Astronomy at the University of Canterbury
Department of Physics and Astronomy
and Mt John University Observatory —
annual report 1998

Director: Prof. J.B. Hearnshaw

Report for the period 1 January 1998 to 31 December 1998

1 Staff

In June N. Frost joined the technical staff at Mt John, with responsibilities primarily for the mechanical workshop and vacuum equipment.

Prof. J.B. Hearnshaw continued as Mt John director and A.C. Gilmore as Mt John superintendent throughout the year. Assoc. Prof. P.L.Cottrell was promoted to associate professor in January, and was elected to be deputy head of the department in August and head of department in November. He continued to serve on the Carter Observatory board in 1998, and became deputy chair. Dr W.Tobin moved to a half-time contract in 1998, working only the first six months of every year in Christchurch and the remainder in France.

Dr J. Pritchard continued as a Marsden-financed postdoctoral fellow. In the first half of the year, Dr M. Albrow was on a New Zealand Science and Technology Postdoctoral Fellowship and since July he has been a Marsden-funded postdoctoral fellow. Dr K. R. Pollard continued as a New Zealand Foundation for Research, Science and Technology Postdoctoral Fellow. Dr I. Bond continued as a Marsden-funded postdoctoral fellow with the MOA group, and since April was based at Mt John and affiliated with both Auckland and Canterbury universities.

P.M. Kilmartin was promoted to technician grade 3 during the year. Hearnshaw continued as president of IAU Commission 30 (radial velocities) and Prof. W.J. Baggage as president of IAU Commission 22 (meteors and interplanetary dust) during the year. Hearnshaw also served on the board of IAU Div. IX (optical techniques), on the IAU Working Group for the world-wide development of astronomy, and he was appointed to the council of the Royal Astron. Soc. of N.Z. as fellows’ representative.
2 Students

S.J. Wheaton completed her research for her MSc thesis in March on the rapidly brightening Sakurai’s object (supervisor Cottrell). Also in March, S.I. Persson completed his MSc research with the support of the Marsden Fund (supervisor Tobin) on the H and K lines of β Pictoris and 51 Ophiuchi, and graduated with first class honours. I.N. Cummings (supervisor Hearnshaw) submitted her PhD thesis on high precision radial-velocity measurements of late-type evolved stars in October and obtained her degree early in the new year.

S.J. Barnes commenced his M.Sc. thesis research on spectroscopy of the star β Pictoris (supervisors Tobin and Pollard). G. Bayne (supervisors Tobin, Bond and Pritchard) commenced his PhD in March on a part-time basis, working on eclipsing binary stars in the Magellanic Clouds.

The following students have continued their PhD research during the year: D.J. Pooley on post AGB stars: abundances, pulsations and modelling, with Cottrell, Albrow and Pollard as supervisors; L.C. Watson on active-chromosphere stars detected by the ROSAT survey (supervisor Hearnshaw, assisted by Pollard); J. Skuljan (supervisors Hearnshaw and Cottrell) on Eggen’s moving groups of stars and galactic dynamics, L. Skuljan (supervisor Cottrell) on RCB stars; O. Petterson on binary cepheid variables (supervisors Cottrell and Albrow).

3 Visitors

Prof. D.L. Lambert (Univ. of Texas, Austin) arrived in July for a six-month visit and to take up an Erskine fellowship and lecture on element nucleosynthesis to senior astronomy undergraduates (ASTR322). Dr A. Fokin (Inst. of Astronomy, Russian Academy of Sciences) spent six months in the department from August on a Marsden-funded fellowship to work on the dynamics of pulsating stars. Dr G.W. Wolf (S.W. Missouri State Univ.) spent March and April at Canterbury while on sabbatical, to work on the photometry of eclipsing binary systems in the uvby system, using the O.C. telescope at Mt John. Dr P. Woitke (Technische Universität, Berlin) was at Canterbury during November. He is involved with the modelling of dust formation processes in late-type stars. Prof. Kameswara Rao (Indian Institute of Astrophysics, Banagalore) visited the department for one week in November.

Dr D.J. Sullivan (Victoria Univ. Wellington) made five observing visits to Mt John, in February, April, May, July and August, to carry out photometry on the 1-m McLellan and 60-cm O.C. telescopes on pulsating white dwarfs and other objects, in part for the Whole Earth Telescope collaboration.
Dr R.J. Dodd (Carter Observatory, Wellington) undertook Vilnius system photoelectric photometry at Mt John in July, August, September and October.

4 Conferences

The RASNZ annual conference was held in July in Christchurch, and was attended by Lambert (Erskine fellow), Hearnshaw, Cottrell, Albrow, Pollard, Cummings, Watson, J. and L. Skuljan, Petterson, Barnes, Gilmore, Kilmartin, Frost and Barlowe. The following gave papers: Lambert on element nucleosynthesis, Hearnshaw on AGNs and the HST, Cottrell on SALT, L. Skuljan on recent declines in southern RCB stars, J. Skuljan on Hipparcos and galactic dynamics, Pollard on RV Tauri stars in the LMC, Petterson on Cepheid variables.

Cottrell attended the SALT/HET workshop in Cape Town in March and talked on astronomical connections between N.Z. and South Africa, past, present and future. He also participated in the Astron. Soc. of Australia meeting in Adelaide in July and gave there a presentation on SALT. In November he organized a workshop on RCB stars and related objects at Canterbury, in which most of the astronomy group and the four current astronomical visitors participated.

Pritchard attended IAU Symposium 190 on the Magellanic Clouds in Victoria, B.C., Canada in July and presented a paper on eclipsing binaries in the LMC.

Hearnshaw, Cummings and J. Skuljan attended IAU Coll. 170 on precise stellar radial velocities in Victoria, B.C. Canada in June and presented papers on the Hercules spectrograph (JBH), on precise velocities for red giants (INC), on stellar velocities from Hipparcos astrometry (JS), on radial velocities with the MJUO échelle spectrograph and CCD (JS) and on photoelectric scanner radial velocities obtained at DAO (JS).

Albrow, Pollard and Pooley attended IAU Symposium 191 in Montpellier, France in August and presented papers on AGB stars and on RV Tauri stars in the Magellanic Clouds.

Hearnshaw, Cottrell and Pollard participated in the Royal Society conference in Wellington in December on leadership priorities for N.Z. science, at which Pollard was invited to give a presentation on her experiences as a young scientist working in New Zealand. Her talk was on "Astronomy and Astrophysics Research in New Zealand: A Personal Perspective".

In December Albrow and Pollard attended the second PLANET workshop which was held at the University of Tasmania in Hobart, Australia.
5 Instrumentation and computers

The series 200 CCD camera from Photometrics in Tuscon (with SITe SI003AB CCD) has been performing well in 1998. The vacuum problems that have beset this camera since its receipt from Photometrics are now more or less under control. Currently the camera is being returned to Christchurch for pumping every 3–6 months depending on how the vacuum holds. All other aspects of the camera perform as expected and it continues to see increasing use. During the year, Barnes measured the gain and readout noise of the Photometrics Series 200 CCD system. Pritchard has developed a V-Pascal software suite for use with V for Windows, the controlling software for this detector system. Additionally, a separate Linux image-acquisition application is being developed.

Hearnshaw, with the assistance of G.R. Nankivell and N.J. Rumsey (Wellington), has completed working on the design of the new fibre-fed échelle spectrograph, HERCULES (High Efficiency and Resolution Canterbury University Large Echelle Spectrograph). Nankivell visited Canterbury in March to confer and make Zemax ray-tracing computations. Two spectrographs, one with an R2 échelle grating and one with an R4 grating, were designed, but in the end, the former was selected for construction. Glass blanks have been ordered from Glass Fab (Rochester, New York) and Nankivell began optical work in September.

A Sun Enterprise 450 server was installed at Mt John during 1998 for the MOA project. This machine includes 4 CPUs with 90 GB of internal disc storage space. Raw images from the CCD camera are archived onto DLT tape where the capacity is 20-40 GB per tape (see section 8).

6 Other research

This section gives further details, not included above, and highlights of selected research programmes.

Persson, Barnes and Tobin worked on the H and K profiles of $\beta$ Pictoris. A particular feature of Persson’s observations was the presence of strong, blue-shifted absorptions during 1997. In March Barnes commenced his M.Sc. thesis, also on the spectroscopic monitoring of the variable CaII absorptions in this star and during 1998 obtained over 400 simultaneous H and K spectra. $\beta$ Pictoris again proved active in 1998.

Bayne and Tobin have worked on the subject of eclipsing binary stars in the Magellanic Clouds. Work so far has concentrated on implementation of the Grison period-finding algorithm with a view to searching for eclipsing binaries in the MOA
Petterson with Albrow and Cottrell has continued working on binary cepheids, with data being reduced and analysed from observations collected at Mt John with the échelle and series 200 CCD system on the 1-m telescope. Much work was done on developing a stable data reduction pathway and investigating how to get the most precise radial velocities when the échelle spectrograph is used in direct mode on the 1-m telescope (not fibre fed). Petterson has worked with Fokin on modelling the behaviour of the classical cepheid AX Cir with some quite successful results. Work is continuing on the further analysis of the radial-velocity data and comparing with predictions from the model.

L. Skuljan reports that some key observations were undertaken in 1998 on her RCB star programme. A decline of one of the brightest RCB stars (V854 Cen) has been covered with both the high resolution and the medium resolution spectrographs at Mt John Observatory. Observations were finished at the end of 1998. Analysis of V854 Cen decline spectra has provided some important information about the evolution of emission lines throughout the decline.

J. Skuljan reports that in 1998 the reduction of the MJUO radial-velocity observations was concluded, and a general precision of about 10–20 m/s was obtained. A two-week observing run at the DAO (Canada) was undertaken in March-April, and about 300 observations of northern stars were collected on the 1.2-m telescope using the RV scanner. The analysis of the Hipparcos data back in Christchurch was continued and some important results were derived. A paper on this subject (“Velocity distribution of stars in the solar neighbourhood”) was submitted for publication.

R.J. Dodd (Carter Observatory) is carrying out a revised calibration of the Vilnius photometric system in $M_V$ and $T_{\text{eff}}$. For this some 500 new bright stars in both hemispheres are being observed. The project started in the northern hemisphere in 1997 with the measurement of 200 summer stars. Included in the calibration list are 216 stars in the southern hemisphere with good temperatures and absolute magnitudes.

G.W. Wolf (SW Missouri State Univ.) is working on light curve solutions for eclipsing binaries that are of value in determining masses and radii for stars. He obtained useful data on 12 of the scheduled nights on the eclipsing binaries DW Car, LT Cen, BF Cen, and VZ Cen. The data have been reduced, extinction values determined and resolving time of the photometer system analysed. He is now determining solutions for the light curves.

Pollard continued her FoRST-funded research programme entitled “The evolutionary status of the RV Tauri variables”. This project involves the acquisition and analysis of optical and infrared photometric data as well as low-, medium- and high-
resolution spectroscopy from MJUO, SAAO, Mount Stromlo and Siding Springs Observatories and the Anglo-Australian Telescope. The major goal of the research is to improve our understanding of the properties and evolutionary status of the RV Tauri stars and other related evolved objects. Highlights of this research include results from the analysis of the MACHO photometry and also some low-resolution spectroscopy obtained at the SAAO of RV Tauri stars in the Large Magellanic Cloud.

During the past year, both Albrow and Pollard have made numerous observing trips, including one each to Hobart, Australia, and one to Sutherland, South Africa, to undertake CCD photometric observations for the PLANET (Probing Lensing Anomalies NETwork) collaboration. The main aim of this project is to search for planets around stars using the gravitational microlensing effect – an effect in which foreground stars amplify the light of background sources in the Galactic Bulge. In order to achieve this objective, PLANET operates a world-wide network of four southern hemisphere telescopes which continuously monitor microlensing events towards the centre of the Galaxy. Pollard was a Visiting Astronomer at the South African Astronomical Observatory (SAAO) in August 1998. During this time, she worked on the classification of RV Tauri stars in the Large Magellanic Cloud with SAAO collaborator, Dr T. Lloyd Evans.

D. Pooley (with Pollard and Cottrell) has continued his work and modelling on spectroscopy and photometry of post AGB stars to investigate their pulsations and binarity. I. Cummings (supervisor Hearnshaw) completed her work on precise radial-velocity observations of 44 late-type southern evolved stars.

D. Sullivan (Victoria University of Wellington) undertook high-speed photometry of a variety of compact stars. Ten nights were spent using the 1-m telescope in combination with his VUW three channel photometer observing pulsating white dwarfs. For 12 nights the photometer was attached to the O.C. 60-cm telescope and both a subdwarf B pulsator and a doubly degenerate binary were observed as part of international campaigns. Nine nights used the new Mt John CCD attached to the 1-m telescope to observe the object GW Lib, which is a faint cataclysmic variable incorporating a pulsating white dwarf. This last work was carried out in collaboration with J. Pritchard.

Hearnshaw has observed F supergiant stars on the fibre-fed échelle spectrograph, as part of a collaborative programme with P. Rosenzweig (Universidad de los Andes, Venezuela) to determine atmospheric parameters.
7 Miscellaneous

The 1998 year was the second of a triennium in which the Canterbury astronomy group has benefitted from a grant from the Marsden Fund administered by the Royal Society of New Zealand for curiosity-driven research. The grant covers five research projects, namely stellar variability, Cepheid variables, eclipsing binaries, β Pictoris and moving groups of stars. More details are given in the WWW site http://www.phys.canterbury.ac.nz/research/astronomy/marsdenplc.html, including the year two annual report.

Partly as a result of the Marsden grant, the demand for telescope time on the 1-m McLellan telescope has continued at a high level, with typically 40 per cent excess demand over the nights available.

8 MOA project

The MOA (Microlensing Observations in Astrophysics) project has continued at Mt John during 1998. The project involves about 6 scientists in four institutions (including University of Canterbury Dept. of Physics and Astronomy) in New Zealand, and about 2 dozen scientists in six institutions in Japan. Principal investigators in N.Z. are P. Yock (Auckland), D. Sullivan (Victoria), R. Dodd (Carter) and J. Hearnshaw (Canterbury). The New Zealand operations are funded by a grant from the Marsden Fund to Auckland University. P.M. Kilmartin worked half-time as an observer at Mt John for the project.

From May 1998, a new 24 mega-pixel CCD camera was commissioned on the 60-cm B&C telescope at Mt John. The new camera comprises a mosaic of 3 thinned back-illuminated SITe CCD chips. Each chip is 4096 by 2048 pixels. To enable timely reductions and analysis of CCD images obtained by the new camera, work commenced in April 1998 on the development of an on-site analysis system. A Sun Enterprise 450 server was installed during 1998. Raw images from the CCD camera are archived onto DLT tape.

Work also commenced in 1998 on the development of software for the reduction of MOA CCD images into individual light curves. The main aim of the on-line analysis software is to produce light curves of microlensing events in progress. The analysis procedures will be based on pixel lensing and difference imaging photometry. This software will be in place in time for the 1999 winter viewing season.

Observations continued throughout the year of microlensing events towards the Magellanic Clouds and the Galactic Bulge. Additional measurements were also made of the edge-on galaxy IC5249 using the new camera described above, to complement
those that had been taken the previous year with the old MOA camera.

During July, the first opportunity arose to search for evidence of extra-solar planets in a gravitational microlensing event of high magnification. It had previously been pointed out that these events should provide the best detection efficiency for extra-solar planets. The July event was monitored comprehensively from Mt John for three consecutive nights, almost without interruption. The data were reduced and transmitted to colleagues in USA for inclusion with observations that were made from Mt Stromlo.

As in previous years, the continued operation of the project was made possible by the provision of telescope time by the University of Canterbury, and the provision of a CCD camera by Japan.

9 Weather at Mt John

In 1998 there were 97 fully photometric nights (27%), 74 partly photometric nights (21%), 71 spectroscopic nights (19%) and 123 unusable nights (34%). These figures are compared with those of recent years in Table 1. The distribution of usable nights throughout the year is shown in Table 2.

10 Publications


Table 1: Table of Mt John weather, 1992–1998

<table>
<thead>
<tr>
<th>Year</th>
<th>Photometric</th>
<th>Partly photom.</th>
<th>Spectroscopic</th>
<th>Unusable</th>
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<tbody>
<tr>
<td>1992</td>
<td>73</td>
<td>47</td>
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<tr>
<td>1998</td>
<td>97</td>
<td>74</td>
<td>71</td>
<td>123</td>
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Table 2: Table of usable nights distribution

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<tr>
<th>Month</th>
<th>Phot. nights</th>
<th>Part phot. nights</th>
<th>Phot. hours</th>
<th>Per cent phot.</th>
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<tr>
<td>Jan</td>
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<td>15</td>
<td>74</td>
<td>40</td>
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<tr>
<td>Feb</td>
<td>10</td>
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<td>10</td>
<td>19</td>
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<td>May</td>
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