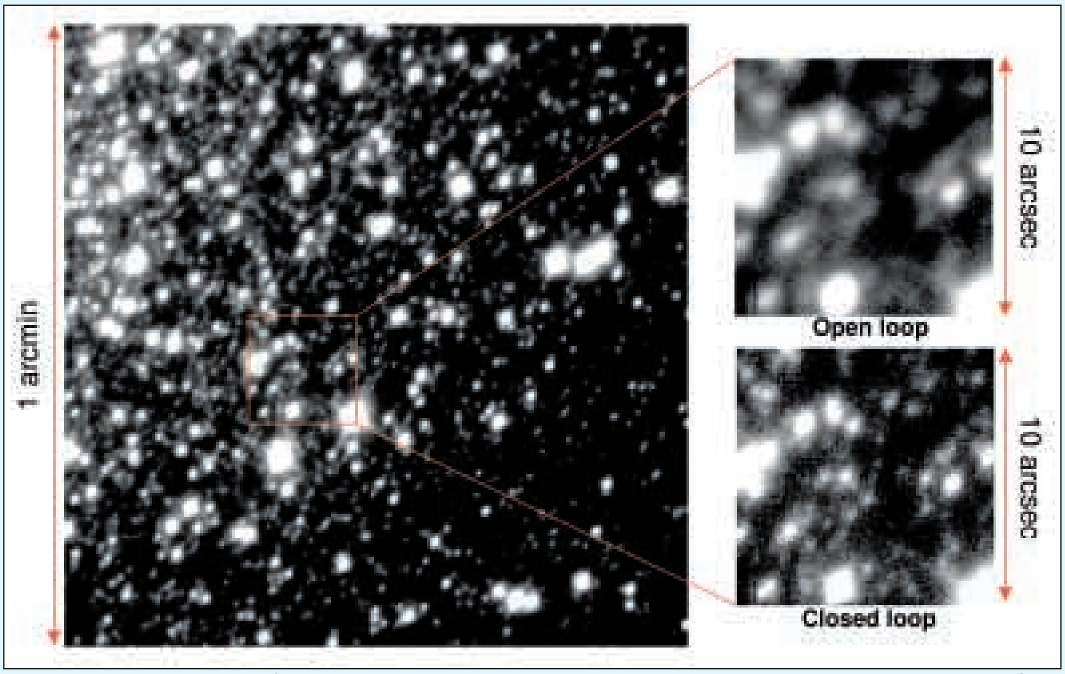
No. 5, October 2001

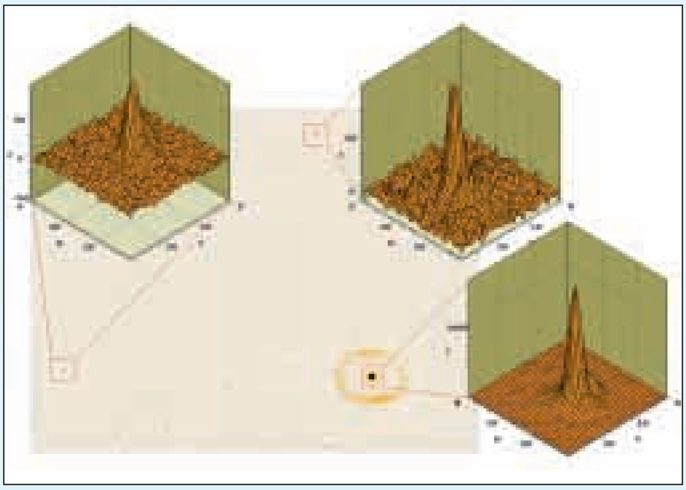
The Isaac Newton Group of Telescopes

NEWSLETTER

First Results from NAOMI in the Optical



This H-alpha image (top) of globular cluster M13 was taken with the WHT's adaptive-optics system NAOMI. The FWHM has been improved from 0.8 arcsec (natural seeing) to 0.4 arcsec, allowing many faint stars to be resolved. The image was taken during September 2001 tests of NAOMI's performance at optical wavelengths, and provides a realistic outlook of the AO potential at the William Herschel Telescope. Given that the median natural seeing on La Palma is about 0.7 arcsec, an image quality of ~0.3 arcsec in the R and I bands should be achieved regularly.



AO capability at optical wavelengths is not common place at other observatories. In the infrared, where diffraction limited performance is more readily obtained, NAOMI has already proven its capability. The image to the left shows the K-band diffraction limited (0.13 arcsec FWHM) central star of the planetary nebula BD+30 3639. The nebula has a radius of ~2.5 arcsec on this image. Interestingly, field stars as far away as 30 arcsec from the central star still enjoy very good AO correction, indicating that on La Palma good AO correction can be achieved over moderately wide fields. (See also article by Benn et al. on page 19).

Message from the Director

Dear Reader,

By the time this ING Newsletter reaches your screen, library or desk, a new fibre module for the Autofib fibre instrument will have been fully commissioned. Although at the time of writing there is still much work to be done, the new unit has been put through its paces on the telescope. And very successfully so! This project is one of the main instrumentation development activities that are fully carried out by ING staff on La Palma. But most importantly, this project will provide significant improvements to the capability of multi-object fibre spectroscopy at the WHT. The interest in this field of observational astronomy is reflected in the large number of high quality applications that have been received.

THE ISAAC NEWTON GROUP OF TELESCOPES

The Isaac Newton Group of Telescopes (ING) consists of the 4.2 m William Herschel Telescope (WHT), the 2.5 m Isaac Newton Telescope (INT) and the 1.0 m Jacobus Kapteyn Telescope (JKT), and is located 2,350 m 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. 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 by the Instituto de Astrofísica de Canarias (IAC).

(Continued from front cover)

As multi-object fibre spectroscopy is seen as one of the key roles for the WHT in future years it is heartening to see that there is so much interest in this new fibre module. You will read more on the new fibre module in the pages that follow.

An important event occurred in February of this year when an international and independent group of four eminent scientists conducted a review of the ING. This Visiting Group, chaired by Prof Kenneth Freeman, was asked by the ING Board to review progress made on the recommendations from the review that was carried out three years earlier, and to review the operations and development plans and future prospects of the ING. The outcome of this review has been very supportive of what the ING has accomplished in recent years and what our strategic plans are for the future. This review has already had an important impact and will serve as a reference point for several years to come.

For one thing, the international review helped ING focus on the options for further international collaboration, and on the more important role that the IAC could play in the operation and development of the observatory. This has led to an investigation on how collaborations may develop further. At the moment talks are ongoing for collaborations at various levels between ING and the IAC, the Italian National Telescope Galileo, Calar Alto Observatory, and the Canada-France-Hawaii Telescope. These practical initiatives are all aimed at providing better, and more cost-effective service for the community of users in the longer term.

René G. M. Rutten

The ING Newsletter

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The ING Newsletter is published twice a year in March and September. If you wish to submit a contribution, please contact Javier Méndez (*jma@ing.iac.es*). Submission deadlines are 15 July and 15 January.

The ING Board

The ING Board oversees the operation, maintenance and development of the Isaac Newton Group of Telescopes, and fosters collaboration between the international partners. It approves annual budgets and determines the arrangements for the allocation of observing time on the telescopes. ING Board members are:

Prof. T. de Zeeuw, *Chairman* – Leiden
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SCIENCE

The Andromeda Stream: A Giant Trail of Tidal Stellar Debris in the Halo of M31

M. Irwin (Institute of Astronomy), A. Ferguson (Kapteyn Astronomical Institute), N. Tanvir (Physical Sciences, University of Hertfordshire), R. Ibata (Observatoire de Strasbourg) and G. Lewis (Anglo-Australian Observatory)

Our panoramic wide field imaging survey of M31 using the Wide Field Camera (WFC) on the 2.5-m Isaac Newton Telescope (INT) has unambiguously revealed the presence of a giant stellar stream within M31's halo (Ibata et al., 2001, *Nature*, **412**, 49). The source of the stream is likely to be either, or both, of the peculiar dwarf galaxies M32 and NGC 205, close companions of M31, which may have lost a substantial amount of stars, gas and dust due to their tidal interactions with the massive host galaxy. The broad agreement of the metallicity distribution of the stream stars with these two dwarf satellites together with their alignment, physical proximity, and distorted morphological appearance, point to a common origin. The well-known disparity in properties between the Milky Way and M31 stellar haloes would be understandable if the majority of M31's stellar halo arose as relatively recent tidal debris from prolonged bouts of aggressive tidal interaction with its two nearest neighbour satellites. Together with recent observations of tidal debris in the Milky Way halo, these results clearly demonstrate that the epoch of galaxy building still continues, and that substructure in the form of huge, recently-deposited tidal streams, could be a generic feature of large galaxy haloes.

Modern cosmology holds that the development of large complex structures occurs through hierarchical gravitational capture of smaller sub-units. Cosmologists initially had in mind the evolution of galaxy clusters and yet larger scale structures, however, the scale-invariance of the underlying primordial fluctuations implies that similar growth-by-capture should also occur on the scale of individual large galaxies. Until quite recently the two most well-studied nearby large galaxies, M31 and the Milky Way, had stubbornly refused to yield any unambiguous direct evidence of this type of bottom-up growth. Without the corroborating stellar detritus, even the impressive giant arc of gas in the Magellanic Stream can be interpreted as ram pressure stripping by a hot gaseous halo and not as direct tidal accretion.

The discovery of the Sagittarius dwarf (Ibata, Gilmore, & Irwin, 1994, *Nature*, **370**, 194), a satellite galaxy of the Milky Way caught in the act of tidal destruction, irrevocably changed our opinion of the local universe. Further work since then has revealed stellar debris from this system encircling the Galactic Halo, in line with theoretical predictions (Ibata et al., 2001, *ApJ*, **551**, 294). During such a merger, tidal forces shock both the dark matter and the stellar components of the dwarf galaxy, making them gravitationally unbound. The complete destruction of the victim is usually progressive and may take several orbits. However, the tidal debris from the destroyed dwarf galaxy follows a similar orbital path to the progenitor, and tends to be deposited over a broad range in distance in the halo of the larger galaxy (see Figure 1).

The structural and kinematic properties of these streams provide powerful probes of the galactic haloes, especially in regions perpendicular to the disk where the dark matter distribution is essentially unknown. Dynamical mass estimates using such streams provide the key to determining the distribution of the dark matter since the stream stars can be employed as test-particles along orbits through the halo. Evidence for the phase-space clumping of halo stars has even been found in the Solar Neighbourhood, where ~10% of stars may be associated with a single ancient accretion event (Helmi et al., 1999, *Nature*, **402**, 53).

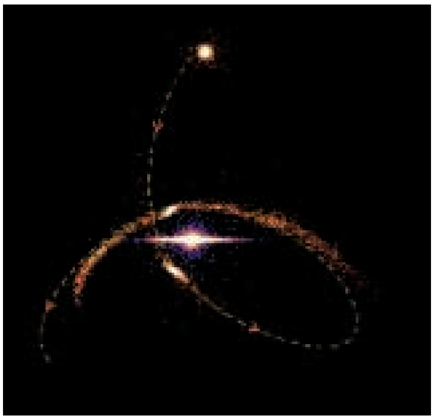

Figure 1. The progressive destruction of a dwarf galaxy on a plunging orbit around a large host system. Credit Katherine Johnston.

Further evidence of the importance of tidal interactions is provided by the sparse halo globular cluster Palomar 5 which beautifully illustrates both the development of tidal tails in the halo and the morphological evolution of globular cluster systems (Odenkirchen et al., 2001, *ApJ*, **548**, 165). The most compelling example of an external galaxy in which substantial halo sub-structure has been found is NGC 5907 (Shang et al., 1998, *ApJ*, **504**, 23), which has a spectacular low surface brightness elliptical loop, 45 kpc in extent, interpreted as the tidal stellar debris of a now defunct dwarf satellite galaxy.

Are these systems particularly unusual or are tidal streams a common feature in galaxies today?

To answer this, in September of last year we trained the INT WFC on the southeastern half of the halo of our nearest large neighbour (D ≈ 780 kpc), M31, a prime target for both a detailed photometric and kinematic study (see Figure 2).

Previous imaging studies of the M31 halo and outer disk have either sampled only a few discrete locations, or have taken a panoramic, but much shallower view. However, even with a field of view of ≈ 35×35 arcmin it took fifty eight adjacent, slightly overlapping, pointings of the INT WFC to tile the southern half of M31's halo out to a projected distance of 50 kpc. By integrating for 900s in V and i' passbands we attained 5-sigma limits of i'=23.5 and V=24.5 and could probe the top 2–3 magnitudes of the Red Giant Branch (RGB) of the M31 halo population. In conjunction with the large area coverage, this allowed us to make an uninterrupted study of the spatial variations in stellar density as a function of both magnitude and colour over a large fraction of the halo.

All of the on-target data plus calibration frames were processed back in Cambridge using the standard INT WFS (Wide Field Survey) data processing pipeline (Irwin & Lewis, 2001, *New Astronomy Reviews*, **45**, 105). The pipeline provides the usual facilities for instrumental signature removal, including in this case defringing of the i'-band data, plus tools for object catalogue creation, astrometric and photometric calibration, morphological classification and cross-matching catalogues from different observations.

Colour-magnitude Diagrams (CMDs) for three halo regions, fields #30, #22, #13, at similar projected distances from the centre of M31, are shown in Figure 3, highlighting the colour diversity, and variation in surface density of the M31 halo population.

The overall surface density variation of stellar objects with magnitudes and colours consistent with belonging to an M31 RGB halo population are shown in Figure 4. Simple visual inspection of this figure shows the presence of a stream-like over-density of sources in the halo, close to but distinct from the minor axis of M31. Additional unusual sub-structure is also present but is not so straightforward to interpret. Interestingly, the main stream points directly towards the Andromeda satellites M32 and NGC 205, and lies close to the direction of elongation of the tidally distorted outer isophotes of both M32 and NGC 205, suggesting a relationship between the Andromeda Stream and these two dwarf galaxies.

Figure 2. A 3×3 degree view of the Andromeda galaxy with the dwarf companions M32 and NGC 205 visible at projected distances of 5 kpc and 9 kpc respectively. Credit Richard Sword.

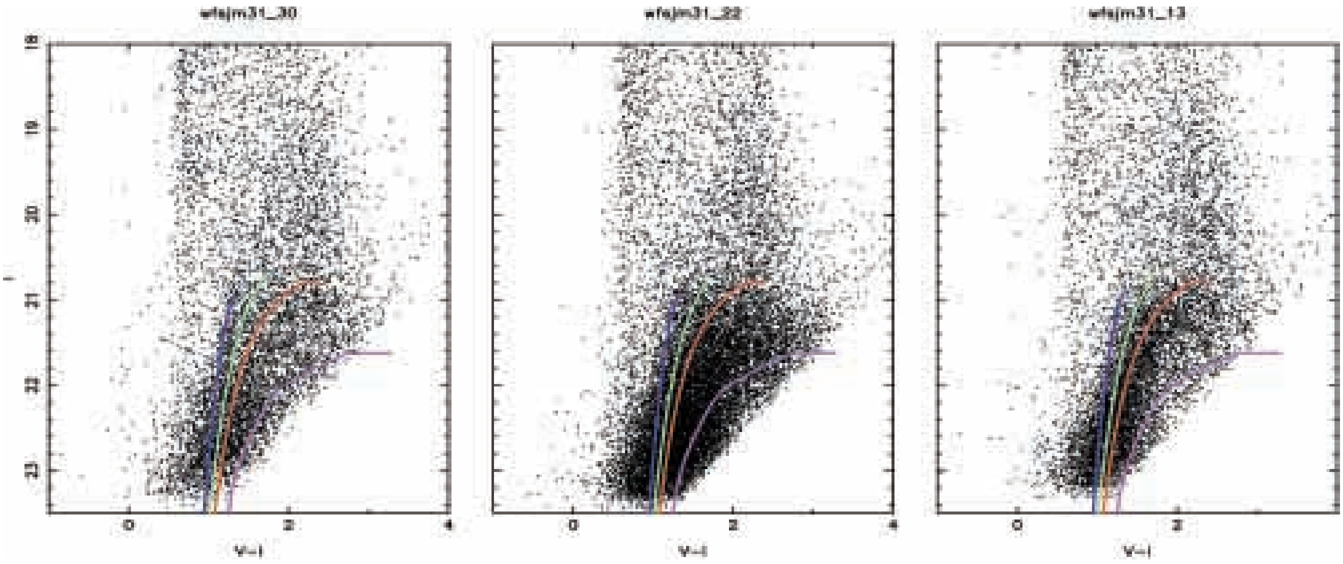

Figure 3. Colour-magnitude diagrams for survey fields: a. wfsjm31_30 lying close to the minor axis at a projected distance of ≈ 20 kpc at standard coordinates +1.0, –1.1; b. wfsjm31_22 sitting in an apparent halo stream at a similar projected distance to #30 but at standard coordinates +0.4, –2.0; c. wfsjm31_13 lying further round and down from #22 at standard coordinates –0.7,–2.3 (see Figure 4 for a location overview). Note that even though all three fields are at comparable halo distances from the centre of M31, the on-stream field #22 has a far higher density of RGB stars than the minor axis field #30; whilst the RGB of field #13 has a different colour distribution to #22, with an apparent deficit of the more metal rich stars clearly visible in field #22. The fiducial sequences overplotted are Galactic globular cluster sequences with, from the blue end, [Fe/H] = –1.91, –1.29, –0.71, – 0.2 respectively.

The surface brightness of the stream is about $V \approx 30$ mag arcsec^{-2} and by making plausible assumptions to allow for fainter stream stars, the incompleteness of the survey and the uniformity of the stream, we estimate that the absolute magnitude is $M_V \approx -14$. This luminosity is around a factor of 10 lower than that of M32 and NGC 205, consistent with the possibility that the stream represents debris torn from one, or both, of these two dwarf galaxies during a recent encounter with M31.

To understand more fully the nature of the stream further followup observations are planned. Similar panoramic imaging of the northern half of the halo is required, since if M32 and/or NGC 205 are the progenitors a similar tidal stream is expected in the northern half of the halo. An extension of the southern halo survey is also needed since the current data do not reach the end of the stream. Finally, since the brightest halo and stream members have magnitudes of around i'=21, kinematic measurements of large numbers of putative stream stars are feasible and will help to probe not only the nature and origin of the stream but also the dark matter distribution in the halo of M31.

But perhaps the final word on this should belong to an observer from a different era.

"*While observing the Andromeda Nebula with a fine 18-ft telescope ... I saw another small nebula about one minute in diameter which appeared to throw out two small rays; one to the right and the other to the left.*"

G-J-H-J-B Le Gentil de la Galazière, October 29, 1749, Remarks on the Nebulous Stars (1759).

Thanks to Michael Drinkwater for drawing our attention to Le Gentil de la Galazière's quotation in Mario Mateo's perceptive *Annual Review* article. ¤

Mike Irwin (mike@ast.cam.ac.uk)

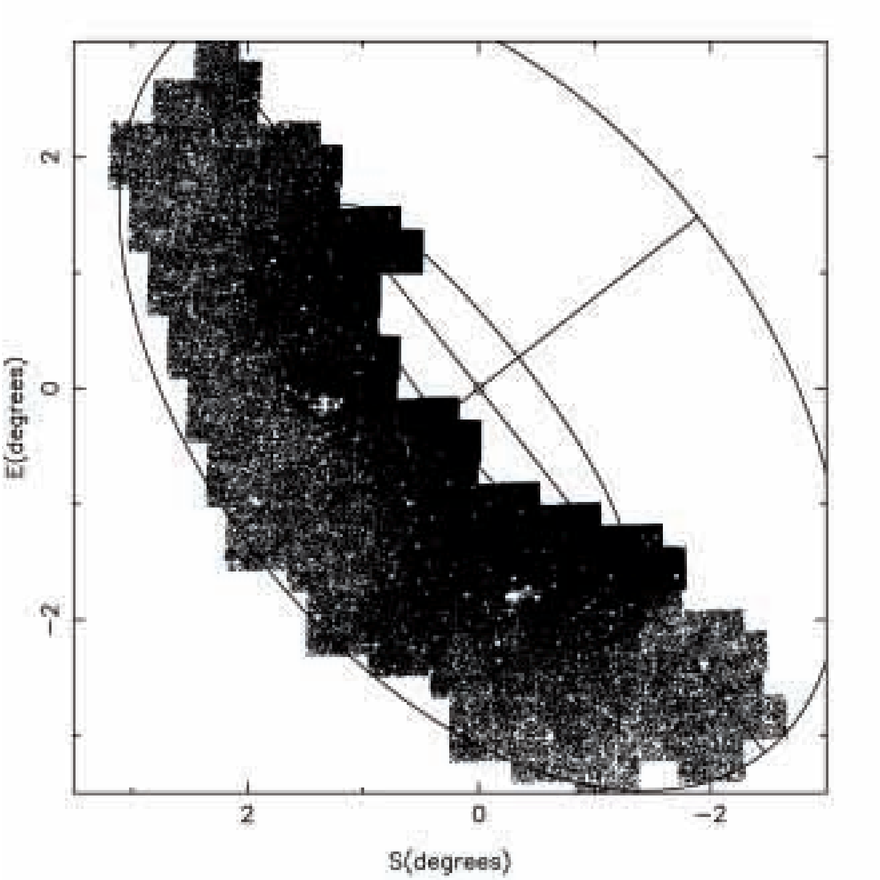

Figure 4. Surface density of RGB stars over the southeastern halo of M31. The over-density of stars is seen as a stream extending out of M31 close to, but distinct from, the minor axis.

The SAURON Survey of Early-Type Galaxies in the Nearby Universe

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1: University of Nottingham. 2: Observatoire de Lyon. 3: Sterrewacht Leiden. 4: Durham University. 5: International Gemini Project.

In 1999, a new and unique integral-field spectrograph, SAURON, made its debut at the WHT. SAURON has a large field of view and high throughput, and was developed as a private instrument in a collaborative effort between groups at Observatoire de Lyon, Leiden Observatory, and the University of Durham. It is optimised for the systematic study of the stellar and gaseous kinematics and the line-strength distributions of nearby early-type galaxies and bulges. The design of SAURON (Figure 1) is similar to that of the prototype integral-field spectrograph TIGER and its successor OASIS built for the CFHT (Bacon et al., 1995, 2000). The field of view is 33×41 arcsec with spatial sampling of 0.94×0.94 arcsec. SAURON provides 1,577 spectra in the wavelength range from 4810Å to 5350Å. Of these, 146 are sky-spectra 1.9 arcmin away from the main field. A complete description of the design

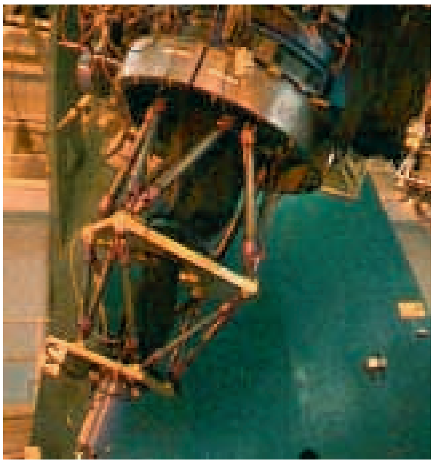

Figure 1. SAURON at the Cassegrain focus of the WHT.

and construction of SAURON, and the corresponding data reduction software is given in Bacon et al. (2001b). Details about the commissioning, together with some early results, can be found in an article in the *ING Newsletter* of March 2000 (de Zeeuw et al., 2000). The article also describes the SAURON project, an ambitious survey of the dynamics and stellar populations of large, nearby early-type galaxies and bulges. Here we give a progress report on the survey, describe what we have been able to do in five observing runs, and what we plan to do in the near future.

SAURON Project: A Survey of Early-Type Galaxies and Bulges

The aim of the SAURON collaboration, and the reason for building the instrument, is to study a representative sample of nearby ellipticals, lenticulars and bulges of early-type spirals, in order to measure their intrinsic shapes, velocity and metallicity distributions, and to gain insight into the relation between their stellar and gaseous kinematics and stellar populations. The SAURON data will be combined with high spatial resolution spectra of the nuclei, and interpreted through state-of-the-art dynamical and stellar population modelling.

We defined the SAURON sample in the following way. We first compiled a complete list of accessible E/S0 galaxies and Sa bulges for which SAURON can measure the stellar kinematics: $-6° \leq \delta \leq 64°$ (to limit the zenith distance and therefore the instrumental flexure), $cz \leq 3000\,\mathrm{km s^{-1}}$ (to ensure that the lines of interest are in the spectral band), and $M_B \leq -18$ (so that $\sigma \geq 75\,\mathrm{km s^{-1}}$ and velocity dispersions can be measured). The objects span a factor 50 in luminosity and cover the full range of environment, nuclear cusp slope, rotational support, and apparent flattening. The galaxies were then divided into six categories (E/S0/S; field/cluster) and a representative sample of 12 objects was selected in each category to populate the ellipticity versus absolute magnitude planes homogeneously (see Figure 2). Since we are trying to observe each galaxy to one half-light radius, we took multiple-pointing mosaics for many of our objects, thus ensuring the internal structure of these galaxies is fully mapped to large scales.

We are making excellent progress. We have had 5 observing runs, and observed a total of ~50 galaxies. More than half our objects were observed during an exceptionally good run in March, 2001. Of a total of 12 nights allocated by British and Dutch committees we lost only about 3 hours due to technical problems, and none to weather. Exceptional conditions were coupled with the excellent performance of the new ULTRADAS readout system recently installed at La Palma, which has more than halved readout times and overheads, adding 30–60 minutes of usable time per night. This run enabled us to finish our subsample of elliptical galaxies, and to almost complete the S0-subsample. The efficiency of observing with SAURON in this run also reflects the first-class support offered by the ING staff, and illustrates how well the instrument has been integrated into the observatory. We have now taken ~115,000 independent galaxy spectra, a similar number to, e.g., the 2dF survey (Colless et al., 2001).

Although one might think that the data reduction for an instrument like SAURON, with dataframes containing about 1,600 spectra each, is exceedingly complicated, the fact that almost everything in SAURON is fixed makes the data reduction the same for each galaxy. For this reason it has been possible to build an automatic reduction pipeline, named `Palantir`, which converts the data from raw CCD-frames to calibrated data-cubes. `Palantir` uses individual programs of the `XSAURON` software, developed in Lyon in a way similar to the `XOASIS` package. After analysing in detail part of the data we find that the SAURON measurements are comparable to, and usually significantly better than, the highest-quality determinations in the literature (de Zeeuw et al., 2001).

Science with SAURON

The information contained in the SAURON spectra can be divided roughly in three classes: stellar kinematics, absorption line-strengths, and gaseous kinematics and emission line-strengths. In the following we show examples of all three classes, and how the data can be used to better understand the formation and evolution of early-type galaxies.

Counter-rotating Gas in the Spiral Galaxy NGC 7742

NGC7742 is a nearly face-on spiral galaxy classified as S(r)b in the RC3

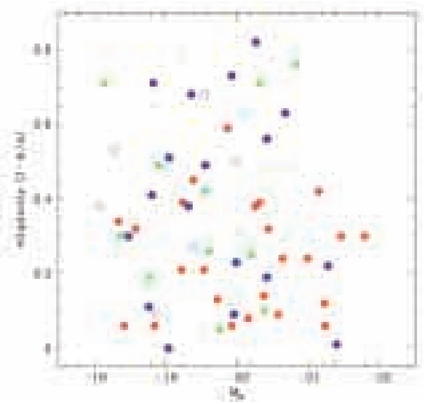

Figure 2. Galaxies of the SAURON survey in the luminosity — ellipticity plane. Galaxies that have been observed to date are shown with filled symbols. Red dots are elliptical galaxies, blue dots are S0's and green dots denote the spirals.

($M_B=-20.99$), and it is an example of the latest type spirals included in our sample. The galaxy contains an inner stellar ring with bright H II regions, flocculent spiral arms, a significant amount of neutral hydrogen, molecular gas, and dust (de Vaucouleurs & Buta, 1980; Roberts et al., 1991; Wozniak et al., 1995). The nucleus is classified as a transition LINER/H II object (Ho et al., 1997).

Figure 3 shows SAURON maps based on a single pointing taken on October 13, 1999. Most of the Hβ and [OIII] emission is confined to the ring of star formation surrounding the bulge. Hβ is dominant everywhere in the ring, where the ratio [OIII 5007Å]/Hβ ranges from 0.06 to 0.14. In the center the ratio is larger than 20. Figure 3 also shows a colour-coded reconstructed SAURON image, and an image based on broadband HST/WFPC2 images. The SAURON map does not have the spatial resolution of HST, but it does demonstrate that our analysis technique is capable of providing accurate emission-line maps.

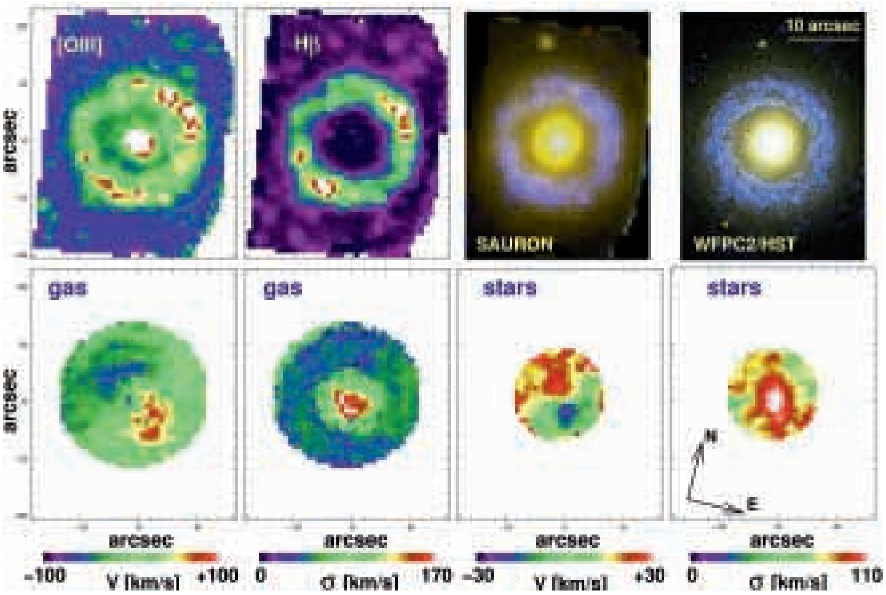

Figure 3. SAURON measurements of NGC 7742, based on 1 pointing, exposed for 4×1800 s. The top panels show the emission-line intensity distributions of [OIII] and Hβ, followed by a colour-coded reconstructed image composed of [OIII] (blue), blue continuum (green), and red continuum (red) derived from the SAURON data cube, and a similar colour-coded image composed of HST/WFPC2 exposures with the (blue), (green) and (red) filters. The bottom row shows (from left to right) the derived gas velocity and velocity dispersion fields, and the stellar velocity and velocity dispersion fields.

The bottom panels of Figure 3 show the mean velocity and velocity dispersion fields of the gas and stars in NGC 7742. The galaxy is observed almost face-on, and the amplitude of the velocities is accordingly modest. The zero-velocity directions are well-defined, and their position angles are consistent with each other (PA = 42°±12° for the stars and 35°±5° for the gas). However, gas and stars rotate in the opposite sense. This suggests that the observed gas does not originate from the stars, but has most likely been accreted.

The Stellar Populations of Galaxies with Kinematically-Peculiar Cores

Until the mid 1970s elliptical galaxies were thought to be smooth, structureless, red objects containing only old stars. Through the development of larger telescopes, coupled with improved detectors and better instrumentation, it has become apparent that this picture is far from correct. It was found that luminous ellipticals rotate very slowly. They do not maintain their ellipsoidal shape as a result of rotation, but are supported by an anisotropic stellar velocity distribution. Several indications were found that elliptical galaxies were the results of mergers of spiral galaxies. Many ellipticals contain significant fractions of interstellar matter, and not all stars were formed at the same time.

Of order 30% of the nearby elliptical galaxies contain a hint of so-called Kinematically Decoupled Core (KDC), i.e., a central component in which the stars rotate in a different sense to the stars in the main body of the galaxy. This can range from a simple counter-rotating component to a component with a skewed rotation axis. It is now thought that KDC's are formed in the last episode of major star formation of a galaxy. The fact that the orientation of their rotation is different from most of the stars indicates that this burst must have been induced by a galaxy merger (e.g., de Zeeuw & Franx, 1991). For a few galaxies the stars in the KDC have been studied in reasonable detail, to find out when they were formed, e.g., soon after the formation of the bulk of the galaxy, or later, during a minor merger event. Most KDC's seems to have the same age as the host galaxy (e.g., NGC 5322, Bender, 1988), while some show evidence for very recent star formation (e.g., NGC 2865, Hau et al., 1999).

SAURON is the ideal instrument to study KDC's. It provides the orientation of the rotation of the KDC with respect to that of the main galaxy with an accuracy that is nearly impossible to achieve with long-slit spectroscopy along multiple position angles. At the same time it provides line-strength maps, which can be used to study the ages of both components. Another non-negligible advantage is that with SAURON one can very accurately compare the kinematic and photometric centres. If they are different, as is, e.g., the case for M 31 (Bacon et al., 2001a), a long-slit spectrum through the photometric centre of the galaxy does not necessarily catch the kinematic centre, and is therefore very hard to interpret. Our sample of galaxies observed to date contains three elliptical galaxies for which previous work had demonstrated a dramatic KDC: NGC 4365, 4406 and 5813 (resp. Wagner et al., 1988; Franx, Illingworth & Heckman, 1989; Efstathiou, Ellis & Carter, 1980). All three objects have a flat central surface brightness profile (a core) of a few arcseconds in size, after which the surface brightness starts to fall rapidly (Figure 4, top). Apart from this, there is no photometric indication of the presence of a KDC.

The velocity fields, however, are not regular at all (Figure 4). For both NGC 4365 and NGC 4406 the main body of the galaxy rotates around the *major* axis, while the KDC rotates approximately around the minor axis. NGC 5813 contains a rapidly rotating central component, has negligible rotation beyond that, and shows weak evidence of minor axis rotation. In none of the cases is the misalignment of photometric and kinematic major axes exactly 90°, which would be expected if the galaxies were fully axisymmetric ellipsoidal objects. This means that probably all three are triaxial. An important advantage of SAURON is that one obtains at the same time a number of absorption-line maps, which are excellent indicators of the age and metallicity of the stellar populations. In the wavelength region between 4810 and 5350 Å that is covered by SAURON, there are various features (e.g., Hβ, Mg b and Fe 5270) that can be used to derive constraints on the age and metallicity of the stars at every position.

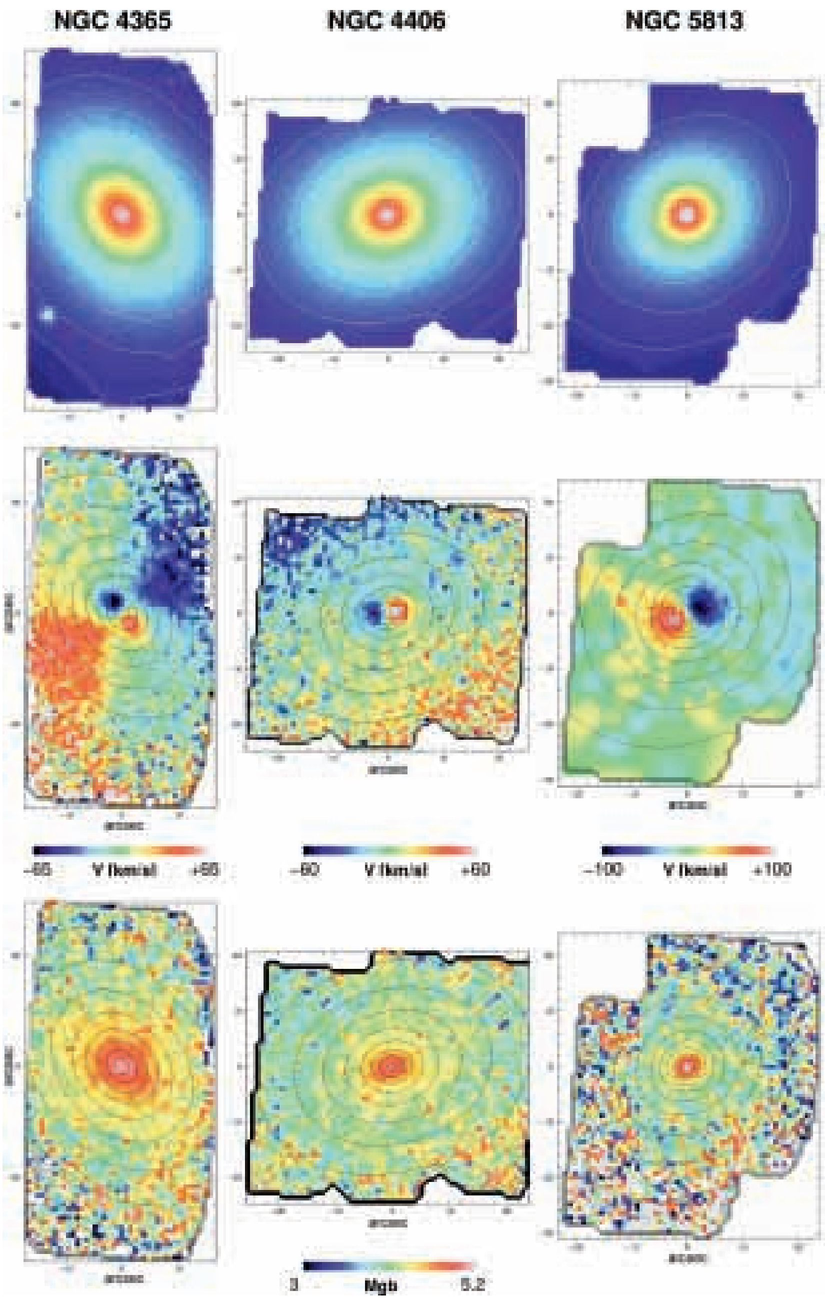

Figure 4. Top row: Reconstructed intensity maps of NGC 4365, 4406 and 5813. Middle row: Radial velocity maps of the three galaxies. Bottom row: Mg b line-strength maps. The data for NGC 4365 consist of a mosaic of two SAURON pointings, observed on March 29 and 30, 2000. NGC 4406 was observed on March 20, 2001, and consists of three pointings. NGC 5813 was observed on March 29 and 30, 2000 and on April 4, 2000, with two pointings. All pointings consist of four exposures of 1800 seconds each.

In Davies et al. (2001), we present a detailed analysis of the stellar populations in the region of the KDC of NGC 4365. As can be seen from Figure 4 (bottom) the KDC is not visible in the Mg b maps. The same can be said for other line-strength maps like Hβ. The Mg b line-strength increases towards the centre, following the isophotes. Hβ is more or less constant for the whole galaxy. When one compares the data with stellar population models one sees that the centre is about 2 Gyr younger than the rest of the galaxy (Figure 5). The stellar populations on the major axis (in the KDC) however, are the same as the ones on the minor axis at the same deprojected distance, perpendicular to the KDC (the red and green point are in the same place). The main body of the galaxy and the KDC are indistinguishable in age. This analysis shows that the process which formed the KDC induced star formation everywhere in the central regions. The newly formed stars have the highest metallicities, showing that they were formed from interstellar matter processed by stars in the galaxy itself, rather than from material that was captured from outside. For NGC 4406 and NGC 5813 we find a similar stellar population structure. Mg b is enhanced everywhere in the inner regions, not just in the region of the KDC. For NGC 5813 the measurement of Hβ is complicated by strong emission lines from gas in the inner regions of this galaxy (see our analysis in de Zeeuw et al., 2001). Using a technique described in Goudfrooij & Emsellem

(1996) we have been able to separate absorption from emission, and find that Hβ does not change in the inner 10 arcsec, similar to NGC 4365.

Next Steps

We are at present at a crucial stage of the SAURON project. From the outset (de Zeeuw et al., 2000) we hoped to have the observations of the whole sample completed in the spring of 2002. We are on track, and if time is allocated and the weather is cooperative, we will succeed. At present two papers have appeared in refereed journals, one has been submitted, and more than half a dozen conference proceedings have appeared as well. Several publications about individual objects and subsamples are in preparation. The highest priority now is to keep up with the data analysis. To do this, several subteams are investigating various aspects of the data: the dynamics, the stellar populations, the link between the two, the properties of the ionised gas, the early-type galaxies and the bulges, etc. The detailed measurements for individual objects will be compared with fully general galaxy models constructed by means of Schwarzschild's (1979) numerical orbit superposition method (cf. Rix et al., 1997). The modelling uses all appropriate imaging and spectral data that are available, including HST and OASIS spectra, to constrain the mass of a central black hole and the orbital structure in the main body of the galaxy. When combined with the constraints on the stellar populations derived from the line-strength distributions (Kuntschner & Davies, 1998), this will shed new light on the fundamental connections between the large and small scale dynamics, the formation (and existence) of supermassive BHs and galactic nuclei, and the history of metal enrichment in early-type galaxies and bulges.

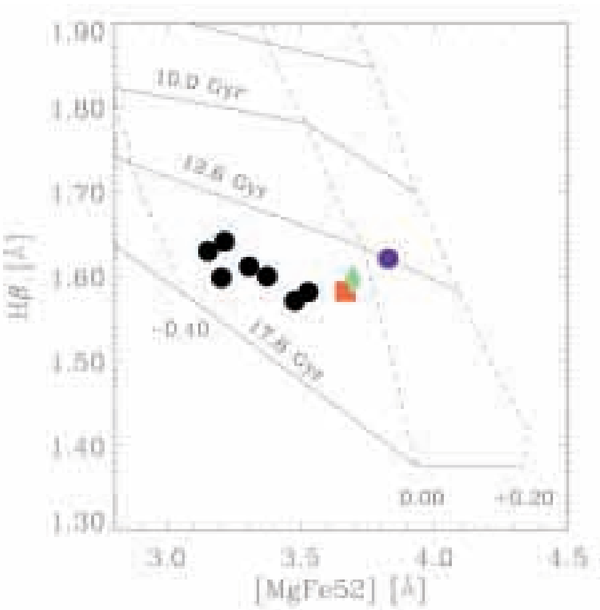

Figure 5. The [MgFe52] (=$\sqrt{Fe5270 \times Mgb}$) vs Hβ equivalent width diagram. The blue circle represents the average line-strength of the very central data points (r < 1.6 arcsec), the green diamond represents the region of the KDC, and the red square reflects the mean of the data in the main body of the galaxy at the same radii as the KDC but along the minor axis. For larger radii, the data were averaged in elliptical annuli centered on the photometric nucleus (filled circles); Overplotted are the predictions of stellar population models from Vazdekis (1999). The solid lines are lines of constant age, and the dashed lines are lines of constant metallicity ([M/H]).

Acknowledgements

It is a pleasure to thank the ING staff, in particular René Rutten, Tom Gregory and Chris Benn for enthusiastic and competent support on La Palma. The SAURON project is made possible through financial contributions from NWO, the Institut National des Sciences de l'Univers, the Université Claude Bernard Lyon I, the Universities of Durham and Leiden, and PPARC.

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The Central Kiloparsec of Starbursts and AGN: The La Palma Connection

Johan H. Knapen (ING & Univ. of Hertfordshire)

La Palma receives a steady stream of astronomical visitors throughout the year, most of whom come for short visits to observe using one of the telescopes on the island. In May 2001, however, over 100 astronomers flew in from around the globe for an astronomical research conference on the central kiloparsec of starbursts and AGN, organised by the Isaac Newton Group of Telescopes, and in fact the first major scientific conference organised wholly on La Palma.

Figure 1. Françoise Combes and Isaac Shlosman, two of the invited reviewers at the conference, walking on the grounds of the hotel Hacienda San Jorge.

The conference was held from May 7 to 11, 2001, in Hotel Hacienda San Jorge in the small resort town of Los Cancajos, located between Santa Cruz de La Palma and the airport. The meeting was attended by 120 delegates from 15 countries, among whom were many (about 50) from the USA, and several from as far away as Japan, Australia, India, Brasil, and Chile. A number of people had to be disappointed because the capacity of the hotel and conference room would not allow more attendees. Only a minority of the participants had visited La Palma before, and it is fair to say that all were impressed by the island, and by the telescopes standing on its highest peak. The scientific programme was full and included nine oral and two poster sessions. Long lunch breaks were often used for further discussions or collaborative work. The social programme included a lecture on the geography and biology of La Palma, a guided tour of the telescopes at the Observatory followed by a typical Canarian meal at a local restaurant, the conference dinner where an excellent meal was ended with two Palmeran delicacies: Malvasia wine and *puros* (cigars), and finally an excursion around the Southern part of the island.

The fact that many high-resolution studies of galaxies have been made using data obtained on La Palma makes the island a fitting "connection" to the field of study. In this field, recent advances in high-resolution observations, in theory and in modelling have focussed our attention on the central kiloparsec regions of nearby disk galaxies. These regions often show profound starburst and/or nonstellar (AGN) activity, accompanied by intricate gas and dust morphologies and kinematics. The origin and evolution of the phenomena occurring in these central regions, their possible causal interrelationships, links to the host galaxies, and the role the central regions play in galaxy evolution, form an intriguing subject which was the main topic of the conference.

Figure 2. John Beckman giving his opening review talk on the first day of the conference.

Figure 3. Part of the local organising committee.

The meeting brought together specialists in a relatively restricted area of astrophysics, which focussed the discussions and led to a very productive exchange of ideas. Some of the most important topics dealt with were, for instance, the detailed interconnection between an AGN and a starburst when both are present simultaneously in a galaxy, and detailed studies of the physics of star formation and of non-stellar activity, using tracers at wavelengths ranging from the X-ray to radio domains. The relations between the presence and properties of an AGN and/or a (circum)nuclear starburst on the one hand and the properties of its host galaxy on the other were explored at length, albeit without reaching clear conclusions. It does seem plausible that any such relation may be weakened by the AGN's destroying the evidence of its origin. For example, an AGN may destroy the bar which initially fuelled it. Also, both AGN and bars may work with specific "duty cycles", which can in principle imply that any non-active or non-barred galaxy as observed now, may have been active or barred some unspecified time in the past, or may become so sometime in the future. Significant collaborations between observers, theorists and modellers are needed to advance here.

Real progress is being made across the field though, thanks notably to a

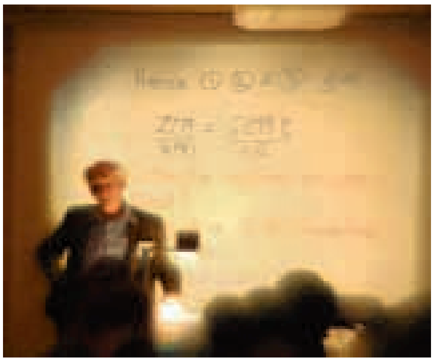

Figure 4. Donald Lynden-Bell presenting his invited review on black holes and accretion jets.

continuing stream of *Hubble Space Telescope* observations, to X-ray images obtained with new orbiting observatories, but also to imaging and spectroscopy from ground-based optical/near-infrared telescopes, such as ING's. In addition, numerical simulations of gas dynamics are progressing quickly, reaching higher resolutions and deepening our insight into a range of physical processes. For instance, a number of workers presented new results on nuclear spiral arms, which seem to occur rather frequently in the central regions of active and non-active galaxies, but which rather more infrequently take the shape of two-armed, "grand-design", spirals, such as those known well in disks of galaxies such as M51. Relationships between massive black holes, thought to be connected to AGN activity but also found frequently in non-active galaxies, and the bulges surrounding them received considerable attention. Other topics, not at first sight related directly to the main topic of the conference, took center stage at least at some point during the conference; these included attempts to quantify empirical relations between star formation and underlying gas density in disks, but also in the central kiloparsec regions.

It is appropriate to thank the financial sponsors of the conference here. The Isaac Newton Group provided cash and facilities before, during and after the conference, without which we could not have organised it. The Excmo. Cabildo Insular de La Palma (Island Government), and its Patronato de Turismo (Tourist Board) made very generous contributions to the social programme, in particular a sumptuous welcome reception, the beautiful conference dinner, and two excursions. Our local organising committee, consisting of ING staff and students Daniel Bramich, Begoña García Lorenzo, Joanna Holt, Javier Méndez, Rachael Miles, Saskia Prins, Peter Sørensen, Aditya Tayal, and Almudena Zurita, provided time, effort, and dedication to make all those seemingly unimportant details fall into place, without which the conference could never have become the success it was. We must also thank other staff who helped out at various stages, for instance by locating missing registration fee payments, by getting a linux PC talking to the outside world, or by showing our distinguished visitors round the telescopes.

The proceedings of the conference are now in press, and will be published later this year as a 750-page volume in the conference series of the Astronomical Society of the Pacific[1]. Although the proceedings necessarily focus on the *status quo* of research, as reported during the conference, the invited reviews and contributed papers set the stage for important breakthroughs in the field, which we anticipate both in the numerical aspects and due to new instrumental opportunities. The latter will allow observations with higher resolution, sensitivity, and area coverage, and at more wavelength bands, than ever before. With instruments like OASIS, ING can be expected to continue to play a vital role in this field. ¤

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Symbiotic Stars Probing Stellar Evolution

ING is organising a second astronomy research conference, on the topic of "Symbiotic Stars Probing Stellar Evolution", to be held in May 2002 in La Palma. Information on this conference can be found on ING's webpages:

`http://www.ing.iac.es /conferences/symbiotics/`

Figure 5. Conference attendants at the Observatory.

[1]: The Central Kiloparsec of Starbursts and AGN: the La Palma Connection, eds. J. H. Knapen, J. E. Beckman, I. Shlosman and T. J. Mahoney, 2001, ASP conference series, vol. 249 (ASP: San Francisco), in press.

TELESCOPES AND INSTRUMENTATION

An International Review of ING

René G. M. Rutten (Director, ING)

As technology and organisation of ground based astronomical enterprise rapidly develops, existing facilities are required to revisit the role they play. The competitive nature of astronomical research implies a continuous development and re-assessment of existing telescopes and their instrumentation. The ING is no exception to this.

The volume, quality and impact of science carried out with the ING telescopes is known to be very high by international standards, which is now well documented. But with an eye on what is coming, a plan for the future role of the telescopes, and in particular that of the William Herschel Telescope, must be developed and assessed.

Over the last few years gradually a strategy for the future use and further development of the ING telescopes has emerged. At the same time it has become clear that the finance available for the operation and development of the ING telescopes will decrease. These key changes prompted the ING Board to set up an independent international review panel to provide a perspective on the ING's likely scientific programme over the next 5–10 years. The panel was asked to specifically look at the likely astronomical prospects for the ING in the era of 8-m class telescopes, to provide an assessment of options to ensure that the facility meets the strategic needs of the UK and NL astronomical communities, to comment on options for development of the facilities, their mode of operation, time allocation and support, and to advise on the ideas on the long term future of the ING. The review panel was also asked to assess progress made since the previous international review which took place in 1998.




Pictures taken during the visit of the review panel to the observatory.

The review panel consisted of Prof Kenneth Freeman (Chairman; Australian National University), Prof Bruce Carney (University of North Carolina), Prof Holland Ford (Johns Hopkins University and Space Telescope Science Institute), and Prof Guy Monnet (European Southern Observatory). Before coming to La Palma they met with members of the user community, with representatives from the Instrumentation Working Group, and with officials from the funding agencies and the IAC. The community was also invited to present their views in writing, and many emails were received.

The Executive Summary of the report is printed below. The ING Board discussed the report extensively and provided an official response, which is also reproduced below.

From the perspective of the ING it is heartening to see strong recognition for the changes and hard work of the past years, and it is also reassuring to learn of the broad support for our plans for the future. I am indebted for the hard work that the review panel put into this review.

The review report has already led to significant activity, much of which directly involved the ING Board. Most importantly, talks with representatives from the funding agencies and the IAC have led to a clearer vision on the future prospects for the ING. Furthermore, talks between the ING and the IAC, the Italian National Telescope Galileo, the Calar Alto Observatory, and the Canada-France-Hawaii Telescope on prospects for close collaboration have been initiated. Some of these initiatives may well form the basis for future collaborations on a wider European scale, such as those being proposed by the OPTICON working group or as part of the European Northern Observatory.

Clearly we live in a time of change, but ING is in a very good position to take profit of these changing winds.

EXECUTIVE SUMMARY OF THE ING VISITING GROUP REPORT

1. INTRODUCTION

The ING Director and his staff have been outstandingly successful in restructuring the management and operations of the ING. The ING has made a very satisfactory response to the recommendations in the Cannon Report that are under its control.

The ING staff have a strong and clear vision for the future of the ING. They are planning for a WHT instrumentation future that concentrates on the high quality of the site and the wide field capabilities of the telescope. The VG concurs with this vision, and recommends that the ING establish a director's advisory committee which would (i) help spread the vision to the user communities and (ii) provide a stronger partnership between the ING and the broader communities.

2. SCIENTIFIC USE AND COMPETITIVENESS OF ING

By all scientific measures, the WHT is a well managed, highly productive and competitive telescope on an excellent site, and ranks among the top two 4-m class telescopes in the world. The INT is well ranked among the world's 2-m class telescopes, in terms of impact and productivity.

3. ASTRONOMICAL PROSPECTS FOR ING IN 8-M ERA

In the 8-m era, telescopes in the 2- to 4-m class have excellent prospects for general user frontline science that is well matched to their medium aperture and large field. The ING should make the most of the opportunities provided by the excellent site, the wide field of the WHT, and the flexibility of its operations system. The VG strongly endorses the ING proposal to concentrate on adaptive optics, wide-field multi-object spectroscopy, and frontline specialised visitor instruments for the future (see section 4 of the main report). A prerequisite is that adequate funding is retained.

4. OPTIONS FOR DEVELOPMENT OF FACILITIES

The VG endorses the proposed rationalisation of instruments, with basically one instrument per focus and enough flexibility to implement queue observing.

(i) ISIS is a low maintenance and highly productive workhorse instrument that is much in demand and should be retained till the end of agreement.

(ii) A high resolution spectrograph is valued by both the UK and NL communities. We recommend that the ING negotiates with the TNG for the use of its SARG spectrograph, or continue the use of UES at the WHT as a very low maintenance fiber-fed facility.

(iii) AUTOFIB/WYFFOS with the current upgrades will be competitive for at least the next 4 years. The input of the ING project staff is critical to the success of this overall project.

(iv) The VG is enthusiastic about the role of AO in the future of the WHT, but urges a clear and fast path to a science-driven facility. Specifically, the main staple in the short term should be visible IFU spectroscopy with TEIFU/OASIS. Near-IR AO imaging with INGRID/NAOMI is a welcome addition. The VG sees this AO development as exciting but not without risk. Consequently, we recommend an expert review of AO at the WHT to be conducted right after the NAOMI commissioning runs in 2001A. We propose that Dr Guy Monnet should identify an appropriate group of experts and chair this review.

(v) A modest wide field imaging capability should be retained at the INT. Alternatively, it may be preferable for the ING to negotiate with the CFHT for use of its forthcoming 1 square degree facility, with reciprocal access to AUTOFIB.

(vi) Queue observing in service mode will be essential in the AO era, because of unpredictable sky conditions. Some innovative approaches to personnel resources will be needed to cope with the costs of queue observing.

(vii) The ING appears well-prepared for remote observing from the sea-level facility. This should be a goal for the future, and makes sense in the context of a coordinated La Palma Observatory at sea-level.

(viii) The relationship between scientific impact and the grades of proposals in the time allocation process should be seriously evaluated. The time allocation process will need to adapt, to handle large projects and queue scheduling in a tight budget situation.

5. ASSESSING THE OPTIONS

The VG believes that the challenges of continued internal project work are essential for the future success of the ING. The ratio of operations to development activities should be maintained at the present level, even with a diminished budget.

The IAC is building a new sea-level facility to be shared with other users of the ORM. We believe that the ING sharing in this new facility offers many opportunities for scientific and technical synergy and financial saving.

The WHT is a great asset, and its loss would be a real setback for the astronomical communities, especially in terms of access to the Northern sky. The VG favors the Director's model A with continued development and enhancement of the WHT given top priority over keeping the smaller telescopes open. It sees this model as a framework for continuing the highly successful operation of the WHT with reduced funding. The ING and ING Board should have the flexibility to sell time on the smaller telescopes if demand for them from the UK and NL communities ramps down in the future.

The Director's strongly reduced model B is seen as incompatible with adaptive optics implementation and serious in-house developments. The VG believes that it would lead to demotivation of the staff, followed by growing non-competitiveness, and would very likely lead to the closure of the facility by mid-decade.

6. THE LONG-TERM FUTURE

The ING should actively foster co-operation between the ING and IAC, and the other users of the ORM. The long-term goal, by the end of the agreement, should be a negotiated and collaborative integration of the ING within an umbrella that includes the IAC and many other users of the ORM, based in a common sea-level facility. The VG urges the ING and its parent agencies PPARC and NWO to take a prompt and proactive role in bringing about this integration.

The primary scientific goal here would be access to the GTC for the UK and NL communities, in exchange for instrumental input and access to the smaller telescopes. Operational savings would also be likely.

ING BOARD RESPONSE TO THE REPORT OF THE INTERNATIONAL REVIEW OF THE ISAAC NEWTON GROUP OF TELESCOPES, APRIL 2001

1. INTRODUCTION

The Board welcomes and accepts the Review Report. It is very pleased to have independent, international and in-depth confirmation of the high quality of the ING facilities, of the very high quality of the staff who operate them, and of the appropriateness of the strategic direction which has been evolving in the Board's policies.

2. SCIENTIFIC USE AND COMPETITIVENESS OF ING

The Board welcomes and affirms the Review's assessment of the excellent scientific record of the ING, which has led the field in a number of high priority science areas. The WHT is considered to be one of the two top 4-m class telescopes in the world. This is in part due to the excellence of the site, telescopes and reliability of the instruments, but also due to the dedication of the staff who support the science programme. The Board approves the moves that have been made since the closure of the RGO, noting that this has led to a better integration of the programme for improvements with the operation of the telescopes and a focussed and successful development programme. Additionally, for many La Palma staff this has led to better quality work and greater involvement in the development of the facilities, creating an increased sense of ownership. The Board is happy to echo the praise that the Report gives to the Director and senior management of the ING for their role in this transition.

3. ASTRONOMICAL PROSPECTS FOR THE ING IN THE 8-m ERA

The Board is convinced, in line with the Report, that the ING has a very important role to play in key science areas for at least the next decade, notably in support of the 8-m class telescopes but also in providing capabilities or modes of operation which the 8-m telescopes are unlikely to be able to offer. These include exploitation of the wide field of view of the WHT, and development of AO assisted high-resolution imaging and spectroscopy in the optical (NAOMI+OASIS). Other exploitable assets include geographic position (in the Northern hemisphere and in Europe). However, in order to retain the ING's world-leading position, the Board accepts that further changes will be necessary and it is working actively with the senior management and staff of the ING in developing a reasoned and well-planned strategy for the future. The Board notes that the recently agreed plans for accession of the UK to the European Southern Observatory has brought these issues to a focus for the UK. The Board is keen to reassure staff that they will be properly consulted and informed during the coming months as the plans for the ING future develop further.

The Board strongly endorses the Report's recommendation to set up a Director's advisory group. This would provide an improved link between the ING management and the user community and ensure that priorities are consistent with the aspirations of the community. The Board has asked the Director to develop terms of reference for this advisory group and to propose a membership, which should include representation from the UK, the Netherlands and Spain, together with independent members with broad international experience. It expects the new body, replacing and incorporating the ING Instrumentation Working Group, to be in place and to have met before the next meeting of the Board.

4. OPTIONS FOR DEVELOPMENT OF FACILITIES

The Board is pleased that the Report supports the Board's policy by its endorsement of the proposed rationalisation of instruments, with basically one instrument per focus and enough flexibility to implement queue observing. It agrees with the suggestion that for the WHT this suite include ISIS and AUTOFIB/WYFFOS, as well as AO assisted integral-field spectroscopy (NAOMI+OASIS), and access to a high-resolution spectrograph (possibly through collaboration with other telescopes), and that the INT retains a modest wide-field imaging capability. The Board encourages the Director in his discussions with the Directors of other facilities, and through OPTICON (the EU-funded Network in Optical/IR Astronomy), with regard to sharing of instrument capability.

The Review points out that one of the unique features of the WHT is its ability to receive newly developed (visitor) instruments, and highlighted the success of instruments such as SAURON. The Board agrees that it is of key importance for the ING to continue to provide a flexible approach to support of visitor instruments which rapidly exploit exciting and novel niche areas. Since Adaptive Optics is expected to be a major driver for the future of ground-based astronomy, the Review recommended that an expert group be set up to consider the possibilities for AO on the WHT in more depth. The Board endorses this recommendation and has asked the Director to take this forward in a timely manner, so that the review can take place immediately after the next NAOMI commissioning run in June 2001.

The Review emphasised the need to retain the ability for staff to undertake project-related work in order to provide interest in the future of the facilities and to foster good morale and quality employment. The Board endorses this requirement to maintain a high quality operational capability and agrees to try to ensure that there remains sufficient flexibility within the ING budget, even if decreased, to allow the process of upgrading and developing systems and instruments to be continued.

The Board welcomes the encouragement by the Review to move to queue observing in order to increase the observing efficiency and to maximally exploit periods of excellent seeing. It has asked the Director to develop a proposal to do so, but notes, as the VLT experience is showing, that this move would not be without cost to the ING. It expects that the Funding Agencies will use savings and efficiencies in cost of travel to the Observatory in helping to reduce the direct cost to the ING.

The Board has considered the arguments for simplifying the time allocation procedures, noting that there had been a single UK/NL Time Allocation Committee (TAC) up to the early nineties and accepting that the multi-TAC approach was not optimal. It believes that the present system has been proven to work, with reservations about the arrangements for International Time, and senses that it would not be easy to change the opinions of the user communities. However, given the changes that are likely to occur in the way in which the telescopes are operated and the type of programme supported, the proposal to change the time allocation system should be reviewed in the medium term. The Board is also aware of an OPTICON proposal to establish a common pool of telescope time with a European-wide TAC. If the ING agrees to contribute to this pool with the International Time or more, then at least some proportion of ING time would be allocated by this unified European TAC.

5. ASSESSING THE OPTIONS

The Review accepted that, because of scientific advances such as the completion of larger telescopes, the financial climate within which the ING would be operating in the coming years would be less favourable than in the past and that savings would need to be made. Considering the scientific prospects for the facility and the likely needs of the community, it recommended that the Board seek to move by 2005, for a period beyond the formal expiry date of the International Agreements in 2009, to a model of operations described by the Director as model A, i.e., one that

– rationalised the instrumentation suite for the WHT,
– maintained the INT with a single instrument and minimal support,
– continued the JKT only at no cost to the UK/NL,
– expanded the capability for service and queue observing,
– minimised overheads where possible but
– retained the ability to support specific enhancement and development for the WHT.

Continued development and enhancement of the WHT should be given priority over keeping the smaller telescopes open.

The Board endorses the Review's recommendation but notes that the savings required by the UK by 2005 are greater than those which such a model might deliver. However, it is convinced that there is a very real opportunity to develop the ING through greater collaboration with Spain, which would include a larger share of the observing time in return for Spanish contributions to operations and support. The Board welcomes the IAC's open approach to this possibility, which would provide a high quality ING while satisfying the interests of all parties. The Board recognises that this will have to be a staged process, building on common ground and shared goals but felt that the benefits could be considerable for both parties. Accordingly, it has asked the Chair to discuss this possibility with the IAC and the funding agencies.

The Review and the Board offered strong support to shared participation in the IAC's proposed La Palma sea level centre (CCALP). This could act as a focus for scientific and technical collaborations not only with the GTC/IAC but also with other partners in the ORM. The Board and ING management is under no illusions that realising the full potential of co-location will be easy, but agrees that, assuming the basis for the ING locating its sea level operations at CCALP can be agreed, efforts should be made to foster natural affinities and shared facilities. The Board has asked the Director ING to consider options for remote observing from sea level, noting that the GTC was also considering this as a mode of operation.

The Review recommended that a working group, at the level of managers and scientists, be set up to explore how to progress this collaboration further. The Board has asked the Director ING to take steps to set up this group, bearing in mind the progress of discussions at Funding Agency/ING Board chair level.

At the same time the Board encourages the Director to further pursue his discussions with other potential partners who have expressed interest in collaboration with the ING where the benefits to the ING community could be clearly demonstrated in terms of science capability.

The Board is determined to make every effort to ensure that the new model of support and operations will be at a level in keeping with the needs and priorities of the majority of the user community. It recommends that the Director implements a plan to reduce the operation of the ING facilities to be consistent with model A by 2005. This will allow the retention of the balance between operation and development and allow the prospect for planning significant developments in due course. Many of the components of this plan are already within the Director's strategic plan for the facility and some have already been applied.

The Board agrees with the Report that reducing operations beyond that proposed within model A is incompatible with the long-term viability of the facility. Further reductions will not allow further development of the WHT and will, by default, lead to a steady decline in effectiveness and the ING's ability to recruit and retain high quality staff, leading to early closure before, if not in, 2009. The Board does not believe that this is in line with the needs of the UK, Netherlands or Spanish communities and firmly rejects it as a possible model.

6. THE LONG-TERM FUTURE

There is much work to be done to realign the short-term future of the ING with the likely resources to which it will have access, the changing needs of its user community, and to take advantage of the opportunities offered by working more closely with its partners in the ORM and elsewhere. The Board strongly believes that the ING can play a key role in the strategic needs of its three partners, that it will continue to deliver world-class science and that it has the potential to develop as a model for wider European collaboration. It has confidence that, working with the Director and staff, these challenges can and will be met.

7. THANKS

The Board offers its thanks to Professor Freeman and the Review Panel and to the Director and his staff for their support. ¤

The Planetary Nebula Spectrograph Successfully Commissioned

M. R. Merrifield (University of Nottingham), N. G. Douglas (Kapteyn Institute), K. Kuijken (Kapteyn Institute) and A. J. Romanowsky (Kapteyn Institute), for the PN.S Consortium

The Planetary Nebula Spectrograph (PN.S) was successfully commissioned on the William Herschel Telescope on the night of 2001 July 16. This instrument was designed and built by an international consortium with members in Australia, The Netherlands, Italy, the UK, ESO and the USA (a full list of contributors can be found at `http://www.astro.rug.nl/~pns/pns_team.html`). The PN.S is specifically designed to detect large numbers of planetary nebulae (PNe) in external galaxies and measure their line-of-sight velocities in a single exposure. In essence, it comprises twin slitless wide-field spectrographs behind a narrow band 5007 Å filter. These spectrographs disperse light in opposite directions, so that images of PNe, which emit most of their light in the 5007 Å [OIII] emission line, are shifted in opposite directions in the two arms of the spectrograph by amounts proportional to their Doppler shifts. Thus, by matching up pairs of PN images in the two arms, it is possible simultaneously to determine the locations of PNe, measure their brightnesses, and determine their line-of-sight velocities. A more complete description of the instrument, the technique, and its application to studying galaxy dynamics, can be found in *ING Newsletter*, 4, 23.

The commissioning team, led by Nigel Douglas (Kapteyn Institute), mounted the PN.S at the Cassegrain focus of the WHT (see Figure 1) over the weekend of 2001 July 14–15. Integrating the instrument with the telescope and ING CCDs went very smoothly. Focussing and wavelength calibration proved straightforward using the telescope's calibration lamps to illuminate a grid of holes in a moveable mask inside the spectrograph. The Observatory Open Day on July 15 gave plenty of opportunity for quantifying the negligible flexure in the PN.S as the telescope was slewed around the sky for the visitors (and the commissioning team made an interesting extra "exhibit" on the tour!). On the commissioning night of 2001 July 16, the instrument was put through its paces on the sky. Photometric conditions allowed confirmation that the instrument meets its designed 30% sky-to-detector efficiency – this high throughput is made possible by the custom design of the instrument to observe the single 5007 Å line. Unfortunately, exceptionally poor seeing (more than five arcseconds at times!) meant that the full potential of the PN.S to detect faint point-source PNe could not be fully tested.

Poor seeing, broken cloud and dust on the following three nights of the science run (jointly awarded by the UK and Netherlands TACs) restricted the range of science that could be attempted, but some data was obtained for nearby galaxies and Galactic calibration sources. An example of the raw data from the two arms of the spectrograph, and the ease with which they can be combined to detect PNe and their kinematics, is shown in Figure 2.

In September, a six night observing run coincided with some rather better weather, and excellent observations were made of a number of flattened early-type galaxies. Figure 3 shows the kinematics that were derived from a preliminary analysis of an observation of the S0 galaxy NGC 7457. With data of this quality, the study of stellar dynamics in early-type galaxies is set to be revolutionized. ¤

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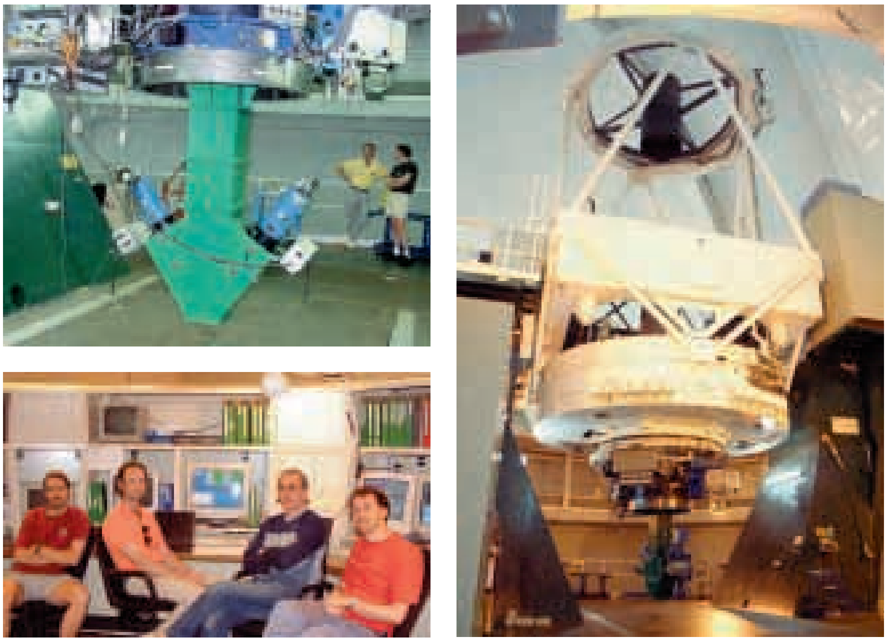

Figure 1. Top left: The Planetary Nebula Spectrograph fully assembled and integrated with the WHT, and EEV CCDs and controllers mounted on each arm of the spectrograph. Bottom left: First light commissioning team. Right: General view of the PN.S and the WHT.

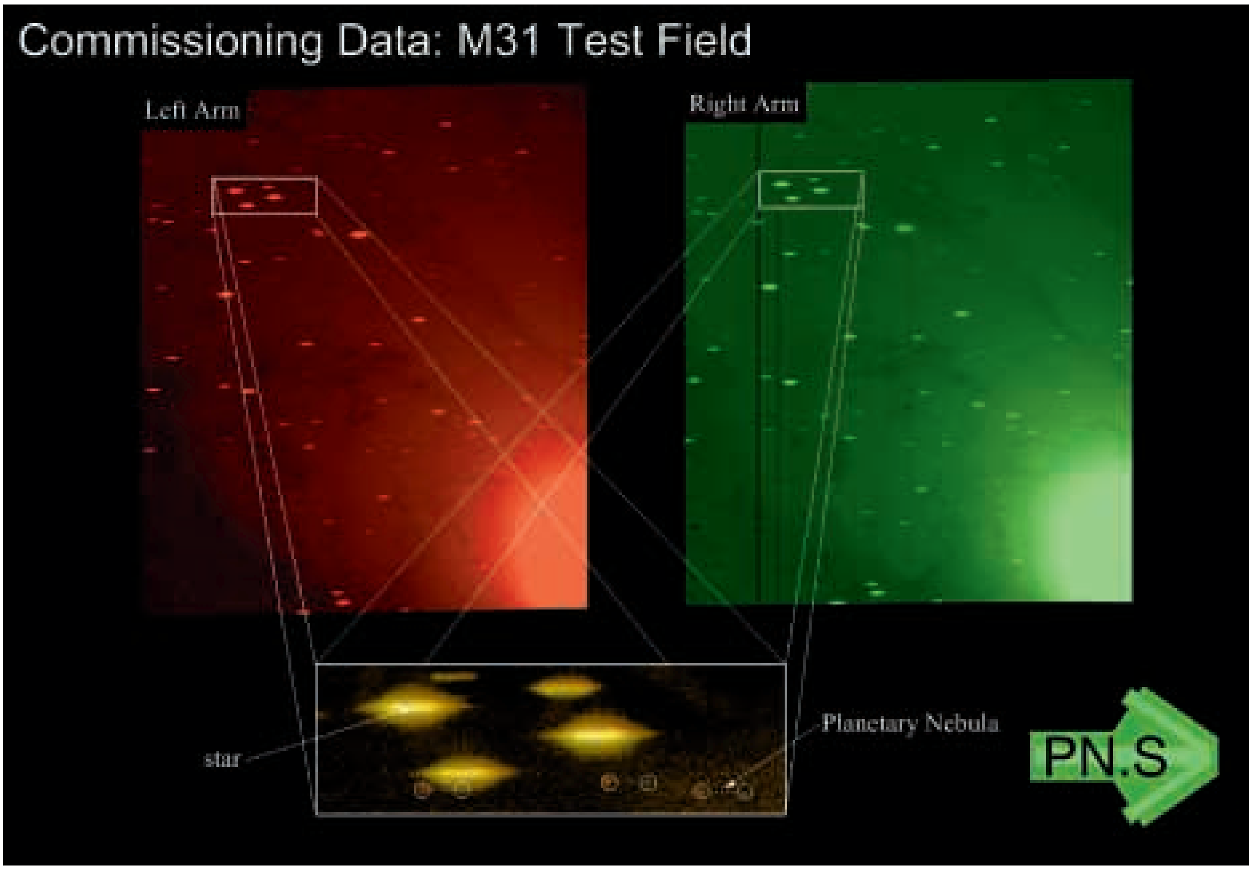

Figure 2. One of the observed fields in M31, showing the data recorded by the two arms of the spectrograph, colour coded in red and green. The inset combined image shows how stellar spectra appear as superposed continua, limited in length by the response of the narrow-band filter, whereas planetary nebulae show up as point sources, offset between the two arms by an amount depending on each nebula's Doppler shift.

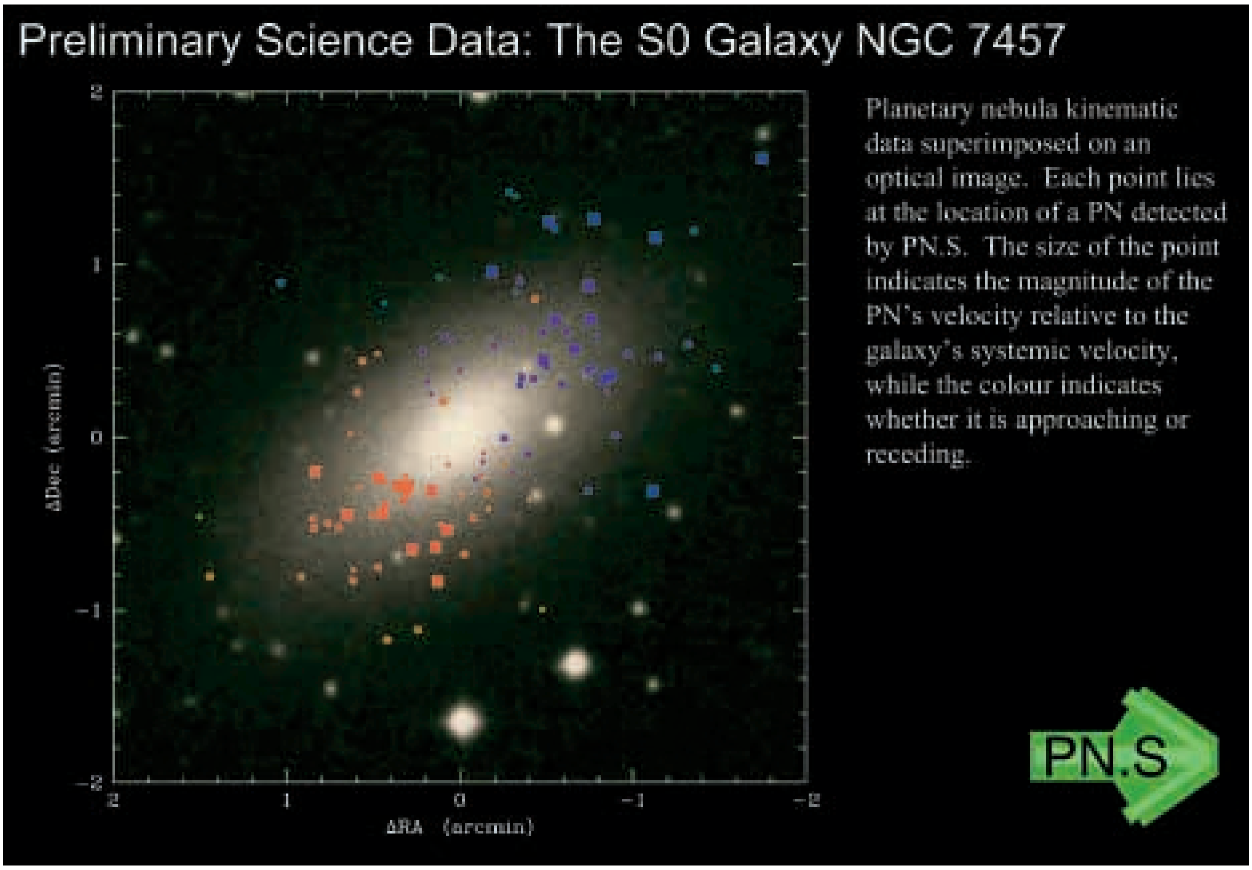

Figure 3. Preliminary analysis of a PN.S observation of the S0 galaxy NGC 7457.

NAOMI News

C. Benn (ING), R. Ostensen (ING), R. Myers (Univ. of Durham), T. Gregory (ING) and A. Longmore (ATC)

NAOMI, the WHT's adaptive-optics unit, is currently offered to observers with the IR imager INGRID. Performance predictions were given in the March 2001 *ING Newsletter*, and updates can be found on the ING web page, at `http://www.ing.iac.es/Astronomy/instruments/naomi/`

Much progress was made during NAOMI's recent commissioning run in May/June. The AO loop was closed on guide stars as faint as V=13, dithered observations were achieved without opening the loop (by moving the telescope and guide-star pickoff mirror in tandem), and a new control *gui* was implemented, allowing observing to be carried out routinely by ING staff.

NAOMI is optically and electronically much more stable than in the past, and it is now normal to observe for a whole night without having to repeat the afternoon calibration of the mirror shape. As usual, unexpected events (a devastating hacker attack, failure of the x-stage motor on the deformable mirror, and accidental rotation of one of the off-axis paraboloids) ate into the nights available, but for the first time NAOMI/INGRID service observing was attempted (25 proposals were submitted).

Performance with faint guide stars was found to be degraded by the lack of baffling around the guide-star pickoff mirror, allowing each cell on the wavefront sensor to see ~20 square arcsec of sky. A baffle is being installed.

The high (~100%) emissivity in K band has now been traced mainly to surfaces in the Nasmyth derotator and in the (NAOMI-specific) foreoptics in INGRID. Replacements for both are being investigated. Observing in H and J bands is not affected.

In September, NAOMI's performance in the optical (R, I bands) was characterised on sky. In reasonable seeing, NAOMI typically reduced the FWHM by a factor of nearly 2, and an example of this spectacular performance is shown on the front cover. This bodes well for deployment of the integral-field spectrograph, OASIS, with NAOMI in late 2002. Significant correction was obtained for guide stars down to R=14. Galaxies will be the principal science targets of OASIS, and the AO loop was successfully closed on the nuclei of several, including M31 and NGC 1068.

Performance in the IR (J, H, K bands) is not yet well characterised, and one of the goals for 2002A is to map performance as a function of guide-star magnitude, band, radius from guide star, and natural seeing (a large parameter space). Another important goal is commissioning of a mode in which information is binned up on the wavefront sensor, allowing ~1 mag fainter guide stars to be reached, and thus increasing sky coverage (but with poorer correction).

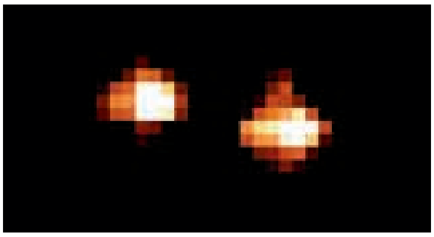

Figure 1. This 0.5-arcsec double star, R=11, was selected from the Palomar Sky Survey (on which it is unresolved) as the guide star for NAOMI observations of a nearby QSO. The wavefront sensor took this double image in its stride, and the delivered FWHM on the above 30-sec H-band exposure is 0.16 arcsec.

Commissioning of the coronographic feed to the science detectors (INGRID, OASIS) will take place early in 2002. ¤

Chris Benn (crb@ing.iac.es)

First Light on the New Small Fibre Module of Autofib2/WYFFOS

R. L. M. Corradi, K. M. Dee, R. A. Bassom, M. F. Blanken, S. J. Goodsell and M. van der Hoeven (ING)

Autofib2/WYFFOS is the multi-object, wide field fibre spectrograph working at the prime focus of the William Herschel Telescope. At the prime focus, the fibres are placed onto a field plate by the robot positioner Autofib2 (AF2) at user-defined sky coordinates. Object light collected at prime is transmitted along fibres 26 metres in length to the Wide Field Fibre Optical Spectrograph (WYFFOS). The path from prime focus to the spectrograph consists of a prism, fibre button, 26 metres of fibre, finger, microlens and the facet block.

At the end of July 2001, a major upgrade of the instrument was performed by successfully installing the new Small Fibre Module of AF2. With the new fibres, AF2 can presently observe up to 150 science targets over a field of 1 degree diameter (with an unvignetted field of 40 arcminutes). Each of the 150 science fibres has a diameter of 1.6 arcsec (90 micron), and runs without connectors from AF2 to WYFFOS. The fibres are high-content OH fused silica made by Polymicro.

The small fibres replace the Large Fibre (2.7 arcsec diameter) Module, and have the following two main advantages:

i) No light is lost because of fibre connectors, providing a much more homogeneous distribution of fibre relative throughput as compared to the large fibres, and a higher mean throughput.

ii) The sky/background contribution in observations with the small fibres is 3 times lower than with the large fibres. This means that, with the small fibres, the noise level in sky-limited observations is down by a factor of 0.6. The 1.6 arcsec diameter was chosen as a the optimal compromise between minimum sky contribution and maximal source contribution under good seeing conditions.

At the spectrograph focus, the small fibres are imaged onto less than 2 pixels (FWHM) on the TEK6 detector in the spatial and spectral directions. The full spatial image of the fibres is therefore sampled by less than 3 pixels. The fibre distance in the WYFFOS entrance slit is 1 mm, which transforms onto a peak-to-peak aperture distance of 6–7 pixels on the detector. Although the nominal spectral resolving power has increased as the ratio of large to small fibre diameters, the actual resolution is limited by the CCD pixels, because of the undersampling along the spectral direction. WYFFOS can achieve dispersions as high as 0.8 Å/pixel with the 2400 line grating with the present TEK CCD with 24 micron pixels. With the WYFFOS echelle grating the dispersion ranges from 0.24 Å/pixel to 0.57 Å/pixel.

With the Small Fibre Module, 10 new fiducial imaging bundles are available for field acquisition and guiding. Each imaging bundle (450 micron diameter) contains 10,000 individual fibres providing a rough imaging capability over a 8 arcsec round field. The new coherent bundles also allow for autoguiding.

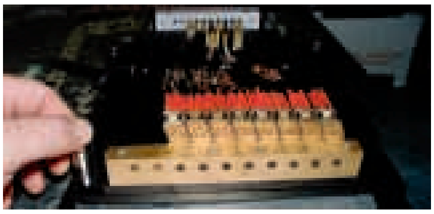

Figure 3 (left). Alignment of fibres into micro-lens finger holder. Figure 4 (top right). Fingers mounted onto the facet block. Figure 5 (bottom right). The Small Fibre Module at WHT prime focus.

In July 2001, we obtained the first measurements of the relative and absolute throughput of the science fibres. As mentioned above, the distribution of relative throughput is much more homogeneous than for the large fibres, and most fibres lie in the region within 15% from the median throughput. The absolute throughput of the small fibres was measured using grating R600B, under variable seeing conditions of 1–1.3 arcsec. Table 1 reports the magnitude of a star giving 1 electron/sec/Angstrom when observed at zenith. Numbers are scaled to the "median" fibre (i.e. to the median relative throughput).

These figures are similar to those measured in the past for the best large fibres, implying a substantial gain with respect to all those large fibres that had a much lower throughput because of light loss in the connectors.

λ	4500	5000	5500	6000	6500
Mag	16.5	16.7	16.8	16.7	16.6

Table 1. Magnitude of a star giving 1 electron/sec/Angstrom when observed at zenith.

The Small Fibre Module is currently being offered to observers. More information about AF2 can be found in our web pages at: `http://www.ing.iac.es/Astronomy/instruments/af2/`

In spite of the successful commissioning, quite a lot of work is needed in order to improve and fully characterise the performance of AF2 and its new fibres. Further enhancements to the system are planned. A major improvement will be the introduction of the WYFFOS long camera. This will give twice the spectral resolution of the current camera, allowing us to increase the number of fibres on the chip. The long camera is under construction and is expected to become available at the WHT at the end of 2002.

Finally, we would like to acknowledge all people who took part in the various stages of the development of AF2, and in particular Mariet Broxterman, Nick Ferneyhough, Robert Greimel,

Figures 1 and 2: Top and side views of a fibre prism and gripper button.

Steve Magee, Neil O'Mahoney, Roberto Martínez, John Telting, Bart Van Venroy and Sue Worswick. ¤

Romano Corradi (rcorradi@ing.iac.es)

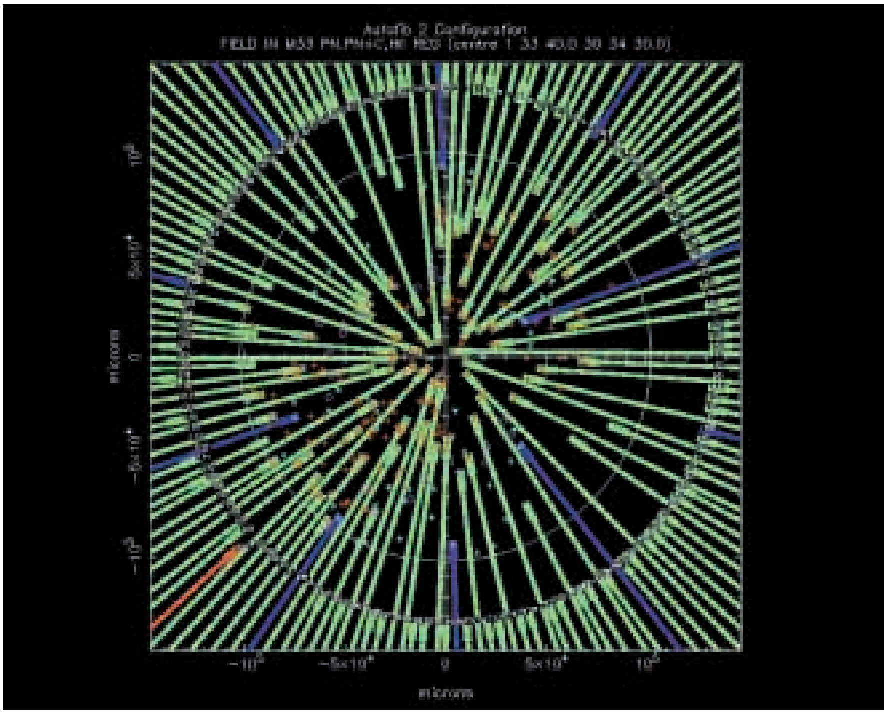

Figure 6. Example of a science fibre configuration on the nearby galaxy M33. The science fibres are shown in green (in red a fibre that was temporarily disabled), and the fiducial bundles in blue. Targets are the red crosses, while light-blue stars are fiducial stars for acquisition and guiding. The white circle shows the usable field of view (1 degree diameter).

The ING Red Sensitive CCD Project

Simon Tulloch (ING)

This project aims to improve the red sensitivity of our instruments through the use of low-fringing high-Quantum Efficiency (QE) CCDs. These are being produced by MIT Lincoln Labs for a consortium of observatories. Gerry Luppino manages the consortium at the University of Hawaii. His Company, GL Scientific, is providing CCD packages and cables. The ING commitment to the consortium is $141,000. This will give us at least three science grade devices.

The wafers will be divided and put through two different processes. The first process, called BIV, will give excellent red response but very poor blue performance. The second process, called UV or MBE, will improve the blue response whilst leaving the red response intact. The MBE process is still being developed (as of spring 2001). We have requested that our first chip be from the BIV process. This chip will be used at ISIS RED as its blue response is not important. Our subsequent chips will hopefully come from the MBE process, depending on its success. Two of these devices will be incorporated into a mosaic camera for use with WYFFOS long, UES and possibly for prime focus imaging on the WHT. If the wafer run has good yields we can expect a fourth device for use with OASIS. Additional sources are being investigated for a fourth chip should the yields from this contract be lower than expected.

CCD Characteristics

Size: 2048 × 4096 pixels
Type: CC1D20
Pixel size: 15 × 15 microns

Two outputs with a high sensitivity of 15 μV/e⁻

Fringing at 1000 nm ≤ 10%

Manufactured from 40-micron thick high-resistivity silicon

The Physics of Deep Depletion CCDs

Standard thinned CCDs are typically 15 microns thick. As the wavelength approaches 1 micron, the absorption depth of silicon increases rapidly and the CCD becomes transparent. The red sensitivity suffers accordingly. There is an additional problem, called 'fringing' which in some applications is an even more serious drawback than poor QE. As the transparency of the chip increases at longer wavelengths the CCD acts as a Fabry-Perot cavity with light reflecting back and forward between the front and rear surfaces. Interference is produced that heavily modulates the spatial uniformity and reduces the SNR of the observations. The solution is to make the CCDs thicker than the absorption depth of the silicon, incident photons will then be absorbed on their

Figure 1. Image showing the effects of fringing in a thinned astronomical CCD.

first pass and reflection from the rear surface will be greatly reduced. Our CCDs will be 40 microns thick. Standard silicon cannot be used for this process since it cannot sustain the high electric field throughout the full depth of the device that is so important for good QE. Instead a special grade of high-purity high-resistivity silicon must be used.

Latest Quantum Efficiency Data

QE data is available for the BIV CCD with a broad band coating. The red response is impressive; up to three times better than a thinned EEV. QE data on the MBE (blue boosted) CCD is only available for a device with an anti-reflection coating optimised for the blue. The red response of this device is not fantastic but should approach that of the BIV, once a broad band coating is applied. Marconi have also started to produce deep depletion CCDs, and the QE of their device is shown in Figure 3.

Figure 2. A photo of one of the ING cameras (with a test chip mounted) complete and awaiting the delivery of the first red CCD.

The first of the ING cameras is complete and awaiting the delivery of the first CCD. For additional information, please see the project web site : http://www.ing.iac.es/~smt /redsense/redsense.htm ¤

Simon Tulloch (smt@ing.iac.es)

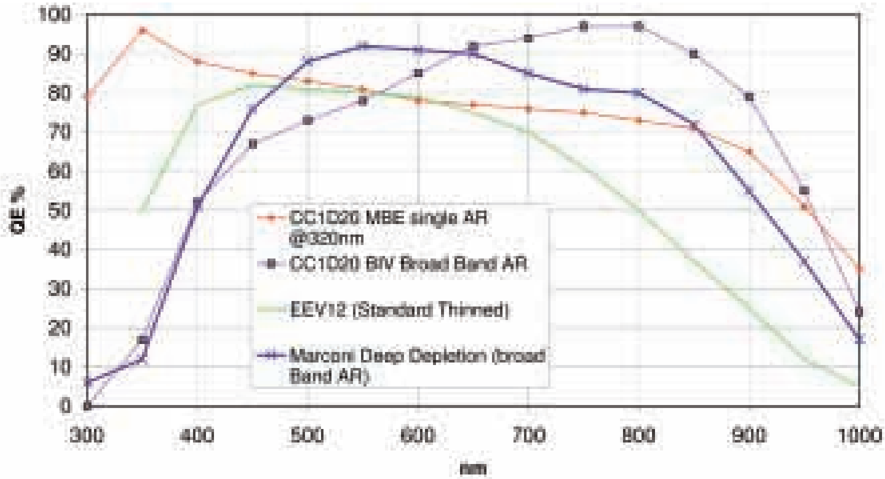

Figure 3. Quantum Efficiency comparison between current and new red CCDs.

First Results from the Rayleigh Laser Guide Star Project

Paul Clark (University of Durham)

The Restricted Conjugate Adaptive Optics project is part of the University of Durham Astronomical Instrumentation Group's rolling grant programme, funded by PPARC. The project aims to demonstrate the feasibility of using commercially available laser technology to provide a Rayleigh back-scatter laser guide star system for use with Adaptive Optics. In particular the project investigates low order AO correction over a wide field of view for use with multi-object spectroscopy on the WHT.

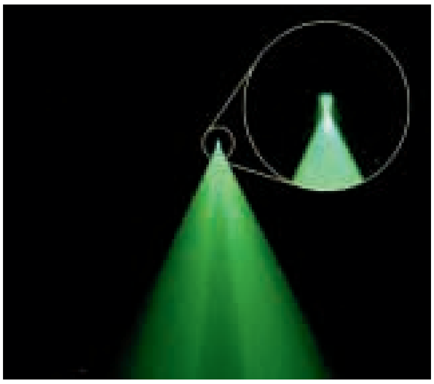

Figure 1. High power laser launch through the 30-cm f/6 launch system.

The project is ongoing with the first (Phase A) run having been completed at the Isaac Newton Group of Telescopes on La Palma during May 2001. Launch tests were conducted using both the 4.2-m William Herschel Telescope and a custom-made 30-cm f/6 launch system housed in an outbuilding adjacent to WHT.

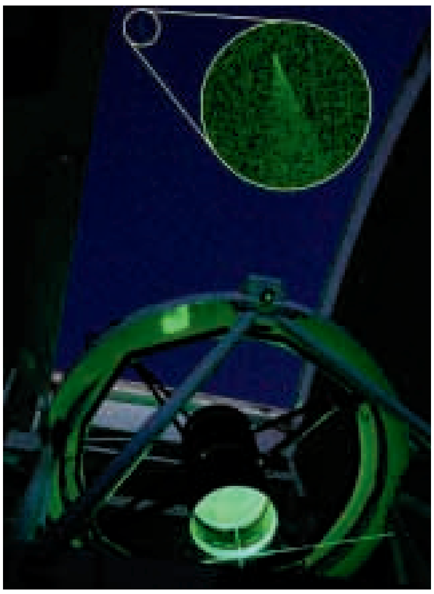

Figure 2. The laser launch through the WHT.

Figures 1 and 2 show the high power laser launch through the 30-cm f/6 launch system and the WHT. Safety considerations form a major part of the project. The laser is only operated by trained staff using protective goggles to prevent eye damage. A plane spotter is used to ensure that no harm comes to aircraft that may fly through the laser beam (the mountain top itself is actually a 'no fly' zone).

The 'bow tie' structure seen in Figure 1 is a result of focussing the laser at a particular altitude. The laser is actually pulsed (although the beam appears continuous to the human eye) and a high speed pockels cell shutter is used to range-gate the return pulse at the focal height. The focal spot then appears as a low altitude star which can be used to correct atmospheric turbulence with an Adaptive Optics system. The novel optical configuration used during the Phase A run is shown in Figure 3.

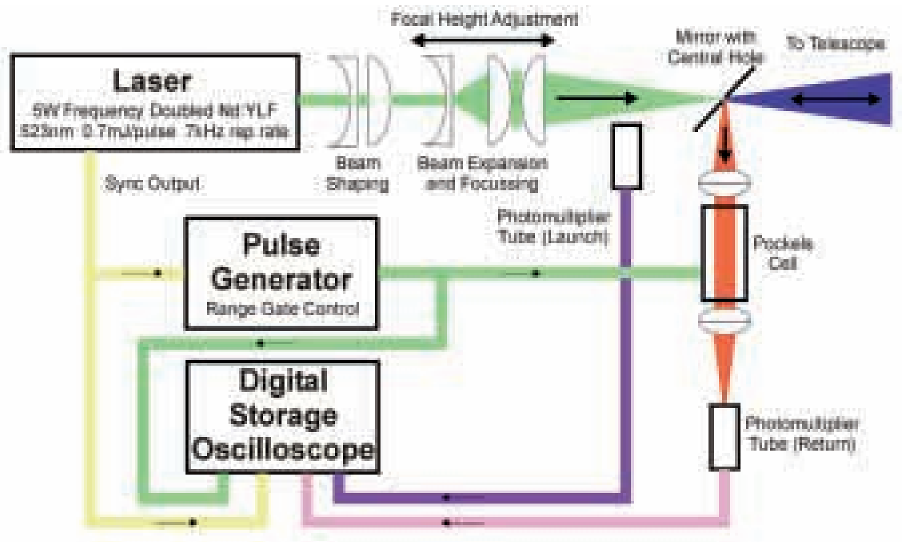

Figure 3. Optical configuration used during the Phase A run.

Fluorescence Measurement

One of the main objectives of the WHT run was to establish if fluorescence from the telescope optics would prevent return measurements during the next phase of the project. The trace in Figure 4, taken just before sunrise on May 13th using a photomultiplier tube, shows return scatter and fluorescence from the telescope optics decaying within 2.5 µs, establishing that return above 400 m should be observable without difficulty.

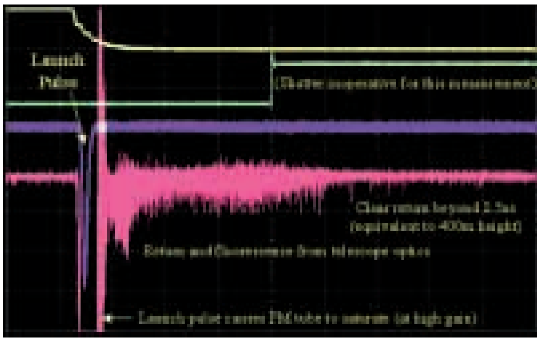

Figure 4. Fluorescence measurement.

Range-Gated Return

The range-gate pockels cell shutter was tested during the May 13th slot on the WHT. The return from differing altitudes was observed using a photomultiplier tube looking at the telescope via a 'mirror with a hole' (to separate launch and return beams — see Figure 3). The 'bow tie' structure is formed as the return passes through focus where most of the light is lost through the hole (see Figure 5). The bow tie was seen to change position as expected as the focal height was altered.

Figure 5. Range-gated return.

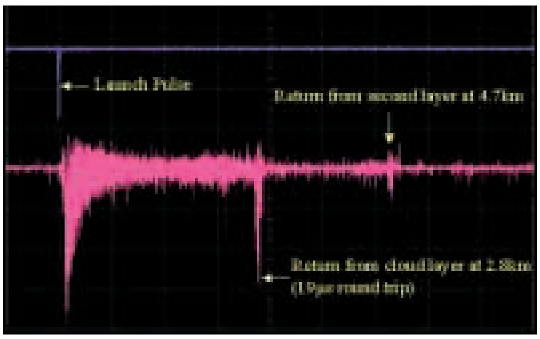

Figure 6. Cloud ceiling detection.

Cloud Ceiling Detection

An interesting by-product of the Rayleigh laser system, when used with photomultiplier return detection, is the ability to accurately resolve cloud layers above the telescope. The trace in Figure 6 was taken on May 15th using the 30-cm f/6 launch system from the LN_2 building. Two thin cloud layers at 2.8 km and 4.7 km are clearly visible. ¤

Paul Clark (paul.clark@durham.ac.uk)

OTHER NEWS FROM ING

Dragons Breath Cooling for ING, TNG & NOT CCDs

Alan Chopping (Head of Site Services, ING)

As the nearest commercial supplier for liquid nitrogen for the Observatory is located in Tenerife, ING produces liquid nitrogen on the Roque site, to provide cooling for all its CCDs. This has enabled us to eliminate the logistic problems of transporting large liquid volumes of nitrogen between islands, and has been found to be more economical. Also from the surplus produced we have been able to supply our neighbouring institutions.

While this arrangement has worked successfully for the past decade, over the past couple of years demand for liquid nitrogen has grown to accommodate development work, larger CCDs and instrumentation at all the ORM institutions. This resulted in the existing plant working for long periods, leaving little time for maintenance and the threat of losing telescope time for us, and our ORM partners if a major breakdown occurred.

The justification for purchasing a second plant was made by an agreement between the ING, TNG and NOT in which each would pay a third of the provision of a second hand plant. Fortunately the Dutch supply company "Sterling Cryogenics" were in the process of decommissioning a suitable plant in Hong Kong. There, the plant had been used as part of a theme park attraction called "The Dark Ride" providing liquid nitrogen as simulated smoke for a large dragons breath.

The plant was then flow back to Holland where it was fully serviced before arriving on La Palma during March. Since then the plant has been installed and connected to a new 3,000 litre storage vessel. This unit in tandem with the original plant now ensures sufficient liquid nitrogen for our entire site needs at the ORM. ¤

Alan Chopping (akc@ing.iac.es)

The ING liquid nitrogen plant.

WHT Scientific Impact

Chris Benn (ING)

In the March 2001 *ING Newsletter*, we reported a citations-based analysis of the scientific impact of telescopes worldwide for 1995–8. Amongst 4-m optical telescopes, WHT ranked second only to CFHT in impact.

Georges Meylan of STScI has now carried out a similar analysis (unpublished) of astronomy papers which appeared in 1999. He finds the top 10 telescopes that year to be, in decreasing order of citation impact, HST, JCMT/SCUBA, ROSAT, CGRO, Keck, BeppoSAX, SOHO, CTIO 4-m, WHT and RXTE, i.e. the WHT remains one of the two most-cited 4-m telescopes. The WHT citation fraction for 1999 is approximately double that for 1995–8, and both the most-cited and second-most-cited papers of 1999 were based in part on WHT data. The first of these papers, by Perlmutter et al. (1999, *ApJ*, **517**, 565) reported measurement of cosmological parameters from observations of Type Ia supernovae. The second, by Steidel et al. (1999, *ApJ*, **519**, 1) reported a survey for Lyman-break galaxies at redshift >4. Both teams used imaging cameras at the WHT. ¤

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A New Look for the INT

As part of the regular maintenance of the telescope, the INT has recently been repainted in white. Furthermore, a new motorized counterweight has been installed to facilitate the change-over between IDS and the WFC (or CIRSI). To compensate the additional weight added by this system, two old finders have been removed and it is planned to remove FOS before the end of the year.

Thomas Augusteijn (tau@ing.iac.es), *INT Manager*

News from the Computing Facilities Group

Don Carlos Abrams
(Head of Computing, ING)

The CFG recently appointed Juan Vicente Piñero Pérez as the ING's Data Manager. He has taken over this role from Luis Javier Hernández who is now our Network Manager. One of Juan's principal objectives will be the development of a graphical user interface for querying and extracting images from the DVD archive. In the meanwhile, the DVD archiving system continues to write images from the INT to DVDs. Recently we have also started writing images from the WHT to DVDs.

The introduction of the ING's Beowulf cluster for reducing data from the INT has been a total success. Robert Greimel successfully completed the installation several months ago and the system has been operational ever since. The success of this system has attracted a great deal of support and interest, so much so that another Beowulf cluster was purchased and installed to reduce data from the WHT and the JKT.

As part of the ING's computing enhancement strategy we have introduced Sun Microsystems' Sun Ray Appliances as an alternative computing platform. These devices have proved very popular in offices were conventional machines are deemed to be environmentally undesirable in terms of noise pollution or heat production. It is hoped that, were practicable, the Sun Ray Appliances will replace the aging and obsolete X Terminals on the ORM. In addition to the Sun Ray roll out, we have introduced a Sun Enterprise E250 at the SLO. This is a general compute server with two 400 Mhz UltraSPARC-II processors and 2Gb of memory. Finally, the FTP server was replaced with an Ultra 10 and now boosts in excess of 200 Gb of disk space. Similarly, the ING mail server was upgraded to an Ultra 10 with 75 Gb of disk space.

On 9 June the Spanish Ministro de la Presidencia, Juan José Lucas, visited the WHT. The Spanish goverment is very interested in the development of the Observatory and in particular the GTC telescope. In this photo we can see the Minister (in front of René Rutten) listening to the explanations given by Francisco Sánchez.

Over the last few months we have been engaged in fruitful discussions with IAC personnel, namely; Juan Carlos Pérez Arencibia, Jesús Jiménez Fuensalida and Diego Sierra González. The discussions have centred on improving the computing facilities in the Residencia. As a result of these discussions we have extended the ING network to within the Residencia. A standard 10/100 Mbps hub has been installed in the computer room, as well as a wireless hub. These devices are there for the benefit of the ING staff and visitors. To use the wireless hub, you will need a wireless network card, which we can provide. The standard hub can be used as if you were in any of the ING telescopes. Clearly, both of these systems require an ING authorised IP address.

We have been working very closely with Ian Skillen to address a number of problems with the Service System. Whilst we can only apologise for recent problems that have made the system problematic, we have introduced a more robust solution that will be more tolerant of recent problems. In the short term, with the collaboration of Ian, we will be migrating the whole of the Service System to a dedicated machine with the intention of improving this service. ¤

Don Carlos Abrams (don@ing.iac.es)

Seminars Given at ING

Visiting observers are politely invited to give a seminar at ING. Talks usually take place in the sea level office in the afternoon and last for about 30 minutes plus time for questions afterwards. Astronomers from ING and other institutions on site are invited to assist. Please contact Johan Knapen (knapen@ing.iac.es) and visit this web page http://www.ing.iac.es/Astronomy/science/seminars.html for more details. These were the seminars given in the last six months:

30 August. *Two-dimensional spectroscopy of the gravitational lens SBS 0909+532*, V. Motta (IAC)
29 August. *Searching for obscured supernovae in nearby starburst galaxies*, S. Mattila (Imperial College)
22 August. *Results from the Palomar mirror cleaning and coating conference*, J. Rey & M. Blanken (ING)
8 August. *Brown Dwarfs: Origins, Evolution and Fate*, E. Martín (IfA Hawaii)
26 July. *Near-Earth Objects: Unanswered Questions*, A. Fitzsimmons (Belfast)
24 July. *AXIS (An XMM-Newton International Survey)*, X. Barcons (Santander)
10 July. *The Turkish National Observatory in Antalya*, S. O. Selam (Ankara Observatory)
27 June. *WHT/INTEGRAL and the VLA give clues on the formation of shell galaxies*, M. Balcells (IAC)
31 May. *Probing the Fossil Record of Galaxy Evolution in M31*, A. Ferguson (Groningen)
23 May. *CCD Design: Current Developments*, S. Tulloch (ING)
27 April. *Spectral analysis of Galactic OB stars*, C. Villamariz Cid (IAC)
23 April. *Weird faint wee red beasties that make X-rays (Red counterparts to faint X-ray sources in a deep ROSAT survey)*, A. Newsam (Liverpool JMU)
28 March. *WFCAM, quasars, and other things*, S. Warren (Imperial College)
27 March. *Quasar absorption lines as a cosmological probe: exploring the Lyman forest with VLT/UVES*, S. Cristiani (ESO)
26 March. *Do Luminous Ellipticals Have Young Discs?* R. McDermid (Durham)
22 March. *The Galileo telescope and its instrumentation*, E. Oliva (TNG)
16 March. *Status of the SAURON Project on Nearby Early-type Galaxies*, T. de Zeeuw (Leiden)
12 March. *Observational evidence for black holes*, E. Harlaftis (Nat. Obs., Athens)
7 March. *The 2.3m ARISTARCHOS telescope*, E. Harlaftis (Nat. Obs., Athens)

John Davies caught this unusual alignment quite by chance one morning in August 2000 when observing at the JKT. Stepping out to check the dawn sky conditions he found the shadow of the JKT projected onto the dome of the WHT by the rising Sun. John wrote the following: *2000 years from now archeologists will excavate the foundations of the JKT and WHT and say "These temples are aligned with the summer sunrise, the ancient people who built them must have known something about astronomy."*

Recent Visits of TV Teams

In the last months ING has received several visits from TV teams. In July and August ING was filmed twice for BBC's Final Frontier. In September the program Crónicas, shown on the Spanish TVE and Canal Internacional, reported on the work at the telescopes. And finally in October the Spanish producers New Atlantis started the series Futuro dedicated to science discoveries.

Personnel Movements

John Telting left the astronomy group after nearly five years of service at the ING. Although he left the ING, he is still regularly detected not far from his previous office, as he is now working at the Nordic Optical Telescope on La Palma.

Saskia Prins, who worked for ING some time ago, has again strengthened the astronomy group carrying out part-time administrative support tasks.

Roy Ostensen joined ING on a Marie-Curie Fellowship. Roy will be working in the area of adaptive optics, and in particular on aspects of astronomical exploitation of the NAOMI instrument.

David González has filled a vacancy in the mechanical engineering section where he focusses on operational support activities.

Big telescopes have exercised their attractive effect on **Steve Magee**. He will exchange the island of La Palma for the Hawaiian Big Island where he will start working for the Keck Telescopes.

In the administration section **María Batista** commenced as part-time office assistant. You'll find her on the second floor of the Mayantigo building in Santa Cruz.

The long-standing vacancy in the computer facilities group has finally been filled by **Juan Vincente Piñero**.

Phil Symonds will be returning to the UK where he will be working at the UK Astronomy Technology Centre. We thank him for so many years of service at the ING.

Other ING Publications and Information Services

[INGNEWS] is an important source of breaking news concerning current developments at the ING, especially with regard to instruments.

You can subscribe to this mailing list by sending an email to `majordomo@ing.iac.es` with the message *subscribe ingnews* in the body. Please leave the subject field and the rest of the body of the message empty.

Once subscribed, you can subscribe a colleague by sending to `majordomo@ing.iac.es` the command *subscribe ingnews your_colleague's_address*. To unsubscribe from [INGNEWS] send to `majordomo@ing.iac.es` the command *unsubscribe ingnews*. More information on [INGNEWS] can be found on this web page: `http://www.ing.iac.es/Astronomy/science/bulletin/`. These are the subjects of the last messages sent to the list:

10 September

- "ING Instrumentation in Semester 2002A"
- "EC Funding for Observers"
- "Availability of SARG on the TNG"

20 June

- "Supplementary 2001B Call for INT/JKT Proposals"

27 April

- "ING Announcement of Adaptive Optics Service Observing Opportunity"

12 March

- "ING Instrumentation in Semester 2001B"
- "EC Funding for Observers"
- "Availability of ING Newsletter No. 4"

Two new **Technical Notes** have been published recently:

- "No 126 Maps of the standard arc-lamps for the WHT ISIS-Red Arm", B. García Lorenzo (ING) and J. Holt (ING, Univ. of Sheffield), September 2001
- "No 125 Maps of the standard arc-lamps for the WHT ISIS-Blue Arm", B. García Lorenzo (ING) and J. Holt (ING, Univ. of Sheffield), September 2001

Other ING publications are available on-line at the URLs below:

Manuals:
`http://www.ing.iac.es/Astronomy/observing/manuals/`

Annual Reports:
`http://www.ing.iac.es/PR/AR/`

Press Releases:
`http://www.ing.iac.es/PR/press/`

In-house Research Papers:
`http://www.ing.iac.es/Astronomy/science/ingpub/`

News from the Roque

The Roque de Los Muchachos gets its name from the rock formation on the peak which appears from a distance to look like a crowd of lads. Now it seems that the crowd is growing with the new 'muchachos' like GRANTECAN, MAGIC and the Liverpool Telescope.

GRANTECAN is currently in the process of constructing the dome as illustrated in the accompanying pictures. First light is expected in early 2003.

The largest Cherenkov telescope in the world, MAGIC, is beginning to take shape with the preparation of the foundations close to the Residencia. Finally foundation laying is also taking place for the robotic 2-m Liverpool Telescope next to the other newcomer Mercator. ¤

The pictures above show different views of GRANTECAN taken from east (top left), north (top right) and south (bottom left). The picture bottom right is taken from the JKT looking towards GRANTECAN with the WHT in the foreground.

MAGIC foundations close to the former HEGRA site with the Residencia in the background.

This picture shows the position of the Liverpool Telescope to the left of Mercator. The INT is off the picture to the right.

The ING High-Quality CCD Image Collection Continued

The pictures below were recently obtained from the ING Archive or donated by various observers and are all available at our Public Information web pages. The final preparation of these true-colour images was performed as usual by Nik Szymanek. We thank him for his continous support.


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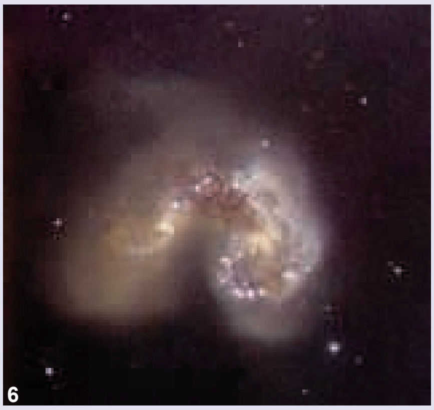
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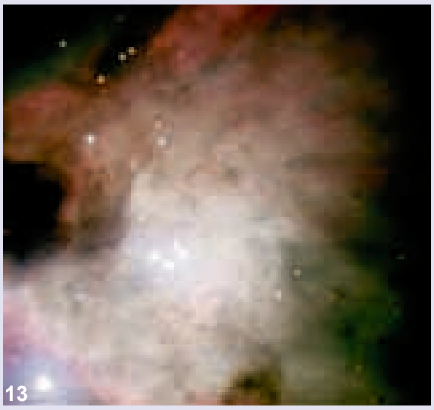
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Figure	**Object**	**Telescope**	**Instrument**	**Detector**	**Filters**	**Credit**
1	*M74*	*INT*	*WFC*	*EEV*	*V,R,I*	*Paul Vreeswijk and Nik Szymanek*
2	*M101*	*INT*	*WFC*	*EEV*	*B,V,R*	*Peter Bunclark and Nik Szymanek*
3	*NGC 7331*	*JKT*	*CCD*	*SITE*	*B,g',r'*	*Daniel Bramich and Nik Szymanek*
4	*M92*	*JKT*	*CCD*	*SITE*	*B,V,R*	*Daniel Bramich and Nik Szymanek*
5–15	*NGC 4321, NGC 4038, NGC 2841, NGC 3034, NGC 2336, NGC 2685, NGC 3627, NGC 2403, M42, NGC 4486, NGC 4826*	*JKT*	*CCD*	*TEK*	*B,V,R*	*ING Archive and Nik Szymanek*

TELESCOPE TIME

Applying for Time

Danny Lennon (Head of Astronomy, ING)

It is important that applicants for telescope time familiarise themselves with the latest news on instrumentation and detector combinations on offer, as well as with our scheduling restrictions. For the very latest news always refer to the ING web pages, homepage `http://www.ing.iac.es`, where application forms and style files may also be obtained. The ING's scheduling constraints were summarised in the first issue of the *ING Newsletter* and will not be repeated here, please refer to that issue, which is also available on our Astronomy web pages.

Note that PPARC are no longer distributing the PATT newsletter. Therefore UK applicants, along with all prospective applicants, are encouraged to subscribe to INGNEWS. You can subscribe to this mailing list by sending an email to `majordomo@ing.iac.es` with the message 'subscribe ingnews' in the body of the message. Please leave the subject field and the rest of the body of the message empty. A number of weeks before each application deadline, you will then receive a bulletin detailing instrument availability for the relevant semester.

What's New

As shown on the front cover of this issue, NAOMI tests have had considerable success with impressive performance even in the optical. In a separate article in this issue Chris Benn summarises the progress so far. Note that OSCA, the coronograph being developed for NAOMI, is now likely to be commissioned in semester 2002A.

Progress on the long-awaited new Small Fiber Module for AF2 was excellent and it was successfully commissioned in July 2001. Current estimates of the throughput of AF2 with the new fibres is that the they are similar to the best of the old large fibres. Since the relative throughput of the new fibres is quite uniform, unlike the old fibres, the average throughput is improved and estimated at 20%. An additional advantage with the new system is the use of coherent fibre bundles for fiducial stars which now permits autoguiding. Further details may be found in the article by Corradi et al. elsewhere in this issue. Note that large fibres can no longer be offered as an observing option!

Important Dates

Deadlines for submitting applications

UK PATT and NL NFRA PC:
31 March, 30 September

SP CAT: **1 April, 1 October**

ITP: **30 June**

Semesters

Semester A:
1 February – 31 July

Semester B:
1 August – 31 January

As announced in the previous issue, availability of UES will be curtailed due to work on the Nasmyth platform this coming summer. In order to continue to provide access to a high resolution spectrograph at the ING we have successfully negotiated access to SARG on the TNG. Depending on demand, up to seven nights per semester will be available to the UK and NL communities. Prospective applicants should continue to apply to their respective national panels for SARG/TNG time. In exchange the Italian community will receive observing time on the WHT. Further details on the TNG and SARG may be found at `http://www.tng.iac.es`. ¤

Danny Lennon (djl@ing.iac.es)

Telescope Time Awards Semester 2001B

For observing schedules please visit this web page:
`http://lpss33.ing.iac.es:8080/cgi-bin/schedules.pl`

ITP Programmes on the ING Telescopes

– Barcons (IF Cantabria), *An XMM-Newton international survey (AXIS-II): unveiling the hard X-ray source populations.* **ITP/2001/2**
– Doressoundiram (Paris), *Multi-color taxonomy of trans-Neptunian objects.* **ITP/2001/1**
– Moles (IMAFF Madrid), *A photometric wide-field survey of low-z clusters: defining the local reference sample for distant cluster studies.* **ITP/2001/3**

William Herschel Telescope

UK PATT

– Bower (Durham), *The outer-cluster environment at z=0.4.* **W/2001B/47**
– Bridges (AAO), *A spectroscopic study of globular clusters in M31: Part II.* **W/2001B/15**
– Carter (Liverpool), *The nature of the dark halos of the Local Group galaxies M31 and M33.* **W/2001B/21**
– Davies (Durham), *Mapping early type galaxies along the Hubble Sequence.* **W/2001B/28**
– Dhillon (Sheffield), *Imaging star-spots on the secondary stars in cataclysmic variables.* **W/2001B/6**
– Edge (Durham), *Emission line kinematics in central cluster galaxies in cooling flows.* **W/2001B/5**
– Farrah (Imperial College), *The environments of hyperluminous infrared galaxies.* **W/2001B/39**

- Green (Open University), *Lightcurves of massive EKBOs — Binaries or icy spots?* **W/2001B/25**
- Harries (Exeter), *A search for Zeeman polarization in the emission lines of classical T Tauri stars.* **W/2001B/27**
- Howarth (UCL), *Line formation in O-type stars.* **W/2001B/71**
- Irwin (Cambridge), *Kinematics of a giant tidal stellar stream in the halo of M31.* **W/2001B/44**
- Jeffries (Keele), *Wide binary brown dwarfs.* **W/2001B/64**
- Keenan (Belfast), *High spatial and spectral resolution observations of high velocity cloudlets towards M15.* **W/2001B/4**
- Knapen (Hertfordshire, ING), *A check of the theory of bar driven spirals based on deep K-band images of nearby galaxies.* **W/2001B/16**
- Marsh (Southampton), *The low luminosity cataclysmic variable, GD552.* **W/2001B/35**
- Meikle (Imperial College), *Detection and study of supernovae in nuclear starburst regions.* **W/2001B/34**
- Merrifield (Nottingham), *Planetary nebula kinematics of flattened early-type galaxies.* **W/2001B/12**
- Metcalfe (Durham), *Infra-red photometry of Chandra sources on the extended Herschel Deep Field.* **W/2001B/38**
- Peroux (Cambridge), *Tracing Galactic haloes at $3.0<z<4.5$ using C IV absorption lines.* **W/2001B/62**
- Pettini (Cambridge), *Star-forming galaxies and the Ly-alpha forest at $z \simeq 3$: the Galaxy–IGM connection.* **W/2001B/1**
- Pollacco (QUB), *Restarting the fast wind in the Sakurai Object (V4334 Sagittarii).* **W/2001A/12 LT**
- Rawlings (Oxford), *Tracing large scale structure with radio galaxies.* **W/2001B/49**
- Refregier (IoA), *Measuring cosmological parameters with weak gravitational lensing.* **W/2001A/62 LT**
- Ryan (Open University), *Carbon nucleosynthesis in the first stars.* **W/2001B/11**
- Shanks (Durham), *A spectroscopic test of anomalous two-colour diagrams of cepheid open clusters.* **W/2001B/42**
- Smail (Durham), *Testing photometric redshifts using cluster lenses.* **W/2001B/66**
- Smail (Durham), *The role of dark matter in cluster formation and galaxy evolution: Wide-field IR imaging of the cluster Cl 0024+1654.* **W/2001B/57**
- Smartt (Cambridge), *A complete survey of the Wolf-Rayet content of M33.* **W/2001B/10**
- Smartt (Cambridge), *Wolf-Rayet content of the starburst galaxy IC10: an anomaly for stellar and galactic evolution?* **W/1999B/79 PB**
- Tadhunter (Sheffield), *The nature of the far-IR/sub-mm excess in powerful radio galaxies.* **W/2000B/70 PB**
- Tanvir (Hertfordshire), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **W/2001B/60**
- Vink (Imperial College), *Could Herbig stars be magnetic accretors?* **W/2001B/36**
- Ward (Leicester), *The nature and environment of Galactic super-Eddington Sources.* **W/2001B/33**
- Willott (Oxford), *The Fundamental Plane and black hole masses of $z=0.5$ radio galaxies.* **W/2001B/67**
- Wills (Sheffield), *Triggering the activity in giant elliptical galaxies.* **W/2001B/45**

NL NFRA PC

- Förster Schreiber (Leiden), *Near-infrared snapshot survey for bright lensed red high-redshift galaxies.* **w01bn014**
- Ferguson (Groningen), *A search for recent massive star formation in gas-rich ellipticals/SOs.* **w01bn001**
- Hulleman (Utrecht), *What powers the anomalous X-ray pulsar 4U 0142+61?* **w01bn011**
- Kuijken (Groningen), *Planetary nebula kinematics of flattened galaxies.* **w01bn012**
- Lacerda (Leiden), *Rotational properties of (smaller) Kuiper Belt objects.* **w01bn003**
- Mengel (Leiden), *Star formation history in nearby mergers.* **w01bn021**
- Nelemans (Amsterdam), *Identification of low-luminosity cataclysmic variable candidates in the Faint Sky Variability Survey.* **w01bn022**
- Vreeswijk (Amsterdam), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **w01bn019**
- de Zeeuw (Leiden), *Mapping early-type galaxies along the Hubble Sequence.* **w01bn009**

SP CAT

- Castro-Tirado (IA Andalucía), *Rapid optical and IR detection of GRB counterparts.* **W11/2001B**
- Colina (IF Cantabria), *Integral field spectroscopy of ultraluminous infrared galaxies.* **W8/2001B**
- Delgado-Sánchez (IA Andalucía), *Spectroscopy of Pre-Main Sequence candidates in young clusters.* **W1/2001B**
- Erwin (IAC), *Inner bars, disks and nuclear rings along the Hubble sequence.* **W16/2001B**
- Esteban (IAC), *Chemical abundances based on recombination lines in ionized nebulas.* **W10/2001B**
- López (Barcelona), *Kinematic structure of the transversal part of stellar jets.* **W6/2001B**
- Mampaso (IAC), *Chemical gradients and evolution in M33 based on PN and HII regions.* **W23/2001B**
- Martínez (Valencia), *The mass and extent of halos in elliptical galaxies.* **W14/2001B**
- Neguerela (Strasbourg), *The orbit of V0332+53.* **W12/2001B**
- Paredes (Barcelona), *Search for new microquasars: spectroscopic confirmation of candidates.* **W2/2001B**
- Pérez (IA Andalucía), *Kinematic corrugations in spiral galaxies.* **W4/2001B**
- Prieto (IAC), *A study of high redshift galaxies with extreme star formation.* **W21/2001B**
- Rebolo (IAC), *A search for isolated Jovian planets in Orion.* **W25/2001B**
- Rebolo (IAC), *Sulphur abundances in metal-poor stars.* **W22/2001B**
- Sulentic (IA Andalucía), *The physics of the ISM in past and present interaction events.* **W15/2001B**
- Zurita (ING), *Dust in regions of massive star formation.* **W18/2001B**

Instruments Builder's Guaranteed Time

- Packham (Florida), *The initial conditions to star formation.* **GT/2001B/1**

Isaac Newton Telescope

UK PATT

- Benn (ING), *An extinction map of M31.* **I/2001B/40**
- Bonnell (St Andrews), *Inflow and outflow in T Tauri systems: splashback or disc-wind?* **I/2001B/23**
- Boyce (Bristol), *CCD imaging of gas-rich low surface brightness galaxies found at 21cm.* **I/2001B/21**
- Burleigh (Leicester), *Asteroseismology of a pulsating helium-atmosphere white dwarf.* **I/2001B/1**
- Hewett (Cambridge), *Probing the dark halo of M31 with pixel microlensing.* **I/2001B/4**
- Liu (UCL), *A deep optical recombination line abundance survey of northern hemisphere planetary nebulae.* **I/2001B/30**
- Marsh (Southampton), *Subdwarf-B stars: tracers of binary evolution.* **I/2001B/12**

– Marsh (Southampton), *Subdwarf-B stars: traces of binary evolution. II. Galactic plane sample.* **I/2001B/29**
– McLure (Oxford), *A photometric redshift study of radio galaxy environments spanning 3 decades in luminosity.* **I/2001B/13**
– North (Southampton), *The ages of cataclysmic variables.* **I/2001B/10**
– Pinfield (Liverpool John Moores University), *An intermediate age population of very low-mass stars & brown dwarfs.* **I/2001B/8**
– Sharples (Durham), *The disk galaxy population in nearby clusters.* **I/2001B/11**
– Tanvir (Hertfordshire), *A CCD Survey of the halo and outer disk of M31.* **I/2001B/14**
– Tanvir (Hertfordshire), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **W/2001B/60 [sic]**

NL NFRA PC

– Jimenez (Groningen), *A much-improved stellar library for stellar population synthesis.* **i01bn002**
– Lacerda (Leiden), *Rotational properties of (larger) Kuiper Belt objects.* **i01bn001**
– Nelemans (Amsterdam), *Follow-up of possible type Ia supernova progenitors.* **i01bn004**
– Sackett (Groningen), *The MEGA Survey: Mapping microlensing in M31.* **i01bn006**
– Vreeswijk (Amsterdam), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **w01bn019 [sic]**

UK/NL WFS Programmes

– Dalton (Oxford), *The Oxford Deep WFC Survey.* **WFS/2001B/6**
– van den Heuvel (Amsterdam), *The Faint Sky Variability Survey II.* **WFS/2001B/1**
– McMahon (IoA), *The INT Wide Angle Survey.* **WFS/2001B/8**
– Walton (ING), *The Local Group census.* **WFS/2001B/4**
– Watson (Leicester), *An imaging programme for the XMM-Newton Serendipitous X-ray Sky Survey.* **WFS/2001B/3**

SP CAT

– Balcells (IAC), *Deep U & I imaging of high-redshift galaxies with extreme star formation.* **I8/2001B**
– Castro-Tirado (IA Andalucía), *Rapid optical and IR detection of GRB counterparts.* **IW11/2001B**
– Gallego (Comp. Madrid), *Evolution of the Star Formation Rate density of the Universe at intermediate redshift.* **I13/2001B**
– Gonçalves (IAC), *The nature of low-ionization microstructures in PNe: determination of the physical parameters.* **I12/2001B**
– Magrini (Florence), *PN and the intergalactic stellar population in the M81 system.* **I6/2001B**
– Popovic (Belgrade), *Disk emission in AGN.* **I18/2001B**
– Rebolo (IAC), *The rotation of brown dwarfs.* **I19/2001B**
– Ribas (Barcelona), *Direct determination of the distance to M31 using eclipsing binaries.* **I4/2001B**
– Vílchez (IA Andalucía), *Constrants to the evolution of ring galaxies from abundance gradients.* **I5/2001B**
– Villamariz Cid (IAC), *CNO abundancies in galactic OB stars: rotation and mixing processes.* **I16/2001B**

Jacobus Kapteyn Telescope

UK PATT

– Boyce (Bristol), *H-alpha imaging of gas-rich low surface brightness galaxies found at 21cm.* **J/2001B/10**
– Bucciarelli (Turin), *Photometric calibrators for the Palomar Sky Surveys.* **J/2001B/4**
– Burleigh (Leicester), *Optical variability of cool stars in the Galactic Plane.* **J/2001B/14**
– Davies (JAC), *Lightcurves of Near Earth Objects.* **J/2001B/2**
– Dhillon (Sheffield), *Imaging star-spots on the secondary stars in cataclysmic variables.* **J/2001B/1**
– Fitzsimmons (Belfast), *The size and composition of Near-Earth Objects.* **J/2001B/7**
– Folha (Porto), *Pulsations in pre-Main Sequence Herbig Ae stars.* **J/2001B/15**
– James D (St Andrews), *Rotation period determinations in the intermediate-aged open cluster NGC2168.* **J/2001B/12**
– James P (LJMU), *A survey of star formation in the local Universe.* **J/2000A/11 LT**
– McBride (Open University), *Physical and thermal properties of Earth crossing asteroid 1998 WT24.* **J/2001B/6**
– Pollacco (Belfast), *Central stars of bipolar Planetary Nebula: ~100% binarity?* **J/2001B/5**
– Schönberner (Potsdam), *The mass loss history of planetary nebulae with 'normal' and WR-type nuclei.* **J/2001B/3**
– Smith (Cork), *A search for optical variability in radio intermediate quasars.* **J/2001B/8**
– Tanvir (Hertfordshire), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **W/2001B/60 [sic]**

NL NFRA PC

– Ferguson (Groningen), *Star formation in nuclear and outer regions in barred spirals.* **j01bn001**
– Noordermeer (Groningen), *Multi-color imaging of galaxies in the WHISP sample.* **j01bn002**
– Vreeswijk (Amsterdam), *Rapid imaging of GRB error boxes and spectroscopy of GRB-related optical/IR transients.* **w01bn019 [sic]**

SP CAT

– Baes (Vienna), *Tracing the dynamic interplay between the gas-dominated and star-dominated disk components in barred spirals.* **J5/2001B**
– Carraro (Padova), *Formation and evolution of the Milky Way: the Galactic disk.* **JI17/2001B**
– Castro-Tirado (IA Andalucía), *Rapid optical and IR detection of GRB counterparts.* **JW11/2001B**
– Kidger (IAC), *Definition of an accurate 1–30μ flux calibration system for GTC.* **J2/2001B**
– Lara (IA Andalucía), *The dust and gas coma of comet C/2000 WM1 (Linear).* **J1/2001B**
– López Aguerri (Basel), *Restriction on the amount of dark matter in SAB galaxies.* **J3/2001B**
– Pérez García (IAC), *Atlas of starburst galaxies through H recombination lines imaging.* **J4/2001B**

Abbreviations:

CAT	Comité para la Asignación de Tiempo
ITP	International Time Programme
NFRA	Netherlands Foundation for Research in Astronomy
NL	The Netherlands
PATT	Panel for the Allocation of Telescope Time
PC	Programme Committee
SP	Spain
UK	The United Kingdom
WFS	Wide Field Survey

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