University Infrastructure

Based on submissions to Working Group 3.3

The University of Tasmania radio observatories: Mt. Pleasant and Ceduna

(John Dickey and Simon Ellingsen)

Funding Institution

University of Tasmania (Salaries + maintenance + some running costs)
ARC (Salaries + equipment + travel)
Consulting (everything not covered by the University or ARC e.g. page charges, other running costs)

Background

The University of Tasmania operates two radio astronomy observatories. The Mt Pleasant observatory is approximately 20 km from the University of Tasmania main campus at Hobart. The observatory has two telescopes, a 26m prime focus parabolic antenna which was donated to the University by NASA in 1985 (it was previously located at Orroral Valley near Canberra) and a 14m prime focus parabolic antenna built at the University of Tasmania.

The 26m antenna has state of the art radio astronomical equipment, including cryogenically cooled receivers that operate in a range of frequency bands from 1.4-25 GHz, a flexible digital autocorrelation spectrometer (based on the Parkes multibeam correlator design) and S2, MKV and MRO VLBI recording systems. It is used for a wide variety of types of observations including monitoring of the flux density of AGN, searches and monitoring of molecular masers and timing of pulsars.

The Ceduna observatory is approximately 40 km north of the town of Ceduna, which is 850 km west of Adelaide. The observatory has a 30m Nasmyth focus antenna which was donated to the University by Telstra in 1995. Similarly to the Mt Pleasant 26m the Ceduna 30m is able to make sensitive observations over a wide frequency range (2-25 GHz). The antenna is a vital element in the Australian Long Baseline Array (LBA), being the only antenna west of the main concentration of telescopes in NSW. The Ceduna 30m antenna is used for the COSMIC (COntinuous Single dish Monitoring of Intraday variability at Ceduna). COSMIC commenced in March 2003 and is the world's first experiment dedicated to monitoring intraday variability for sources which show characteristic timescales in excess of a few hours. COSMIC is able to measure the flux density of sources stronger than 1 Jy to an accuracy of better than a few percent and is yielding interesting results, groups in the US and Japan are setting up projects to copy COSMIC.

The 14m antenna is dedicated to making timing of the Vela pulsar, which it has been doing 18 hours per day continuously for a period of more than 20 years. The 14m antenna makes simultaneous observations in 3 frequency ranges centred on 650, 990 and 1320 MHz. The main purpose of the Vela experiment is to catch the pulsar in the act of glitching (sudden changes in the arrival time of the pulsar), which it has done on 6 occasions.

Role of the Facility

The Mt Pleasant and Ceduna antennas play an important role in the Australian Long Baseline Array, a national facility operated jointly by the Australia Telescope National Facility and the University of Tasmania. The University of Tasmania antennas are the only Australian telescopes outside NSW that regularly participate in observations. As such they provide all of the long baselines (Hobart in the north-south direction, and Ceduna in the east-west direction), that are vital for high-resolution imaging. The Mt Pleasant 26m antenna is a member of the International VLBI Service geodetic VLBI array, and participates in approximately forty 24 hour experiments each year. When not participating in VLBI observations the telescopes are in constant use for staff and student research projects and as a teaching facility for undergraduate students.

Immediate Future of the Facility

The observatories currently enjoy good support and an adequate level of funding from the University of Tasmania. In combination with funding for ARC projects and consultancies the operating budget on the 2005-2007 timescale is healthy.
The participation of the Mt Pleasant antenna in regular geodetic VLBI observations coordinated by the International VLBI Service is currently funded through an ARC Linkage project (2003-2007), with Geoscience Australia as the industry partner. The geodetic observations are undertaken largely as a service to the geodetic research community, but future funding of geodetic VLBI operations is uncertain as Geoscience Australia is no longer an eligible industry partner for Linkage applications. If alternative sources of funding cannot be found then we will have to cease the geodetic program as it requires significant resources.

Future Vision of Facility

Future upgrades:

- Fibre optic links - Mt Pleasant $600k (ARC LIEF project being undertaken during 2005) ; Ceduna $500k - $2M (2005/6, funding source unknown)
- Broadbanding of receivers - Mt Pleasant & Ceduna $500k (2006, funding source unknown)
- Hobart Interferometer – Upgrading of the 14m antenna to operate at 5 GHz and construction of a correlator to enable the 14 and 26m antennas to form an interferometer for IDV monitoring, a pathfinding project for DIVA $300k (ARC Discovery application submitted, awaiting results).

Future role:
The Mt Pleasant and Ceduna antennas undergo regular upgrading of equipment, particularly the instrumentation involved in VLBI observations. Projects are in progress to link all the antennas in the Australian Long Baseline Array with fibre optics with 10 Gbps capacity and use the ATCA broadband correlator for form the world's most sensitive VLBI array, operating in real-time by 2007. The Mt Pleasant and Ceduna antennas will continue with similar projects to those currently being undertaken when not participating in VLBI observations, with particular focus on monitoring of intraday variability, detection of radio transients and observations of interstellar masers.

High Profile Work Done by the Facility

The Mt Pleasant and Ceduna telescopes were vital participants in the first space VLBI missions VSOP, operated by the Japanese agency ISAS. This mission has provided unique high-resolution imaging of a large number of distant quasars and AGN.
The Mt Pleasant and Ceduna telescopes were part of the 17 telescope world-wide array that tracked the Huygens probe as it landed on Saturn’s largest moon Titan in January 2005. This experiment

showed the potential of VLBI for precision spacecraft tracking and our ability for rapid response and development. The project required observations at a significantly higher data rate than had ever been attempted before and the time from conception of the project to implementation was less than a year.

Observations of a glitch in the Vela pulsar in January 2000 by the Mt Pleasant 14m telescope have shown that the spin-up time for the glitch is less than 10 seconds and place tight constraints on the neutron star equation of state. The rapid detection of the glitch led to a target of opportunity observation of the pulsar by NASA's *Chandra* x-ray space telescope.

University of Sydney: Molonglo Observatory (MOST)

(Anne Green, Director of Molonglo Observatory)

The University of Sydney owns and operates the Molonglo Observatory, which is located in NSW, 30 km east of Canberra. There has been a telescope operating on the site since 1965. The present telescope is an earth-rotation synthesis interferometer called the Molonglo Observatory Synthesis Telescope or MOST. It consists of two parabolic cylindrical arms, each 778 m long and 11 m across, aligned east-west. The telescope operates at present in the radio continuum at 843 MHz, with an angular resolution of about 43 arcsec and a sensitivity of 1mJy/beam for a 12 hour fully synthesized image. It is an excellent instrument for survey work, with a field of view more than 5 square degrees. Once programmed, the telescope carries out an observation, including appropriate calibration measurements, automatically.

The facility is evolving and is presently undergoing a redevelopment to produce a new low frequency spectral line facility operating between 300 and 1400 MHz, with an instantaneous bandwidth of 50 MHz. Full polarisation imaging will be possible over a field of view of about 4 square degrees. This project is the SKA Molonglo Prototype or SKAMP, which is part of Australia's contribution to the international SKA prototyping project.

Role of the Facility

The current role of the Facility is to provide the University staff and its students (both undergraduate and graduate) with a world class radio telescope for research and training purposes. There is also an opportunity for external users to apply for particular observations, although it is not formally a National Facility. The MOST has a policy of releasing all data publicly after appropriate analysis and quality control. Once the SKAMP project is complete there will be an opportunity to apply for observing time through a procedure administered by the Australia Telescope National Facility.

Strengths & Scientific Highlights

Access to the facility is readily available for both staff and students and external users. There are already several international collaborations in place to use the telescope, particularly in response to target-of-opportunity programs. There is a strong cohort of students at all levels gaining expertise and knowledge by using the MOST.

Since 1997, when the telescope was upgraded to give its present field of view, the principal science project has been a complete survey of the southern sky, the Sydney University Molonglo Sky Survey (SUMSS), including a 2^{nd} epoch survey of the Galactic Plane. There is also a long-standing program to monitor transient sources, the most famous of which is the supernova SN 1987A in the Large Magellanic Cloud.
The telescope schedule can be changed on a timescale of a few hours to detect and monitor new transients.

The SUMSS project has produced a deep census of the southern sky, discovering high redshift galaxies, many giant and relic radio galaxies, and enabling studies of the distribution and evolution of distant galaxies. The Galactic Plane survey has found new supernova remnants and revealed large and complex filaments and structures. Several transients, mostly X-ray binaries and Soft Gamma-ray Repeaters, have been studied and the telescope has participated in many high profile discoveries.

Future Role and Requirements

Once the SKAMP redevelopment is complete there will be a new spectral line capability with full polarisation imaging, which makes the facility more flexible and powerful. The distribution of neutral hydrogen and its role in galaxy assembly will be studied at epochs when the Universe was half its present age. Cosmic magnetism can be explored, allowing a detailed map of the Galactic magnetic field and some insights gained into early magnetic field distribution and evolution.

The facility will continue to expand its training role, with a cohort of Honours and postgraduate students as well as students from Senior undergraduate years and the Talented Student Program. There will be a greater range of research projects with the extended frequency range and the capacity for spectroscopy. Upgrades needed to exploit the full polarimetric capability will be to remesh the telescope and replace the existing drive mechanism to allow more accurate pointing and tracking.

To maintain the telescope and undertake a program of scheduled upgrades,
a minimum of four full-time staff members are required at the Observatory, including the Officer-in-Charge. Additional technical support is required in Sydney for the computer network, data archiving and electronic development. This area has been under-resourced in recent times. Funding opportunities are principally through the ARC. Some industry collaboration has occurred during the SKAMP project and opportunities to continue such collaborations are desirable. The SKAMP redevelopment has been largely funded as a partner in the MNRF-2 program, with complementary ARC and University funding.

Annual budget: Staff salaries at site $300K with a further $100K in Sydney.
Maintenance and operational costs $80K

Capital works:
SKAMP project $3million

Budget does not include research and teaching academic salaries or student support.

University of Sydney: Stellar Interferometer (SUSI)

(William Tango)

The facility

SUSI is a two-element optical interferometer located at the Paul Wild Observatory (30° S, 150°E). It operates in the visible/near infrared part of the spectrum (~440 to ~1000 nm). There are 11 input stations arranged in a N-S configuration providing baselines from 5 m to 640 m. Each input station is equipped with a 200mm siderostat to steer light via evacuated pipes to a central laboratory building. Currently all baselines up to 160 m are fully operational.

The central laboratory building houses an optical path length compensator, beam-combining systems and a control room. The optical path length compensator is 70 m long and involves a computer controlled optical carriage moving differentially between the two input beams to equalize the optical paths at the point of beam combination. The carriage position and speed are monitored by laser metrology. There are two beam-combining and detection systems – one operating in the blue (400-550 nm) and one in the red (550-1000 nm).

The instrument is controlled from graphical user interfaces and one person can operate the instrument via a scheduler programme. A recent rewiring of SUSI with a high speed LAN has improved the efficiency of operation.

Role, strengths, highlights

The primary role of SUSI is to provide academic staff and students with a world class facility designed specifically for high angular resolution studies of single and multiple stars. In the case of single stars, SUSI is used to make precise measurements of their angular diameters. Combination of the angular diameter with the bolometric flux enables an empirical determination of the effective temperature of a star and, if the parallax is known, its radius and luminosity can be determined.

In the case of Cepheid variables SUSI is used to measure the angular diameter as a function of pulsation phase. The distances to these stars, a foundation of the distance scale of the Universe, can be determined by combining the angular variations with the radial displacements of the stellar surface determined from radial velocity variations.

By combining interferometric and spectroscopic observations of binary star systems the semi-major axis a in km of the orbit, the masses of the two components stars, and the distance to the system can be determined.

Recently it has been demonstrated with SUSI that polarimetric interferometry can used to investigate the dust shells around Mira variables.

Future role

The only other optical interferometer in the southern hemisphere is ESO's VLTI at Cerro Paranal in Chile. In many respects SUSI and the VLTI are complementary in that SUSI has a larger range of baselines and operates at shorter wavelengths than the VLTI. Collaborations between VLTI and SUSI staff on calibration issues and specific star studies are ongoing.

Currently SUSI has four Ph.D. students. SUSI in fact has had an outstanding track record in training students in optical interferometry and its graduates have senior positions at several major overseas facilities including the CHARA Array at Mt Wilson in California, JPL, and the Keck Interferometer at Mauna Kea.

A Memorandum of Understanding has been signed by the University of Sydney (SUSI) and Georgia State University (CHARA Array) for collaborative studies. To date SUSI students and staff have visited the CHARA Array for observational sessions, a CHARA staff member has spent time with the SUSI group, and collaboration on analysis and control software development has been valuable to both projects.

The infrastructure costs for operating SUSI are funded mainly by the University of Sydney. Costs associated with observing (lodge costs, etc.) and instrumentation upgrades and maintenance have been funded through the Australian Research Council. Academics salaries and support for postgraduate students are provided by the University. We estimate that the external support needed for SUSI will be $100k/yr over the next three years.

In terms of future development, a significant improvement in the instrument's sensitivity could be achieved by replacing the camera for the tip-tilt seeing corrector with and the fringe detectors new generation L3CCD cameras. This would cost approximately $100,000.

There is also an ongoing program to link the optical delay line in SUSI with the ATNF/CA in order to increase the bandwidth of the CA at millimetre wavelengths

The Swinburne University Supercomputer

(James Murray)

The Centre for Astrophysics and Supercomputing hosts one of the most powerful supercomputers in Australia. Funded predominantly from Swinburne research funds, it is predominately used by Swinburne based astronomers and their collaborators (national and international) to process observational data, and to run theoretically based calculations.

The machine

The Swinburne machine currently consists of 60 dual processor rack-mounted servers, and 232 desktop machines. These nodes are connected so as to form a linux “Beowulf” cluster with a theoretical peak performance of 2 teraflops (2 trillion floating point operations per second). In addition, the supercomputer has over 50 terabytes of data storage in a combination of dedicated hard disk RAID sets and local storage on the various nodes.

In addition to the main node of the supercomputer at Swinburne, the Centre maintains clusters at Parkes and Narrabri, and a 3D virtual reality theatre that is principally used for visualising astronomical data, and for astronomy public outreach.

To date Swinburne University has provided an annual budget of approximately $300,000 for upgrades to the supercomputer hardware, and provides over 200K in salary support and a further 100K in power, airconditioning and network support.

Principal uses of the machine

The Swinburne supercomputer was originally designed to provide the number crunching power necessary to reduce the large volumes of pulsar timing data being recorded at Parkes by Professor Bailes and collaborators. As the Centre has grown however the supercomputer user base has diversified. A selection of the major projects relying upon the supercomputer is given below:

- Simulations of the Square Kilometre Array
- High time resolution observations of pulsars
- Very long baseline radio interferometry. A major program is underway to use the Swinburne computer to reduce radio data from several telescopes round Australia in real time. Preliminary tests making use of data cached at the telescopes have proved successful.
- N-body simulations of galaxy formation and interactions
- Modelling the chemodynamic evolution of galaxies
- (Magneto)-hydrodynamic modelling of accretion processes in binary star systems
- Hydrodynamic simulations of the earliest stages of planet formation

The applications run on the machine include codes written at Swinburne (e.g. the pulsar timing and VLBI data reduction software), public domain N-body and hydrodynamics codes (e.g. SWIFT, ZEUS and GADGET). Both grid and particle based hydrodynamics codes are used. Many of the codes can be run in parallel across several nodes of the cluster.

User Profile

As of April 2005 the supercomputer user base was divided as follows:

Centre for Astrophysics and Supercomputing users	44
Other (non-astronomy) Swinburne users	30
External astronomy users	89
Total	163

In addition, the supercomputer hosts an archive of pulsar timing data that is regularly accessed by pulsar researchers not included in the above table.

Summary

The supercomputer is demonstrably an important resource for both observational and theoretically based astronomers within Australia and worldwide. As well as the hardware itself, the Centre has staff expert in developing and running a large range of astrophysical codes, and in the effective visualisation of the results.

The University of New South Wales: Mopra Millimetre Wave Observatory

(Michael Burton)

Short description of facility

Mopra is a 22 m diameter radio telescope operating in 3 mm band (as well as in the cm-bands), located below Siding Spring Observatory, near Coonabarabran in NSW. It is currently equipped with a single-element SIS receiver operating from 85-115 GHz (3.5-2.6 mm), with up to 256 MHz of bandwidth, and a dual polarization, single sideband, 1024-channel correlator, with spatial resolution of ~35". Mopra is currently being upgraded, and by the end of 2006 should have a MMIC receiver and an 8 GHz bandwidth correlator with 16,000 channels, with the ability to zoom into four specified bands within the 8 GHz window. The upper frequency cut-off of the MMIC receiver has yet to be determined, but will be in the 105-115 GHz range. Mopra can be used for stare observations (via nodding) and also for mapping using on-the-fly (OTF) scanning, typically fully-sampling a 5'x5' region in one hour.

Mopra is a part of the CSIRO Australia Telescope National Facility, and is operated as part of the ATNF Narrabri observatory. Since 2000, however, operations have been conducted through a collaborative arrangement between the CSIRO and UNSW, resulting in an investment of ~$1m into the emerging field of mm-wave astronomy in Australia, through ARC and university capital development grants. This arrangement has also facilitated the building of a mm-wave community within Australia, through the training of students, employment of postdoctoral fellows, and the holding of regular mm astronomy workshops.

Current role, strengths and scientific highlights

Mopra has had a particular role to play in the training of students in the skills of mm astronomy and in the hands-on operation of telescopes. This role will continue, but with the maturing of the facility its scientific program will now provide the central focus to its future use.

With the closure of the 15m SEST telescope in Chile (as part of the funding arrangements leading to development of ALMA), Mopra is now the only large diameter 3-mm wave telescope operating in the southern hemisphere. It is therefore the only such facility able to probe the lowest rotational lines of many of the most abundant molecules in the interstellar medium (e.g. CO, HCN and HCO^+). Mopra will also be able to provide complementary information to the sub-mm telescopes now being built in Chile, which will record the higher rotational transitions of the same molecules.

The primary science project to be conducted during this development phase of Mopra has been the search for chemical signatures of hot molecular cores (HMCs), associated with the earliest stages of massive star formation. Using the signpost of methanol maser emission to target prospective massive protostellar cores, sources have been examined for the rich spectrum of an organic reservoir. Methyl cyanide (CH_3CN) has been commonly found, indicating a pre-UCII phase of massive star formation.

With the development of OTF mapping, a project has begun to survey the environment of molecular cloud complexes, to examine the role of turbulence in driving and regulating star formation. A square degree of the fourth quadrant of the Galaxy has been targeted (the 'δ-quadrant survey'), to be sampled in a variety of molecules sensitive to different physical environments in the gas.

Future role of the facility

Mopra has three key features that provide the focus for future science projects:

- Access to the 3-mm band, for which Mopra will remain the only large telescope in the south where this will be the primary operations band.
- The wide-band (8 GHz) correlator, facilitating extra-galactic studies (wide lines, uncertain central wavelengths), systematic searches for lines (e.g. the identification of biogenic molecules through spectral fingerprinting), and the simultaneous measurement of up to four separated lines in a source (in spectral zoom mode).
- OTF mapping, with the ability to map degree-sized regions of the sky in up to 4 lines.

These features also provide complementarity to the sub-mm and terrahertz facilities now being built in the high Atacama plateau of Chile, in particular the 12m APEX (Germany, Sweden) and ASTE (Japan) telescopes and the 4m NANTEN2 telescope (a Japanese, German, Korean, Chilean university consortium). Mopra will provide comparable beam sizes and mapping speeds (depending on frequency), thus facilitating joint survey programs. Mopra also provides a finding telescope for the ATCA mm-interferometer, facilitating the selection of sources for higher resolution interferometric imaging. Further ahead, the mm-ATCA will provide the same service for ALMA.

Three particular upgrades would greatly facilitate the scientific capability of the Observatory:

- *A 7mm spectrometer.* This spectral window remains relatively unexplored (e.g. high dipole moment molecules), though is readily accessible from the Mopra site.
- *Focal Plane Arrays.* OTF mapping is limited to covering degree-sized regions if using just a single element detector. FPAs would greatly increase Mopra's survey power, making mapping of large areas of the Galaxy or the Magellanic Cloud possible, for instance.
- *Million-channel spectrometers.* There is every expectation that million-channel devices will be available in a few years, enabling the entire mm spectral windows to be accessed simultaneously, with a spectral resolution sufficient to resolve even the thermal widths of all lines present.

Funding opportunities

Funding for the scientific utilisation of Mopra is well within the scope of typical ARC Discovery and LIEF grants, supplemented by university and/or CSIRO contributions. Developments such as FPAs and million-channel spectrometers however, go beyond what could be obtained through such schemes, and would rely on developing suitable strategic alliances. The best opportunities for promoting the scientific utilisation of Mopra in the coming decade lies in developing international collaborations with those countries participating in the construction of sub-mm facilities on the Atacama plateau of Chile (e.g. Chile, Germany and Japan), driven by the complementarity of the science that can be carried out in the sub-mm and the 3-7 mm-bands.

The University of New South Wales: AASTO (Automated Astrophysical Site Testing Observatory)

(John Storey)

Description

Built in 1996 to facilitate Antarctic site testing, the AASTO pioneered many of the technologies currently used in the AASTINO (Automated Astrophysical Site Testing International Observatory). The AASTO is a small, self-heated, self-powered, autonomous laboratory that serves as a host to a variety of astronomical instrumentation. The AASTINO was originally design to use thermo-electric generators fuelled by propane, but was later modified to use a Stirling engine and jet fuel. The AASTO was initially funded jointly by RSAA and UNSW, and was constructed by Lockheed Missiles and Space, California.

Current role, strengths and scientific highlights

The AASTO provided much of the original site testing data now used to support international proposals for new astronomical facilities at eth South Pole. Pioneering data from the AASTO included sub-mm opacity, sky brightness in both the near and mid infrared, atmospheric turbulence, seeing, and auroral and sky brightness measurements in the visible.

With the South Pole now well characterized for astronomical research, the AASTO is currently being used as support facility for the Vulcan South planet search program, a collaboration involving NASA Ames and UNSW.

Future role

The AASTO is likely to continue in its present role for the foreseeable future.

Funding opportunities

Funding for Australian participation in Vulcan South, and other programs involving the AASTO, is within the scope of ARC Discovery and LIEF grants.

The University of New South Wales: AASTINO (Automated Astrophysical Site Testing International Observatory)

(John Storey)

Description

The AASTINO is a small, self-heated, self-powered, autonomous laboratory that serves as a host to a variety of astronomical site-testing instrumentation. It was developed with UNSW funding in order to facilitate characterization of unattended sites on the high Antarctic plateau. The AASTINO generates 800 watts of electrical power and 6kW of heat (at sea-level) via two Stirling engines running on jet fuel. An additional 300 watts of solar power is available during daylight hours. Communication is provided via the Iridium satellite network, giving full global coverage.

Current role, strengths and scientific highlights

The AASTINO is currently located at Dome C, Antarctica. It is the only facility of its type in the world. By making possible the characterization of unmanned sites, even in extremely remote areas, the AASTINO has played a key role in showing that Dome C offers astronomical observing conditions far better than those available at currently operating observatories. In 2005 the AASTINO supports the following instruments:

- Acoustic Radar (SODAR)
- Multi-Aperture Scintillation Sensor (MASS)
- Sub-millimeter Tipper (SUMMIT)
- Optical sky-brightness spectrometer (Nigel)
- Cloud Monitors (Icecam and COBBER)
- Vaisala FD12 precipitation monitor (contributed by Joseph Fourier University, Grenoble)

Future role

In future years the AASTINO will continue to support both UNSW-built instruments and those contributed by international partners. New instruments scheduled for deployment in 2006 include:

- Shadow band scintillometer (SHABAR, contributed by Arcetri Observatory)
- Sky brightness cameras (Gattino, contributed by Arcetri Observatory)
- Mid-infrared sky monitor (contributed by Lethbridge University, Canada)
- Son of MISM (UNSW)

The AASTINO will also be used as a model for several future autonomous laboratories. One will carry a suite of instruments to the highest point of the Antarctic plateau, Dome A, as part of an international program to explore the site during the International Polar Year 2007 – 8. A third AASTINO will carry a terahertz observatory, HEAT, as described separately under "Future Antarctic Programs".

Funding opportunities

The operational and upgrade costs of the AASTINO are well within the scope of typical ARC Discovery and LIEF grants. Additional instrumentation will be developed in-house, or contributed by international partners.

The University of Tasmania:
Mt. Canopus Observatory

(John Greenhill)

Background

The observatory is situated in the Meehan Ranges 10 km from the city of Hobart. It was built during the 1970's by Dr Mike Waterworth with financial support from the ARGS (predecessor to the ARC) and the University of Tasmania. One of the principal scientific objectives (inspired in part by US astrophysicist Theodore Dunham) was to conduct high resolution spectroscopy of the southern skies with particular emphasis on the Magellanic Clouds. The principle instrument is a 1.04 m telescope of Richey-Chretien design with CCD and high speed photometers at a folded Cassegrain focus and a high resolution Coude spectrograph. In the mid 1990's a professional quality CCD photometer was purchased and Mt Canopus became part of the chain of telescopes involved in the international PLANET microlensing collaboration. The observatory site is also home to the amateur Astronomical Society of Tasmania (AST) who use the University's 40 cm telescope as well as several smaller (10" and 12") telescopes

Science programmes

The 1 m telescope is used continuously, for 4 to 6 months per year as part of the international PLANET microlensing collaboration. The primary goal of PLANET is the search for exo-planets similar to those in our solar system. The light curves of selected microlensing events towards the Galactic Bulge are measured with high time resolution looking for anomalies due to planets about the lensing star. Lens stars with stellar binary companions cause caustic structures in the amplification pattern which drift across the disc of the source star. This permits spatially resolved spectroscopy of the source star atmosphere using 8 m class telescopes such as the ESO VLT.

At other times the telescope is available for target of opportunity studies of X-ray binaries either alone or in coordinated campaigns with observatories in South America and South Africa. Of particular interest is the study of accretion processes in micro-quasars (jet emitting systems) and millisecond X-ray pulsars. During 2005 the telescope will be used under contract to ESO for long term photometry of comet 9P/Tempel 1 for four months of the NASA Deep Impact mission.

In a new programme we have commenced monitoring of AGN's in conjunction with radio observations at the Mt Pleasant and other observatories, in order to characterise their intrinsic variability. This project is an example of the multi-wavelength synergy within the University of Tasmania's physics department.

Significant scientific achievements

- Detection of the atmosphere of Pluto by photometric measurements during a stellar transit.
- Detection of a transient millisecond period modulation of the emission from supernova 1987A.
- Making the first ever measurement by microlensing of the limb darkening profile of a K giant during the MACHO-1997-BLG-28 event.
- Contributing as part of the PLANET collaboration in demonstrating that MACHO-1997-BLG-41 event was due to microlensing by a stellar binary lens with rotation effects and not, as had previously been claimed, by a binary system with planetary companion.
- Data taken by PLANET until 1999 imply that less than 1/3 of bulge M-dwarfs are surrounded by jupiter-mass companions at orbital radii between 1 and 4 AU. These limits are likely to be reduced to a few percent by the end of 2005.

- Providing the key photometric data necessary for scheduling ESO VLT spatially resolved spectroscopy of an M6III giant with UVES while the lens transited the source (OGLE-2004-BLG-482).
- Making the first optical identification of the third millisecond X-ray pulsar XTE. J0929-314 and making the only detailed optical studies of it and another millisecond pulsar SAX J1808-314 during outburst.

New developments

A tip-tilt drive for the tertiary mirror is expected to become available about mid 2005. This will provide improved tracking and first order image correction for photometry.

A second camera with SITe 1024x1024 pixel CCD and Leach controller is being commissioned. This will provide an 8x8 arcminute FOV for photometry and will also be used with the Coude high resolution spectrograph. The spectrograph is being modified for fibre feed from the Cass focus. This will provide R=15,000 for objects to magnitude 12 or 13. A low resolution (2 pixel resolution 2.6 A) facility will also be available. Changeover from photometry to spectroscopy will be virtually instantaneous. This will be used for spectral identification of microlensed objects, study of X-ray transients etc. An aspheric corrector near Cass focus provides a high quality, flat field to about 40 arcseconds diameter. A pilot programme is under way to investigate the feasibility of fitting a multi-fibre feed for radial velocity measurements to study the dynamics of clusters of galaxies.

We have begun an investigation the of photodiodes and superconducting tunnel junctions for fast photometry and spectrophotometry. There is a lot of interesting astrophysics possible by exploring the short time domain; optical pulsars, flare stars, flickering and QPO's of CV's, disk and stream mapping of CV's including black hole neutron stars systems, direct measurement of radii of white dwarfs in eclipsing systems, and imaging giant stars .

These projects use the advantages of Mt Canopus: being able to take up new observations quickly and conduct long term monitoring. Observing time on Australia's large optical telescopes has been at a premium and inflexible scheduling has made it difficult to observe targets of opportunity (TOO) and conduct long term monitoring. Recently, more flexible scheduling has been helpful but the trend towards large dedicated surveys means that it remains difficult to obtain time for TOO observing and long term monitoring. Our objective is to optimise the facilities at Mt Canopus to maximise its use for these types of observing.

Education and public outreach activities:

- Undergraduate physics and astronomy students visit the observatory and use it for short duration research projects. These include measurements of globular clusters and orbital period changes in cataclysmic variables.
- Research higher degree students work on projects relating to the PLANET microlensing programme and the study of X-ray transients.
- The School of Maths and Physics and the AST jointly conduct public viewing nights and illustrated lectures at the observatory several times a year, or when events of special astronomical interest occur. Visits by school classes and various community groups are available by appointment.
- The AST offers short evening courses in astronomy to the general public. These are held in the seminar room at the observatory and make use of the 40 cm and smaller telescopes.

Future prospects: Cluster dynamics

Should the present feasibility study on prospects for fitting a multi-fibre system to the spectrograph prove successful it will open a new niche area of research for the instrument. While a small, 40 fibre, system on Mt Canopus could not compete with instruments such as AAOmega it would afford the opportunity to conduct small scale specialised observational programmes and train students in multi-fibre techniques. One such niche area that fits with current staff interest at the University of Tasmania would be to examine the velocity dispersion profiles of AMP clusters in more detail. At present there are still some clusters for which radial velocities have only been measured for less than 4 member galaxies. The true nature of these systems and their relationship to the larger supercluster environment are poorly constrained. A 1m class telescope like Mt Canopus could easily improve this situation.

The observatory suffers from increasing light pollution due to housing development and the world-wide trend to increased artificial lighting. The local council planning scheme includes a 2.5 km radius buffer zone with restricted housing densities and outside lighting around the observatory. Surprisingly, light pollution in several sectors remains below IAU recommended maxima but the pressure for development so close to the city is increasing and a move to a more isolated site seems likely. Optical seeing measurements are planned for several alternative sites within 100 km of Hobart. Being at higher altitude and more remote from the influence of the sea it is likely that these will provide significantly better conditions for astronomy. If the observatory is relocated it will be modified to permit remote operation.

The University of New South Wales: APT (Automated Patrol Telescope)

(Michael Ashley)

Description

The APT is an automated 0.5m aperture Schmidt telescope with a CCD detector and UBVRI filters. The APT is located at Siding Spring Observatory. The telescope's field-of-view is currently 2×3 degrees using a CCD with 770×1152 pixels, however, the telescope is currently being upgraded to a 6×6 degree field-of-view with 6k×6k pixels.

The APT has been automated since 1995. Incremental improvements to the automation had been made over the last decade, and the telescope is now used remotely via the Internet on every clear night.

UNSW has two all-sky cameras associated with the APT, and data from these is made available to other observers on the mountain. We are also archiving data from the cameras so that observers can examine the historical record of cloud during any desired night.

Current role, strengths and scientific highlights

The APT is currently working on three major projects: a wide-field survey for transiting extra-solar planets, a survey for novae in the Large Magellanic Cloud, and, during the few days around each Full Moon, obtaining precision light curves for Delta Scuti and other variable stars.

The APT's main strength is its ability to operate all night with very little intervention. A single observation script is able to run the telescope all night. Human operators (connected via the Internet) are only necessary for safety reasons in the event of hardware failure.

The APT is also capable of very high precision photometry (down to 2 millimag RMS in a 60 second exposure) by virtue of a technique we have pioneered: raster scanning the telescope over a 1×1 pixel square during an exposure. This technique greatly reduces the effect of intra-pixel sensitivity variations in the CCD detector.

The APT plays a very important role in the education of undergraduate and graduate students. Over 45 final year Electrical Engineering and Computer Science students have worked on instrumental aspects of the APT for their fourth year thesis projects. A half-dozen Physics Honours students have also used the telescope for their theses, and ~10 PhD students.

Future role

With the awarding of a significant ($370K) LIEF grant in 2005, the APT is poised to undergo a major upgrade. The new CCD camera, currently being built by the Anglo-Australian Observatory, will be 2-3 times more sensitive than the existing camera, faster to read out, cover ~6 times the area of the sky, and have smaller pixels to sample the point spread function of the telescope. This new capability will greatly increase the productivity of the telescope and its ability to conduct multiple scientific programs in an efficient manner.

Funding opportunities

Funding through ARC Discovery and LIEF grants, supplemented by internal UNSW grants, is expected to be sufficient.

The University of New South Wales: ROTSE-IIIa (Robotic Optical Transient Search Experiment)

(Michael Ashley)

Description

ROTSE-IIIa is a 0.45m fully robotic optical reflecting telescope located at Siding Spring Observatory. It is equipped with an unfiltered 2048×2048 pixel CCD giving a 1.9×1.9 degree field-of-view on the sky. ROTSE-IIIa is part of a worldwide consortium of four identical telescopes (the others are in Texas, Namibia, and Turkey) designed to identify optical transients associated with gamma ray bursts and to provide photometric measurements of these transients during the crucial first few minutes of the outburst.

The particular strength of the ROTSE-III telescope design it is that it is capable of beginning an exposure at any location in the sky within approximately 6 seconds of notification of the position via the Internet.

When not observing an optical transient, ROTSE-IIIa is available for other wide-field astronomical imaging programs.

70% of the time on ROTSE-IIIa is allocated to the consortium, 30% to the University of New South Wales.

ROTSE-IIIa became fully operational in 2003.

The institutional members of the ROTSE-III consortium are the University of Michigan, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, the University of Texas, the University of New South Wales, the Max Planck Institute for Nuclear Physics, and a variety of institutions in Turkey.

Current role, strengths and scientific highlights

With the recent (December 2004) commissioning of the *Swift* satellite, there is now a source of frequent, accurate, coordinates for gamma ray bursts. The ROTSE-III telescopes have been responding regularly (on a weekly basis) to these alerts, and ROTSE-IIIa has been performing well. Optical transients that were observed by ROTSE-IIIa include:

GRB 030329 – The second brightest optical transient ever observed: a 13^{th} magnitude source 1.5 hours after the burst. ROTSE-IIIa obtained some of the earliest data on the subject through patchy cloud. A ROTSE-IIIa image of the GRB appeared on the front page of the Sydney Morning Herald.

GRB 041006 – A detection of a 17^{th} magnitude source 26 seconds after the burst (15 seconds after the trigger).

GRB 050401 – A detection of a 17^{th} magnitude source 33 seconds after the burst (and 6.2 seconds after the trigger). This detection is notable in that it is only the second time that an optical transient has been observed *during* the emission of gamma rays.

ROTSE-IIIa has participated in a number of consortium projects to obtain light curves of various objects. UNSW is currently using the telescope for a survey of novae in the Small Magellanic Cloud.

Future role

ROTSE-IIIa will be actively employed observing optical transients for at least the lifetime of the *Swift* satellite, which is about 5 years. Future satellites are expected to extend the productive lifetime of ROTSE-IIIa indefinitely.

We are working to improve the imaging performance of the telescope so that it can contribute to a variety of wide-field photometric experiments. We are also exploring avenues for providing multicolour photometry and/or low resolution spectroscopy.

Funding opportunities

Funding through ARC Discovery and LIEF grants, supplemented by internal UNSW grants, and with assistance from other consortium members, is expected to be sufficient.

The Macquarie University Observatory

(Alan Vaughan and Quentin Parker)

For over 20 years we have operated a small observatory on the campus at Macquarie University with two fixed-dome buildings. We have a number of optical telescopes with apertures from 400mm down to 100mm. We also have two remotely controlled radio telescopes with dish sizes of 4 and 2 metres. The observatory is mainly used for undergraduate teaching and for our public outreach program.

Instrumentation for the telescopes includes a number of CCD cameras and spectrographs which have recently been upgraded. These are mainly used by advanced undergraduates and Honours students.

Some of the telescopes are controlled by computers.

We have an inflatable planetarium that is very popular with school groups on and off campus.

There are well developed plans to significantly upgrade our observatory infrastructure to incorporate a small planetarium and classroom. This will enable expansion of the activities especially into the day-time when school groups can more readily attend.

There is also the possibility that the observatory might become a node for school groups to access the 2-m Faulkes robotic educational telescopes with professional assistance from MU staff. MU is an official partner of the Australian Faulkes Telescope consortium and provides a support astronomer.

Some serious monitoring of Eta Carina has recently been accomplished on the 40cm telescope by students and postgraduates.

The astronomy group now comprises 16.5 individuals as follows: staff (3.5) , honours (2), Phd (7), MSc(1) and Postdoc/RA (3). This represents a very significant increase compared to the situation in 2002 (staff (1.5), honours (1).

The University of South Queensland: Mt. Kent Observatory

(Brad Carter)

Description

Mt Kent Observatory is operated by the University of Southern Queensland (USQ) for astronomy education, research training and public outreach. The Observatory is located at a dark-sky site outside Toowoomba. On site are 3 telescopes in separate domes, plus the Educational Development Group (EDG) Facilities building and a communications tower.

The telescopes comprise:

- Meade 40cm Schmidt-Cassegrain for hands-on visual observing
- Celestron 35cm optics + Paramount ME robotic mount for web-based observing
- 40cm Cassegrain telescope for photoelectric photometry

The EDG Facilities building contains a lecture room, control room, computer room, workshop, kitchen, bathrooms and sleeping quarters. The communications tower provides high-speed data transfers to USQ Toowoomba and the internet via a microwave link.

Current role, strengths and scientific highlights

Mt Kent Observatory's **role** is to support the USQ's teaching and student research in astronomy and astrophysics, focusing on the activity of solar-type stars. The Observatory's **strengths** are its location at a dark-sky site convenient to a major population centre, and its capability for remote and robotic observing. The Observatory's main **contribution to scientific research** is the photometry provided to support more detailed studies of solar-type stars using Zeeman Doppler Imaging.

Future role

Mt Kent Observatory's **future role** will continue to be the **training** of undergraduate and postgraduate astronomy **students** via research into the **science of solar-type stars** and the further development of **robotic astronomy**. During 2005 the Observatory is used for:

- Field nights for classes totalling ~60 undergraduate students
- 1 MSc student
- 1 PhD student
- 3 fourth-year engineering students

The Observatory's present **operational needs** are estimated to be:

- $23K per year for casual staffing, travel and equipment
- technical support ~0.1FTE
- teaching & research management ~0.1FTE

Upgrade: The 40cm Cassegrain telescope is scheduled to be replaced in 2005 by a 0.5m aperture Celestron-20 telescope, as part of USD$170,000 NASA-funded robotic astronomy collaboration with the University of Louisville.

Funding opportunities

Student enrolment income remains the primary basis for future USQ funding of Mt Kent Observatory. Collaboration with the University of Louisville however is expected to provide extra income for about 2 years. As a University facility, the Observatory is also eligible for funding by the ARC, though none is currently provided or requested. The Observatory's public outreach work represents a minor budget item run on a cost-recovery basis. Commercial interest has been expressed in the technology developed at USQ for remote operation of observatory domes.

University of Western Sydney: Campbelltown Rotary Observatory

(Ragbir Bhathal)

OZ OSETI PROJECT (UWS CAMPBELLTOWN CAMPUS)

The Observatory began operation in 2000 and was built mainly from donations from the private sector. It is probably the only university observatory which has been built mainly from funds obtained from the private sector. It houses a fully computerised 16 inch telescope with associated equipment.

The main project at the Observatory is to search for ETI in the optical spectrum. The OZ OSETI Project uses specially designed high speed equipment to search for nanosecond laser pulses which may be beamed at the Earth by advanced ETI civilisations. The project is searching for ETI among ten thousand sun like stars. To date several southern globular clusters and several hundred stars have been searched for nanosecond optical signals. The 16 inch telescope is used in association with the 24 inch telescope at UWS Werrington North campus. The OZ OSETI project is the only dedicated optical search for ETI in the southern hemisphere.

Two international conferences on SETI have been organised one on-shore and the other in the US. A book on Searching for ET has been published along with a number of papers on SETI. The work of the Observatory has appeared on Channel 7, ABC Catalyst Science Show, Discovery Channel, BBC and on radio. It has also been mentioned in a number of books on SETI and the search for life in the universe and the London Financial Times, Astronomy & Geophysics and the New Scientist. Five books on astronomy have been published.

There are plans to build a dedicated one metre optical telescope to carry out an all-sky optical pulse survey. It is envisioned that the wide-field optical telescope will be used in transit mode. Funding is being sought from the private sector.

It is opened to the public on four or five astronomy nights a year.

University of Western Sydney: Werrington North Campus

The Observatory was built from funds from the Commonwealth Government. It houses a fully computerised 24 inch telescope with associated equipment. The telescope was refurbished and made operational a few months ago. It is mainly used for teaching and student research projects especially by engineering students both local and overseas. It is also used in association with the Campbelltown Rotary Observatory for the OZ OSETI project. It runs an astronomy program for schools in the western suburbs of Sydney and is also used a few times a year for astronomy nights for the general public with speakers coming from the professional astronomical community.

The Observatory has produced a number of PhD and MSc graduates in collaboration with national facilities. It has links with other astronomy groups in Australia and overseas.

A 3.5 m satellite dish has been installed at the Observatory site for use by local and overseas engineering students for projects in telecommunications, satellite and space communications.

Director of UWS Observatories: Dr Ragbir Bhathal (r.bhathal@uws.edu.au)

The Queensland University of Technology: The Nanango TIE QUT Observatory (NTQO)

(Steven Hughes)

NTQO is a Queensland University of Technology (QUT) observatory which is part of the Telescopes in Education (TIE) netowork which includes a 14" telescopes based in Arizona (USA) and Chile as well as in Australia. NTQO was initially funded by NASA, Education Queensland and QUT. Additional funding is currently being sought from the federal government and the ARC. The purpose of this funding is to provide staff for running NTQO and replacing the current satellite link with a broad-band land line. The following table summarises the current equipment.

Telescopes Two 14" Celestron (C14) + Paramounts (Capacity for 3 extra C14s)
Two CCD cameras Apogee AP7b, 512 × 512, 24 μm pixels, 14.5' × 14.5' FOV, 16-bit
Colour (Cousins) filter wheels • B: 370–520 nm • V: 480-690 nm • R: 560-1060 nm • I: 670-1100 nm
Satellite link • download 512 kbps • upload 128 kbps • (2 Mbps landline possible)
Power • 12 solar panels, 5.2 Kwh per day • 27 hours battery operation

NTQO is currently used by school students in the US and Queensland. The 14" NTQO telescopes are still undergoing development, for example, browser software is being developed to make the telescopes easier to use over the internet. The 14" TIE telescope in Chile has been used for an undergraduate project at QUT to search for supernova, and by year 11 and 12 students attending QUT under the CSIRO student research scheme. We hope to increase the use of NTQO in undergraduate projects and also involve high school from around Queensland in professional research projects, for example, colour photometry. For more information on NTQO please visit: http://www.bee.qut.edu.au/projects/ntqo/

The University of New South Wales: HEAT (High Elevation Antarctic Telescope)

(John Storey)

HEAT (High Elevation Antarctic Telescope) will use a robotic telescope to carry out a 1.5THz spectral line survey of the Galaxy. HEAT is an international collaboration led by the University of Arizona; Australia's contribution will be in power, thermal management and communication systems. HEAT is described in *Proc SPIE,* **5489,** 470-480 (2004).

The University of New South Wales: ASO (Antarctic Submillimetre Observatory).

(John Storey)

ASO will be a 12 metre single-dish terahertz telescope, fitted with a variety of focal plane instruments for continuum and spectral line observations. ASO will take advantage of the superior atmospheric conditions at Dome C, Antarctica, to carry out observations that are complementary to those of the APEX telescope at Chajnantor. ASO's main advantage will be in the 150 - 450 micron range, where it will be used for spectral line studies of the dense interstellar medium and continuum studies of protostars and early galaxies. ASO has been proposed by a consortium of Italian, UK and Australian groups led by the Institute of Radio Astronomy, Florence.

The University of Tasmania, The University of Sydney, Swinburne University: DIVA (Dedicated Variability Array)

(David Jauncey)

- DiVA is a small, dedicated array telescope designed to search for and monitor radio variability on all time-scales from minutes to years. As such it will explore a largely unexplored parameter space for variability.

- The DiVA science program will be a world leader in the rapidly expanding area of inter-stellar scintillation as well as in the study of transient phenomena.

- The research output from DiVA will provide a unique opportunity for collaboration with several high energy space programs with entry to be provided through DiVA's science capability.

- DiVA will provide direct educational capabilities for under graduate and post graduate students to carry out their own observational programs.

- In addition by facilitating International Collaboration with several high energy space programs DiVA opens the door for direct student and staff collaboration in these programs.

- Funding for DiVA is proposed from a university, ARC and ATNF collaboration. The Hobart Interferometer is a first step towards establishing the science program and evaluating both performance and costing of the final DiVA facility.

The Proposed DiVA Facility

The proposed modest facility consists of an array of a minimum of 4 small, >~ 15 m, dishes to cover the frequency range 1.5 to 10 GHz. The array is to be spread over baselines of up to ~ 1 km, although longer baselines are also feasible. Spectral resolution will be from ~100 KHz to ~ 1 GHz in order to explore both wide and narrow band variability. DiVA would be a two dimensional array to avoid large changes in background confusion as the Earth rotates. A minimum of four antennas will provide both phase and amplitude closure.

It is DiVA's ability as an array to provide the complex visibilities that makes it such a powerful instrument. Any variable source in the field can be reliably subtracted from the background whether confusion or structure. The phase is a much more reliable indicator of the presence of a weak source than its amplitude; the phase follows a Gaussian distribution, the amplitude a Rice distribution.

DiVA will have dual linear polarization feeds since it has been found that the fractional variability of the polarized flux density is often greater than that of the total flux density. In many AGN the polarization and its variability are powerful probes of the magnetic field and its variability.

An array, albeit a modest one, was chosen because of its proven ability to provide fast, accurate and reliable full Stokes parameters measurements. Arrays also provide both phase and amplitude measurements. So for weak transient phenomena DiVA will provide high sensitivity confusion subtraction, from measurements of the background after the transient has faded. With a 30 m equivalent collecting area and expected 40K system temperatures and 1 GHz bandwidth, DiVA will possess an rms noise level of less than 1 mJy per minute with both polarizations.

Scientific Objectives

DiVA is directed at studying a variety of variability phenomena. Because it is dedicated to such studies it will allow both long- and short-time scale interstellar scintillation monitoring as well as have the flexibility to study transient phenomena such as Gamma-Ray bursts and X-Ray transients. Being dedicated to variability gives the instrument an extremely rapid response capability.

Interstellar scintillation

For a source to scintillate it must contain a component with microarcsecond, μas, angular size. ISS is presently the only technique with μas angular resolution currently available at any wavelength in astrophysics. Thus DiVA's principal objective is to study the μas structure and evolution of scintillating AGN. This is achieved through long-term, detailed flux density monitoring to determine the annual evolution of the variability characteristics, e.g. time-scales and amplitudes. The observed variability characteristics evolve due to changes in the annual cycle and to changes in the source and/or nature of the interstellar medium (ISM). It is known that ISS can be seen in up to 25% or more of all flat-spectrum AGN and that this fraction increases with decreasing flux density, so that there are many scintillating sources that will become targets for DiVA.

In addition to determining source structure and evolution DiVA will inevitably probe the structure and evolution of the ISM that is the cause of the scintillation. Moreover, a basic component of DiVA's role will also be to undertake the scintillation surveys in the south necessary to complement the northern MASIV VLA survey.

The largest amplitude scintillation variability takes place near the transition frequency, which for most sources is ~ 5 GHz due to the properties of the Galactic ISM. As a dedicated instrument DiVA will maintain long-term monitoring programs in both the weak, ~5 < 10 GHz, and strong, 1.5 < ~5 GHz, scattering regimes. Outside the nominal 1.5 and 10 GHz limits the amplitude of scintillation, except in the most unusual cases (e.g. the H2O mega-masers in the Circinus galaxy) decreases rapidly for frequencies above 10 GHz and below 1.5 GHz. Moreover, for strong scattering the time-scales become many weeks or months at frequencies below 1 GHz.

Dedicated long-term monitoring of ISS is essential. The MASIV 5 GHz VLA scintillation survey revealed that the great majority of scintillators have characteristic time-scales of a day or more. MASIV showed that two thirds of all scintillators are episodic in the sense that they appear to scintillate for periods of months and are then quiet for some longer period longer than the year over which MASIV was undertaken. Thus DiVA will not only follow known scintillators it must also undertake its own scintillation surveys. With an rms noise of less than 1 mJy per minute DiVA will be quite capable of routinely undertaking such surveys. Such long-term intensive monitoring observations are essentially impossible for the National Facility instruments such as the ATCA, the VLA and the WSRT because of their large customer base and heavy oversubscription rates.

High Energy Transient Sources

High energy transient sources form another major component of DiVA's program. The next generation of high energy gamma-ray and X-ray space missions, e.g. AGILE, Astro-E2 and GLAST, will discover increasing number of outbursts and transient sources. Follow-up observations with small radio and optical telescopes are required to characterize the nature of these highly energetic sources. For example DiVA will be able to characterize the scintillation of the radio emission from strong Gamma-Ray bursts in a way that has not proven possible with the VLA, thus allowing detailed determination of their size evolution with μas resolution.

In addition to the above cases of rapid variability, DiVA will provide data on the long-term intrinsic variability of AGN. Such information will be essential to the interpretation of the intrinsic variability seen from space at X-Ray and Gamma-Ray energies. For example, DiVA will be programmed for routine observations of the known Gamma-Ray AGN in order to establish their variability characteristics in preparation for later cross-correlation with their variable high energy variability.

Education and Training

As a university facility DiVA offers excellent educational opportunities. It will be operated remotely so that observers, students or staff, can operate their own programs. Most importantly such space collaborations give the DiVA partners direct access to participate in international high energy astronomy in a variety of overseas space missions. This is of considerable value given Australia’s present minimal role in space science. This is an essential component of the training and educational program associated with DiVA.

International Collaboration

DiVA science program In addition by facilitating International Collaboration with several high energy space programs DiVA opens the door for direct student and staff collaboration in these programs.

Funding Opportunities

As a primarily university facility funding for DiVA is proposed to come from a university, ARC and ATNF collaboration. The Hobart Interferometer is a first step towards establishing the science program and evaluating both performance and costing of the final DiVA facility. Universities who have expressed support include the University of Tasmania, Swinburne University of Technology and Sydney University.