

**Astronomy at the University of Canterbury
Department of Physics and Astronomy
and Mt John University Observatory —
annual report 2007**

Director: Prof. J.B. Hearnshaw

Report for the period 1 January 2007 to 31 December 2007



Mt John from the air, April 2007 (courtesy Fraser Gunn)

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1. Introduction

This is the twenty-ninth annual report of the astronomy group at the department of Physics and Astronomy and Mt John University Observatory. The year saw two important developments. One was the start of discussions on the feasibility of founding an institute to serve as an umbrella organization that would bring New Zealand astronomers together under one virtual roof. (It was later decided to name this the Beatrice Tinsley Institute.)

The other was the decision taken at the end of the year to initiate user charges for observers at Mt John who are not affiliated to the Department. The charging regime commenced in February 2008. Details are given on the observatory website.

It is sadness that the Department noted the passing of Dr Frank Bateson, the first astronomer-in-charge at Mt John, on 16 April 2007 in Tauranga. Frank Bateson played the leading role in the site-testing of Mt John in the early 1960s and he was also instrumental in founding the observatory and its early development between 1965 and 1969.

The author of this report thanks Pam Kilmartin for compiling data on Mt John weather statistics, Peter Cottrell for information on SALT in 2007, Phil Yock (Auckland) for

information on the MOA project in 2007 and most members of the Canterbury astronomy group for miscellaneous information and photographs supplied.

2. Staff

In 2007 Associate Professor Roger Reeves continued as Head of Department and Prof. John Hearnshaw continued as Mt John director and Alan Gilmore as Mt John superintendent.

Hearnshaw continued as chair of the Royal Society Committee on Astronomical Sciences (RSCAS) until June 30, when he retired from the committee after six years' service. Hearnshaw continued to serve on the organizing committee of IAU Commission 46 (Astronomy education and development) and he chaired the Commission 46 Program Group for the World-wide Development of Astronomy (PGWWDA). During 2007, Hearnshaw served on the Scientific Organizing Committee of the 10th IAU Asia-Pacific regional Meeting, to be held in Kunming, China in August 2008. In June, Hearnshaw presented a departmental seminar entitled: 'The 25 greatest discoveries in astronomy and astrophysics of the 20th century'. In September, Hearnshaw gave a talk in Tekapo to the University of Canterbury Alumni Association on the occasion of their third annual visit to Mt John.

In January Hearnshaw undertook a two-week-long visit to Thailand and Laos on behalf of Commission 46 of the International Astronomical Union. He visited four universities in Thailand (Chiang Mai, Naresuan, Khon Kaen and Mahidol) and one in Laos (National Univ. Laos, Vientiane), and presented nine seminars to staff and students. He also visited the National Astronomical Research Institute of Thailand (NARIT) in Chiang Mai and the summit of Doi Inthanon (2550 m) where a 2.4-m telescope will soon be installed.

Dr Michael Albrow continued as University of Canterbury representative on the SALT (Southern African Large telescope) Science Working Group. He also served as chair of the Departmental IT committee. He is a member of the PLANET science committee. Albrow gave a departmental conference talk on 'An introduction to Markov chain Monte Carlo techniques' and a seminar to the Canterbury Astronomical Society on 'What's new with old clusters'.

Dr Karen Pollard continued as President of the Royal Astronomical Society of New Zealand during 2007. She also served as a committee member of IAU Commission 27 'Variable Stars'.

Assoc. Prof. Peter Cottrell continued as the University of Canterbury's Director on the SALT Board. He attended one (of the two meetings) SALT Board meeting at the University of Kwa-Zulu Natal, Durban, October 22 – 27, which included a workshop on some of the astrophysics undertaken with SALT. Cottrell discussed the globular cluster work of Albrow and Gopal and Cottrell, Wylie de Boer and Worley, including the analysis of their Performance Verification observations with SALT. Cottrell was on Erskine Leave for about one month in January and

February, visiting Melbourne and Canberra in Australia. Cottrell gave the November monthly talk at the Auckland Astronomical Society, with a presentation entitled 'Southern African Large Telescope: latest news, including first science'.

Cottrell served on the Editorial Board of the Publications of the Astronomical Society of Australia during 2007 as part of a three-year term. Cottrell continued serving as Deputy Head, Department of Physics & Astronomy during all of 2007. He was also a reviewer of five large astronomical grant applications for the Australian Research Council.

Professor Jack Baggaley continued to serve on the organizing committee of IAU Commissions 21, Light of the night sky, and 22, Meteors, meteorites and interplanetary dust. He is also a member of the IAU working group for Meteor Shower Nomenclature. Baggaley visited the Ondrejov Observatory, Czech Republic, in September to work on a project on simultaneous radar and video recordings of meteors. He also visited the University of Western Ontario Canada in August in a collaboration that employs radar systems symmetrically placed with respect to the Earth's equator to study the solar system dust cloud.

Gilmore served as president of IAU Commission 6 (Astronomical telegrams) during 2007 as part of a three-year term. He is also on the organizing committee of IAU Commission 20 (Positions and motions of comets). He served as editor of the monthly RASNZ Newsletter. The Newsletter is circulated widely beyond the Society's membership.

Pam Kilmartin continued as a member of the IAU Division III (Planetary Systems Sciences) Committee for Small Bodies Nomenclature (CSBN). The CSBN deals with about 100 name proposals per month. She also served as secretary of RASNZ.

Gilmore gave talks at Stardate South Island at Staveley in February, at the Dunedin Astronomical Society in October and at the Temuka and Timaru North Rotary in November.

Hearnshaw, Gilmore and Kilmartin attended the funeral of Frank Bateson in Tauranga in April, and spoke briefly there about Frank's life and work for Mt John.

Dr David Ramm continued as a research associate in astronomy in the department during 2007. Mt John technical staff who continued to serve throughout 2007 were Stephen Barlow (computers and electronics) and Nigel Frost (mechanical workshop and vacuum systems).

Staff members in the Department with Marsden grants in 2007 were as follows: Pollard and Albrow continued as PIs on a program as part of the PLANET collaboration for extrasolar planets using microlensing.

Hearnshaw continued as a member of the MOA microlensing collaboration, which is supported through a Marsden grant to Dr I. Bond at Massey University, Albany.

Cottrell and Albrow, as co-PIs, received a Marsden Fund grant in 2007 entitled: ‘Element enrichment through mergers and stellar nucleosynthesis’. Further details are in section 9.

Dr Jenni Adams received a Marsden grant in 2008 to support her work in neutrino astrophysics with the IceCube project at the South Pole.

3. Students

The following students continued throughout the year with their Ph.D. research: Mita Gopal: CNO abundances in the globular cluster ω Centauri (supervisors Albrow, Cottrell and Pollard); Siramas Komonjinda (international student, Thailand): An analysis of southern spectroscopic binaries with nearly circular orbits (supervisors Hearnshaw and Ramm); Veronica Miller: A search for extra-solar transiting planets in the Galactic Plane (supervisors Albrow and Jean-Phillipe Beaulieu, IAP, Paris); Judy Mohr: Optical atmospheric turbulence using SCIDAR techniques (supervisors Cottrell, and Drs R.A. Johnston, R.G. Lane, M.D. Albrow); Clare Worley: Chemical abundance variations in stars in globular clusters (supervisor Cottrell); Duncan Wright: A study of non-radially pulsating stars (supervisors Pollard and Cottrell).

Rachel Soja commenced her PhD on ‘The dynamics of solar system meteoroids’ in August (supervisor Baggaley) and was awarded a Top Achiever Doctoral Scholarship by the Foundation for Research, Science and Technology. Florian Maisonneuve arrived in the Department in September from Bishops University in Montreal, Canada, and commenced a PhD on asteroseismology entitled ‘Probing the interiors of stars’ (supervisor Pollard, co-supervisors Cottrell and Hearnshaw).

Malcolm Cropp: CCD photometry of Galactic clusters (supervisors Albrow and Tobin) discontinued his PhD enrolment early in 2007.

Andrew Rakich (co-supervised by Hearnshaw and Dr William Tobin and by Dr Craig Smith, EOS, Canberra) completed his PhD thesis on Four-mirror anastigmatic telescope systems in April and successfully passed his oral in August. He was placed on the Dean’s list for excellence of his thesis. He is now an optical engineer at the Large Binocular Telescope in Tucson.

In February Worley visited Mt Stromlo Observatory in Canberra to meet with her associate supervisor Prof. K. Freeman. Komonjinda gave a seminar on her research at Chiang Mai University, Thailand, in January. Schumacher gave a seminar in the Department on her thesis work in October on eclipsing binary stars.

The following students undertook MSc thesis research in 2007: Tamsyn McLelland: An historical survey of gravitational microlensing (supervisors Hearnshaw and Pollard). She is a half-time extramural student resident in Wellington. Hana Schumacher commenced an MSc thesis on selected eclipsing binary stars (supervisor Albrow, co-supervisor Hearnshaw); Robyn Woollands commenced an MSc thesis on a photometric analysis of

RCB stars in the Magellanic Clouds (supervisor Cottrell). She suspended her enrolment in November in order to enrol for a Graduate certificate in Antarctic studies over the ensuing summer.

Three students undertook ASTR480 research projects in 2007. They were Emily Brunsten on 'Spectroscopic analysis of the gamma Doradus type variable star HD49434', supervised by Pollard and Cottrell; Jeffrey Simpson on 'Stellar nucleosynthesis and its implications for stars in globular clusters' supervised by Cottrell; and Vincent Thompson on 'The signal-to-noise ratio of fibre-fed échelle spectra' supervised by Hearnshaw. Michele Bannister (supervisors David Nobes, Geological Sciences and Cottrell), undertook a BSc Hons research project in Antarctic geology entitled 'Polygonal patterned ground and ancient buried ice on Mars and in Antarctica'.

Jeffrey Simpson undertook an ASTR391 research project (Colour-magnitude diagrams of NGC2419) over the 2006–07 summer, supervised by Albrow. Michele Bannister also did a summer ASTR391 research project (Transects across polygonal patterned ground in the Dry Valleys of Antarctica: geophysical data for comparison to polygonal features on Mars), supervised by Cottrell and D. Nobes (Geological Sciences).

Chris Hindmarsh (Otumoetai College, Tauranga) was appointed Aurora Scholar in astronomy for 2007. He was mentored by Cottrell, and he made an extensive trip to observatories in Chile as part of his award.

4. Visitors

Professor Fulvio Melia from the University of Arizona was an Erskine Fellow in the Department from 24 February to 24 April. He gave a seminar on high-energy activity in the Galactic Centre.

Professor Keith Horne, from the University of St Andrews, Scotland, was an Erskine Fellow in the Department from early September until 15 November. He gave a seminar in September on the quest for extrasolar planets and contributed lectures to the ASTR322 course in cosmology.

Dr Torsten Boehm, from the Observatoire Midi-Pyrénées, Toulouse, France, visited Mt John for an observing run from the end of December 2006 and into January 2007. He used Hercules to study asteroseismology of RS Cha.

Drs Miloslav Zejda and Marek Wolf from the Astronomical Institute, Charles University, Prague, Czech Republic, visited Mt John January 11-24 to undertake CCD photometry on the 1-m and O.C. telescopes.

Dr Alberto Castro-Tirado from the Instituto de Astronomía de Andalucía in Granada Spain visited the department in March and gave a seminar on gamma-ray bursts. He also visited Mt John.

Drs Sylvie and Gérard Vauclair from the Observatoire de Paris-Meudon visited the Department in February. Sylvie Vauclair gave a seminar on asteroseismology of exoplanet host stars.

Dr Attila Meszaros from the Astronomical Institute, Charles University, Prague, Czech Republic, visited the Department in March and gave a seminar on Cramer's theorem and gamma-ray bursters.

Professor Raymond Volkas, from the School of Physics, University of Melbourne, visited the Department in March and gave a seminar on 'The standard model on a domain wall brane'.

Dr Barry Welsh (Univ. California, Berkeley) continued his observations at Mt John on the local interstellar medium (in collaboration with Henderson and Hearnshaw). He used the Hercules spectrograph in April and November.

Dr Stuart Barnes (McDonald Observatory, University of Texas at Austin) undertook observing runs at Mt John using the Hercules spectrograph in May and in June-July in order to test an iodine cell for precise radial velocity measurements.

David and Anne Mace visited Mt John on May 7. David was Grand Master of the NZ Freemasons who organised the 2006 Royal Society science video competition.

Two officials from UNESCO in Paris, Drs Thomas Schaaf (Man and Biosphere program) and Mechtild Roessler (World Heritage Committee) and also Kate Barker (New Zealand National Commission for UNESCO, Ministry of Education, Wellington) visited Mt John Observatory in July after the World Heritage Committee meeting in Christchurch in June.

Dr Denis Sullivan (Victoria University of Wellington) made CCD observations of rapidly pulsating white dwarf stars using the McLellan telescope at Mt John, with runs in April, June, July and October.

Dr Leslie Young from the Southwest Research Center, Boulder, Colorado, USA visited the Department in July and gave a seminar on Pluto's changing atmosphere. She used the 1-m McLellan telescope at Mt John at the end of July to observe an occultation of a star by Pluto. Dr Robert Howell (University of Wyoming) also assisted her at Mt John with this observation, which was concluded successfully.

Dr Thomas Widemann from the Observatoire de Paris-Meudon also successfully observed this occultation by Pluto using the Boller and Chivens and O.C. telescopes.

Dr Clemency Montelle (Canterbury Dept. of Mathematics and Statistics) gave a seminar in August on eclipse prediction in the ancient world.

Burcu Ozkades and Derya Dogru from the Canakkale Onsekiz Mart University (COMU), Canakkale, Turkey visited Mt John in September and October with Dr E. Budding (COMU and Carter Observatory, Wellington) in order to make observations of eclipsing binary stars. They used the Hercules spectrograph on the 1-m telescope and a CCD photometer on the O.C. telescope.

Dr Graham Hill from the University of Auckland visited the department in October and gave a seminar on a spectroscopic study of the rapidly rotating pole-on star Vega. Gavin Milne from Mt Albert Grammar School also came in October and gave a seminar on 'Teaching astronomy in NZ high schools'.

Professors Ian Shaw and Steve Weaver (respectively Pro-Vice chancellor, Science and deputy PVC, Science at Canterbury) visited Mt John in November for an overnight visit (accompanied by Hearnshaw).



Left to right: Alan Gilmore, Carolyn Murray (ESL), Graeme Murray (ESL), John Hearnshaw, Ian Shaw (PVC Science), Steve Weaver (deputy PVC Science), Keith Horne (visiting Erskine Fellow, St Andrews) and Anne Magurran (wife of Keith Horne) at Mt John, 6 November 2007

5. Aurora School in Astronomy

The 2007 Aurora School in Astronomy was held 16-20 April. Twenty-three very keen and promising high-school students attended the School, mostly from year 13 but some were year 12. The School's supervisor was Pollard. The first two mornings were on campus, with seminars and laboratories on astronomical topics. The students then went to Mt John for the practical part of the School. On Tuesday night, the students were able to observe directly through the 0.6-m OC telescope and took CCD images of interesting astronomical objects using the 1.0-m telescope. They also had a tour of the 1.8-m MOA telescope.

On the Wednesday, Gilmore presented a talk on 'Hunting asteroids' which prompted a lot of questions. On Thursday the students returned to campus, and had most of Friday for more astronomy lectures and laboratories. The students had a great time and asked lots of questions about the lectures, about studying and about research in general.

Joan Gladwyn from Science Outreach helped with all the logistics and administration. The following people gave a great variety of lectures to the students (Hearnshaw, Albrow, Baggaley, Wiltshire, Pauline Harris, Dharamvir Ahluwalia and Adams). The following astronomy graduate students helped with organization: Woollands, Worley, Schumacher, Gopal, Miller, Bannister and Simpson.



Students at the 2007 Aurora School visit Mt John, April 2007

6. Conferences and schools

Five members of the Canterbury astronomy group attended the RASNZ 2007 annual conference in Auckland in July. They were Cottrell, Gilmore, Kilmartin, Komonjinda, and Pollard. Talks presented were as follows: Cottrell on ‘Southern Skies: New Zealand Astronomy on view’ (NZ stamp issue), Gilmore on ‘The physics of Comet McNaught’, Komonjinda on ‘New detectable eccentricities of southern binary star systems’, Pollard on ‘Searching for planets: now and in the future’.

Four Canterbury astronomers attended the annual conference of the Astronomical Society of Australia in Sydney in July; they were Albrow (who talked on ‘High resolution spectral models for globular clusters’), Miller (who presented a poster on ‘Phase dispersion minimisation as a period determination technique’), Gopal (who presented a poster on ‘High Resolution Spectral Models for Globular Clusters: Construction of the Models and Applications to Local Group Globular Clusters’) and Woollands (who presented a poster paper on ‘A high-precision orbital solution for the short-period δ Scuti binary star, RS Cha’). Miller, Gopal and Woollands attended the Harley Wood School for graduate students in astronomy in Sydney in June, prior to the ASA meeting.

Cottrell, Albrow, Gopal and Worley attended an international astronomy conference, entitled “A New Zeal for old galaxies” in Rotorua in March. Cottrell gave a short presentation on New Zealand astronomy as well as being involved in Worley’s poster presentation on ‘s-process element abundances throughout the CMD of 47 Tuc’. Albrow presented a poster on ‘Beyond Lick: CN abundances in local group globular clusters’. Gopal, Albrow and Cottrell presented a poster on ‘Carbon abundances in RGB stars in omega Centauri’.

Cottrell and former graduate student Dr Elizabeth Wylie de Boer and current graduate student Clare Worley attended and presented papers at the Stellar Interiors and Nucleosynthesis workshop entitled ‘Nuclear astrophysics and nucleosynthesis’ in January at Monash University, Melbourne, at which the latest developments in observational and theoretical astrophysics in stars were discussed. In October, Worley attended the IXth Torino Workshop on the Evolution and Nucleosynthesis of AGB stars, held in Perugia, Italy, where she presented her results from performance verification observations made using the Robert Stobie spectrograph on SALT.

Two Canterbury graduate students attended the IAU’s International School for Young Astronomers in Kuala Lumpur and Langkawi Island in Malaysia in March. They were Komonjinda and Woollands.

Komonjinda presented an oral paper on her work at the Thai National Astronomy meeting in Nakorn Pathom in March.

Hearnshaw and Komonjinda attended the UNESCO World Heritage Committee conference in Christchurch in June, where the concept of the World Heritage Committee Starlight Reserve was promoted.

Hearnshaw attended the Hanoi Astrophysics School at the Hanoi University of Education in Hanoi, Vietnam, in August as one of four invited lecturers. He gave six lectures on stellar atmospheres (two lectures), age measurements in astronomy, gravitational microlensing, element nucleosynthesis and the physics of the interstellar medium.

Albrow attended the PLANET collaboration meeting in Hobart, Tasmania in December.

7. Southern African Large Telescope

Since completion of the construction phase of SALT, the SALT Foundation has contracted a group at the South African Astronomical Observatory (SAAO) to operate SALT. This phase has included completing the commissioning of the telescope and its two first-light instruments, SALTICAM and the Robert Stobie Spectrograph (RSS). RSS has been undergoing modifications in Wisconsin and the direct imaging SALTICAM camera has been the sole instrument on SALT. Image quality at the telescope has been an issue, but recent reports indicate that progress is being made to improve the image quality.

In May 2007 two new partners joined the SALT Consortium: the American Museum of Natural History (AMNH) and the Indian Inter-University Centre for Astronomy and Astrophysics (IUCAA).

The University of Canterbury completed the design of the high resolution spectrograph for SALT (SALT HRS) in 2005 but because of a lack of funding the SALT Foundation was not in a position to offer a contract to the UC team. By the time SALT had the necessary funds the UC team was no longer in a position to tender for SALT HRS. Instead, tenders for spectrograph construction were let in 2006 and a contract awarded to the University of Durham in the UK in 2007. They will build the spectrograph to the University of Canterbury design. Completion is expected in early 2010 at a cost of about \$US3 million. UC was awarded shares for its design work and also the UC design team were guaranteed commissioning time and joint author status on the initial series of SALT HRS papers.

8. Instrumentation

The Spectral Instruments 600 series CCD camera with 4096 by 4096 pixels was in routine service during 2007, after arriving back at Mt John in December 2006 (after the Fairchild 486 chip had failed). It has been in routine use throughout the year. It is able to capture nearly all the spectrum from about 380 nm to almost one micron in a single exposure, though in practice the fibre OH absorption in the far red and the strong argon emission lines from the thorium-argon calibration lamp, also in the far red, effectively limit the useful wavelength range to 380-900 nm.

During the year a number of upgrades to the Hercules performance have been effected. These include the active temperature control of the Hercules room, an improved cooling system for the Hercules exposure meter photomultiplier tube, and the initial experiments with an iodine cell for precise stellar radial velocities.

The new control system was designed to maintain the room temperature to 21°C, close to the previous summer maximum. This ensures that a stable temperature of $T = 21.00^\circ\text{C}$ could be maintained without cooling. In practice the air temperature is controlled to $T = 21.00 \pm 0.03^\circ\text{C}$ over a night and to $T = 21.0 \pm 1.0^\circ\text{C}$ long-term seasonal variation. (Previously the variations were 10 times larger).

Hercules uses an EMI 9924A photomultiplier tube in the exposure meter (the tube is an end-window PMT with a 30-mm S11 photocathode). A new cooling system for the photomultiplier tube was inaugurated in 2007. This system has Peltier-effect devices to remove heat from the PMT enclosure, which is mounted just externally to the Hercules vacuum tank. Heat from the hot side of the devices is removed in a new closed-cycle water-cooling system. The water circulates from a small domestic refrigerator to the PMT enclosure by means of a domestic aquarium pump. Photomultiplier-tube temperatures of about -15°C can be maintained indefinitely with this system. Previously water cooling was used without any temperature control of the water temperature and in a continuous slow flow rate. This was wasteful of water and gave seasonal temperature variations of the tube.

Initial tests have been made in collaboration with Dr S. Barnes (McDonald Observatory, Texas) with an iodine vapour cell placed in the telescope beam just ahead of the Cassegrain focus. The path length through the cell was 15.0 cm and the iodine vapour temperature was $T = 50.0 \pm 0.1^\circ\text{C}$. The tests were made during two runs in May and June 2007 using α Centauri A and B as the targets. An immediate improvement in radial-velocity precision to about 2.5 m/s was found from these tests, which is close to the photon-noise limit.

An agreement was reached in November 2006 between the Department and the American Association of Variable Star Observers (AAVSO) in Cambridge, Mass., for the upgrade of the 60-cm O.C. telescope to make it into a fully robotic telescope for CCD photometry of variable stars. Design work on this system was undertaken at AAVSO in 2007 and some mechanical work on the polar axle drive was initiated at Mt John by N. Frost from November 2007. Completion of the upgrade of the telescope is expected in 2008.

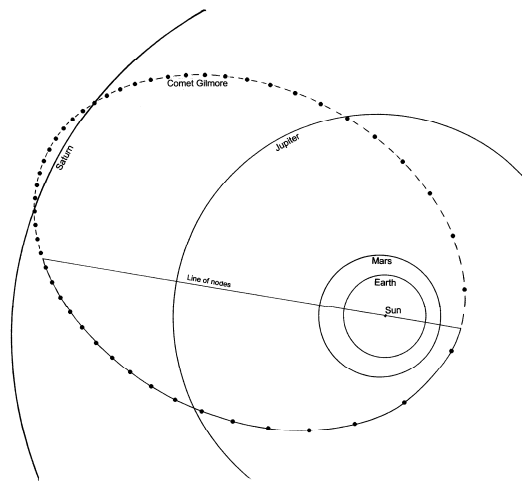
9. Other research

This section briefly mentions some other research undertaken within the astronomy group at Canterbury which is not mentioned in other sections of this report, or it expands on some items briefly covered elsewhere.

Cottrell and Albrow, as co-Principal Investigators, and Professor K. Freeman as an Associate Investigator from the Australian National University, received a 3-year Marsden Fund grant in 2007 for a project entitled, "Element enrichment through mergers and stellar nucleosynthesis". This research will explore the chemical evolution of the oldest halo objects in our Galaxy and other nearby galaxies. These halo objects are the surviving remnants of the pre-galactic satellite fragments, which were the first systems to form stars in the universe. Our goal is to understand the star formation that occurred in these very early star formation sites. The spectroscopic observations will be obtained on the world's largest optical telescope, the South African Large Telescope (SALT) and the innovative AAOmega spectrograph on the Anglo-Australian Telescope."

In February, Worley and Cottrell visited collaborator, Professor K. Freeman at the ANU in Canberra. This collaborative research project uses the Southern African Large Telescope (SALT) data of globular cluster stars, where Prof. Freeman's contribution is his expertise in dynamical modelling. The specific outcomes were an initial research paper on the SALT data and a strengthened link to Freeman and his group. During this visit it was announced that former Canterbury doctoral student, Elizabeth Wylie de Boer, had been offered a post-doctoral fellowship with Freeman at the ANU.

Pollard continued as co-PI (in collaboration with Albrow) on the Marsden-funded research on the search for extra-solar planets. This work is a part of the PLANET collaboration involving coordinated photometric observations and analysis of gravitational microlensing events.



Orbit of Comet Gilmore, which was discovered in 2007 by Alan Gilmore at Mt John

Gilmore discovered a comet from his work at Mt John on the 1-m McLellan telescope in August. It is Comet Gilmore or P/2007 Q2. At discovery it was 19th magnitude, and follow-up observations from Australia and China confirmed it to be a comet from its very

short and faint tail. The period is about 13 years. This is the second comet discovered at Mt John (the first was Comet Clark in 1973).

Hearnshaw continued work on a book 'Astronomical spectrographs and their history' for Cambridge University Press. Submission of the manuscript is anticipated early in 2008 and publication early in 2009. Hearnshaw continued Hercules observations of bright southern supergiants in a program in collaboration with P. Rosenzweig (Universidad de Los Andes, Venezuela).

Schumacher studied two WUMa-type eclipsing binaries for her MSc research. They were BP Velorum and V752 Centauri. She also studied one detached eclipsing binary, V392 Carinae. CCD photometry of all three systems were obtained at Mt John. The light curve of BP Vel was analysed using the modelling software PHOEBE. Hercules spectra were used to analyse the radial velocity variations of V392 Car and V752 Cen. She showed that the last of these systems is in fact a triple-lined spectroscopic quadruple system.

Ramm extended the work on several spectroscopic binary systems which he had begun in his doctoral thesis, which was completed in 2004. His work entails the study of high-precision orbital solutions derived from observations with the Hercules spectrograph at Mt John.

10. The MOA project

The MOA (Microlensing Observations in Astrophysics) is a joint project of Massey, Auckland, Canterbury and Victoria universities in collaboration with Nagoya University in Japan. The aim is to discover and observe gravitational microlensing events, especially in the Galactic Centre, which result in the brightening of stars caused by gravitational bending of light rays caused by objects at intermediate distance along the line of sight. MOA involves about two dozen scientists at five universities. The principal goal is the discovery of extrasolar planets through analysis of microlensing events. The MOA 1.8-m telescope belonging to Nagoya University and sited at Mt John, was installed in 2004. MOA's website is at <http://www.phys.canterbury.ac.nz/moa/>.

Throughout 2007, MOA was supported by a grant from the Marsden Fund, which provides for NZ observers and graduate students working on the project. The grant is administered through Dr Ian Bond at Massey University, Albany. MOA is a joint project involving astronomers at Massey, Auckland, Canterbury and Victoria universities and Nagoya University in Japan. Paul Tristram was employed as a MOA observer from March to October and Pam Kilmartin was also employed as a part-time MOA observer. Both were funded through the Marsden grant.

For some years members of the MOA group urged the microlensing community, at conferences and in papers, to concentrate its efforts on events of high magnification, of order 100 or more. This continued to be the main focus of MOA in 2007. These events are the most sensitive to planets, including to those of Earth-mass.

The following table summarizes events of high magnification that were found by MOA during 2007. All such events offer the opportunity to provide sensitive information on the presence of planets orbiting the lens star at separations in the range 2-4 AU.

Table 1: Chief characteristics of 24 high magnification events found by MOA in 2007. The final column is the approximate percentage of the FWHM that was accurately monitored by the microlensing community as a whole.

MOA ID#	OGLE ID#	50 < mag < 200	200 < mag	FWHM
27	57	*		0%
33	114	*		0%
43	-		*	20%
51	13	*		50%
86	105	*		0%
103	050		*	100%
105	157	*		0%
110	-	*		10%
163	224		*	100%
170	220	*		20%
192	-		*	10%
193	-	*		0%
233	302	*		60%
281	-	*		50%
291	-	*		0%
312	388	*		100%
340	423	*		100%
378	-	*		50%
379	349		*	100%
397	538		*	100%
400	-		*	100%
403	-	*		50%
433	-		*	0%
464	514		*	50%

Two of the events found by MOA in 2007 and observed by MOA, PLANET and other groups have resulted in new planet discoveries. They are MOA-2007-BLG-192 and MOA-2007-BLG-400. Results will be presented in next year's report.



Planetary system found in MOA-2007-BLG-192 consisting of a 3 Earth-mass planet orbiting a feebly magenta-coloured brown dwarf (drawing courtesy NASA's Exoplanet Exploration Program).

11. Southern Skies stamp issue

Cottrell initiated and worked closely with New Zealand Post throughout the more than two years that it took for this series of stamps to be released in time for Matariki (the Maori New Year) in June. Each of the five stamps in the issue had a telescope and an astronomical image of the sky. The University of Canterbury's facilities were intricately connected to this stamp issue, including the 1-m McLellan telescope and the 1.8-m MOA telescope at Mt John and the 11-m SALT facility in South Africa in which the University of Canterbury has a shareholding. The astronomical images were taken by New Zealand astrophotographers. They were selected following a competition organized by the RASNZ Astrophotography Section. As well as the individual stamps, there was a miniature booklet that contained a number of other images of astronomical objects and an explanation of each of the telescopes and objects. Cottrell was involved in the content for this booklet.



Some examples of the Southern Skies stamp issue from New Zealand Post

12. Public outreach: Earth and Sky Ltd and Townsend Observatory

Earth and Sky Ltd (ESL), a company to which the University of Canterbury has granted exclusive tourists rights on Mt John, has continued to develop day-time tours of the observatory and its facilities. Night-time tours are also provided, using a 40-cm Meade telescope. The Astrocafe on Mt John was completed by ESL in November 2006, and has proved to be immensely popular for day-time visitors to the observatory. During 2007 often around 100 cars on a fine day visited Mt John and the Astrocafe.

Mt John is a supporter of the UNESCO Starlight Reserve initiative, aimed at protecting dark skies at key location around the globe for stargazing. To this end, G. Murray of ESL participated in the Starlight Initiative conference in the Canary Islands in April. Mike Crean of 'The Press' visited Mt John on August 9 to research an article on the Starlight Reserve initiative.

Apart from the public outreach through ESL, Gilmore has continued an active public outreach program at Mt John on an ad hoc basis. School groups that came included Cathedral Grammar, Christchurch (March 9), Burnside High School (May 26), Cromwell College (June 5), Rudolph Steiner School, Christchurch, (July 19 and 20), Albury School (August 13), Christ's College (visit organized by Clare Worley) (December 9-10). Various other community groups to visit Mt John were a group from Science Alive!, Christchurch (February 21-22), St John's, Fairlie, group (March 19), Fairlie Lions (April 19), Deaf Children's group (May 15 and November 24), a Pleasant Point youth group (August 17). A Philosophy of Science student group from the University of Canterbury visited Mt John on May 10. A Discovery Channel film crew visited on August 27.

Gilmore continued to produce monthly sky chart sets, widely used by schools, astronomical societies, and other educational groups. A PDF issue of the chart set was started in December.

Mt John Open Nights, run by Gilmore, Kilmartin, Frost and ESL, were held on March 15-17 but were almost completely overcast. So a second set of Open Nights was held on May 18-19.

Fine views of Comet McNaught were obtained from Mt John in January. Kilmartin recorded the image shown here.



Comet McNaught, recorded by Pam Kilmartin at Mt John, January 2007

During the total lunar eclipse of August 28 Gilmore provided some radio commentary. Kilmartin answered numerous news media enquiries. Gilmore spoke on monthly astronomy chats with Bryan Crump on National Radio 'Nights', April to November. Gilmore had brief monthly astronomy chats on a children's programme on Sunday mornings on Christchurch's RDU student radio (July to December).

Gilmore assisted judging at the Fairlie Science Fair (August 8). Gilmore also assisted judging at the South Canterbury Science Fair (September 5). Gilmore and Kilmartin sponsor an astronomy prize at the Fair.

Public outreach was continued at the Townsend Observatory, Arts Centre, Christchurch on Friday evenings during the 2007 winter months. The observatory is owned by the University and operated by the Department of Physics and Astronomy. These free public sessions use the classic Cook six-inch refractor at the observatory. Andrew Brown and Holly Neighbours were appointed as Townsend observers for 2007.

13. Undergraduate and graduate programme

The following is a summary of courses offered in astronomy in 2007 (and in recent years). These courses are part of the BSc, BSc Hons, and MSc degrees and also of the Postgraduate Diploma in Science. At Canterbury it is possible to major in astronomy for all these qualifications. Most students in astronomy courses are, however, doing a BSc and majoring in physics or other science subjects with astronomy as a minor component.

ASTR/PHYS109: This course was introduced in 2001 and has continued to flourish with an enrolment of typically 150. The course has no lab class and uses minimal mathematics. It caters for BA and BSc first-year students who do not plan to progress further in astronomy.

ASTR112: This is our standard first-year astronomy course for BSc students and covers topics in the Sun and stars, the Milky Way Galaxy and extragalactic astronomy and cosmology. Forty-seven students enrolled in 2007. Six of the first-year students taking this paper went on to do the second-year astronomy paper (ASTR211) offered in semester 2 of the same year. As in previous years, a day-time field trip to Mt John was organized in March for the ASTR112 class.

ASTR211: This course (along with ASTR212 offered in alternate years) has a solid enrolment with 34 students taking the course in 2007. The course covers coordinates and time in astronomy and astronomical instruments and measurements. The next time this course is offered (in 2009) it will be renamed Imaging the Sky and have a more hands-on approach to CCD imaging.

ASTR/PHYS381: Every year a field trip to Mt John is organized for undergraduates who are doing the third-year laboratory course. This year six students participated in a two-night trip in late September. During the visit, the students were shown a number of interesting celestial sights through the OC telescope by Gilmore, who also instructed the students on the use of the telescope and instrumentation for CCD photometric observations. The students acquired time-series images of an asteroid and an eclipsing binary star that were analysed as part of their laboratory project work.

ASTR321: Techniques in observational astronomy. The course covers aspects of stellar photometry and spectroscopy, including data acquisition and reduction methods.

ASTR322: Theoretical and observational cosmology.

ASTR323: Stellar structure and evolution.

All the third-year courses above are also offered as fourth-year courses (at BSc Hons or MSc levels).

ASTR424: Radiative transfer processes in astrophysics. This course covers the theory of stellar atmospheres and of line formation in stellar spectra, and also theoretical aspects of the interstellar medium.

14. Weather at Mt John

(data compiled by Pam Kilmartin)

The weather at Mt John in 2007 was close to the mean of recent past years (since 1992) in so far as observing conditions go.

Table 2 below compares 2007 weather with that of recent past years, while Table 3 gives a breakdown of 2007 weather month by month. July, September and June (in that order) had the greatest number of photometric hours; in 2006 the best months were August, June and then May. In 2007 there were 1113 photometric hours (32% of the total night-time hours) at Mt John, which is the same percentage as in 2006. This makes the weather for observing in 2007 fairly good in the century so far, but not as good as 2003 (1275 photometric hours, 37%).

Table 2: Table of Mt John weather, 1992-2007, giving the nights usable for photometry and spectroscopy

Year	Photometric		Partly phot.		Spectroscopic		Unusable	
1992	73	20%	47	13%	80	22%	166	45%
1993	63	17%	61	17%	75	21%	166	45%
1994	66	18%	59	16%	95	26%	145	40%
1995	73	20%	61	17%	105	28%	126	35%
1996	72	20%	77	21%	104	28%	113	31%
1997	79	22%	84	23%	86	24%	116	32%
1998	97	27%	74	21%	71	19%	123	34%
1999	90	25%	43	12%	105	28%	117	32%
2000	66	18%	84	23%	104	28%	112	31%
2001	76	21%	73	20%	109	30%	107	29%
2002	56	15%	69	19%	136	37%	104	29%
2003	94	26%	80	22%	80	22%	111	30%
2004	61	17%	79	22%	82	22%	144	39%
2005	53	14%	70	19%	116	32%	126	35%
2006	86	23%	61	17%	102	28%	116	32%
2007	86	23%	75	21%	95	26%	109	30%

Table 3: Table of usable nights distribution, 2007

Month	Nights fully photometric	Nights fully or partly phot.	Hours photometric	Per cent hours photometric
Jan	10	3	66	35%
Feb	11	3	93	41%
Mar	5	8	78	27%
Apr	5	7	81	24%
May	7	5	105	28%
Jun	6	8	124	32%
Jul	11	6	153	38%
Aug	5	9	101	29%
Sep	9	9	141	47%
Oct	3	8	51	18%
Nov	9	6	83	41%
Dec	5	3	87	21%
Total	86	75	1113	32%

15. Publications

(Canterbury authors are in bold face)

(a) Books and books edited

Hearnshaw, J. B.; Martinez, P. (eds.), Astronomy for the Developing World. IAU Special Session #5, Astronomy for the Developing World. 26th meeting of the IAU, held 21-22 August, 2006 in Prague, Czech Republic, Cambridge Univ. Press (2007)

(b) Refereed journal papers

Pollard, K. R.; **Wright, D. J.**; **Cottrell, P. L.**; **Woollands, R. M.**; **Ramm, D. J.**; Böhm, T., Coordinated observational campaigns for non-radially pulsating objects. Comm. in Asteroseismology, 150, p. 133 (2007)

Reyniers, M.; Abia, C.; van Winckel, H.; Lloyd Evans, T.; Decin, L.; Eriksson, K.; **Pollard, K. R.**, AGB nucleosynthesis in the Large Magellanic Cloud. Detailed abundance analysis of the RV Tauri star MACHO47.2496.8. Astron. & Astrophys., 461, pp. 641-650 (2007)

Wiltshire, D.L., Exact Solution to the Averaging Problem in Cosmology, Phys. Rev. Letters, 99, id. 251101 (2007)

Wiltshire, D.L., Cosmic clocks, cosmic variance and cosmic averages, New J. Physics, 9, p. 377 (2007)

Wright, D. J.; **Pollard, K. R.**; **Cottrell, P. L.**, Analysis tools for non-radially pulsating objects. Comm. in Asteroseismology, 150, p. 135 (2007)

(c) Refereed conference papers

Baggaley, W.J.; Marsh, S.H.; Close, S., Interstellar meteors. In ‘Workshop on Dust in Planetary Systems’ (ESA SP-643). September 26-30 2005, Kauai, Hawaii. Eds: Krueger, H. and Graps, A., pp.27-32 (2007)

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Díaz, F.; **Hearnshaw, J.;** Rosenzweig, P.; Guzman, E.; Sivarani, T.; Parthasarathy, M., Radial-Velocity Analysis of the Post-AGB Star, HD101584. In ‘Binary Stars as Critical Tools and Tests in Contemporary Astrophysics’, IAU Symp. 240, in Prague, Czech Republic, Ed. W.I. Hartkopf, E.F. Guinan and P. Harmanec. Cambridge Univ. Press, p. 127 (2007)

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Komonjinda, S.; Hearnshaw, J. B.; Ramm, D. J. An Investigation of the Small Eccentricity in the Spectroscopic Binary System ζ TrA. In ‘Binary Stars as Critical Tools & Tests in Contemporary Astrophysics’, IAU Symp. 240, in Prague, Czech Republic. Ed. W.I. Hartkopf, E.F. Guinan and P. Harmanec. Cambridge Univ. Press, p. 531-535 (2007)

(d) Unrefereed journal papers

Baggaley, W.J.; The IAU Meteor Stream Archiving Project, *Southern Stars* 46 (3), pp. 14-18 (2007)

Baggaley, W.J.; Meteor streams – their optimum designation, *Southern Stars* 46 (4), pp. 5-8 (2007)

Komonjinda, Siramas; Hearnshaw, John B.; Ramm, David J.; New Detectable Eccentricities of Southern Binary Star Systems, *Southern Stars*, 46, 7 (2007)

Beaulieu, J.P.; **Albrow, M.;** Bennett, D.; Brillang, S.; Caldwell, J.A.R.; Calitz, J.J.; Cassan, A.; Cook, K.H.; Coutures, C.; Dieters, S.; Dominik, M.; Dominis-Prestel, D.; Donatawicz, J.; Fouqué, P.; Greenhill, J.; Hill, K.; Hoffman, M.; Jørgensen, U.G.; Kane, S.; Kubas, D.; Marquette, J.-B.; Martin, R.; Meintjes, P.; Menzies, J.; **Pollard, K.;** Sahu, K.; Vinter, C.; Wambsganss, J.; Williams, A.; Woller, K.; Zub, M.; Horne, K.; Allan, A.; Bode, M.; Bramich, D.M.; Burgdorf, M.; Fraser, S.; Mottram, C.; Rattenbury, N.; Snodgrass, C.; Steele, I.; Tsapras, Y., Hunting for Frozen Super-Earths via Microlensing, *ESO Messenger*, 128, p. 33 (2007)

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