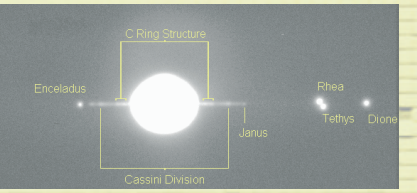
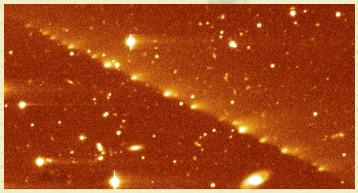
The Solar System

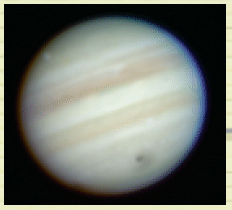
Planets

A planet is an astronomical body in orbit around the Sun, or another star, which has a mass too small for it to become a star itself (less than about one-twentieth the mass of the Sun) and shines only by reflected light. Planets may be basically rocky objects, such as the inner planets - Mercury, Venus, Earth and Mars - or primarily gaseous, with a small solid core like the outer planets - Jupiter, Saturn, Uranus and Neptune. Together with Pluto, these are the major planets of the Solar System.

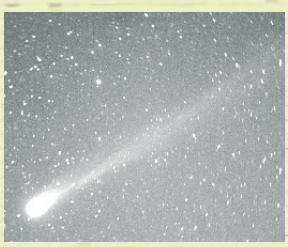


Saturn with edge-on rings in 1995. Image taken using the William Herschel Telescope and the Auxiliary Port CCD camera.





In July 1994 the individual fragments of Comet Shoemaker-Levy 9 impacted onto the planet Jupiter. Images obtained from the 1m Jacobus Kapteyn Telescope clearly showed the ejecta plume of debris rising over the planet's limb from the impact site of fragment L. At the same time the 2.5m Isaac Newton Telescope was used to observe spectroscopic emission from the vaporised comet, revealing some of its constituent elements. Finally, continued imaging showed clearly the effects on the Jovian atmosphere, as in the image above of the impact site of fragment G.



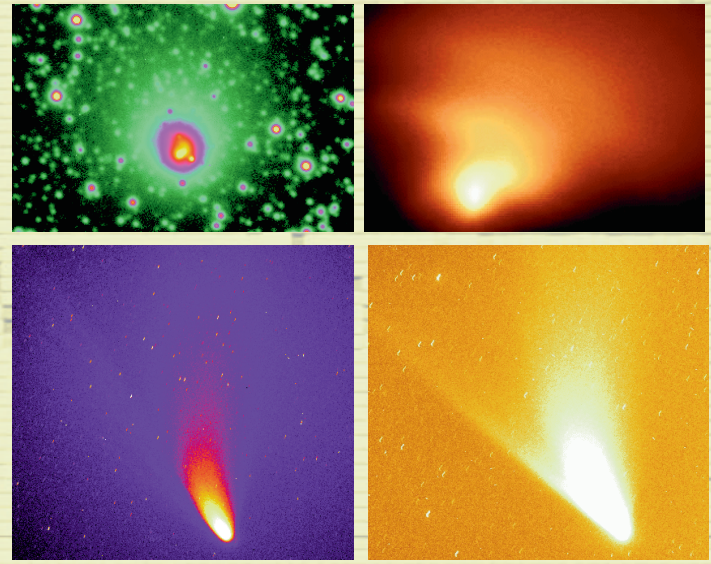
Comet Hyakutake observed from La Palma on the night of 24 March 1996. At this time the Comet was making an extremely close approach to the Earth passing within 14 million kilometres (about 9 million miles) from us. This was the closest approach of a comet for 13 years and the brightest comet within the last 20 years. At this time the comet extended some 30 degrees in the sky which translates to a physical length of around 6 million kilometres (about 4 million miles) and was easily visible to the naked eye having an apparent brightness equal to that of the brightest stars. Its apparent diameter was equal to three full moons while its real diameter was around 250,000 kilometres (150,000 miles). This image was taken using a CCD detector mounted on a 35-mm telephoto lens.

The Sun, together with the planets and moons, comets, asteroids, meteoroid streams and interplanetary medium held captive by the Sun's gravitational attraction. The solar system is presumed to have formed from a rotating disc of gas and dust created around the Sun as it contracted to form a star, about five billion years ago. The planets and asteroids all travel around the Sun in the same direction as the Earth, in orbits close to the plane of the Earth's orbit and the Sun's equator. The planetary orbits lie within 40 astronomical units (6 thousand million kilometres) of the Sun, though the Sun's sphere of gravitational influence can be considered to be much greater. Comets seen in the inner solar system may originate in the Oort cloud, many thousands of astronomical units away.

Comets

Comets are icy bodies orbiting in the Solar System, which partially vaporises when it nears the Sun, developing a diffuse envelope of dust and gas and, normally, one or more tails. Ground-based observations of the behaviour of many comets, together with results from the investigation in 1986 of Halley's Comet from space probes, support the view first proposed by F. Whipple in about 1949 that the nuclei of comets are essentially 'dirty snowballs' a few kilometres across. They appear to be composed of frozen water, carbon dioxide, methane and ammonia, in which dust and rocky material is embedded. As a comet approaches the Sun, solar heating starts to vaporises the ices, releasing gas that forms a diffuse luminous sphere, called the *coma*, around the nucleus. The coma may be up to a million kilometres across. The nucleus itself is too small to be observed directly.

Dust and gas leave the comet nucleus from jets on the side facing the Sun, then stream away under the Sun's influence. Electrically charged ionised atoms are swept away directly by the magnetic field of the solar wind, forming straight ion tails (alternatively called Type I, plasma or gas tails). Variations in the solar wind cause the ion tail to take on structure, or even break off in a disconnection event. Small neutral dust particles are not carried along by the solar wind but get 'blown' gently away from the Sun by radiation pressure. Dust tails (also called Type II tails) are often broad and flat. The tail grows as a comet approaches the Sun and are always directed away from the Sun: they can be as much as a hundred million kilometres long. Large dust particles become strewn along the comet's orbit and form meteor streams.



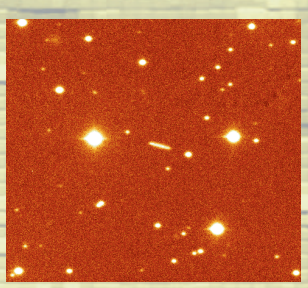
Comet Hale-Bopp was a spectacular object in the evening skies during the spring of 1997. The image on top left was obtained on the 25th of August, 1995 using the Jacobus Kapteyn Telescope when the comet was 6.9 AU (1,030,000,000 kilometres) from the sun and 6.3 AU (940,000,000 kilometres) from the Earth. A large number of stars are visible, as at this time the comet was in the direction of the constellation of Sagittarius. On the 1st March, 1997 the William Herschel telescope took the on top right which shows a spiral jet and some dusty arcs ejected from the nucleus. CoCAM camera, the wide field imaging facility of ING, began to observe comet Hale-Bopp on the first days of March, 1997. Bottom images are good samples of the observations carried out. Finally, on the 16th April CoCAM discovered a new type of cometary tail, the sodium tail (the straight line from the right bottom to the left top in the image bottom right), which consists of neutral atoms, never seen before.

Meteors

A meteor is a brief luminous trail observed as a particle of dust or piece of rock from space when it enters the Earth's upper atmosphere, The popular name for a meteor is shooting star or falling star.

Leonids meteor shower. On the night 16/17 November 1998 astronomers observing at ING witnessed a splendid spectacle. The picture on the right was taken on 1600 ASA colour film and using standard 50mm lens.

Asteroids

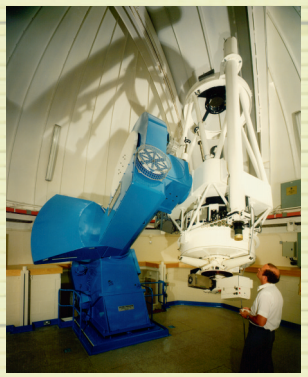


Asteroid 3634 Iwan (the straight line in the middle). Image obtained on the night of 30/31 August 1995. ING telescopes have also observed and discovered the most distant Kuiper Belt objects. This is a 2.8x2.8 arcmin image obtained using the 1.0m Jacobus Kapteyn Telescope.

On the first day of January 1801, Giuseppe Piazzi discovered an object which he first thought was a new comet. But after its orbit was better determined it was clear that it was not a comet but more like a small planet. Piazzi named it Ceres, after the Sicilian goddess of grain. Three other small bodies were discovered in the next few years (Pallas, Vesta, and Juno). By the end of the 19th century there were several hundred.

Several hundred thousand asteroids have been discovered and given provisional designations so far. Thousands more are discovered each year. There are undoubtedly hundreds of thousands more that are too small to be seen from the Earth. There are 26 known asteroids larger than 200 km in diameter. Our census of the largest ones is now fairly complete: we probably know 99% of the asteroids larger than 100 km in diameter. Of those in the 10 to 100 km range astronomers have catalogued about half. But we know very few of the smaller ones; perhaps as many as a million 1 km sized asteroids may exist.

The Jacobus Kapteyn Telescope



The Jacobus Kapteyn Telescope has a parabolic primary mirror of diameter 1.0 m. It is equatorially mounted, on a cross-axis mount. Instruments can be mounted at the f/15 cassegrain focus. Total weight of the telescope is 15.5 tones. The role of the telescope is as a facility for CCD imaging.

The Isaac Newton Group of Telescopes (ING) consists of the 4.2m William Herschel Telescope (WHT), the 2.5m Isaac Newton Telescope (INT) and the 1.0m Jacobus Kapteyn Telescope (JKT). The ING is located 2,350m above sea level at the Roque de Los Muchachos Observatory (ORM) on the island of La Palma, Canary Islands, Spain. The WHT is the largest telescope of its kind in Western Europe. The construction, operation, and development of the ING telescopes is the result of a collaboration between the United Kingdom and the Netherlands. The site is provided by Spain, and in return Spanish astronomers receive 20 per cent of the observing time on the telescopes. A further 75 per cent of the observing time is shared by the United Kingdom and the Netherlands. On the JKT the international collaboration embraces astronomers from Ireland and the University of Porto (Portugal). The remaining 5 per cent is reserved for large scientific projects to promote international collaboration. The ING operates the telescopes on behalf of the Particle Physics and Astronomy Research Council (PPARC) of the United Kingdom and the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of the Netherlands. The Roque de Los Muchachos Observatory, which is the principal European northern hemisphere observatory, is operated on behalf of Spain by the Instituto de Astrofísica de Canarias (IAC).