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No. 7

DREAM
OF
STARS



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DREAM OF STARS

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PREFACE

Dream of Stars is the seventh 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.

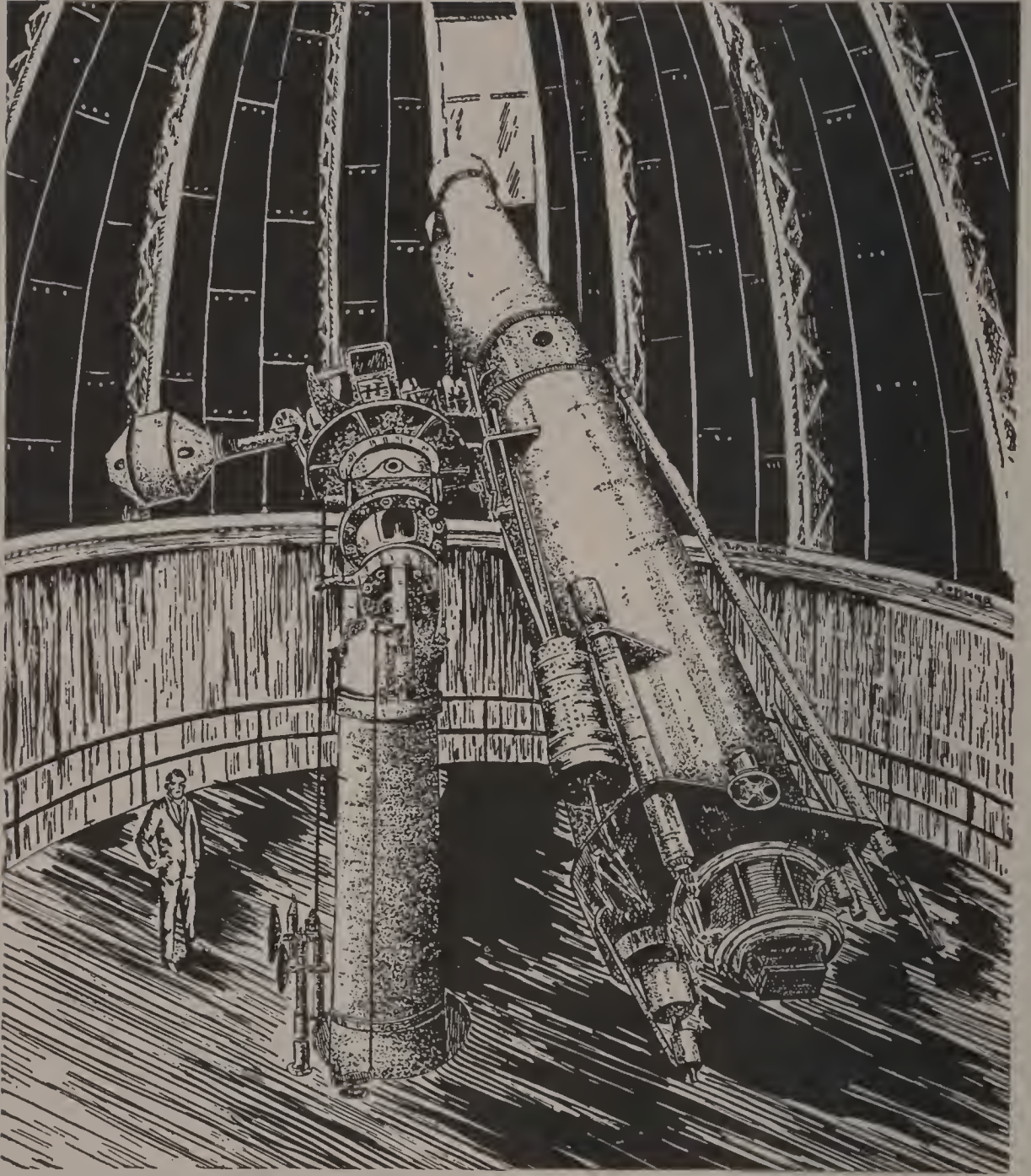
This booklet was written by Mark Bartman. It was edited by Katharine Britton, of the State office staff.

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CONRAD C. LESLEY
Acting State Supervisor

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EVEN THROUGH THIS POWERFUL TELESCOPE THE STARS LOOK
LIKE PINPOINTS OF LIGHT.

DREAM OF STARS

If we stand on a city street and look up at the sky, the stars seem dim and far away. The lights of the city blind us. Tall buildings black out great parts of the sky.

But let us go out and climb a hill some clear summer night. The city's lights and buildings are left far behind. The sky seems like a soft blue velvet curtain over our heads. And the stars are scattered over it like diamonds.

As we stand looking upward, we are doing something that men have done from the beginning of history. Wise men

and shepherds of old gazed in wonder at the same pinpoints of light. What were they made of? How did they come to be up there in the sky?

People watched the heavens to find answers to these questions. The study of the stars is the oldest of all sciences. We call it Astronomy.

EARLY ASTRONOMY

People of long ago knew much less about the world than we do. Often they believed things that were not true.

They saw many groups of stars up in the sky. They gave each group a name, and made up stories to tell how it came to be where it was. These groups are the constellations.

The constellations were named for gods and giants, heroes and beautiful girls, fish and dragons and horses. The bright wide belt that runs across the sky over-



THE BRIGHT WIDE BELT THAT CROSSES THE SKY OVERHEAD
IS THE MILKY WAY.

head was thought to be a road that the sky people traveled over.

On a clear summer night we can find that bright road today. We call it the Milky Way.

And we can find the stars of each constellation too. We may be surprised when we first see them. To us most of them do not even seem to have the shape of any living thing. But we still call the stars and the constellations by the names given to them by the people of long ago.

The very first astronomers learned one important thing about the stars. They saw that every year at the same time the stars were in the same place in the sky.

As soon as men knew that, they could make use of the stars in many ways. By watching the sky they could tell what time of the year it was. They could keep track of time, and they could make a calendar.

They discovered, too, that one star never moved at all. It always shone directly to the north. So they called it the North Star, or the Pole Star. Now they could go farther on the sea in ships. As long as the captain could see the North Star, he knew which way he was going.

Early astronomers also learned that all the stars seemed to move together. They moved as if they were stuck to a great ball turning around the earth. No star ever appeared to come closer to another star or get farther away from it. So men said the stars were fixed.

But early astronomers were soon surprised to see that not quite all the stars were fixed stars. Five stars seemed to move differently from the others. Sometimes they rose in one part of the sky, sometimes in another. Sometimes all five of them could be seen, sometimes



TWO BRIGHT STARS IN THE BIG BEAR POINT TO THE NORTH STAR.

none. And because they acted in this strange way, the early astronomers called them planets. That means wanderers.

Now even in those days not all the people believed that the stars were gods and heroes. There were wise men at work who knew those were just make-believe stories. They tried to find out the truth.

One of these wise men was an Egyptian

named Ptolemy. Ptolemy had watched the sky very carefully. He knew that the sun seemed to move across the sky in the daytime. At night the stars and the moon moved across the sky.

Ptolemy was more clever than most of the people of his time. He figured out that the earth must be round. And he was right about that.

Ptolemy thought that the earth was set inside a great hollow ball. The inside of this ball was the sky. On its surface were set the stars, each in its place. Within the big ball were smaller glass-like balls that held the sun and the moon and the planets.

Ptolemy thought the earth was standing still in the center of the great ball. And all the balls circled around the earth. So the stars and the sun and the moon and the planets seemed to ride across the sky.

Most people did not believe that any of Ptolemy's ideas were right. They believed that the earth was flat. Astronomers knew that the earth must be round. But a few astronomers thought Ptolemy was wrong about the glass-like balls. A short time after Columbus discovered America, a truer idea was given to the world by Copernicus, a man from Poland.

COPERNICUS

Copernicus said that the stars and the sun did not turn around the earth. Instead, it was the earth that was turning! The sun and the stars were not really moving.

Sometimes when we are riding on a train it seems as though the trees outside are moving quickly past us. But the trees only seem to be moving. The truth is that the train is moving past the trees. In the same way, the sun and the stars

seem to be moving over the earth in the sky. But it is the earth that is really moving.

The earth is turning like a top. And as it turns, half of it is always facing the sun, and half of it is in darkness. When the United States is facing the sun, we have daylight. When the United States is turned away from the sun, we have night.

There are stars all around the world, but we can see them only at night. The sun shines so brightly in the daytime that it outshines the stars.

So the stars disappear in the daytime. But at night they appear again, and move together across the sky.

Suppose some night after dark we look at the sky. Then we look at it again two hours later. The stars have moved over to the west a little!

Now if we look at the sky a month later

at the same time, we see that the stars have moved even farther to the west. In the east are some stars that were not there a month before.

The reason for this change night after night is that every night the place where we are on the earth is turned toward a slightly different part of the sky. The earth is moving in a wide circle around the sun, and every night it is at a different place in the heavens.

When one year has passed, the earth is in the place from which it started. And so every year at the same time the stars look exactly the same.

Other astronomers who came after Copernicus found out that he had been right. But it was a long time before everyday people could believe that the earth on which they lived was not the center of the whole world. And as astronomers found out more about the stars,

people had to learn to believe even stranger things.

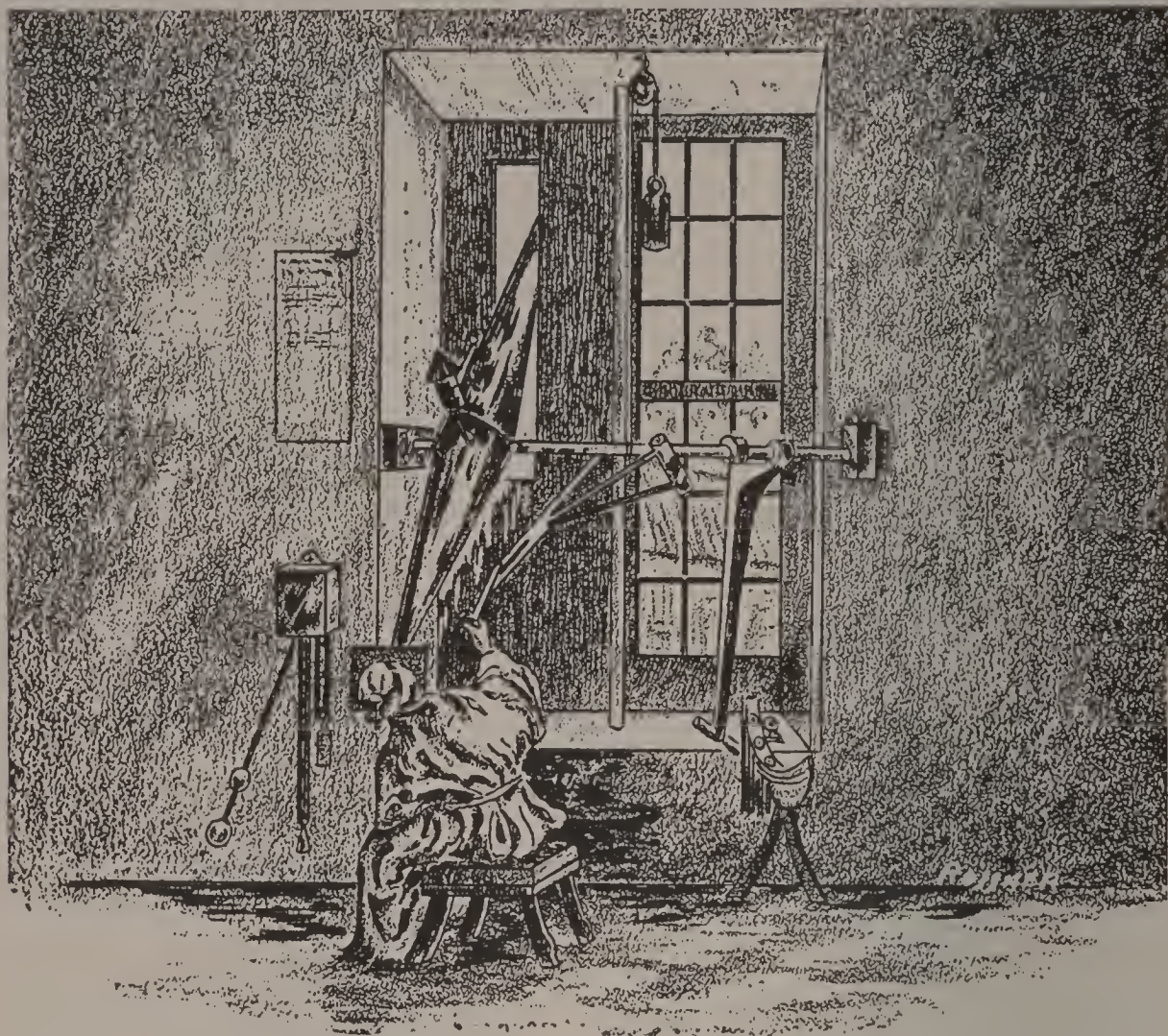
THROUGH THE TELESCOPE

About three hundred years ago an Italian named Galileo heard about something which made it possible to find out much more about the heavens. This thing was a telescope.

The telescope is a long tube with special pieces of glass in it that make things far away seem bigger. It is something like field glasses, but is very much stronger.

During the three hundred years that have passed since Galileo first made a telescope for star study, men have been making bigger and better telescopes. And with these powerful telescopes, astronomers have found out some very exciting things about the stars.

With the telescope people could see that there were many, many more stars



THIS TELESCOPE WAS NEW MORE THAN 250 YEARS AGO.

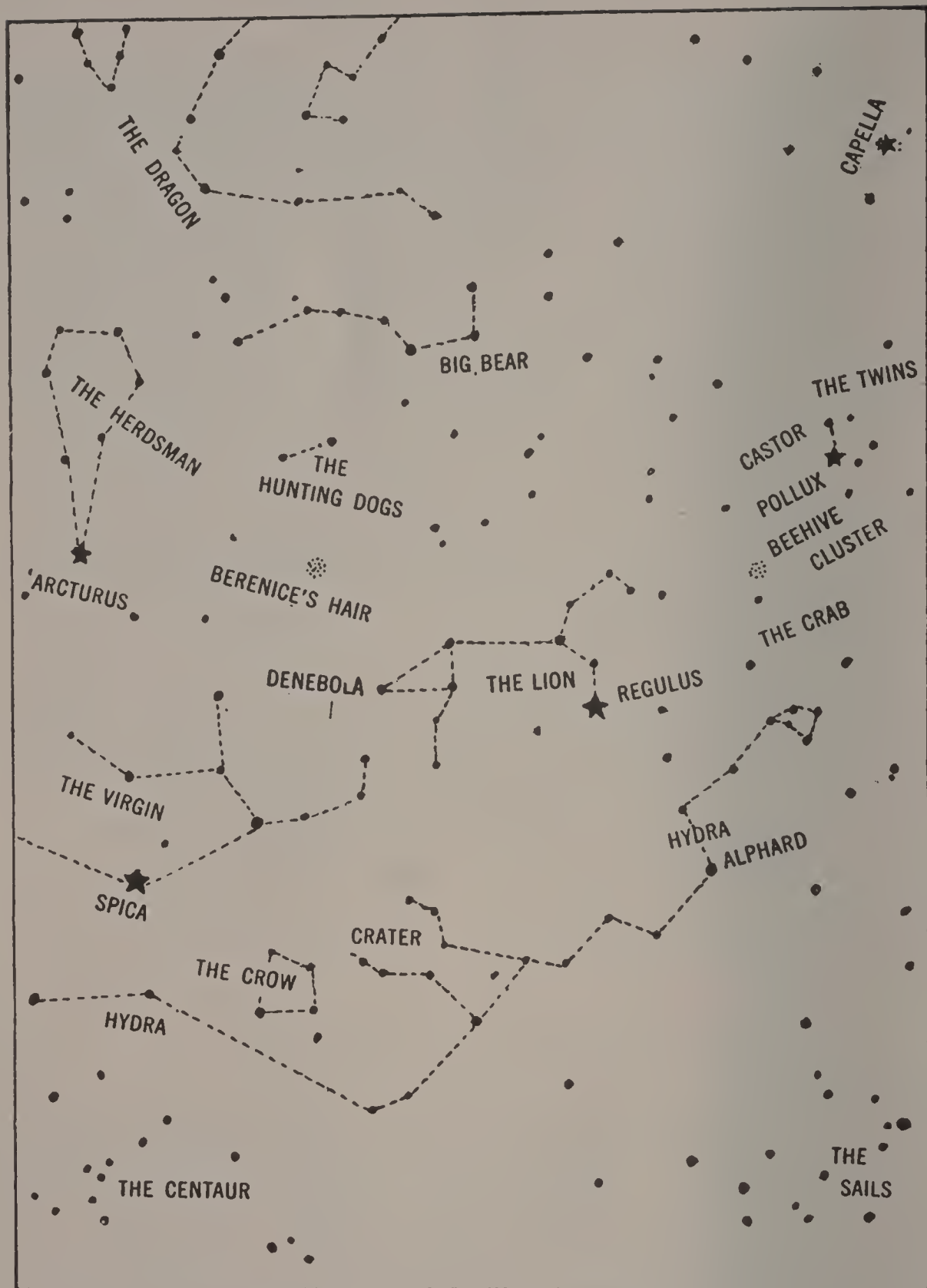
than they had ever dreamed of. Even Galileo's first weak telescope showed that the Milky Way was not just a cloud pathway across the sky. It was made of millions of stars, crowded close together.

Using nothing but our own eyes, we can see about six thousand stars. But with the latest telescope we can see one thousand million! There are many more, so far away that we cannot see them even through the telescope. Astronomers tell us that there are probably a hundred billion in our own neighborhood. And there are at least one million such neighborhoods!

The number of stars is so great that we can scarcely think of what it means. There are fifty times as many stars in our neighborhood as there are people on the whole earth.

BILLIONS OF SUNS

What are these billions of bright stars in the sky? They are suns! They are not small bright pinpoints at all. They are great glowing suns, some of them thousands of times bigger than our own



OUR SKIES IN THE SPRING.

sun. They look small because they are so far away. A kite also looks small when it is high up in the air.

The stars are very much higher than any kite could fly. Some of them are so far away that if we could think of going on and on for many years we could still not think of how far they are.

Suppose we tried to write out the distance to the stars in miles. The numbers would stretch right across a whole page. So astronomers have thought of a simpler way to tell how far away the stars are. They tell the distance by the amount of time it takes the light from the stars to reach us.

We all know that light travels with terrific speed. Lightning flashes across the sky so fast that it is gone almost before we see it. Light moves thousands and thousands of times faster than our fastest airplanes. One beam of light



DAVE
CAIN

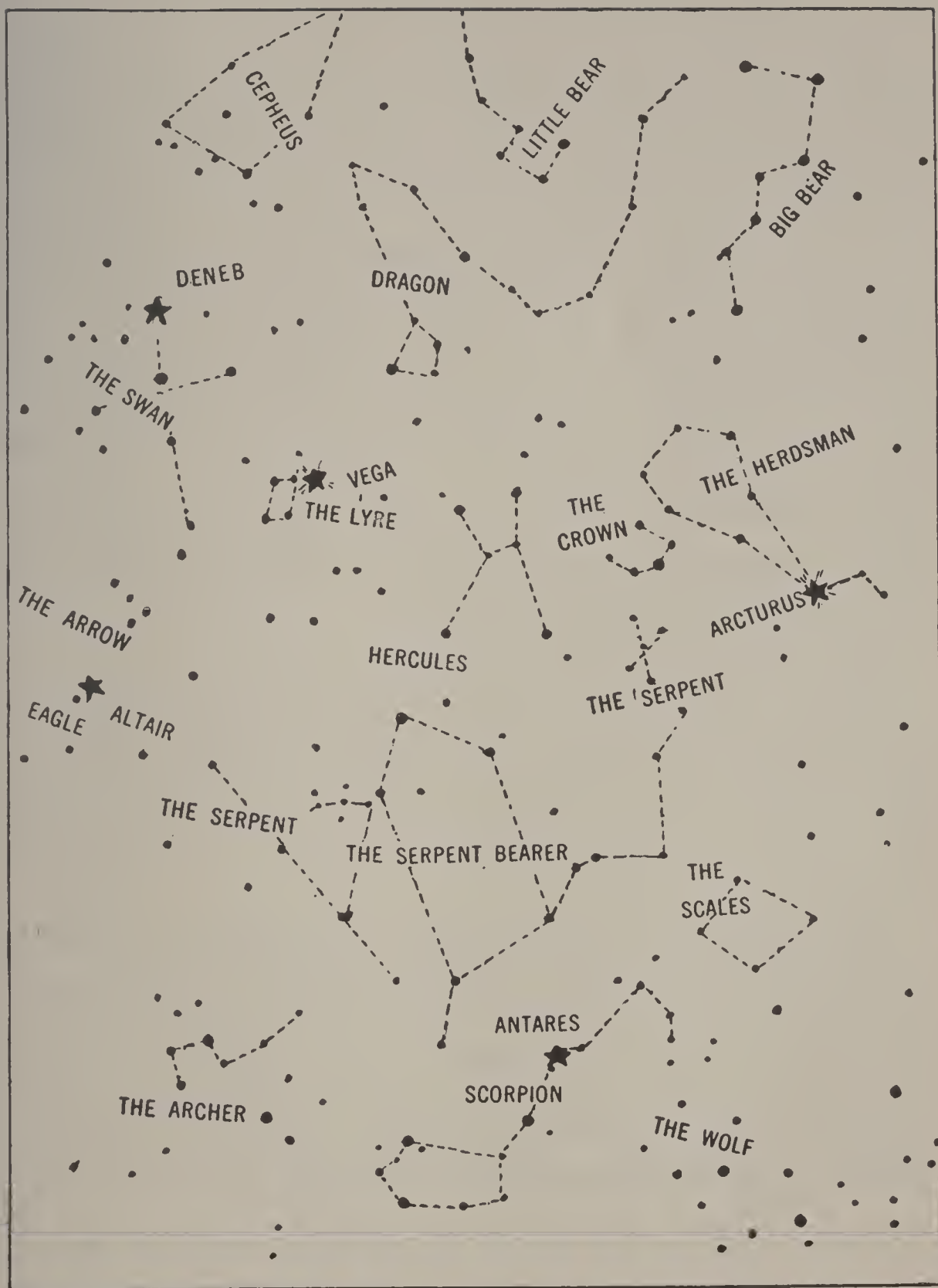


could flash around the whole earth seven and one-half times in one *second*. In one second it travels 186,000 miles!

Yet the nearest star is so far away that it takes the light from it four years to get to the earth. Many stars are so far that the light reaching us from them now started before Jesus was born. That was two thousand years ago. Some are much farther than that.

One of the nearest stars is Sirius. Sirius is in the southern part of the sky in the winter time. It seems like the very brightest and biggest of all the stars in the sky. But that is not true. Sirius looks big and bright partly because it is much nearer than the other stars. Some of the dimmest stars are really hundreds of times bigger than our own sun. Sirius is only three times bigger than the sun.

One of the very biggest stars is Antares, another winter star. Antares is so big



OUR SKIES IN THE SUMMER.

that it looks bright even though it is much farther away than Sirius. It is one of the brightest stars in the sky.

Antares is more than a million times bigger than our sun. Betelgeuse, another bright star in the southern part of the winter sky, is more than half a million times as big as our sun. So we can see that our sun is very small beside the other heavenly bodies.

The largest stars are called giants. And the smaller ones are dwarfs. Betelgeuse and Antares are giants, but our sun is a dwarf.

We might think that the giants would always be much heavier than the dwarfs, because they are so much bigger. But that is not always true. Betelgeuse is light and thin, almost like a shining cloud. It is so thin that the earth could pass through it just as we would walk through a fog.

WHAT MAKES THE STARS BRIGHT?

If we watch the stars carefully on a clear moonless night, we see that they are not all the same color. Sirius looks blue-white. Antares looks orange-red. Betelgeuse looks red. Others look green, or yellow, or pure white.

All these great balls are shining with a great light. And they are very, very hot. Anything that came close to them would be burned to nothing in an instant. We are lucky that they are so far away. If they were close they would burn up the earth.

The stars are glowing as an electric bulb glows when we turn on the electricity. The wire in the bulb gets so hot that it shines. Iron also gets bright when it is heated. The great heat of the stars makes them glow in much the same way.

Now the light of the electric bulb is a

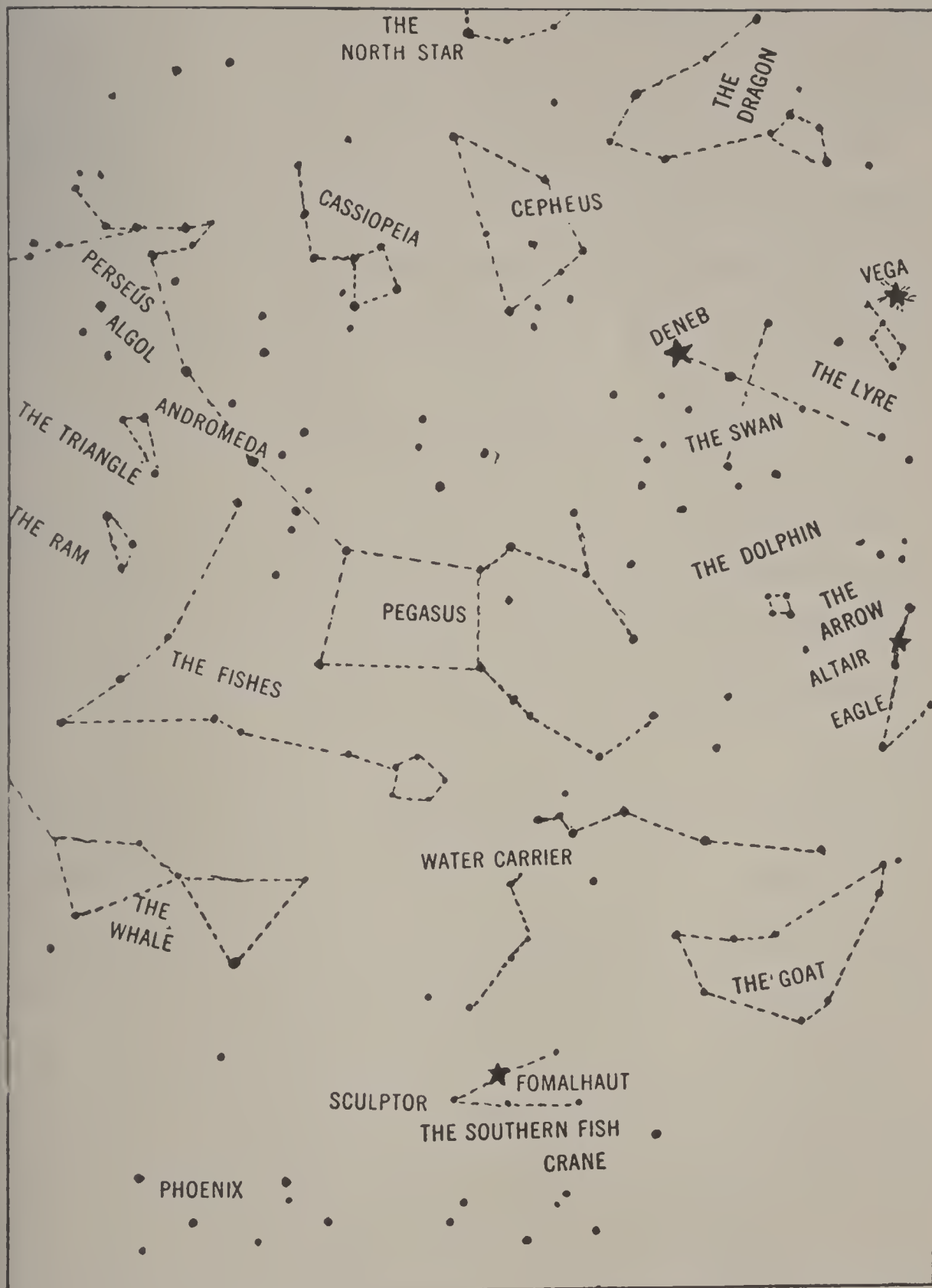
different color from that of the hot iron. This is because the wire in the bulb is much hotter than the red-hot iron. If we heated the iron more, it too would get brighter and whiter.

This is true also of the stars.

Astronomers tell us that some of the stars are hotter than others. The very hottest ones are blazing white. Those not quite so hot are yellow, and those less hot than the yellow ones are red.

Astronomers used to think that all stars began as red stars and grew hotter until they were white. Then they were thought to cool off and get red again. But astronomers do not believe this any longer.

Today some astronomers believe that perhaps all stars just keep on getting hotter and hotter. If this is true, our own sun may some day be white like Sirius. But it would take millions of



OUR SKIES IN THE AUTUMN.

millions of years for this to happen.

So we cannot be sure that the ordinary stars change. If they do, they change so slowly that we would see no difference in them even if we watched for many years.

STARS THAT CHANGE

But while we cannot see any change in most of the stars, there are some in which we can see a change in color and in brightness. These are called variable stars.

Some of the variable stars are like balloons. For a certain length of time they swell, just as a balloon does when we blow air into it. Then they look big and bright. After a while they get small again, as a balloon does when we let the air out of it. And then they look dim. No one knows why this happens, but we know that they are swelling and shrinking all the time.

But this is not the only kind of variable star.

If we look at the star map, we see a star called Algol. And if we watch Algol in the sky, we see that every three days it gets very dim. It stays dim for a few hours, then it gets bright again.

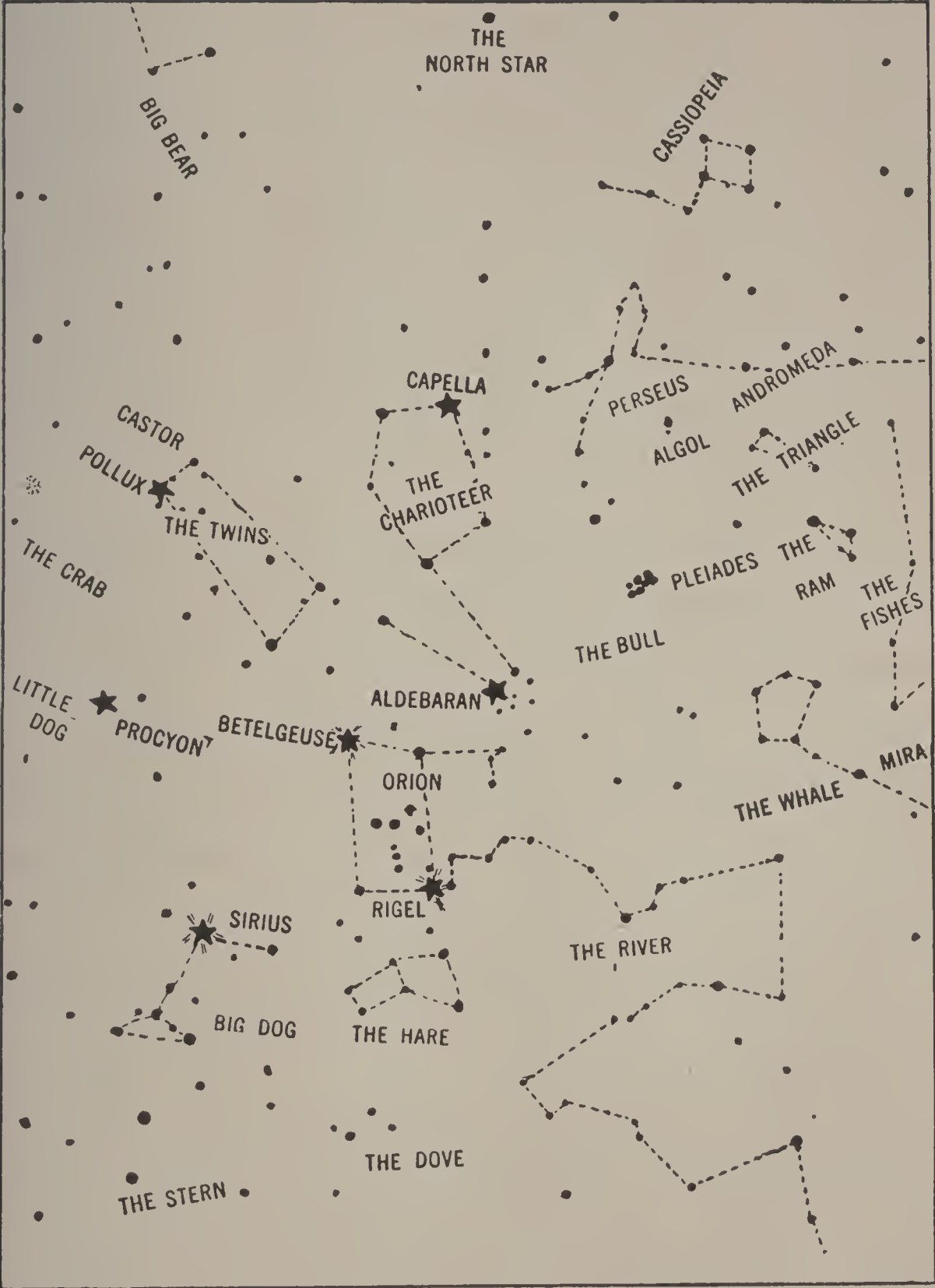
For hundreds of years men had known that the star did this. But no one knew why it happened. That was why the Arabs called the star Algol. For Algol means demon, or devil. The Arabs thought there was some black magic in this star.

And then, not so long ago, astronomers had a new idea about what made Algol get dim every few days. Suppose there was another darker star that was circling around Algol. Suppose this darker star got in front of Algol every few days. Then the light from the brighter Algol could not reach the earth. Only light from

the dim star would be seen. They tested the idea and found that it was right.

Astronomers know now that very many of the stars in our neighborhood have other stars traveling with them. Often there are two stars close together. Sometimes there are three or more. But to us they always look like just one star. They are so far away that we cannot see the space between them without a telescope. The North Star is really two stars. Sirius has another star with it. Perhaps half the stars have companions.

The change we see in variable stars is a change in brightness only. None of the stars seem to change in any other way. If we watched the sky all our lives, we could never see one star move closer to another, or farther away. The shape of the constellations does not seem to change. We can always find each star right where it was last year at the same time.



OUR SKIES IN THE WINTER.

DO THE STARS MOVE?

Yet these fixed stars really are moving. They are flashing through space many times faster than our fastest airplanes. Our sun is traveling twelve miles a second. That means seven hundred miles a minute, and forty-two thousand miles an hour!

The sun is rushing along through space, carrying the earth with it. It is rushing in the direction of Vega, the brightest star in the summer sky. In the middle of the summer, we can see Vega shining very bright and white, almost right over our heads.

But the sun will not be anywhere near Vega for a long time. It is rushing very fast, but Vega is very far away. Many hundreds of thousands of years must pass before our sun gets near the place where Vega is now. By that time, Vega will be somewhere else.

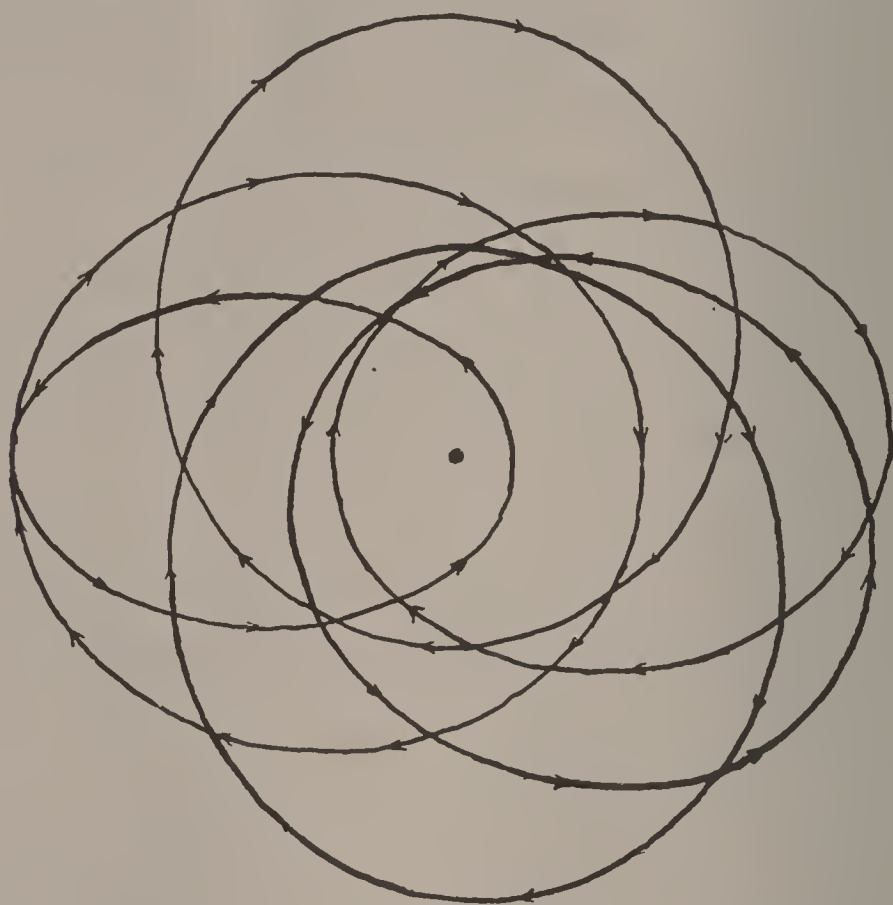
The other stars are moving too. Some of them are moving more slowly than the sun. Some of them are moving much faster. The hottest stars seem to move more slowly. Most of the hottest stars travel about seven miles a second. Most of the cooler ones travel 21 miles a second. That is almost twice as fast as the sun moves. The stars that are almost dead usually move the fastest. Many of them are traveling about 43 miles a second.

Some of the fastest stars could go around the earth in two minutes. These are called runaway stars.

No one has yet been able to find out why the stars move in the way they do. At first astronomers could not even see which way they were moving. The stars are so very far away that it is hard to study their movements.

Astronomers have worked very hard to find out about this. They have carefully

measured the movements of the stars. They thought at first that each star was moving in a straight line. But now they have found out that this is not so.



THESE LINES SEEM TO BE GOING IN MANY DIRECTIONS. YET EACH IS FOLLOWING A CURVE AROUND THE SAME CENTER. THIS IS HOW THE STARS MOVE AROUND THE CENTER OF THE GALAXY.

To understand how the stars move we must know a little about how they are arranged in space. Astronomers tell us

that the stars in our neighborhood are scattered in such a way that the whole group would appear in space like a great watch. A watch is round if we look at it from one side. And it looks thin and flat if we look at it from the edge. That is how our star system or neighborhood would look if we could stand off and look at it. We call this star system the Galaxy.

Now each star is moving around the center of the Galaxy, just as the earth moves around the sun. Each one is moving in its own path, or orbit. It only seems as though the stars are shooting through space in many directions without reason. They do move in many directions, but each star is following a path around the center of the Galaxy.

In spite of all this movement of the stars, we cannot see them change their places from year to year. But if we

could see them thousands of years from now, we should see that they had moved quite a bit.

Astronomers have been able to figure out exactly where some of the stars will be some day. They have made a map to show where the stars in the Big Bear will be in 50,000 years.

THE PLANETS

Suppose we sat down with a star map and learned all the different constellations. When we looked up at the sky we could find each one. We would know the names of all of them.

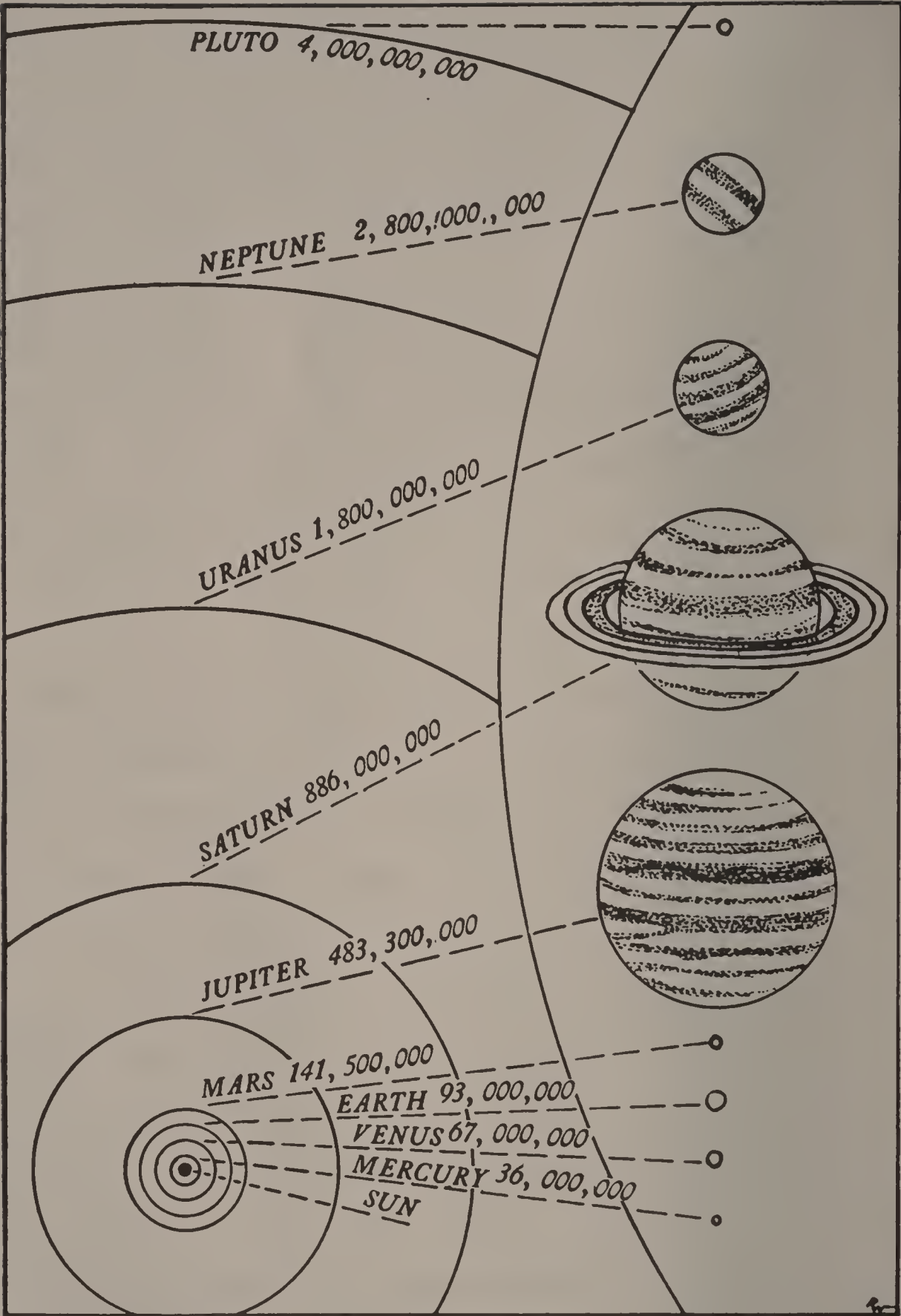
But then, one night we might see in some constellation a star that was not there when we looked before. And we would feel just as the astronomers of old felt when they saw a strange star move into a constellation. We would see why this strange star is called a wanderer, or planet.

The planets look a little different from the stars. The stars twinkle. Planets do not. They shine with a calm, clear light.

They look very pretty to us. They don't look frightening. Yet for a long time people were afraid of them. Because they moved in such a surprising way, people thought they had a strange power.

What are the planets and why do they wander over the sky? The planets are big round worlds that circle around the sun just as the earth does. They appear to wander around because all of them are circling the sun at different speeds.

Today we know of nine planets. But only five of them can be seen without a telescope. These are Mercury, Venus, Mars, Jupiter, and Saturn. Each of them circles around the sun in a certain path. The path that a planet follows is called the orbit of the planet.



NUMBERS SHOW DISTANCE IN MILES FROM EACH PLANET TO THE SUN. ON THE RIGHT, PLANETS ARE COMPARED IN SIZE.

Some of the planets are quite near to the sun and some are very far away. Only two of them are nearer to the sun than the earth is. Mercury is the nearest. Then comes Venus. These two are quite small and they move fast.

Some of the planets outside the earth's orbit are very large and they all move more slowly. Their names are Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

Venus and Mars are the planets that come closest to the earth. So they look very bright. Venus is brighter than the brightest star in the sky. Mars shines with a clear red light.

Venus and Mars are more like the earth than any of the other planets. One astronomer, Percival Lowell, thought that Mars might have people upon it. Many stories have been written about men on Mars. But astronomers are sure

now that there are no men there, though there may be some other forms of living things.

If we looked at the planets through a telescope, they would appear much bigger than the stars. Some of them would look bigger than the moon does without a telescope. Even through a telescope the stars just look like pinpoints of light.

We can see many strange things about the planets through the telescope. Some of them have moons that circle around them as our moon circles around the earth. We can see that Mars has two moons. Jupiter has eleven moons. Saturn has nine. Uranus has four. And Neptune, like the earth, has only one. Mercury, Venus, and Pluto have none.

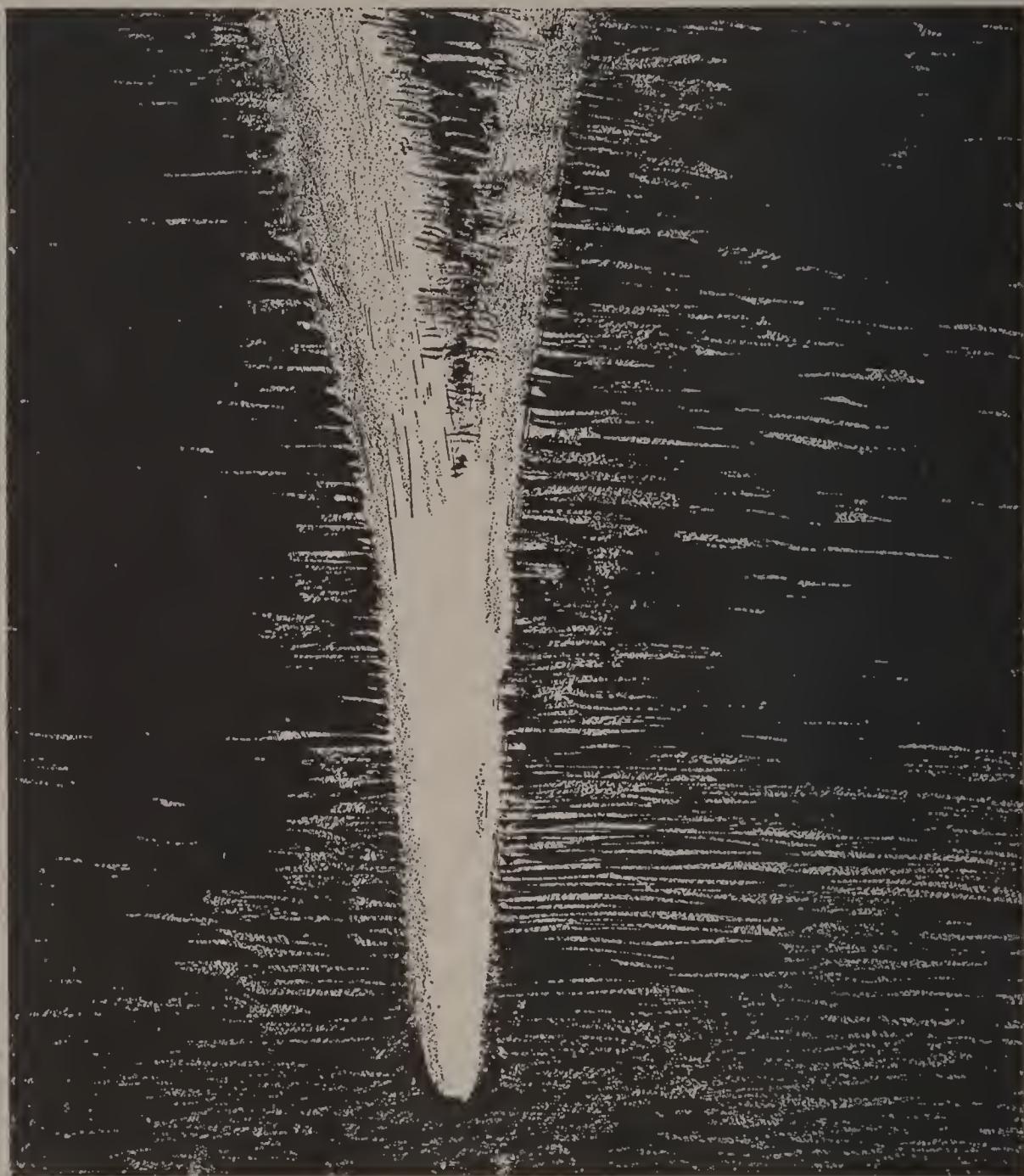
If these planets are like the earth, why do they shine like stars? The planets really have no light of their own. The sun shines on the planets, just as it does

on the moon. The moon and the planets are lighted by the sun just as clouds and trees and sky on earth are lighted by the sun during the day. When we see the planets shining, we are really seeing light from the sun.

Astronomers can tell just where each planet is going to appear and when we can see it. If we study about the planets long enough, we can learn to do this too.

COMETS AND SHOOTING STARS

The planets are not the only wanderers of the sky. There are some things that wander even farther and longer. And they are called comets. Long after people had got over being frightened of planets, they still thought the comets were bad beasts that roamed the skies. They were afraid that the comet would suddenly turn on the earth, and destroy them.



COMETS HAVE ROUND HEADS AND LONG TAILS, AND ARE VERY BRIGHT.

But even if a comet did hit the earth, nothing much would happen. A comet is really a harmless thing.

Comets have round heads and long tails, and they are very bright. Sometimes they look like heads with long hair streaming behind them. That is why they are called comets. Comet means long-haired.

Like the stars and planets, comets are far away, but we can measure their size. The head of a small comet is as wide as the Pacific Ocean. And a big comet's head is ten times as big as the earth. Its tail is millions of miles long. Then why wouldn't this great big thing hurt us if it hit the earth? Because it isn't solid. It is thin like a cloud. Its tail is nothing but glowing gas. And its head is made of small pieces that could not hurt the earth.

Some comets can be seen for a few months. Then they go away. Some of them come back in a certain number of years. Some are never seen again.

Perhaps these comets that never return have broken into pieces. For some astronomers think that shooting stars are pieces of broken comets.

Most of us have seen shooting stars on a warm summer night. They flash suddenly across the sky and then they are gone. There are certain summer nights when we can see hundreds of these.

Another name for shooting stars is meteors. Meteors are the only heavenly bodies that are not much bigger than they look. They really are small. Most of them are so small that we could hold hundreds of them in our hands.

Often meteors fall to the earth and are found. They are made of stone or iron. Yet they were shining brightly when they fell through the sky. This was because they were going so fast. They were going so fast that they got very hot. This heat is made by air rubbing the meteor,



M.A.P.

A METEOR SHINES BRIGHTLY AS IT FALLS. IT IS COLD AND
DULL WHEN WE FIND IT.

just as pennies get hot if we rub them on a carpet.

The meteors got so hot that they began to glow, just like red-hot iron. But they cooled off very quickly. When we find them they look much like any stone we would find in the fields, except that they often seem to have been burned or melted.

OUR GUIDES AND FRIENDS

But it is not comets or meteors that are of much use to us here on earth. It is the fixed stars that help us. They help sailors to find their way today, just as they did long ago. And they still help us to tell time.

Our Navy has a building down in Washington, D. C., where men watch the stars all the time. This is called an observatory. The men at the observatory can tell exactly what time it is by the position of the stars. At certain

hours they check the time exactly and flash it by radio over all the land and to all the ships at sea. And so, no matter where they are, the captains of ships know exactly what time it is.

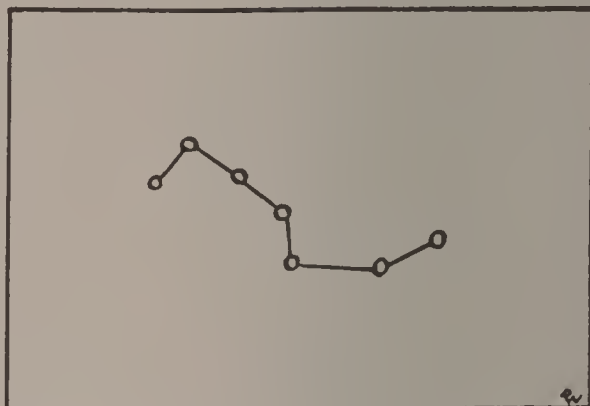
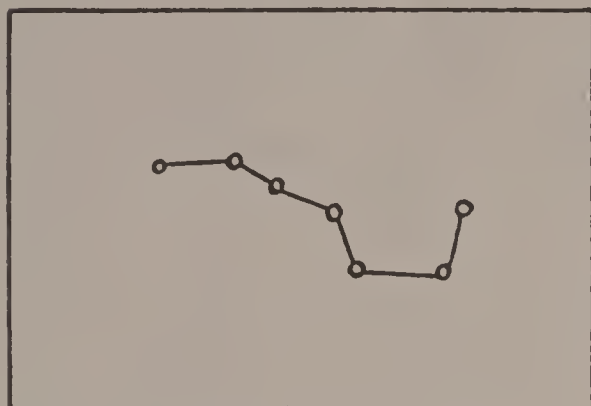
When the captains know the exact time, they can look at the stars and figure out exactly where their ships are. The stars are a much better guide than anything else that man has discovered.

Most of us do not need the stars to tell time or to find our way. Other people do this work for us. Most of us do not have a telescope to study the stars.

But all of us can have fun with the stars. We can make the stars our friends. We can learn their names. We can find the constellations. We can see the shapes of the great giants and strong men that people long ago saw in the sky.

Then, no matter how far we may travel

later, we will always feel at home in the world. For wherever we go, we will find bright stars shining. They are friends that will never leave us.



THE BIG BEAR, OR BIG DIPPER, AS IT IS TODAY (LEFT) AND AS IT WILL LOOK IN 50,000 YEARS.

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