The AAO telescopes at Siding Spring Observatory

Siding Spring Observatory lies in NSW, about 400 km from Sydney and overlooking Warrumbungle National Park near the town of Coonabarabran. The site is owned by the Australian National University, but is home to telescopes belonging to several institutions. Two of the telescopes—the Anglo-Australian Telescope and the UK Schmidt Telescope—are operated by the Anglo-Australian Observatory (AAO), an institution jointly established by Australia and the UK in 1971.

The Anglo-Australian Telescope has a mirror 3.9 m in diameter, which makes it the largest telescope in Australia. The UK Schmidt Telescope is smaller, with a 1.2-m diameter correcting lens and a 1.8-m diameter mirror: it is specialised for doing large-scale surveys of the sky.

What are the AAO telescopes used for?

The UK Schmidt Telescope does only survey work. The AAT is both used to study individual stars and galaxies and to perform large-scale surveys and searches. Some of the recent and current projects are:

- the Radial Velocity Experiment (RAVE) survey. The UK Schmidt Telescope is collecting data on a million stars in our Galaxy: their chemical composition, and the speeds and directions they are travelling in;
- the Six-Degree Field Galaxy Survey (6dFGS), the most detailed survey made to date, anywhere, of galaxies in the nearby Universe;
- a survey to look for 'dwarf planets' like Pluto in the Kuiper Belt, a region in the outer solar system;
- the Anglo-Australian Planet Search, a long-term, high-precision search using the Anglo-Australian Telescope that has found more than 20 planets around stars other than the Sun;
- searches for "planetary nebulae"—shells of glowing gas that some stars form late in their lives. Finding more will help us understand better the late phases of stars' lives; and
- WiggleZ ("wiggles"), a program to help determine the nature of Dark Energy (an unknown entity that is making the Universe expand at an ever-increasing rate) by measuring the clustering patterns of distant galaxies.

Achievements of the AAO telescopes

The AAO telescopes have:

- detected clouds near the surface of the planet Venus through the very dense atmosphere;
- observed the spectacular explosion of Supernova 1987A, the brightest supernova since the invention of the telescope four centuries earlier. This supernova gave astronomers unprecedented insight into the death of a star;
- discovered the Sagittarius dwarf galaxy, a small galaxy being swallowed by our own Galaxy;
- discovered extremely small, "ultra-compact" dwarf galaxies; and
- made the first detection of an isolated brown dwarf star in our Galaxy.

How do the telescopes work?

Professional astronomers don't look through telescopes: they have developed instruments that are far better at recording and analysing light than eyes are. The telescope itself is just a set of mirrors for collecting starlight and funnelling it to a location where it can be recorded as an image or analysed into a spectrum.

The Anglo-Australian Telescope (AAT)
The AAT has a mirror 3.9 m in diameter, the largest in Australia. It was inaugurated in 1974 and began regular observations in 1975: despite its age, excellent instrumentation has kept it doing leading research, and it remains one of the most productive telescopes of its class.

Imaging
Amateur photographers have moved from film-based cameras to digital ones. The same change has taken place in astronomy: images were once recorded with sensitive photographic plates, but are now captured by electronic detectors (CCDs). The AAT is now used mainly for spectroscopy (see below): its current imaging instrument, IRIS2, works in the infrared, using a detector of 1024 x 1024 pixels. This detector is not large by the standards of commercial digital cameras, but it is much more sensitive normal camera detectors.

Spectroscopy
Analysing the light from stars and galaxies is called *spectroscopy*, and involves spreading the light out into its component wavelengths (just as sunlight going through a prism is spread into its component colours, violet to red).

What astronomers do

Astronomers work in teams. Most astronomers using the AAT are from Australia and the UK, but scientists from all over the world can be members of the observing teams. A team applies to use the Anglo-Australian Telescope by writing an observing proposal and submitting it to a committee, the Anglo-Australian Time Assignment Committee. The committee looks at the proposed projects, and the nature of the observing time needed (e.g. if the project can be done when then Moon is bright) and then allocates time to projects. Not all proposals can be accepted: usually about twice as much time is asked for as is available. A schedule is then drawn up. A year is divided into two semesters for observing: in a given semester, only some of the telescope's instruments are made available to observers.

The UK Schmidt telescope is use for large surveys, and is scheduled by negotiation. At present the Schmidt is being used for a project called RAVE (Radial Velocity Survey), which aims to get detailed data on about a million stars in our Galaxy.

Instrument building

Telescopes are giant light buckets. Analysing the light, however, is done with specialised instruments attached to the telescope. No two of the world's large professional telescopes are exactly alike, so instruments are generally built to go on one particular telescope. (A small number of instruments are built to use on different telescopes.)

The AAO helped pioneer the use of optical fibres in astronomy and has become one of the world's leading institutions in this field. By using flexible optical fibres, the light from many individual objects—stars, galaxies, or even particular parts of galaxies—can be directed into a spectrograph and analysed simultaneously. This greatly improves the speed and efficiency of data gathering.

In the 1990s the AAO built a ground-breaking instrument for the AAT, the two-degree field or "2dF" system. The system used a robotic arm to place optical fibres onto a large field plate, allowing astronomers to collect light from objects (usually galaxies) spread over a large (two degree) field of view—a piece of sky about 16 times the size of the full Moon. Light from up to 400 objects could be gathered simultaneously. Optical fibres carried the light into a pair of spectrographs to be analysed. In one night, astronomers could collect and analyse the light from thousands of stars or galaxies, a task that would have taken years in the past. The 2dF system required both innovative engineering and specifically written software to control the robot and analyse the huge data stream the instrument generated.

In 2006 the AAO replaced the original 2dF spectrographs with a powerful new spectrograph, AAOmega, which can produce much more detailed spectra and analyse the light from fainter objects. AAOmega is the world's best instrument for wide-field spectroscopic surveys, and is not likely to be surpassed for many years.

The Anglo-Australian Telescope: facts and figures

Altitude	
Base of dome	1134 m
Top of dome	1184 m
Primary mirror	
Working diameter	3.893 m
Thickness at outer edge	0.63 m
Mass	16.19 tonnes
Cervit blank cast	May 1969
Figuring of surface completed	June 1973
Diameter of central hole	1.057 m
Coated annually with 2.5 g of aluminium	
Dome	
Diameter	37 m
Mass	560 tonnes
Rotation time	5 minutes
Rotates on 32 bogeys	
Driven by four 3.5 kW motors	
Observing	
Average clear nights	65%
"Director's time" (special projects)	36 nights / yr
Service time	30 nights /yr
Allocated projects	300 /yr
Astronomers using AAT	300 /yr

Telescope	
Length	15 m
Mass of central tube and mirrors	116 tonnes
Mass including horseshoe mounting	260 tonnes
Other mirrors	8
Total	5
Maximum in use at any time	0.376 – 1.47 m
Diameters	860 kg
Weight of largest	
Building	
Height to base of dome	26 m
Diameter	37 m
Depth of excavation	0.3 m
Number of floors	9
Directors	
Dr E J Wampler	1974 – 1976
Dr D C Morton	1976 – 1987
Dr R D Cannon	1987 –1996
Dr B J Boyle	1996 –2003
Dr M J Colless	2003 –

More information: www.aao.gov.au

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