Neptune

 Neptune was discovered as a result of calculations. By the early 19th century, astronomers realized that Uranus was not following its expected orbit. The gravitational pull of an unknown planet beyond Uranus seemed the most likely explanation. In 1845, the English mathematician John Couch Adams (1819-1892) announced that he had calculated the probable position of a planet beyond Neptune, but his findings were ignored. In June 1846, the Frenchman Urbain LeVerrier did the same. This time, observers took notice. Johann Galle (1812-1910) of the Berlin Observatory found Neptune on September 23, 1846. Astronomers continued to speculate about another planet beyond Neptune. Pluto was eventually discovered in 1930 and was considered to be the ninth major planet until 2006. Between 1992 and 2006, hundreds of small icy bodies had been found beyond Neptune, in what is called the Kuiper belt. They include Eris, which is larger than Pluto. In 2006, astronomers decided to class both Pluto and Eris as dwarf planets.

Pluto

Pluto was discovered in 1930 as the result of a systematic search by an American astronomer, Clyde Tombaugh (1906- 1997), working at the Lowell Observatory in Arizona. Its orbit was found to be unusual, being much more elongated than the orbits of the previously known planets. Pluto is sometimes closer to the Sun than Neptune. Gradually, astronomers realized that Pluto was much smaller than they originally thought. It has only one-fifth the mass of our Moon. The first spacecraft ever to be sent to Pluto, New Horizons, was launched in 2006 and will fly by Pluto in 2015.

 Uranus

URANUS WAS THE FIRST PLANET to be discovered since the use of

the telescope. It was discovered by accident, when William Herschet

observing from Bath, England, set about remeasuring all the major stars

with his 6-in (15-cm) reflector telescope (p.24). In 1781 he noticed an

unusually bright object in the zodiacal constellation of Gemini. At first he

assumed it was a nebula (pp.60-61) and then a comet (pp.58-59), but it

moved in a peculiar way. The name of Uranus was suggested by the

German astronomer Johann Bode, who proposed that the planet be

named after the father of Saturn,

in line with established

classical traditions. Bode

is also famous as the

creator of Bode's law-a

mathematical formula that

predicted roughly where

planets should lie.

Venus

PEOPLE OFTEN MISTAKE VENUS for a star. After the Moon, it

is the brightest object in our night sky. Because it is so

close in size to Earth, until the 20th century astronomers

assumed that it might be in some ways like Earth. The

probes sent to investigate have shown that this is not so.

The dense cloudy atmosphere ofVenus hides its surface

from even the most powerful telescope. Only radar can

penetrate to map the planet's features. Until it became

possible to determine the surface features-largely flat,

volcanic plains-scientists could not tell how long the

Venusian day was. The atmosphere would be deadly

to humans. It is made up of a mixture of carbon

dioxide and sulfuric acid that causes an extreme

1/ greenhouse effect," in which heat is trapped

by the atmosphere. The ancients, however,

saw only a beautifully bright planet, and

so they named it after their goddess

of love. Nearly all the features mapped

on the surface ofVenus have been

named after women, such as Pavlova,

Sappho, and Phoebe.

Sun

 ALMOST EVERYANCIENT CULTURE recognized the Sun as the giver

of life and primary power behind events here on Earth. The Sun is the

center of our solar system, our local star. It has no permanent features

because it is gaseous-mainly incandescent hydrogen. The temperature

of the Sun's visible yellow disk-the photosphere-is about 9,900oP

(5,500°C). Over the photosphere, there are layers of hotter gas-the

chromosphere and corona. The thin gas in the corona is at about a

million degrees. By using spectroscopic analysis (pp.30-31), scientists

know that the Sun, like most stars (pp.60-61), is made up mostly of

hydrogen. In its core, the hydrogen nuclei are so compressed that they

eventually fuse into helium. This is the same thing that happens in a

hydrogen atomic bomb. Every minute, the Sun converts 240 million

metric tons of mass into energy. Albert Einstein's famous formula,

E=mc2, shows how mass and energy are mutually interchangeable

(p.63), helping scientists to understand the source of the Sun's energy.

Saturn

THE GIANT PLANET SATURN, with its flat rings, is probably

the most widely recognized astronomical image. For the

classical world, Saturn was the most distant known planet.

They named it after the original father of all the gods. Early

astronomers noted its 29-year orbit and assumed that it

moves sluggishly. Composed mostly of hydrogen, its

atmosphere and structure are similar to Jupiter's, but its

density is much lower. Saturn is so light that it could float

on water (p.4S). Like Jupiter, Saturn rotates at great speed

causing its equator to bulge outward. Saturn also

has an appreciable magnetic field. Winds in its upper

atmosphere can travel at l100 mph (l800 km/h)

but major storms are rare. White spots tend to develop

during Saturn's northern-hemisphere summer, which

happens every 30 years or so, the

last being in 1990.

Mercury

 THE PLANET MERCURY IS NAMED after the Greco-Roman

messenger of the gods, because it circles the Sun faster than the

other planets, completing its circuit in 88 Earth days. Because it

travels so close to the Sun, Mercury is often difficult to observe.

Even though its reflected light makes it one of the brightest objects

in the night sky, Mercury is never far enough from the Sun to be

able to shine out brightly. It is only visible as a "morning" or

"evening" star, hugging the horizon just before or after the Sun

rises or sets. Like Venus, Mercury also has phases (p.20). Being so

close to the Sun, temperatures during the day on Mercury are hot

enough to melt many metals. At night they drop to -291°F (-180aC),

making the temperature range the greatest of all the planets. The

gravitational pull of the Sun has" stolen" any atmosphere that

Mercury had to protect itself against these extremes.

Mars

 MARS APPEARS PALE ORANGE IN THE NIGHT SKY.The

Babylonians, Greeks, and Romans all named it after their

gods of war. In reality, Mars is a small planet-only half

the size of Earth-but there are similarities. Mars,

like Earth, has a 24-hour day, polar caps, and an

atmosphere. Not surprisingly, Mars has always

been the most popular candidate as a site for

possible extraterrestrial life. Many scientists

believe that some form of life-or at

least evidence of past life-may

remain within the planet, but no life

could survive on the surface. The

atmosphere is too thin to block

out deadly ultraviolet rays.

Mars is also farther from the

Sun than Earth, making it

much colder.

Jupiter

TIDS HUGE, BRIGHT PLANET is the largest world in our solar

system; four of its moons are the size of planets. It is different

in structure from the solid inner planets. Apart from a small

rocky core, Jupiter is mainly hydrogen and helium. Below the

cloudy atmosphere, the pressure is so great that these are liquid

rather than gas. Deep down, the liquid hydrogen behaves like

a metal. As a result, Jupiter has a strong magnetic field and

fierce radiation belts. Jupiter emits more heat radiation than it

receives from the Sun, because it continues shrinking at a rate

of a fraction of an inch per year. Had Jupiter been only 13 times

more massive, this contraction would have made the center

hot enough for nuclear fusion reactions (p.38) to begin, though

not to be sustained for as long as in a star. It would have become a brown dwarf-

a body between a planet and a.

star: The Galileo spacecraft, which

orbited Jupiter from 1995-2003, some amazing

photographs of Jupiter and its moon.

Moon

THE MOON 15 EARTH' 5 only satellite, about 239,000 miles

(384,000 km) away. Next to the Sun it is the brightest object in

our sky,more than 2,000 times as bright asVenus. Even without a

telescope, we can see large areas on the Moon that are darker

than the rest. Early observers imagined these might be seas,

and they were given names such as the Sea of Tranquillity.

We now know that there is neither liquid water nor an

atmosphere on the Moon. The so-called" seas" are plains

of volcanic rock where molten lava flowed into huge

depressions caused by giant meteorites, then

solidified. Volcanic activity on

the moon ceased about two

billion years ago.

The Celestrial Sphere

 THE POSITIONS OF ALL OBJECTS IN SPACE are measured

according to specific celestial coordinates. The best way to

understand the cartography, or mapping, of the sky is to recall how

the ancient philosophers imagined the universe was shaped. They

had no real evidence that Earth moves, so they concluded that it

was stationary and that the stars and planets revolve around it. They

could see the stars wheeling around a single point in the sky and

assumed that this must be one end of the axis of a great celestial

sphere. They called it a crystalline sphere, or the sphere of fixed

stars, because none of the stars seemed to

change their positions relative to each

other. The celestial coordinates used

today come from this old-fashioned

concept of a celestial sphere. The

starry (celestial) and earthly

(terrestrial) spheres share the

same coordinates, such as a

north and south poles and

an equator.

Astrology

THE WORD /I ASTROLOGY" comes from the Greek astron, meaning

"star,"and the suffix" -logy," meaning" study of." Since Babylonian

times, people staring at the night sky were convinced that the

regular motions of the heavens were indications of some great

cosmic purpose. Priests and philosophers believed that if they

could map the stars and the movements of the stars, they could

decode these messages and understand the patterns that had an

effect on past and future events. What was originally observational

astronomy-observing the stars and planets-gradually grew into

the astrology that has today become a regular part of many people's

lives. However, there is no evidence that the stars and planets have

any effect on our personalities or our destinies. Astronomers now

agree that astrology is superstition. Its original noble motives

should not be forgotten, however. For most of the so-called"Dark

Ages," when all pure

science was in deep

hibernation, it was

astrology and the

desire to know about

the future that kept

the science of

astronomy alive.

The Solar System

THE SOLAR SYSTEM is the group of planets, moons, and space debris orbiting around our Sun. It is held together by the gravitational pull of the Sun, which is nearly 1,000 times more massive than all the planets put together. The solar system was probably formed from a huge cloud of interstellar gas and dust that contracted under the force of its own gravity five billion years ago. The planets are divided into two groups. The four planets closest to the Sun are called "terrestrial," from the Latin word terra, meaning "land," because they are small and dense and have hard surfaces. The four outer planets are called "Jovian" because, like Jupiter, they are giant planets made largely of gas and liquid. Between Mars and Jupiter and beyond Neptune there are belts of very small bodies and dwarf planets called the asteroid belt and the Kuiper belt.

**Astronomy** is a [natural science](https://en.wikipedia.org/wiki/Natural_science) that studies [celestial objects](https://en.wikipedia.org/wiki/Astronomical_object) and phenomena. It applies [mathematics](https://en.wikipedia.org/wiki/Mathematics), [physics](https://en.wikipedia.org/wiki/Physics), and [chemistry](https://en.wikipedia.org/wiki/Chemistry), in an effort to explain the origin of those objects and phenomena and their [evolution](https://en.wikipedia.org/wiki/Chronology_of_the_Universe). Objects of interest include [planets](https://en.wikipedia.org/wiki/Planets), [moons](https://en.wikipedia.org/wiki/Natural_satellite), [stars](https://en.wikipedia.org/wiki/Star), [galaxies](https://en.wikipedia.org/wiki/Galaxies), and [comets](https://en.wikipedia.org/wiki/Comet); the phenomena include [supernova explosions](https://en.wikipedia.org/wiki/Supernova), [gamma ray bursts](https://en.wikipedia.org/wiki/Gamma_ray_burst), and [cosmic microwave background radiation](https://en.wikipedia.org/wiki/Cosmic_microwave_background_radiation). More generally, all phenomena that originate outside [Earth's atmosphere](https://en.wikipedia.org/wiki/Atmosphere_of_Earth) are within the purview of astronomy. A related but distinct subject, [physical cosmology](https://en.wikipedia.org/wiki/Physical_cosmology), is concerned with the study of the [Universe](https://en.wikipedia.org/wiki/Universe) as a whole.[[1]](https://en.wikipedia.org/wiki/Astronomy#cite_note-1)

Astronomy is one of the oldest of the natural sciences. The early civilizations in [recorded history](https://en.wikipedia.org/wiki/Recorded_history), such as the [Babylonians](https://en.wikipedia.org/wiki/Babylonian_astronomy), [Greeks](https://en.wikipedia.org/wiki/Greek_astronomy), [Indians](https://en.wikipedia.org/wiki/Indian_astronomy), [Egyptians](https://en.wikipedia.org/wiki/Egyptian_astronomy), [Nubians](https://en.wikipedia.org/wiki/Nubians), [Iranians](https://en.wikipedia.org/wiki/Iranian_peoples), [Chinese](https://en.wikipedia.org/wiki/Chinese_astronomy), [Maya](https://en.wikipedia.org/wiki/Maya_civilization), and many ancient [indigenous peoples of the Americas](https://en.wikipedia.org/wiki/Indigenous_peoples_of_the_Americas) performed methodical observations of the [night sky](https://en.wikipedia.org/wiki/Night_sky). Historically, astronomy has included disciplines as diverse as [astrometry](https://en.wikipedia.org/wiki/Astrometry), [celestial navigation](https://en.wikipedia.org/wiki/Celestial_navigation), [observational astronomy](https://en.wikipedia.org/wiki/Observational_astronomy) and the making of [calendars](https://en.wikipedia.org/wiki/Calendar), but professional astronomy is now often considered to be synonymous with [astrophysics](https://en.wikipedia.org/wiki/Astrophysics).[[2]](https://en.wikipedia.org/wiki/Astronomy#cite_note-2)

Professional astronomy is split into [observational](https://en.wikipedia.org/wiki/Observational_astronomy) and [theoretical](https://en.wikipedia.org/wiki/Theoretical_astronomy) branches. Observational astronomy is focused on acquiring data from observations of astronomical objects, which is then analyzed using basic principles of physics. Theoretical astronomy is oriented toward the development of computer or analytical models to describe astronomical objects and phenomena. The two fields complement each other, with theoretical astronomy seeking to explain observational results and observations being used to confirm theoretical results.

Astronomy is one of the few sciences where amateurs still play an active role, especially in the discovery and observation of transient [phenomena](https://en.wikipedia.org/wiki/Phenomena). [Amateur astronomers](https://en.wikipedia.org/wiki/Amateur_astronomy) have made and contributed to many important astronomical discoveries, such as finding new comets.

Planets

A **planet** is an [astronomical body](https://en.wikipedia.org/wiki/Astronomical_body) [orbiting](https://en.wikipedia.org/wiki/Orbit) a [star](https://en.wikipedia.org/wiki/Star) or [stellar remnant](https://en.wikipedia.org/wiki/Stellar_evolution#Stellar_remnants) that is massive enough to be [rounded](https://en.wikipedia.org/wiki/Hydrostatic_equilibrium) by its own [gravity](https://en.wikipedia.org/wiki/Gravity), is not massive enough to cause [thermonuclear fusion](https://en.wikipedia.org/wiki/Thermonuclear_fusion), and has [cleared its neighbouring region](https://en.wikipedia.org/wiki/Clearing_the_neighbourhood) of [planetesimals](https://en.wikipedia.org/wiki/Planetesimal).

The term *planet* is ancient, with ties to history, [astrology](https://en.wikipedia.org/wiki/Astrology), science, [mythology](https://en.wikipedia.org/wiki/Mythology), and religion. Several planets in the [Solar System](https://en.wikipedia.org/wiki/Solar_System) can be seen with the naked eye. These were regarded by many early cultures as divine, or as emissaries of [deities](https://en.wikipedia.org/wiki/Deity). As scientific knowledge advanced, human perception of the planets changed, incorporating a number of disparate objects. In 2006, the [International Astronomical Union](https://en.wikipedia.org/wiki/International_Astronomical_Union) (IAU) officially adopted a resolution [defining planets](https://en.wikipedia.org/wiki/IAU_definition_of_planet) within the Solar System. This definition is controversial because it excludes many objects of [planetary mass](https://en.wikipedia.org/wiki/Planet#Planetary-mass_objects) based on where or what they orbit. Although eight of the planetary bodies discovered before 1950 remain "planets" under the modern definition, some celestial bodies, such as [Ceres](https://en.wikipedia.org/wiki/Ceres_(dwarf_planet)), [Pallas](https://en.wikipedia.org/wiki/2_Pallas), [Juno](https://en.wikipedia.org/wiki/3_Juno) and [Vesta](https://en.wikipedia.org/wiki/4_Vesta) (each an object in the solar asteroid belt), and [Pluto](https://en.wikipedia.org/wiki/Pluto) (the first [trans-Neptunian object](https://en.wikipedia.org/wiki/Trans-Neptunian_object) discovered), that were once considered planets by the scientific community, are no longer viewed as such.

The planets were thought by [Ptolemy](https://en.wikipedia.org/wiki/Ptolemy) to orbit [Earth](https://en.wikipedia.org/wiki/Earth) in [deferent and epicycle](https://en.wikipedia.org/wiki/Deferent_and_epicycle) motions. Although the idea that the [planets orbited the Sun](https://en.wikipedia.org/wiki/Heliocentrism) had been suggested many times, it was not until the 17th century that this view was supported by evidence from the first [telescopic](https://en.wikipedia.org/wiki/Telescope) [astronomical observations](https://en.wikipedia.org/wiki/Observational_astronomy), performed by [Galileo Galilei](https://en.wikipedia.org/wiki/Galileo_Galilei). At about the same time, by careful analysis of pre-telescopic observation data collected by [Tycho Brahe](https://en.wikipedia.org/wiki/Tycho_Brahe), [Johannes Kepler](https://en.wikipedia.org/wiki/Johannes_Kepler) found the planets' orbits were not circular but [elliptical](https://en.wikipedia.org/wiki/Elliptic_orbit). As observational tools improved, [astronomers](https://en.wikipedia.org/wiki/Astronomer) saw that, like Earth, the planets rotated around tilted axes, and some shared such features as [ice caps](https://en.wikipedia.org/wiki/Ice_cap) and seasons. Since the dawn of the [Space Age](https://en.wikipedia.org/wiki/Space_Age), close observation by [space probes](https://en.wikipedia.org/wiki/Space_probe) has found that Earth and the other planets share characteristics such as [volcanism](https://en.wikipedia.org/wiki/Volcano), [hurricanes](https://en.wikipedia.org/wiki/Hurricane), [tectonics](https://en.wikipedia.org/wiki/Tectonics), and even [hydrology](https://en.wikipedia.org/wiki/Hydrology).

Planets are generally divided into two main types: large low-density [giant planets](https://en.wikipedia.org/wiki/Giant_planet), and smaller rocky [terrestrials](https://en.wikipedia.org/wiki/Terrestrial_planet). Under IAU definitions, there are eight planets in the Solar System. In order of increasing distance from the [Sun](https://en.wikipedia.org/wiki/Sun), they are the four terrestrials, [Mercury](https://en.wikipedia.org/wiki/Mercury_(planet)), [Venus](https://en.wikipedia.org/wiki/Venus), Earth, and [Mars](https://en.wikipedia.org/wiki/Mars), then the four giant planets, [Jupiter](https://en.wikipedia.org/wiki/Jupiter), [Saturn](https://en.wikipedia.org/wiki/Saturn), [Uranus](https://en.wikipedia.org/wiki/Uranus), and [Neptune](https://en.wikipedia.org/wiki/Neptune). Six of the planets are orbited by one or more [natural satellites](https://en.wikipedia.org/wiki/Natural_satellite).

Earth

**Earth** is the third [planet](https://en.wikipedia.org/wiki/Planet) from the [Sun](https://en.wikipedia.org/wiki/Sun) and the only object in the [Universe](https://en.wikipedia.org/wiki/Universe) known to harbor [life](https://en.wikipedia.org/wiki/Life). According to [radiometric dating](https://en.wikipedia.org/wiki/Radiometric_dating) and other sources of evidence, Earth [formed](https://en.wikipedia.org/wiki/Age_of_the_Earth) over 4 [billion years ago](https://en.wikipedia.org/wiki/Bya).[[24]](https://en.wikipedia.org/wiki/Earth#cite_note-USGS1997-28)[[25]](https://en.wikipedia.org/wiki/Earth#cite_note-29)[[26]](https://en.wikipedia.org/wiki/Earth#cite_note-30) [Earth's gravity](https://en.wikipedia.org/wiki/Gravity_of_Earth) interacts with other objects in space, especially the Sun and the [Moon](https://en.wikipedia.org/wiki/Moon), Earth's only [natural satellite](https://en.wikipedia.org/wiki/Natural_satellite). Earth [revolves around the Sun](https://en.wikipedia.org/wiki/Earth%27s_orbit) in 365.26 days, a period known as an Earth [year](https://en.wikipedia.org/wiki/Year). During this time, Earth [rotates about its axis](https://en.wikipedia.org/wiki/Earth%27s_rotation) about 366.26 times.[[n 5]](https://en.wikipedia.org/wiki/Earth#cite_note-sidereal_solar-31)