RESEARCH SCHOOL OF ASTRONOMY & ASTROPHYSICS – ANNUAL REPORT 2001*

John Norris, Interim Director

March 13, 2002

1 Overview

2001 was an interim year for RSAA. Professor Jeremy Mould resigned as Director in January. After an international search, Professor Penny Sackett of Rijksuniverseit Groningen accepted the position in February 2002.

The excellence of the research undertaken at the School was recognised in two ways. First, at the ISI symposium "Honouring Excellence in Australian Research" held at the Australian Academy of Science in March, six of the 33 Australian citation laureates were RSAA staff members. Second, RSAA's Professor Michael Dopita was awarded a Federation Fellowship.

The School was successful in attracting a number of significant grants: it was part of the Major National Research Facilities proposal "Gemini and SKA – Australia's Astronomy Future"; 60% of its ARC Discovery proposals were funded; and it was successful in obtaining a large grant from the Systemic Infrastructure Initiative to upgrade the facilities at Siding Spring Observatory.

A number of significant scientific discoveries were made during the period. Highlights included the discovery of young, nearby, stars which might host, and permit detailed study of, extrasolar planets; a deeper understanding of conditions at the centre of our Galaxy; the demonstration of the existence of stars in intergalactic space; and important constraints on the large scale structure and acceleration of the Universe.

The School hosted two international scientific meetings. The first was in honour of its Duffield Professor, Kenneth Freeman, on the occasion of his 60th birthday, while the second was "Planetary Nebulae: Their Evolution and Role in the Universe" – also known as Fourth Stromlo Symposium – held at the Australian Academy of Science.

2 RSAA Directorship

In January 2001, Prof. Jeremy Mould resigned as Director RSAA, to become Director of the National Optical Astronomy Observatory in Tucson, Arizona. He had served as Director RSAA for seven years, during which Mount Stromlo & Siding Spring Observatories became the ANU's ninth Research School. He strengthened RSAA's ties with ANU's Faculties and other Australian Universities, and fostered Australia's becoming a partner in the International Gemini consortium to establish twin 8 metre optical telescopes in Hawaii and Chile.

*RSAA Annual Reports may be found at http://msowww.anu.edu.au/astronomy/

Prof. John Norris was appointed Interim Director of the School.

Following an international search, the Directorship was offered to Prof. Penny Sackett of the Kapteyn Astronomical Institute, Rijksuniverseit Groningen, who accepted the position in February 2002. Prof. Sackett's areas of expertise include Galactic and extragalactic astronomy – from the search for extra-solar planets to the little-understood dark matter which comprises some ~90% of individual galaxies. Prof. Sackett is expected to begin her Directorship in June 2002.

3 Major Prizes, Honours, Awards

In March, the Institute of Scientific Information (ISI) held its symposium "Honoring Excellence in Australian Research" at the Australian Academy of Science, during which it celebrated the achievement of the thirty-three scientists whose research had been the most influential in Australian research during the period 1981-1998. Six of these "ISI Citation Laureates" were RSAA staff members – Prof. M.S. Bessell, Dr. M.M. Colless, Prof. M.A. Dopita, Prof. K.C. Freeman, Prof. J.R. Mould, and Dr. B.A. Peterson – a remarkable achievement for the School by any standard.

Figure 1: *RSAA's ISI citation laureates. From left to right: M.A. Dopita, K.C. Freeman, M.S. Bessell, B.A. Peterson, M.M. Colless. (J.R. Mould could not be present for the photograph.)*

In September, Prof. Michael Dopita was awarded a Federation Fellowship for research into "The Epoch of Galaxy Formation". The proposed research ensures Australian leadership in the theoretical modelling of interstellar plasmas at the epoch of galaxy formation. It will develop pan-spectral diagnostics, and apply these to observations to determine fundamental parameters of collapsing galaxies and their massive Black Holes.

4 Significant Achievements in Research and Teaching

4.1 Research Highlights

4.1.1 The search for extra-solar planets

Bessell, with Zuckerman and Song (UCLA), discovered 22 young stars that are coeval and comoving with Beta Pictoris, the archetypal A star surrounded by a planetary disk. These stars are the closest group of young stars to Earth and are obvious candidates to search for orbiting hot Saturn/Jupiter mass planets with the Hubble Space Telescope. They were found with a survey program conducted with the 2.3 metre telescope at Siding Spring Observatory.

4.1.2 Strong magnetic fields at the Galactic centre

Bicknell and Li proposed a fundamentally new model to explain one of "The Great Mysteries of the Galactic Center" – the existence of filaments of nonthermal emission associated with magnetic fields that are about 300 times stronger than observed elsewhere in the Galaxy. Their model appeals to the energy released by reconnection in twisted magnetic flux tubes to accelerate electrons to relativistic energies. The explanation for the strong magnetic field ($\sim$400 μG in this case) is that it originates in the cores of molecular clouds in which the magnetic field is anchored and that a strong self-confining toroidal field results from twisting by the rapidly rotating core.

4.1.3 Stars between galaxies

With a team of international collaborators, Freeman discovered that the space between the galaxies in the Virgo cluster is not empty, but inhabited by a diffuse population of stars. They found that these intracluster stars contribute at least 20% of the total light of the cluster. Where do these intracluster stars come from? Maybe they were torn from their parent galaxies by the tidal field of the cluster. Maybe they formed much earlier, when the cluster itself was assembling in the early Universe. Each possibility has its signature, and the team is now testing to see which is correct.

4.1.4 Structure of the local Universe

The 2dF Galaxy Redshift Survey (Colless, Peterson, Jackson + 25 Australian and UK collaborators) has now mapped 200,000 galaxies in the largest-ever survey of the structure of the local Universe. This information has been used to determine fundamental cosmological parameters such as the mass density of the Universe and to study the properties and formation history of the galaxy population. In June, the RSAA members of the collaboration produced the public release of the first 100,000 redshifts from the survey. For further details, see http://www.mso.anu.edu.au/2dFGRS.

4.1.5 Accelerating Universe

Using data taken with the Hubble Space Telescope, Schmidt and colleagues have measured the distance to a supernova which exploded more than 10 billion years ago. The object, called SN 1997ff, reveals the Universe at a time when gravity dominated the cosmos, and was causing the Universe to slow down. This slowing down is just as predicted by the existence of a Dark Energy pervading all of space as indicated by the work done by Schmidt and colleagues in 1998. This work, named the Science Magazine's 1998 "Breakthrough of the Year", demonstrated that over the past 5 billion years, the Universe has been accelerating in its rate of expansion. See http://msowww.anu.edu.au/$\sim$brian for more details.

4.2 International Conferences

In 2001 RSAA organised two international conferences:

The first was entitled *"The Dynamics, Structure and History of Galaxies"* in celebration of RSAA's Duffield Professor Kenneth C. Freeman's 60th birthday. The meeting, which was held at Dunk Island,

was attended by 50 astronomers from around the world, including 16 of Ken's current and former graduate students, who presented papers in areas to which he has made a number of outstanding contributions. The meeting was organised by Dr. Gary Da Costa.

The second was the Fourth Stromlo Symposium (aka IAU Symposium 209) and was entitled *"Planetary Nebulae: Their Evolution and Role in the Universe"* and was held in the Shine Dome of the Australian Academy of Science, in November. Despite the events of September 11, out of 187 registrants the meeting had 156 attendees representing 28 countries. There were 45 talks and 173 poster papers on all aspects of planetary nebulae, which provide important insights into numerous important areas of astronomy. Prof. M.A. Dopita had overview of the organisation of the meeting.

5 New Grants

5.1 Major National Research Facilities

RSAA was part of a successful consortium which was granted $23.5M for the project "Gemini and SKA – Australia's Astronomy Future". The specific aims of the project are to increase Australia's role in the International Gemini Partnership (twin 8 metre optical telescopes in Hawaii and Chile) from 5% to 10%, and to enhance Australia's existing radio-telescopes by demonstrating enabling technologies for the Square Kilometer Array.

5.2 Systemic Infrastructure Initiative

RSAA, in partnership with other Australian Universities, obtained funding of $5.6M to upgrade the facilities at ANU's Siding Spring Observatory. The project will improve existing facilities, construct new instrumentation, and automate both ANU and UNSW telescopes to allow them to be operated remotely. The aim is to provide telescope control centres to participating universities to expand their access to these facilities, enhance their student training, and optimise their research outcomes.

5.3 ARC Discovery & Linkage Grants

Discovery: Projects	M.M. Colless	The 6dF Galaxy Survey	$279k
Discovery: Projects	M.A. Dopita & R. Sutherland	Interstellar Physics at the Epoch of Galaxy Formation	$300k
Discovery: Projects	B.P Schmidt	Taking Measure of the Universe with Exploding Stars	$232k
Linkage: Infrastructure*	RSAA, ANU	Australian Membership of Gemini Partnership	$1602k
Linkage: Infrastructure*	G.V. Bicknell	CANGAROO III Gamma-ray Telescope	$220k
Linkage: Infrastructure	B.P. Schmidt	A Renewed Great Melbourne Telescope	$210k
Linkage: International	M.S. Bessell	Discovering the First Generation of Stars	$70k

* RSAA not administering institution.

6 Budget Performance

In 2001, the School received a block grant of $5507k, external funds of $2405k, and income from ancillary activities of $988k.

At the end of 2000, RSAA had carried forward a recurrent deficit of $244k, while at the end of 2001 there was a recurrent surplus of $251k.

RSAA operates three business units: Mount Stromlo Visitors' Centre, SSO Lodge & Visitors' Centre, and Mount Stromlo Housing. At the end of 2001, all returned small operating surpluses. (The Stromlo and SSO Visitors' Centres were visited by some 26,000 and 12,000 people, respectively.)

7 Gender Equity Performance

In 2001, nine of the School's 21 graduate students were female – a relative doubling over the situation five years ago. Women represent some 24% of the general staff – relatively unchanged over recent years. Only one of RSAA's 21 academic staff is female – a decrease of one from 2000.

In December 2001, the Directorship of RSAA was offered to Prof. Penny Sackett (see Section 1), who accepted the position in February 2002.

8 Student Numbers

The Graduate Program in Astronomy & Astrophysics currently comprises 21 students. In 2001, seven students entered the program: Scott Edwards, Craig Harrison and Matthew Coleman accepted APA/GSS scholarships; Laura Stanford, Bradley Warren and David Weldrake accepted ANU Scholarships; and Alexey Avakyan accepted a VC's tuition scholarship and an ANU scholarship. For 2002, seven offers of scholarship have been made.

RSAA runs a yearly Summer Research Scholar Program. During the summer of 1999-2000 the program was convened by Dr. Carol Jackson and Dr. Peter Wood: six undergraduates from Australian Universities participated for about eight weeks, working on projects supervised by RSAA staff. The 2001-02 program is being convened by Dr. Agris Kalnajs with seven scholars taking part. The program provides a regular source of incoming graduate students.

9 Future Directions

2001 has been an interim period for the School, during which it consolidated its Cosmology initiative (funded by the Institute Planning Committee in 2000), with the arrival of Dr Simon Driver. In the short term, the School is committed to upgrading the facilities at SSO as part of its success in the Systemic Infrastructure Initiative, and individual research programs are being submitted for funding by the ARC. Future directions will be shaped under the Directorship of Prof. Sackett.

10 Compliance with ANU Environmental Policy

RSAA works closely with ANU Facilities & Services in managing its sites at Mount Stromlo and SSO to ensure compliance with the ANU policy. In 2001, work was completed on upgrading septic waste systems at SSO costing in excess of $0.5M. This project was undertaken in consultation with the Environmental Protection Agency and the National Parks & Wildlife Service. RSAA operates its own water treatment plant at SSO which produces high quality water for consumption by staff and visitors. At MSO, we regard land management as a high priority and liaise regularly with F & S, ActewAGL and ACT Forestry in maintaining the site. Recycling practices were implemented at both sites in 2001 acting on recommendations submitted by F & S.

11 Achievements against ANU's Strategic Directions Implementation Plan

Achievements are listed against (numbered) items in the University's Plan.

1. Enhance our international reputation and develop our international roles

• RSAA is committed to enhancing ANU's and Australia's role in international astronomy. It plays a critical role in the Australian consortium of universities which support Australia's membership of the international Gemini project (twin 8 metre optical telescopes in Hawaii and Chile). Currently, Australia has a 5% share of the project. In 2001, RSAA participated in the successful MNRF bid "Gemini & the SKA – Australia's Astronomy Future" (see Section 5.1), which sought to increase

Australia's Gemini share to 10%.

• ANU and Faulkes Telescope Ltd. have agreed to locate Faulkes Telescope South (FTS) at SSO. The telescope, with a 2 metre primary mirror, is valued at some $9.5M, and will complement a similar instrument (Faulkes Telescope North) in Hawaii. It will be equipped with a state-of-the-art imaging system. The telescopes are the core of an educational program of UK businessman Dr. Martin Faulkes to bring astronomy into schools in the UK, USA and Australia. 15% of the time on FTS will be available for use by the School, and RSAA and Swinburne University of Technology have developed an agreement to use the time for educational purposes in Australian schools and outreach centres.

2. Identify our national roles

• Siding Spring Observatory is a national facility owned by the ANU and operated by RSAA. It represents Australia's major on-shore optical observatory, and is available for use by all Australian astronomers and their students in open competition, based on scientific merit. International astronomers also have access to the facility, principally through collaboration involving Australian astronomers. In 2001, RSAA was successful in obtaining a grant of $5.6M to upgrade the facilities of the observatory (see Section 5.2).

• RSAA participated in the Mid-Term Review of the decadal plan "Australian Astronomy: Beyond 2000". The review, entitled "Beyond 2000: The Way Ahead", was prepared under the auspices of the Australian Academy of Science, and published by the Australian Research Council.

• In keeping with the Mid-Term Review, RSAA is playing a major role in defining the Australian National Institute of Theoretical Astrophysics, a virtual network comprising eight Australian groups, to enhance the nation's program of theoretical/computational astrophysics.

3. Improve the educational experience of our students

• RSAA encourages its students to attends meetings and courses outside the ANU to broaden their experience. In 2001 our students attended six Australian workshops/ winter school/ scientific meetings in Melbourne, Lorne, Narrabri, Sydney and Dunk Island. Lisa Kewley, Marc Metchnik and Paul Price travelled overseas to attend meetings and work on their theses with international astronomers.

9. Compliance with ANU environmental policy

See Section 10.

12. Diversify funding base

• RSAA's instrumentation program enhances its ability not only to construct innovative astronomical instruments but also to diversify the School's funding base. Construction of the $4.5M Gemini instrument "Near-Infrared Integral Field Spectrograph" is scheduled for completion early in 2003. In 2001, RSAA was successful, under the leadership of Dr. Peter McGregor, in winning a contract for a conceptual design study for a further instrument "Gemini-South Adaptive Optics Imager".