Isaac Newton Group of Telescopes

La Palma

Annual Report

1998

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Front Cover: Photo-composition made by Nik Szymanek (of the amateur UK Deep Sky CCD imaging team of Nik Szymanek and Ian King) in summer 1997. The telescope shown here is the Jacobus Kapteyn Telescope.

Isaac Newton Group of Telescopes

Annual Report

of the PPARC-NWO Joint Steering Committee

PPARC NWO

1998

Isaac Newton Group

William Herschel Telescope

Isaac Newton Telescope

Jacobus Kapteyn Telescope

OF TELESCOPES

The Isaac Newton Group of Telescopes (ING) consists of the 4.2m William Herschel Telescope (WHT), the 2.5m Isaac Newton Telescope (INT) and the 1.0m Jacobus Kapteyn Telescope (JKT). The ING is located 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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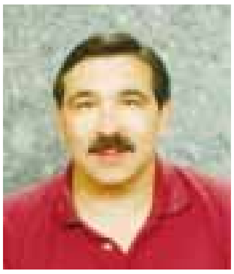

Prof Carlos Frenk

Chairman of the Joint Steering Committee

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.

INTRODUCTION

Dr René Rutten

Director of ING

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.

Chapter 1

Scientific Highlights

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(1). 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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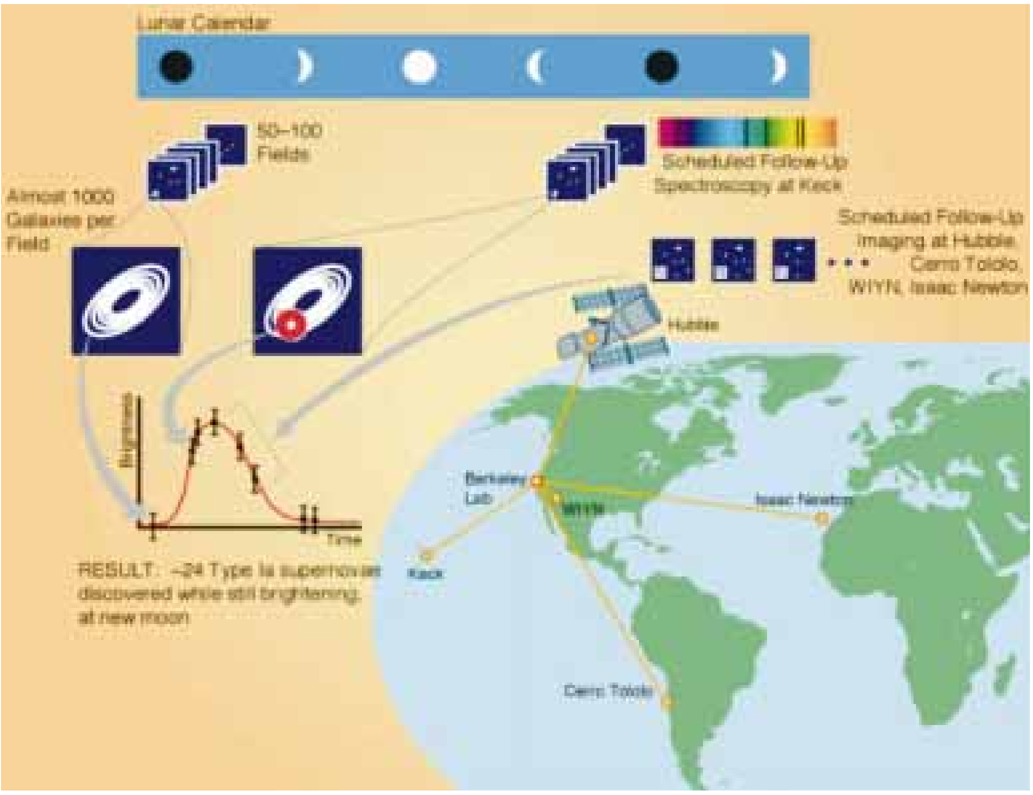
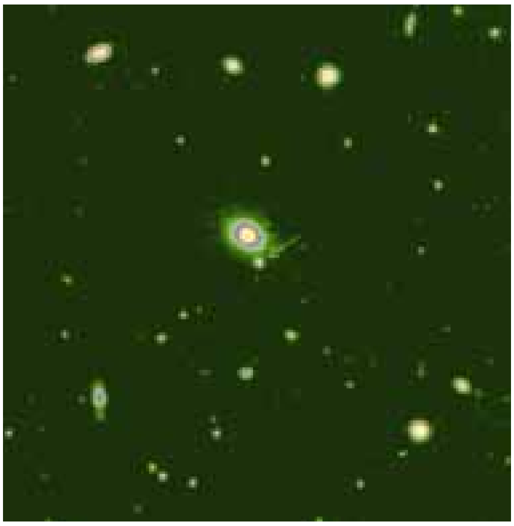
S Perlmutter et al, 1997, "Measurements of the Cosmological Parameters Omega and Lambda from the First Seven Supernovae at z ≥ 0.35", *Astrophys J*, **483**, 565.

S Perlmutter et al, 1998, "Discovery of a supernova explosion at half the age of the universe", *Nature*, **391**, 51.

S Perlmutter et al, 1999, "Measurements of Omega and Lambda from 42 High-Redshift Supernovae", *Astrophys J*, **517**, 565.

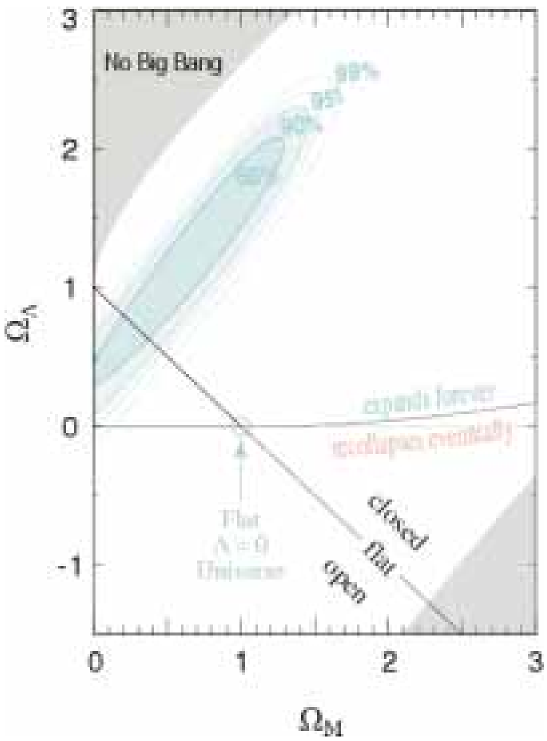


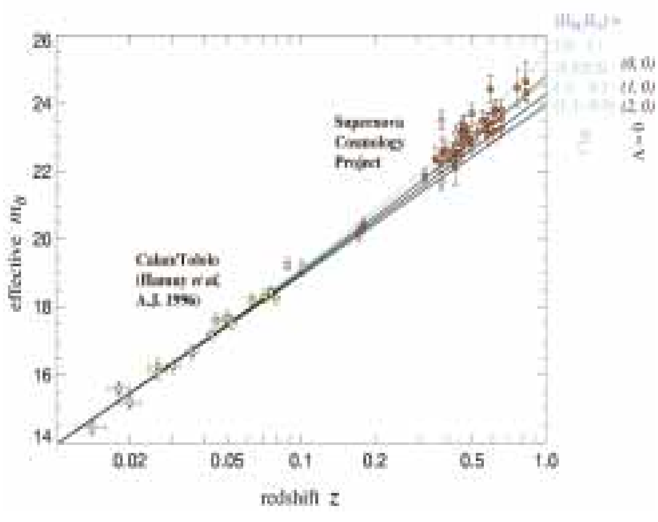
The observing strategy allows the team to find sets of high-redshift supernovae on the rising part of their light curves and guarantees the date of discovery, thus allowing follow-up photometry and spectroscopy of the transient supernovae to be scheduled. The supernova light curves are then followed with scheduled R-, I- and some B-band photometry at the INT and other telescopes.

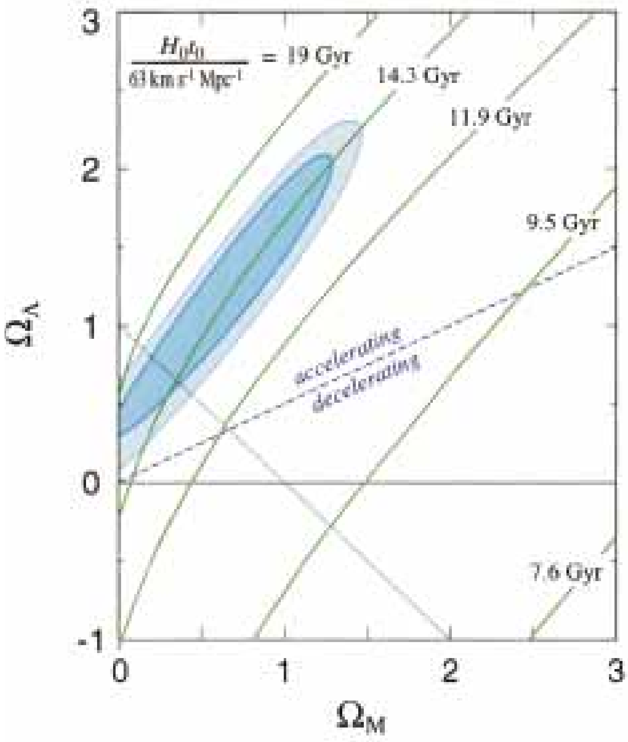


Left: INT image of a high-redshift type Ia supernova thousands of millions of light years away. When a star explodes as a type Ia supernova its brightness is similar to the host galaxy. This latter feature along with the possibility of calibrating their maximum brightness, make type Ia supernovae the 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 Ω_M–Ω_Λ 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 $H_0 \geq 50\,km\,s^{-1}\,Mpc^{-1}$.

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 Ω_M–Ω_Λ plane. The isochrones are labelled for the case of $H_0=63\,km\,s^{-1}\,Mpc^{-1}$. 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 Ω_Λ non-equal to zero is favoured from the data of all the observed supernovae.







THE FAINTEST KUIPER BELT OBJECTS

INT+WFC

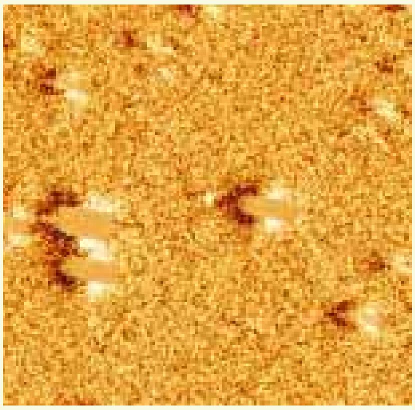
Starting in 1992, astronomers have become aware of a vast population of small bodies orbiting the Sun beyond Neptune. There are at least 70,000 “Trans-Neptunians” with diameters larger than 100 km in the radial zone extending outwards from the orbit of Neptune (at 30 AU) to 50 AU. There may be many more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

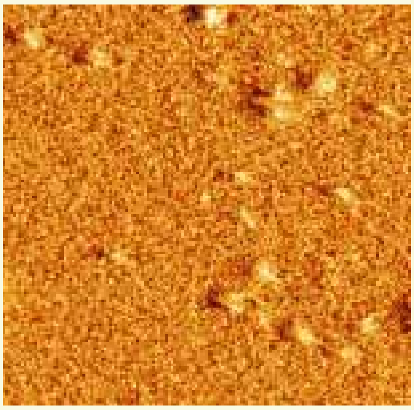
The Kuiper Belt holds significance for the study of the planetary system on at least two levels. First, it is likely that the Kuiper Belt objects are extremely primitive remnants from the early accretion phases of the Solar System. The inner, dense parts of the pre-planetary disk condensed into the major 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.

References:

E Fletcher, M Irwin, and A Fitzsimmons, 1998, “1997 UF25”, *MPEC 1998-G08*.

E Fletcher, M Irwin, and A Fitzsimmons, 1998, “1997 UG25”, *MPEC 1998-G09*.

THE BRIGHTEST OBJECT EVER OBSERVED

INT+IDS, JKT+JAG CCD

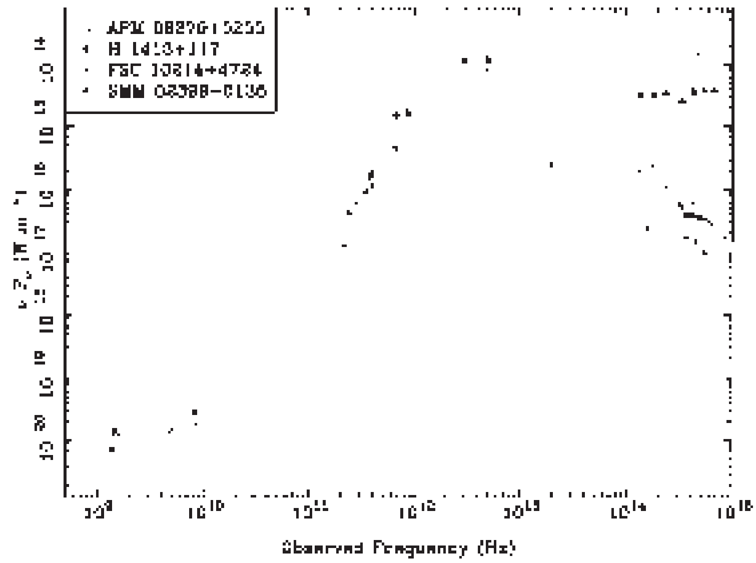
APM 08279+5255 is an extremely bright quasar four to five million, billion times brighter than the Sun and about 100 times brighter than the next brightest object that has been observed. The light from the quasar has been travelling to us for roughly 11 billion years, nearly 90% of the age of the universe 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



Spectral energy distribution of APM 08279+5255 (z=3.87) compared to the ultra-luminous galaxies IRAS FSC 10214+4724 (z=2.29), SMM 02399-0136 (z=2.8), and H 1413+117 (z=2.56).

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.

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A Blain, 1998, “Through a glass brightly”, *Nature News and Views*, **393**, 520.

M J Irwin et al, 1998, “APM 08279+5255: an ultraluminous broad absorption line quasar at a redshift z=3.87”, *Astrophys J*, **505**, 529.

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.

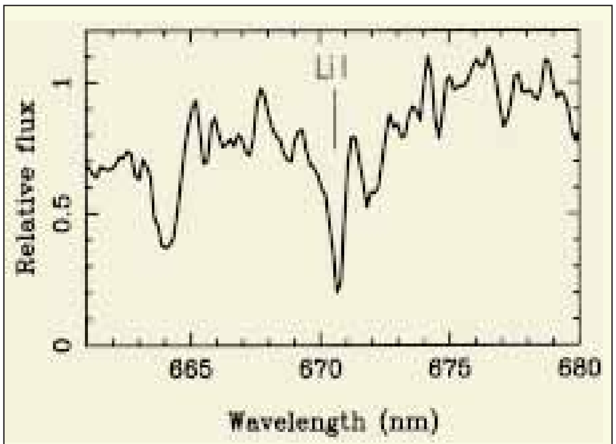
The observed optical and infrared colours present no strange anomaly that might be attributed to an unresolved less massive companion to G 196-3, and no indication of changes in the radial velocity is found beyond the uncertainties of the measurements determined with high-resolution spectra taken at 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_o = 4.1 when the oldest age (main sequence) is assumed and log L/L_o = 3.6 for the youngest age (L_o, 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_{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±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_{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_{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.



Intermediate-resolution spectrum obtained at the WHT telescope showing the Li detection at 670.8 nm in G 196-3B.

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R Rebolo et al, 1998, “Discovery of a Low-Mass Brown Dwarf Companion of the Young Nearby Star G 196-3”, *Science,* **282**, 1309.

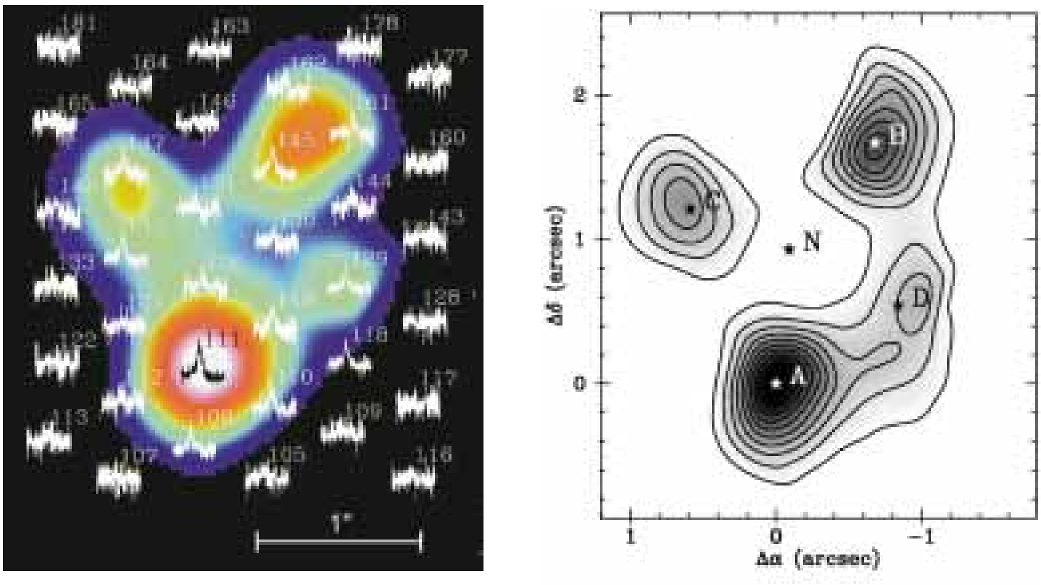
AN ARC OF EXTENDED EMISSION IN THE GRAVITATIONAL LENS SYSTEM Q2237+0305

WHT+INTEGRAL

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] λ1909 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 ≈<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]λ1909 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.



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).

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.

References:

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S Arribas et al, 1998, “INTEGRAL: a matrix optical fiber system for WYFFOS”, *Proc SPIE*, **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 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.

References:

S B Howell et al, 1998, “Time-resolved Spectroscopy of AL Comae”, *Astrophys J*, **494**, L223.

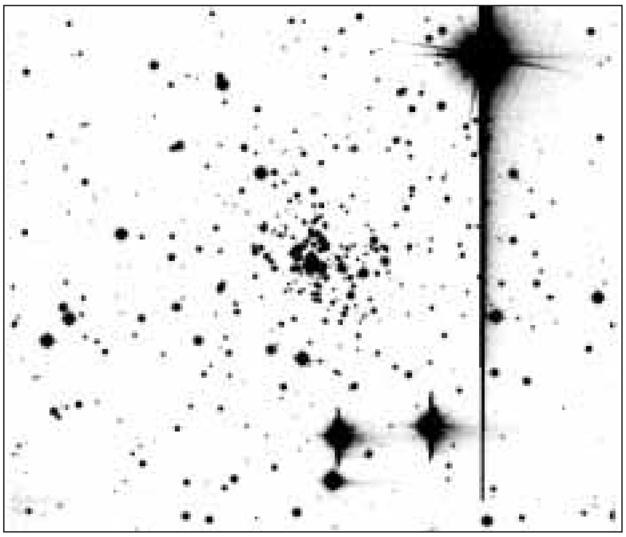
PALOMAR 1: A YOUNG GALACTIC HALO GLOBULAR CLUSTER

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 that 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.



Central 4.3' × 4.3' image of Palomar 1, taken with the I filter and an exposure time of 600 s.

References:

A Rosenberg et al, 1998, "Palomar 1: Another Young Galactic Halo Globular Cluster?", *Astron J*, **115**, 648.

A Rosenberg et al, 1998, "The Metallicity of Palomar 1", *Astron J*, **115**, 658.

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 H α 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.

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 haven 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.

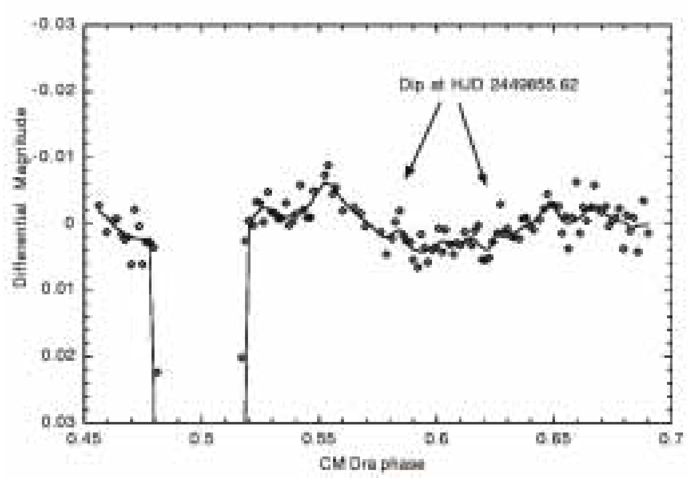
Previous observational tests have been prevented by the required photometric precision (which is about 1 part in 10^5 in the case of an Earth-sized planet transiting a sun-like star), and by the generally low probability that a planetary plane is aligned correctly to produce transits. An observationally 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 90º.

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 89.82º. 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:

H J Deeg et al, 1998, "Near-term detectability of terrestrial extrasolar planets: TEP network observations of CM Draconis", *Astron Astrophys*, **338**, 479.



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 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 disco-seismological interpretation was achieved for the first time (J-E Solheim et al, 1998, "Whole Earth Telescope observations of AM Canum Venaticorum – discoseismology 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 planetaries 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,

"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.

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 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.

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.

Chapter 2

New Instrumentation and Enhancements

WILLIAM HERSCHEL 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.

ELECTRA has a deformable mirror consisting of 76 individual segments. Each of the segments is driven by three (hysteresis corrected) piezoactuators, hence giving it 228-degrees-of-freedom. Hysteresis correction is maintained through strain gages on the piezos.

Multi-object and integral field spectroscopy will become a more important aspect of the instrumentation suit of the WHT. The WYFFOS spectrograph, which has been specially designed to be fed by optical fibres, therefore fulfils a central role. The INTEGRAL coherent fibre feed to the WYFFOS spectrograph at the Nasmyth focus of the WHT successfully passed final commissioning. This fibre feed, a collaboration between the Instituto de Astrofísica de Canarias, the Royal Greenwich Observatory and ING, comprises three science bundles which can be inter-changed quickly and remotely. Field sizes range from 10 to 40 arcseconds. The different fibre core sizes allow observers to make the most efficient use of the prevailing seeing conditions. INTEGRAL was used successfully for scheduled science observations.

The multi-object fibre unit for the prime focus of the WHT, AUTOFIB, also feeding the WYFFOS spectrograph, has undergone major modifications to the chassis and fibre-griper to eliminate problems that had plagued the system. The new system was extensively used with very few problems and much improved positional accuracy of the fibres.

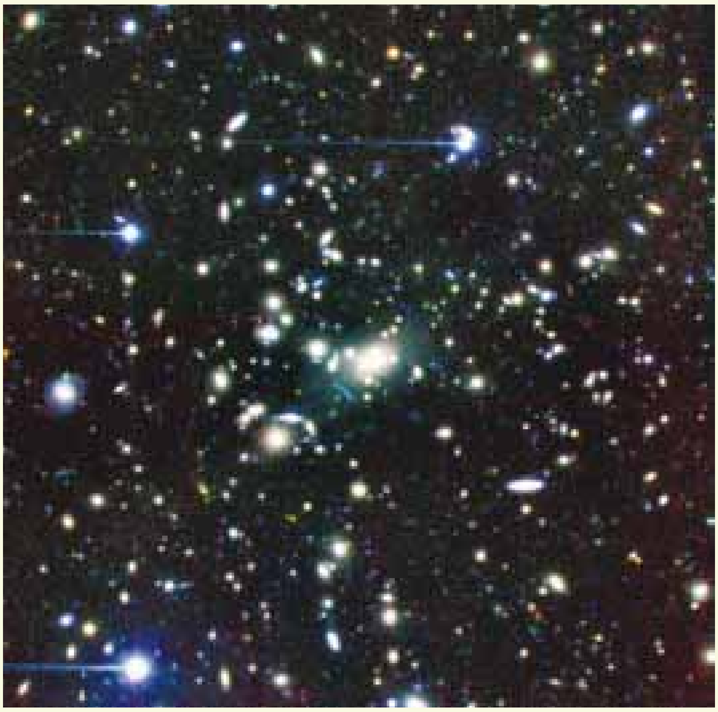
Commissioning of the WYFFOS echelle mode was successfully completed in August 1998. In this mode, one of 5 orders is selected with an order-sorting filter, giving a range on the current CCD of between 580 and 250 Å, and highest resolution 0.8 Å.

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.

Prof Ian Halliday, PPARC Chief Executive, at the instrumentation laboratory in the WHT during his visit to ING in November 1998. The instrument in the background is AUTOFIB-2. In this photo he appears accompanied by Kevin Dee, Head of Mechanical Engineering, and Prof Carlos Frenk, JSC Chairman, (to the left) and Dr René Rutten, Director of ING (to the right).



Upper left: CIRSI camera on the INT prime focus in December 1997. Bottom left: CIRSI on the WHT prime focus in January 1998. Right: Three-colour image of the galaxy cluster Abell 2219 based on a 2.5hr H band exposure obtained with CIRSI combined with B and I band optical CCD images. This image was obtained on the 4.2m William Herschel Telescope in June 1998 and it reveals evidence for lensed features. The observation are being used to trace the dark matter distribution within the cluster. The field of view is 4.8' x 4.8'.

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.

Chapter 3

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 CO_2 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 new optics laboratory at the ING sea-level base.

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.

Chapter 4

Telescope Performance

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.

Allocation of time for semesters 98A+98B

	WHT		INT		JKT	
	Nights	%	Nights	%	Nights	%
UK PATT*	170.5	46.7	157.0	43.1	201.0	55.1
SP CAT	59.0	16.2	62.0	17.0	59.5	16.3
NL PATT	40.5	11.1	39.0	10.7	50.5	13.8
UK/NL WFS (from 98B on)	–	–	33.0	9.0	–	–
ITP	16.0	4.4	16.0	4.4	16.0	4.4
Service/Discretionary	46.0	12.6	29.0	7.9	18.0	4.9
Commissioning	29.0	7.9	26.0	7.1	17.0	4.7
Stand-down	4.0	1.1	3.0	0.8	3.0	0.8
Total	365.0	100.0	365.0	100.0	365.0	100.0

*Includes Irish and Portuguese time on the JKT

USE OF INSTRUMENTATION

The following tables show for each telescope the number of nights in semesters 98A and 98B for which the different instruments were used. Stand-down (but not commissioning) periods are excluded. The abbreviations are explained in J. The list of common-user instruments for the same period of time can be found in Appendix B.

Again ISIS, as spectrograph or spectropolarimetre, and UES are the most used WHT instruments, but with the improved large CCD detectors available, prime focus imaging and AUTOFIB-2 are becoming very popular. Both AUTOFIB-2 and INTEGRAL are used in combination with WYFFOS spectrograph at GHRIL. When the telescope is in Nasmyth or Cassegrain configuration, imaging at the auxiliary port of the Acquisition and Guidance Unit at the Cassegrain focus is also possible. On the INT, dark time periods are becoming almost exclusively used for CCD imaging with the Wide Field Camera. JKT is now a single instrument telescope for CCD imaging.

TELESCOPE RELIABILITY

Telescope downtime due to technical problems averaged 2.7, 5.2, and 2.3% on the WHT, the INT, and the JKT respectively in 1998 (semesters 98A and 98B). The continuing low figures are particularly creditable in view of the range of new systems, both instruments and infrastructure, that were commissioned during the period, and the substantial reductions in night time technical and astronomy support.

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

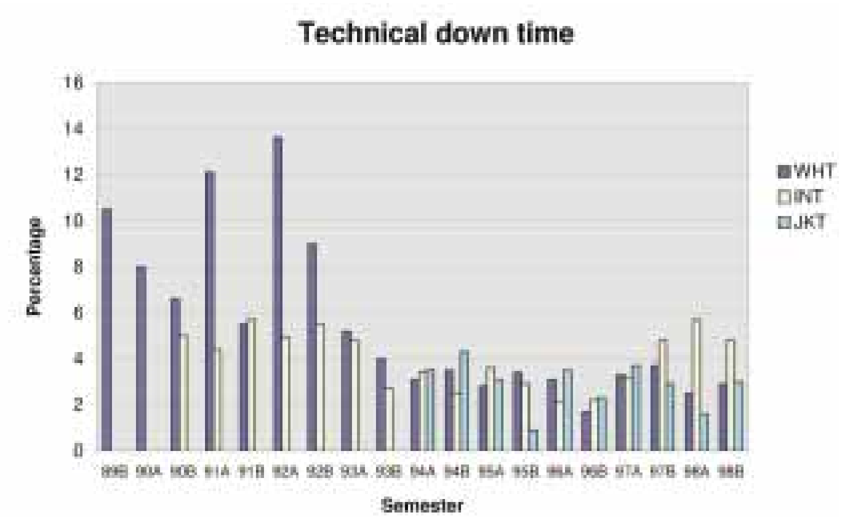
William Herschel Telescope

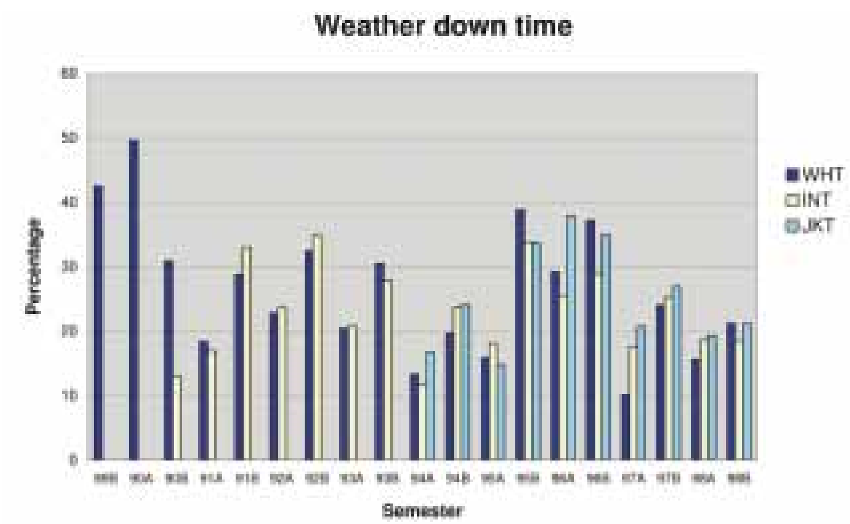
	ISIS	ISIS Pol	UES	LDSS	PF	AUTOFIB	GHRIL	WHIRCAM	INTEGRAL	TAURUS	CIRSI
Nights	102.0	22.0	73.0	20.5	27.0	30.5	3.0	25.0	17.0	22.0	4.0
%	28.3	6.1	20.2	5.7	7.5	8.4	0.8	6.9	4.7	6.1	1.1

	MCCD	ELECTRA	Total
Nights	10.0	5.0	361.0
%	2.8	1.4	100.0

Isaac Newton Telescope

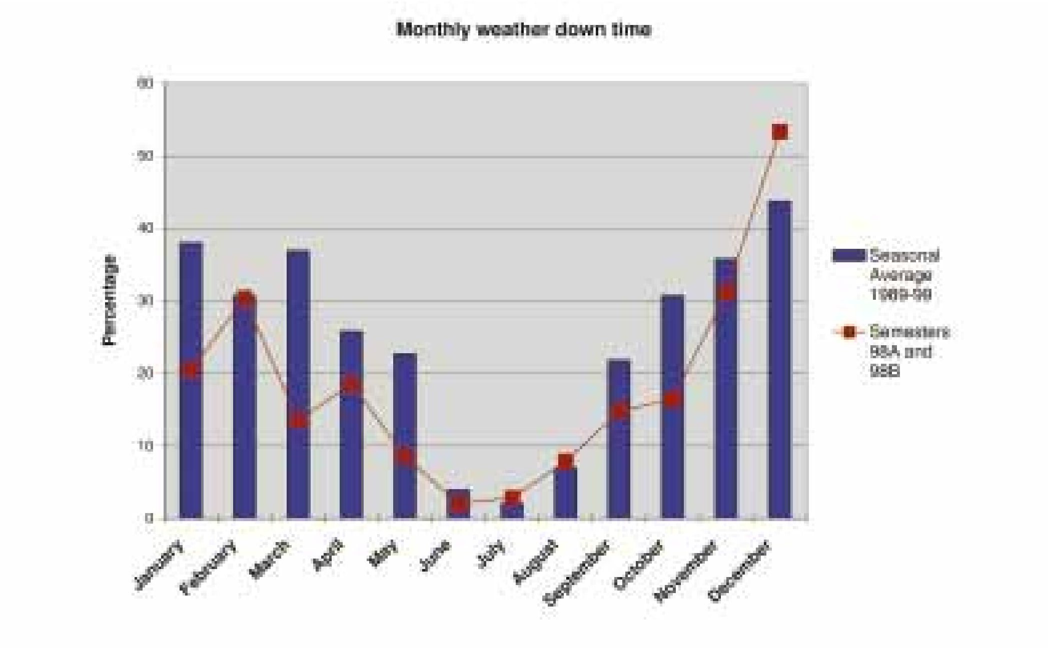
	WFC	IDS	Musicos	CIRSI	MOMI	Total
Nights	148.0	142.0	37.0	29.0	6.0	362.0
%	40.9	39.2	10.2	8.0	1.7	100.0





Percentage of weather and technical down time by semester

Semester	WHT weather	WHT technical	INT weather	INT technical	JKT weather	JKT technical
89B	42.5	10.5				
90A	49.6	8.0				
90B	30.9	6.6	13.0	5.0		
91A	18.4	12.1	16.9	4.4		
91B	28.8	5.5	33.0	5.7		
92A	22.8	13.6	23.6	4.9		
92B	32.4	9.0	34.8	5.5		
93A	20.4	5.2	20.7	4.8		
93B	30.5	4.0	27.9	2.7		
94A	13.3	3.1	11.8	3.4	16.7	3.5
94B	19.7	3.5	23.7	2.5	24.1	4.3
95A	15.8	2.8	18.1	3.6	14.8	3.1
95B	38.8	3.4	33.8	2.9	33.7	0.9
96A	29.2	3.1	25.5	2.1	37.9	3.5
96B	37.2	1.7	28.9	2.2	34.9	2.3
97A	10.1	3.3	17.6	3.2	20.7	3.7
97B	24.0	3.7	25.2	4.8	26.9	2.9
98A	15.6	2.5	18.6	5.7	19.3	1.6
98B	21.1	2.9	18.5	4.8	21.2	3.0



Chapter 5

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.

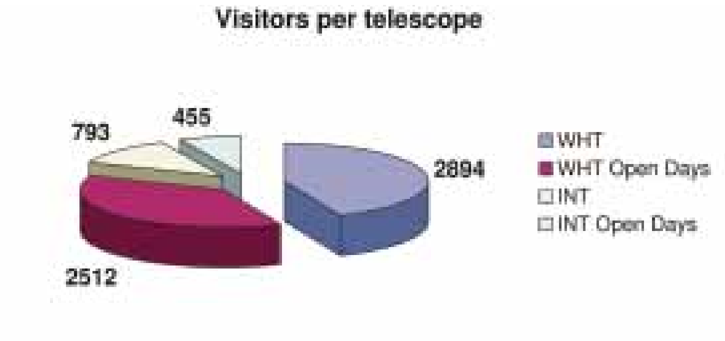
ING has now established relationships with the Royal Astronomical Society, the recently set up Royal Observatory Greenwich at the National Maritime Museum in London, and the British Astronomical Society.

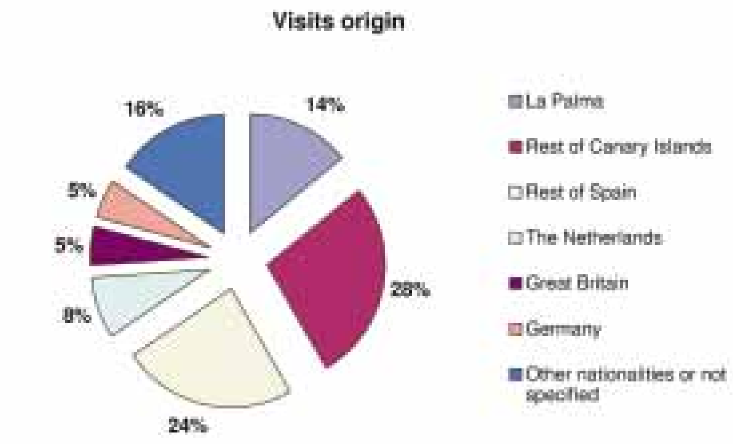
Amateur astronomers, Nik Szymanek and Ian King from the UK Deep Sky CCD imaging team produced an impressive collection of photo-compositions, which were very kindly provided to ING. These photos have been published by many different and prestigious astronomical publications. We have also used the photographs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

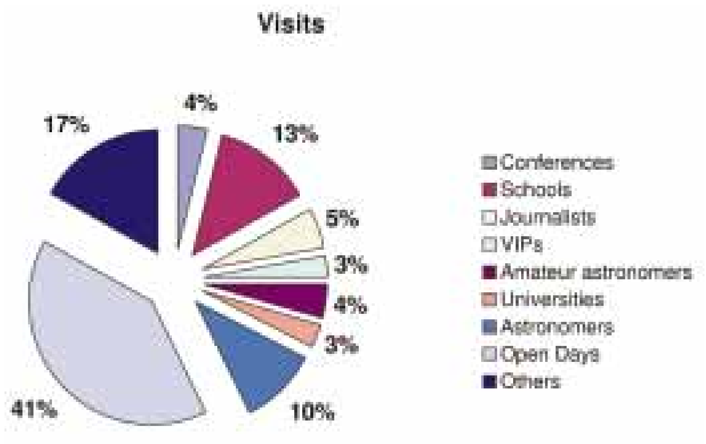
The SPECTRUM newsletter was effectively discontinued with the closure of the Royal Greenwich Observatory. The resulting vacuum in the dissemination of information about the ING will be addressed by creating an ING Newsletter which will be published and distributed both in printed form and through the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







Appendix A

The Isaac Newton Group of Telescopes

The Isaac Newton Group of Telescopes (ING) consists of the William Herschel Telescope (WHT), the Isaac Newton Telescope (INT) and the Jacobus Kapteyn Telescope (JKT). The 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:

	Latitude	Longitude	Ground Floor Height
WHT	28° 45′ 38.3″ N	17° 52′ 53.9″ W	2,332 m
INT	28° 45′ 43.4″ N	17° 52′ 39.5″ W	2,336 m
JKT	28° 45′ 40.1″ N	17° 52′ 41.2″ W	2,364 m

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 Archipiélago 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.

Appendix B

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.

Focus	Instrument	Detector
William Herschel Telescope		
Cassegrain	ISIS double spectrograph	Tektronix and EEV CCDs
	TAURUS Fabry-Perot imager	Tektronix and EEV CCDs
	Low Dispersion Survey Spectrograph (LDSS-2)	SITe CCD
	CCD imager (Acquisition and Guidance Unit Auxiliary Port)	Tektronix CCD
	TAURUS CCD imager (f/2 or f/4)	Tektronix and EEV CCDs
Nasmyth	Ground Based High Resolution Imaging Laboratory (GHRIL)	Tektronix and EEV CCDs
	William Herschel Infrared Camera (WHIRCAM)	InSb array
	Utrecht Echelle Spectrograph (UES)	SITe CCD
	INTEGRAL	Tektronix CCD (WYFFOS at GHRIL)
Prime	Prime Focus Camera	Tektronix and EEV CCDs
	Autofib Fibre Positioner (AUTOFIB-2)	Tektronix CCD (WYFFOS at GHRIL)
Isaac Newton Telescope		
Cassegrain	Intermediate Dispersion Spectrograph (IDS)	Tektronix and EEV CCDs
	Faint Object Spectrograph (FOS-1)	Loral CCD
Prime	Wide Field Camera	4 × EEV CCDs
Jacobus Kapteyn Telescope		
Cassegrain	JAG CCD camera	Tektronix and SITe CCDs

Appendix C

Staff Organisation

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 Martínez
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 Rodríguez
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

W/98A/03	*Cameron*	St Andrews	V361 Lyr: A Rosetta Stone for classical T Tauri accretion phenomena?
W/98A/11	*Cameron*	St Andrews	High-resolution planetary spectroscopy
W/98A/15	*Sansom*	UCLAN	Ages of elliptical galaxies versus X-ray emission – Testing hierarchical versus monolithic formation theories
W/98A/19	*Wood*	Keele	Testing the measurement of $v \sin i$ in close binaries
W/98A/20	*Howarth*	UCL	Large-scale structure in OB-star outflows *** Backup ***
W/98A/21	*Sharples*	Durham	The disk galaxy population in nearby clusters
W/98A/23	*Marsh*	Southampton	The accretion-powered light-house of old nova DQ Her *** Backup ***
W/98A/29	*Mason*	MSSL	The evolution of low luminosity AGN at intermediate redshifts
W/98A/31	*Merrifield*	Southampton	Dark halos and planetary nebula kinematics in S0 galaxies
W/98A/34	*Merrifield*	Southampton	An infrared imaging survey of edge-on galactic bulges
W/98A/36	*Maxted*	Southampton	Post common-envelope binaries – new systems, new problems
W/98A/40	*Fabian*	IoA	Long term X-ray variability in a flux limited sample of QSOs
W/98A/41	*Mobasher*	IC	A spectroscopic study of dwarf galaxies in the Coma Cluster
W/98A/42	*Ellis*	IoA	Dark matter in clusters: Optimising and verifying weak lensing methods
W/98A/43	*Still*	St Andrews	Mapping the accretion disk and companion star in X-ray binaries using X-ray/UV/optical time delays
W/98A/49	*Sansom*	UCLAN	Star formation histories of spiral bulges
W/98A/50	*Lumsden*	AAO	Towards a true unification model for AGN: spectropolarimetry of a statistically complete sample of Seyfert 2s

W/98A/58	*Asif*	ING	Dynamics of the ionized gas within the ENLRs of Seyfert Nuclei
W/98A/60	*Mittaz*	MSSL	Identification of faint hard X-ray sources: Solving the X-ray background spectral paradox
W/98A/61	*Tanvir*	IoA	Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Backup ***
W/98A/62	*Terlevich*	IoA	Do all AGN have nuclear star formation?
W/98A/66	*Abraham*	RGO	Observations of infall in local galaxy clusters
W/98A/67	*Ellis*	IoA	A UV-selected galaxy redshift survey: Understanding the star formation history of galaxies
W/98A/72	*Haswell*	Sussex	Pinning down spectral variability in V404 Cyg: Advective flow or accretion disc
W/98A/73	*Terlevich*	IoA	Systematic search for temperature fluctuations in giant extragalactic H II regions
W/98A/77	*Terlevich*	RGO	The dense circumstellar medium around peculiar type II supernovae
W/98A/78	*Butler*	Armagh	Comparison of theoretical stellar flare models with high time-resolution spectroscopic observations
W/98A/80	*García*	Harvard	Is the X-ray transient 4U2129+47 a triple system?
W/98A/86	*Wood*	Keele	Rapid spectroscopy of the mysterious pulsations in the dwarf Nova WZ Sge *** Backup ***
W/98A/90	*Bower*	Durham	The triggering mechanism for the Butcher Oemler Effect
W/98A/95	*McHardy*	Southampton	Complete Identification of the Extended UK Deep ROSAT Survey - NELG evolution and the X-ray background
W/98A/100	*Smail*	Durham	The nature of luminous sub-mm galaxies found in the First Deep SCUBA Survey of Cluster Lenses

Isaac Newton Telescope

I/98A/03	*Croom*	Durham	QSO clustering environments at z=1-2
I/98A/04	*Cameron*	St Andrews	Differential rotation patterns on young late-type dwarf stars
I/98A/13	*Jeffries*	Keele	Lithium, rotation and activity in NGC 6633
I/98A/15	*Irwin*	RGO	Carbon stars as probes of the phase space structure of the Galactic Halo
I/98A/23	*Carter*	LJMU	The origin and dynamics of cD galaxies
I/98A/25	*Gilmore*	IoA	The stellar, brown dwarf and MACHO IMF
I/98A/30	*Pollacco*	ING	Sakurai's object: a real time evolution in a stellar thermal pulse *** Long Term ***
I/98A/32	*Eales*	Cardiff	A first statistical survey of the submillimetre properties of the Local Universe *** Long Term ***
I/98A/35	*Tanvir*	IoA	Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Overriding ***
I/98A/37	*Crawford*	IoA	The cluster environment of distant radio quasars *** Backup ***
I/98A/39	*Lawrence*	Edinburgh	Rapid variability in the feeblest AGN, NGC 4395
I/98A/42	*Moran*	Southampton	The period distribution of detached double degenerate and sub-dwarf binaries
I/98A/43	*McMahon*	IoA	A near infra-red survey for galaxy clusters with z > 1 *** Long Term ***
I/98A/48	*Ray*	Dublin	Large scale Herbig-Haro flows from luminous young stars
I/98A/51	*Penny*	RAL	A new Strömgren age determinator for globular clusters
I/98A/53	*Jeffery*	Armagh	The dimensions of binary sdB stars *** Backup ***
I/98A/54	*Tanvir*	IoA	Intergalactic planetary nebulae in the Virgo cluster and Leo-I group
I/98A/55	*Oliver*	ICSTM	CCD identification of sources from the European Large Area ISO Survey

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	*Knapen*	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 H II 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	*Lucey*	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

Jacobus Kapteyn Telescope

J/98A/N2	*Lehnert*	Leiden	The distribution of extinction, stars and emission-line gas in starburst galaxies
J/98A/N3	*Swaters*	Groningen	BRI broadband imaging of kinematically lopsided galaxies
J/98A/N4	*Britzen*	Dwingeloo	1: Imaging of ~40 ten-GHz peakers
			2: Imaging of ~250 flat-spectrum objects to prepare for optical spectroscopic and radio interferometric studies

SPANISH SUCCESSFUL PROPOSALS - SEMESTER 98A

William Herschel Telescope

CAT W3	*Deeg*	IAC	A search for genuinely young galaxies near interacting systems
CAT W4	*Vílchez*	IAC	Influence of the temperature variations on the primordial He abundance determination
CAT W5	*Vílchez*	IAC	Infrared imaging of dwarf galaxies in the Virgo cluster *** Backup ***
CAT W6	*Gorgas*	IAC	Stellar populations in bright spheroidal galaxies in Virgo
CAT W10	*Barcons*	Cantabria	UKMS-6H23: A new highly obscured AGN?
CAT W14	*Campos*	OAN	13h 12m +42 deg: A cluster of galaxies at z=2.56?
CAT W25	*Martínez*	Santander	Spectroscopic confirmation of cluster galaxies candidates at high redshift
CAT W26	*Colina*	STScI	Two-dimensional spectroscopy of ultraluminous infrared galaxies
CAT W28	*Corradi*	IAC	Spectropolarimetry of Miras symbiotic stars and bipolar planetary nebulae
CAT W30	*Centurión*	IAC	Chemical evolution of young galaxies
CAT W31	*Mediavilla*	IAC	Microlensing in gravitational lenses *** Backup ***
CAT W35	*M-Tuñón*	IAC	Spectroscopic determination of the physical association of young dwarf galaxies to interacting systems
CAT W36	*Balcells*	IAC	Elliptical galaxies formation: towards the kinematic detection of photometric shells
CAT W40	*G-Lorenzo*	IAC	Bidimensional spectroscopy of active galaxies
CAT W46	*del Burgo*	IAC	Bidimensional spectroscopy of the central regions of early galaxies
CAT W49	*Zapatero*	IAC	Search for brown dwarfs and giant planets surrounding young K and M stars
CAT W53	*Abia*	Granada	Nucleosynthesis at the AGB stage: the relationship between Lithium and the heavy elements

Isaac Newton Telescope

CAT I4	*T-Tagle*	IoA	The process of chemical enrichment in dwarf galaxies
CAT I6	*Barrado*	CfA	Duplicity, Lithium and activity in coeval clusters: Praesepe versus Hyades
CAT I8	*Guerrero*	IAC	Standard sources for emission line photometry in the northern hemisphere *** Backup ***
CAT I11	*Castander*	Chicago	Optical observations of clusters of galaxies in X-rays fields
CAT I12	*M-González*	IAC	Quantifying biasing in the selection of quasar candidates and study of gravitational lensing in the CFHT/MMT catalog
CAT I13	*Rosenberg*	Padova	Galactic Globular Clusters ages and the Milky Way formation
CAT I14	*Martínez*	IAC	Stellar formation history in Local Group dwarf spheroidal galaxies
CAT I16	*González*	IAC	Spectroscopy of SW Sex systems candidates *** Backup of I19 ***

CAT I17	*Gutiérrez*	IAC	The fundamental plane in satellite galaxies
CAT I19	*P-Fournon*	IAC	H-band survey of ELAIS areas *** Backup of I16 ***
CAT I21	*Rebolo*	IAC	Young K and M stars in the solar neighbourhood

Jacobus Kapteyn Telescope

CAT J1	*Sánchez*	Santander	Optical photometry of a complete sample of radio QSOs: dust obscuration in quasars
CAT J2	*Kemp*	IAC	CCD surface photometry of faint features of galaxies in the Virgo cluster
CAT J3	*González*	IAC	A photometric search for miniblazars in low polarisation quasars
CAT J4	*Martínez*	IAC	Tidal disruption of the Ursa Minor dwarf spheroidal galaxy

BRITISH SUCCESSFUL PROPOSALS - SEMESTER 98B

William Herschel Telescope

W/98B/01	*Barbieri*	Padova	High-resolution spectroscopy of the Moon's atmosphere
W/98B/03	*Carter*	Liverpool	Formation of cores in recent merger remnants
W/98B/04	*Barnes*	St Andrews	Differential rotation patterns on alpha Persei G dwarfs
W/98B/05	*Bailey*	AAO	Spectro-astrometry of Pre-Main-Sequence stars
W/98B/06	*Howarth*	London	Large-scale structure in OB-star outflows
W/98B/08	*Smail*	Durham	A complete survey of luminous sub-mm galaxies found in deep SCUBA fields
W/98B/11	*Feltzing*	RGO	Chemical abundance anomalies in the Galactic halo
W/98B/15	*Maxted*	Southampton	Post common envelope binaries - new systems, new problems
W/98B/16	*Oey*	IoA	Constraining elemental mixing metallicity dispersions vs. star formation in dwarf irregular galaxies
W/98B/17	*Oey*	IoA	Warm ionized medium in NGC891: search for radial variation in ionization structure
W/98B/21	*Putman*	MSSSO	Determining the distances to High Velocity Clouds
W/98B/22	*B-Hawthorn*	AAO	Tracing dark haloes beyond the H I edge in spirals
W/98B/23	*Kuntschner*	Durham	The ages and metallicities of M31 globular clusters
W/98B/26	*Fitzsimmons*	QUB	Sublimation rates in distant comets
W/98B/30	*Bowen*	ROE	Identifying galaxies responsible for high-ionization QSO absorption lines
W/98B/31	*Asif*	ING	Dynamics of the ionized gas within the ENLRs of Seyfert nuclei *** Backup ***
W/98B/32	*Knapen*	Hertfordshire	Resonant structures and gaseous inflow: circumnuclear activity in barred spiral galaxies
W/98B/38	*Jeffery*	Armagh	Radial velocities of pulsating sdB stars
W/98B/43	*Hughes*	IoA	The metallicity dependence of the Cepheid period-luminosity relation
W/98B/44	*Smartt*	ING	Quantitative spectroscopy of luminous blue supergiants in M31
W/98B/46	*Young*	Hertfordshire	Optical spectropolarimetry of seyfert 1 galaxies *** Backup ***
W/98B/47	*Maddox*	IoA	Tracing large-scale structure using the FIRST survey
W/98B/49	*Tanvir*	IoA	Rapid imaging of GRB error boxes *** Overriding ***

W/98B/51	*Crowther*	London	The Wolf-Rayet phenomenon in extragalactic environments: What role for metallicity?
W/98B/52	*Tadhunter*	Sheffield	Starbursts and the origin of the activity in powerful radio galaxies
W/98B/54	*Pettini*	RGO	The large scale structure of galaxies at redshift $z \approx 3$ ***Long Term ***
W/98B/59	*Wood*	Keele	Phase resolved spectroscopy of SW Sex stars through eclipse *** Backup ***
W/98B/65	*Rawlings*	Oxford	Quantifying the space density of radio galaxies at $z > 4$
W/98B/66	*Jeffries*	Keele	Does the Li I 6708Å line yield true photospheric lithium abundances in the Pleiades?
W/98B/71	*Birkinshaw*	Bristol	Mapping the masses of Sunyaev-Zel'dovich effect clusters
W/98B/72	*Pedrosa*	ING	On the nature of the properties of strong emission lines in T Tauri stars
W/98B/74	*Pollacco*	ING	Extinction distances of Planetary nebulae: spectral classification of field stars
W/98B/75	*McBride*	Kent	Surface reflectance properties of Kuiper Belt objects
W/98B/76	*McMahon*	IoA	The evolution of the neutral gas content of the high redshit universe *** Long Term ***
W/98B/77	*Pooley*	MRAC	IR/radio observations of GRS 1915+105 *** Overriding ***

Isaac Newton Telescope

I/98B/01	*Alton*	Cardiff	The dust-to-gas ratio of the intergalactic gas in the M81 group
I/98B/03	*Steele*	LJMU	A multiwavelength investigation of a systematic sample of Be stars: optical classification
I/98B/04	*Keenan*	QUB	Determination of empirical evolutionary tracks for OB-type stars
I/98B/05	*Salamanca*	IoA	The star formation rate density of the universe at high redshift
I/98B/10	*Irwin*	RGO	The stellar stream of the Sgr dSph
I/98B/12	*Marsh*	Southampton	Ca II spikes and the mass donors of cataclysmic variable stars
I/98B/18	*Fitzsimmons*	QUB	A deep survey of the Kuiper-Belt
I/98B/23	*Bowen*	ROE	Identifying galaxies responsible for high-ionization QSO absorption lines
I/98B/32	*Crawford*	IoA	The cluster environment of distant radio quasars
I/98B/37	*Tanvir*	IoA	Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Overriding ***
I/98B/45	*Wood*	Keele	Is magnetic activity suppressed in rapidly rotating M-dwarfs in close binaries?
I/98B/46	*Moran*	Southampton	The period determination of detached double degenerate and sub-dwarf binaries

Jacobus Kapteyn Telescope

J/98B/01	*Davies*	JAC	Lightcurves and colours of the Centaur 1997CU_{26}
J/98B/03	*Clarke*	Glasgow	Colour photometry of solar-type stars in the Pleiades
J/98B/04	*Haswell*	AC	A bearch for the quasi-periodic signature of advective accretion
J/98B/05	*Maxted*	Southampton	Companions to binary subdwarfs
J/98B/07	*Warren*	IC	Remote halo blue horizontal branch stars and the mass of the Milky Way *** Long Term ***
J/98B/09	*Ward*	Leicester	The galactic environment of narrow-line Seyfert 1s
J/98B/11	*Johnson*	IoA	Narrow-band imaging of nearby galaxies
J/98B/12	*Johnson*	IoA	Emission line imaging of low luminosity AGN

J/98B/13	*Knapen*	Hertfordshire	Disc morphology and circumnuclear activity in barred spiral galaxies
J/98B/15	*Tanvir*	IoA	Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients *** Overriding ***
J/98B/16	*Hewett*	IoA	Quasar-galaxy pairs and gravitational lensing
J/98B/17	*Rolleston*	QUB	The determination of faint Strömgren standard stars for CCD photometric studies *** Long Term ***
J/98B/18	*Edge*	Durham	Photometry of brightest cluster galaxies in a complete X-ray sample

DUTCH SUCCESSFUL PROPOSALS - SEMESTER 98B

William Herschel Telescope

W/98B/N1	*Jaffe*	Leiden	Detailed mapping of the optical signature of cooling flows
W/98B/N2	*Jaffe*	Leiden	Star forming at large radii in Abell 2597
W/98B/N4	*Best*	Leiden	The K-z relationship and precise determination of the growth of massive galaxies
W/98B/N6	*Galama*	Amsterdam	Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical transients
W/98B/N7	*Lehnert*	Leiden	Probing the evolution of stellar populations in giant ellipticals using GPS radio sources
W/98B/N8	*Lane*	Groningen	Identification of low redshift damped Lyman-alpha galaxies
W/98B/N10	*Kuijken*	Groningen	Weak lensing from poor clusters
W/98B/N11	*Swaters*	Groningen	Stellar Velocity Dispersion measurements of Very Late Type Spiral Galaxies
W/98B/N12	*Ehrenfreund*	Leiden	High resolution spectroscopy of Diffuse Interstellar Bands and large molecules
W/98B/N14	*v Woerden*	Groningen	Distance and Metallicity of HVC AntiCenter Complexes and of HVC Complex H

Isaac Newton Telescope

I/98B/N1	*Katgert*	Leiden	The fundamental planes of ellipticals in 25 nearby, rich clusters
I/98B/N3	*D-Thorpe*	Groningen	Spectroscopy of a sample of 10 GHz peakers
I/98B/N5	*Telting*	ING	Round-the-globe spectroscopic observations of non-radially pulsating early-B type stars
I/98B/N8	*Swaters*	Groningen	The gaseous extent of nearby dwarf irregular galaxies

Jacobus Kapteyn Telescope

J/98B/N1	*D-Thorpe*	Groningen	Imaging of a sample of 10 GHz peakers: the smallest radio-loud AGN
J/98B/N2	*Tschager*	Leiden	The optical hosts of young radio sources
J/98B/N3	*Lehnert*	Leiden	The distribution of extinction, stars and emission-line gas in starburst galaxies
J/98B/N4	*Le Poole*	Leiden	Photometric calibrators for the Second Generation Guide Star Catalog
J/98B/N5	*Ford*	Amsterdam	Simultaneous X-ray and optical observations of a low mass X-ray binary

SPANISH SUCCESSFUL PROPOSALS - SEMESTER 98B

William Herschel Telescope

CAT W3	*López*	Barcelona	Kinematics structure of stellar jets

CAT W5	*Israelian*	IAC	Oxygen abundances in extremely low-metallicity stars from OH lines in the near UV
CAT W6	*Méndez*	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

1. I Aretxaga, R J Terlevich & B J Boyle, "Multi-colour imaging of z = 2 QSO hosts", *MNRAS*, **296**, 643.

2. S Arribas, E Mediavilla & J J Fuensalida, "A new technique for performing two-dimensional spectroscopy of objects of large dynamic range: the binary system HD 167605 A+B", *Astrophys J*, **505**, L43.

3. M W Asif, C G Mundell, A Pedlar, S W Unger, A Robinson, B Vila-Vilaró & J R Lewis, "Kinematics of the dusty circumnuclear ring in the barred Seyfert galaxy NGC 4151", *Astron Astrophys*, **333**, 466.

4. N Bade, V Beckmann, N G Douglas, P D Barthel, D Engels, L Cordis, P Nass & W Voges, "On the evolutionary behaviour of BL Lac objects", *Astron Astrophys*, **334**, 459.

5. E J Bakker & D L Lambert, "The circumstellar shell of the post-asymptotic giant branch star HD 56126: the ^{12}CN/^{13}CN isotope ratio and fractionation", *Astrophys J*, **502**, 417.

6. E J Bakker, D L Lambert, H van Winckel, J K McCarthy, C Waelkens & G González, "Spectral variability of the binary HR 4049", *Astron Astrophys*, **336**, 263.

7. X Barcons, R Carballo, M T Ceballos, R S Warwick & J I González-Serrano, "Discovery of an X-ray selected radio-loud obscured AGN at z = 1.246", *MNRAS*, **301**, L25.

8. J R Barnes, A Collier Cameron, Y C Unruh, J -F Donati & G A J Hussain, "Latitude distributions and lifetimes of star-spots on G dwarfs in the α Persei cluster", *MNRAS*, **299**, 904.

9. C R Benn, M Vigotti, R Carballo, J I González-Serrano & S F Sánchez, "Red quasars not so dusty", *MNRAS*, **295**, 451.

10. W J G de Blok & J M van der Hulst, "Star formation and the interstellar medium in low surface brightness galaxies. I. Oxygen abundances and abundance gradients in low surface brightness disk galaxies", *Astron Astrophys*, **335**, 421.

11. F C van den Bosch, W Jaffe & R P van der Marel, "Nuclear stellar discs in early-type galaxies - I. HST and WHT observations", *MNRAS*, **293**, 343.

12. D V Bowen, M Pettini & B J Boyle, "Ly-α absorption in the nearby Universe: the sightline to Q1821+64", *MNRAS*, **297**, 239.

13. A A Breeveld & E M Puchnarewicz, “A search for optical polarization from the narrow-line Seyfert 1 galaxy RE J1034+396”, *MNRAS*, **295**, 568.

14. C Briceño, L Hartmann, J Stauffer & E Martín, “A search for very low mass pre-main-sequence stars in Taurus”, *Astron J*, **115**, 2074.

15. D Burns et al, “Large-amplitude periodic variations in the angular diameter of R Leonis”, *MNRAS*, **297**, 462.

16. R F Butler, A Shearer, R M Redfern, M Colhoun, P O’Kane, A J Penny, P W Morris, W K Griffiths & M Cullum, “TRIFFID photometry of globular cluster cores - I. Photometric techniques and variable stars in M15”, *MNRAS*, **296**, 379.

17. R Carballo, S F Sánchez, J I González-Serrano, C R Benn & M Vigotti, “K-band imaging of 52 B3-VLA quasars: nucleus and host properties”, *Astron J*, **115**, 1234.

18. N Cardiel, J Gorgas & A Aragón-Salamanca, “Spectral gradients in central cluster galaxies: further evidence of star formation in cooling flows”, *MNRAS*, **298**, 977.

19. J Casares, P Charles & E Kuulkers, “The mass of the neutron star in Cygnus X-2 (V1341 Cygni)”, *Astrophys J*, **493**, L39.

20. A J Castro-Tirado et al, “Photometry and Spectroscopy of the GRB 970508 Optical Counterpart”, *Science*, **279**, 1011.

21. M Centurión, P Bonifacio, P Molaro & G Vladilo, “Nitrogen abundances in damped Ly-α galaxies”, *Astrophys J*, **509**, 620.

22. N E Clark, D J Axon, C N Tadhunter, A Robinson & P O’Brien, “Jet-induced shocks in 3C 171: An intermediate-redshift analog of high-redshift radio galaxies”, *Astrophys J*, **494**, 546.

23. J S Clark et al, “Long-term variability of the Be/X-ray binary A 0535 +26 - I. Optical and UV spectroscopy”, *MNRAS*, **294**, 165. (INT,JKT)

24. E A Corbett, A Robinson, D J Axon, S Young & J H Hough, “The profiles of polarized broad Hα lines in radio galaxies”, *MNRAS*, **296**, 721.

25. L Decin, H van Winckel, C Waelkens & E J Bakker, “Photospheric composition of the carbon-rich 21_m post-ABG stars IRAS 22223+4327 and IRAS 04296+3429”, *Astron Astrophys*, **332**, 928.

26. P G van Dokkum, M Franx, D D Kelson, G D Illingworth, D Fisher & D Fabricant, “The colour-magnitude relation in CL 1358+62 at z = 0.33: evidence for significant evolution in the SO population”, *Astrophys J*, **500**, 714.

27. J G Doyle, C I Short, P B Byrne & P J Amado, “Chromospheric and coronal activity levels in the nearby faint M dwarf Gl 105B”, *Astron Astrophys*, **329**, 229. (INT)

28. T Ebbels, R Ellis, J-P Kneib, J-F Le Borgne, R Pelló, I Smail & B Sanahuja, “Spectroscopic confirmation of redshifts predicted by gravitational lensing”, *MNRAS*, **295**, 75.

29. M T Eibe, “Prominence and plage activity in the recently discovered late-type rapid rotator, RE 1816+541”, *Astron Astrophys*, **337**, 757.

30. C D Fassnacht & J G Cohen, “Keck spectroscopy of three gravitational lens systems discovered in the JVAS and class surveys”, *Astron J*, **115**, 377.

31. R P Fender & G G Pooley, “Infrared synchrotron oscillations in GRS 1915+105”, *MNRAS*, **300**, 573.

32. I Ferreras, N Benítez & E Martínez-González, “Imaging around PC1643+4631A at the Lyman limit”, *Astron Astrophys*, **333**, 43.

33. D Fisher, D Fabricant, M Franx & P van Dokkum, “A spectroscopic survey of the galaxy cluster CL1358+62 at z = 0.328”, *Astrophys J*, **498**, 195.

34. T J Galama et al, “Optical follow-up of GRB 970508”, *Astrophys J*, **497**, L13.

35. M R García, P J Callanan, D Moraru, J E McClintock, E Tollestrup, S P Willner, C Hergenrother, C R Robinson, C Kouveliotou & J van Paradijs, “Power-law decays in the optical counterparts of GRB 970228 and GRB 970508”, *Astrophys J*, **500**, L105.

36. R J García López & M R Pérez de Taoro, “Beryllium abundances in parent stars of extrasolar planets: 16 Cygni A & B and ρ^1 Cancri”, *Astron Astrophys*, **334**, 599.

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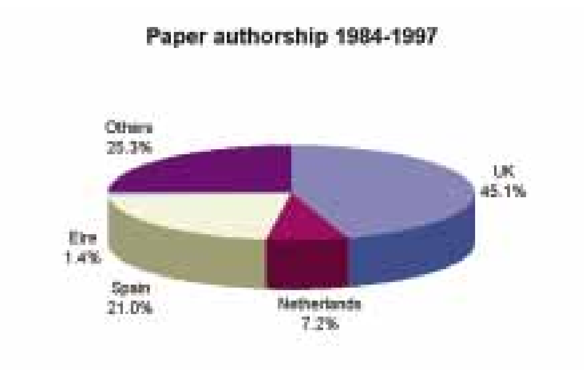
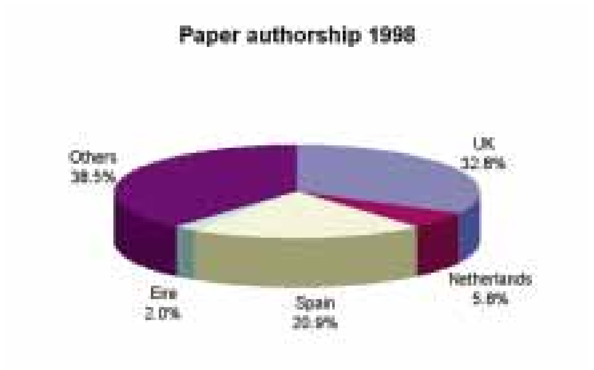
17. L van Zee, E D Skillman & J J Salzer, “Neutral gas distributions and kinematics of five blue compact dwarf galaxies”, *Astron J*, **116**, 1186.

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.





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.

Number of publications 1984-1998

	WHT	INT	JKT	Total
1984	-	1	-	1
1985	-	10	3	13
1986	-	24	8	32
1987	-	36	16	52
1988	5	52	12	69
1989	15	58	15	88
1990	37	54	26	117
1991	39	63	19	121
1992	42	56	25	123
1993	55	70	30	155
1994	78	63	44	185
1995	90	81	29	200
1996	100	84	52	236
1997	113	77	35	225
1998	118	72	38	228
Total	692	801	352	1,845

ING publications per instrument in 1998

WHT	
ISIS	46
Aux	4
TAURUS imag.	5
TAURUS FP	3
LDSS	6
UES	24
GHRIL	1
FAST	1
WHIRCAM	8
WYFFOS/INTEGRAL	2
WYFFOS/Autofib	2
PFC	4
Triffid	1
HHS	1

INT	
IDS	32
PF	27
WFC	1
IPCS	3

JKT	
CCD	25
RBS	5
High Speed Photometer	1

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

J E Little, A Fitzsimmons, P J Andrews, R Catchpole, ***N A Walton***, I P Williams, "The evolution of debris from comet D/Shoemaker-Levy 9 on Jupiter", *Icarus*, **131**, 334.

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

R Baptista, K Horne, R A Wade, I Hubeny, K S Long, ***R G M Rutten***, "HST spatially resolved spectra of the accretion disc and gas stream of the nova-like variable UX Ursae Majoris", *MNRAS*, **298**, 1079.

A Castro-Tirado, J Gorosabel, ***N A Walton***, M R García, J E McClintock, E Barton, P Calannan, "XTE J2012+381", *IAU Circ*, **6931**.

M Centurión, P Bonifacio, ***N A Walton***, D King, Extra-Solar Planet Observational Research Team, "Supernova 1998bu in NGC 3368", *IAU Circ*, **6918**.

A Fassia, W P S Meikle, T R Geballe, ***N A Walton***, ***D L Pollacco***, ***R G M Rutten***, C Tinney, "^{56}Ni dredge-up in the type IIp supernova 1995V", *MNRAS*, **299**, 150.

H F Henrichs, J A de Jong, C Schrijvers, ***J H Telting***, B Foing, J Oliveira, E Stempels, P Ehrenfreund, J-F Donati, C Catala, J Landstreet, T Boehm, I Tuominen, R Duemmler, I Ilyin (I V Il'in), Y Unruh, J Hao, H Cao, J Neff, C Johns-Krull, N Morrison, C Mullis, T Kennelly, "Nonradial pulsations in the O7.5 giant xi Per?", *Astron Soc Pac Conf Ser*, **135**, 151.

H F Henrichs, J A De Jong, J S Nichols, L Kaper, K Bjorkman, D Bohlender, Huilai Cao, K Gordon, G Hill, Y Jiang, I Kolka, Hongbin Li, Wu Liu, J Neff, D O'Neill, B Scheers, ***J H Telting***, "A Search for the cause of the cyclical variability in O star winds: a multi-wavelength approach", Ultraviolet Astrophysics Beyond the IUE Final Archive. Proceedings of the conference held in Sevilla, Spain, from 11th to 14th November 1997. Published by ESA Publications Division, 1998 (ESA SP; **413**), 157.

R I Hynes, P Roche, C A Haswell, ***J H Telting***, M Lehnert, Y Simis, "CI Camelopardalis", *IAU Circ*, **6871**.

R I Hynes, P Roche, ***N A Walton***, R M Hjellming, M P Rupen, A J Mioduszewski, "J2012+381", *IAU Circ*, **6932**.

C S Jeffery, ***D L Pollacco***, "The detection of binary companions to subdwarf B stars", *Astron Soc Pac Conf Ser*, **131**, 411.

C S Jeffery, ***D L Pollacco***, "The detection of binary companions to subdwarf B stars", *MNRAS*, **298**, 179.

C Knigge, K S Long, R A Wade, R Baptista, K Horne, I Hubeny, ***R G M Rutten***, "Hubble Space Telescope eclipse observations of the nova-like cataclysmic variable UX Ursae majoris", *Astrophys J*, **499**, 414.

C Koen, D O'Donoghue, ***D L Pollacco***, A Nitta, "The EC 14026 stars. XI. Feige 48: a link in its class", *MNRAS*, **300**, 1105.

R G M Rutten, "3D eclipse mapping", *Astron Astrophys Suppl*, **127**, 581.

C Schrijvers, ***J H Telting***, "Line-profile variability as a probe for l and m", *Astron Soc Pac Conf Ser*, **135**, 99.

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

H C Spruit, ***R G M Rutten***, "The stream impact region in the disc of WZ Sge", *MNRAS*, **299**, 768.

J H Telting, C Schrijvers, "Line-profile variability in the rotating β Cephei stars ε Cen, ω^1 Sco, and δ Sco", *Astron Soc Pac Conf Ser*, **135**, 149.

J H Telting, C Schrijvers, "A new bright beta Cephei star: line-profile variability in ω^1 Sco", *Astron Astrophys*, **339**, 150.

J H Telting, C Schrijvers, "Line-profile variability as a diagnostic for non-radial pulsation mode identification", Cyclical Variability in Stellar Winds. Proceedings of the ESO Workshop held at Garching, Germany, 14-17 October 1997. Edited by L Kaper and A W Fullerton. Publisher: Berlin, New York: Springer-Verlag, 1998. *ESO Astrophysics Symposia*, ISBN 354064802X, 187.

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Y C Unruh, J-F Donati, L Balona, T Böhm, H Cao, C Catala, A Collier Cameron, P Ehrenfreund, B Foing, T Granzer, J Hao, A Hatzes, H Henrichs, C Johns-Krull, J De Jong, T Kennelly, J Landstreet, N Morrison, C Mullis, J Neff, J Oliveira, C Schrijvers, T Simon, E Stempels, K G Strassmeier, ***J H Telting***, ***N A Walton***, "MUSICOS Observations of SU Aur", *Astron Soc Pac Conf Ser*, **154**, 2064.

THE GALAXY

K Exter, M Barlow, R Clegg, ***N A Walton***, Q Parker, "Chemistry of the Galactic Bulge", Asymptotic Giant Branch Stars. Proceedings of the conference held in Montpellier, France, Aug 28 – Sept 1, 1998. *IAU Symp*, **191**, poster session #P6-02.

R E Hibbins, P L Dufton, ***S J Smartt***, W R J Rolleston, "The carbon abundance in main-sequence B-type stars towards the Galactic anti-centre", *Astron Astrophys*, **332**, 681.

K A Venn, ***S J Smartt***, D J Lennon, P L Dufton, "New identifications for blue objects towards the Galactic centre: post-AGB stars, Be/disk stars and others", *Astron Astrophys*, **334**, 987.

GALAXIES

M W Asif, C G Mundell, A Pedlar, S W Unger, A Robinson, B Vila-Vilaró, J R Lewis, "Kinematics of the dusty circumnuclear ring in the barred Seyfert galaxy NGC 4151", *Astron Astrophys*, **333**, 466.

C R Benn, M Vigotti, R Carballo, J I González-Serrano, S F Sánchez, "Red quasars not so dusty", *MNRAS*, **295**, 451.

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R Carballo, S F Sánchez, J I González-Serrano, ***C R Benn***, M Vigotti, "K-band imaging of 52 B3-VLA quasars: nucleus and host properties", *Astron J*, **115**, 1234.

C Packham, S Young, J H Hough, C N Tadhunter, D J Axon, "Near-infrared imaging polarimetry of Cygnus A", *MNRAS*, **297**, 936.

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M Vigotti, S F Sánchez, J I González-Serrano, R Carballo, ***C R Benn***, "A limit on dust extinction in B3QS sample", *Astron Soc Pac Conf Ser*, **146**, 338.

OBSERVATIONAL COSMOLOGY

G Aldering, S Perlmutter, R A Knop, P Nugent, G Goldhaber, D E Groom, M Y Kim, C R Pennypacker, S Deustua, R Quimby, A Goobar, R Pain, S Fabbro, I M Hook, C Lidman, A Kim, B Schaefer, R Ellis, M Irwin, ***N A Walton***, P Ruiz-Lapuente, A Fruchter, N Panagia, "Measurements of OMEGA and LAMBDA from high-redshift supernovae", *Bull Am Astron Soc*, **30**, 1305.

C R Benn, "Large Scale Structure from Radio Surveys", Large Scale Structure: Tracks and Traces. Proceedings of the 12th Potsdam Cosmology Workshop, held in Potsdam, September 15th to 19th, 1997. Edited by V Mueller, S Gottloeber, J P Muecket, J Wambsganss. Published by World Scientific, 1998.

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A J Castro-Tirado, J Gorosabel, T Galama, P Groot, J van Paradijs, C Kouveliotou, ***J H Telting***, B García-Lorenzo, L Jones, "GRB 970508", *IAU Circ*, **6848**.

T J Galama, P J Groot, J van Paradijs, C Kouveliotou, R G Strom, R A M J Wijers, N Tanvir, J Bloom, M Centurión, ***J H Telting***, ***R G M Rutten***, P Smith, C Mackey, ***S J Smartt***, ***C R Benn***, J Heise, J J M in't Zand, "Optical follow-up of GRB 970508", *Astrophys J*, **497**, L13.

P J Groot, T J Galama, J van Paradijs, C Kouveliotou, R A M J Wijers, J Bloom, N Tanvir, R Vanderspek, J Greiner, A J Castro-Tirado, J Gorosabel, T von Hippel, M Lehnert, K Kuijken, H Hoekstra, N Metcalfe, C Howk, C Conselice, ***J H Telting***, ***R G M Rutten***, J Rhoads, A Cole, D J Pisano, R Naber, R Schwarz, "A search for optical afterglow from GRB 970828", *Astrophys J*, **493**, L27.

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J Méndez, P Ruiz-Lapuente, ***N A Walton***, "GRB 971227", *IAU Circ*, **6806**.

S Perlmutter, G Aldering, M Della Valle, S Deustua, R S Ellis, S Fabbro, A Fruchter, G Goldhaber, A Goobar, D E Groom, I M Hook, A G Kim, M Y Kim, R A Knop, C Lidman, R G McMahon, P Nugent, R Pain, N Panagia, C R Pennypacker, P Ruiz-Lapuente, B Schaefer, ***N A Walton***, "Discovery of a supernova explosion at half the age of the Universe", *Nature*, **391**, 51.

S Perlmutter, G Aldering, B J Boyle, P G Castro, W J Couch, S Deustua, S Fabro, R S Ellis, A V Filippenko, A Fruchter, G Goldhaber, A Goobar, D E Groom, I M Hook, M Irwin, A G Kim, M Y Kim, R A Knop, J C Lee, T Matheson, R G McMahon, H J M Newnerg, C Lidman, P Nugent, N J Nunes, R Pain, N Panagia, C R Pennypacker, R Quimby, P Ruiz-Lapuente, B Schaefer, ***N A Walton*** – The Supernova Cosmology Project, "Measurements of Omega and Lambda from 42 High-Redshift Supernovae", Abstracts of the 19th Texas Symposium on Relativistic Astrophysics and Cosmology, held in Paris, France, Dec. 14–18, 1998. Edited by J Paul, T Montmerle, and E Aubourg (CEA Saclay).

SITE CHARACTERIZATION

M Azzaro, M Breare, "Some meteorological parameters affecting the image quality of the William Herschel Telescope on La Palma", *New Astron Rev*, **42**, 471.

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

C Packham, ***N O'Mahony***, R Wilson, "Recent developments in the Half Arcsecond Programme", *New Astron Rev*, **42**, 431.

INSTRUMENTATION

S Arribas, D Carter, L Cavalier, C del Burgo, ***R Edwards***, F J Fuentes, A A García, J M Herreros, L R Jones, E Mediavilla, M Pi, ***D L Pollacco***, J L Rasilla, ***P C Rees***, N A Sosa, "INTEGRAL: a matrix optical fiber system for WYFFOS", *Proc SPIE*, **3355**, 821.

S Arribas, C del Burgo, D Carter, L Cavaller, ***R Edwards***, J Fuentes, B García-Lorenzo, A García-Marín, B Gentles, J M Herreros, L Jones, E Mediavilla, M Pi, ***D L Pollacco***, J L Rasilla, ***P C Rees***, N Sosa, "INTEGRAL: an Optical-Fiber System for 2-D Spectroscopy on the 4.2-m William Herschel Telescope", *Astron Soc Pac Conf Ser*, **152**, 149.

R J Lewis, ***N A Walton***, "Holistic approach to data management at the Isaac Newton Group", *Proc SPIE*, **3349**, 263.

N A Walton, P S Bunclark, ***M P Fisher***, ***F J Gribbin***, E L Jones, ***P C Rees***, G T Rixon, "Improving the effectiveness of 2-m-class telescopes through control systems redesign", *Proc SPIE*, **3351**, 197.

Appendix G

Financial Statement

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

Budget centre	Allocation K£	Allocation Mptas	Allocation Total K£	Expenditure K£	Expenditure Mptas	Expenditure Total K£	Exp – Alloc K£
Administration group	5.0	3.2	20.7	4.2	2.3	15.3	-5.4
Astronomy support	13.2	4.6	35.7	9.8	4.8	33.5	-2.2
Common services	—	11.5	56.4	0.1	11.4	56.0	-0.4
Communications	5.5	22.8	117.3	4.2	25.3	128.6	11.3
Computing facilities	75.0	5.0	99.5	67.4	7.1	102.3	2.8
Detectors laboratory start-up	33.9	—	33.9	26.5	1.6	34.2	0.3
Electrical services	48.3	6.7	81.1	45.4	7.0	79.7	-1.4
Electronics maintenance	35.9	4.5	58.0	18.8	6.5	50.6	-7.4
Library/Public relations	30.0	1.5	37.4	37.4	0.0	37.4	—
Local staff costs	4.7	160.0	789.0	3.6	160.1	788.5	-0.5
Mechanical engineering	30.0	3.2	15.7	35.4	4.8	58.9	43.2
Re-engineering programme	110.0	—	110.0	76.2	0.1	76.4	-33.6
Residencia costs	—	18.0	88.2	—	20.1	98.3	10.1
Safety	29.5	2.5	41.8	18.1	1.1	23.4	-18.4
Sea-level base	0.2	27.8	136.5	2.2	28.4	141.5	5.0
Site services	15.2	31.5	169.6	14.0	31.5	168.4	-1.2
Site works	4.0	12.5	65.3	5.8	9.1	50.7	-14.6
Transport fleet maintenance	—	10.9	53.6	0.1	11.5	56.5	2.9
Transport fleet replacement	—	—	—	—	-0.7	-3.6	-3.6
UK/NL shared staff costs	2.2	1.7	10.5	1.8	3.0	16.9	6.4
UK/NL support	14.0	0.2	15.0	8.1	0.1	8.2	-6.8
Enhancement programme	285.0	—	285.0	209.9	—	209.9	-75.1
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

Budget centre	Allocation K£	Allocation Mptas	Allocation Total K£	Expenditure K£	Expenditure Mptas	Expenditure Total K£	Exp – Alloc K£
Administration group	7.0	1.4	12.8	1.5	3.0	13.7	1.0
Astronomy support	12.0	2.3	21.5	10.6	3.2	24.0	2.5
Common services	—	3.0	12.4	—	10.1	41.7	29.3
Communications	3.2	14.7	63.9	3.1	12.1	53.0	-11.0
Computing facilities	42.2	12.9	95.5	49.5	16.4	117.4	21.9
Electrical services	55.8	6.7	83.5	53.0	7.8	85.1	1.6
Electronics maintenance	25.0	7.0	53.9	7.0	6.1	32.0	-21.9
Library/Public relations	30.0	3.0	42.4	32.6	1.2	37.7	-4.7
Local staff costs	3.1	175.2	726.9	5.2	175.1	728.9	2.0
Mechanical engineering	27.8	4.2	45.2	22.3	5.9	46.8	1.7
Mechanical safety	11.5	—	11.5	—	—	—	-11.5
Residencia costs	—	20.0	82.6	—	19.8	81.7	-1.0
Safety	23.5	2.9	35.5	23.9	1.8	31.3	-4.2
Sea-level base	0.5	26.0	107.9	1.2	26.6	110.9	3.0
Sheffield Workshop	—	—	—	5.8	—	5.8	5.8
Site services	3.0	34.0	143.5	3.2	28.3	120.0	-23.5
Site works	3.0	7.5	34.0	—	8.1	33.6	-0.3
Software	12.0	3.0	24.4	4.1	3.3	17.8	-6.6
Transport fleet maintenance	—	10.9	45.0	0.5	9.3	39.1	-5.9
Transport fleet replacement	—	—	—	—	7.5	30.9	30.9
UK/NL management	8.0	1.9	15.8	5.8	3.8	21.4	5.5
UK/NL science support	8.5	—	8.5	0.3	—	0.3	-8.2
Enhancement programme	457.2	—	457.2	315.3	—	315.3	-141.9
Total	**733.2**	**336.6**	**2,124.0**	**544.9**	**349.4**	**1,988.5**	**-135.4**

Appendix H

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	*NFRA 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*

PATT ING 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

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Fax: +34 922 425401

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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.
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585 (JKT control room)
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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.

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Appendix J

Acronyms and Abbreviations

AAO	Anglo-Australian Observatory
Astron Astrophys	Astronomy and Astrophysics Journal
Astron Astrophys Suppl	Astronomy and Astrophysics Journal Supplement Series
Astron J	Astronomical Journal
Astron Soc Pac Conf Ser	Astronomical Society of the Pacific Conference Series
Astrophys J	Astrophysical Journal
Astrophys J Suppl	Astrophysical Journal Supplement Series
Astrophys Space Science	Astrophysics and Space Science Journal
AU	Astronomical Unit (1.496×10^{8} km)
AUTOFIB	Autofib Fibre Positioner
Aux	Auxiliary Port at the WHT Cassegrain focus
Bull Am Astron Soc	Bulletin of the American Astronomical Society
Cass	Cassegrain focus
CAT	Comité para la Asignación de Tiempos (Spanish panel for the allocation of telescope time)
CCD	Charge-Coupled Device
CCI	Comité Científico Internacional (International Scientific Committee) for Astrophysics
CfA	Harvard-Smithsonian Centre for Astrophysics
CIRSI	Cambridge Infra Red Survey Instrument
DAS	Data Acquisition System
DIAS	Dublin Institute for Advanced Studies
DIMM	Differential Image Motion Monitor
ELECTRA	Enhanced Light Efficiency Cophasing Telescope Resolution Actuator
ESTEC	European Space Technology Centre
Fib	AUTOFIB fibre positioner
FOS	Faint Object Spectrograph
FWHM	Full Width Half Maximum
GHRIL	Ground Based High Resolution Imaging Laboratory
HST	Hubble Space Telescope
IAC	Instituto de Astrofísica de Canarias
IAU	International Astronomical Union
IAU Circ	IAU Circular
IC	Imperial College
ICS	Instrument Control System
ICSTM	Imperial College of Science, Technology and Medicine
IDS	Intermediate Dispersion Spectrograph
ING	Isaac Newton Group
INGRID	ING Red Imaging Device
Int Astron Union Symp	International Astronomical Union Symposium

INT	Isaac Newton Telescope
INTEGRAL	Integral field fibre feed for WYFFOS
IoA	Institute of Astronomy
IR	Infrared
Irish Astron J	Irish Astronomical Journal
ISIS	ISIS double spectrograph
ITP	International Time Programme
JAG	JKT Acquisition and Guiding Unit
JKT	Jacobus Kapteyn Telescope
JOSE	Joint Observatories Seeing Evaluation programme
JSC	Joint Steering Committee
LDSS	Low Dispersion Survey Spectrograph
LIRIS	Long-Slit Intermediate-Resolution Infrared Spectrograph
LJMU	Liverpool John Moores University
MARTINI	Multi-Aperture Real Time Image Normalisation Instrument
MCCD	Mosaic CCD camera or National Astronomical Observatory of Japan camera
Mem Soc Astron Ital	Memorie della Società Astronomica Italiana
MNRAS	Monthly Notices of the Royal Astronomical Society
MOMI	Manchester Occulting Mask Imager
MSSL	Mullard Space Science Laboratory
MSSSO	Mount Stromlo and Siding Spring Observatories
Musicos	Multi-SIte COntinuous Spectroscopy (fibre spectrograph on the INT)
NAOMI	Natural guide star Adaptive Optics system for Multiple-Purpose Instrumentation
NBST	National Board of Science and Technology of Ireland
New Astron	New Astronomy Journal
New Astron Rev	New Astronomy Review
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
OAN	Observatorio Astronómico Nacional
ORM	Observatorio del Roque de Los Muchachos (Roque de los Muchachos Observatory)
PASA	Publications of the Astronomical Society of Australia
PASP	Publications of the Astronomical Society of the Pacific
PATT	Panel for the Allocation of Telescope Time
PF	Prime Focus
PFC	Prime Focus Camera
Planet Space Sci	Planetary and Space Science Journal
PP	People’s Photometer
PPARC	Particle Physics and Astronomy Research Council
Proc	Proceedings
RBS	Richardson-Brealy Spectrograph
RGO	Royal Greenwich Observatory
RAL	Rutherford Appleton Laboratory
Space Sci Rev	Space Science Reviews
SPIE	Society of Photo-Optical Instrumentation Engineers
STScI	Space Telescope Science Institute
TAG	Time Allocation Group
TAURUS	TAURUS Fabry-Perot spectrograph or imager
TCS	Telescope Control System
TRIFFID	Galway/DIAS Image Sharpening Camera
UCLAN	University of Central Lancashire
UES	Utrecht Echelle Spectrograph
UKIRT	United Kingdom Infrared Telescope
WHIRCAM	William Herschel Infrared Camera
WFC	Wide Field Camera
WFS	Wide Field Surveys with the WFC
WHT	William Herschel Telescope
WYFFOS	Wide Field Fibre Optics Spectrograph
ZAMS	Zero-Age Main Sequence

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