

**RESEARCH SCHOOL OF  
ASTRONOMY & ASTROPHYSICS**

**ANNUAL REPORT  
2001**



**The Institute of Advanced Studies  
The Australian National University**

Research School of Astronomy & Astrophysics  
Institute of Advanced Studies  
The Australian National University  
(CRICOS #00120C)

Mount Stromlo Observatory  
Cotter Road  
Weston Creek  
Canberra ACT 2611  
Australia

Ph: +61 (02) 6125 0230  
Fax: +61 (02) 6125 0233  
www: <http://msowww.anu.edu.au>

Siding Spring Observatory  
Coonabarabran NSW 2057  
Ph: +61 (02) 6842 6262  
Fax: +61 (02) 6842 6240

Mount Stromlo Visitors' Centre  
Ph: +61 (02) 6125 0232  
Fax: +61 (02) 6125 8045  
www: <http://msowww.anu.edu.au/exploratory>

Front Cover:

A montage of Institute of Scientific Information Citation Laureates: Prof. Jeremy Mould, Prof. Mike Dopita, Prof. Ken Freeman, Prof. Mike Bessell, Dr Bruce Peterson and Dr Matthew Colless.

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### RESEARCH SCHOOL OF ASTRONOMY & ASTROPHYSICS

#### STAFF

<i>Director</i>	JR Mould (to February)
<i>Interim Director</i>	JE Norris (from February)
<i>Associate Directors</i>	MS Bessell ( <i>Associate Director for Instrument Development</i> ) JE Norris ( <i>Associate Director for Observatory Operations</i> )
<i>Professors</i>	MS Bessell, BSc, Tas., PhD MA Dopita, MA Oxf., MSc, PhD, Manc., FAA KC Freeman, BSc, W. Aust., PhD, Camb., FAA, FRS JR Mould, BSc, Melb., PhD, FAA (to February) JE Norris, BSc, PhD
<i>Adjunct Professor</i>	RD Ekers, BSc, Adel., PhD, FAA, ARAS
<i>Senior Fellows</i>	TS Axelrod, BS, Caltech, MS Stanford, PhD UCSC GV Bicknell, MSc, PhD, Syd. MM Colless, BSc, Syd., PhD, Camb. GS Da Costa, BSc, Monash, PhD AJ Kalnajs, SB, MIT, PhD, Harv. PJ McGregor, BSc, Adel., PhD BA Peterson, ScB, MIT, MS, PhD, Caltech PR Wood, BSc, Qld., PhD
<i>Fellows</i>	SP Driver, BSc, Leicester, PhD, Cardiff (from Nov) PJ Francis, BA, PhD, Camb (Snr.Lecturer, Physics, The Faculties) RP Saglia, IREX Fellow, Munich BP Schmidt, BS, Phys, BS Astron, Az., AM, PhD, Harv.
<i>Adjunct Fellows</i>	J Bland-Hawthorn, BSc Astron, PhD, Sussex EM Sadler, BSc, Qld., PhD CW Stubbs, BSc, Virginia, MSc, PhD, Washington
<i>Research Fellows</i>	M de Kool, BSc, PhD, Amst. CA Jackson, MA, PhD, Camb, FRAS H Jerjen, Dip PhD, Basel RS Sutherland, BSc, PhD

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<i>Postdoctoral Fellows</i>	R De Propriis, BSc, London, MSc, PhD, Victoria (from Oct) MN Sevenster, BSc, MSc, PhD, Leiden (to June) Dr EC Sung, IREX Fellow, Korea Astron. Obs.
<i>Visiting Fellows</i>	Dr H Cao, Beijing Astronomical Observatory Prof M-S Chun, Yonsei University Dr L Ferrario, Department of Mathematics, ANU Dr R Fux, Geneva Dr W Harris, McMaster University, Canada Dr G Harris, University of Waterloo, Canada Mr T Jarvis, Morehead Scholar, North Carolina Dr P Mazzali, Max-Planck Institute for Astrophysics Dr C Saxton, University of Sydney Prof DWN Stibbs, Napier Professor Emeritus, St Andrews
<i>Honorary Faculty</i>	Em Prof SCB Gascoigne, AO, MSc NZ, PhD Brist, FAA, ARAS Em Prof DS Mathewson, MSc Qld., PhD Manc, FTS, FAIP
<i>Observatory Visitors</i>	Mr Stephen Barlow, University of Canterbury Mr Michael Begam, University of Virginia Dr Luc Binette, Inst. De Astronomia, Mexico Dr Mariarosa Cioni, Leiden Obs., Netherlands Dr Alejandro Clocchiatti, Pontificia Univ. Catolica
<i>de Chile</i>	Ms Kathryn Deeley, UNSW Ms Marianne Doyle, University of Queensland Dr Don Faulkner (retired) Rev Dr Tom Frame, Bungendore (The History of MSO) Dr Marla Geha, University of California, Lick Dr Paul Harding, Case Western Reserve University Prof Philip Ianna, University of Virginia Dr Masatoshi Imanishi, National Optical Ob., Japan Ms Inese Ivans, University of Texas at Austin Ms Mi-Ju Kang, Chungnam Natl. University, S. Korea Mr Kevin Krisciunas, Cerro Tololo Interamerican Obs,
<i>Chile</i>	Dr Zdenka Kuncic, University of Sydney Dr Ariane Lançon, Observatoire de Strasbourg Ms Cornelia Lang, University of Massachusetts Dr Jianke Li, Dept Education, Training & Youth Affairs Dr Chris Lidman, European Southern Observatory Ms Lucile Martin, Universite de Paris Mr Shinki Oyabu, University of Tokyo Ms Oak-Kyoung Park, Lawrence Livermore, USA Ms Maria Pereira, University of Cambridge Ms Isabel Perez, University of Chile

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Mr Ian Price  
Ms Heike Richter, Inst. for Astron. & Astrophys, Berlin  
Ms Hyun-Ah Ryu, Chungnam Natl. University, S. Korea  
Ms Maria Elena Salvo, Padua University, Italy  
Dr Gary Schmidt, University of Arizona  
Dr Maartje Sevenster  
Dr Bob Shobbrook, Coonabarabran  
Dr Piet van der Kruit, Kapteyn Astronomical Institute  
Prof Jasper Wall, Oxford University

*Postgraduate Students*

Alexey Avakyan, BSc, Moscow  
Michelle Buxton, BSc, Tas.  
Matthew Coleman, BSc  
Catherine Drake, BSc, Monash  
Scott Edwards, BSc  
Brent Groves, BSc, Monash  
Sebastian Gurovich, BSc, UWS (Nepean)  
Craig Harrison, BSc, QUT, BSc, (Hons)  
Minh Huynh, BSc, UWA  
Lisa Kewley, BSc, Adel. (to July)  
Marc Metchnik, BSc Comp.Sci, BSc Math, U.Qld  
Rachel Moody, BSc  
Jess O'Brien, BSc, U.Melb.  
Encrico Olivier, BSc, MSc, Western Cape, S.Africa  
Paul Price, BSc, U.Qld  
Shobha Sankarankutty, BSc, MSc, UFRN, Brazil  
Holly Sims, BSc  
Laura Stanford, BSc, Flinders, BSc (Hons)  
Bradley Warren, BSc, Monash  
David Weldrake, BSc, (Hons) Herts  
Gregg Wilson, BSc

*Research Officers*

S Sabine, BSc, Adel. (to March)  
V Ford, B App Sc. CCAE (from Sept)

*School Librarian*

J Regan, Assoc. Dip. Lib. Studies, BA U.Canb.

*Observatories Secretary*

T Gallagher, BA Vanc. (from June)

**ADMINISTRATION:**

<i>Business Manager</i>	V O'Connor
<i>Assist. to Bus. Mgr.</i>	I Sharpe
<i>Operations Officer</i>	D Bourne
<i>Purchasing Officer</i>	M Miller
<i>Purchasing Clerk and Publications Officer</i>	M O'Dowd
<i>Site, Fire, Security Off. Personal Assistant</i>	G Blackman
<i>Service Staff</i>	F Aplin
<i>Gardener</i>	P Walshe
	H Coyle

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**MECHANICAL ENGINEERING**

*Chief Engineer* J Hart, BE (Mech) NSW

**DESIGN OFFICE**

*Designers* P Conroy, CME CTC  
D Stevanovic, BSc, PhD (from Oct)

**MECHANICAL WORKSHOP**

*Workshop Supervisor* C Vest

*Instrument Makers* J Bowman (from Dec)  
A Cappuccio  
R Commons (to Dec)  
J de Smet  
H Gebauer, CME  
R Miles  
R Tranter

*Laboratory Technician* D Mitchell

**OPTICAL WORKSHOP**

*Senior Technical Officer* G Bloxham, DAP GIT

**COMPUTING LABORATORY**

*Head* P Young, BSc

*Programmers* W Roberts, BSc  
M Jarnyk, BEng, MEng, PhD (from June)  
K Sebo, BSc WA, PhD  
J Smillie, BSc Qld (Jan-Sept)  
I Price, BSc Newcastle (to June)  
J Nielsen, BSc WA, BA Murdoch (from July)  
H Nyguen, BSc Griffith  
L Wilson, BSc UNSW (to Dec)

*Student Programmers* M Buxton, BSc Tas (25%)  
L Kewley, BSc Adel (10% to July)  
G Wilson, BSc (25%)

**ELECTRONICS**

*Chief Engineer* J van Harmelen, Drs Delft

*Engineer in Charge,  
MSO Electronics* M Dawson, BEng MEng

*Engineers* D Bishop, BEng (to May)  
M Downing, BAS MAS Melb.  
G Hovey, BSc, PhD  
M Jarnyk, BEng, MEng, PhD (to May)  
S Owens, BSc Macq, MSc Syd (Sept – Dec)

*Technical Officers*                      J Atkin (Apr - Jul)  
  A de Gans  
  W Goydych, BSc Syd  
  M Menzies, Ass Dip EE (Aug - Dec)  
  S Trevethan (Aug - Dec)

**MT STROMLO VISITORS' CENTRE**

*Exhibition Officer*                      V Ford, B App Sc. CCAE (to Sept)  
*Retail Supervisor*                      M Maloney  
*Marketing Officer*                        M McGregor  
*Information Officer*                      N Aked

**SIDING SPRING OBSERVATORY STAFF**

**ADMINISTRATION**

*Site Officer*                                W Green  
*Assistant Site Officer*                    T Houghton  
*Operations Officer*                        H Davenport  
*Research Officer*                         R McNaught, BSc (Hons), St Andrews  
*Casual Staff*                                P Nguyen, P Anderson, K Fiegert

**TECHNICAL**

*Engineer*                                    M. Harris, BEEng, NSW  
*Technical Officers*                        M Callaway  
  W Campbell, B App Sc, U Canb.  
  J Goodyear, HND BEEng, Edin.  
  M Kanonczuk  
*Casual Staff*                                D Shobbrook  
  R Shobbrook, BSc, St Andrews, PhD

**LODGE**

*Lodge Supervisor*                        M Noy  
*Hospitality Staff*                         V Mathews, S McWilliam, R Penny, L Ryder, DM  
**Shobbrook**

**SSO EXPLORATORY**

*Supervisor*                                 J Dicello-Houghton  
*Casual Staff*                                H Goodyear, D Hynds, M Verrender

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## SCIENTIFIC HIGHLIGHTS

### Institute of Scientific Information Citation Laureates

In March, the Institute of Scientific Information (ISI) held its symposium “Honouring Excellence in Australian Research” at the Australian Academy of Science. The symposium celebrated the achievement of the 33 Australian based scientists whose research had been the most influential in research during the period 1981-1998.

Six of these “ISI Citation Laureates” were RSAA staff members - a remarkable achievement for a School of some 21 academics - which attests to the excellence of the research being undertaken.



*A montage of Institute of Scientific Information Citation Laureates.  
L – R: Prof. Jeremy Mould, Prof. Mike Dopita, Prof. Ken Freeman, Prof. Mike Bessell,  
Dr Bruce Peterson and Dr Matthew Colless*

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RSAA's laureates, and their areas of achievement, are:

Prof. Michael Bessell, for analysis of the chemical compositions of stars, and the establishment of fundamental photometric systems.

Dr. Matthew Colless, for the study of the large-scale structure of the Local Universe. His work in the 2dF Galaxy Redshift Survey has established that most of the mass of galaxies is unseen.

Prof. Michael Dopita, a Fellow of the Australian Academy of Science, for fundamental contributions to the understanding of interstellar shocks, star formation and active galaxies.

Prof. Ken Freeman, a Fellow of the Royal Society, a Fellow of the Australian Academy of Science and the inaugural holder of the Duffield Chair of Astrophysics at the RSAA, for studies of galactic dynamics and the gravitational microlensing by low-mass stars in our Galactic halo.

Prof. Jeremy Mould, a Fellow of the Australian Academy of Science, former Director of the RSAA and current Director of the National Optical Astronomy Observatories in the USA, for leading an international team that used the Hubble Space Telescope to determine the age and expansion velocity of the Universe.

Dr. Bruce Peterson, for studies of gas in the Early Universe, of galactic clustering, and gravitational microlensing by low-mass stars in our Galactic halo.

### **Federation Fellowship to Prof. Michael Dopita**



*Prof. Michael Dopita*

In September, Prof. Michael Dopita was awarded a Federation Fellowship for research into "The Epoch of Galaxy Formation".

Prof. Dopita became a member of the School in 1975, and established himself as a world authority on the interstellar medium, star formation and active galaxies. During

that time he has played an active role in the teaching program of the School and has supervised some 15 PhD students. He has also played a major role in the development of the School's research program.

The proposed Federation Fellowship research ensures Australian leadership in the theoretical modelling of the interstellar medium which dominates the physics of collapsing galaxies. The mystery of the formation of galaxies is one of the central problems of modern astrophysics. The epoch of galaxy formation, which occurred between one and six billion years after the Big Bang, was initiated by the collapse of overdense regions of matter, resulting in extraordinary bursts of star formation, rapid growth of massive nuclear black holes, and the rapid structural evolution of the early Universe.

Until the last decade, this key epoch was largely inaccessible to observation - telescopes were simply too small, and instruments too insensitive to provide useful data in reasonable times. However, with 10m-class ground based telescopes, adaptive optics, sensitive detectors, and large space telescopes, great steps are now being made in our understanding. In the next decade, a new generation of large space telescopes for the infra-red (IR) and X-ray will come on line, new radio facilities such as the Square Kilometre Array will be built, and 30m or even 100m ultra-large telescopes are being designed. These will accumulate a huge volume of data on the epoch of galaxy formation. Theoretical interpretation should then allow us to answer the following key questions:

- What are the star formation rates, both within individual galaxies and averaged per unit co-moving volume as a function of epoch?
- How do the massive black holes formed at this time interact back on their host galaxies?
- How is the gas chemically enriched, and how much is recycled to the intergalactic medium?
- What is the role of dust physics in all of these processes?

The central goal of the Fellowship program is to address these questions by developing techniques to theoretically model the fundamental processes involved, with an emphasis on understanding the dust physics and the hydrodynamical processes. This will lead to a prediction of emission line fluxes, emission line ratios, and the broadband spectral energy distributions from radio to X-ray frequencies which can be used to interpret the new observational material.

## **Gemini South Adaptive Optics Imager**

RSAA was selected in 2001 to perform one of two Conceptual Design Studies funded by the Gemini Telescopes Consortium for the Gemini South Adaptive Optics Imager (GSAOI). This will be a near-infrared camera with an image scale commensurate with the diffraction limit at near-infrared wavelengths of the Gemini South 8 m telescope in Chile. GSAOI will be the workhorse instrument used with the Multi-Conjugate Adaptive Optics System being developed for Gemini South. The Conceptual Design Study will run from November 2001 to June 2002 and may lead to a construction

contract for the instrument. Parts of the instrument will be designed and constructed at the Anglo-Australian Observatory if RSAA is selected for this work.

Adaptive optics systems are being implemented on most large ground-based telescopes to correct the image “blur” caused by the Earth’s atmosphere. A shortcoming of existing adaptive optics systems is that they fully correct images within only about 20 arcseconds of the reference object (either a natural guide star or an artificial laser guide star formed in the upper atmosphere). Multi-Conjugate Adaptive Optics Systems will use multiple natural guide stars, laser guide stars, and deformable mirrors conjugated to different heights in the atmosphere to correct images over larger areas. In the case of Gemini South, it is expected that diffraction-limited images will be obtained over regions approximately 80 arcseconds on size.

This relatively wide-field adaptive optics correction means that new science programs will be addressed. These range from studies of faint low mass stars and brown dwarfs in nearby star forming regions through studies of individual stars in nearby external galaxies to studies of colour gradients in distant field and cluster galaxies at high redshifts.

## OTHER HIGHLIGHTS

### Dunk Island Conference

In August, RSAA supported a conference entitled "The Dynamics, Structure and History of Galaxies". This conference, held in the convivial surroundings of Dunk Island in northern Queensland in late July, was a celebration of the achievements of Duffield Professor of Astronomy Ken Freeman in his 60th year. Over 50 astronomers from across the globe attended, including many of Ken's long term collaborators. Particularly pleasing was the fact that sixteen of Ken's current and former graduate students were able to attend, with many of them giving invited papers. The conference focussed on the areas of Astronomy and Astrophysics to which Ken has made a number of outstanding contributions. The sessions were held in the mornings and the late afternoons so that participants could enjoy their surroundings while still taking part in a full program of presentations and discussions. The proceedings will be published in 2002 by the Astronomical Society of the Pacific as part of their conference volumes series.



*Ken with some of his former and present students. From left to right: Peter Quinn, Stefanie Cote, Heather Morrison, Mun-Suk Chun, Isabel Perez, Greg Wilson, Jayanne English, Elaine Sadler, Martin Bureau, Gary Da Costa, Mary Putman, Sebastian Gurovich, Garth Illingworth, Claude Carignan, Yong-Ik Byun, Sylvie Beaulieu.*

### Fourth Stromlo Symposium

The Fourth Stromlo Symposium, aka IAU Symposium #209; Planetary Nebulae: Their Evolution and Role in the Universe, was held in Canberra in the Shine Dome of the Australian Academy of Science, 19-23 November 2001. Apart from support from the RSAA and the IAU the conference was supported financially by the ATNF, the AAO, Monash University and the government of the ACT. The conference was formally

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opened by the ANU Vice-Chancellor, Prof. Ian Chubb. The attendance was very pleasing. Despite the events of September 11 being so close in time, out of 187 registrants we still had 156 attendees representing some 28 countries. There were a total of 45 talks given, and 173 poster papers.

In addition to a very lively scientific conference, the social program was a great success. The “traditional” Stromlo Symposium wine-tasting crammed 107 people into the Red Belly Black Café – a new record, and was ably conducted by our local Chevaliers du Vin, Brian Schmidt and Mike Dopita. In addition, there were outings to Tidbinbilla nature reserve, horse riding and high tea at Bungendore, and a conference dinner given in the great hall of University House.

A brief report on some of the scientific highlights of the conference:

Through new surveys, large numbers of new PNe are being discovered not only in our galaxy (such as the southern H $\alpha$  survey of Parker et al.), but also in external galaxies, which provides a rapidly growing field of research. The surveys of extragalactic PNe made possible in large part by new large telescopes and specialised instruments, are leading to an understanding of dynamics and stellar evolution in external galaxies. In particular, it is clear that the distribution of the PNe is a great way to trace the distribution of luminous matter down to surface brightnesses that would be impossible to observe directly. Such studies are revealing, for example a whole population of intra-cluster PNe in Virgo. Spectroscopic studies of extragalactic PNe beyond the local group are just beginning using the new instruments coming on line on 10m- class telescopes.

In our own galaxy, the problem of the distance scale remains. Regrettably, the progress reported in this area at the conference was rather small.

As far as impact of stellar evolution modelling on PNe precursor stars and PNe evolution was concerned, it is clear that a great deal of progress has been made. The theoretical models have become very sophisticated, and both need to and do incorporate new opacities, nuclear reaction rates, convection theory, dredge-up and mixing, binary evolution and mass-exchange, pulsation theory and mass-loss theory. In the PNe evolution itself, both pure hydrodynamic and magneto-hydrodynamic models have been produced. To explain the rich phenomenology of the shaping of PNe, it now seems likely that a combination of binary evolution, stellar rotation and magneto-hydrodynamical modelling is required.

The full non-LTE treatment of the PNe stellar atmospheres has become very sophisticated, and in some well-observed cases the agreement between theory and observation is very impressive. We can therefore be much more confident in the predictions of the EUV spectrum, required in photoionisation modelling of the PNe shell. For these shells, photoionisation modelling has now been coupled to stellar evolution models to provide dynamical modelling, although much work still remains to be done here. A major advance is that the new X-ray data obtained with Chandra and XMM has at last confirmed the two-wind model put forward many years ago by Kwok.

Nebular abundance determinations still provide lively debate. We are finally obtaining reliable abundances from the far-IR lines observed by ISO. A lively debate on the difference between abundances derived from forbidden lines, or from recombination lines in the optical looks likely to be resolved as a consequence of the existence of dense, metal rich, low temperature knots of material in the PNe shell. However, we have little idea how such knots might have formed.

Perhaps the highlight of the conference was the progress reported on astro-mineralogy, enabled by the IR signatures reported using ISO. An amazing variety of grain species has now been detected. These include crystalline silicates, amorphous silicates, organic carbon grains of both aliphatic and aromatic forms, as well as material approaching that of anthracite in its composition. There is evidence for surface-hydrogenated nano-diamonds, water ice, carbides (SiC, MgC, TiC), sulphides (FeS, MgS, SiS<sub>2</sub>,) and even carbonates (CaCO<sub>3</sub>, CaMg(CO<sub>3</sub>)<sub>2</sub>). This last material is a complete mystery, since such minerals form normally only in the presence of liquid water..

## PUBLIC OUTREACH

### Mount Stromlo Observatory Visitors' Centre



*Students observing sunspots in the Mount Stromlo Observatory Visitors' Centre Sun Room. The realtime image of the sun is reflected from a heliograph. A rainbow of the Sun's full spectrum of colours is also displayed on the wall.*

Mount Stromlo Observatory Visitors' Centre (MSOVC) continued throughout 2001 to develop its profile as an important 'second tier' regional attraction (as distinct from the well-known 'Big Ten' located in or near the national triangle). The Centre was restructured in September 2001, with three full-time staff and 25 volunteer explainers coordinating the visitor programs, assisted by RSAA astronomers. Recreational visitors to the Mount Stromlo campus in 2001 numbered over 65,000. Local, interstate and international visitors and school groups toured the Observatory and participated in educational outreach programs, including night observing and special events linked to celestial occurrences such as the Leonids meteor shower in November.

Schools outreach continued to grow in 2001, with 240 school groups, comprising 9200 primary and secondary students, visiting the Observatory. According to figures released by the Canberra Tourism and Events Corporation, this represented some 7.5

per cent of the total schools visiting the national capital during the year. The chief factors influencing schools' decisions to visit were educational merit, relevance to curriculum and cost-effectiveness. Open Day in April 2001 attracted an estimated 4,000 visitors, prefacing a successful National Science Week of workshops, talks and themed tours. Linkages with other major attractions such as the new National Museum of Australia also assisted in raising MSO Visitors' Centre public profile.

Sponsorship revenue from the Adopt-a-Star Program grew substantially in 2001, contributing \$73,600 towards the Centre's activities. All major stars have now been sponsored, and planning commenced for the next stage of the program, "Deep Space" stars of magnitudes greater than 6. Fundraising in 2001, including donations from corporate partners and philanthropic bodies, contributed a total of over \$151,000 in support of the Centre's public astronomy outreach activities.

### **Siding Spring Observatory Visitors' Centre**

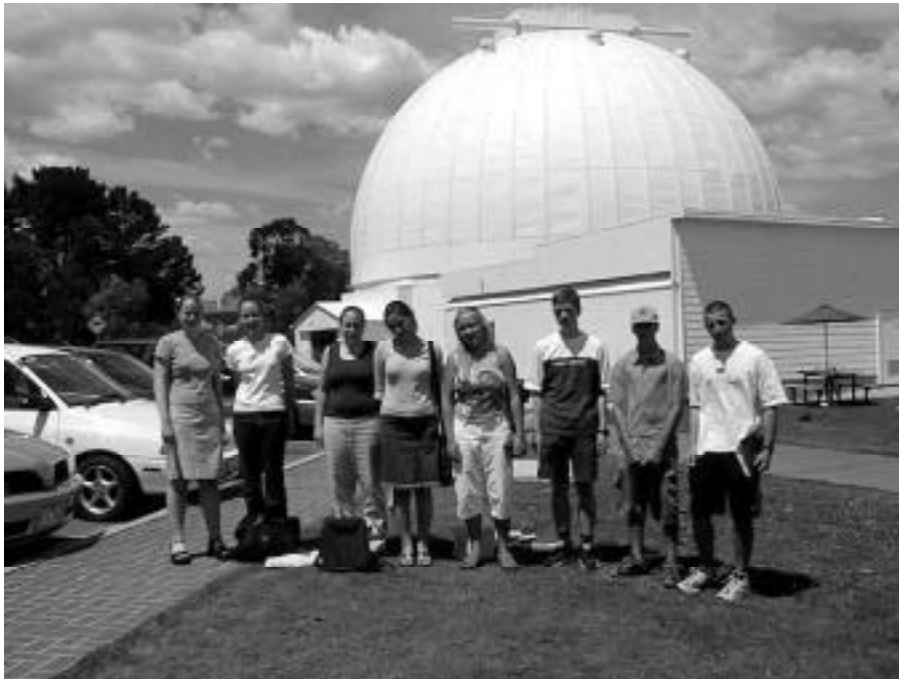


*An aerial view of Siding Spring Observatory in the Warrumbungle National Park, NSW*

Located at the site entrance, the Siding Spring Observatory Visitors' Centre continues to perform an important public relations and outreach role for all institutions based at SSO. The small number of committed staff are responsible for exhibition admissions, sale of refreshments and souvenirs and conducting tours for visitors. In 2001, 12,000 visitors paid to enter the exhibition and tour the site. Unlike the MSO Visitors' Centre, the SSO Visitors' Centre restricts its operations to day-time activities since all telescopes are used for observing purposes at night.

## **Year 10 Astronomy Summer School**

Every year in December, Mt Stromlo Observatory hosts its Year 10 Summer School. A small group of keen students from around Australia is flown to Canberra to take part in the school. During the week, they carry out their own research projects using the giant 1.9m telescope (the third biggest in Australia). They mingle with professional astronomers, visit NASA's tracking station nearby, listen to talks and generally experience the life of research astronomers. The Summer School is sponsored by Perpetual Trustees. Participants came from every state in Australia: This year they were: Nathan Deutscher, Julia Leeson, Amie Milligan, Natalie Spillman, Kathryn Sutherland, Aliya Walifu, Tristan Webber and Braden Young.



*Year 10, 2001 Astronomy Summer School students  
outside the Mt Stromlo 1.9m telescope*

## **FROM THE DIRECTOR'S OFFICE**

### **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.

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, Rijksuniversiteit Groningen, who accepted the position in February 2002. Prof. Sackett's areas of expertise include Galactic and extragalactic astronomy - from the search for extrasolar 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.

### **ARC Entry and Other Grant Successes**

2001 saw the entry of RSAA's first cohort into the ARC grants scheme. It was also a busy and successful year for the School in its responses to the Federal Government's Major National Research Facilities program and its Systemic Infrastructure Initiative. As Interim Director I wish to acknowledge the drive and enthusiasm of the staff in their contributions to the success of these endeavours.

### **Major National Research Facilities Program**

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 partnership 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. In the bid it is envisaged that RSAA will build an instrument for Gemini as part of the entry requirement.

### **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.

## ARC Discovery and Linkage Grants

The School achieved a 60% success rate on its ARC Discovery proposals, and was able to obtain support from the ARC Linkage programs.

### Discovery: Projects

MM Colless	The 6dF Galaxy Survey,	\$279k
MA Dopita/ R Sutherland	Interstellar Physics at the Epoch of Galaxy Formation	\$400k
BP Schmidt	Taking Measure of the Universe with Exploding Stars	\$232k

### Linkage: Infrastructure\* (\* RSAA not administering institution)

RSAA, ANU	Australian Membership of Gemini	\$1602k
GV Bicknell	CANGAROO III Gamma-ray Telescope	\$220k

### Linkage: Infrastructure

BP Schmidt	A Renewed Great Melbourne Telescope	\$210k
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### Linkage International

MS Bessell	Discovering the First Stars	\$70k
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## National Facilities

### Number of Nights Allocated for External and Collaborative Use on RSAA Telescopes During 2001

	2.3m		74"		40"		24"	
Overseas users	22	167	109	99	56	97	46	27
UNS universities			30	4	41	7	74	19
AAO/CSIRO	6		5		23			
Other							11	
<b>Total nights</b>	<b>229</b>		<b>261</b>		<b>269</b>		<b>84</b>	

The first entry of each pair is the number of nights allocated entirely for external use; the second is the number of nights allocated for collaborative projects involving RSAA and external researchers.

AAO = Anglo-Australian Observatory.

The 24" is scheduled less regularly than the larger telescopes.

## Personnel Information

Dr Maartje Sevenster left RSAA to return to the Netherlands. Dr Eon-Chang Sung from the Korea Astronomy Observatory, and Dr Roberto Saglia from the Munich Observatory, joined us as IREX Fellows. Dr Simon Driver from St Andrews, and Dr Roberto De Propriis, from the University of New South Wales, joined the research staff.

**Sources of Revenue**

Source of revenue	1999 \$000	2000 \$000	2001 \$000
IAS block grant	5210	5273	5507
External funds	806	2788	2405
Ancillary activities	1027	967	988

**Gender Equity Performance**

The overall gender profile of the School has remained essentially unchanged from that in 2000. The numbers of men and women have each decreased by one.

On a timescale of five years the following changes have occurred. 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 1996.

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

John Norris  
Interim Director  
17 February 2002

## EULOGY

### **Natarajan Visvanathan (1932- 2001)**



Natarajan Visvanathan was known to his astronomical colleagues simply as 'Vis'. He enjoyed their deep affection and esteem throughout his full and productive career. Vis's association with Mount Stromlo spanned two phases - first as a graduate student in the early 1960s, and later as a staff member until his retirement in 1997.

Vis first came to Mount Stromlo to undertake his PhD studies in 1962, having graduated in science at Madras. He was recruited by Stromlo's Director, Bart Bok. Bok had a passion for working with students, and an urgent desire to establish a world-class graduate school at Stromlo. Right from the start, he wanted his programme to be international in composition and ethos, so he contacted colleagues around the world persuading them to act as his recruiting agents. It was Vainu Bappu, a former student of Bok's at Harvard, then working back in India, who recommended Vis to Bok as a young scientist of the calibre he was seeking. Vis was amongst the first dozen students whom Bok appointed.

Vis chose as his area of thesis research the technically demanding field of polarimetry. This involves using special filters at the telescope to investigate how the light from individual stars has been affected by the presence of magnetic fields and dust particles on its long journey through space. In 1965 he submitted a thesis entitled 'Polarisation in the Galaxy and the Large Magellanic Cloud', and graduated with his PhD in May of the following year.

Vis then went to Mount Wilson and Palomar Observatories in California. With his experience in polarimetry, he used the large telescopes there to make polarisation observations of radio galaxies. He showed for the first time that the optical light from some of these objects does not come from stars; it is primarily synchrotron radiation emitted by electrons moving in a magnetic field.

While in California, Vis began a long and productive collaboration with Allan Sandage,

one of the world's most influential astronomers. Together they did a memorable polarization study of the filaments in the starbursting galaxy M82. They showed that the light of these filaments is polarised because it comes from the hidden inner regions and is scattered by dust. This was a novel and influential idea.

In 1975, Vis returned to Mount Stromlo as a staff member, and the Observatory became his career home for the rest of his working life. Here his interests moved to the field that made him famous: galaxy photometry. The colours of galaxies depend on how bright the galaxies are: very bright galaxies are systematically redder, because their stars have different chemical properties from those in the fainter galaxies. This is called the colour-luminosity (C-L) relation for galaxies. It seems to be a universal relation, the same everywhere in the nearby universe. Vis developed the techniques to measure the C-L relation precisely, and acquired his well-deserved reputation as one of the few people in the world who could do precise and reliable photometry of galaxies.

The high point of Vis's work on galaxy colours came in a series of very influential papers with Sandage in the late 1970s, on the C-L relation for elliptical and S0 galaxies. These papers are still much cited, with more than 200 references for each paper in the series. One can use the C-L relation to measure the distances to galaxies, and in this way to estimate the elusive Hubble constant; this tells us how fast the Universe is expanding, thus yielding an estimate for its age. In the late 1970s, there was considerable controversy about the value of the Hubble constant. It was a stormy time in extragalactic astronomy. Vis used his observations to derive a value which disagreed with that favored by most other workers at the time. He had the courage to stand by what his data were telling him. Now, twenty years later, we think we know the true value of Hubble's constant, and it turns out that the result that Vis obtained is very close to the current estimate.

Although Vis will be remembered particularly for his work on galaxy photometry, he had other research interests, deriving from his photometric skills. Two stand out:

- With Don Mathewson and Vince Ford, Vis made an exciting study of the Small Magellanic Cloud, which showed that it is being ripped apart by its interaction with the neighbouring Large Cloud.
- Vis had a long interest in a kind of magnetised variable star called AM Herculis objects - these show some dramatic changes that can be studied well with the photometric techniques that Vis was expert in. With Dayal Wickramasinghe and others, Vis published several papers about these stars.

Vis was an enthusiastic researcher and passed his enthusiasm on to his PhD students - David Griersmith, Andrew Pickles, Glen Mackie, and Anya Schroeder.

We shall miss Vis, and we shall remember him. We sympathise with his family in their sad loss.

Don Faulkner  
Ken Freeman  
John Norris

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## RESEARCH

\* not a member of the University

### SOLAR SYSTEM

#### Detection of Objects in the Outer Solar System

Axelrod is a member of the TAOS Project, an effort to detect Kuiper belt objects by observing their occultation of background stars. The three 0.5 meter telescopes acquired for the experiment have had continuing optical problems which have delayed the initial operation of the experiment at LuLin Mountain in Taiwan.

The cloud detector that is being used for the robotic operation of the Great Melbourne Telescope at Mt. Stromlo is being redesigned and a new unit delivered to the TAOS Project.

A second project, including Axelrod, Schmidt and Moody, the Southern Edgeworth-Kuiper Survey, continued operating using the MSO 50 inch telescope and MACHO camera system. The goal of this survey is to perform a complete census of bright objects in the outer solar system located in a 20 degree wide band centered on the ecliptic. During 2001 a data pipeline was implemented to detect moving objects. This pipeline has several unique features. The most important of these is that the calculation of the detection efficiency is tightly integrated into the pipeline. A representative population of about one million artificial solar system objects is dynamically evolved and added to the survey images that they would appear in. The data pipeline then treats real and artificial objects in an identical fashion until the end, at which point the calculation of the efficiency is straightforward. Detected objects are also automatically checked against the database maintained by the Minor Planet Center at SAO. The authors find that about only 40% of their detected objects are already known. They have not made any unambiguous detections of new TNO's, however. This apparently is due to two factors: their observing strategy resulted in most objects being detected far from opposition, which makes their distance problematic to determine; and their orbit fitting code needs improvement. Their focus during 2002 is on rectifying these problems and thereby detecting new TNO's.

### STELLAR ASTROPHYSICS

#### Trying to Explain the Large Diameters of Mira Variables

The diameters measured for the pulsating red giants called Mira variables are much larger than the diameters predicted by stellar pulsation theory. One possible explanation for this result is that the outer atmospheres of the Mira variables contain dust particles which scatter the light coming from lower down in the star, effectively creating a fuzzy halo. Bedding\*, Jacob\*, Scholz\* and Wood have explored the

occurrence of dust in Mira atmospheres and its effect on the brightness distribution across the observed stellar disk (limb darkening) under schematic assumptions about dust temperatures and dust particle properties. Dust particles that are thermodynamically coupled to the surrounding gas may form and may affect limb darkening, though only by very little in infrared continuum bandpasses. Dust particles that assume the equilibrium temperature given by the mean intensity of the radiation field only form under rare circumstances. Overall, the results show that the unexpectedly large radii observed by infrared interferometry are unlikely to be caused by atmospheric dust; however, radius measurements may be significantly affected by molecular band contamination.

### **Mass Functions of Intermediate-Age Clusters**

Sung\*, Bessell & Chun have been studying intermediate-age stellar systems, namely, young open clusters, using the Wide-Field Imager. Carrying out UBVI and H $\alpha$  photometry, they are trying to identify pre-main sequence stars and determine whether there are differences in initial mass-function between clusters. Whilst H $\alpha$  emission is an excellent youth indicator in K and M dwarfs, for hotter stars, X-ray emission is the best criterion and data from pointed observations with X-ray satellites has proved invaluable.

### **Survey for Extremely Metal-Deficient Stars**

Christlieb\*, Bessell and associates have continued intermediate resolution follow-up observations on the 2.3m telescope Double Beam Spectrograph (DBS) of extremely metal-deficient candidates from the Hamburg-ESO Objective Prism survey. Initially, the candidates were mostly dwarfs and sub-giants near the main-sequence turnoff but later in the year, samples of cooler giant branch stars were included. In November, six giants with lower metallicity than 1/1000 solar were discovered, including one star with a preliminary abundance of 1/30000 of the Ca in the sun, the lowest metallicity ever found in a halo star. Many of these low metallicity stars found have extremely strong bands of CH, indicating large carbon overabundances. Christlieb is refining the algorithm used to identify weak-line giants from their objective prism spectra in line with the abundances derived from with DBS spectra in order to improve the yields of extremely metal-deficient giants. Time is being sought on 8m class telescopes to follow-up all stars with abundances below 1/1000 that of the sun.

## **THE GALAXY**

### **The Spaghetti Project**

Norris and Freeman are members of the "Spaghetti" collaboration, together with astronomers from the US and Germany. The stellar halo of our Galaxy is now believed to have been built up largely by the debris of dwarf galaxies accreted into the halo. The goal of the spaghetti project is to discover the fossil remains of these disrupted dwarfs from among the far more numerous foreground stars of the galactic disk. Using

new techniques, the collaboration has successfully discovered giant stars of the halo out to distances of up to 80 kpc from the sun. They have detected a concentration of giants at 50 kpc and at 80 kpc: the radial velocities of these giants indicate that they are part of the disrupting Sagittarius dwarf galaxy, whose center is 60 degrees away.

### **Search for Young Stellar Groups in the Solar Neighborhood**

Zuckerman\*, Song\* and Bessell have been using the 2.3m telescope to identify very young stars with common space motions that are close to the sun and therefore will make good candidates in the search for planetary disks by infra-red imaging with space telescopes or ground based telescopes with adaptive optics. Young stars are identified by X-ray emission, H $\alpha$  emission and/or a strong Li line. Seventeen additional star systems comprising 24 stars have been found to share the motions of Beta Pictoris, the archetypical star with an extensive dusty circumstellar disk. The search is being extended for other young co-moving groups which may have broken away from the Sco-Cen association.

### **Looking for MACHOs with Hubble Space Telescope**

The MACHO Project detected a previously unknown population of compact objects in the Milky Way through their gravitational lensing effect on the light of distant stars. These objects may make up a significant fraction, perhaps 20 percent, of the dark matter that dominates the dynamics of the Galactic halo. If so, they are probably ancient, cold white dwarfs left over from a first epoch of star formation. There are an increasing number of direct searches being undertaken for these cold white dwarfs, and many are being found. The interpretation of their origins is proving quite difficult, however, due to the still poor statistics, uncertainties in initial mass functions and white dwarf cooling physics, and incompletely understood detection efficiencies of the various surveys.

To help resolve these issues, Mould and Axelrod, with Lawrence Livermore postdoc Nelson, performed a search for white dwarf stars as high proper motion objects in a second epoch WFPC2 image of the Groth-Westphal strip. The strip is a survey area first visited by the Hubble Space Telescope in 1994. The survey covers  $\sim 75$  sq arcmin, and is complete to  $V \sim 26.5$  mag.

Five of the high proper motion objects are identified as strong white dwarf candidates on the basis of their colour. Nelson created a model of the Milky Way thin disk, thick disk and stellar halo and found that this sample of white dwarfs is clearly an excess over the  $\sim 1$  detections expected from these known stellar populations. The origin of the excess signal is less clear. Possibly, the excess cannot be explained without invoking a fourth galactic component: a white dwarf dark halo. Previous work of this nature has separated white dwarf samples into various Galactic components based on kinematics; distances, and thus velocities, are unavailable for a sample as faint as this. Therefore, a statistical separation of the sample was devised into the four components, using only the directly observable variables.

A maximum likelihood analysis was performed to find the most likely local white dwarf densities. This implied a 7% white dwarf halo and six times the canonical value for the thin disk white dwarf density (at marginal statistical significance). This result is consistent with the possibility that the objects detected by the MACHO experiment at Mt Stromlo during 1993-2000 were white dwarfs in the halo of the Milky Way.

### **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 Centre" - the existence of filaments of non-thermal 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 ( $\sim 400\mu\text{G}$  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.

## **GALAXIES AND GALACTIC STRUCTURE**

### **Proper Motion of the Magellanic Clouds**

Axelrod, with Alcock, Geha\*, Cook\*, Drake\*, and van der Marel\*, was awarded Cycle 11 HST time to perform a first epoch of observations with the Advanced Camera for Surveys to determine the proper motion of the Magellanic Clouds. This work is based on the use of the QSO's discovered in the MACHO Project for an extragalactic astrometric reference frame.

### **The Shape of Galactic Bars and Dark Matter**

Galactic bars are density waves which are amplified when they lose angular momentum. Angular momentum can be lost when the rotating bar causes gaseous spiral shocks to form in the outer parts of the galaxy, or through interaction with the halo stars.

Kalnajs made use of numerical experiments to explore the effects of weak torques on bars. He showed that the triaxial bars behaved as modes of an oblate spheroid: positive torques made the triaxial figures rounder, while negative torques would make them more bar-like. But he also noticed that there was an upper limit to the amplitude of the bar mode as measured by the ratio of the minor to major axes,  $b/a$ . It could not be made smaller than  $2/5$ . The existence of the  $b/a$  limit is due to the random motions that are necessary to suppress dynamical instabilities.

The above  $b/a$  limit pertains to self-gravitating bars. If the bar is embedded in a dark halo, the random motions needed to suppress dynamical instabilities decrease and therefore one can have a smaller  $b/a$  or a more elongated bar.

### **The Metallicities of Elliptical Galaxies**

Saglia et al have been measuring the strength of the Calcium Triplet line around 8600 Å in local elliptical galaxies. This line is thought to trace the metal content of old stellar populations. They find that large galaxies have weaker lines than smaller objects. This puzzling result suggests that the fraction of low mass stars (with weak Calcium lines) present in large ellipticals might be higher than in smaller ellipticals.

### **The Tully-Fisher Relation of Distant Field Spirals**

Looking at objects at high redshifts is a way to trace the evolution of galaxies with time. Saglia et al studied the properties of spiral galaxies up to redshift 0.8 with the VLT. They find that, when compared to nearby galaxies, spirals at redshifts 0.2-0.8 with small rotational velocities show an increase in luminosity more pronounced than spirals with large rotational velocities.

At even higher redshifts one can observe galaxies while they start forming their stars. The observations of these faint, distant objects is eased, if a cluster of galaxies acts as an additional gravitational telescope that magnifies them. Using the VLT, Saglia et al observed such starbursting galaxies at redshift 2 to 3.3 in the field of the cluster 1E0657. They find indications that the metal content of these galaxies decreases with look-back time.

### **Large Magellanic Cloud Cepheids**

Sebo and Mould completed the analysis of a homogeneous set of BVRI photometry of 600 Cepheids to check the Cepheid Period-Luminosity (PL) relation in the Large Magellanic Cloud (LMC). The PL relation is the most celebrated standard candle of classical astronomy.

The Cepheid distances to nearby galaxies obtained by the Hubble Space Telescope Key Project on the Extragalactic Distance Scale were computed assuming a 'standard' PL relation based on a compilation of photoelectric observations of ~35 Cepheids and a standard distance to the LMC of 50 kiloparsecs. The final Key Project results substituted a statistically stronger PL relation obtained by the OGLE collaboration.

In their paper Sebo and collaborators compare their Siding Spring Observatory and Las Campanas Observatory data with the OGLE PL Relation. Some of the data had been obtained by Daya Rawson as part of his PhD thesis. (We report with sadness that Daya died in 1999.)

The subsample of LMC Cepheids with similar periods to those discovered in the nearby galaxies is fainter at the relevant periods by 0.04 +/- 0.02 mag than the OGLE sample. Substituting in turn, this PL relation for that of the OGLE collaboration, would raise the Hubble Constant by 2% +/- 1%, a correction which is not significant. The Key Project, reported in last year's annual report, found a Hubble Constant of 72 +/- 8 km/sec/megaparsec and an age of the Universe of 13 billion years.

## **GALAXIES AND GALAXY EVOLUTION**

### **Intracluster Stars in the Virgo Cluster**

With a team of international collaborators from Italy, Switzerland, Germany and the USA, Freeman discovered that the space between the galaxies in the Virgo cluster is not empty, but inhabited by a diffuse population of stars. They detect this population of stars from their planetary nebulae, and find 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.

Intracluster planetary nebulae are discovered by their [OIII] emission lines, through narrow-band imaging surveys. These surveys also detect high redshift galaxies ( $z \sim 3.1$ ) whose Lyman-alpha emission lines are redshifted into the passband of the narrow-band filter. These high redshift galaxies are a serious contaminant. With Japanese collaborators, using the 8-m Subaru telescope, Freeman and Arnaboldi\* showed how these contaminating galaxies can be effectively excluded by combining the [OIII] survey data with images in the light of the H-alpha line.

### **HST/WFPC2 Observations of M31 Dwarf Spheroidal Companion Galaxy Andromeda VI**

Da Costa, Armandroff\* and Caldwell\*, and Da Costa, Armandroff\*, Jacoby\* and Pritzl\*, have been carrying out programs with the Hubble Space Telescope WFPC2 camera to study the dwarf spheroidal (dSph) companions to M31, the nearest examples of these galaxies (other than the companions of the Milky Way). During the report year the M31 dSph companion And VI was surveyed for variable stars. A total of 118 variables were found with 111 being RR Lyrae stars, 6 Anomalous Cepheids and 1 unclassified. The And VI Anomalous Cepheids have properties consistent with those for Anomalous Cepheids in the Galaxy's dSph companions. As for the And VI RR Lyrae stars, they lie close to Oosterhoff type I Galactic globular cluster RR Lyrae in the period-amplitude diagram, although the mean period of the ab-type variables is slightly longer than those for typical Oosterhoff type I clusters. The mean magnitude of the RR Lyrae also yields a distance for And VI that is consistent with that derived from the I magnitude of the tip of the red giant branch. Similarly, the properties of the And IV RR Lyrae yield a mean abundance for this dSph which is consistent with that derived from the mean red giant branch colour. Thus, at least as regards the properties of its variable stars, the Andromeda VI dSph galaxy is indistinguishable from the Galaxy's dSph companions.

## ACTIVE GALACTIC NUCLEI

### What Excites the Gas Around Seyfert Galaxies

Around the so-called Seyfert galaxy nuclei one sees extended regions of gas excited in some way by the violent processes associated with mass accretion onto the  $\sim 10$  million solar mass black hole located at the nucleus. However, the actual mode of excitation has remained something of a mystery. Extensive surveys show that the emission line ratios are remarkably uniform within a given object, and very similar (with typically less than 0.5 dex variation) from one object to another. This indicates that the excitation process is very similar point to point within any galaxy, and between different galaxies.

The standard paradigm proposes that these regions are excited by photons originating at or near a compact nuclear source, presumably by the accretion process itself. In such models the excitation is in large measure controlled by the ionization parameter,  $U$ , which is free to vary over a wide range. Instead  $U$  appears to take a similar value in all objects. Modellers have been therefore forced to make the arbitrary (and possibly unphysical) assumption that the gas density in the ionized clouds must fall exactly as the inverse square of the distance from the nucleus.

An alternative model is provided by the excitation due to fast shocks, the so-called ‘‘Stromlo Paradigm’’ developed by Dopita, Sutherland, Bicknell and their collaborators over a number of years. This replaces a central source of photons with a local one, the fast shock. This model is very successful in explaining the dynamics, excitation, and association between optical and radio emission seen in many objects. However, it has difficulty reproducing the very strong high-excitation coronal lines; [Fe VII], [Fe X], [S VIII], [S XII], [Si VI] or [Si VII] which are better described by photoionization models. Second, it cannot reproduce the large line widths of the [O III] line seen in some objects.

In the past year Dopita and Groves in collaboration with Luc Binette of UNAM, Mexico, have developed an entirely new model which recognises the great importance that radiation pressure acting on dust can have in determining the structure and temperature distribution of the ionised plasma. They have shown that above a certain critical ionisation parameter,  $U > 0.01$ , the dust dominates the absorption of the ultraviolet radiation, and radiation pressure dominates over the gas pressure. As a consequence, the line ratios usually used to indicate excitation in the optical become almost independent of the ionisation parameter. The modelled line ratios agree excellently with those observed in real objects. The models lead to the conclusion that the ionisation parameters are much larger than was thought, of order unity.

A consequence of the very high radiation pressure is that gas can be driven off photoablating clouds at very high velocities; in excess of 1000 km/s. Such flows are seen in Hubble Space Telescope observations of NGC1068 and have been reported in a conference paper by Gerald Cecil working with Dopita, Sutherland and Groves at the RSAA.

## **Quasar Absorption Lines**

The supermassive black holes that power quasars live in a very complex environment. The standard probes for the properties, distribution and velocities of thermal gas in this environment on scales ranging from 0.1 to 100 parsec are ultraviolet and optical emission lines. The study of these emission lines has led to the phenomenological model of a region with high density, rapidly moving clouds at a distance of 0.1 parsec - the Broad Emission Line region (BEL) - and a much larger region about 10-100 parsec in size in which much lower density clouds give rise to the Narrow Emission Lines (NEL). It has proven to be very difficult to derive any information on the character of the velocity field that causes the observed line width in these two regions. In recent years, however, the study of QSO absorption lines, which have just been shown to be formed at similar distances to the black hole as the emission lines, has shown that the velocity fields are dominated by outflow.

De Kool, in collaboration with Becker\*, Arav\* and Korista\* has been continuing his work on the interpretation of QSO absorption lines, following his earlier results that for the first time established a fairly accurate distance of the absorption line region to the black hole, allowing the study of absorption lines to be tied in with what was already known about the QSO environment from different types of observation. The earlier results were confirmed and a similar analysis was applied to several other QSO absorption line systems. A tentative picture is beginning to emerge where absorption line systems seem to come in two kinds, with properties that are remarkably similar to those of the BEL and NEL clouds. De Kool has also started to develop a new analysis tool that takes into account that the absorbing regions are likely to be inhomogeneous, with large column density fluctuations across the background light source. Initial modelling shows that this approach is able to explain many observed characteristics of intrinsic QSO absorption line systems, that can not be reproduced by models assuming a homogeneous absorber.

## **Red Quasars from the Two Micron All Sky Survey**

The Two Micron All Sky Survey (2MASS) is a \$30 million US project to map the whole sky at near-IR wavelengths. This survey has found many sources with anomalously red colours at near-IR wavelengths. Francis, Cutri\* and Nelson\* have been using the 2.3m to find out what these red objects are. It turns out that they are mostly quasars, obscured by small amounts of dust. These quasars are at least as common as all previously known quasars, but were previously quite unknown. Some of these new quasars are among the brightest ever found, making it all the more surprising that they had never been seen before.

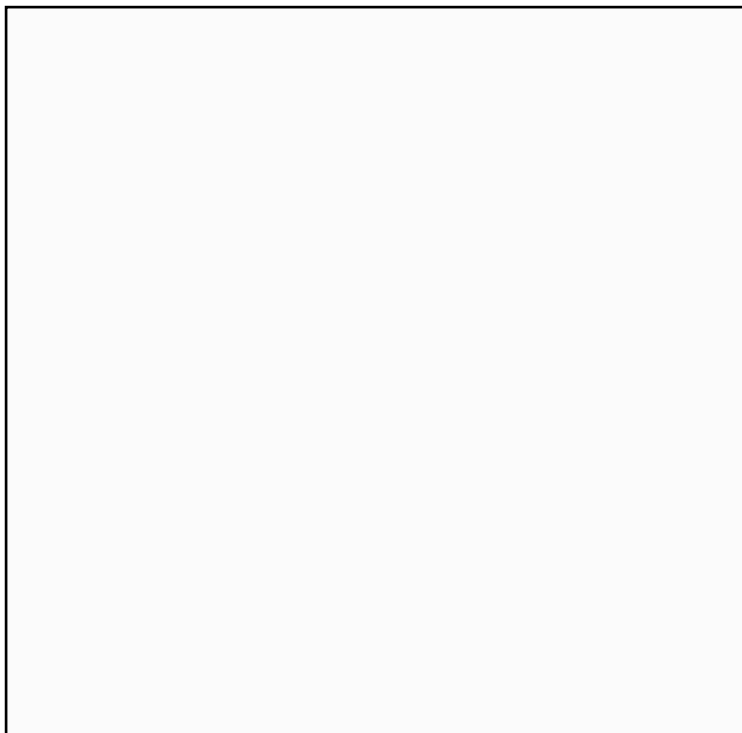
### **Extragalactic Radio Sources: Populations and Evolution**

Jackson, Wall\*, Shaver\* and Hook\* have determined that powerful flat-spectrum quasars peaked in space density around redshifts 2 - 3, with a definite down-turn in space density at redshifts greater than 4. A full analysis of the sample of 878 such objects is being presented in a series of 3 papers, with the third giving a detailed statistical analysis which accounts for selection effects of both intrinsic and cosmic spectral steepening.

### **A Water Maser in the Edge-on Galaxy IRAS F01063-8034**

McGregor, principally with Greenhill\*, Ellingsen\*, and Norris\*, detected 22 GHz water maser emission from the galaxy IRAS F01063-8034 using the Parkes radio telescope. Water maser emission is rare in galaxies, but is potentially an important diagnostic of conditions in the accretion disks surrounding the massive black holes that are thought to power active galactic nuclei. One of the most convincing pieces of evidence for the existence of a massive black hole in an active galactic nucleus has been the detection of water maser knots in a thin edge-on accretion disk orbiting the  $4 \times 10^7 M_{\odot}$  black hole in the edge-on galaxy NGC 4258. Unfortunately, not all extragalactic water masers are located in edge-on accretion disks. Water maser emission has been detected in the prototype Seyfert 2 galaxy, NGC 1068, adjacent to the active nucleus where the radio jet appears to collide with an interstellar gas cloud. Water maser knots have also been localised to the radio jet in the radio galaxy NGC 1052. The emission in this object is smooth and broad, whereas multiple narrow emission lines at irregular velocities are more commonly seen. This may reflect the different emission mechanisms involved.

IRAS F01063-8034 is an edge-on galaxy that was selected because it was believed to exhibit excess radio emission. In fact, higher resolution radio images obtained with the Australia Telescope Compact Array show that the radio excess is due to an unrelated background object. Nevertheless, faint 22 GHz water maser emission was detected at Parkes and later confirmed at Tidbinbilla. The emission is broad, as in NGC 1052, so may be associated with a jet. The flux is too weak to permit higher resolution Very Long Baseline Interferometry that would resolve this. The galaxy shows no other signs of activity in its optical or radio properties, so this may be a fortuitous detection of nuclear activity solely through water maser emission. X-ray observations have been proposed. These may provide a further indication of the activity level in the optically obscured nucleus.



*Spectra of  $H_2O$  maser emission in IRAS F01063-8034. The discovery spectrum obtained with the Parkes telescope is shown at the top. The confirmation spectrum obtained with the Tidbinbilla antenna 13 days later is shown at the bottom. The curves are fitted Gaussian profiles.*

## **COSMOLOGY**

### **Public Release of the Largest 3D Map of the Universe**

The largest existing 3D map of the Universe was publicly released on 30 June 2001 by the 2dF Galaxy Redshift Survey (2dFGRS) team, led by Colless and Peacock\*, and including Peterson and Jackson. This map, consisting of the positions and redshifts for 100,000 galaxies, was made available both on the WWW (see <http://www.mso.anu.edu.au/2dFGRS>) and on CDROM and has been distributed to 300 individuals and institutions. The survey has continued to forge ahead since the release, with over 200,000 galaxies now mapped and 15 papers published or submitted. A number of major results have emerged from the survey during 2001. One of the most remarkable is the first detection in the structure of the galaxy distribution of the predicted signature of an interaction between ordinary matter, dark matter and photons which occurred in the first hundred thousand

years after the Big Bang. The same measurements also yield estimates of the relative densities of the ordinary matter and the dark matter that are in excellent agreement with completely independent measurements based on anisotropies in the cosmic microwave background radiation. The density of another important constituent of the universe - the stars in galaxies - was also accurately measured, by combining the redshift survey with photometry from the 2MASS infrared sky survey. Other new results include: the first unambiguous determination of the way in which the clustering of the galaxy distribution depends on the luminosity of the galaxies; the most precise measurement to date of the luminosity distribution of radio galaxies, with separate measurements for active galaxies and star-forming galaxies; and constraints on the star-formation history of the Universe from the combined spectrum of all the galaxies in the survey.

### **The Distant Universe**

Schmidt leads a team of more than 20 astronomers on four continents who discover supernovae - stars which explode at the end of their lives with the energy of an entire galaxy. This team, known as the the High-Z SN Search discovered that the Universe was accelerating in its expansion, research named Science Magazine's "Breakthrough of the Year". This result is most easily interpreted as the Universe being filled with some previously undetected Dark Energy. There are still some lingering doubts in this result because it is so difficult to show that the distant supernovae are the same as their nearby counterparts. The High-Z team undertook the most ambitious program of supernova discovery yet, using the Canada-France-Hawaii and Subaru Telescopes, located on Mauna Kea, to continuously monitor 5 fields for a period of 4 months. This program commenced in October and is continuing into 2002, and has already uncovered more than 100 objects. Five of these objects have been sent to the Hubble Space Telescope (HST) for careful monitoring. This experiment is intended to produce a collection of very distant supernovae, the observations of which will show if the Universe is behaving in a manner consistent with the 1998 observations.

In addition, Schmidt, Riess\* and colleagues presented the observations of SN 1997ff using the HST, showing this was the most distant supernova ever detected. Originally detected in 1997 in a survey using HST, SN 1997ff was largely forgotten because there were not sufficient observations to discern any useful information about the object. However, in early 1998, a large program using Hubble's now defunct infrared camera, by accident, scanned the region containing the supernova for a month long period, a coincidence only realised at the end 2000. These observations suggest that the Universe, 10 billion years ago, was not accelerating, but slowing down. This result, seemingly in contradiction to the work in 1998, instead is a confirmation of the Dark Energy theory. Like two wrestler's vying for domination of the Universe, Dark Energy and Matter are poised against each other in a fight for the future of the Universe. Dark Energy pushes the Universe apart, while Matter pulls it together. The far-flung stellar detonation, SN 1997ff, happened 10 billion years ago when the universe was only about one-quarter its present age, at a time before gravity lost its grip and the universe began accelerating. Now Dark Energy is dominating the cosmic struggle and is driving the Universe apart.

Despite the death of one GRB satellite, the mothballing of another, and the poor performance of the new HETE2 satellite, significant progress was made on Gamma-Ray Bursts (GRBs) - the most violent explosions in the Universe. Axelrod and Schmidt's student Price, working with Kulkarni\* and Fox\*, identified the first afterglow from a Gamma-Ray Burst (GRB) that was localised by the newly-operational High Energy Transient Explorer (HETE-2) satellite. They find that GRB 010921 is a relatively nearby event. Price, Schmidt, Axelrod and Ryder\* tracked the decay of another nearby GRB afterglow, GRB 011121, with the newly-commissioned infrared imager IRIS2 on the Anglo-Australian Telescope. Hubble Space Telescope observations of these two afterglows are expected to definitively test the theory that GRBs are caused by dying stars, by searching for the tell-tale signature of a supernova underneath the GRB.

### **The Local Universe**

Schmidt, Salvo and Ashley\* are using the University of New South Wales Automated Patrol Telescope to scan the nearby universe for supernovae. This telescope provides a large field of view, and will, when upgraded, allow them to scan the entire sky every four days. In 2001 they began to take data regularly of approximately 20% of the visible sky, and were able to get pre-discovery images of two nearby supernovae. The data pipeline, under development, should, in the near future, provide a hundred exploding stars per year, as well as near earth asteroids, variable stars, and other transient objects.

## INSTRUMENTATION

### **The Gemini Near-infrared Integral Field Spectrograph**

The Near-infrared Integral Field Spectrograph (NIFS) is a cryogenic near-infrared spectrograph being built at RSAA for the Gemini North 8m telescope in Hawaii. It is a fast-tracked instrument aimed at providing Gemini North with a near-infrared spectroscopic capability as quickly as possible.

The novel feature of NIFS is its Integral Field Unit (IFU) that optically reformats a 3"x3" area of sky so that spectral information is recorded for each 0.1"x0.1" segment of this field. NIFS will be used with the ALTAIR adaptive optics systems on Gemini North to perform imaging spectroscopy at near to the diffraction limit of the telescope. RSAA performed a Conceptual Design Study for the instrument in 1999, and signed the construction contract in mid-2000. RSAA is working with the Institute for Astronomy of the University of Hawaii on the science detector system and some mechanical components are being manufactured at the University of Hawaii.

Much progress has been made on NIFS during 2001. The detailed design was developed through the early part of 2001, and the Critical Design Review was successfully completed in April 2001. Part of the fast-tracked approach to the instrument construction has been the duplication of many designs from the Gemini Near-Infrared Imager (NIRI). This has permitted construction work to commence on the cryostat, On-Instrument Wavefront Sensor (OIWFS), control system, and control software before the Critical Design Review.

A major milestone was achieved in August 2001 with the first cooldown of the cryostat. The cryostat contained only the cold work surface plate and radiation shields. However, the vacuum pump, pressure gauges, cryocoolers, water coolers, and the full temperature control system had to be operational for the test. The cooldown was a success with the cold work surface plate reaching a temperature of 46 K after 40 hours. The system was exercised for a further 40 hours after which time the coolers were switched off and the cryostat was returned to ambient temperature over the course of 35 hours.

Key components of the NIFS IFU are the pupil and field mirror arrays. These are each monolithic arrays of 29 toroidal mirrors that optically reformat the input field. They are each diamond machined in a single aluminium bar to achieve the required alignment accuracy and stability when cooled to the cryogenic operating temperature. Their manufacture requires a 3-axis diamond mill, rather than the more common 2-axis diamond lathes. Achieving the required low surface roughness with a 3-axis machine has been a concern. The pupil mirror array was successfully manufactured in October 2001 by Labor Fuer Mikrozerspanung (LFM) at the University of Bremen using aluminium coated with electroless nickel. The RMS surface roughness is 7.6 nm after light post-polishing, which meets our requirement to minimise scattered light.

Construction of the OIWFS is well-advanced and construction of the spectrograph is now underway. NIFS is expected to be commissioned on Gemini North in mid 2003.



*Peter Conroy supervising the installation of the NIFS cold work surface plate and radiation shields in the NIFS cryostat prior to the first cooldown.*

### **Gemini South Adaptive Optics Imager**

RSAA was selected in 2001 to perform one of two Conceptual Design Studies funded by the Gemini Telescope Consortium for the Gemini South Adaptive Optics Imager (GSAOI). For more details on this project, please see the *Scientific Highlights* section of this report.

## The Planetary Nebula Spectrograph

For studies of the stellar dynamics of elliptical and S0 galaxies, planetary nebulae are excellent probes, because it is relatively straightforward to measure their velocities from the [OIII] 5007A line. The Planetary Nebula Spectrograph (PNS) is a novel high performance counter-dispersed imaging spectrograph which is able to detect extragalactic planetary nebulae and measure their velocities in a single observation. It was built by an international collaboration (Italy, Netherlands, Germany, UK and Australia: Freeman is the PI) for use on the f/11 4-m class telescopes at La Palma Observatory. The PNS was designed by RSAA design staff and much of the construction was done in the RSAA shops. The instrument was commissioned in 2001 and exceeds its specifications, with an all-up throughput of about 35%.

## Multicolour Active Galactic Nuclei Monitoring (MAGNUM)

Peterson is working Prof. Y. Yoshii (Institute of Astronomy, University of Tokyo) and Prof. Y. Kobayashi (National Astronomical Observatory of Japan) to construct and operate a 2 m telescope at 3000m on the summit of Haleakala, Maui, for the purpose of Multicolour Active Galactic Nuclei Monitoring (MAGNUM). The MAGNUM telescope has been constructed by Electro Optic Systems, and installed on Haleakala. It is equipped with a camera that images in the U, B, V, R, I, J, K, and L bands using a CCD and an IR array. The purpose of the project is to derive redshift independent distances to QSOs and AGN, and to use these distance measurements along with the redshift to determine the geometry of the Universe. Preliminary results are encouraging.

Peterson is also working Prof. K. Kawara (Institute of Astronomy, University of Tokyo) to carry out a survey of the southern sky with the Tokyo Institute of Astronomy Schmidt Telescope Camera (TIOASTC). The camera saw first light on the UK Schmidt Telescope at Siding Spring Observatory in December. The TIOASTC contains two 2k x 4k thinned CCDs, and covers 1.1 x 1.1 degrees.



*Silhouette of the TIOASTC on the UK Schmidt telescope as seen through the corrector.  
The two CCDs can be seen to the lower left.*

### **Future Facilities (the Square Kilometer Array)**

Jackson has an award from the University of Sydney (astrophysics) to develop the science drivers for the proposed Square Kilometer Array (SKA) radio telescope. This is a half-time contract for 6 months. To date Jackson has led a quantitative analysis which matches the science drivers for the SKA with the telescope design parameters working with a team of astronomers at the University of Sydney.

### **Antarctic Astronomy**

With the successful refurbishment of the ADIMM/GMOUNT telescopes in Dec 2000/Jan 2001, the ADIMM was operational through the 2001 winter season, collecting data until sunrise in October 2001. The equipment has been handed over to the University of New South Wales, after Mt Stromlo's decision not to continue with Antarctic site testing. PhD student Tony Touvillion at UNSW has been collecting and analysing the results in parallel with atmospheric solar observations. We expect the results to become available in 2002.

**GRADUATE PROGRAM IN ASTRONOMY AND  
ASTROPHYSICS  
RESEARCH SCHOOL OF ASTRONOMY AND ASTROPHYSICS  
Mount Stromlo and Siding Spring Observatories**

**REPORT OF THE GRADUATE PROGRAM  
FOR THE YEAR TO 15 DECEMBER 2001**

**Enrolments and Submissions**

In the leadup to the 2001 academic year, 6 offers of APA/GSS scholarships were made, of which 3 were accepted (Scott Edwards, Craig Harrison and Matthew Coleman). Laura Stanford, Bradley Warren and David Weldrake were offered and accepted ANU scholarships. Alexey Avakyan was offered and accepted a VC's tuition scholarship and an ANU scholarship. Lisa Kewley submitted her thesis during the period of this report.

Currently, there are 21 students in the program (\* denotes an international student):

- 1996 Oak-Kyoung Park\*
- 1997 Michelle Buxton
- 1998 Greg Wilson
- 1999 Sebastian Gurovich, Marc Metchnik, Rachel Moody, Jess O'Brien, Holly Sims
- 2000 Catherine Drake, Brent Groves, Minh Huynh, Ricky Olivier\*, Paul Price, Shobha Sankarankutty\*
- 2001 Alexey Avakyan\*, Matthew Coleman, Scott Edwards, Craig Harrison, Laura Stanford, Bradley Warren, David Weldrake\*



*Students enrolled in 2001 (l-r): Bradley Warren, David Weldrake, Matthew Coleman, Laura Stanford, Craig Harrison, Alexey Avakyan, Scott Edwards*

### Lecture Courses

The Astrophysics Honours program in the Faculties continued into its third year. Although this program is not formally part of the Astronomy and Astrophysics Graduate Program, it is convened by Paul Francis who holds a joint appointment in the Physics Department of the Faculties and at the RSAA, in collaboration with SMS staff, and most of the lectures and honours project supervision were provided by RSAA staff.

As in previous years, RSAA and SMS staff gave a series of lectures on core astrophysics subjects, which our graduate students must take if they have not already done equivalent courses at ANU or elsewhere. Most of these courses double as third and Honours year undergraduate courses in the Astrophysics program. RSAA staff also give undergraduate astrophysics courses at first and second year level in the Physics department.

### Summer Research Scholar Program

Another very successful Summer Research Scholarship program was run during the 1999-00 summer vacation, convened by Dr Carole Jackson and Dr Peter Wood. Six undergraduates from Australian universities participated for about 8 weeks working on projects supervised by MSO staff. Also included in the program was a series of lectures and a tour of the major observatory sites in NSW. The 2001-02 Summer Research Scholar program has commenced, with 7 scholars taking part; Dr Agris Kalnajs is the convenor. This program provides a regular source of incoming graduate students for our program.



*2001 Summer Research Scholars*

*Back Row (l-r): Tom Faulkner, Ewan Cameron, Nathan Madsen, Graham Appleby.*

*Front Row (l-r): Laura Dunn, Elizabeth Wylie, Linda Pittroff*

### **The Harley Wool School of Astronomy and the ASA Annual Meeting**

The Harley Wood School and the annual scientific meeting of the Astronomical Society of Australia were held in Lorne, Victoria this year, in early July. These are important occasions for our students, and each year we send as many as we possibly can. It gives the students the opportunity to meet with graduate students and astronomers from other universities, present talks and take part in a focussed series of graduate-level lectures.

### **The Alex Rodgers Travelling Scholarship**

Funds for this scholarship come from an endowment made in 1998 to the ANU's Endowment for Excellence by Mrs Ruth Rodgers, in memory of her husband the late Professor Rodgers, Director of MSSSO from 1987-92. The scholarship is to assist a currently enrolled student in the Graduate Program in Astronomy and Astrophysics to travel abroad to attend scientific meetings and/or to work with astronomers at another institution on some chosen research project of direct relevance to the thesis work being undertaken. Paul Price was this year's recipient of the Alex Rodgers Travelling Scholarship. He is working at Caltech with Prof Shri Kulkarni, on problems of gamma ray bursters.

### **Recruitment Activities**

For 2002, we have 7 Australian applicants plus two overseas applicants. Seven offers have been made, with one more pending.

### **2001 Board of Studies**

The current Graduate Program Convenor, Ken Freeman, operates the program together with the Co-Convenor, Gary Da Costa.

Membership of the Board of Studies now comprises:

- \* five ex officio members (the Director, the Graduate Program Convenor and Co-Convenor, the Convenor of the Astrophysics Honours program, and the Convenor of the RSAA Summer Research Scholar Program),
- \* three elected RSAA staff including one position for an RSAA postdoc
- \* one staff member external to the School, and
- \* four student members.

At the end of 2001, the membership for the Board was:

Interim Director, RSAA: John Norris

Convenor, Graduate Program in Astronomy & Astrophysics: Ken Freeman

Co-Convenor, Graduate Program in Astronomy & Astrophysics: Gary Da Costa

Convenor, Astrophysics Honours Program: Paul Francis

Convenor, RSAA Summer Research Scholar Program: Agris Kalnajs

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Elected Staff members: Tim Axelrod, Lilia Ferrario SMS, Geoff Bicknell, Carole Jackson

Student members: Craig Harrison, Rachel Moody, Paul Price, Jess O'Brien

### **Concluding Comments**

I would again like to put on record the contributions of Dr Paul Francis to the Astrophysics Honours program. Although this program is not formally part of the Astronomy and Astrophysics Graduate Program, it makes a substantial impact on the graduate program in several ways: a large and lively body of students in the advanced lecture courses, a significant increase in the number of students doing research projects at RSAA.

Co-convenor Brian Schmidt stepped down in August because of pressure of other work, and was replaced by Gary Da Costa. It is a pleasure to acknowledge the contribution that Brian's judgement, enthusiasm and personal good sense made to the success of our Graduate Program over the last three years.

After a difficult year without an RSAA School Secretary, we welcome Terry Gallagher to this position. She is making the job of the convenor and co-convenor much easier.

Kenneth Freeman

Convenor

Graduate Program in Astronomy and Astrophysics

7 December, 2001

## VISITORS TO THE OBSERVATORIES AND COLLOQUIA

### Visitors to Siding Spring Observatory

The Hon. Dr David Kemp, MP, Minister for Education, Training and Youth Affairs.

### Visitors to Mount Stromlo Observatory

#### Colloquium Speakers

Prof C Akerlof, Physics	University of Michigan
Prof L. Berdnikov	Sternberg Astron. Inst., Moscow State Univ.
Mr E Berger	California Institute of Technology
Dr L Binette	Instituto de Astronomia, Mexico
Dr M Cioni	Leiden Observatory
Dr R Cole	Faulkes Telescope Program Manager
Dr R De Propriis	University of New South Wales
Dr E de Blok	Australia Telescope National Facility
Ms C Drake	RSAA
Prof D Forbes	Swinburne University
Prof O Gingerich	Smithsonian Astroph. Obs., Harvard Univ.
Prof W Harris	Dept. of Phys and Astronomy, McMaster Univ.
Ms M Huynh	RSAA
Ms R Moody	RSAA
Prof J Mould	RSAA
Dr B J O'Mara	University of Queensland
Dr P Podsiadlowski	Oxford University
Mr P Price	RSAA
Mr R. Romani	ATNF/University of Syd/Stanford Univ
Dr R Saglia	Universitäts Sternwarte, München
Prof J Sellwood	Rutgers University
Ms H Simms	RSAA
Prof J Stocke	University of Colorado, Boulder
Dr D Sullivan	Victoria University of Wellington
Mr M. Takami	University of Hertfordshire
Prof J Wall	Oxford University
Dr D Welch	McMaster University
Dr J Wilms	University of Tübingen
Dr A Wilson	University of Maryland
Dr M Zwaan	University of Melbourne

### Non-ANU Observers on RSAA Telescopes

Dr D Barnes	Swinburne University
Dr B Balick	Washington University
Dr S Beaulieu	University of Victoria, B.C.
Mr S Benlloch	University of Tübingen
Dr L Berdnikov	Sternberg Astron. Inst., Moscow State Univ.
Dr T Berghoefer	Hamburger Sternwarte
Ms H Bignall	Australia Telescope National Facility
Dr J Bland-Hawthorne	Anglo-Australian Observatory
Dr T Bridges	Anglo-Australian Observatory
Ms H Buttery	University of Cambridge
Dr R Cannon	Anglo-Australian Observatory
Dr B Carter	University of Southern Queensland
Dr L Cawley	Space Telescope Science Institute
Dr P Charles	University of Southampton
Dr K Cheng	California State University
Mr D Cho	Seoul National University
Dr D Christian	University of California, Berkeley
Dr M Cioni	University of Leiden
Dr S Ciroi	University of Padua
Ms L Clewley	Imperial College, London
Dr E Colbert	Lawrence Livermore National Laboratory
Dr K Cook	Lawrence Livermore National Laboratory
Dr G Cotter	Cambridge University
Mr N Crighton	University of New South Wales
Dr S Croom	Anglo-Australian Observatory
Dr R Cutri	NASA/IPAC
Dr R L Davies	University of Durham
Dr N d'Cruz	University of Sydney
Dr E de Blok	Australia Telescope National Facility
Dr R de Propriis	University of New South Wales
Dr N Drake	Sobolev Institute, St Petersburg
Dr M Drinkwater	University of Melbourne
Ms L Elliot	Monash University
Ms C Fechner	Hamburger Sternwarte
Dr F Fekel	Tennessee State University
Dr C Fluke	Swinburne University
Dr M Geha	Lick Observatory, U. California Observatories
Dr B Gibson	Swinburne University
Dr F Grundhall	Aarhus University
Dr H Habing	Leiden Observatory
Dr K Hinkle	National Optical Astronomy Observatory
Dr M Hawkins	Royal Observatory Edinburgh
Dr P Hewett	Cambridge University
Mr M Hidas	University of New South Wales
Dr I Howarth	University College London
Dr PA Ianna	University of Virginia

Dr R Ibata	Observatoire de Strasbourg
Dr M Irwin	Institute of Astronomy, Cambridge
Dr A Jacob	University of Sydney
Dr D J James	University of St Andrews
Dr H Johnston	University of Sydney
Dr R Joyce	National Optical Astronomy Observaotry
Ms A Karick	University of Melbourne
Ms L Kedziora-Chudczer	Australia Telescope National Facility
Dr S Keller	IGPP/Lawrence Livermore National Lab.
Dr H Kuntschner	University of Durham
Dr J Lattanzio	Monash University
Dr A Lancon	Observatoire de Strasbourg
Dr W Lawson	Australian Defence Force Academy
Dr T Lebzelter	Institute for Astronomy, Vienna
Mr K Lee	University College London
Dr G Lewis	Anglo-Australian Observatory
Dr H Liang	University of Bristol
Mr J Liske	University of St Andrews
Ms D Londish	University of Sydney
Dr S Marsden	University of Southern Queensland
Ms P Majewski	University of Melbourne
Dr R Mardling	Monash University
Mr S Massey	Amateur Astronomer
Mr M Mengle	University of Southern Queensland
Dr R Minchin	Cardiff University
Dr J Neff	University of Charleston, South Carolina
Dr B Nelson	NASA/IPAC
Ms A Oshlack	University of Melbourne
Dr Q Parker	Institute for Astronomy, Edinburgh
Dr N Polosukhina	Crimea Astrophysical Observatory
Mr K Pottschmidt	Tuebingen University
Dr A Ptak	Johns Hopkins University
Dr P Rafanelli	University of Padua University
Dr G Ramsay	Mullard Space Science Laboratory
Dr A Riffato	Osservatorio Astron. di Capodimonte
Dr D Rupke	University of Maryland
Dr S Ryder	Anglo-Australian Observatory
Dr G Schmidt	Steward Observatory
Mr O Schnurr	University of Montreal
Dr R Shaw	Space Telescope Science Institute
Dr R Smith	Cardiff University
Dr I Song	University of California, Los Angeles
Dr L Stanghellini	Space Telescope Science Institute
Dr R Statharkis	Anglo-Australian Observatory
Dr L Staveley-Smith	Australia Telescope National Facility
Mr J Stevens	University of Melbourne
Dr D Sullivan	Victoria University of Wellington
Dr E Sung	Korea Astronomy Observatory
Dr H Sung	Seoul National University

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Dr T Tzioumis	Australia Telescope National Facility
Prof P van der Kruit	Kapteyn Institute, Nederlands
Dr S Veilleux	University of Maryland
Dr I Waite	University of Southern Queensland
Dr M Walker	University of Sydney
Dr S Warren	Imperial College London
Dr J Webb	University of New South Wales
Dr R Webster	University of Melbourne
Dr D Welch	McMaster U/Lawrence Livermore Natl. Lab.
Mr M Whiting	University of Melbourne
Dr J Wilms	University of Tübingen
Dr K Wu	University of Sydney
Dr B Zuckerman	University of California, Los Angeles

## STAFF ACTIVITIES

### HONOURS, AWARDS AND GRANTS

#### **Prof M Bessell**

Bessell was one of the ISI Citation Laureates for authoring high-impact papers between 1981-1998

Bessell, Gibson, Swinburne and Bland-Hawthorn, AAO were awarded \$18,000 from the MNRFI fund toward their research on Galaxy Evolution using the 6dF facility on the AAT Schmidt Telescope

Bessell and Christlieb, Hamburg were awarded an ARC Linkage-International Fellowship 2002 Grant of \$70,442 for "Discovering the First Generation of Stars in the Galaxy - The Most Metal Poor Stars"

#### **Dr G Bicknell**

ARC Large Grant, 1999-2001, held in Department of Physics, Faculties

ARC LIEF grant in conjunction with the Department of Physics and Mathematical Physics, University of Adelaide, \$220,000 for "Development of the CANGAROO III Very High Energy Gamma-ray Telescope"

#### **Dr M Colless**

Promoted to Senior Fellow

ISI Citation Laureate 2001, one of the 33 most highly-cited Australian scientists, with 7 high-impact papers in the period 1981-1998

Finalist for the 2001 Eureka Prize for Scientific Research

International Research Exchange Fellowship to host Dr R Saglia, Munich University Observatory for 1 year - \$81,461

ARC Discovery Projects Grant to support the 6dF galaxy survey for 4 years, 2002-2005 - \$279,000

#### **Dr G Da Costa**

Travel funds of approximately \$9,000 from the ARC/USydney Gemini Travel Fund to cover costs associated with attending two International Gemini Project meetings during 2001

Travel grant of \$US650 from the Local Organizing Committee to assist with costs associated with attending IAU Symposium 207 "Extragalactic Star Clusters" in Pucon, Chile

#### **Dr M de Kool**

ANSTO Access to Major Facilities: Award of \$2,000 for travel to Kalamazoo, USA in March

#### **Prof M Dopita**

Institute of Scientific Information Australian Citation Laureate, March

Yeshe Fenner, Honours student of Michael Dopita won the Bok Prize of the Astronomical Society of Australia for the best Astronomical Honours Thesis entitled: "Solving the Mystery of the Warm Ionised Medium", July

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ARC Discovery Grant: "Interstellar Physics at the Epoch of Galaxy Formation",  
\$400,000 2002-05, with Ralph S Sutherland, Sept  
Awarded an ARC Australian Federation Fellowship, Sept  
DETYA Systemic Infrastructure Initiative Grant to upgrade the facilities at Siding  
Spring Observatory: \$5579M over three years 2002-2004, Nov

**Prof K Freeman**

Tinsley Professor, University of Texas  
Bishop Lecturer, Columbia University  
Named by ISI as one of Australia's 33 most cited scientists, ranked number 5

**Dr R Fux**

Research Fellow of the Swiss National Science Foundation  
Swiss National Science Foundation travel grant, 3720 CHF  
Korean travel grant, \$US1,000

**Dr C Jackson**

Appointed Honorary Associate of the School of Physics, University of Sydney for the  
term 6 May 2001 - 5 May 2004  
Grant for visit to the University of Oxford, May 2001, equiv to \$1,500  
Access to Major Research Facilities program, \$7000 for observing run at the Swedish  
European Submillimeter Telescope with Ms M Huynh, July 2001  
SKA International meeting at Berkeley USA, July 2001, ATNF MNRFI travel grant of  
\$1,950  
University of Sydney, SKA science grant to develop SKA science case, \$16,800, Sept 01  
- Mar 02  
SKA Australian meeting, Adelaide Oct 2001, travel grant of \$920 from University of  
Sydney SKA fund  
Appointed Honorary Fellow of the Australia Telescope National Facility (Feb 2001 -  
Feb 2002)

**Prof J Mould**

ISI Citation Laureate 2001, one of the 33 most highly-cited Australian scientists, with  
7 high-impact papers in the period 1981-1998

**Dr B Peterson**

Institute of Scientific Information Australian Citation Laureate, March

**Dr B Schmidt**

ANSTO Access to Major Facilities: Award of \$9,000 for travel to Aspen, Colorado in  
June  
ARC Discovery Grant \$230,000 over 3 years "Taking Measure of the Universe"  
ARC LIEF Grant \$210,000 "Upgrading the Great Melbourne Telescope"  
ANU Major Equipment Fund Grant, \$99,000 "Upgrading the Great Melbourne  
Telescope"  
Oliphant Lecture, Inaugural, The Australian Academy of Sciences  
Burbidge Lecture, Auckland Astronomical Society  
Harley Wood Lecture, Astronomical Society of Australia  
Pawsey Medal, The Australian Academy of Sciences

**Dr R Sutherland**

ARC Large Grant, 1999-2001, with G Bicknell, held in Department of Physics, Faculties  
ARC Discovery Grant: Interstellar Physics at the Epoch of Galaxy Formation, C-Is  
MA Dopita, RS Sutherland, \$400,000, 2002-2005

**EXTERNAL COLLABORATIONS**

**Dr T Axelrod**

Macho Project, by Dr T Axelrod, Prof K Freeman, Dr B Peterson with Dr R Allsman, ANUSF, Dr K Cook, Dr A Drake, Dr M Geha, Dr S Marshall, Dr D Minniti, Dr P Popowski, Dr C Nelson,, Lawrence Livermore National Lab, Dr P Quinn,, ESO, Dr C Stubbs, Dr A Becker, University of Washington, Dr W Sutherland, Oxford, Dr D Welch, McMaster, Dr D Alves, STSci, Dr D Bennett, Notre Dame, Dr K Griest, Dr T Vandehei, UCSD, Dr C Alcock, and Dr M Lehner, U Penn  
TAOS Project, by Dr T Axelrod with Dr C Alcock, Dr M Lehner, U Penn, Dr K Cook, Dr S Marshall, Lawrence Livermore National Lab, Dr T Lee, Dr C-Y Wen, Dr SK King, Academia Sinica, Taiwan, Dr WP Chen, Dr A Wang, National Central University, Taiwan, Dr I de Pater, UC Berkeley, and Dr J Lissauer, NASA Ames  
Southern Trans-Neptunian Object Survey, by Dr T Axelrod, Dr B Schmidt, Dr C Jackson, Ms R Moody, with Dr C Alcock, Dr K Cook, Dr S Marshall, Lawrence Livermore National Lab, Dr I de Pater, UC Berkeley, and Dr J Lissauer, NASA Ames  
REACT, by Dr T Axelrod, Prof J Mould, Dr B Schmidt, Mr P Price with Dr S Kulkarni, Dr F Harrison, and Dr T Galama, CalTech

**Prof M Bessell**

Search for Young Stellar Groups in the Solar Neighborhood, by Prof MS Bessell with Prof B Zuckerman, UCLA and Dr I Song, UCLA  
CM Diagrams and Initial Mass Functions of Intermediate Age Clusters, by Prof MS Bessell with Dr H Sung, Seoul National University and Dr M-Y Chun, SNU  
Survey for Extremely Metal-Deficient Stars, by Prof MS Bessell with Dr N Christlieb, University of Hamburg  
Spectroscopic Study of the Nature of Be 'Bumpers' in the Magellanic Clouds, by Prof MS Bessell with Dr S Keller and Dr K Cook, Lawrence Livermore Laboratory

**Dr G Bicknell**

Magnetised Accretion Discs, by Dr G bicknell with Dr Z Kuncic, University of Sydney  
High Energy Emission from Blazars and the Interpretation of Morphological and Spectral Features of Radio Galaxy Hot Spots, by Dr G Bicknell with Prof SJ Wagner, Landessternwarte, Heidelberg  
The Interpretation of Variable Radio Emission from the Quasar PG 1407+265, by Dr G Bicknell with Dr K Blundell, Oxford and Dr A Beasley, NRAO  
The Gamma-Ray Group of the Institute for Cosmic Ray Research at the University of Tokyo and the High Energy Astrophysics Group at the University of Adelaide with Dr G Bicknell on various projects involving the interpretation of high energy gamma-ray observations from CANGAROO II and III

**Dr M Colless**

- The 2dF Galaxy Redshift Survey, by Dr MM Colless, Dr BA Peterson and Dr CA Jackson with Dr J Bland-Hawthorn, Dr IR Lewis, Dr TJ Bridges and Dr RD Cannon, AAO, Dr WJ Couch and Dr R De Propris, UNSW and UK and US collaborators
- OzPoz: design and construction of a fibre positioner unit for the FLAMES spectrograph on the European Southern Observatory's Very Large Telescope, by Dr MM Colless with Dr K Taylor, Caltech, AProf WJ Couch, UNSW
- The 6dF galaxy survey: a survey of the mass and motions in the local universe using a new fibre spectrograph on the AAO Schmidt Telescope, by Dr MM Colless with Dr QA Parker, Dr W Saunders, Dr FG Watson, AAO and other collaborators in Australia, USA, UK, France and Japan

**Dr G Da Costa**

- The Dwarf Spheroidal Companions to M31, by Dr G Da Costa with Dr T Armandroff, NOAO, and Dr N Caldwell, CfA
- The Variable Stars of the Dwarf Spheroidal Companions to M31, by Dr G Da Costa with Dr T Armandroff, NOAO, Dr G Jacoby, WIYN, and Dr B Pritzl, NOAO
- The Chemical Histories of the Fornax and Carina Dwarf Spheroidal Galaxies, by Dr G Da Costa with Dr T Smecker-Hane, UC Irvine, Dr J Hesser and Dr P Stetson, DAO, and Dr D Hatzidimitriou, Univ of Crete
- The Origin of Globular Cluster Abundance Anomalies - Clues from the Main Sequence, by Dr G Da Costa with Prof J Norris, Ms L Stanford, Dr R Cannon, AAO, and Dr B Croke, ANU
- The Globular Clusters of the Dwarf Ellipticals NGC 185 and NGC 205, by Dr G Da Costa with Dr T Armandroff, NOAO, Mr SC Kim, Seoul Nat Univ, Dr MG Lee, Seoul Nat Univ, Dr D Geisler, Concepcion, and Dr A Sarajedini, Univ of Florida

**Dr M de Kool**

- Spectral Properties of Radio-selected Broad Absorption Line QSOs, by Dr M de Kool with Prof RH Becker, Lawrence Livermore National Laboratories
- Analysis and Interpretation of HST-STIS Broad Absorption Line QSO spectra, by Dr M de Kool with Dr N Arav, University of California Davis and Dr KT Korista, University of Western Michigan
- The Physical Process behind the Spectral Turnover in the GPS Source PKS 1718-649, by Dr M de Kool with Dr S Tingay, ATNF

**Prof M Dopita**

- The COLA Project: Compact Objects in Low-powered AGN, by Prof M Dopita and Ms LS Kewley with Dr PN Appleton, Iowa State U, Dr AP Marston, Caltech, Andreas, Dr R Norris, ATNF & Dr A Zezas, CFA
- Astronomical Site Testing at Dome C in the Antarctic, by Prof JR Mould, Prof MA Dopita, and Dr RS Sutherland with Prof J Storey, Dr M Ashley, and Dr M Burton, University of New South Wales, Prof J Vernin, Dr C Coulman, and Dr M Azouit,, Université de Nice Prof P Maffei and Dr L Valenziano, Universita di Perugia, and Prof R Viotti, Instituto di Astrofisica Spaziale, Frascati
- The Helical Jet/ISM Interaction in NGC 4258, by Dr GN Cecil, Univ of N Carolina, USA with Prof MA Dopita, RSAA, Dr LJ Greenhill, CfA, USA Dr JM Moran, CFA, USA and Dr CG De Pree,, NRAO, USA

- FUSE Observations of NGC1068, by Dr GN Cecil, Univ of N Carolina, USA & Dr W Zheng, JHU, USA with Prof MA Dopita, Dr GV Bicknell and Mr B Groves, RSAA, Dr Z Tsvetanov, JHU, USA, Dr MG Allen, U Strasbourg, France & Dr L Binette, UNAM, Mexico
- What Excites LINERs: The Brilliant Case of NGC 3998, by Dr L Dressel, STScI, USA with Prof MA Dopita, RSAA
- Are Narrow Line Regions in Active Galaxies Dusty and Radiation Pressure Dominated?, by Prof MA Dopita, Mr B Groves, & Dr RS Sutherland, RSAA with Dr L Binette, UNAM, Mexico and Dr GN Cecil, U of N Carolina, USA

**Dr P Francis**

- Red Quasars from the Two Micron All Sky Survey, by Dr PJ Francis with Dr R Cutri and Dr B Nelson, IPAC
- Gas in High Redshift Galaxy Clusters, by Dr PJ Francis with Dr BE Woodgate, NASA GSFC, Dr G Williger, Johns Hopkins and Dr P Palunas, UT Austin
- IR Excess Searches for QSOs, by Dr PJ Francis with Dr MJ Drinkwater and A/Prof RL Webster, U of Melbourne

**Prof K Freeman**

- Studies of Neutral Hydrogen in Dwarf Elliptical Galaxies of the Centaurus A Group, by Prof K Freeman and Dr H Jerjen, with Dr S Beaulieu, University of Cambridge, and Prof C Carignan, University of Montreal
- HST Studies of The Post-Starburst Galaxy NGC 5102, by Prof K Freeman, with Dr S Beaulieu, Cambridge University, Prof C Norman, Johns Hopkins University, Prof N Scoville, Caltech, and Dr P Quinn, ESO
- Kinematics of Planetary Nebulae in Nearby Galaxies and in the Intracluster Medium of the Virgo Cluster, by Prof K Freeman, with Dr M Arnaboldi and Prof M Capaccioli, Osservatorio di Capodimonte, Naples; Prof O Gerhard, University of Basel; Prof R Kudritzki and Dr R Mendez, University of Muenchen and University of Hawaii; Prof H Ford, Johns Hopkins University; Prof R Ciardullo, Penn State University; Dr J Feldmeier, Case Western Reserve University, and Dr G Jacoby, NOAO
- New Studies of the Planetary Nebulae Population in the Virgo Cluster, by Prof K Freeman, with Prof S Okamura, University of Tokyo and the Suprime-Cam team, Dr M Arnaboldi, Osservatorio di Capodimonte, and Prof O Gerhard, University of Basel
- The Planetary Nebulae Spectrograph project, by Prof K Freeman, with a team from Osservatorio di Capodimonte, University of Groningen, University of Nottingham, ESO and Caltech
- HST Studies of the Inner Regions of Barred Galaxies, by Prof K Freeman with Dr M Carollo, Columbia University, and Prof T de Zeeuw, Leiden University
- The MACHO Project, by Dr T Axelrod, Dr B Peterson and Prof K Freeman, with the MACHO Team, University of Pennsylvania, Lawrence Livermore National Laboratory, University of California, University of Washington, McMaster University
- HST Studies of Lyman-alpha Absorption of QSOs by the Outer Regions of Spiral Galaxies, by Prof K Freeman with Dr S Cote, HIA, and Prof C Carignan, University of Montreal

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- Studies of Unmixed Debris in the Galactic Halo, the Spaghetti Project, by Prof K Freeman, with Prof J Norris; Dr H Morrison and Dr P Harding, Case Western Reserve University; Dr M Mateo and Dr R Dohm-Palmer, University of Michigan, and Dr E Olszewski, Steward Observatory
- Radial Velocities in the Globular Cluster Omega Centauri, by Prof K Freeman with Ms R Reijns and Prof T de Zeeuw, University of Leiden, and Dr P Seitzer, University of Michigan
- Scaling Laws for Dark Matter, by Prof K Freeman with Prof J Kormendy, University of Texas
- Studies of Disk Galaxies, by Prof K Freeman with Prof P van der Kruit and Drs M Kregel, University of Groningen
- The Formation of the Milky Way, with Dr J Bland-Hawthorn, AAO
- The Parkes Multibeam All-Sky HI Survey, HIPASS, by Prof K Freeman, with the Multibeam Team, about 30 astronomers, from Australian, US and UK institutions

### **Dr R Fux**

- Structure of the Galactic Bulge from the MACHO Red Clump Stars, by Dr R Fux, Dr T Axelrod, with Dr P Popowski, MPI Garching, Germany

### **Dr C Jackson**

- Evolution and Unified Schemes of Radio-loud AGN, by Dr C Jackson with Prof JV Wall, University of Oxford
- The Evolution of the Local Radio Source Populations, by Dr C Jackson with Dr EM Sadler and the 2dFGRS team (Colless et al)
- The Space Density of Flat Spectrum Radio Quasars, by Dr C Jackson with Prof JV Wall, University of Oxford, Dr PA Shaver, European Southern Observatory, Garching and Dr I M Hook, Gemini
- Optically-faint, Radio-bright Radio Galaxies at High Redshift, by Dr C Jackson with Prof R Norris et al, CSIRO/ATNF
- Analysis of the SKA science drivers to potential telescope designs, future directions and the science case for the Australian SKA demonstrators, by Dr C Jackson with the Australian and International SKA Science Working Groups
- Deep Radio Imaging of the Hubble Deep Field South, by Dr C Jackson with Prof R Norris et al, CSIRO/ATNF

### **Dr H Jerjen**

- Distance and Depth of the Fornax Cluster from Surface Brightness Fluctuation Distances of Dwarf Elliptical Galaxies, by Dr H Jerjen, PI, with Dr B Binggeli, Astronomical Institute of the University of Basel, Switzerland, Mr F Barazza, Astronomical Institute of the University of Basel, Switzerland, Dr S de Rijcke, Astronomical Institute of the University of Basel, Switzerland
- Search for Cosmological Fingerprints in the Supergalactic Plane, by Dr H Jerjen, PI, with Prof M Valtonen, Tuorla Observatory, Finland, Mr R Rekola, Tuorla Observatory, Finland, and Dr L Takalo, Tuorla Observatory, Finland
- The All-Sky 21cm Survey at the Parkes Radio Telescope, by Dr H Jerjen with Prof R Webster, PI, University of Melbourne with Dr G Banks, University of Wales, Dr DG Barnes, ATNF, Prof R Bhathal, UWS, Prof MJ Disney, University of Wales, Prof RD Ekers, ATNF, Prof KC Freeman, RSAA, Dr B Gibson, University of

Colorado, Dr P Henning, New Mexico, Mrs V Kilborn, University of Melbourne, Dr B Koribalski, ATNF, Dr P Knezek, STScI, Dr D Malin, AAO, Prof J Mould, RSAA, Dr T Osterloo, ATNF, Dr RM Price, ATNF, Dr SD Ryder, AAO, Prof EM Sadler, University of Sydney, Dr L Staveley-Smith, ATNF, Dr AE Wright, ATNF

**Dr A Kalnajs**

Dynamics of the Shearing Sheet, by Dr AJ Kalnajs with Prof A Toomre MIT

**Dr P McGregor**

Gemini Near-infrared Integral Field Spectrograph project, by Dr P McGregor and team with Dr K Hodapp and team, Uni of Hawaii

Gemini South Adaptive Optics Imager Conceptual Design Study, by Dr P McGregor and team with Dr R Haynes and team, AAO

Water Maser Emission in the Edge-On Galaxy IRAS F01063-8034 by Dr P McGregor with Dr L Greenhill, Harvard, Dr S Ellingsen, University of Tasmania, and Dr R Norris, ATNF

**Prof J Mould**

The Multiband Photometric Imager for SIRTf, by Prof J Mould with Drs E Arens, UC Berkeley, C Beichman, Caltech, T Gautier, JPL, E Haller, LBL, C Lada, Harvard Smithsonian, G Rieke & F Low, U Arizona, G Neugebauer, Caltech, P Richards, UC Berkeley, M Rieke & P Strittmatter, U Arizona, and M Werner, JPL

Identification of the Galaxy's Missing Mass, by Prof J Mould with Dr T Axelrod, Dr K Cook & Dr C Alcock, Lawrence Livermore National Lab, Prof K Freeman, and Dr G Da Costa

**Prof J Norris**

The Most Metal Deficient Stars, by Prof JE Norris, with Prof TC Beers, Michigan State University, and Dr SG Ryan, Open University, United Kingdom

Lithium Abundances of Halo Stars, by Prof JE Norris, with Prof TC Beers, Michigan State University, Dr SG Ryan, Open University

Carbon-Rich Metal-Poor Stars, by Prof JE Norris and Prof MS Bessell, with Dr H Ando, National Astronomical Observatory, Japan, Dr W Aoki, National Astronomical Observatory, Japan, Prof TC Beers, Michigan State University, and Dr SG Ryan, Open University

The Origin of Globular Cluster Abundance Anomalies: Clues from the Main Sequence, by Dr GS Da Costa and Prof JE Norris, with Dr RD Cannon, Anglo-Australian Observatory, and Dr B F Croke, University of Crete

The Origin of Globular Cluster Abundance Anomalies: Magnesium Isotope Ratios in Omega Centauri and other clusters, by Prof JE Norris and Dr GS Da Costa, with Dr J Lattanzio, Monash University and Ms I Ivans, University of Texas at Austin

In Situ Studies of the Old Populations of the Galaxy, by Prof JE Norris and Prof KC Freeman, with Prof G Gilmore, Cambridge University, and Prof RFG Wyse, Johns Hopkins University

Studies of Structure in the Galactic Halo, by Prof JE Norris and Prof KC Freeman, with Dr HL Morrison, Case Western Reserve University, Prof M Mateo, University of Michigan, Dr E Olszewski and Mr P Harding, University of Arizona

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Blue Horizontal Branch Stars and the Mass of the Galaxy, by Prof JE Norris, with Dr P Hewett, University of Cambridge and Dr SJ Warren, Imperial College London

### **Dr B Peterson**

Constructing and Operating a 2 m Telescope at 3000m on the Summit of Haleakala, Maui, for the Purpose of Multicolour Active Galactic Nuclei Monitoring, (MAGNUM), by Dr B Peterson, with Prof Y Yoshii, Institute of Astronomy, University of Tokyo and Prof Y Kobayashi, National Astronomical Observatory of Japan

A survey of the Southern Sky, by Dr B Peterson, with Prof K Kawara, Institute of Astronomy, University of Tokyo with the Tokyo Institute of Astronomy Schmidt Telescope Camera (TIOASTC)

### **Dr B Schmidt**

The High-Z SN Search, by Dr BP Schmidt with Drs N Suntzeff, C Smith, R Schommer, CTIO, A Clocchiatti, U Catolica, R Kirshner, P Challis, P Garnavich, Harvard, B Leibundgut, J Spyromilio, P Woudt, ESO, M Phillips, Carnegie, M Hamuy, Arizona, C Stubbs, C Hogan, D Reiss, A Diercks, UW, A Filippenko, A Riess, Berkeley, J Tonry, Hawaii, R Gilliland, STScI

Supernova Intensive Study with HST, by Dr BP Schmidt with Drs R Kirshner, Harvard, D Branch, Oklahoma, R Chevalier, Virginia, A Filippenko, Berkeley, C Fransson, Stockholm, B Leibundgut, ESO, N Panagia, STScI, M Phillips and N Suntzeff, CTIO, C Wheeler, Texas

The Trans Neptunian Search, by Dr BP Schmidt and Dr T Axelrod, with Dr C Alcock, U Penn, and Dr K Cook, LLNL

The REACT Gamma Ray Burst Study by Dr BP Schmidt, Dr T Axelrod and Mr P Price, with Dr S Kulkarni and Dr F Harrison, CalTech, and Dr D Frail, NRAO

Southern All Sky Supernova Survey, by Dr BP Schmidt and Ms M Salvo, with Dr M Ashley, UNSW

### **Dr R Sutherland**

Astronomical Site Testing at Dome C in the Antarctic, by Prof JR Mould, Prof MA Dopita, and Dr RS Sutherland with Prof J Storey, Dr M Ashley, and Dr M Burton, University of New South Wales, Prof J Vernin, Dr C Coulman, and Dr M Azouit, Université de Nice Prof P Maffei and Dr L Valenziano, Università di Perugia, and Prof R Viotti, Istituto di Astrofisica Spaziale, Frascati

Are Narrow Line Regions in Active Galaxies Dusty and Radiation Pressure Dominated? by Prof MA Dopita, Mr B Groves and Dr RS Sutherland, with Dr L Binette, UNAM, Mexico and Dr GN Cecil, U of N Carolina, USA

### **Dr P Wood**

Stellar Evolution and Nucleosynthesis on the AGB, by Dr PR Wood with Dr J Lattanzio, Monash University

Theoretical Models of Mira Variables, by Dr PR Wood with Prof M Scholz, University of Heidelberg

Observational Studies and Theoretical Models of Mira Variables, by Dr PR Wood with H Richter, Technical University of Berlin

Optical/Near-IR Spectra of AGB Stars, by Dr PR Wood with Dr A Lancon, University of Strasbourg

Infrared and SiO Observations of Stars near the Galactic Center, by Dr PR Wood with Dr S Deguhi, Nobeyama Radio Observatory  
Infrared Observations of ISO Sources in the Magellanic Clouds, by Dr PR Wood with Dr T Tanabe and Dr Y Nakada, University of Tokyo  
Studies of MSX Sources in the Magellanic Clouds, by Dr PR Wood with Dr M Cohen, Berkeley  
Studies of the Variability of AGB Stars in the Magellanic Clouds and Near the Galactic Centre, by Dr PR Wood with Prof H Habing and M Cioni, Leiden and Dr A Omont, IAP Paris  
Orbital Velocities of Symbiotic Stars, by Dr PR Wood with Dr K Hinkle, NOAO, Dr R Joyce, NOAO, and Dr F Fekel, Tennessee State University  
Pulsation Velocities and Mass Loss in Red Variables in 47 Tuc, by Dr PR Wood with Dr T Lebzelter, Vienna

## **CONFERENCES ATTENDED, PAPERS AND LECTURES PRESENTED**

### **Dr T Axelrod**

Workshops on LSST and on GRB's, Aspen Center for Physics, Aspen, Colorado, June.

### **Prof M Bessell**

Lecture at the AAO Observational Techniques Workshop held at Macquarie University, Sydney, 17-20th April.

Annual Meeting and Scientific Sessions of the ASA, at Queenscliffe, Victoria, 1-3 July.  
Cool Stars 12 Meeting "The Future of Cool-Star Astrophysics" in Boulder, Colorado, 30 July-3 August .

### **Dr G Bicknell**

AGN Variability Workshop, Australia Telescope National Facility, 25-29 June.

ASA Annual General Meeting, Lorne, Victoria, 1-4 July.

Charlene Heisler Workshop, Mt Stromlo Observatory, 6-7 December.

### **Dr M Colless**

American Astronomical Society, San Diego, California, USA. 8-11 January. Talk: "The 2dF Galaxy Redshift Survey".

Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA. 19 January. Invited Seminar: "The 2dF Galaxy Redshift Survey".

Dept of Astronomy, Caltech, Pasadena, California, USA. 31 January. Invited Seminar: "Large-Scale Structure and Cosmology from the 2dF Galaxy Redshift Survey".

Australian Institute of Physics/Sydney Association for Astrophysics, UNSW, Sydney. 13 March. Invited Talk: "Maps of the Universe".

AAO/ATNF Symposium, Lindfield. 23 March, Talk: "Cosmology from the 2dF Galaxy Redshift Survey".

Oort Meeting on Galaxy Formation, Lorentz Center, Leiden University, Leiden, The Netherlands. 9-11 May. Invited Talk: "Clustering and the Environmental Dependence of Galaxy Formation and Evolution".

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Scientific Drivers for ESO Future VLT Instrumentation, Garching, Munich, Germany. 11-15 June. Talk: "MAXIMUS - Exploiting the Full Power of OzPoz".  
Astronomical Society of Australia, Lorne, Victoria. 1-4 July. Talk: "The 2dF Galaxy Redshift Survey 100k Data Release".  
ESO FLAMES Users Workshop. Garching, Munich, Germany. 9-10 July. Invited Talk: "Lessons Learnt from 2dF".

### **Dr G Da Costa**

International Astronomical Union Symposium 207 "Extragalactic Star Clusters", Pucon, Chile, 12-16 March. Invited presentation "The Star Cluster Systems of the Magellanic Clouds". Poster presentation "Surface Photometry of Star Clusters in the Dwarf Elliptical Galaxies NGC 185 and NGC 205".  
Conference on "The Dynamics, Structure and History of Galaxies", Dunk Island, Queensland, 30 July - 2 August. Invited presentation "Local Dwarf Spheroidal Galaxies and their Histories".  
Workshop on Observational Techniques, Anglo-Australian Observatory, Sydney, 18 April. Invited presentation "Wide-Field Imaging".  
Workshops on Gemini Instrumentation, Mt Stromlo Observatory, 27 September and Anglo-Australian Observatory, 18 October. Invited presentation "Overview of Gemini and the MNRF proposal".  
Year 10 Science classes, Radford College, 4 April. Lecture "Modern Astronomy".  
International Gemini Observatory: Committee of Gemini Offices, Instrument and Operations Forum, La Serena, Chile, 10-14 January. NIFS Critical Design Review, Mt Stromlo Observatory, 19-20 April. Board of the International Gemini Observatory, Pasadena, USA, 12-13 November.

### **Dr M de Kool**

The Catholic University of America, Washington, March 8-10. Talk: "Mass Outflow in Active Galactic Nuclei: New Perspectives".  
6th Annual Stromlo AGN Workshop, Canberra, 8-10 December. Presentation: "Intrinsic QSO Absorption Lines".

### **Prof M Dopita**

Conference on the World Space Observatory, Chiang Shan, Beijing, 9-11 May. Invited Talk: "World Space Observatory and the Interstellar Medium".  
Congresso Elba, Italy, 21-24 May. Invited Contribution: "The ENLR and the Dusty Torus: Shocks, Photoionisation & Radiation Pressure".  
Meeting of the Science Oversight Committee of the Wide Field Camera #3, Institute of Astronomy, Hilo, Hawaii, 11-13 June.  
The 23rd AGM of the Astronomical Society of Australia, Lorne, Vic, 1-5 July. Talk: "The World Space Observatory for the UV".  
Meeting of the Science Oversight Committee of the Wide Field Camera #3, Space Telescope Science Institute, Baltimore, MD. 29-31 October.  
IAU Symposium #209, "Planetary Nebulae: Their Role in the Universe", Academy of Science, Canberra, 18 - 23 Nov. Invited talk given: "Summary of the Conference".  
Conference: mm Science with the Upgraded Australia Telescope, U Melbourne, 29-30 Nov. Talk given: "Dust and the sub-mm Continuum".

5th Charlene Heisler Workshop on Active Galaxies & Starbursts, RSAA, 6-7 Dec. Talk Given: "Star Formation in High-Redshift Galaxies: How to Correct for Dust?".  
Visitor to Osservatorio Astronomico di Capodimonte, 12 May - 9 June. Seminar: "The ENLR and the Dusty Torus".  
Visitor to LLNL, Livermore, California, 23-27 October Seminar: "The Evolution of the Narrow Line Region of AGN"..

**Dr P Francis**

Observational Techniques Workshop, Macquarie Uni, 17-20 April. Invited Lecture "Telescope Proposal Writing".  
ASA Annual Scientific Meeting, Lorne, 2-4 July. Talk "Red Quasars from 2MASS".

**Prof K Freeman**

Visit to University of Texas, 24 March - 4 June, as Tinsley Professor.  
Visit to Columbia University, 11 - 16 April. Bishop Lecture: "Omega Centauri: Cluster or Galaxy".  
ASA General Meeting, 1-4 July. Ellery Lecturer.  
Dunk Island Workshop, "The Dynamics, Structure and History of Galaxies", 29 July - 2 August.  
Haro Workshop "Disks of Galaxies", Tonantzintla, Mexico. 4-14 June.  
Haro Conference "Disks of Galaxies", 5-9 November, Puebla, Mexico. Invited review "Optical Properties of Disks".  
Workshop "Omega Centauri", 13-16 August, Cambridge Conference summary.  
Fourth Stromlo Symposium "Planetary Nebulae: Their Role in the Universe", 19-23 November, Canberra. Invited talk: "Planetary Nebulae as Probes of Dark Matter".  
Visit to University of Tokyo and National Astronomical Observatory of Japan, 23 November - 3 December, for data analysis.

**Dr R Fux**

First Korean Astrophysics Workshop, "Numerical Methods for Astrophysical Flows", Pusan, 26-29 June. Invited talk: "PMDSPH: a Hybrid N-body and SPH Code and its Application to the Milky Way".  
Workshop "The Dynamics, Structure and History of Galaxies", Dunk Island, 30 July - 2 August.  
Conference "Disks of Galaxies: Kinematics, Dynamics and Perturbations", Puebla, 5 - 9 November. Contributed talk: "The 3D Structure of the Galactic Bulge from the MACHO Red Clump Stars".  
Marseille Observatory, 23 March. Colloquium: "Inner Gas Flow and Local Stellar Kinematics Induced by the Galactic Bar".  
Geneva Observatory, 10 April. Colloquium: "Effects of the Bar Induced Chaos on the Local Stellar Kinematics".

**Dr C Jackson**

SKA: Australian SKA Consortium meeting and symposium, Sydney, 8 February. Invited contribution "The SKA View of the AGN Phenomenon".  
NSW Government Spokeswomen's conference, Sydney 3-4 May. Invited speaker on "Choice Power".

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ATNF/CSIRO CMB & Foreground workshop, Sydney, 3 July. Invited contribution "Foreground Sources at mm-wavelengths".

SKA: Defining the Future, 9-12 July, Berkeley. Contributed paper "The SKA View of the AGN Phenomenon".

SKA: Australian Challenges and Opportunities, Adelaide. 3 October, Invited contribution "An astronomer's view of the SKA".

Millimetre Science with the Upgraded AT, University of Melbourne, 29-30 November, attendee.

Next-Generation Astronomical Surveys workshop, Sydney, 3-4 December, Contributed papers: "The Hubble Deep Field South" and "A Science-driver Parameter Space Analysis for the SKA".

### **Dr H Jerjen**

Dunk Island Workshop, "The Dynamics, Structure and History of Galaxies", 29 July - 2 August. Invited Review: "The 10 Mpc Sphere".

### **Dr A Kalnajs**

Dunk Island Workshop, "The Dynamics, Structure and History of Galaxies", 29 July - 2 August. Invited Lecture: "The Magical Properties of Freeman Bars".

### **Dr P McGregor**

AAO Observational Techniques Course, Macquarie University, 18 April. Talk: "CCD's in Astronomy".

Douglas Mawson Telescope Science Workshop, UNSW, 4 May.

Monash Student Visit, Canberra, 13 September. Talk: "Astronomical Spectrographs".

Charlene Heisler Workshop, Canberra, 6-7 December. Talk: "Seyfert Galaxy Narrow Line Regions with NIFS".

### **Prof J Mould**

University of Chile, Astronomy Department Colloquium, January. Talk: "Thick Disk White Dwarfs".

### **Prof J Norris**

Dunk Island Workshop, "The Dynamics, Structure and History of Galaxies", 29 July - 2 August. Invited Review: "Chemical Evolution and Enrichment of the Galactic Halo".

### **Dr B Schmidt**

Harvard-Smithsonian Cambridge, Massachusetts, USA, 23 March. Invited colloquium: "The Transient Universe".

Oort Symposium, Leiden, Netherlands. 24 April. Invited colloquium: "The Accelerating Universe".

Australian Institute of Physics, Adelaide. 11 May. Invited Public Speaker: "Measuring the Universe with the Hubble Space Telescope".

UIMP Course on the Philosophy of Cosmology, Santander, Spain, 10-14 July. Invited Lecturer: "Shifting the Paradigm of the Standard Cosmological Model".

Kapteyn Institute Colloquium, Groningen, Netherlands, 23 August. "The Transient Universe".

The Bohr Institute's Cosmological Constant, Copenhagen, Denmark 24 August. Invited Speaker: "Measuring the Cosmological Constant with Type Ia Supernovae".  
Oxford University Colloquium, Oxford, UK. 30 August. "The Transient Universe".  
Space Futures Conference, Canberra. 6 October. Invited Lecturer: "Cosmology from Space".  
NATO Conference on Phase Transitions in the Early Universe, Erice, Sicily, 8-15 December. Invited Lecturer: "Measuring the Universe with Supernovae".  
Session Organiser, The Texas Symposium of Relativistic Astrophysics Austin, Texas, USA, 17-19 December. "The Cosmological Constant".

**Dr R Sutherland**

5th Charlene Heisler Workshop on Active Galaxies & Starbursts, Canberra, 6-7 December. Talk Given: "Ultra Lightweight Jets".  
IAU Symposium 209: Planetary Nebulae and their Role in the Universe, Canberra, 18 - 23 November.

**Dr P Wood**

IAU Symposium 209, "Planetary Nebulae", Canberra, 19-23 November.  
"Millimetre Science With the Upgraded Australia Telescope", workshop, Melbourne, 29-30 November.  
National Youth Science Forum, MSO Visitors Centre, 18 January. Talk: "Evolution and Pulsation of Stars",  
Year 10 Astronomy Summer School, MSO, 20 December. Lecture: "Seeing and Adaptive Optics".

**TEACHING/COURSES TAUGHT**

**Dr G Bicknell**

Department of Physics, Faculties, ANU.  
"Case Studies in Computational Physics" (PHYS 3038).  
Honours Physics: "High Energy Astrophysics", This course was also delivered via videoconference to 4<sup>th</sup> year students at Monash University.

**Dr M Colless**

Observational Techniques Workshop, "Astronomical Surveys".  
Harley Wood Winter School, "Maps, Matter and Gravity".  
RSAA Graduate Student Lectures, "Astrophysics from Spectra".  
Centre for Continuing Education, "Maps of the Universe".

**Dr G Da Costa**

In consultation with a number of RSAA faculty and graduate students, Da Costa provided direct supervision, May visit and oversight, September visit for two 4 day visit of approximately 20 Monash third year astrophysics undergraduates. The students learnt basic observing and reduction techniques through use of the 74-inch telescope.

**Dr M de Kool**

"Stars and Astrophysical Fluid Dynamics" (ASTR3001) with P Wood.

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**Prof M Dopita**

RSAA Honours/Graduate student lecture course, "Physics of the Interstellar Medium".

**Dr P Francis**

"Planets and the Universe" (ASTR1002).

"Astrophysics" (ASTR1001).

"The Big Questions" (PHYS1007).

**Prof K Freeman**

"Galaxies and Cosmology" (C3002H) with H Jerjen.

**Dr C Jackson**

Summer research scholar supervisor: student Susanne Hartl Project: "Compact FIRST Radio Sources in 2dFGRS".

National Youth Science Forum guest lecture, 4 January.

RSAA Summer research scholar guest lecture, 17 January.

National Maths summer school lecturer/evening visit co-ordinator, 18 January.

CCE course lecturer "Active Galactic Nuclei", 23 October.

**Dr H Jerjen**

"Galaxies and Cosmology" (C3002H) with K Freeman.

**Dr P Wood**

"Stars and Astrophysical Fluid Dynamics", ASTR3001 with M de Kool.

## **COMMITTEE SERVICE AND RELATED RESPONSIBILITIES**

### **RSAA COMMITTEES (March 2001 – March 2002)**

#### **ADVISORY BOARD**

Ex officio: Interim Director, Prof J Norris (Chair)  
Dr C Alcock, IGPP, Lawrence Livermore National Laboratory  
Prof H Bachor, Dept of Physics and Theoretical Physics  
Dr J Bland-Hawthorne, Anglo-Australian Observatory  
Prof D Evans, Research School of Chemistry  
Prof F Jackson, DVC Research/Chair, BIAS  
Dr P McGregor  
Prof D Melrose, SRC for Theoretical Astrophysics, USydney

#### **APPOINTMENTS COMMITTEE**

Ex officio: Interim Director, Prof J Norris (Chair)  
Dr G Bicknell  
Dr M Colless (pro-tem for Prof J Norris)  
Dr C Jackson (vice Dr M Sevenster)  
Dr D McClelland (Physics, FOS)  
Dr P McGregor  
Dr R Webster (Melbourne)

#### **BUDGET COMMITTEE**

Ex Officio: Interim Director, Prof J Norris (Chair)  
Prof M Bessell  
Prof M Dopita  
Mr V O'Connor

#### **COLLOQUIUM COMMITTEE**

Ex officio: Convener of Feast-of Facts, Dr P Wood (Chair)  
Dr M de Kool  
Dr H Jerjen  
Dr C Saxton  
Ms S Sankarankutty (student member)

#### **COMPUTER COMMITTEE**

Ex officio: Head of Computer Section, Mr P Young  
Ex officio: Head of Electronics, Mr J van Harmelen  
Dr T Axelrod (Chair)  
Dr G Bicknell  
Dr H Jerjen  
Dr A Kalnajs  
Dr R Sutherland  
Mr G Wilson  
Dr P Wood

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**EQUITY AND DIVERSITY COMMITTEE**

Ex Officio: Interim Director, Prof J Norris (Chair)

Dr G Bicknell

Dr M Colless

Ms M Miller

Ms J O'Brien

Dr B Peterson

Dr Susan Scott (Physics, FOS)

**FACULTY**

Prof M Dopita, (Chair)

Ex officio: Interim Director, Prof J Norris

Dr T Axelrod

Prof M Bessell

Dr G Bicknell

Dr M Colless

Dr G Da Costa

Dr M de Kool

Dr P Francis

Prof K Freeman

Dr C Jackson

Dr H Jerjen

Dr A Kalnajs

Dr P McGregor

Dr B Peterson

Dr B Schmidt

Dr R Sutherland

Dr P Wood

Prof R Ekers (Adjunct Professor)

Dr J Bland-Hawthorn (Adjunct Fellow)

Dr E Sadler (Adjunct Fellow)

Dr C Stubbs (Adjunct Fellow)

Dr R Fux

Dr R Saglia

Dr C Saxton

Dr E-C Sung

Prof DWN Stibbs

Mr B Groves (Student Member)

Ms R Moody (Student Member)

Ms L Stanford (Student Member)

Dr S Scott, Physics, FOS

Dr B Lewis, RSPHysSE

Dr D McClelland, Physics, FOS

Mr M Callaway

Mr C Vest

**FACULTY BOARD**

Ex officio: Interim Director, Prof J Norris (Chair)  
Prof M Bessell, Associate Director for Instrument Development  
Dr P McGregor  
Dr C Jackson  
Prof M Dopita (Chair of Faculty)

**GRADUATE PROGRAM BOARD OF STUDIES**

Ex officio Interim Director, Prof J Norris  
Ex officio Convener, Prof K Freeman  
Ex officio Co-Convener, Dr G Da Costa  
Ex officio Honours Convener, Dr P Francis  
Ex officio Summer Scholar Program, Dr A Kalnajs  
Dr T Axelrod  
Dr G Bicknell  
Dr L Ferrario (SMS)  
Mr C Harrison (Student Member)  
Dr C Jackson  
Ms R Moody (Student Member)  
Mr P Price (Student Member)  
Ms J O'Brien (Student Member)

**INSTRUMENT COMMITTEE**

Ex officio: Associate Director for Instrumentation: Prof M Bessell (Chair)  
Ex officio: Interim Director & Assoc. Dir. for Observatory Operations, Prof J Norris  
Ex officio: Head of Design, Mr J Hart  
Ex officio: Head of Electronics, Mr J van Harmelen  
Ex officio: Head of Computer Section, Mr P Young  
Dr T Axelrod  
Dr M Colless  
Dr G Da Costa  
Mr M Dawson  
Prof M Dopita  
Prof K Freeman  
Dr P McGregor  
Dr B Peterson  
Ms I Perez  
Dr B Schmidt  
Mr P Price/Mr S Gurovich (Student Member)

**LIBRARY COMMITTEE**

Dr R Sutherland (Chair)  
Ex officio: Librarian, Ms J Regan  
Dr M de Kool  
Dr A Kalnajs

**MONASH STUDENT VISITOR PROGRAM**

Ex officio: Graduate program Co-convenor, Dr B Schmidt  
Dr H Jerjen (Convenor)

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**PROMOTIONS COMMITTEE**

Ex officio: Interim Director, Prof J Norris (Chair)

Prof M Bessell

Prof M Dopita

Prof K Freeman

Dr B Lewis (RSPHysSE)

**SCHOLARSHIPS COMMITTEE**

Ex officio: Interim Director, Prof J Norris (Chair)

Ex officio: Convener, Graduate Program, Prof K Freeman

Dr G Da Costa

Dr P Francis

Dr C Jackson

Dr H Jerjen (vice Dr M Sevenster)

Dr N Manson (Laser Physics, RSPHySE)

Dr B Schmidt

Dr S Scott (Physics, FOS)

**STAFF CONSULTATIVE COMMITTEE FOR APPOINTMENT OF NEW  
RSAA DIRECTOR**

Dr G Bicknell (Chair)

Dr C Jackson

Mr B Roberts

Dr B Schmidt

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Commission 33 (Structure and Dynamics of the Galactic System)  
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## PUBLICATIONS

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