ISAAC NEWTON
GROUP OF TELESCOPES

Annual Report
of the PPARC-NWO Joint Steering Committee

1998
The Isaac Newton Group of Telescopes (ING) consists of the 4.2m William Herschel Telescope (WHT), the 2.5m Isaac Newton Telescope (INT) and the 1.0m Jacobus Kapteyn Telescope (JKT). The ING is located 2,350m above sea level at the Roque de Los Muchachos Observatory (ORM) on the island of La Palma, Canary Islands, Spain. The WHT is the largest telescope of its kind in Western Europe.

The construction, operation, and development of the ING telescopes is the result of a collaboration between the United Kingdom and the Netherlands. The site is provided by Spain, and in return Spanish astronomers receive 20 per cent of the observing time on the telescopes. 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 and the Netherlands. On the JKT the international collaboration embraces astronomers from Ireland and the University of Porto (Portugal). The remaining 5 per cent is reserved for large scientific projects to promote international collaboration 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 and the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of the Netherlands. The Roque de Los Muchachos Observatory, which is the principal European northern hemisphere observatory, is operated on behalf of Spain by the Instituto de Astrofísica de Canarias (IAC).
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Foreword

I am delighted to write the foreword to the 1998 Annual Report of the Isaac Newton Group of Telescopes, on behalf of the Joint Steering Committee. Not only is this my last foreword, as I step down from the Chairmanship of the Committee, but it is also the last foreword by any Chairman of the JSC since this body has now been disbanded and replaced by the ING Board.

It gives the JSC great satisfaction to see that the scientific productivity of the ING telescopes has continued to increase during this year. Of particular note is the continuing high number of publications and the low percentage of nights lost to faults. Despite the considerable disruption which the reorganisation of the Royal Observatories in the UK caused, it is clear that, for the most part, the ING has continued to move in a forward direction. The closure of the RGO in Cambridge has posed a new set of challenges for the Observatory which its staff has taken on with confidence and vision.

An important development this year was the very positive report from the international Review Committee, chaired by Russell Cannon. The recommendations of this review, which are now in the public domain, were fully endorsed by the JSC and the funding agencies. Over recent months, we have been working with the Director of ING and the funding agencies to implement these recommendations. For example, the Director has taken steps to reorganise operations support and has targeted the effort released towards the highest priority enhancement programmes. The replacement of the JSC by the ING Board, which now includes a representative of the Spanish astronomical community, was also an outcome of this review. I hope that the Board will strengthen the relationship between the ING staff, its Director and the user community and build upon the basis established by the Joint Steering Committee.

We can look forward to the significant enhancement in image quality which the commissioning of the natural guide star adaptive optics system (NAOMI) will bring, utilising the new infrared camera (INGRID). I am sure these two developments will help ensure that the WHT remains at the forefront of world-class 4 metre optical/near IR facilities.

The year also saw the commencement of the Spanish 10 metre GranTeCan (GTC) project, a development which was warmly welcomed by the JSC. The GTC will have a significant impact on the future of the ING and it is important that the ING should work with the GTC project to ensure that this is to their mutual benefit. Discussions continue as to how this will work in practice.

I would like to take this opportunity to thank the Director of ING and all his staff for their continued belief in the facility and their considerable efforts, to which this Annual Report is a suitable tribute. I have very much enjoyed my time as Chairman of the JSC and ING Board and I know that I leave it in good hands with the new Chairman, Tim de Zeeuw.
This year work at the Isaac Newton Group of Telescopes was greatly affected by the closure of the Royal Greenwich Observatory in Cambridge. The design, construction and development of the telescopes and their instruments would have been inconceivable without the creativity, enthusiasm, and devotion of many staff at the RGO. Workers at ING have had to adapt to the many changes and complications as a result of this restructuring, and it is to their credit that the telescopes have been performing well and that development work did not stop. The development of major new instruments has now been concentrated in Edinburgh, Scotland, at the United Kingdom Astronomy Technology Centre. The ING is looking forward to a long and fruitful collaboration with the UK-ATC.

Various instrument developments took place and are reported in these pages. Most notable has been the success of the wide field multi-object fibre positioner and spectrograph for the William Herschel Telescope. Full deployment of the Wide Field Camera on the Isaac Newton Telescope and the large scale survey work that was initiated has re-defined the role of that telescope. This camera has been perfectly matched by the Cambridge Institute of Astronomy’s panoramic infra-red camera that was used in the prime focus of both the INT and the WHT.

One very exciting highlight at the Observatory was the definite announcement of the development of the Gran Telescopio Canarias (GTC). This telescope of 10 metre aperture based on the segmented mirror design is currently funded by Spain and will have a major impact on the future of the observatory as a whole. ING is looking forward to this development with anticipation.
The following presents a selection of highlights, intended to be representative of the scientific quality and range of research being undertaken.

THE UNIVERSE WILL EXPAND FOREVER

WHT+ISIS, INT+PFC

New studies of supernovae in the farthest reaches of deep space indicate that the universe will expand forever because there isn’t enough mass in the universe for its gravity to slow the expansion, which started with the Big Bang.

This result rests on analysis of 42 of the roughly 78 type Ia supernovae so far discovered by the Supernova Cosmology Project. By the time the light of the most distant supernova explosions so far discovered by the team reached telescopes on Earth, some seven billion years had passed since the stars exploded. After such a journey the starlight is feeble, and its wavelength has been stretched by the expansion of the universe, i.e. red-shifting its wavelength. By comparing the faint light of distant supernovae to that of bright nearby supernovae, one could tell how far the light had travelled. Distances combined with redshifts of the supernovae give the rate of expansion of the universe over its history, allowing a determination of how much the expansion rate is slowing. Although not all type Ia supernova have the same brightness, their intrinsic brightness can be determined by examining how quickly each supernova fades.

Since the most distant supernova explosions appear so faint from Earth, last for such a short time, and occur at unpredictable intervals, the Supernova Cosmology Project team had to develop a tightly choreographed sequence of observations to be performed at telescopes around the world, among them, the Isaac Newton and the William Herschel telescopes. While some team members are surveying distant galaxies using the largest telescopes in Chile and La Palma, others in Berkeley are retrieving that data over the Internet and analysing it to find supernovae. Once they detect a
potential supernova they rush out to Hawaii to confirm its supernova status and measure the redshifts using the Keck telescope. Meanwhile, team members at telescopes outside Tucson and on La Palma are standing by to measure the supernovae as they fade away. The Hubble Space Telescope is called into action to study the most distant of the supernovae, since they are too hard to accurately measure from the ground.

Reaching out to these most distant supernovae teaches us about the cosmological constant. If the newly discovered supernovae confirm the story told by the previous 42, astrophysicists may have to invoke Einstein’s cosmological constant to explain the observed accelerated expansion of the universe. This cosmological constant has nowadays an interpretation in terms of vacuum energy density which works against gravity to produce the observed accelerated rate of expansion.

(1) The Supernova Cosmology Project is a collaboration between the following institutions: Lawrence Berkeley National Laboratory (USA), Institute of Astrophysics, Cambridge and Royal Observatory of Edinburgh (UK), LPNHE, Paris and College de France, Paris (France), University of Barcelona (Spain), and Isaac Newton Group, La Palma (UK and the Netherlands), Stockholm University (Sweden), ESO (Chile), Yale University (USA) and STScI (USA).

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The observing strategy allows the team to find sets of high-redshift supernovae on the rising part of their light curves and guarantees the date of discovery, thus allowing follow-up photometry and spectroscopy of the transient supernovae to be scheduled. The supernova light curves are then followed with scheduled R-, I- and some B-band photometry at the INT and other telescopes.
Left: INT image of a high-redshift type Ia supernova thousands of millions of light years away. When a star explodes as a type Ia supernova its brightness is similar to the host galaxy. This latter feature along with the possibility of calibrating their maximum brightness, make type Ia supernovae the best known standard candles to investigate the geometry and the dynamics of our universe. The plot below the INT image shows the best-fit confidence regions in the $\Omega_M - \Omega_\Lambda$ plane. The 68%, 90%, 95%, and 99% statistical confidence regions are shown. Note that the spatial curvature of the universe—open, flat, or closed—is not determinative of the future of the universe’s expansion, indicated by the near-horizontal solid line. In cosmologies above this near-horizontal line the universe will expand forever, while below this line the expansion of the universe will eventually come to a halt and recollapse. The upper-left shaded region, labelled ‘no big bang’, represents ‘bouncing universe’ cosmologies with no big bang in the past. The lower right shaded region corresponds to a universe that is younger than the oldest heavy elements for any value of $H_0 \geq 50 \text{ km s}^{-1} \text{ Mpc}^{-1}$.

Bottom left: Hubble diagram (effective B-magnitude at maximum versus redshift) containing 42 high-redshift supernovae (red dots) that could be width-luminosity corrected, and 18 from the lower-redshift Calán/Tololo Supernova Survey. Magnitudes have been K-corrected, and also corrected for the width-luminosity relation. The inner error bar corresponds to the photometry error alone, while the outer error bar includes the intrinsic dispersion of type Ia supernovae after stretch correction. The solid curves indicate theoretical model predictions based on different cosmological parameters. Bottom right: Isochrones of constant $H_0 t_0$, the age of the universe relative to the Hubble time, $H_0^{-1}$, with the best-fit 68% and 90% confidence regions in the $\Omega_M - \Omega_\Lambda$ plane. The isochrones are labelled for the case of $H_0 = 63 \text{ km s}^{-1} \text{ Mpc}^{-1}$. If $H_0$ were taken to be 10% larger, the age labels would be 10% smaller. The diagonal line labelled accelerating/decelerating is drawn for $q_0 = \Omega_M/2 - \Omega_\Lambda = 0$ and divides the cosmological models with an accelerating or decelerating expansion at present time. A value of $\Omega_\Lambda$ non-equal to zero is favoured from the data of all the observed supernovae.
THE FAINTEST KUIPER BELT OBJECTS

S tarting in 1992, astronomers have become aware of a vast population of small bodies orbiting the Sun beyond Neptune. There are at least 70,000 “Trans-Neptunians” with diameters larger than 100 km in the radial zone extending outwards from the orbit of Neptune (at 30 AU) to 50 AU. There may be many more similar bodies beyond 50 AU, but these are presently beyond the limits of detection. This population is generally referred to as the Kuiper Belt.

The Kuiper Belt holds significance for the study of the planetary system on at least two levels. First, it is likely that the Kuiper Belt objects are extremely primitive remnants from the early accretion phases of the Solar System. The inner, dense parts of the pre-planetary disk condensed into the major planets, probably within a few millions to tens of millions of years. The outer parts were less dense, and accretion progressed slowly. Evidently, a great many small objects were formed. Second, it is widely believed that the Kuiper Belt is the source of the short-period comets. It acts as a reservoir for these bodies in the same way that the Oort Cloud acts as a reservoir for the long-period comets.

Recently, two new Kuiper Belt objects have been discovered, named 1997 UG25 and 1997 UF25, and they are some of the faintest objects ever seen orbiting our Sun. One is estimated to be 150 km across and the other 110 km. Both are about 45 times farther from the Sun than Earth (4,200 million miles or 6,750 million kilometres), and more remote than the planet Pluto.

Based on present ideas about how Kuiper Belt objects formed, astronomers expected to be finding these faint objects at even greater distances. Since they did not, those ideas may need to be revised. It may be that the average size of the Kuiper Belt objects is smaller the farther away they are, so the most distant ones were too faint even for this survey. Or it might be that the objects actually discovered mark the outer edge of the Kuiper Belt.

The discovery team used the prime focus Wide-Field Camera at the Isaac Newton Telescope to image the sky for 7 nights, searching a total area slightly smaller than that covered by the full Moon. During each night they stared continuously at different patches of sky for up to four hours at a time. In each patch of sky several thousand distant stars and galaxies could be seen. However even these images were not sensitive enough to record the objects the team were seeking, so they combined the images by computer in a way that eliminated all stars, galaxies and nearby asteroids and revealed only faint Solar System objects at large distances from the Sun.

Left: Discovery image of 1997 UG25. The trans-neptunian object is the stellar-like object in the centre of the image. 1997 UF25 was discovered in images obtained on the 25th/26th October 1997. At a red magnitude of 25.0, it is so faint that it was only discovered by co-adding roughly 20 images of the same field. From observations over two nights, a distance of 44.9 AU was calculated. Right: Discovery image of 1997 UF25. Again, the trans-neptunian object is the stellar-like object in the centre of the image. At a red magnitude of 24.5, it was found in a similar manner to 1997 UF25. It may never be seen again, but was at a distance of around 43.3 AU at discovery.
THE BRIGHTEST OBJECT EVER OBSERVED

INT+IDS, JKT+JAG CCD

APM 0827+5255 is an extremely bright quasar four to five million, billion times brighter than the Sun and about 100 times brighter than the next brightest object that has been observed. The light from the quasar has been travelling to us for roughly 11 billion years, nearly 90% of the age of the universe and set out on its long journey when the universe was only about 10% of its present age.

The only way such a huge amount of energy could be generated is from accretion of dust and gas particles onto a super massive black hole, located at the centre of the quasar. The object’s apparent brightness actually comes from two different regions around the black hole. Light in the ultraviolet and optical range comes directly from an accretion disk surrounding the super massive black hole. Gas and dust and even entire stars are attracted by the black hole’s gravitation and generate energy, including light, from friction as they are torn apart and fall toward the black hole.

The second source of brightness, in the infrared portion of the spectrum, comes from dust further away from the central engine, which is heated by radiation from the centre of the quasar and which re-radiates this radiation at much longer wavelengths in the infrared.

Quasars are generally the most energetic objects observed in the universe. Each quasar generates more energy than the rest of a galaxy’s stars combined. Yet a quasar, its accretion disk and the glowing dust surrounding it occupy a relatively small amount of space, not much larger than the size of the Solar System.

Most quasars are not bright enough to reveal this strong infrared signature. However a few, much closer, ultra-luminous galaxies have similar properties. By comparing the newly discovered object with these fainter nearby well studied examples, it is possible to weigh the amount of dust in the object and find a staggering value of almost a billion solar masses. This is more than the entire dust mass in the Milky Way, yet has been created and accreted in a small fraction of the time and is contained in a volume the size of the Solar System.

Since this quasar is such a powerful beacon of light and has travelled 11 billion light years, it can also be used to investigate intervening objects that leave an imprint on the light from the quasar. By studying these imprints we can learn what conditions in the early universe were like and measure how primordial gas was converted into the stars and galaxies that we see around us today.

It is possible that some of these intervening absorbing systems may have acted as giant gravitational lenses and magnified the light from the quasar. Gravitational lenses are often seen to be the cause of apparently extremely bright objects. Typically, such a lens might exaggerate the real light level by a factor of 30 or 40, which however in this case, would still make APM 0827+5255 an order of magnitude brighter than its nearest competitor.

References:


**DISCOVERY OF A LOW-MASS BROWN DWARF COMPANION OF A YOUNG NEARBY STAR**

**WHT+ISIS, INT+IDS**

Direct imaging searches for brown dwarfs and giant planets around stars explore a range of physical separations complementary to that of radial velocity measurements and provide key information on how substellar-mass companions are formed. Any companion uncovered by an imaging technique can be further investigated by spectroscopy, which allows information about its atmospheric conditions and evolutionary status to be obtained. Young, nearby, cool dwarf stars are ideal targets of searches for substellar-mass companions (brown dwarfs and giant planets) using direct imaging techniques, because (i) young substellar objects are considerably more luminous when undergoing the initial phases of gravitational contraction than at later stages; (ii) stars in the solar neighbourhood (that is, within 50 pc of the Sun) allow the detection of faint companions at physical separations of several tens of astronomical units; and (iii) cool stars are among the least luminous stars, which favours full optimization of the dynamic range of current detectors to achieve detection of extremely faint companions by means of narrow-band imaging techniques at red wavelengths.

Using X-ray emission as an indicator of youth, a number of late-type stars (K and M spectral classes) was selected in the solar neighbourhood, of which deep images were obtained. After several targets of the programme were observed, a very red companion to the high-proper-motion M-class dwarf star G 196-3 was discovered 16.2 arcsec away from the star. This red companion was called G 196-B. Further photometry and spectroscopy allowed the astronomers to constrain spectral classification and proper motions of both stars, coming to the conclusion that G 196-3 is a M2.5 star and G 196-3B is a L brown dwarf. From the comparison with other known brown dwarfs they derived a temperature of 1800±200 K.

The observed optical and infrared colours present no strange anomaly that might be attributed to an unresolved less massive companion to G 196-3, and no indication of changes in the radial velocity is found beyond the uncertainties of the measurements determined with high-resolution spectra taken at the Isaac Newton Telescope over a time interval of several hours to days. This makes it very unlikely that the star is actually a close-contact binary. The spectral type combined with the observed fluxes indicate that the star is at a minimum distance of 15.4 pc.

An upper limit to the age of G 196-3 can be imposed from comparison to the Hyades cluster (600 My), where the average chromospheric and coronal emission of M2-M3 stars is considerably lower than in G 196-3. This star appears to be substantially younger than the Hyades, and hence 300 My is adopted, an age intermediate between that of the Pleiades and Hyades, as a reasonable upper age limit. The lower age limit can be derived from observations of Li I at 670.8 nm. Lithium is a fragile element that burns efficiently in the interiors of fully convective stars over short time scales (a few tens of millions of years). Convection drains material from the stellar atmosphere into the innermost layers, where the temperature is high enough for Li burning to take place. There are several models in the literature that predict the Li depletion rate as function of mass for low-mass stars and give consistent results. A search was made for the Li I line in G 196-3, and an optical spectrum was obtained with the Intermediate Dispersion Spectrograph. An upper limit on the equivalent width of 0.005 nm was imposed, which gives a Li depletion factor larger than 1,000 with respect to its original abundance. This constrains the age of the star to be older than 20 My. All these considerations provide a most likely age for G 196-3 that locates the star in the pre-main sequence evolutionary phase and thus at a more luminous stage than expected for its main-sequence lifetime.

According to the age range derived, the most probable distance from Earth to the system is 21±6 pc, the minimum value corresponding to the case of the primary star already on the main sequence and the maximum distance taking into account the youngest possible age.

Assuming this distance interval, the luminosity of the companion G 196-3B can be estimated from the measured I and K magnitudes and the K bolometric correction as a function of the colour (I through K). The values obtained are log \(L/L_\odot = 4.1\) when the oldest age (main sequence) is assumed and log \(L/L_\odot = 3.6\) for the youngest age (\(L_\odot\), Sun luminosity). The comparison of the optical and infrared magnitudes with the recent evolutionary tracks, which include dust condensation, allows the astronomers to conclude that the mass of G 196-3B is 25–10+15 Jupiter masses \(M_{\text{Jup}}\), where the upper and lower values result from the age limits discussed above.
An independent confirmation of the substellar nature of this faint companion was achieved with the detection of the Li I resonance doublet at 670.8 nm. An intermediate-resolution optical spectrum was obtained at the William Herschel Telescope using the ISIS double-arm spectrograph. The equivalent width of the doublet is $0.5 \pm 0.1$ nm that, using model atmospheres, gives an atmospheric abundance consistent with no depletion at all of Li. The presence of Li, combined with the low atmospheric temperature, rules out the possibility that the object is a star. Any brown dwarf with a mass below $65 \ M_{\text{Jup}}$ should preserve its initial Li content for its entire lifetime, and an object with such a small mass as that of G 196-3B should necessarily show a high Li content. Although in more massive substellar objects the presence of Li would help to determine its evolutionary stage more precisely through the time dependence of Li burning, for our object this detection provides a necessary check of consistency.

The distance to the system implies a physical separation between the two components of more than 250 AU, being 350 AU at 21 pc. It could be even larger if the system were younger and therefore more distant from the Sun. This large distance and the high mass ratio of 16:1 between the two components favour the fragmentation of a collapsing cloud as the most plausible explanation for the formation of the system. The possibility cannot be excluded, however, that the accretion of matter in a protoplanetary disc may produce an object more massive than $15 \ M_{\text{Jup}}$ at such large distances. Accretion discs extending up to several hundred astronomical units are known to exist around several stars. Surveys similar to that conducted here will provide a statistically significant number of substellar-mass companions that can be used to test the proposed formation mechanisms and may well promote the development of new ideas, as occurred because of the recent findings of giant planets with highly eccentric orbits around solar-type stars.

References:


**AN ARC OF EXTENDED EMISSION IN THE GRAVITATIONAL LENS SYSTEM Q2237+0305**

The quadruple system of images Q2237+0305 at $z=1.695$ is one of the most interesting gravitational lens system owing to the proximity of the lens galaxy and to the high degree of symmetry for which it is also named the ‘Einstein Cross’.

Two-dimensional spectroscopy of this system was obtained with the INTEGRAL fibre system in subarcsecond seeing conditions. The four components of the system, compact QSO images, appeared clearly separated in the continuum intensity maps. However, the intensity map of the C III] $\lambda 1909$ line exhibited an arc of extended emission connecting three of the four refracted components. This result can be explained if, as is usually assumed, the continuum arises from a compact source $\sim 0.05$ pc in extent in the nucleus of the object while the line emission comes from a much larger region. A lens model fitted to the positions of the four compact images also accounts for the arc morphology. In the framework of this model, the region generating the C III] $\lambda 1909$ emission would have dimensions of about $400 \ h^{-1}$ pc across. The astronomers interpret the observed arc as a gravitational lens image of the extended narrow line region of the source.

These results add to the observational domain a new type of gravitational lens system for integral field spectroscopy, where the lens galaxy images the extended narrow line region of the lensed QSO host.
steadily losing material to an accretion disk around
the white dwarf. The two stars are closer to each other
than Earth is to its Moon; they orbit one another every
82 minutes.

What sets AL Comae apart from other cataclysmic
binaries is the amount of mass shed by the white
dwarf’s companion. Although it seems to have started
out as a type-G or K dwarf with a mass approaching
our Sun’s, the astronomers place the companion’s
present-day mass at a mere 0.04 to 0.09 solar masses
(40 to 90 Jupiters). This mass value is similar to those
of brown dwarfs and of some massive planets in other
solar systems.

But AL Comae’s lightweight constituent is neither of
these. Rather, it appears to be an exposed stellar core
whose interior was mixed up as it lost mass to its
white-dwarf companion. This notion is buttressed by
the system’s hydrogen-poor spectrum and by the
companion’s inferred density: a thousand times
smaller than a white dwarf’s, yet a hundred times
larger than that of a regular main-sequence star.

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L223.

INTEGRAL is an optical fibre system for two-
dimensional spectroscopy which links the Nasmyth
focus of the WHT with the WYFFOS spectrograph.
INTEGRAL was designed and built by the Instituto de
Astrofísica de Canarias in collaboration with the Royal
Greenwich Observatory and the ING.

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3355, 821.

A STRIPPED-DOWN STELLAR
CORE

WHT+ISIS

In most binary systems, the component stars evolve
essentially independently. But in others, the stars
are so closely interacting that regular stellar evolution
is disrupted. AL Comae Berenices, a 21st-magnitude
object, consists of a 20,000 K white dwarf and a ruddy,
low-mass companion star. That companion has been

Left: Image of the Einstein Cross obtained with INTEGRAL. The four components of the lens system can be
seen, and superimposed on these, the spectra obtained with INTEGRAL at the William Herschel Telescope.
Right: Intensity map of the emission in the C III] λ1909 line. Orientation is as in the figure on the left.
Isophotes are linearly scaled between 0.02 and 0.2 with steps of 0.02 (units are arbitrary).
PALOMAR 1: A YOUNG GALACTIC HALO GLOBULAR CLUSTER

INT+PFC, IDS

Globular clusters are well known as the oldest conglomerations of stars in the Milky Way. Once thought all to have formed at roughly the same time, a small number of these clusters were recently found to have ages at least 3 Gyr younger than their siblings.

According to deep V and I CCD images of the loosely populated galactic globular cluster Palomar 1 and the surrounding field obtained with the Isaac Newton Telescope, an estimated age at 6.3 to 8 Gyr was derived. That makes Palomar 1 just over half as old as typical globulars and the youngest Galactic globular cluster identified so far. Also surprising are its comparatively low luminosity and uncrowded population of stars – unusual traits for a globular.

The astronomers have discussed the possibility that Palomar 1 is in fact a very old open cluster. But that would be an even worse fit for its properties. Furthermore, Palomar 1’s location in the outer halo, about 55,000 light-years from the Galaxy’s centre, would be difficult to reconcile with an open-cluster classification. An alternative explanation, which may also account for the other young globular clusters, could be a different formation process. Most globulars are thought to have coalesced at the same time as the Galaxy itself. The younger ones, on the other hand, may have come in three other ways: as gas clouds that survived in the halo after the Milky Way’s formation, later to form stars; as captured intergalactic star groups; or as cannibalised dwarf galaxies.

References:


THE SEARCH FOR EXTRA-SOLAR PLANETS

Planetary Systems: Their Formation and Properties

WHT, INT, JKT

The team EXPORT (EXoPlanetary Observational Research Team) was awarded the 1998 International Time Programme ‘Planetary Systems: their formation and properties’. The project focused on formation and evolution of planetary systems, the search for spectral signatures of extra-solar planet atmospheres, and planet searches.

Formation and evolution of planetary systems. An enormous data set including high and intermediate resolution spectroscopy, optical photopolarimetry and near-IR photometry of Herbig AeBe, T Tauri, UXORs and β Pic-like stars at different stellar evolutions stages was collected. The data were taken simultaneously, which is crucial since many of the phenomena that have to do with preliminary stages in planet formation are variable. Monitoring took place on time-scales of one night (hours), consecutive nights (days), different runs (months). The wide spectral coverage allowed the astronomers to study the behaviour of many transitions of different species and to establish correlations – if any – with broad-band photometry and polarimetry. A large number of the spectra show interesting and puzzling events: evidence of infalling solid bodies (possibly comets) by red-shifted Ca II and Na I components, rotating (possibly stable condensed structures) by flips in Hα components, and many other dynamical features. This data set seems to contain a key for the understanding of disk structures that might ultimately lead to planet formation.

Central 4.3' × 4.3' image of Palomar 1, taken with the I filter and an exposure time of 600s.
Spectral signatures of extra-solar planet atmospheres. After the detection of massive planets in close orbits around their star the question of their nature is raised. Although it seems that these planets are large gas giants, similar to Jupiter, large solid planets cannot be ruled out. For these observations, the astronomers adopted the hypothesis that the planets around the stars 51 Peg and τ Boo are large gas giants. Due to interaction with the UV flux of the star, stellar wind, or thermal escape, atoms and molecules of their atmosphere may escape and fill a large volume around the planet. Such extended exosphere could be detected by obtaining spectra of the stars during transit of their planets through the Earth-star line. Spectra of 51 Peg and τ Boo were obtained at the WHT using UES covering several atomic and ionic transitions of potential constituents in a Jupiter-like planet. The stars were observed on two consecutive nights: during transit of the planet and when the planet was not in the line-of-sight. The analysis of the spectra includes a very careful comparison of spectra taken on and off-transit.

Search for planets. More than a dozen exo-planets have been reported. These detections are based on the radial velocity method. Two competitive observing strategies are microlensing and planet transit searches in clusters. Both techniques can be carried out with small 1-m class telescopes. The JKT was hence used to obtain CCD images of two open clusters. The observing strategy consisted in taking R band images of the same cluster position, each image corresponding to a 10 min exposure. Several hundred images were obtained with roughly 1,000 stars within the field of view. This large amount of data provided very accurate light curves of the cluster stars. Many images have already been tested for transit events and several possible candidates have been found.

Extrasolar Planetary Transits

JKT+JAG CCD, INT+PFC

The TEP (Transits of Extrasolar Planets) network has been observing photometrically the eclipsing binary CM Dra since 1994. This is the first long-term observational application of the transit method for the detection of extra-solar planets.

The transit method is based on observing small drops in the brightness of a stellar system, resulting from the transit of a planet across the disk of its central star. Such transits would cause characteristic changes in the central star’s brightness and, to a lesser extend, colour. The depth of a transit is proportional to the surface area of the planet, and the duration of a transit is indicative of the planet’s velocity. If the central star’s mass is known, the distance and period can be obtained with great precision.

Previous observational tests have been prevented by the required photometric precision (which is about 1 part in 10^5 in the case of an Earth-sized planet transiting a sun-like star), and by the generally low probability that a planetary plane is aligned correctly to produce transits. An observationally appealing application is available with close binary systems, where the probability is high that the planetary orbital plane is coplanar with the binary orbital plane, and thus in the line of sight. This makes the observational detection of planetary transits feasible in systems with an inclination very close to 90°.

The CM Dra system is the eclipsing binary system with the lowest mass known. The total surface area of the system’s components is about 12% of the Sun’s, and the transits of a planet with 3.2 R_E (Earth radii), corresponding to 2.5% of the volume of Jupiter, would cause a brightness drop of about 0.01 magnitudes, which is within easy reach of current differential photometric techniques. The low temperature of CM Dra also implies that planets in the thermal regime of solar system terrestrial planets would circle the central binary with orbital periods on the order of weeks. This allows for a high detection probability of planetary transits by observational campaigns with coverages lasting more than one planetary period. Planets with orbital periods of 10–30 days around CM Dra are especially interesting, since they would lie within the habitable zone, which is the region around a star where planetary surface temperatures can support liquid water, and therefore the development of organic life. CM Dra is relatively close (17.6 pc) and has a near edge-on inclination of 89.82°. With this inclination, coplanar planets within a distance of CM Dra of ≈ 0.35 AU will cause a transit event. This maximum distance corresponds to a circular orbit with a period of about 125 days. There is also a low probability of observing orbits from planets inclined out of CM Dra’s binary orbital plane, if the ascending or descending nodes of the planetary orbits are precessing across the line of sight.

To obtain sufficient observational coverage, the TEP network was formed with the participation of several observatories in 1994. The final lightcurve contains 17,176 points acquired over three years, and gives a complete phase coverage for CM Dra. Six suspicious
events, one of them detected by the JKT, were found by planets with sizes between 1.5 and 2.5 \( R_E \). Such events are typified by being temporary faintenings of CM Dra's brightness by a few milimagnitudes, with normal durations of 45 - 90 minutes. However, none of these events has amplitudes compatible with planets larger than 2.5 \( R_E \). Planets smaller than 1.5 \( R_E \) cannot be detected in the data without a sub-noise detection algorithm. A preliminary signal detection analysis shows that there is a 50% detection confidence for 2 \( R_E \) planets with a period from 10 to 30 days with the current data.

References:


The INT and the Prime Focus Camera participated in a new Whole Earth Telescope (WET) campaign to observe AM Canum Venaticorum. 143.2 hours of time-series photometry were collected over a 12-day period. Thanks to the detection of 5 harmonically related frequency modulations, a successful disico-seismological interpretation was achieved for the first time (J-E Solheim et al, 1998, “Whole Earth Telescope observations of AM Canum Venaticorum – disico-seismology at last”, *Astron Astrophys*, 332, 939).

More evidence for a population of intracluster planetary nebulae in the Virgo cluster was found by observing a blank, 50-square-arcminute patch of the Virgo Cluster’s core using the Prime Focus Camera on the WHT. A planetary nebula can be seen only for a few thousand years of a star’s multi-billion-year life, and only the brightest planets can be detected at the cluster’s distance (50 million light-years). Consequently, the planetaries found may indicate that a significant fraction of the Virgo Cluster’s stars are intergalactic (R H Méndez et al, 1997, “More evidence for a population of intracluster planetary nebulae in the Virgo Cluster”, *Astrophys J*, 491, L23).

From high resolution spectra obtained with the UES, astronomers have found that the spectral type of the post-red supergiant IRC+10420 changed from F8I+ in 1973 to early A type in 1994, and is probably en route to landing among the Wolf-Rayet stars. So far IRC+10420 is the only object known in this transition phase (R D Oudmaijer, 1998, “High resolution spectroscopy of the post-red supergiant IRC+10420”, *Astron Astrophys Suppl*, 129, 541).

Pulsars spin from several dozen times to a second to once every few seconds. Their rotation is left over from their birth, when the core of a massive star collapsed in a supernova explosion. Millisecond pulsars however weren’t born that way; a collapsing supernova core might not have that much angular momentum. Something probably spun them up later. The usual explanation has been that a close companion star transferred angular momentum to the pulsar by pouring mass onto it. A binary system called SAX J1808.4-3658 has finally been caught in the midst of this spin-up process. In April this object flared up for several weeks and astronomers examined it with the Rossi X-Ray Timing Explorer, finding that its X-ray output pulses 401 times per second. Announcements followed and quickly brought other teams into the chase. Finally the JKT identified a 16.6 magnitude star at the X-ray source’s location as the optical counterpart of the X-ray transient (P Roche, 1998, ING Annual Report 1999 • 21

Planetary transit event candidate as observed at the JKT. The lightcurve is plotted against the phase of CM Dra. The data are shown as squares; the line indicates a smoothing fit to the data.

**OTHER HIGHLIGHTS**

Observations carried out by the Isaac Newton Telescope greatly improved the orbit determination of two recently discovered distant irregular moons of Uranus (B J Gladman et al, 1998, “Discovery of two distant irregular moons of Uranus”, *Nature*, 392, 897). Both moons, S/1997 U1 and S/1997 U2, are unusually red in colour, suggesting a link between these objects—which were presumably captured by Uranus early in the Solar System’s history— and other recently discovered bodies orbiting in the outer Solar System.
The ING telescopes continued to search for optical counterparts of Gamma-Ray Bursts and follow them up photometrically. The wide field of view and sensitivity of the imaging instruments on the WHT, INT and JKT, along with a rapid response thanks to the override programme, allowed the astronomers to observe and make stronger restrictions on the possible models for GRBs (*IAU Circulars 6806, 6848, 6855*).

A spectroscopic study of seven galactic H II regions was performed using the INT, with the aim of determining and comparing the gaseous iron abundance in nebulae located at different galactocentric distances and characterised by different physical conditions. The resulting iron abundances relative to oxygen are found to be 3 to 30 times lower than the solar value, implying that most of the iron atoms are depleted on to the dust grains known to coexist with the ionised gas.

Motivated by recent discoveries of nearby galaxies in the Zone of Avoidance (e.g. Dwingeloo 1 discovered by the INT in optical light in 1994) a new search for more new galaxies through the dusty, obscuring plane of the Milky Way was carried out. 10 out of 18 candidates were confirmed spectroscopically as galaxies by the INT, making for a better than 50 percent success rate (O Lahav, 1998, “Galaxy candidates in the Zone of Avoidance”, *MNRAS, 299*, 24).

Thanks to ISIS observations of the cataclysmic variable BZ Camelopardalis, astronomers were able to measure the acceleration law of a cataclysmic variable wind for the first time. They found that the velocity increases linearly with time in 6 to 8 minutes after starting near rest. They also found a subsequent linear deceleration to nearly rest in 30-40 minutes (F A Ringwald and T Naylor, 1998, “High-speed optical spectroscopy of a cataclysmic variable wind: BZ Camelopardalis”, *Astron J, 115*, 286).

The fifth large MUSICOS (Multi-Site COntinuous Spectroscopy) campaign took place at the end of 1998 and it involved 13 telescopes mostly equipped with cross-dispersed echelle spectrographs. The ESA-MUSICOS spectrograph, first commissioned in April 1996 and installed in the INT, participated again in this campaign. This spectrograph has also been offered to the general community and used for programmes of stellar variability, support to space observations, and as part of multi-site campaigns.

“SAX J1808.4-3658 = XTE J1808-369”, *IAU Circular 6885*), which allowed other astronomers to carry out optical observations confirming the binarity of the system. The entire picture of SAX J1808-3658 was assembled by independent teams in just 10 days and it’s the first binary millisecond X-ray pulsar ever found.

The fifth large MUSICOS (Multi-Site COntinuous Spectroscopy) campaign took place at the end of 1998 and it involved 13 telescopes mostly equipped with cross-dispersed echelle spectrographs. The ESA-MUSICOS spectrograph, first commissioned in April 1996 and installed in the INT, participated again in this campaign. This spectrograph has also been offered to the general community and used for programmes of stellar variability, support to space observations, and as part of multi-site campaigns.
New Instrumentation and Enhancements

WILLIAM HERSHEYEL TELESCOPE

The most important instrument development project for the WHT is the common-user adaptive optics system, NAOMI, which progressed well during 1998. The NAOMI project aims to deliver a focal plane of the telescope in which wavefront distortions introduced mainly by the atmosphere are corrected to a high degree. To this end, first the rapidly varying wavefront distortions are sensed many times per second. Based on that information, subsequently all adjustable elements of a segmented mirror are positioned in such a way that the light reflected off this mirror is corrected for the distortions originally introduced by the atmosphere. The result will be diffraction limited image quality in the near infra-red, and very substantial improvement of image quality at visible wavelengths. The first instrument that will be used to exploit this adaptive-optics corrected focus will be an infra-red imaging camera. First implementation of NAOMI will use natural guide stars to determine the required wavefront corrections, but future developments could include laser guide stars. NAOMI is a collaborative development between the University of Durham, the UK Astronomy Technology Centre in Edinburgh, and the ING.

At the core of the adaptive optics system is the ELECTRA segmented mirror, developed at Durham University. This segmented mirror consists of 76 elements, each of which can be positioned very quickly and accurately to take out the rapidly changing wavefront distortions. The mirror motions are controlled by actuators, and accurate strain-gauges provide hysteresis compensation. The fully functioning segmented mirror has been successfully tested at the telescope, producing images with a width of only 0.15 arcseconds. Other components of the NAOMI system such as the opto-mechanical chassis and the wavefront sensor have continued to make progress. At the telescope the Nasmyth enclosure is being prepared for future deployment of the adaptive optics system.

The ING Red Imaging Device, INGRID, is the new infra-red camera for the WHT, replacing WHIRCAM. This new camera is based around a 1024 × 1024 elements
HgCdTe array from Rockwell and is optimized for a wide field of view at relatively short wavelengths, with good performance expected up to a wavelength of 2.2 microns. This camera will primarily be deployed at the Cassegrain focus of the WHT for direct imaging at a pixel scale of 0.25 arcseconds/pixel, and it will be the principal detector for the NAOMI Adaptive Optics system, where it will provide a pixel scale of 0.04 arcseconds/pixel. Work on the camera has progressed well, although difficulties were encountered due to the closure of the Royal Greenwich Observatory where the project was originally carried out. Commissioning of the camera is expected to take place during the first quarter of 2000.

Commissioning of the WYFFOS echelle mode was successfully completed in August 1998. In this mode, one of 5 orders is selected with an order-sorting filter, giving a range on the current CCD of between 580 and 250 Å, and highest resolution 0.8 Å.

The Instituto de Astrofísica de Canarias is developing a cooled near-infrared spectrograph for the Cassegrain focus of the WHT. This instrument, named LIRIS, will use a Rockwell 1024 ×1024 HgCdTe array covering a large spectral range and a wide spatial field of view. The optical design by the UK-Astronomy Technology Centre has been completed. ING and the IAC are collaborating to achieve a high level of commonality between the data acquisition and instrument control systems of INGRID and LIRIS. This ensures fast and full integration of LIRIS in the existing infrastructure.

ISAAC NEWTON TELESCOPE

The INT Wide Field Camera was upgraded from the set original Loral CCDs to four thinned, large format 4k × 2k EEV CCDs. These EEV devices combine much improved data quality with excellent quantum efficiency, and at the same time more than double the field of view. Commissioning of the upgraded array took place in April 1998, leaving a fully operational system for scheduled observing, and making the INT Wide Field Camera the largest optical imager using thinned chip technology.
The Cambridge Institute of Astronomy’s CIRSI IR panoramic camera (J, H bands) was fully commissioned at the INT and WHT prime foci. The detector comprises a mosaic of 4 Rockwell 1024 × 1024 pixel devices. This is currently the largest-area near-IR camera in the world, which makes it a highly competitive instrument in the near infrared.

**DETECTOR ENHANCEMENTS**

The main line of detector development concentrated on procurement, testing and commissioning of the new generation of 2k × 4k thinned CCDs from EEV. By the end of the year two of these devices were in regular use on the telescopes and had become the detectors of choice for most of the observations. Their excellent quantum efficiency at short wavelengths, combined with good spatial resolution, low read noise and high cosmetic quality renders these detectors the best currently available for nearly all areas of observations. The final stage of delivery of these devices will include a two-chip mosaic to be deployed at the prime focus of the WHT. Future procurement of new detectors will concentrate on devices with high quantum efficiency at longer wavelengths, and with reduced fringing.

A programme was initiated to replace the current generation of CCD controllers with San Diego State University (SDSU) controllers. These controllers have various benefits over the existing controllers, such as much faster readout speeds, lower susceptibility to pickup noise, are easier to configure, and share commonality with many other observatories (e.g. the Gemini telescopes). The first of these controllers will be deployed at the INT during the summer of 1999.
Telescope Operation

TELESCOPEs

Telescope operation has enjoyed a year of relative stability with telescope downtime due to technical problems averaging 2.7, 5.2, and 2.3% on the WHT, the INT, and the JKT, respectively. The relatively high down-time on the INT results from having introduced several new control systems as explained further on in this report.

The international collaboration on which our organisation is based was extended in 1998. Following the signing of an international agreement, the University of Porto joined ING in February. As part of this collaboration the University of Porto obtains 28 nights of observing time on the JKT and access to the INT and WHT under open competition with other astronomers through the normal peer review process. The University of Porto has placed personnel at ING in support of telescope operation.

The scientific role of the Isaac Newton Telescope evolved in a substantial way through the initiation of large scale survey observation using the prime focus Wide Field Camera. At its meeting in October 1997 the UK/NL Joint Steering Committee considered a proposal to devote a substantial percentage of observing time on the INT to survey observations. It was considered timely, given the advent of the Wide Field Camera, to exploit this unique instrument extensively, in particular for survey observations serving a wide community of researchers. This new initiative also allowed the telescope to evolve in a way that best serves the new generation of large telescopes. In addition, a severe budgetary constraint on the operation of the ING telescopes forces the observatory to look for more cost-effective ways of running the telescopes. The survey observations provide a step in this direction.

An Announcement of Opportunity was sent out inviting the UK and NL community to propose large-scale survey programmes to be carried out with the Wide Field Camera. This announcement met with a very good response. An independent assessment panel recommended priorities and the amount of observing time that
should be devoted to these survey observations. Subsequently observing time was granted on condition that the raw and reduced data should be made available to the UK/NL community as quickly as possible after the observations have been taken, to allow fast exploitation of the unique database.

The Wide Field Survey observations duly commenced in August 1998. The approved programmes cover a wide range of science topics. The largest programme, a wide-angle survey covering more than 100 square degrees in multiple wavebands, will address key issues ranging from the determination of cosmological parameters to the search for Solar System objects. A second programme will take very deep images over a number of selected fields to study the evolution of galaxy clustering, to yield a catalogue of rich galaxy clusters, and to detect significant numbers of quasars. The third programme will study variability of all objects over 100 square degrees of sky at mid-galactic latitudes in support of a wide variety of investigations including stellar population studies, Kuiper Belt objects, and Gamma-ray Bursters.

Modernisation of the general telescope infrastructure passed an important milestone with the installation of a DEC-Alpha based Telescope Control System on all three telescopes, replacing the old computers and software systems. The common platform for the three telescopes has greatly reduced the support effort. A further milestone has been the installation on the JKT of a new Unix based data acquisition system and instrument control system, similar to the one already in operation at the INT. These upgrades have much reduced observing overheads and improved user friendliness of the observing systems. The INT has reached a level of integration where a single person can operate the telescope without much difficulty, and, equally important, through observing scripts the telescope can operate unassisted for extensive periods.

The Faint Object Spectrograph, FOS-2 on the WHT was decommissioned. The main Cassegrain spectrograph, ISIS, already covers most of the functionality offered by FOS-2, and therefore that instrument was no longer competitive.

The primary mirrors of the three telescopes were aluminised in autumn. Regular CO2 snow cleaning of the primary mirrors allows longer periods between aluminising runs and from now on the mirrors will not be aluminised annually. New digital positional sensors were fitted to the WHT mirror cell during the aluminising exercise, which allows re-positioning of the mirror to higher accuracy. Shack-Hartmann tests of the optical quality after the mirror had been re-seated confirmed its successful re-placement.

An extensive campaign to assess the influence of the local environment on the image quality that is delivered at the focus of the WHT was completed during 1998. This campaign comprised regular measurements of the wavefront distortions in the Nasmyth focus, independent ‘natural’ seeing measurements using a Differential Image Motion Monitor (DIMM), long term monitoring of various meteorological parameters, extensive thermometry within the dome and telescope structure, and analysis of energy dissipation in the building. Over the years many improvements were implemented to protect the dome environment against excessive warming up during the day. The most important impact was the installation during the autumn of 1996 of a more effective bearing oil cooling system that has significantly reduced image degradation within the dome. Analysis of the wave front sensor data and DIMM seeing measurements collected over more than two years have now shown that image degradation arising within the dome introduces a (maximum) image spread of 0.25 arcsec. When added in quadrature to the median year round site seeing of 0.71 arcsec, image degradation caused within the dome contributes no more than 0.1 arcsec to the image spread. The extensive statistics that have been collected on natural seeing at the observatory confirms that the Roque de los Muchachos Observatory enjoys excellent seeing conditions comparable to those of the best sites in the world.

A detailed assessment of ING’s susceptibility to the Year 2000 problem was initiated. A risk analysis will be carried out, and solutions will be implemented where necessary. The observing system on the three telescopes will be tested on Year 2000 compliance well before the millennium date change.

The work model for day-to-day operation of the telescopes was substantially changed with the introduction of the Operations Team. This model is designed to provide a better focus on operational engineering duties, and to improve the skill base required for operational duties. The long-term goal is to reduce the number of staff required for operational duties and to make more time available for enhancement and development work.
OBSERVATORY INFRASTRUCTURE

New instruments and large format CCDs, in particular those used in the Wide Field Camera on the INT, have resulted in far greater volumes of data. This development highlighted the urgent need for upgrading the computer network infrastructure and computing power at the observatory. The much larger data rates required a different network topology and improved data handling and storage facilities. New backbone fibre optics cables were installed between the telescopes, data network bottlenecks were cleared by installing local ethernet switches and by resolving network configuration problems. Future steps will include installation of new workstations, servers, backup systems, and data storage capacity.

In support of instrument development work on the new multiple fibre optics unit for AUTOFIB a fibre optics laboratory has been set up in the observatory offices in Santa Cruz. For similar reasons of extended maintenance activities on CCD detectors a well laid-out test facility in the WHT building was completed. Future major development work on detectors and controllers will, however, take place in the observatory building at sea level and in collaboration with the UK ATC.

Following the closure of the Royal Greenwich Observatory in Cambridge, part of the RGO library was transferred to ING. This transfer implies a substantial extension of the existing library, which will be a great benefit to research activities.

ING VISITING PANEL REPORT

The UK/NL Joint Steering Committee (JSC) set up an ING Visiting Panel to review the operation and development of the ING in order to provide an international and independent perspective on its operation and needs. The Visiting Panel made recommendations to the JSC and the Director of the ING. The Visiting Panel was asked to comment on the international competitiveness of the ING and its likely astronomical prospects in the era of 8-m class telescopes, to review how the ING is organised, and to comment on the requirements for the facility to ensure that the astronomical needs of the user communities in the United Kingdom and the Netherlands are satisfied in the best possible way.

The Visiting Panel constituted of Dr Russell Cannon (Chairman, Anglo-Australian Observatory), Prof Marijn Franx (University of Leiden), Prof Ken Freeman (Mount Stromlo and Siding Spring Observatories), Dr Augustus Oemler (Carnegie Institution of Washington), and Dr Richard Wade (Rutherford Appleton Laboratories).

The report submitted by the Panel touches on many important aspects concerning the current state and future direction of the observatory. The Panel's overall impression is that the ING is functioning as an internationally competitive optical observatory, and that the funding and staffing levels are appropriate for the current programme. Given good management and adequate resources, the ING should be able to maintain its position and continue to make a cost-effective contribution to astronomy in the United Kingdom and the Netherlands. Provided that it is run efficiently, and is equipped with instruments which can compete with or complement those on larger-aperture telescopes, the ING will remain viable indefinitely. To this end, the ING must develop a long-term instrumentation plan, soundly based on astronomical objectives and exploiting the quality of the telescopes and the site. The report stresses that although ING is currently functioning at an appropriate level in comparison with similar international observatories, the ING must find ways to undertake cost-effective cutting-edge science in the era of 8-m telescopes. It also recommended that a larger amount of the resources available to ING be channelled towards development of instrumentation. Possible ways to achieve this are through simplifying telescope operation, and by establishing more suitable facilities at sea level. On the issue of external management the Panel commented that the current arrangements are unwieldy and inefficient, and that a simpler linear structure is needed. The Panel's recommendations were welcomed and endorsed by the JSC and steps are being taken to implement them.
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/commissioning time.

The PPARC-NWO Joint Steering Committee has delegated the task of time allocation to British and Dutch astronomers to the PPARC Panel for the Allocation of Telescope Time (PATT). On the other hand it is the responsibility of the IAC to allocate the Spanish time via the Comité para la Asignación de Tiempos (CAT). The ratio of UK PATT:CAT:NL PATT:ITP is nominally 60:20:15:5. This ratio is monitored and small differences in these proportions in any one year are corrected over a number of observing seasons.

Service nights listed in the following table belong to UK PATT and NL PATT (ratio 5:1). CAT also provides service time out of their quota. The aim of the ING service 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 per night.

Discretionary nights are used partly for 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. They are scheduled together with service nights for greater flexibility, but a careful record of service observations per nationality is kept.

Stand-down and commissioning time is used for basic maintenance, quality control, and upgrades to the telescope and instrument systems.

The way the available observing time on the ING telescopes has been shared in semesters 98A and 98B is summarised in the following table.
LARGE SCALE IMAGING SURVEYS WITH THE INT WIDE FIELD CAMERA

During the spring of 1997 the Wide Field Camera was commissioned in the prime focus of the INT. This new instrument offers unique opportunities for the UK/NL communities to execute high resolution, deep, wide field optical imaging surveys.

At its meeting in October 1997 the Joint Steering Committee considered ways to stimulate the use of the INT Wide Field Camera for survey programmes. The Committee reflected on the changing role of the INT in the era of the 8-meter class telescopes. It considered the INT ideally suited for programmes of target selection for later follow-up study with large telescopes, and for larger scale survey programmes with a clear scientific goal in their own right. This observing time will be allocated independently from the existing time allocation committees such as PATT, the NL PATT, and the CCI International Time Projects.

The JSC delegated the assessment and peer review of these programmes to the ING Survey Review Panel (ISRP). The ISRP reported to the May 1998 meeting of the JSC and recommended that five weeks of time be devoted to survey programmes in semester 98B and six weeks in semester 99A.
Use of instrumentation for semesters 98A+98B

**William Herschel Telescope**

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**Isaac Newton Telescope**

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**Technical down time**

**Weather down time**
### Percentage of weather and technical down time by semester

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</tr>
<tr>
<td>95A</td>
<td>15.8</td>
<td>2.8</td>
<td>18.1</td>
<td>3.6</td>
<td>14.8</td>
<td>3.1</td>
</tr>
<tr>
<td>95B</td>
<td>38.8</td>
<td>3.4</td>
<td>33.8</td>
<td>2.9</td>
<td>33.7</td>
<td>0.9</td>
</tr>
<tr>
<td>96A</td>
<td>29.2</td>
<td>3.1</td>
<td>25.5</td>
<td>2.1</td>
<td>37.9</td>
<td>3.5</td>
</tr>
<tr>
<td>96B</td>
<td>37.2</td>
<td>1.7</td>
<td>28.9</td>
<td>2.2</td>
<td>34.9</td>
<td>2.3</td>
</tr>
<tr>
<td>97A</td>
<td>10.1</td>
<td>3.3</td>
<td>17.6</td>
<td>3.2</td>
<td>20.7</td>
<td>3.7</td>
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<tr>
<td>97B</td>
<td>24.0</td>
<td>3.7</td>
<td>25.2</td>
<td>4.8</td>
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</tr>
<tr>
<td>98A</td>
<td>15.6</td>
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<td>18.6</td>
<td>5.7</td>
<td>19.3</td>
<td>1.6</td>
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<tr>
<td>98B</td>
<td>21.1</td>
<td>2.9</td>
<td>18.5</td>
<td>4.8</td>
<td>21.2</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Public Relations

1998 has been a year of intensive work as far as public relations is concerned. We have not only dealt with numerous requests for information from many different organisations, but also have received many visits. Because of this ING has very much welcomed the news that the Spanish government plans to build a visitors’ centre at the observatory.

A total of 5,905 people visited the ING in 1998. 134 visits were organised throughout the year and 90 during the Open Days. Most of the visitors are from Spain and in particular from the Canary Islands. However it’s remarkable the high number of visits from the United Kingdom and the Netherlands. Excluding the Open Days, schools and astronomers are the most frequent visiting groups. The most visited telescope was the WHT with 5,406 visitors followed by the INT with 1,248 visitors.

As during previous years, three public Open Days were organised this summer and they attracted more visitors than ever before. More than 5,000 people visited the Observatory, of which over 3,000 came to see the ING telescopes.

ING has now established relationships with the Royal Astronomical Society, the recently set up Royal Observatory Greenwich at the National Maritime Museum in London, and the British Astronomical Society.

Amateur astronomers, Nik Szymanek and Ian King from the UK Deep Sky CCD imaging team produced an impressive collection of photo-compositions, which were very kindly provided to ING. These photos have been published by many different and prestigious astronomical publications. We have also used the photographs to make a start with our own collection of souvenirs.

The SPECTRUM newsletter was effectively discontinued with the closure of the Royal Greenwich Observatory. The resulting vacuum in the dissemination of information about the ING will be addressed by creating an ING Newsletter which will be published and distributed both in printed form and through the World Wide Web.

A total of 11 press releases were sent out reporting on scientific discoveries following from observations at ING and other news.
These plots show some statistics of the visits to the ING telescopes in 1998. In spite of not organising casual visits to the ING, the number of visitors is very high every year - only group visits by school parties, amateur astronomical societies and similar bodies are organised. Hence, Open Days are essential giving a positive response from the visitors.
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 three telescopes have complementary roles. 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 2.5m diameter primary mirror and is mostly used for wide-field imaging and spectroscopy. The JKT has a primary mirror of 1m diameter. It is mainly used for observing relatively bright objects. Both INT and JKT were first operational in May 1984.

The Isaac Newton Group operates the telescopes on behalf of the Particle Physics and Astronomy Research Council (PPARC) of the United Kingdom and the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO) of the Netherlands.

The following table shows each telescope’s location:

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Ground Floor Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHT</td>
<td>28° 45’ 38.3” N</td>
<td>17° 52’ 53.9” W</td>
<td>2,332 m</td>
</tr>
<tr>
<td>INT</td>
<td>28° 45’ 43.4” N</td>
<td>17° 52’ 39.5” W</td>
<td>2,336 m</td>
</tr>
<tr>
<td>JKT</td>
<td>28° 45’ 40.1” N</td>
<td>17° 52’ 41.2” W</td>
<td>2,364 m</td>
</tr>
</tbody>
</table>

The ING is located at the Observatorio del Roque de Los Muchachos (ORM), on the island of La Palma. The ORM, which is the principal European northern hemisphere observatory, is operated on behalf of Spain by the Instituto de Astrofísica de Canarias (IAC), as is the Teide Observatory on Tenerife. 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 Carlsberg Meridian Telescope, the 3.6m Italian Galileo National Telescope, the 2.5m Nordic Optical Telescope, the 60cm telescope of the Swedish Royal Academy of Sciences, the 50cm Swedish Solar Telescope, the 45cm Dutch Open Solar Telescope, and the German High Energy Gamma-Ray Array.
The observatory occupies an area of 1.89 square kilometres approximately 2,350m 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 Archipelago and the Canary Islands are an autonomous region of Spain.

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. The site is clear of cloud for 90 per cent of the time in the summer months.

The construction, operation, and development of the ING telescopes is the result of a collaboration between the United Kingdom and the Netherlands. The site is provided by Spain, and in return Spanish astronomers receive 20 per cent of the observing time on the telescopes. A further 75 per cent is shared by the United Kingdom and the Netherlands. On the JKT the international collaboration embraces astronomers from Ireland and the University of Porto (Portugal). The remaining 5 per cent is reserved for large scientific projects to promote international collaboration between institutions of the CCI member countries. The allocation of telescope time is determined by scientific merit.

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

THE INTERNATIONAL AGREEMENTS

The international agreements by which the Roque de Los Muchachos and 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 later 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 PPARC-NWO JOINT STEERING COMMITTEE

The PPARC and the NWO have entered into collaborative agreements for the operation of and the sharing of observing time on the ING telescopes. The Joint Steering Committee (JSC) has been set up to oversee the operation of this agreement, to foster and develop collaboration between astronomers of the United Kingdom and the Netherlands and to ensure that the telescope installations are maintained in the forefront of world astronomy. In particular, the JSC oversees the construction programme of the telescopes and instrumentation, determines the programme of operation, maintenance and development of the installations, approves annual budgets and forward estimates and determines the arrangements for the allocation of observing time.
TELESCOPE TIME AND DATA OWNERSHIP

Spain has at its disposal 20 per cent of the observing time on each of the three telescopes. It is the responsibility of the IAC to make this time available to Spanish institutions and others, via the Comité para la Asignación de Tiempos (CAT).

A further 5 per cent of the observing time is for international collaborative programmes 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.

The remaining 75 per cent of the time is distributed as follows. The PPARC and NWO share the time on all three telescopes with 80 per cent being allocated to PPARC and 20 per cent to NWO. The PPARC-NWO Joint Steering Committee has delegated the task of time allocation to astronomers to the PPARC Panel for the Allocation of Telescope Time (PATT), which has set up procedures for achieving the 80 : 20 ratio whilst respecting the separate priorities of the United Kingdom and Dutch communities. The PPARC has made 27 nights per year of its share on the JKT available to the National Board of Science and Technology of Ireland (NBST) and the Dublin Institute for Advanced Studies (DIAS). The Irish Advisory Committee for La Palma set up by the two Irish Institutions has decided that JKT proposals by Irish astronomers should also be submitted to PATT. Irish astronomers are not however discouraged from applying for use of the other telescopes of the ING. PATT includes representatives from the Netherlands and the Republic of Ireland.

In a similar way, the University of Porto (Portugal) has 28 nights of observing time on the JKT and access to the INT and WHT under open competition with other astronomers.

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.

PATT allocates time on all PPARC supported telescopes in two semesters, from 1 February to 31 July (semester A) and from 1 August to 31 January (semester B). The corresponding closing dates are the end of September and March respectively. Decisions on time allocations are made on the basis of scientific merit and technical feasibility of the proposed observations.

The PPARC-NWO JSC and the CCI have decided that 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 or CAT scheduled astronomers, or by service requests.
Telescope Instrumentation

The INT and JKT are equipped with a restricted set of instruments that match the capabilities of the telescopes whilst satisfying the requirements of a large percentage of users. The number of instrument changes on these telescopes is kept to a minimum to reduce costs and increase reliability. The design of the WHT allows much greater flexibility, since it is straightforward to switch between the Cassegrain and the two Nasmyth focal stations, and a much greater variety of instruments may be left on the telescope. A broad functional division between the WHT, INT and JKT is as follows:

**WHT**
- Spectroscopy and spectropolarimetry over a wide range of resolving powers
- Multi-object spectroscopy
- Areal (fibre bundles) spectroscopy
- CCD imaging
- Infrared imaging
- High-resolution imaging and other projects in a laboratory environment
- Fabry-Perot imaging spectroscopy

**INT**
- Intermediate- and low-dispersion spectroscopy
- CCD imaging

**JKT**
- CCD imaging

The following table summarises the common-user instruments which were available during 1998.
<table>
<thead>
<tr>
<th>Focus</th>
<th>Instrument</th>
<th>Detector</th>
</tr>
</thead>
<tbody>
<tr>
<td>William Herschel Telescope</td>
<td><strong>Cassegrain</strong> ISIS double spectrograph</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td></td>
<td>TAURUS Fabry-Perot imager</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td></td>
<td>Low Dispersion Survey Spectrograph (LDSS-2)</td>
<td>SITe CCD</td>
</tr>
<tr>
<td></td>
<td>CCD imager (Acquisition and Guidance Unit Auxiliary Port)</td>
<td>Tektronix CCD</td>
</tr>
<tr>
<td></td>
<td>TAURUS CCD imager (f/2 or f/4)</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td>Nasmyth</td>
<td>Ground Based High Resolution Imaging Laboratory (GHRIL)</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td></td>
<td>William Herschel Infrared Camera (WHIRCAM)</td>
<td>InSb array</td>
</tr>
<tr>
<td></td>
<td>Utrecht Echelle Spectrograph (UES)</td>
<td>SITe CCD</td>
</tr>
<tr>
<td></td>
<td>INTEGRAL</td>
<td>Tektronix CCD (WYFFOS at GHRIL)</td>
</tr>
<tr>
<td>Prime</td>
<td>Prime Focus Camera</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td></td>
<td>Autofib Fibre Positioner (AUTOFIB-2)</td>
<td>Tektronix CCD (WYFFOS at GHRIL)</td>
</tr>
<tr>
<td>Isaac Newton Telescope</td>
<td><strong>Cassegrain</strong> Intermediate Dispersion Spectrograph (IDS)</td>
<td>Tektronix and EEV CCDs</td>
</tr>
<tr>
<td></td>
<td>Faint Object Spectrograph (FOS-1)</td>
<td>Loral CCD</td>
</tr>
<tr>
<td>Prime</td>
<td>Wide Field Camera</td>
<td>4 × EEV CCDs</td>
</tr>
<tr>
<td>Jacobus Kapteyn Telescope</td>
<td><strong>Cassegrain</strong> JAG CCD camera</td>
<td>Tektronix and SITe CCDs</td>
</tr>
</tbody>
</table>
During 1998, the staffing position at the ING was a little more stable after the significant turnover that had occurred during 1997. However, there was a significant change in the management team through a mixture of new arrivals and internal promotions.

For 1998, the telescope managers were: for the WHT, Dr C R Benn; for the INT, Dr N A Walton; and for the JKT, Dr J H Telting.

The financial year 1998/99 saw a further reduction in the level of UK staff effort for La Palma operations from 36.6 of the previous year (29.6 staff on-island and 7 staff at the RGO) to 29.6 (27.6 on island and 2 in Cambridge). The total approved staff effort for the Netherlands was 6.9 on-island and 1 in Cambridge.

For many years the La Palma Support Group of the Royal Greenwich Observatory’s Astronomy Division had provided astronomical support for the ING. Latterly, the Support Group had been headed by Dr Bill Martin who sadly died during December 1998. He will be missed by his many friends from the Royal Observatories and the astronomy community as a whole.

The list of staff in post on La Palma during 1998 is set out below.

MANAGEMENT

R G M Rutten, Director
R L Miles, Bilingual Secretary

ADMINISTRATION

M Acosta
E C Barreto
L I Edwins, Head of Administration
A Felipe
S S Hunter
M Lorenzo
J Martinez
H J Watt (from 19/10/98)
ASTRONOMY

M W Asif (to 8/10/98)
M Azzaro
C R Benn
M Broxterman
J N González
D Lennon (from 1/07/98), Head of Astronomy
C Martín
J Méndez
C Moreno (to 18/12/98)
N O’Mahony
C Packham
D Pollacco
J C Rey
S J Smartt
P Sorensen
J Telting
N A Walton

Students:
J Abbott (from 1/9/98), University of Hertfordshire
A Humphrey (from 1/9/98), University of Hertfordshire

ENGINEERING

R G Talbot, Head of Engineering

Engineering Groups:

Computing Facilities

D-C Abrams (from 9/10/98)
V Borraz (to 23/1/98)
L Hernández (from 16/03/98)
N R Johnson (from 1/1/98)
G F Mitchell
P G Symonds
P v d Velde

Control Software

D Armstrong (from 2/2/98)
M Bec (from 16/2/98)
S M Crosby
P M Fishwick (to 31/7/98)
F Gribbin
P C T Rees (to 17/2/98)
S G Rees

Electronics

C Benneker
S J Crump (to 30/6/98)
T Gregory
A Guillén
C Jackman
K Kolle
R Martínez
E J Mills
P Moore
R J Pit
A Ridings
G Woodhouse

Mechanical Engineering

F Concepción
K M Dee
K Froggatt (from 1/11/98)
P Jolley (from 1/11/98)
P S Morrall
S Rodriguez
J C Pérez
M van der Hoeven (from 1/12/98)
B van Venrooy
E Villani (from 26/10/98)

Site Services

C Alvarez
A K Chopping
J R Concepción
J M Díaz
D Gray
M V Hernández
A C Osborne (to 30/9/98)
C Ramón
C Riverol
M Simpson
## Appendix D

### Telescope Time Awards

The Panel for the Allocation of Telescope Time (PATT) and the Comité para la Asignación de Tiempos (CAT) made time awards to the following ING proposals. Only the PATT or CAT reference, the principal applicant, his or her institute, and the title of the proposal are given in each case. Semester A is from February to July and semester B is from August to January.

### BRITISH SUCCESSFUL PROPOSALS - SEMESTER 98A

**William Herschel Telescope**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Principal Applicant</th>
<th>Institute</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>W/98A/03</td>
<td>Cameron</td>
<td>St Andrews</td>
<td>V361 Lyr: A Rosetta Stone for classical T Tauri accretion phenomena?</td>
</tr>
<tr>
<td>W/98A/11</td>
<td>Cameron</td>
<td>St Andrews</td>
<td>High-resolution planetary spectroscopy</td>
</tr>
<tr>
<td>W/98A/15</td>
<td>Sansom</td>
<td>UCLAN</td>
<td>Ages of elliptical galaxies versus X-ray emission – Testing hierarchical versus monolithic formation theories</td>
</tr>
<tr>
<td>W/98A/19</td>
<td>Wood</td>
<td>Keele</td>
<td>Testing the measurement of $\sin i$ in close binaries</td>
</tr>
<tr>
<td>W/98A/20</td>
<td>Haworth</td>
<td>UCL</td>
<td>Large-scale structure in OB-star outflows *** Backup ***</td>
</tr>
<tr>
<td>W/98A/21</td>
<td>Sharples</td>
<td>Durham</td>
<td>The disk galaxy population in nearby clusters</td>
</tr>
<tr>
<td>W/98A/23</td>
<td>Marsh</td>
<td>Southampton</td>
<td>The accretion-powered light-house of old nova DQ Her *** Backup ***</td>
</tr>
<tr>
<td>W/98A/29</td>
<td>Mason</td>
<td>MSSL</td>
<td>The evolution of low luminosity AGN at intermediate redshifts</td>
</tr>
<tr>
<td>W/98A/31</td>
<td>Merrifield</td>
<td>Southampton</td>
<td>Dark halos and planetary nebula kinematics in S0 galaxies</td>
</tr>
<tr>
<td>W/98A/34</td>
<td>Merrifield</td>
<td>Southampton</td>
<td>An infrared imaging survey of edge-on galactic bulges</td>
</tr>
<tr>
<td>W/98A/36</td>
<td>Maxted</td>
<td>Southampton</td>
<td>Post common-envelope binaries – new systems, new problems</td>
</tr>
<tr>
<td>W/98A/40</td>
<td>Fabian</td>
<td>IoA</td>
<td>Long term X-ray variability in a flux limited sample of QSOs</td>
</tr>
<tr>
<td>W/98A/41</td>
<td>Mobasher</td>
<td>IC</td>
<td>A spectroscopic study of dwarf galaxies in the Coma Cluster</td>
</tr>
<tr>
<td>W/98A/42</td>
<td>Ellis</td>
<td>IoA</td>
<td>Dark matter in clusters: Optimising and verifying weak lensing methods</td>
</tr>
<tr>
<td>W/98A/43</td>
<td>Still</td>
<td>St Andrews</td>
<td>Mapping the accretion disk and companion star in X-ray binaries using X-ray/UV/optical time delays</td>
</tr>
<tr>
<td>W/98A/49</td>
<td>Sansom</td>
<td>UCLAN</td>
<td>Star formation histories of spiral bulges</td>
</tr>
<tr>
<td>W/98A/50</td>
<td>Lumsden</td>
<td>AAO</td>
<td>Towards a true unification model for AGN: spectropolarimetry of a statistically complete sample of Seyfert 2s</td>
</tr>
<tr>
<td>Code</td>
<td>Author</td>
<td>Institution</td>
<td>Title</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>W/98A/58</td>
<td>Asif</td>
<td>ING</td>
<td>Dynamics of the ionized gas within the ENLRs of Seyfert Nuclei</td>
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<tr>
<td>W/98A/60</td>
<td>Mittaz</td>
<td>MSSL</td>
<td>Identification of faint hard X-ray sources: Solving the X-ray background spectral paradox</td>
</tr>
<tr>
<td>W/98A/61</td>
<td>Tanvir</td>
<td>IoA</td>
<td>Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Backup ***</td>
</tr>
<tr>
<td>W/98A/62</td>
<td>Terlevich</td>
<td>IoA</td>
<td>Do all AGN have nuclear star formation?</td>
</tr>
<tr>
<td>W/98A/66</td>
<td>Abraham</td>
<td>RGO</td>
<td>Observations of infall in local galaxy clusters</td>
</tr>
<tr>
<td>W/98A/67</td>
<td>Ellis</td>
<td>IoA</td>
<td>A UV-selected galaxy redshift survey: Understanding the star formation history of galaxies</td>
</tr>
<tr>
<td>W/98A/72</td>
<td>Haswell</td>
<td>Sussex</td>
<td>Pinning down spectral variability in V404 Cyg: Advective flow or accretion disc</td>
</tr>
<tr>
<td>W/98A/73</td>
<td>Terlevich</td>
<td>IoA</td>
<td>Systematic search for temperature fluctuations in giant extragalactic HII regions</td>
</tr>
<tr>
<td>W/98A/77</td>
<td>Terlevich</td>
<td>RGO</td>
<td>The dense circumstellar medium around peculiar type II supernovae</td>
</tr>
<tr>
<td>W/98A/78</td>
<td>Butler</td>
<td>Armagh</td>
<td>Comparison of theoretical stellar flare models with high time-resolution spectroscopic observations</td>
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<tr>
<td>W/98A/80</td>
<td>Garcia</td>
<td>Harvard</td>
<td>Is the X-ray transient 4U2129+47 a triple system?</td>
</tr>
<tr>
<td>W/98A/86</td>
<td>Wood</td>
<td>Keele</td>
<td>Rapid spectroscopy of the mysterious pulsations in the dwarf Nova WZ Sge *** Backup ***</td>
</tr>
<tr>
<td>W/98A/90</td>
<td>Bower</td>
<td>Durham</td>
<td>The triggering mechanism for the Butcher Oemler Effect</td>
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<tr>
<td>W/98A/95</td>
<td>McHardy</td>
<td>Southampton</td>
<td>Complete Identification of the Extended UK Deep ROSAT Survey - NELG evolution and the X-ray background</td>
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<tr>
<td>W/98A/100</td>
<td>Smail</td>
<td>Durham</td>
<td>The nature of luminous sub-mm galaxies found in the First Deep SCUBA Survey of Cluster Lenses</td>
</tr>
</tbody>
</table>

**Isaac Newton Telescope**

<table>
<thead>
<tr>
<th>Code</th>
<th>Author</th>
<th>Institution</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/98A/03</td>
<td>Croom</td>
<td>Durham</td>
<td>QSO clustering environments at z=1.2</td>
</tr>
<tr>
<td>I/98A/04</td>
<td>Cameron</td>
<td>St Andrews</td>
<td>Differential rotation patterns on young late-type dwarf stars</td>
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<td>I/98A/13</td>
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<td>Lithium, rotation and activity in NGC 6633</td>
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<td>I/98A/15</td>
<td>Irwin</td>
<td>RGO</td>
<td>Carbon stars as probes of the phase space structure of the Galactic Halo</td>
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<td>I/98A/23</td>
<td>Carter</td>
<td>LJMU</td>
<td>The origin and dynamics of cD galaxies</td>
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<td>I/98A/25</td>
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<td>I/98A/32</td>
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<td>Tanvir</td>
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<td>I/98A/51</td>
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<td>I/98A/53</td>
<td>Jeffery</td>
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<tr>
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<td>Oliver</td>
<td>ICSTM</td>
<td>CCD identification of sources from the European Large Area ISO Survey</td>
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Jacobus Kapteyn Telescope

J/98A/02 Cameron St Andrews V361 Lyr: A Rosetta Stone for classical T Tauri accretion phenomena?
J/98A/03 A-Salamanca IoA Star-forming and post-starburst galaxies in Coma: star formation and morphological evolution
J/98A/05 James LJMU Observational tests of spiral density wave theories
J/98A/08 Knappen Herts Disc morphology and (circum)nuclear activity in barred spiral galaxies
J/98A/12 Hewett IoA Quasar-Galaxy pairs and gravitational lensing
J/98A/13 Pollacco ING The morphology of a magnitude limited sample of planetary nebulae *** Backup ***
J/98A/15 Burleigh Leicester A photometric search for the faint optical counterparts of ROSAT EUV sources
J/98A/19 Haswell Sussex Quasi-periodic oscillations in the black hole candidate V404 Cyg *** Backup ***
J/98A/20 Smith Cork Optical variability probe of conditions in weak jets in radioquiet quasars
J/98A/21 Terlevich IoA Improved determination of luminosity - Linewidth relation for Giant Extragalactic HII Regions
J/98A/23 Roche Sussex Yet more optical identifications of X-ray binaries in outburst *** Overriding ***
J/98A/25 Jeffery Armagh Pulsations in hot helium-rich subdwarfs *** Backup ***
J/98A/26 Lucy Durham Streaming motions of Abell Clusters: Completion of the all-sky survey
J/98A/27 Hughes RGO The spatial structure and distance of the Virgo cluster

DUTCH SUCCESSFUL PROPOSALS - SEMESTER 98A

William Herschel Telescope

W/98A/N1 Best Leiden The K-z relationship and precise determination of the growth of massive galaxies
W/98A/N5 Schoenmakers Utrecht Constraining radio source evolution using K-band observations of a sample of giant radio galaxies
W/98A/N6 Best Leiden The nature and evolution of radio galaxies at redshift one
W/98A/N7 Voors Utrecht Kinematics of the G79.29+0.46 nebula
W/98A/N8 Kuijken Groningen Weak lensing from poor clusters
W/98A/N9 Jaffe Leiden The true optical line emission from cooling flows
W/98A/N11 Kuijken Groningen Dark matter in clusters: Optimising and verifying weak lensing methods
W/98A/N12 Galama Amsterdam Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients
W/98A/N17 Briggs Groningen Identification of low redshift damped Lyman-alpha galaxies

Isaac Newton Telescope

W/98A/N4 Schoenmakers Utrecht Cosmological evolution of Giant Radio Galaxies and the intergalactic medium
I/98A/N1 Oliveira ESTEC Tomography and flare diagnostics in FK Com type ultra fast rotating stars
I/98A/N2 Van Dokkum Groningen The star formation history of early-type galaxies in the Coma cluster
I/98A/N3 Britzen Dwingeloo Formation of a high z sample for space VLBI observations
I/98A/N4 Zwaan Groningen Optical imaging of very Low Surface Brightness Galaxies
I/98A/N5 Telting ING High-resolution spectroscopy of non-radial pulsations in early-type stars
The distribution of extinction, stars and emission-line gas in starburst galaxies

BRI broadband imaging of kinematically lopsided galaxies

1: Imaging of ~40 ten-GHz peakers
2: Imaging of ~250 flat-spectrum objects to prepare for optical spectroscopic and radio interferometric studies

A search for genuinely young galaxies near interacting systems

Influence of the temperature variations on the primordial He abundance determination

Infrared imaging of dwarf galaxies in the Virgo cluster *** Backup ***

Stellar populations in bright spheroidal galaxies in Virgo

UKMS-6H23: A new highly obscured AGN?

13h 12m +42 deg: A cluster of galaxies at z=2.56?

Spectroscopic confirmation of cluster galaxies candidates at high redshift

Two-dimensional spectroscopy of ultraluminous infrared galaxies

Spectropolarimetry of Miras symbiotic stars and bipolar planetary nebulae

Chemical evolution of young galaxies

Microlensing in gravitational lenses *** Backup ***

Spectroscopic determination of the physical association of young dwarf galaxies to interacting systems

Elliptical galaxies formation: towards the kinematic detection of photometric shells

Bidimensional spectroscopy of active galaxies

Bidimensional spectroscopy of the central regions of early galaxies

Search for brown dwarfs and giant planets surrounding young K and M stars

Nucleosynthesis at the AGB stage: the relationship between Lithium and the heavy elements

The process of chemical enrichment in dwarf galaxies

Duplicity, Lithium and activity in coeval clusters: Praesepe versus Hyades

Standard sources for emission line photometry in the northern hemisphere *** Backup ***

Optical observations of clusters of galaxies in X-rays fields

Quantifying biasing in the selection of quasar candidates and study of gravitational lensing in the CFHT/MMT catalog

Galactic Globular Clusters ages and the Milky Way formation

Stellar formation history in Local Group dwarf spheroidal galaxies

Spectroscopy of SW Sex systems candidates *** Backup of I19 ***
The fundamental plane in satellite galaxies

H-band survey of ELAIS areas *** Backup of I16 ***

Young K and M stars in the solar neighbourhood

Optical photometry of a complete sample of radio QSOs: dust obscuration in quasars

CCD surface photometry of faint features of galaxies in the Virgo cluster

A photometric search for miniblazars in low polarisation quasars

Tidal disruption of the Ursa Minor dwarf spheroidal galaxy

High-resolution spectroscopy of the Moon's atmosphere

Formation of cores in recent merger remnants

Differential rotation patterns on alpha Persei G dwarfs

Spectro-astrometry of Pre-Main-Sequence stars

Large-scale structure in OB-star outflows

A complete survey of luminous sub-mm galaxies found in deep SCUBA fields

Chemical abundance anomalies in the Galactic halo

Post common envelope binaries - new systems, new problems

Constraining elemental mixing metallicity dispersions vs. star formation in dwarf irregular galaxies

Warm ionized medium in NGC891: search for radial variation in ionization structure

Determining the distances to High Velocity Clouds

Tracing dark haloes beyond the HI edge in spirals

The ages and metallicities of M31 globular clusters

Sublimation rates in distant comets

Identifying galaxies responsible for high-ionization QSO absorption lines

Dynamics of the ionized gas within the ENLRs of Seyfert nuclei *** Backup ***

Resonant structures and gaseous inflow: circumnuclear activity in barred spiral galaxies

Radial velocities of pulsating sdB stars

The metallicity dependence of the Cepheid period-luminosity relation

Quantitative spectroscopy of luminous blue supergiants in M31

Optical spectropolarimetry of seyfert 1 galaxies *** Backup ***

Tracing large-scale structure using the FIRST survey

Rapid imaging of GRB error boxes *** Overriding ***
<table>
<thead>
<tr>
<th>Report No.</th>
<th>Author</th>
<th>Institution</th>
<th>Title</th>
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<tbody>
<tr>
<td>W/98B/51</td>
<td>Crowther</td>
<td>London</td>
<td>The Wolf-Rayet phenomenon in extragalactic environments: What role for metallicity?</td>
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<td>W/98B/52</td>
<td>Tadhunter</td>
<td>Sheffield</td>
<td>Starbursts and the origin of the activity in powerful radio galaxies</td>
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<td>W/98B/54</td>
<td>Pettini</td>
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<td>The large scale structure of galaxies at redshift $z = 3$ <em><strong>Long Term</strong></em></td>
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<tr>
<td>W/98B/59</td>
<td>Wood</td>
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<td>Phase resolved spectroscopy of SW Sex stars through eclipse *** Backup ***</td>
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<tr>
<td>W/98B/65</td>
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<td>Quantifying the space density of radio galaxies at $z &gt; 4$</td>
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<td>W/98B/66</td>
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<td>W/98B/71</td>
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<td>Mapping the masses of Sunyaev-Zel’dovich effect clusters</td>
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<tr>
<td>W/98B/74</td>
<td>Pollacco</td>
<td>ING</td>
<td>Extinction distances of Planetary nebulae: spectral classification of field stars</td>
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<tr>
<td>W/98B/75</td>
<td>McBride</td>
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<td>Surface reflectance properties of Kuiper Belt objects</td>
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<tr>
<td>W/98B/76</td>
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<td>W/98B/77</td>
<td>Pooley</td>
<td>MRAC</td>
<td>IR/radio observations of GRS 1915+105 *** Overriding ***</td>
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Isaac Newton Telescope

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<tr>
<td>I/98B/01</td>
<td>Alton</td>
<td>Cardiff</td>
<td>The dust-to-gas ratio of the intergalactic gas in the M81 group</td>
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<tr>
<td>I/98B/03</td>
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<td>A multiwavelength investigation of a systematic sample of Be stars: optical classification</td>
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<td>I/98B/04</td>
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<td>QUB</td>
<td>Determination of empirical evolutionary tracks for OB-type stars</td>
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<tr>
<td>I/98B/05</td>
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<td>IoA</td>
<td>The star formation rate density of the universe at high redshift</td>
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<td>I/98B/10</td>
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<td>I/98B/12</td>
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<tr>
<td>I/98B/23</td>
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<td>Identifying galaxies responsible for high-ionization QSO absorption lines</td>
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<tr>
<td>I/98B/32</td>
<td>Crawford</td>
<td>IoA</td>
<td>The cluster environment of distant radio quasars</td>
</tr>
<tr>
<td>I/98B/37</td>
<td>Tanvir</td>
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<td>Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Overriding ***</td>
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<td>I/98B/45</td>
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<td>Is magnetic activity suppressed in rapidly rotating M-dwarfs in close binaries?</td>
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<td>I/98B/46</td>
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<td>Southampton</td>
<td>The period determination of detached double degenerate and sub-dwarf binaries</td>
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Jacobs Kapteyn Telescope

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<td>J/98B/01</td>
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<td>Lightcurves and colours of the Centaur 1997CU$_{26}$</td>
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<td>J/98B/03</td>
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<tr>
<td>J/98B/04</td>
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<td>A search for the quasi-periodic signature of advective accretion</td>
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<tr>
<td>J/98B/05</td>
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<td>Southampton</td>
<td>Companions to binary subdwarfs</td>
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<tr>
<td>J/98B/07</td>
<td>Warren</td>
<td>IC</td>
<td>Remote halo blue horizontal branch stars and the mass of the Milky Way *** Long Term ***</td>
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<td>J/98B/09</td>
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<td>Leicester</td>
<td>The galactic environment of narrow-line Seyfert 1s</td>
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<td>J/98B/11</td>
<td>Johnson</td>
<td>IoA</td>
<td>Narrow-band imaging of nearby galaxies</td>
</tr>
<tr>
<td>J/98B/12</td>
<td>Johnson</td>
<td>IoA</td>
<td>Emission line imaging of low luminosity AGN</td>
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</table>
Disc morphology and circumnuclear activity in barred spiral galaxies

Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients

Quasar-galaxy pairs and gravitational lensing

The determination of faint Strömgren standard stars for CCD photometric studies

Photometry of brightest cluster galaxies in a complete X-ray sample

DUTCH SUCCESSFUL PROPOSALS - SEMESTER 98B

Detailed mapping of the optical signature of cooling flows

Star forming at large radii in Abell 2597

The K-z relationship and precise determination of the growth of massive galaxies

Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients

Probing the evolution of stellar populations in giant ellipticals using GPS radio sources

Identification of low redshift damped Lyman-alpha galaxies

Weak lensing from poor clusters

Stellar Velocity Dispersion measurements of Very Late Type Spiral Galaxies

High resolution spectroscopy of Diffuse Interstellar Bands and large molecules

Distance and Metallicity of HVC AntiCenter Complexes and of HVC Complex H

The fundamental planes of ellipticals in 25 nearby, rich clusters

Spectroscopy of a sample of 10 GHz peakers

Round-the-globe spectroscopic observations of non-radially pulsating early-B type stars

The gaseous extent of nearby dwarf irregular galaxies

Imaging of a sample of 10 GHz peakers: the smallest radio-loud AGN

The optical hosts of young radio sources

The distribution of extinction, stars and emission-line gas in starburst galaxies

Photometric calibrators for the Second Generation Guide Star Catalog

Simultaneous X-ray and optical observations of a low mass X-ray binary

SPANISH SUCCESSFUL PROPOSALS - SEMESTER 98B

Kinematics structure of stellar jets
CAT W5  Israeli  IAC  Oxygen abundances in extremely low-metallicity stars from OH lines in the near UV
CAT W6  Møndez  IAC  The interplay between ionized gas kinematics and star formation in dwarf Wolf-Rayet galaxies
CAT W8  Zamorano  UCM  Ionized gas kinematics in star-forming dwarf galaxies
CAT W11  Castander  Chicago  Search for high redshift clusters of galaxies near radio-galaxies
CAT W14  González  IAC  The accretion disc’s magnetic field of SS Cygni
CAT W17  Centurión  IAC  Abundances at high redshift
CAT W22  Beckman  IAC  Lithium ratios in halo and disk stars *** Backup ***
CAT W24  Bonifacio  Trieste  Determination of the primordial He abundance in new metal poor BCG
CAT W26  Gómez  IAC  Evolution of SNe from low resolution spectroscopy
CAT W30  Rebolo  IAC  Search for brown dwarfs and giant planets surrounding young K and M stars
CAT W34  P-Fournon  IAC  Investigating the central engines of LINERs

Isaac Newton Telescope

CAT I2  Castander  Chicago  Optical study of clusters of galaxies in X-ray fields
CAT I3  Perinotto  Firenze  A search for planetary nebulae, HII regions and symbiotic stars in M33
CAT I4  F-Figueroa  UCM  Estudio del comportamiento simultáneo de varios indicadores de actividad en estrellas binarias activas
CAT I6  Iglesias  IAC  Chemical evolution in spiral galaxies in compact groups
CAT I8  Piotto  Padova  Stellar population in Globular Clusters: A ground-based follow-up of an HST project
CAT I9  Gallego  Madrid  Mass functions of starburst galaxies
CAT I12  Zapatero  IAC  Low mass brown dwarfs in Pleiades and Orionis
CAT I13  García  IAC  Optical counterparts and lithium abundances of ROSAT discovered candidates in the alpha Persei open cluster
CAT I14  Benítez  Berkeley  Are the GRBs correlated with clusters of galaxies?
CAT I15  Rebolo  IAC  The youngest K and M stars in the solar neighbourhood

Jacobus Kapteyn Telescope

CAT J1  Jordi  Barcelona  Metallicity, distance and age of the open clusters NGC 1817 and NGC 1807
CAT J2  Iglesias  IAC  Multi-frequency analysis of the gas component of two nearby mergers
CAT J3  González  IAC  A photometric search for miniblazars in low polarisation quasars
CAT J4  Kemp  IAC  The structure and colours of the envelopes of cD galaxies

LARGE SCALE IMAGING SURVEYS WITH THE INT WIDE FIELD CAMERA (semester 98B)

WFS 9  McMahon  IoA  The INT Wide Angle Survey
WFS 16  Dalton  Oxford  A Deep UBVRI imaging survey with the WFC
WFS 10  Paradijs  Amsterdam  Variability of the Faint Sky at mid-Galactic latitudes

INTERNATIONAL TIME PROPOSALS FOR 1998

ITP1  Eiroa  UAM  Planetary systems: their formation and properties
Appendix E

ING Bibliography and Analysis

Below is the list of research papers published in 1998 that resulted from observations made at the telescopes of the Isaac Newton Group. Only papers appearing in refereed journals have been included, although many useful data have also appeared elsewhere, notably in workshop and conference proceedings. Papers marked (INT) or (JKT) at the end of the reference indicate those papers also include results from the INT or JKT.

WILLIAM Herschel TELESCOPE


45. R W Hilditch, S A Bell, G Hill & T J Harries, “Light-curve analysis and eclipse mapping of the contact binaries KQ Gem and V412 Her”, *MNRAS*, 296, 100. (JKT)


63. R P van der Marel & F C van den Bosch, “Evidence for a $3 \times 10^8 M_\odot$ black hole in NGC 7052 from Hubble Space Telescope observations of the nuclear gas disk”, *Astrophys J*, 116, 2220.

64. R P van der Marel, N Cretton, P T de Zeeuw & H-W Rix, “Improved evidence for a black hole in M32 from HST/FOS spectra. II. Axisymmetric dynamical models”, *Astrophys J*, 493, 613.


72. P Molaro, M Centurión & G Vladilo, “Chemical abundances in the young galaxy at $z = 2.309$ towards PHL 957”, *MNRAS*, 293, L37.


86. M Rozas, N Sabalisck, J E Beckman & J H Knapen, “Internal turbulence, viriality and density bounding of the most luminous HII regions in the spiral galaxy M 100”, *Astron Astrophys*, 338, 15.


89. N S P Sabalisck, M Rozas, J E Beckman & J H Knapen, “Internal kinematics of the most luminous HII regions in M100”, *PASA*, 15, 161.


**ISAAC NEWTON TELESCOPE**


17. P C Hewett, C B Foltz, M E Harding & G F Lewis, “Two close separation quasar-quasar pairs in the large bright quasar survey”, *Astron J*, 115, 383. (JKT)


JACOBUS KAPTEYN TELESCOPE


**ANALYSIS**

The charts below show the authorship of all papers from 1984-1997 and for 1998 only, according to national group. The nationality of each author is attributed according to his or her address and equal weight is given to each author. It can be seen that the contribution from the rest of the world (others) has increased significantly as compared to the UK (only) contribution, which encourages us to believe that collaborative programmes are on the increase.

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**Analysis Chart 1984-1997**

- UK: 45.1%
- Others: 25.5%
- Spain: 21.0%
- Netherlands: 7.2%
- USA: 1.4%

**Analysis Chart 1998**

- UK: 38.5%
- Others: 32.8%
- Spain: 20.9%
- Netherlands: 5.6%
- USA: 1.3%
The above list contains 191 publications, some of which include results from more than one telescope. 118 papers contain results from the WHT, 72 contain results from the INT and 38 contain results from the JKT. The corresponding figures for 1997 were 113 from the WHT, 77 from the INT and 35 from the JKT. The combined publication rate is 228, slightly higher than in 1997. The table at the bottom shows the number of papers published using data taken with each instrument, when this was specified, in 1998.
Appendix F

ING Staff Research Publications

The following list includes research papers published by ING staff in refereed and unrefereed publications in 1998. It is organised by subjects and sorted in alphabetical order. ING authors appear in bold and italic.

SOLAR SYSTEM


S Veranim C Barbieri, C R Benn, G Cremonese, “Possible detection of meteor stream effects on the lunar sodium atmosphere”, Planet Space Sci, 46, 1003.

STARS


C Schrijvers, J H Telting, “Spectral line-profile variability as a probe for l and |m|”, IAU Symp, 185, 393.


THE GALAXY


GALAXIES


OBSERVATIONAL COSMOLOGY


SITE CHARACTERIZATION


C R Benn, S L Ellison, “Brightness of the night sky over La Palma”, New Astron Rev, 42, 503.


INSTRUMENTATION


At its May 1997 meeting, the Joint Steering Committee confirmed funding for financial year 1997/98 from the partner countries of £813K and 305.6Mptas, equivalent to a total budget of £2,171.2K. This sum was subsequently increased by the carry forward of unspent revenue from the previous year, compensation for staff effort shortfall and a one-off payment from the UK to reflect under indexation. These additions increased the available revenue to a total of £2,333.1K.

Financial year 1997/98 was dominated by the continuing uncertainty over the future of the two UK Royal Observatory sites which finally culminated on 12 December 1997 with the announcement that the Royal Greenwich Observatory was to close during the course of the following calendar year. Not unsurprisingly, this had significant impact on those parts of the ING’s programme carried out at RGO to the extent that the financial year closed with an overall underspend of £98K, most of which was attributable to the enhancements programme. This sum was carried forward to the following financial year.

For the financial year 1998/99, the JSC approved funding of £703.3K and 339.5Mptas, which was equivalent to £2,093.2K at the agreed exchange rate for the year of 242.0399 ptas/£. This sum was subsequently increased to £2,189.7K by additional receipts from repayment work and compensation for staff effort shortfall under operations and enhancements.

Both programmes suffered from disruptions associated with the closure of the RGO and the enhancements programme was further delayed by the UK ATC having difficulty recruiting staff. These problems resulted in there being a significant underspend on enhancements, although this money will be carried forward into the following financial year.

Details of the allocations and expenditure for ING joint UK/NL operations and enhancements programmes for the years 1997/98 and 1998/99 are set out below.
### ING operations and enhancement programme.  
**Allocations and expenditure for financial year 1997/98**

<table>
<thead>
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<th>Budget centre</th>
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<th>Expenditure (K£)</th>
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**Total** 741.6 328.1 2,320.2 589.0 335.1 2,231.6 -98.0

### ING operations and enhancement programme.  
**Allocations and expenditure for financial year 1998/99**

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</table>

**Total** 733.2 336.6 2,124.0 544.9 349.4 1,988.5 -135.4
Committee Membership

During 1998 the membership of the Joint Steering Committee and associated bodies was as follows:

**JOINT STEERING COMMITTEE**

Prof C S Frenk – **Chairman**  
*University of Durham*

Prof P T de Zeeuw – **Vice Chairman**  
*University of Leiden*

Dr W H W M Boland  
*NRAO Dwingeloo*

Prof P A Charles (until 31.8.98)  
*University of Oxford*

Prof M Rowan-Robinson  
*Imperial College of London*

Dr A Collier Cameron (from 1.9.98)  
*University of St Andrews*

Dr P G Murdin  
*Particle Physics and Astronomy Research Council*

Dr C Vincent – **Secretary**  
*Particle Physics and Astronomy Research Council*

**INSTRUMENTATION WORKING GROUP**

Prof P A Charles – **Chairman**  
*University of Oxford*

Dr M S Cropper  
*University of London*

Dr K H Kuijken  
*University of Groningen*

Dr R M Meyers  
*University of Durham*

Dr C N Tadhunter  
*University of Sheffield*

Dr N A Walton – **Technical Secretary**  
*Isaac Newton Group of Telescopes*
PATTING TIME ALLOCATION GROUP

WHT TAG

Dr C N Tadhunter – Chairman  
University of Sheffield

Dr A Aragón-Salamanca  
University of Cambridge

Dr R D Jeffries  
University of Keele

Dr R M Redfern (until 31.8.98)  
University College Galway

Dr N Hambly (from 1.9.98)  
Royal Observatory Edinburgh

Dr H F Henrichs  
University of Amsterdam

Dr T R Marsh  
University of Southampton

Dr J H Knapen  
University of Hertfordshire

Dr W L Martin – Technical Secretary  
Royal Greenwich Observatory

INT/JKT TAG

Dr E A Fitzsimmons – Chairman  
Queen’s University of Belfast

Dr C S Crawford  
University of Cambridge

Dr S T Hodgkin  
Leicester University

Dr T Naylor (until 31.8.98)  
University of Keele

Dr P A James (from 1.9.98)  
Liverpool John Moores University

Dr M T Lago  
University of Porto

Dr W L Martin – Technical Secretary  
Royal Greenwich Observatory
Appendix I

Addresses and Contacts

Isaac Newton Group of Telescopes (ING)

Apartado de correos 321
E-38700 Santa Cruz de la Palma
Canary Islands
SPAIN
E-mail: <username>@ing.iac.es
URL: http://www.ing.iac.es/
      http://www.ast.cam.ac.uk/ING/ (UK mirror)

Sea-level Base:
Edificio Mayantigo
c/ Alvarez de Abreu, 68, piso 2
E-38700 Santa Cruz de La Palma
Canary Islands
SPAIN
Open from 08:30 to 17:00 Monday to Thursday and from 08:30 to 16:30 on Friday, closed for lunch from 13:00 to 14:00.
Tel: +34 922 425400
Fax: +34 922 425401

Mountain Top:
Reception is on the first floor of the INT building.
Open from 09:00 to 16:00 Monday to Thursday and from 09:00 to 15:30 on Friday, closed for lunch from 12:30 to 13:30.
Tel: +34 922 405655 (Reception)
  559 (WHT control room)
  640 (INT control room)
  585 (JKT control room)
Fax: +34 922 405646 (Reception)

Director:
Dr René G M Rutten
Tel: +34 922 425420 (secretary)
Fax: +34 922 425408
E-mail: rgmr@ing.iac.es, miles@ing.iac.es (secretary)
Enquiries about the operation of the Roque de Los Muchachos Observatory can be made to: Instituto de Astrofísica de Canarias (IAC); c/ Vía Láctea s/n; E-38200 La Laguna; Canary Islands; SPAIN; Tel: +34 922 605200; Fax: +34 922 605210; URL: http://www.iac.es/

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.

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, Comité Científico Internacional (CCI), at the IAC address given above.

**CONTACTS AT ING**

<table>
<thead>
<tr>
<th>Name</th>
<th>Telephone (+34 922)</th>
<th>E-mail</th>
</tr>
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<tbody>
<tr>
<td>Head of Administration</td>
<td>Les Edwins</td>
<td>425418</td>
</tr>
<tr>
<td>Head of Astronomy</td>
<td>Danny Lennon</td>
<td>425441</td>
</tr>
<tr>
<td>Head of Engineering</td>
<td>Gordon Talbot</td>
<td>425419</td>
</tr>
<tr>
<td>Site Receptionist</td>
<td>Mavi Hernández</td>
<td>405655</td>
</tr>
<tr>
<td>Public Relations</td>
<td>Javier Méndez</td>
<td>425464</td>
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<tr>
<td>Telescope Scheduling</td>
<td>Ian Skillen</td>
<td>425439</td>
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<td>425439</td>
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<tr>
<td>WHT Manager</td>
<td>Chris Benn</td>
<td>425432</td>
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<tr>
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<td>Nic Walton</td>
<td>425440</td>
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<tr>
<td>JKT Manager</td>
<td>John Telting</td>
<td>425430</td>
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<tr>
<td>Instrumentation Scientist</td>
<td>Nic Walton</td>
<td>425440</td>
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<tr>
<td>Engineering Operations Manager</td>
<td>Clive Jackman</td>
<td>425446</td>
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<td>Scott Hunter</td>
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<td>Alan Chopping</td>
<td>405633</td>
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<tr>
<td>Freight</td>
<td>Juan Martínez</td>
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### Acronyms and Abbreviations

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<tr>
<td>Astron Astrophys</td>
<td>Astronomy and Astrophysics Journal</td>
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<tr>
<td>Astron Astrophys Suppl</td>
<td>Astronomy and Astrophysics Journal Supplement Series</td>
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<td>Astronomical Journal</td>
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<tr>
<td>Astron Soc Pac Conf Ser</td>
<td>Astronomical Society of the Pacific Conference Series</td>
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<tr>
<td>Astrophys J</td>
<td>Astrophysical Journal</td>
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<tr>
<td>Astrophys Space Science</td>
<td>Astrophysics and Space Science Journal</td>
</tr>
<tr>
<td>AU</td>
<td>Astronomical Unit ($1.496 \times 10^8$ km)</td>
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<tr>
<td>AUTOFIB</td>
<td>Autofib Fibre Positioner</td>
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<tr>
<td>Aux</td>
<td>Auxiliary Port at the WHT Cassegrain focus</td>
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<tr>
<td>Cass</td>
<td>Cassegrain focus</td>
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<td>CAT</td>
<td>Comité para la Asignación de Tiempos (Spanish panel for the allocation of telescope time)</td>
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<tr>
<td>CCD</td>
<td>Charge-Coupled Device</td>
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<tr>
<td>CCI</td>
<td>Comité Científico Internacional (International Scientific Committee) for Astrophysics</td>
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<tr>
<td>CIA</td>
<td>Harvard-Smithsonian Centre for Astrophysics</td>
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<tr>
<td>CIRSI</td>
<td>Cambridge Infra Red Survey Instrument</td>
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<tr>
<td>DAS</td>
<td>Data Acquisition System</td>
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<tr>
<td>DIAS</td>
<td>Dublin Institute for Advanced Studies</td>
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<tr>
<td>DIMM</td>
<td>Differential Image Motion Monitor</td>
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<tr>
<td>ELECTRA</td>
<td>Enhanced Light Efficiency Cophasing Telescope Resolution Actuator</td>
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<tr>
<td>ESTEC</td>
<td>European Space Technology Centre</td>
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<td>Fib</td>
<td>AUTOFIB fibre positioner</td>
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<td>FOS</td>
<td>Plate Object Spectrograph</td>
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<td>FWHM</td>
<td>Full Width Half Maximum</td>
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<td>GHRIL</td>
<td>Ground Based High Resolution Imaging Laboratory</td>
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<td>HST</td>
<td>Hubble Space Telescope</td>
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<td>IAC</td>
<td>Instituto de Astrofísica de Canarias</td>
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<td>MARTINI</td>
<td>Multi-Aperture Real Time Image Normalisation Instrument</td>
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<td>MCCD</td>
<td>Mosaic CCD camera or National Astronomical Observatory of Japan camera</td>
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<td>MOMI</td>
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<td>MSSL</td>
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<td>NAOMI</td>
<td>Natural guide star Adaptive Optics system for Multiple-Purpose Instrumentation</td>
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<td>NWO</td>
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<td>OAN</td>
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<td>TAURUS Fabry-Perot spectrograph or imager</td>
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</table>
ISAAC NEWTON GROUP
OF TELESCOPES (ING)

Apartado de Correos 321
E-38700 Santa Cruz de La Palma
Canary Islands
SPAIN
Tel: +34 922 425400, 405655
Fax: +34 922 425401, 405646
URL: http://www.ing.iac.es/