No. 10, December 2005

THE ISAAC NEWTON GROUP OF TELESCOPES

NEWSLETTER

The spiral galaxy NGC 7217 in Pegasus. Image obtained using the Prime Focus Imaging Camera at the William Herschel Telescope in B, V and R bands. Courtesy of Mischa Schirmer (ING) and Gilles Bergond (IAA, Granada).

Message from the Director

Dear Reader,

This is the 10th issue of the ING Newsletter. Now 'ten' does not read like a big number, but knowing the effort it takes to produce these Newsletters on a more or less regular basis it is worth a big thank-you to all those people who have contributed over the years! And let me state the obvious: volunteers for contributions are always welcome.

This Newsletter brings a number of important scientific and technical highlights. Worth a mention here are the nice results obtained with the telescopes on La Palma of the collision of the Deep Impact probe on comet Swift-Tuttle. ING's current main instrumentation development project, GLAS, which aims to build a laser guide star for adaptive optics, is summarised in this Newsletter as well. I hope you will find these and several other contributions of interest.

An important event for the observatory took place in July when an independent international panel of scientists reviewed the functioning and future prospects of the ING. This activity was commissioned by the Board of the ING to evaluate the WHT and INT in a wider international context and provide an independent vision of the observatory's current and future scientific health.

The ING finds itself at an important crossroads for various reasons. Since the previous review of this kind a number of major changes have taken place. For example, measures were introduced to drastically reduce the overall operational cost of the telescopes. Furthermore, developments around the world on large telescopes have resulted in changes in the requirements for the ING telescopes from the user community. And on the organisational side, the international agreements that have formed the basis of the scientific partnership on La Palma for a quarter of a century will be up for renewal in 2009. These issues formed the core of the questions on which

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 2350 m above sea level at the Roque de Los Muchachos Observatory on the island of La Palma, Canary Islands, Spain. The WHT is the largest telescope of its kind in Western Europe.

The construction of the ING telescopes was 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, the Netherlands and the Instituto de Astrofísica de Canarias (IAC). The remaining 5 per cent is reserved for large scientific projects to promote international collaboration between institutions of the CCI member countries.

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

(Continued from front cover).

the visiting committee was asked to provide its opinion.

The review committee was chaired by Jeremy Mould (NOAO) with Brian Boyle (CSIRO), Bruce Carney (Univ. of North Carolina) and Bruno Leibundgut (ESO) as members. The panel first visited La Palma for two days to commence their work at the observatory. After that, the group met with scientists from the three main user communities as well with representatives of the funding agencies: PPARC for the UK, NWO for the Netherlands, and the IAC for Spain.

At the time of writing, the report from the committee has been submitted to the ING Board and the funding agencies. It now forms part of the background information that the agencies will require in order to make informed decisions on the future investment in the ING. It is expected that the report will be made public shortly, but in anticipation of that I am pleased to be able to report that the committee placed the ING in an extremely favourable light, saw very good scientific prospects for the WHT for several more years, and gave its full support to the developments that are currently under way.

Depending on the outcome of the ongoing deliberations, the ING may well be producing at least another ten issues of this Newsletter, presenting scientific highlights and developments in future years.

René G. M. Rutten

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. van der Hulst (Univ. of Groningen), *Chairperson*.
Dr. D. Telfer (PPARC), *Secretary*.
Dr. P. Crowther (Univ. of Sheffield).
Dr. G. Dalton (Univ. of Oxford).
Dr. R. García López (IAC).
Prof. J. Hough (Univ. of Hertfordshire).
Dr. R. Stark (NWO).
Dr. C. Vincent (PPARC).

The ING Director's Advisory Committee

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

Dr. M. McCaughrean (Univ. of Exeter), *Chairperson*.
Dr. M. Balcells (IAC).
Dr. P. A. James (Liverpool John Moores Univ.).
Dr. N. Tanvir (Univ. of Hertfordshire).
Dr. E. Tolstoy (Univ. of Groningen).

The ING Newsletter

ISSN 1575–8958 (printed version).
ISSN 1575–9849 (electronic version).
Legal license: TF–1959/99.

Published in Spain by THE ISAAC NEWTON GROUP OF TELESCOPES (ING); Apartado 321; E-38700 Santa Cruz de La Palma; Canary Islands; Spain.
Telephone: +34 922 425400.
Fax: +34 922 425401.
URL: `http://www.ing.iac.es/`.

Editorial team: Javier Méndez, René Rutten and Danny Lennon.
Consultant: Johan Knapen.
Designer: Javier Méndez.
Preprinting: Gráficas El Time.
Printing: Gráficas Sabater.

The ING Newsletter is primarily published on-line at `http://www.ing.iac.es/PR/newsletter/` in HTML and PDF format. Notification of every new issue is given by e-mail using the [INGNEWS] mailing list. More information on [INGNEWS] can be found on page 25. Requests for one-off printed copies can be emailed to Javier Méndez (`jma@ing.iac.es`).

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.

SCIENCE

A Galactic Jet-Blown Nebula Observed with the Isaac Newton Telescope

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Galactic black holes release an unknown fraction of their accreting matter and energy in the form of collimated outflows (or jets) that travel into the surrounding medium. Black Hole X-ray Binaries (BHXBs) are the essential laboratories for understanding the overall physics of the accretion process in these systems, and have provided us with a wealth of understanding of, for example, the properties of the accretion disc. In comparison, the energy and matter content of the jets produced by BHXBs are not well constrained because they are radiatively inefficient (Fender, 2001). Measuring as accurately as possible the total power content of the jets (which are produced by BHXBs throughout the majority of their lifetimes; Fender, Belloni & Gallo, 2004), and hence their importance with respect to the accretion process in terms of energetics, is a primary aim of high-energy astrophysics.

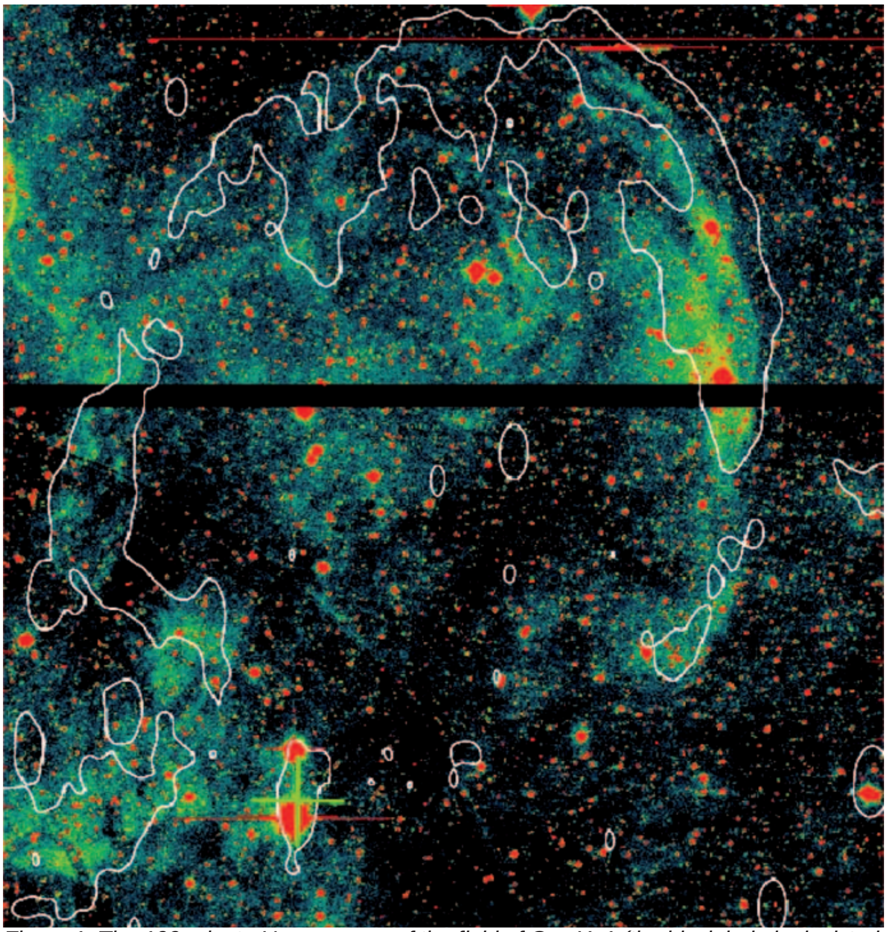

Figure 1. The 100-minute Hα exposure of the field of Cyg X–1 (the black hole is depicted by the cross on the bottom-left) and the ~5.5 arcmin jet-blown nebula. 3σ radio contours are overplotted in white.

Attempts at measuring the jet power from radio luminosities are riddled with assumptions about its spectrum and radiative efficiency. However, the jet power can also be constrained by analysing its interaction with the surrounding ISM. Synchrotron radio lobes associated with jets from AGN are commonly used as accurate calorimeters of the [power×lifetime] product of the jets (Burbidge, 1959), a method only very recently applied to jets from stellar mass BHs. In 2004, very deep low radio frequency observations of the field of Cyg X–1 resulted in the discovery of a shell-like structure which is aligned with the resolved radio jet of this BHXB (Gallo et al., 2005). This radio shell has been interpreted as the result of a strong shock that develops at the location where the collimated jet impacts on the ambient ISM. Models of jet-ISM interactions predict a shell of shocked compressed ISM visible via bremsstrahlung emission, containing a bubble of relativistic synchrotron-emitting plasma (Kaiser et al., 2004). The spectrum of the shocked shell should be approximately flat from radio to much higher frequencies and possess spectral lines in emission. To test this, the Cyg X–1 'jet-blown nebula' was consequently observed at optical wavelengths with the INT WFC.

In Fig. 1, the resulting 100-minute exposure in Hα is overplotted with contours of radio flux. The shell of the nebula is clearly visible; an Hα flux lower limit of $m \leq 23.1$ arcsec^{-2} from the nebula was calculated from the observations. This corresponds to an intrinsic flux density of the nebula (accounting for the optical extinction towards Cyg X–1; $A_V = 3.3$) of ≥ 0.022 mJy arcsec^{-2}. From the measured radio flux density, we calculated the corresponding radio-optical spectral index; $a > 0.2$ (a is defined such that the monochromatic flux F_ν scales as ν^a). This implies an emission mechanism with a flat spectrum, such as bremsstrahlung, plus excess flux possibly due to line emission, as expected in the case of radiative shock. The spectrum is inconsistent with that of optically thin synchrotron radiation, where $\alpha \approx -0.7$. This, therefore, is the first discovery of a thermal shell of gas that is shocked by its interaction with a jet of a Galactic black hole (Gallo et al., 2005).

The optical-radio spectrum of the nebula acts as an effective jet calorimeter, and, also for the first time, allows an estimate of the [power × lifetime] product of the jets from radio–optical measurements, which is independent of the uncertainties associated with their spectrum and radiative efficiency. We calculated that to account for the observed broadband spectrum of the shocked gas, the power carried by the jet of Cyg X–1, averaged over its lifetime, is $\sim 9\times10^{35} \leq P_{jet} \leq 10^{37}$ erg s^{-1}. Taking into account the contribution of the counter jet, the total power in the jets is then $f \sim 0.06$–1 × the bolometric X-ray luminosity of the system. This significantly overshoots all previous estimates of the jet power in black hole X-ray binaries.

This profitable technique has potential for constraining the jet power associated with other BHXBs if further jet-blown nebulae are identified. With the confirmation of this jet-ISM interaction associated with Cyg X–1, it is clear not only that there may be an undiscovered population of jet-blown bremsstrahlung nebulae associated with BHXBs, but also that these nebulae may easily be found with simple wide-field red-optical imaging. To this end, we have been awarded 4 nights with the INT WFC in October 2005 and 3 nights in the southern hemisphere on the ESO/MPI 2.2 m WFI in February 2006, to search the fields of ~20 known Galactic BHXBs.

The power in the jets of persistent BHXBs such as Cyg X–1 are orders of magnitude larger than those of transients, which spend the majority of their lifetimes in quiescence. However, Cyg X–1 is short lived, and the [power × lifetime] product, and therefore the expected luminosity of shocked ISM gas, is comparable to the older quiescent sources. Essentially, the apparent magnitude of the thermal shell of a jet-blown nebula is highly dependent on the distance, the Galactic dust extinction towards the source and the local density of the ISM surrounding the BHXB. Given these constraints and the existing estimates for these variables for Galactic BHXBs (where known), nebulae associated with ≤20 BHXBs may be visible with the INT and ESO/MPI 2.2 m telescopes during the observing runs.

In addition to searching for more jet-ISM interactions, follow-up observations of the Cyg X–1 nebula, for example optical spectra using the WHT, may also confirm the presence of emission lines and their flux, will further constrain the power of the jets and the nature of the composition of the nebula. Eventually, accurate high-resolution spectroscopy will reveal the temperature and velocity distribution of the shocked shell. ¤

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The Deep Impact Event as Seen from the Roque de Los Muchachos Observatory

Javier Licandro (ING and IAC)

At 05:44:36 UT on July 4th, 2005 the Deep Impact (DI) spacecraft collided with comet Tempel 1, producing an impact of 19 GJ of kinetic energy and excavating a crater shaped by gravity. DI consisted in two spacecrafts: an impactor, weighting 364 kg; and a flyby spacecraft for observing the impact and relaying data from the impactor. The main goal of the mission was to study the interior and outer layers of a comet. Until the impact, very little was known of the internal structure and the physical evolution of the outer layers of a comet nucleus. Most of what we know relies primarily on theoretical models. The relationship between the coma's composition and the nucleus composition is also uncertain. Even if the coma is formed by material from the nucleus, there are several physical and chemical processes that rapidly affect the material ejected from the nucleus.

The DI mission was designed to have much of the mission-critical science done from Earth-based telescopes. An unprecedented worldwide coordinated campaign was organised. Many observatories around the world and in space observed the comet before, during and after the impact, to follow the effects of the event and its evolution.

The Roque de Los Muchachos Observatory (ORM) played a substantial role in this campaign. Starting in 2000, photometric observations performed during several runs by Tozzi and Licandro with the 3.6-m Italian Telescopio Nazionale Galileo (TNG) were used together with others worldwide, to understand the rotational properties of the comet. From March to June 2005 the comet activity was also tracked by our group with the TNG by means of imaging and spectroscopic studies every month. But the interesting part of the game started on July 2nd. From July 2nd to July 10th a campaign involving the three largest telescopes of the ORM, the William Herschel (WHT), the TNG and the Nordic Optical Telescope (NOT) was driven by our group. LIRIS at the WHT was used from July 3rd to 7th to obtain near infrared images in the *J* and *K* bands and near infrared spectra. DOLORES at TNG was used from July 2nd to 9th to obtain broad-band images and low-resolution spectra in the visible spectral range. NICS at TNG was used from July 8th to 10th to obtain near infrared images. SARG at TNG was used from July 3rd to 5th to obtain high resolution spectra in the visible range. ALFOSC at the NOT was used from July 3rd to 10th to obtain deep broad-band images and low-resolution spectra in the visible. Also another group lead by Stephen Lowry (QUB) used the INT and the Liverpool Telescope to follow the activity of the comet from July 1st to 7th (see article elsewhere in this issue). The five largest telescopes of the ORM were used simultaneously to track an astronomical experiment in an unprecedented way.

The first aim of the campaign was to study the dust ejected by the impact by using the high S/N images obtained in the visible and near-IR, and the spectra in the near-IR where there are many features due to gas emission. The evolution of the intensity and colour of the dust gives important information on the size of the ejected grains, like their size distribution and ejection velocities. The second aim of the campaign is to measure possible variations of the gas emission by means of visible spectroscopy, to detect any possible new activity in case the impactor penetrated deep enough to meet the fresh ices below the dust mantle. This would evaporate part of them and expose ices to the sun-light generating a new active area.

The impact produced an ejecta cloud of dust easily seen in our images. The wonderful atmospheric conditions (all nights were photometric, and the seeing was as good as 0.4 arcsec) allowed us to obtain a set of excellent

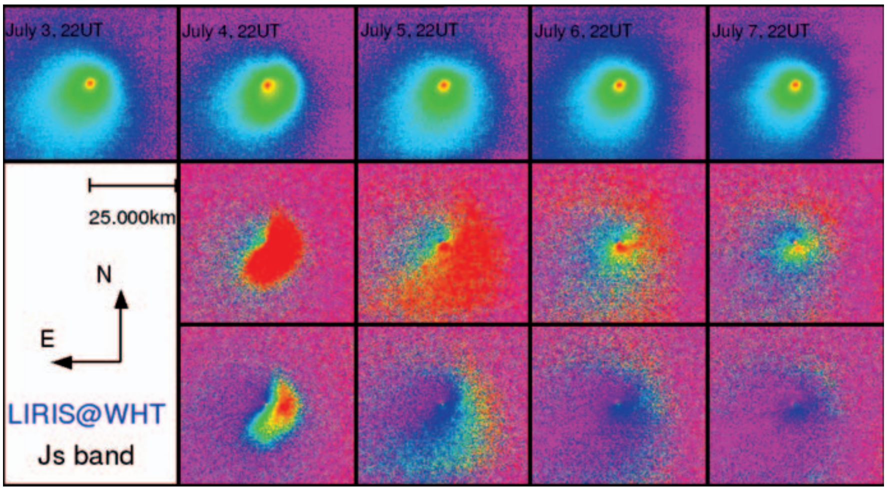

Figure 1. First row: Sequence of calibrated near-infrared J-images of the dust coma of comet Tempel 1 obtained with LIRIS at WHT. Notice the changes in the images from July 3rd (pre-impact) to July 4th (taken 16 hours after the impact). Second row: Post-impact J-images processed to show only the dust ejected by the impact. Each image has been divided by the pre-impact one obtained on July 3rd. The evolution of the ejecta cloud is clearly seen (see text). Third row: Same as 2nd row shown in a different flux scale.

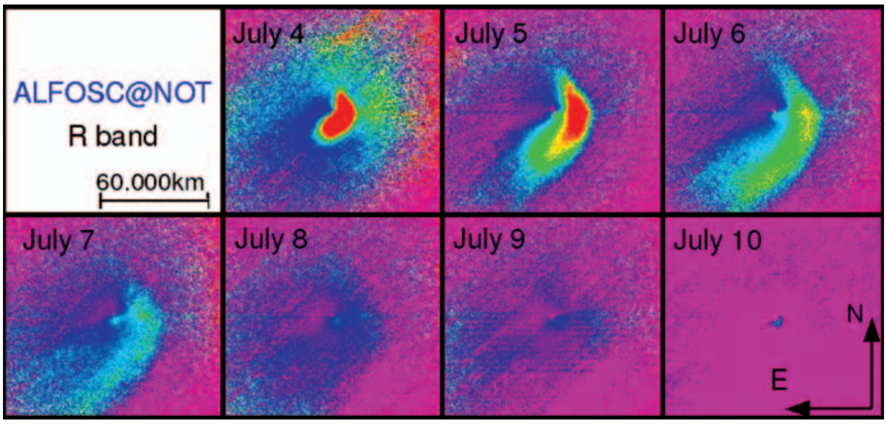

Figure 2. Sequences of processed post-impact R-band images as in 2nd row of Fig. 1. Images were obtained with ALFOSC at NOT. The rainbow scale goes from 1.0 in violet, to 1.5 in red. Notice that on July 9th the image is almost identical to that of July 3rd.

images in particular in the *R* and *J* bands (see Fig. 1 and 2). At these wavelengths the images were sampling the reflected sunlight by the dust in the coma. Our spectra also show that the gas contribution was very low in particular in the near infrared. Some preliminary conclusions about the dust cloud ejecta can be derived from our data:

1. The dust ejected by the impact formed a semi-circular expanding cloud that extended from position angles (PA) 145° to 325°.
2. Assuming an albedo typical of cometary grain size, the flux of the dust ejecta allowed us to estimate that the total mass of dust ejected was $\sim 10^6$ kg (equivalent to about 10 hours of normal comet activity).
3. The orientation of the ejecta proves that the impact happened below the orbital plane of the comet.
4. The position of the leading edge of the dust cloud present on the July 4th images show that it expanded outward at a projected speed of about $200 \pm 20\,\mathrm{m\,s^{-1}}$ (though varying with azimuth).
5. In the following days the shape of the cloud changed because of the effect of solar radiation pressure that moved the dust particles to the tail of the comet (PA=110°). The maximum projected distance in the sunward direction, achieved on July 7th, was 30,000 km. By July

9th most of the ejected dust was moved to the coma and the comet looked like as in the pre-impact phase. The ejected dust is diluted in the comet tail.

The study of the structures of the dust coma in high S/N images (Fig. 3) provided also very interesting results:

1. The comet presented some dust structures in the pre-impact phase that indicate that the nucleus had some particularly active regions.
2. These structures remained after the impact, thus these active regions were not affected.
3. The new structures observed after the impact on July 4th rapidly disappeared and none remained at a high S/N level after a few days.

In conclusion, the ORM campaign showed that the impact was an impulsive event that affected the dust mantle of the comet. A large amount of dust was ejected into the coma in a very short time. In no more than 5 days this dust dissipated. Also, if the impactor reached the fresh-ices below the dust mantle, it did not excavate enough to expose a sufficient amount of ices to create a new region sufficiently active to be easily detected.

Further studies of the dust and gas properties will be done. The images will be analysed with the help of Monte-Carlo modelling techniques to derive the dust grain size distribution and ejected velocities. Visible and infrared spectra will be analysed to determine the gas production rates and the colour of the comet dust.

The scientific team was composed by Javier Licandro (ING and IAC), Miquel Serra Ricart (IAC), Julia de León Cruz (IAC), Noemí Pinilla Alonso (TNG and IAC), M. Teresa Capria (INAF), Rafael Barrena (IAC), Mischa Schrimer (ING), Luisa Lara-López (IAA), and Gian Paolo Tozzi (INAF, Oss. di Arcetri). ¤

Javier Licandro (licandro@ing.iac.es)

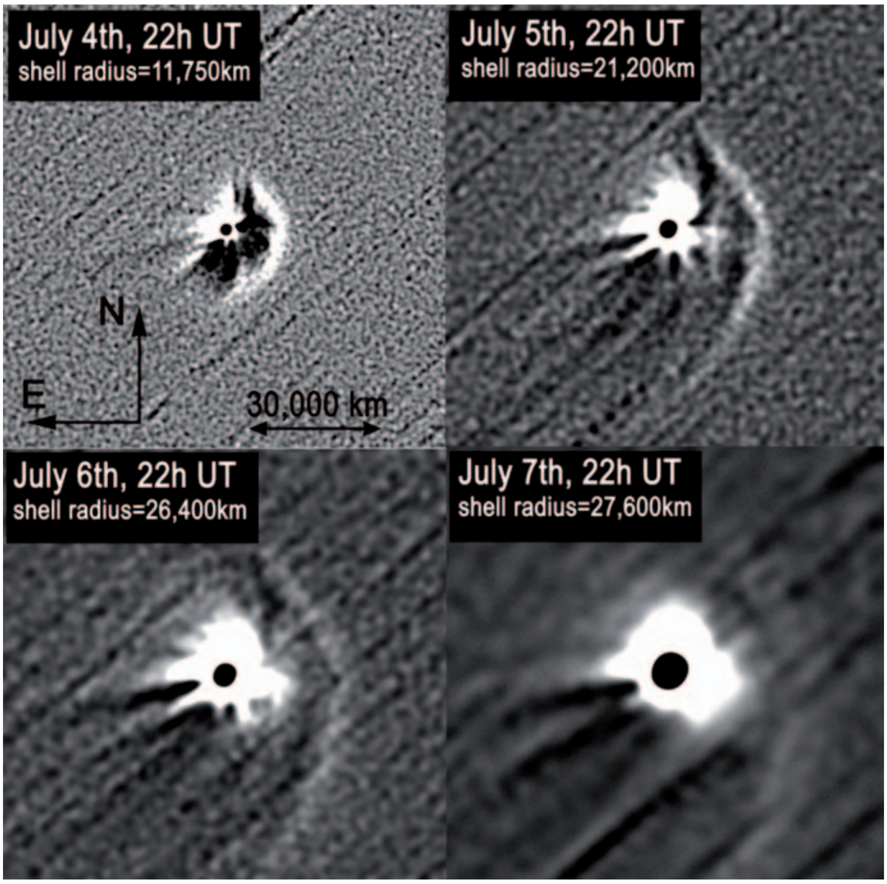

Figure 3. Sequences of R-band images obtained with ALFOSC at NOT processed with a Laplacian filtering technique to detect dust structures. Dust jets appear as black straight jets close to the nucleus, dust shells appear as white curved structures. Filtering was optimised to detect the white shell on the right. This shell indicates the day-by-day expansion of the border of the dust cloud ejecta.

Deep Impact Observing at the Isaac Newton Telescope

Stephen C. Lowry[1], Andrew J. Coates[2], Alan Fitzsimmons[1], Geraint H. Jones[3] and Carey M. Lisse[4]

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On July 3rd, 2005 the NASA Deep Impact impactor probe successfully separated from its mother craft onto a trajectory that would plunge the probe into the nucleus of comet 9P/Tempel 1 at a velocity of 10 km s^{-1}. Impact occurred at 05:52 UT on July 4th, and the world looked on in amazement as the first spectacular images of the impact were received at Earth*. Meanwhile, observatories around the world and in space were closely monitoring the comet before, during, and after the impact. This was an unprecedented coordinated observational campaign, which included over 550 whole or partial nights of observation using 73 ground-based telescopes at 35 observatories. The Deep Impact mission was designed to have much of the mission-critical science done from Earth-based telescopes. These facilities would observe the comet's evolution in wavelength regimes and timescales inaccessible to the spacecraft (The

Tempel 1 Observing Collaborators Team, 2005).

Comets are remnants of the early stages of the formation of our Solar System and thus contain the most pristine material from that era, as well as clues to its subsequent evolution. Whatever evidence we have into their internal composition comes either from remote observation and modelling of the dust and gases that are lifted off the surface, or from in-situ analysis of data from recent spacecraft flybys. Deep Impact was designed to provide a first look at the interior of a comet by striking the surface to expose the material underneath the opaque crust.

The target comet was 9P/Tempel 1. This is one of a class of comets known as the Jupiter-family of comets, most of which are believed to have formed in the trans-Neptunian region. These objects have low inclination orbits and typically take less than 20 years to orbit the Sun. Their orbits are strongly influenced by Jupiter, hence their name. 9P/Tempel 1 orbits the sun once every 5.5 years, and the Deep Impact encounter was scheduled to take place at perihelion, when the comet was at 1.5 and 0.9 Astronomical Units from the Sun and Earth, respectively.

Observations at the Isaac Newton Telescope

The 2.5m Isaac Newton Telescope (INT) was used as part of the campaign. The observations from La Palma were very important for completing the time base coverage of the comet as it fell below the sky from the primary observing site at Mauna Kea, Hawaii. The INT team members include Dr. Stephen Lowry and Prof. Alan Fitzsimmons of Queen's University Belfast, Dr. Andrew Coates of the Mullard Space Science Laboratory, Dr. Geraint Jones from the Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany, and Dr. Carey Lisse from Johns Hopkins University, USA.

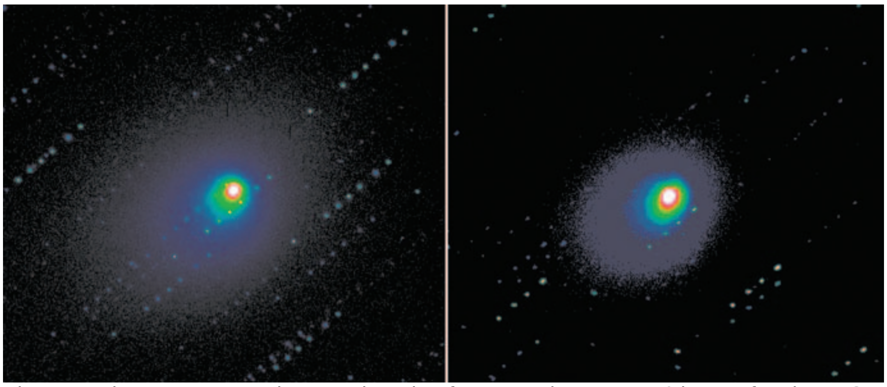

Figure 1. When comet Tempel 1 came into view from La Palma, some 16 hours after the NASA Deep Impact probe struck the comet, members of the La Palma Deep Impact Collaborating Observers Team were able to start tracking the target comet with the 2.5m Isaac Newton Telescope. Both images above are a combination of 7×20 second Sloan-Gunn r' (red) filter images which isolate the dust component of the coma. The image on the left was taken on July 3rd between 21:56 and 23:03 Universal Time, about 7 hours before impact. The image on the right was taken between 22:08 and 23:56 UT on July 4th, 16 hours after probe impact which occurred on July 4th 05:52 UT. The comet was seen to increase in brightness by a factor of two —as measured in the central pixel— before and after the impact as seen from this location. Even in these images the effects of the impact can be seen by the changing coma shape between the two images. North is up and East to the left. The field of view in both images is 340×340 arcseconds, which is equivalent to ~220,000×220,000 km at the comet.

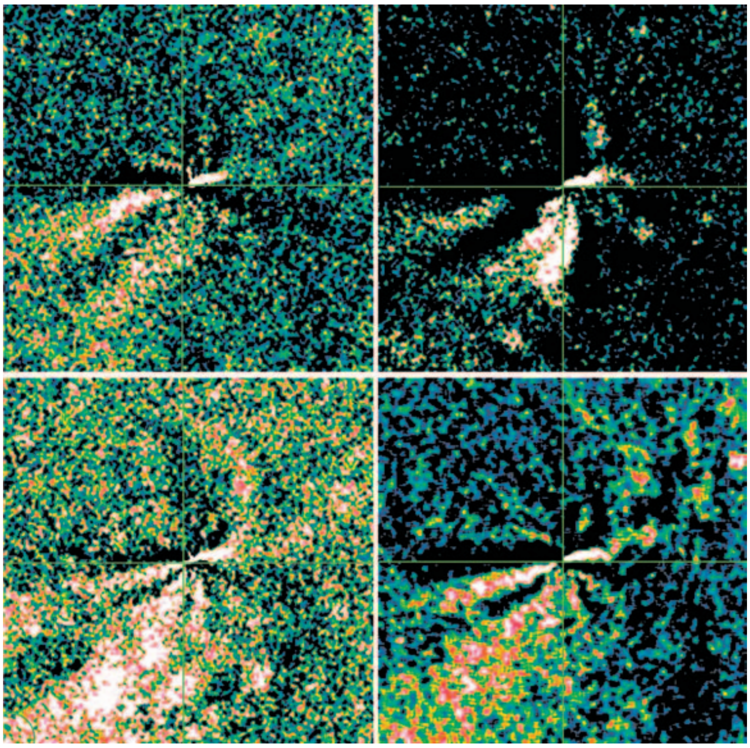

Figure 2. We applied Larson-Sekanina image processing techniques to the coadded r'-filter coma images from four of the nights to reveal the dramatic changes in the structure of the dust coma that resulted from the impact. Before impact on July 3rd (upper left panel), three jet structures can be seen to be emanating from the comet's nucleus. On July 4th, just 16 hours after probe impact, the intensity of the jet/coma structures in the West and Southern direction increase dramatically (upper right panel). North is up and East to the left. On July 5th, new curved structures can be seen in the North-Western quadrant (lower left panel), possibly made visible by the extra material ejected into the coma from the impact. The structures seem to return to their pre-impact status on July 6th (lower right panel). The first three panels are directly comparable in terms of atmospheric seeing (variable seeing can complicate matters when comparing such processed images). The seeing on July 6th is actually much better than the other images. The images have been scaled to account for the slight extinction and geometry changes from night to night. Also, the images were taken under photometric conditions. Of course, nucleus rotation will need to be factored into this analysis, but even so, impact effects are still clearly seen in these images. The field of view in every image is 95×95 arcseconds, which is equivalent to ~62,000×62,000 km at the comet.

*: `http://deepimpact.jpl.nasa.gov/`

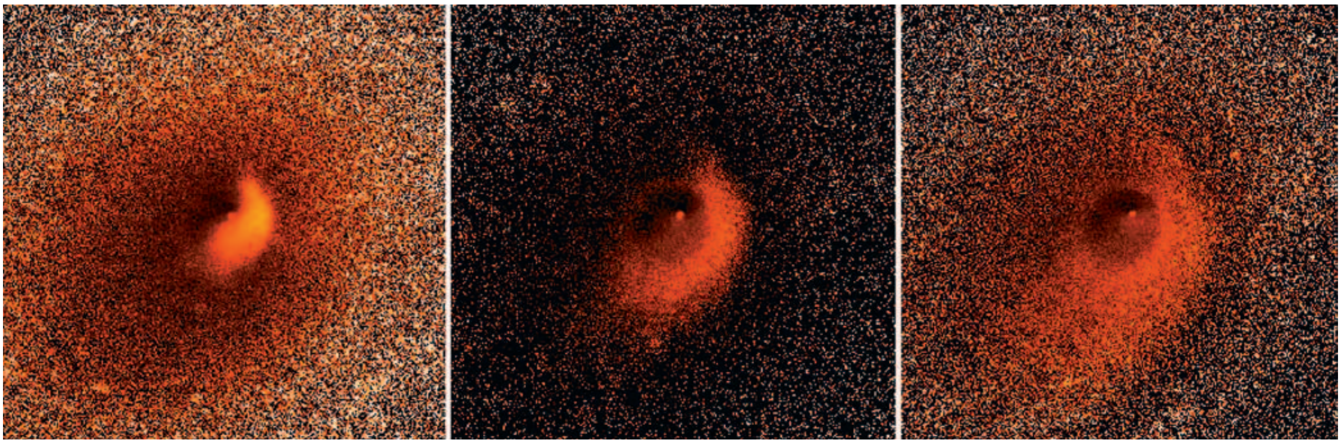

Figure 3. These dramatic images of the expanding and dissipating ejecta plume were obtained by dividing the July 4th, 5th, and 6th coadded images of the comet by the pre-impact image on July 3rd. North is up and East to the left. The plume expands mostly into the South-Western quadrant, and appears to be decelerating at a non-uniform rate. The dust particles at the leading edge of the plume, are expanding at a rate of ~210 m s^{-1} (±10%) on July 4th (measured at a Position Angle of 225°). The field of view in every image is 190×190 arcseconds, which is equivalent to ~123,000×123,000 km at the comet.

Our observing slot ran from July 1st to July 7th, 2005. A period which overlapped the Deep Impact encounter allowing us three nights pre-impact and four nights post impact observing. Our strategy was to use the Wide Field Camera to obtain image mosaics up to 5 million kilometres along the projected anti-solar direction to look for ion-tail features that may have been produced as a result of the impact. The post impact observations quickly revealed that no such ion features were present, which was subsequently confirmed by other observers performing similar programs. With this in mind we decided to focus on deep optical imaging of the central gas and dust coma through *UBVr'i'O+* filters. We were rather fortuitous in that the observing conditions remained beautifully clear for the entire duration of the observing run.

When we imaged the comet on July 4th, about 16 hours after the impact, the comet was seen to have increased in brightness by a factor of two — as measured in the central pixel — compared to the July 3rd pre-impact levels. Some dramatic changes were seen in the dust coma which are shown in Figures 1–3. The Deep Impact event did not create a new period of sustained cometary activity, and in many ways the artificial impact resembled a natural outburst (The Tempel 1 Observing Collaborators Team, 2005; Lara et al., 2005). The observed optical properties of the dust coma from this abundant data set will be modelled by our team. ¤

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Lara L. et al., 2005, in preparation.

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The SAURON View of the Nuclear Ring in M100

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Nuclear rings located within the central 1–2 kiloparsecs of barred spiral galaxies are often found to contain a large fraction of the total star formation taking place in a galaxy (Knapen et al., 2000; Benedict et al., 2002). Under the influence of a bar, gas can be channelled inwards along narrow ridges where shocks develop in the gas flow. We observe these shocks as dark dustlanes along the length of the bar, as can be seen in Figure 1, a real-colour image of the spiral galaxy NGC 4321, perhaps better known as Messier 100. The presence of the bar can set up resonances in the disk. At the location of these resonances, gas experiences no net torque, and hence can accumulate, forming a ring. Through gravitational instabilities or shocks in the gas, star formation can be triggered, and the result is a brightly star-forming nuclear ring, such as we see in M100 (Figure 1). Nuclear rings exist in some 20% of local spiral galaxies (Knapen, 2005). The process of massive star formation in these rings transforms inflowing disk gas into stars, and can thus contribute to the growth of the bulge, assisting the secular evolution of its host galaxy (Kormendy & Kennicutt, 2004).

Most of what is known about the dynamical origin and evolution of these rings stems from detailed numerical modelling, confirmed on the observational side mainly from the gas kinematics. Two-dimensional kinematics of the stars from actual observations are mostly lacking, but are needed to provide essential constraints on the theoretical models. In addition, detailed spectroscopic studies of the stellar populations in the rings are rare, but needed to confirm the detailed mechanism leading from inflowing gas to star formation.

Observations and Data Reduction

We have observed the nearby spiral galaxy M100 with the SAURON integral field unit (Bacon et al., 2001) on the WHT to help rectify this situation. SAURON boasts a relatively large field of view of 33×41 arcsec, and by using 3 pointings mosaiced together we have covered the ring and bar region of M100 (Figure 1). SAURON has a wavelength range of 4760–5350Å, which contains the Hβ and [OIII] emission lines from which we can measure the gas kinematics, and the Hβ and Mg*b* absorption lines to measure the stellar kinematics.

The data were reduced using the specially developed `XSauron` software (Bacon et al., 2001) and were spatially binned to a constant signal to noise ratios of 10 for the gas and 60 for the stars (using the Voronoi 2D binning method of Cappellari & Copin, 2003). To extract the kinematics, we have made use of the Penalized Pixel Fitting method (PPXF) of Cappellari & Emsellem (2004). This method fits the galactic spectrum to a stellar template library (Vazdekis, 1999) while convolving with a line of sight velocity distribution (LOSVD). We fit the LOSVD with a modified Gaussian and from this we derive the stellar kinematics. With this technique we can successfully separate the stellar and gas components in the individual spectra. To measure the gas kinematics we fit individual Gaussians to the emission lines. Using the PPXF method it is also possible to measure emission and absorption line strengths.

Results

We present here some of the most salient results from our analysis (see also Allard et al., 2005).

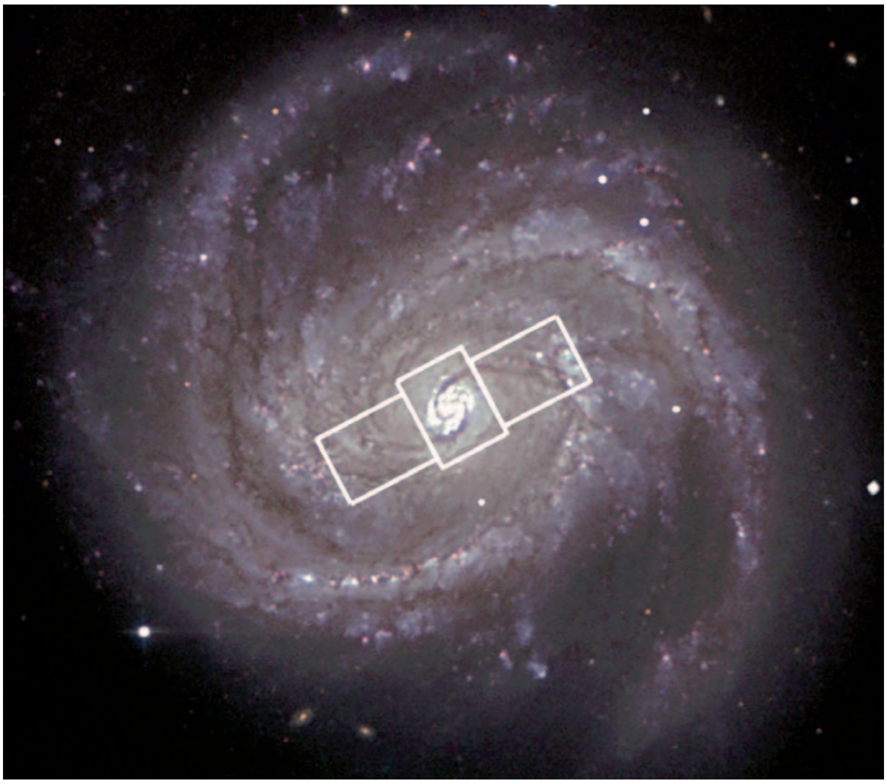

Figure 1. Optical image of M100 (courtesy of Nik Szymanek) showing the location of the three SAURON fields. Our fields span the complete bar, while the nuclear ring is contained within the central pointing. All images shown in this paper are orientated North up, and East to the left. Reproduced with permission from Allard et al. (2005).

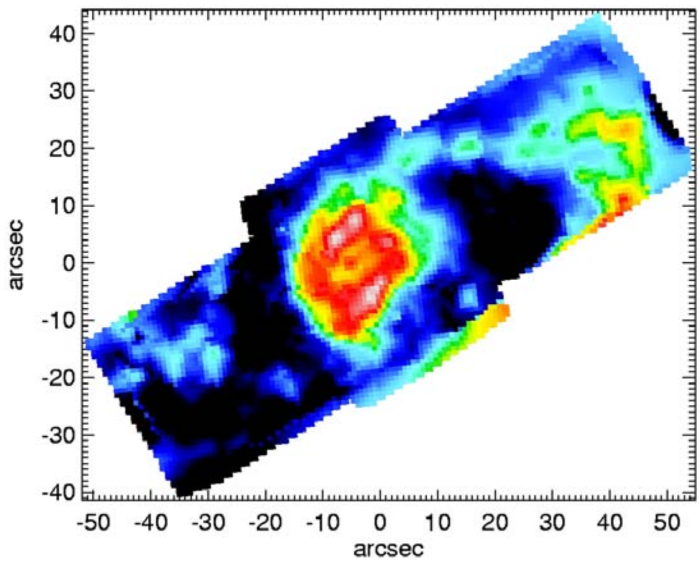

Figure 2. Hβ emission across the field. Reproduced with permission from Allard et al. (2005).

Firstly, we describe the Hβ emission across the field (Figure 2). This shows clearly the nuclear ring of star formation, connected to a cluster of HII regions at the end of the bar (at a position angle of 153°) by a thin arc of emitting material. A closer inspection of the ring reveals it to consist of four tightly wound spiral armlets (cf. Knapen et al., 1995a, b).

The gas and stellar velocity fields are presented in Figures 3 and 4. The stellar kinematics probe the underlying gravitational potential while the gas kinematics probe the response of the gas to this potential. The gas velocity field (Figure 3) shows strong deviations from circular motion, evident from the twists and wiggles in the velocity contours near the centre of the galaxy (previously seen in the Hα velocity field, Knapen et al., 2000). These deviations are interpreted as a combination of two effects: streaming motions due to a spiral density wave and streaming due to the bar.

The stellar velocity field (Figure 4) shows predominantly circular motion, although some indication of non-circular motions is present along the minor axis of the bar, at the location of the nuclear ring. This may either be due to the stellar orbits being affected by the injection of gas into the region, or to young stars having similar kinematics to their parent gas cloud. As our stellar kinematics are derived from stellar absorption features, strongest in older stars, the former explanation is more plausible.

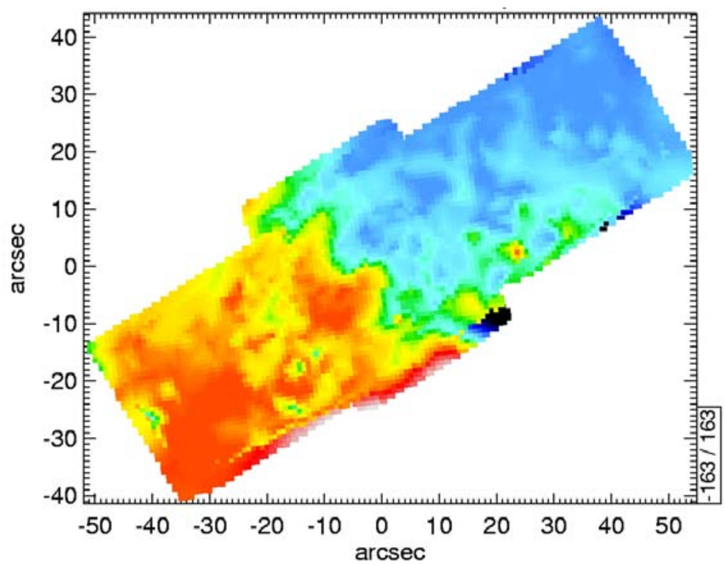

Figure 3. Mean gas velocity field. Red and blue indicate redshifted and blueshifted material. The minimum and maximum values are quoted in the bottom right box.

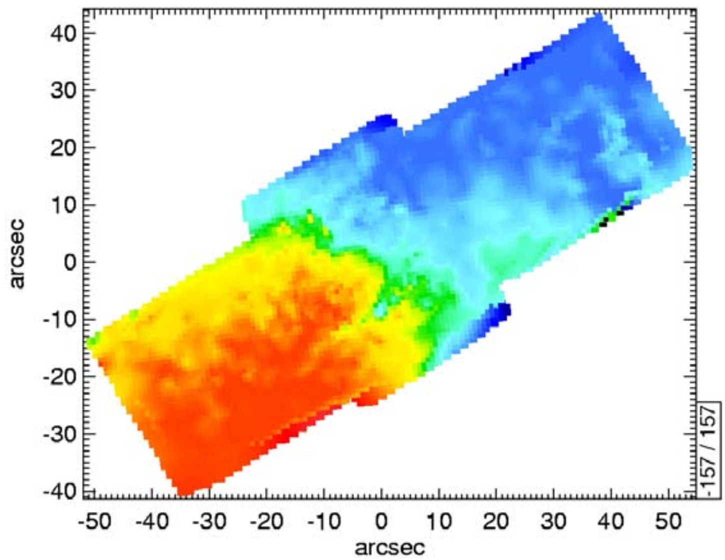

Figure 4. As Figure 3, now for the mean stellar velocity field.

Relatively Cool Gas from which Stars Form

We also present here the gas velocity dispersion across the field (Figure 5). This shows a high central value of around 130 km/s, and a much lower value of around 60 km/s in a ring around the centre. We have overlaid Hβ emission contours over the dispersion map to show that this low dispersion material lies at the exact location of the star forming ring. The low gas dispersion at the location of the ring is further evidence of the existence of a resonance region there, specifically the pair of Inner Lindblad resonances described before (e.g., Knapen et al., 1995a). Cold gas is very unstable to star formation, and we are detecting here the cold gas from which the massive stars form.

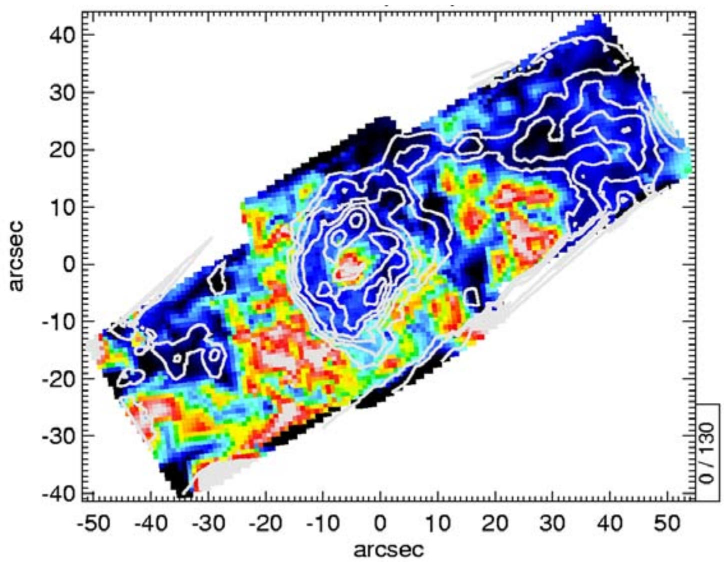

Figure 5. Gas velocity dispersion across the field. Overlaid are Hβ emission contours indicating the location of the ring. Values are in km/s with red and blue colours representing high and low values respectively. Reproduced with permission from Allard et al. (2005).

The relatively low dispersion gas is also spatially correlated with Hβ emission at other locations, such as in the HII regions at the end of the bar and along the thin arc connecting these with the ring. This confirms that the origin of the cold gas is further out in the disk of the galaxy, and that it is being driven inwards along the dustlanes in the bar, where it finally accumulates in a ring (Allard et al., 2005).

The Hβ emission appears to follow the curved dustlanes, as can be seen in

Figure 1, so to investigate any spatial correlation between the two we have overlaid Hβ emission contours onto a *B–R* colour image (Figure 6). There is a clear offset between the dustlanes and the star formation of around 700 pc. At the location of the shocks we expect strong shear, and so star formation will be prevented. Immediately downstream from the shock, however, the piling up of gas allows material to cool and acquire lower velocity dispersion, and star formation can be triggered.

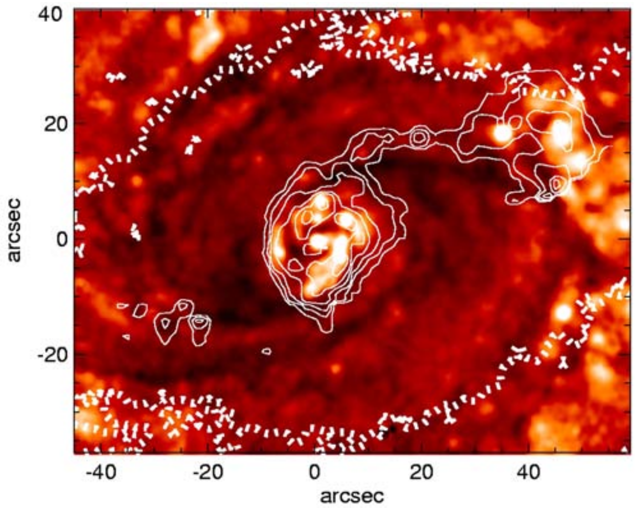

Figure 6. B–R image of M100. Overlaid are Hβ emission contours (thin white line), and a K_S-band contour outlining the bar (white dashed line). Reproduced with permission from Allard et al. (2005).

Summary

The results presented here support the theoretical picture in which star formation at the centres of spiral galaxies is brought about by the injection of gas into the area through shocks (manifested as dustlanes), and the creation of rings in the presence of resonances. Our SAURON data have allowed an unprecedented view of the two-dimensional relationships between the different gas and stellar tracers. Further results from our analysis will be published in a forthcoming paper (Allard, Knapen & Peletier, in preparation). ¤

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TELESCOPES AND INSTRUMENTATION

Progress on the GLAS Rayleigh Laser Beacon System for the William Herschel Telescope

René G. M. Rutten (ING) and Gordon Talbot (ING)

Adaptive Optics (AO) has been central to the development strategy of the WHT. The generally good seeing conditions make the site very attractive for AO exploitation and has the potential to offer major new advantages for astronomy. The higher spatial resolution achieved through AO has the obvious advantage of distinguishing finer structure and avoiding source confusion in dense fields.

Existing AO instrumentation at the WHT, NAOMI, is located in a purpose built enclosure occupying one of the Nasmyth foci. Science instruments include a 1024 by 1024 pixel HgCdTl infra-red camera, INGRID, an optical integral field spectrograph, OASIS, and a coronagraph unit, OSCA. In particular the OASIS spectrograph offers unique capability, and for that reason the focus of AO science exploitation lies in the wavelength range of 0.6 to 1.0 micron.

Although natural guide star operation of the NAOMI AO system is now well established, the limited sky coverage for higher order AO operation has proven a serious limiting factor in its science use. For that reason in 2004 a project was embarked upon to develop a facility class general purpose Rayleigh laser beacon system. The

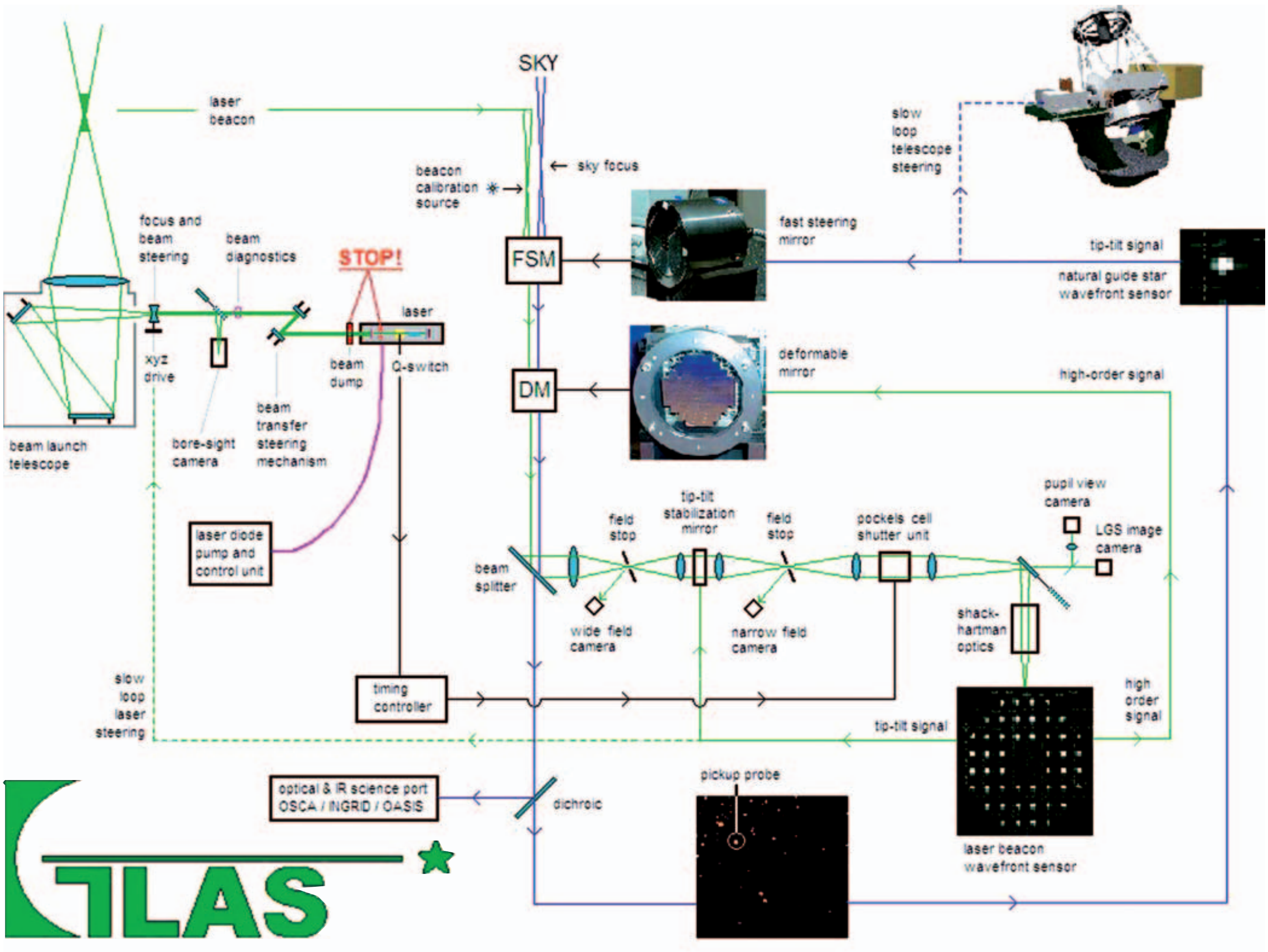

Figure 1. GLAS system diagram.

project acronym, GLAS, stands for Ground-layer Laser Adaptive optics System. The overall scientific aim of the GLAS project is to drastically improve the sky coverage for high-order AO. In order to provide the enhanced scientific capability on the shortest possible timescale, the GLAS system will be kept relatively simple and use existing commercial laser technology, without compromising the quality of engineering or safety aspects.

GLAS is a project led by ING, in collaboration with groups at the University of Durham, Leiden Observatory, the ASTRON institute, and the IAC. Without the enthusiastic collaboration of many people at these institutes, GLAS would no be feasible. The project was made possible through a grant from the Netherlands Organisation for Scientific Research, NWO. This paper gives a brief overview of the status of the project.

The practical challenge of GLAS is to project a bright laser beam to an altitude of 20 km above the observatory, bringing it to a sharp focus, and use the Rayleigh back scattered return signal for sensing atmospheric turbulence. To implement a Rayleigh laser beacon system with the existing AO instrumentation suite three main components have to be built in addition to the existing AO system:

(i) a laser unit and laser beam relay system leading the laser light to behind the WHT secondary mirror,
(ii) a beam projection telescope that will be mounted behind the secondary mirror, and
(iii) a laser beacon wavefront sensor system.

Real-time control software and user interface software must pull the components together into a working system. Much attention will also be paid to safety aspects and to avoid the laser light from interfering with other telescopes at the observatory.

A top-level system overview of the full AO and laser system, with the main interactions and feedback loops indicated, is shown in Figure 1.

The laser unit will be located at the top of the WHT in a temperature controlled and gravitationally stabilised unit (see Figure 2). The laser beam, once directed to the beam launch telescope behind the WHT secondary mirror, will be expanded to 35 cm and leave the dome, to be focussed to a spot about 10 cm wide at a distance of 20 km.

The choice of laser wavelength is defined primarily by availability of suitable solid-state lasers. The ability to provide a small spot in the sky is intimately linked to the laser beam quality. In particular the output beam should have a stable, uniform, Gaussian intensity profile. Combining beam quality with high power output is only found in few commercially available lasers (within the cost envelope allowed by the GLAS project). For GLAS a pulsed Yb:YAG laser has been sourced that delivers a rather unique combination of high power output and excellent beam quality. This so called disk laser employs novel techniques for laser pumping and temperature stability of the lasing medium that is essential in delivering the beam quality and power. Its bright 400 ns pulses running at 5000 Hz will carry a total output power of 30 W at a wavelength of 515 nm.

Rayleigh back scattered laser light seen by the WHT and entering the Nasmyth focus is picked up by a 15 nm narrow band notch filter. This filter is the only additional optical component in the science beam when observing in laser guide star mode. Of course the spectral band in the immediate vicinity of the laser wavelength cannot be exploited for science observations (see Figure 5). But as the scientific advantages for AO exploitation fall primarily at longer wavelengths this limitation is not considered critical. Moreover, GLAS will be engineered in such a way that AO operation without the laser will still be possible.

The back scattered laser light will return from the whole of the atmosphere. In order to produce a tight spot for the purpose of wavefront sensing a fast shuttering system is used that will admit back scattered light to enter a very brief period after the laser pulse went out. That way only light returning from a certain distance in the atmosphere set by the light travel time, will enter the wavefront sensor. The shutter will be based on Pockels cells, whose open and closed state will be set by a fast timer unit that will provide a time delay of some 130 μs between the laser pulse leaving the dome, and the backscattered light returning from 20 km. The resulting brightness of the laser beacon equates to a star of about 9.5 mag.

Once having traversed the shutter light will enter a standard Shack-Hartmann wavefront sensor with 8×8 elements sampling the telescope pupil, using a standard high speed CCD detector. The signals from this wavefront sensor will be fed back to the deformable mirror at a rate of about 300 Hz.

A laser guide star AO system still requires a natural guide star for sensing the tip-tilt component of atmospheric turbulence. Since the laser light passes essentially the same atmospheric turbulence on the upward and downward pass, the return beam does not carry accurate information of the wavefront tilt induced by the atmosphere as starlight from infinity would experience. The availability of such natural tip-tilt stars still poses a limiting factor on sky coverage. But this limitation is much reduced from the case of normal AO as the star can be much fainter and is allowed to be much further away from the science object. Also if the science object itself

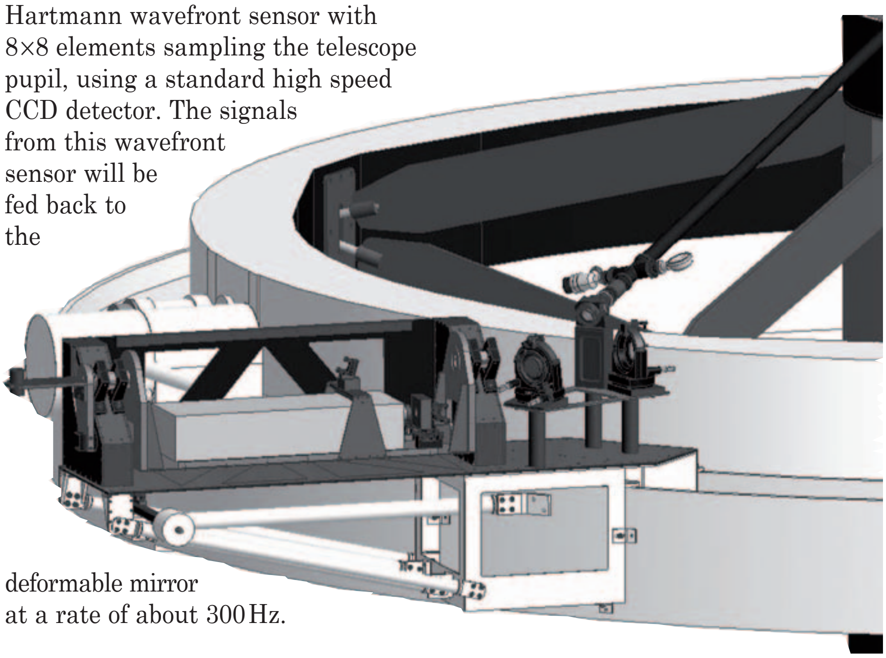

Figure 2. Engineering drawing of the laser cradle, attached to the top ring of the WHT. The laser beam will pass from this cradle to the projection telescope behind the secondary mirror through an evacuated pipe. The full light path will be enclosed for safety reasons and to reduce light and thermal polution.

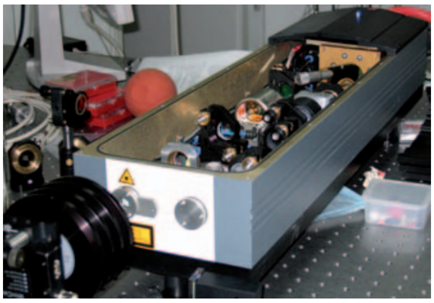

Figure 3. The GLAS laser unit.

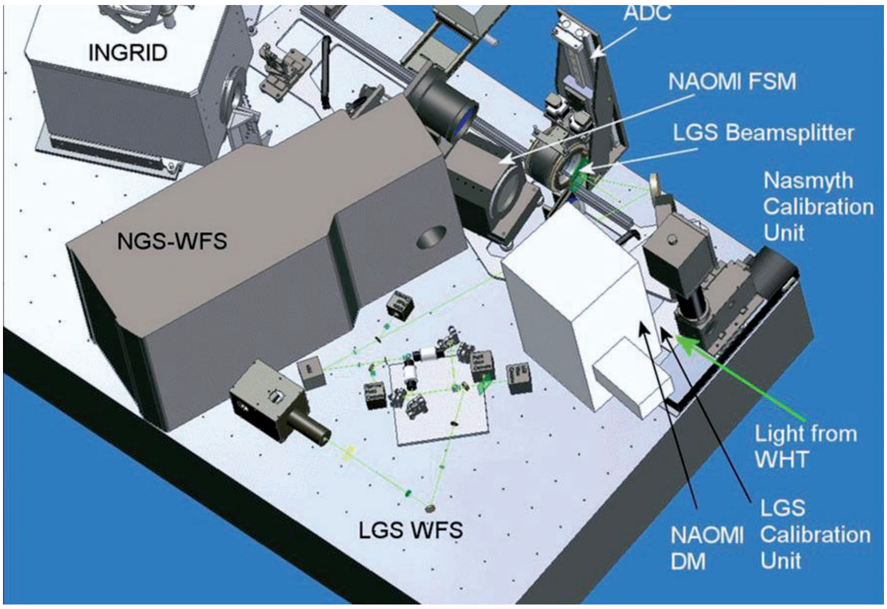

Figure 4. Laser wavefront sensor on the NAOMI optical bench layout.

is bright enough to serve as tilt reference source then of course a separate star will not be required. The GLAS system will accommodate moderately extended sources such as galaxy cores for this purpose.

The resulting sky coverage will depend primarily on the chance to find a bright enough star for tip-tilt sensing. Under nominal operating conditions a star as faint as R=18 should suffice for closed loop tip-tilt sensing at 100 Hz. As for such faint signals detector read noise poses an important limiting factor, we have opted for a low light level CCD which through on-chip signal amplification achieves sub-electron read noise. The unvignetted search field is 2 arcmin. While in the case of natural guide star AO sky coverage is of order one percent or less, the GLAS system will give nearly 100% sky coverage up to a galactic latitude of 40º, tailing off to 50% coverage at the Galactic Pole. Note that the exact values will depend on the passband used for OASIS observations, as OASIS competes with the tip-tilt sensor for the visible wave band, and on the exposure time for tip-tilt sensing.

The AO correction that will be achieved will be moderate in terms of Strehl ratio, but scientifically very attractive in terms of improved FWHM. Extensive modelling has been carried out to understand the anticipated system performance. Table 1 gives a few of the key results from model calculations based on a laser beacon at an altitude of 20 km and a natural tip-tilt star of R=17. The model includes representations of the atmosphere, telescope, laser guide star and the AO sub-systems. Performance predictions were calculated using end-to-end Monte-Carlo simulation software developed by Richard Wilson (Durham University).

The results summarised in Table 1 reflect a realistic range of seeing conditions on La Palma where median seeing is 0.69 arcsec. Calculations were done for the atmospheric turbulence ("Fried-") parameter r_0 values of 0.11 m, 0.14 m and 0.19 m, specified at 500 nm, corresponding to natural seeing at 550 nm of 0.90 arcsec, 0.69 arcsec and 0.50 arcsec respectively. Image FWHM were assessed at four wavebands: R (650 nm), I (850 nm), J (1250 nm), and H (1650 nm). Table 1 presents the FWHM values for the various combinations of r_0 and filter, for the case of a natural guide star on-axis, and 1 arcmin off-axis, covering the full range of operation. It should be noted that the results are based on statistical analysis and are therefore not exact. For reference, λ/D as a measure of the diffraction limit is shown as well.

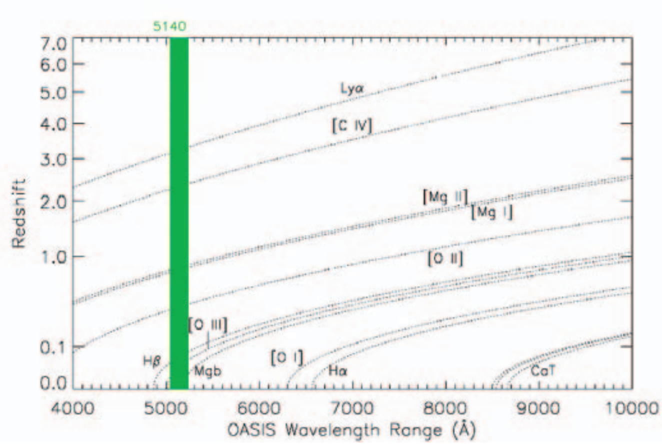

Figure 5. Diagram showing the impact of the laser notch filter on important spectral lines as a function of redshift.

	r_0	R	I	J	H
Natural tip-tilt star on-axis	0.19	0.12	0.09	0.09	0.10
	0.14	0.27	0.17	0.13	0.12
	0.11	0.41	0.29	0.18	0.16
Natural tip-tilt star 1' off-axis	0.19	0.18	0.14	0.13	0.12
	0.14	0.31	0.24	0.19	0.16
	0.11	0.45	0.35	0.24	0.20
λ/D		0.03	0.04	0.06	0.08

Table 1. GLAS performance expectations. FWHM in arcseconds for different values of r_0 and wavebands.

In summary, the on-axis models predict near diffraction limited performance in the J and H bands for good seeing conditions. At shorter wavelengths the diffraction limit will not be reached, but there will be a very attractive improvement in the delivered point spread function. It should be noted that any source as faint as R=17, and possibly even fainter, may serve as a self-referencing tip-tilt source. Hence for any such point source good AO correction will be obtained. For fainter science targets or diffuse sources an off-axis natural guide star is required, causing some degradation of AO performance.

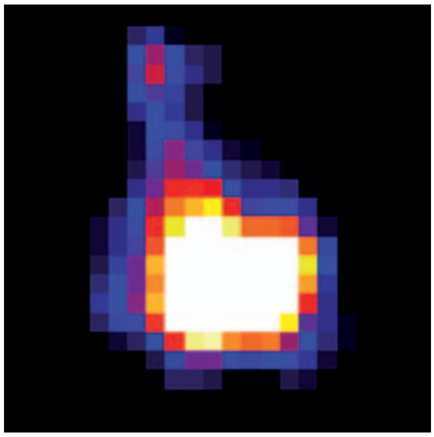

Figure 6. AO corrected I-band image of a bright 0.22 arcsec binary obtained with OASIS and NAOMI during excellent seeing conditions.

Over the typical OASIS field of view the PSF uniformity will be excellent. For the INGRID IR camera, with its 40 arcsec field of view, however, there will be a noticeable field dependence from centre to edge of about 15% in FWHM.

How realistic these performance predictions are is maybe best underlined by Figure 6, showing a NAOMI+OASIS I-band exposure of a close 0.22 arcsec binary. During excellent seeing, a FWHM of 0.1 arcsec was obtained.

Based on the La Palma seeing statistics we anticipate that suitable seeing conditions for general AO and laser beacon operation will exist about 75% of the available observing time. Periods for which ground layer turbulence dominates, and hence will be especially suitable for GLAS, occur about 25% of the time.

If all goes well, by the end of 2006 the GLAS laser system should be up-and-running. It will drastically improve sky coverage and thus boost the science use of adaptive optics. AO performance will provide attractive image quality improvement at visible wavelengths and close to diffraction limited performance in the infra-red. The GLAS laser beacon will therefore be crucial in opening new avenues for spectroscopic surveys at spatial resolutions that are considerably better than offered under natural seeing conditions.

Last but not least, the work on GLAS to date has been the effort of many people, including from the participating institutes: Don Carlos Abrams, Nikolaos Apostolakos, Richard Bassom, Chris Benn, Maarten Blanken, Diego Cano, Alan Chopping, Kevin Dee, Nigel Dipper, Eddy Elswijk, David González, Tom Gregory, Rik ter Horst, Ron Humpfreys, Jan Idserda, Paul Jolley, Sjouke Kuindersma, Juan Martínez, Richard McDermid, Tim Morris, Richard Myers, Sergio Picó, Renee Pit, Johan Pragt, Simon Rees, Jürg Rey, Servando Rodríguez, Ton Schoenmaker, Jure Skvarc, Remko Stuik, Niels Tromp, Simon Tulloch, Auke Veninga, Richard Wilson (and now just hope we have not forgotten anyone!). ¤

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CIRPASS on the William Herschel Telescope: Measuring the Global Star Formation Rate Over Most of History

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An issue which has tantalised high-redshift observers for the past decade is the star formation history of the Universe. Essentially, we want to determine the epoch when majority of stars formed. Since the legendary (perhaps notorious) "Madau-Lilly" diagram first appeared in the mid-1990s (Madau et al., 1996, Lilly et al., 1996; Pei & Fall, 1995) astronomers have puzzled over measuring the total star formation rate density over the history of the Universe. It has long been established that at modest redshifts ($z \approx 0.5$–1) the Universe was forming stars much more rapidly than today, perhaps even ten times as fast. However, the behaviour at redshifts beyond one has caused much consternation in the community, with various groups claiming declining/constant/rising star formation density. Even at redshifts 1–2 (our own backyard by current standards when we are routinely discovering galaxies at redshift 6) there is still an order of magnitude uncertainty in the global star formation rate (see Hopkins et al., 2001, 2005 for a recent compilation of measurements). The probable reasons for this embarrassingly large scatter in measurements are a combination of different diagnostics of star formation rate (with uncertain relative calibration) and the insidious effect of dust obscuration, which tends to hit the rest-frame UV particularly hard —a measure used at higher redshifts, where it is measured from optical photometry.

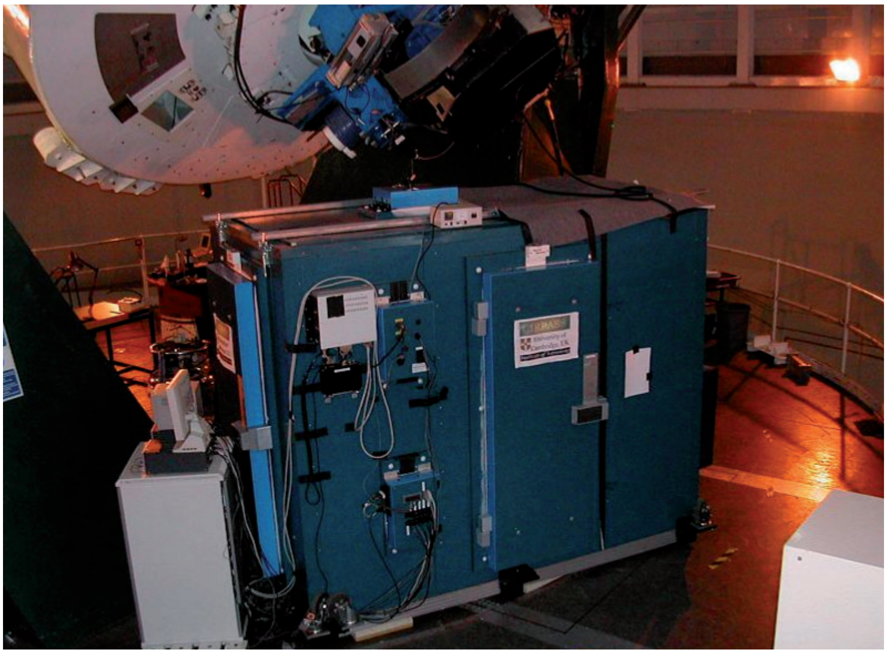

Figure 1. The CIRPASS spectrograph enclosure on the azimuth platform of the WHT.

Clearly, the star formation history determinations so far have been a bit of a mess. To make a fair comparison, we need to use the same reliable instantaneous tracer of star formation

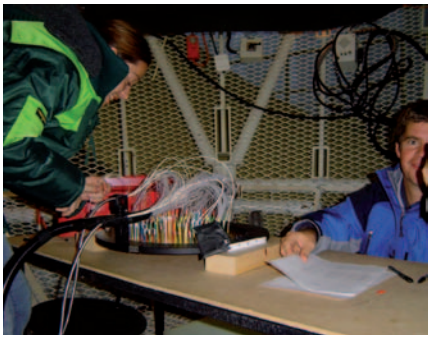

Figure 2. Fibering up a plug plate.

at high redshift as locally. The Hα emission line, used in surveys of star formation at low redshift, is eminently suitable as it is relatively immune to metallicity effects and is much less susceptible to extinction by dust than the rest-UV continuum and Lyman α (which is a particularly bad indicator as it is resonantly absorbed). However, tracing Hα to early epochs forces a move to the near-IR at $z>1$. Building statistically significant Hα samples at these redshifts has been impossible until now because of the inefficiency of single-object long-slit spectroscopy.

Multi-object spectroscopy (MOS) has long been established in the optical, but is still in its infancy at infrared wavelengths. We are still a generation away from IR-MOS instruments on the 8-m class telescopes, but this technology has already been successfully demonstrated on the WHT with the visiting instrument, CIRPASS. This is the "Cambridge Infra-Red Panoramic Survey Spectrograph" (Parry et al., 2004), built by the Institute of Astronomy, Cambridge with the support of PPARC and the Sackler Foundation. CIRPASS works in the *J*- and *H*-bands, at wavelengths 1–1.8 µm.

CIRPASS is a fibre-fed spectrograph with a Hawaii 2k Rockwell array. The whole instrument sits in a refrigerated cold room at –42°C (a commercial cold meat locker, which greatly reduced costs) which is free-standing on the dome floor (Fig. 1). This makes the spectrograph inherently stable. The flexibility of such a fibre fed instrument has allowed CIRPASS to be used with telescope as diverse as an 8-inch reflector in the grounds of the IoA in Cambridge, and the 8-m Gemini South telescope in Chile where we pioneered integral field "3D" spectroscopy in the infrared (Metcalf et al., 2004; Smith et al., 2004; de Grijs et al., 2004).

The WHT has an unvignetted field of 15 arcminutes at the Cassegrain focus, and we used CIRPASS with 150 fibres which could be deployed over that field on individual galaxies. In fact, we allocated half the fibres to sky to improve background subtraction. Our science goal was to measure the Hα emission from galaxies at z=0.7–1.0, redshifted to the *J*-band at ≈1.2µm.

We used a plug plate system (the old AAT FOCAP); while outdated by the standards of modern robot fibering systems such as the WHT's own Auto-Fib, 2dF at the AAT or the Echidna system soon to be deployed with FMOS at Subaru, our army of graduate student and postdoc "plate pluggers" (Fig. 2) had lower running costs (and marginally better break-down rates) than most robots. In practice, we only attempted two fields per night, so the 45 min refibering represented a <10% overhead.

We spent Christmas 2003 on La Palma. Our Christmas list included a sample of galaxies from the Hubble Deep Field North redshift survey of Cohen et al. (2000). We successfully detected Hα in several of these (Doherty et al., 2004, Fig. 3). We believe this to be the first published demonstration of IR MOS on high redshift galaxies.

With CIRPASS, we were able to detect Hα to 10^{-16} ergs cm^{-2} s^{-1} at 5σ in three hours, corresponding to a star formation rate (SFR) of 5M$_{\odot}$ yr^{-1} at z~1, comparable to that of the Milky Way today. Over the 2003 run, and another run in October 2004, we have targeted ~200 galaxies in three field —an order of magnitude more than previously attempted with IR spectroscopy (Glazebrook et al., 1999; Tresse et al., 2002). We have been able to determine the total star formation rate density at z ~1 (Michelle Doherty's PhD at the IoA, Fig. 4). We find that rest-UV studies underestimate this by about a factor of 3 (Doherty et al., in preparation).

What is the future for such work? We have set the scene for the FMOS instrument on Subaru (Lewis et al., 2003), which is partly based on the CIRPASS design and will explore large samples of star-forming galaxies at these redshifts down to faint luminosities. Both FMOS and CIRPASS are limited to wavelengths shorter than 1.8µm, but new instruments such as LIRIS on WHT (Manchado et al., 1998) have a multi-object capability in the *K*-band. This will enable us to chase Hα out to z=2.5. Monitoring other emission lines such as Hβ, [OIII] and [OII] also

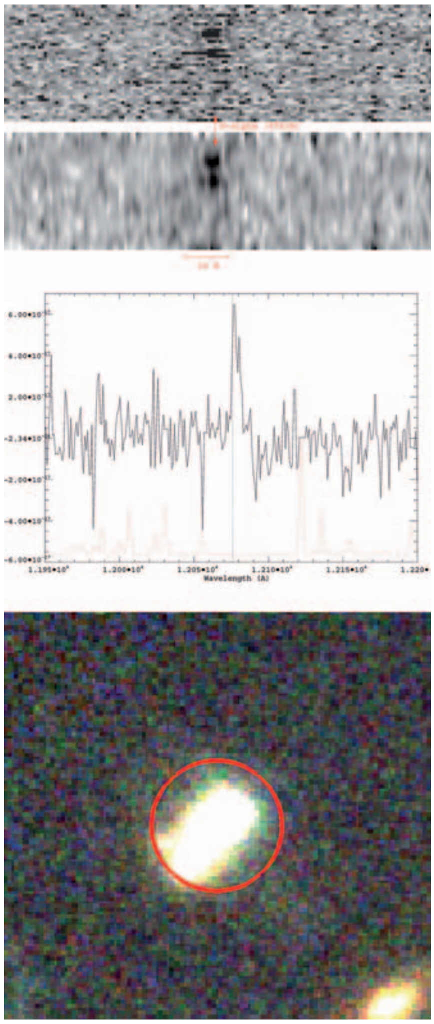

Figure 3. 2D spectrum for the full HDF sample of 62 objects, each shifted back to the rest-frame. Rows containing spectra of objects with $z_{H\alpha}$<0.768 have been masked out. Hα is clearly visible as a line in the 2D frame (top). The bottom frame has been gaussian smoothed by σ=2 fibres (in y) and 0.1Å (in x) to bring out this feature. An example spectrum and the three colour (BRI) HST composite is shown overlayed with the CIRPASS fibre.

give us a handle on the dust extinction and metallicity in distant galaxies.

We have taken the first few steps towards a coherent, self-consistent picture of the evolution of the star formation rate density, measuring Hα from galaxies that existed when the Universe was half its current age. New instrumentation offers the exciting prospect of mapping similar galaxies even further back in time, and lifting the veil on obscured star formation in the early Universe. ¤

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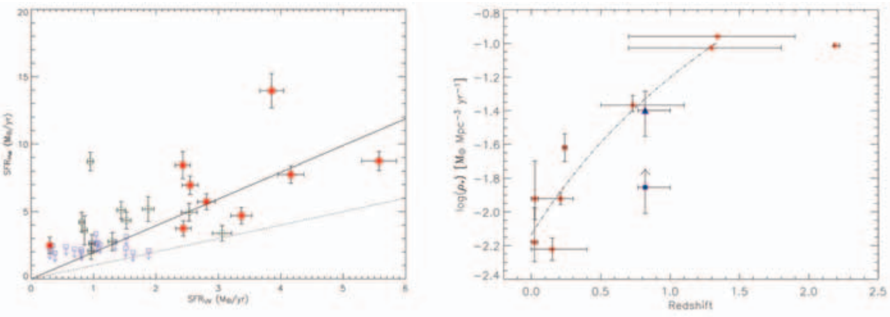

Figure 4. Left: Comparison of SFRs obtained from UV continuum flux at 2400Å versus Hα flux for the individual galaxies. The SFRs derived from UV luminosity are consistently underestimated. The filled circles are the robust detections, the open circles are greater than 3σ and the squares are 3σ upper limits. The solid line has a gradient of 1.98 and represents the line of best fit to the data (using a least squares fit, through zero). The dotted line is the line of zero extinction i.e. where SFR(Hα)= SFR(UV). Right: Evolution of the star formation rate density using SFRDs determined from Hα measurements only, with no reddening corrections. Red circles are points taken from the literature, converted to a Λ-CDM cosmology. Overlaid is our lower limit (blue square) to the SFRD, and our estimate including luminosity bias and aperture corrections (blue triangle).

Pyramid Wavefront Sensor at the William Herschel Telescope: Towards Extremely Large Telescopes

S. Esposito, E. Pinna, A. Tozzi, A. Puglisi and P. Stefanini (INAF — Osservatorio Astrofisico di Arcetri, Italy)

The major technological challenge for optical astronomy in the near future is surely the design and realisation of so called Extremely Large Telescopes (ELT) (Gilmozzi, 2004; Nelson, 2000). These instruments, having a diameter in the range of 30–100 meters, will have primary and even secondary mirrors made up of segments (Andersen, 2003; Dierickx, 2004). These telescopes are supposed to work most of the time using Adaptive Optics (AO) to correct for atmospheric turbulence perturbations, achieving a previously unobtainable angular resolution of 1 milliarcsecond in the *V* band. To achieve this spectacular performance the mirror segments need to be co-phased, thus acting as a monolithic mirror (Chanan, 1999). Phasing the segmented primary mirror is a key activity at the Keck 10-meter optical telescope. At Keck two different sensors are successfully used for phasing (differential piston correction) and alignment (tip-tilt correction) (Chanan, 2000). This process is done before the observations as part of the telescope optical alignment. Then the primary is kept stable in the correct configuration using capacitive sensors built into the segments. Given the importance of this alignment and co-phasing issue several groups have started working on the subject in Europe (Schumaker, 2001; Yaitskova, 2005; Gonté, 2004).

The Arcetri AO group showed in 2001, using numerical simulation, that the pyramid WFS is able to do phasing and alignment of the mirror segments at the same time (Esposito, 2002). In the period 2000–2004 the AO group developed this concept, and have built a lab prototype of the pyramid co-phasing sensor.

Briefly the Pyramid wavefront sensor has been introduced by R. Ragazzoni in 1996 as a modification of the well known Foucault test for optical shop testing (Ragazzoni, 1996). To use it in AO, where X and Y derivatives of the wavefront have to be measured simultaneously, the knife edge is replaced with a refractive pyramid that provides four edges. This WFS is actually working at the TNG telescope (Ragazzoni, 2002) and will be part of the first light AO system of the LBT (Esposito, 2004).

A unique opportunity to calibrate and test our prototype of a co-phasing sensor (PWFS) in the lab and on the sky has been provided by the WHT and its AO system NAOMI. This is because the NAOMI deformable mirror is a segmented mirror with 72 segments controllable in piston, tip and tilt. The AO system location on the Nasmyth platform allows a simple integration of the PWFS board in the AO system optical train. In direct collaboration with the WHT staff, the PWFS board has been installed and operated twice at the WHT in November 2004 and July 2005. Results achieved during the first run are in publication in an *Optics Letters* paper (Esposito, 2005) and demonstrated for the first time that the PWFS can control piston, tip and tilt of the segments achieving a mirror flatness of 10 nm rms (see Figure 1). This performance was obtained using the calibration source of NAOMI.

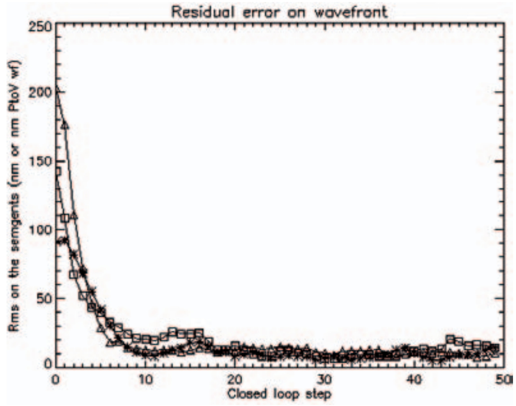

Figure 1. An example of mirror phasing and alignment taken from the July 2005 run. The plot reports piston (asterisk), tip-tilt rms on the 13 controlled segments of the NAOMI DM during the close loop operation. Mirror flatness achieved is about 5 nm and 10 nm for piston and tip & tilt respectively.

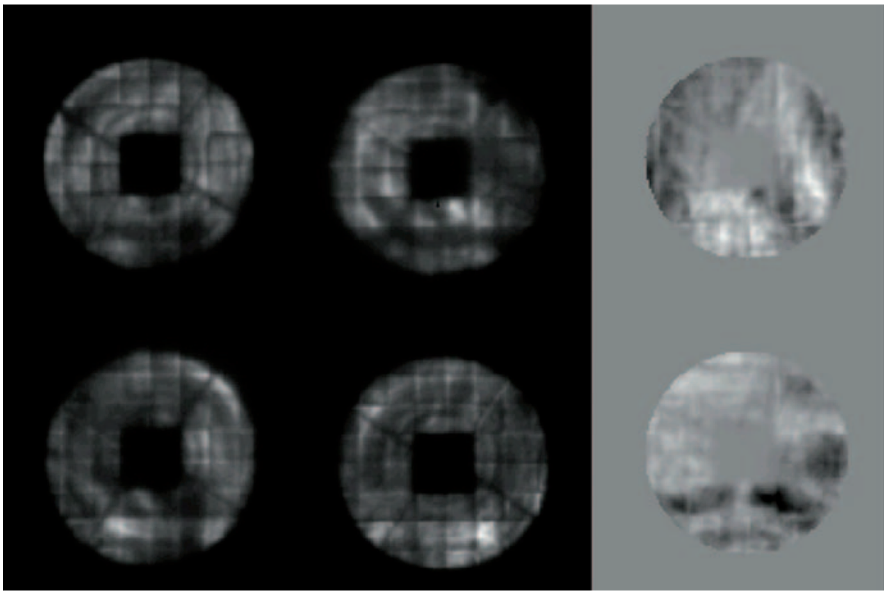

Figure 2. Left: the pupil of the WHT as seen from the PWFS pointing a natural guide star. Right: the X and Y signals obtained from this frame.

The ultimate goal of the experiment is to demonstrate the ability of phasing and aligning the mirror segments using a natural guide star in the sky. In the run last July the system was ready to start the sky test but bad weather allowed only 2 hours of observations. Nevertheless some parts of the wavefront sensing system have been successfully checked and we have achieved the first sky images with the PWFS (see Figure 2). A sample of these long exposure images is reported below. A next run should take place in April 2006 and we strongly believe that we can show that a single wavefront sensor can perform on sky co-phasing and segment alignment.

As a final remark we note that the PWFS configuration is the same for co-phasing and AO so that the same WFS can drive at the same time the AO loop and the segment control. This approach, if demonstrated, would provide the most effective solution in achieving the theoretical performance of ELTs needed for a long list of challenging observations in future astronomy. ¤

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ING User Questionnaire — Summary of the Results

René G. M. Rutten (ING)

Earlier this year a questionnaire was issued to our community of telescope users with a number of questions regarding the current and future use of the telescopes. Many responses were received and these are of great value to the observatory and have served as input to the International Review of the ING that was held in July of this year. The tables and diagrams below capture some of the information received in statistical form and give a flavour of what has been the outcome of the questionnaire.

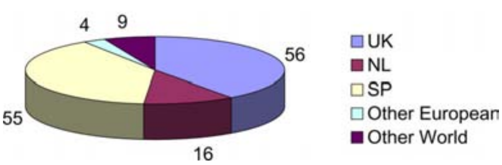
To pick just a few highlights: ING's user community expresses a strong interest in spectroscopic tools, not only on the WHT, but also on the INT. There is a growing interest in Adaptive Optics observations. Current work-horse instruments will remain important for a number of years to come. With regards to the scientific scheduling of the telescopes many commented on the increased need for large science programmes. This is also strongly supported by the ING and new opportunities for this will be created in the near future. Another area stressed by many respondents is the importance of visiting instruments, which will remain part of ING's strategy. On the other hand, and maybe not surprisingly, there remains a diversity of interests in access to science instruments. Depending on what ING's future will bring, this may not be affordable long term. However, collaboration with other telescope groups on La Palma is actively being pursued and could well develop into an affordable model where diversity of instrumentation will remain possible, but spread over more telescopes.

These and many more results from the questionnaire will serve as a reference for the observatory for the next few years. ¤

René Rutten (rgmr@ing.iac.es)

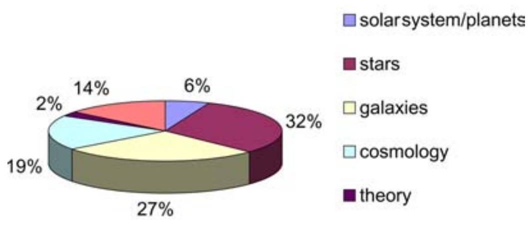
Respondents' Country of Work and Position

Country	*Permanent*	*Postdoc*	*PhD*	*Other*	***Total***
UK	39	10	3	4	**56**
NL	9	5	2	0	**16**
SP	27	15	9	4	**55**
Other European	2	1	0	1	**4**
Other World	4	4	0	1	**9**
Total	**81**	**35**	**14**	**10**	**140**



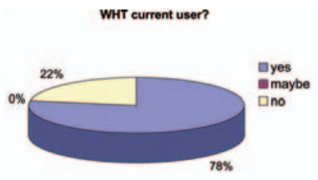
Respondents' Research Background

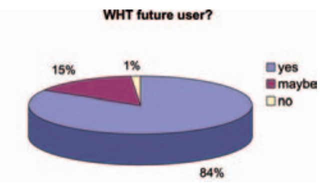
Subject	*Number*	*%*
Solar System/Planets	15	6
Stars	75	31
Galaxies	66	27
Cosmology	45	19
Theory	6	2
Instrumentation	34	14
Total	**241**	**100.0**



Current and Future User of WHT

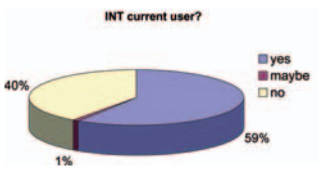
	Yes (%)	*Maybe (%)*	*No (%)*
WHT current user	78	0	22
WHT future user	84	15	1

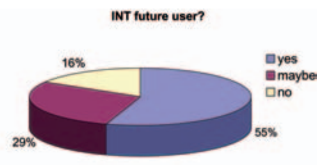




Current and Future User of INT

	Yes (%)	*Maybe (%)*	*No (%)*
INT current user	59	1	40
INT future user	55	29	16





Instrument Interests

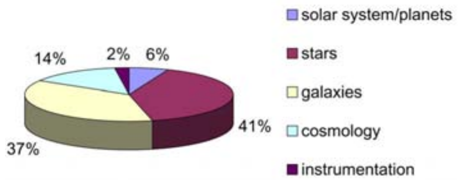
Instrument Type	*Yes (%)*	*Neutral (%)*	*No (%)*
AO optical spectroscopy (OASIS)	36	55	9
AO NIR imaging (INGRID)	39	49	11
Optical spectroscopy (ISIS)	71	27	2
Optical multi-object spectroscopy (AF2/WYFFOS)	49	41	10
Optical imaging (PFIP)	35	52	13
NIR spectroscopy (LIRIS)	56	38	6
NIR multi-object spectroscopy (LIRIS)	37	52	11
NIR imaging (LIRIS)	39	51	11
INT wide field camera (WFC)	54	31	15

WHT New Instruments

Option	*Number*	*%*
High time resolution spectroscopy	13	12
High time resolution imaging	5	5
High resolution optical spectroscopy	21	20
Near IR spectroscopy	7	7
High resolution near IR spectroscopy	4	4
Wide field multi object optical spectroscopy	17	16
Wide field optical imaging	6	6
Wide field near IR imaging	4	4
AO imaging / spectroscopy	19	18
Other (polarimetry/thermal IR/filters/gratings/IFUs)	10	9
Total	**106**	**100**

WHT Future Research

Subject	*Number*	*%*
Solar system/planets	11	6
Stars	71	40
Galaxies	66	37
Cosmology	25	14
Instrumentation	4	2
Total	**177**	**100.0**

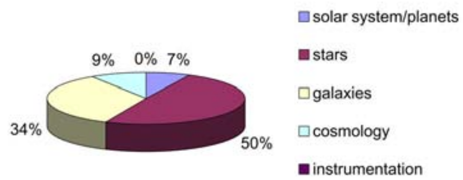


INT New Instruments

Option	*Number*	*%*
High time resolution imaging	6	9
Medium resolution optical spectroscopy	37	54
High resolution optical spectroscopy	11	16
Optical IFU spectroscopy	2	3
Near IR spectroscopy	1	1
Wide field multi object optical spectroscopy	1	1
Wide field optical imaging	6	9
Wide field near IR imaging	2	3
Other (thermal IR, visiting instruments)	2	3
Total	**68**	**100**

INT Future Research

Subject	*Number*	*%*
Solar system/planets	7	7
Stars	48	49
Galaxies	33	34
Cosmology	9	9
Instrumentation	0	0
Total	**97**	**100.0**



Service Issues

Issue	*Yes (%)*	*Neutral (%)*	*No (%)*
Support visiting instruments	74	24	2
More instrument flexibility	12	80	8
Want service/queue observing	29	32	39
Compensate for weather loss	54	29	17
Data archive important	45	32	23
Shared access with other telescopes	55	34	11
Single TAC with other telescopes	43	32	25

OTHER NEWS FROM ING

An RAS Specialist Meeting, London, 14 October 2005: "Science from La Palma — Looking Beyond 2009"

Danny Lennon (ING), Chris Evans (ING/ATC) and Janet Drew (Imperial College, London)

As discussed in the Director's opening message, the ING is reaching an important point in its history. In 2009 the international agreement setting up the Roque de los Muchachos Observatory on the island of La Palma will have been in existence for a period of 30 years. In 2007 the United Kingdom will have to make a decision on whether or not to withdraw from that agreement and PPARC, through its ownership of the Isaac Newton Group of Telescopes, has the responsibility of deciding on the UK's involvement in the observatory beyond 2009. As part of the decision making process, and in support of the UK's overall strategic re-evaluation in astronomy, the ING was reviewed during 2005. It was therefore thought timely to assess recent scientific achievements from the Roque de los Muchachos, and to consider what role the observatory might have beyond 2009. Under the auspices of the Royal Astronomical Society a Specialist Meeting was held in Burlington House, Piccadilly, London on October 14th 2005 and was attended by approximately 100 astronomers from around the UK. The meeting was structured to allow two morning sessions of science talks with contributors from various fields in astronomy, followed in the afternoon by a series of strategy talks, culminating in a half-hour discussion on the future of the ING.

Lecture theatre of the Geological Society at Burlington House, Piccadilly, London.

The morning session, chaired by Gavin Dalton (Oxford Univ.), was opened by Danny Lennon (ING) who welcomed the participants and summarised the motivation for the meeting. This was quickly followed by Peter Meikle (Imperial College) with an excellent contribution on supernova studies showing how telescopes of different aperture sizes can all contribute effectively to this field of research. Some highlights included recent results on the search for supernovae in the nuclei of starburst galaxies, and on the physics of type Ia supernovae. Mike Irwin (IoA) then reviewed the achievements of the INT in the area wide field surveys, paying particular attention to the impressive results in recent years on such topics as satellites and tidal tails in the Local Group. Jim Hough (Hertfordshire Univ.) emphasised how the low intrinsic telescope polarisation of the WHT makes it the ideal platform for his visitor instrument PLANETPOL, used in pursuit of the direct detection of the atmospheres of extrasolar planets. Tom Marsh (Warwick Univ.) brought us up to the coffee break with a review of his work using the INT and WHT to search for double degenerates, concentrating as well on the important contribution the WHT is making to Supernova Progenitor Survey in following up and characterising double degenerate systems.

Don Pollacco (QUB) chaired the post-coffee session which opened with a presentation by Mark Wilkinson (IoA) on observations of stars in Local Group dwarf spheroidal galaxies using the ING's AF2/WYFFOS instrument on the WHT, showing how their kinematics are excellent probes of dark matter properties on various scales. This was followed by two complementary contributions by Mike Merrifield (Nottingham Univ.) and Tim de Zeeuw (Leiden Univ.) on the visiting instruments, the Planetary Nebula Spectrograph (PNS) and the integral field spectrograph SAURON respectively. We saw how PNS has been used to investigate the dynamics of PNe and dark matter in the distant haloes of galaxies while SAURON has focused on the inner regions of galaxies, with additional fine scale in the nuclear regions being revealed with the ING's adaptive optics assisted integral field spectrograph OASIS. Both talks painted a very bright picture for the future of these instruments at ING. Rob Jeffries (Keele Univ.) then discussed results from the ING on binary systems among low mass stars and brown dwarfs, highlighting the high fraction of short-period binary systems found in the Sigma Orionis cluster. Vik Dhillon (Sheffield Univ.) closed the morning session with an overview of the science produced with another visitor to the WHT, the high-speed triple-beam CCD camera Ultracam, now being used to exploit the time domain in astronomy.

The afternoon strategy session, chaired by Tim de Zeeuw (Leiden Univ.), kicked off with an invited contribution from Rafael Rebolo (IAC) concerning the status and capabilities of Grantecan, Spain's 10m telescope on La Palma. Rafael emphasised the complementarity of the ING telescopes with Grantecan and Spain's very strong interest in seeing the telescopes continue beyond the 2009 watershed. This was followed by a review of the ING's current instrumentation suite and development plans by René Rutten (Director, ING). This included an overview of the Adaptive Optics and laser guide star project (GLAS) due for completion in 2006, and also introduced the idea of possible joint operations of all the night-time telescopes by a common organisation, a Common Northern Observatory (CNO), which might well be a viable path for the future. Bruno Leibundgut (ESO, ING Visiting Committee member) then gave a summary of the findings of the ING Visiting Committee, highlighting for example the strategic importance of the ING as a platform for innovative instrumentation leading campaign-style programs, its northern hemisphere location and the excellence of the site, its lead in adaptive optics, and the potential for support of space astronomy. Thijs van der Hulst (Groningen, Chairman of ING Board) re-iterated much of this in his presentation of the ING Board's view of ING beyond 2009, stating that in the Board's opinion it is vital to continue ING into the next decade and pointed out importance of getting a commitment from all three parties (PPARC, NWO and IAC) to a common policy. The meeting finished with an open discussion, chaired by Janet Drew (Imperial College), during which there was a lively discussion of the CNO idea (Johannes Andersen, NOT Director). Gerry Gilmore (IoA) emphasised that the future scientific direction of the telescopes needs to be addressed as well as these organisational issues. It was also pointed out that an important aspect of ING operations is the significant degree of hands-on participation by young astronomers in science projects. The flexibility of the ING to allow various visitor instruments access to the WHT was also praised and valued. The discussion finished with a statement by Roger Davies (Oxford Univ.) promising to bring the flavour of the meeting to the attention of PPARC's Science Committee. ¤

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ING Workshop on Adaptive-Optics Assisted Integral Field Spectroscopy

In May 2005 a three-day workshop took place on the above subject. The main reason for organising this workshop was the commissioning of the OASIS integral field spectrograph on the WHT and the latest project to augment the use of AO on the WHT with a laser beacon system. Both these developments imply major new possibilities for the use of the telescope. Moreover, the advent of the laser will allow large science programmes to be carried out and the workshop served as a forum to discuss what type of programmes would be most suitable. For these reasons it was timely to get knowledgeable people around the table to discuss the science opportunities (and difficulties) of using such complex instruments.

Group photograph of workshop participants.

About sixty participants shared their ideas and experience in this area. Many exciting results and developments were highlighted from other observatories, including Gemini, ESO-VLT, Keck, CFHT and Calar Alto. Also several ideas for large science programmes emerged at the workshop, ranging from surveys of star-forming regions, studies of stellar populations in dense clusters, through a statistical survey of the kinematics in the cores of galaxies. The ideas that were generated indicate that there is indeed much science potential to be exploited. The plan is that once the laser project on the WHT comes to fruition an announcement of opportunity for large key science programmes for the use of adaptive optics will be issued.

The proceedings of this workshop are being printed by Elsevier Publishers as a special issue of *New Astronomy Reviews*. These proceedings contain several extensive review articles as well as shorter papers on the subject. For anyone interested in this field and in understanding recent achievements as well as future prospects in AO-assisted integral field spectroscopy these proceedings will be an excellent starting point. ¤

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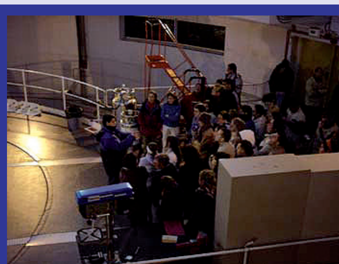
Visits to ING

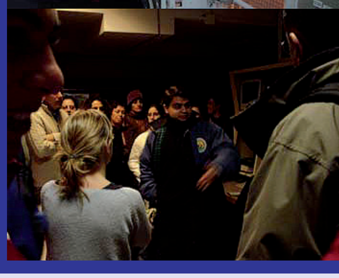
A total of 2349 visitors split in 117 tours were shown round the WHT and occasionally the INT in 2005. Visitors included Dr. Jan A. C. van de Donk, the Dutch Ministry of Education, Culture and Science and ESO Council member.

Conciding with the fiesta of La Bajada de la Virgen de Las Nieves, a new model for organising tours on Open Days to reduce the impact on the observatory operations was attempted. This time visitors had to book online their tours. The number of tours per day was reduced from 28 to 6 while increasing the total number of Open Days from 2 to 5.

Every year the people from Garafía, the municipality the observatory belongs to, are invited to visit the observatory and get together with the observatory staff for a barbecue. On 19th August another Garafía Open Day took place and 90 Garafians visited the WHT.

The participants to the astronomy course "Taller aplicado de investigación y observación astronómica en La Palma", organised by La Laguna University and the Spanish Distance Learning University (UNED), and with the collaboration of ING among others, and to the European Science and Technology Week (see accompanying photos by Luis Cuesta, IAC), also had the opportunity of visiting the WHT. Both visits received the financial support of OPTICON Public Outreach. ¤





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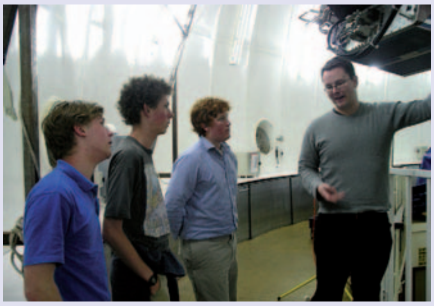
School Pupils Join Oxford Astrophysics Team for Two Nights on the Isaac Newton Telescope

C. Barcley (Marlborough College, Wiltshire)

Driving up the winding road from Santa Cruz and sighting the tiny white domes on the Roque after a year's break (a pilot visit was conducted last year) was as exciting as the first time view for the 3 school pupils from Marlborough College in Wiltshire. The two staff (both astronomy teachers) and the pupils (all astronomers aged 16, 17 and 18) were booked into the Residencia for two nights in April as part of a week's expedition to the island. Through the organisation of René Rutten (ING) and Roger Davies (Oxford University) we were able to join a research team from Oxford Astrophysics led by Matt Jarvis on the INT.

The arrangements on the Roque were superb thanks to Javier Méndez and we booked into our own apartment before visits to WHT and INT. After tours and supper we met up with the research team. Weather was not perfect as there was high cloud around, luckily this cleared and we watched a fine sunset from the INT balcony as other surrounding telescopes opened up. Using the dark Moon time, Matt and his team were searching for Lyman-α sources at redshift 3 in the Lockman hole, a dark area of sky between the 'pointers' in Ursa Major away from the Galactic Plane. The pupils were able to follow first the opening up of the telescope and priming with liquid nitrogen and then the imaging processing of flat-fielding and then to see the data acquisition using 10 to 30 minute exposures through narrow band Hα and Hβ filters and wide-band Sloan g' and r' filters and subsequent analysis using software expressly designed to weed out possible targets, which had to be done immediately given time allocation on the WHT over the next couple of days to follow up with spectra of suspected targets.

Cloud around 3 am forced an early end and a tentative drive with low lights back to the Residencia. Visits had also been arranged by Javier Méndez to Grantecan, MAGIC and the Liverpool Telescope. The Swedish Solar telescope also kindly allowed a tour, for which I am most grateful. The visit to Grantecan's new site, viewing the huge scale of the construction put the plans for a 50 m telescope (let alone a 100 m mirror) into perspective. MAGIC was just that, both architecturally beautiful and inspiring for its size and manoeuvrability. One of the pupils on return has already made MAGIC the focus for his final year physics project. A second night on the INT was even more successful and though tiredness forced a couple of early departures, the two older pupils remained until cloud stopped the observing run at 5.30 am.



Top: School pupils at the INT control room. Bottom: INT observer introduces the pupils to the Wide Field Camera.

For school pupils to visit the Roque was amazing in itself, but to have 2 nights on the INT with researchers, seeing first hand an observing run was a unique experience. We headed down to sea level tired but very grateful to Javier Méndez for his organisation and to René Rutten for the initial invitation. We very much hope to return next year. ¤

Charles Barcley (ceb@marlboroughcollege.org)

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 Danny Lennon at `djl@ing.iac.es` and visit this URL: `http://www.ing.iac.es/Astronomy/science/seminars.html`, for more details. Below the latest seminars are listed:

17 March. Lara Baldacci (Osservatorio Astronomico di Bologna), "Population of variable stars in the dwarf irregular galaxy NGC6822".

5 May. Thais Mothe Diniz (Paris Observatory, Meudon), "Asteroid Families: A new analysis".

20 June. Nic Walton (IoA, Cambridge & Astrogrid Consortium), "The AstroGrid Virtual Observatory System: Release 1.0".

8 July. Roopesh Ojha (Australia Telescope National Facility. CSIRO), "Is Scintillation the key to an improved ICRF?"

26 August. Tim Naylor (School of Physics, University of Exeter, UK), "OB associations in the era of planet formation".

7 September. Ben Davies (Dept. of Physics & Astronomy, University of Leeds, UK), "Extreme clumping in the winds of Luminous Blue Variables".

23 September. Angela Bragaglia (INAF-Osservatorio Astronomico di Bologna, Italy), " Old open clusters as tracers of galactic chemical evolution".

13 October. Jan-Erik Solheim (Institute of Theoretical Astrophysics, Oslo), "Remote observations with the NOT at the Nordic-Baltic summer school in August 2005".

24 October. Preben Nørregaard (Copenhagen University Observatory, Denmark), "Features and performance of the Copenhagen generation 3 array-controller".

14 November. Simon Tulloch (ING), "New developments in CCD technology".

A Conference Organised by the ING on the Nature of V838 Monocerotis and Its Spectacular Light Echo

The ING is organising a conference on "The Nature of V838 Mon and Its Light Echo", that will be held from May 16th to 19th, 2006, in the Hotel H10 Taburiente Playa in the beach resort of Los Cancajos, near Santa Cruz de la Palma.

The outburst of V838 Monocerotis was discovered in 2002, and has been one of the major hits in stellar astrophysics in recent years. The object is the most studied member of an exciting class of rare objects undergoing tremendous stellar explosions, so powerful as to make V838 Mon at peak brightness one of the most luminous stars in the whole Local Group (at M_V=–10 mag). During and after the outburst, V838 Mon displayed a complex light curve and spectral evolution. In spite of large ejection velocities at the outburst onset (~500 km/sec), the ejecta never reached optically thin conditions, and became cooler and cooler with time, and finally entering the new realm of L-type supergiants, a spectral type never seen before in the Universe and characterised by temperatures so low that were previously measured only in brown dwarfs.

Besides this, V838 Mon became one a major attraction in stellar astrophysics by displaying a bright circumstellar light-echo, the first one seen in our Galaxy in the last 70 years (see the image in the accompanying poster). HST soon started imaging the light-echo evolution, providing spectacular images that appeared even on the front cover of *Nature* (issue number 422, 2003), and will continue the monitoring in the next seasons.

Little consensus has been reached so far on the nature and causes of the outburst of V838 Mon. The interpretations published in the literature cover a wide range of possibilities such as the swallowing of giant planets, merging of the components of a binary star, surface helium flash in a highly evolved and very massive star and a highly degenerate hydrogen flash in a low mass, cool and very slowly accreting white dwarf.

Given the many important questions opened by the intensive study of V838 Mon in the last three years, a conference dedicated to the subject is planned for May 16–19, 2006, in La Palma. The conference aims to bring together researchers interested in V838 Mon and related stars, in light-echos, in the atmospheres and chemistry of cool giant stars, in circumstellar cocoons, in the latest evolutionary stages of very massive stars and in the various alternative scenarios proposed to account for the unique properties of V838 Mon and its associates. One main goal of the conference is to compare observational evidence and theoretical interpretations, so as to gain a better understanding of the V838 Mon phenomenon. Another objective is to foster cooperation and coordination of future observational and modelling efforts, both concerning its still active outburst phase and in view of the return to quiescence conditions in the years to come.

The organisers of the conference and co-chairs of the scientific organising committee are Romano Corradi, from the ING, and Ulisse Munari, from the Osservatorio Astronomico di Padova, Italy. Financial support will be provided by the ING, the Spanish Ministerio de Educación y Ciencia, the Excmo. Cabildo Insular de La Palma, and the Patronato de Turismo de La Palma.

More information is provided on the conference web page at: `http://www.ing.iac.es/conferences/v838mon/`. ¤

Romano Corradi (rcorradi@ing.iac.es)

News from the Roque

Step-by-step the 10-m GTC is coming closer to completion. The telescope mechanical structure is already complete and is being tuned and balanced. Encoders and motors will be fitted soon, after which the telescope control system can be tested in anger. All main optical components are already on site, including the secondary mirror, which has been a demanding item because of its material and complex shape that mimics the shape of the primary. As soon as the telescope structure is operational the first segments of the primary mirror will be mounted, preparing GTC for its technical 'first-light' milestone.

On these pages in the past we have reported the construction of the 17-m MAGIC Cherenkov telescope. That telescope, now having been completed, is about to receive its twin, MAGIC-2. The new telescope will be very similar to the first one and will be erected in the same area, at about 85 m distance from from MAGIC-1. The magic delivered by both together will be bigger than the sum of each. At the time of writing the concrete for the telescope base is already in place.

In the previous newsletter we mentioned the construction of the new IAC centre on La Palma, CALP: "Centro de Astrofísica en La Palma". Since then the building has been inaugurated by the Spanish minister of Education and Science and has been taken in use. The GTC offices are located at CALP.

Not so visible, but nevertheless an important infrastructure improvement is the higher bandwidth from site to the outside world. The observatory now enjoys a 32 Mbps internet connectivity. Now this may not seem much if you're working in a research institute in Europe, but the observatory on top of our little island on the ocean it's 15 times better than what we're used to! The improved bandwidth allows ING to carry out data archiving to Cambridge over the internet. We are waiting for the ING offices in Santa Cruz de La Palma to be connected to the same bandwidth infrastructure as well. ¤

MAGIC-1 (right) and MAGIC-2 (left, under construction).

Inauguration event of CALP (credit Luis Cuesta, IAC).

René Rutten (rgmr@ing.iac.es)

Perseids from Roque de Los Muchachos Observatory

Each year about 12 August Earth intersects orbit of the comet 109P/Swift-Tuttle and debris from this comet which is distributed all along the orbit, enters Earth's atmosphere, burning in a form of meteors. They appear from a radiant in the constellation of Perseus and are therefore called Perseids. Some years they produce very active showers. In 2005 the activity was below average, nevertheless some very bright and beautiful meteors could be seen.

To capture this event, a simple photographic setup was placed in a quiet place next to the JKT telescope. It comprised of the Canon 350D digital camera, the Peleng 8 mm/f3.5 fish eye lens and a photographic tripod. The camera was controlled by a computer to take images every 30 seconds. Many interesting meteors were photographed and from the photos an animation was created, showing dark La Palma sky lit by the Milky Way and occasional bright meteors. The photos and the animation are available from `http://www.ing.iac.es/~jure/perseids2005/`. ¤

One distiguished event happened about 4:38 local time when a very bright fireball exploded and left a smoke trail which was visible on photos for several minutes before it was dispersed by wind.

Jure Skvarc (jure@ing.iac.es)

Other ING Publications and Information Services

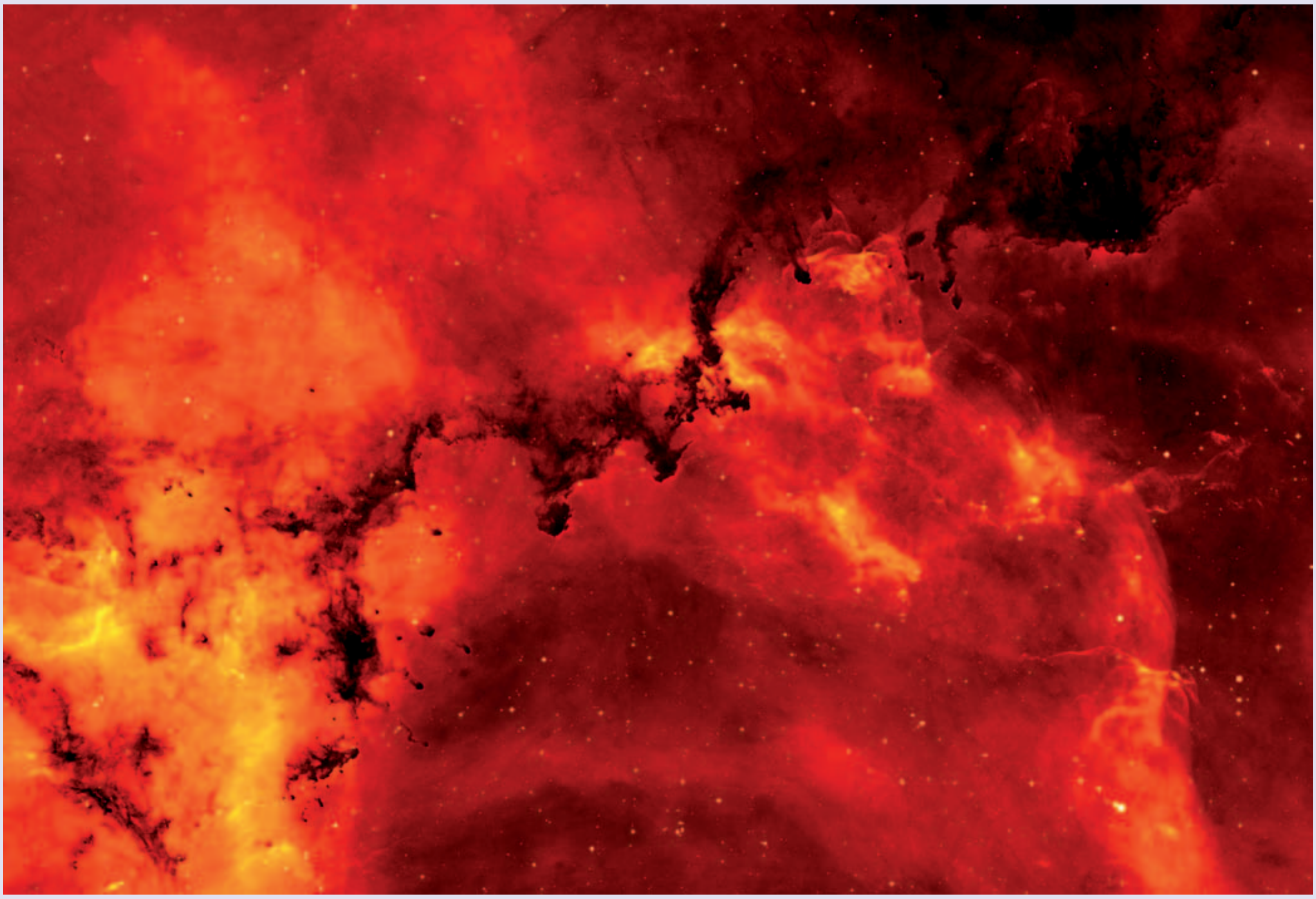
[INGNEWS] is an important source of breaking news concerning observing time and current developments, especially with regard to instruments. You can subscribe to this mailing list by sending an email to `majordomo@ing.iac.es` with the message `subscribe ingnews` in the body from the email address you want to subscribe. Please leave the subject field and the rest of the body of the message empty. More information: `http://www.ing.iac.es/Astronomy/science/bulletin/`.

Really Simple Syndication (RSS) is XML-based code for distributing news. **ING's News Feeder for RSS Browsers** is file `http://www.ing.iac.es/rss/index.html`, and the same news are also posted on our home page.

Annual Reports are available online at: `http://www.ing.iac.es/PR/AR/`, and **Press Releases** at: `http://www.ing.iac.es/PR/press/`. Recent and old **Technical Notes** can be downloaded from: `http://www.ing.iac.es/Astronomy/observing/manuals/man_tn.html`.

Proceedings of the conferences organised by ING in the last years have been printed by external publishers. More information can be found at: `http://www.ing.iac.es/Astronomy/science/conferences.html`.

Beautiful Images from IPHAS Survey



Dust lanes in the centre of the Rosette Nebula. Image produced by Nick Wright (UCL) on behalf of the IPHAS collaboration. Size is 30×20 arcmin, north to the left, east is down. This image was taken as part of the IPHAS survey and are primarily Hα images taken with the WFC on the INT. For more images produced by Nick Wright visit `http://www.star.ucl.ac.uk/~nwright/imaging.html`. *IPHAS collaboration web page can be found at* `http://astro.ic.ac.uk/Research/Halpha/North/`.

Personnel Movements

Clive Jackman escaped our pen on previous occasions, but trust me, he was not forgotten! Clive for many years was ING's SuperMan in the area of electronics and general systems knowledge. His in-depth practical knowledge build up over many years of experience was often essential to resolve problems quickly. Clive returned to the UK and is now living in Wales.

Richard Bassom left the software team over summer. Richard worked on several of ING's key systems, and most recently delivered the critical improvements to the Autofib fibre positioning system. Richard, now living in the UK, will retain ties to ING developments through his work on specific projects.

Lucy Lawler has worked for five years as Head of Personnel at ING, but returned to the UK with her family during fall. Lucy played a particularly important role in guiding ING through a difficult period of restructuring, which has now come to an end. She quickly found new employment and is now looking after a company that is a few orders of magnitude bigger than ING.

Chris Evans was appointed as a PDRA at ING. Like all good things in life, also this came to an end. Chris returned to the UK and is now employed at the UK-ATC to work on issues related to the future extremely large telescopes.

A big family. *This photograph was taken during our summer barbecue in the Refugio de El Pilar, La Palma, and it shows members and relatives of some of the La Palma-based staff from GTC, ING, TNG, NOT and Mercator. Indeed, a family photograph (credit Olivier Martin).*

TELESCOPE TIME

Applying for Time

Danny Lennon (Head of Astronomy, ING)

The coming year, 2006, will see important changes taking place at ING which will provide new opportunities for observers. The WHT will acquire a laser guide star for its adaptive optics system. IDS is likely to be offered once more on the INT, along with Ultracam, a high speed CCD camera. More details of these and other enhancements, are discussed below.

The Ground layer Laser Adaptive optics System (GLAS) project should come to fruition during the latter half the year, opening up most of the sky to high spatial resolution integral field spectroscopy with OASIS and infrared imaging with INGRID, both using the NAOMI adaptive optics system. This project is described in the article by René Rutten on page 11 of this issue, where further details on its expected performance may be found. At the time of writing, on-sky commissioning of GLAS is scheduled for early in semester 2006B and as a consequence the ING expects to release an announcement of opportunity for large programmes which can exploit this new facility during that semester. OASIS itself continues to perform well although at the time of writing the 33 mm enlarger (pixel size 0.42", field of view 12.0"×16.7") is not yet commissioned. For the latest information on this enlarger please contact Chris Benn (crb@ing.iac.es).

Applicants for adaptive optics programmes are reminded that their programmes are currently being carried out in service mode and in the event that AO observations are not possible we will switch to a TAC approved backup programme with either ISIS or LIRIS, depending on which is available. For this reason, if AO applicants have their own backup programme they must include this in their telescope application proposal to be judged in competition with other AO backup proposals. For all ISIS backup proposals, applicants *must* use the default ISIS dichroic (the new Barr 5200 dichroic).

At the Cassegrain focus the new ISIS dichroic is performing well, users please note that this is now the default dichroic and proposals requesting an alternative must include a justification for their choice. The throughput of the ISIS image slicer has proved to be rather disappointing and pending the results of an investigation into the causes of its poor performance it is not yet being offered to observers. The introduction of the new observing system software for ISIS, the Auxiliary port camera and the A&G box has proved to be very successful. It has been well received by visiting astronomers since it now enables the creation of observing scripts for ISIS, a feature which improves both efficiency and reliability. Other developments on the ISIS front during 2006 will include further testing of the new L3 CCDs which may provide an opportunity for offering a high-speed spectroscopic facility with ISIS.

The Prime focus instruments, AF2 and PFC are also benefitting from the software improvements to their observing system. In addition, AF2 has had a major upgrade of its fibre positioning software with a new release on a Linux PC platform providing improved speed and reliability. For example, a complete setup of fibres at the telescope now takes less than 20 minutes. Furthermore, the fibre configuration software, previously only available on a Sun/Solaris platform has now been successfully ported to a Linux platform.

LIRIS continues to perform very well, the high resolution (R=2500) K-band grism has now arrived and its efficiency will be quantified during the commissioning in early 2006 with a view to offering it for 2006B (though it may be available for service during 06A). The high resolution H-band grism is scheduled for the end of 2006, while funding has now been secured by the IAC for the high resolution grisms for Z and J. In principle, coronagraphy and both imaging and spectro-polarimetry are possible with LIRIS however all these three modes need further characterisation which will take place during semester 06A. Interested parties should contact the LIRIS instrument specialist, Mischa Schirmer (mischa@ing.iac.es), for the latest news on LIRIS. Finally on LIRIS, it is expected that the multi-slit mode will be offered more widely to users although the logistical and scheduling problems entailed by this still need to be addressed.

The INT will see substantial changes in 2006. It is expected that semester 06B will likely see the return of the Intermediate Dispersion Spectrograph (IDS), while the high speed CCD camera Ultracam (http://www.shef.ac.uk/physics/people/vdhillon/ultracam/) may also be offered on the INT. Essentially these two instruments will be competing for time with the Wide Field Camera (WFC) with the following restrictions: no single instrument will be scheduled on the INT for a block of time of less than 4 weeks, though of course each block may consist of smaller individual programmes of 1 week or more in length. IDS will be offered with the 235 mm camera only and with an EEV 2k×4k detector but with the usual choice of collimators and gratings for each observing run. Ultracam will be supported by the Ultracam team from Sheffield and as compensation for their efforts in providing the instrument and support the Ultracam PIs, Dhillon and Marsh, must be allowed co-authorship on publications resulting from these observations. Further details of these and other restrictions will be released during the course of 2006. The intention is clearly to encourage large programmes with these instruments. Another development for the INT is that we have now acquired three new red-shifted Hα narrow band filters for the WFC which will be commissioned early in 2006. Please refer to the WFC web pages for the most recent information or contact the instrument specialist, Romano Corradi (rcorradi@ing.iac.es). ¤

Danny Lennon (djl@ing.iac.es)

IMPORTANT

APPLYING FOR OBSERVING TIME:
http://www.ing.iac.es/Astronomy/observing/INGinfo_home.html

SUBMISSION DEADLINES:

UK PATT
15 March, 15 September

NL NFRA PC
15 March, 15 September

SP CAT
1 April, 1 October

ITP
http://www.iac.es/gabinete/cci/

SEMESTERS:
A: 1 February – 31 July
B: 1 August – 31 January

SUBMITTING A SERVICE PROPOSAL:
http://www.ing.iac.es/Astronomy/observing/service/service.html

SUBMITTING AN OVERRIDE REQUEST:
http://www.ing.iac.es/Astronomy/observing/overrides.html

APPLYING TO USE A NEW VISITOR INSTRUMENT:
http://www.ing.iac.es/Astronomy/observing/NewVisitorInstruments.html

APPLYING FOR OPTICON EU FUNDING:
http://www.otri.iac.es/eno/

Telescope Time Awards Semester 2005B

Listed below are the telescope time awards for semester 2005B. For every programme the following information is provided: principal applicant (institution or university), title, and reference (in bold). Programmes are sorted in alphabetical order of principal applicant's name and grouped by telescope and type of allocation. Service programmes are not included. Observing schedules can be found at `http://www.ing.iac.es/ds/sched/`.

ITP Programmes on the ING Telescopes

– Peletier (Kapteyn), MAGPOP — The star formation history of dwarf galaxies, **ITP4**.

William Herschel Telescope

UK PATT

– Bosma (Observatoire de Marseille), Deep K-band surface photometry of low surface brightness galaxies, **W/2005B/28**.
– Chappelle (Liverpool), The role of gravity upon ultracool dwarf dust formation, **W/2005B/18**.
– Chrysostomou (Hertfordshire), Verifying the absence of jets from "misaligned" T-Tauris in the Taurus-Auriga molecular cloud, **W/2005B/59**.
– Fender (Southampton), Echo-mapping a Quiescent Black Hole, **W/2005B/75**.
– Hatch (IoA), Investigating the effects of the Perseus ICM on a supersonically infalling galaxy, **W/2005B/38**.
– Hodgkin (IoA), Spectroscopy of Transit Candidates in the Orion and M34 Clusters, **W/2005B/53**.
– Hough (Hertfordshire), PLANETPOL polarimetry of Upsilon Andromedae b, **W/2005B/48**.
– Huxor (Hertfordshire), Metallicity and Radial Velocity Determinations of Newly Discovered M31 Halo Globular Clusters, **W/2005B/52**.
– Jeffries (Keele), Binary statistics and the formation of low-mass stars and brown dwarfs, **W/2005B/50**.
– Leigh (Liverpool), Spectroscopic detection and characterisation of the planet orbiting upsilon Andromeda, **W/2005B/10**.
– Levan (Leicester), Probing the high redshift universe with GRBs, **W/2005B/46**.
– Littlefair (Sheffield), J1702+3229 — a CV in the period gap with an evolved secondary, **W/2005B/66**.
– Lucas (Hertfordshire), Determination of the primordial incidence of binarity in Orion Brown Dwarfs, **W/2005B/55**.
– Marsh (Observatoire de Marseille), The nature of the white dwarfs in long period cataclysmic variables (CVs), **W/2005B/32**.
– Nandra (ICL), The AGN luminosity function at z=3, **W/2005B/26**.
– Napiwotzki (Leicester), Testing common envelope theory and SN Ia progenitor models with double white dwarfs, **W/2005B/47**.
– Naylor (Exeter), Does star formation take a long time? **W/2005B/67**.
– Nichol (Portsmouth), Spectroscopy of SNe Ia detected in the Sloan Digital Sky Survey II, **W/2005B/19**.
– Oudmaijer (Leeds), NAOMI/OASIS observations of evolved cool supergiants: mirror, mirror on the wall, **W/2005B/73**.
– Pollacco (QUB), Search for substellar companions to stars with extrasolar planets, **W/2005B/23**.
– Pozzo (ICL), Late-time study of the very nearby Type IIP Supernova 2004dj, **W/2005A/13**.
– Roques (Observatoire de Paris), Detection of small Kuiper Belt objects by stellar occultations, **W/2005B/12**.
– Tanvir (Hertfordshire), The physics of short bursts and relativistic blast waves, **W/2005B/25**.

NL PATT

– Aerts (Nijmegen), ULTRACAM asteroseismology: combining pressure and gravity modes to probe structure of BAL090100001, **w05bn003**.
– Besselaar (Nijmegen), Follow-up of DB+dM binary systems, **w05bn010**.
– Groot (Nijmegen), Optical-NIR Spectral eclipse mapping of Accretion disks, **w05bn014**.
– Jonker (SRON), Phase resolved photometry of the msec X-ray pulsar IGR J00291+5934 in quiescence, **w05bn005**.
– McDermid (Leiden), Mapping the nuclear regions of early-type galaxies with OASIS, **w05bn009**.
– Nelemans (Nijmegen), Testing common envelope theory and SN Ia progenitor models with double white dwarfs, **w05bn008**.
– Nelemans (Nijmegen), Determining the accretion geometry and distance to the 10 min binary ES Cet, **w05bn012**.
– Nelemans (Nijmegen), Fast photometry of the 10 min binary ES Cet with ULTRACAM, **w05bn013**.
– Perez (Kapteyn), Origin of the very sub-solar hot gas abundances in X-ray low luminosity ellipticals, **w05bn006**.
– Quirrenbach (Leiden), Line Bisector Variations for K Giants, **w05bn007**.
– Roelofs (Nijmegen), Constraining the nature of the enigmatic variable V407 Vul, **w05bn015**.
– Starling (Amsterdam), The physics of short bursts and relativistic blast waves, **w05bn002**.
– Wijers (Amsterdam), Probing the high redshift universe with GRBs, **w05bn001**.

SP CAT

– Barrado (LAEFF), Membership of substellar candidates of the Collinder 69 and Barnard 35, **WHT6/05B**.
– Beckman (IAC), Basic properties of nuclear bars in double bar galaxies, **WHT15/05B**.
– Casares (IAC), Possible orbital period derivative in the black hole binary V404, **WHT56/05B**.
– Casares (IAC), Determining system parameters of a Soft X-ray transient in outburst, **WHT60/05B**.
– Castro-Tirado (IAA), GRB physics in the INTEGRAL and SWIFT era, **WHT32-A/05B**.
– Elías de la Rosa (Observatorio di Padova), Detailed study of the physics of nearby Supernovae, **WHT44-E/05B**.
– Erwin (IAC), The nature of bars in late-type spiral galaxies, **WHT35/05B**.
– Erwin (IAC), How many galactic bulges are imposters? **WHT55/05B**.
– García (IAC), 3D-spectroscopy of the Orion nebula. Local properties of the ionised gas associated with proplyds, **WHT28/05B**.

– Gómez (IAC), Infrared characterisation of supernova progenitors, **WHT13/05B**.
– González (CSIC), Finding an evolutionary link between radio galaxies and very luminous infrared galaxies, **WHT3/05B**.
– Herrero (IAC), Luminous blue stars along the spiral arms of M33, **WHT26/05B**.
– Kehrig (IAA), The problem of metal pollution in low metallicity HII-Galaxies, **WHT27/05B**.
– López (IAC), Studying the origin of nuclear bars, **WHT16/05B**.
– López (IAC), Star forming regions in starburst galaxies with tidal streams, **WHT21/05B**.
– Martínez (IAA), Does M31 have as many satellites as predicted by Cold Dark Matter theory? **WHT49/05B**.
– Negueruela (Alicante), A survey of blue stragglers in young open clusters, **WHT58/05B**.
– Rodríguez (IAC), Unravelling the role of the SW Sextantis stars in the evolution of cataclysmic variables, **WHT43-A/05B**.
– Rodríguez (IAC), The magnetic nature of the SW Sextantis stars, **WHT48/05B**.
– Vázquez (IAC), Asteroseismology of the open cluster NGC7039, **WHT23/05B**.

Spanish Additional Time

– Acosta (IAC), Catalogue of infrared polarimetric standards of low luminosity, **WHT47/05B**.
– Balcells (IAC), The GOYA survey. Photometric characterisation of high-z galaxies, **WHT14/05B**.
– Bergond (IAA), Globular cluster populations of well defined isolated galaxies, **WHT46/05B**.
– Hammersley (IAC), Visible spectroscopy of the GTC standards, **WHT50/05B**.
– Manchado (IAC), **LIRIS GT**.
– Martín (IAC), Preparation for GTC follow-up of brown dwarf candidates in young open clusters, **WHT4-A/05B**.

WHT–TNG Time Share

– Benn (ING), The nature of BAL outflows in quasars, **T60**.
– Leone (OA Catania), Detecting magnetic fields in planetary nebulae, and understanding their role in the nebular shaping, **T41**.
– Zaggia (OA Trieste), Hunting for cores of dwarf spheroidal galaxies in the external Milky Way Halo, **T69**.

Instrument Builders' Guaranteed Time

– Bacon (Lyon), **GT Type A**.
– Bacon (Lyon), **GT Type B**.

Isaac Newton Telescope

UK PATT

– Burleigh (Leicester), Faint planetary nebulae around hot white dwarfs, **I/2005B/9**.
– Drew (ICL), IPHAS — the INT/WFC photometric Hα survey of the Northern Galactic Plane, **I/2005B/10**.
– Fender (Southampton), Jet-blown optical nebulae from black hole X-ray binaries, **I/2005B/4**.
– Irwin (IoA), Searching for planetary transits in the Orion Nebula Cluster, **I/2005B/17**.
– Irwin (IoA), A targeted CCD survey of the outer halo of M31, **I/2005B/18**.
– Jarvis (Oxford), A wide-field search for Lyα haloes: A pre-requisite for massive galaxy formation? **I/2005B/2**.
– Littlefair (Exeter), How long do young stars remain locked to their discs? **I/2005B/11**.
– Shanks (Durham), A UV survey to probe interactions between z~3 galaxies and the IGM, **I/2005B/15**.
– Todd (QUB), The distance scale: eclipsing binaries and Cepheids in the dwarf irregular galaxy IC1613, **I/2005B/8**.

NL PATT

– Baes (ESO), Dust, dynamics and dark matter in elliptical galaxies — optical photometry, **i05bn004**.
– Groot (Nijmegen), IPHAS — the INT/WFC photometric Hα survey of the Northern Galactic Plane, **i05bn001**.
– Roelofs (Nijmegen), The HeI survey of the Galactic Plane: the AM CVn population, **i05bn003**.
– Waters (Amsterdam), Search for faint Be stars in the COROT fields, **i05bn002**.

SP CAT

– Alonso (IAC), The search for hot Neptunes using the field star transit method, **INT3/05B**.
– Castro-Tirado (IAA), The physics of GRBs in the INTEGRAL and SWIFT era, **INT11/05B**.
– da Rocha (Göttingen), Intra-group light in Hickson compact groups, **INT5/05B**.
– Deeg (IAC), Sample definition for exoplanet detection by the COROT spacecraft, **INT9/05B**.
– López (IAC), Quantitative morphology of galaxies in nearby clusters, **INT6/05B**.
– Mampaso (IAC), IPHAS — the INT/WFC photometric Hα survey of the Northern Galactic Plane, **INT3/05B**.
– Morales (LAEFF), Exploring the different initial mass functions in the λ Orionis SFR, **INT1/05B**.
– Rosenberg (IAC), The formation and evolution of the Milky Way (III): the Galactic disc, **INT4/05B**.

Spanish Additional Time Allocations

– Herrero (IAC), Detecting the blue massive star population to 5 Mpc for OSIRIS, **INT10/05B**.
– Ruiz (Barcelona), Supernovae at z=0.05–0.35: studying the nature of the dark energy (II), **INT15/05B**.
– Vílchez (IAA), Deep Hα imaging of clusters of galaxies in the WINGS survey, **INT14/05B**.

Abbreviations:

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Telescope Time Awards Semester 2006A

Listed below are the telescope time awards for semester 2005B. For every programme the following information is provided: principal applicant (institution or university), title, and reference (in bold). Programmes are sorted in alphabetical order of principal applicant's name and grouped by telescope and type of allocation. Service programmes are not included. Observing schedules can be found at `http://www.ing.iac.es/ds/sched/`.

ITP Programmes on the ING Telescopes

- Peletier (Kapteyn Astronomical Institute), MAGPOP — The star formation history of dwarf galaxies, **ITP4**.

William Herschel Telescope

UK PATT

- Aigrain (IoA), Spectroscopy of transit candidates in the M50 open cluster, **W/2006A/44**.
- Allard (Hertfordshire), Probing the vertical structure of nuclear bars, **W/2006A/61**.
- Benn (ING), The nature of BAL outflows in quasars, **W/2006A/13**.
- Dobbie (Leicester), Constraining the initial mass-final mass relation using Praesepe white dwarfs, **W/2006A/1**.
- Fitzsimmons (QUB), The March 12th/13th stellar occultation by Pluto, **W/2006A/43**.
- Gaensicke (Warwick), The cataclysmic variable period gap: fact or myth? **W/2006A/29**.
- Hewett (IoA), Imaging and spectroscopy of galaxy-galaxy gravitational lenses from the SDSS, **W/2006A/2**.
- Jameson (Leicester), Brown dwarf stars in Melotte 111 in the Coma Berenices open star cluster, **W/2006A/26**.
- Jarvis (Oxford), Spectroscopic confirmation and investigation of a sample of high-redshift Ly α nebulae, **W/2006A/15**.
- Keenan (QUB), A search for binarity in B-type post-AGB stars, **W/2006A/21**.
- Knapen (Hertfordshire), Origin and evolution of bars in SO and spiral galaxies, **W/2006A/60**.
- Knigge (Southampton), Spectroscopic reconnaissance of faint emission line stars discovered by IPHAS, **W/2006A/55**.
- Levan (Hertfordshire), Probing the high redshift universe with GRBs, **W/2006A/46**.
- Littlefair (Sheffield), On the evolutionary status of short period cataclysmic variables, **W/2006A/57**.
- Lucas (Hertfordshire), PLANETPOL polarimetry of the hot Neptune planet 55 Cnc e, W/2006A/11.
- Marsh (Warwick), The first eclipsing AM CVn star, SDSS J0926+3624, **W/2006A/8**.
- Marsh (Warwick), Angular momentum loss and exchange in white dwarf/main-sequence binary stars, **W/2006A/53**.
- Merrifield (Nottingham), Determining the dynamics of round elliptical galaxies using the Planetary Nebula Spectrograph, **W/2005A/37**.
- Page (MSSL), Star formation, cosmic downsizing, and the AGN luminosity function, **W/2006A/59**.
- Pettini (IoA), Characterising the metal and dust abundances of DLAs at $0.6<z<1.2$, **W/2006A/3**.
- Pinfield (Hertfordshire), Confirming and studying brown dwarf companions at wide separation, **W/2006A/35**.
- Sansom (Lancashire), Star formation histories and age distributions across cD galaxies, **W/2006A/27**.
- Skillen (ING), A search for low-mass planets in the TrES-1 system, **W/2006A/32**.
- Tadhunter (Sheffield), Ultraluminous infrared galaxies: quasars and radio galaxies in the making? **W/2006A/12**.
- Tadhunter (Sheffield), Fast neutral outflows in radio galaxies: a major source of feedback in galaxy formation? **W/2006A/16**.
- Vink (ICL), The geometry and strength of B supergiant winds, **W/2006A/22**.
- Watson (Sheffield), Imaging star-spots on the secondary stars in cataclysmic variables, **W/2006A/28**.
- Wilkinson (IoA), Hunting for tidal tails in the globular cluster NGC 5466, **W/2006A/17**.
- Wilman (Durham), The Ly α haloes of sub-mm galaxies: exploring superwinds and feedback at $z=3$, **W/2006A/7**.

NL PATT

- Besselaar (Nijmegen), Follow-up of DB+dM binary systems, **w06an004**.
- Cappellari (Leiden), Dark matter in early-type galaxies: stellar line-of-sight velocity-distribution at $5R_e$ using SAURON, **w06an007**.
- Emonts (Kapteyn), Fast neutral outflows in radio galaxies: a major source of feedback in galaxy formation? **w06an015**.
- Ham (Nijmegen), Optical and NIR spectral eclipse mapping of accretion discs, **w06an005**.
- McDermid (Leiden), Mapping the nuclear regions of early-type galaxies with OASIS, **w06an001**.
- Merin (Leiden), Optical spectroscopy of a new young stellar population in Serpens, **w06an018**.
- Morales (Nijmegen), Close binaries in the Faint Sky Variability Survey, **w06an002**.
- Nelemans (Nijmegen), Testing common-envelope theory and SN Ia progenitor models with double white dwarfs, **w06an010**.
- Serra (Kapteyn), Stellar populations in HI-rich early-type galaxies, **w06an016**.
- Snellen (Leiden), Detection of direct thermal emission from the exoplanet TrES-I, **w06an011**.
- Starling (Amsterdam), The physics of short bursts and relativistic blast waves, **w06an012**.
- Wijers (Amsterdam), Probing the high redshift Universe with GRBs, **w06an014**.

SP CAT

- Arribas (STSCI), INTEGRAL study of very luminous infrared galaxies, **WHT9/06A**.
- Arribas (STSCI), INTEGRAL spectroscopy of HD209458b: a new method to study exoplanetary atmospheres, **WHT10/06A**.
- Barrado (LAEFF), SEDs and variability in brown dwarfs of the 5 Myr Collinder 69 cluster, **WHT12/06A**.
- Cairós (IAC), Mapping young and old stars in star-forming dwarfs with INTEGRAL, **WHT35/06A**.
- Cardiel (CAHA), Properties of dry galaxy mergers and the origin of early-type galaxies, **WHT47/06A**.
- Casares (IAC), Determining system parameters of a soft X-ray transient in outburst, **WHT16/06A**.

– Castro-Tirado (IAA), The physics of gamma-ray bursts in the SWIFT era (ToO), **WHT3-A/06A**.
– Gómez (IAC), A NIR systematic study of the spectroscopic properties of CCSNe, **WHT14/06A**.
– Kehrig (IAA), The problem of metal pollution in low metallicity HII-Galaxies, **WHT34/06A**.
– Martín (IAC), Follow-up of the first UKIDSS ultracool dwarf candidates, **WHT13/06A**.
– Mediavilla (IAC), Photometric and spectroscopic variability of gravitational lenses, **WHT56-C/06A**.
– Mollá (CIEMAT), Stellar populations in the nuclear region of barred spiral galaxies, **WHT45/06A**.
– Negueruela (Alicante), A survey of blue stragglers in young open clusters, **WHT2/06A**.
– Padilla (IAC), Searching for baryonic matter at supercluster scales, **WHT49/06A**.
– Rodríguez (IAC), Unraveling the role of the SW Sextantis stars in the evolution of cataclysmic variables, **WHT22-A/06A**.
– Shahbaz (IAC), Ultra-compact X-ray binaries: The endpoints of binary stellar evolution, **WHT21/06A**.
– Zapatero (LAEFF), Near-infrared imaging polarimetry of young brown dwarfs, **WHT30/06A**.
– Zurita (IAC), The origin of the optical variability in the X-ray transient V404 Cyg, **WHT27/06A**.

Spanish Additional Time

– Acosta (IAC), Infrared catalogue of low-luminosity polarimetric standards, **WHT15/06A**.
– Balcells (IAC), The GOYA deep infrared survey, **WHT43/06A**.
– Manchado, **LIRIS GT**.
– Najarro (IAC), Massive stars in galactic obscured massive clusters: MASGOMAS, **WHT38/06A**.

WHT–TNG Time Share

– Bardelli (OA Bologna), Detailed merging dynamics of A2061: creating shocks and radio relics, **T8**.
– Ferraro (Bologna), Probing the cluster dynamics: the radial distribution of blue stragglers, **T33**.
– Trevese (Roma), Investigating the nature of Low Luminosity Active Galactic Nuclei (LLAGN), **T16**.
– Zaggia (OA Trieste), Hunting for cores of dwarf spheroidal galaxies in the external Milky Way halo, **05B/T69**.
– Zaggia (OA Trieste), Hunting for disrupted cores of dwarf spheroidal galaxies in the external Milky Way halo, **T76**.

Instrument Builders' Guaranteed Time

– Bacon (Lyon), **OASIS GT**.

Isaac Newton Telescope

UK PATT

– Burleigh (Leicester), Faint planetary nebulae around hot white dwarfs, **I/2006A/4**.
– Feltzing (Lund Observatory), Disentangling the outer parts of the Draco dwarf spheroidal galaxy, **I/2006A/5**.
– Fitzsimmons (QUB), Rotation and shapes of 4 cometary nuclei, **I/2006A/7**.
– Gaensicke (Warwick), Characterising the SDSS cataclysmic variable population, **I/2006A/6**.
– Hodgkin (IoA), Kinematics of cool white dwarfs towards the Serpens dark cloud, **I/2006A/13**.
– Jarvis (Oxford), A wide-field search for Ly α haloes: A pre-requisite for massive galaxy formation? **I/2006A/3**.
– Murphy (IoA), Host-galaxies of the strong CaII quasar absorbers at low redshift, **I/2006A/9**.
– Page (MSSL), The cosmic evolution of the faint AGN and starburst populations, **I/2006A/10**.
– Pollacco (QUB), Eclipsing binaries in nearby galaxies —tools to recalibrate the Cepheid PL relationship, **I/2006A/12**.
– Southworth (Warwick), Simultaneous photometry of six eclipsing binary stars in open cluster NGC 7128, **I/2006A/11**.

NL PATT

– Groot (Nijmegen), The Northern Galactic Plane UV-excess survey: UVEX, **i06an001**.
– Kovac (Kapteyn), The optical counterparts of the smallest gas-rich galaxies, **i06an005**.
– Oosterloo (Bonn), Warps in low surface brightness galaxies, **i06an004**.
– Snellen (Leiden), Practical astronomy for 2nd year students, **i06an003**.

SP CAT

– Alonso (IAC), Searching for hot Neptunes using the field star transit method, **INT9/06A**.
– Beckman (Open), The links between bars and star formation: An advanced survey, **INT6/06A**.
– Beckman (Open), Calibration of the HII region luminosity function as an extragalactic standard candle, **INT10/06A**.
– Castro-Tirado (IAA), The physics of gamma-ray bursts in the SWIFT era (ToO), **INT1-I/06A**.
– da Rocha (Göttingen), Intra-group light in Hickson compact groups, **INT3/06A**.
– Kiss (Konkoly Observatory), A comparative study of extinction and infrared emission in dark clouds, **INT4/06A**.
– López (IAC), Diffuse light in galaxy groups, **INT5/06**A.
– Martín (IAC), A pilot survey for very low-mass brown dwarfs and free-floating planets in Upper Sco, **INT11/06A**.
– Rebolo (IAC), Searching for baryonic matter at superclusters scales, **INT8/06A**.
– Ruiz (Barcelona), Supernovae at z=0.05–0.35: studying the nature of dark energy (II), **INT2/06A**.
– Vázquez (IAC), Observing convection in solar-type stars, **INT7/06A**.
– Viironen (IAC), New planetary nebulae found by the IPHAS survey, **INT12/06A**.

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