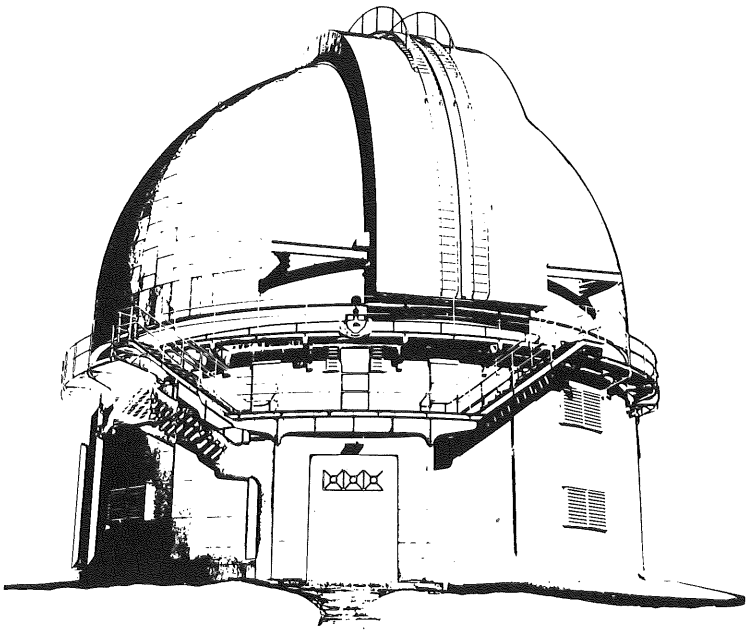

# THE DAVID DUNLAP DOINGS

Vol. 19, No. 3 October 27, 1986.

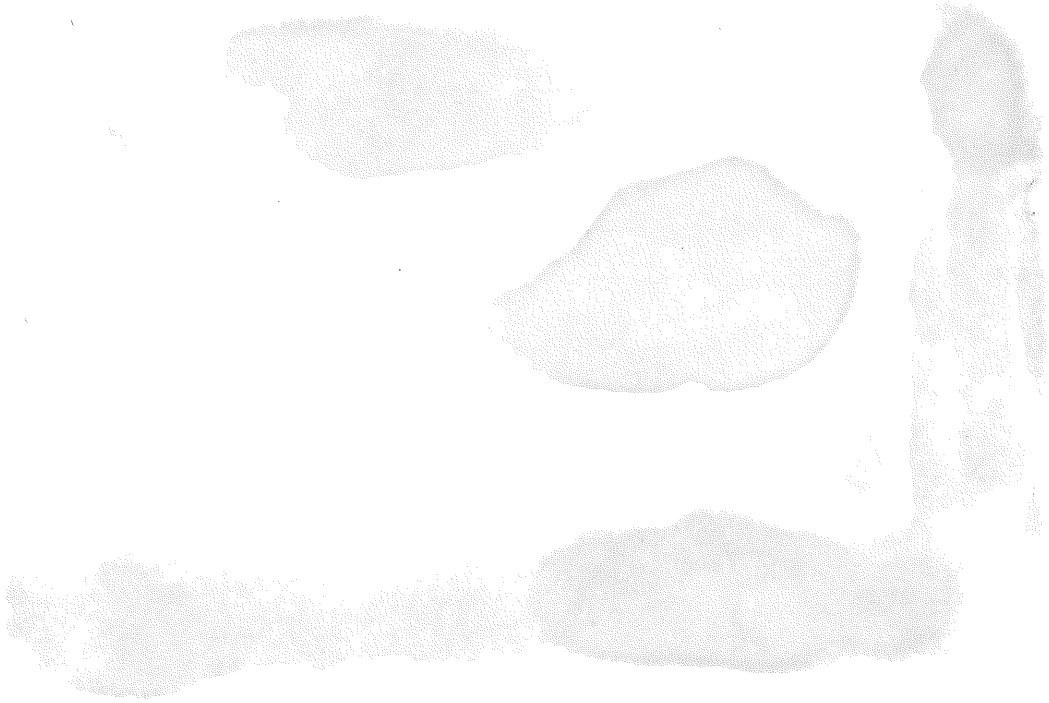

*Photo of Scarborough Theory Group*
First row: Peter Ip, Peter Leonard, Mike Seufert, Lee Oattes
Second row: Charles Dyer, Rachael Webster, Martin Duncan, Dan Blanchard, and John Harper

## A WORD FROM THE DIRECTOR

I am pleased to announce that starting with this issue the editor of the Doings will be Bob Garrison, assisted by Chris Rogers. The new editors have announced their firm intention of restoring the Doings to a more regular issuance, which is good news to everyone. To that end may I urge you all to contribute short notes and articles and, at the very least, news of what you have been up to. The pleasure of reading the Doings is greatly enhanced by wide-ranging contributions. In particular, we would love to have news of old friends who are now elsewhere. Please let's hear from you!

Don Fernie

## EDITORIAL

Chris Rogers and I (rG) are the new editors. We hope to get this venerable newsletter back on track; we've all missed it lately. Amazingly, I've received several *unsolicited* contributions, including 5 pages from Tom, who responded to my look of incredulity with: "You aren't the only one who wants to see a revival of the newsletter." Whatever the reasons, this is a chance for a new start and we plan to make the most of it.

One of the changes I'd like to institute is a broadening of the base. The newsletter belongs to everybody; secretaries, electricians, caretakers, faculty, machinists, students, visitors, and all the readership "out there" (those with some past or present connection with the observatory). So, if you have something to say, please feel free; you are not just being invited, you are being ENCOURAGED.

If you don't have something for a particular issue in time for the deadline, think about it for the next, which will follow closely. Instead of waiting for a deadline, submit material anytime. If you go to a meeting or on an observing run or a vacation, or if something occurs to you that might be interesting to share, write it up while it is fresh in your mind; it will be put in a queue. We intend to put an issue out every 2 months, as of old.

Help us, the new editors, to make the renewed DOINGS something we can all enjoy reading.

Bob Garrison

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*Production: Esther Oostdyk*

## $D^3$ Goes Electronic

The "New Doings" will be published electronically. Esther Oostdyk will create a TEX manuscript from the VAX files that Bob and I have edited. We hope that everyone who has a VAX account will submit their contributions by VAX mail to (ATLAS::)ROGERS. Our readership extends far beyond Toronto; become a correspondent and use BITNET (bitnet%"rogers@utorphys"). Not only will this make editing easier for us, but you'll save Esther from re-typing your submission. For those of you who are not familiar with computers, please don't let this high-tech system deter you from contributing. Write, type, phone, *or even whisper*, and we'll make sure that it will appear in the next issue. (Deadline for December issue: 21 November).

Chris Rogers

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**With great sadness, we note the passing away of Chris McAlary (Ph. D. 1982). The next issue will contain a tribute to him and his work written by Dennis Crabtree. If you have something to contribute, please send it to the editors by 21 November.**

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*Scarborough Status Report*

*A photograph of the Scarborough theory group appears on the front cover.*

*The biggest excitement over the summer in the Scarborough Astrophysics group was the arrival of our new Sun 3-160 supermicro. With the floating-point accelerator it proves to be 3 to 4 times faster than a micro Vax. Several of the students' theses will be developed on this machine.*

*Charles Dyer and Lee Oattes participated in GR-11 in Stockholm from July 6 to 12. They presented four papers concerning work on inhomogeneous cosmological models (one with G.C. McVittie) and on tensor algebra systems. John Harper ported the Reduce version of the muTNSR system to the new machine. Following an enthusiastic response to it at GR-11, the microcomputer version of this system was augmented to include virtual-memory management in preparation for further distribution.*

*Martin Duncan attended back-to-back meetings in Princeton this summer; the first was IAU Symposium 127, "Structure and Dynamics of Elliptical Galaxies", and the second was a workshop on the use of supercomputers in stellar dynamics. He presented papers at both meetings. Mike Seufert also attended the second meeting.*

*Peter Leonard presented a paper at the CASCA meeting and Rachel Webster participated in the Summer school on the early universe held in the West.*

## CONGRATULATIONS

To *Slavek Rucinski*, who has been appointed assistant professor. This position was created through the award of a Killam Fellowship to Barry Madore, on leave at Cal Tech.

To *Richard Gray* (Garrison), *Mercedes Richards* (Bolton), and *Christoper Stagg* (Percy) who recently completed their Ph.D. requirements. Richard has taken a NATO fellowship to Denmark, Mercedes has moved to Chapel Hill, N. C. and Chris is currently holding teaching assistantships in the department while carrying on his research.

To *David Holdsworth* who finished his M.Sc. thesis under Stefan Mochnacki and to *Cathy Westbury* who completed her M.Sc. requirements under Peter Martin's supervision.

To *Dale Frail*, *Michael Bietenholz*, *Bob Hill*, and *Patricio Ortiz* who passed their general exams.

To *Tom Bolton* and *Susan Challenger* who were married on October 3 in the Observatory library.

To *Dale Frail* and *Ruth Milner* (SYSRUTH) who were married on August 15.

To *Judith Irwin* and *Dieter Bruckner* who are engaged to be married next year.

## COMINGS AND GOINGS

Lee Anne Willson returned to Iowa State Univ. after a one-year Sabbatical here.

Nancy Morrison finished her sabbatical stay at U of T and has returned to U of T (Toledo).

Rob Managan wrapped-up his post-doctoral work with Maurice Clement and has moved on to Lawrence-Livermore where he will be a systems analyst.

Dennis Crabtree (Ph.D. 1982) passed through Toronto on his way to the Space Telescope Institute where he will be for the next several months. Dennis is establishing the data reduction facility at DAO.

Return of the Dougs: Welsh (DAO, Ph.D. 1986) and Gies (Texas, Ph.D. 1985) also passed through Toronto. The former even had time to deliver a special colloquium.

K-T. Kim returned from Penticton to finish writing his Ph.D. thesis under Phil Kronberg's direction.

Mario Pedreros (Ph.D. 1984) is back in Canada, on a leave of absence from the University of Chile. He is at Saint Mary's University in Halifax working as a research associate with Turner, Welch, and Reed. Welcome back, Mario!

Several new students have arrived. M.Sc. students: John Dubinski (Waterloo), Mike Fieldus (UofT), Rob Straker (Calgary). Ph.D. students: Jim Picha (UBC), and Yin Zhan (China). Dimitar Sasselov (Sofia) is expected to arrive this spring.

Petrusia Kowalsky has left the department to study at the Faculty of Education, U of T.

Petr Harmanec and Pavel Koubsky of the Ondrejov Observatory, Czechoslovakia, spent three weeks and one week here, respectively, on their way to IAU Colloquium 92 (The Physics of Be Stars) in Boulder.

Ms. Patricia Monger has just arrived to work as a consultant on computer systems for Phil Kronberg. Patricia spends part of her time as a programming consultant for the Space Telescope Science Institute at Baltimore, where she also worked prior to coming to the Toronto area. She has previous positions at the Astronomy department at Berkeley, and the Institute of Astronomy at Cambridge. Welcome Patricia!

It is a pleasure to welcome Nancy Evans (Ph.D. 1974, assistant professor at Erindale 1983) back to the Department after several years in the States working on IUE. She and her family are once again domiciled in Toronto, and she will be working as a Research Officer with Don Fernie and John Percy.

The Cray supercomputer arrived on campus and is up and running.

## POTPOURRI

*Helen Hogg gave an invited paper on "Shapley's Era" at IAU Symposium 126, held at Harvard University August 24-29, and was joint author of a poster paper: "A Candidate for the Recovered Nova of 1938 in the Globular Cluster M14" by Michael M. Shara, Michael Potter, Anthony F.J. Moffat, Amelia Wehlau, and Helen Sawyer Hogg.*

*On May 12 Helen Hogg was the speaker at the annual dinner of the President's Committee of the University of Waterloo held at the Seagram Museum. She spoke on the subject of Halley's Comet.*

*On May 31 she and her husband (F.E.L. Priestley) attended her 60th class reunion at Mount Holyoke College, South Hadley Massachusetts. At this event, the 125 surviving members of the class presented the College with one-million dollars to establish the Professorship of the Class of 1926.*

*David Blyth received a letter from the Embassy of the USSR in Ottawa, thanking him for his "...personal contribution to the defeat of fashism [italics added; ed.] as a participant of the convoys to the Soviet Arctic ports during the Second World war when our two countries were allies." David served in the Royal Navy during the war and participated in the convoys from 1941-44. The Soviet Embassy recently awarded medals to Canadians who served on the H. M. C. S. ships Haida and Huron in 1944, so Dave enquired about the eligibility of the Royal Navy, which participated longer.*

*Petrusia Kowalsky and John Percy between them taught several sections of astronomy at the Peel Summer Academy, an Erindale College and Peel Board of Education program for gifted elementary students.*

*Several members of the department are involved in teaching an astronomy course to the U of T Later Life Learning program. About 250 are enrolled in the course.*

*Keith Marcus is working for a few months with John Percy on a project to determine period changes in Cepheids. His position is funded by a job creation program of Employment and Immigration Canada.*

*Don Fernie, Petrusia Kowalsky and John Percy attended the 75th Anniversary Meeting of the AAVSO in Cambridge from August 5 to 10. The highlight of the meeting was the dedication of the AAVSO's new permanent headquarters. Don gave a review paper on R CrB stars, John gave a review of variable star astronomy 1900-1986, and Petrusia and John gave a contributed paper on the determination of period changes in several hundred Mira Stars from 75 years of AAVSO visual data.*

*Tom Bolton, Alex Fullerton, Bob Garrison, John Percy, and Chris Stagg attended IAU Colloquium 92 (the Physics of Be Stars) in Boulder.*

*Don Fernie, Alex Fullerton, Rob Managan, and Nancy Evans attended the John Cox Memorial Symposium in Los Alamos from August 11 to 15.*

*In June Phil Kronberg was appointed as first Chairperson of the University of Toronto Supercomputer Users' Group. By virtue of this office, he also is a member of the Management Board of the Centre for Large Scale Computation at the University of Toronto. The Management board has executive authority over all aspects of the new supercomputer facility, including the commerical marketing. In September he was also appointed by the President to the Inter-University Advisory Board. This board, which has five U of T members, one from the Ontario government, and six (including the Chair) from other Ontario universities will advise the director of CLSC on overall policy, particularly as it affects researchers in other universities.*

*Phil Kronberg participated in an international workshop on Interstellar Magnetic fields at Ringberg Castle in Bavaria, from 8 to 12 September 1986.*

*In August, K.T. Kim presented some of his results on the Coma cluster at an NRAO Workshop on galaxy clusters.*

*Phil and Ernie are anticipating the imminent arrival of their new Sun 3 computer, which will form the nucleus of the new AIPS Cage on the 16th floor.*

*Don Fernie and his family spent July in South Africa. En route home he stopped off to give an invited review paper on R CrB stars at the AAVSO 75th anniversary meeting being held at Harvard during the first week of August. The following week he gave a paper on BM Cas at a stellar pulsation conference held in Los Alamos, New Mexico. He has also given two talks on pulsating stars to RASC centres: the Niagara Centre in April, and the Hamilton Centre at the beginning of October. A talk on the history of the Observatory was given to the Richmond Hill Historial Society in May.*

## From Our Far-Flung Graduates .....

Christine Wilson (B. Sc. 1984) discovered a comet in August. Since she worked at the DDO for two summers, we remember her better than most of our undergraduates. Now Christine is a Cal Tech student, working with Wal Sargent.

Comet Wilson will be seen most easily from the Southern Hemisphere, and may turn out to be a naked-eye object; like the infamous Comet Kohoutek, it was discovered while still out beyond the orbit of Mars, so nobody is willing to risk a prediction, especially for the media.

The Los Angeles times ran a full-page spread on her and her discovery, including a few paragraphs on her Toronto history. The Pasadena Star-News also published a long article, with a picture of Christine. It did make it into a few of the Toronto papers, but only with a few paragraphs and no pictures. It's no wonder nobody knows much about Canadian science and scientists.

Richard Gray (Ph.D. 1986) writes from Denmark that he is settling in well and looks forward to a productive two years. He has met Stromgren (who is now 78 and, as Denmark's leading scientist, occupies the Carlsberg House on the grounds of the famous brewery, previously occupied by Bohr) and was impressed with how every excited and knowledgeable he still is about astronomy. Since Richard's thesis compared the uvby$\beta$ system with his revised MK classifications for a large sample of stars, they should have lots to talk about.

With Erik Olsen, Richard applied for and received very generous support (3,300 Cdn!) from the Danish NSF for his observing trip to Chile in November/December to use the UTSO 60cm telescope. In addition, they have applied for an observing run in April to use the Danish 50cm and our 60cm. ESO will pay.

Some of you will remember that Richard spent 7 years in the boondocks of Cameroon, where he met and married Mary. He writes: "I know the Wum area very well and had actually been planning a trip to Lake Nyos, but couldn't fit it in before we left. There are hundreds of such volcanic lakes in Northwest Cameroon; there is one in the village I lived in for 4 years!"

## From the CITA NEWSLETTER.....

The Canadian Institute for Theoretical Astrophysics, a national centre hosted by the University of Toronto, is expanding. They have nearly taken over the 12th floor of Burton Tower trying to accommodate their growing staff. New Research Fellows this year include: Hyung Mok Lee (Princeton), Lorne Nelson (Queen's, MIT), Tom Quinn (Princeton), Arnold Boothroyd (McGill, CalTech), Chong-An Chang (Pittsburg, Beijing), Tatsuhiko Hasegawa (Tohoku, Japan), and Alberto Noreigo-Crespo (Santa Cruz). Past and future Reinhardt Fellows at CITA are Kim Innanen (York), Walt Duley (York), Ray Carlberg (York), and Kayll Lake (Queen's). Recent long-term visitors include Jacob Bekenstein (Ben-Gurion),and Peter Eggleton (Cambridge). Soon

the permanent staff will be increased to four; a new tenure-stream position for CITA is being advertised.

In June a U of T Doctor of Science degree was presented to Jim Peebles (Princeton), who will return to CITA in March.

CITA is actively involved in several workshops and conferences: Cosmology Summer School (Vancouver Island, Aug. 17-30), Ring Systems of Uranus and Neptune (Sept.12-13), Gravitational Lenses (Oct. 3-4), "Kingston" meeting (Victoria, Oct. 17-18), Supernova Remnants and the ISM (DRAO, June 10-12 1987), and Star Formation (NATO, Whistler, B.C. June 21-July 4).

## The CCD at UTSO

Marshall McCall

As most of you know, in April the Department of Astronomy decided to commit $100,000 towards the purchase of a CCD camera for the University of Toronto Southern Observatory. The CCD committee decided to buy a complete camera and data acquisition system from Photometrics, Ltd. in Tucson, Arizona. Here is a progress report.

The system will be based around a Tektronix $512 \times 512$ CCD. Pixels are $27\,\mu\mathrm{m} \times 27\,\mu\mathrm{m}$. At the $f/15$ focus of the 24-inch (scale $22.6\,\mathrm{arcsec\,mm^{-1}}$), each pixel will subtend $0.61 \times 0.61$ arcsec, and the field of view will be $5.2 \times 5.2$ arcmin. Not only does the chip offer a wide field of view, but it makes possible reasonable sampling of images at times of good seeing. The readout noise is specified to be below $10\,\mathrm{e^-\,pix^{-1}}$ at a readout rate of $50\,\mathrm{kpix\,s^{-1}}$. Yes, that was 10, not 100! The charge transfer efficiency is 0.99999 (i.e. excellent), and the full well is $750,000\,\mathrm{e^-}$. At 4000 Å the quantum efficiency is expected to be greater than 30% (this is Tektronix' specification). The quantum efficiency peaks at 60% to 70% around 5500 Å, is greater than 50% at 7000 Å, and may be above 30% at 9000 Å, although this last number is presently a wild guess. The chip is rugged in the sense that the silicon has a supporting back which is bonded to a ceramic glass substrate, i.e. the silicon membrane is not supported by its edges, as is the case for RCA CCD's. Another important characteristic is the flatness control, since this has a bearing on the smoothness of the quantum efficiency curve and fringing during exposure to monochromatic light. The surface is flat to $\pm 1\,\mu\mathrm{m}$ locally, and has less than a $10\,\mu\mathrm{m}$ bow from one side to the other. These characteristics are better than any other chip in operation, as far as I know.

Now here is the bottomline: an exposure of 3 hours in V should enable 1% photometry down to magnitude 21.5 in an uncrowded field.

When Sydney Wolff was here, she said that NOAO had just received a Tektronix chip and had subjected it to one night of testing. Based on this limited data, the chip was clearly better than any other chip on the mountain. The readout noise was $7\,\mathrm{e^-\,pix^{-1}}$.

Our data-acquisition system will consist of a graphics terminal, printer, monochrome TV monitor, camera controller, Heurikon MC68010 computer, 140 Mbyte hard disk, $5\frac{1}{4}$ inch floppy disk drive, and Thorne-EMI 1600 bpi tape drive. Photometrics is not willing to interface write-once optical disk drives to their system at this time, even though systems meeting our requirements do exist. The problem is that there is no standardization yet in this fledgling industry. Both Unix and Forth operating systems are provided. Included with Unix are compilers for Fortran77, Pascal, and C. Tapes can be written in FITS format. We expect to run the system under Unix.

The control software enables considerable flexibility with respect to readout of the CCD. For example, it will be possible to read out arbitrary small portions of the CCD (e.g. a single star) rather than the whole chip. The software also enables considerable control over image display and analysis. A mouse is included to handle cursor control and readout.

One of the problems with UTSO is that there is no clean room in which to store sensitive computer equipment. We are very concerned about placing the data acquisition system, particularly the tape drive, in the open dome. Therefore, a vertical laminar flow cabinet is being purchased to provide a filtered air environment in which to store the computer rack. By adjusting the air flow, it will be possible to have some control over the temperature as well (integrated circuits won't work below 0° C). Whether or not images are adversely affected by the air flow can only be learned by experience. However, the cabinet provides us with enough flexibility that we can adjust according to the circumstances.

Photometrics has received our order, and has indicated that the system could be ready by mid-November (yes, that is this year) once a chip is received. Unfortunately, Tektronix has encountered more problems in the fabrication of Grade 1 (the highest quality) chips, and has ceased deliveries. Grade 1 chips have no bad columns and fewer than 10 point defects. Grade 2 chips have 1 or fewer bad columns and fewer than 20 point defects, while Grade 3 chips have 3 or fewer column defects and 40 or fewer point defects. As far as I can tell, NOAO got a Grade 3 chip. We ordered a Grade 1 chip. Therefore, we are in waiting mode. If by the end of the year there appears to be no end in sight to the fabrication problems, the CCD committee will look seriously at ordering a Tektronix chip of a lower grade. It is felt that Tektronix presently makes chips which are state-of-the-art and which are unrivalled in the market-place. I personally am not inclined to get a chip from another company.

The cost of the CCD system after accounting for exchange will be almost exactly $100,000. We have requested that a representative of Photometrics go down to Chile with us to make it operational. Any expenditures over the departmental grant (such as the cabinet and Photometrics' installation charges) will be covered by operating grants (i.e. mine and Barry Madore's).

Considering the prospects for research and education, I feel that the money is well spent. Pray that the Canadian dollar doesn't decline in the next few months.

## The Future of Optical/IR Astronomy in Canada

Marshall McCall

The Subcommittee on Optical/IR Astronomy, which reports both to the Canadian Astronomical Society and the Associate Committee on Astronomy of the National Research Council, met in Toronto on Saturday, October 4. In attendance were Bruce Campbell (Chairman), Gretchen Harris, Sun Kwok, Tony Moffat, Harvey Richer, Jean-René Roy, and I. Bob McLaren and Daniel Nadeau were unable to attend. Even though the final report has yet to be written and agreed upon, the meeting was important enough that I thought that it would be worthwhile to convey the tone if for no other reason than to stimulate thought and discussion about the most important issues.

The morning was devoted to a discussion of the future of CFHT. The committee believes that the telescope is an extremely valuable asset of the Canadian astronomical community, and that it should be supported with vigour. Top priority was given to optimizing the telescope for imaging, since this is one area where CFHT should remain competitive for years to come (monster telescopes won't have as good images, and the ST suffers from a small field of view). Besides encouraging continued work on the dome seeing, the committee recommends exploration of adaptive optics. Already on the drawing board and capable of being implemented within a year is an inexpensive system (consisting of a tilt-mirror and automatic shutter) capable of providing high quality images over a field of 1 arcmin. The committee is recommending as a top priority that this system be financed and installed as soon as possible at least to give us a lead-in to more complex adaptive optics which will be considered farther down the line. Also, it is recommended that CFHT buy a single Tektronix $2048 \times 2048$ CCD once such chips become available.

While the IR instrumentation is used by few people, it was recognized that CFHT is competitive with the best infrared telescopes in the world. Therefore, the committee recommends that the FTS and IR photometers be maintained for the present, with the understanding that the ultimate aim should be to equip the f/36 focus with an IR array detector.

The afternoon was devoted to setting a list of priorities for Canadian optical/IR astronomy. The options considered were:

1. Investment in an 8–10 meter telescope.
2. A 2–3 meter telescope.
3. Investment in a multi-object spectrographic telescope.
4. A space experiment.
5. A CCD mosaic for CFHT.

Before the meeting, I expected that this discussion would be rather heated. However, it was soon recognized that there was really only one option. The committee unanimously agreed that the highest priority should be given to the construction of a wide-field, high-resolution imaging telescope for the space station, preferably with wavelength sensitivity from the vacuum ultraviolet to the near-IR.

Part of the problem with past proposals for expensive research experiments is that they have been made without ever identifying a source of funding. At the moment, there is one and only one identifiable source of funding for major endeavours, namely the government's financial commitment to the space station. Money is already available for Phase A studies of *astronomical* experiments.

Apparently, the horizontal platform of the space station will be launched in 1994. There will be no permanent manned presence for the first five years. Therefore, the initial environment will be suitable for astronomy.

The need for a complement to ST remains. I believe that STARLAB's demise was in part due to its attempt to do too many things. Furthermore, since that time, detector technology has advanced to the point that bare CCD's are a viable option. A space station telescope devoted to wide-field high-resolution imaging (with maybe a grism or objective prism for low resolution spectroscopy) might just be exciting enough to attract government support yet still cost little enough to be economically feasible. Of course, involvement other countries with such a project might also be considered. Our case might be made even better if the telescope could be made to point down as well as up, since a larger segment of the Canadian research community could benefit.

Such a telescope would require a mosaic of detectors to access an acceptably large field. To obtain a resolution of 0.1 arcsec at 3000 Å over a field of 20 arcmin, as would be possible with 1 m telescope, a $12 \times 12$ array of large-format Tektronix CCD's would be required. Therefore, the committee is suggesting that research into CCD mosaics be encouraged within the astronomical community. Of course, such research would also have spinoffs for CFHT.

Ultimately, our list of priorities contained only one item, i.e. the space telescope. We did not want to dilute the importance of the number one priority by listing anything else. It was gratifying to see such a diverse group of astronomers rationally converge on such an important issue.

Any comments anyone might have about these subjects and others are always welcome.

## Shectograph Progress

Stefan Mochnacki

During the summer, the Shectograph software was debugged and thoroughly tested. It works with a PC or clone as the host, although most of the work is done by the on-board 6809 processor. Fabrication of the head components was essentially finished, and the last remaining hurdle is the potting of the image tube stack. The signal train from Reticons to host computer works well. All the electronics boards with the exception of the CPU are duplicated (or triplicated) so that any malfunction in the signal processing electronics can be overcome quickly by replacing the defective board with its spare.

In December, the Shectograph will go on the Cassegrain spectrograph of the 74-inch telescope, without cooling. We anticipate two or three months of operation during the winter. In the meantime, we are building an off-telescope fibre-fed spectrograph, which will allow the Shectrograph's image tubes and Reticons to be housed in a cold-box at $-25°C$.

## The SEDS University Of Toronto Space Conference

Stefan Mochnacki

The U of T chapter of Students for the Exploration and Development of Space held a conference in McLennan Labs on the 19th and 20th of September. An impressive line-up of speakers included Tom Bolton, Martin Duncan, Bob Garrison and Stefan Mochnacki, as well as speakers from industry, government, other universities and the media. A showing of the IMAX movies "Hail Columbia" and "The Dream is Alive" at the Cinesphere was particularly well attended, with RASC members out in numbers. The talks were well balanced between technical, political and moral themes, and went off according to schedule thanks to the remarkably disciplined chairmanship of Jayanne English. Those who attended the conference included students, faculty, amateur astronomers and space buffs.

It was clear to me that this is a serious organization deserving of our support. It is precisely what a University is all about: the discussion of important issues in a thoughtful manner in an open forum. Given the extremely long-term nature of space activities, the serious discussion of space-related issues at the student level is vitally important for the (unfortunately distant) future. Interested people can contact Jayanne English at 591-6758.

## The Synoptic High Resolution Spectroscopic Observing Group Workshop

Tom Bolton

It has become increasingly apparent over the past few years that large-scale surveys and long-term monitoring of time variable phenomena* are essential to progress in many fields of astronomy. This is especially true in stellar astronomy where some phenomena, such as stellar activity (e.g. star spot) cycles, extend over periods of decades and other phenomena, such as nonradial pulsation, can only be studied by repeated observations over periods of weeks or months. Observing programs of this nature can sometimes be carried out at university and private observatories, but the opportunities for these programs at national observatories are severely limited by operating and scheduling policies which are designed to maximize numbers of users and short term returns.

This situation, the threatened demise of the long term stellar activity program at Mt. Wilson Observatory, the most successful of the synoptic programs to date, the possibility that NOAO may get a new 3.5-4-m telescope in a few years, which might be dedicated to synoptic observations, and the recent success of the Global Oscillations Network Group (GONG) in obtaining funds for a network of instruments dedicated to observing solar oscillations prompted Jeff Linsky to organize a small workshop to consider what steps could be taken to best enhance the opportunities for synoptic observing programs.

The workshop, which was held at NOAO headquarters in Tucson during the first week of September, was attended by 28 astronomers from 15 different institutions. Two thirds of those in attendance were from groups associated with NOAO or the University of Colorado which are interested primarily in observing stellar activity cycles, so the group was not broadly representative of the community interested in synoptic observations. This undoubtedly had some impact on the final conclusions of the workshop, but it was nonetheless a useful first step toward defining the need for a synoptic observing facility and setting up an organization to work toward its creation.

Most of the first day of the workshop was taken up with presentations on the science requirements for various fields where synoptic observations are needed. These included: convection, rotation and turbulence (W. Livingston, NSO), astereoseismology** (J. Harvey, NSO), nonradial oscillations of stars (M. Smith, NSO), Doppler imaging of star spots (J. Neff, JILA), magnetic fields in solar type stars (S. Saar, JILA), pre-main sequence stars [PMS] (M. Giampapa, NSO), flare stars (B. Bopp, U. of Toledo), cool

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* Some astronomers have started to call these synoptic observations, but the closest definition of this term is "affording a general view of the whole", which suggests that we need to find a better term

** The science of probing the interior structure of stars by studying their high order pulsational modes. [Spelling is controversial and was vehemently defended at the meeting; see Cassiopeia, autumnal equinox 1986, (ed.)]

flare stars (B. Bopp, U. of Toledo), cool giants and symbiotic stars (G. Wallerstein, U. of Washington), circumstellar envelopes and mass loss in OB stars (T. Bolton, DDO), and binary stars (T. Bolton, DDO). Although photometric and extragalactic research programs were not well represented at the workshop, the participants were aware that a synoptic observing facility would also have applications in these areas.

Late on the first day there were several presentations on instrumental concepts for synoptic observing facilities. L. Ramsey (Penn State) and S. Barden (KPNO) discussed spectrographs, R. Dunn (NSO) described possible directions for innovative (i.e. inexpensive) telescope and spectrograph designs specialized for synoptic work, and R. Green discussed the properties and availability of CCD detectors. All of the discussions of spectrographs centered around fiber-optics-fed echelle spectrographs that would have wide wavelength coverage and could be easily moved from one telescope to another.

It is possible to build a single spectrograph that would satisfy most, if not all, of the scientific requirements described in the science presentations, but it would have to be large and expensive ($>$ 1 megabuck US). Alternatively, we could design a small, inexpensive ($<$ 100 kilobucks US) spectrograph which would meet the needs of most programs (but not astereoseismology) and could be easily duplicated by many observatories. This would help to promote the development of a synoptic observing network based on existing 2-m class telescopes.

During the discussion of telescope specifications, it was realized that convenience and economical operation are important considerations for facilities intended for long term dedicated observing programs. This means that the telescopes should be located at a developed site or close to a University campus. Large, 3-4-m class, telescopes should be located at good sites, but convenience, economy, and simplicity of operation may be more important considerations than site quality for 2-m class telescopes. Which is what we've been saying for years about the 74-inch telescope at DDO.

The second day was taken up with summaries of the instrumental and time allocation and scheduling requirements for the various possible research programs, descriptions of the status of current and planned synoptic programs, and discussion of other plausible options for synoptic programs. It was generally agreed that astereoseismology was the most exciting synoptic program. The scientific requirements for successful astereoseismology are not completely clear, but arguments based on the experience with the sun suggest that the instrument will have to be able to obtain spectra with a resolution approaching 100,000 at S/N=100 with a time resolution of 1 minute at V=9! In addition, the detector will have to be large enough to insure that at least 1000 lines are included in the region of the spectrum recorded, and the spectrograph will have to be extremely stable, because the velocities to be measured are on the order of 10 cm/sec. To my surprise, no one thought such a system was impossible, but everyone agreed it would require a very large telescope and be very expensive to meet all of these specifications. Furthermore, the scheduling requirements for astereoseismology

(minimum two week blocks on a single star) will interfere with the scheduling of other synoptic programs on the same instrument.

The PMS and flare stars programs require relatively modest spectral resolution and S/N for significant work, but the faintness of the stars and the short time scales for some of the variability (V<15 and 5 minutes for PMS stars, and V<12 and seconds for the flare stars) means that an optimum program will also require a large telescope. For most of the other areas, the requirements for time resolution and limiting magnitude are such that significant progress could be made with a 2-m class telescope, or a network of such instruments, if the scheduling of the telescope(s) was sufficiently flexible. However, it would be possible to observe many more objects with a larger telescope.

I found that the review of current and planned synoptic programs was somewhat depressing. Six programs were discussed, only two of which, the NSO program on the McMath telescope and the long-term stellar activity program on the Mt. Wilson 60-inch telescope, are currently active, and the funding to continue the latter program has not yet been approved. The remaining programs fall along a continuum from concept development to funded instruments now under construction, and most were intended to study activity in solar type stars. Clearly there is room for additional synoptic observing programs, because even if all of these programs were to proceed as outlined, which is unlikely, they would not begin to address all of the scientific issues where progress depends on this type of observing.

Unfortunately, it is not clear how we can quickly improve the opportunities for synoptic observing. Given the large over subscription rates on moderate-sized and large telescopes at NOAO and the entrenched user communities on these instruments, there is no possibility of changing their scheduling policies to accommodate more synoptic programs. The only immediate possibility for a dedicated synoptic instrument is the Mt. Wilson 100-inch telescope. R. Ulrich (UCLA) summarized the present status of this instrument. As yet there is no administrative structure or funding in place to reopen the telescope. If and when these become available, some repairs will have to be made to the telescope before it can be used. It would also be desirable to build a new spectrograph that is better suited to the format of CCD detectors.

In the longer term, there is a possibility that NOAO will get a new 3.5-4-m telescope which could be partly or wholly dedicated to synoptic programs. NOAO expects to get the mirror blank for such a telescope next year, but since this mirror is to be used initially for testing of concepts for the NNTT, it will be at least two years after that before it is available for use in a telescope. Given the usual time-scales for funding and construction, a new telescope is at least 5 years away, and there are competing proposals for the use of the instrument.

On the final morning, there was a general discussion of the important questions that had been raised on the previous two days. It was generally agreed that we should aggressively pursue enhanced opportunities for synoptic observing programs and that it is important to try to do something as soon as possible rather than wait on the somewhat nebulous possibility of a dedicated facility at NOAO. It was also agreed that in the long term it would be best to have any synoptic observing facility managed by NOAO, but it may be necessary to find short term opportunities within some other framework. Finally, it was agreed that we should begin to design ideal spectrographs for the synoptic programs discussed above and look for a suitable telescope to host one or more of these instruments until a large telescope dedicated to synoptic observations can be obtained. The Mt. Wilson 100-inch and McMath solar telescopes are the most likely possibilities at this time.

At the end of the Workshop, a steering committee consisting of J. Linsky, M. Giampapa, J. Gallagher, M. Smith, and L. Ramsey was formed to carry on the work begun at the workshop, and subcommittees were appointed to work on spectrograph designs (L. Ramsey, R. Dunn, and J. Harvey) and investigate the feasibility of re-opening the Mt. Wilson 100-inch telescope for synoptic observing (R. Radick and G. Wallerstein). There will be another workshop to assess progress and make further plans on 1987 July 11 in Boulder, Colorado, after the next meeting on Cool Stars, Stellar Systems and the Sun.

## My Experiences With The Very Large Array

Slavek Rucinski

After having observed with optical telescopes of various sizes, ranging from about 0.4m (KPNO, IUE) to 4m (KPNO), I decided to try something really big, with an effective aperture of 130m. As you know, this is not really a solid aperture but an array of smaller ones (called by radio-astronomers "antennas") scattered over many kilometers of the New Mexico high plains. The mounting data on stellar activity badly needs supplementing by information on the hottest parts of stellar coronae; this information can be obtained only by observing in two vastly different regions: in X-rays and in radio-wavelengths. Since most of x-ray satellites are defunct now, we must try in the radio. And only the VLA is sensitive enough to see coronal radio emission, even from nearby stars.

Frankly, I was a bit afraid of possible problems. After all, crossing the optical astronomy - radio astronomy border line is not advisable after 30 and may be dangerous after one becomes 40 years old! But the stimulating radio-atmosphere of our department helped; I closed my eyes - and tried. Now my initial impressions: 1) It is surprisingly easy to obtain time on the VLA. I took the success of the first two proposals prepared with experienced radio-astronomers (Ernie Seaquist here and Dave Gibson, New Mexico Tech.) as an indication that they knew how to write proposals.

But, to my surprise, my own proposal also got quite a bit of time. 2) The VLA proposals do not have to be big, at least when you compare them with the KPNO, CFHT, IUE, Exosat, IRAS, etc. standards. One page of the standard form and one-two pages of descriptions in enough! The VLA must be less over-subscribed than telescopes at typical national facilities. 3) The instrument seems to be rather easy to use; the manuals are very well written. Given the immense complexity of the VLA, its use seems to be easier than that of a typical cassegrain spectrograph. 4) the radio-astronomical weather can be very temperamental; sometimes it may be very bad. And here an unpleasant surprise: "you cannot say how good this weather will be by looking out of the window" (this is told to every newcomer to the VLA site). 5) The amount of data reduction is really colossal. The methods are well described and moderately easy to follow. But computers at the VLA site are running close to their capacity all the time and sometimes reductions take very very much time.

What remains to be added to these initial impressions are thanks to various people who helped me in my first steps in becoming an (almost) radio astronomer. I would like to thank (in order of time spent on my education) Ernie Seaquist, Dave Gibson, Brian Glendenning and Judith Irwin for their patience and understanding.

## How I Spent My Summer Vacation

Alex Fullerton

Like any seasoned graduate student, I had certain expectations as the spring term ended: rec-league baseball, the GSU after rec-league baseball, and inordinately long lunch breaks. Alas, this year my expectations were wildly perturbed by toil and travel as I was introduced to the peripatetic ways of an observational astronomer.

The hectic activity began during the last two weeks of June as Tom and I jetted off for mauno-lithic Mauna Kea, one more time. My initial enthusiasm for 13 nights of CFHT time in 6 months had been eroded considerably by the volume of data I had acquired in December, and on the day we flew my will to live was also ebbing since I'd made a late night trip to Room 1318 to find my finder charts. Fortunately, everything was "upslope" from that point, and the run was in the mythical category of "beyond wildest dreams". We had 7 consecutive nights of good seeing, lost a few hours to the TCS computer, but still managed to achieve our goal of 300 high quality spectra. A large fraction of our program stars were "performing" in one way or another, and the nights passed quickly. True to form, the vent of Kilauea which is currently active kicked off on our second last night, and we had a good view of the eruption until dawn. We descended feeling pleased with ourselves, and I gave a progress report on our project at CFHT headquarters on Canada Day.

Tom and I spent about half a day looking at the beach and then parted company. My next stop was Victoria, to give a colloquium at DAO on O-star line-profile variability on July 4 (principle of conservation of talks on national holidays). My host was the inimitable Douglas of Arabia but by some strange quirk, Dr. M. L. McCall also happened to be on the observing schedule. In the face of almost certain fun, we actually worked at night and "fished" during the day. However, I shall reserve the telling of the story of "Fishing on Brentwood Bay with Doug, Marshall, and the Viscious Samoan War Club" for a forum less likely to generate legal complications. This was my first trip to the West coast and DAO, and I was very impressed by the scenery and the 48″, respectively.

I returned to room 1318 on July 9, somewhat the worse for wear but in time to relate the wonders of Hawaii to Doug Gies (during one of his patented whirlwind visits) and attend Ricardo Gray's Ph.D. bash. The next few weeks are rather muddled, but I think I was frantically engaged in reducing three hundred spectra and writing a poster paper with Myron Smith (over the phone, of course). I must have finished, for August 10 saw Rob Managan and I jetting to Los Alamos to attend the conference "Stellar Pulsation: A Memorial to John P. Cox" along with Don Fernie and Nancy Evans. I presented a couple of papers (no marks for guessing themes), and found myself on the receiving end of the criticism stick, much to my suprise. The experience was painfully rewarding, as were the long sessions of the conference which covered every aspect of the field of stellar pulsation, both from the observational and theoretical vantage point. Among my special memories from Los Alamos were the moving tributes paid to the science and humanity of John Cox by his colleagues and students.

The following week I rolled on to Boulder to IAU Colloquium 92 on the physics of Be stars, there to meet with several Torontonians (Bln, Py, rG, Stg) and numerous collaborators. This meeting was more focussed and more interesting, but I had already overdosed on learned 15-minute lectures and too much colloquium coffee, so my attention span was not good. For me, most of the highlights occurred during informal conversations with various researchers. In any event, the realities of the McDonald observing schedule forced Doug Gies and me to head south before the conference ended.

This observing run was to be the grand finale. End of thesis observing, dawn of new age of enlightenment, and so on. We had amassed a large arsenal of instruments and 7 investigators (known as the "O Team") in a haphazard but reasonably efficient manner to determine once and for all whether the photospheric variations we've been studying are related to the wind fluctuations which others have noticed. We'd decided to observe 4 stars simultaneously using a total of 5 telescopes (including some 60 consecutive hours of IUE time), concentrating on high quality spectroscopy and polarimetry. We had tried a similar venture last year at precisely the same time; the failure of one of IUE's gyro's killed that attempt, although we had a tremendously successful optical run. Consequently, we paid little heed to rG's warnings about the monsoon season at McDonald - and we were all but wiped out by mist, fog, and rain. **OF COURSE**, IUE performed flawlessly .... perhaps we can amass a similar battery next year (three

times lucky) and the "Zero Team" can redeem itself. For the second year running Doug Gies and I put on our astronomical "McKenzie Brothers" performance for the public night at the 107″, but even this was bittersweet since it was the last public night held in the big dome. Tom told me there'd be runs like this!

I returned to Toronto on Labour Day, just in time to get back to work.

## Unforgettable Penticton

K. T. Kim

If you take a look at a standard map, a lovely town called Penticton is found in the midst of the western part of Canada; where contours of equi-altitude are dense and gradients of the slope are large, you will find one of the sunniest and most "radio quiet" places in all of Canada. The Dominion Radio Astrophysical Observatory is 12 miles south-east of downtown Penticton. DRAO has a synthesis radio telescope consisting of four 9-m dishes on a 600-m long baseline, and operating at dual frequencies, 1420 MHz (line and continuum) and 408 MHz (continuum). A 26-m dish is also used.

The wilds of British Columbia provide a variety of challenges which increase the dynamic range of life. A beautiful harmony between nature and civilization has been maintained. Orchards in the Okanagan valley produce fruits such as cherries in late June and later on plums, peaches, apricots, apples, and grapes. The observatory kitchen table is full of such delights till early autumn. Snow on the mountains which surround the observatory reflects light from the rising Sun. The volleyball game starts at lunch and lasts thirty minutes. Players have developed their own odd skills but basically the ball, which is tossed and scooped back and forth, mimics the Fermi particle acceleration process in supernova remnants (or the somewhat less well-known "Fernie process" on the DDO court: eds.).

The darkness of night on the observatory site is scary though not awful. Everything disappears into nothingness except my heartbeat which recalls the life within me. Twinkling starlights dance on the surface of the tea in my mug. "Okanagan Arches", the northern lights, occasionally stretch north-south across the sky confusing visiting astronomers who wonder whether the Milky way has rotated by 90 degrees over the night. Coyotes howl in a sporadic and incoherent fashion and remind us it is a full-moon.

The first two months in Toronto after coming back from Penticton were a tough period of "phase transition". A great multitude of people and the extremely humid weather were noticed immediately. "You will love the DRAO!", Judith said when I was ready to leave for Penticton three years ago. Now, I would tell you that "I will not forget those people at the DRAO who made my life in Penticton beautiful." As time passes, the memory will fade but the truth will last forever.

## Shareware

Raymond Rusk

Newcomers on the microcomputer scene are often unaware of the large body of public domain software which is free for copying. This is software which you can feel good about distributing among your colleagues because that is what the author intended. Several user groups have been developed to organize and distribute this software. It also appears on computer bulletin boards such as the UTCS Bulletin Board.

While in the early days of microcomputing computerized bulletin boards and user groups were often the only source of software which would run on a given microcomputer (take my Heathkit Z89 for instance, please!), now most computers are IBM hardware and software compatible and there are many commercial software vendors. New microcomputer users, through ignorance of this public domain software, often purchase several packages (most notably communications programs) which are inferior to their public domain counterparts.

Catalogs of software (available from PCanada, PCSIG, and NYACC which can be downloaded to your computer by telephone or ordered by mail) are maintained on the VAX in the directory ATLAS::ASTRO:[ASTRONOMY.PC_USER_GROUPS]. You can print these catalog files, type them to your screen or search for keywords like "YALE BRIGHT STAR CATALOG". They contain descriptions of MSDOS and PCDOS programs occupying a couple of thousand diskettes. (Similar amounts of CP/M software are also available but very little new CP/M software is being published. Catalogs of Macintosh, Amiga and Atari software are still growing.) If you are an individual who wants it all, the first 500 volumes of PCSIG are available on CD-ROM for about $180 U.S. dollars.

Some of the software is highly specialized. For instance, there are diskettes teaching Origami (the ancient Japanese art of paper folding) and diskettes containing programs to analyze Nuclear Magnetic Resonance experiments. However, there is much that is useful to anyone. Good editors, data managers, communications programs, memory resident utilities and task-switchers abound. Many are available with source code so they can be adapted to specific hardware and software configurations.

You will also find that a lot of mainframe software has been "ported" to the IBM PC. There are half a dozen NROFFs, ROFFs and many other Unix-like utilities (ls, cat, cp, chmod, grep, graph, etc.), editors (like EMACS), C-shells, CMS shells, IBM mainframe cross-assemblers, and Tektronix, VT100 and IBM 3270 emulators. So don't re-invent the wheel when you start micro-computing. Look in the various user group catalogs and find a program which you can modify.

And for the sake of your personal (or the public's) pocketbook, see whether a suitable public domain program is available before investing in commercial software. Magazines like Dr. Dobb's Journal, Microsystems and Computer Language often review public domain software and BYTE occasionally contains articles on FREEWARE/SHAREWARE programs. (For instance, see the October 1986 issue of BYTE.)

## *NEWS FROM THE LIBRARY*

Marlene Cummins

The most serious problem of the past year has now been resolved (but not to everyone's satisfaction). The main library has cut 16 of our serials at a value of $5448. Two of these will be reinstated using department funds. Ten astronomical serials have been cut at other locations. The total number of serial titles cut by the library is approximately 1600 for a savings of approximately $260,000.

Of interest to those of you who use the main libraries, a contract has been signed with UTLAS for an automated circulation and catalogue system. It is planned that the new system will be "ready to go" by next September. Most of the time between now and then will be taken up loading the database of 2.1 million records. The extraordinary size of the database has been the main stumbling block to implementing a system before now.

Closer to "home" - the departmental library has been granted funds by the administration to purchase a badly needed microcomputer. It will be up and running as soon as bureaucracy allows and the first effect will be cheaper on-line searches. The next major effect will be a change in the preprint listings.

Another library project this fall will be the expansion into Room 1309, formerly Barry's office. (Barry has moved to 1310). This new space will be the home of the observatory publications, computer tapes and other things that will benefit from a cool, dark environment. So now we can move those books from off the top of the shelving units.

And, now that the summer students have left, cleaning up the catalogue room at DDO is again a top priority.

## Preprints Received In The Astronomy Library From Department Staff And Students

Evans, N.R. and R. Lyons. Radial velocity curves for the classical cepheids T Vul, TT Agl, and Y Oph. 86.4.18.

Evans, Nancy Remage and C. Thomas Bolton. The mass of the classical cepheid SU Cygni. 86.09.08.

Evans, Nancy Remage and Armando Arellano-Ferro. The luminosities of the binary cepheids SU Cyg, SU Cas, and W Sgr. 86.10.07.

Fullerton, A.W., D.R. Gies and C.T. Bolton. Preliminary results of a survey for line profile variations among the O stars. (for "Stellar pulsation: a memorial to John P. Cox", ed. A.N. Cox. Springer-Verlag.

Grieve, G.R. and Barry F. Madore. Photometric studies of Magellanic Cloud supergiants. I. Mean magnitudes and reddenings. 86.05.02.

Grieve, G.R. and Barry F. Madore. Photometric studies of Magellanic Cloud supergiants. II. Variability. 86.05.02.

Grindlay, Jonathan E. and Ernest R. Seaquist. Radio observations of galactic bulge and globular cluster x-ray sources. 86.05.12.

Kamper, Karl W. Astrometric-spectroscopic binary stars orbits: I: HR 5273. 86.09.23.

Kronberg, P.P., R. Wielebinski and D.A. Graham. VLA and 100-m telescope observations of two giant radio galaxies: 0634-20 and 3C 445 (2221-02). 86.06.27.

Man Hoi and C. Rogers. Thermal emission from Bok globules. 86.08.18.

Leonard, Peter J.T. Star counts in the open cluster NGC 2420. 86.10.07.

Noreau, Louis and P.P. Kronberg. The amorphous galaxy NGC 3448. I: Photometry dynamics and modelling. 86.07.23.

Percy, John R., M.G. Richer et al. Photometric variability of 27 Cygni. (IBVS) 86.04.28.

Percy, John R. Observations of rapid variability in Be stars. (IAU Coll. 92) 86.09.30.

Reipurth, B. et al. including S.M. Rucinski. The yellow supergiant R Pup: Optical/infrared photometry and radial velocity observations. 86.07.24.

Rogers, C. and P.G. Martin. Half-range moment methods for radiative transfer in spherical geometry IV. Multi-frequency problems with radiative equilibrium. 86.05.14.

Rucinski, S.M. Relation between the (V - R) and (V - I) colors and activity for solar-type stars. 86.05.23.

Seaquist, E.R. and A.R. Taylor. Detailed analysis of the radio emission from the symbiotic star RX Puppis. 86.07.14.

Shara, Michael M., Anthony F.J. Moffat, Michael Potter, Helen S. Hogg, Amelia Wehlau. First optical candidate for a recovered classical nova in a globular cluster: Nova 1938 in M14. 86.6.12. (STScI)

Willson, L.A., G.H. Bowen, C. Struck-Marcell. Mass loss on the main sequence. (+CITA). 86.03.27.

Willson, L.A., Guzik, J. and W. Brunish. Effects of main sequence mass loss on solar models. (+CITA) 86.03.28.

## 1986 Fall Colloquia

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| October 29 | John Bally | Stellar Jets in Molecular Clouds,<br>Bell Labs. |
| November 5 | Peter Conti | Massive Stars in Local Group Galaxies,<br>JILA |
| November 12 | Lawrence Anderson | Radiative Cooling in the Solar Chromosphere,<br>U. of Toledo |
| November 19 | Harvey Richer | Globular Clusters and the Universe,<br>UBC |
| November 21 | Bruce Campbell | The Search for Sub-Stellar Mass Companions,<br>DAO |
| November 26 | Paul Hewett | How I discovered the Most Distant Object<br>in the Universe,<br>Inst. of Astron. Cambridge U. |
| December 3 | Richard Wade | A Modern View of the Dwarf Nova<br>Z Camelopardalis,<br>Steward Obs. |
| December 10 | Johannes Anderson | TBA,<br>Ctr. for Astrophys. |
| December 17 | Raymond Rusk | TBA,<br>U of Toronto |

## THESIS ABSTRACTS

Since the previous issue, several theses have been completed. In this issue, we feature abstracts of theses by Chris Stagg (Percy's Ph. D. student) and David Holdsworth (Mochnacki's M. Sc. student). Next issue will contain abstracts by Richard Gray (Garrison's Ph. D. student) and Mercedes Richards (Bolton's Ph. D. student).

### Short Term Variability In Be Stars

Christopher Stagg

Two studies have been undertaken. In the first, repeated UBV photometric measurements were made of the 86 bright Be stars south of declination -20°, and a network of comparison stars was set up. Many, if not most, of the Be stars appear to be undergoing some brightness variations. Short- or intermediate-term variability also seems to be occurring in about half of the Be stars, and to be more evident in the stars of earlier spectral type. Eleven of these variables have been identified, and four (all of early B spectral type) appear to exhibit significant variability on a timescale of a day or less. More intensive observations of one of these stars, 28 $\omega$ CMa, indicate short term variations consistent with the published spectroscopic period of 1.37 days.

In addition, data from an international photometric campaign on five northern Be stars have been analysed. Observers from several countries took part during a two week period. Slightly earlier and later measurements, plus some made a year later, have also been analysed. Simultaneous radial-velocity measurements were also obtained. All the stars appear to exhibit short-term periodic variation in their brightness. In o And the light curve is nonsinusoidal but well defined, and the amplitude appears to vary from year to year. Marginally significant radial-velocity variations are also observed. KX And is also undergoing large-amplitude, long-term variations. In KY And the light variations are sinusoidal, but there is considerable scatter about the mean light curve. The light curve of LQ And is well defined. EW Lac has a nonsinusoidal light curve which has been observed to change abruptly on a timescale of a day or less. Only two models were able to account for the short-term variability in all the stars observed. The nonradial pulsator required special assumptions to explain nonsinusoidal light curves, however, and the magnetic-oblique-rotator model ran into serious difficulties in explaining the abrupt change in the light curve of EW Lac.

## A Study of Optical Fibers for Astronomical Instrumentation

David Holdsworth

Modern optical fibers are produced with such low attenuation over the frequency range 400 to 900 nm that they are capable of transmitting light for several meters with negligible losses. The excellent transmission of these new fibers combined with their relatively low cost has made them useful as links between telescopes and ancillary instruments. In this thesis I report on recent uses of fiber optics in astronomy and the results of my own investigations of several fibers. A method of producing microlenses on optical fibers by melting the fiber tip with a high power laser has been successfully applied to 100 micron diameter silica fibers and bulb lenses with radii of curvature as large as 190 microns have been produced. The spectral transmission and focal ratio transfer properties of several fibers have been investigated and the results indicate that the most promising fiver for astronomical applications is a step index silica fiber fro Fujikura Industries. This fiber exhibits less attenuation between 400 and 900 nm than other fibers tested and preserves the input beam focal ratio more faithfully as well. I conclude that this fiber should be incorporated into the planned fiber optic link between the 1.88 m telescope and a remote spectrograph at the David Dunlap Observatory.