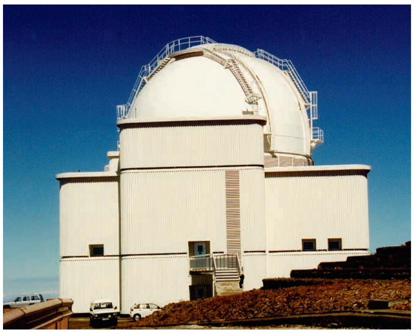
The 2.5-m Isaac Newton Telescope



The Isaac Newton Group of Telescopes (ING) consists of the William Herschel Telescope (WHT), the Isaac Newton Telescope (INT) and the Jacobus Kapteyn Telescope (JKT). Construction, operation, and development of the ING telescopes are the result of a collaboration between the United Kingdom and the Netherlands.

The Isaac Newton Telescope has a 2.54-metre primary mirror with a focal ratio of f/2.94. It uses a polar-disc/fork type of equatorial mount. Instruments can be mounted at the corrected f/3.29 Prime or f/15 Cassegrain foci. Total weight of the telescope is about 90 tonnes. The telescope is used for wide-field imaging and intermediate dispersion spectroscopy.

Scientific Highlights

The brightest object ever observed. Quasars are generally the most energetic objects observed in the universe. APM 08279+5255 was discovered using the INT in 1998. It's an extremely bright quasar four to five million, billion times brighter than the Sun and about 100 times brighter than the next brightest object that had been observed until then. The light from the quasar has been travelling to us for roughly 11 billion years, nearly 90% of the age of the universe and set out on its long journey when the universe was only about 10% of its present age. Since this quasar is such a powerful beacon of light and has travelled 11 billion light years, it can also be used to investigate intervening objects that leave an imprint on the light from the quasar. By studying these imprints we can learn what conditions in the early universe were like and measure how primordial gas was converted into the stars and galaxies that we see around us today.

Resolving accretion disks. Accretion disks play an important role in many astrophysical environments, such as active galactic nuclei, protostellar systems, X-ray binaries and cataclysmic variables. The lack of spatially resolved information, however, has meant that models for accretion disks are in general poorly constrained by observations. By using the shape of the light curve from an eclipsing cataclysmic variable, UX Ursae Majoris, astronomers reconstructed the spectral energy distribution across the face of an accretion disk for the first time in 1994. In 1997 for the first time again, astronomers detected spiral structure in the disc of gas that surrounds one of the stars in an interacting binary star system known as IP Pegasi. Such detailed reconstructions of accretion disks have helped to bridge the gap between observations and theoretical models.

The Bubble Nebula

Star-forming NGC 281 and IC 1590 nebulas

M101 Galaxy

The Dumbell Nebula

The Cygnus Loop

Discovery of the best-ever stellar-size black hole candidate in a compact binary star system. Unequivocal evidence for a stellar-size black hole in the Galaxy had been sought for decades. X-ray source Cyg X-1 was a strong candidate, but the massive companion star made it difficult to set a lower limit of better than 3 solar masses to the mass of the compact object. In order to get a good coverage of the radial velocity curve of V404 Cyg, the associated optical source, 73 spectra were obtained using the William Herschel and the Isaac Newton telescopes in 1992. From the mass function of the system, it was possible to set lower limits to the mass of the primary star. The astronomers got 6.26 solar masses which substantially exceeds the 3 solar masses maximum allowed mass of a neutron star. So they concluded that the compact object had to be a black hole.

The Wide Field Survey. The ING's Wide Field Survey (WFS) makes use of the Wide Field Camera to carry out a range of scientific programmes. The WFS archive, started in 1998, contains (to March 2001) some 0.7 terabytes of reduced and calibrated image data on-line. This equates to some 2000 square degrees of sky coverage and currently represents the world's largest reduced (ready for research) CCD sky survey available on the web.

The number of scientific highlights from the WFS has been very high and includes the first ever detection of a dark galaxy (a galaxy made of dark matter), the discovery of a low surface brightness dwarf galaxy nearby, and the discovery of many intermediate redshift type Ia supernovae which have helped astronomers to study in depth the recently discovered accelerated expansion of the universe.

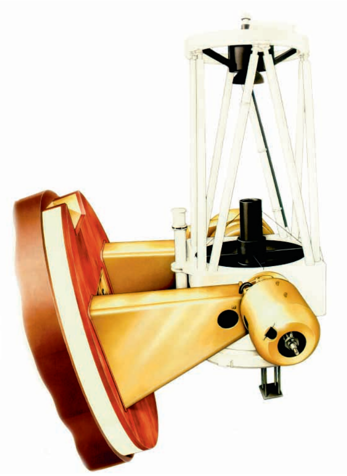
Technical Description

The optics. The optical system of the INT is a conventional Cassegrain configuration with a paraboloid primary mirror and a hyperboloid secondary. The primary has a diameter of 2.54 metres (the original 98-inch primary mirror was replaced by a 100-inch mirror when the INT was moved to La Palma; the telescope was first put in operation in the United Kingdom) and a focal length of 7.5-m. It weighs 4,361 kg, is made of low expansion *Zerodur*.

There are two focal stations, the f/3.29 Prime focus (with focal corrector) and the f/15 Cassegrain focus. The f/50 Coudé focus was never implemented. The Prime focus gives a unvignetted field of view of 40 arcminutes and Cassegrain, 20 arcminutes.

Both Prime and Cassegrain foci are equipped with instrument rotators and autoguiders. The autoguiders continuously analyse the image of a guide star and provide small corrections to the telescope tracking. That is their main function but they also monitor transparency and seeing. Pointing accuracy of the telescope is around 5 arcseconds and guiding accuracy is better than 0.3 arcseconds.

The mounting. The telescope has a polar disc/fork type equatorial mounting supported by five axial and three radial hydrostatic oil bearing pads. The born-again INT, at La Palma, differs significantly in its mechanics, electronics and optics from the earlier incarnation at Herstmonceux, U.K. The change in latitude to 28 degrees 45 minutes has resulted in a large change of angle to the polar disc.



The Foundations of the Isaac Newton Telescope

1642 Dec 25	Isaac Newton born.
1942	Tercentenary celebrations of the birthday of Sir Isaac Newton delayed because of war.
1945-6	Proposal for large telescope for use of all British astronomers is made.
1946 Jul 7	First day of official celebration of tercentenary of Newton's birth. Announcement that funds voted for construction of 100-inch telescope.
1949	McGregor Fund donates 98-inch glass mirror blank.
1959	The telescope is ordered.
1965	First light at Herstmonceux, U.K.
1967 Dec 1	Telescope inaugurated by Queen Elizabeth II.
1981	Telescope shipped to La Palma.
1982 Dec	The new 100-inch mirror arrives on La Palma.
1984 Feb	First light on La Palma.
1984 May 29	First scheduled observer on La Palma.
1985 Jun 29	Royal inauguration of the observatory.
1997 May	Commissioning of the new Wide Field Camera, a four CCD camera operating at the Prime focus.

The instruments. The two common-user instruments at the INT are:

– The Intermediate Dispersion Spectrograph (IDS) at the Cassegrain focus, with a choice of two cameras of different focal lengths.

– The Wide Field Camera (WFC) at the Prime focus, a four CCD camera covering a 0.5 square degree field of view. This new instrument offers unique opportunities to execute high resolution, deep, wide field optical imaging surveys.

Both instruments are fitted with state-of-the-art detectors, which record the spectra or images received. Current CCD (Charge Coupled Device) detector technology provides nearly perfect solid-state, digital detectors that are now widely used in astronomy and have replaced other light sensitive devices such as photographic plates and photomultipliers.

Occasionally visiting instruments like MUSICOS, a fibre fed high-resolution spectrograph, or CIRSI, a wide field of view near-infrared imager, are mounted on the telescope.

The control systems. The telescope and the dome are normally operated by means of a dedicated computer, the so-called Telescope Control System (TCS).

The telescope control room is located on the third floor of the INT building, next to the observing floor and the telescope. When entering the control room through the west entrance, we encounter the following (all on your right):

– The instrument and data monitors. These units are part of the Instrument Control and Data Acquisition Systems (ICS and DAS respectively). The astronomers normally sit at these terminals at night.

– The control desk. This is the large panel with push buttons, TV monitors, keyboards, etc. mainly used for engineering functions of the telescope.

– The engineering rack. A tall blue rack standing on the east side near the observing floor window. It serves for manual control of telescope functions and the dome during start up.

– The weather monitor. This tells the observer about conditions outside. For safe operation of the telescope, relative humidity must be below 90% and wind speed must not rise above 80 km/h.