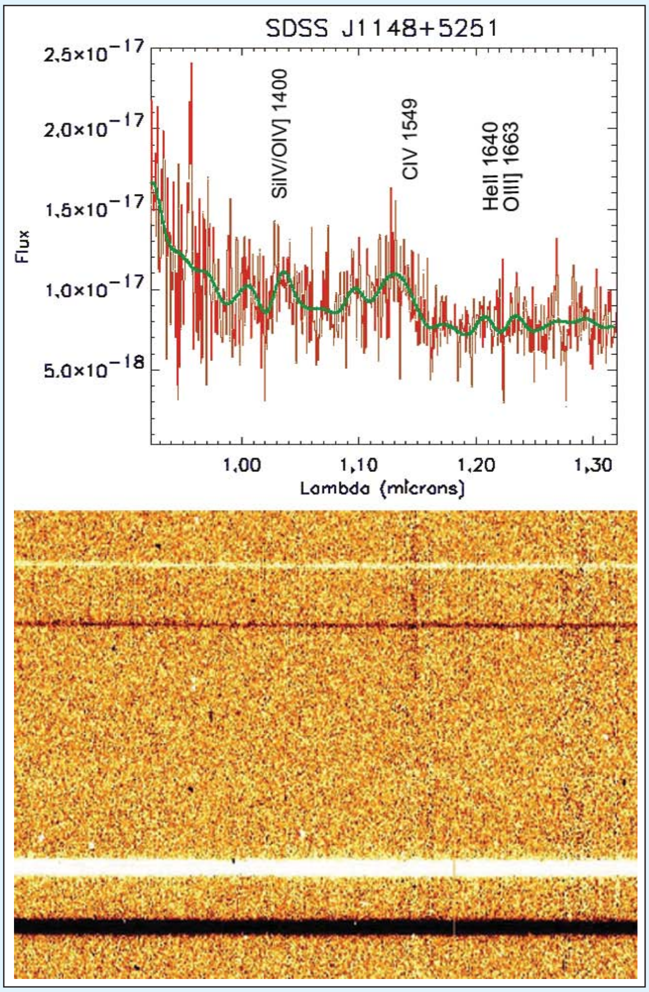
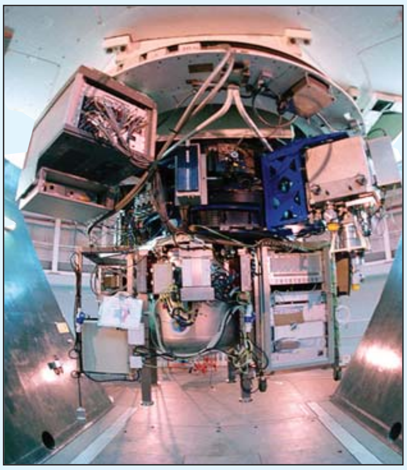
No. 7, December 2003

THE ISAAC NEWTON GROUP OF TELESCOPES

NEWSLETTER

First Light on LIRIS





Above: Picture of the near-infrared imager and spectrograph LIRIS mounted on the Cassegrain focus of the William Herschel Telescope. Left: LIRIS two-dimensional spectrum of the most distant QSO at z=6.41 (top row). The extracted spectrum is shown in the top left panel. A fit to the spectrum is also shown, where several broad emission lines are identified. The most intense feature is the CIV line, detected with a S/N ratio of 10. The spectrum is the co-addition of 5 frames of 850s exposure time each, giving an approximate total time of 70min. (see article by J. A. Acosta Pulido et al. on page 15).

Message from the Director

Dear Reader,

Change and evolution are signs of progress, but are not always without pain. The situation at the ING telescopes is evolving rapidly. The process of restructuring, focussing on making the ING run at a much reduced cost while still delivering top-class service to the astronomical community is our form of evolution. The process will result in a smaller but stronger observatory, based on a strong team of engineers and astronomers. Moreover, new international relations are being developed, that will set the scene for the future.

An important milestone was reached on May 6th, with the signing in Tenerife of the new international agreement for the operation of the ING telescopes between PPARC, NWO and the IAC. Our new relationship with the IAC holds the prospect of stronger future collaborations in scientific programmes and projects. With this partnership, Spain gains nearly 10% of the available telescope time. In return, the financial contribution from the IAC offsets cost savings that were required from the side of the UK. Moreover, the IAC is constructing a world-class IR spectrograph, LIRIS, for the William Herschel Telescope that will be offered to all users of the telescope, thus adding to the scientific capability of the telescope.

THE ISAAC NEWTON GROUP OF TELESCOPES

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

The construction, operation, and development of the ING Telescopes is the result of a collaboration between the United Kingdom and the Netherlands. The site is provided by Spain, and in return Spanish astronomers receive 20 per cent of the observing time on the telescopes. The operation of the site is overseen by an International Scientific Committee, or Comité Científico Internacional (CCI).

A further 75 per cent of the observing time is shared by the United Kingdom, 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)

With this agreement ING has found a new balance with its three partners that will bring scientific benefits for all astronomers as well as a positive outlook towards a strong collaboration with our Spanish colleagues. The article in this Newsletter by the Director of the IAC, Prof Francisco Sánchez, sets out the clear vision on this new collaboration from the Spanish perspective.

A second important result of international collaboration in recent months has been the development of a very large proposal requesting funds to the European Community under the Framework-6 programme. Many areas of observational astronomy are combined within this proposal, named OPTICON. The ING telescopes play a prominent role in the part of the proposal that aims to foster access to the various telescopes on a truly European scale.

This Newsletter again highlights a number of scientific successes through excellent articles. Also progress on various projects is reported here. I trust you will enjoy this issue.

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 J Drew, *Chairperson* – ICL
Prof T van der Hulst, *Vice Chairperson* – Univ. of Groningen
Dr G Dalton – Univ. of Oxford
Dr R García López – IAC
Prof T Marsh – Univ. of Warwick
Dr R Stark – NWO
Dr C Vincent – PPARC
Dr S Berry, *Secretary* – PPARC

The ING Director's Advisory Group

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

Dr M McCaughrean, *Chairperson* – Astrophysikalisches Institut Potsdam
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

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

IAC Partnership with ING

Francisco Sánchez Martínez (Director IAC)

The Instituto de Astrofísica de Canarias (IAC) opened its observatories to the international scientific community in 1979, as a result of the Agreement on Co-operation in Astrophysics. Ever since, its vocation has been to serve as more than a mere venue for telescopes and instruments from different countries. It has gradually become involved in new telescopes and it has strengthened its bonds of co-operation with the user institutions.

The Isaac Newton Group of Telescopes, pioneer in astronomical observations at the Roque de los Muchachos Observatory, is one of the most complete and advanced collections of optical/infrared telescopes in Europe. For over 20 years, these telescopes have given the British, Dutch and Spanish scientific communities the chance to make state-of-the-art observations, which have made a tremendous contribution to pushing back the frontiers of knowledge in many fields of astronomy. Discovery of the optical counterparts of gamma ray bursts, studies of galaxy formation and the search for and characterisation of brown dwarfs are but a few of many examples we could mention.

The vital role these telescopes have played in the development of Spanish astronomy is beyond doubt. Their value can be seen from the fact that many more observing proposals are submitted to the WHT and INT than can be carried out. On the WHT, four out of five good observing proposals from Spanish groups cannot be carried out due to lack of telescope time.

It is well-known that optimum use of 10-m telescopes requires medium-sized telescopes (between 2 and 4 metres) to act as support and to prepare projects to be carried out on larger diameter telescopes. With the imminent start of operations of the Gran Telescopio de Canarias, the ING telescopes will play an important role.

For this reason, PPARC's decision to reduce the funding available for operating the ING telescopes was a cause of deep concern for the IAC. In the face of this uncertainty and concerned about the ING's future, the IAC decided to explore possible ways to reinforce co-operation with the ING to ensure its continuity and to guarantee that its telescopes will continue to operate in optimum conditions.

The agreement with PPARC and NWO has ensured operational continuity of the ING, whilst, at the same time, providing additional time for Spanish astronomers. The IAC contribution consists of qualified staff, astronomers and engineers, plus an infrared imaging spectrograph for the WHT (LIRIS). The overall IAC contribution is equivalent to about half a million euros per year. The Spanish astronomy community increases its share of ING telescope time by 9.1% a year. In particular, this time is being used to prepare the science that will be done with the GTC.

Because drafting of the legal texts of agreements between institutions of several different countries is seldom easy, formal signing of the agreement has been delayed. This, however, has not prevented the agreement from being applied. Since 2002, observing time has been made available and IAC staff have gradually joined ING telescope activities. Furthermore, the first commissioning of the LIRIS instrument was highly successful, far exceeding the expectations of both the ING and the IAC.

Spanish astrophysicists have already benefited from the increased access to time on these telescopes, with a start being made on several programmes that were approved after the relevant announcement of opportunity was made to the entire Spanish astronomical community.

From top to bottom: IAC in La Laguna (Tenerife), Observatorio del Teide (Tenerife) and Observatorio del Roque de Los Muchachos (La Palma). Both observatories are operated by the IAC.

We are sure that this agreement will help to reinforce co-operation among our institutions, thus facilitating increased collaboration in the future within the "European Research Area" that the European Union is promoting. We are convinced that this will strengthen astronomy on La Palma, where the exceptional natural conditions will continue to be attractive for the installation of new generation telescopes. This will have a direct impact on European astronomy, particularly if the European Extremely Large Telescope is finally installed at the Roque de los Muchachos Observatory in the next decade.¤

Francisco Sánchez (director@ll.iac.es)

SCIENCE

First Evidence for an Extended Dark Halo in the Draco Dwarf Spheroidal

Jan T. Kleyna, Mark I. Wilkinson, Gerard Gilmore, N. Wyn Evans (IoA)

Over the past several years, we have been engaged in a project to obtain velocities at large radii in the Draco and Ursa Minor dwarf spheroidal (dSph) galaxies. Draco and UMi are low-luminosity ($L \approx 2\times10^5 L_\odot$) galaxies about 70 kpc from the Milky Way. Stellar velocity measurements in the centres of Draco and UMi suggest a central mass-to-light ratio $M/L \approx 10^2\ M_\odot/L_\odot$ (Aaronson, 1983; Armandroff, Olszewski, & Pryor, 1995; Hargreaves et al., 1996). If this excess mass takes the form of dark matter, then Draco, UMi, and other dSphs with large M/L should be excellent laboratories in which to study structure formation and dark matter haloes: low mass galaxies like the dSphs are probably the basic components from which all larger structures form, and an understanding of the low-mass end of the galaxy spectrum provides an important constraint for evaluating Cold Dark Matter (CDM) and other theoretical models of structure formation.

In the past, stellar velocity measurements have been concentrated in the cores of dSphs, and dynamical modelling has largely been limited to fitting the central velocity dispersion to an isotropic mass-follows-light King profile. However, the assumption that mass follows light is known to be incorrect for virtually all other galaxies, and the assumption of isotropy masks the crucial degeneracy between anisotropy and mass. Thus, a prime objective of this work is to obtain stellar velocities at large projected radii within Draco and other northern dSphs. Combined with modelling methods that relax the assumption that mass follows light and permit varying halo shapes, this new data set should allow us to map out the true masses and shapes of dSph matter distributions.

Draco

With the commissioning of the AUTOFIB2/WYFFOS instrument on the WHT, it became possible to obtain simultaneous spectra of about a hundred stars over a one degree field, overcoming the problem of Galactic contamination near the outer limits of the dSphs' stellar distribution. In four nights in June 2000, we were able to measure the velocities of 159 Draco member stars, extending nearly to the King tidal radius (Kleyna et al., 2001). From these data, it is apparent that Draco's velocity dispersion remains flat or even increases with radius, strongly suggesting the presence of an extended dark halo. An isotropic Jeans equation mass estimate of the mass contained within Draco's light distribution gives $M{\sim}10^8\ M_\odot$, with a mean mass-to-light ratio $M/L \approx 500\ M_\odot/L_\odot$.

By performing a maximum likelihood fit of Draco to a family of dynamical models parameterised by the halo shape and anisotropy (Wilkinson et al., 2002), it was possible to lift the degeneracy between Draco's mass and orbital anisotropy. In these models, the overall velocity normalisation was fitted by the projected central dispersion, the halo shape parameter α could vary from from mass follows light (α=1) to constant density (α=−2), and the logarithmic anisotropy parameter ν could be radially anisotropic ($\nu > 0$) or tangentially anisotropic ($\nu < 0$). The likelihood contours of Figure 1 shows the result of our modelling: Draco is fit best with an isotropic orbital distribution in a halo that becomes approximately isothermal ($\alpha \approx 0$) at large radii. Both a mass-follows-light distribution and a completely flat halo density are ruled out at the ~2.5σ level. The best fit mass, $M{\sim}8\times10^7 M_\odot$, is similar to the Jeans estimate.

Ursa Minor

Ursa Minor (UMi) resembles Draco in size, luminosity, and velocity dispersion. Unlike Draco, it is elongated and appears to have a second peak along the major axis. Often, this peak

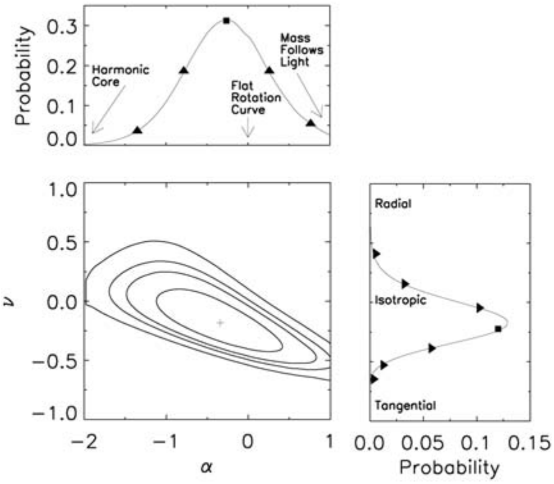

Figure 1. Likelihood contours of the fit of our Draco data to the two-parameter α,ν models of Wilkinson et al. (2002). The contours are at enclosed two-dimensional χ^2 probabilities of 0.68, 0.90, 0.95, and 0.997. The most likely value is indicated by a plus sign. The top and right panels of each plot represent the probability distributions of α and ν, respectively; the median of each distribution is represented by a square, and the triangles show the 1σ, 2σ and (for ν) 3σ limits.

is attributed to tidal disruption, though a plausible mechanism for this has not been proposed. In May 2002, we undertook a 4-night AF2/WYFFOS run to obtain large-radius stellar velocities in UMi, with the aim of fitting for the halo shape and orbital anisotropy using our α, ν models. However, 2.5 nights were clouded out, and poor seeing limited the quality of the data of the remaining 1.5 nights.

Though our data was insufficient for detailed modelling, we were nevertheless able to obtain a number of velocities in the vicinity of UMi's second density peak. After combining our data set with previously published UMi velocities, we noted that the velocity histogram of the clump appeared narrower than the dispersion of UMi as a whole (Kleyna et al., 2003). Accordingly, we modelled UMi's velocity distribution as the sum of two Gaussians: a Gaussian subpopulation with adjustable normalisation, width and mean, and an $8.8\ \mathrm{km\ s^{-1}}$ Gaussian representing the bulk of UMi's stars. We then scanned the face of UMi to determine where there was a signature of a kinematical subpopulation. As suggested by the histograms, only the region near the second clump contained statistically significant ($p=99.45\%$) evidence of a second kinematical population (Figure 2).

We note that a dynamically coherent population can survive inside a cored halo, because sinusoidal orbits in the (nearly) harmonic potential of a core do not diverge over time. However, kinematical substructure would be quickly smeared out if UMi's halo had a density cusp, as predicted by CDM. Detailed dynamical simulations demonstrate that a cold clump could survive for a Hubble time in a $5\times10^7\ M_\odot$ UMi-like dSph if the halo has a core larger than ~500 pc. If the halo has a cusp, however, all evidence of substructure is erased within several hundred million years.

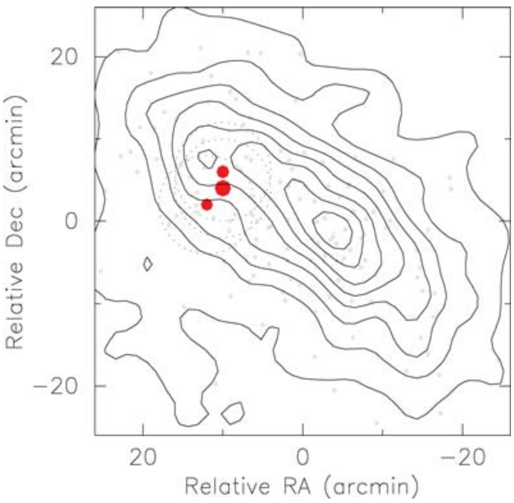

Figure 2. Result of search for kinematic sub-populations in UMi. Coutours are linearly spaced stellar isopleths; the second peak of UMi's stellar population is visible above and to the left of the centre. Gray stars are UMi red giant branch member stars with measured velocities. The filled circles represent points where a model with a kinematically cold sub-population is at least 1000 times more likely than a model composed of a single $8.8\ \mathrm{km\,s^{-1}}$ Gaussian. The size of each dot is proportional to the logarithm of the relative likelihood.

Summary

Using large-radius velocity data obtained using AF2/WYFFOS, we show that the Draco dSph possesses an anisotropic velocity distribution and a dark halo that is isothermal in the limit of large radii. In Ursa Minor, we show that the second peak in the stellar density has a cold kinematical signature. This signature strongly suggests that the feature is a persistent clump sloshing back and forth within a dark matter core, and is inconsistent with the cusped halos that are predicted by Cold Dark Matter theory.¤

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The SAURON Deep Field: Investigating the Diffuse Lyman-α Halo of "Blob1" in SSA 22

R. G. Bower[1], S. L. Morris[1], R. Bacon[2], R. Wilman[1], M. Sullivan[1], S. Chapman[3], R. L. Davies[4], P. T. de Zeeuw[5]

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Recent studies of star-forming objects in the early universe, measuring their clustering properties and determining their luminosity functions, have shown that these galaxies are key to understanding the star formation and metal enrichment history of the universe and the role of galactic "super-winds" in regulating the conversion of baryons into stars.

In this article, we describe how, using the SAURON integral field spectrograph, we study the formation of the most massive galaxies in the Universe. The primary target is the bright Ly-α emission line halo in the conspicuous SSA 22 super-cluster at $z=3.07-3.11$ (Steidel et al., 2000). The highly-obscured very luminous submillimeter galaxy found by SCUBA near the centre of this halo probably is an example of a forming massive elliptical galaxy (Chapman et al., 2001).

Using SAURON, we can map the three-dimensional velocity structure of the SSA 22 'blob 1' halo. This allows us to probe the nature of the ionised gas surrounding the SCUBA source, gaining insight into the origin of the diffuse halo (is it primordial material infalling onto the central object, or material expelled during a violent star burst), the mass of its dark matter halo, and the energetics of any super-wind being expelled from the galaxy. We can also trace the large scale structure surrounding the central source, and investigate whether similar haloes are surrounding other galaxies in the field. The answers to these questions will allow us to understand how galaxy formation is regulated in massive galaxies in the high-redshift Universe. They offer key insight into the "feedback" process and will help explain why less than 10% of the baryon content of the universe ever forms into stars (the "cosmic cooling crisis"; Cen & Ostriker, 1999; Balogh et al., 2001).

This is new ground for the SAURON instrument. Although it was designed to study the dynamics and stellar populations of nearby elliptical galaxies, we will show that it can very effectively be used to study low surface brightness emission features only detectable in long integrations. These observations offer a fore-taste of the deep field observations that can be made with the VIMOS and MUSE integral field spectrographs on 8 m telescopes.

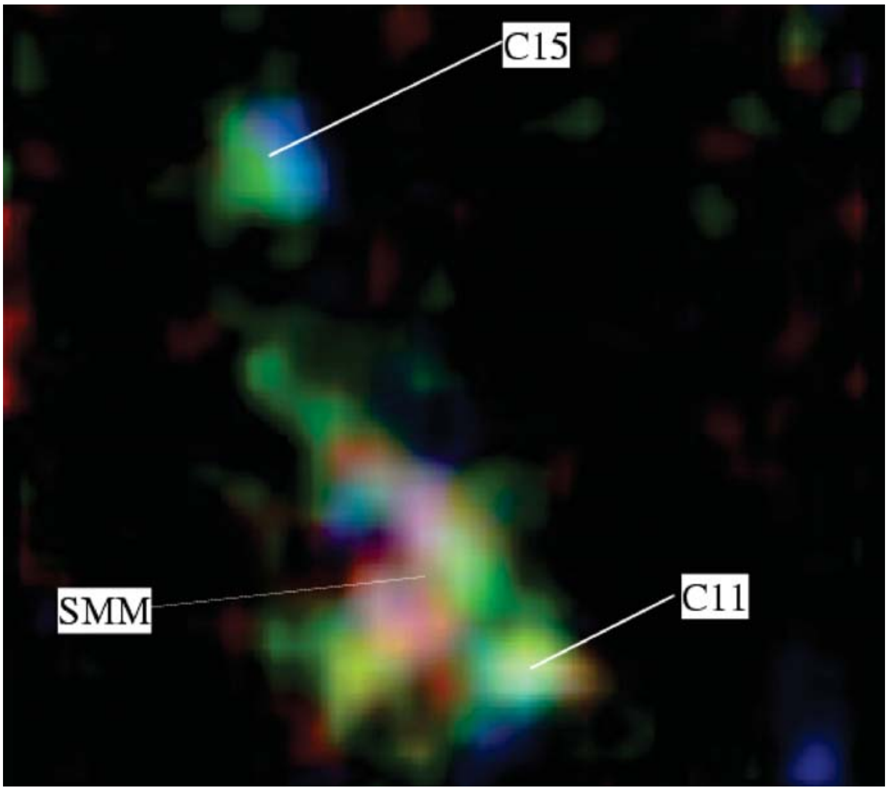

Figure 1. A colour representation of the wavelength shifts of Ly-α emission in the diffuse halo of SSA 22 'blob 1'. A simple interpretation of the image is that red, green and blue channels represent the red-shifted and blue-shifted motions of the ionised material in the halo. The positions of the two Lyman break galaxies C11 and C15 are marked, along with the position of the submillimeter source (SMM). The area shown is 37″×46″.

The Data-Cube

The SAURON instrument is a high throughput integral field spectrograph (Bacon et al., 2001) that is currently operated on the William Herschel Telescope. It was designed and built by a partnership between Lyon, Durham and Leiden with the main objective of studying the dynamics and stellar populations of early-type galaxies (de Zeeuw et al., 2002). It combines a wide field (41″×33″ sampled at 0.95″) with a relatively high spectral resolution (4 Å FWHM, equivalent to $\sigma = 100\ \mathrm{km\,s^{-1}}$ in the target rest frame). The instrument achieves this by compromising on the total wavelength coverage, which is limited to 4810 to 5400 Å. This spatial and spectral sampling ensure that low surface brightness features are not swamped by read-out noise. However, the limited spectral coverage means that it is only possible to study the Ly-α emission from systems at redshifts between $z = 2.95$ and 3.45. Fortunately, the SSA 22 supercluster lies within this redshift range. The sky background is devoid of strong night sky emission in the Sauron wavelength range. For these observations, the SAURON grating was upgraded with a VPH unit giving an overall system throughput of 20%.

Sauron was used to observe the SSA 22 source for a total of 9 hours, spread over 3 nights in July 2002. The raw data was reduced using the `XSauron` software. The extraction procedure uses a model for the instrumental distortions to locate each of the spectra, and to then extract them using optimal weighting. The extraction process takes into account the flux overlap between adjacent spectra. To remove small flat-field and sky subtraction residuals, a super-flat was created using the eighteen 30 min individual exposures. This procedure improved the flat field accuracy up to 1% RMS. Each individual datacube was then registered to a common spatial location using the faint star in the south east of the field and then merged into the final data-cube. To produce the map of Ly-α emission, we subtract the continuum, using a low order polynomial fit to the full wavelength range. The end result is a 3-D (x, y, λ) map of the Ly-α emission from the region.

Results

Three dimensional data of this type must be carefully visualised in order to extract the maximum information from the data. We started by creating a colour projection of the data cube shown in Figure 1. In this view, the

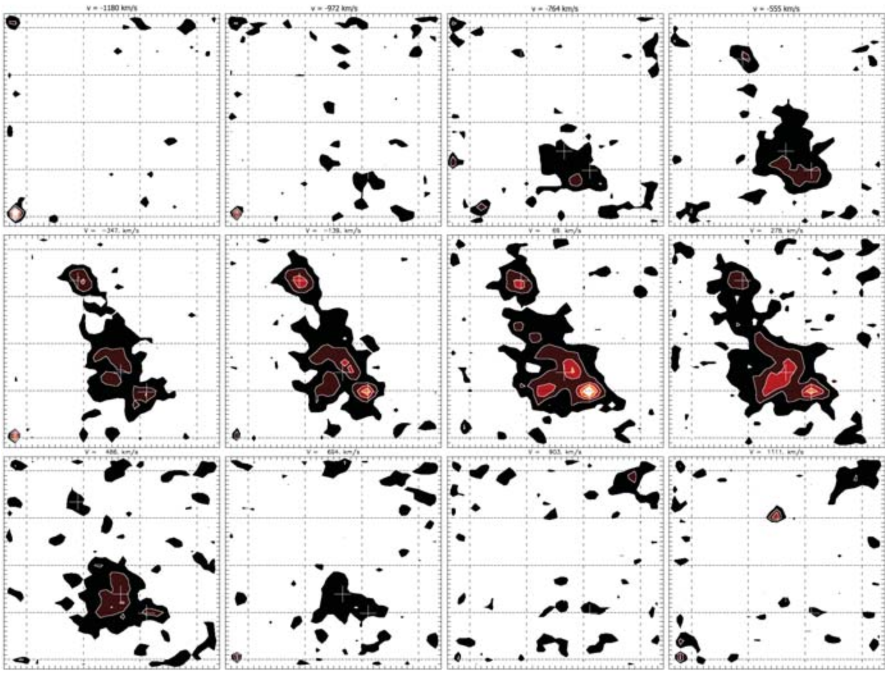

Figure 2. A sequence of contour plots showing the changing morphology of the Ly-α emission at different wavelengths. The velocity step between each map is 208 km s^{-1}, with each slice combining a 5.75Å wavelength range so that alternate panels show independent data. Crosses mark the positions of Lyman break galaxies and the submillimeter source. The grid squares have a spacing of 8″.

red, green and blue colour channels have been created from the data in the wavelength ranges 4976.05, 4964.75, 4988.70. Each channel is 5.75Å wide (350 km s^{-1} in the system rest frame). The image has also been smoothed spatially with a Gaussian of 1″ width. We have marked the positions of the Lyman break galaxies, C11 and C15, identified by Steidel et al. (1996) and the location of the sub-mm source identified by Chapman et al. (2003) (see below). The data-cube can alternatively be viewed as a sequence of wavelength slices as shown in Figure 2, or these slices can be combined together to make an animation.

Many striking structures can be clearly seen in the main halo. The overall width of the emission is very broad (~1500 km s^{-1} FWHM) but separate emission structures can be identified. If we interpret the wavelength shift as a Doppler shift, the systems differ in velocity by a few hundred km s^{-1}. There is significant velocity asymmetry in the emission region around the Lyman break galaxy C11 and across the main halo. The morphology of the diffuse emission also becomes clear in these velocity slices: particularly interesting is the depression seen near the centre of the halo (this is partially filled by redshifted emission), and the diffuse extension of the halo towards the nearby Lyman break galaxy C15. C15 itself is centred in a separate but much smaller halo. There is a clear E–W velocity shift across this 'mini-halo'. We discuss each of these features below.

The optical counter-part of the sub-mm source has been identified by Chapman et al. (2003) after detecting the associated CO emission. To locate the emission relative to the SCUBA source more precisely, we aligned the IFU data cube and the HST STIS image of Chapman et al. using the locations of the alignment star and the Lyman break galaxies C11 and C15. Figure 3 shows the STIS image overlayed with the contours of the total Ly-α emission. This clearly shows the location of the sub-mm source close to the centre of the 'cavity' in the emission structure.

Discussion

Below we divide our results into the separate features seen in our data and discuss some ideas for how we might interpret them. The interpretation is complicated because Ly-α is a resonant line. Thus shifts in the feature can appear both because of genuine gas motion and because photons diffuse in wavelength to escape from optically thick regions. In what follows we assume that bulk motion is the dominant source of line broadening.

- The main halo has a complex structure. Within the broad emission, there are many halo components. The variations in line width and velocity are inconsistent with a simple outflowing shell. The distribution is better modelled by distinct gas components, moving relative to each other with speeds of several hundred km s^{-1}. One (certainly naive) interpretation of the wavelength variations is that they reflect the free motions of separate gas clumps bound in a common gravitational potential.

- If the above were true, we could use the magnitude of the velocity differences to infer the halo mass within ~75 kpc (or 10″, the typical radius at which the clumps can be identified). If we assume that the clumps are on random orbits with a line of sight velocity dispersion of 500 km s^{-1}, this suggests a mass of order 1.3×10^{13} M$_{\odot}$, as expected for a small cluster. It is likely, however, that in fact the clumps have a net outflow or inflow, or are subject to drag from the intergalactic medium (IGM). This makes the mass estimate uncertain.

- Figure 3 shows the relative location of the emission-line halo and the optical counterpart of the strong sub-mm source (Chapman et al., 2001; 2003). The overlay suggests that the sub-mm source may be located at the centre of a 'cavity' in the Ly-α emission. There are several possible interpretations of this cavity. (1) It may be a genuine cavity in the ionised gas distribution. This might be evidence for a strong wind being blown away from the central

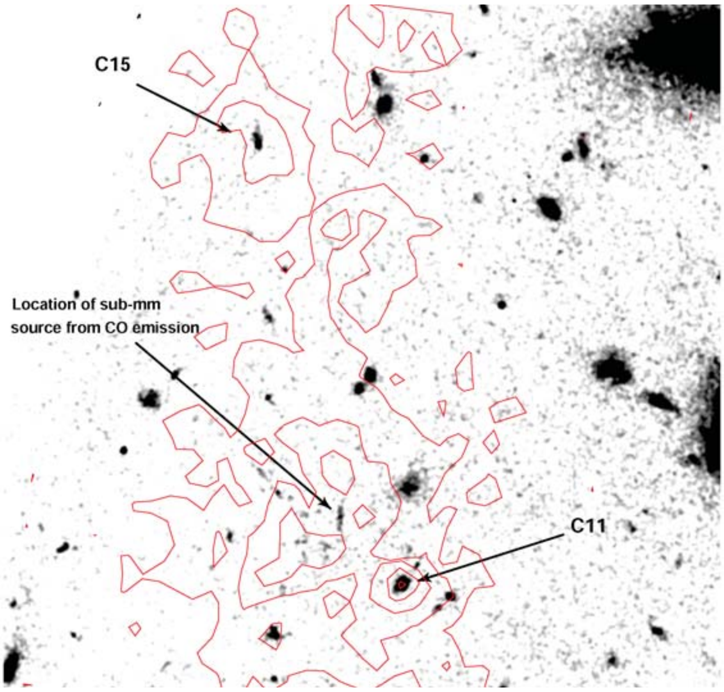

Figure 3. A deep STIS image of the SSA 22 'blob 1' region showing the position for the SCUBA counterpart (Chapman et al., 2003) relative to the total Ly-α emission (contours). The sub-mm source may lie in a 3-D cavity in the emission (compare contours with Figure 1). The Lyman break galaxies C15 and C11 are marked. Their distinct haloes are clearly seen in the 3-D data set.

sub-mm source. This would obviously not be consistent with the more distant material being discrete gas clumps moving on orbits with their motion dominated by the gravitational potential. (2) The cavity may occur because the ionised gas in this region contains significant dust. As the Ly-α diffuses out of the region, it is strongly extincted. This would be consistent with redshifted emission being seen in this location (this wavelength is not resonantly scattered). This explanation is appealing since we know that the central SCUBA source has high extinction. (3) It is possible that we are seeing the optical equivalent of Wide Angle Tail radio sources, where line emission is coming from poorly collimated outflows from a central galaxy, which are then decelerated by the IGM, while the central source moves on through the IGM.

- The two other Lyman break galaxies embedded in the structure appear to have dynamically distinct haloes. This is particularly clear for C15, to the north of the main halo. Indeed there is faint emission that bridges between C15 and the central halo. A similar feature can also be discerned around C11. This is a surprising discovery that leads us to consider whether other Lyman break galaxies would also have extended Ly-α haloes.

- The mini-halo around the C15 Lyman break galaxy has its own characteristic velocity shear pattern. We can identify the morphology of this galaxy from the STIS imaging of Chapman et al. (2003). C15 is elongated at roughly 60 degrees (Figure 3) to the velocity shear seen in Ly-α. This, together with the morphology of the emission, makes it unlikely that the shear reflects the rotation of a conventional gas disk. Instead, the shear pattern is reminiscent of the super-wind outflows predicted from proto-galactic disks (Springel & Hernquist, 2002), and observed (on a smaller scale) in local starburst galaxies such as M82.

Next Steps

These observations clearly demonstrate the ability of deep integral field spectroscopy to detect low surface brightness emission from distant galaxies in the early universe. They give us fascinating insight into the nature and structure of the ionised halo of SSA 22-1. It is interesting to now see how far this powerful new technique can be taken. On the one hand it is fundamental to establish whether the diversity of structure seen in SSA 22-1 is a generic property of other highly luminous sub-mm galaxies, or whether the deep potential well of the SSA 22 super-cluster is necessary to produce emission of this luminosity and extent. It will also be important to determine whether other Lyman break galaxies show mini-haloes similar to C15.

Our observations with the SAURON spectrograph also lay out a path for forthcoming integral fields units. For example, OASIS, an adaptive optics optimised integral field spectrograph, could be used to complement SAURON by studing the higher surface brightness emission line regions in greater detail. The MUSE spectrograph being designed for the VLT will offer the ideal combination of all these instruments providing a combination of wide-field coverage, good spatial resolution and optimal spectral resolution.

Acknowledgments

We thank the SAURON instrument team for their support of this program, and for creating an instrument with the superb sensitivity of SAURON. RGB acknowledges the support of the Leverhulme foundation.¤

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The Unusual Supernova Remnant Surrounding the Ultraluminous X-Ray Source IC 342 X-1

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WHT/INTEGRAL observations have shown a large-diameter (110 pc) supernova remnant to encircle the position of the Ultraluminous X-ray Source (ULX) IC 342 X-1 (Roberts et al., 2003). We infer a remarkable initial energy input to the SNR, at least 2–3 times greater than the canonical value for an 'ordinary' SNR of 10^{51} erg. In addition, two regions on the inside of the SNR shell are bright in [OIII] λ5007 emission, possibly as the result of photoionization by the ULX. If this is the case, the morphology of the nebulosity implies that the X-ray emission of the ULX is anisotropic. The presence of the ULX, likely to be a black hole X-ray binary, within an unusually energetic SNR suggests that we may be observing the aftermath of a gamma-ray burst.

Background

Ultraluminous X-ray sources are the most luminous point-like extra-nuclear X-ray sources located coincident with nearby galaxies, displaying X-ray luminosities in excess of 10^{39} erg s^{-1}. Whilst some ULXs are known to be associated with recent supernovae, the majority appear to show the characteristics of accreting black holes (Makishima et al., 2000). However, at their observed X-ray luminosities they match, or in many cases greatly exceed, the Eddington limit for accretion onto a stellar-mass (~10 $M_\odot$) black hole. ULXs may therefore provide observational evidence for accretion onto a new, 10^2–10^5 $M_\odot$ intermediate-mass class of black hole (e.g. Colbert & Mushotzky, 1999). Alternatively, they could constitute the extreme end of the accreting stellar-mass black hole population, with their high apparent luminosities a result of either truly super-Eddington X-ray emission (Begelman, 2002), or an anisotropic radiation pattern (e.g. King et al., 2001).

One method of investigating the nature of ULXs is through detailed multi-wavelength follow-up observations. We have undertaken one such programme using the integral field unit INTEGRAL on the William Herschel Telescope to obtain optical spectro-imaging data, through 189 fibres over a 16.5×12.3 arcsecond^2 field-of-view, of the immediate environment of fourteen nearby ULXs. A crucial element of this programme is that we use sub-arcsecond X-ray astrometric data from NASA's *Chandra* X-ray observatory to locate the ULXs, which dramatically reduces the confusion problems inherent to older, less accurate X-ray positions. This programme has already borne fruit with the detection of the first stellar optical counterpart to an ULX; a young stellar cluster coincident with NGC 5204 X-1 (Roberts et al., 2001; Goad et al., 2002), which suggests that this ULX may be an extremely luminous high-mass X-ray binary. Here, we outline the results of an observation of the environment of a second ULX, IC 342 X-1, which reveals a very different optical counterpart.

The IC 342 X-1 Nebula

The first observation, on February 1st 2001, highlighted a shell-like emission-line nebula in the immediate environment of IC 342 X-1 (Figure 1; this nebula, and its SNR-like line ratios, was also detected by Pakull & Mirioni (2003a), who christen it the "tooth" nebula due to its distinctive morphology). A high [SII]/Hα emission-line ratio of ~1.1 is seen over the extent of the nebula, a classic indicator that the nebula is a supernova remnant (SNR). Our new *Chandra* position clearly locates the ULX in the central regions of the nebula, raising the intriguing possibility that the two may be physically related.

By utilising both the imaging and spectroscopic measurements provided by INTEGRAL, and assuming the SNR is in the pressure-driven snowplough phase (c.f. Cioffi, McKee & Bertschinger, 1988), we were able to place the constraints on the SNR properties shown in Table 1. The SNR appears unusually large, with a projected diameter of at least 110 pc. For comparison, Matonick & Fesen (1997) argue that a typical single SNR with an initial energy E_{51}=1 should not remain visible once it has expanded beyond a diameter of 100 pc. The

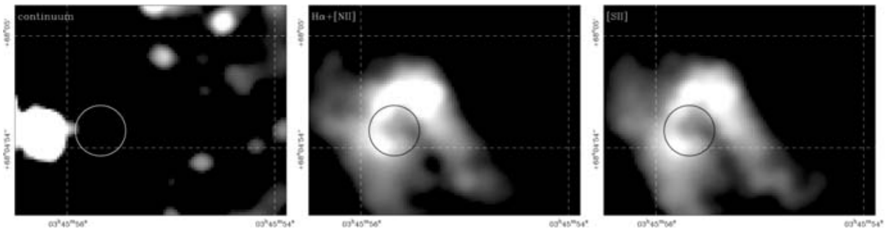

Figure 1. Narrow-band INTEGRAL images of the environment of IC 342 X-1 in the 5300–5500 Å continuum band (left), continuum-subtracted Hα+[N II] (centre), and continuum-subtracted [S II] (right). The circle represents the uncertainty in the ULX position relative to the INTEGRAL data, and each panel is 16.5×12.3 arcsecond^2 in size.

unusual size of this SNR can be attributed to an extraordinary initial energy (assuming a single explosion) of at least $2{\times}E_{51}$.

Radius (for d = 3.9 Mpc):	$R_{\rm neb}$=55 pc
Shell velocity:	$V_{\rm s}$<180 km s^{-1}
Age:	$\tau_{\rm neb}$>92,000 yr
Initial energy (×10^{51} erg):	E_{51}>2
Ambient ISM density:	n_0>0.12 cm^{-3}
Electron density:	$N_{\rm e}$<40 cm^{-3}
Electron temperature:	$T_{\rm e}$<3×10^{4}K

Table 1. The properties of the SNR.

[O III] Nebulosity

A second remarkable feature of this nebula is demonstrated in Figure 2. The morphology of its [O III] emission is distinctly different to the other emission-lines, appearing to sit in two patches on the inside of the larger nebula. Importantly, the [O III] recombination time for the inner edge of the nebula is far less than its age, implying that a process other than the supernova blast wave must have energised the [O III] emission. One possibility is that the excitation originates in the high-energy emission of the ULX. Unfortunately our observation is not sensitive to the He II λ4686 line, the classic signature of an X-ray Ionised Nebula (XIN; Pakull & Angebault, 1986). However, calculations show that the ULX can produce a photoionizing flux sufficient to excite at least the inner regions of the SNR shell. If the excitation is due to the ULX, then its morphology strongly suggests that the X-ray emission of the ULX is anisotropic, consistent with the beamed X-ray binary models of King et al. (2001).

A Hypernova Remnant?

The location of a probable black hole X-ray binary within an unusually energetic supernova remnant appears to satisfy the conditions for a hypernova remnant, i.e., the aftermath of a gamma-ray burst in which a massive star has collapsed to a black hole triggering a very energetic supernova explosion. If so, this observation provides direct evidence that gamma-ray bursts do occur when black holes are formed.

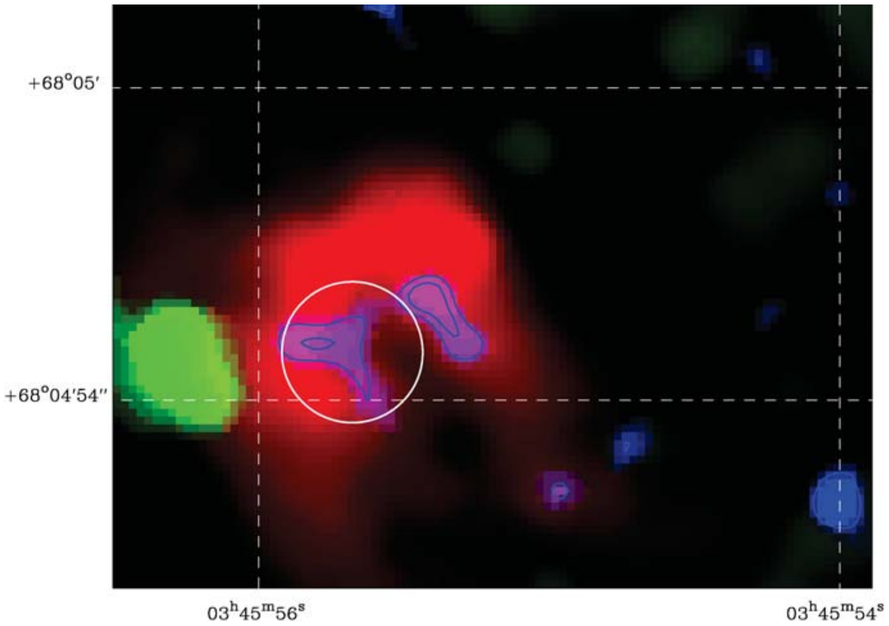

Figure 2. The unusual ionization structure of the IC 342 X-1 SNR. The three colours show 5300–5500 Å continuum emission (green), continuum-subtracted Hα +[N II] emission (red), and continuum-subtracted [O III] (blue, highlighted by contours). The uncertainty in the position of IC 342 X-1 is again shown by the circle.

However, there are other possible origins for the nebula. It might be the result of multiple supernovae occurring in a relatively short space of time (~10^5 yr). This would require a population of young stars within the nebula, which future deep optical continuum observations would detect if present. A second alternative origin could be in jets originating in the ULX. A Galactic analogue of such a system is the W50 nebula, thought to be inflated by the relativistic jets of the microquasar SS 433 (Dubner et al., 1998), which has similar energetic requirements to the IC 342 X-1 nebula. Finally, it is possible that the entire nebula could be X-ray ionised. Pakull & Mirioni (2003b) suggest that XIN should contain an extended warm low-ionisation region with strong characteristic lines such as [S II], which would mimic a SNR spectrum.

Acknowledgments

We thank the WHT/INTEGRAL team for their assistance in the planning and implementation of our programme, and for the use of their data reduction routines. TPR is grateful to PPARC for financial support in the form of a PDRA at the University of Leicester.¤

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The Census of Planetary Nebulae in the Local Group

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

The technique used for searching PNe in external galaxies is almost invariably that of obtaining a narrow-band, continuum-subtracted image in a filter isolating the forbidden emission at 5007 Å from double-ionised atomic oxygen [OIII]. A large fraction of the total luminosity of the star is in fact concentrated in this line, and this is the unique property that makes individual stars in the planetary nebula phase visible to very large distances: up to several hundred solar luminosities can be emitted in a single and very narrow spectral line! Observation of the hydrogen Hα line, also very bright, is sometimes added to discriminate against the detection of highly redshifted galaxies (e.g. [OII] emitting galaxies at redshift z=0.34, which shifts the O+ emission to the rest wavelength of [OIII]λ5007, or Lyman-α emitters at redshift 3.1), or to estimate the ionisation class and discuss possible contamination by compact HII regions. Another basic criterium to select candidate extragalactic PNe is that they are not spatially resolved by ground based imaging, their sizes being usually a fraction of a parsec which translates into a couple of hundredth of an arcsec at a distance of 1 Mpc, approximately the outer edge of the Local Group.

PNe in external galaxies provide a tool to investigate some important astrophysical problems. First of all, their number reflects the total mass of the underlying stellar population from which they derive. In fact, one of the most robust predictions of stellar evolution theories allows us to relate the number of objects n_j in any post main-sequence evolutionary phase to the lifetime of that specific phase, in the hypothesis of a population of coeval, chemically homogeneous stars (Renzini & Buzzoni, 1986). The relation is as simple as this:

$$n_j = \dot{\xi} \cdot L_T \cdot t_j \quad ,$$

where $\dot{\xi}$ is the so-called specific evolutionary flux (number of stars per unit luminosity leaving the main sequence each year), L_T is the total luminosity of the galaxy, and t_j the duration of the evolutionary phase j ($\leq$10,000 yrs for the PN phase). Note that $\dot{\xi}$ is only slightly dependent on the age of the stellar population, its initial mass function and metallicity. Thus counting PNe implies measuring the total mass of the parent stellar population. Once the masses of the progenitors of the PNe are estimated, it also allows us to discuss the star formation history of the host galaxy for the range of ages covered by the PN progenitors, roughly 1 to 10 Gyr (it is still not clear which is the lower mass limit for forming a planetary nebula). In particular, PNe have proven to be excellent tracers of stellar populations in large volumes with a relatively low density of stars, whose integrated stellar light is low and hardly detectable, like the intergalactic and intracluster space and in the haloes of elliptical galaxies (Arnaboldi et al., 2002).

Extragalactic PNe also provide important information on the chemical evolution of the host galaxies, as the nebular abundances of elements like oxygen, neon, sulphur, or argon, do not vary significantly during the evolution of low-mass stars (i.e. they are not significantly produced or destroyed). Therefore the abundances of these elements probe the initial metallicity of their environment at the time when their progenitors were born. This covers a range in ages that can be hardly covered using other classes of stars.

Moreover, nowadays PNe are used as reliable extragalactic distance indicators, through the invariance of their luminosity function with galaxian type and metallicity (Jacoby, 1989). Finally, as they are also detected in stellar systems of low surface brightness, they are extremely valuable test particles to map the dynamics of stars in galaxies up to very large galactocentric distances (the Planetary Nebula Spectrograph at the WHT is an instrument especially built for this purpose, see e.g. Merrifield et al. (2001).

For the reasons above, we have been intensively searching for PNe in nearby galaxies as one of the main objectives of the Local Group Census (LGC). The LGC is a narrow-band survey of the galaxies of the Local Group observable from La Palma, that was awarded observing time during period two of the ING Wide Field Imaging Survey programme (`http://www.ing.iac.es//WFS/`). Observations are being obtained with the Wide Field Camera at the 2.5m Isaac Newton telescope, covering a field of view of 34′×34′. The aim of the survey is to find, catalogue and study old and young emission-line populations (e.g. HII regions, PNe, SN remnants, Luminous Blue Variables, WR stars, symbiotic binaries, etc.) to unprecedented levels. The value of narrow band [OIII], Hα, [SII], and HeII images is enhanced with complementary broad band data (*g*, *r*, *i*). This enables, in principle, the linkages between stellar populations to be probed.

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

Before our census, only a small number of PNe were known in the dwarf irregular galaxies of the Local Group (3 in Sagittarius, Walsh et al., 1997; Dudziak et al., 2000; one in Fornax, Danziger et al., 1978; one in Leo A and another one in Sextans A, Jacoby & Lesser, 1981; one in NGC 6822, Killen & Dufour, 1982). With our survey, so far 16 PNe in IC 10, 5 in Sextans B and 3 in IC 1613 were newly discovered, while the existence of one candidate planetary nebula in Leo A, one in Sextans A, and about 25 in NGC 6822 were confirmed (Magrini et al., 2002, 2003; Leisy et al., 2003). No PNe are instead found in GR 8, as expected because of the small luminosity of this galaxy. The data are illustrated in the colour figures in the next page; in each image, green is the [OIII] emission, red the Hα one, while blue corresponds to the broad band Sloan-*g* images, mainly dominated by continuum stellar emission. In these images, planetary nebulae stand out as green or yellow dots (a striking example is the green luminous object on the upper-left side of the image of Leo A).

The LGC detections provide a more complete view of the population of PNe in the Local Group. These new data appear to be consistent with the predictions of the stellar evolution theories mentioned above, as the number of observed PNe in each galaxy scales reasonably well with the luminosity of the galaxy (Magrini et al., 2003). In spite of this agreement, there are also some interesting peculiarities. For instance, Sextans A and Sextans B have very similar *V*-band luminosities and mass, but while five PNe were discovered in Sextans B, only one candidate is detected in Sextans A. Statistically, this difference is only marginally significant, but may suggest some differences in their star formation history, as evidenced by the stronger main-sequence population of Sextans A compared to Sextans B.

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

Another result of our survey is the discovery of candidate planetary nebulae at large galactocentric distances, like in the case of IC 10 where they cover an area of 3.6×2.7 kpc, much more extended than the 25 mag·arcsec^{-2} diameter (1.1×1.3 kpc). Are these PNe related to the enormous neutral hydrogen envelope surrounding IC 10 (Huchtmeier, 1979)?

The new detections of the LGC are clearly a starting point for future spectroscopical studies of individual objects, aimed at confirming their nature as PNe and, more importantly, at determining their physical and chemical properties and of their host galaxies. This will be our next objective, together with the analysis of the other galaxies observed by the LGC.

Updated information on the status of the project, including the list of all the astronomers and institutions involved, can be found at: `http://www.ing.iac.es/~rcorradi/LGC/`. ¤

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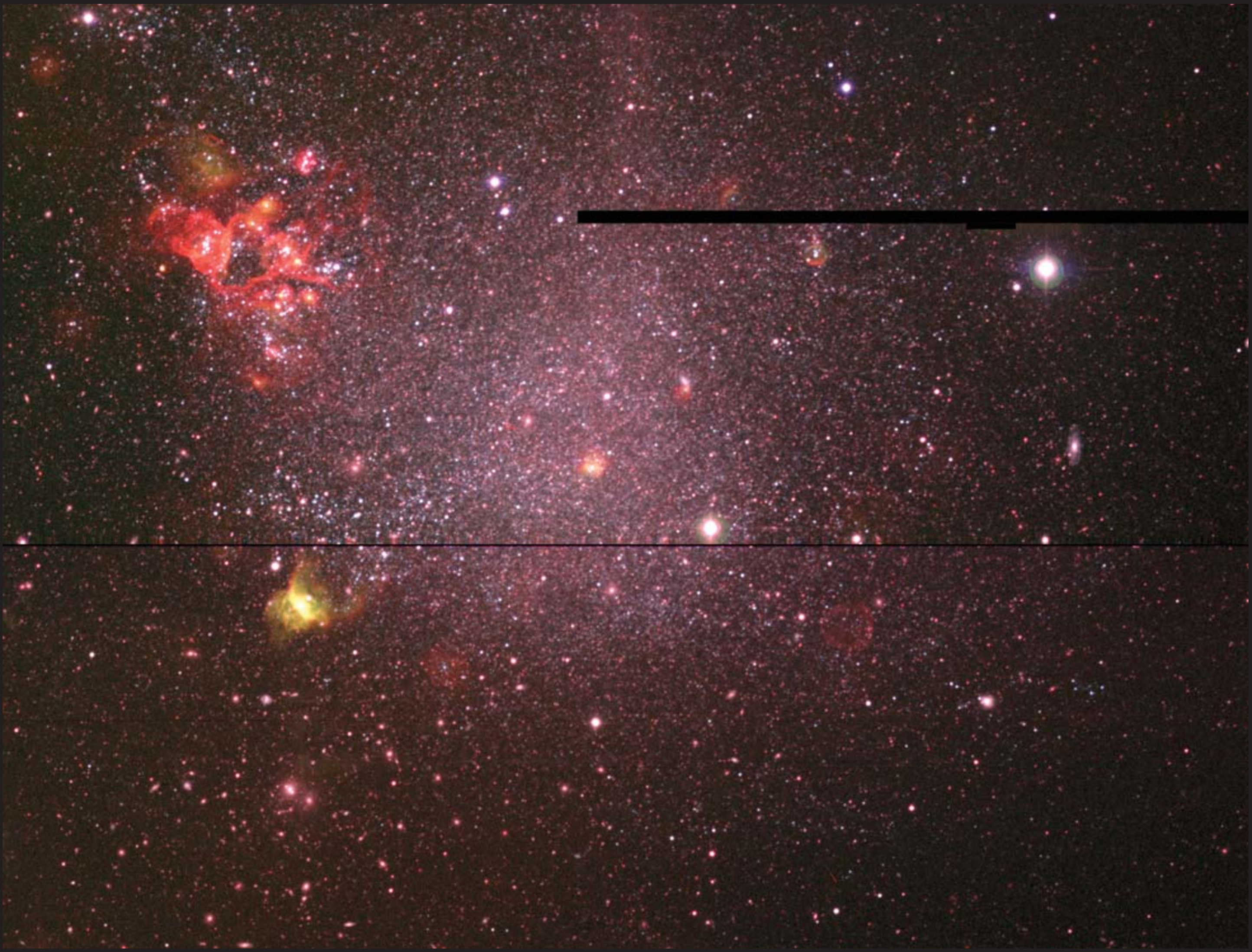
Next page: Three-colour images of NGC6822, IC1613, IC10, Leo A, GR8, Sextans B, Sextans A and WLM galaxies of the Local Group. In each image, green is the [OIII] emission, red the Hα one, while blue corresponds to the broad band Sloan-g images, mainly dominated by continuum stellar emission. In these images, planetary nebulae stand out as green or yellow dots (a striking example is the green luminous object on the upper-left side of the image of Leo A).

NGC 6822



IC 1613

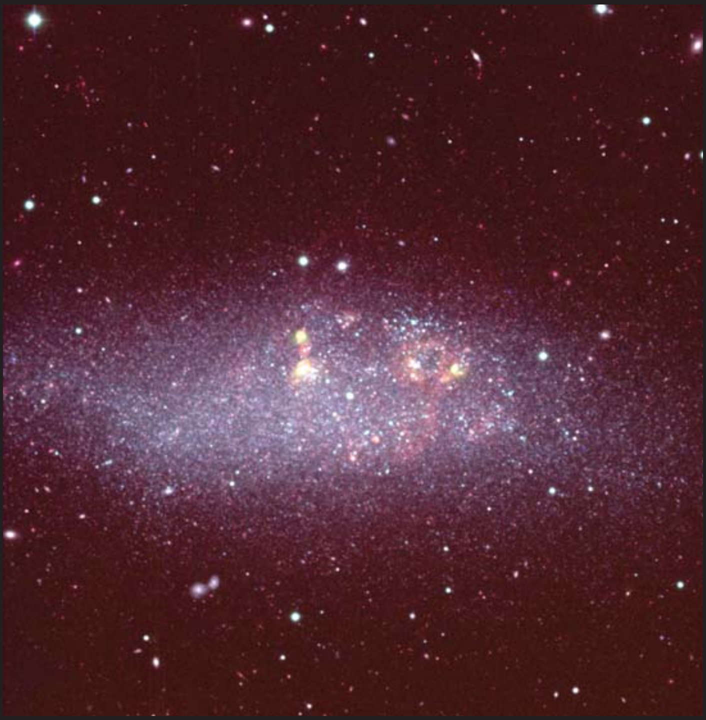
IC 10

Leo A

GR 8

Sextans B

Sextans A



WLM

TELESCOPES AND INSTRUMENTATION

First Commissioning of the IR Spectrograph LIRIS

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J. M. Delgado, C. Domínguez-Tagle, E. Hernández, R. López, A. Manescau, A. Manchado,
H. Moreno, J. Olives, L. Peraza, F. Prada, P. Redondo, V. Sánchez, N. Sosa, F. Tenegi (IAC)

The near-infrared spectrograph LIRIS was first commissioned on the WHT on the nights of 15–19 Feb 2003. During all that time the instrument functioned with no major failures. At the time of commissioning LIRIS included imaging and spectroscopic observing modes. Spectroscopy could be done at low resolution (about 700 using the narrowest slit of 0.65″) using two grisms: One simultaneously covers the bands Z and J (9230–15,425 Å) with a dispersion of 6.1 Å/pix; and the other covers the bands H and K (14,600–24,946 Å) with a dispersion of 10 Å/pix.

The weather conditions during the commissioning were good; 3 out of 4 nights were photometric and only half a night was lost due to high humidity. On two of the nights the seeing was about 0.5″, as measured by LIRIS. The image quality over the whole field appeared to be very good (see Figure 2). The PSF over the whole field remained very uniform, with variations of width smaller than half a pixel (0.13″) across the whole field of view. The image quality was very good in the different bands, and the best telescope focus results constant, independent of the filter used.

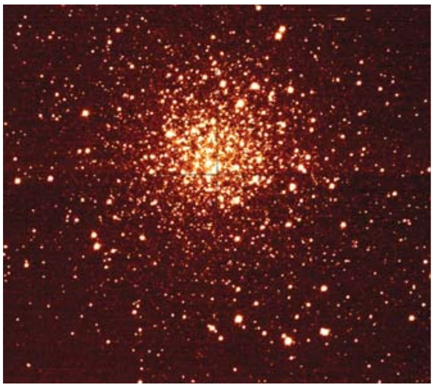


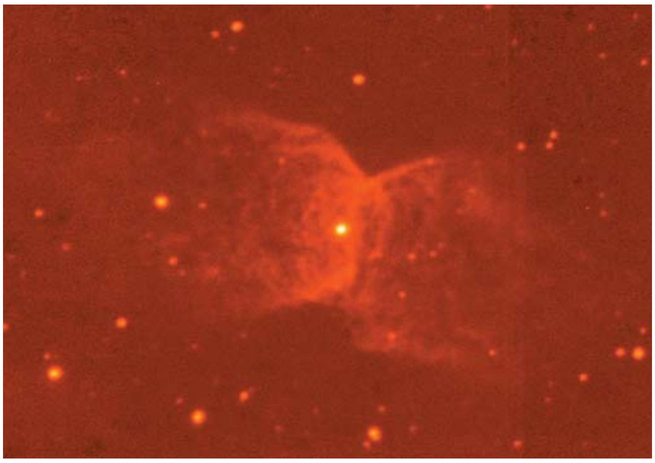
Figure 1 (top left). LIRIS mounted on the WHT Cassegrain focus. LIRIS cryostat can be seen at the bottom of the telescope focus, with the two electronics racks at both sides. Figure 2 (top right). The globular cluster M5 in the J band. The FWHM of the PSF was 2 pixels corresponding to 0.5″. The image quality is very good over the whole field of view (4.2arcmin^2). Figure 3 (right). Arrival of LIRIS at the WHT in January.

LIRIS was funded and built by the IAC, the optical and the conceptual mechanical designs were provided under contract by the UKATC. The Spanish contractor INGOVI manufactured the LIRIS vacuum vessel and optical bench. For more detailed information about LIRIS' design, manufacturing and capabilities see Acosta-Pulido et al. (2002, *ING Newsletter*, **6**, 22). For updated information, including instrument simulator, please consult our web site at: `http://www.iac.es/proyect/LIRIS/`. LIRIS is equipped with a 1024×1024 Hawaii detector, using a SDSU controller. The engineering detector was used during the commissioning. The detector temperature was kept stable at 61 K. The readout noise was 4.8 ADU or 24 e^- in double correlated mode. This value can be effectively reduced using multiple non-destructive readouts (for instance it reduces to 12 e^- when 4 readouts are made). The minimum integration time allowed by the controller is 1 s. LIRIS is always limited by background noise for imaging mode in H and K_s bands, and in J band for exposures longer than 4.5 s. In spectroscopic mode the same condition is reached for exposure times longer than 380 s and 42 s in the ranges $Z-J$ and $H-K$, respectively.

The photometric zero point and the system efficiency (optics & detector) were measured in the different bands (see Table 1). We also report the average sky brightness. Remarkably, the sky background in K_s measured with LIRIS is among the lowest reported with similar instrumentation at different telescopes. We would like to point out the fact that the WHT is not an IR optimised telescope. The limiting magnitude was computed for detection at 3σ in an hour of on-source integration with a seeing of 0.7″.

Filter	J	H	K_S
Zero Point	24.83	25.17	24.55
Efficiency	0.34	0.53	0.52
m_{lim}	23.4	22.4	21.8
$<m_{\mathrm{sky}}/\mathrm{arcsec}^2>$	15.4	14.2	13.0

Table 1. LIRIS photometric characteristics.



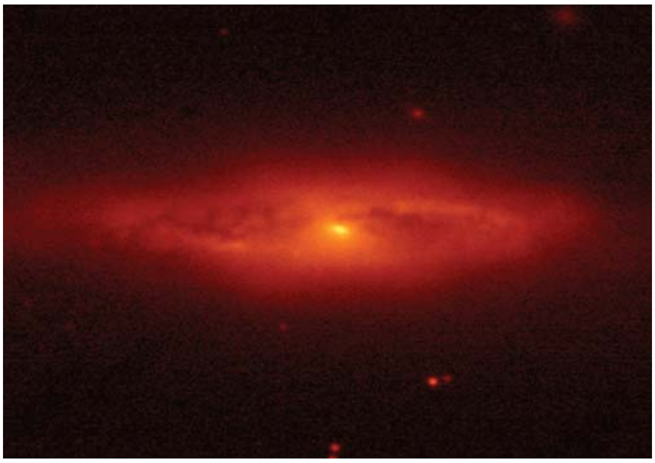


Figure 4 (left). The planetary nebula NGC 2346 in the emission of H2 v =1-0 S(1) at 2.122 μm. The field of view covered in this picture is approximately 3.2 x 2.8 arcmin^2. North is to the right and East is at the top. Note the clumpy structure in the lobes and the bright central star, only visible in the infrared. Figure 5 (right). The Seyfert 2 galaxy NGC 4388 observed in the J filter. The field of view covered in this picture is 2.5x2 arcmin^2. North is at the top and east to the left. Note the very bright active nucleus and the patchy structure of the spiral arms, revealing the presence of obscuring dust lanes.

The rigidity of the instrument, in particular the flexures of the slit wheel with respect to the rest of optics is a critical point for spectroscopic observations. A displacement along the spectral axis during a LIRIS exposure will introduce several unwanted effects, such as smearing of the spectral features, and flux losses due to light coming from the object not passing through the slit. Moreover the position of the slit on the detector needs to be known at any time in order to accurately centre the target object. The LIRIS rigidity was checked with good results. It was found that the maximum shift (with respect to zenith position) along the spectral direction does not exceed 0.5 pixel, or 0.12″, at 45º zenith distance (ZD), although it reaches 0.8 pixel at 60º ZD. The flexures along the spatial direction were slightly worse, reaching about 1 pixel (0.25″) at 45º ZD and certain rotation angles of the Cassegrain turnplate.

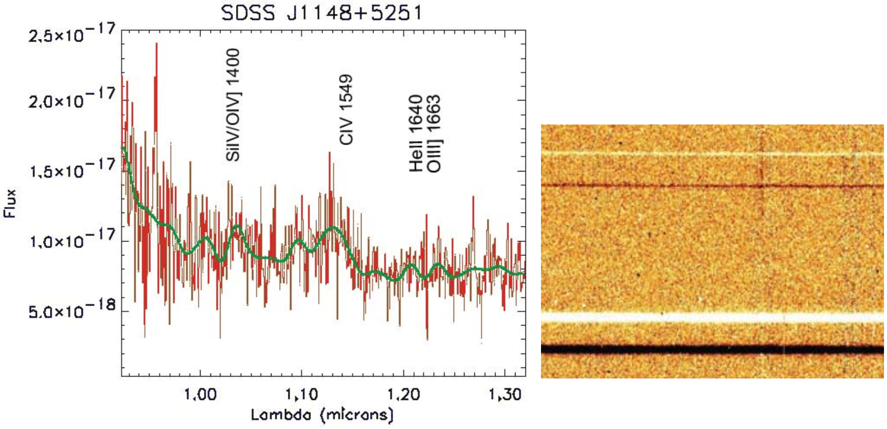


Figure 6. Two-dimensional spectrum of the most distant QSO at z=6.41 (top bright row). The extracted spectrum is shown in the left panel. A fit to the spectrum is also shown, where several broad emission lines are identified. The most intense feature is the CIV line, detected with a S/N ratio of 10. The spectrum is the co-addition of 5 frames of 850 s exposure time each, giving an approximate total time of 70 minutes.

A key issue in near-IR astronomy is the sky background subtraction. This is generally performed by following dithering patterns on the sky, which involves a good deal of interaction of the instrument data acquisition with the telescope. The WHT was already prepared for this based on the INGRID experience, although the instrument LIRIS introduces new demands in the spectroscopic mode. For IR spectroscopy the target is often offset along a narrow slit and should be always maintained well centred on it to avoid flux losses. For this purpose the telescope and the auto-guider should work in synchronisation with the instrument data acquisition. It was found that the repeatability of the offsets could not be guaranteed beyond 1 pixel or 0.25″, which involved target re-centring after a couple of movements. However the WHT auto-guider is going to be changed and the situation should improve.

The next commissioning period is foreseen for February 2004. During that period the multi-object spectroscopy mode will be the main focus. We also expect that LIRIS can provide polarimetric and coronographic capabilities.

The instrument has so far been used to observe several astrophysical targets of interest. Some of the initial results are presented in the accompanying figures (see Figures 4, 5 and 6). One of the most remarkable results was the observation of the most distant quasar known at the time (SDSS J1148+5251, z=6.41). A spectrum in the bands Z and J was obtained, in which several broad features were detected.

We would like to thank all ING staff and the IAC Instrumentation Area for their excellent support during the preparation and commissioning periods.¤

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OSCA — The Coronographic Mask Device for NAOMI

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1: Isaac Newton Group;
2: University College London

In May 2002 the adaptive optics system NAOMI on the WHT received an instrument upgrade: the coronographic mask device OSCA (Optimized Stellar Coronograph for Adaptive optics).

Coronography in astronomy intends to overcome huge brightness differences on small spatial scales — meaning high contrast imaging. Thus the main science driver for coronography is the investigation of the close enviroment of bright stellar objects, e.g. looking for faint companions or dusty material.

Seeing limited imaging techniques can only provide poor contrast ratios between the peak of the point spread function (PSF) and its wings. Employing adaptive optics (AO) techniques allows for diffraction limited images to be obtained in which the detectivity of faint objects/structures close to bright objects is greatly improved. It is important to note that even using AO the form of the PSF still contains a halo the size of the seeing disk on which the diffraction limited core is located. Adaptive optics is best suited for coronography as the amount of suppression achievable with a coronograph depends directly on the image quality (e.g. FWHM and Strehl ratio).

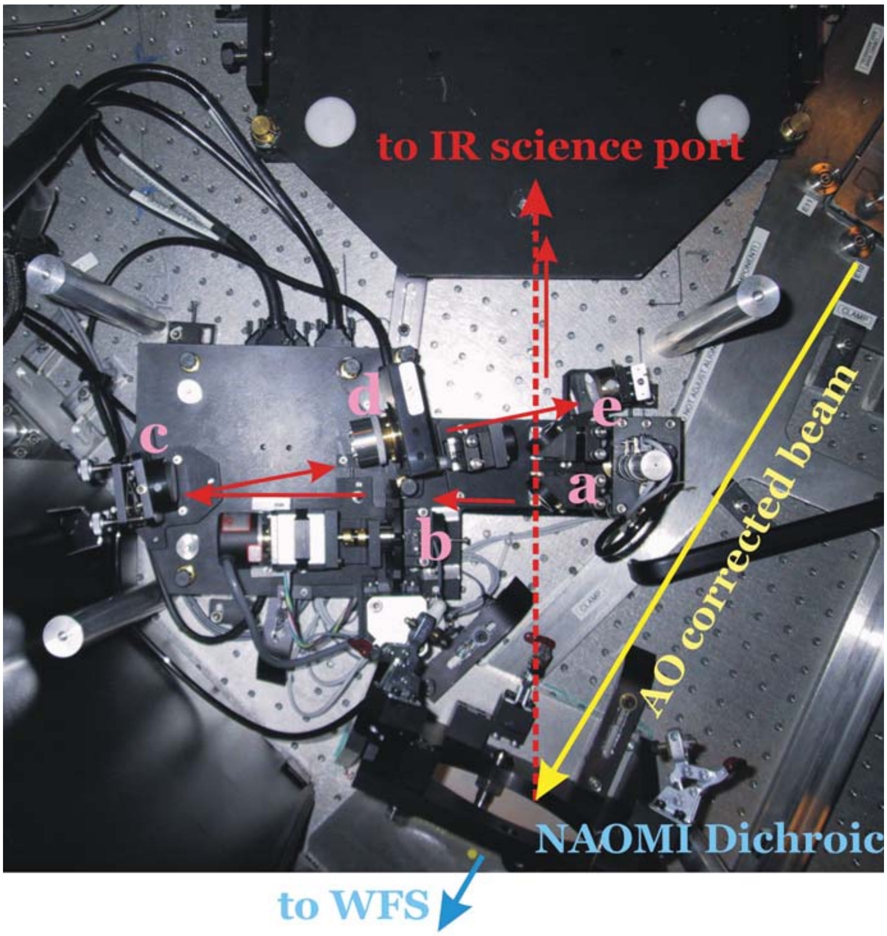
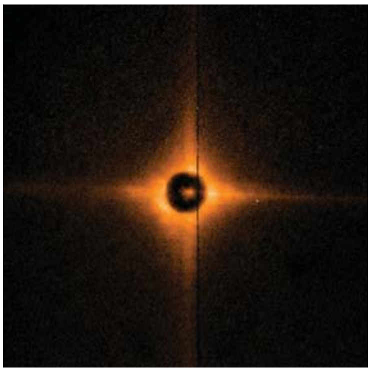


Figure 1. Photograph of OSCA from above the NAOMI bench. The light path is indicated by the arrows. The dashed red line shows the lightpath without OSCA. The pink letters indicate the OSCA optical components and are described in the text.

The coronograph OSCA has been designed and built at University College London by a team led by P. Doel. Here we give only a brief overview over the optical system of OSCA. For further details, please refer to the paper by Thompson et al. (2003). OSCA is permantly mounted on the optical bench of NAOMI. To deploy it into the light path a pneumatic system lifts OSCA from its parking position into the light beam (see Figure 1). Once in the lightpath, a mirror (a) picks up the converging beam coming from NAOMI and directs it onto the focal plane masks (b) and then onto the first off axis paraboloid (c). Currently six hard edged masks with sizes between 0.25″ and 2.0″ are installed. These masks are not fully opaque thus enabling good centering of the target behind them and also allowing good astrometry to be obtained as the light centre of the target can be well measured. In addition to these masks, two gaussian shaped masks with FWHM=0.5″ and 0.6″ for optical wavelengths, have been available since early 2003. All masks are deposited onto wedged substrates giving a circular field of view of approximatly 20″ in diameter. After passing a Lyotstop (c) the beam leaves OSCA via an optical system (d) which conserves the focal point and *f*-ratio of the NAOMI beam. Therefore OSCA can be used with any instrument fed by the AO system.

First on-sky tests show that OSCA allows contrast ratios to be overcome of about $\Delta H \sim 8$ mag compared to the peak intensity over a distance of 2″ or a suppression of about 0.5 – 1 mag compared to the non-coronographic image. This is comparable to other coronographic systems on 4 m class telescopes using AO systems. As OSCA is not a cooled coronograph it will not be used at wavelengths longer than H-band which is also the current limitation of INGRID used with NAOMI. Also, as OSCA is part of the NAOMI system the same restrictions apply for OSCA as for NAOMI observations. For details see the



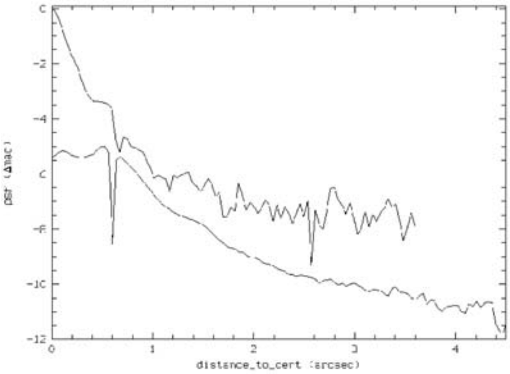


Figure 2 (left). Example of a star behind the 2″ coronographic mask. As the mask is not fully opaque the stars light peak can still be seen and indicates in this case that the star is not perfectly centered behind the mask. Figure 3 (right). Suppression test of OSCA. The upper line indicates a radial cut of a star without OSCA in the NAOMI beam. The relatively low signal to noise of that cut is due to the short integration time of that image. The lower line shows a radial cut through a coronographic image taken with OSCA.

NAOMI webpage:
`http://www.ing.iac.es/Astronomy/`
`/instruments/naomi/index.html`

With OSCA, ING now offers to its users a coronographic device in conjunction with its adaptive optics system NAOMI. At present it can be only used for near infrared imaging using ING's infrared camera INGRID. Observers interested in using OSCA can apply for time in the same way as for other instruments at ING.

With its move to the new temperature controlled Nasmyth station – GRACE – in early 2003 ING's adaptive optics facility NAOMI is expected to perform better and with greater stability in the near future, positively influencing coronographic work.

ING is going to also offer a unique facility to combine AO-fed integral field spectroscopy with coronography. A new instrument for the adaptive optics system will be the integral-field-spectrograph OASIS, installed and commissioned during summer 2003. OASIS will receive an AO corrected input beam from NAOMI. OSCA can then be operated as a NIR imaging coronograph but as well as in the following instrument combination: NAOMI+OSCA+OASIS.

Updated OSCA informations are provided on its webpage:
`http://www.ing.iac.es/Astronomy/`
`/instruments/osca/index.html`.¤

References:

Thompson, S., Doel, P., Bingham, R., et al., 2003, *SPIE Proc*, **4839**, 1085.

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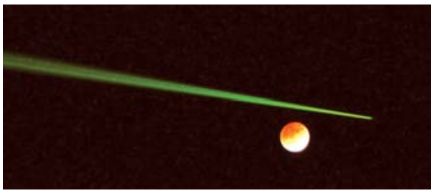
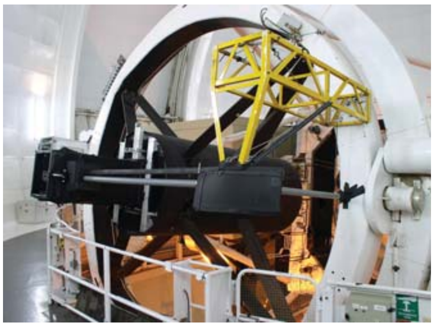
Rayleigh Laser Guide Star Returns to the WHT

Tim Morris (Durham Univ.)





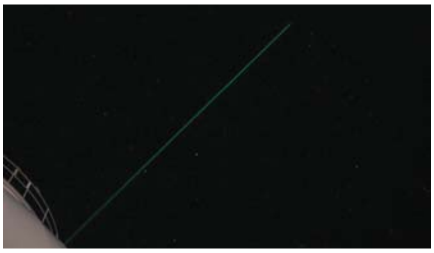


Figure 1 (top). The laser launch coincided with a Lunar eclipse. Figure 2 (middle). Laser launch telescope mounted at the top of the WHT, behind the telescope secondary mirror. Figure 3 (bottom). The laser beam seen projected against the night sky above the WHT.

On the nights of November 7th to 10th, a team from the University of Durham Astronomical Instrumentation Group, together with colleagues from MPIA Heidelberg, had a highly successful second run with the prototype laser guide star on the WHT. Representing the completion of Phase B of the Durham experimental Rayleigh Laser Guide Star (LGS) programme, the two teams were able to collect simultaneous natural and laser guide star wavefront data.

3.5W of 523 nm laser light was projected onto the sky using a custom-made 30 cm launch telescope mounted behind WHT secondary. The laser itself was installed in GRACE and the beam relayed to the launch telescope via enclosed fold mirrors attached to the WHT structure.

A novel, focus-insensitive, wavefront sensor was utilised by the MPIA team to observe the LGS return in GHRIL. Early analysis of the collected data indicates that the focussed spot size at 4.5 km was approximately 2×4 arcseconds in seeing of 1 arcsecond, the spot elongation being due to the ellipticity of the laser output itself.

Reduction of the collected data is underway. The laser operated reliably over the 3.5 nights with no technical downtime. This development work indicates that the proposed 20 W common-user Rayleigh laser guide star system for NAOMI can be implemented with confidence.

The assistance and support provided by ING, without which the trial would not have been possible, is gratefully acknowledged.¤

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SLODAR: Profiling Atmospheric Turbulence at the WHT

Richard Wilson, Christopher Saunter (University of Durham)

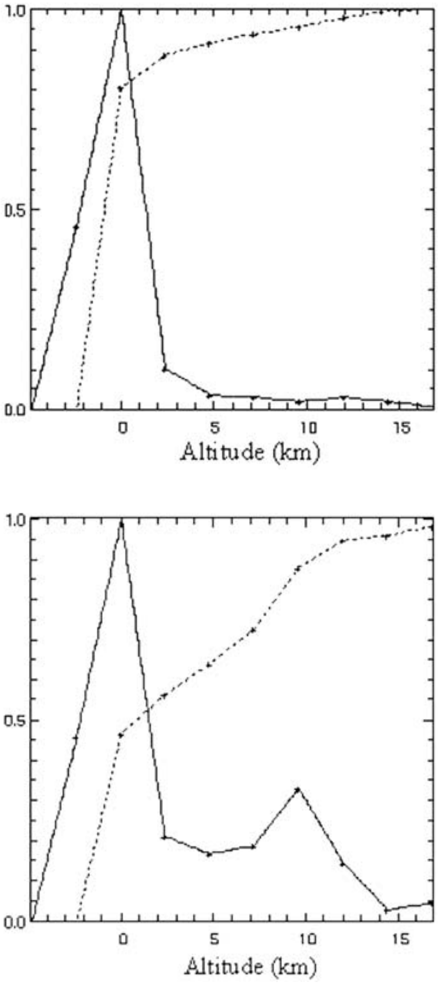

Figure 1. Normalised profiles of the strength of optical turbulence versus altitude for April 15 21:38 UT (top) and April 16 20:45 UT (bottom), 2003.

A new method for measuring the altitude and velocity of turbulent layers in the atmosphere —which cause the astronomical seeing and scintillation or ‘twinkling’ of the stars— has been demonstrated at the WHT. SLODAR (SLOpe Detection And Ranging) is a triangulation method, in which the turbulence profile is recovered from observations of bright binary stars using a Shack-Hartmann wavefront sensor.

In the past, astronomers have been concerned only with the overall effects of the turbulence, in terms of the resulting image spread or ‘seeing angle’ (FWHM for a point source) at the telescope focus. However with the advent of adaptive optical correction for astronomy, measurements of the changing atmospheric turbulence structure are of increasing importance.

The altitude distribution of the turbulence determines the corrected or ‘isoplanatic’ field of view for adaptive optics (AO). High altitude layers reduce the isoplanatic angle, since for these layers the wave-front aberrations measured in the direction of the AO guide star will not coincide perfectly with the aberrations at off-axis field-angles.

The velocities of the turbulent layers are also important, since these determine the rate of change of the seeing aberration at the telescope, and hence the temporal bandwidth of the AO control system required to achieve effective image correction.

SLODAR is a highly automated system which can provide real-time data for optimising and calibrating observations with AO. More details of the method and instrument can be found at the Durham astronomical instrumentation website: `http://aig-www.dur.ac.uk//fix/projects/slodar/res/wht.html`.

Figures 1 and 2 show SLODAR results for April 15th and 16th, both recorded in excellent seeing (0.45 arcsec), but with contrasting turbulence profiles. The conditions on April 15th were dominated by ground-level turbulence, whereas significant turbulence at higher altitudes was present on the 16th. Hence although the overall seeing was the same for the two nights the conditions for AO were different. The isoplanatic angle was very large on April 15th, but was reduced on the 16th by the presence of the high altitude turbulence.¤

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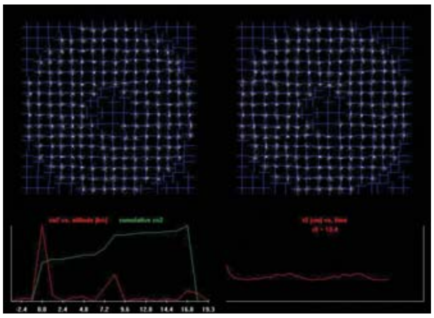


Figure 2. Snapshot of the WHT SLODAR system graphical user interface, showing the Shack-Hartmann spot patterns for a binary star, and real-time plots of the turbulence-altitude profile and the integrated turbulence strength versus time.

Amazing GRACE

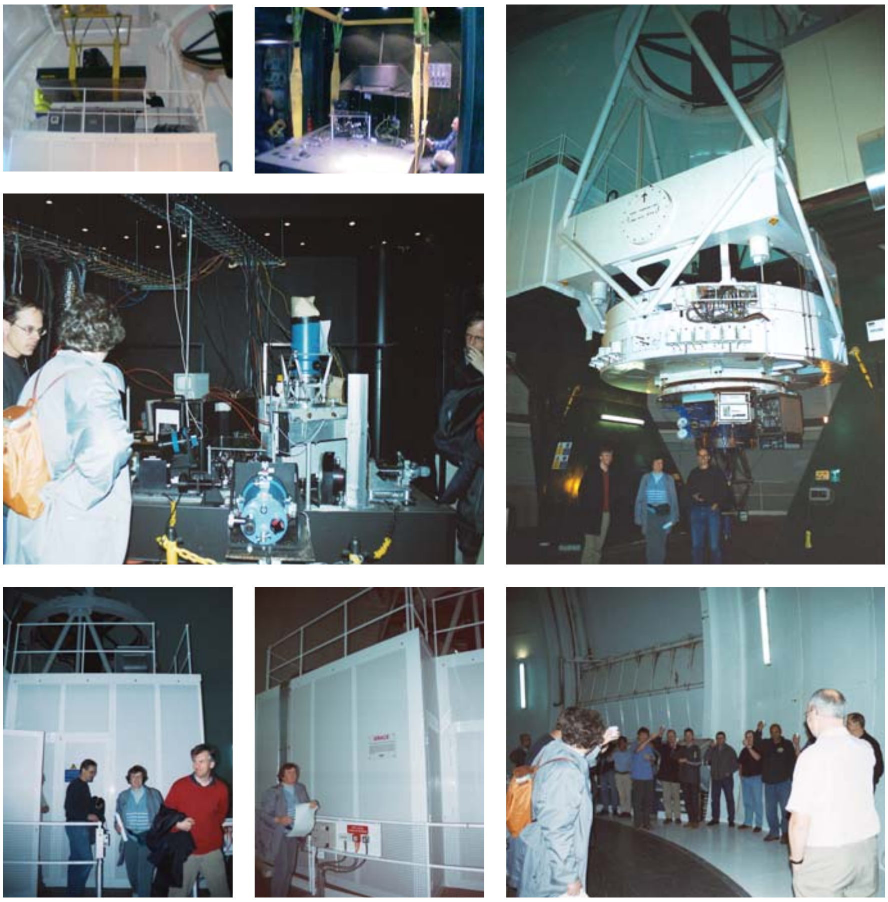
G. Talbot, A. Chopping, K. Dee, D. Gray, P. Jolley (ING)

The profile of the William Herschel Telescope (WHT) has changed since the beginning of this year, with the addition of a new facility at one of the telescope’s Nasmyth platforms. For many years the WHT has had the GHRIL building on the Nasmyth1 platform —now the ING has added GRACE to the opposite side of the telescope. GRACE (**GR**ound based **A**daptive optics **C**ontrolled **E**nvironment) is a dedicated structure designed to facilitate the routine use of adaptive optics (AO) at the WHT, using ING’s AO instrument suite. The design of GRACE allows for the future use of laser guide stars.

The AO suite consists of the AO system NAOMI, the coronograph OSCA, near IR imager INGRID and the optical integral field spectrograph OASIS. The bench-mounted NAOMI system achieved first light in 2000 with INGRID as its science camera in GHRIL, but until the advent of GRACE, the NAOMI optical bench complete with delicate (and expensive!) optical and electronics components has had to be craned in and out of GHRIL every time there has been an instrument change. Quite apart from the risk involved, there has been a massive overhead for ING staff in disconnecting and removing everything, with an even more massive overhead in putting everything back, aligning it and getting it working — three weeks was allowed for this!

After the first NAOMI instrument change, it was realised that for routine operation moving NAOMI about was not sustainable. This was re-inforced with the signing of the agreement with the Centre de Recherche Astronomique de Lyon (CRAL) to bring OASIS to the WHT, which added a further large complex instrument to the equation.

Accordingly ING made the decision to create a dedicated facility on the Nasmyth 2 platform then used by the Utrecht Echelle Spectrograph (UES). A suitable building was designed taking into account the requirements of the AO suite. To provide sufficient space an extension to the Nasmyth platform was needed and this was also designed at this time. A local La Palma company, Grolei Servicios S. L., was successful in winning the contact to construct the building. Their proximity to ING allowed progress to be monitored, problems resolved and modifications to be made quickly resulting in an excellent building, fulfilling ING's requirements.



Top left: NAOMI suspended from the crane (by the yellow straps) above GRACE, just before being lowered through the access hatch. Middle top: The Eagle has landed! The NAOMI bench complete with deformable mirror being lowered onto its kinematic mounts inside GRACE. Right top: Dr Ronald Stark, Dr Annejet Meijler and Dr René Rutten standing up in front of WHT. GRACE can be seen on the Nasmyth platform on the left, opposite to GHRIL. Middle left: Inside GRACE. Bottom left: Inaugurating committee leaving GRACE. Bottom middle: Dr Annejet Meijler uncovering the inauguration plate. Bottom right: Dedication to ING staff.

GRACE is not just a building, it offers all of the systems associated with providing the controlled environment necessary, especially cooling and filtering of the air, together with all of the services needed including electrical supplies, lighting and a computer network. While the building was being built, we continued to design and specify these systems.

Crucial to success is environmental control. The GRACE electronics room is maintained at a constant temperature by an air-handling unit mounted on the roof. For the optics room, the air is again maintained at a constant temperature for the stability of the instruments, additionally being finely filtered and introduced at low velocity through laminar flow units to minimise air currents. The heat from GRACE is removed (not dumped in the dome) through a water glycol circuit. The opportunity was taken to upgrade the cooling capacity to the whole of the WHT, in order to meet future needs including a laser guide star, by buying and installing a new external plant.

The first step was the removal of UES and the extension and modification of the platform ready for the building.

Installation of the completed building, which was dismantled for transportation, began late in 2002. A significant moment was reached on 18 March 2003 when the NAOMI adaptive optics system on its bench was lifted into its new and permanent home. This was followed quickly by its first light in GRACE using INGRID on 13 April at the beginning of a nine-night run. The second 'first light' event for GRACE followed soon after when, on the 11 July, OASIS went on sky with NAOMI on its first commissioning night.

A key concern was that GRACE would not change the telescope performance when replacing UES. During the construction phase several blocks (weighing a tonne each) were used to ensure that the removal of UES did not unbalance the telescope. These were progressively removed as GRACE was assembled. The opportunity was taken to brace the new platform extension to the telescope structure. Tests after GRACE installation was complete show this was effective in raising the natural frequency considerably, away from the telescope's azimuth locked rotor frequency, which was the required result.

During the time of restructuring for ING, the creation of GRACE is a major achievement, especially when set against the background of other project work not least adding the Universal Science Port to NAOMI to feed OASIS. Many, if not most ING staff have contributed to GRACE and in getting the AO suite installed and working. In the end —over the last months, then weeks— it's still hard to believe how much was done and how hard everyone worked.

Dr Annejet Meijler, the Director of the Council of Physical Sciences of the NWO, formally inaugurated GRACE on May 2nd, 2003. ING staff take pride in having a world class environment for AO which was, in the words of the plaque unveiled, 'conceived, designed and built' by them.¤

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OASIS at the WHT

Chris Benn (ING),
Gordon Talbot (ING),
Roland Bacon (Univ. of Lyon)

The optical integral-field spectrograph OASIS, formerly at the CFHT, has moved permanently to the WHT. It is now installed at one of the science ports of NAOMI, the WHT's adaptive-optics system. OASIS was successfully commissioned on-sky with NAOMI in July 2003, and it is offered to the community on a shared-risks basis in semester 2004A.

OASIS offers a range of spatial and spectral resolutions. An area of sky between 3 and 16 arcsec in diameter (4 enlarger options) can be imaged onto the array of 1100 lenslets in the focal plane. Six grisms provide spectral resolutions in the range $1000<\Re<4000$. The 1100 resulting spectra are imaged onto a deep-depletion MIT/LL CCD, with dispersion 1 to 4 Å/pixel (15 μ pixels). The CCD has high QE (0.9 at 0.75 microns) and low readout noise (2.3 electrons rms in slow mode). The fringing level is low, ~3% at 0.8 μ, and ~10% peak-to-peak at 1 μ. A version of CFHT's XOASIS data reduction package is available at ING for reduction of OASIS data. OASIS can also be used in imaging mode (primarily for target acquisition), with a field diameter of 38 arcsec. Further information about OASIS can be found on the web page: `http://www.ing.iac.es/Astronomy/` `/instruments/oasis/index.html`.

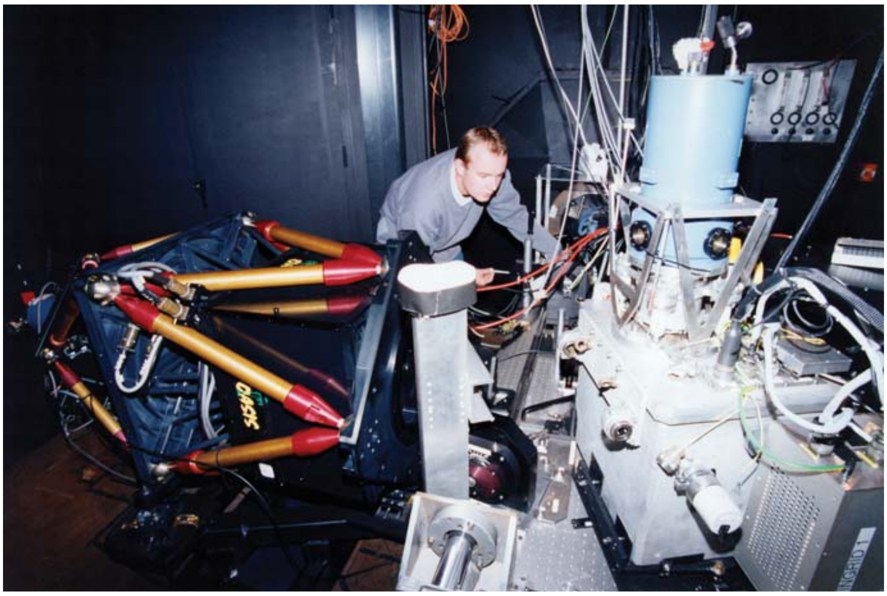

Figure 1. OASIS (left) joins NAOMI in the WHT's new AO-dedicated, temperature-controlled Nasmyth enclosure, GRACE. The IR camera INGRID is visible in the foreground on the right.

OASIS can be used with or without AO correction. NAOMI typically delivers a reduction in FWHM of a few tenths of an arcsec at wavelengths 0.6–1.0 μ. The best corrected seeing achieved during the July 2003 OASIS commissioning was 0.3 arcsec. Guide stars must currently be brighter than V ~13. The guide object may also be a galaxy nucleus, if sufficiently compact. Some correction is achieved even when the science target lies several 10s of arcsec from the guide star. Performance and throughput are expected to be at least as good as achieved at CFHT. Information about NAOMI can be found on the web page: `http://www.ing.iac.es/Astronomy/` `/instruments/naomi/index.html`. ¤

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Figure 2. OASIS logo for joint operation with NAOMI.

RoboDIMM —The ING's New Seeing Monitor

Neil O'Mahony (ING)

A brand new dome stands near the William Herschel Telescope, its white surface reflecting the strong mountain sunshine. Inside is ING's automatic seeing monitor, RoboDIMM, which became operational in August last year. What was announced as a project in the March 2001 *ING Newsletter*, **4**, 27, in an article by Thomas Augusteijn, is now a fully functioning reality.

The Differential Image Motion Monitor, proposed by Sarazin and Roddier (1990, *A&A*, **227**, 294) and based on a small telescope and relatively inexpensive equipment, has over the last 10 years become the most common seeing measurement method used in site testing and characterisation. Nowadays, whether for control of image quality or to help decision making in queue scheduling, DIMM-type seeing monitors have become an indispensable tool in observatories around the world. The seeing has become just one more "meteorological" datum that ground-based astronomy is expected to have at its fingertips.

This is why, in common with observatories in Chile and elsewhere, the ING chose to replace its DIMM (1994–1999) with a new "robotic" DIMM. ING's RoboDIMM now fulfills its projected function, which was to make reliable seeing measurements available throughout the night, requiring user intervention only for startup and shutdown, and controlled remotely from the WHT control room.

RoboDIMM started observing in August 2002, to coincide with the first NAOMI "science run" at the WHT. It sampled the seeing on 85 nights until December, missing only 20% of nights, mostly due to poor weather. Around this time, a fault with a telescope drive motor began causing significant down-time. Now the motor has been replaced and RoboDIMM again accompanied the NAOMI run of April 2003. It has continued in its routine job of seeing monitoring throughout last summer without pause.

Figure 1 (left). RoboDIMM stands ready at sunset for a night's observation at the Roque de Los Muchachos observatory. The dome is opened remotely from the WHT control room and the automatic observing program is started. The tower, 5 m tall, is located about 75 m north of the dome of the William Herschel Telescope, on a gentle slope facing unobstructedly the prevailing winds.

Figure 2 (right). The RoboDIMM telescope at polar park position, with the WHT in the background. The entrance aperture forms 4 separate images of the same star (the large central aperture is no longer used). The sub-apertures, covered by optical wedges, are aligned along N/S and E/W (despite what the perspective here may suggest). Both photos by R. Gorter of Startel.

Installed atop a 5 m tall tower (see Figure 1), which it inherited from the previous DIMM installation, RoboDIMM is built out of a combination of off-the-shelf hardware items, with the vital addition of custom-made software.

The main commercially available components are a Meade 12″ Schmidt-Cassegrain telescope (LX200 model), an ST-5C CCD from Santa Barbara Instruments (SBIG), and a 12′ diameter (3.7 metre) dome with motorised opening supplied by Astrohaven in Canada. The other vital component, a mask that goes over the telescope entrance aperture, was machined in-house, to which some specially ordered small-deviation prisms ('optical wedges') were added.

It is worth mentioning some special properties of the tower, designed by Dario Mancini of Capodimonte Observatory and used elsewhere at ORM and at ESO's Paranal Observatory. It consists of a vibration-proof central truss, 5.2 m tall, upon which the telescope is mounted, and a second tower that surrounds it and supports an "access platform". In the case of RoboDIMM the latter has been slightly widened to house the dome. The two structures are mechanically independent, so that the telescope is isolated from vibration caused by wind buffeting of the dome. When fully open, the dome presents a 1.5 m-high barrier to the wind, from which the telescope stands proud. Since ground layer heating is significantly reduced at the height of the tower, we assume that the dome induces minimal optical turbulence and has insignificant effect on the DIMM measurements. The support struts allow the wind to flow around them, and louvered ports in the dome floor open automatically, improving vertical airflow.

The control software was written for ING by Startel Ltd., in the Netherlands (`www.startel.nl` (Dutch language), `www.robodimm.com` (in construction)). It is a C++ program, running on a Linux-based PC, and controls all relevant automatic functions: from choosing suitable targets and acquiring them, to controlling the CCD, processing measurements and writing them to a database. The telescope is commanded through a serial port connection to the PC, exploiting a feature of the Meade LX200. The program runs a continuous sequence of tasks but also allows user intervention and control of status and data quality through a graphical interface.

Operation

At present the dome must be opened and closed by ING personnel, formally the WHT Telescope Operator, from the control room of the WHT. This may be automated in the future, and the upgrade to the telemetry system that this would require is being considered. We may then be able to implement automatic closure in response to adverse weather conditions.

The control program can be left running permanently, because it automatically stops observing at sunrise and will automatically start again around the following sunset, depending on the brightness of available targets. This lightens the workload on the TO at the beginning of the night and helps to provide an early seeing estimate, sometimes even before the sun has gone down! Such an early estimate has clear applications in queue observing. If a seeing measurement is available over the previous 5 minutes, it is published on the ING Weather Station Web page, (`www.ing.iac.es/ds/weather/`). A graph of the night's data is also publicly available (at night time) through the Weather Page, as is the full set of archived data (or see http://`www.ing.iac.es/ds/robodimm/`).

The chosen target is the brightest available star within 30 degrees of the zenith, in a magnitude range of 2 to 4, although brighter stars can be used in cloudy conditions. The acquisition field is almost 4×3 arc minutes, but if no star is found in the first CCD image taken at the target position, the program starts a search spiral. In clear conditions this usually results in a successful acquisition within a few minutes. Once the star is near enough to the centre of the CCD, the pointing offset of the telescope is updated, the readout is windowed and a series of 200 images with 10 ms exposure is taken. After this, there is a brief pause while the standard deviation of the images' relative positions is measured and the FWHM is calculated from this. The program then repeats the sampling and measurement cycle to provide continuous monitoring, moving to a new star when the observing elevation goes below 60 degrees.

A seeing measurement is made at irregular intervals of approximately 2.5 minutes, and most of that time is spent taking the 200 images in the sample. This is a much longer duty cycle than the original ING DIMM, but it may be possible to speed this up in future by customising the firmware on the CCD controller. We estimate a further 20% of operative time for which no measurement is available due to miscellaneous overheads, which may be improved upon. The software is now fully functional with small improvements continually being added, in close collaboration with the software authors, Startel.

Interpretation

RoboDIMM forms 4 images of the same star (see Figure 2), measuring image motion in two orthogonal directions from each of the two pairs of images, from which it derives 4 simultaneous and independent estimates of the seeing. When the system is correctly set up, these 4 measurements should agree, over a reasonably sized sample. We find that relative sizes vary from night to night and show a noticeable sensitivity to the focus position of the Meade telescope, which has been observed to flop after a telescope slew. At present the focus has to be adjusted by user command using an electronic focuser mounted above the CCD, but we are investigating whether to fix the focus mechanically or make automatic adjustments in the future.

The measurement published on the Weather Page is the average of 4 simultaneous database entries, and users should be aware that this page is compiled using data from up to 5 minutes prior to the posted time. Up-to-date and individual measurements can be viewed by following the 'Seeing' link on the Weather Page. The database values are automatically corrected for the observing zenith distance (dividing by airmass to the power 3/5) and a wavelength of 550 nm and the time listed is that at the middle of the sample. The four instantaneous values can differ by, say, 20%, but what matters is that there should be no significant long term difference.

The general impression is that the average seeing published on the Weather Page agrees reasonably well with seeing being obtained at the William Herschel Telescope, including NAOMI and Richard Wilson's "Slodar" wave front sensors (see article on page 19), and with that obtained at other telescopes. It has shown sensitivity to all seeing conditions, registering averages as low as 0.35″ and (during the passing of a warm front) as high as 7″! A comparison with seeing data from the IAC DIMM (provided by the Sky Quality Group at the Instituto de Astrofísica de Canarias), using simultaneous samples of several hours length from 9 nights in October 2002, shows a 91% correlation (see Figure 3) between the seeing FWHM measurements made at the two instruments. The differences between the median values is scattered around $y = x$ by an amount varying between 3 and 15% on any given night, or about 8% on average. This average discrepancy is no larger than the internal error of either instrument.

The good agreement exists in spite of the large distance between the two monitors (several kilometres), the factor 10 difference between their sample duty cycles and their independent designs. Periods of rapidly fluctuating seeing were generally excluded from the samples used in this comparison, to avoid possible local effects.

While this result is encouraging and allows a good deal of confidence in RoboDIMM's seeing measurements, it is not conclusive, since no median below 0.6 arc seconds was used. Calibration of RoboDIMM is ongoing, including characterisation of intrinsic errors and comparison with other seeing monitors such as NAOMI's Wave Front Sensor.

As regards hardware components, ING's RoboDIMM bears a close resemblance to the CTIO's automatic seeing monitor (which, incidentally, is also called RoboDIMM, but the originality of that name is disputable! See `www.ctio.noao.edu/telescopes/dimm/dimm.html`). There is an important difference in that the CTIO's takes samples alternating between 5 and 10 ms exposure time. This forms two samples from which the image motion at "zero seconds exposure" is extrapolated, following the method established by ESO in its Chilean seeing monitors. The zero-second seeing may reportedly be 10–20% larger than the 10 ms estimate (A. Tokovinin, 2002, *PASP*, **114**, 1156), depending on the speed and altitude of turbulent layers. When comparing results from different sites, it is important to bear instrumental differences in mind but we should also remember that the strength of the exposure time "blurring" effect may differ greatly between sites, as well as vary over time.

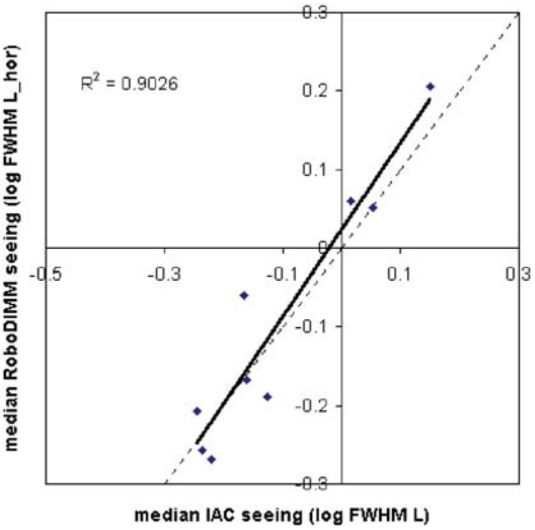


Figure 3. A scatter plot of the seeing FWHM measured by the IAC DIMM as a function of simultaneous RoboDIMM seeing. The best fit line, close to y=x, and the large correlation coefficient (0.91) illustrate the close dependence of these two variables. Each of the 9 points represents the median seeing from simultaneous samples formed by a continuous period of stable seeing lasting several hours. The logarithmic scale is necessary to convert seeing FWHM into an approximately normally distributed variable.

Conclusion

With the commissioning of the RoboDIMM seeing monitor, ING has provided its Adaptive Optics programme with an important auxiliary instrument. It provides a seeing FWHM estimate at regular intervals that can be relied upon to within about 10% in stable conditions. RoboDIMM allows NAOMI performance to be monitored in real time, and also provides essential information for AO observing in queue mode. Additionally RoboDIMM provides all telescopes on site with data that can help astronomers to optimally adjust telescope and instrument focus. It allows them to make sure they are fully availing of the superb natural seeing available at the Observatorio del Roque de los Muchachos.¤

Neil O'Mahony (nom@ing.iac.es)

CONCAM — ING's All-Sky Camera

René Rutten (ING)

It has been a long-standing wish at the observatory to have a night-time all-sky cloud monitor. A cloud monitor, in the first place, allows astronomers in the control room to assess the actual situation of the night sky without the need of having to rush out for a visual check. The latter usually requires rushing up and down stairs, standing in the cold outside, and waiting for the eyes to get adapted to the dark, and even then one would only have a partial snapshot of the situation in the sky.

The ideal cloud monitor works at infrared wavelengths where the contrast between the cloudless night sky and the relatively warm clouds is high. However, a suitable infrared camera is rather complex and expensive to build, and as the equipment has to be located outside, there is a significant maintenance overhead as well. To avoid these problems we have been looking for an alternative for some time and came across CONCAM.

CONCAM stands for CONtinuous CAMera, designed and built by Robert Nemiroff and his team at Michigan Technical University. It is a well designed and built, self-contained system that only requires connecting to electrical power and the internet. CONCAM consists of a fish-eye lens that projects the night sky onto an SBIG CCD camera. The camera itself is controlled by a small notebook PC. The full system sits in a small, well-sealed weather tight box, located on the roof of the liquid nitrogen plant building, close to the junction of the road leading up to the WHT.

The camera switches itself on during evening twilight and stops at the end of the night. Images are taken every couple of minutes, and exposure times are up to a few minutes during moonless periods. Data is automatically transferred to Michigan, and immediately bias corrected and flat fielded. The reduced data and nightly movies are then made available on the web through the on-line CONCAM archive at Michigan (see `www.concam.net`). Copies of the reduced (and compressed) nightly movies are archived locally on La Palma and available at `catserver.ing.iac.es/weather/` `/archive/index.php` (follow the link to the archive and select the required day).

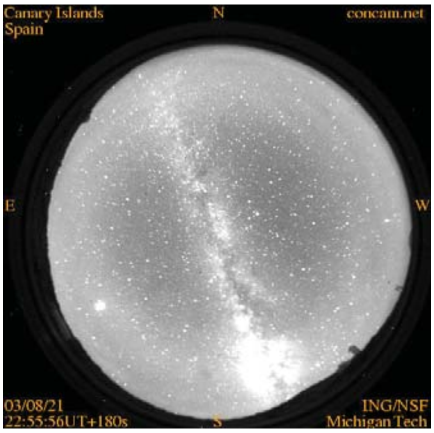
Currently, CONCAM systems are installed not only on La Palma, but also at Mauna Kea, Kitt Peak, Mt Wilson, Wise Observatory (Israel), Rosemary Hill (Florida), South Africa and Siding Spring.

The initiative leading to the development of CONCAM was centred around the idea of monitoring the brightness of relatively bright objects and to permanently look for bright transient events across the whole sky. Besides these primary goals, CONCAM also offers very good possibilities for stimulating public interest, as the sequence of CONCAM images very clearly demonstrate how the sky varies during nights. CONCAM images can show a number of interesting atmospheric and night-sky features. CONCAM shows of course the position of planets and the moon, but also shows the zodiacal light, it announces sunrise and sunset, and even makes visible the patterns in the OH night sky lines. An excellent set of examples of what CONCAM sees is shown at `www.concam.net/phenomena.html`. For ING, however, the main role it serves is that of all-sky cloud monitor.

The all-sky movies that are automatically generated give a very good visual impression of transparency variations across the sky, and how it varies in time. Clouds can be seen rolling in, allowing the astronomer to take advantage of the best parts of the sky and plan the observing programme. Together with the weather maps, the meteorology data, and the robotic seeing measurements, ING now possesses a comprehensive set of tools for planning observations and assessing post-observing data quality.

We are very grateful for the superb collaboration and assistance received from the team at Michigan Technical University, in particular from Robert Nemiroff and David Crook.¤

René Rutten (rgmr@ing.iac.es)



Top left: CONCAM on the roof of the liquid nitrogen plant. Top right: A closer view of CONCAM. Above: CONCAM image of the Palmeran night sky.

L3 CCD Technology

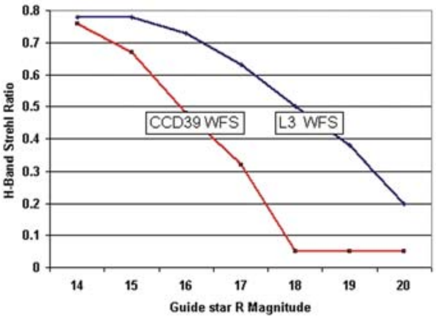
Simon Tulloch (ING)

Low Light Level (L3) CCD technology is a recent development from E2V that opens up interesting new observational regimes. The technology allows production of scientific CCDs in which the read noise of the on-chip amplifier becomes negligibly low. Additionally, this effective zero-noise performance is decoupled from readout speeds and the almost zero noise performance holds up to frame rates of 1 KHz. E2V achieve this by using an avalanche multiplication mechanism in the horizontal register of the CCD. A single photo-electron entering this register exits as a substantial charge packet; the exact gain being variable and determined by the level of a high voltage multiplication clock. At gain levels of around 500 it becomes possible to identify individual photon events in the image. The downside of L3 technology is that the multiplication process degrades the SNR at higher signals by a factor of $\sqrt{2}$. There is also a small additional noise contribution from spuriously generated electrons within the device.

L3 CCDs should be useful in any observing regime currently limited by detector noise. Wavefront sensing is an obvious application and E2V have produced the 128×128 pixel frame transfer CCD60 with this in mind. We have purchased one of these and are currently working on an upgrade to the Naomi WFS. Figure 1 shows the kind of gains we can expect once this system is commissioned. For comparison, the performance of Naomi's current WFS, the CCD39, is also shown.

Other applications for L3 technology are currently being evaluated on the WHT using a cryogenic test camera in which we have mounted the CCD60 (see Figure 2).

This camera was mounted on the Auxiliary port in November where we tested its performance as a fast photometer. On the 10th we observed the Crab Nebular pulsar and were able to directly distinguish its 30 Hz variability. The camera used its own data acquisition system based around a Linux PC and a slightly modified SDSUII controller. This DAS combined the functions of an acquisition TV and a science camera. This was important given the rather small 14 arcsec field of view. Once the image was acquired, the camera switched to its fast photometry mode in which it made a rapid sequence of 1024 windowed readouts at a rate of 180 frames per second. The resultant image format consisted of a ‘movie strip’ of consecutive frames, a short section of which is shown in Figure 3.



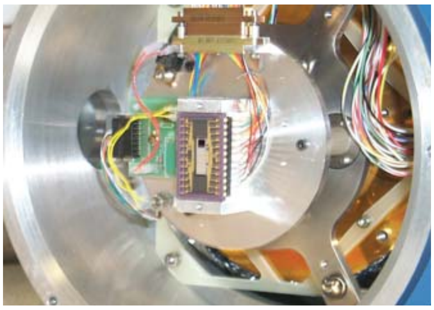


Figure 1 (left). Potential L3 gains in NAOMI. Thanks to Richard Wilson for providing Figure 1. Figure 2 (right). The L3 Test Camera.

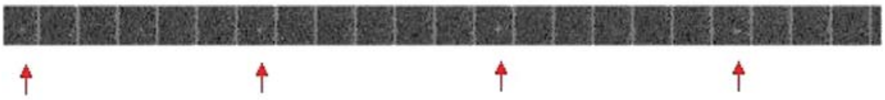


Figure 3. The Crab Pulsar indicated by the red arrows in this series of frames.

Although faint, the pulsar is visible. The red arrows indicate the frames in which the brightness peaks. An animated GIF of these pulsar observations can be found at: `http://www.ing.iac.es/~smt/WFS/` `/CrabMovie.gif`.

We currently have on order a larger engineering grade L3 CCD measuring 512×512 pixels. This will be incorporated into a second test camera and mounted on ISIS where its suitability for rapid spectroscopy will be investigated .

Thanks to Durham University’s RLGS team and to Vik Dhillon for their cooperation in the testing of this new camera.¤

Simon Tulloch (smt@ing.iac.es)

GMOS / bHROS Fibre Connection

M. F. Blanken (ING), G. Talbot (ING), M. Aderin (UCL)

Over the last year (2002–2003) ING was subcontracted by University College London (UCL) to produce a module of 18 science fibres for the bHROS instrument, one of the instruments on the Gemini South telescope.

bHROS is a high-resolution ($\Re$=150,000) prism cross dispersed echelle spectrograph, situated in the pier of Gemini-South. It is fed by optical fibres mounted on the GMOS instrument located at the Cassegrain focus of the telescope. bHROS will have the highest spectral resolution among the optical spectrographs currently being designed and built for 8–10m class telescopes.

The optical fibre connection between GMOS and bHROS consists of 18 fibres; 9 fibres with a 120µm core diameter and 9 fibres with a 160µm core diameter. Both types of fibre had to be ground and polished at both ends. The GMOS end also had to be mounted and aligned in an optical assembly (a body plate). 10 fibres of each type were delivered by UCL to the ING out of which 9 of each were to be used for science. The 10th fibre of both types was manufactured in case of any breakage.

The first stage after receiving the fibres was cutting them to the desired length. After this metal tubes were glued over the fibre ends to make the grounding, polishing and handling easier. The metal tubes were also connected to the outer PTFE sleeve of the fibre, using heat shrinks, to give extra strength and reduce the risk of breaking. Both ends of the fibres were ground and polished to a flatness of <¼ of a wavelength (632nm).

The body plate for the GMOS end consists of 18 sapphire ball lenses of two sizes (3 mm and 4 mm diameter) and 18 silica optical windows (3 mm diameter, 300 µm thick and 4 mm diameter, 400 µm thick). The balls and the windows were glued in the body plate using UV-optical curing glue. Before the fibres were aligned in the body plate a throughput test was done to check the relative transmission of the 20 fibres. The best 18 fibres were aligned on top of the silica windows and the sapphire ball lenses in the body plate. The alignment was done using a target that simulates the Gemini telescope pupil (fibre positioning tolerances were 0.02 mm). After the alignment, the fibres were glued in the body plate by using the UV-optical curing glue and super glue.

After the polishing, aligning and gluing the fibres were sent to the UK for installation of the optics for the bHROS end. The fibres are now complete and are waiting to be installed between GMOS and the bHROS instruments in Chile. bHROS will be fully integrated with the telescope in 2004.

ING is experienced in fibre work after making several successful fibre projects. One project in particular, “Small fibres” consisted of 160 fibres with a core diameter of 90 µm for the Autofib2 (robotic positioner)/ WYFFOS (optical spectrograph) commissioned in July 2001 (see also *ING Newsl.*, **4**, 26 and *ING Newsl.*, **5**, 19 for more information and first light report). The procedures and experience of the “Small fibres” project were used in the GMOS/bHROS project. ING is actively looking for more fibre work from external institutes for the future.

For more information on the GMOS/ bHROS project please visit the following sites:

Gemini South telescope:
`http://www.gemini.edu/`

HROS project page:
`http://www.osl.ucl.ac.uk/hros/ /new/fm-index.html` ¤

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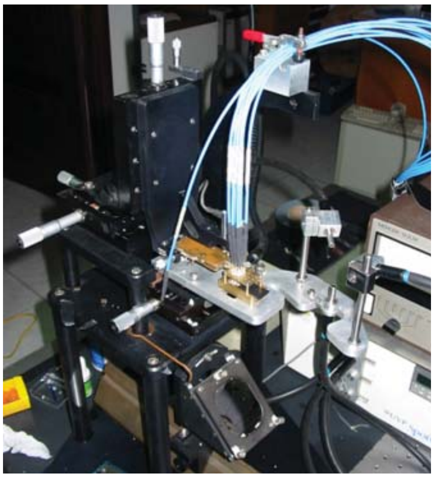

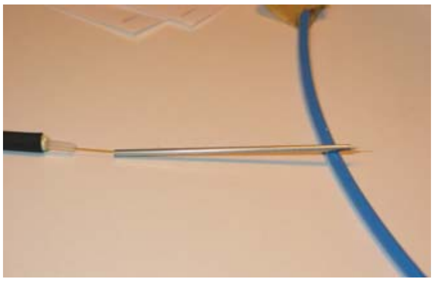

Figure 1 (left). Fibre grounding and polishing. Figure 2 (top right). Fibres in body plate gluing. Figure 3 (bottom right). Metal tube gluing.

Do It Dry... INT Primary “Vapour Cleaning”

M. F. Blanken, A. K. Chopping, K. M. Dee (ING)

In June 2003 ‘vapour cleaning’, a concept invented by ING staff, was used to clean the Isaac Newton Telescope’s primary mirror (2.5m) for the very first time.

The primary mirrors of the telescopes at the Isaac Newton Group are regularly cleaned to decrease the frequency of aluminising. Over the last few years ING has moved from annual aluminising to condition based aluminising, only doing it when the reflectivity and scatter measurements indicate it is needed. The advantage is that an extra three nights are available to observers every year that aluminising is not carried out, not to mention the real risk of damage to the primary mirrors every time they are removed from the telescope for aluminising.

Regular cleaning is currently done by a method called “snow cleaning” or “CO_2 cleaning”. This cleaning method uses liquid CO_2 that forms snowflakes once it is in the open air. These snowflakes hit the mirror surface and capture dust particles. The temperature shock between the cold snowflake and the “warm” mirror will easily break the bond between the dust particles and the mirror. The particles together with the snowflakes fall down onto the telescope structure. There the dust can be wiped away from the structure. This way of cleaning the mirrors is quick and easy restoring the reflectivity by about 1–2% and decreasing the scattering.

Unfortunately stains like water and oil cannot be removed using this method. A better way of cleaning the mirror is to use water, soap and natural sponges. First we wet the mirror surface with water to flush away all the big dust particles. By dabbing and with the use of soap on the sponges the water and oil stains can be removed. The rest of the soap has to be washed away by using water before drying. The best way of drying is to keep the surface wet until the very last moment when the water is blown away with filtered clean air. All the dust and most of the heavy stains can be removed using this method. The reflectivity and scattering can be recovered to values close to those retained after aluminising. Therefore this method is much better than the “CO_2 cleaning”method.

A disadvantage of the “washing in situ” method is that it uses roughly 5–10 litres of water per square meter. This can be a problem when a copious amount of water is running around mirror cells and associated equipment. Particularly electronics have to be protected. So normally novel ideas have been developed to seal the mirror or optical component to stop the water leaking around the telescope which reduces the risk of water damage. By using the “water vapour method” only 1–2 litres of water is used per square meter. The advantage is optical results equal to “water washing” without the risk of water damage. The small amount of water used is easily controlled with sponges or towels placed at the bottom of the telescope structure.

The ING invested in 3 industrial vapour cleaners to be used for the "vapour cleaning" process. Before the machines were used on a telescope mirror, extensive tests were done on similar coated mirrors. It was found that it was very difficult to cause any damage to the aluminium coating. Indeed only one test, which involved holding the vapour stream only a couple of centimetres away from the surface and in one position for 20 minutes caused a slight degradation of the coating.

The primary advantage of vapour cleaning starts with wetting the mirror. For this part of the procedure a soapy vapour can be used by pre-mixing water with soap. By wetting the mirror this way, the soapy vapour will start cleaning whilst removing the large dust particles. The vapour is heated to a temperature of about 35°C. Therefore the temperature shock between the warm vapour and this time the "cold" mirror helps to release the particles from the mirror (reverse of the "CO_2 cleaning" method). Before drying the mirror, the soap can be cleaned away from the surface and the steam can keep the surface wet. Even without touching the mirror surface the "vapour cleaning" will give a better result than the "CO_2 cleaning". Finally to achieve the same results as the "water washing" method, sponges and dabbing still need to be applied to the mirror surface after the wetting.

The result of the washing of the INT 2.5m primary was so successful that plans are made to repeat this procedure on the William Herschel Telescope primary (4.2m). This is believed to be the very first time that such a process has been used on a major telescope mirror anywhere.¤

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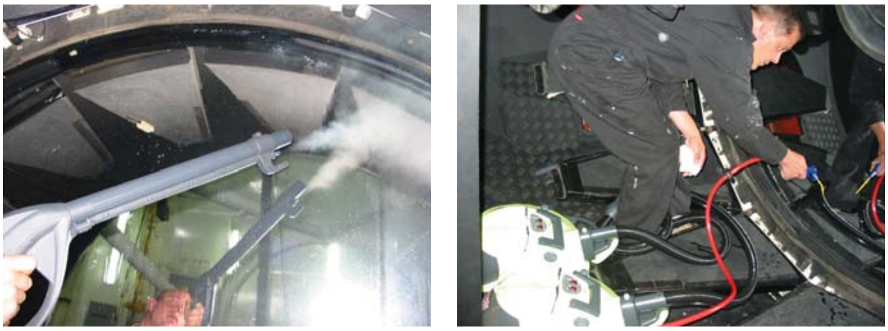
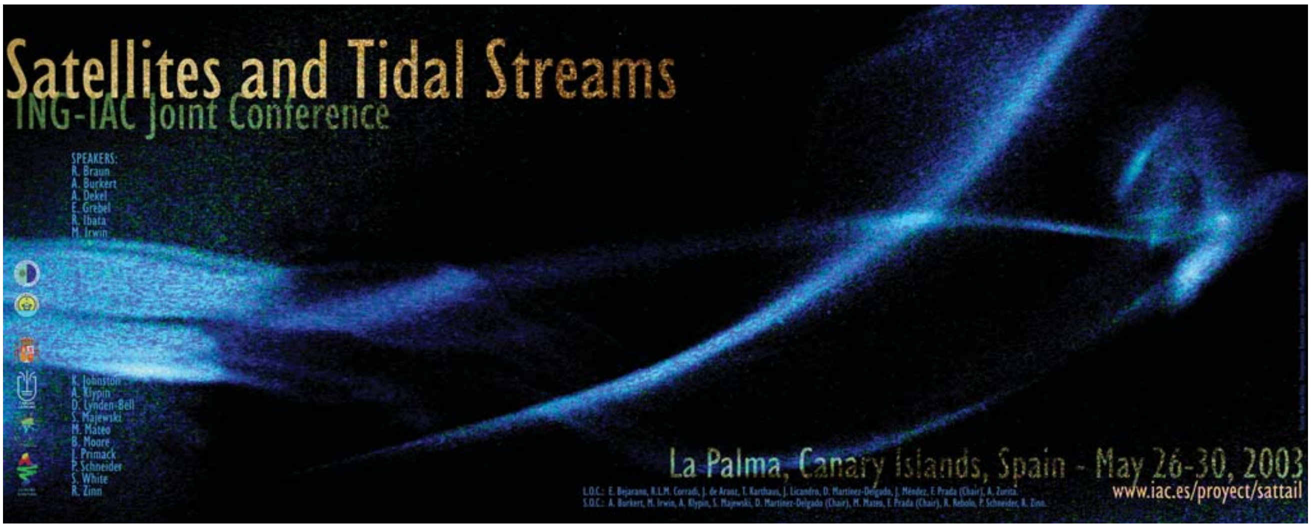


Vapour cleaning (left) and drying (right) INT primary mirror.

Satellites and Tidal Streams, an ING–IAC Joint Conference

On May 26–30, 2003 ING, jointly with the IAC, organized the third major astronomical conference on La Palma, with the title "Satellites and Tidal Streams". As with previous conferences, generous financial support was provided by the Excmo. Cabildo Insular de La Palma and the Patronato de Turismo. The venue was the pleasant seaside resort of Los Cancajos, a few kilometers south of the main town of Santa Cruz de La Palma.

Current cosmological models predict that galaxies form through the merging of smaller substructures. Satellites and tidal streams might then represent the visible remains of the building blocks of giant galaxies. They therefore provide important information on the merging history and galaxy formation in the Universe. In this conference the observational evidence for substructures, their internal structure and their dynamical evolution and disruption within the tidal field of the host galaxy was discussed and confronted with theoretical cosmological predictions of hierarchical merging and galaxy formation. With some 90 participants, including 'old hands' as well as a healthy contingent of young astronomers, the conference underlined the vibrant developments in this field and was a great success!



OTHER NEWS FROM ING

NAOMI Workshop

Adaptive Optics has been the centre piece of ING's development programme for some years now. First results of the NAOMI AO system at the WHT have been presented in earlier issues of this newsletter. As ING is climbing the steep learning curve of adaptive optics, the time was considered ripe to compare our experience at the WHT with that of other telescopes with many more years of experience. In order to keep the workshop well focussed and encourage the best opportunities for debating results only a small number of participants were invited to attend. Key invited guests included Norbert Hubin from the European Southern Observatory, Francois Rigaut from GEMINI, Stefan Hippler from the Max Planck Institute for Astronomy, and Eric Steinbring from the Centre for Adaptive Optics. But apart from the invited guests, we also had excellent contributions from Adriano Ghedina of the Telescopio Nazionale Galileo, where adaptive optics features as part of the instrument set, and from Nicholas Devaney of the GTC 10-m telescope project. Plans for GTC include an AO system as part of their second-generation instrument suit. Presentations on design and current performance of NAOMI and the OSCA coronograph were given by Richard Myers from Durham University, and by Chris Benn and Sebastian Els from the ING.

Presentations and discussions included aspects such as performance expectations and reality of operational AO systems; performance characterisation; specific problems and advantages of segmented and continuous deformable mirrors; calibration and data reduction aspects. For the AO group at ING this sharing of experience and open discussion has been an extremely useful event which helped the team to focus on key questions with some of the world specialists in the field.¤

René Rutten (rgmr@ing.iac.es)

Snapshots and participants of the NAOMI Workshop 9-11 January 2003.

VIP Visitors

Anatoly Karpov, world chess champion 1975–85 and 1993–99, visited the William Herschel Telescope in November 2002 (see picture on the right), accompanied by the presidents of the chess federations of La Palma and of the Canary Islands. A few days earlier, he played 18 simultaneous matches in Gran Canaria, half of them via internet with opponents on other islands. The La Palma challenger was Chris Benn, manager of the William Herschel Telescope (the sponsors of the event wanted somebody in a remote location), playing from a computer in the observatory with members of the local chess federation acting as referees. Having 18 times as long as Karpov to think about each move was encouraging, but by move 15, Karpov's pieces had somehow taken over the centre of the board. Then Chris made a weak move, and Karpov very rapidly demolished his defences and checkmated on move 24. He won the other 17 games too. Other VIP visitors were Josep Piqué (Spanish Science and Technology Minister), Annejet Meijler (director of the Physical Science Council of NWO) and Richard Wade (Director of PPARC's Programmes). ¤

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Personnel Movements

The most difficult aspect of the changes ING is going through is that several of our personnel have left or will be leaving ING. These colleagues have helped building ING and played a role in delivering the service to the community. As a consequence of these changes, both **Michael Simpson** and **Rachael Miles** recently left ING.

Theresa Dorward, working in the administration group, is now finding fortune elsewhere, whilst **Betty Vander Elst** joined this group on a part-time basis. We're very pleased that **Chelo Barreto** has returned to her original post after a three-year tour to work at the Joint Astronomy Centre on Hawaii.

Begoña García and **Johan Knapen** came to the end of their tours and returned to their home institutes in Tenerife and Hertfordshire, respectively. Last year, a new support astronomer, **Pierre Leisy**, started work at ING under the agreement with the IAC. Also joining the astronomy group as a short-term EU-funded Marie-Curie fellow has been **Ilona Soechting**.

Two engineers joined ING, also under the IAC agreement: **Andy Hide** will lead the Telescopes and Instruments group, while **Olivier Martin** will become primarily responsible for looking after the telescope systems.

News from the Roque

Since the last Newsletter, there have been many developments at the observatory. The most significant ones are those focussing on the 10-m GRANTECAN telescope, where the building, services and dome have now largely been completed. At the time of writing this, the azimuth bearing is being mounted. The next several months will see the erection of the telescope structure. If you want to monitor progress on how the telescope is being erected, see `http://www.gtc.iac.es/webcam_s.asp`.

The MAGIC Cherenkov telescope, officially inaugurated together with the Mercator telescope, on 10 October, has dramatically changed the skyline of the observatory. This 17-m telescope, out in the open, is now being fitted out with its segmented mirrors that later this year will catch the photons of Cherenkov light from high energy air showers. The HEGRA experiment, often referred to by visitors as the bee hives that were constructed in the same area, has been dismantled and removed.

The Liverpool telescope keeps making good progress. Some setbacks with the enclosure are being tackled, while the telescope structure is now essentially complete and the optics were recently put into the telescope. The Liverpool telescope was the centre of attention in May, as it was inaugurated by dignitaries from the UK and Spain.

In December La Palma was hit by a storm with exceptionally strong winds. The storm not only wreated havoc in the banana plantations on the island, but also caused the MERCATOR dome to suffer serious damage, sufficiently to stop operation for some time while a new dome was ordered. The adjacent picture shows how the new dome is being seated on top of the building.

The sometimes very strong winds hitting the island, under the right atmospheric conditions give rise to weird cloud formations. Last year Michiel van der Hoeven was lucky to be in the right place at the right time to take the adjacent remarkable picture, showing a dome-shaped cloud overarching the telescopes, lit by the setting Sun. This picture was one of the centre pieces of an exhibit of exceptional cloud formations organised by the aviation authorities on La Palma.

ING is participating in the development of SuperWASP, a robotic set of cameras that will monitor a very large part of the sky every night. The project is led by the Queen's University of Belfast. The system will sit in its own enclosure that is being erected over the summer, located not far from the JKT. More news on this project will be presented in the next issue of the ING Newsletter.

If you drive up to the WHT you will see on your left-hand side a slender tower with a small telescope at the top. This is a solar seeing monitor in support of the site testing campaigns for the planned Advanced Technology Solar Telescope (ATST), a 4-m solar telescope under study in the US. La Palma is one of the few pre-selected sites for this telescope.¤

René Rutten (rgmr@ing.iac.es)






From top to bottom: MAGIC telescope near completion (credit Lise Autogena); MAGIC telescope and adjacent control room under construction; inauguration of Liverpool Telescope on 7 May; replacement of damaged MERCATOR telescope; a fantastic cloud over La Palma (credit Michiel van der Hoeven); SuperWASP building.

BBC's All Night Star Party!

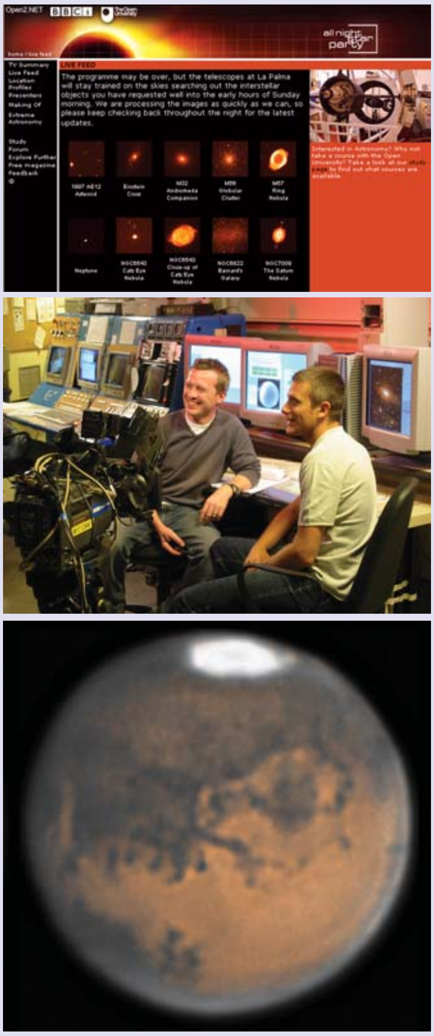
Coinciding with the closest approach of Mars to Earth in the last 60,000 years, BBC Two had a party. The All Night Star Party, a special live Open University programme for BBC Two, took place on 23 August night and lasted for one hour and a half.

In the course of this special programme BBC Two handed over the Isaac Newton Telescope to 600,000 viewers giving them the chance to point the telescope to stunning objects live and see the images on screen and online as they came out from the Wide Field Camera. The programme also focused on several aspects of British amateur and professional astronomy, in particular, the Beagle 2 Mars lander and, of course, obtaining an image of Mars live. This latter task was the responsability of two amateur astronomers, Damian Peach and John Mills, who were based on the roof of INT's building.

The event was followed by 400 amateurs at Jodrell Bank where the main broadcast centre had been placed.

I would like to thank all ING staff for the impressive effort made for this big event and without whom this couldn't have been possible. I would also like to thank all the people involved at the Open University and the BBC, in particular, Peter Brown, programme producer, Martin Mortimore, La Palma broadcast director, and Chris Riley, presenter on La Palma.¤

Javier Méndez (jma@ing.iac.es)



The programme may be over, but the telescopes at La Palma will stay trained on the skies searching out the interstellar objects you have requested well into the early hours of Sunday morning. We are processing the images as quickly as we can, so please keep checking back throughout the night for the latest updates.

Top: Online live feed of images. Middle: Presenter Chris Riley and support astronomer Romano Corradi. Bottom: Image of Mars obtained by Damian Peach and John Mills from INT's roof.

Other ING Publications and Information Services

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

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Recent and old ING's **Technical Notes** can be downloaded from: `http://www.ing.iac.es/Astronomy/observing/manuals/man_tn.html`.

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

In-house Research Publications: `http://www.ing.iac.es/Astronomy/science/ingpub/`
Annual Reports: `http://www.ing.iac.es/PR/AR/`
Press Releases: `http://www.ing.iac.es/PR/press/`

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 `(djl@ing.iac.es)` and visit this URL: `http://www.ing.iac.es/Astronomy/science/seminars.html`, for more details. These were the seminars given in the last 18 months:

Sep 18. Simon Jeffery (Armagh Obs.), "The results of binary white dwarf mergers".

Oct 29. Michael Pohlen (IAC), "The nature of stellar disk truncations in galaxies".

Nov 7. Mario Melita (Queen Mary, London), "The dynamical structure of the Kuiper Belt".

Nov 21. Jorick Vink (Imperial College), "The winds from the most luminous stars".

Nov 27. Hugo Schwarz (CTIO-NOAO), "The SOAR telescope".

Dec 10. Juan Cortina (Universitat Autonoma de Barcelona), "The MAGIC telescope".

Dec 17. Xuefei Gong (Nanjing, China), "The SOAR telescope".

Jan 13. Ivo Saviane (ESO Chile), "The luminosity-metallicity relation of dwarf irregular galaxies".

Jan 27. John Taylor (Keele), "Eclipsing binaries in open clusters".

Jan 31. Birgitta Nordstrom (Lund, Sweden & Copenhagen, Denmark), "Nucleosynthesis in the Early Galaxy".

Feb 18. Paul Harding (Case Western Reserve, USA), "Star Streams in the Milky Way: Fragments of its History".

Feb 27. Laura Colombon (ING), "Kinematics perturbations and low activity galaxies connection".

Feb 28. Sebastián Sánchez (Potsdam), "Integral field spectroscopy at the AIP".

Mar 12. Sebastian Els (ING), "Planet formation: a new way to observe them forming".

Mar 18. Gijs Nelemans (IoA-Cambridge), "Observing double white dwarfs: test for common envelope theory, type Ia supernova progenitor models and gravitational wave noise predictions".

Mar 25. Eran Ofek (Tel Aviv University), "Measuring the time delay of the lensed quasar HE1104–180".

Apr 21. Daniela Lazzaro (Observatorio de Rio de Janeiro), "Spectroscopic observations of asteroids: the S3OS2 and Vestoids Project".

Apr 24. Ilona Söchting (ING), "Environment of Quasars".

May 7. Giangiacomo Gandolfi (CNR, Roma, Italy), "Short GRBs: an unsolved enigma".

May 8. Olga Kuhn (JAC, Hawaii), "Probing the faint end of the z>3 quasar luminosity function".

May 15. Gloria Andreuzzi (Osservatorio Astronomico di Roma), "VLT-FORS1 observations of NGC 6397: Evidence for Mass Segregation".

Jun 5. Humberto Campins (University of Central Florida), "Comets and Origin of Earth's Water".

Jul 2. Simone Marchi (University of Padova, Italy), "Spectroscopic Investigations of Near-Earth Objects".

Nov 26. Silva Järvinen (NOT), "Photometric Study of Young Active Stars".

TELESCOPE TIME

Applying for Time

Danny Lennon
(Head of Astronomy, ING)

It is important that applicants for telescope time familiarise themselves with the latest news on instrumentation and detector combinations on offer, as well as with our scheduling restrictions. For the very latest news always refer to the ING web pages, homepage `http://www.ing.iac.es`. The ING's general scheduling constraints were summarised in the first issue of the Newsletter and will not be repeated here, please refer to that issue, which is also available on our public information web pages. Due to the increasing interest shown by the community in applying to bring new visitor instruments to the WHT we have introduced a technical appraisal form to try to smooth the transition of these instruments from the laboratory to the telescope. This form is linked to the New Visitor Instruments web page at `www.ing.iac.es/Astronomy/observing//NewVisitorInstruments.html` and it must be completed and submitted along with any national application form which proposes bringing a new visitor instrument to the WHT.

What's New

The year 2003 saw many changes at the ING. On the positive side, and from a visiting astronomer's point-of-view, we saw the commissioning of the integral field spectrograph OASIS at the AO focus of the WHT (page 21), plus the first very successful commissioning run of the IR imaging spectrograph LIRIS on the WHT (see the cover page and page 15 of this issue). OASIS is currently available to visiting observers, prospective applicants should contact Chris Benn (`crb@ing.iac.es`) for help and information. We hope to accept proposals for LIRIS in semester 2004B, pending the success of its commissioning runs in 2004A. Users should note that for imaging, LIRIS should provide very similar capabilities compared to INGRID, and therefore it is envisaged that LIRIS will replace INGRID as the default Cassegrain IR imaging device in the future (INGRID remaining at the AO focus).

As mentioned in the preceding section, visitor instruments continue to be very successful in acquiring observing time at ING. Sometimes an opportunity arises to offer these instruments for service mode observing, with the collaboration of their development teams of course. ULTRACAM, an ultra-fast, triple-beam CCD camera provided such an opportunity in 2003, we thank Vik Dhillon for his cooperation in this venture. The available ULTRACAM service time was hugely oversubscribed and we apologise to the many applicants who did not receive any observations. However we hope to offer the instrument again in 2004, the announcement of opportunity will be sent via the usual [INGNEWS] bulletin.

Other major changes have been the discontinuation of the JKT as a common user telescope, and the decommissioning of IDS on the INT. We have also withdrawn Telescope Operator support from the INT, which is now a single-instrument telescope having just the WFC. Night-time support on the INT will be provided by the ING student support group for the first night of each observing run only, although an ING astronomer will continue to act as the scientific contact for each observing run. While the INT/WFC is a rather easy telescope/instrument combination for a single user to manage, applicants are reminded that it is inadvisable to send unaccompanied inexperienced observers (student or otherwise) to this telescope. Furthermore if the observing programme is demanding, perhaps requiring a lot of real-time interaction, it is suggested that more than one observer should be present.

The International Scientific Committee (CCI) of the Roque de los Muchachos (ORM) and Teide (OT) observatories invites applications for International Time Programmes (ITP) on telescopes installed at these Observatories. The ITP offers up to 5% of the observing time, evenly spread throughout the year and the lunar cycle. An ITP proposal can request observing time over a period of up to two subsequent years. Full details of the scheme for night-time telescopes can be found at `http://www.iac.es/gabinete/cci//tinoc1.htm`. Proposals are considered on an annual cycle and the closing date for submission of proposals to the 2004 ITP is Friday 6th February, for projects which may start during the fall of the same year.

During 2004 it is expected that limited access to ING telescopes will be granted to all EU astronomers under the auspices of Opticon, funded by EU's Sixth Framework Programme. Details are expected to be announced soon, interested parties should refer to `http://www.otri.iac.es/eno/`. ¤

Danny Lennon (djl@ing.iac.es)

Important

DEADLINES FOR SUBMITTING APPLICATIONS

UK PATT and 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**

ONLINE INFORMATION ON APPLYING FOR TIME ON ING TELESCOPES

`http://www.ing.iac.es/Astronomy/`
`http://www.ast.cam.ac.uk/ING/Astronomy/`

Telescope Time Awards Semester 2003A

For observing schedules please visit this web page:
`http://www.ing.iac.es/ds/sched/`.

William Herschel Telescope

UK PATT

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

NL NFRA PC

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

SP CAT

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

Spanish Additional Time

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

TNG-TAC

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

Isaac Newton Telescope

UK PATT

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

NL NFRA PC

- Habing (Leiden), Monitoring of asymptotic giant branch stars in Local Group Galaxies. **i03an006**
- Helmi (Utrecht), Star streams and high velocity clouds in the Milky Way halo. **i03an003**

- Kuijken (Groningen), Sloan standard fields for the photometric calibration of OmegaCAM. **i03an001**
- Wijers (Leiden), The origin and physics of gamma-ray bursts. **w03an005 (override)**

UK/NL WFS Programmes

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

SP CAT

- Casares (IAC), Simultaneous observations of Galactic gamma-ray sources with INTEGRAL. **I6/2003A**
- Casares (IAC), Radial velocity curve and mass function of LS5039 microquasar. **I7/2003A**
- Castro-Tirado (IAA), The nature of GRBs. **W5/2003A (override)**
- Deeg (IAC), Sample definition for exoplanet detection by the COROT spacecraft. **I13/2003A**
- Hammersley (IAC), A deep multi-wavelength survey of the Galactic plane. **I9/2003A**
- Martí (Jaén), Radial velocity curves of microquasars. **I8/2003A**
- Montes (Complutense, Madrid), Spectroscopic characterisation of K and M stars members of moving young groups. **I10/2003A**
- Negueruela (Alicante), Determination of the orbit of the X-ray eclipsing binary XTE J1855-026. **I5/2003A**
- Vazdekis (IAC), Towards a robust scale of metallicities in globular clusters. **I11/2003A**

Spanish Additional Time

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

Jacobus Kapteyn Telescope

UK PATT

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

SP CAT

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

NL NFRA PC

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

Telescope Time Awards Semester 2003B

For observing schedules please visit this web page:
`http://www.ing.iac.es/ds/sched/`.

William Herschel Telescope

UK PATT

- Bower (Durham), The Sauron deep survey: exploring the Lyman-α haloes of massive galaxies at $z=3$. **W/2003B/19**
- Burleigh (Leicester), NAOMI followup observations of very low mass companions to nearby white dwarfs . **W/2003B/63**
- Charles (Southampton), Determining system parameters of a soft X-ray transient in outburst. **W/2003B/39**
- Collins (John Moores), Environmental dependence of the fundamental plane of brightest cluster galaxies. **W/2003B/27**
- Crowther (UCL), Wolf-Rayet stars in the metal-rich environment of M31. **W/2003B/09**
- Dalton (Oxford), Star formation at $z\sim1$. **W/2003B/61**
- Dhillon (Sheffield), ULTRACAM observations of the transiting extrasolar planet HD209458b. **W/2003B/31**
- Dufton (Belfast), Spectroscopy of h + χ Persei to support VLT/FLAMES survey. **W/2003B/03**
- Fitzsimmons (Belfast), The 13th/14th November stellar occultation by Titan. **W/2003B/45**
- Folha (Porto, Portugal), Excess emission in T Tauri stars: the missing link. **W/2003B/15**
- Folha (Portugal), Excess emission in T Tauri stars: the missing link. **W/2003B/16**
- Jarvis (Oxford), Weak lensing by cluster mass distributions traced by radio galaxies at $z=0.5$. **W/2003B/37**
- Marsh (Southampton), Stochastic variability of accretion discs. **W/2003B/55**
- Marsh (Southampton), Orbital periods of post common envelope binary stars from the SDSS. **W/2003B/56**
- Mathioudakis (Belfast), High frequency oscillations in active cool stars. **W/2003B/26**
- McCaughrean (AIP, Germany), Spectral typing IR/X-ray selected brown dwarf candidates in the Trapezium Cluster. **W/2003B/64**
- McLure (Edinburgh), Exploring the connection between bulge/black-hole mass and radio luminosity from $z=0$ to $z=2$. **W/2003B/49**
- Meikle (ICL), Detailed study of the physics of nearby Type Ia supernovae. **W/2003B/02 (override)**
- Merrett (Nottingham), A deep kinematic survey of planetary nebulae in M31. **W/2003B/32**
- Nelemans (Cambridge), Testing common envelope theory and SN Ia progenitor models with double white dwarfs. **W/2003B/29**
- Nelemans (Cambridge), Follow-up of new AM CVn candidates. **W/2003B/30**
- Østensen (ING), Resolving sdB binary systems with adaptive optics. **W/2003B/60**

- Page (MSSL), Optical identification of faint X-ray sources in the 1^{H} XMM-Newton/Chandra spectroscopic survey. **W/2003B/52**
- Pollacco (Belfast), Characterising the planetary nebula central star population. **W/2003A/22 (long term)**
- Smartt (Cambridge), An image archive to identify the progenitors of future core-collapse supernovae. **W/2003B/22**
- Smith (Hertfordshire), Scattering geometries and the broad-line region in radio-quiet quasars. **W/2003B/05**
- Smith (UCL), The massive star population of Wolf-Rayet galaxies. **W/2003B/20**
- Vink (ICL), Spectropolarimetry of T Tauri stars. **W/2003B/24**
- Wesson (UCL), ORL abundances and hydrogen-deficient clumps in PNe with H-deficient central stars. **W/2003B/62**
- Wills (Sheffield), Triggering the activity in giant elliptical galaxies. **W/2003B/13**

NL NFRA PC

- Douglas (Groningen), A deep kinematic survey of planetary nebulae in M31. **w03bn014**
- Emonts (Groningen), Origin and evolution of AGN activity in gas-rich radio galaxies. **w03bn005**
- Groot (Nijmegen), Spectroscopic classification of the KISO survey: a search for AM CVn stars. **w03bn017**
- Klein Wolt (Amsterdam), Optical analogues of X-ray timing phenomena in X-ray binaries using ULTRACAM and RXTE. **w03bn008**
- Kuijken (Leiden), M31 microlensing: checking Mira contamination with NIR AO imaging. **w03bn004**
- Peletier (Groningen), Mapping the stellar dynamics and populations of barred galaxies. **w03bn006**
- Prins (ING), Spectroscopic confirmation of supernova remnants in M31. **w03bn009**
- Quirrenbach (Leiden), Line bisector variations for K giant stars with possible planetary companions. **w03bn015**
- Wijers (Amsterdam), The nature of gamma-ray bursts and their use as cosmological probes. **w03bn003 (override)**
- de Zeeuw (Leiden), A spectroscopic survey of the centers of intermediate-to-late spiral galaxies with SAURON. **w03bn013**

SP CAT

- Alfaro (IAA), Spectral mapping of a large star forming region of NGC 6946. **W28/2003B**
- Arribas (IAC), INTEGRAL spectroscopy of galaxies, ULIRGs, gravitational lenses, QSO's hosts and planetary nebulae. **W14/2003B**
- Casares (IAC), Determining system parameters of a Soft X-ray transient in outburst. **W2/2003B (override)**
- Castro-Tirado (IAA), The nature of GRBs. **W18/2003B (override)**
- Christensen (AIP, Germany), 3D spectroscopy of merger galaxies: clues to star formation and AGN triggering. **W11/2003B**
- Erwin (IAC), How many galactic bulges are imposters? **W21/2003B**
- Negueruela (Alicante), Stellar parameters of XTE J1855–026 optical counterpart. **W7/2003B**
- Pérez (IAA), Kinematic rippling in spiral galaxies. **W3/2003B**
- Pérez-Fournon (IAC), A depp WHT U-band extragalactic survey in SWIRE fields. **W27/2003B**
- Rebolo (IAC), The substellar-stellar connection in σ Orionis. **W10/2003B**
- Ruiz-Lapuente (Barcelona), Supernovae at $z=0.35-0.65$: study of the nature of the dark energy. **W25/2003B**
- Ruiz-Lapuente (Barcelona), Stellar companions to supernovae. **W24/2003B**
- Sánchez (AIP, Germany), 3D spectroscopy of merger galaxies: clues to star formation and AGN triggering. **W12/2003B**
- Shahbaz (IAC), High time-resolution imaging of the black hole X-ray transient J0422+32. **W20/2003B**
- Vílchez (IAA), Direct measuring of the inner abundance-gradient of M33 using bright PNe. **W9/2003B**
- Zapatero (LAEFF, Madrid), Planets around young and bright stars in σ Orionis. **W8/2003B**
- Zurita (ING), Propagation of ionising radiation in HII inhomogenous regions. **W22/2003B**

Spanish Additional Time

- Cepa (IAC), The OTELO project: deep BRI survey of SA68 and VIRMOS-0226. **W17/2003B**
- Herrero (IAC), WLRs of early B supergiants in M31/M33. **W13/2003B**

TNG-TAC

- Moretti (Padova), Ages and metal abundances of star clusters in M33. **T032**

Isaac Newton Telescope

UK PATT

- Drew (ICL), IPHAS — The INT/WFC photometric Hα survey of the northern galactic plane. **I/2003B/14**
- Fitzsimmons (Belfast), Rapid-response astrometry of potentially hazardous asteroids. **I/2003B/09**
- Inskip (Cambridge), Understanding the stellar populations and alignment effect in distant radio galaxies. **I/2003B/10**
- Irwin (Cambridge), Probing the spatial distribution and structure of the Monoceros Ring. **I/2003B/12**
- McGroarty (Dublin), Final epoch observations of large scale outflows from young stars. **I/2003B/07**
- McLure (Edinburgh), A photometric redshift study of radio galaxy environments. **I/2003B/03**
- Naylor (Exeter), What triggers star formation? A study of the recent star formation history of the Perseus Arm and Local Spur. **I/2003B/11**
- Ramsay (MSSL), WFC high time resolution survey — exploring a new temporal parameter space. **I/2003B/02**
- Tanvir (Hertfordshire), The nature of gamma-ray bursts and their use as cosmological probes. **I/2003B/13**

NL NFRA PC

- Aragon (Groningen), Measuring Galaxy Spin Alignments along the Pisces-Perseus Ridge in the Vicinity of A262. **i03bn002**
- van den Berg (OAB, Italy), Photometric variability of optically faint Chandra X-ray sources in M67. **i03bn007**
- Braun (NFRA), The STARFORM/Hα survey: Probing the recent history of star formation in spirals. **i03bn005**
- Habing (Leiden), Monitoring of asymptotic giant branch stars in Local Group galaxies. **i03bn003**
- Helmi (Utrecht), Star streams and high velocity clouds in the Milky Way halo. **i03bn006**
- Kuijken (Leiden), A survey for halo planetary nebulae in M31. **i03bn001**
- Wijers (Amsterdam), The nature of gamma-ray bursts and their use as cosmological probes. **w03bn003 (override)**

UK/NL WFS Programmes

- Walton (Cambridge), The Local Group census. **WFS4**
- Watson (Leicester), An imaging programme for the XMM-Newton Serendipitous X-ray sky survey. **WFS3**

SP CAT

- Castro-Tirado (IAA), The nature of GRBs **W18/2003B (override)**
- Deeg (IAC), Sample definition for exoplanet detection by the COROT space craft. **I1/2003B**
- Erwin (IAC), The outer disks of S0 galaxies: clues to disk evolution. **I10/2003B**
- Leisy (ING), IPHAS – The INT/WFC photometric Hα survey of the northern galactic plane **I6/2003B**
- López-Aguerri (IAC), Search of planetary nebulae in the intergroup region of HCG 44. **I7/2003B**
- Martínez-Delgado (MPIA, Germany), The building-blocks of the Milky Way: searching for dwarf galaxy remnants around globular clusters. **I12/2003B**
- Ribas (Barcelona), Direct determination of the distance to M31 from eclipsing binaries. **I2/2003B**
- Rosenberg (IAC), Formation and evolution of the Milky Way (III): the Galactic disk. **I9/2003B**
- Vílchez (IAA), A search for star forming galaxies in nearby clusters. **I5/2003B**

Spanish Additional Time

- Balcells (IAC), Deep UV survey for COSMOS and OTELO. **I11/2003B**
- Herrero (IAC), Detecting the blue massive star population to 5Mpc for OSIRIS. **I8/2003B**

Abbreviations:

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

Table of Contents

SCIENCE

TELESCOPES AND INSTRUMENTATION

OTHER NEWS FROM ING

TELESCOPE TIME

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