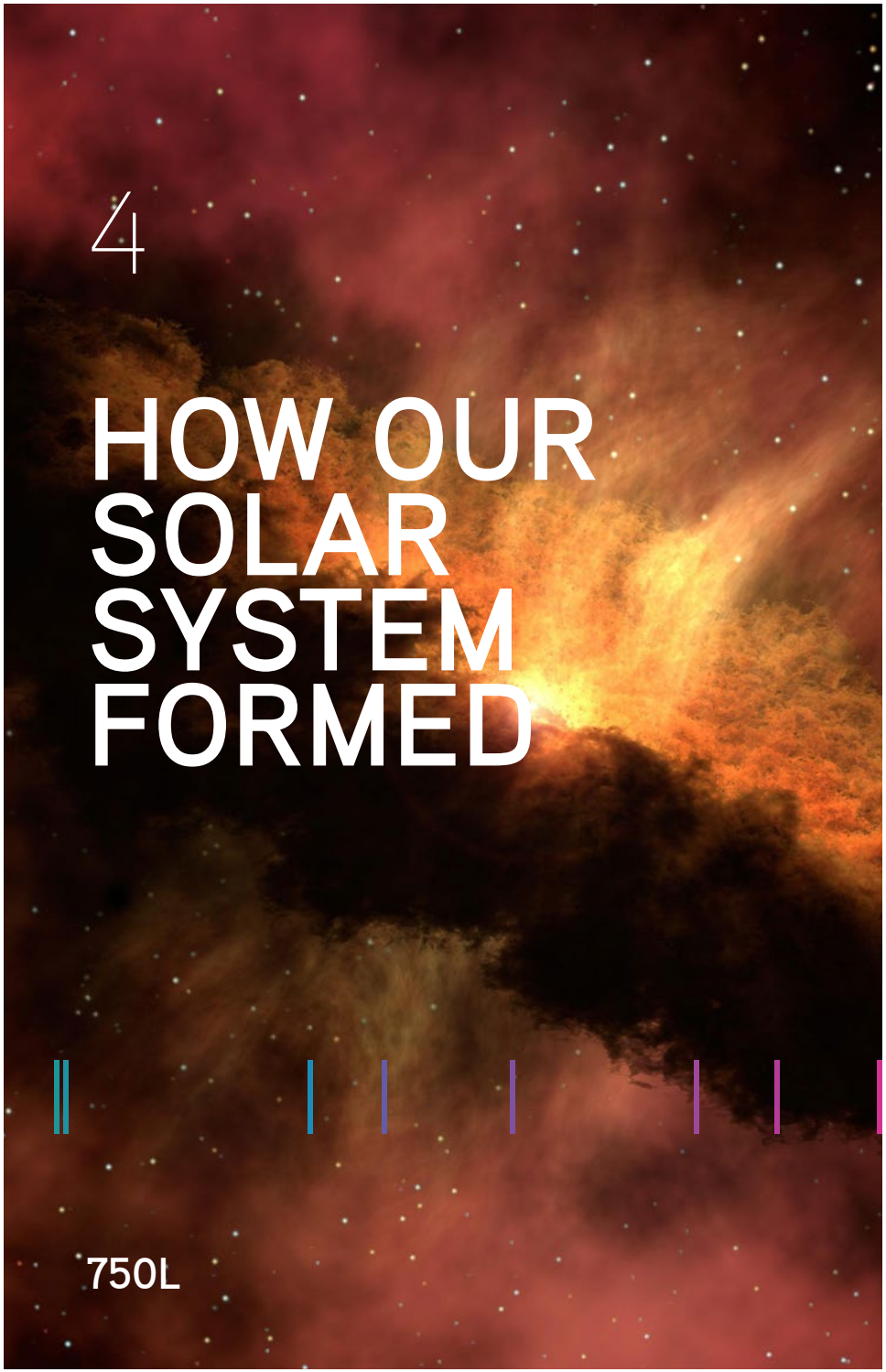


BIG HISTORY PROJECT

HOW OUR SOLAR SYSTEM FORMED

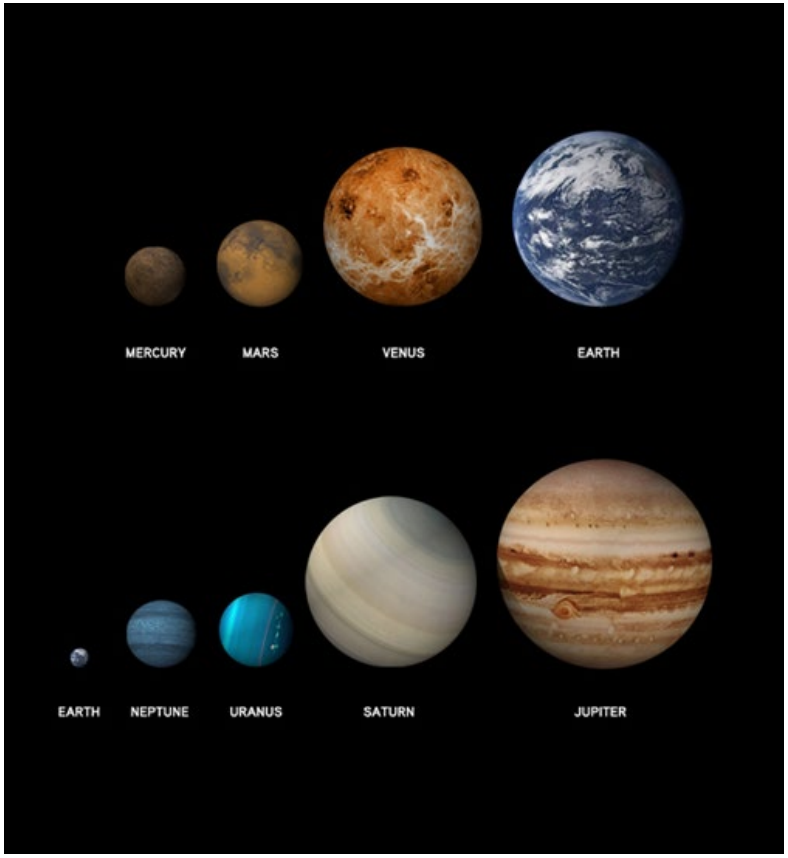
A CLOSE LOOK AT THE PLANETS ORBITING OUR SUN

By Cynthia Stokes Brown, adapted by Newsela

Planets come from the clouds of gas and dust that orbit new stars. Billions of years ago, things were just right for Earth and the other planets in our Solar System to form.

The Solar System that we live in has a medium-size star at its center. It's better known as our Sun. Eight planets orbit it. The planets in our Solar System are of two different types. The four closest to the Sun are Mercury, Venus, Earth, and Mars. They are smaller and made mainly of metals and rocks. The four outer planets — Jupiter, Saturn, Uranus, and Neptune — are larger and made mostly of gases.

What are planets? Where did they come from? Why would some be rocky and some gaseous? What is our planet like? This essay will address those questions.



Each of the planets in our Solar System is unique. They vary in size and composition.

The birth of the Sun

Let's quickly review how our Sun came into being. Five billion years ago, a giant cloud floated in our Milky Way galaxy. This cloud, called a nebula by astronomers, was made up of dust and gas, mostly hydrogen and helium. It had just a small percentage of heavier atoms. These heavier atoms had been formed earlier in the history of the Universe when other stars aged and died.

The nebula began to contract. It collapsed in on itself. Atoms separated. Once loose, they began to bump against each other. Their collisions generated heat. In the rising heat, the atoms collided more often and more violently. Eventually, they reached a temperature at which the protons at the centers of the atoms began to fuse, in a process called nuclear fusion. As they did, a tiny bit of matter transformed into enormous energy. And our Sun was born.

The birth of the planets

Some of the material in the nebula didn't absorb into the Sun. What was left over swirled around it. It flattened into a disk of dust and gas. Material in the disk began sticking together, or accreting. The Sun's gravity held this "accretion disk" in orbit.

Each planet began as microscopic grains of dust in the accretion disk. Atoms and molecules began to stick together, or accrete, into larger particles. By gentle collisions, some grains built up into balls. As they grew larger, they formed into objects a mile in diameter, called planetesimals. Now they were big enough to attract other planetesimals by gravity.

If planetesimals collided at high speeds, they could shatter. But gentle collisions helped the objects combine and grow. For some 10 to 100 million years, these protoplanets orbited the Sun and bumped into each other.

This illustration shows the accretion disk of a star that, like our Sun, could go on to form planets from the dust and gas around it.

Worlds collided and combined. When it was over, eight planets remained. But there are rules about what makes a planet. To be called a planet, it must orbit the Sun. It must also be massive enough for its own gravity to shape it into a sphere. And a planet must have cleaned its orbit of smaller objects.

In 2007, scientists at the University of California determined the age of our Solar System. They concluded that it formed 4.568 billion years ago. The scientists discovered this by determining the age of rocky materials from the asteroid belt. The belt is an area filled with millions of asteroids. Asteroids are small, rocky, icy, and metallic bodies. They were left over from the formation of the Solar System.

As the Solar System formed, the Sun sent out energy and particles in a stream called the stellar winds. These powerful winds blew the gases off the four planets closest to the Sun. Without their gases, these planets became smaller. Only their rocks and metals were left. That's why they are called rocky, or terrestrial, planets.

The four outer planets are much farther from the Sun. From such a distance, the winds could not blow away their ice and gases. These outer planets stayed in a gas form. Their only hard part was a small rocky core. However, these four were made of more hydrogen and helium gases than the others to begin with. Heavier materials had already been pulled closer to the Sun by the Sun's gravity when it formed.

Between the inner and outer planets lies the asteroid belt. No planet formed in the belt. Jupiter is incredibly large and therefore has a strong gravitational pull. Astronomers theorize that Jupiter's gravity influenced this region so much that no planet could take shape. Jupiter is 11 times the size (in diameter) of Earth.

Of the four rocky planets, Mercury is the smallest. It's about two-fifths the size of Earth. Earth and Venus are almost the same size. Mars is about half their size. Astronomers believe that a smaller object must have hit Mercury, vaporizing its crust. The impact left behind only its large iron core.

Conditions on Earth

When the rocky planets first formed, they were largely melted (molten) rock. Over hundreds of millions of years they cooled. Eventually, Mercury and Mars, because they are small, solidified. They hardened all the way to their centers.

Only on Earth, and possibly on Venus, have conditions remained in an in-between state. Earth is partially molten. Its crust is solid rock. Beneath the crust is the mantle. It's the layer separating Earth's core from the crust. Over the short-term, the mantle seems solid. But the mantle's rock is hot and melts sometimes. It flows slowly over time. At the center of Earth is a solid iron core. It spins in hot liquid, called magma.

Some scientists and Big Historians use the term "Goldilocks Conditions" to describe conditions on Earth. This comes from "Goldilocks and the Three Bears." In the story, Goldilocks wanders into the home of three bears. The bears are away. She tries out their porridge, their chairs, and their beds. She finds some too hot or too cold, too hard or too soft, too large or too small. But one of each is just right. Likewise, Earth is not too hot or too cold, not too big or too little, not too near the Sun or too far away. It's just right for life to grow.

Earth's Moon

The rocky object nearest to us is the Moon. The Moon orbits Earth, not the Sun, so it is not a planet. The Moon is about one-fourth the size of Earth. Astronauts first walked on the Moon in 1969 and brought back rock and soil samples to study.

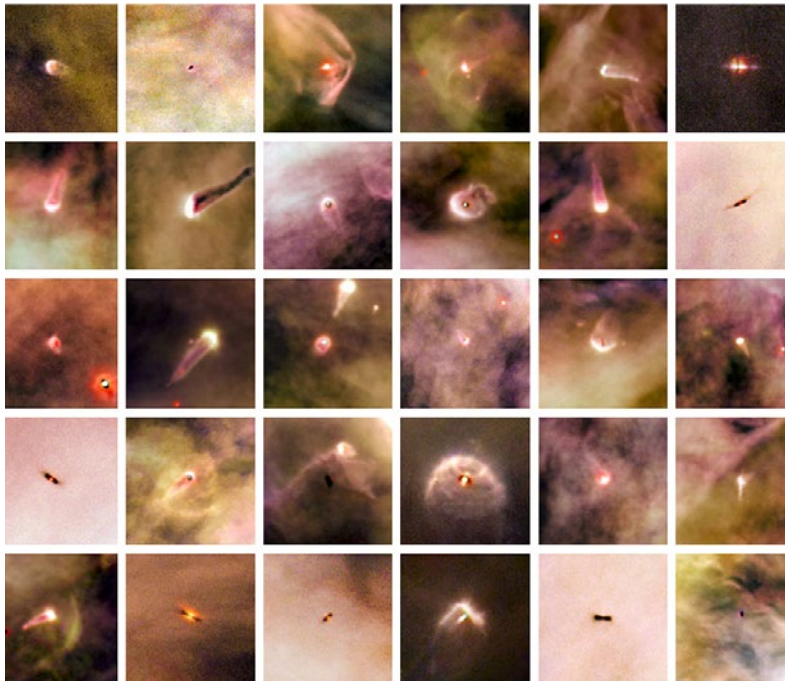
The origin of the Moon remains mysterious. Scientists today believe that a very small planet must have collided with Earth about 4.45 billion years ago. At the time, Earth was still red-hot. A thin crust had just formed on its surface. Some of the material from the impact was absorbed into the liquefied Earth. However, some material flew off into space. There it settled into orbit and came together as the Moon.

The Moon significantly affects conditions on Earth. The impact that produced the Moon tilted Earth on its axis. This causes Earth's seasons. The side tilted toward the Sun for one-half the year's journey around the Sun receives more direct sunlight. The Moon's gravity is also responsible for the oceans' tides.

Pluto and beyond

Before 2006, scientists said our Solar System had nine planets. Pluto was the ninth. However, in 2006, the International Astronomical Union declared that Pluto does not count as a planet. It doesn't meet the three requirements. Pluto is smaller than Earth's Moon. It orbits way out in a belt of asteroids beyond Neptune. Finally, it does not have enough gravity to clear its orbit of rocky bodies. Therefore, Pluto was downgraded to a "dwarf planet."

Astronomers feel confident that our Solar System formed by accretion. They're sure because a similar process is occurring in the Orion Nebula. This planet-forming area is in a giant cloud complex covering much of the Orion constellation. Orion's collection of stars is 1,500 light-years from Earth. Since 1993, astronomers have discovered several hundred stars forming



Dust-and-gas clouds surround nascent stars in the Orion Nebula.

there. Most of them are surrounded by rings of dust in accretion disks. These are just like the one they believe produced our solar system. These clouds of dust and gas around the new stars in the Orion Nebula may develop into planetary systems like our own.

In 1995 astronomers found a planet beyond our Solar System orbiting an ordinary star. Such a planet is called an exoplanet. More than 700 exoplanets have been discovered since. Most of them are giants, closer in size to Jupiter. Planets of that size are easier to detect hundreds of light-years away. One light-year equals 6 trillion miles.

Most exoplanets are not seen visually. They're typically spotted indirectly by measuring the effect of their gravity on their parent star. Or scientists can get a glimpse of changes in light. When a planet passes in front of its parent star, that star's light dims briefly.

In 2009, the National Aeronautics and Space Administration (NASA) sent a telescope into orbit around the Sun as part of the Kepler mission. Its goal is to hunt for planets outside our Solar System that could support life. Kepler's telescope will monitor 100,000 stars. They're a few hundred to a few thousand light-years away. In the first two years alone, it has found 17 planets that life could possibly survive on.

In summary, planets are bodies orbiting a star. Planets form from particles in a disk of gas and dust. The particles collide and stick together as they orbit the star. The planets nearest to the star tend to be rockier. Their heavier materials were attracted by the star's gravity and stayed close to it. The star's wind blows away their gases because they are so close. In the Sun's system, Earth is one of four rocky planets. But it's a unique one, with rigid and molten layers.

Image credits

Illustration of a fledging solar system,
NASA/JPL-Caltech

A size comparison of the planets,
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Illustration of an accretion disk,
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