the shadow moved around the face of the dial.

The main trouble with the sundial was that it could not be used during

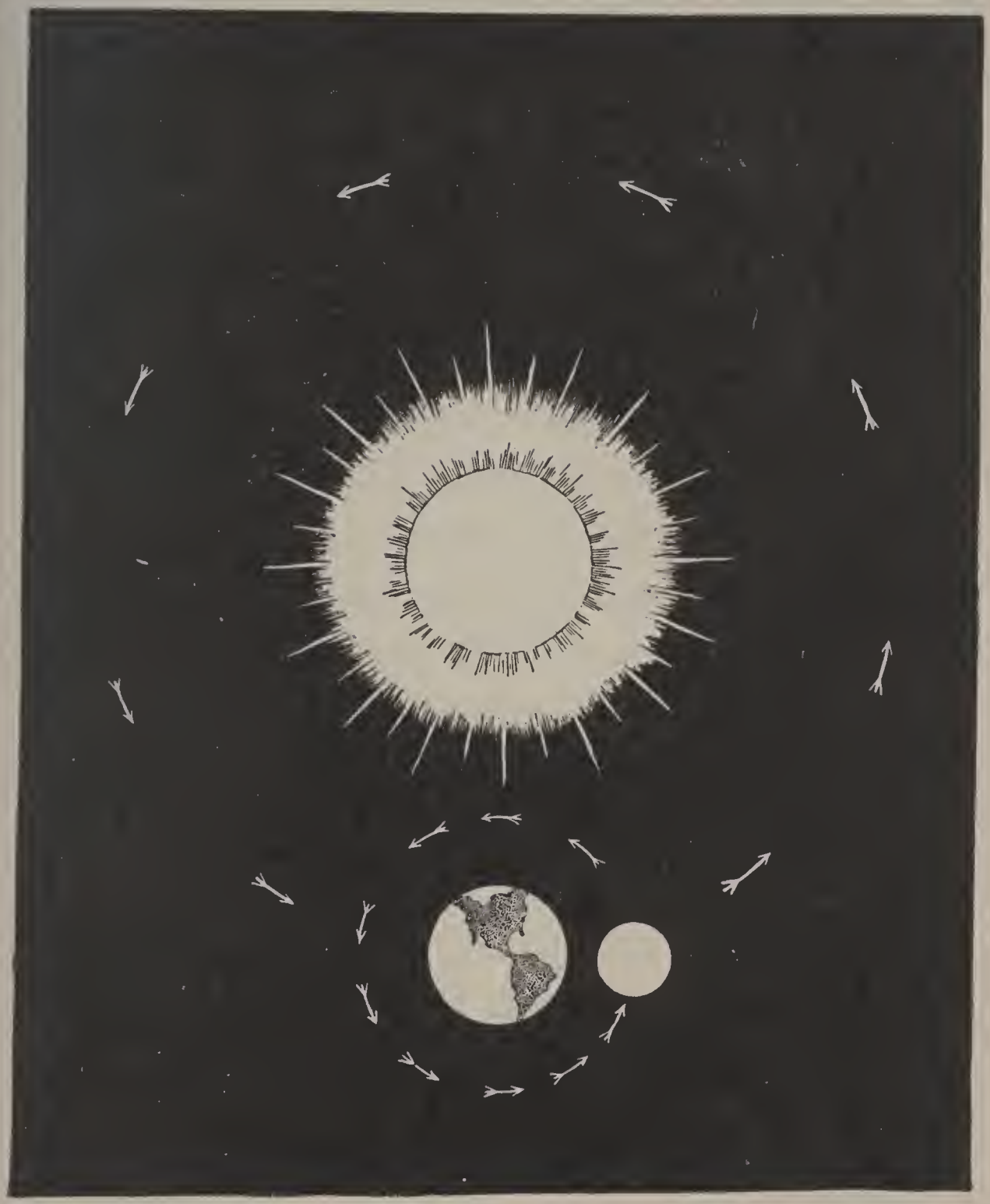
SUNDIALS LIKE THIS ONE CAN STILL BE SEEN SOMETIMES IN PARKS AND GARDENS.

the night or during cloudy weather. Also, it was not correct at all times and for all places on the earth. Several hundred years ago clocks came into use. Today sundials are no longer used to tell time. But we can still see them sometimes, in parks or in gardens.

THE SEASONS OF THE YEAR

The earth's time is divided not only into days, but also into years. Every 365 days a new year begins on earth. Each year has a winter, a spring, a summer, an autumn. Even before we know exactly why this is, we can guess that the earth's moving must have something to do with it. And that is true. Let us see if we can find out how it happens.

We know that the earth is turning like a top, and makes one whole turn every twenty-four hours. Well, the earth is moving in another way too.



WHILE THE EARTH SPINS, IT ALSO TRAVELS IN ITS ORBIT AROUND THE SUN. AT THE SAME TIME, THE MOON TRAVELS IN AN ORBIT AROUND THE EARTH.

While it spins, it also travels in a big circle around the sun. This circle is called the earth's orbit. It takes the earth about 365 days to make one whole trip around the sun and come back to the place from which it started. So every 365 days the earth is in the same place in its orbit, and the sun is shining on it the same way.

When it was first suggested that the earth moved around the sun, people were frightened. At that time they still believed that the sun traveled around the earth. They thought that it would make the earth less important if it traveled around the sun. It made them unhappy to hear that the earth was not the center of everything. So for a long time they refused to believe the truth. Today no one minds at all the idea that the earth is not the center of the heavens. Men are eager to find out all they can about its movements.

From day to day as it moves in its or-

bit, the sun's rays fall on different parts of the earth in different ways. At any particular time, some parts are facing the sun, and the sun's rays are falling straight down on them. So they get a great deal of heat from the sun and they become very warm. At the same time, other parts of the earth are getting only low slanting rays. Those parts receive very much less heat, and they become cold.

Every year about June 22, the sun's rays are falling almost straight down on the northern half of the world, the half in which we live. Our summer begins at that time. Corn and grain begin to grow tall in the fields, and then they ripen in the hot sun, and are cut and gathered. Slowly the position of the world is changing, until the sun's rays are reaching us at a slant. The wind grows colder, and whips the yellow leaves from the trees. Sadly we say that the sun is moving south.

By December 22, the sun's rays are coming to us at a very great slant. Even in the sunlight, the air is bitter cold. Our winter begins. Snow falls and frost draws beautiful pictures on the windows. For us, this is the time of snow battles and sleds. But now the sun's rays are falling nearly straight down on the southern half of the world. And while we are having winter, flowers and fruits are blooming down there, and the sun is tanning people's skins from white to brown.

Each second of the day during the summer we receive more heat from the sun than we do in the winter. But there is another thing which helps to make summer so hot and winter so cold. In summer we are receiving heat for a longer time each day. On the longest day, there are about fifteen hours of light and only nine hours of darkness. So we are receiving heat from the sun for fifteen hours, and we have only nine

WHEN THE SUN'S RAYS ARE FALLING ALMOST STRAIGHT DOWN ON THE NORTHERN HALF OF THE WORLD, OUR SUMMER BEGINS. PLANTS GROW TALL AND RIPEN.

IN WINTER THE SUN'S RAYS REACH US AT A VERY GREAT SLANT. THIS IS THE TIME OF SNOW BATTLES.

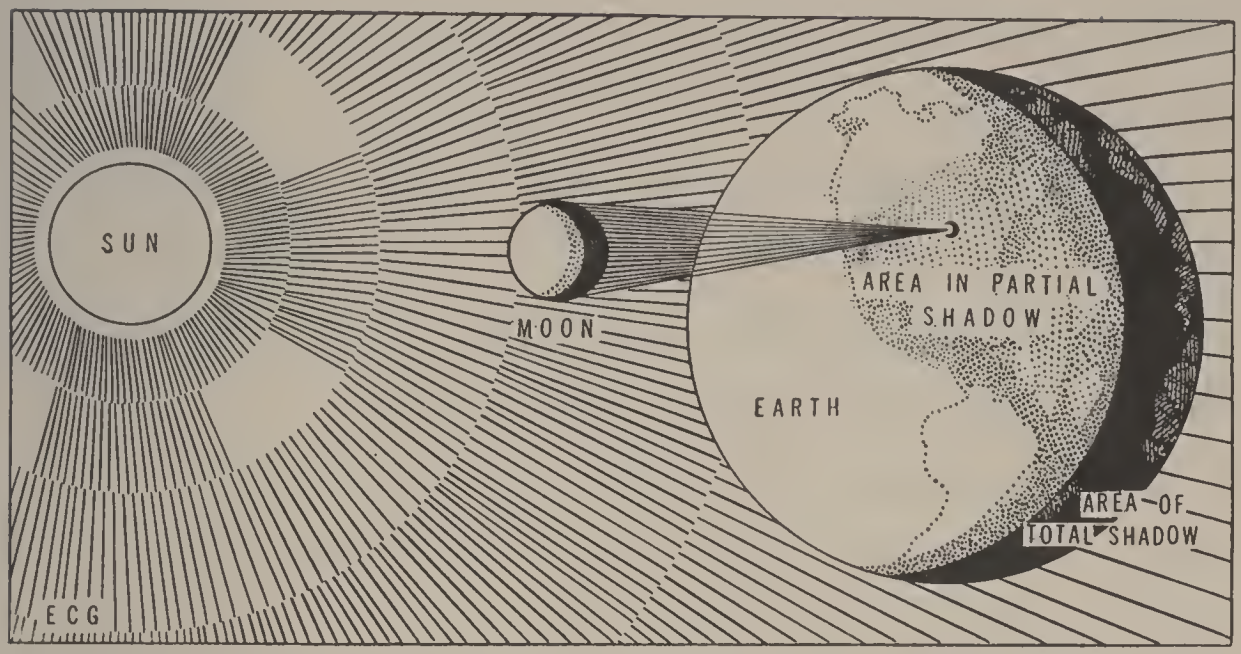
hours in which to cool off. In the winter, however, darkness lasts for fifteen hours, and the earth grows very cold during the night.

THE WORLD'S BIGGEST SHADOW

Long ago people noticed that once in a great while the whole sun, or part of the sun, seemed to disappear, even on a clear day. Sometimes at night the moon seemed to become dim for a while. People were greatly frightened when they saw these things, and they tried to think of reasons to explain what happened.

Many years ago the people of northern Europe believed that the sun and the moon were chased by two very large wolves. Once in a great while the wolves caught them, and ate part of them.

The Chinese of long ago believed that there was a dragon which sometimes tried to swallow the sun. When the sun disappeared, they would rush out into the streets, beating gongs and making a great noise to frighten the dragon away. Then when the sun came out



SOMETIMES THE MOON GETS RIGHT BETWEEN THE SUN AND THE EARTH, AND THE SUN IS HIDDEN FROM VIEW.

again there was dancing and singing and feasting.

Neither the Chinese nor the people of the North were right, of course. But we would not be far wrong if we said that the sun and the earth and moon play hide-and-seek with one another. Before we can understand their game, however, we must know several important things about the moon.

The moon is a big ball, though it is

much smaller than the earth. It circles around the earth in the same way that the earth circles around the sun. It has its orbit, or path, around the earth. As the earth moves around the sun, the moon moves with the earth.

Sometimes, as the moon moves in its orbit, it gets right between the sun and the earth, and the sun is hidden from view. This is called an eclipse of the sun. It is as if someone had passed a saucer over the sun's face. When the whole sun is hidden, there is a total eclipse. When the moon does not cover all of the sun's face there is a partial eclipse.

There can be an eclipse of the moon too. When that happens, the earth is right between the sun and the moon. So all of the sun's light cannot reach the moon, and the moon fades and turns dull red.

But eclipses do not happen very often.

In one year there are only from two to five eclipses of the sun in different parts of the world. There are at most three eclipses of the moon. Most of these are only partial eclipses, since part of the sun or the moon is not hidden.

Even during a total eclipse of the sun, the shadow cast by the moon does not cover the whole earth, of course. Only a part of the earth is in shadow, while one small place is in darkness. But a total eclipse is not likely to be seen from any one spot more than once in 300 years. Astronomers make long trips from distant parts of the earth to the place where a total eclipse will be seen best.

If we watch a total eclipse of the sun through a pair of dark glasses, we see the round moon slowly covering the face of the sun. For a few minutes the earth becomes dark and stars come out. Birds stop singing, flowers close, cows start

TONGUES OF ROSE-COLORED LIGHT CAN BE SEEN AROUND THE MOON DURING AN ECLIPSE.

for home, chickens go to roost. Then the moon passes on and the sun shines again.

WHEN THE SUN IS COMPLETELY HIDDEN DURING AN ECLIPSE, A CROWN OF PEARLY-WHITE LIGHT CALLED THE CORONA APPEARS.

During the time when the sun is completely covered, a great number of tongues of rose-colored light can be seen around the edge of the moon. And shooting out beyond these on all sides are great streamers of pearly-white light. This crown of pearly-white light is called

the Corona. Waiting for the Corona to appear is the most exciting part of watching an eclipse.

By figuring very carefully and keeping records, astronomers can tell when an eclipse is going to happen, even to the exact moment. So it is easy to find out when the next eclipse can be seen from our homes. Then we must take care not to miss it, for a long time will pass before we can see another.

SUNSPOTS

Several hundred years ago an Italian astronomer named Galileo heard about an invention which made objects far away seem much bigger. This was a telescope, a long tube with special pieces of glass in it. Telescopes are something like field glasses, but very much larger. With the telescope it was possible to find out many new facts about the sun.

Galileo said that the telescope showed

spots on the sun's face. But people did not believe this. They thought Galileo was crazy. They said that he was insulting the sun by saying that it was not perfect.

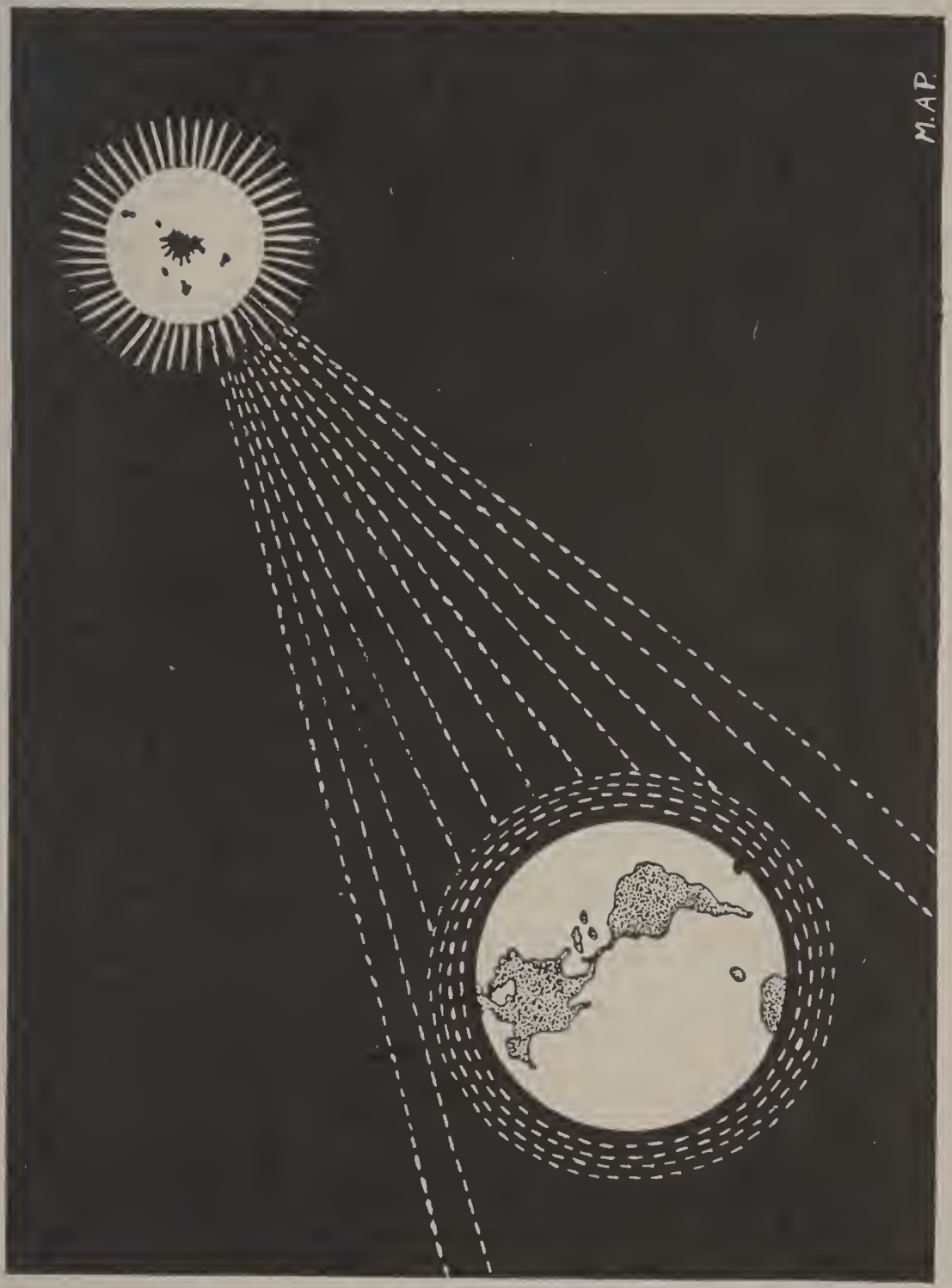
Later studies, however, have showed that Galileo was right. There really are spots on the sun. They are patches not so hot as the rest of the sun's surface, so they look less bright. Most of them are too small to be seen from the earth without a telescope. Yet they are really from one thousand to several hundred thousand miles across.

With a camera and a telescope, astronomers can take special pictures of the sunspots. These pictures show that the spots are giant eddies, or whirlpools, in the sun's surface. They look somewhat like water whirling below a waterfall. If we look at a picture of a tornado, or windstorm, we can get a very good idea of what the sunspots are like.

They are simply pools of gases in the sun's surface, whirling just like the wind and clouds in a tornado.

As astronomers watched the sunspots through their telescopes, they saw that all the spots were moving. Every day each spot would be moving nearer to one edge of the sun's face. Finally it would disappear over the edge. Then after a number of days had passed, it might be seen again on the other edge. Suddenly someone saw the reason for this. The sun must be turning like a top, just like the earth. So astronomers counted the days that it took a sunspot to travel around and come back to the same place. They found that the sun made one whole turn in about 27 earth days.

Sometimes there are no sunspots. Sometimes the sun's face is full of them. It has been found that they appear in greatest numbers about every eleven



THE ELECTRIC WAVES REACHING THE EARTH FROM SUNSPOTS INTERFERE WITH OUR ELECTRIC WAVES.

years. Then there may be 50 to 100 seen at one time. No one knows why this happens. But astronomers have noticed that the number of sunspots seems to affect other things, both on the sun and on the earth.

For instance, the shape of the Corona seen during an eclipse depends upon the number of sunspots. When there are a great many sunspots, the Corona is round. At other times it is longer and narrower.

But the number of sunspots has another effect, which is more important to the people on earth. The huge pools of whirling gases that make the spots are full of electricity. Waves of electricity are pouring down upon the earth from any spots that are turned in our direction. These electric waves do strange things to the electricity made by men. They cause electric storms here on earth, and these electric storms

do as much damage as heavy rainstorms can do to trees and flowers. They interfere with the radio and the telephone. They mix words and letters so that messages sent by telegraph are destroyed.

The sunspots also affect the electric waves which cause the Northern Lights, those bright white and colored lights that we sometimes see in our northern sky. When there are many sunspots, the Northern Lights become very much brighter and more beautiful.

Some men think that when the number of sunspots is great, there are also more of those sun rays that make vitamins and build health. But this has not yet been proved.

There are other ideas, too, about the action of the sunspots. Some men say that they cause war or peace, and bring wealth or poverty to nations. Others say that people's feelings, thoughts, and health are changed by the sunspots.

However, from what we know of the sunspots today, there is no reason to think that these people are right. The sunspots are still a mystery.

SUN WORSHIP

Since the sun was so important to men, and at the same time was such a mystery to them, it is not surprising that there have been many people who believed that the sun was a god and worshiped it. It gave them warmth and growth and strength. It seemed to give them even life itself.

The early Egyptians prayed to the sun. The Greeks had a sun god, the beautiful Apollo. The Japanese still use the sign of the sun on their flag. They call their country the Land of the Rising Sun, and claim that their ruler is descended from the sun.

The Indians of the western United States were also among those who

thought the sun was a god. Every year about the time of the harvest they held a sun dance. Each tribe of Indians had its special reason for the dance. Sometimes they wanted to ask for help. But often they just wanted to thank the sun for the good things it gave them.

The sun dance celebrations lasted eight days. The members of the tribe arranged their tepees, or tents, around the big tepee of the medicine man, leaving an open space facing the rising sun. The Indians, with bodies painted in many colors, danced around a decorated pole in the center.

Today the sun dance is still performed among some Indians of the West, and many people go there to see it. But it has been greatly changed. Our Government does not permit it in its old form because of the tortures that took place during the celebration.

Of course, we know today that the sun

is not a god. But we can agree with the people of long ago that it is the source of many good things. Even though it is not worshiped any longer, the sun still gives us light and heat and strength and health.