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Instrumentation plans for the William Herschel Telescope

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Abstract. With the advent of 8-m class telescopes the role of the 4-m class telescopes around the world is being redefined. The development strategy for the 4.2-m William Herschel Telescope on the island of La Palma focuses on exploitation of the excellent seeing condition at the Roque de los Muchachos Observatory site, and of the wide field capability of the telescope's primary focus. Adaptive optics developments play a central role in these plans, in particular in carrying out high spatial resolution integral field spectroscopy at relatively short wavelengths. At the same time the WHT continues to play an important role as platform for visiting instruments. Apart from instrument developments, also attention will focus on optimizing the overall observing efficiency through queue observing and developing tools for on-line data quality assessment.

Key words. Telescopes – Instrumentation – Adaptive Optics

1. Introduction

The Isaac Newton Group of Telescopes (ING) was set up in the early 1980's as the flagship Northern-hemisphere optical observatory for the United Kingdom and The Netherlands through a bilateral partnership between the national research councils, now the UK Particle Physics and Astronomy Research Council, and the Netherlands Organization for Scientific Research. Recently the partnership was extended to include the Instituto de Astrofísica de Canarias, who formally joined the ING in 2002. The most important telescope of the ING is the 4.2-m William Herschel Telescope (WHT). The WHT has now been in operation for nearly 15 years and possesses a well developed infrastructure. Scientific productivity of the telescopes, in particular that of the WHT, has been extremely high (both in quantity and quality) to international standards. This was recently borne out in a comparative study by Benn & Sánchez (2001). The WHT has been one of the most scientifically productive telescopes with well over 100 papers annually produced in refereed journals and a high scientific impact. Important, if not crucial in its success to date has been the continuous development of new instruments and the enhancement of the capability of existing instruments (e.g. better detectors). However, rapid technological advances and the construction of several 8-m class telescopes imply that ING's telescopes have to adapt to a new scientific role for the future in order to remain competitive and complement facilities elsewhere.

2. Development targets for the WHT

The future central role of the WHT focuses on two strands: (i) exploitation of adaptive optics, in particular at visible and near IR wavelengths, and (ii) multi-object spectroscopy over a wide field. Both these areas provide important science capabilities competitive with, and complementing those at larger telescopes. At the same time these areas tie in well with large scale survey activities that are being planned (e.g. VISTA, VST, UKIRT). With these areas of focus the WHT optimally exploits the excellent properties of the La Palma observatory site and the quality of the telescope and its infrastructure, whilst offering a long-term development path that provides important instrumentation capability to the astronomical community.

3. Adaptive Optics

Adaptive optics instrumentation is now an integral part of a growing number of telescopes around the world, including the WHT with the recent delivery of a high-order natural guide star AO system, called NAOMI. NAOMI is based on a 72-element fully steerable segmented deformable mirror. First results have shown the potential of NAOMI in delivering diffraction limited image quality at IR wavelengths, and also attractive image improvement at wavelengths as short os 650nm. The scientific gains from image quality that defeats atmospheric turbulence are huge. Not only does higher spatial resolution allow objects to be resolved better, but also the sky background and hence S/N improves. Clearly observations from space are hard to beat from the ground, even with adaptive optics. But combined with novel instrumentation and a large telescope collecting area ground based AO systems do provide cutting edge performance. This is where the WHT will be competitive. The WHT, placed on a site with excellent seeing conditions, is well positioned to build its scientific use on AO techniques, and therefore our long-term aim is to exploit AO for the widest possible area of observational astronomy. Currently the NAOMI AO system on the WHT has been used for near IR imaging, including coronographic imaging. In the near future the scientific capability will be expanded considerably when the OASIS integral field spectrograph is installed. This spectrograph will allow highly efficient area spectroscopy to be performed over small fields at a typical spatial resolution of 0.2 arcsecond. Such capability will allow for instance analysis of the kinematic structure in the cores of nearby galaxies, or unveil the chemical and kinematic structure of star forming regions. A major drawback for general science exploitation of natural guide star adaptive optics is the limited number objects that can be studied. The reason for this limitation lies in the fact that the object of interest needs to be a bright point source, or close to a bright source that serves as the beacon to measure the wavefront distortions of. Typically the sky coverage for natural guide star AO systems is only one or a few percent at best. The way around this limitation is creating an artificial beacon high in the atmosphere that will serve as a point source on which the wavefront distortions can be measured. Such beacon can be created by firing a laser into the atmosphere and use either fluorescent back scattering off Sodium atoms at about 90km altitude, or Rayleigh back scattering at lower elevations. The latter method has the disadvantage of the laser beacon not illuminating all of the atmospheric turbulence perfectly, thus reducing overall performance. But the advantage is that it does not require rather exotic and expensive laser technology while it still illuminates well the low level turbulence. For that reason at the WHT our aim is to develop a Rayleigh laser beacon system. Such Rayleigh laser system would greatly enhance the sky coverage for adaptive optics, bringing into reach spectroscopic surveys of for instance galaxy core kinematics at high spatial resolution. It would fulfill our strategy of exploiting adaptive optics for the widest possible range of observational projects.

4. Wide field capability

Several of the existing 4-m class telescopes are focusing their future role around the relatively wide fields that these telescopes offer with respect to the available fields of view of the 8-

m class telescopes. Also for the WHT exploiting the wide field in the prime focus remains an important part of the strategy. However, with so much effort in Europe already being focussed on wide field optical and infrared imaging (CFHT, UKIRT, VST, VISTA) it does not seem logical to duplicate this effort at the WHT. Alternatively, the WHT will build on its strength of offering wide field multi object spectroscopy. This capability nicely complements imaging survey activities as well as multi-object spectrographs at larger telescopes. Objects in catalogues generated from imaging surveys can then be studied in detail using multi-object spectroscopy. The WHT will focus on the somewhat brighter objects spread over a 1 degree field, while the 8-m telescope will naturally focus on the fainter objects in more narrow fields.

Existing instrumentation, specifically the AUTOFIB robotic fibre positioner combined with the WYFFOS fibre spectrograph already offer important capability in this field. Ongoing developments now focus on allowing more fibres to be deployed and improving overall efficiency by having larger format CCDs with the highest possible quantum efficiency.

5. Visiting instruments

Visiting instruments, i.e. instruments that have been developed by external groups for specific scientific goals, historically have been an important aspect of the instrumentation effort at the WHT. Although the overheads for the observatory in supporting visiting instruments are relatively large, the scientific returns are very significant and clearly fulfills a need that exists within our community. Visiting instruments are usually build and used by a project team with well focussed objectives, motivated to scientifically exploit their instrument to the full as quickly as possible. Examples of the currently active and very successful visiting instruments at the WHT are: the SAURON integral field spectrograph that has been used for carrying out a survey of the kinematics in nearby galaxies; the Planetary Nebula Spectrograph, which is a slit-less spectrograph optimized to detect the positions and kinematics of PNe in nearby galaxies; ULTRACAM, which is a triple beam high speed CCD camera system ideal for studying rapidly variable objects; and SCAM, a camera based on the novel technology of super conducting tunnel junction detectors, capably of very high speed photon detection and measuring photon energies at the detector. Based on the success of these and other visiting instruments, the policy for the WHT will remain to allow visiting instruments to come to the telescope.

6. Improving service and efficiency

An increasingly important part of an observatory, fostered by growing expectations of the user community and the need for increasing observing efficiency, is the level of service offered to the users. Rather than just providing an observing platform to carry out astronomical observations ever more attention has to be given to the different aspects of the life cycle of astronomical experiments. For instance data reduction tools for data quality assessment, pipeline data reduction, and queue observing are becoming more important at the WHT. In particular the development of queue observing has major advantages in terms of delivering higher observing efficiency. For example, in queue observing mode a much higher success rate for top ranked observations can be secured, and as single nights can be used for different observing proposals, much better use of the available moonless dark skies can be achieved. But queue scheduled observations also require the development of various methods and tools such as proposal submission tools, an observing decision support system, and ways to carry out quality control. Overall queue scheduled observing requires much more effort from the observatory in conducting the observations. In spite of these complications our long-term goal for the WHT has been set to develop into this direction for the benefit of improved service and overall observing efficiency.

References

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