- Astronomical photography / Astronomical instruments

HISTORY



DID YOU KNOW? The first photograph showing the entire disc of Earth was taken by a Russian satellite in 1966

PICTURING THE PLANETS

WORDS ANDREW MAY

Our knowledge of other worlds in the Solar System has grown enormously since the dawn of the Space Age, along with ever more detailed photographs

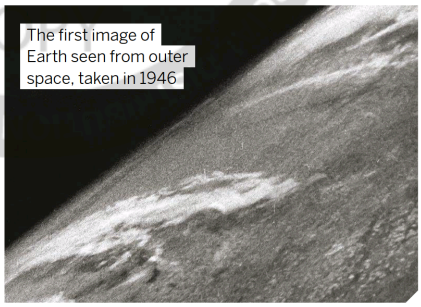
Over 3,000 years ago, Babylonian astronomers discovered that five bright points of light moved across the night sky in a different way from all the other stars. These were the planets we now call Mercury, Venus, Mars, Jupiter and Saturn. In those early days, the only way to observe astronomical objects was with the unaided eye, making it impossible to discern any detail. A planet looked virtually identical to any other star, the only difference being its distinctive wandering motion. The very word planet comes from the Greek planētēs, meaning 'wanderer'.

The next major step forward came in 1609, when Galileo first observed the night sky with an early telescope. This showed the planets to be extended discs rather than star-like points of light, and it was only with this discovery that people came to realise that the planets might be other worlds like Earth. As telescopes improved over time, two further such worlds were discovered that had previously been too faint to see: Uranus in 1781, followed by Neptune in 1846.

The first person to observe surface features on another planet was the Dutch astronomer Christiaan Huygens, who long before the invention of photography made a pencil sketch of Mars in 1659. Later observers of the Red Planet spotted white areas around the poles, which were speculated to be ice caps, as well as clouds and evidence of changing seasons. Such discoveries led to fanciful portrayals of Mars as an Earth-like world, complete with vegetation and maybe even intelligent inhabitants – the latter idea bolstered by the supposed observation of linear features that were dubbed 'canals'. These wild speculations only came to an end in 1964 – just 60 years ago – when a NASA spacecraft finally took the first close-up photographs of the Red Planet.

PHOTOGRAPHING OUR HOME PLANET

Although people have always had a close-up view of Earth from its surface, seeing it from a wider perspective as a planet had to wait until the advent of space travel in the 20th century. The first photograph of Earth from space was taken on 24 October 1946 during the test flight of a rocket over New Mexico. This was a modified version of the German V-2 that had been used as a weapon during World War II, and while it wasn't powerful enough to go into orbit, it did reach an altitude of 65 miles – technically high enough to count as outer space.



The first image of Earth seen from outer space, taken in 1946

© Getty / US Army

HISTORY

THE INNER PLANETS

Mercury and Venus are the only two planets that orbit closer to the Sun than Earth does. Back in the days when astronomers could only observe them with ground-based telescopes, both worlds were something of a mystery – Mercury because of its small size and the fact that it always appears close to the Sun in the sky, and Venus because it's permanently shrouded in thick clouds. The first detailed pictures of them had to wait until NASA's Mariner 10 mission, which visited Venus first before heading on to Mercury.

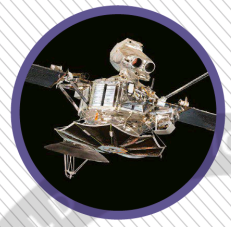
Did you know?
Surface features on Venus are named after women

The spacecraft made a single flyby of Venus, passing within 3,584 miles of its surface on 5 February 1974. It used this opportunity to grab the first close-up photograph of our nearest neighbouring planet using a special ultraviolet filter to capture the complexity of the Venusian cloud systems. As it whizzed past, the spacecraft exploited Venus' gravitational pull to slingshot itself towards its next destination, Mercury.

It took its first photograph of this small world, visually resembling our own Moon, on 24 March 1974 from the distant perspective of 3.3 million miles away. It went on to get much closer, at a distance of just 437 miles on 29 March. After that it made two further passes of Mercury in September 1974 and March 1975, taking a total of more than 2,700 pictures of the planet.

THE HELLISH SURFACE OF VENUS

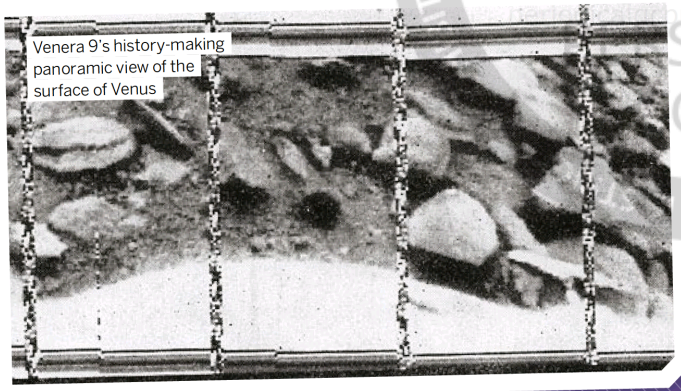
Landing a spacecraft on Venus and successfully operating it – even for just a few minutes – is an enormous challenge due to the extremely high temperatures and pressures there. To date, only four landers have managed to send back pictures of the Venusian surface, all part of the Soviet Union's Venera program. The first craft to do so was Venera 9 on 22 October 1975. During 50-odd minutes of operation, its camera scanned back and forth to create a panoramic image of its immediate surroundings. This was not just the first picture of the surface of Venus, but the first from any planet other than our own.



MARINER 10

CAMERA
Television Photography Experiment

CAMERA RESOLUTION
700 x 832 pixels



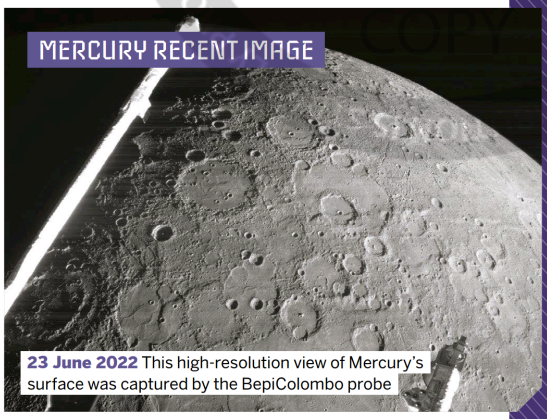
Venera 9's history-making panoramic view of the surface of Venus

© Russian Academy of Sciences



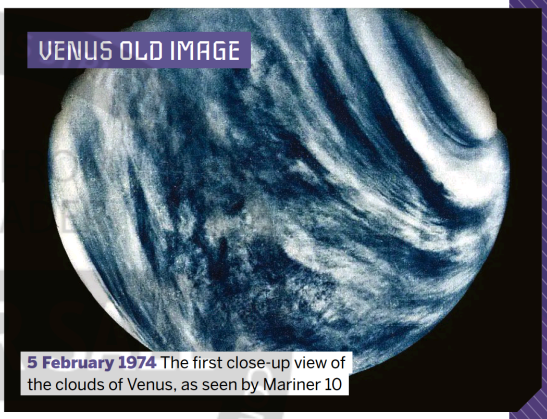
MERCURY OLD IMAGE

24 March 1974 Mariner 10's first glimpse of Mercury from just over 3 million miles away



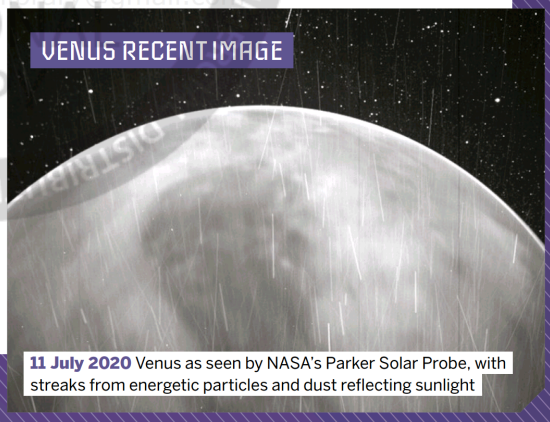
MERCURY RECENT IMAGE

23 June 2022 This high-resolution view of Mercury's surface was captured by the BepiColombo probe



VENUS OLD IMAGE

5 February 1974 The first close-up view of the clouds of Venus, as seen by Mariner 10



VENUS RECENT IMAGE

11 July 2020 Venus as seen by NASA's Parker Solar Probe, with streaks from energetic particles and dust reflecting sunlight

DID YOU KNOW? In a book written in 1656, the scholar Athanasius Kircher described Mars as a volcanic wasteland

THE RED PLANET

As soon as spaceflight beyond Earth became possible in the 1960s, NASA set its sights on Mars. Many scientists still believed it had an atmosphere and climate not too different from Earth, and might even be home to life. Pictures taken with ground-based telescopes showed little detail, so a space mission was seen as a high priority.

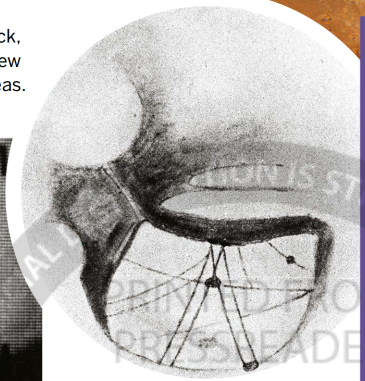
The first spacecraft to fly past the Red Planet was Mariner 4. This was originally designed without a camera – just an array of specialised scientific instruments. Fortunately, NASA realised that obtaining images of the Martian surface would be a useful addition, both scientifically and from the point of view of the public. Mariner 4's flyby of Mars occurred on 15 July 1965, passing just over 6,000 miles from its surface and taking 22 photographs. These were then transmitted to Mission Control at the slow rate of just over eight bits per second, meaning each photograph took ten hours to reach Earth. Sadly, the pictures were disappointing – both for scientists and the public – because they merely showed a heavily cratered surface similar to the Moon. This was sheer bad luck, as the part of the Martian surface that Mariner 4 flew over happened to be one of its least interesting areas.



15 July 1965 The very first image of Mars sent back by Mariner 4



23 July 2018 This picture from Hubble shows Mars enshrouded by a global dust storm



Mars as drawn by a professional astronomer in 1894, showing its famously non-existent 'canals'



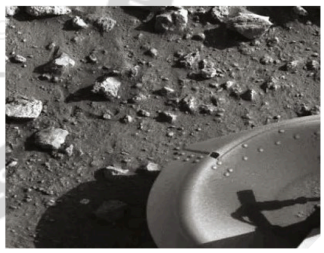
MARINER 4

CAMERA
Mars TV Camera

CAMERA RESOLUTION
200 x 200 pixels

SEEING MARS ON THE GROUND

NASA's Viking project consisted of two almost-identical spacecraft, both composed of an orbiter and a lander. First to arrive on the surface was Viking 1 on 20 July 1976. Just a few minutes after touching down it took the first close-up photograph of the Martian surface, looking straight down from the camera at the ground just 1.4 metres below it. While the rock-strewn terrain may look slightly like the Moon, there's a crucial difference. A little light seeps into the shadow of the lander's footpad due to reflection from the Martian sky – something that could never happen on the atmosphere-lacking Moon.



Viking 1's first view after landing on the Martian surface

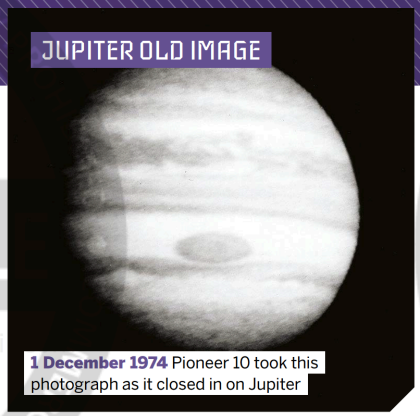
© NASA / ESA / Getty / Alamy

HISTORY

THE GAS GIANTS

Pioneer 10 was NASA's first mission to venture into the Solar System beyond Mars. It flew past Jupiter on 3 December 1973, passing within 82,200 miles of the cloud tops. Launched around a year later was Pioneer 11, which initially followed a similar route to Jupiter. It took advantage of Jupiter's strong gravity to slingshot itself towards the next planet out, Saturn. Pioneer 11's encounter with Saturn took place on 1 September 1979, with a closest approach of just 13,000 miles.

As the Pioneer probes swept past Jupiter and Saturn, they sent back the first close-up images of those planets. But despite their great historical value, these aren't much better in quality than pictures taken with ground-based telescopes. This was a consequence of NASA's limited budget for those missions, and it meant that the Pioneer images were soon overshadowed by those from a more ambitious pair of spacecraft: Voyager 1 and 2. Each with around three times the mass of the earlier Pioneer probes, they carried far more sophisticated cameras than their predecessors. Both Voyagers visited Jupiter and Saturn between 1979 and 1981, and have carried on travelling outwards ever since.



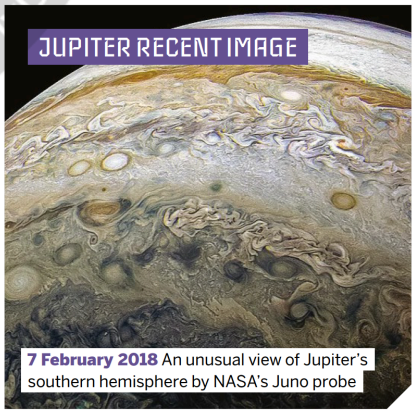
JUPITER OLD IMAGE

1 December 1974 Pioneer 10 took this photograph as it closed in on Jupiter



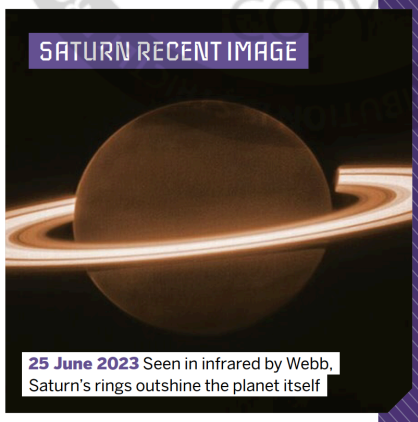
SATURN OLD IMAGE

26 August 1979 Pioneer 11's view of Saturn, taken a few days before its closest approach



JUPITER RECENT IMAGE

7 February 2018 An unusual view of Jupiter's southern hemisphere by NASA's Juno probe

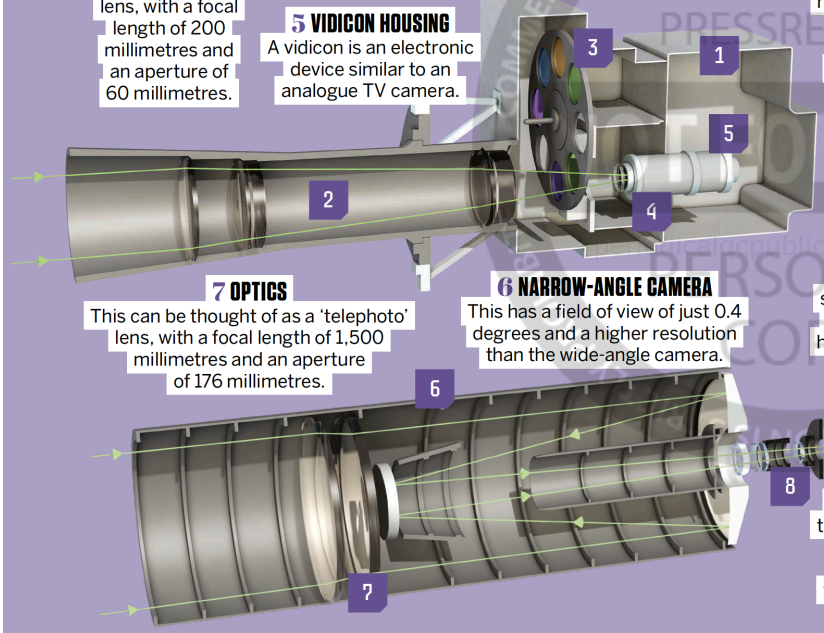


SATURN RECENT IMAGE

25 June 2023 Seen in infrared by Webb, Saturn's rings outshine the planet itself

VOYAGERS' CAMERAS

The Voyager probes carried a pair of cameras that were state of the art for their time



1 WIDE-ANGLE CAMERA
This camera provides a relatively wide field of view of just over three degrees at a moderate resolution.

2 OPTICS
This is essentially a standard camera lens, with a focal length of 200 millimetres and an aperture of 60 millimetres.

3 FILTER WHEEL
This wheel carries a number of single-colour filters which can be selected as desired.

4 VIDICON FACEPLATE
This is where the sensor would be in a digital camera, but here there is a device called a vidicon.

5 VIDICON HOUSING
A vidicon is an electronic device similar to an analogue TV camera.

6 NARROW-ANGLE CAMERA
This has a field of view of just 0.4 degrees and a higher resolution than the wide-angle camera.

7 OPTICS
This can be thought of as a 'telephoto' lens, with a focal length of 1,500 millimetres and an aperture of 176 millimetres.

8 FACEPLATE
Beyond this point, the vidicon assembly is essentially the same as in the wide-angle camera.



PIONEER 10 & 11

CAMERA
Imaging Photopolarimeter

CAMERA RESOLUTION
500 x 500 pixels



VOYAGER 1 & 2

CAMERA
Imaging Science Subsystem

CAMERA RESOLUTION
800 x 800 pixels

DID YOU KNOW? The dwarf planet Pluto is smaller than our Moon

THE OUTER PLANETS

After its encounter with Saturn, Voyager 2 headed on to the Solar System's two outermost planets, first passing within 50,600 miles of Uranus on 24 January 1986 and then carrying on to pass a mere 3,080 miles from Neptune on 25 August 1989. To this day, Voyager 2 remains the only space probe to have visited either of these icy planets or to have obtained high-quality photographs of them.

Both Uranus and Neptune are a pleasant shade of pastel blue, but apart from that they're distinctly more bland in appearance than the other planets. Neptune's atmosphere does show a hint of the same kind of banding seen on Jupiter and Saturn, but Uranus looks almost featureless – in the Voyager photographs, at least. The reason for this is interesting in its own right because it highlights one of the unique properties of Uranus. Unlike all the other planets, Uranus has an axis of rotation that's tilted almost perpendicular to its orbit around the Sun. This means that at certain points during its orbit, one of its poles can point directly inwards towards the Sun. Voyager 2 was unlucky in that its encounter occurred at just such a time, so all it saw was this 'pole-on' view.

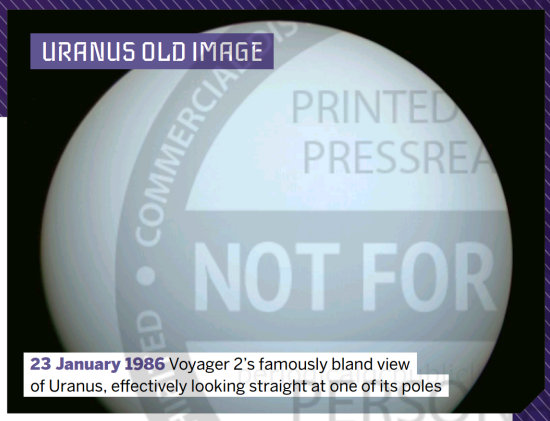
Did you know?
Before spacecraft visited it, Saturn was only known to have 11 moons

PLUTO PHOTOS

When NASA's New Horizons spacecraft was launched in January 2006, Pluto was still considered the ninth and outermost planet of the Solar System, and the mission was billed as a trip to the last unexplored planet. A few months later, Pluto was reclassified as a dwarf planet, and it wasn't until almost a decade later that New Horizons finally flew past it, making a closest approach of just 7,800 miles on 14 July 2015. As it whizzed past the tiny globe, the spacecraft's high-resolution Multispectral Visible Imaging Camera captured some stunningly detailed images of its frozen landscape.

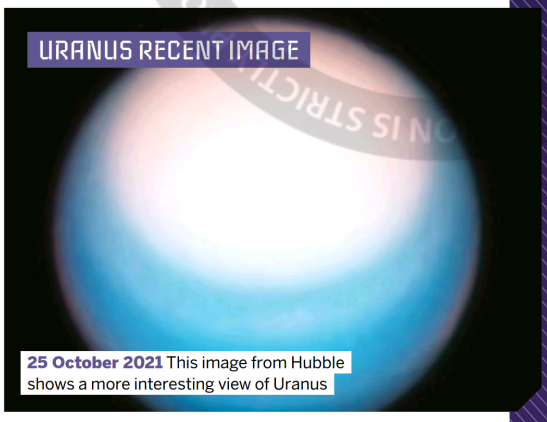


The first close-up view of Pluto is as impressive as any of the 'real' planets



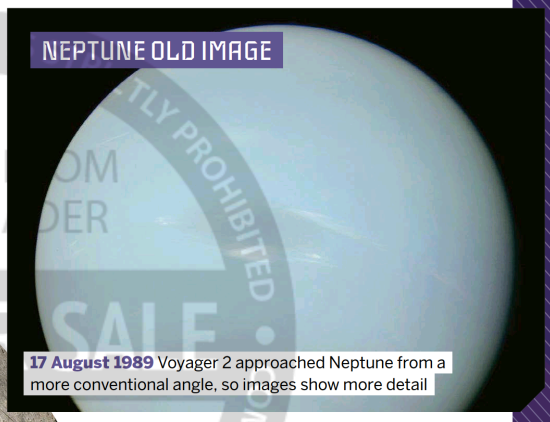
URANUS OLD IMAGE

23 January 1986 Voyager 2's famously bland view of Uranus, effectively looking straight at one of its poles



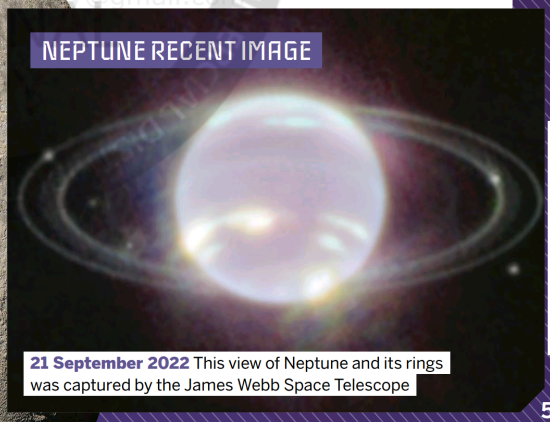
URANUS RECENT IMAGE

25 October 2021 This image from Hubble shows a more interesting view of Uranus



NEPTUNE OLD IMAGE

17 August 1989 Voyager 2 approached Neptune from a more conventional angle, so images show more detail



NEPTUNE RECENT IMAGE

21 September 2022 This view of Neptune and its rings was captured by the James Webb Space Telescope

© Illustration by Adrian Mann / NASA / Alamy