A BANK STREET MUSEUM BOOK

PLANETARIUM

BY BARBARA BRENNER • ILLUSTRATED BY RON MILLER

THE MUSEUM THAT EXPLORES THE MANY WONDERS OF OUR SOLAR SYSTEM

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PLANETARIUM

By Barbara Brenner • Illustrated by Ron Miller
With an introduction by Dr. William R. Alschuler, Science Consultant

To Carl, in memory of stargazing.
–B.B.

Series graphic design by Alex Jay/Studio J
Senior Editor: Sarah Feldman
Assistant Editor: Kathy Huck
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Additional scientific review from Suzanne Gurton, Astronomical Writer and Producer, Hayden Planetarium.

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Introduction

All through my years in grade school, the principal of my school used to come around once a year and give a talk about the planets and the Sun, and how we were going to travel to them on giant spaceships. I later found out that most parents, including my own, thought he was a bit crazy for talking about rockets to the moon and Earth satellites. This was in the early 1950s when many people considered such things science fiction. Yet just a few years later, in 1957, the first satellites went up. My principal inspired me to look to the skies to dream of interplanetary voyages, and to set my sights on becoming an astronomer.

Today we have actually begun these great voyages and can now sit at home and watch wonderful live TV pictures showing close-ups of sulphur volcanoes and ice seas on the moons of Jupiter, Uranus spinning like a knocked-over top, and the patterns of fierce cold winds of Neptune. Still, I get a great thrill any time I go outside on a dark, clear night, far from city lights, and look up at all the stars, and let my eye wander along the Milky Way. If you live in a big city, then just cast your eye upon the Moon. Binoculars or a very small telescope (on a steady mount) will reveal amazing details of mountains, cliffs, craters, and dusty plains. This book should send you on your way to space. Use it, and look at the sky with new questions and new dreams!

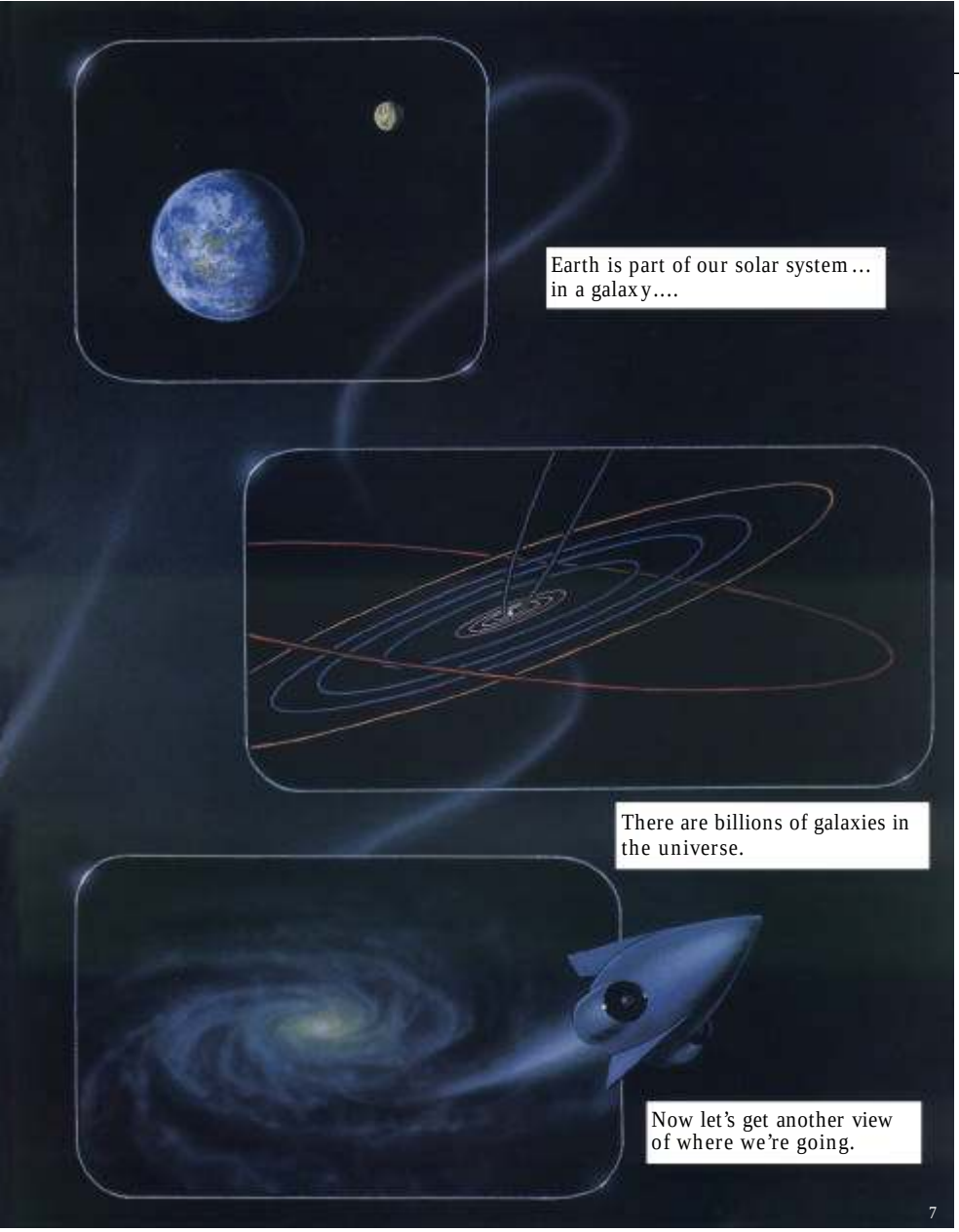
Dr. William R. Alschuler
President, Future Museums

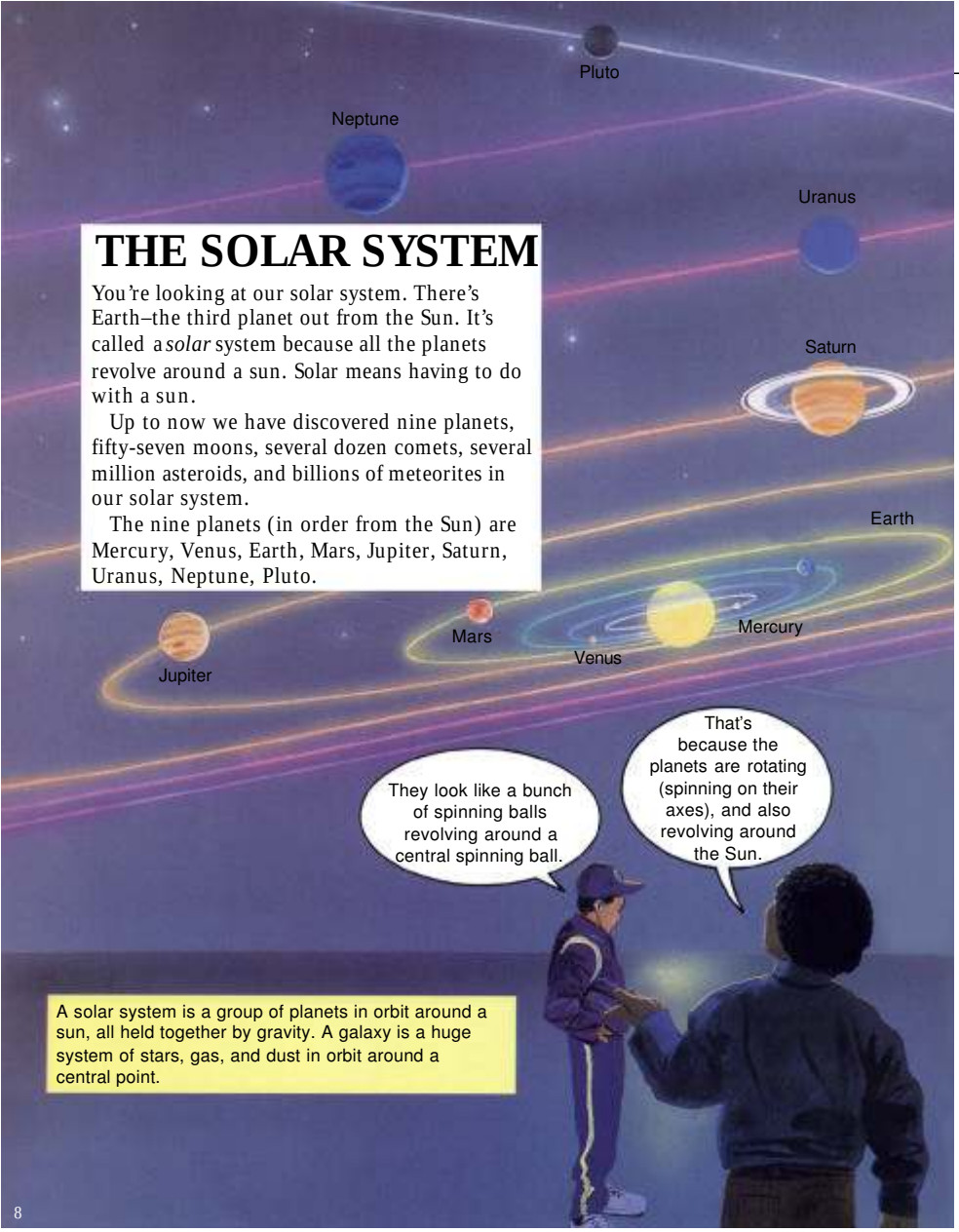
If the Sun
were an orange,
Mercury would be
a grain of sand.
Venus,
a pinhead.
Earth,
another pinhead.
Mars, a grain of sand.
Jupiter,
a marble.
Saturn,
a pea.
Uranus,
a small pill.
Neptune,
a pill.
Pluto,
a third pinhead.
–A. E. Nourse

If you flew in a spaceship at 5,000 miles per hour through the center of the solar system starting at the Sun, it would take eighty-four years to get past Pluto.

Welcome to the Planetarium. You are about to take a trip through our solar system. But first climb aboard *Fantasy 1* and let's see where we are…

We're in the Planetarium... in a city... in the United States... on Earth...


Earth is part of our solar system…
in a galaxy….
There are billions of galaxies in
the universe.
Now let's get another view
of where we're going.



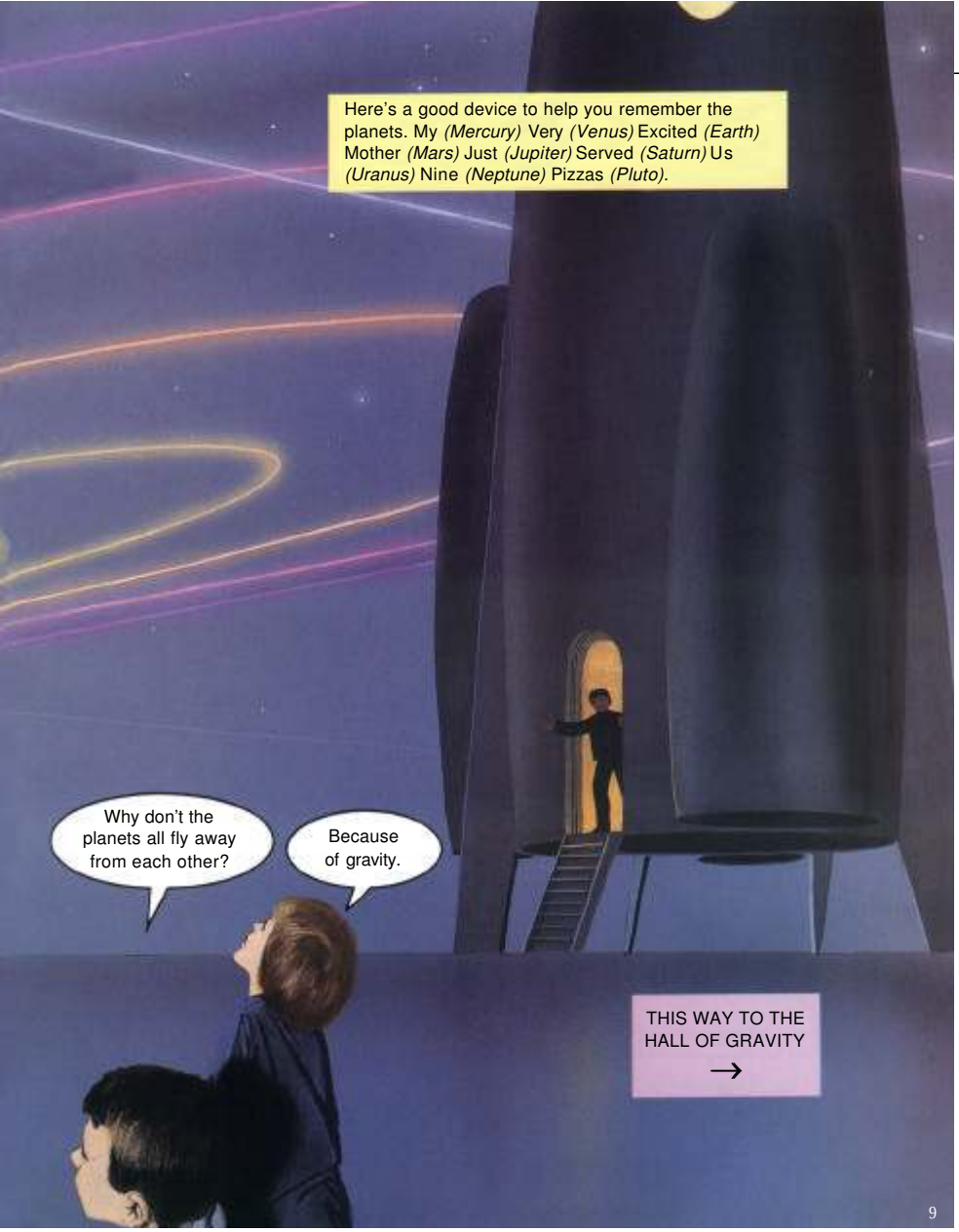
THE SOLAR SYSTEM

You're looking at our solar system. There's Earth–the third planet out from the Sun. It's called a *solar* system because all the planets revolve around a sun. Solar means having to do with a sun.

Up to now we have discovered nine planets, fifty-seven moons, several dozen comets, several million asteroids, and billions of meteorites in our solar system.

The nine planets (in order from the Sun) are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

A solar system is a group of planets in orbit around a sun, all held together by gravity. A galaxy is a huge system of stars, gas, and dust in orbit around a central point.


Here's a good device to help you remember the planets. My *(Mercury)* Very *(Venus)* Excited *(Earth)* Mother *(Mars)* Just *(Jupiter)* Served *(Saturn)* Us *(Uranus)* Nine *(Neptune)* Pizzas *(Pluto)*.
Why don't the planets all fly away from each other?
Because of gravity.
THIS WAY TO THE HALL OF GRAVITY
→

HALL OF GRAVITY

You can't see it or feel it, but this hall is full of gravity! Gravity is everywhere in the universe. You can feel the pull of gravity every time you lift something. If there were no gravity you couldn't stay seated in a chair or pour a glass of water. Gravity is a mysterious force. No one knows exactly how it works, but here's what it does.

Earth's gravity pulls everything toward the center of the Earth. That's what keeps us on its surface. The more mass an object has, the stronger its pull of gravity. Earth has more mass than the Moon, so its gravity is stronger than the Moon's. You would weigh less on the Moon than on Earth because the Moon has a weaker pull of gravity. That's why the astronauts were able to walk lightly there even in heavy spacesuits.

Experiment 1
When you weigh yourself, you're really measuring how much gravity pulls on you.

Experiment 2
This robot has a pail with a foam ball inside. The robot turns the pail upside down. What happens? *The ball falls out of the pail.*

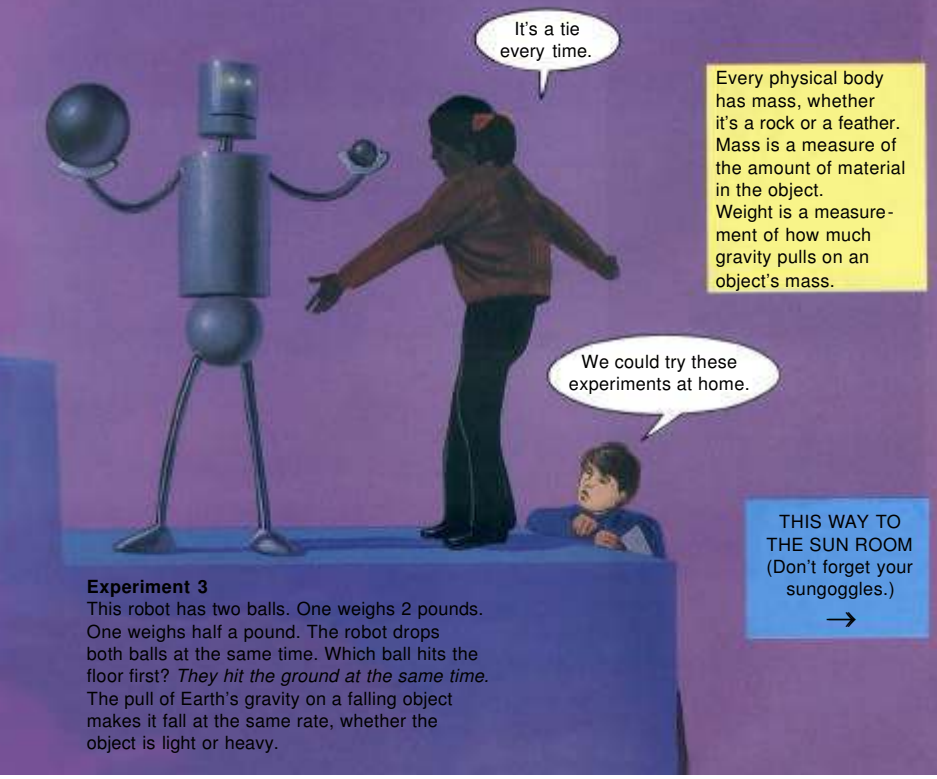
Now the robot picks up the string and whirls the pail around its head. What happens? *The ball stays in the pail.*

Gravity is pulling the ball toward the ground. At the same time, the force of the whirling motion is balancing the force of gravity, so the ball stays in the pail.

Suppose the robot were to swing the pail just a little. That force might not be enough to balance gravity's pull.

Gravity is what keeps our solar system together. The Earth stays in its path around the Sun because of gravity. The Moon travels around Earth because of gravity. Even Neptune, one of the farthest planets in our system, feels the pull of the Sun's gravity.

The farther away two objects are from each other, the weaker the pull between them. That's why Pluto, the farthest planet from the Sun, is held so weakly by the Sun and travels around its orbit so slowly.

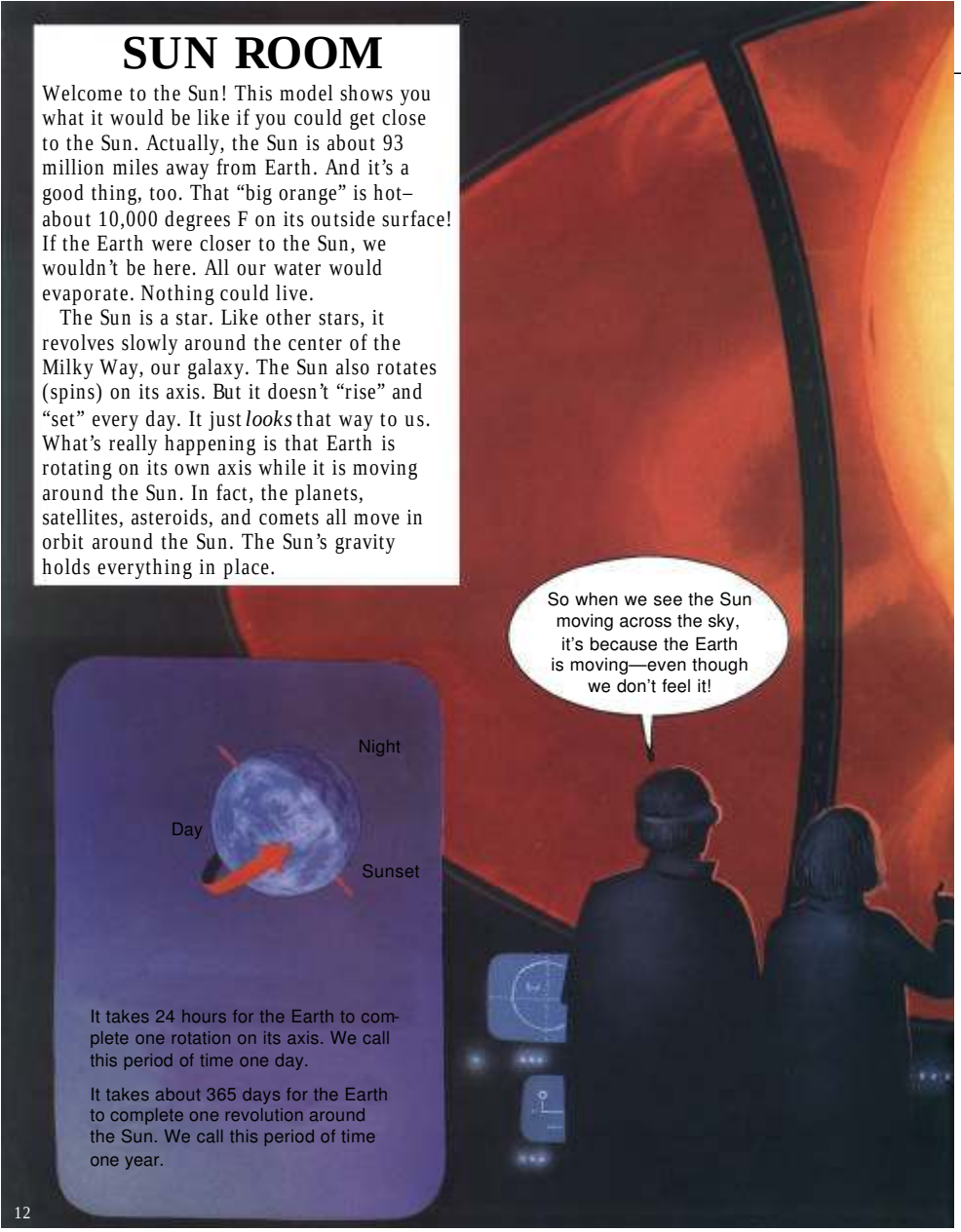


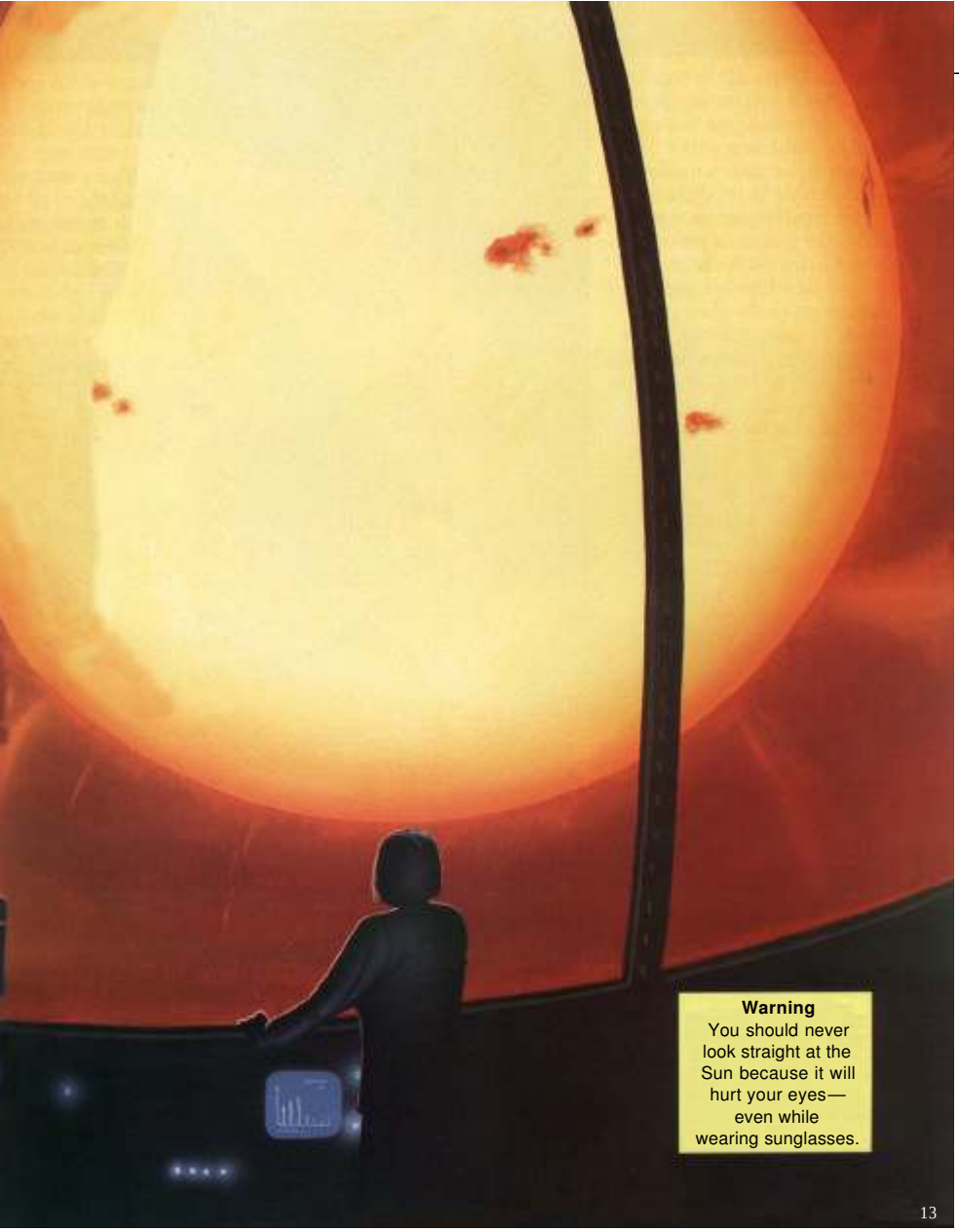
Experiment 3
This robot has two balls. One weighs 2 pounds. One weighs half a pound. The robot drops both balls at the same time. Which ball hits the floor first? *They hit the ground at the same time.* The pull of Earth's gravity on a falling object makes it fall at the same rate, whether the object is light or heavy.

SUN ROOM

Welcome to the Sun! This model shows you what it would be like if you could get close to the Sun. Actually, the Sun is about 93 million miles away from Earth. And it's a good thing, too. That "big orange" is hot–about 10,000 degrees F on its outside surface! If the Earth were closer to the Sun, we wouldn't be here. All our water would evaporate. Nothing could live.

The Sun is a star. Like other stars, it revolves slowly around the center of the Milky Way, our galaxy. The Sun also rotates (spins) on its axis. But it doesn't "rise" and "set" every day. It just *looks* that way to us. What's really happening is that Earth is rotating on its own axis while it is moving around the Sun. In fact, the planets, satellites, asteroids, and comets all move in orbit around the Sun. The Sun's gravity holds everything in place.




Warning
You should never look straight at the Sun because it will hurt your eyes—even while wearing sunglasses.


The Sun is one of the smaller stars. But it is giant compared to the planets in our solar system. If the Sun were hollow, more than a million Earths could fit inside it.
The most important thing about the Sun is its making of energy. This comes from the core–that white-hot part in the center. In the core, giant nuclear explosions take place all the time. They are fueled by hydrogen gases and, like hydrogen bombs, they release enormous quantities of energy. This energy is constantly working its way to the surface of the Sun. The Sun uses up over 4 million tons of hydrogen per second. But it still has enough hydrogen to last for the next 5 billion years.
Core
Photosphere
Wow! If only scientists could harness the Sun's power!
I've seen lights and toys that run on solar energy.

Experiment
Take two large cans. Paint one black. Fill both with cold water. Put them both out in the sun on a sunny day.

After two hours, measure the temperature of the water in each can. Which can of water is warmer? Which one collected more solar energy? *It is the black one, because the color black absorbs more light than any other color.*

How could you use this idea in your own home?

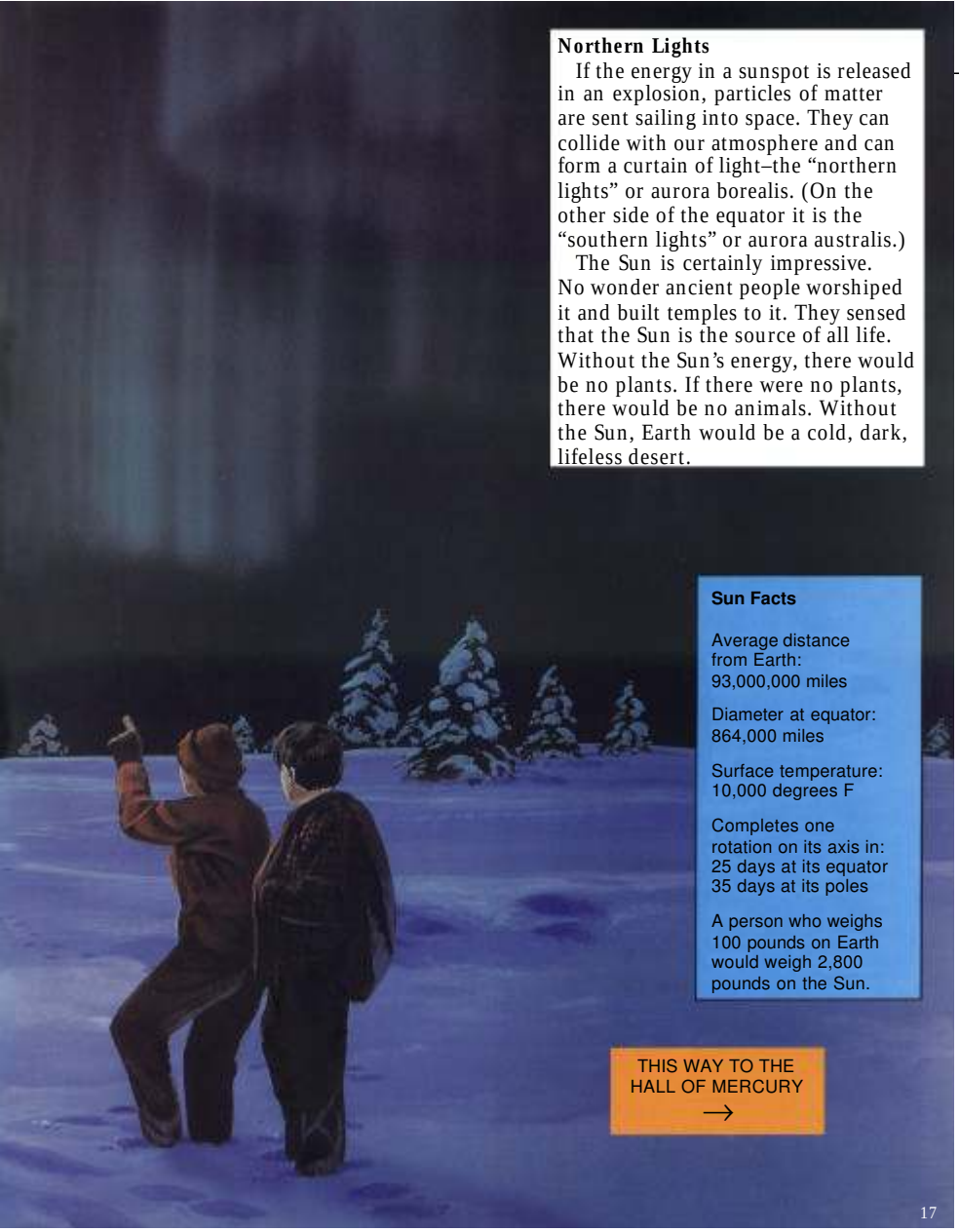
The outer layer of the Sun, the photosphere, is made up of boiling gases. That's why the Sun looks to us like a ball of fire.

The Sun revolves around our galaxy. It completes one orbit every 225 million years.

Sunspots
Sunspots are giant storms on the surface of the Sun. One of these "spots" can release enough electrical energy to take care of all Earth's energy for 1 million years. Sunspots come in cycles. Maximum numbers of sunspots appear about every 22 years. The last big year for sunspots was 1991. So the next one will be 2013.

The largest sunspot ever seen was recorded on April 18, 1947. It covered an area of 7 billion square miles.

Going toward Earth in a spaceship you might see the Sun this way at the edge of Earth's horizon.



Northern Lights

If the energy in a sunspot is released in an explosion, particles of matter are sent sailing into space. They can collide with our atmosphere and can form a curtain of light–the "northern lights" or aurora borealis. (On the other side of the equator it is the "southern lights" or aurora australis.)

The Sun is certainly impressive. No wonder ancient people worshiped it and built temples to it. They sensed that the Sun is the source of all life. Without the Sun's energy, there would be no plants. If there were no plants, there would be no animals. Without the Sun, Earth would be a cold, dark, lifeless desert.

Sun Facts

Average distance from Earth: 93,000,000 miles

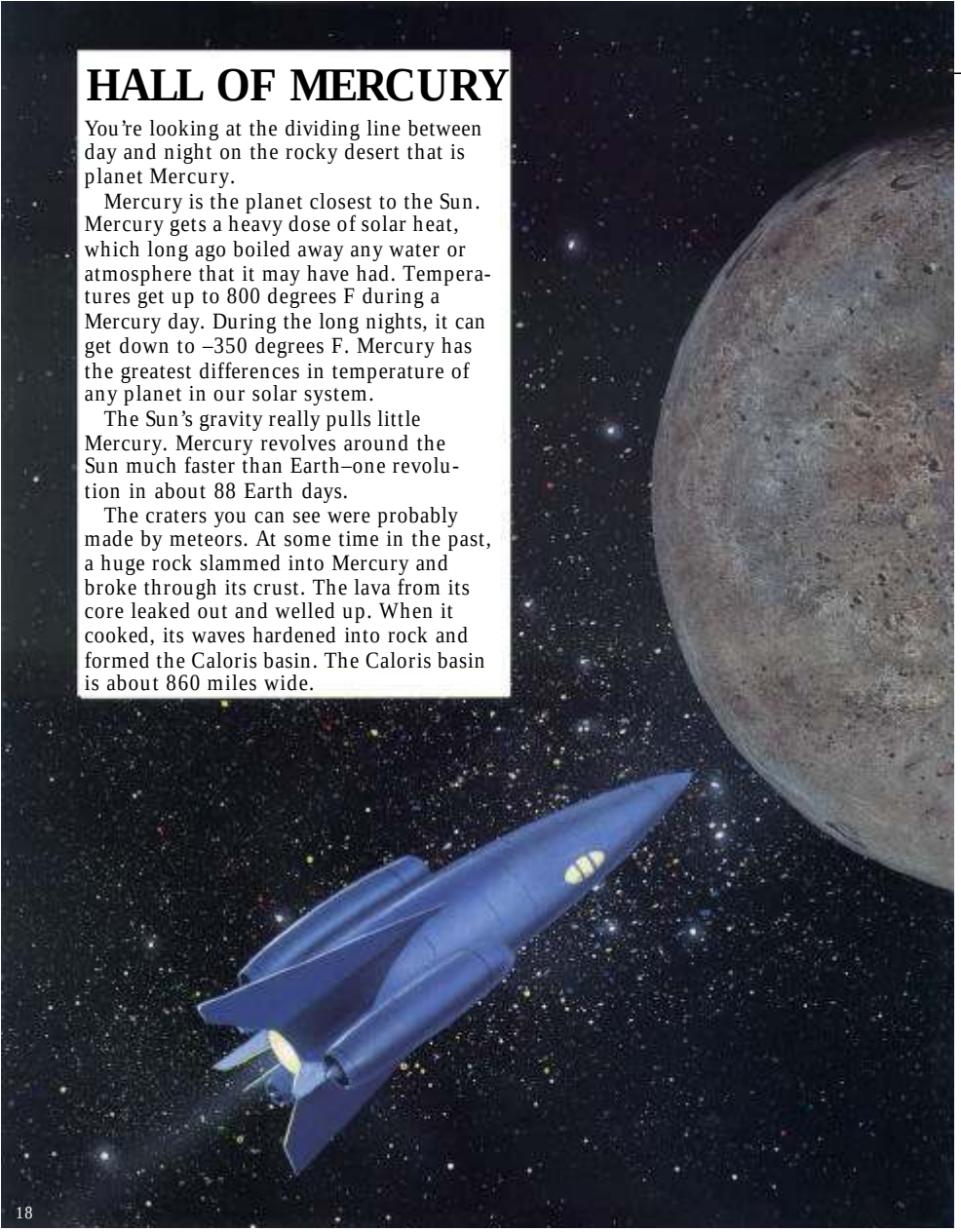
Diameter at equator: 864,000 miles

Surface temperature: 10,000 degrees F

Completes one rotation on its axis in: 25 days at its equator 35 days at its poles

A person who weighs 100 pounds on Earth would weigh 2,800 pounds on the Sun.

THIS WAY TO THE HALL OF MERCURY →



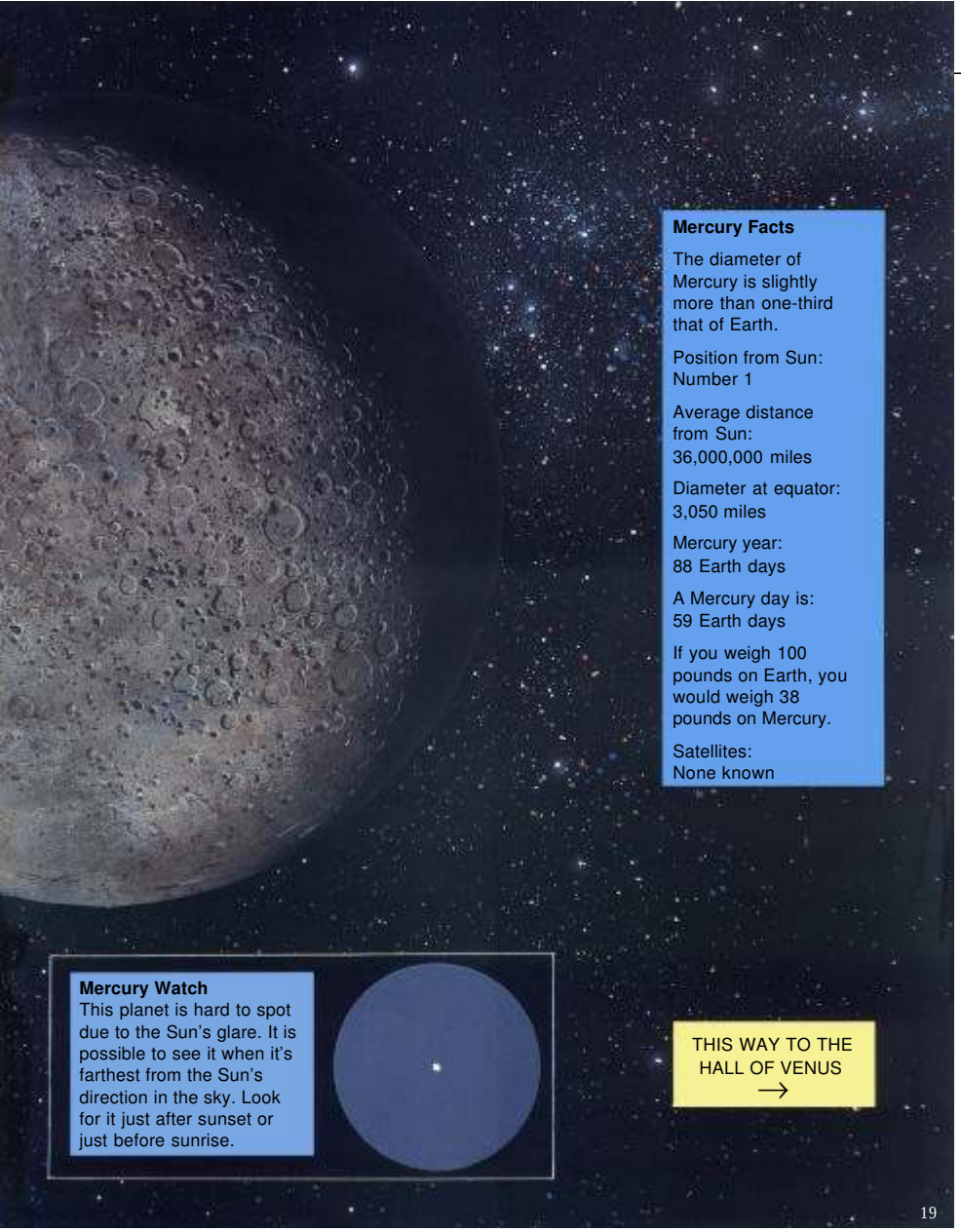
HALL OF MERCURY

You're looking at the dividing line between day and night on the rocky desert that is planet Mercury.

Mercury is the planet closest to the Sun. Mercury gets a heavy dose of solar heat, which long ago boiled away any water or atmosphere that it may have had. Temperatures get up to 800 degrees F during a Mercury day. During the long nights, it can get down to –350 degrees F. Mercury has the greatest differences in temperature of any planet in our solar system.

The Sun's gravity really pulls little Mercury. Mercury revolves around the Sun much faster than Earth–one revolution in about 88 Earth days.

The craters you can see were probably made by meteors. At some time in the past, a huge rock slammed into Mercury and broke through its crust. The lava from its core leaked out and welled up. When it cooked, its waves hardened into rock and formed the Caloris basin. The Caloris basin is about 860 miles wide.



Mercury Facts

The diameter of Mercury is slightly more than one-third that of Earth.

Position from Sun:
Number 1

Average distance from Sun:
36,000,000 miles

Diameter at equator:
3,050 miles

Mercury year:
88 Earth days

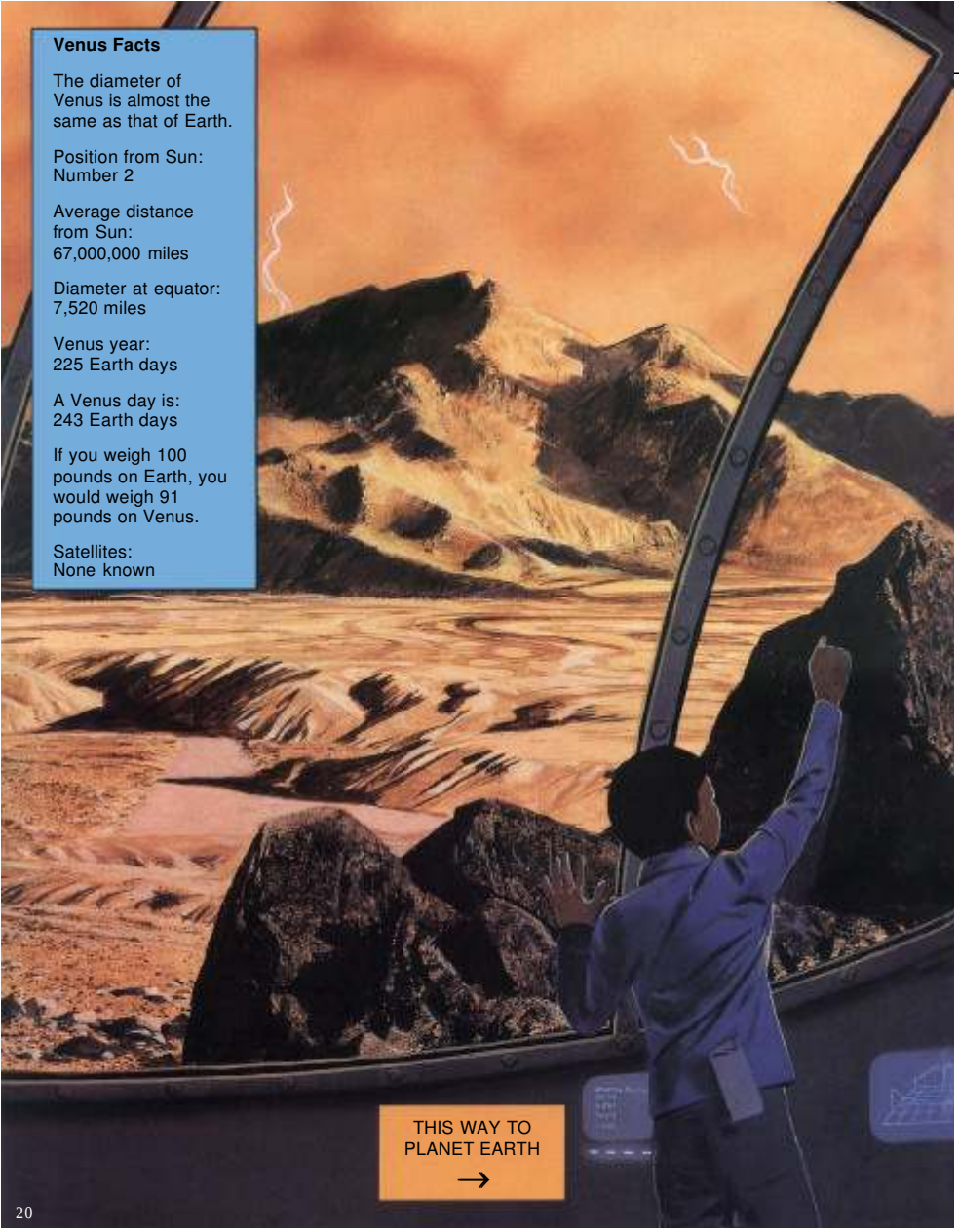
A Mercury day is:
59 Earth days

If you weigh 100 pounds on Earth, you would weigh 38 pounds on Mercury.

Satellites:
None known

Mercury Watch
This planet is hard to spot due to the Sun's glare. It is possible to see it when it's farthest from the Sun's direction in the sky. Look for it just after sunset or just before sunrise.

THIS WAY TO THE HALL OF VENUS →


Venus Facts
The diameter of Venus is almost the same as that of Earth.
Position from Sun: Number 2
Average distance from Sun: 67,000,000 miles
Diameter at equator: 7,520 miles
Venus year: 225 Earth days
A Venus day is: 243 Earth days
If you weigh 100 pounds on Earth, you would weigh 91 pounds on Venus.
Satellites: None known
THIS WAY TO PLANET EARTH
→

HALL OF VENUS

WEIRD AND DEADLY

We are now looking at the surface of Venus. Venus is named after the Greek goddess of love. But in reality, Venus is not lovely. It is surrounded by deadly carbon dioxide. Its clouds are sulfuric acid instead of water vapor. It's too hot for anyone from Earth to live there, and even if you could stand the heat, you'd be crushed by the air pressure, which would be as great as if you were diving 3,000 feet into the ocean. Venus is also contrary. It rotates on its axis opposite to the rotation direction of every other planet. If there were people on Venus, they would see the Sun rise in the west and set in the east.

In 1975, the first successful space probe to Venus began to send back information. Before that time, space probes were crushed by the heavy atmosphere before they could send any data. So far, twenty-one spacecraft have visited Venus. None has ever returned. The latest, *Magellan,* is now making detailed maps of Venus.

Venus is almost the same size as Earth, but its mountain ranges are much higher. They may be the largest ranges of mountains in our solar system.

Venus Watch
Look for Venus in the sky just after sunset or just before sunrise. It shines very brightly because its 20-mile-thick cloud cover reflects sunlight like a field of snow.

PLANET EARTH

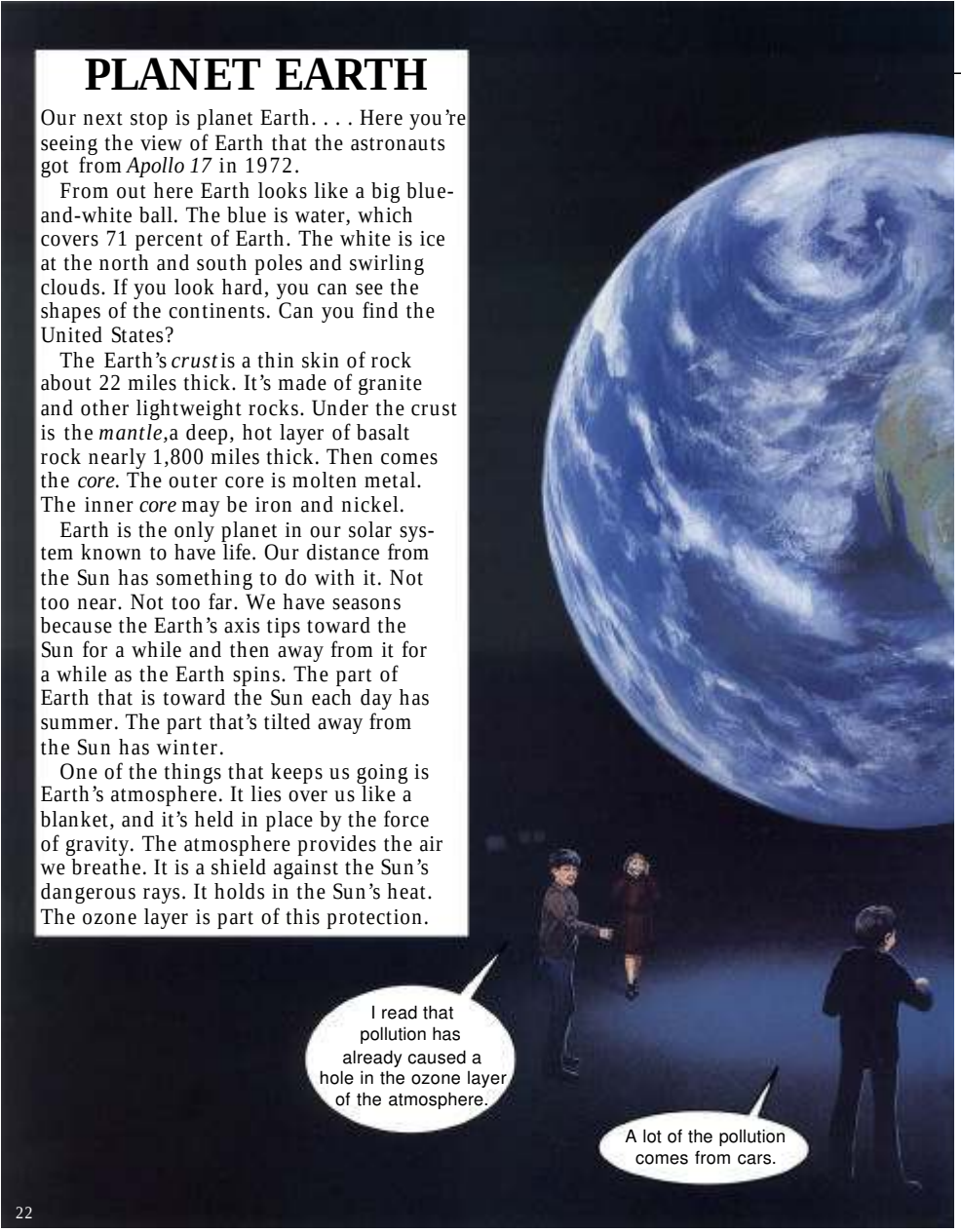
Our next stop is planet Earth. . . . Here you're seeing the view of Earth that the astronauts got from *Apollo 17* in 1972.

From out here Earth looks like a big blue-and-white ball. The blue is water, which covers 71 percent of Earth. The white is ice at the north and south poles and swirling clouds. If you look hard, you can see the shapes of the continents. Can you find the United States?

The Earth's *crust* is a thin skin of rock about 22 miles thick. It's made of granite and other lightweight rocks. Under the crust is the *mantle*, a deep, hot layer of basalt rock nearly 1,800 miles thick. Then comes the *core*. The outer core is molten metal. The inner *core* may be iron and nickel.

Earth is the only planet in our solar system known to have life. Our distance from the Sun has something to do with it. Not too near. Not too far. We have seasons because the Earth's axis tips toward the Sun for a while and then away from it for a while as the Earth spins. The part of Earth that is toward the Sun each day has summer. The part that's tilted away from the Sun has winter.

One of the things that keeps us going is Earth's atmosphere. It lies over us like a blanket, and it's held in place by the force of gravity. The atmosphere provides the air we breathe. It is a shield against the Sun's dangerous rays. It holds in the Sun's heat. The ozone layer is part of this protection.



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