

Astronomy at the University of Canterbury Department of Physics & Astronomy and at the Mt John University Observatory

Observatory Director: Prof. J.B. Hearnshaw

Annual Report 2005

Report compiled by Dr William Tobin, Deputy Director

Report for the period 2005 January 1 to December 31

Staff

At the beginning of the year the Observatory directorship rotated to Professor John Hearnshaw. At the same time, Dr William Tobin was appointed Deputy Director. Alan Gilmore was reappointed as Mt John superintendent. Other permanent technical staff at the Observatory are Pam Kilmartin, Stephen Barlow and Nigel Frost. Maryrose Fowlie continued to keep the living areas spick and span. Other academic staff in Christchurch are Associate Professor Peter Cottrell and Drs Michael Albrow and Karen Pollard.

During the year, Hearnshaw continued service on the organizing committee of International Astronomical Union (IAU) Commission 46 (Astronomy Education and Development). He continued as chair of the Commission 46 Programme Group for the World-Wide Development of Astronomy (PGWWDA), and as a member of the Programme Group Teaching for Astronomy Development. He was also Vice-President of IAU Division IX (Optical and Infrared Techniques) and served on the organizing committee for the young astronomer's session at the forthcoming IAU General Assembly in Prague. He was a member of the Scientific Organising Committee of the Ninth IAU Asian-Pacific Regional Meeting, held in Bali in July, at which he gave talks about the MOA telescope and project, and (with J. Fierro, Mexico) about astronomy in Cuba and Mongolia. He continued as chair of the Royal Society of New Zealand's (RSNZ's) Committee on Astronomical Sciences and served on the committee for the Square Kilometre Array in New Zealand (SKANZ).

On behalf of the PGWWDA, Hearnshaw visited Havana, Cuba, in January, and the University of the West Indies in Trinidad in December. Starting in November, he visited the Universidad de Los Andes in Mérida, Venezuela, where he interacted with M.Sc. student Fabiola Diaz for whom he is acting as external co-supervisor for a project on the spectrum of a southern asymptotic giant branch (AGB) star. He also visited the Centre for Research in Astronomy in Mérida, and visited Margarita Island to liaise with Rowena Hill, the sister of the late



Prof. John Hearnshaw's IAU Commission 46 visit to Cuba. *Left to right:* Lilliam Álvarez Díaz (Scientific Director, Cuban Ministry of Science), Hearnshaw, Julieta Fierro (Universidad Nacional Autonoma de México), and Lourdes Palacio (Director of Havana's Institute of Geophysics and Astronomy).

Beatrice Tinsley. During all these trips he gave a number of seminars and lectures. The visits to Venezuela and Trinidad were supported by the University of Canterbury's Erskine Fund.

In March, Hearnshaw gave an RSNZ-sponsored presentation in Parliament Buildings, Wellington, on the benefits of astronomy. He lectured at the Canterbury Museum in April, and to the Canterbury Astronomical Society in June. In September he lectured on Beatrice Tinsley at the opening of a play about her life at the Circa Theatre, Wellington.

Cottrell and graduate student and fixed-term staff member Stuart Barnes attended meetings concerning the Southern African Large Telescope (SALT) in Cape Town in May. After their return they gave a seminar at the Research School of Astronomy & Astrophysics (RSAA) of the Australian National University about SALT and the high-resolution spectrograph that has been designed for it by the team at the University of Canterbury. In November, Cottrell and Albrow participated in further SALT meetings in Cape Town, followed by the SALT inaugu-

ration (see separate SALT section for more details). In December, Cottrell acted as the international reviewer of the final design of the Wide Field Spectrograph (WiFeS) which is to be built by the RSAA as a replacement for the Double-Beam Spectrograph on the 2.3-m Telescope at Siding Spring Observatory.

During the year Tobin gave talks on the French physicist Léon Foucault at various venues, including the Hansen Experimental Physics Laboratory (Stanford University), the Department, UC Opportunity, the RASNZ annual meeting in Nelson, Christ's College, the Lycée Marcelin Berthelot (St-Maur des Fossés, France) and the Université de Rennes-1 (France).

Pollard continued during 2005 as one of the Vice-Presidents of the Royal Astronomical Society of New Zealand.

Around the beginning of the year, the Department in Christchurch began hosting Emeritus Professor Roy Kerr and Dr Kent Cullers (formerly of the SETI Institute) as research associates.

Students

David Ramm passed his Ph.D. oral examination in February (external examiners Drs Graham Hill, Auckland, and Hugo Levato, Argentina). His thesis was entitled 'A spectroscopic study of detached binary systems using precise radial velocities' (supervisor Hearnshaw). Stuart Barnes' Ph.D. thesis 'The design and performance of high-resolution échelle spectrographs in astronomy' (same supervisor) was examined the following month. (External examiners Peter Gillingham, Anglo-Australian Observatory, and Dr David Latham, Harvard-Smithsonian Center for Astrophysics, both attended in person.) Both students received their degrees at the April graduation ceremony.

Ph.D. student Malcolm Cropp (supervisors Albrow & Tobin) completed the observational part of his thesis on CCD photometry of Galactic clusters.

Siramas Komonjinda (supervisors Hearnshaw & Tobin) began observations using Hercules for her Ph.D. study of binary star orbits using precise radial velocity measurements. A question that has arisen is whether the small but statistically significant eccentricities determined by Ramm during his Ph.D. actually imply an elliptical orbit or derive from some other physical mechanism. In June-July she attended the Vatican Observatory Summer School (this year devoted to astrobiology: the search for our origins and life elsewhere), followed by the IAU Asian-Pacific Regional Meeting in Bali, where she presented a poster.

Veronica Miller (supervisor Albrow) continued her Ph.D. search for transiting planets in the Galactic bulge.

Judy Mohr continued her research into active optics and turbulence measurements using SCIDAR techniques under the supervision of Cottrell, and Drs Richard Lane

& Rachel Johnson (both of Applied Research Associates New Zealand Ltd). In April she suspended her thesis until early 2006 for birth of her second child.

Extramural student Andrew Rakich continued his doctoral work on four-mirror anastigmats (supervisors Hearnshaw, Tobin, Norman Rumsey of Lower Hutt, and Dr Craig Smith of EOS, Queanbeyan, New South Wales). In July he gave an invited talk at the SPIE 50th Annual Conference in San Diego entitled 'The 100th birthday of the conic constant and Schwarzschild's revolutionary papers in optics.'

Duncan Wright (supervisors Pollard and Cottrell) began Ph.D. research on non-radially pulsating stars, in particular the study of γ Doradus using photometric and spectroscopic observations. He has continued to be involved in a number of other multi-site observational campaigns and papers on HD 160641 and FG Virginis were submitted for publication in the latter part of the year.

Liz Wylie continued her Ph.D. project on heavy element abundances in AGB stars (supervisor Cottrell). As in the two previous years, she was awarded the Dennis William Moore Scholarship. In May she attended IAU Symposium 228 in Paris, where she presented a paper on AGB stars in the globular cluster 47 Tucanae. She moved to part-time enrolment for the latter part of the year in order to spend more time with her husband before his posting overseas with the armed forces.

Mita Gopal started the thesis part of her M.Sc. degree in 2005, but towards the end of the year transferred to the Ph.D. programme where she will research CNO abundances in the globular cluster ω Centauri (supervisors Albrow, Cottrell & Pollard).

Under the supervision of Cottrell & Johnston, Clare Worley completed a Stage 4 project on the atmospheric turbulence at Mt John. In November she presented an oral paper on this work at the Dunedin conference of Image and Vision Computing New Zealand.

An anonymous donor has kindly provided trial funding for a scholarship for a young, first-year student. For 2005, this Aurora Scholarship was awarded to David Jolly of Nayland College, Nelson. As part of this award, he organised a tour (assisted by his mentor, Cottrell) for early 2006 of astronomical facilities in Hawaii, California, New Mexico, Texas and Chile.

The same donor provided funding for an Aurora School in Astronomy (organiser Pollard). Over sixty Year 12 students applied of whom 20 were accepted for the week-long school held in April.

Visitors

The group welcomed Professor Hans Zinnecker (Astrophysikalisches Institut Potsdam) as an Erskine Visiting Fellow between February and April. He taught star formation as parts of the ASTR323/423 courses and gave numerous other lectures. A second astronomy-related Erskine visitor was Professor Malcolm Longair (Cavendish

Laboratory, Cambridge) who gave a dozen lectures celebrating the World Year of Physics in September-October.

Other astronomical visitors to the group or department were: Professors Robert Buchler (Florida), Sergei Gulyaev (Director of the Centre for Radiophysics and Space Research at the Auckland University of Technology), who talked about New Zealand plans to join the Square Kilometre Array, and Drs Boonrucksar Soonthornthum (Chiang Mai) and Barry Welsh (Berkeley).

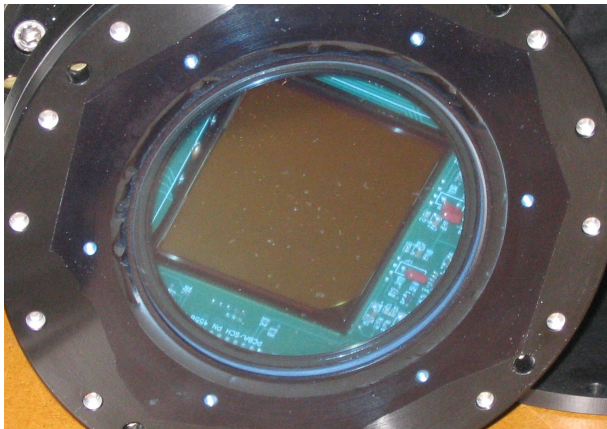
Ph.D. student Lisa Elliott (Centre for Stellar & Planetary Astrophysics, Monash University) visited in September to work with Cottrell and Wylie. Diaz (Universidad de Los Andes) visited in September-November for M.Sc. co-supervision by Hearnshaw.

Visitors who observed at Mt John during 2005 were Dr Denis Sullivan (Victoria University, Wellington) and Ms Jennie McCormick (Pakuranga).

Instrumentation

The HERCULES high-resolution spectrograph continued as the principal instrument used on the McLellan 1-m Telescope. During the year Ross Ritchie installed a temperature control system in the HERCULES room. The temperature can now be controlled to $\pm 0.01^\circ\text{C}$ and the spectrograph and room will henceforth be maintained accurately at 20°C . Ritchie has also built a recovery system for the water which removes heat from the Peltier-effect photomultiplier-tube cooler in the HERCULES exposure meter. It will be installed at Mt John early in 2006.

The vacuum on the Photometrics Ltd SI-200 CCD system failed in May. The cryostat was returned to its manufacturer, Janis Research Company Ltd of Wilmington, Massachusetts, who confirmed that an interior weld had leaked. Repair necessitated removal of the CCD chip and associated electronics by Photometrics in Tucson. The opportunity was seized for an overhaul, including replacement of the electronics plug, in which a pin was



The $4\text{k}\times 4\text{k}$, 60-mm square chip in the new Spectral Instruments cryogenic CCD system destined for use with the HERCULES spectrograph at Mt John.

suspected to be close to failure having been bent. The cryostat returned to operations on Mt John in late August.

Early in the year, Spectral Instruments of Tucson, Arizona, began assembly of a new cryogenic CCD detector system for HERCULES incorporating a $4\text{k}\times 4\text{k}$ Fairchild 486 chip. Unfortunately, the first 486 chip delivered did not meet noise specifications when cold, but by the end of the year a system had been received in Christchurch and commissioning had begun.

Southern African Large Telescope

The University of Canterbury is a partner in the Southern African Large Telescope project, and the telescope itself is complete and undergoing its final verification. First-light pictures, obtained with the SALTICAM prime-focus camera, were released in September. Performance verification of SALTICAM and the Prime Focus Imaging Spectrograph (PFIS, but now renamed the Stobie Spectrograph) has begun and the first paper using SALT observations was submitted for publication by the SALTICAM team. It is entitled 'First science with SALT: peering at the accreting polar caps of the eclipsing polar SDSS J105543.40+002707.2'.



One of several first-light images obtained with SALT. It shows a central region of the Lagoon Nebula. Image sharpness will improve further when SALT's active optics system is fully implemented.

The highlight of the year was the inauguration of the telescope on November 10 by South African President Thabo Mbeki. Over one thousand guests were present, including Cottrell, Albrow and Canterbury Vice-Chancellor Professor Roy Sharp. "Even those of us who know nothing about astronomy have awaited this day with great anticipation," the President said, "feeling, perhaps instinctively, that this giant eye in the Karoo would tell us as yet unknown and exciting things about ourselves." The New Zealand High Commissioner to South Africa, H.E. Mr Warren Searell, also attended the inauguration. A dinner for Sharp and Cottrell was hosted by



The SALT inauguration on November 10 began with a rendition of the South African national anthem by this choir of primary-school children from Sutherland.



The New Zealand High Commissioner to South Africa, Warren Searell (*left*), Peter Cottrell, and Hanlie Booysen enjoying a reception in Stellenbosch the day before the SALT inauguration.

the High Commissioner along with the Vice Chancellor of the University of Cape Town (UCT), Professor N.S. Ndebele, his Deputy VC (Research), Professor C. de la Rey, their Dean of Science, Professor D. Reddy, and the Head of the UCT Department of Astronomy, Professor R.C. Kraan-Korteweg.

As part of its contribution to SALT, the University of Canterbury expects to build the telescope's high-resolution spectrograph (SALT HRS). The instrument passed Critical Design Review in Christchurch in April (Principal Investigator Cottrell, HRS Project Scientist Albrow). Other Department of Physics & Astronomy personnel involved in this project are Barnes, as the principal optical designer, Graeme Kershaw, as the principal mechanical designer, Frost, Ritchie and Geoff Graham. Additional optical design work was provided by

Damien Jones (Prime Optics, Australia) while project management services were furnished by Graham Hodge (Unilogix Ltd, Christchurch). Due to a shortfall in funds within the SALT project, a contract for construction of the SALT HRS had not been concluded by year's end.

The MOA Project

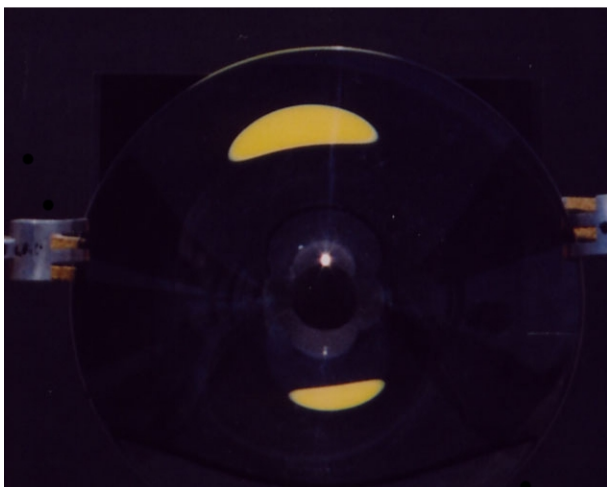
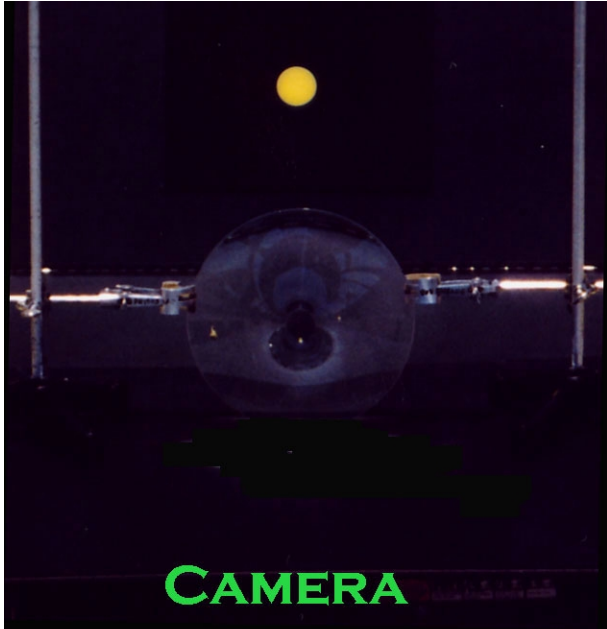
During the year, commissioning of the new 1.8-m MOA-II telescope proceeded, with some scientific observations beginning in June; however most MOA data continued to be acquired with the 0.6-m Boller & Chivens telescope. The programme benefited from the excellent observing skills of Kilmartin and Paul Tristram for yet another year in 2005, and also of Tui Britton during the mid-winter months. In addition, many visiting observers from Japan operated the MOA-II telescope.

Beginning in February, Tobin hosted Miriam ter Brake, a student from the Technische Universiteit Delft. During her two-month project, she automated the determination of ephemerides for a forthcoming catalogue of eclipsing binary stars in the Large Magellanic Cloud detected via MOA observations made in 1997.

In April, data were obtained on the microlensing event OGLE 2005-BLG-071. This event had a moderately high magnification value of about 50, and the light curve exhibited a very clear perturbation due to a planet. This was recorded by many microlensing groups in addition to MOA, such as PLANET. The planetary signal was so large that it was readily detectable with small telescopes. Two amateur astronomers, Jennie McCormick and Dr Grant Christie, both from Auckland's Stardome Observatory and members of the μ FUN collaboration, successfully recorded the signal with 25cm and 35cm telescopes respectively. This event provided clear confirmation of the excellent sensitivity of gravitational microlensing events of high magnification to extrasolar planets.

During 2005, the MOA group published a re-analysis of the microlensing event MOA 2002-BLG-33. This event had a binary lens that had already permitted a precise measurement of limb darkening on the source star, a solar-like star at a distance of about 16 000 light years. In the re-analysis, non-sphericity of the source star was searched for. Assuming an elliptical shape, the ratio of the semi-major to semi-minor axis was constrained to lie in the range $1.02^{+0.04}_{-0.02}$. The angular resolution of the shape measurement was 0.04 micro arcsec, approximately one million times sharper than the diffraction limit of the Hubble Space Telescope. A figure illustrates the star, including limb darkening.

In September, the New Zealand part of the MOA collaboration was awarded a Marsden Grant of \$300,000 for each of the next three years. The prime goal is to detect Earth-like planets through microlensing and the grant will, *inter alia*, finance the observing campaign with the



Laboratory simulation of gravitational microlensing using a plastic lens milled to mimic the gravitational deflection of a star. *Upper:* The lens, a more distant, artificial 'source' star of uniform surface brightness, and emplacement of the camera acting as a telescope. *Lower:* The pair of Einstein arcs seen through the lens. In real cases, the separation between them is too small to be resolved: only the integrated light of the pair is recorded. As proper motions alter the Earth–lens–source–star alignment, the arcs rotate and vary in size (though not surface brightness for a uniform source star). The measured total light describes a characteristic light curve. If the lens star has a planet orbiting it, and if either of the arcs comes close to aligning with the planet, the arc is further amplified. The planetary amplification appears as a detectable perturbation on the light curve. (Lens courtesy of David Cochrane, Industrial Research Ltd. Photographs by Philip Yock.)

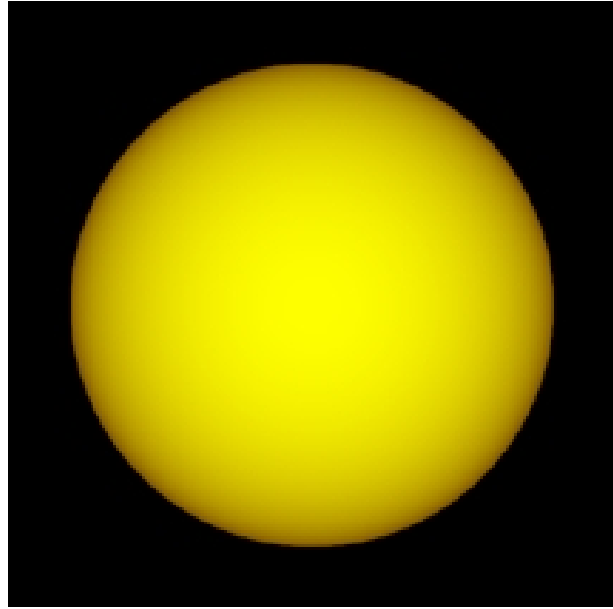


Image of the source star of MOA 2002-BLG-33 deduced from gravitational microlensing. The star is similar to the Sun but situated at a distance of approximately 16 000 light years. The angular resolution of the image, 0.04 micro arcsec, is perhaps the finest yet obtained in any area of science.

new 1.8-m Telescope. Principal investigators are Dr Ian Bond (Massey University, Albany campus), Hearnshaw and Dr Denis Sullivan (Victoria University, Wellington). Associate investigators are Dr Winston Sweatman (Albany campus), Tobin, and Associate Professor Phil Yock (University of Auckland).

In October, the MOA collaboration was pleased to welcome Dr Christine Botzler (ex Ludwig-Maximilians Universität München) as a postdoctoral fellow. She made an initial visit to Christchurch but is currently working at the University of Auckland with Yock. She will transfer to Canterbury in March or April 2006.

Other Conferences and Workshops

In March, Hearnshaw, Prof. Jack Baggaley and Komonjinda participated in a workshop on radioastronomy at the Auckland Institute of Technology, where Hearnshaw gave an invited talk. In late June, Cullers, Gilmore, Hearnshaw, Jolly, Kilmartin, Tobin and Wright attended the Annual Conference of the RASNZ in Nelson. A variety of talks were delivered.

Mt John site

During the year Gilmore had several meetings with Tekapo developers, lighting manufacturers and distributors, and Mackenzie District Council (MDC) representatives on matters of streetlight specification and suitability in Tekapo's new subdivisions. In November he gave

a talk on lighting to the Tekapo Community Board with MDC representatives present. He presented a draft hand-out on lighting intended for prospective house builders, prepared at the Council's invitation. This was approved but has not yet been officially endorsed by the Council's compliance officers.

Earth & Sky Ltd (ESL, principals Graeme Murray and Hide Ozawa of Tekapo) began commercial daytime tours of the Observatory during the summer of 2004-5. These ran until the end of April; thereafter tours were run from their village office on demand. The tours included visits to the McLellan 1-m and the MOA 1.8-m Telescopes.

Much renovation work was done on the '16-inch' dome (the dome which used to house Dr Frank Bateson's 16-inch reflector). Frost, assisted by Barlow and commercial contractors, improved the dome's mechanical operation. The dome support rollers were replaced and an electric drive added for dome rotation. The dome shutter also required extensive work. In October, ESL installed a 40-cm (16-inch!) Meade telescope in the dome along with a fenced viewing platform around the pier. The telescope is used for commercial night visits.

The old Bamberg cameras were removed from the Bamberg Building during the year. ESL is considering installing a solar telescope there for daytime tours.

In November ESL was given permission to remove the interior walls of the old Astrograph Building and make a small lecture theatre. Work was proceeding rapidly by the end of the year.

Current weather conditions at Mt John can be ascertained thanks to a webcam run by ESL (visit www.tekapotourism.co.nz/webcam.htm).

Other

In 2004, the Ministry of Research, Science & Technology commissioned Professor Mike Bessell (Australian National University) to write a report on New Zealand's future requirements for a National Observatory. The report was made public in 2005 February. The report recommended that Carter Observatory should cease to be the National Observatory, and that a new National Observatory should be set up on the University of Canterbury campus. This National Observatory would, *inter alia*, provide some funding for Mt John as well as buying time for New Zealand astronomers on overseas telescopes such as SALT and the Anglo-Australian Telescope. The Ministry had not formulated any official response to the Bessell report by the end of the year.

As part of its restructuring, Carter Observatory gifted its library to the University. Funds were obtained from the Frank Bradshaw & Elizabeth Pepper Wood Fund for its transfer to Mt John, where 369 boxfulls arrived in 2004 October. Subsequently Kilmartin has inventoried the material, much of which is of great historical interest. Most of the older observatory publications, dating

from the 1830s, have been accepted for secure storage by the Physical Sciences Library in Christchurch, which has also received some of the books to fill gaps in its collection.

Open nights held at Mt John on April 14–16 were attended by some three hundred members of the public. A group from the Alumni Association was hosted in September and lectured to by Hearnshaw.

Weather at Mt John

(Compiled by Pam Kilmartin)

During 2005, 53 nights (14%) were fully photometric; 70 nights (19%) were partly photometric; a further 116 nights (32%) were suitable for spectroscopy only, and 126 nights (35%) were unusable. There were thus somewhat fewer fully photometric nights than usual for the last decade, for which there were an average of 76 (standard deviation 14) photometric nights per year (21%). In other measures the year was typical, the ten-year averages being 72 (s.d. 12) partly photometric nights (20%); 98 (s.d. 19) spectroscopic nights (27%); and 117 (s.d. 12) unusable nights (32%).

The Table below details the monthly photometric conditions during 2005.

Month	Nights fully photometric	Partly photometric	Hours photometric	Percentage photometric hours
Jan	7	5	58	30%
Feb	3	7	42	19%
Mar	8	9	99	34%
Apr	7	7	103	31%
May	4	3	52	14%
Jun	5	3	68	18%
Jul	5	5	79	21%
Aug	2	7	50	14%
Sep	2	5	38	13%
Oct	3	9	58	21%
Nov	5	4	45	22%
Dec	2	6	27	15%
Total	53	70	719	21%

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