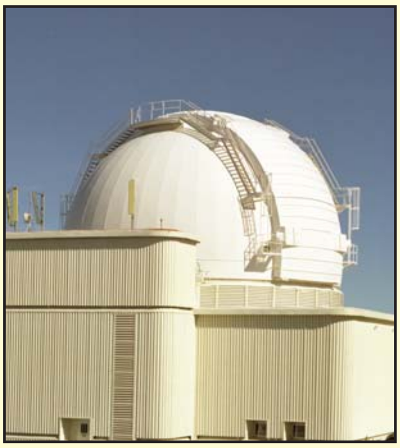
Isaac Newton Group of Telescopes

Biennial Report 2002 2003



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Apartado de Correos, 321
E-38700 Santa Cruz de La Palma; Spain
Tel: +34 922 425 400
Fax: +34 922 425 401
URL: `http://www.ing.iac.es/`

Editor and designer: Javier Méndez (jma@ing.iac.es)
Preprinting: Luis Castañeda. Tel: +34 922 416 651
Printing: Gráficas Sabater. Tel: +34 922 623 555

Front cover: True-colour image of M83 galaxy obtained using the Prime Focus Camera on the William Herschel Telescope. Credit: Chris Benn (ING) and Nik Szymanek (University of Hertfordshire).Inset: Picture of the Isaac Newton Telescope. Credit: Jens Moser.

Other picture credits: Jens Moser (WHT, p. 4); Nik Szymanek (INT, p. 4); Nik Szymanek (JKT, p. 4); Nik Szymanek (ING, p. 5); Jens Moser (WHT, back); Jens Moser (INT, back); Nik Szymanek (JKT, back).

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Isaac Newton Group of Telescopes

Biennial Report

of the PPARC-NWO-IAC ING Board

2002 – 2003

Isaac Newton Group

William Herschel Telescope

Isaac Newton Telescope

Jacobus Kapteyn Telescope

OF TELESCOPES

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 2350m 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, The Netherlands and Spain. The site is provided by Spain, and in return Spanish astronomers receive 20 per cent of the observing time on the telescopes. The operation of the site is overseen by an International Scientific Committee, or Comité Científico Internacional (CCI).

A further 75 per cent of the observing time is shared by the United Kingdom, the Netherlands and the Spanish Instituto de Astrofísica de Canarias. On the JKT the international collaboration embraces astronomers from Ireland. The remaining 5 per cent is reserved for large scientific projects to promote international collaboration between institutions of the CCI member countries.

The ING operates the telescopes on behalf of the Particle Physics and Astronomy Research Council (PPARC) of the United Kingdom, the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of The Netherlands and the Instituto de Astrofísica de Canarias (IAC) of Spain. The Roque de Los Muchachos Observatory, which is the principal European northern hemisphere observatory, is operated by the IAC.

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FOREWORD

Professor Janet Drew
Chair of the ING Board

It is a pleasure to write this foreword to the 2002-2003 Biennial Report of the Isaac Newton Group of Telescopes, on behalf of the ING Board.

In the 2000-2001 Report it was already appropriate to note that times were both 'interesting' and 'difficult'. This remains the case as the ING continues to work at the forefront, whilst the staff reorganisation and reduction envisaged in 2000-2001 has taken effect. Inevitably, it has been sad seeing staff members, often after many years of highly-valued service, moving on. But it has been a huge benefit to the Canaries observatories collectively, and indeed to European astronomy that a way through for the ING in a harsher financial climate has been found and taken successfully. The Board has been impressed by the way telescope operations have held together as a profound change has had to occur. We applaud everyone on the staff who has made a positive contribution to this tough transition.

So indeed, despite the considerable upheaval of the past two years, excellent science has continued to flow off the telescopes. The scientific highlights presented in this new report illustrate very well the enormous breadth of astronomical problems the William Herschel and Isaac Newton Telescopes are able to support: everything —from tracking a Near Earth Object supported by NAOMI adaptive optics, through to measuring cosmic shear in the large-scale Universe— is here. Recent times have seen quite a volume of traffic of specialised visitor instruments onto the William Herschel, and so it is entirely right to find a number of science highlights linked with them. My own favourite among these has to be the controversial result on the seeming absence of dark matter from a number of elliptical galaxies. Where would we be in science if expectations were always met?! More seriously though, the fact of the several visitor instruments, together with continuing impressive in-house instrumentation developments attest to a continuing and essential dynamism at the ING.

An important moment in the last year was the formal signing of the new agreement between PPARC, NWO and the IAC that sets out the funding framework up until 2009. The new, formal involvement of the IAC in the expanded three-way partnership has already become real through the in-kind and much-needed contribution of new staff to the ING. In terms of shaping the future science direction of the ING, a very important recent event has been the NWO decision to release enough funds to give the go-ahead to the build of a fast-track Rayleigh Laser Guide Star system (RLGS) for the William Herschel. The Board sees this as bringing the long-running adaptive optics development at the ING to proper fruition, and it looks forward to the benefit this capability will bestow on the partner astronomy communities —the nearly all-sky access the RLGS will offer AO-assisted astronomy will transform it from niche to mainstream. All being well, the RLGS could come into being by spring 2006. As part of the reorganisation of the ING, it has been necessary in 2003 to bring observing with the Jacobus Kapteyn Telescope to an end. But in the belief that good telescopes never 'die', the Board hopes to soon be reviewing bids from interested parties that will give the JKT a new and different lease of life.

It only remains to invite you the reader to discover for yourself in this Biennial Report how the ING has continued to play its important role in world astronomy. And on behalf of the Board I would like to take this opportunity to re-affirm our commitment to working with the ING Director and senior management team into the ever-changing future. It is a privilege, as well as a challenge.

INTRODUCTION

Welcome to the Biennial Report of the Isaac Newton Group of Telescopes for the years 2002 and 2003. The period covered by this report contains many scientific highlights and technical achievements, combined with significant developments in the organisation and the international collaborations. This report provides an overview of the main events and summarises the financial status and scientific output of the telescopes.

Dr René Rutten
Director of ING

A key milestone over the reporting period has been the signing of a new agreement between PPARC, NWO and the IAC on collaboration in the operation and development of the ING telescopes. The new agreement implies that ING now forms a tri-partite international organisation. The new collaboration fits into the ongoing process of restructuring the observatory, which has a primary goal of achieving a model for operation that is significantly less costly to the funding agencies. As a result of this collaboration, the Spanish community gains more access to the ING telescopes, while the IAC will offer their newly developed IR spectrograph, LIRIS, as a common-user instrument on the William Herschel Telescope. Several important scientific discoveries are reported in the following pages, underlining the continued scientific relevance of the ING facilities, next to the new generation of very large telescopes. In particular worth mentioning is the impact of the Wide Field Survey activities on the Isaac Newton Telescope, which has resulted in expansion of our knowledge of the galactic structure and of our Local Group of galaxies. Also visiting instruments such as SAURON and the Planetary Nebula Spectrograph continued to offer high-impact science results, emphasising the importance of our strategy to welcome such novel developments.

Looking back on the very successful period covered by this report, it is important to realise that the achievements have only been possible thanks to the continued efforts and motivation of the staff. This has been particularly noteworthy considering the difficult situation as a result of budget reductions. I hope you will enjoy reading about ING's activities, the scientific results and technical achievements at the telescopes.

Chapter 1

SCIENTIFIC HIGHLIGHTS

NAOMI FOCUSES ON A NEAR EARTH ASTEROID

WHT+NAOMI

The adaptive optics system NAOMI on the WHT was used to take a remarkable image of a Near-Earth Asteroid (NEA). On the night of August 17 to 18 NAOMI imaged the NEA 2002 NY40 just before its closest approach to the Earth. These are the first images of a NEA obtained with an Adaptive Optics system.

The asteroid was observed when it was only 750,000 kilometres away, twice the distance to the Moon, and moving rapidly across the sky at 65,000 kilometres per hour. Despite the technical difficulties this rapid movement caused, the astronomers using the WHT obtained very high quality images in the near-infrared with a resolution of 0.11 arcseconds. This resolution is close to the theoretical limit of the telescope, and sets an upper limit of 400 meters to the size of the asteroid.

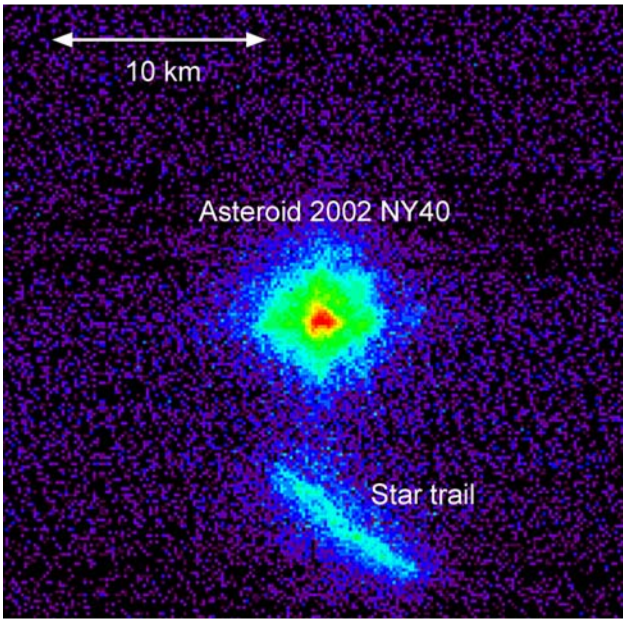


Figure 1. H-band (1.63 microns) NAOMI image of asteroid 2002 NY40 taken on the night of August 17, 2002.

Near-Earth asteroids are those that periodically approach or cross the orbit of our planet, and there is a very small probability that one could collide with the Earth. Measuring the size of asteroids helps astronomers understand their nature and how they were formed, as well as the potential threat they pose. Variations in the brightness of 2002 NY40 suggest that it is highly elongated and is tumbling. Further monitoring of these variations will tell the astronomers whether the asteroid was viewed end-on or side-on, thus allowing them to determine the size and shape more precisely.

NAOMI was built by a team from the University of Durham and the UK Astronomy Technology Centre in Edinburgh. In good conditions, it can deliver images as sharp as those from the Hubble Space Telescope.

CANNIBALISTIC STARS HOLD CLUE TO BIG BANG

WHT+UES

The lithium content of halo stars near the main-sequence turnoff is of great importance for several reasons. The near constancy of the Li abundances, which are broadly independent of metallicity or effective temperature, means that these were hardly altered from the primordial value. That discovery prompted numerous studies over the ensuing two decades, with the aim of using the inferred primordial abundance as a constraint on the baryon density of the universe, Ω_B.

Lithium is also important because it is a sensitive probe of mixing below the stellar surface. Since Li is destroyed in stars at relatively low temperatures, it survives in halo main-sequence turnoff stars only in a thin surface layer making up a few percent of the stellar mass.

Although the majority of halo main-sequence turnoff stars have almost identical Li abundances, about 7%

have very low (thus far undetected) Li abundances. It has been unclear why these small numbers of stars should differ so significantly from the Li-normal stars. Their evolutionary states and the presence (or lack) of abundance anomalies for other elements had thus far failed to provide unambiguous evidence of their origin.

Astronomers analysed the Li abundances of 18 halo main-sequence turnoff stars. They found that four of them were ultra-Li-deficient objects. During detailed spectral analysis of other elements using UES on the WHT, they recognised that three of the Li-depleted stars, but none of the Li-normal stars, exhibited unusually broad absorption lines. They believe that this is due to rotational broadening.

In principle, most 14-billion-year-old stars do not spin very fast at all but these ones had up to 16 times as much spin energy as the Sun. The extra energy could come from only one source: another star.

When these stars formed out of the primordial gas cloud, not just one but two stars formed very near one another. As they grew older, the smaller one captured the outer layers of the larger one. Very little now remains of what was the larger star; it has been cannibalised by its companion. The material captured by the companion carried orbital energy that was converted into spin energy. The scientists believe that the lithium was destroyed in nuclear reactions shortly before the star-eating episode occurred.

It was the discovery of the excessive spin energy that revealed the history of the objects and it explains one of the mysteries surrounding the Big Bang. Astronomers conclude that such objects must be avoided in studies of the primordial Li abundance and in investigations into the way normal single stars process their initial Li.

FLARES ILLUMINATE THE SECRET LIFE OF A QUIESCENT BLACK HOLE

WHT+ISIS, JKT+CCD

Quiescent black hole X-ray transients provide the best evidence we have for the existence of stellar mass black holes within our own Galaxy. These X-ray binaries contain a relatively low-mass star accreting onto a likely black hole via Roche lobe overflow and an accretion disc. The gas becomes so hot that it glows with X-rays.

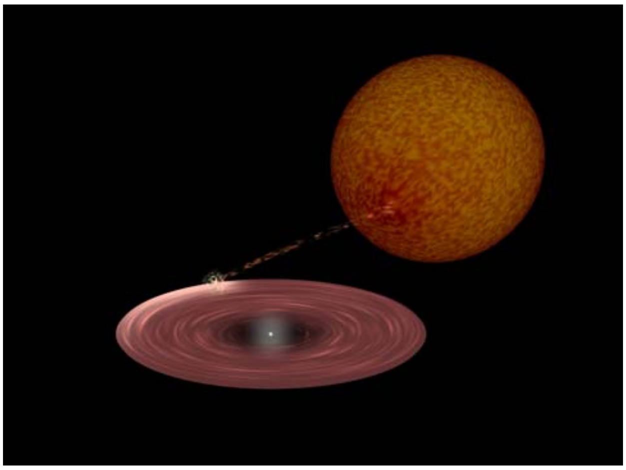


Figure 2. An impression of what a quiescent stellar black hole may look like. Gas is fed from the companion star into an accretion disc around the black hole. Some X-rays are produced as the hot gas falls into the black hole but these are much fainter than when an outburst occurs. In these quiescent black hole binary stars the companion star is actually brighter than the gas falling into the black hole. During the flares the X-rays fall upon the accretion disc and cause it to light up and become much brighter.

In their quiescent state the accretion flow becomes extremely faint and so the companion star can be directly observed. It is the companion, and in particular its radial velocity variations, that provides the key to measuring the black hole mass. It is believed that less gas is falling onto the black hole or neutron star at these times, but quiescent systems with black holes appear even fainter than the ones with neutron stars. This might be because energy is disappearing past the black hole's event horizon — the point of no return beyond which energy is irretrievably lost. But to be sure, astronomers need to know more about how the dribble of gas flows onto the black hole during the quiescent period.

To investigate this, a team of astronomers from UK and Spain used the William Herschel Telescope and the Jacobus Kapteyn Telescope to look at the visible light from the gas disc of a quiescent black-hole X-ray binary star (V404 Cygni). The glow from the disc varied by a large amount — during flares lasting for a few hours, gas all around the black hole was lit up, most likely by X-rays shining on it.

The strongest flares involved development of asymmetry in the line profile, with the red wing usually strongest independent of orbital phase. Based on the line profile changes during the flares, the researchers conclude that the most likely origin for the variability is variable photoionisation by the central source, although local flares within the disc cannot be ruled out.

So astronomers probing the intimate details of apparently quiescent stellar black holes have found that in reality they are dynamic, lively places, subject to flares that briefly illuminate the whole of the gas disc around the black hole. These observations are helping to build up a picture of precisely where X-rays are generated in the gas as it heats up to extreme temperatures and swirls around under incredible gravitational forces before cascading into the black hole itself.

DISCOVERY OF THE LEAST MASSIVE PLANETARY-MASS BODY OUTSIDE THE SOLAR SYSTEM

WHT+INGRID

Since the discovery of brown dwarfs (i.e., objects unable to burn hydrogen stably in their interiors and with masses below 72 M_{Jup}) both in the field and in young open clusters, many questions remain unanswered. A very important one is the minimum mass for the formation of very low mass objects in isolation, which would represent the bottom end of the Initial Mass Function (IMF) for free-floating objects. Very recent photometric and spectroscopic searches suggest that the IMF extends further below the deuterium burning mass threshold at around 13 M_{Jup}. This is usually referred as the "planetary-mass" domain. The least massive objects so far identified in young stellar clusters of Orion have masses around 5–10 M_{Jup} and cover the full range of the spectral type L.

A team of astronomers discovered a free-floating methane dwarf towards the direction of Orion. The researchers found evidence for its membership in the σ Ori star cluster, which implies that this object is likely the least massive planetary-mass body imaged to date outside the solar system.

The candidate was selected from a JH near-infrared survey, in which the south western region of the young σ Ori cluster was targeted down to 3σ detection limit of JH~21 mag. An area of 55.4 $arcmin^2$ was covered with the near-infrared camera INGRID mounted at the Cassegrain focus of the William Herschel Telescope. This camera is equipped with a 1024×1024 Hawaii detector, which provides a pixel size of 0.242" projected onto the sky. The total integration time was 3240s in each of the J and H filters. S Ori 70, as it is called by the discovery team, showed a rather blue J–H colour of about −0.1 mag and J=20.28 mag.

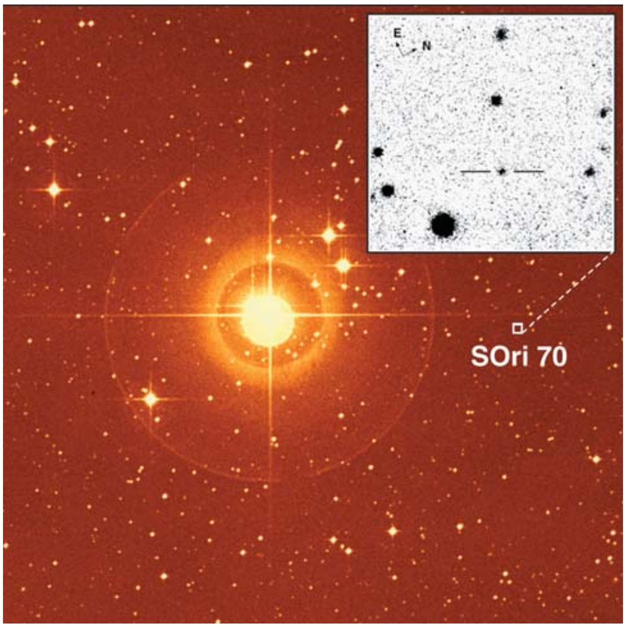


Figure 3. An image of the σ Ori region. The multiple star σ Ori, which is visible with the naked eye, is at the centre. A box indicates the position of the planet candidate, which is only 8.7 arcminutes from the star. The image was taken from the Digital Sky Survey and has a size of 23×22 square arcminutes. The inset shows the infrared image obtained using INGRID at the William Herschel Telescope.

Based on the object's far-red, optical, and near-infrared photometry and spectroscopy, the astronomers conclude that it is a possible member of the σ Ori association. and if it is a true member of σ Ori, the comparison of the photometric and spectroscopic properties of S Ori 70 with state-of-the-art evolutionary models yields a mass of 3±2 Jupiter mass for ages between 1 and 8 Myr. The presence of such a low-mass object in the small search area would indicate a rising substellar initial mass function in the σ Ori cluster, even for planetary masses.

This discovery indicates that objects only slightly heavier than Jupiter may exist free-floating in σ Ori. Their formation process is not yet established. Theory predicts that opacity-limited fragmentation of cool gravitationally collapsing gas clouds is capable of producing 7–10 M_{Jup} Population I objects in isolation. Moreover, this minimum Jeans mass, the critical mass above which gas collapses to form a star, seems to be insensitive to changes in the opacity of protostellar clouds (amount of dust, size of grains, cosmic-ray flux). These models, however, do not include rotation, magnetic fields, and further external accretion onto the cloud fragment, which might alter the final mass of the nascent object. S Ori 70 is probably less massive than the minimum Jeans mass of 7–10 M_{Jup} and thus prompts us to refine the collapse-and-fragmentation models and/or to rethink possible formation mechanisms for such low-mass objects. Recently, several formation scenarios have been suggested that include tidal interactions and ejection of low-mass objects from multiple systems before brown dwarfs and planetary-mass objects can accrete enough gas to become stars. Others suggest that brown dwarfs are formed in the same way as more massive hydrogen burning stars, that is, by the process of supersonic turbulent fragmentation.

QUASAR REDSHIFTS FROM S-CAM OBSERVATIONS: DIRECT COLOUR DETERMINATION OF ~12 GYR-OLD PHOTONS

WHT+SCAM

Large ground and space telescopes combined with solid state detectors have revolutionised optical astronomy over the past two decades, yet deriving physical diagnostics of stars and galaxies still requires the somewhat indirect methods of filter photometry or dispersive spectroscopy to measure spectral features, energy distributions, and redshifts. The recent development of high-efficiency superconducting detectors has introduced the possibility of measuring individual optical photon energies directly. Many extensive observational programmes which aim at determining the large-scale structure of the universe, and galaxy formation and evolution, demand high-efficiency extragalactic spectroscopy.

For the first time astronomers obtained optical measurements of spectral energy distributions of quasars using an imaging detector with intrinsic energy resolution. They also showed that they can determine their redshifts directly with excellent precision.

They observed 11 quasars in the redshift range z=2.2−4.1, the sample comprising relatively bright high-redshift Lyman-limit quasars from the published literature, supplemented by three lower redshift objects, two of which were discovered in objective prism-type surveys.

Observations used the ESA superconducting tunnel junction (STJ) camera, S-CAM2, on the William Herschel Telescope. The camera is a 6×6 array of $25\times25\,\mu m^2$ ($0.6\times0.6\,arcsec^2$) tantalum junctions, providing individual photon arrival time accuracies to about 5 μs, a resolving power of $\Re\approx8$ at λ=500 nm, and high sensitivity from 310 nm (the atmospheric cutoff) to about 720 nm (currently set by long-wavelength filters to reduce the thermal noise photons).

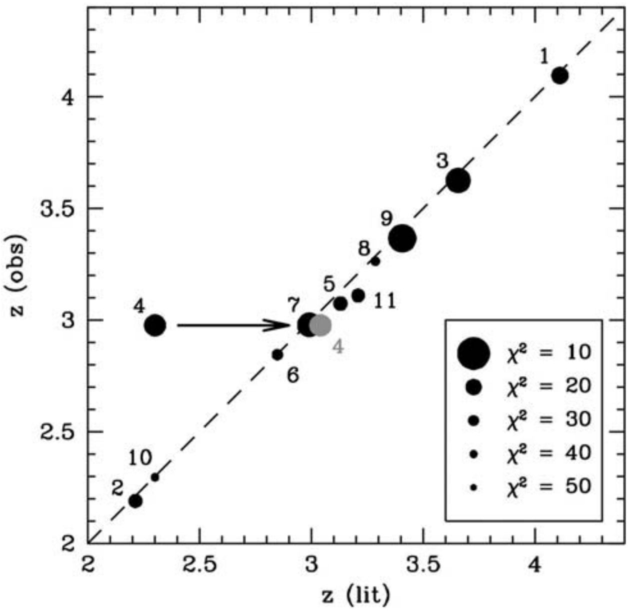


Figure 4. Observed versus literature redshifts. Symbol sizes correspond to χ^2; smaller symbols indicate a poorer fit. QSO 0127+059 has an incorrect literature redshift of 2.30; follow-up spectroscopy has yielded z=3.04, moving the point to the position shown in grey. The dashed line shows the 1:1 correlation.

They determined each quasar redshift by comparing the calibrated energy distribution with a single rest-frame composite quasar spectrum. Only one differed significantly from the literature value. It was discovered in a thin prism survey, classified as a possible quasar, and tentatively assigned a redshift of $z\approx2.30$, but with an uncertain line identification. Although the quality of the S-CAM2 fit was acceptable, the investigators obtained z=2.976. Subsequently they determined a spectroscopic redshift z=3.04, which agrees with the S-CAM2 estimate to about 2%, and confirming that the literature value was incorrect and presenting a very good example of the kind of observations SCAM2 may carry out in the future.

THE BEST CANDIDATE TO UNDERGO A SUPERNOVA EXPLOSION

WHT+UES

The Utrecht Echelle Spectrograph (UES) on the William Herschel Telescope has allowed astronomers to monitor the star Rho Cassiopeiae (ρ Cas or HD 224014) in detail from 1993 to 2002. The observations were aimed at investigating the processes occurring when yellow hypergiants approach and bounce against the so-called Yellow Evolutionary Void, an uncommon combination of stellar brightness and temperature, and the results revealed almost regular variations of temperature within a few hundred degrees. However, what happened with ρ Cas during the summer of 2000 went beyond anybody's expectations.

The star suddenly cooled down from 7000 to 4000 degrees within a few months. Astronomers discovered molecular absorption bands of titanium-oxide (TiO) formed in the slowly expanding atmosphere, suggesting that they had witnessed the formation of a cool and extended shell which was detached from the star by a shock wave carrying a mass equal to 10% of our Sun or 10,000 times the mass of the Earth. This is the highest amount of ejected material astronomers have ever witnessed in a single stellar eruption.

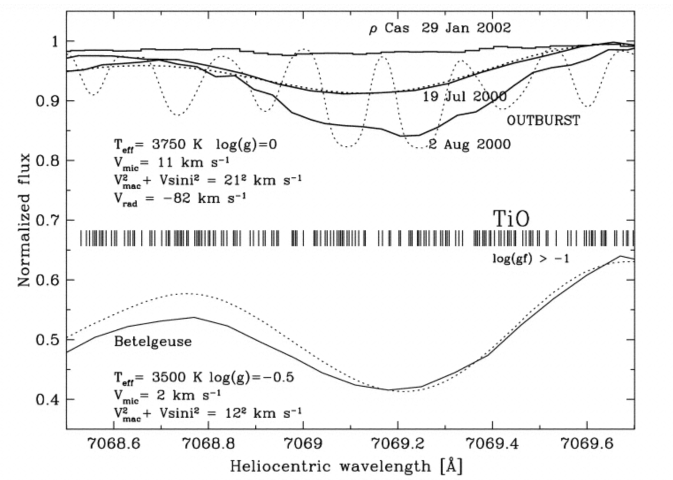


Figure 5. TiO band at 7069.2 Å, observed during the outburst of ρ Cas on 2000 July 19 in the top panel, best fitted (dotted line) for a model atmosphere with T_{eff} = 3750 K and log g=0 in the bottom panel. The spectrum of 2002 January with higher T_{eff} does not show the TiO bands. A microturbulence velocity of 11 km s^{-1} and macrobroadening of 21 km s^{-1} are required to broaden the synthetic spectrum (dotted line) of ρ Cas to the observed shape of the TiO band. The best fit yields a radial velocity of -82 km s^{-1}, or an expansion velocity of 35 km s^{-1}. The strongest TiO lines for the synthesis, with log g values greater than -1, are marked (vertical lines). The synthetic spectrum for Betelgeuse (lower dotted line) and the fit parameters are also shown.

ρ Cas experienced periods of excessive mass loss in 1893 and around 1945, that appeared to be associated with a decrease in effective temperature and the formation of a dense envelope. The results suggest that ρ Cas goes through these events approximately every 50 years.

The recurrent eruptions of ρ Cas recorded over the past century are the hallmark of the exceptional atmospheric physics manifested by the yellow hypergiants. These cool luminous stars are thought to be post-red supergiants, rapidly evolving toward the blue supergiant phase. They are rare enigmatic objects, and continuous high-resolution spectroscopic investigations are limited to a small sample of bright stars (only seven of them are known in our Galaxy), often showing dissimilar spectra, but with very peculiar spectral properties.

Yellow hypergiants are the candidates "par excellence" among the cool luminous stars to investigate the physical causes for the luminosity limit of evolved stars. They are peculiar stars because they display an uncommon combination of brightness and temperature, which places them in a so-called Yellow Evolutionary Void. When approaching the Void these stars may show signs of peculiar instability. Theoretically, they cannot cross the Void unless they have lost sufficient mass. During this process these stars end up in a supernova explosion: their ultimate and violent fate. The process of approaching the Void however, has not yet been studied observationally in sufficient detail as these events are very rare.

Since the event in the year 2000, ρ Cas' atmosphere has been pulsating in a strange manner. Its outer layer now seems to be collapsing again, an event that looks similar to one that preceded the last outburst. The researchers think ρ Cas, at a distance of 10,000 light-years away from the Earth, could end up in a supernova explosion at any time as it has almost consumed the nuclear fuel at its core. It is perhaps the best candidate for a supernova in our Galaxy and the monitoring of this and other unstable evolved stars may help astronomers to shed some light on the very complicated evolutionary episodes that precede supernova explosions.

ENHANCED OPTICAL EMISSION DURING CRAB PULSAR'S GIANT RADIO PULSES

WHT+TRIFFID

A correlation between optical and giant radio pulse emission from the Crab pulsar was detected for the first time. Optical pulses coincident with the giant radio pulses were on average 3% brighter than those coincident with normal radio pulses. Combined with the lack of any other pulse profile changes, this result showed the astronomers that both the giant radio pulses and the increased optical emission are linked to an increase in the electron-positron plasma density.

Despite more than 30 years of observation, the emission mechanism of pulsars is still a matter of debate. A broad consensus does exist: that the luminosity is powered by the rotation of the pulsar, that the pulsed radio signal comes from a coherent process, and that the optical–to–X-ray emission is incoherent synchrotron radiation, whereas the γ-ray emission is curvature radiation. What is not agreed on is the mechanism that accelerates the electrons to the energy required for synchrotron and curvature radiation, where this acceleration takes place, how coherency is maintained, and the stability of the electron-positron plasma outflow from the neutron star's surface. From the radiopulse profile at 1380 MHz and the optical profile for the Crab pulsar, two primary features can be identified: a main pulse and an interpulse. At lower energies, a radio precursor can be seen, and at higher energies in the optical, X-ray, and γ-ray regions, bridge emission can be seen between the main pulse and the interpulse. One suggestion is that the precursor represents emission from the pulsar polar cap region near the neutron star surface, similar to the radio emission from most pulsars, and that the other features come from higher in the magnetosphere. This picture is made more complex by the existence of giant radio pulses (GRPs) that occur at random intervals, in phase with either the main pulse or the interpulse, and that have energies about 1000 times as high as the mean energy. In the optical and infrared energy regions, the pulse profile is constant at the 1% level.

Any observed variation in the emitted flux, pulse morphology, or phase relations at higher energies coincident with a GRP would provide explicit constraints on pulsar (coherent/incoherent) emission physics and geometry. To investigate whether there is a link between the radio and optical emission from the Crab pulsar, simultaneous observations were carried out with the Westerbork Synthesis Radio Telescope (WSRT) and with the Transputer Instrument for Fast Image Detection (TRIFFID) optical photometer mounted on the William Herschel Telescope.

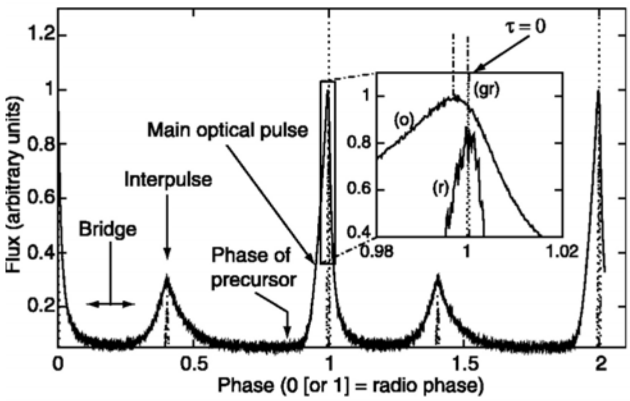


Figure 6. The Crab pulse profile showing the optical light curve (o), the average radio light curve at 1380 MHz (r), and a single giant pulse at 1357.5 MHz (gr). τ, time. Two periods are shown for clarity. Various pulse parameters have been identified. Also shown is the location of the precursor observed at lower frequencies and the bridge emission seen particularly at higher frequencies. On this scale, the GRP width corresponds to 0.00035 units of phase (12 μs), the radio pulse to 0.009 (300 μs), and the optical pulse to 0.045 (1500 μs). The avalanche photodiode (APD) band pass for these observations was from 6000 to 7500 Å. Phase 0 corresponds to the arrival at the solar system barycenter of the peak radio pulse. The optical light curve for this plot was divided into 5000 phase bins.

A total of 10,034 optical data sets of 41 periods each were collected. An average pulse profile was formed by folding the optical photons at the Crab's period and then averaging over all data sets (but not including the period associated with a GRP). By comparing the pulse profile formed by averaging only the optical pulses coincident with a GRP astronomers found that the giant optical pulses are on average 3% brighter than normal optical pulses. They also analysed other pulse parameters: arrival time, pulse shape, and interpulse height. None of these parameters showed any statistically significant variation with the presence of a GRP.

The fact that only the optical pulse, which is coincident with a GRP, shows enhanced intensity suggests that the coherent (radio) and incoherent (optical) emissions produced in the Crab pulsar's magnetosphere are linked. A consistent explanation is that the optical emission is a reflection of increased plasma density that causes the GRP event. Whatever triggers the GRP phenomenon, it releases energy uniformly throughout most of the electromagnetic spectrum, as implied by the similar energies of radio and enhanced optical pulses. Changes in the pair production rate at the level of a few percent could explain the optical variations. However, an additional mechanism would be needed to account for the radio GRPs, which are orders of magnitude stronger than the average pulse level. It has been suggested that this could be achieved by local density enhancements to the plasma stream, which increase the coherent emission ($\propto n^2$) with little effect on the (high-energy) incoherent radiation ($\propto n$). These changes must occur on tiny time scales (<10 μs) to explain the observed change in optical flux. Whatever the mechanism, these observations demonstrate a clear link at the individual pulse level between the coherent and incoherent emission regimes in the Crab pulsar.

ONE RING TO ENCOMPASS THEM ALL

INT+WFC, WFS Archive

A vast, but previously unknown structure was discovered around our own Milky Way galaxy by an international team of astronomers. Their observations suggest that there is a giant ring of several hundred million stars surrounding the main disk of the Milky Way. Despite its size, the ring has not been clearly seen before since the stars are spread around the whole sky, and are far fewer in number than the tens of billions of stars making up the rest of the Galaxy.

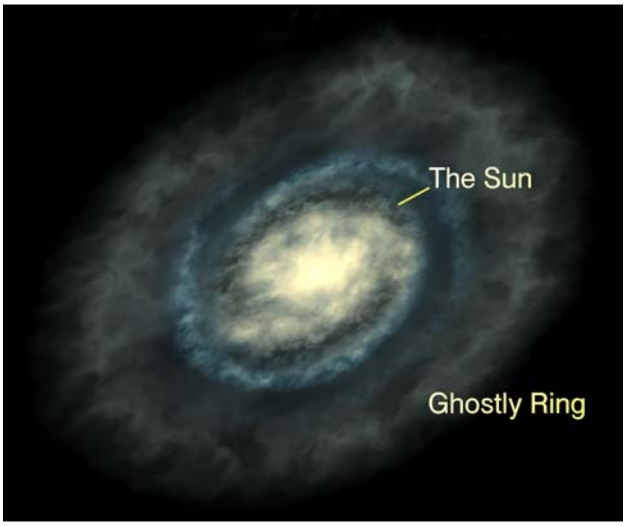


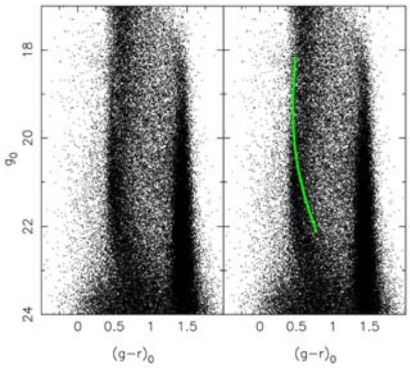
Figure 7. This schematic figure illustrates the geometry of the newly discovered ring, in relation to the spiral structure of the Milky-Way. It has long been supposed that the disk of the Milky Way galaxy slowly declines in brightness, vanishing into darkness at its edge 50,000 light years from its centre. This startling new discovery shows the outer regions of the disk are considerably more complicated than previously thought, and sheds new light on the evolutionary history of our Galaxy.

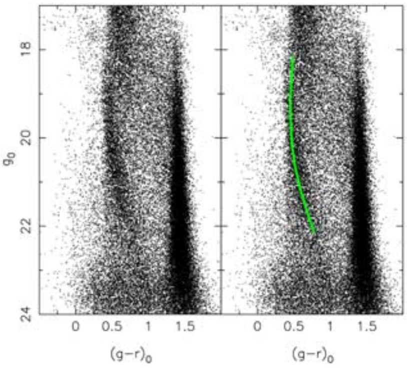
Although known to be warped, probably from encounters with its orbiting satellite galaxies, the disk of the Milky Way was otherwise thought to be a relatively simple structure. The disk is roughly 100,000 light years across, with the Sun embedded in it and offset some 30,000 light years from the centre. From this vantage point, the nearest edge of the ring is about 30,000 light years away, in the direction of the constellation Monoceros, opposite the centre of the Galaxy. This region of sky is where traces of the ring were first discovered.

Further detailed surveys in the constellation Andromeda showed that stars belonging to the ring are visible 100 degrees away from the original discovery site and that these stars closely mimic the vertical distribution of the Milky-Way's so-called thick disk. Additional survey areas also serendipitously yielded evidence of the ring's presence, allowing to get the first hints of the immense size of the structure.

The data, taken with the Isaac Newton Telescope Wide Field Camera, show a population narrowly aligned along the line of sight, but with a galactocentric distance that changes from ~15 to ~20 kpc. This population of stars was identified from the colour–magnitude diagrams of selected regions in the sky. Despite being narrowly concentrated along the line of sight, the structure is fairly extended vertically out of the plane of the disc, with a vertical scale height of 0.75 ± 0.04 kpc. The structure is seen both below the Galactic plane and above it, covering a vertical range of more than 50°. The fields at Galactic latitude larger than $|b| \sim 30°$ did not show up a similar feature in the colour–magnitude diagram. It seems roughly to encircle the disk, but is considerably thicker, probably shaped like a giant doughnut. The structure appears to be confined close to the Galactic plane. Assuming that the ring is smooth and axisymmetric, the total stellar mass in the structure may amount to $\sim 2 \times 10^8$ up to $\sim 10^9$ solar masses.

Owing to our location within the disc of the Milky Way, studies of the global structure of this Galactic component are hampered by projection problems, crowding, dust, and the presence of intervening populations (such as the bulge). Nowhere is this so





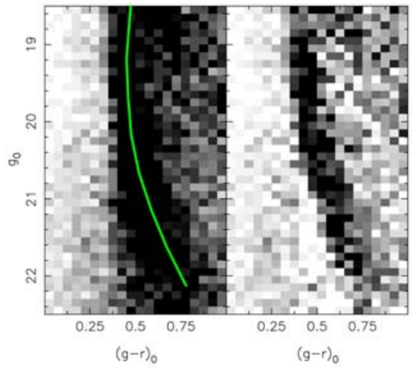


Figure 8 (left). The colour-magnitude diagram of the Elais field N1 (l= 85°, b=+44°), which it is used as a control field. This comparison region shows the usual Galactic components.

Figure 9 (middle). The colour-magnitude diagram of a field WFS-0801 at l=150°, b=+20°. An additional colour-magnitude feature is present here over the expected disc, thick disc and halo components, and is seen as a narrow colour-magnitude diagram structure, similar to a main sequence with turn-off at $(g-r)_0 \sim 0.5$, $g_0 \sim 19.5$ (in the Vega system). The right-hand panel shows this ridge-line overlaid on the colour-magnitude diagram. The similarity in the turn-off colour of this feature and that of the Galactic thick disc and halo shows that its stellar population is of comparable age to those ancient Galactic components.

Figure 10 (right). The left-hand panel shows the Hess diagram of the INT WFS-0801 field and the right-hand panel displays the result of subtracting the Elais-N1 comparison region from the data in the left-hand panel. The excess population stands out very clearly. This excess is detected at signal-to-noise ratio >30.

problematic as in the study of the very outer edge of the disc. The advent of the recent wide-area infrared surveys (e.g. 2MASS and DENIS) have alleviated the extinction problem, but the other problems remain, with the distance ambiguity being particularly limiting.

The INT WFS devotes a large fraction of observing time to deep and wide-field surveys. Many fields have now been observed since 1998. In examining INT WFC survey fields, the discovery team of astronomers has been able to detect the presence of this unexpected feature in several distant fields. However, the resulting coverage at the present time is patchy, with most time having been spent in large extragalactic surveys towards the Galactic polar caps. In Figure 8 an example of one of these fields is displayed, the Elais field N1, located at l=85°, b=+44°, which shows the normal Galactic stellar population sequences. The Galactic disc dwarfs contribute to the well-populated red vertical structure at $(g-r)_0 \sim 1.4$, whereas the progressive main-sequence turn-offs of the thick disc and halo give rise to the blue vertical structure at $(g-r)_0 \sim 0.5$. Eventually, at magnitudes fainter than $g_0 \sim 22$, the halo sequence curves round to the red because of the rapidly falling density at large Galactocentric distance. The right-hand panel shows the same data as the left-hand panel, but with the ridge-line of the structure of interest superposed.

Figure 9 displays the colour-magnitude diagram of the INT WFC field WFS-0801 (located at l=180°, b=+30°); a population that follows a track similar to a narrow main sequence is seen in addition to the usual Galactic components. This sequence is shown more clearly in the right-hand panel of Figure 10, in which the Elais-N1 field has been used as a background to subtract the normal Galactic components.

It is clear that this structure cannot be related to the normal thin disc, as it lies several magnitudes below the expected thin disc sequence. The rapid decline in the density of the feature away from the Galactic plane also rules out a direct connection to the halo. This leaves the thick disc as the only normal Galactic option. However, its nature remains a puzzle, and it is difficult to ascertain whether it is a Galactic ring, an inhomogeneous mess arising from ancient warps and disturbances, or part of a disrupted satellite stream.

Ultimately, detailed studies of this kind of the structure of the Milky Way and other galaxies, reveal how they came into being and have evolved over the lifetime of the universe. If this manifestly old population turns out to be the outer stellar disc, it will pose a very interesting challenge to galaxy formation models that predict inside-out assembly. Alternatively, if it transpires that the structure is due to a disrupted satellite whose orbit has been circularised and accreted along with its cargo of dark matter on to the disc, it will provide a unique first-hand opportunity to understand the effect of massive accretions on to the inner regions of galaxies.

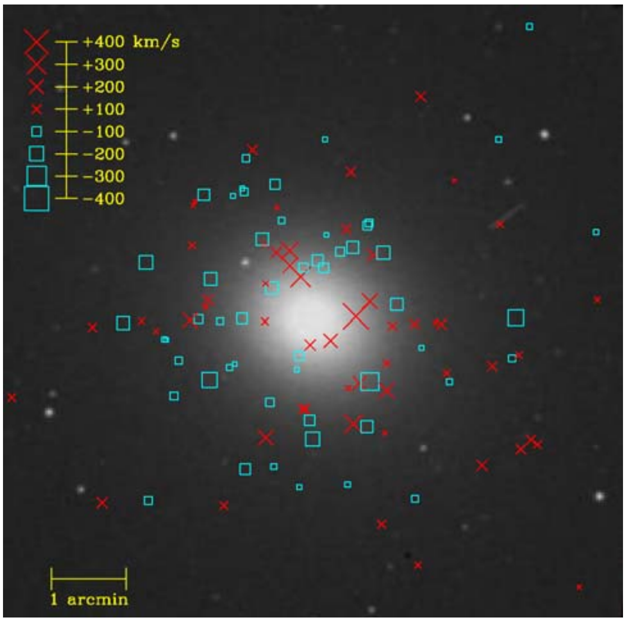
A DEARTH OF DARK MATTER IN ORDINARY ELLIPTICAL GALAXIES

WHT+PN.S

Over the past 25 years, astronomers have progressed from being surprised by the existence of dark matter to understanding that most of the universe is dominated by exotic nonluminous material. In the prevailing paradigm, the gravitational influence of cold dark matter (CDM) is crucial to the formation of structure, seeding the collapse and aggregation of luminous systems. An inherent consequence of CDM's role in these processes is that galaxies have massive, extended CDM halos. Indeed, such halos are evident around spiral galaxies, in which the rotational speeds in the extended cold-gas disks do not decrease outside the visible stars — a gravitational signature of dark matter.

The evidence for dark matter in elliptical galaxies is still circumstantial. Assessments of the total masses of individual elliptical systems have generally been confined to the very brightest systems, for which the gravitational potential can be measured using X-ray emission or strong gravitational lensing, and to nearby dwarfs, for which the kinematics of individual stars offer a probe of the mass distribution. More "ordinary" elliptical galaxies are more difficult to study because in general they lack a simple kinematical probe at the larger radii, where dark matter is expected to dominate. The velocity distribution of the diffuse stellar light is the natural candidate, but studies have been limited by the faintness of galaxies' outer parts to radii that are $2R_{eff}$, where R_{eff} is the galaxy's effective radius, which encloses half of its projected light.

A powerful alternative is offered by Planetary Nebulae (PNe), which are detectable even in distant galaxies through their characteristic strong emission lines. Once found, their line-of-sight velocities can be readily determined by the Doppler shift in these emission lines. These objects have been used in the past as tracers of the stellar kinematics of galaxies, but the procedure of locating them with narrow-band imaging surveys and then blindly obtaining spectra at the identified positions has proven difficult to implement efficiently on a large scale.



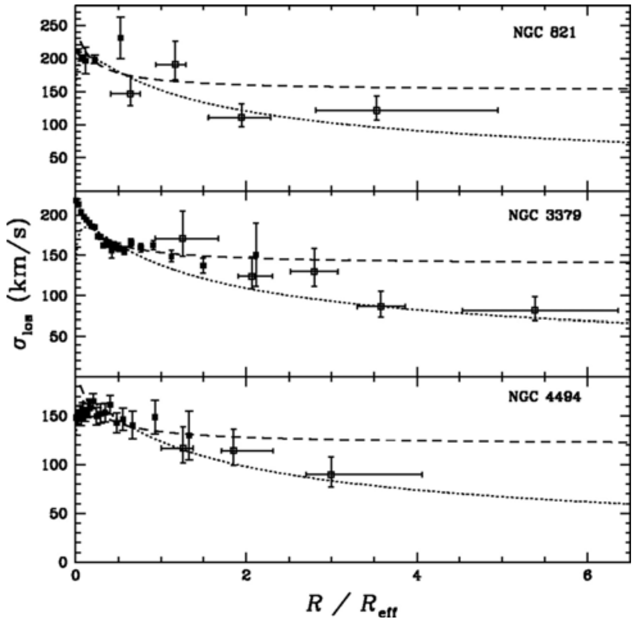


Figure 11 (left). NGC 3379 (M 105) with 109 PN line-of-sight velocities relative to the systemic velocity, as measured with the PN.S instrument on the William Herschel Telescope. The symbol sizes are proportional to the velocity magnitudes. Red crosses indicate receding velocities, and blue boxes, approaching velocities. Field of view is 8.4×8.4 arcmin = 26×26 kpc = 14×14 R_{eff}.

Figure 12 (right). Line-of-sight velocity dispersion profiles for three elliptical galaxies, as a function of projected radius in units of R_{eff}. Open points show planetary nebula data (from the PN.S); solid points show diffuse stellar data. The vertical error bars show 1 uncertainties in the dispersion, and the horizontal error bars show the radial range covered by 68% of the points in each bin. Predictions of simple isotropic models are also shown for comparison: a singular isothermal halo (dashes) and a constant mass-to-light–ratio galaxy (dots).

A specialised instrument, the Planetary Nebula Spectrograph (PN.S), was developed specifically to study the kinematics of PNe in elliptical galaxies. The PN.S uses counter-dispersed imaging (a type of slitless spectroscopy) over a wide field to detect and measure velocities for PNe simultaneously by using their [O III] emissions at 500.7 nm. Because it is optimized for this purpose, the PN.S is far more efficient for extragalactic PN studies than any other existing instrumentation.

Observations with the PN.S on the William Herschel Telescope allowed astronomers to extend stellar kinematic studies to the outer parts of three intermediate-luminosity elliptical galaxies: NGC 821, NGC 3379, and NGC 4494. In each of these systems, they measured 100 PN velocities with uncertainties of 20 km s^{-1} out to radii of 4 to 6 R_{eff}. The line-of-sight velocities in the outer parts of all of these galaxies show a clear decline in dispersion with the radius. A decrease in random velocities with the radius has been indicated by small samples of PNs around NGC 3379, but the more extensive data set presented here provides a more definitive measurement of this decline, and reveals that it also occurs in other similar galaxies. The new data are inconsistent with simple dark halo models and thus different from kinematical results for brighter ellipticals.

More unexpectedly, the velocity dispersion data are consistent with simple models containing no dark matter, showing the nearly Keplerian decline with the radius outside 2 R_{eff} that such models predict and suggesting that these systems are not embedded in massive dark halos.

This result clashes with conventional concepts of galaxy formation. In particular, if ellipticals are built up by mergers of smaller galaxies, it is puzzling that the resulting systems show little trace of their precursors' dark matter halos. And it is also apparent that some important physics is still missing from the recipes for galaxy formation. For example, substantial portions of these galaxies' dark matter halos could have been shed through interactions with other galaxies. Such stripping has been inferred for ellipticals near the centres of dense galaxy clusters, but the galaxies studied here are in much sparser environments, in which substantial stripping is not expected to be an important process.

Crucial to understanding the incidence and origin of this low-dark matter phenomenon will be the results for a large sample of ellipticals with a broad range of properties, including differing environmental densities, which could be a key factor in determining halo outcomes; the continuing PN.S observing program will provide this sample.

A PHOTOMETRIC AND SPECTROSCOPIC STUDY OF DWARF AND GIANT GALAXIES IN THE COMA CLUSTER

WHT+MCCDII, AF2/WYFFOS, JKT+CCD

The Coma cluster (Abell 1656) is one of the best studied nearby clusters of galaxies. Among nearby clusters, it is the richest and the most compact one showing a reasonable degree of spherical symmetry. Since the Coma cluster is more than 5 times as distant as the Virgo cluster, its dwarf galaxy population has not been studied well. Assuming that Coma dwarfs are similar to Virgo and Fornax dwarfs, they have scale length of about 1" and are fainter than R ~ 16. The image area of a single CCD is quite small and inefficient to cover the whole extent of the Coma cluster with sufficient angular resolution.

The technique of CCD mosaicking was a breakthrough to this dilemma. Mosaic CCD cameras made observations of dwarf galaxies feasible beyond a few

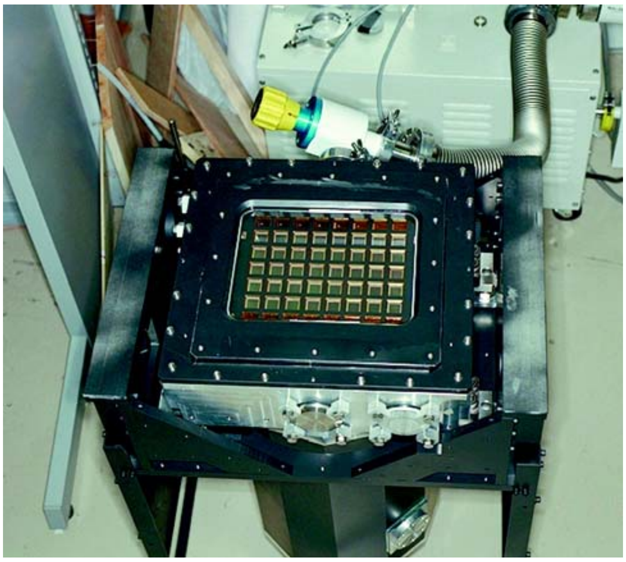


Figure 13. Mosaic CCD Camera II (MCCDII). Forty CCDs are seen aligned in a 5×8 array. A liquid nitrogen tank is attached backside of the Dewar to cool the CCDs down to appropriate temperature.

very nearby clusters such as the Virgo and the Fornax clusters.

A team of astronomers has carried out a deep photometric and spectroscopic survey of wide areas in the Coma cluster, aiming to investigate the properties of galaxy population in different environments within the cluster, using a wide-field mosaic CCD camera (MCCDII) for photometric survey and the AF2/WYFFOS multiobject spectrograph at prime focus of the WHT to increase spectra of both giant and dwarf galaxies available to the study.

Imaging data covered a large field of view ($2.22\,deg^2$) from the cluster centre to the outskirts, and the photometry was complete to a limiting magnitude of R≅23 mag. This photometric survey covered a wide area down to a considerably deep limiting magnitude compared to previous studies. In particular, the surveyed area is the largest among the recent CCD surveys of the Coma cluster. It covers the area in the Johnson B and Cousins R bands for which only photographic data had been available before.

The Mosaic CCD Camera II (MCCDII) was developed in a collaborative program between the University of Tokyo and National Astronomical Observatory of Japan. MCCDII has 40 1k×1k CCDs produced by TI/Japan. Since the CCDs are not buttable, they are aligned in the 5×8 array with gaps (hence one contiguous image consists of 160 frames). The camera is designed so that four different exposures provide one contiguous image without any gap. The gap between each CCD is about 900 pixels, which is optimized to give both as large field of view as possible and an appropriate overlap (100 pixels) between adjacent images. MCCDII was attached to the prime focus of the William Herschel Telescope. The scale at the prime focus of WHT is $17.75''\,mm^{-1}$, which results in 0.21″ per pixel sampling and $50\times32\,arcmin^2$ field of view is attained with four exposures.

To study the spectral properties of galaxies as a function of their local environment, two fields were selected for spectroscopic observations to cover both the core and outskirts of the cluster. Medium resolution spectroscopy was then carried out for a total of 490 galaxies in both fields, using the AF2/WYFFOS multifiber spectrograph. The limiting magnitude was R=19.75 and a total of 279 galaxies were identified as members of the Coma Cluster.

The mean metallicity decreases with galaxy magnitude and, at a given luminosity, appears to be generally lower for galaxies in the southwest region of Coma as compared to the centre of the cluster. A broad range of ages, from younger than 3 Gyr to older than 9 Gyr, is found in galaxies of any magnitude. However, systematic trends of age with luminosity are present among galaxies in the central field, including a slight decrease of the mean age for fainter galaxies. Furthermore, in the central Mpc of Coma, a large fraction of galaxies at any luminosity show no evidence in their central regions of star formation occurred at redshift $z<2$, while the proportion of galaxies with significant star formation occurring at intermediate ($0.35<z<2$) and low ($z<0.35$) redshifts is found to depend on galaxy luminosity. An additional surprising result is that the faint galaxies with young luminosity-weighted ages appear to have a bimodal metallicity distribution that would point to a composite formation scenario involving different physical processes.

The R-band luminosity function is found to be the same between the inner and outer regions and close to those from measurements for field galaxies. This is remarkable given the variation in the spectral types of galaxies between field and cluster environments. The total B-band luminosity function shows a dip at $M_B=-18$ mag, in agreement with previous studies. The luminosity function is studied in B−R color intervals and shows a steep faint-end slope for red (B−R>1.35) galaxies, at both the core and outskirts of the cluster. This population of low-luminosity red galaxies has a higher surface density than the blue (B−R<1.35) star-forming population and dominates the faint end of the Coma Cluster luminosity function. It is found that the relative number of high surface brightness galaxies is larger at the cluster core, implying the destruction of low surface brightness galaxies in the dense core environment.

A significant gradient in Mg_2, in the sense that galaxies in the core of the cluster have stronger Mg_2 is found in a sample of galaxies spanning a wide range of absolute luminosity in the Coma Cluster. The astronomers attribute the Mg_2 gradient to changes in metal abundance. One possible mechanism to create this abundance gradient is pressure confinement by the intracluster medium of material from supernova-driven winds early in the history of the galaxies.

The ages of stellar populations in 52 elliptical and S0 galaxies in the Coma Cluster were also investigated.

More than 40% of the S0's are found to have undergone star formation in their central regions during the last 5 Gyr, while such activity is absent in the ellipticals. Galaxies in this sample have absolute magnitudes in the range $-20.5<M_B<-17.5$, and the fraction of S0 galaxies with recent star formation is higher at fainter luminosities. The observed luminosity range of S0 galaxies with signs of recent star formation activity is consistent with them being the descendants of typical star-forming spirals at intermediate redshift whose star formation has been halted as a consequence of the dense environment.

THE CENSUS OF PLANETARY NEBULAE IN THE LOCAL GROUP

INT+WFC

Planetary Nebulae (PNe), the fate of the vast majority of stars with a mass similar to the Sun or a few times higher, represent a short but well characterised stage of stellar evolution. It is the time at which stars experiment their last thermonuclear burning on the surface of a core that has been left naked by strong mass loss during the previous red giant phase. The combination of a hot luminous star (up to 500,000 K and to more than 10,000 solar luminosities) and a low density expanding wind, allows the formation of extremely luminous nebulae that reprocess the energetic continuum radiation from the stellar nucleus into specific emission-line spectra from atomic ionised gas. This makes PNe easily observable in our own Galaxy, but equally well detectable in external galaxies even with relatively small telescopes.

The technique used for searching PNe in external galaxies is almost invariably that of obtaining a narrow-band, continuum-subtracted image in a filter isolating the forbidden emission at 5007Å from double-ionised atomic oxygen [OIII]. A large fraction of the

Figure 14. The data are illustrated in these colour figures; in each image green is the [OIII] emission, red the Hα one, while blue corresponds to the broad band Sloan-g images, mainly dominated by continuum stellar emission. In these images, planetary nebulae stand out as green or yellow dots (a striking example is the green luminous object on the upper-left side of the image of Leo A).

total luminosity of the star is in fact concentrated in this line, and this is the unique property that makes individual stars in the planetary nebula phase visible to very large distances: up to several hundred solar luminosities can be emitted in a single and very narrow spectral line. Observation of the hydrogen Hα line, also very bright, is sometimes added to discriminate against the detection of highly redshifted galaxies (e.g. [OII] emitting galaxies at redshift z=0.34, which shifts the O+ emission to the rest wavelength of [OIII] 5007, or Lyman-α emitters at redshift 3.1), or to estimate the ionisation class and discuss possible contamination by compact HII regions. Another basic criterium to select candidate extragalactic PNe is that they are not spatially resolved by ground based imaging, their sizes being usually a fraction of a parsec which translates into a couple of hundredth of an arcsec at a distance of 1 Mpc, approximately the outer edge of the Local Group.

PNe in external galaxies provide a tool to investigate some important astrophysical problems. First of all, their number reflects the total mass of the underlying stellar population from which they derive. Extragalactic PNe also provide important information on the chemical evolution of the host galaxies, as the nebular abundances of elements like oxygen, neon, sulphur, or argon, do not vary significantly during the evolution of low-mass stars. Therefore the abundances of these elements probe the initial metallicity of their environment at the time when their progenitors were born. This covers a range in ages that can be hardly covered using other classes of stars. Moreover, nowadays PNe are used as reliable extragalactic distance indicators, through the invariance of their luminosity function with galaxian type and metallicity. And finally, as they are also detected in stellar systems of low surface brightness, they are extremely valuable test particles to map the dynamics of stars in galaxies up to very large galactocentric distances.

For the reasons above, an intense search for PNe in nearby galaxies, as one of the main objectives of the Local Group Census (LGC), was started. The LGC is a narrow-band survey of the galaxies of the Local Group observable from La Palma, that was awarded observing time within the INT Wide Field Imaging Survey programme. The aim of the survey is to find, catalogue and study old and young emission-line populations (e.g. HII regions, PNe, supernova remnants, Luminous Blue Variable Stars (LBVs), Wolf-Rayet stars, symbiotic binaries, etc.) to unprecedented levels. The value of narrowband [OIII], Hα, [SII], and HeII images is enhanced with complementary broad band data (g, r, i). This enables, in principle, the linkages between stellar populations to be probed.

The first part of the analysis of the survey data has been focused on the search for PNe in dwarf irregular galaxies of the Local Group. This is of particular interest as dwarf galaxies are the most numerous galaxies in the nearby universe. According to the hierarchical scenarios of galaxies formation, dwarf galaxies are the first structures to form and from them merging larger galaxies are built. The Local Group, which appears to the rest of the universe as an ordinary collection of dwarf galaxies (90% of its 40 known members) dominated by two main spiral galaxies, is an ideal laboratory as the low-luminosity dwarf galaxies can be studied in detail.

Before this census, only a small number of PNe were known in the dwarf irregular galaxies of the Local Group. With the present survey, so far 16 PNe in IC 10, 5 in Sextans B and 3 in IC 1613 were newly discovered, while the existence of one candidate planetary nebula in Leo A, one in Sextans A, and about 25 in NGC 6822 were confirmed. No PNe are instead found in GR8, as expected because of the small luminosity of this galaxy.

The Local Group Census detections provide a more complete view of the population of PNe in the Local Group. With these new data, the picture appears to be consistent with the predictions of the stellar evolution theories, as the number of observed PNe in each galaxy scales reasonably well with the luminosity of the galaxy. In spite of this agreement, there are also some interesting peculiarities. For instance, Sextans A and Sextans B have very similar V-band luminosities and mass, but while five PNe were discovered in Sextans B, only one candidate is detected in Sextans A. Statistically, this difference is only marginally significant, but may suggest some differences in their star formation history, as evidenced by the stronger main-sequence population of Sextans A compared to Sextans B.

The behaviour of the numbers of planetary nebulae with galaxy metallicity was also investigated, and found a possible lack of PN when [Fe/H]<<−1.0, which might indicate that below this point the formation rate of PNe is much lower than for stellar populations of near solar abundances. This might in turn be related to the mass loss mechanism in evolved red-giants, that is governed by radiation pressure on dust grains, and is therefore sensitive to a significant deficiency of heavy elements in the stellar atmosphere.

Another result of the survey is the discovery of candidate planetary nebulae at large galactocentric distances, like in the case of IC 10 where they cover an area of 3.6×2.7 kpc, much more extended than the 25 mag×arcsec^{-2} diameter (1.1×1.3 kpc).

The new detections of the LGC project are a starting point for future spectroscopical studies of individual objects, aimed at confirming their nature as PNe and, more important, at determining their physical and chemical properties and those of their host galaxies.

DIRECT CONFIRMATION OF TWO PATTERN SPEEDS IN THE DOUBLE-BARRED GALAXY NGC 2950

JKT+CCD

Large-scale bars are present in some two-thirds of all disk galaxies. Secondary stellar bars within large-scale bars are also common, occurring in about one-third of the barred galaxies. Interest in secondary stellar bars is motivated by the hypothesis that they are a mechanism for driving gas to small radii to feed the supermassive black holes powering active galactic nuclei. However, the efficiency of such transport is uncertain because of the lack of knowledge of the pattern speeds of the primary and secondary bars. Whereas a number of pattern speeds of large-scale bars have been measured, no such measurements in nested systems have been performed yet. The presence of nested bars with different pattern speeds has been inferred largely on the basis of their apparently random relative orientations. Secondary bars can naturally form and survive for more than a few rotation periods in pure stellar disks. However, simulations have also found other possibilities, including cases in which two stellar bars counterrotate.

An ideal target for measuring primary and secondary pattern speeds is the galaxy NGC 2950, which is a large and bright early-type barred galaxy. NGC 2950 is classified RSBO(r), and the presence of a secondary stellar bar has been discussed by several authors. The secondary bar of NGC 2950 has an intermediate inclination, and both bars have intermediate position angles between the major and minor axes of the disk and no evidence of spiral arms, patchy dust, or significant companions.

The photometric observations of NGC 2950 were carried out at the Jacobus Kapteyn Telescope. The astronomers took multiple exposures in the Harris B, V, and I bandpasses using the SITE2 CCD, and the spectroscopic observations were carried out at the Telescopio Nazionale Galileo.

The astronomers found that the primary bar in NGC 2950 is rapidly rotating. If this is the norm in this type of galaxies, then it guarantees that primary bars are efficient at funnelling gas down to the radius of influence of secondary bars. They also establish that in NGC 2950 the two bars have different pattern speeds, with the secondary bar having a larger pattern speed. This is the first time this is measured directly.

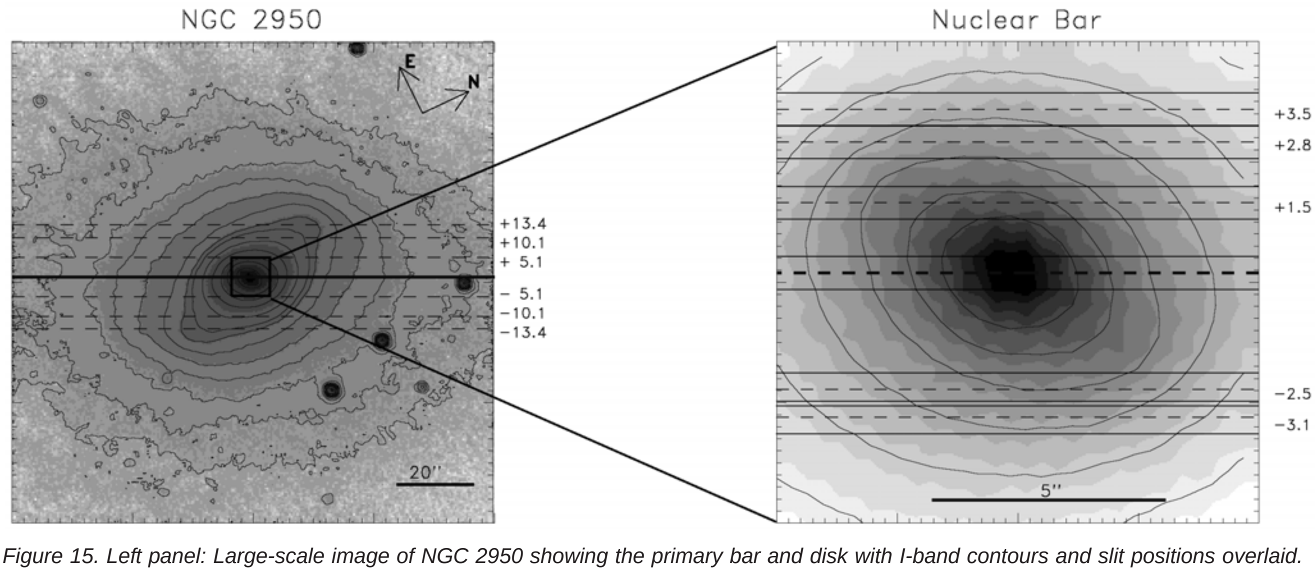


Figure 15. Left panel: Large-scale image of NGC 2950 showing the primary bar and disk with I-band contours and slit positions overlaid. Right panel: Zoom into the central region of NGC 2950 showing its secondary bar.

EXTENDING COSMIC SHEAR MEASUREMENTS WITH THE WHT

WHT+PFC

Weak gravitational lensing of background galaxies by intervening large-scale structure ('cosmic shear') provides direct information about the total mass distribution in the universe, regardless of its nature and state. Thus a measurement of cosmic shear bridges the gap between theory, which is primarily concerned with dark matter, and observation, which generally probes only luminous matter. The recent detection of coherent distortion of faint galaxies using the WHT in 2000 have triggered great interest in the provision of new constraints on the amount and distribution of dark matter, together with measurements of several cosmological parameters.

If intrinsic galaxy orientations are essentially random in a given survey, any coherent alignment must arise from distortion due to weak lensing. Light paths from galaxies projected close together on the sky pass through, and are gravitationally distorted by, the same dark matter concentrations. This coherent distortion contains valuable cosmological information. In particular, the variance of the distortion field measures the amplitude of density fluctuations ($\sim\sigma_8\Omega_m^{0.5}$). This shear measurement is free from assumptions about Gaussianity or the mass-temperature relation, and whilst the shear-based measurement is currently comparable in precision to that from local cluster abundance, further progress is limited solely by the number of fields observed.

The validity of results from cosmic shear surveys depends sensitively on the treatment of systematic errors. A further issue arises from sample (or 'cosmic') variance, the impact of which can be limited by using numerous independent sightlines to complement panoramic imaging of a few selected areas. With these motivations in mind, a team of astronomers compared the cosmic shear observed with two independent instruments (Keck and WHT), using two different survey strategies.

Astronomers extended the original detection of the cosmic shear on the WHT by increasing the number of observed fields, with a further increase in area as a result of the larger 16×16 arcmin^2 size of field with the new prime focus mosaic camera. The aim of the survey was to acquire deep ($z\cong1$) fields representing numerous independent lines of sight, sufficiently scattered to sample independent structures and thus to minimise uncertainties owing to sample variance. These lines of sight were chosen in a quasi-random fashion, without regard to the presence or absence of mass concentrations, in order to obtain a representative sample of the mass fluctuations in the universe.

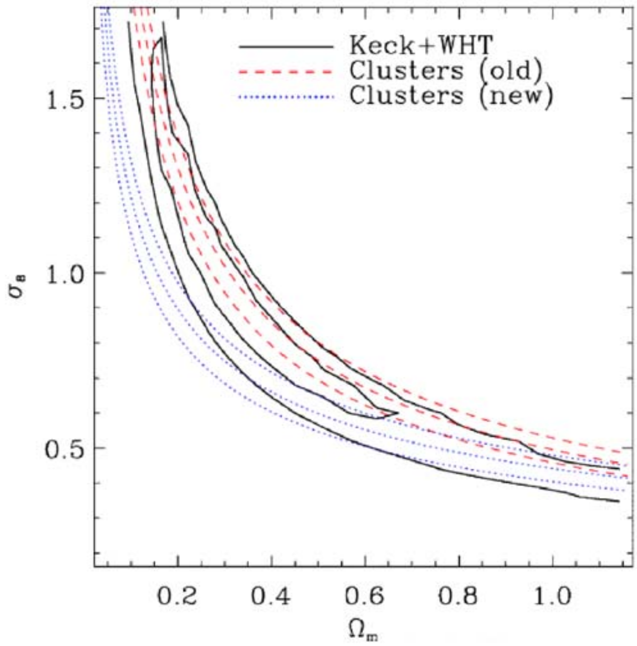


Figure 16. Constraints on the joint distribution of Ω_m and σ_8 for the combination of Keck and WHT measurements.

The cosmic shear with both Keck and WHT was measured at a signal-to-noise of 5.1, finding an amplitude of the matter power spectrum of $\sigma_8(\Omega_m/0.3)^{0.68}=0.97\pm0.13$, with $0.14<\Omega_m<0.65$, including all contributions to the 68 per cent confidence level uncertainty: statistical noise, sample variance, covariance between angular bins, systematic effects and redshift uncertainty. A measurement of this quantity from cosmic shear is cosmologically valuable, as it represents a direct measure of the amplitude of mass fluctuations. These results for Keck and WHT are consistent with each other. The joint results are also consistent with other recent cosmic shear measurements. However, they cannot rule out lower cluster-abundance normalisation which has been derived recently. This discrepancy, if confirmed, could arise from unknown systematics in either the cluster or cosmic shear methods. It is important to understand the origin of the discrepancy between cosmic shear and cluster abundance methods. If this is not explained by such systematics, it could point towards a failure of the standard ΛCDM paradigm, and therefore have important consequences for cosmology.

Chapter 2

OPERATION, MAINTENANCE AND ENHANCEMENTS

TELESCOPE OPERATION

During the two-year period 2002/03 covered by this report, the ING telescopes again performed very well, with downtime figures due to technical problems averaging only 2.4%, 1.0%, and 2.1% on the William Herschel Telescope (WHT), the Isaac Newton Telescope (INT), and the Jacobus Kapteyn Telescope (JKT), respectively. These figures are well below the target value of a maximum of 5 percent technical downtime. Observing time lost due to poor weather over the same period averaged 24%.

Day-to-day telescope operations support is carried out by a small operations team, taking responsibility for the three telescopes. Efforts of day-time and night-time support activities focus on the WHT. On this telescope, five common-user instruments are supported, as well as several visiting instruments. Many observing teams visit the telescope every year. The INT operates in a much simpler fashion and developed as of August 2003 into essentially a single-instrument facility. For the night-time operation a telescope operator in present each night on the WHT. Telescope operator support on the INT became unnecessary as a result of its simpler operating mode. Modernisation and integration of the various control systems over recent years have achieved that the INT and JKT can easily be operated by a single person. On the INT astronomy support is now largely carried out by students.

In view of the increasing importance of adaptive optics observations, night time operation at the WHT will gradually be adapted to ensure optimal scientific use of the best seeing periods. To achieve this, the observing programme has to be flexible, and the observer has to be able to switch from one observing programme to another, and even switch between instruments, in response to the actual observing conditions. Such queue-scheduled observations require hardware and software infrastructure to assist the astronomer in making the right decisions and to ensure that the scientifically most important observations are carried out. Developments are currently under way that prepare the WHT for queue scheduled observations.

The year 2002 marked the start of a significant reorganisation required by the phased reduction of operating cost of the observatory. These measures unavoidably have an impact on the service delivered to the visiting astronomers. Most notably, the 1-m Jacobus Kapteyn Telescope was withdrawn from normal operation in 2003, and the operation of the 2.5-m Isaac Newton Telescope was streamlined, with less scheduling flexibility and only the minimum of technical and astronomy support offered. However, in other areas the service, focussing on the WHT, has been strengthened.

As mentioned in the introduction to this report, the Instituto de Astrofísica de Canarias has become a full partner in the ING. The international agreement that formally establishes this new collaboration was signed on May 6th 2003 in Tenerife. This new partnership holds the prospect of stronger future collaborations in scientific programmes and projects. With this partnership, a re-adjustment of financial contributions has taken place, and as a result Spain obtains significantly more telescope time (see Table 1).

Figure 1. Signing of agreement between ING and IAC.

	2001	2002	2003	2004	2005+
UK	60.0	54.0	50.0	48.9	47.6
NL	15.0	15.0	15.9	17.0	18.3
Spain	0.0	6.0	9.1	9.1	9.1
Site contribution	20.0	20.0	20.0	20.0	20.0
CCI	5.0	5.0	5.0	5.0	5.0
Total	100.0	100.0	100.0	100.0	100.0

Table 1. Timeline of percentage breakdown of observing time.

Moreover, the IAC is constructing a world-class IR spectrograph, LIRIS, for the William Herschel Telescope, that will be offered to all users of the telescope, thus adding to the scientific capability.

Since 2002 the ING can count on a new advisory body: the Director's Advisory Committee, or DAC. This committee advises the Director on all major issues that affect ING, including strategic use of the telescopes, instrumentation developments, international collaborations, and operational aspects. The DAC, under chairmanship of Dr M McCaughrean (Potsdam), has already provided important advice on various issues.

From 2001 onwards, ideas for setting up collaborations between European observatory groups have been discussed intensely. The driving force was the realisation that there is significant overlap and duplication of interests and instrumentation between the various telescopes to which European astronomers have access. Better collaboration and coordination of development programmes across different telescopes could provide an overall better service to all astronomers than is currently the case through essentially national facilities. This initiative is sponsored by OPTICON, a EU-funded network for the wider coordination of optical and infra-red ground-based initiatives. As the goal of wider European collaboration is in line with the objectives set by the European Union, the EU decided it will provide financial support in future years for such collaboration between observatories.

As an example of European collaboration, an agreement for sharing observing time with the 3.6-m Italian Telescopio Nazionale Galileo (TNG), also located at the Roque de los Muchachos Observatory, was set up. As the TNG and WHT possess complementary instrumentation, it seemed opportune that through sharing of observing time both communities would obtain optimal access to the telescopes. So far, this time share scheme has worked very well: various Italian astronomers have been using the WHT for their observing programmes, while astronomers from the UK and the NL have exploited the TNG.

INFRASTRUCTURE

With Adaptive Optics (AO) being a key element of the development programme for the WHT, also infrastructure improvements have centred on supporting future AO activities at that telescope. In order to be much better prepared for future exploitation of the AO system, a dedicated controlled environment, GRACE, has been constructed. GRACE consists of a pre-fabricated building that encloses one of the Nasmyth foci. The internal environment is cooled and treated as a (moderate) clean room in order to protect and stabilise the AO equipment, in particular NAOMI, as much as possible. This new facility allows NAOMI to remain permanently mounted at the telescope, an essential requirement for future queue scheduled observations. Apart from NAOMI, its design also allows the deployment of OASIS, the AO-assisted integral field spectrograph, and even possible future equipment for laser guide star deployment. Dr A. Meijler, Director of the NWO Council for Physical Sciences, inaugurated the GRACE building in May of 2003.

Figure 2. Inside GRACE during its inauguration.

Creating a Nasmyth focus dedicated to AO implied the removal of the Utrecht Echelle Spectrograph occupying that focal station. That spectrograph was retired from service in 2002. A study is under way to explore the feasibility to adapt the spectrograph to work at the 10-m GTC telescope, currently under construction on La Palma.

Taking care of optical components is an important task at any observatory. Arguably the most important components are the telescope mirrors, for which general cleanliness is a major concern in order to maximize their light reflecting capability. ING's procedures for mirror maintenance include snow cleaning, washing, and re-coating. During the reporting period a new technique for mirror washing has been tested, using water vapor rather then classical wet washing techniques. The major advantage with vapor is the relatively small quantities of liquid involved, which is a major benefit when dealing with large mirrors in-situ.

Figure 3. Vapour mirror cleaning.

As part of a phased modernisation of key observing systems, all science CCD detector systems have now been converted to the SDSU controllers and new high-level data acquisition software. This and other infrastructure improvements help increase the overall observing efficiency and user friendliness. But equally important in having uniform systems is the advantage of easier maintenance and holding of spares.

The existing autoguider systems (and ultimately also the TV acquisition cameras) are also gradually being upgraded to SDSU controller-based systems with frame-transfer CCDs. This will allow ING to retire

Figure 4. Picture of one of the new CCD acquisition cameras.

older controllers and software that is becoming difficult to support, and at the same time improves overall performance. Three systems have been commissioned: one for NAOMI acquisition and two that will be used for object acquisition at Cassegrain and with INTEGRAL, and for autoguiding with AUTOFIB.

In August of 2003 the JKT was taken out of regular service as a common-user telescope. This unfortunate but necessary step had to be taken under the pressure of budget reductions. The telescope and its associated infrastructure, however, will be maintained for some time in a state so that it can be put back into service with little effort. An initiative has been started to seek potential self-financing activities to reactivate this still productive telescope facility.

The reporting period also saw the completion of ING's robotic seeing monitor, RoboDIMM. This system measures atmospheric seeing based on measurement of differential image motion of star images produced by pairs of small apertures. Free atmosphere seeing is deduced from the relative motion of two simultaneous

Figure 5. Left: RoboDIMM tower and dome. Middle: telescope. Right: typical seeing plot from a single day. RoboDIMM is situated some meters north of the WHT.

images obtained with very short exposures. The system consists of a small telescope and associated equipment, and is located on a dedicated tower, not far from the WHT dome. Apart from start-up and closedown, the system is fully automatic; it finds suitable stars and tracks these stars, measuring seeing all night. Seeing data is stored in a database, together with meteorology data. A web-based interface allows on-line assessment of the seeing, monitoring development of seeing during the night, as well as easy recovery of historic data. RoboDIMM will be a key tool for effective queue observing in the future.

A long-standing wish at ING has been the construction of an all-sky (cloud) monitor. Such system is useful for assessing sky quality, to plan observations at night, and even to measure sky transparency and sky brightness as a function of sky position. Recently a project at Michigan Technical University came to fruition, producing a visible-light all-sky continuous camera, CONCAM. Although originally developed for scientific purposes as an all-sky monitor for variable objects, it serves also well as a cloud monitor. ING has acquired a system that has been installed on the roof of one of its buildings, bringing the observatory's actual night sky live on the web.

At the INT, installation of a cold air circulation system to take away warm air that builds up during the day immediately below the INT observing floor was completed. It is expected that this system will reduce heat transfer into the dome area, and thus improve local seeing conditions.

At the WHT, a major infrastructure upgrade was the replacement of the air conditioning units servicing the control room, computer room and terminal area. The new system will be much easier to maintain, and will operate more cost efficiently as well.

ING's computing infrastructure has also seen considerable further evolution to keep abreast with the evolving requirements and ever increasing data rates. Faster machines and more data storage capacity was installed where most urgently required. Also firewalls to protect the computer network and computer systems from malicious, external intrusions were installed, both at the observatory and at the sea-level offices. Computing infrastructure is now properly protected against malicious use, while a reasonable level of flexibility can still be offered to visiting astronomers and their equipment.

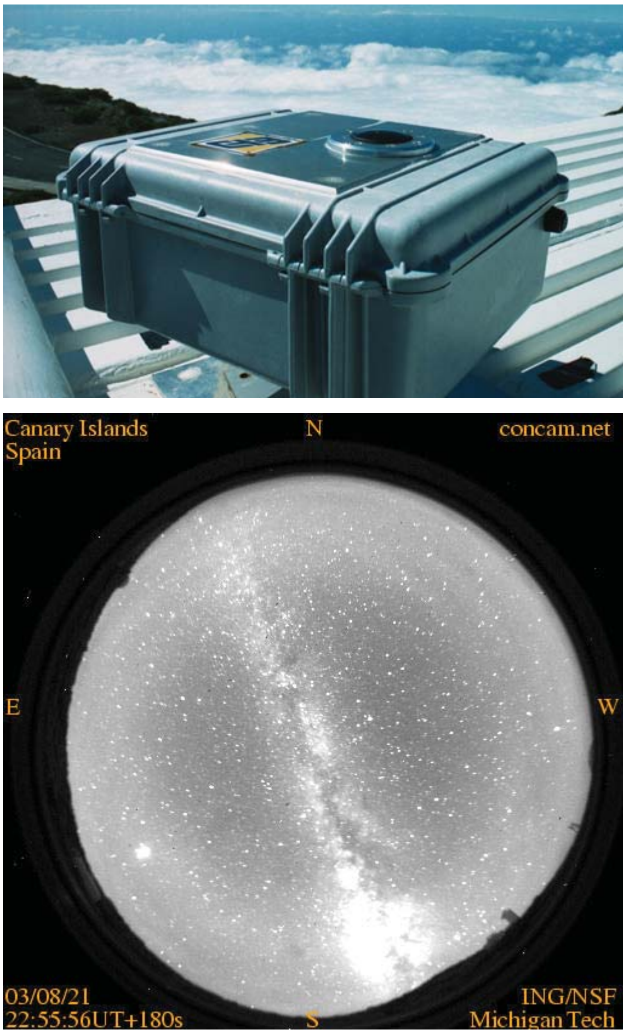


Figure 6. CONCAM camera and a typical night all-sky image.

A weak link in ING's network services is the reliability and bandwidth of the observatory's computer connection to the outside world. ING's critical dependence on the external network has grown. Moreover, new major telescope installations will soon start using the same limited bandwidth available to the observatory, while there is no matching growth of bandwidth capacity foreseen. For that reason the technical feasibility of alternative network connectivity is under study.

A significant re-organisation of office space has taken place in the sea-level base, in the Mayantigo building in Santa Cruz de La Palma. As a result of staff reductions the required number of offices is reducing. Re-organisation of the offices will achieve more efficient use of the available space, and as a result some more space can be let to other observatory groups.

INSTRUMENTATION

Adaptive Optics remains central to the instrumentation development at ING and has progressed significantly during the reporting period. Various science observations were carried out and a much better understanding of the system performance was gained. An important step was the decision to dedicate one of the WHT Nasmyth foci to AO instrumentation. As a result, during 2003 a dedicated AO laboratory enclosure was completed and taken in use. This enclosure, called GRACE, not only provides a cleaner and more stable platform for AO exploitation, but it also avoids disruptive and labour intensive instrument changes. With the advent of GRACE, AO has become a permanent feature at the WHT.

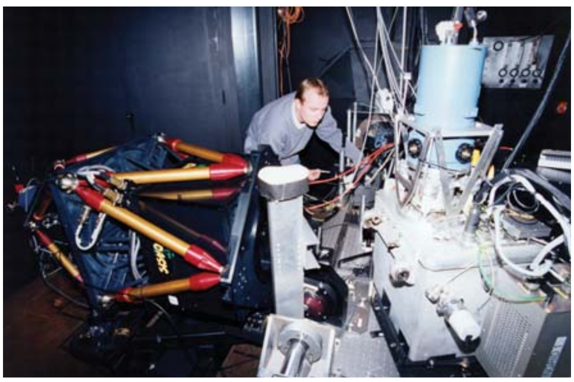
Science observations covered circumstellar dusty shells, planets near isolated stars, microstructure in PNe, cD galaxies, post-AGB circumstellar envelopes, QSO hosts, companions to cool dwarfs, and near-Earth asteroids. One of the latter yielded FWHM 0.11-arcsec images of the fast-moving (up to 5 arcsec/sec) near-Earth asteroid 2002NY40 during its night of closest approach, resulting in a press release and BBC coverage.

A key achievement for NAOMI has been the successful performance tests at visible wavelengths, in preparation for the integral-field spectrograph that has been installed and passed through its first commissioning tests in 2003. Significant improvements in image quality were proven, and the system could be locked on relative faint point sources as well as more extended sources such as the nucleus of the galaxy M31. NAOMI is now routinely delivering images with FWHM ~0.2 arcsec in the near-IR. Further characterisation of NAOMI's performance continues with measuring image quality as a function of wavelength, guide-star magnitude, radius from guide star and natural seeing. Although operation of the AO system has become much more robust and streamlined, the overall performance of AO correction leaves room for improvement. Optimisation of AO performance has now become the focus of further activities.

Following extensive preparations, the OASIS integral field spectrograph was installed at the WHT in the summer of 2003. The OASIS spectrograph is optimised to work with AO instrumentation with its typical plate scale of 0.2 arcsecond per focal-plane lenslet element. OASIS was deployed before on the Canada-France-Hawaii Telescope. This project is being carried out in collaboration with the Centre de Recherche Astronomique de Lyon where OASIS was built. The project required modifications not only to OASIS itself, but also a new optical science port with a changeable pass band had to be constructed for the NAOMI AO system. Together, this system delivers unique capability for carrying out spectroscopy at high spatial resolution. Such facility will allow, for instance, the study of the dynamics within galaxy cores or star forming regions.

The NAOMI AO system was also enhanced in 2002 with a coronographic facility, OSCA. Basic functionality of OSCA was proven during the first commissioning run. The coronagraph unit sits on an articulated plate that can be deployed quickly in/out of the beam. This makes remote switching between 'normal' AO observations and coronographic work fast and easy. OSCA's all-reflective optics are designed to work both at optical and IR wavelengths. The system was designed and built at the University College London.

Another important development for the WHT is being carried out at the IAC, where the intermediate resolution IR spectrograph and imager, LIRIS, is being constructed. This instrument, based on a 1024 by 1024



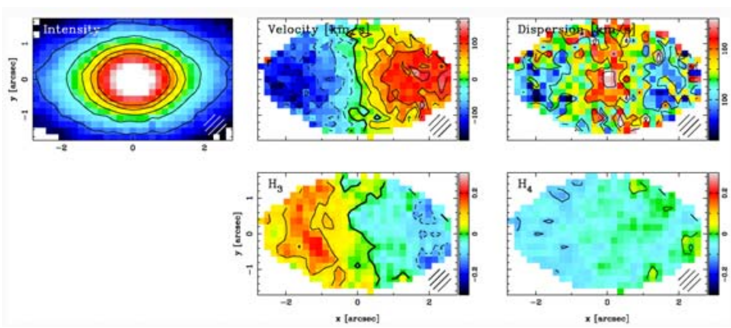


*Figure 7. Left: OASIS joins NAOMI in WHT's AO-dedicated, temperature-controlled Nasmyth enclosure, GRACE. The IR camera INGRID is visible in the foreground on the right. Right: OASIS stellar kinematical maps of NGC 3377 (Copin et al., 2004, A&A, **415**, 889).*

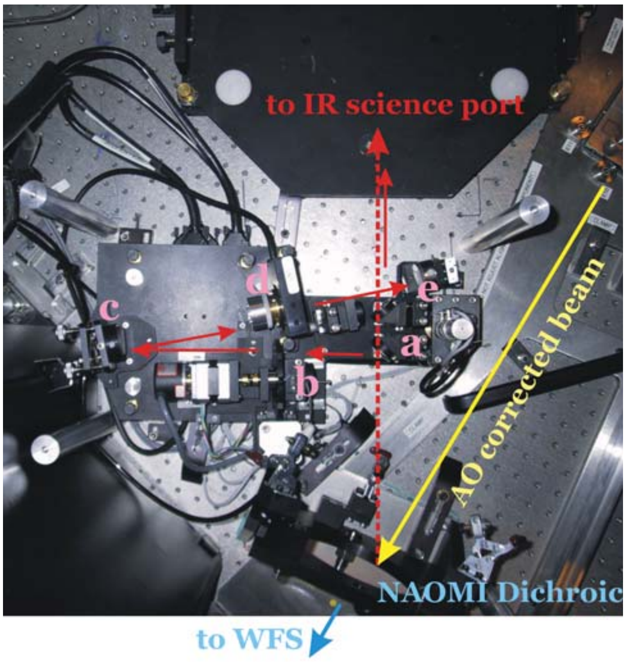


Figure 8. OSCA on the NAOMI bench. The light path is indicated by the arrows. The dashed red line shows the lightpath without OSCA. (a) OSCA picks up the converging beam coming from NAOMI and directs it onto the focal plane masks (b) and then onto the first off axis paraboloid (c). The beam leaves OSCA via an optical system (d) which conserves the focal point and f-ratio of the NAOMI beam.

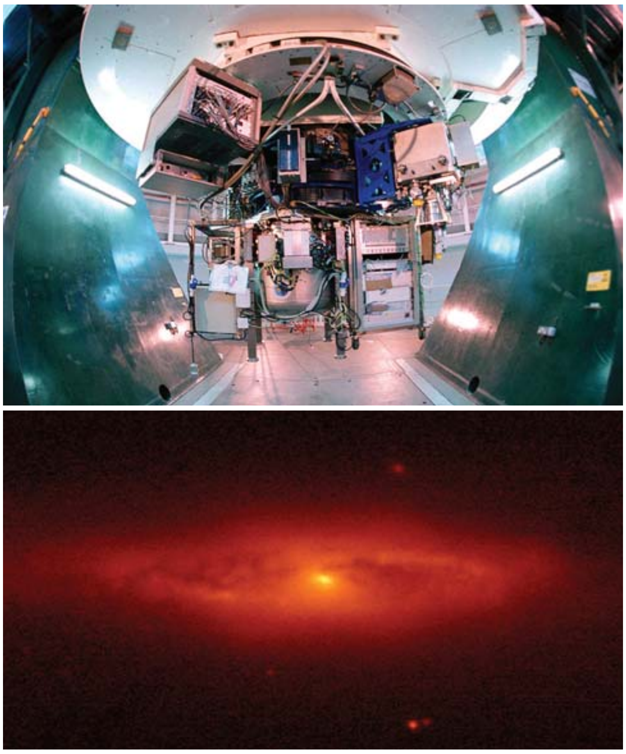


Figure 9. LIRIS mounted on the WHT Cassegrain focus. LIRIS cryostat can be seen at the bottom of the telescope focus, with the two electronics racks at both sides. First light image of the Seyfert 2 galaxy NGC4388 observed in the J filter. Note the very bright active nucleus and the patchy structure of the spiral arms, revealing the presence of obscuring dust lanes.

pixel Hawaii array detector will be placed in the Cassegrain focus of the telescope and allow high quality imaging and multi-object spectroscopy at near IR wavelengths. LIRIS has passed its first integration tests successfully and has produced high quality images and spectra in the laboratory. The instrument saw its first technical commissioning run at the WHT Cassegrain focus early in 2003, which worked out highly satisfactory. LIRIS is expected to become one of the workhorse instruments for the telescope. Final scientific commissioning and operation of LIRIS will take place during the first half of 2004.

In 2002 the Utrecht Echelle Spectrograph was decommissioned and removed from the telescope Nasmyth platform to the ground floor at the WHT. Although the instrument has been decommissioned in its original implementations, it is being studied how the instrument can continue to deliver scientific high resolution spectral observations, possibly as a fibre fed spectrograph on the 10-m GTC telescope.

The fibre-fed WYFFOS spectrograph is awaiting an important enhancement following the completion of a new camera. This so-call 'long camera' has the advantages over the current camera that it will (i) accommodate a much larger number of fibres (up to 1000), (ii) have an external focus permitting change of detector; and (iii) provide a somewhat higher spectral resolution. Detailed design and construction of the camera was largely carried out at ASTRON in The Netherlands. Although the optics and mechanics were completed in 2003, final commissioning has been postponed until 2004, mainly due to conflicts with other activities.

An integral part of the instrumentation strategy for the WHT is to act as a platform for visiting instruments and experimental setups. During the reporting period the WHT has enjoyed the interest of many such instruments. Visiting instruments included, for example, the integral field spectrograph SAURON that continued its large survey to study the kinematics of the cores of nearby galaxies, and the Planetary Nebula Spectrograph that has been used several times to detect PNe as tracers of the kinematics of the outer regions of galaxies.

A new visiting instrument that has come to the WHT is ULTRACAM, a triple-beam CCD camera, imaging up to a 5-arcmin field, designed for high-speed readout as fast as several times per second, and was commissioned in 2002. ULTRACAM fills a niche and has been used with great success during many nights. Since CCD exposures in the three different wavelength bands are carried out simultaneously, this system is capable of delivering very high quality photometric colour information of variable objects such as for instance cataclysmic variable stars and flare stars.

Observations of a more experimental nature have been carried out in the GHRIL Nasmyth focus of the WHT.

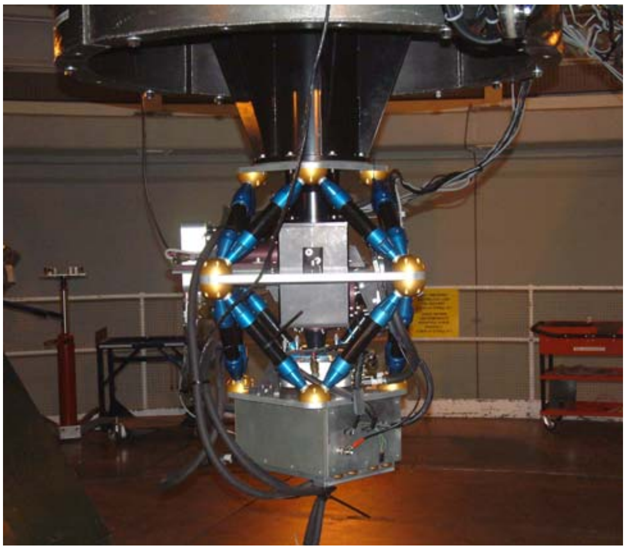


Figure 10. ULTRACAM on the WHT.

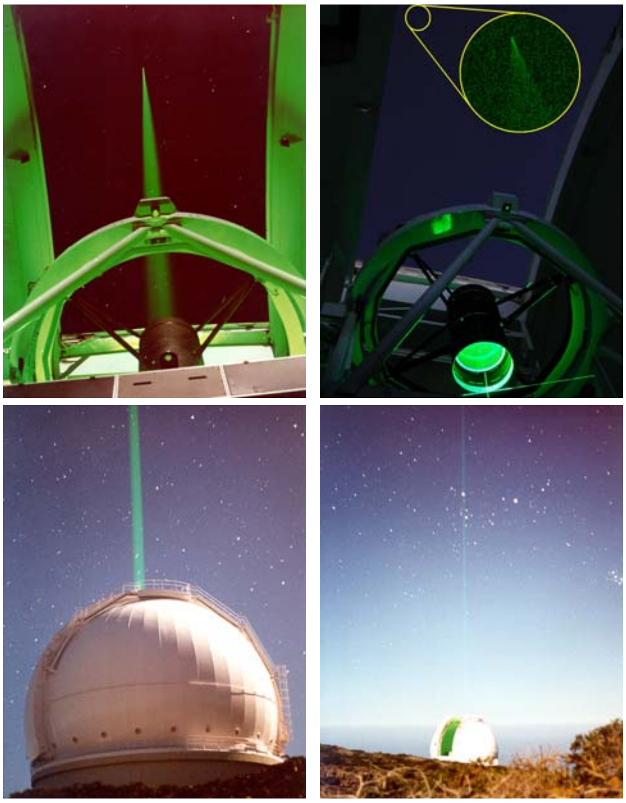


Figure 11. Different views of the Rayleigh laser launch.

In particular, a number of experiments for the deployment of laser guide stars and detection of atmospheric turbulence have been carried out. The laser guide star experiments mainly focus on testing new techniques for exploiting laser beacons on large and future extremely large telescopes. Through these experiments experience is build up that might benefit ING in the future, when a common-user laser system will be deployed at the WHT. The astronomical instrumentation group of the University of Durham has taken a central role in these developments.

Measurements of atmospheric turbulence were carried out by a team from Durham University and from the IAC. Various techniques exist to measure atmospheric turbulence. The IAC team deployed the SCIDAR (scintillation-detection-and-ranging) technique on the JKT, while the Durham team tested a new method, SLODAR (slope-detection-and-ranging) on the WHT using double stars to measure the C_n^2 profile of atmospheric turbulence. Both groups aim to obtain good statistics on the measurements of atmospheric turbulence through systematic measurements over extended periods. Such measurements are extremely valuable for understanding the atmosphere above the observatory.

Apart from major new developments in instrumentation, there are also various smaller scale projects that aim to significantly enhance the capabilities of existing instruments: ING's programme of continuing detector improvements has achieved some major successes. ING joined a large consortium to procure MIT-Lincoln Lab CCDs. These large format CCDs will nearly double the quantum efficiency in the

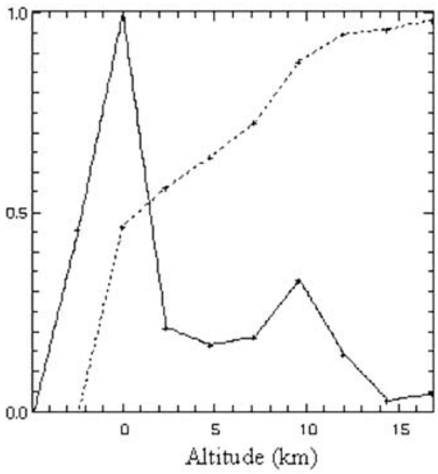


Figure 12. Example SLODAR normalised profile of the strength of optical turbulence versus altitude on 16 April, 2003.

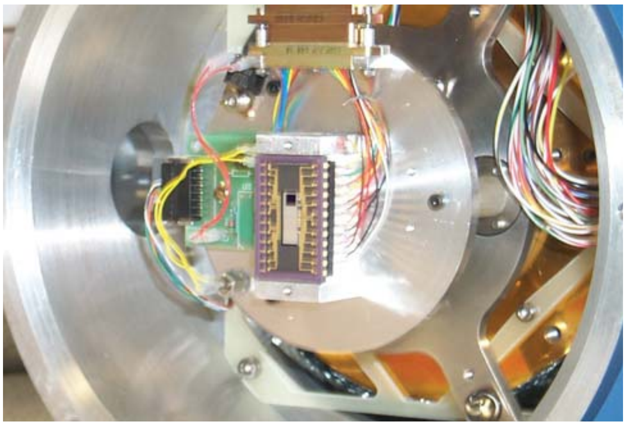


Figure 13. One of ING's L3 CCD.

far red, and suffer much less from 'fringing' than ING's older CCDs. The advantage of the new CCDs is particularly important for spectroscopic work on the red spectrograph arm of ISIS, and on OASIS. One of the CCDs was received and taken into operation as the dedicated detector for the OASIS spectrograph. A Marconi CCD of similar characteristics was purchased, taken into operation on the ISIS spectrograph.

Recently, a new development in CCD technology was announced by the company E2V (formerly Marconi/ EEV) which allows read noise to be reduced to nearly zero electrons, providing very important gains in photon detection efficiency at low light levels. These Low-Light-Level CCDs (or L3 CCD) possess an extended readout register, allowing the weak signals from the detector to be amplified prior to digitisation, thus achieving very high signal gains. This reduces read noise to close to zero electrons, at the expense of effective loss of QE for high count rates. In situations where a measurement is read-noise limited, as it is usually the case for continuous high-speed wavefront sensing in AO applications, an L3 CCD can be of enormous benefit, and therefore an investigation was started to study the suitability of this new technology for the NAOMI wavefront sensor. Preliminary results have been very positive, predicting a possible very significant gain in faint detection limit for the wavefront sensor of 1–2 magnitudes.

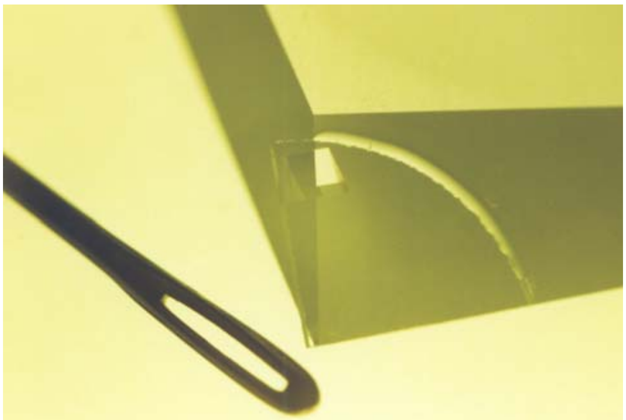


Figure 14. ISIS image slicer and needle for reference.

A very different and small but significant development is that of the design and construction of a focal plane image slicer for ISIS. An image slicer of the kind envisaged for ISIS will accept the full image of a star in the telescope focal plane, and cut the image by optical means into narrow slices. The optically re-arranged image slices will form a narrow, virtual spectrograph slit. The advantage of such a system is that even under mediocre seeing conditions all the light from a point source will still enter the spectrograph without compromising spectroscopic resolution. This image slicer therefore will greatly improve the overall throughput and effective resolution of the spectrograph for point sources under mediocre seeing conditions. The importance of this is particularly high, come the time of extensive queue observing with NAOMI, when under less than ideal seeing conditions another instrument such as ISIS must be used. The image slicer will ensure excellent throughput. This in-house development should be available for commissioning next year.

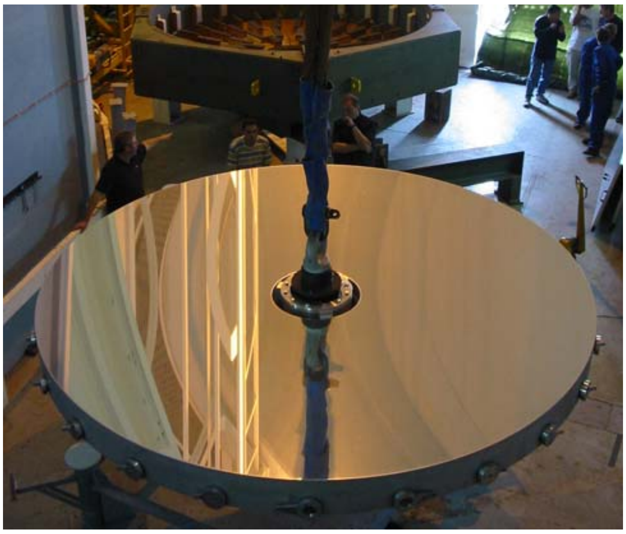


Figure 15. Part of aluminisation process of TNG's primary mirror at ING.

Apart from ING's in-house activities of telescope operation and instrument developments, some projects for other observatory groups are carried out as well. Recurrent activities include the production and distribution of liquid nitrogen, provision of backup generator power, and cleaning and re-aluminisation of mirrors. A major exercise was the aluminising of the TNG primary, secondary and tertiary mirrors.

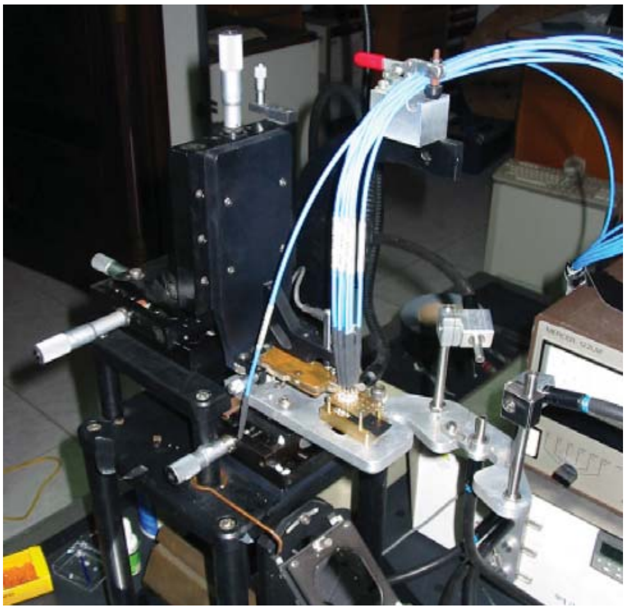


Figure 16. bHROS fibres being glued on base plate.

During the work on the AUTOFIB small fibre unit staff at ING acquired specialist skills on the preparation of optical fibres. ING was approached by the Gemini telescope bHROS team to carry out fibre work for that echelle spectrograph for Gemini-South. That work was carried out successfully, and the fibres are currently in use.

A recent new installation at the Roque de los Muchachos Observatory site houses the SUPERWASP experiment, led by the Queen's University Belfast. The installation consists of a number of wide-field cameras on a robotic mount, located in an automatic roll-off roof enclosure. ING has been providing assistance in the construction of this robotic wide-field camera system. The main scientific aim of this experiment is the detection of planets around stars through their occulting effect when the planet transits the stellar surface. The system saw first light only a few months after building permission was granted.

Figure 17. SUPERWASP enclosure.

Chapter 3

USE OF OBSERVING TIME AND SCIENTIFIC PRODUCTIVITY

USE OF TELESCOPE TIME

The available observing time on the ING telescopes is allocated between British, Dutch and Spanish time allocation committees, the CCI International Time Programmes (ITP), service and discretionary nights, and scheduled stand-down and commissioning time.

The ING Board has delegated the task of time allocation to British astronomers to the PPARC Panel for the Allocation of Telescope Time (PATT), and to Dutch astronomers to the NFRA Programme Committee (PC). It is the responsibility of the Instituto de Astrofísica de Canarias (IAC) to allocate the Spanish time via the Comité para la Asignación de Tiempos (CAT). For committee membership see Appendix I.

The PPARC made 27 nights per year of its share on the JKT available to the National Board of Science and Technology of Ireland and the Dublin Institute for Advanced Studies, until the JKT was taken out of service on August 1st, 2003.

The aim of the ING service observing programme is to provide astronomers with a way to obtain small sets of observations, which would not justify a whole night or more of telescope time. For each telescope and instrument several nights per month are set-aside especially for this purpose. During those nights, ING support astronomers perform observations for several service requests. As a result of the budget reductions, the service programme is now only active on the WHT.

Stand-down, commissioning and discretionary nights are used for major maintenance activities, commissioning of new instruments, minor enhancements, calibration and quality control tests, etc., and partly for astronomy, for example, as compensation for breakdowns or for observations of targets of opportunity.

The way the available observing time on the ING telescopes has been shared in 2002 and 2003 is summarised in Table 1.

	WHT		INT		JKT	
Time Allocation	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**
UK PATT	156	159	125	134	175	90
NL PC	43	52	34	45	46	29
SP CAT	76	93	85	101	83	54
UK/NL WFS	—	—	60	50	—	—
ITP	10	—	17	—	16	—
Service	33	21	25	9	13	—
Instrument Builder's Guaranteed Time	4	—	—	—	—	—
Discretionary	43	40	19	26	32	8
Total	365	365	365	365	365	181

Table 1. Allocation of nights from Semester 2002A to 2003B. UK PATT allocation on the JKT includes Irish time. Service nights include UK and NL service time, and SP CAT time includes Spanish service time. Discretionary time includes all nights used for commissioning, maintenance, and stand-down activities. The JKT stopped operating in August 2003.

USE OF INSTRUMENTATION

Figure 1 shows the allocation of nights per instrument on the WHT in 2002 and 2003. As in previous years, the ISIS spectrograph and polarimeter was the most popular instrument, taking up some 30 to 40% of the scheduled observing time. These years, the visiting instruments have had a major impact, and the INGRID infrared camera and the AF2 fibre spectrograph enjoyed much interest.

Visiting instruments on the WHT during this period include the SAURON integral field spectrograph, the Planetary Nebula Spectrograph PN.S, the high-speed multi-CCD camera ULTRACAM, and the IR multi-object spectrograph CIRPASS.

On the INT, dark time periods were almost exclusively used for CCD imaging with the Wide Field Camera (over all nights: 69% and 81% for 2002 and 2003 respectively). The rest of the time was for the use of the IDS spectrograph (31% and 19%). Since decommissioning of IDS in August 2003, the INT became solely dedicated to wide field imaging programmes.

The JKT was a single instrument telescope for CCD imaging during the reporting period.

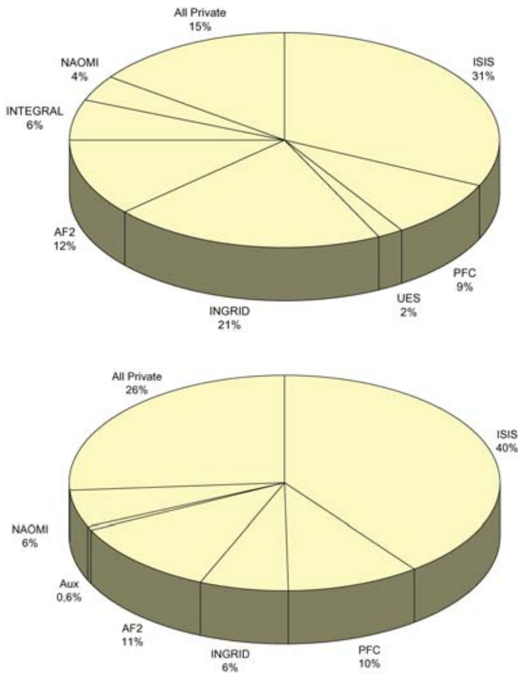


Figure 1. Above: Use of instrumentation in semesters 2002A and 2002B on the WHT. All private includes ULTRACAM, PN.S and SAURON. Below: The same for semesters 2003A and 2003B. Commissioning nights are excluded. All private includes ULTRACAM, SAURON, PN.S, INTEGRAL, CIRPASS.

TELESCOPE RELIABILITY

During the year 2002 and 2003 the ING telescopes again performed very well, with downtime figures due to technical problems averaging at 2.6%, 1.1%, and 1.7% in 2002 and 2.3%, 1.0% and 2.7% in 2003 on the WHT, the INT, and the JKT respectively. These figures meet the target value of a maximum of 5% technical downtime. Down time due to poor weather averaged 26% in 2002 and 23% in 2003. The historical trends of technical down time and weather down time by semester are plotted in Figures 2 and 3. Figure 4 shows the seasonal average.

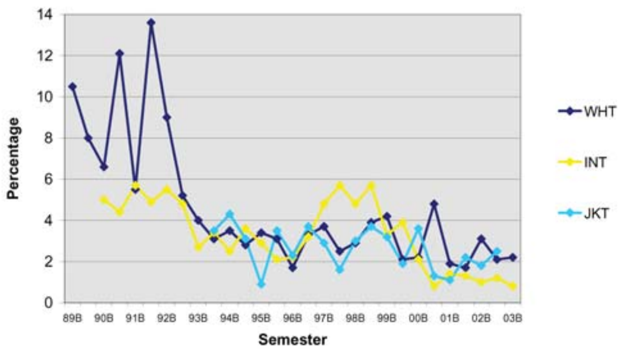


Figure 2. Technical downtime per semester.

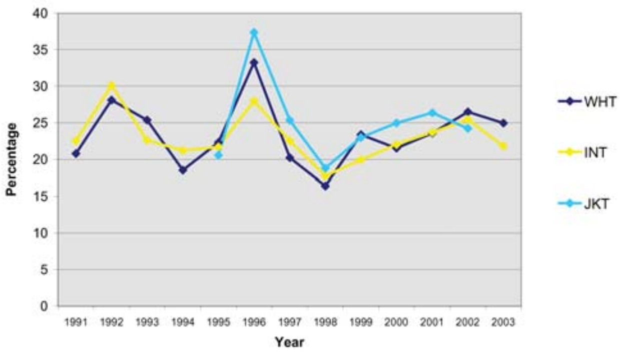


Figure 3. Weather downtime per year.

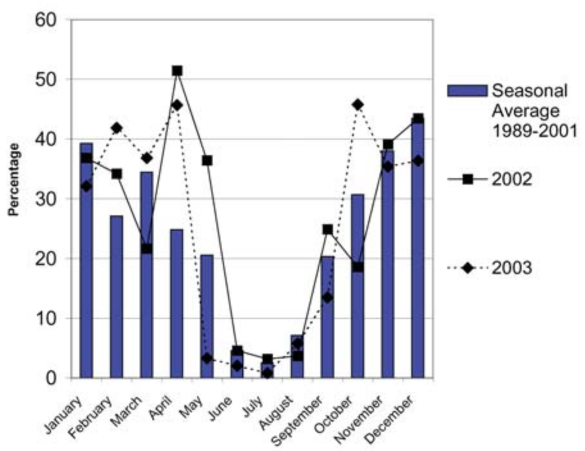


Figure 4. WHT monthly weather downtime.

SCIENTIFIC PRODUCTIVITY

An important metric of the success of the ING telescopes is the number of publications published in refereed journals and for this reason the ING bibliography (see Appendix E) is updated annually. Traditionally, this bibliography has been compiled by visually scanning all articles in many journals and identifying those which make use of data from our telescopes. However most journals are now published electronically and often have quite sophisticated search engines associated with them and it is therefore appropriate to conduct the search with the help of these facilities.

Our selection process identifies papers that make direct use of observations obtained with the ING telescopes, in order to qualify. Papers that refer to data presented in earlier papers (derivative papers) are not counted.

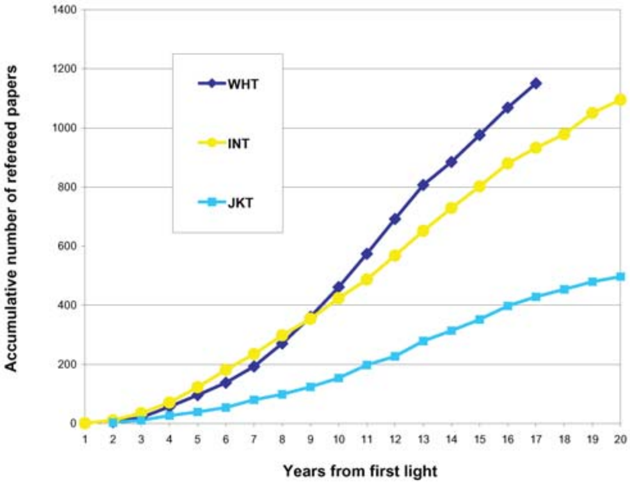


Figure 5. Accumulative number of refereed papers per telescope from first light.

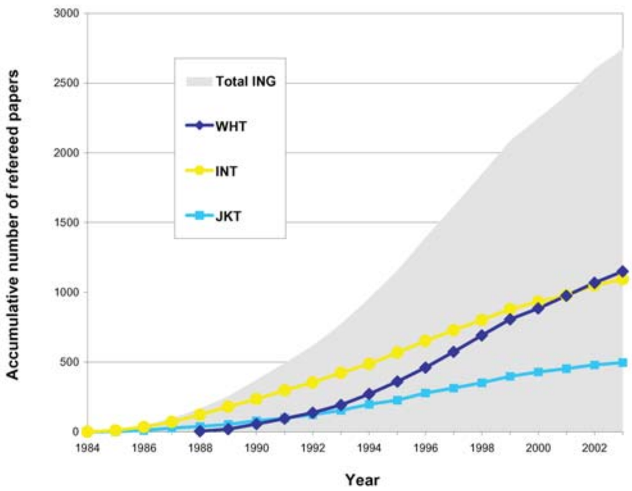


Figure 6. Accumulative number of refereed papers per year.

When we analyse ING publications for the five years between 1995 and 1999 inclusive it can be seen that more than 95% of articles are published in a small number of core journals. These core journals consist of the British journal *Monthly Notices of the Royal Astronomical Society*, the American journals *Astrophysical Journal*, *Astrophysical Journal Letters*, *Astrophysical Journal Supplement Series*, *Astronomical Journal* and *Publications of the Astronomical Society of the Pacific*, plus the European journal *Astronomy and Astrophysics* (including the now defunct *Astronomy and Astrophysics Supplement Series*). We also include *Nature* and *Science* as core journals due to their perceived high impact. Journals making up the remainder of publications are widely spread among such journals as *Icarus* and the *Irish Astronomical Journal* to name a few. The bibliography for the years 2002 and 2003 was compiled from only the core journals listed above for reasons of efficiency (up until the year 2000 a wider search was conducted which partly explains the drop in publications). Search engines were used to select papers and the resulting list of papers visually inspected to ensure that they satisfied the selection criteria described above.

An analysis of these numbers follows (see Figures 5–8 and Table 2). Note that if a paper makes use of more than one telescope we count that paper for each telescope. Also, concerning perceived nationality we use the nationality of the first author's institution although in a few cases two institutions are credited. Similarly, if

Year	WHT	INT	JKT	Total
1984	—	1	—	1
1985	—	10	3	13
1986	—	24	8	32
1987	—	36	16	52
1988	5	52	12	69
1989	15	58	15	88
1990	37	54	26	117
1991	39	63	19	121
1992	42	56	25	123
1993	55	70	30	155
1994	78	63	44	185
1995	90	81	29	200
1996	100	84	52	236
1997	113	77	35	225
1998	118	72	38	228
1999	115	78	46	239
2000	78	53	31	162
2001	91	46	25	162
2002	93	72	26	191
2003	82	44	17	143
Total	1151	1094	497	2742

Table 2. Number of refereed papers per year and telescope.

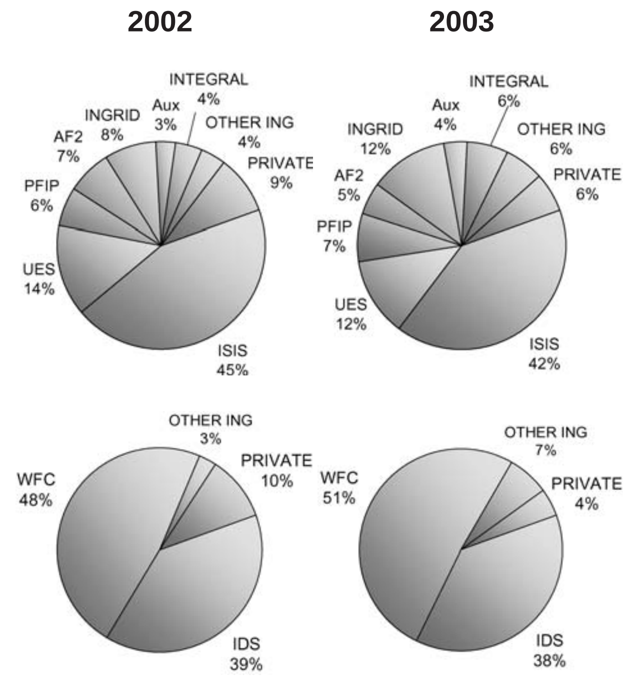


Figure 7. Top: Use of instrument data in WHT papers. Bottom: Use of instrument data in INT papers.

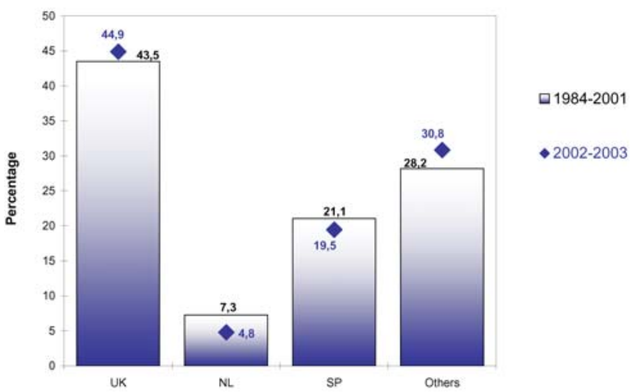


Figure 8. ING's paper authorship.

a paper makes use of more than one instrument, that paper is counted against each instrument.

Of all the available instruments on the WHT, the ISIS spectrograph remains the most productive instrument, with 42% of all publications during the reporting period. In 2003 INGRID became the second most productive instrument. The number of papers from visitor instruments on the WHT also remained significant, with 14 papers over two years.

On the INT the papers are split very evenly between IDS spectrograph and the Wide Field Camera as might be expected from the split of observing time between these instruments, roughly 50–50.

Concerning the nationality of the first author's institution, there is little change, at least considering the fluctuations from year to year. The UK share is steady around 45%, and the Spanish share about 20%. The NL share also showed little systematic change. Interestingly, about one third of the papers have a first author from other countries, emphasising the international character of the observatory and the high level of international collaboration between research groups.

THE ING ARCHIVE

All data taken with the ING telescopes is archived in the UK, at the Institute of Astronomy, Cambridge. The data archive is managed by the Cambridge Astronomy Survey Unit.

Archival data from the ING telescopes is made available to anyone upon request, after a one-year proprietary period. The number of archive retrieval requests has remained high over the past two years, with over 500 requests per year, for retrieval of more than 40,000 data sets. The historic trend of the archive requests can be seen in Figure 9. This level of archive use underlines the importance of the ING archive as a general tool for astronomy research.

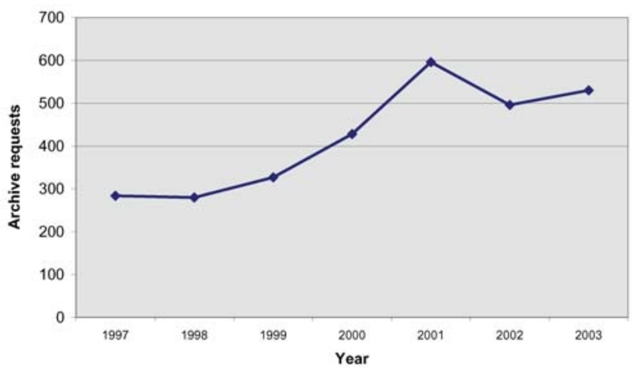


Figure 9. Number of ING archive requests.

Chapter 4

IN-HOUSE RESEARCH

The in-house research effort at ING comprises 1 full-time equivalent (FTE) from its recurrent operational budget, plus an additional 2 FTEs contributed by PPARC. This effort is distributed amongst 9 members of the Astronomy Group which includes the Head of Astronomy, 6 support astronomers and 2 PPARC research fellows. In addition to these staff there are/were an additional 3 research-active staff (Dr Roy Østensen, Dr Sebastian Els and Dr Ilona Söechting) funded by the European Community's Marie Curie Host Training scheme, while an additional research astronomer (Dr Chris Evans) joined us 2002 via a PPARC Postdoctoral research grant award to Dr Danny Lennon. One additional research-active astronomer (Dr Charo Villamariz Cid) joined us for a period of one year on secondment from the IAC.

During the years 2002 and 2003, ING staff's research productivity, as measured by publication rate was maintained at its previous high 2001 level. In this period they published approximately 200 papers in various scientific publications, approximately 45% of these appearing in refereed journals. A complete list of these papers is included in Appendix F.

An important aspect of the research effort is that ING staff continue to be closely involved with on-going research programmes which are heavily dependent on observations carried out on our telescopes. A typical example of this synergy between research and operations is the continuing lead ING staff provide for the "Local Group Census" Wide Field Survey programme plus their active participation in the successful bid to carry out an INT/WFC Hα survey of the north Galactic plane (the IPHAS survey, PI: Prof Janet Drew). This latter survey is also noteworthy in that it represents a major collaboration between all three communities served by the ING; Spain, Britain and the Netherlands. ING astronomers continue to be successful applicants for time with key instruments on the WHT such as NAOMI and AF2. Further details on individuals' research interests and activities are summarised below.

The La Palma astronomy seminar programme continued to be run by ING, with Johan Knapen and Francisco Prada being the organisers. A total of 44 seminars were presented during the course of the last two years and this programme continues to be an important forum for local staff to discuss science and new developments, as well as a vital link with our visiting astronomers. The full seminar programme is presented in an Appendix G.

INDIVIDUAL RESEARCH ACTIVITIES

Chris Benn completed his search for z~4 radio quasars, defining a sample which allowed measurement of the evolution with redshift of the space density of highly-luminous quasars (showing that the decline in space density beyond z~2 is slower for the most optically-luminous). A follow-up spectrum of one of the more unusual quasars is shown in Figure 1. Chris is involved

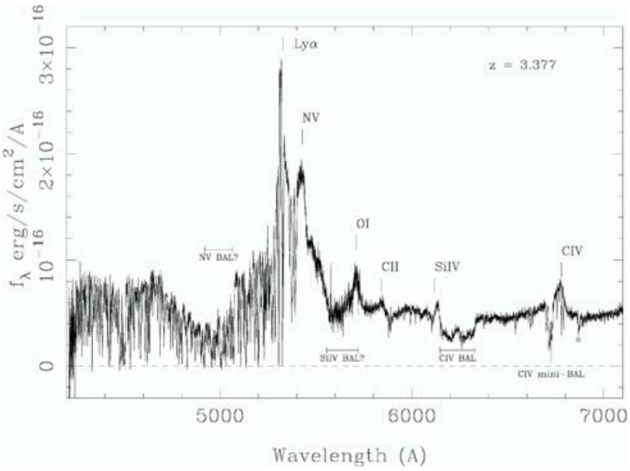


Figure 1. ISIS spectrum of an unusual Broad-Absorption-Line (BAL) quasar discovered during a search for high-redshift quasars (Benn et al.). The broad trough centred at 6230Å is due to CIV absorption by gas streaming out from the quasar at between 21,000 and 29,000 km s^{-1} (i.e.~0.1c). The physics of the acceleration and confinement of the gas in BAL outflows is unknown. The unusual feature of this quasar is the CIV absorption near 6700Å. This shows velocity structure on a scale smaller than the CIV doublet separation (11Å at this redshift), allowing one to solve for both the fraction of the nuclear source covered by the gas (~0.5 in this case), and the true optical depth of the absorption, allowing estimation of column densities.

in several related investigations, of quasar host galaxies (using NAOMI), of the origin of red colours in quasars, and of the statistics of proximate DLAs (using SDSS). He was PI on a deep INT imaging search during 2003 for Ly-α emission from $z\sim4.5$ galaxies.

Romano Corradi continued his study of the dynamical evolution of Galactic planetary nebulae. During 2002, the research was mainly focussed on the formation of collimated large-scale and small-scale morphological components, and on the search and study of giant ionised haloes around the main bodies of the nebulae. In parallel, the search for planetary nebulae in external galaxies continued, mainly in the framework of the Local Group Census, our INT survey programme of emission-line imagery of the Local Group. The observations of the survey are now complete, and their analysis has increased significantly the number of planetary nebulae known in irregular and elliptical dwarf galaxies. Spectroscopic follow-ups are in progress. In 2002, a rare and spectacular event caught the attention of the astronomical community, the light echo around the mysterious erupting star V838 Monocerotis (see Figure 2). The WHT and the INT played an important role in following the evolution of the light echo, and subsequent HST observations led to a publication in *Nature*. In 2003, his work on Galactic planetary Nebulae was mainly focused on the study of their haloes, which are the last observable signature of the mass loss occurred during the red giant phase prior to the final envelope ejection from solar-like stars. A comprehensive observational search and study of such haloes was published on *MNRAS*. The systems of rings found in the inner regions of a number of haloes were also investigated, showing that mass loss modulation is a rather common (and thus important) characteristic of the last ten thousand years of the asymptotic giant branch phase. Together with Almudena Zurita and ING student, Dimitris Mislis, analysis has begun of the extragalactic HII regions using the data from the Local Group Census. He is also involved in the Hα survey of the Milky Way (IPHAS).

Sebastian Els is a Marie Curie Fellow and has been carrying out high contrast Adaptive Optics (AO) observations of extrasolar planetary systems in order to search for additional low mass companions. If such substellar companions exist in wide orbits they are undetectable using stellar radial velocities, hence the need for high spatial resolution observations. He is also involved in extending the radial velocity method towards young active stars, and has completed an

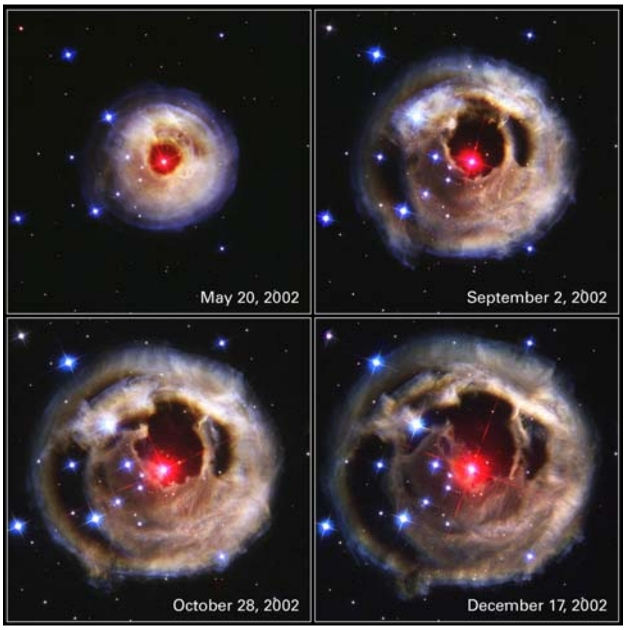


Figure 2. Images obtained by Hubble Space Telescope of erupting star V838 Monocerotis on 20 May, 2 September, 28 October and 17 December, 2002.

observational programme related to this programme. Finally he has begun an investigation to search for planets forming inside protoplanetary accretion disks.

Robert Greimel, our Data Pipeline Scientist and WFC specialist, has worked with Thomas Augusteijn and Paul Groot (Nijmegen) on Cataclysmic Variables in a follow up from the Wide Field Camera Survey "Faint Star Variability" programme. He has also collaborated on the "Local Group Census" survey and is involved in the Hα survey of the Milky Way (IPHAS).

Danny Lennon, together with Chris Evans (postdoc) and Carrie Trundle (PhD student) worked on a number of projects concerning hot massive stars. In the course of 2002–03 a strong collaborative relationship was developed with the hot star group at the IAC (led by Prof Artemio Herrero). As part of this process Charo Villamariz Cid spent one year at ING on secondment from the IAC, while there have been frequent exchange visits between ING and IAC staff. Highlights from this group's activities include the discovery of extremely weak stellar winds for O-type dwarfs in the SMC; compelling evidence of the important role of rotation on the evolution of massive single stars; strong disagreement between theoretical predictions and observations of the mass-loss rates of B-type supergiants in the SMC, but confirmation of the predictions of radiation theory for the terminal velocities of massive supergiants. The group is also an important participant in an international collaboration which was awarded VLT Large Programme status for “A FLAMES survey of Massive Stars in the Magellanic Clouds”. In addition to these joint activities, Lennon collaborated on further investigations of the chemical composition of massive stars in nearby resolved galaxies, which included the first stellar abundances for the dIrr galaxy WLM, and a new look at the stellar abundance gradients in M31 (with Trundle). He was also involved in showing that the surface abundances of Sher 25, a B-type supergiant with a bipolar nebula similar to that of SN1987A, are not the product of dredge-up during the red supergiant phase of evolution. This result contradicts previous thinking on the evolutionary history of this supergiant. Evans continued working on his definitive 2dF survey of massive stars in the SMC, was involved in the revision of the temperature scale for massive stars, and played a key role in the planning and preparation of the VLT/FLAMES observational programme.

Pierre Leisy has been looking for new extragalactic Planetary Nebulae in Local Group galaxies and beyond with wide field imaging facilities at ING and ESO, with follow-up spectroscopy planned using multi-object spectrographs on the WHT, TNG and VLT. The objective is to determine accurate HII region and PNe abundances for comparison with local PNe in our Galaxy and with the LMC and SMC. The main goal is to better understand the dredge-up and enrichments into the low-intermediate mass stars and constrain the evolution of galactic metallicities over their entire lifetimes (since PNe are abundance tracers over 200 million to 10 billion years). Pierre is also a leading participant in the Hα survey of the North Galactic Plane with a major allocation of INT time allocated to this project. He has also completed a major study of 180 PNe in the Magellanic Clouds.

Javier Licandro carried out an extensive observational programme focused on understanding the solar system ‘zoo’, acquiring spectra in the near infrared of 7 Trans-Neptunian Objects, 8 Centaurs, 2 cometary nuclei; spectrophotometry in the visible and near-IR of approximately 60 Near Earth Objects; visible and near-IR spectroscopy of approximately 50 Near Earth Asteroids and asteroids in cometary orbits. This extensive body of work included the first published infrared spectra of a cometary bare nucleus and a detailed analysis of the behaviour of Comet 21P/Giacobini-Zinner during its 1998 perihelion (illustrated in Figure 3).

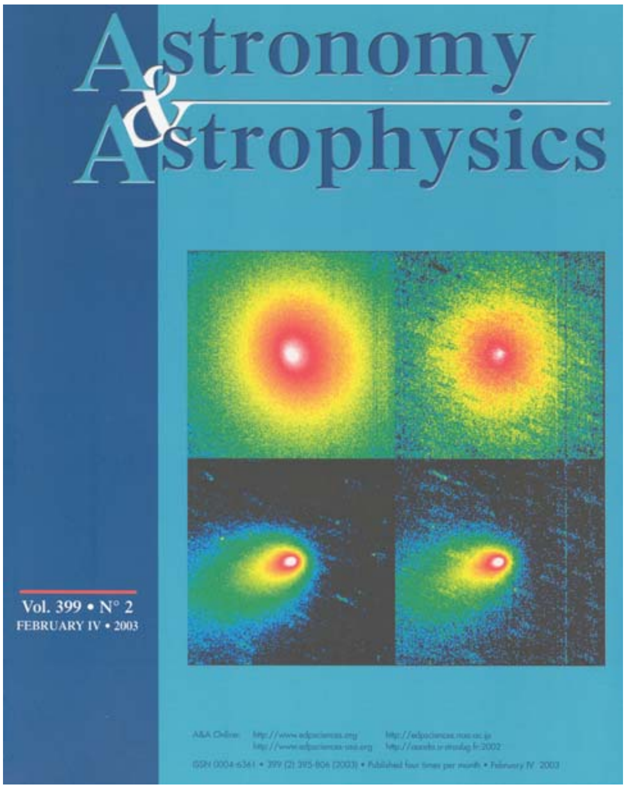


Figure 3. Front cover of Astronomy and Astrophysics, Vol. 399, No. 2, February 2003.

Roy Østensen’s Marie Curie Fellowship at the ING ended in April 2003, but continued as a PPARC postdoctoral research fellow in June of the same year. He is continuing his work with the ING AO, where his work has focused on characterisation of AO performance. In his research he has continued his ongoing work on pulsations in subdwarf B-type stars, discovering several new examples of this interesting type of short period pulsating star, as well as two interesting short period binary sdB+dM systems. He has also undertaken a survey of spectroscopic subdwarf B binaries with NAOMI in order to put the different evolutionary scenarios proposed for these stars to a test. Collaborations in this field have been extended to include Pierre Maxted (on the AO studies of sdB binaries), John Telting from the Nordic Optical Telescope (on time resolved spectroscopic studies of pulsating sdB stars) and a Spanish group including Ana Ulla, Raquel Oreiro and Christina Rodríguez López of the IAC and the University of Vigo. As a byproduct of the candidate selection work underlying the pulsation survey, Østensen has developed a complete database system for hot subdwarf stars, bringing together results from the numerous blue star surveys into one searchable databank. He is also working on mining the Sloan Digital Sky Survey for spectroscopic and photometric data on new and known subdwarf stars.

Ian Skillen continued his work on the distance scale but during 2003 his main research effort went into the SuperWASP project. This project is an ultra-wide angle photometric survey of bright stars primarily aimed at searching for planets (Wide Angle Search for Planets) and aims to photometrically survey large numbers of stars in the magnitude range 7 to 13 to better than 1% precision over a wide area of sky. It plans to obtain very well sampled lightcurves for all the stars in each field which will be used to detect planetary transits and track Near-Earth Objects and optical transients. The resulting database will be useful for a variety of science goals. Ian assisted Don Pollacco (QUB) in achieving first light with SuperWASP during the course of 2003.

Almudena Zurita has continued her research on the population of HII regions and the Diffuse Ionised Gas (DIG) of spiral galaxies. She and her collaborators are working on the development of a new photoionisation model for HII regions. It offers the advantage of taking the ISM as non-homogeneous (clumpy), and this provides more realistic models than the ones normally used. The first results obtained, although the code is still under development, are encouraging, reproducing very well the observed radial brightness profiles of HII regions in nearby galaxies. One of the aims of the use of this photoionisation model is to calculate the fraction of photons escaping from the HII regions and that ionise the DIG in a galaxy. Also, she has been working on Hα Fabry-Perot TAURUS data cubes of spirals with the aim of improving our understanding of both the global dynamics of disc galaxies, and of the relation between kinematics and massive star formation. Among these results, one in particular deserves special mention; the strongly barred spiral NGC 1530 reveals a clear anti-correlation between star forming zones and zones of high velocity shear, as well as evidence that the latter coincide precisely with the dust lanes mapped via broad band images. She has also continued with the programme to calibrate the change in slope or glitch observed in the Hα luminosity functions of the HII regions of spirals and irregulars, for measuring extragalactic distances. Finally, Almudena has been collaborating with Carrie Trundle to use the Local Group Census data to select both blue supergiant stars and associated HII regions M31 for a comparative study of their respective chemical compositions.

Other research active staff no longer in ING employment are: Thomas Augusteijn who worked on cataclysmic variables and X-ray binaries; Begoña García Lorenzo working on starburst galaxies, blue compact galaxies and extinction at intermediate redshifts; Francisco Prada, a support astronomer at ING for a period of 1 year who worked on tidal streams, dark matter and galaxy evolution; Ilona Söechting who held a 1-year Marie Curie Fellowship and worked on quasars and large-scale structure; Johan Knapen who held a PPARC fellowship until late-2002 and worked on the dynamics and morphology of disk galaxies. While these staff left ING employment during the course of 2002/03 their publications during the relevant periods are included in the staff bibliography (Appendix F).

In addition to the above, a number of ING scientific and technical staff in zero research time posts contribute to the research environment at ING through their own interests. Javier Méndez (Librarian and Public Relations Officer) completed a spectroscopic, photometric and radial velocity survey of the centre of Tycho supernova remnant aimed at identifying the companion star of Tycho SN. Additional observations are scheduled with HST during Cycle 12 and Javier has observed for the Supernova Cosmology Project, The Physics of Type Ia Supernova Explosions (RTN) and the European Supernova Consortium (ESC) collaborations. Marco Azzaro (Telescope Operator) worked closely with Francisco Prada on galaxy evolution and mergers, Saskia Prins (Astronomy Administration) continued her investigation into supernova remnants in M31.

SCIENTIFIC CONFERENCES

Hosting an astronomy conference is fast becoming an annual event at ING with conferences being organised in both 2002 and 2003. During May 27–31, 2002, a Euroconference named “Symbiotic Stars Probing Stellar Evolution” was organised by Romano Corradi (Co-Chair of SOC, Chair of LOC) and held in Los Cancajos near Santa Cruz de La Palma. In addition to the financial support from the ING, the conference took advantage of substantial support awarded to Dr Corradi by the European Commission “High-Level Scientific Conferences” programme. This helped many people to attend this Euroconference, but above all attracted and supported a large number of young researchers (almost a half of the participants), both PhD students and post-docs from basically all the European states.

The Euroconference was attended by one hundred astronomers (from almost thirty different countries) working in various disciplines that are directly or indirectly related to the study of symbiotic stars. This led to a very productive exchange of ideas, allowing the participants not only to discuss the most recent results in the field of symbiotic stars and debate on the still many open questions, but also to strengthen the links with specific related fields like planetary nebulae and novae, or even suggest fascinating physical relationship with objects at the other end of the energy scale in the Universe, like quasars.

Among the most important scientific achievements of the conference was the confrontation of high quality multifrequency observations, both from modern ground-based telescopes and from space, with the theoretical models and evolutionary scenarios. In particular, the role of chemical composition remains a bit of mystery, and should be certainly addressed in future studies. It seems to be now well-established that the hot component of most, if not all symbiotic systems, is a white dwarf accreting material from its giant companion. There is strong evidence from rotational velocity measurements that the symbiotic giants do not fill their Roche lobes and the symbiotic binary components interact via stellar wind. However, some of

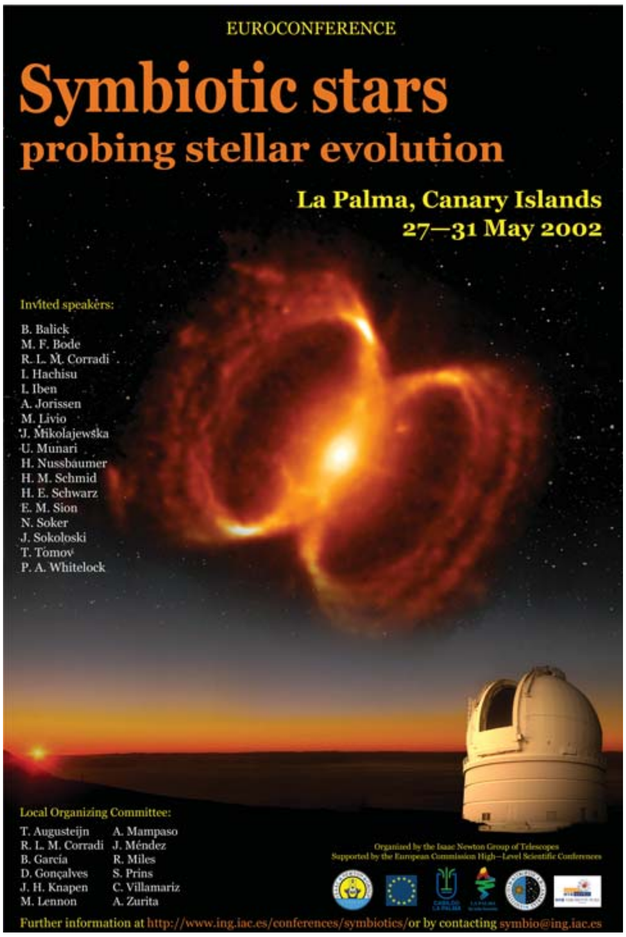


Figure 4. Poster of the Euroconference "Symbiotic Stars Probing Stellar Evolution".

these systems with low Roche lobe-filling factor show evident ellipsoidal changes. Related to this is the important problem of the possible formation of an accretion disk. While there is no direct evidence for the accretion disk presence in any system, disks would help to understand the Z And-type activity, the formation of

Figure 5. Poster of the ING-IAC joint conference "Satellites and Tidal Streams".

jets in active systems and the bipolar structure of many symbiotic nebulae. The capability by HST and ground-based imaging of resolving these circumstellar nebulae is also a fascinating result of the research in the field of symbiotic stars in the last years. Their morphological and dynamical similarities with planetary and pre-planetary nebulae attracted a number of researchers working in the latter fields, and great discussion resulted during the conference from the mutual comparison, both observational and theoretical.

On May 26–30, 2003, the first joint ING-IAC conference was organised by Francisco Prada (Co-Chair SOC, Chair of LOC) on "Satellites and Tidal Streams". Current cosmological models predict that galaxies form through the merging of smaller substructures. Satellites and tidal streams might then represent the visible remains of the building blocks of giant galaxies. They therefore provide important information on the merging history and galaxy formation in the Universe. In this conference the observational evidence for substructures, their internal structure and their dynamical evolution and disruption within the tidal field of the host galaxy were discussed and confronted with theoretical cosmological predictions of hierarchical merging and galaxy formation. Important topics included; dark matter in galaxies, galactic halo substructure and the formation of the Milky Way, satellites and CDM Models, the dark matter content of dwarf spheroidals, mass substructure from gravitational lensing, tidal streams and the disruption of satellite galaxies, galaxy formation and the faint end of the luminosity function. This conference also highlighted the important contribution which the telescopes on La Palma have made to this cutting edge field of research.

Chapter 5

PUBLIC RELATIONS

The reporting years have seen intense activities in organising workshops and conferences, with two large-scale scientific conferences and four workshops. From May 27–31 2002 ING's second major scientific conference on the subject of "Symbiotic Stars Probing Stellar Evolution" was held on La Palma, attracting some 120 participants. The conference was made possible through significant financial and in-kind contributions the Excmo. Cabildo Insular de La Palma, the Patronato de Turismo de La Palma, the EU, and the IAC.

Almost exactly one year later, on May 26–30 of 2003 the third ING conference, jointly organised with the IAC, was held on the subject of "Satellites and Tidal Streams". This conference also enjoyed a large international participation of over 80 participants.

On a smaller scale, workshops were organised covering the subjects "Science from La Palma — Past, Present and Future", in honour of Dr Paul Murdin, on the use of laser guide stars at the observatory, on the future operations and development plans for the WHT, and on performance aspects of NAOMI and other adaptive optics systems.

As in previous years also during the summer of 2002 and 2003 observatory open days were organised. About 1800 visitors were shown the WHT and INT. Also the custom of a special open day for the people of the town of Garafía was continued. In spite of the lower turnout during the general open days, this year's event was again considered a success.

Throughout the years, many groups visited the ING telescopes. For the educational visits special attention is being paid to school classes, particularly those from La Palma. These activities help strengthen the ties between the observatory and the public on La Palma. Apprenticeships for a small number of technical students have been hosted by the observatory, providing further added value of the observatory to the local community.

The many new development activities have also attracted several important persons who were shown the WHT. VIPs include members of European commissions and governing bodies, members of the European Parliament, the president of the commission of Industry, Energy, External Trade and Research, members of the Centre for Research in Economics and Statistics (CREST), the UK ambassador in Spain, Mr Peter James Torry, the Spanish minister of science and technology, Mr Josep Piqué, together with a party of the Consejo Rectores of the IAC, and a delegation from Utrecht University Council.

Furthermore various TV teams visited ING, and the resulting footage was shown on the Spanish national television TVE, UK's BBC channel, the German ZDF, the Hungarian TV and as part of a Spanish research series that is still in preparation. Arguably the most important of these events took place on 23 August 2003 with a live BBC2 TV broadcast from the Isaac Newton Telescope as part of the special programme "The All Night Star Party". During the 90 minutes broadcast from Jodrell Bank, La Palma and the INT Wide Field Camera featured a number of times when live images of requested objects were shown to the audience.

Figure 1. Presenter Chris Riley and support astronomer Romano Corradi at INT control room getting ready for BBC2's The All Night Star Party programme.

Appendix A

THE ISAAC NEWTON GROUP OF TELESCOPES

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). The WHT, with its 4.2m diameter primary mirror, is the largest in Western Europe. It was first operational in August 1987. It is a general purpose telescope equipped with instruments for a wide range of astronomical observations. The INT was originally used at Herstmonceux in the United Kingdom, but was moved to La Palma in 1979 and rebuilt with a new mirror and new instrumentation. It has a 2.54m diameter primary mirror and is mostly used for wide-field imaging and spectroscopy. The JKT has a primary mirror of 1.0m diameter. It is mainly used for observing relatively bright objects. Both the INT and the JKT were first operational in May 1984.

The WHT has an altazimuth mount with a f/2.5 parabolic primary mirror. The WHT is of classical Cassegrain optical configuration. The paraboloidal primary mirror is made of a glass-ceramic material (Cervit) having near-zero coefficient of expansion over the operating temperature range. Instruments can be mounted at the corrected f/2.81 prime focus, f/11 Cassegrain focus, or either of two f/11 Nasmyth foci. The primary mirror is made of a glass-ceramic material (Cervit) having near-zero coefficient of expansion over the operating temperature range, and it weighs 16.5 tonnes. When not operating at prime focus, a convex hyperboloidal secondary mirror, made of Zerodur, 1.0m in diameter, directs the light through a central hole in the primary mirror to the main instrumentation mounted at the Cassegrain focus beneath the primary mirror cell. The telescope also incorporates a third main mirror, a flat, angled at 45 degrees, which can be motor-driven into position at the intersection of the axes, just above the primary mirror, so that the light from the secondary is diverted sideways either through one of the altitude bearings to the Nasmyth platforms.

The INT has a 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. The optical system of the INT is a conventional Cassegrain with a paraboloidal primary mirror and a hyperboloidal secondary. It weighs 4.4 tonnes and it is made of Zerodur.

The JKT has a parabolic primary mirror of diameter 1.0m and a focal length of 4.596m. It weighs 215kg. It is equatorially mounted, on a cross-axis mount. The JKT has two optical configurations: Harmer-Wynne and Cassegrain. The former one uses a f/8 spherical secondary and the latter one a f/15 hyperbolic secondary. The two optical systems share the same parabolic primary mirror. At present only the Cassegrain configuration is available and instruments mount at the Cassegrain focus.

The following table shows each telescope’s location:

	Latitude	Longitude	Ground floor height
WHT	28° 45' 38.3" N	17° 52' 53.9" W	2332m
INT	28° 45' 43.4" N	17° 52' 39.5" W	2336m
JKT	28° 45' 40.1" N	17° 52' 41.2" W	2364m

The ING operates the three telescopes on behalf of the Particle Physics and Astronomy Research Council (PPARC) of the United Kingdom, the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of the Netherlands, and the Instituto de Astrofísica de Canarias (IAC) of Spain.

The ING is located at the Observatorio del Roque de Los Muchachos (ORM), on the island of La Palma, Canary Islands, Spain. The ORM, which is the principal European northern hemisphere observatory, is owned by the Instituto de Astrofísica de Canarias. The operation of the site is overseen by an International Scientific Committee, or Comité Científico Internacional (CCI). Financial and operational matters of common interest are dealt with by appropriate subcommittees.

The observatory also includes the 3.6m Galileo National Telescope, the 2.5m Nordic Optical Telescope, the 2.0m Liverpool Telescope, the 1.2m Mercator Telescope, the 60cm telescope of the Swedish Royal Academy of Sciences, the wide-field imaging facility SuperWasp, the Carlsberg Meridian Telescope, the 0.97cm New Swedish Solar Telescope, the 45cm Dutch Open Solar Telescope, and the atmospheric imaging Cherenkov 17m Magic Telescope.

The observatory occupies an area of 1.89 square kilometres approximately 2350m above sea level on the highest peak of the Caldera de Taburiente National Park, in the Palmeran district of Garafía. La Palma is one of the westerly islands of the Canary Islands.

The site was chosen after an extensive search for a location with clear, dark skies all the year around. All tests proved that the Roque de Los Muchachos is one of the best astronomical sites in the world. The remoteness of the island and its lack of urban development ensure that the night sky at the observatory is free from artificial light pollution. The continued quality of the night sky is protected by law. The mountain-top site has a remarkably stable atmosphere, owing to the local topography. The mountain has a smooth convex contour facing the prevailing northerly wind and the air-flow is comparatively undisturbed, allowing sharp and stable images of the night sky.

Many of the state-of-art telescope and instrument components are custom-built. New instruments are designed and built by technology groups mainly in the United Kingdom, the Netherlands, and Spain, with whom the ING maintains close links, and by astronomers and engineers working at ING.

THE INTERNATIONAL AGREEMENTS

The international agreements by which the Roque de Los Muchachos and the Teide Observatories were brought into existence were signed on La Palma on 26 May 1979. The participant nations at that time were Spain, the United Kingdom, Sweden and Denmark. Later other European countries also signed the agreements. Infrastructural services including roads, communications, power supplies as well as meals and accommodation facilities have been provided by the Spanish side. In return for the use of the observatory and its facilities all foreign user institutions make 20 per cent of time on their telescopes available to Spanish observers. Representatives of the participant institutions meet together as the International Scientific Committee, or Comité Científico Internacional (CCI).

The inauguration of the Canary Islands observatories took place on 29 June 1985 in the presence of the monarchs and members of the royal families of five European countries, and the Presidents of another two.

THE ING BOARD AND THE DIRECTOR'S ADVISORY GROUP

The PPARC, the NWO and the IAC have entered into collaborative agreements for the operation of and the sharing of observing time on the ING telescopes. The ING Board was set up to oversee the operation of this agreement, to foster and develop collaboration between astronomers of the United Kingdom, the Netherlands and Spain, and to ensure that the telescope installations are maintained in the forefront of world astronomy. In particular, the ING Board oversees the programme of instrumentation development, determines the programme of operation and maintenance of the installations, approves annual budgets and forward estimates and determines the arrangements for the allocation of observing time.

The Director's Advisory Group (DAG) assists the observatory in defining the strategic direction for operation and development of the telescopes. It also provides an international perspective and act as an independent contact point for the community to present its ideas.

TELESCOPE TIME AND DATA OWNERSHIP

The construction, operation, and development of the ING telescopes is the result of a collaboration between the United Kingdom, the Netherlands and Spain. 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 is shared by the United Kingdom, the Netherlands and the

IAC. The remaining 5 per cent is reserved for large scientific projects to promote international collaboration between institutions of the CCI member countries. It is intended that this time be used for the study of one, or a few, broad topics each year by several telescopes. This time is allocated by the CCI.

It is the responsibility of the IAC to make the Spanish time available to Spanish institutions and others, via the Comité para la Asignación de Tiempos (CAT). The ING BOARD has delegated the task of time allocation to British and Dutch astronomers to the PPARC Panel for the Allocation of Telescope Time (PATT) and the NFRA Programme Committee (PC) respectively. All the above agreements envisage that observing time shall be distributed equitably over the different seasons of the year and phases of the Moon.

Notwithstanding the above, any astronomer, irrespective of nationality or affiliation, may apply for observing time on the ING. Astronomers who are working at an institute in one of the partner countries should apply through the route appropriate to their nationality or the nationality of their institute.

Time is allocated in two semesters, from 1 February to 31 July (semester A) and from 1 August to 31 January (semester B). Decisions on time allocations are made on the basis of scientific merit and technical feasibility of the proposed observations.

ING policy is that data belongs exclusively to those who collected it for a period of one year, after which it is available in a common archive for all astronomers. It may be used at any time for engineering or instrumental investigations in approved programmes carried out to improve facilities provided at the observatory.

Service observations which are made by support astronomers at the request of others are similarly treated. However, calibration data may well be used for more than one observation and may therefore be available in common to several groups. It may happen that identical or similar service observations are requested by two or more groups. Requests which are approved before the data are taken may be satisfied by requiring the data to be held in common by the several groups. It is up to them how they organise themselves to process, analyse, relate to other work, and eventually publish the data.

Requests for observations from programmes already executed on the telescopes should be referred to the original owners of the data, and/or to the data archive. This is the policy whether or not the data were obtained by PATT, NFRA PC, or CAT scheduled astronomers, or by service requests.

Appendix B

TELESCOPE INSTRUMENTATION

The design of the WHT allows great flexibility in instrumentation, as this telescopes allows fast and easy switching between the Cassegrain and Nasmyth foci. For this reason, and to take advantage of the large light collecting power of this telescope, operation and developmental efforts focus here. Also visiting instruments, i.e. instruments built and used by external groups for their own use, are welcome at the WHT and have attracted a great deal of attention. The INT and JKT are equipped with a restricted set of instruments that match the capability of the telescopes whilst satisfying the requirements of a large percentage of users as well as the financial constraints and scientific priorities for these telescopes. A broad functional division in instrumentation capability between the WHT, INT and JKT is as follows:

William Herschel Telescope	Spectroscopy and spectro-polarimetry over a wide range of resolving powers
	Multi-object spectroscopy
	Areal spectroscopy
	Optical and infrared imaging
	High spatial resolution imaging
Isaac Newton Telescope	Intermediate-dispersion spectroscopy
	CCD imaging
Jacobus Kapteyn Telescope	CCD imaging

The following table summarises the common-user instruments which were available during 2002 and 2003.

Focus	Instrument	Detector
William Herschel Telescope		
Cassegrain	ISIS double spectrograph	EEV and Marconi CCDs
	Auxiliary port camera (AUX)	Tektronix CCD
	Isaac Newton Group Red Imaging Device (INGRID)	Rockwell HgCdTl array
Nasmyth	Utrecht Echelle Spectrograph (UES — until Aug 2002)	SITe or EEV CCDs
	Adaptive optics instrumentation:	
	NAOMI / INGRID / OSCA	Rockwell HgCdTl array
	NAOMI / OASIS	MIT/LL CCD
Prime	Prime Focus Imaging Camera (PFIP)	2 × EEV CCD
	Autofib Fibre Positioner (AF2) and WYFFOS spectrograph	Tektronix CCD
Isaac Newton Telescope		
Cassegrain	Intermediate Dispersion Spectrograph (IDS)	Tektronix and EEV CCDs
Prime	Wide Field Camera (WFC)	4 × EEV CCDs
Jacobus Kapteyn Telescope		
Cassegrain	CCD camera	SITe CCD

Appendix C

STAFF ORGANISATION

As has been referred to elsewhere, the period covered by this Biennial Report saw the start of the implementation of the measures and strategies set out in ING's Restructuring Plan of 2001. Inevitably, such an exercise has had a significant impact on staffing at the observatory, with the number of UK staff dropping from 36 to 26 between 1 April 2002 and 1 April 2004 and a reduction in locally employed staff from 28 to 17over the same period. A few of these departures resulted from natural wastage but the majority of the staff left on redundancy terms.

However, the period in question was not one wholly of doom and gloom. Again as referred to elsewhere in the Report, Spain, through the Instituto de Astrofísica de Canarias (IAC) made a significant increase in its contribution to the operation of ING in return for an increase in observing time for Spanish astronomers. Initially, this contribution was in the form of IAC employed staff seconded to work for ING. However, from 1 January 2004, the IAC's contribution was due to be as cash and the IAC staff were scheduled to transfer to ING contracts of employment.

The list of staff in post on La Palma during 2002 and 2003 is set out below.

DIRECTORATE

R. G. M. Rutten, *Director*
R. L. Miles, *Bilingual Secretary* (until 30.06.03)

ADMINISTRATION

M. Acosta (until 30.09.02)
E. C. Barreto (from 29.07.03)
T. E. Dorward (until 31.01.03)
L. I. Edwins, *Head of Administration*
A. Felipe (until 30.06.02)
N. L. González
L. A. Lawler
J. Martínez
B. Vander Elst
P. v. d. Velde (from 01.09.03)

Students:
G. Leeks (until 30.08.02)
J. Kaye (from 01.09.02 to 30.08.03)
E. C. Barnett (from 06.10.03)

ASTRONOMY

T. Augusteijn (until 02.08.02)
M. Azzaro (until 09.01.04)
C. R. Benn
R. Corradi
B. M. García (until 21.11.02)
J. N. González
R. Greimel
J. H. Knapen (until 31.12.02)
P. Leisy (from 01.11.02)
D. J. Lennon, *Head of Astronomy*
J. Licandro (from 01.07.02)
C. Martín
J. Méndez
N. O'Mahoney
R. Østensen (from 16.06.03)
F. Prada (from 01.07.02 to 31.08.03)
S. Prins (until 30.09.03)
J. C. Rey
W. J. I. Skillen
P. Sorensen (until 20.07.03)
A. Zurita

PPARC Postdoc:
C. Evans (from 14.01.02)

Marie Curie Fellows:
S. Els (from 01.04.02 to 26.02.04)
R. Østensen (until 15.04.03)
I. Söechting (from 25.11.02 to 10.10.03)

Students:
C. Bee (from 09.09.02 until 31.08.03)
C. Davenport (from 04.09.02 until 31.08.03)
S. Folkes (until 30.08.02)

A. García (from 01.09.02)
J. Goodger (from 04.09.02 until 31.08.03)
M. Lamensans (from 01.07.02 until 31.08.03)
F. Monterrey (05.2003)
D. Mislis (from 06.10.03)
D. Russell (from 11.08.03)
N. Styles (from 15.09.03)
C. Trundle (until 31.08.03)
H. Worters (until 30.08.02)

ENGINEERING

R. G. Talbot, *Head of Engineering*

Computing Facilities

D. C. Abrams, *Group Leader*
L. Hernández
G. F. Mitchell
J. Piñero
P. v. d. Velde (until 31.08.03)

Control Software

D. Armstrong
R. Bassom
C. Bevil
S. M. Crosby (until 06.10.02)
S. Goodsell
F. J. Gribbin, *Group Leader*
S. G. Rees
R. Rutherford (until 30.06.02)

Electronics

C. Benneker
T. Gregory
A. Guillén
C. W. M. Jackman, *Group Leader*
K. Kolle (until 17.10.03)
R. Martínez
E. J. Mills (until 09.10.02)
P. C. Moore (until 30.09.02)
R. J. Pit
A. Ridings
S. J. Tulloch

Mechanical

M. Blanken
F. Concepción (until 31.08.03)
K. M. Dee, *Group Leader*
D. González
P. D. Jolley
S. Rodríguez
J. C. Pérez
M. v. d. Hoeven

Site Services

C. Alvarez (until 30.04.02)
A. K. Chopping, *Group Leader*
J. R. Concepción
J. M. Díaz
I. García (until 30.09.02)
D. Gray
M. V. Hernández (until 30.09.02)
C. Ramón (until 30.09.02)
M. Simpson (until 30.02.03)

NOTE: During the period covered by this report, the Electronics, Mechanical and Site Services Groups were restructured into two new groups: the Operations Team and the Telescope & Intrumentation Group. Their staffing was as set out below.

Operations Team

A. K. Chopping
J. R. Concepción
K. M. Dee, *Operations Manager*
J. M. Díaz
D. González
A. Guillén
D. Gray
R. Martínez
J. C. Pérez
R. Pit
S. Rodríguez

Telescope & Instrumentation

C. Benneker
M. Blanken
T. S. Gregory
A. K. Hide (from 17.03.2003), *Group Leader*
M. v. d. Hoeven
C. W. M. Jackman
P. D. Jolley
O. Martin (from 09.05.2003)
A. Ridings
S. M. Tulloch

Student:
N. Apostolakos (from 06.10.03)

Appendix D

TELESCOPE TIME AWARDS

The UK Panel for the Allocation of Telescope Time (PATT), the Dutch NFRA Programme Committee (PC), the Spanish Comité para la Asignación de Tiempos (CAT) and the Comité Científico Internacional (CCI) made time awards to the following observing proposals in 2002 and 2003. The principal applicant, his or her institution or university, the title of the proposal, and the proposal reference are listed below. Semester A runs from February to July and semester B from August to January.

SEMESTER 2002A

ITP Programmes on the ING Telescopes

– Doressoundiram (Paris), Multi-color taxonomy of trans-Neptunian objects. ITP/2002/1
– Ruiz-Lapuente (Barcelona), Supernova and the physics of supernova explosions. ITP/2002/4

William Herschel Telescope

UK PATT

– Axon (Hertfordshire), The Black Hole Mass-Velocity Dispersion Correlation. W/2002A/38
– Barcons (IF Cantabria), An XMM-Newton international survey (AXIS-II): unveiling the hard X-ray source populations. ITP/2001/2
– Barnes (St Andrews), Starspot tracking on the W Ursae Majoris system BW Dra. W/2002A/41
– Benn, (ING), Adaptive-optics imaging of QSO host galaxies. W/2002A/6
– Bower (Durham), The Sauron Deep Survey. W/2002A/50
– Boyce (Bristol), K-band imaging of gas-rich low surface brightness galaxies found at 21cm. W/2002A/52
– Coggins (Nottingham), Mapping Elliptical Galaxy Mass Distributions using Gravitational Redshift. W/2002A/35
– Davies (Durham), Mapping Early Type Galaxies along the Hubble Sequence. W/2002A/21
– Dhillon (Sheffield), Coordinated optical and X-ray observations of the eclipsing polar HU Aqr. W/2002A/9
– Fitzsimmons (Belfast), The Size Distribution and Colours of Short-Period Comets. W/2002A/67
– Gledhill (Hertfordshire), AO imaging of post-AGB circumstellar envelopes. W/2002A/11
– Gray (Edinburgh), Combined X-ray and weak lensing mass profiles of the brightest cluster lenses. W/2002A/80
– Jeffries (Keele), Low mass stellar populations in the most massive OB associations. W/2002A/72
– Kleyna (IoA,Cambridge), Dark matter in the UMi dwarf spheroidal. W/2002A/46
– Kodama (Tokyo), History of Galaxy Mass Assembly in the Hierarchical Universe at $z\sim1$. W/2002A/58
– Marsh (Southampton), Magnetic braking and solar cycles in detached binary stars. W/2002A/7
– McMahon (IoA, Cambridge), Constraining the contribution to the UV background from $z=3$ and $z=5$ quasars. W/2002A/78
– Meikle (Imperial College), Detection and Study of Supernovae in Nuclear Starburst Regions. W/2001B/34 (Long term)
– Meikle (Imperial College), Detailed study of the physics of nearby Type Ia Supernovae. W/2002A/49
– Merrifield (Nottingham), Determining the Dynamics of Round Elliptical Galaxies. W/2002A/20
– Miller (Oxford University), A Survey for wide-separation gravitational lenses from the 2dF QSO Redshift Survey. W/2002A/33
– Page (Mullard Space Science Lab/UCL), Optical identification of faint X-ray sources in a deep XMM-Newton/Chandra survey. W/2002A/43
– Peroux (IoA, Cambridge), Tracing Galactic Haloes at $3.0<z<4.5$ using CIV Absorption. W/2002A/14
– Pettini (IoA, Cambridge), CORALS II: Assessing the Dust Bias in Damped Lyman-α Systems at Intermediate Redshifts. W/2002A/10
– Rolfe (Leicester), The Orbital Velocities and Stellar Masses in the Dwarf Nova IY UMa. W/2002A/28
– Ryan (Open University), Carbon nucleosynthesis in the first stars. W/2002A/1
– Shanks (Durham), A 2dF QSO Lensing Estimate of Wm via Faint QSO Number Counts. W/2002A/76
– Smail (Durham), Testing Photometric Redshifts using Cluster Lenses. W/2002A/5
– Smith (Durham), Probing the Formation Epoch of Massive Elliptical Galaxies. W/2002A/56
– Steeghs (Southampton), The structure of AM CVn binaries and their discs. W/2002A/31
– Tanvir (Hertfordshire), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. W/2002A/65
– Unda Sanzana (Southampton), A new structure on U Gem? W/2002A/51

NL NFRA PC

– Förster Schreiber (Leiden), Near-infrared Snapshot Survey for Bright Lensed Red High-redshift Galaxies. w02an002

– Groot (Nijmegen), Spectroscopic Identification of Old White Dwarf Candidates in the Faint Sky Variability Survey. w02an001
– Habing (Leiden), Asymptotic Giant Branch stars in northern Local Group galaxies. w02an003
– Kuijken (Groningen), Determining the Dynamics of Round Elliptical Galaxies Using the Planetary Nebula Spectrograph. w02an005
– Romanowsky (Groningen), Globular Cluster Kinematics at Large Radii in M49. w02an006
– Salamanca (Amsterdam), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. w02an008
– de Zeeuw (Leiden), Mapping Early-Type Galaxies along the Hubble Sequence. w02an007

SP CAT

– Balcells (IAC), Estudio de galaxias con formación estelar extrema a alto corrimiento al rojo. W23/2002A
– Battaner (Granada), Rotación del sistema estelar en la periferia de galaxias espirales. W6/2002A
– Béjar (IAC), La función de masas subestelar en Orión y Praesepe. W28/2002A
– Cairós (IAC), Multiwavelength studies of metal-poor Blue Compact Dwarf Galaxies. W4/2002A
– Carrera (IAC), Determinación de la relación en cúmulos globulares en destrucción por marea. W26/2002A
– Casares (IAC), Optical reprocessing lines as tracers of companion stars in LMXBs. W19/2002A
– Castro-Tirado (IAA-CSIC, LAEFF), La naturaleza de las explosiones cósmicas de rayos gamma GRBs. W27/2002A
– Colina (IF Cantabria), Integral field spectroscopy of ultraluminous infrared galaxies. W1/2002A
– Manchado (IAC), Near infrared imaging of galaxy fields. W21/2002A
– Martínez-Delgado (IAC), Destrucción de galaxias enanas en el halo Galáctico: cinemática de la corriente Norte de Sagitario. W25/2002A
– Mediavilla (IAC), Curvas de extinción en galaxias con redshift intermedios. W20/2002A
– Pérez (Madrid Complutense), Spatial analysis of populations in local star-forming galaxies. W5/2002A
– Rebolo (IAC), Did very massive stars produce r-elements? W11/2002A
– Rebolo (IAC), JOVIAN: detección directa de planetas gigantes alrededor de estrellas y aislados. W32/2002B [sic]
– Ruiz-Lapuente (Barcelona), Estrellas compañeras de supernovas. W14/2002A
– Ruiz-Lapuente (Barcelona), Supernovas a z=0.35. W15/2002A

Instrument Builder´s Guaranteed Time

– Packham (Florida), The initial conditions to star formation. GT/2002A/1

Isaac Newton Telescope

UK PATT

– Boyce (Bristol), CCD imaging of gas-rich low surface brightness galaxies found at 21cm. I/2002A/15
– Feltzing (Lund Observatory), Metallicity distribution functions in Local Group dwarf spheroidal galaxies. I/2002A/18
– Fitzsimmons (Belfast), Rapid-response astrometry of potentially hazardous asteroids. I/2002A/26
– Gilmore (IoA, Cambridge), Eclipsing K/M Dwarfs and the Low-Mass Stellar M/L Ratio. I/2002A/20
– Hilditch (St. Andrews), Accretion Hot Spots in Near-Contact Binaries. I/2002A/13
– James (Liverpool), Star formation in the local Universe: Hα imaging of the Virgo cluster. I/2002A/25
– Jameson (Leicester), Rigorous limits on the bottom end of the Coma open cluster mass-function. I/2002A/29
– Jeffries (Keele), Low mass stellar populations in the most massive OB associations. I/2002A/32
– Marsh (Southampton), Subdwarf-B stars: tracers of binary evolution. I/2002A/4
– Meikle (Imperial College), Detailed study of the physics of nearby Type Ia Supernovae. I/2002A/14
– Oliver (Sussex), The INT SIRTF-Legacy: Extra-galactic Survey (ISLES). I/2002A/40
– Tanvir (Hertfordshire), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. I/2002A/27

NL NFRA PC

– Beijersbergen (Groningen), UBR imaging of the Coma cluster periphery. i02an003
– Kuijken (Groningen), Sloan standard fields for the photometric calibration of OmegaCAM images. i02an002
– Mack (ASTRON/NFRA), Constraining the BL Lac Luminosity Function. i02an001
– Salamanca (Amsterdam), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. w02an008 [sic]

UK/NL WFS Programmes

– Dalton (Oxford), The Oxford Deep WFC Survey. WFS/2002A/6
– Davies (Cardiff), Multi-coloured large area survey of the Virgo cluster. WFS/2002A/2
– van den Heuvel (Amsterdam), The Faint Sky Variability Survey II. WFS/2002A/1
– McMahon (IoA), The INT Wide Angle Survey. WFS/2002A/8
– Walton (ING), The Local Group Census. WFS/2002A/4
– Watson (Leicester), An Imaging Programme for the XMM-Newton Serendipitous X-ray Sky Survey. WFS/2002A/3

SP CAT

– Balcells (IAC), Estudio de Galaxias con Formación Estelar Extrema a Alto Corrimiento al Rojo. I8/2002A

– Casares (IAC), Curva de velocidad radial y función de masa del microcuasar LS5039. I5/2002A
– Castro-Tirado (IAA-CSIC, LAEFF), La naturaleza de las explosiones cósmicas de rayos gamma GRBs. W27/2002A
– Deeg (IAC), Sample Definition for Exoplanet detection by the COROT SpaceCraft. I10/2002A
– Herrero (IAC), Espectroscopía cuantitativa de estrellas O ionizantes. I11/2002A
– Herrero (IAC), Preparándose para OSIRIS: población estelar joven de NGC 6946. I20/2002B [sic]
– Hidalgo (IAC), Estructuras a gran escala en galaxias irregulares. I19/2002B [sic]
– Lázaro (IAC), Fotometría infrarroja de sistemas Algol. I14/2002A
– López (Basel), Nebulosas planetarias intercumulares y estructura del cúmulo de Virgo. I4/2002A
– Marín (IAC), Sistemas de cúmulos globulares en galaxias elípticas. I2/2002A
– Martínez (IAC), Constrainig the Milky Way dark halo shape from the Sagittarius tidal stream. I12/2002A
– Negueruela (Strasburg), Estrellas pre-secuencia-principal de masas intermedias en cúmulos abiertos. I15/2002A
– Riera (Politécnica Cataluña), The fragmented wind-blown bubbles around intermediate and massive stars. I7/2002A
– Vílchez (IAA), A search for Abundance Gradients in Ring Galaxies. I6/2002A

Jacobus Kapteyn Telescope

UK PATT

– Boyce (Bristol), Hα imaging of gas-rich low surface brightness galaxies found at 21cm. J/2002A/10
– Burleigh (Leicester), Asteroseismology of a pulsating helium-atmosphere white dwarf star. J/2002A/16
– Davies (Edinburgh), Lightcurves of Near Earth Objects. J/2002A/8
– Fitzsimmons (Belfast), Rapid-response astrometry of potentially hazardous asteroids. J/2002A/12
– Fitzsimmons (Belfast), The size and composition of Near-Earth Objects. J/2002A/18
– Green (Open University), Thermo-physical properties of a “cometary” NEO. J/2002A/6
– Hodgkin (IoA, Cambridge), Photometry of candidate halo white dwarfs. J/2002A/17
– Jeffery (Armagh Observatory), Time-resolved observations of the pulsating sdB star PG1605+072. J/2002A/7
– Keenan (Belfast), Four-colour photometry of stars from the Palomar-Green Survey. J/2002A/1
– Marsh (Southampton), Cataclysmic Variable Stars from the 2dF QSO survey. J/2002A/4
– Marsh (Southampton), Companions to sub-dwarf binary stars. J/2002A/5
– Morales-Rueda (Southampton), Measuring orbital periods of dwarf novae. J/2002A/14
– Norton (Open University), Multiwavelength Observations of SXTs: Black Hole Accretion Disk Outbursts. J/2002A/2
– Seigar (JAC, Hawaii), Optical properties of the disks of spiral galaxies. J/2002A/3
– Tanvir (Hertfordshire), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. J/2002A/13

NL NFRA PC

– Röttgering (Leiden), A catalogue of galaxies near bright stars: preparing for VLT-AO and VLTI. j02an002
– Salamanca (Amsterdam), Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients. w02an008 [sic]

SP CAT

– Baes (Viena), Tracing the dynamic interplay between the gas-dominated and star-dominated disk components in barred spirals. J1/2002A
– Calabresi (Rome), Photometry of Centaur Object Chariklo. J2/2002A
– Casares (IAC), Optical reprocessing lines as tracers of companion stars in LMXBs. JW19/2002A
– Castro-Tirado (IAA-CSIC, LAEFF), La naturaleza de las explosiones cósmicas de rayos gamma GRBs. JW11/2002A
– Kidger (IAC), Definition of an accurate 1-30 micron flux calibration system for the GTC and SIRTF. J4/2002A, J4/2002B [sic]
– López (Basel), ¿Hay barras lentas en galaxias interactuantes? J3/2002A
– Rosenberg (IAC), Calibración Homogénea de Cúmulos Globulares del Halo Externo. J5/2002B [sic]

SEMESTER 2002B

ITP Programmes on the ING Telescopes

– Doressoundiram (Paris), Multi-color taxonomy of trans-Neptunian objects. ITP/2002/1
– Ruiz-Lapuente (Barcelona), Supernova and the physics of supernova explosions. ITP/2002/4

William Herschel Telescope

UK PATT

– Blundell (Oxford), After the trigger: the time-resolved evolution of the hosts of powerful active galaxies. W/2002B/68
– Crowther (University College, London), Properties of Wolf-Rayet stars in the metal-rich environment of Andromeda (M31). W/2002B/60
– Crowther (University College, London), Direct constraints on the expansion velocity of hot, WN stars. W/2002B/61
– Dalton (Oxford), Near Infrared Coverage of the Oxford INT Deep Multicolour Imaging Survey. W/2002B/32
– Folha (Porto, Portugal), Excess Emission in T Tauri Stars: the Missing link. W/2002B/54
– Gray (Edinburgh University), Combined X-ray and weak lensing mass profiles of the brightest cluster lenses. W/2002B/74

– Harries (Exeter), A search for Zeeman polarization in the emission lines of classical T Tauri stars. W/2002B/43
– Jeffery (Armagh Observatory), Colorimetric mode identification in pulsating subdwarf B stars. W/2002B/27
– Longmore (Royal Observatory, Edinburgh), Structure of and star formation limits in isolated dark globules. W/2002B/38
– McLure (Edinburgh University), Black-hole mass measurement and the geometry of the broad-line region in AGN. W/2002B/63
– Meikle (Imperial College, London), Detailed study of the physics of nearby Type Ia Supernovae. W/2002B/23 (Override, long term)
– Meikle (Imperial College, London), Direct detection and study of supernovae in nuclear starbursts. W/2002B/56 (Long term)
– Merrifield (Nottingham), 2000 Planetary Nebulae in M31: A Deep Kinematic Survey. W/2002B/64
– Naylor (Exeter), Is there structure in the substellar mass function? W/2002B/52
– Nelemans (Cambridge), Testing common envelope theory and SN Ia progenitor models with double white dwarfs. W/2002B/51
– Page (MSSL-UCL), A pilot spectroscopic study of serendipitous hard spectrum XMM-Newton source. W/2002B/47
– Pettini (Cambridge), CORALS II: Assessing the Dust Bias in Damped Lyman a Systems at Intermediate Redshifts. W/2002A/10 (Long term)
– Poggianti (Padova Observatory, Italy), Star formation and morphological evolution of galaxies in nearby clusters with WYFFOS. W/2002B/28 (Long term)
– Royer (Leuven, Belgium), A complete survey of the Wolf-Rayet content of M33. W/2002B/16
– Smail (Durham), Testing Photometric Redshifts using Cluster Lenses. W/2002B/7
– Smith (Hertfordshire), Scattering geometries and the broad-line region in Radio-Quiet Quasars. W/2002B/20
– Tanvir (Hertfordshire), Gamma-Ray Bursts: Origin, Physics and use as Cosmological Probes. W/2002B/62 (Override)
– Vink (Imperial College), A search for evidence of accretion in Herbig Be stars. W/2002B/4
– Wilkinson (Cambridge), NGC2419 — a radial velocity survey of an unusual stellar cluster. W/2002B/33
– Willott (Oxford), The Fundamental Plane and black hole masses of z=0.5 radio galaxies. W/2002B/49
– Wills (Sheffield), Triggering the Activity in Giant Elliptical Galaxies. W/2002B/9

NL NFRA PC

– Förster Schreiber (Leiden), Near-infrared Snapshot Survey for Bright Lensed Red High-redshift Galaxies. w02bn001
– Ferguson (Groningen), A Search for Recent Massive Star Formation in Gas-Rich Ellipticals/SOs. w02bn010
– Hulleman (Utrecht), The nature of magnetars: UltraCam observations of the Anomalous X-Ray Pulsar 4U 0142+61. w02bn007
– Jarvis (Leiden), An unbiased view of the gaseous environments of high-redshift radio galaxies. w02bn005
– Kuijken (Groningen), M31 microlensing: checking Mira contamination with nIR AO imaging. w02bn011
– Kuijken (Groningen), 2000 Planetary Nebulae in M31: a Deep Kinematic Survey. w02bn002
– Mellema (Leiden), Polarization studies of the rings and haloes of Planetary Nebulae. w02bn008
– O'Brien (Amsterdam), Optical analogues of X-ray timing phenomena. w02bn003
– Van den Heuvel (Amsterdam), The Origin and Physics of Gamma-Ray Bursts. w02bn004 (Override)

SP CAT

– Barrado (LAEFF, Madrid), The Substellar Mass Function: Clues to the Star Formation Process. W7/2002B
– Esteban (IAC, Tenerife), Abundancias químicas a partir de líneas de recombinación en nebulosas ionizadas. W3/2002B
– Gallego (Complutense, Madrid), The evolution of the Star Formation Rate density of the Universe up to z=0.8. W12/2002B
– Gutiérrez (IAC, Tenerife), Búsqueda de galaxias de muy alto z a través del efecto lente gravitatoria en cúmulos. W23/2002B
– Gutiérrez (IAC, Tenerife), Fotometría en Hα y espectroscopía de objetos con corrimientos al rojo anómalos. WN13/2002B
– Martínez (Valencia), La masa y la extensión de los halos en galaxias elípticas. W24/2002B
– Mathieu (IAA, Granada), Do S0 galaxies follow the Tully-Fisher relation? W1/2002B
– Negueruela (Alicante), La órbita de V0332+53. W9/2002B
– Paredes (Barcelona), Búsqueda de nuevos microcuásares: confirmación espectroscópica de candidatos. W19/2002B
– Prieto (IAC, Tenerife), Estudio de galaxias con formación estelar extrema a alto corrimiento al rojo. W27/2002B
– Shahbaz (IAC, Tenerife), High time resolution optical studies of quiescent black hole X-ray transients. W25/2002B
– Zapatero (LAEFF, Madrid), Compañeros de objetos ultra fríos de la vecindad solar. W16/2002B

IAC

– Cepa (IAC, Tenerife), El proyecto OTELO: Cartografiado profundo en B y R de SA68 y NOAO-2h. W31/2002B
– Rebolo (IAC, Tenerife), JOVIAN: detección directa de planetas gigantes alrededor de estrellas y aislados. IW32/2002B

TNG TAC

– Fasano (Padova), Star formation and morphological evolution of galaxies in nearby clusters with WYFFOS. T022
– Mannucci (Arcetri), A critical test of cosmological models: tracing the elusive filaments of hot intergalactic gas. T064
– Moretti (Padova), Ages and metal abundances of star clusters in M33. T083
– Saviane (ESO, Chile), Near-infrared luminosities of dwarf galaxies in the M81 group. T093

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UK PATT

– Baines (Leeds), Spectro-astrometry of Herbig Ae/Be and T Tauri stars. I/2002B/12

– Fitzsimmons (Belfast), Rapid-response astrometry of potentially hazardous asteroids. I/2002B/18 (Override)
– Gänsicke (Southampton), The cataclysmic variable population of the Hamburg Quasar Survey. I/2002B/5
– Irwin (Cambridge), A Panoramic CCD Survey of the Halo and Disk of M31. I/2002B/24
– Jameson (Leicester), Population II/III planetary nebulae and the proper motions of Pleiades BD candidates. I/2002B/8
– Keenan (Belfast), A search for early-type stars in the haloes of distant galaxies. I/2002B/1
– Marsh (Southampton), Identification of faint stellar ROSAT sources. I/2002B/4
– Maxted (Keele), Spectroscopy of detached eclipsing binaries in open clusters. I/2002B/23
– McLure (Edinburgh University), A photometric redshift study of radio galaxy environments. I/2002B/27
– Meikle (Imperial College, London), Detailed study of the physics of nearby Type Ia Supernovae. I/2002B/9 (Override, long term)
– Tanvir (Hertfordshire), Gamma-Ray Bursts: Origin, Physics and use as Cosmological Probes. I/2002B/28 (Override)
– Williams (Queen Mary, London), The asteroidal population at the equilateral Lagrangian points of Saturn. I/2002B/2

NL NFRA PC

– De Jong (Groningen), The MEGA Survey: Mapping Microlensing in M31. i02bn002
– Ferguson (Groningen), A Panoramic CCD Survey of the Halo and Disk of M33. i02bn006
– Groot (Nijmegen), Beyond the Blue Edge in the Faint Sky Variability Survey. i02bn004
– Van den Heuvel (Amsterdam), The Origin and Physics of Gamma-Ray Bursts. w02bn004 (Override)

UK/NL WFS Programmes

– van den Heuvel (Amsterdam), The Faint Sky Variability Survey II. WFS/2002A/1
– McMahon (IoA), The INT Wide Angle Survey. WFS/2002A/8
– Walton (ING), The Local Group Census. WFS/2002A/4
– Watson (Leicester), An Imaging Programme for the XMM-Newton Serendipitous X-ray Sky Survey. WFS/2002A/3

SP CAT

– Aparicio (La Laguna), Large scale distribution of stellar populations in the M33 halo. I13/2002B
– Barrado (LAEFF, Madrid), Deep pencil-beam survey in a young, nearby cluster. I4/2002B
– Carrero (IAC, Tenerife), Calibración del triplete del Ca II como indicador de metalicidad. I7/2002B
– Fernández (IAA, Granada), Pérdida violenta de masa en estrellas jóvenes de tipo solar. I22/2002B
– Garzón (IAC, Tenerife), Understanding of the structure of the Galaxy. I23/2002B
– Herrero (IAC, Tenerife), Preparándose para OSIRIS: población estelar joven de NGC6946. I20/2002B
– Herrero (IAC, Tenerife), Espectroscopía cuantitativa de estrellas O ionizantes. I5/2002B
– Hidalgo (IAC, Tenerife), Estructuras a gran escala en galaxias irregulares. I19/2002B
– Montes (Complutense, Madrid), Spectroscopic and photometric monitoring with high temporal resolution of flare stars. I1/2002B
– Negueruela (Alicante), La distribución espectral de las estrellas Be. I6/2002B
– Pohlen (IAC, Tenerife), The outer edge of the Galaxy. I11/2002B
– Ribas (Barcelona), Determinación directa de la distancia de M31 a partir de binarias eclipsantes. I8/2002B
– Riera (Politécnica de Cataluña), The fragmented wind-blown bubbles around intermediate and massive stars. I2/2002B

IAC

– Balcells (IAC, Tenerife), Cartografiado profundo en U, V, e I para COSMOS y OTELO. I21/2002B
– Rebolo (IAC, Tenerife), JOVIAN: detección directa de planetas gigantes alrededor de estrellas y aislados. IW32/2002B

Jacobus Kapteyn Telescope

UK PATT

– Bucciarelli (Torino Observatory, Italy), Photometric Calibrators for the Palomar Sky Surveys. J/2002B/3
– Burleigh (Leicester), Star Spots on Magnetic White Dwarfs. J/2002B/5
– Fitzsimmons (Belfast), Rapid-response astrometry of potentially hazardous asteroids. J/2002B/8 (Override)
– Keenan (Belfast), Four-colour photometry of stars from the Palomar-Green Survey. J/2002B/2 (Long term)
– Littlefair (Exeter), Are young stars really spun down by their discs? J/2002B/7
– Marsh (Southampton), Companions to sub-dwarf binary stars. J/2002B/1
– Maxted (Keele), Photometry of detached eclipsing binaries in open clusters. J/2002B/10
– McBride (Open University), Physical and thermal properties of Near Earth Objects. J/2002B/6
– Norton (Open University), Multiwavelength Observations of SXTs: Black Hole Accretion Disk Outbursts. J/2002A/2 (Override, long term)
– Tanvir (Hertfordshire), Gamma-Ray Bursts: Origin, Physics and use as Cosmological Probes. J/2002B/12 (Override)

NL NFRA PC

– Röttgering (Leiden), A catalogue of galaxies near bright stars: preparing for VLT-AO and VLTI. j02bn001
– Tolstoy (Groningen), Photometric Zero Points in Local Group Dwarf Galaxies. j02bn004

– van den Berg (Brera Observatory, Italy), Photometry of peculiar X-ray sources in the old open cluster NGC6940. j02bn002
– Van den Heuvel (Amsterdam), The Origin and Physics of Gamma-Ray Bursts. w02bn004 (Override)

SP CAT

– Fuensalida (IAC, Tenerife), Medida del perfil vertical de turbulencia en el ORM. J6/2002B
– Kidger (IAC, Tenerife), Fotometría de alta precisión de estrellas estándar para CanariCam. J7/2002B
– Lara (IAA, Granada), Gas and dust analysis of the Jupiter family comets 30P/Reinmuth 1 and 57P/duToit-Neujmin-Delporte. J1/2002B
– López (IAC, Tenerife), Hay barras lentas en galaxias interactuantes? J2/2002B
– Montes (Complutense, Madrid), Spectroscopic and photometric monitoring with high temporal resolution of flare stars. JI1/2002B
– Rodríguez (IAC, Tenerife), Estudio fotométrico de remanentes de nova débiles y poco estudiados. J3/2002B

IAC

– Beckman (IAC, Tenerife), Strömgren photometry of stars from the Hipparcos catalogue within 300 pc of the Sun. J8/2002B
– Fuensalida (IAC, Tenerife), Medida del perfil vertical de turbulencia en el ORM. J6/2002B
– Kidger (IAC, Tenerife), Definition of an accurate 1–30 micron flux calibration system for the GTC and SIRTF. J4/2002B
– Kidger (IAC, Tenerife), Fotometría de alta precisión de estrellas estándar para CanariCam. J7/2002B
– Rosenberg (IAC, Tenerife), Calibración homogénea de cúmulos globulares del halo externo. J5/2002B

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William Herschel Telescope

UK PATT

– Almaini (IoA), Measuring black hole masses in narrow-line Seyfert 1 galaxies. W/2003A/63
– Charles (Southampton), Probing the accretion geometry of a quiescent black hole. W/2003A/52
– Croom (AAO), A deep wide-field infrared survey for QSOs. W/2003A/4
– Dhillon (Sheffield), Recurrent novae as Type Ia supernova progenitors. W/2003A/8
– Ivison (ATC), A narrow-band imaging survey of SCUBA galaxies. W/2003A/14
– James (John Moores), Cluster evolution and the origin of starburst dwarf galaxies in Abell 1367. W/2003A/40
– Jeffery (Armagh Obs.), Physical parameters for helium-rich subdwarf B stars — an unexplored evolutionary sequence. W/2003A/36
– Jeffery (Armagh Obs.), Analysing sdB star companions to test binary star evolution theory. W/2003A/51
– Kleyna (IoA), Dark matter in the UMi dwarf spheroidal. W/2003A/17
– Knapen (Hertfordshire), Stellar kinematics of the bar and circumnuclear region of M100. W/2003A/65
– Kodama (NAO, Tokyo), History of galaxy mass assembly in the hierarchical universe at $z \sim 1$. W/2003A/12
– Marsh (Southampton), ULTRACAM observations of interacting binary stars. W/2003A/37
– Meikle (ICL), Detailed study of the physics of nearby Type Ia supernovae. W/2002B/23 (Override, long term)
– Meikle (ICL), Direct detection and study of supernovae in nuclear starbursts. W/2002B/56 (Long term)
– Merrifield (Nottingham), Determining the dynamics of round elliptical galaxies using the Planetary Nebula Spectrograph. W/2003A/38
– Miller (Oxford), Wide-separation gravitational lenses from the 2dF QSO Redshift Survey. W/2003A/33
– Nelemans (IoA), Testing common envelope theory and SN Ia progenitor models with double white dwarfs. W/2003A/25
– Page (Mullard Space Science Lab), Optical identification of X-ray sources in the 13H XMM-Newton/Chandra spectroscopic survey. W/2003A/42
– Poggianti (OAP), Star formation and morphological evolution of galaxies in clusters. W/2002B/28 (Long term)
– Pollacco (QUB), Characterising the Planetary Nebula binary central star population. W/2003A/22
– Rawlings (Oxford), FLAGS — the First Look Active Galaxy Survey. W/2003A/39
– Roberts (Leicester), A spectroscopic study of the counterparts and environments of ultraluminous X-ray sources. W/2003A/27
– Smith (Hertfordshire), Spectropolarimetric constraints on the broad-line region in narrow-line Seyfert 1 galaxies. W/2003A/18
– Smith (Hertfordshire), Scattering geometries and the broad-line region in radio-quiet Quasars. W/2003A/20
– Tanvir (Hertfordshire), The origin and physics of Gamma-Ray Bursts. W/2003A/30 (Override)
– Wilkinson (IoA), Constraining the structure of Draco's dark halo — radial velocities at large radii. W/2003A/35

NL NFRA PC

– Douglas (Kapteyn), Determining the dynamics of round elliptical galaxies using the Planetary Nebula Spectrograph. w03an008
– Förster Schreiber (Leiden), Near-infrared snapshot survey for bright lensed red high-redshift galaxies. w03an001
– Habing (Leiden), Census of asymptotic giant branch stars in northern Local Group galaxies. w03an009
– Jarvis (Leiden), The Fundamental Plane and black hole masses of $z = 0.5$ radio galaxies. w03an004
– Thi (Amsterdam), Gas and dust in the protoplanetary disk around the Herbig AeBe star HD 141569. w03an007
– Wijers (Amsterdam), The origin and physics of Gamma-Ray Bursts. w03an005 (override)
– de Zeeuw (Leiden), SAURON mapping of the Virgo ellipticals. w03an003

SP CAT

– Abia (Granada), Production of Li in carbon stars and its metallicity dependence. W6/2003A
– Arribas (STSCI), INTEGRAL spectroscopy of galaxies, ULIRGs, gravitational lenses and QSOs. W25/2003A
– Balcells (IAC), Bi-dimensional spectroscopy of galactic bulges. W26/2003A
– Castro-Tirado (IAA), The nature of the GRBs. W5/2003A (Override)
– Gallego (Complutense, Madrid), The evolution of the Star Formation Rate density of the universe up to $z=0.8$. W17/2003A
– García-Lario (ESA-VILSPA), Subarcsecond observations of PNe precursors and young Proto-Planetary Nebulae. W22/2003A
– Gizani (CAAUL, Lisboa), Rings in powerful radio galaxies. WG13/2003A
– González (IAC), Spectropolarimetry of SW Sex systems. W18/2003A
– Herrero (IAC), Metal abundances in Cyg OB2. W24/2003A
– Iglesias (Marseille), A redshift survey of a UV-selected sample of cluster galaxies. W2/2003A
– Pascual (UCM), Physical properties and chemical abundances of the population of current star-forming galaxies at $z=0.24$. W28/2003A
– Pohlen (IAC), A test of the bar-peanut connection in a bulge-less galaxy. W16/2003A
– Ruiz-Lapuente (Barcelona). Stellar companions to supernovae. W1/2003A
– Sánchez (IAC), Direct detection of giant planets around young nearby stars. W19/2003A
– Shahbaz (IAC), High time resolution optical studies of quiescent X-ray transients. W15/2003A

Spanish Additional Time

– Barrado (LAEFF-INTA), Brown dwarfs in open clusters: the substellar mass function and the new lithium age scale. W31/2003A
– Cepa (IAC), The OTELO project: deep BRI survey of GROTH and SIRTF-FLS. W32/2003A
– Cristóbal (IAC), A study of extreme star-forming galaxies at high-z. W33/2003A
– Vílchez (IAA), A search for star forming galaxies in nearby clusters. WI15/2003A

TNG TAC

– Fasano (OAP), Star formation and morphological evolution of galaxies in nearby clusters with WYFFOS. T061
– Trevese (Roma), Investigating the nature of Low Luminosity Active Galactic Nuclei (LLAGN). T057

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UK PATT

– Benn (ING), Star-formation rate at $z>4$; searching for the epoch of reionisation. I/2003A/33
– Fitzsimmons (QUB), Rapid-response astrometry of potentially hazardous asteroids. I/2003A/28 (Override)
– Gaensicke (Southampton), The cataclysmic variable population of the Hamburg Quasar Survey. I/2003A/12
– Gilmore (IoA), Eclipsing K/M-dwarf binaries and the low mass stellar mass-luminosity-radius relations. I/2003A/29
– Howarth (UCL), Rotational velocities of Be stars. I/2003A/6
– Keenan (QUB), The distances to the M15 and Complex K intermediate velocity clouds. I/2003A/2
– Maddox (Nottingham), Making monsters — the origin of brightest cluster galaxies. I/2003A/23
– Marsh (Southampton), Identification of faint stellar ROSAT sources, part II. I/2003A/19
– Meikle (UCL), Detailed study of the physics of nearby Type Ia supernovae. I/2002B/9 (Override, long term)
– Morales-Rueda (Southampton), The key to binary star evolution. I/2003A/13
– Snellen (Edinburgh), The space-density of high redshift FR I radio galaxies. I/2003A/9
– Tanvir (Hertfordshire), The Origin and Physics of Gamma-Ray Bursts. I/2003A/20 (Override)

NL NFRA PC

– Habing (Leiden), Monitoring of asymptotic giant branch stars in Local Group Galaxies. i03an006
– Helmi (Utrecht), Star streams and high velocity clouds in the Milky Way halo. i03an003
– Kuijken (Groningen), Sloan standard fields for the photometric calibration of OmegaCAM. i03an001
– Wijers (Leiden), The origin and physics of gamma-ray bursts. w03an005 (Override)

UK/NL WFS Programmes

– Dalton (Oxford), The Oxford deep WFC survey. WFS/2002A/6
– van den Heuvel (Amsterdam), The faint sky variability survey II. WFS/2003A/1
– McMahon (IoA), The INT wide angle survey. WFS/2003A/8
– Walton (ING), The Local Group census. WFS/2003A/4
– Watson (Leicester), An imaging programme for the XMM-Newton serendipitous X-ray sky survey. WFS/2003A/3

SP CAT

– Casares (IAC), Simultaneous observations of Galactic gamma-ray sources with INTEGRAL. I6/2003A
– Casares (IAC), Radial velocity curve and mass function of LS5039 microquasar. I7/2003A

– Castro-Tirado (IAA), The nature of GRBs. W5/2003A (Override)
– Deeg (IAC), Sample definition for exoplanet detection by the COROT spacecraft. I13/2003A
– Hammersley (IAC), A deep multi-wavelength survey of the Galactic plane. I9/2003A
– Martí (Jaén), Radial velocity curves of microquasars. I8/2003A
– Montes (Complutense, Madrid), Spectroscopic characterisation of K and M stars members of moving young groups. I10/2003A
– Negueruela (Alicante), Determination of the orbit of the X-ray eclipsing binary XTE J1855-026. I5/2003A
– Vazdekis (IAC), Towards a robust scale of metallicities in globular clusters. I11/2003A

Spanish Additional Time

– Balcells (IAC), Deep UV survey for COSMOS and OTELO. I17/2003A
– Casares (IAC) On the age and formation history of Galactic black hole binaries. I14/2003A
– Vílchez (IAA), A search for star forming galaxies in nearby clusters. I15/2003A

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UK PATT

– Brinkworth (Southampton), Star spots on magnetic white dwarfs. J/2003A/1
– Bucciarelli (OAT, Italy), Photometric calibrators for the Palomar Sky Surveys. J/2003A/3
– Fitzsimmons (QUB), Rapid-response astrometry of potentially hazardous asteroids. J/2003A/9 (Override)
– James (John Moores), Derivation of [N II] contamination corrections for Hα studies of star formation. J/2003A/13
– Keenan (QUB), Four-colour photometry of stars from the Palomar-green survey. J/2002B/2 (Long term)
– Knapen (Hertfordshire), H II region statistics in spiral disks. J/2003A/15
– Kuhn (JAC, Hawaii), Optical/UV continua of $z>3$ quasars. J/2003A/14
– Morales-Rueda (Southampton), Companions to subdwarf B binary stars. J/2003A/11
– Norton (OU), Override multiwavelength observations of SXTs: black hole accretion disk outbursts. J/2002A/2 (Override, long term)
– Pollaco (QUB), The overheating of irradiated atmospheres — observational evidence. J/2003A/4
– Prada (ING), RR Lyrae distances to the Sagittarius stream. J/2003A/12
– Seigar (JAC, Hawaii), Quantifying the outer envelopes of cD galaxies. J/2003A/10
– Tanvir (Hertfordshire), The origin and physics of gamma-ray bursts. J/2003A/5 (Override)

SP CAT

– Calabresi (ARA, Italy), VRI photometry of Centaur Chariklo (10199) and KBO 20022GZ32 and 2002GO9. J1/2003A
– Castro-Tirado (IAA), The nature of GRBs. W5/2003A (Override)
– Kidger (IAC), Definition of an accurate 1–30 micron flux calibration system for the GTC and SIRTF. J5/2003A
– Martín (IfA, Hawaii), Photometry of stellar pairs of twins. J2/2003A
– Negueruela (Alicante), Galactic structure towards the Galactic anti-centre. J3/2003A
– Pohlen (IAC), Spectral energy distribution of quasars. J4/2003A
– Verdes-Montenegro (IAA), Characterizing the ISM in a sample of the most isolated galaxies: Hα survey. J6/2003A

NL NFRA PC

– Douglas (Kapteyn), Photometry of PN.S targets. j03an002
– Jonker (Amsterdam), Optical counterparts of LMXBs. j03an003
– Mack (ASTRON), JKT imaging of radio sources at extreme stages of their evolution. j03an001
– Mack (ASTRON), JKT-imaging of a new sample of radio galaxies. j03an004
– Wijers (Amsterdam), The origin and physics of gamma-ray bursts. w03an005 (Override)
– van Woerden (Kapteyn), Updated epochs of maximum for RR Lyrae stars projected on HVCs to be used for determination of HVC distances. j03an005

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UK PATT

– Bower (Durham), The Sauron deep survey: exploring the Lyman-α haloes of massive galaxies at $z=3$. W/2003B/19
– Burleigh (Leicester), NAOMI followup observations of very low mass companions to nearby white dwarfs . W/2003B/63
– Charles (Southampton), Determining system parameters of a soft X-ray transient in outburst. W/2003B/39
– Collins (John Moores), Environmental dependence of the fundamental plane of brightest cluster galaxies. W/2003B/27
– Crowther (UCL), Wolf-Rayet stars in the metal-rich environment of M31. W/2003B/09
– Dalton (Oxford), Star formation at $z\sim1$. W/2003B/61
– Dhillon (Sheffield), ULTRACAM observations of the transiting extrasolar planet HD209458b. W/2003B/31

– Dufton (Belfast), Spectroscopy of h + χ Persei to support VLT/FLAMES survey. W/2003B/03
– Fitzsimmons (Belfast), The 13th/14th November stellar occultation by Titan. W/2003B/45
– Folha (Porto, Portugal), Excess emission in T Tauri stars: the missing link. W/2003B/15
– Folha (Portugal), Excess emission in T Tauri stars: the missing link. W/2003B/16
– Jarvis (Oxford), Weak lensing by cluster mass distributions traced by radio galaxies at $z = 0.5$. W/2003B/37
– Marsh (Southampton), Stochastic variability of accretion discs. W/2003B/55
– Marsh (Southampton), Orbital periods of post common envelope binary stars from the SDSS. W/2003B/56
– Mathioudakis (Belfast), High frequency oscillations in active cool stars. W/2003B/26
– McCaughrean (AIP, Germany), Spectral typing IR/X-ray selected brown dwarf candidates in the Trapezium Cluster. W/2003B/64
– McLure (Edinburgh), Exploring the connection between bulge/black-hole mass and radio luminosity from $z = 0$ to $z = 2$. W/2003B/49
– Meikle (ICL), Detailed study of the physics of nearby Type Ia supernovae. W/2003B/02 (Override)
– Merrett (Nottingham), A deep kinematic survey of planetary nebulae in M31. W/2003B/32
– Nelemans (Cambridge), Testing common envelope theory and SN Ia progenitor models with double white dwarfs. W/2003B/29
– Nelemans (Cambridge), Follow-up of new AM CVn candidates. W/2003B/30
– Østensen (ING), Resolving sdB binary systems with adaptive optics. W/2003B/60
– Page (MSSL), Optical identification of faint X-ray sources in the 1H XMM-Newton/Chandra spectroscopic survey. W/2003B/52
– Pollacco (Belfast), Characterising the planetary nebula central star population. W/2003A/22 (Long term)
– Smartt (Cambridge), An image archive to identify the progenitors of future core-collapse supernovae. W/2003B/22
– Smith (Hertfordshire), Scattering geometries and the broad-line region in radio-quiet quasars. W/2003B/05
– Smith (UCL), The massive star population of Wolf-Rayet galaxies. W/2003B/20
– Vink (ICL), Spectropolarimetry of T Tauri stars. W/2003B/24
– Wesson (UCL), ORL abundances and hydrogen-deficient clumps in PNe with H-deficient central stars. W/2003B/62
– Wills (Sheffield), Triggering the activity in giant elliptical galaxies. W/2003B/13

NL NFRA PC

– Douglas (Groningen), A deep kinematic survey of planetary nebulae in M31. w03bn014
– Emonts (Groningen), Origin and evolution of AGN activity in gas-rich radio galaxies. w03bn005
– Groot (Nijmegen), Spectroscopic classification of the KISO survey: a search for AM CVn stars. w03bn017
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SP CAT

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TNG TAC

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SP CAT

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Appendix E

ING BIBLIOGRAPHY

Below is the list of research papers published in 2002 and 2003 that resulted from observations carried out at the telescopes of the Isaac Newton Group. The data used in these papers was obtained as part of an observing programme or by mining one of the ING archives. The selection process identifies papers that make direct use of observations obtained with the ING telescopes, in order to qualify. Papers that refer to data presented in earlier papers (derivative papers) are not counted. This bibliography was compiled from only the refereed journals *MNRAS*, *Astrophys J*, *Astrophys J Letters*, *Astrophys J Suppl*, *Astron J*, *PASP*, *Astron Astrophys*, *Nature* and *Science*, although many other publications have appeared elsewhere, notably in workshop, conference proceedings and PhD theses. For every paper the following information is given: author/s, title, journal, volume, first page, nationality of the first institution of the first author (between brackets), used instrument (between parentheses) and the ING Archive as the data source was this was credited in the paper.

2002

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Appendix F

ASTRONOMY STAFF RESEARCH PUBLICATIONS

The following includes all 113 refereed and non-refereed publications of ING staff in the year 2002 (51 refereed journal papers and 62 non-refereed papers in conference proceedings or other publications), and all 88 refereed and non-refereed publications of ING staff in the year 2003 (33 refereed journal papers and 55 non-refereed papers in conference proceedings or other publications). It is sorted by year and in alphabetical order of first ING author (in italic and bold).

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Appendix G

SEMINARS

Date	Title	Speaker	University / Institution
2002			
23 Jan	Star Clusters in NGC 4038/39 (The Antennae)	S. Mengel	Leiden
28 Jan	The Shape of Balmer Lines of AGNs: Contribution of the Accretion Disk	L. Popovic	Belgrade Obs., Serbia
21 Feb	Massive Black Holes in Spiral Galaxies	D. Axon	Hertfordshire
21 Mar	Lyman-break galaxies: Are they forming bulges?	S. Rix	IoA
25 Mar	Adaptive optics developments on Mauna Kea, Hawaii	C. Benn	ING
23 Apr	Binary subdwarf-B stars and the origin of Extreme Horizontal Branch stars	P. Maxted	Keele
16 May	The surface of icy minor planets: trans-neptunian objects, Centaurs, comet nuclei and trojan asteroids	J. Licandro	CGG & TNG
21 May	Double Bars, Inner Disks, and Fossil Nuclear Rings: The Strange and Complex Interiors of Barred Galaxies	P. Erwin	IAC
24 May	The EURO-50 project: The world's largest telescope at the ORM	R. Rutten	ING
3 Jun	TASCA: the Tololo All-Sky CAmera	H. Schwarz	CTIO, Chile
4 Jul	AstroGrid: Creating the UK's Virtual Observatory	N. Walton	IoA
18 Jul	Red Giants in the Magellanic Clouds	M. Rosa Cioni	ESO, Germany
30 Jul	Lucky exposures: diffraction limited CCD imaging	B. Tubbs	IoA
7 Aug	Dynamical Processes in the Central Kpc and AGN	I. Shlosman	JILA & Kentucky, USA
12 Aug	AGN-selected clusters as revealed by weak lensing	M. Wold	IPAC, USA
26 Aug	A study of B-type line-profile variables in close binaries	K. Uytterhoeven	Leuven, Belgium & Mercator Tel.
27 Aug	Planetary Exospheres	C. Barbieri	Padova, Italy
30 Aug	Star formation in spiral galaxies	S. Folkes	Hertfordshire & ING
30 Aug	The exceptional Dwarf Nova, V485 Cen	H. Worters	Sheffield & ING
18 Sep	The results of binary white dwarf mergers	S. Jeffery	Armagh Observatory
29 Oct	The nature of stellar disk truncations in galaxies	M. Pohlen	IAC
7 Nov	The dynamical structure of the Kuiper Belt	M. Melita	Queen Mary, London
21 Nov	The winds from the most luminous stars	J. Vink	Imperial College London
27 Nov	The SOAR telescope	H. Schwarz	CTIO & NOAO, Chile
10 Dec	The MAGIC telescope	J. Cortina	Autónoma de Barcelona, Spain
17 Dec	The SOAR telescope	X. Gong	Nanjing, China
2003			
13 Jan	The luminosity-metallicity relation of dwarf irregular galaxies	I. Saviane	ESO, Chile
27 Jan	Eclipsing binaries in open clusters	J. Taylor	Keele
31 Jan	Nucleosynthesis in the Early Galaxy	B. Nordstrom	Lund, Sweden & Copenhagen
18 Feb	Star Streams in the Milky Way: Fragments of its History	P. Harding	Case Western Reserve, USA
27 Feb	Kinematics perturbations and low activity galaxies connection	L. Colombon	ING
28 Feb	Integral field spectroscopy at the AIP	S. Sánchez	Potsdam, Germany
12 Mar	Planet formation: a new way to observe them forming	S. Els	ING
18 Mar	Observing double white dwarfs: test for common envelope theory, type Ia supernova progenitor models and gravitational wave noise predictions	G. Nelemans	IoA
25 Mar	Measuring the time delay of the lensed quasar HE1104–180	E. Ofek	Tel Aviv, Israel
21 Apr	Spectroscopic observations of asteroids: the S3OS2 and Vestoids Project	D. Lazzaro	Rio de Janeiro Obs., Brasil
24 Apr	Environment of Quasars	I. Söechting	ING
7 May	Short GRBs: an unsolved enigma	G. Gandolfi	CNR, Roma, Italy
8 May	Probing the faint end of the $z>3$ quasar luminosity function	O. Kuhn	JAC, Hawaii
15 May	VLT-FORS1 observations of NGC 6397: Evidence for Mass Segregation	G. Andreuzzi	Osservatorio Astronomico di Roma
5 Jun	Comets and Origin of Earth's Water	H. Campins	Central Florida, USA
2 Jul	Spectroscopic Investigations of Near-Earth Objects	S. Marchi	Padova, Italy
26 Nov	Photometric Study of Young Active Stars	S. Järvinen	NOT
3 Dec	CCD Ron Suppression Technique for Echelle Spectroscopy	A. Järvinen	NOT

Appendix H

FINANCIAL STATEMENT

Financial year 2002/03 saw the start of the planned reduction in PPARC funding as a consequence of the UK's membership of the European Southern Observatory. The budget reductions, which were to be phased in over a 4 year period from 2002/03 to 2005/06, reflected the programme strategies for the observatory set out in ING's Restructuring Plan of September 2001. However, the budget reductions from the UK were compensated for in part through a new collaboration with Spain by which the IAC would provide resources in the form of 6 staff years of effort per annum in exchange for an increase in the observing time available to the Spanish astronomy community. The approved funding for ING's Joint Programme during financial year 2002/03 provided a total requisitions budget of €3641k, including a carry-forward from the previous year and income generated under the EU's Access Programme. However, a decision was taken early in the year to introduce economies so that approximately €500k could be "banked" with PPARC and carried forward to future years in order to help offset the effects of the budgetary reductions in 2005 and thereafter. The resulting allocations and associated expenditure are set out below under the main budget headings (staff costs associated with the international posts at ING are excluded).

Budget centre		Alloc. FY 2002/03 €k	Exp. FY 2002/03 €k
Operations			
Administration and management		70.0	67.8
Astronomy support		90.0	87.2
Conferences		69.0	47.4
Engineering support		494.0	502.1
Local staff		943.3	929.4
ORM operations		602.0	587.9
Sea-level infrastructure and services		225.0	240.0
Students		40.0	20.5
	SUBTOTAL	2533.3	2482.3
Enhancements		730.0	489.7
	TOTAL	3263.3	2972.0

Financial year 2003/04 saw a continuation in the reduction of the UK's contribution to ING operations but the financial situation of the observatory received a significant financial boost when it was agreed that the IAC would in future provide its contribution in the form of cash rather than the 6 staff years of effort previously agreed. This not only provided ING with greater flexibility in how to manage its resources but financially it also meant that the observatory received the overhead costs associated with the 6 posts. Agreement to this change was reached well into the financial year in question so that funding was received only for the final quarter of the year. Including this additional contribution from the IAC, together with the carry-forward from the previous year and further EU funding, the total approved requisitions budget was €3223.8k. This was distributed between the various budget headings as set out below. Again, a contingency sum was held back to be carried forward to future years to help offset the significant step-down in PPARC's contribution that will occur in 2005/06. The resulting allocations and associated expenditure are set out below under the main budget headings (staff costs associated with the international posts at ING are excluded).

Budget centre		Alloc. FY 2003/04 €k	Exp. FY 2003/04 €k
Operations			
Administration and management		65.1	63.9
Astronomy support		87.0	77.8
Conferences		15.1	19.4
Engineering support		438.6	425.7
Local staff		888.6	908.4
ORM operations		589.8	581.9
Sea-level infrastructure and services		259.9	283.1
Students		21.1	22.1
	SUBTOTAL	2365.1	2382.3
Enhancements		752.8	552.3
	TOTAL	3117.9	2934.6

Appendix I

COMMITTEE MEMBERSHIP

Name	Responsibility	Institution
ING BOARD		
Prof P T de Zeeuw	Chairperson (until 04.2002)	University of Leiden
Prof J Drew	Chairperson	Imperial College London
Prof M Merrifield	Vice Chairperson (until 04.2002)	University of Nottingham
Prof T van der Hulst	Vice Chairperson (from 10.2002)	University of Groningen
Dr W H W M Boland (until 10.2002)		NWO
Dr G Dalton (from 10.2002)		University of Oxford
Dr R García López (from 10.2002)		IAC
Dr A Mampaso Recio (until 10.2002)		IAC
Prof T Marsh		University of Warwick
Dr R Stark (from 10.2002)		NWO
Dr C Vincent		PPARC
Dr S Berry	Secretary	PPARC
DIRECTOR'S ADVISORY COMMITTEE		
Dr M McCaughrean	Chairperson	Astrophysikalisches Institut Potsdam
Dr M Balcells (from 10.2002)		IAC
Dr R García López - (until 10.2002)		IAC
Prof T van der Hulst - (until 10.2002)		University of Groningen
Dr P A James		Liverpool John Moores University
Dr A Mampaso Recio - (until 10.2002)		IAC
Dr N Tanvir		University of Hertfordshire
Dr E Tolstoy (from 10.2002)		University of Groningen
ING TIME ALLOCATION GROUPS		
UK Panel for the Allocation of Telescope Time (PATT)		
Prof C Tadhunter	Chairperson	University of Sheffield
WHT TAG		
Dr R Oudmayer	Chairperson (from semester 2003A)	University of Leeds
Dr R D Jeffries	Chairperson (until semester 2002B)	Liverpool John Moores University
Dr J Baker (from semester 2003A)		University of Oxford
Dr R G Bower (until semester 2003B)		University of Durham
Dr G Dalton (until semester 2003A)		University of Oxford
Dr C A Haswell (until semester 2002B)		Open University
Dr N Jackson (until semester 2002B)		Jodrell Bank
Dr P A James (from semester 2003B)		Liverpool John Moores University
Dr P Maxted (from semester 2003A)		University of Keele
Dr S Smartt (from semester 2003B)		University of Cambridge
Dr I Skillen	Technical secretary	ING
INT/JKT TAG (the INT/JKT TAG merged with the WHT TAG as of summer 2003)		
Dr P A James	Chairperson	Liverpool John Moores University
Dr P Callanan		University College Cork
Dr A Robinson		University of Hertfordshire
Dr S Smartt		University of Cambridge
Dr D Steeghs		University of Southampton
Dr I Skillen	Technical secretary	ING
NL ASTRON Programme Committee (PC)		
Prof F Briggs	Chairperson (until 09.2002)	University of Groningen
Dr H Röttgering	Chairperson (from 09.2002)	University of Leiden
SP Comité de Asignación de Tiempos (CAT)		
Dr E Mediavilla	Chairperson	IAC

Appendix J

ADDRESSES AND CONTACTS

Isaac Newton Group of Telescopes (ING). Apartado de correos 321; E-38700 Santa Cruz de La Palma; Canary Islands; Spain; Tel: +34 922 425 400; Fax: +34 922 425 401. URL: `http://www.ing.iac.es/`, `http://www.ast.cam.ac.uk/ING/` (UK mirror).

ING's sea-level office: Mayantigo building; C/ Alvarez de Abreu, 70, 2nd floor; E-38700 Santa Cruz de La Palma; Canary Islands; Spain.
ING at Roque de Los Muchachos observatory: Tel: +34 922 405 500 (residence's reception); 559 (WHT control room); 640 (INT control room); 585 (JKT control room).

	Name	Telephone (+34 922)	E-mail (<user>@ing.iac.es)
Director	René Rutten	425 420	rgmr
Head of Administration	Les Edwins	425 418	lie
Head of Astronomy	Danny Lennon	425 440	djl
Head of Engineering	Gordon Talbot	425 419	rgt
Operations Team	Kevin Dee	405 565	kmd
Head of Control Software	Frank Gribbin	425 426	fjg
Head of Computer Facilities Group	Don Carlos Abrams	425 450	don
Head of Telescope & Instrument Engineering	Andy Hide	425 443	andy
Public Relations	Javier Méndez	425 464	jma
Telescope Scheduling	Ian Skillen	425 439	wji
Service Programme	Pierre Leisy	425 441	service
WHT Manager	Chris Benn	425 432	crb
INT and JKT Manager	Romano Corradi	425 461	rcorradi
Personnel	Lucy Lawler	425 415	lal
Health and Safety	Douglas Gray	405 632	doug
Freight	Juan Martínez	425 414	juan

Note: Updated ING contact information can be found at `http://www.ing.iac.es/About-ING/`.

Particle Physics and Astronomy Research Council (PPARC). Polaris House; North Star Avenue; Swindon SN2 1SZ; United Kingdom; Tel: +44 (0)1793 442 000; Fax: +44 (0)1793 442 002; URL: `http://www.pparc.ac.uk/`.

Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO). P.O. Box 93138; 2509 AD Den Haag; The Netherlands; Tel: +31 (0)70 34 40 640; Fax: +31 (0)70 38 50 971; URL: `http://www.nwo.nl/`.

Instituto de Astrofísica de Canarias (IAC). C/ Vía Láctea s/n; E-38200 La Laguna; Canary Islands; Spain; Tel: +34 922 605 200; Fax: +34 922 605 210; URL: `http://www.iac.es/`.

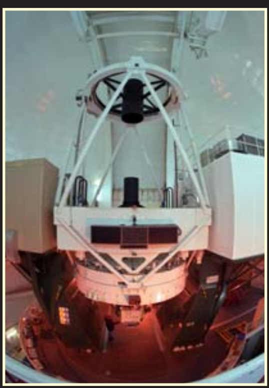
Enquiries about the operation of the Roque de Los Muchachos Observatory can be made to the Instituto de Astrofísica de Canarias (IAC), see address above. Enquiries about observing time on the ING telescopes allocated by the Panel for the Allocation of Telescope Time (PATT) should be made to the executive secretary, PATT, at the PPARC address given above, or for Dutch time to the chairperson of the Programme Committee (PC), email: `nfra_pc@astro.rug.nl`. Enquiries about the share of time at the disposal of Spain should be made to the Comité para la Asignación de Tiempos (CAT), at the IAC address given above. Enquiries about the international time scheme should be made to the Secretary, CCI, at the IAC address given above.

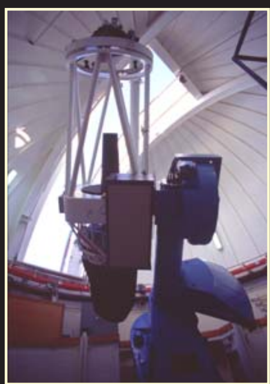
Appendix K

ACRONYMS AND ABBREVIATIONS

AAO	Anglo-Australian Observatory
ASP Conf Ser	Astronomical Society of the Pacific Conference Series
Astron Astrophys	Astronomy and Astrophysics Journal
Astron Astrophys Suppl	Astronomy and Astrophysics Journal Supplement Series
Astron J	Astronomical Journal
Astron Soc Pac Conf Ser	Astronomical Society of the Pacific Conference Series
Astrophys J	Astrophysical Journal
Astrophys J Suppl	Astrophysical Journal Supplement Series
Astrophys Space Science	Astrophysics and Space Science Journal
AU	Astronomical Unit (1.496×10^8 km)
AUTOFIB	Autofib Fibre Positioner
AF2	Autofib Fibre Positioner
Aux	Auxiliary Port at the WHT Cassegrain focus
Bull Am Astron Soc	Bulletin of the American Astronomical Society
Cass	Cassegrain focus
CAT	Comité para la Asignación de Tiempos (Spanish panel for the allocation of telescope time)
CCD	Charge-Coupled Device
CCI	Comité Científico Internacional (International Scientific Committee) for Astrophysics
CfA	Harvard-Smithsonian Centre for Astrophysics
CIRSI	Cambridge Infra Red Survey Instrument
DAS	Data Acquisition System
DIAS	Dublin Institute for Advanced Studies
DIMM	Differential Image Motion Monitor
ELECTRA	Enhanced Light Efficiency Cophasing Telescope Resolution Actuator
ESA	European Space Agency
ESTEC	European Space Technology Centre
Fib	AUTOFIB fibre positioner
FOS	Faint Object Spectrograph
FWHM	Full Width Half Maximum
GHRIL	Ground Based High Resolution Imaging Laboratory
GRACE	GRound based Adaptive optics Controlled Environment
HST	Hubble Space Telescope
IAA	Instituto de Astrofísica de Andalucía
IAC	Instituto de Astrofísica de Canarias
IAU	International Astronomical Union
IAU Circ	IAU Circular
IAUNAM	Instituto de Astronomía de la Universidad Nacional Autónoma de México, Mexico
IC	Imperial College
ICS	Instrument Control System
ICSTM	Imperial College of Science, Technology and Medicine
IDS	Intermediate Dispersion Spectrograph
IFCA	Instituto de Física de Cantabria
IMAFF	Instituto de Matemáticas y Física Fundamental, Madrid
INAOE	Instituto Nacional de Astrofísica, Optica y Electrónica, Mexico
Inf Bull Variable Stars	Information Bulletin on Variable Stars
ING	Isaac Newton Group
ING Newsl	ING Newsletter
INGRID	ING Red Imaging Device
Int Astron Union Symp	International Astronomical Union Symposium
INT	Isaac Newton Telescope
INTEGRAL	Integral field fibre feed for WYFFOS
IoA	Institute of Astronomy
IR	Infrared
Irish Astron J	Irish Astronomical Journal
ISIS	ISIS double spectrograph
ITP	International Time Programme
JAG	JKT Acquisition and Guiding Unit
JKT	Jacobus Kapteyn Telescope
JOSE	Joint Observatories Seeing Evaluation programme
JSC	Joint Steering Committee
LAEFF	Laboratory for Space Astrophysics and Fundamental Physics
LDSS	Low Dispersion Survey Spectrograph
LIRIS	Long-Slit Intermediate-Resolution Infrared Spectrograph

LJMU	Liverpool John Moores University
MARTINI	Multi-Aperture Real Time Image Normalisation Instrument
MCCD	Mosaic CCD camera or National Astronomical Observatory of Japan camera
MES	Manchester Echelle Spectrograph
Mem Soc Astron Ital	Memorie della Società Astronomica Italiana
MNRAS	Monthly Notices of the Royal Astronomical Society
MOMI	Manchester Occulting Mask Imager
MPIA	Max Planck Institute of Astrophysics
MSSL	Mullard Space Science Laboratory
MSSSO	Mount Stromlo and Siding Spring Observatories
Musicos	Multi-SIte COntinuous Spectroscopy (fibre spectrograph on the INT)
NAOMI	Natural guide star Adaptive Optics system for Multiple-Purpose Instrumentation
NBST	National Board of Science and Technology of Ireland
New Astron	New Astronomy Journal
New Astron Rev	New Astronomy Review
NRAL	National Radio Astronomy Laboratory
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
OAN	Observatorio Astronómico Nacional
OASIS	OASIS Integral Field Spectrograph
OAT	Observatorio Astronomico de Trieste
ORM	Observatorio del Roque de Los Muchachos (Roque de los Muchachos Observatory)
OSCA	OSCA Coronograph
PASA	Publications of the Astronomical Society of Australia
PASP	Publications of the Astronomical Society of the Pacific
PATT	Panel for the Allocation of Telescope Time
PF	Prime Focus
PFC	Prime Focus Camera
PFIP	WHT´s Prime Focus Imaging Camera
Planet Space Sci	Planetary and Space Science Journal
PN.S	Planetary Nebula Spectrograph
PP	People's Photometer
PPARC	Particle Physics and Astronomy Research Council
Proc	Proceedings
QMW	Queen Mary and Westfield College
QUB	Queen's University Belfast
RBS	Richardson-Brealy Spectrograph
Rev Mex Astron Astrof	Revista Mexicana de Astronomía y Astrofísica
Rev Mex Astron Astrof Conf Ser	Revista Mexicana de Astronomía y Astrofísica Series de Conferencias
RGO	Royal Greenwich Observatory
RAL	Rutherford Appleton Laboratory
SAURON	Spectrographic Areal Unit for Research on Optical Nebulae
S-Cam	Super-conducting Tunnel Junction Camera
Space Sci Rev	Space Science Reviews
SPIE	Society of Photo-Optical Instrumentation Engineers
STScI	Space Telescope Science Institute
TAC	Time Allocation Committee
TAG	Time Allocation Group
TAURUS	TAURUS Fabry-Perot spectrograph or imager
TCS	Telescope Control System
TNG	Telescopio Nazionale Galileo
TRIFFID	Galway/DIAS Image Sharpening Camera
UCL	University College London
UCLAN	University of Central Lancashire
UCM	Universidad Complutense de Madrid
UES	Utrecht Echelle Spectrograph
UKIRT	United Kingdom Infrared Telescope
ULTRACAM	Ultra-fast, triple-beam CCD camera
WHIRCAM	William Herschel Infrared Camera
WFC	Wide Field Camera
WFS	Wide Field Surveys with the WFC
WHT	William Herschel Telescope
WYFFOS	Wide Field Fibre Optics Spectrograph
ZAMS	Zero-Age Main Sequence





Isaac Newton Group of Telescopes (ING)

Apartado de Correos 321
E-38700 Santa Cruz de La Palma
Canary Islands
SPAIN
Tel: +34 922 425400
Fax: +34 922 425401
URL: http://www.ing.iac.es/