University Facilities

A report to the National Committee for Astronomy for the Australian Astronomy Decadal Plan 2006-2015
By Working Group 3.3

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1. Summary

Australian universities host and maintain a broad variety of astronomy facilities. University facilities include observatories, computation and visualization centres, virtual teaching and research centres, and theoretical research groups. The role of these facilities is to support first class, internationally recognized research, and to offer essential training at the undergraduate and postgraduate level.

Australian universities successfully operate high impact, large facilities such as the MOST radio telescope, the MSSSO optical observatory and the radio telescopes of the University of Tasmania, to the benefit of the Australian and international communities. Universities are particularly suited to operate and maintain low-cost, cutting edge science niche facilities, such as AASTO and AASTINO Antarctic Laboratories and a stellar interferometer (SUSI). University facilities also include small optical observatories, which perform research, teaching and outreach functions; e.g., Mt. Kent Observatory and Mt. Canopus Observatory.

2. Priorities

- It is essential to maintain and strengthen currently operating observatories in order to encourage young people to see science, and astronomy in particular, as an attractive research and teaching career path.
- The accessibility and operating flexibility of university facilities need to be preserved to offer the best environment for experimentation with newly developed technology, promoting fast paced innovation and training opportunities for the future technical and scientific staff of national and international facilities.
- The Working Groups note that universities should maintain a variety of facility types to provide research and training equipment that complements the various stages of graduate and postgraduate study and scientific research.
- The Working Groups recognize that current funding priorities set by the Government make it difficult to maintain and build large astronomical facilities at the University level. Therefore funding opportunities should be sought by forming consortia of universities, collaborations between universities and government research organizations, and collaborations with international partners. Successful examples of such collaborative facilities are AIGO, CANGAROO and the Mopra telescope. Such joint initiatives are an important strategy to ensure that universities participate in internationally recognized, leading edge research in Australia.
- The tools of theoretical astrophysics are fundamental and important component of university facilities. Theoreticians provide the fundamental ideas, which motivate observations and assist in the interpretation of data from university-based and national

observatories. The establishment and maintenance of high quality theoretical groups is an important part of the maintenance and development of university facilities.
- The Australian National Institute for Theoretical Astrophysics (ANITA; http://anita.edu.au) has emerged as an important organisation for the coordination and promotion of theoretical astrophysics. ANITA will require appropriate funds to sustain its activity.

- The Working Groups recognized the importance of maintaining Australia's investment in supercomputing and visualisation through consortia such as AC3, APAC and VPAC and the Supercomputer Centre at the Swinburne University. Visualisation of the observational results and theoretical simulations is an increasingly vital component of astronomical research.
- Universities need to invest in networking technology such as Access Grid to facilitate the remote access to the observatories, and to increase the efficiency of research and training communications.

3. Strengths and Weaknesses

Strengths

- Universities have a long tradition and expertise in building and operating radio and optical observatories, which is advantageous for the development of new facilities.
- Universities naturally form and maintain international collaborations in operating facilities. This opens up Australia's access to new, and often expensive technologies. One example of such collaborations with national and international partners is the CANGAROO project.
- Flexibility in operating university facilities provides Australian access to high energy space astrophysics, which requires investment in observational facilities operating from space (X-ray, gamma-ray missions). Simultaneous observations at radio and optical wavelengths are often requested by agencies operating space missions. Universities are best suited to provide such support and to enter the exchange collaboration.
- University facilities are strongly supported by the work of postgraduate students, which reduces the need for employment of full-time operators.

Weaknesses

- Most of the universities have been successful in obtaining funds for infrastructure and research projects but have difficulty in funding the operating costs on a long-term basis, as research money (ARC Discovery, LIEF etc) generally cannot be used for this purpose. Hence there is a need to find a secure source of 'renewable' funding. Working Groups agreed that the astronomical community should explore the possibility of funding the operating costs of all the small facilities via a nationally agreed model.
- In order to ensure an excellent and consistent quality of research and teaching, the funding of facilities should include salaries for research scientists. In particular, both national and university facilities frequently miss out on well-directed input from theoreticians both in the design and operational phases of new observational initiatives. This could be rectified by the appointment of theoretical astrophysicists to their research programs.
- University Facilities need well-qualified staff for efficient operation. Unfortunately highly trained instrument developers and code builders appear to be disadvantaged in their career opportunities and tend to leave the university structure. The Working Groups agreed that in order to avoid this brain-drain, special fellowships related to infrastructure linkage (equivalent to QEII Discovery grants) should be available, which are suited to support staff engaged in long-term development of instrument or computational components.

4. Opportunities

4.1 Radio Observatories

- Australian investment in the SKA project will require a vibrant radio astronomy community. SKAMP, the intended upgrade of MOST, will test SKA technologies and will maintain radio astronomy training and expertise.
- Australian radio telescopes are an indispensable part of the VLBI international network. Universities are active in the continuing involvement in new developments of VLBI networking (e-VLBI).
- ALMA is viewed as one of the most important radio telescopes of the next decade. The Australian community will benefit strongly from involvement in this project and pursuing science that will complement ALMA. Recent investments in the mm-upgrade of the ATCA and Mopra telescope stimulated the growth of mm-wavelength research in Australia. Universities are well positioned to play a major role in this task by continuing to fund the operation of the Mopra telescope in collaboration with the ATNF and searching for new opportunities arising from the UNSW involvement in the development of Antarctic observing sites.

4.2 Niche Facilities

- SUSI pioneered optical interferometry and its development is important for a continuing Australian contribution in this area of research.
- The AASTINO autonomous laboratory serves as a host to a variety of astronomical site-testing instrumentation.
- Skymapper will be used to complement the science delivered by the SLOAN survey.
- DIVA will provide crucial information on the variable and transient radio sky.
- HEAT will explore our Galaxy through the terahertz window of electromagnetic radiation.

4.3 Small Optical Telescopes

- Although 8 m and larger optical telescopes will dominate the optical astronomy scene in the next decade, small telescopes will have important applications that cannot be covered by larger facilities. Dedicated and continuous monitoring of variable objects, discovery of supernovae and photometric searches for planets are a few examples of such opportunities. Small optical telescopes can quickly respond to Target of Opportunity requests for multi-wavelength observations of transient X-ray and gamma-ray sources. This provides Australian students with the opportunity to participate in international collaborations, and helps compensate for the lack of direct Australian involvement in high energy space astrophysics.
- The Working Groups recognize that in order to maximize these opportunities, some of the smaller observatories will require adequate funding for upgrades and IT modernization. For example, the use of robotic telescopes via the Internet (as already implemented by the QUT, USQ, UNSW and CSU) can increase their availability to the astronomical community and students around the world, and help reduce operational costs.

4.4 New Proposed Facilities

- High Elevation Antarctic Telescope (HEAT) will use a robotic telescope to carry out a 1.5 THz spectral line survey of the Galaxy (see Appendix 16).
- Antarctic Submillimetre Observatory (ASO) will be a 12 metre single-dish terahertz telescope, fitted with a variety of focal plane instruments for continuum and spectral line observations (see Appendix 17).
- Dedicated Variability Array (DIVA) – an array with a minimum of four small (~ 15 m) dishes to cover the frequency range 1.5 to 10 GHz, will be used to study a variety of time-variable phenomena. It will allow both long- and short-time scale monitoring of interstellar scintillation, as well as have the flexibility to study transient phenomena such as gamma-ray bursts and X-Ray transients. Funding for DiVA is proposed from a university/ARC/ATNF collaboration. The Hobart Interferometer is a first step towards establishing the science program and evaluating both the performance and costing of the final DiVA facility (see Appendix 18).

5 Estimates of Investment and Operation Costs

The table below lists the projected operational and investment costs for each university facility within three timeslots of the next decade. For some facilities a more detailed discussion of costs can be found in Appendices. Some indication about the status of funding is denoted as: (F) funded, (S) funding applied for, (N) not funded yet or (C) contingent on other developments. Further descriptions of the facilities may be found in submissions/university facilities.doc

Facility	Costs	1-3 years	4-6 years	7+ years
Mt. Pleasant	Operation	$50k/yr (F)	$50k/yr	$50k/yr
	Investment	$600k fibre optic links (F) $500k broadband receivers (S)		
Ceduna	Operation	$30k/yr (F)	$30k/yr	$30k/yr
	Investment	$500k-$2M fibre optic links (N)		
Molonglo Observatory Synthesis Telescope	Operation	$480k/yr (F)	$480k/yr	$480k/yr
	Investment	$3000k (MNRF-2) (F)		
SUSI (Sydney University Stellar Interferometer)	Operation	$100k/yr (F/S)	$100k/yr	$100k/yr
	Investment	$100k L3CCD (N)		
The Swinburne Super Computer	Operation	$300k/yr (F)	$300k/yr	$300k/yr
	Investment	$300k/yr (F) upgrades	$300k/yr upgrades	$300k/yr upgrades
The Mopra Millimetre Wave Observatory	Operation	Part of ATCA operating budget		
	Investment	8 GHz correlator (F) 7mm receiver $100k (S/N)	FPA: $1-5m (C)	10^6 channel correlator $1-5m (C)
AASTO (Automated Astrophysical Site Testing Observatory)	Operation	$20k/yr (F)		
	Investment			
AASTINO (Automated Astrophysical Site Testing International Observatory)	Operation	$30k/yr (F)	$30k/yr	
	Investment	$300k (F/S)		
Canopus Observatory	Operation	$50k/yr (F)	$50k/yr	$50k/yr
APT (Automated Patrol Telescope)	Operation	$15k/yr (F)	$15k/yr	
	Investment	$300k (S)	$300K	
ROTSE (Robotic Optical Transient Search Experiment)	Operation	$5k/yr (F)	$15k/yr	
	Investment	$50k (S)	$50k	
Macquarie University Observatory	Operation	$20K/yr	$20K	
	Investment	$1.2M (S)		
Mt. Kent Observatory	Operation	$20k/yr (F)	$20k/yr	$20k/yr
	Investment	$40k upgrades (S)	$40k upgrades	$40k upgrades
UWS Observatory	Operation	$15k/yr (S/N)	$18k/yr	$20k/yr
	Investment	$200k	$400k	$400k
Nanango TIE QUT	Operation			
	Investment			
ANITA (Australian National Institute for Theoretical Astrophysics)	Operation	$20k/yr science workshops (N) $50k/yr graduate school (N) $30k/yr 2FTE coordinating activities (N)		
	Investment	$100k establishment (N)		
HEAT (High Elevation Antarctic Telescope)	Operation		$30k/yr	
	Investment	$200k (S)	$200k	
ASO (Antarctic Submillimetre Observatory)	Operation			$150k/yr
	Investment		$1400k	
DIVA (Dedicated Variability Array)	Operation	$120k/yr (S)	$120k/yr	$120k/yr
	Investment	$300k (S) 1-baseline interferometer	$1000k 6-baseline array	