RESEARCH SCHOOL OF ASTRONOMY & ASTROPHYSICS

2002 ANNUAL REPORT¹ TO ANU COUNCIL

Penny D. Sackett, Director

21 March 2003

1 Overview

Prof John Norris completed his term as Interim Director of the Research School of Astronomy and Astrophysics (RSAA) at the ANU on 22 July 2002 when Prof Penny D. Sackett became Director. Norris' leadership saw the remarkably successful entry of the School into the ARC competitive funding process. His fiscal responsibility resulted in a financially healthy Research School at the time that Sackett took the reins mid-year.

Highlights of the year for the School include a conceptual design contract for the Gemini South Adaptive Optics Imager, which led to a successful bid for the construction of the multimillion dollar instrument. In addition, 2002 marked the beginning of the renewal of Siding Spring Observatory as a national facility through the \$5.6M Systemic Infrastructure Initiative, and the integration and coordination of all RSAA international, national and local engineering programs under a new Programs Manager, Dr Liam Waldron. The School completed a second impressive round of Australian Research Council (ARC) competitive funding in 2002, including the award of an ARC Professorial Fellowship.

Just after the 2002 calendar year drew to a close, Mount Stromlo Observatory (MSO) was devastated, along with much of surrounding Canberra, by one of the single worst bush fires in Australia's history. The RSAA suffered several tens of millions of dollars damage, but luckily, no injury or loss of life. Rebuilding is now underway. It is remarkable to reflect back on 2002 in light of this catastrophe to note how many of the School's achievements have stood the test of the firestorm, a testament that the most important asset of the RSAA is the strength, talent and spirit of its staff.

2 Key Achievements

This year was the first that the full RSAA academic staff was able to compete for ARC funding. The 60% success rate of the RSAA in 2001 (when ANU had partial entry into the ARC process) was matched and surpassed in 2002 with a 70% ratio, an indication of the excellence and depth of the academic staff (Section 3.5 lists ARC awards to the RSAA) and successful management of the entry into contestable funding schemes.

The strong reputation of RSAA's advanced instrumentation program was demonstrated by the award of a second major design and construction contract from the international Gemini consortium. After a highly competitive process, Gemini announced its intention in 2002 to give the 6.3M A\$ contact for the Gemini South Adaptive Optics Imager to the RSAA, under the scientific leadership of Dr Peter McGregor. The destruction wreaked by the bush fire on MSO did not reverse this decision. When complete in 2005-2006, the GSAOI will be the

¹ RSAA Annual Reports can be found at http://www.mso.anu.edu.au

flagship instrument on the largest optical telescope to which Australian astronomers have access, and will also serve the wider astronomical community represented by Gemini.



The 8m diameter Gemini South in Chile (above) is one of the world's largest telescopes. Equipped with a new imager (left) designed and constructed by RSAA, it will deliver to images of the cosmos as sharp as those taken by the Hubble Space Telescope.



The incoming Director of RSAA immediately sought to revisit the strategic plan of the School in a manner consistent with the changing challenges and opportunities on the national and international scene. A fully consultative process open to all staff was initiated over a period of three months to draft an outline of the plan, culminating in its presentation to the RSAA Advisory Board in December 2002. This RSAA Strategic Plan (see also Section 3.7) will serve as the foundation for decisions and initiatives that await the School over the next ten years, and will be revisited at least every three years.

3 Summary Reports

3.1 Budget Performance

In 2002, the School received a block grant of \$5496K, external revenue of \$4098K, and income from commercial activities of \$1104K. The breakdown of the external revenue in 2002 is given in the following table.

Gemini NIFS Instrumentation Project	\$ 1058K
DETYA Systemic Infrastructure Initiative	\$ 1327K
ARC Grants	\$ 776K
Gemini South Adaptive Optics Imager Instrumentation Project	\$ 279K
Siding Spring Observatory Site Recoveries	\$ 333K
Near Earth Asteroid Project	\$ 122K
DITR Virtual Reality Theatre Project	\$ 90K
Trans Neptunian Object Search project	\$ 72K
Miscellaneous	\$ 41K
Total	\$ 4098K

The RSAA commercial activities are the Mount Stromlo Visitors' Centre, the Siding Spring Observatory (SSO) Lodge Visitors' Centre, and Mount Stromlo Housing. The Stromlo and SSO Visitors' Centres were toured by approximately 31,000 and 15,000 people, respectively,

in 2002, an increase of 25% over the previous year. In combination, recreational and educational visits resulted in 70,000 people enjoying Stromlo mountain in 2002. Budgetary belt-tightening and a revamping of the business plan for the Mount Stromlo Observatory (MSO) Visitor's Centre has resulted in a modest operating surplus at the end of 2002 calendar year. Following an agreement with ANU central administration, a business plan is now in place to operate the MSO Outreach Centre as a cost-neutral section within RSAA's recurrent budget. A newly-appointed manager will oversee this transition in 2003.

Cash carried forward from 2002 to 2003 will assist the School in meeting cash flow challenges engendered by the bush fires of 18 January 2003.

3.2 Gender Equity Performance

In August 2002, 9 of the School's 21 postgraduate students were female, the same gender ratio as in 2001. Women represent nearly 25% of RSAA general staff (including casuals), a percentage that has remained relatively unchanged over recent years. Two of schools 25.5 academic staff are female, including the Director Prof. Penny D. Sackett. This is an increase of one from 2001. The School is now adopting a policy of advertising more widely and for longer periods of time to foster general equity in RSAA appointment processes.

3.3 Significant Achievements in Research and Teaching

3.3.1 The Oldest Star?

RSAA atronomers have found a star that may have been one of the very first to form in our Milky Way galaxy. The star, HE0107-5240, is 80% as massive as the Sun, but has practically no metals², less than 1/200,000th the amount found in the Sun, making it the most metal-weak star known. Metal-weakness is an indicator of age; younger stars form in regions that have been enriched by the chemicals produced by earlier generations of stars.

The critical observations were made by RSAA Prof Mike Bessell, using the ANU 2.3m telescope at Siding Spring Observatory. His spectra indicated the strength of calcium in the star's atmosphere. HE0107-5240 was one of thousands selected from the Hamburg/ESO Survey by Bessell's collaborator and RSAA Visiting Fellow, Dr Norbert Christlieb. Follow-up observations by Christlieb with the high-dispersion spectrograph on the 8m Very Large Telescope at the European Southern Observatory in Chile confirmed that HE0107-5240 was 10 times more metal deficient than any previously-known star.



Prof Mike Bessell (left) and Dr Norbert Christlieb at the 2.3m telescope at Siding Spring Observatory.

According to some current theories of star formation, low-mass metal-poor stars should not have formed at all. This raises the possibility that there may still be stars that are even poorer in metals, consisting only of material formed in the Big Bang. They would be an invaluable sample of the original chemistry of the Universe, and may be well be found during the continuing survey by Bessell and Christlieb. The original research is reported in the Oct 31, 2002 issue of the science journal *Nature*.

²Astronomers refer to all of the chemical elements other than hydrogen and helium as ``metals''.

3.3.2 The Origin of Gamma-ray Bursts

Gamma-ray bursts (GRBs) are short flashes of intense, high-energy gamma-rays which have been detected by spacecraft since the 1960s. Their origin has been a mystery for nearly 30 years. Mr Paul Price, RSAA PhD student, and Dr Brian Schmidt are part of the international REACT collaboration whose goal is to understand the nature of GRBs.

A major breakthrough was made with the conclusive demonstration by Price, Schmidt and collaborators that a supernova (an exploding massive star) coincided with a cosmological gamma ray burst. The evidence came from Hubble Space Telescope observations of the burst known as GRB 011121, whose light curve showed the tell-tale signature of an underlying supernova, coupled with observations taken with the infrared imager IRIS2 on the Anglo-Australian Telescope, which showed that the exploding object had to be a massive star. Additional work with the Hubble shows, however, that not all GRBs have an associated bright supernova, and so more work remains to be done. One explanation is that GRBs occur when a massive star's core collapses into a black hole, which sometimes consumes so much of the star that it is unable to be observed as a supernova.

3.3.3 Cosmological Results from the Completed 2dF Galaxy Redshift Survey

The largest three-dimensional map made to date of the universe was completed in April 2002, with the end of observations for the Two-degree Field Galaxy Redshift Survey (2dFGRS). The survey, carried out by a 30-strong team, is led by Dr Matthew Colless (RSAA) and Prof John Peacock (Royal Observatory, Edinburgh). The 2dFGRS team also includes RSAA



Shown here is a portion of the 2dF Galaxy Redshift Survey with one point for every galaxy in this cosmic slice. Substructure and voids are evident in the galaxy distribution, and are clues to the forces at play in the evolution of mass and light on large scales in the Universe.

academic staff Drs Peterson, Jackson, Driver and De Propris. The team measured the positions and redshifts of 221,000+ galaxies over five years of observations with the Anglo-Australian Telescope. The 2dFGRS has produced a host of significant results in cosmology, including precise new measurements of the total amount of matter in the universe, and the relative contributions of dark matter, ordinary baryonic matter, and neutrinos to the cosmic mass budget. Sophisticated analyses on the dataset have also provided the first-ever measurements of the galaxy bias parameter, which links the distribution of luminous galaxies to the total matter distribution, and an independent confirmation of the existence of dark energy, in the apparent form of a cosmological constant. The survey has also proved a useful tool in the detailed study of galaxy populations.

3.3.4 The Millennium Galaxy Catalogue - Star Counts

Together with an international team of collaborators, RSAA's Dr Simon Driver, principal investigator of The Millennium Galaxy Catalogue, has placed firm constraints on the flattening of the distribution of stars that make up the halo of our Milky Way Galaxy. The method was based on deep star-counts in an area consisting of a 75 degree strip across the Northern Galactic Cap. The recovered flattening value of 0.56 (+/- 0.01) is indicative of a rotating triaxial spheriod structure, flattened in the plane of rotation. The team went on to demonstrate the lack of significant substructure in the Galactic Halo star population. The smoothness of stellar distribution limits the contribution of recent accretion and disruption events to the build-up of the stellar halo, suggesting that only a limited number of nearby dwarf galaxies that have been devoured recently by our Galaxy.

3.4 Student Numbers

The Graduate Program in Astronomy & Astrophysics currently comprises 21 students, 12 male and 9 female. Five of the students are international. In 2002, 5 students entered the program while 2 students completed their PhD degrees. Two students from the ANU Faculties did honours projects with a supervisor from RSAA.

The School runs a yearly Summer Research Scholar Program. During the summer of 2001-2002 the program was convened by Dr Agris Kalnajs with seven scholars taking part, while the 2002-2003 program was convened by Dr Simon Driver with eight scholars taking part. The program provides a regular source of incoming graduate students.

3.4 Major Prizes, Honours & Awards announced in 2002

RSAA staff continue to be recognised for their achievments at the ANU, nationally, and abroad. Of the 40 Australian scientists named this month by the Institute of Scientific Information (ISI) as the most highly-cited across all disciplines for the period 1981-1999, five were RSAA astronomers: Bessell, Dopita, Freeman and Mould (now Director of the National Optical Observatory in the USA) and Peterson.



RSAA's newest professor, Brian Schmidt.

Dr Brian Schmidt was awarded a prestigious ARC Professorial Fellowship in 2002. Other awards are listed in the table below.

RSAA Staff Awards	
Dr M Colless	Finalist for the 2002 Eureka Prize
Prof K C Freeman	Elected Associate of the Royal Astronomical Society
Dr B P Schmidt	Awarded ARC Professorial Fellowship 2003-2007
Dr B P Schmidt	Vainu Bappu Medal of Astronomical Society of India
RSAA Student Awards	
Gayandhi De Silva	2002 Duffield Scholar
Kelly Kranz	2002 Bok Honours Year Scholar
Brent Groves	2002 Alex Rodgers Travelling Scholarship Recipient
Catherine Drake	2002 Alex Rodgers Travelling Scholarship Recipient
Minh Huynh	2002 Alex Rodgers Travelling Scholarship Recipient

Grant Source	CI Name	Brief Title	Award
			Total
ARC: Discovery	F H Briggs	Atomic Hydrogen	\$ 60K
ARC: Discovery	G Da Costa	Evolution of Dwarf Elliptical Galaxies	\$ 165K
ARC: Discovery	S P Driver	Structural and Physical Properties of	\$ 275K
		Galaxies	
ARC: Discovery	P J McGregor	Galactic Nuclei	\$ 255K
ARC: Discovery	J E Norris	First Stars and Chemical Enrichment of	\$ 375K
		Universe	
ARC: Discovery	B P Schmidt	Southern Sky Survey (including APF)	\$1061K
ARC: Discovery	P R Wood	Dying Stars	\$ 270K
ARC: Discovery*	G Da Costa	Calibrating Cosmology	\$ 162K
ARC: Discovery*	G V Bicknell	CANGAROO III Gamma-ray Telescope	\$ 300K
Gemini (Internat'l)	P J McGregor	GSAOI Conceptual Design Study	\$ 275K

3.5 New RSAA Grants announced in 2002

* RSAA not administering institution

3.7 Future Directions

The directions of the School in the coming years will be guided by a new Strategic Plan drafted in consultation with RSAA staff near the end of 2002. Serving as the foundation of the plan is the mission statement to (1) advance the observational and theoretical frontiers of astronomy and its enabling technologies, (2) provide national and international leadership, and (3) train outstanding scientists. Several broad goals have been identified to advance this mission over the next ten years. Most notably, emphasis is placed on research excellence, national and international engagement, professionalism and innovation in science training, strategic outreach, strengthening engineering capabilities, diversifying the funding base, and leadership roles in the next generation (20-30m class) of optical and infrared facilities worldwide.

As a specific example of how research excellence and innovation in scientific training can combine, the RSAA, together with the Research School of Earth Sciences, has embarked on a new Planetary Science Initiative designed to cultivate a research program of planetary science combining the detailed studies possible in our Solar System with the recent wealth of information from the young field of extrasolar planets. The joint program will combine two strengths of the ANU and is expected to draw external researchers and postgraduate students.

4 Involvement in the National Institutes

The National Institute of Physical Sciences (NIPS) boasts among its membership 14 RSAA academics, three RSAA students and one RSAA general staff member. In addition, one RSAA academic and one member of the School's general staff belong to the National Institute for the Environment. RSAA Prof Michael Dopita serves on the NIPS Board. A major National Institute event, the 2002 Charlene Heisler Workshop, was sponsored by RSAA and NIPS, bringing together the national astronomical community in the seventh of a series of workshops to discuss on-going work on active galactic nuclei and starburst galaxies.