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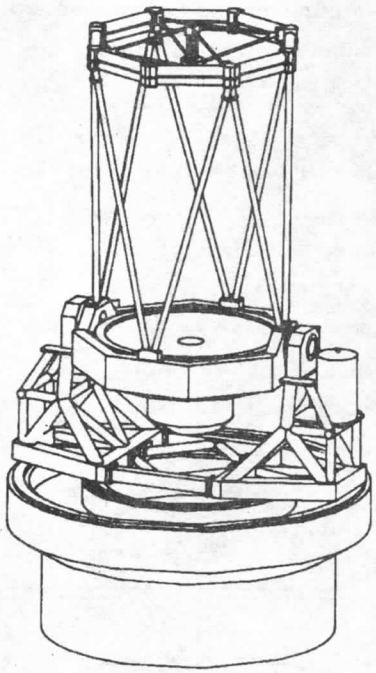
CONTENTS

THE GEMINI CANADA INSTRUMENTATION SESSION MAY 6, 1992 - THE UNIVERSITY OF VICTORIA

During the recent CFHT User's meeting at the University of Victoria, a special session was held to discuss Canadian involvement in the development of instrumentation for the Gemini 8 metre telescopes. Although a complete instrumentation list has yet to be established, a set of basic instruments required for the commissioning of the telescopes has been identified by the Scientific Advisory Council, and these include: (1) an acquisition and guiding interface; (2) CCD imaging cameras for use at f/6 and f/16; and (3) high-resolution optical and infrared imaging cameras. Subsequent instrumentation will probably include, but may not be limited to, a high-resolution spectrograph, a multi-object spectrograph, and a cooled grating spectrograph.

Gemini instrumentation will be developed at institutions throughout Canada, the United Kingdom, and the United States, based on a competitive bidding scheme. The International Project Office, located in Tucson, will provide overall management of the instrumentation program, which will include the distribution of Requests for Proposals (RFP's), the assessment of the responses and supervision of design reviews, and co-ordination of acceptance testing and final commissioning. The Gemini instrumentation effort is managed by Dave Robertson. A firm time scale for the instrumentation effort has yet to be released; however, an Announcement of Opportunity (AO) will precede each RFP by two to three months. The first AO, which will be for the Aquisition and Guiding unit, is expected to appear by the late summer or early fall of this year.

A number of groups made brief presentations at the instrumentation session, and the following expressed interest in participating in the design and construction of Gemini instrumentation: the Dominion Astrophysical Observatory; the University of British Columbia; the University of Calgary; the Université de Montréal; and the Université Laval. Although representatives were not present at this session, expressions of interest have also been received from the Institute for Space and Terrestrial Science and from the National Optics Institute.



OTHER GEMINI NEWS

The original Gemini design featured two Nasmyth platforms, providing locations for instrumentations which were large and/or required a gravitationally stable environment (e.g. the high resolution spectrograph). The Nasmyth focii were to be confocal with the Cassegrain focus, a requirement which led to the primary mirror being situated well below the elevation axis, massive steel structures and marginal mechanical and thermal behaviour of the telescope.

A new design replaces the Nasmyth platform with a side-mounted focal position in which the instrument is pointed vertically upwards, moves the primary up near the elevation axis, and replaces much of the steel in the upper end trusses with carbon-fibre composite material. This is expected to improve the image quality by about 0.2 arcseconds, an important quantity for a telescope which is meant to produce an image quality of considerably better than one second of arc.

A Canadian firm (ASA Automation) has been awarded a contract to study the dynamic performance of the telescope. Also, NRC and RWDI of Guelph have been commissioned to do wind-tunnel testing of enclosure designs for the telescope. A number of future contract opportunities are expected.

The Gemini International Project Office in Tucson is preparing another newsletter (about 20 pages). We will be mailing this out to all those who have asked to be put on the mailing list.

If you would like news on any aspect of the Gemini project, please contact Andy Woodsworth (604)363-0024 [wdswrth@dao.nrc.ca] or Tim Davidge (604)363-0047 [davidge@dao.nrc.ca].

NEWS OF LYMAN FUSE PROJECT

Lyman, the Far Ultraviolet Spectrographic Explorer, is currently in phase B activity in the US, and CSA will shortly appoint a contractor for phase B work on the Canadian components: the telescope baffle and the Fine Error Sensor system.

In the past year, the payload has been allocated to a dedicated new spacecraft and expendable (Delta) launcher, instead of being the third in line to use the shuttle-launched and serviced Explorer platform. This led to a strong recommendation for high earth orbit by the Science team: a 24 hour period that will simplify ground contact and make observing more efficient by a factor of 3 or 4. The higher orbit tradeoff is a smaller telescope (now 64cm aperture), but the increased exposure time more than compensates, and none of the science goals has been compromised.

NASA has just completed a study of the new spacecraft and it operating environment (its elliptical orbit takes it through the radiation belts), and the design looks very satisfactory. The impact of these developments on the Canadian tasks are a) we need to study the radiation effects on the FES detectors and electronics, and b) the baffle is constrained by having to fit within the launch vehicle fairing. Basic optical design has continued at DAO, along with a program of radiation damage study to CCD components. The overall FES and baffle performance has been modelled and appears to be achievable (the telescope has to track on stars as faint as 17 mag, with attitude updates accurate to 0.2 arcsec every 2 seconds). An optical blacks study has been done by ISTS at York, and some baffle model measurements made at the National Optics Institute. FES software development has been done at the University of Birmingham, in collaboration with DAO and the PI institute, Johns Hopkins University.

The present NASA explorer budget and schedule has the telescope launch in the year 2000. The design lifetime is 3 years, and (like IUE) we are doing everything possible to allow the satellite to last well beyond that. Detailed design changes are evolving in all areas of the payload, and generally leading to improvements in performance, reliability, and operations. The CSA contractors and team will work closely with, and contribute to, these continuing developments.

J.HUTCHINGS
Canadian project scientist

WORKSHOP ON THE FUTURE OF MILLIMETER AND SUBMILLIMETER INTERFEROMETRY IN CANADA

This workshop was held at McMaster University on 23 and 24 April 1992. Approximately 60 people met to learn about the current state of this field and to discuss future Canadian participation in the area. The agenda had five parts to it: Existing Facilities, Planned Facilities, Observational Frontiers, Theoretical Frontiers, and an Open Discussion on the Future Direction for mm/submm Interferometry in Canada. A report is now being drafted by the organizers of the workshop and this will be available shortly to all interested persons.

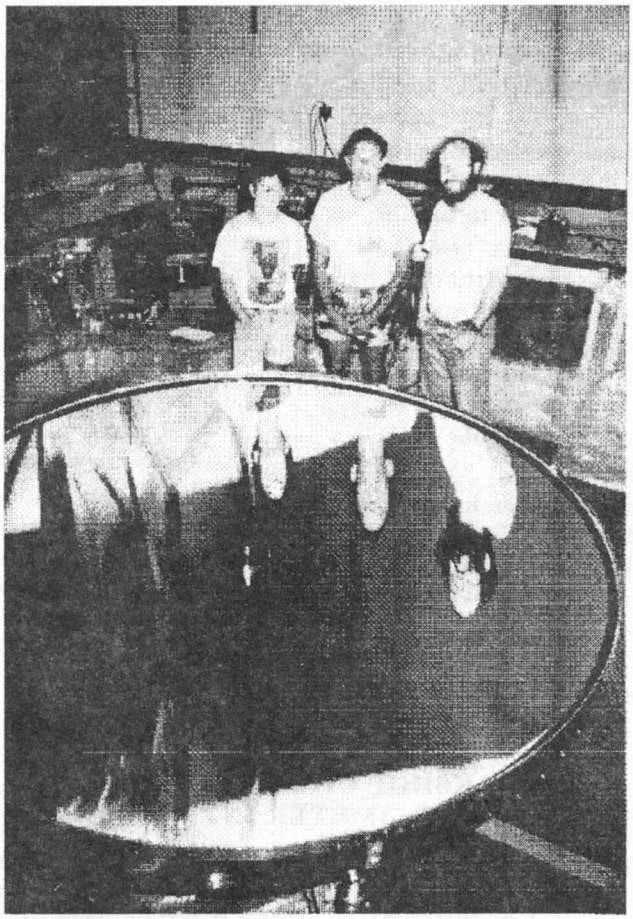
MIKE FICH, UNIVERSITY OF WATERLOO
(On behalf of the organizing committee)

NEWS FROM THE LAVAL LIQUID MIRROR LABORATORY

Construction of the Liquid Mirror Laboratory began 6 years ago, following early promising, but rudimentary, tests of a 1-m diameter liquid mirror. Most of the effort during the first 3 years went to building the testing facilities. In a 1989 Ap.J. Letter we reported on interferometric tests of a 1-5-m diameter liquid mirror that showed diffraction-limited performance. At the same time we carried out observations with 1-m and a 1.2-m LMTs that led to a milestone: a 1989 AJ paper reporting astronomical research done with a LMT.

Although no spectacular new results have been published since, we have carried out considerable work, to improve our testing equipment, understand the behavior of the 1.5-m liquid mirror under external perturbations, perfect the technology, carry out engineering studies of future large systems. This work had to be done to better understand liquid mirrors prior to building larger systems and has led to the 1991 submission of a substantial paper, summarizing our efforts 1989-1991, that will appear in a July 1992 Ap.J.

During the past 6 months, we have upgraded our testing facility in preparation for optical tests of a 2.5-m diameter liquid mirror. We have built the mirror and its mount. At the time of this writing (June 4), the 2.5-m mirror, having a 2-mm layer of mercury, has been spinning for 2 weeks. We have obtained interferograms of the mirror that show well-defined and straight interference fringes. Although quantitative analysis must still be done, the appearance of the interferograms indicates a high quality mirror. Achieving this mirror constitutes a milestone for a telescope having a 2.5-m mirror is, by today standards, a world-class instrument. It is the largest optical mirror in Canada and would be ranked among the 10 to 15 largest astronomical mirrors in the world. The cost of a duplicate mirror, electronics and mechanical components would roughly be $Can 25,000, while labor costs would add another $Can 15,000. We will now thoroughly test the new mirror to understand its behavior.



Photograph of a 2.5-m diameter f/1.2 liquid mirror with the writer, Robert Content (to his left) and Luc Girard (to his right).

One of the often cited limitations of liquid mirrors addresses their limited field of view. However, this criticism implicitly assumes the corrector technology of the 1950s, presently used in astronomical telescopes, that gives a 1 degree-wide field of view . These correctors were designed for use with photographic emulsions to correct simultaneously over a nearly flat field. On the other hand, the advent of CCD detectors allows one to relax these requirements. We therefore are investigating correctors optimized for use with liquid mirrors.

A landmark paper by H.R. Richardson has shown that if one only corrects over a CCD-sized field, it is possible to compensate the aberrations of a parabola 7.5 degrees off-axis with warped glass mirrors. Tracking could be accomplished by moving and warping the mirrors in real time. A collaboration has been started with G. Lemaitre of Marseille observatory to explore the use of deformable glass and metallic mirrors with liquid mirrors. A postdoctoral fellow from Marseille (Min Wang) will join our lab in July to investigate such optical designs. Consider that, in practice, a telescope is seldom used further than 45 degrees from the zenith: a 15-degree field ($\pm$ 7.5) thus represents 1/6th of the practical field accessible to a conventional telescope, rendering liquid mirrors very competitive.

We also are beginning to explore optimized designs with Paul-Baker correctors. This corrector uses 2 nearly spherical mirrors and, essentially, takes a parabola to a Schmidt-like configuration. By analogy with the performance of the Schmidt telescope, we would expect field of views > 16 degrees, especially with high-f-number systems.

ERMANNO F.BORRA

CITA ANNUAL REPORT 1991

Canadian Institute for Theoretical Astrophysics / Institut canadien d'astrophysique théorique

The following is an abbreviated version of the 1991 CITA Annual Report and includes only a brief summary of the scientific activities at CITA in 1991. The full report is available on request (from tremaine@cita.utoronto.ca or from citadmin@maia.utordop.bitnet).

Foreword

The Canadian Institute for Theoretical Astrophysics is a nationally supported research centre for studies in theoretical astronomy and related subjects, hosted by the University of Toronto. CITA has two primary missions: a Canadian one — to foster interaction within the Canadian theoretical astrophysics community, and also between theorists and observational astronomers — and an international one — to serve as a centre of excellence for theoretical studies in astrophysics. In this report, we review the main activities at CITA during 1991. This report has been prepared by Rob Malaney and Larry Widrow.

Personnel Changes in 1991

Nine new staff joined CITA's research team since the Spring of 1991. Robert Malaney (Livermore) was appointed as a research associate. He is also appointed as an adjunct assistant professor at Queen's University. Arif Babul (Cambridge), Man Hoi Lee (Princeton), Avery Meiksen (Space Telescope Science Institute), Prasenjit Saha (Rutgers), Glenn Starkman (IAS/Princeton), Chris Thompson (Caltech), Rien van de Weygaert (Leiden), and Lin Zuo (Caltech) were appointed as postdoctoral research fellows. They joined research associates Omer Blaes and Larry Widrow, and research fellows Luke Dones, Michael Merrifield, Steve Myers, Gerald Quinlan, Barbara Ryden, John Wang, and Gustavo Yepes.

We have also had a number of departures. University Research Fellow Rachel Webster has taken up a Lectureship at the University of Melbourne. Seven research fellows left during the year. Alex Raga has taken a postdoctoral fellowship at Manchester University. Matt Choptuik has taken a PDF in the Numerical Relativity Group at the University of Texas in Austin. Hume Feldman has taken a PDF with the cosmology group at the University of Michigan. Konrad Kuijken received a Hubble fellowship which he is holding at the Harvard-Smithsonian Center for Astrophysics. Bill Latter won a Jansky Fellowship to NRAO which he will hold at the University of Arizona in Tuscon. Peter Tribble has taken a British SERC Fellowship at the Institute of Astronomy in Cambridge. Finally, Mike West has taken a PDF at Leiden University in the Netherlands.

Long-term visitors Lev Kofman and Anatoly Klypin have also departed this year. Lev is now a visiting professor at Princeton University and Anatoly has a research position at the University of Kansas.

Gerald Quinlan (Canada) became the second Jeffrey Bishop Fellow at CITA. This fellowship was instituted in honour of Jeffrey L. Bishop who died in 1988 (the funds are provided by a bequest from his family). Jeff was one of the first research fellows hired in the newly created CITA in 1985.

Nick Kaiser was awarded one of the four E. W. R. Steacie Memorial Fellowships given by NSERC this year for the period July 1, 1991 – June 30, 1993.

Larry Widrow won the John Charles Polanyi Prize in Physics. The prizes were established by the Gov-

ernment of Ontario in honour of the achievement of John Polanyi, co-recipient of the 1986 Nobel Prize in chemistry.

Faculty and research fellows have been involved in the supervision of nine graduate students from the University of Toronto: S.-H. Kim, D. Millar, F. Rouleau, D. Schwartz and P. Zembrowski from Astronomy, W. Keogh and M. Mandy from Chemistry, and P. Papadopoulos and G. Squires from Physics. MIT undergraduate David Hogg conducted research at CITA in the summer of 1991.

The research staff of CITA for the year 1991, along with their primary research interests, are listed below.

CITA Faculty

- J. R. Bond, Professor, *Acting Director until July 1991* (Ph.D. Caltech 1979) - *Cosmology — Very Early Universe, Evolution of Cosmic Structure, Dark Matter, Cosmic Background Radiation, Particle Theory*
- N. Kaiser, (Ph.D. Cambridge, 1982) - *Cosmology, Large-Scale Structure, Galaxy Formation, Galaxy Clusters, Gravitational Lensing*
- P. G. Martin, (Ph.D. Cambridge 1972) - *Interstellar Dust, Interstellar Polarization, H_2, H II Regions, AGN, Chemical Abundances*
- S. Tremaine, (Ph.D. Princeton 1975), Director from July 1991, *Galactic structure, stellar dynamics, solar system formation and dynamics*
- L. Binette, University Research Fellow (Ph.D. Australian National University 1983) -*Radiative Transfer, Diagnostics of Emitting-Line Plasma, Star Forming Regions, Active Galactic Nuclei*
- A. I. Boothroyd, (Ph.D. Caltech 1987) - *Collisional Dissociation of H_2, Stellar Evolution: Lithium, Carbon Stars, Mass Loss*
- R. L. Webster, University Research Fellow (Ph.D. Cambridge 1985) - *Gravitational Lensing, Rich Clusters of Galaxies, Comet Searches*

Research Fellows 1991

- A. Babul‡, (Ph.D. Princeton 1989) - *Physical Cosmology, Large-scale Structure, Lyα Clouds*
- O. M. Blaes, (Ph.D. Trieste 1986) - *Gamma-Ray Bursts, Neutron Stars, Accretion Disks, Gravitational Lensing*
- M.W. Choptuik†, (Ph.D. UBC 1986)–*Numerical Relativity, Computational Physics*
- L. Dones, (Ph.D. UC Berkeley 1987) - *Solar System Dynamics, Planetary Rings, Light Scattering*
- Hume A. Feldman†, (Ph.D. Stony-Brook 1989) - *Cosmology, Very Early Universe, Inflation, Cosmological Perturbations, Loitering Universe, Structure Formation.*
- A. Klypin, (Ph.D. Moscow 1980) - *Cosmology, Large-scale Structure, Microwave Background Radiation*
- L. Kofman†, (Ph.D. Tartu Observatory 1983) - *Large-scale Structure, Early Universe, Inflation*
- K. Kuijken†, (Ph.D. Cambridge 1988) - *Galactic Structure, Dynamics, Dark Matter*
- W.B. Latter†, (Ph.D. Arizona 1989) - *Astrochemistry, Interstellar Medium, Mass Loss Processes, Planetary Nebulae, Magnetic White Dwarfs*
- Robert A. Malaney‡, (Ph.D. St. Andrews 1986) - *Cosmology, Nuclear and Neutrino Astrophysics, Cosmic Rays*
- A. A. Meiksin‡, (Ph.D. Berkeley 1988) - *Cosmology, Large-Scale Structure, Intergalactic Medium, Astrophysical Hydrodynamics*
- M. R. Merrifield, (Ph.D. Harvard 1991) - *Galactic Structure, Dynamics and Evolution Of Clusters of Galaxies*
- S. T. Myers, (Ph. D. Caltech 1990) - *Cosmology, Microwave Background Radiation, Large-scale Structure, Active Galactic Nuclei*
- G. D. Quinlan, (Ph.D. Cornell 1989) - *Stellar Dynamics, Solar-System Dynamics*
- A. C. Raga†, (Ph.D. University of Washington 1985) - *Astrophysical Hydrodynamics, Young Stars, Stellar Outflows, Pulsating Stellar Atmospheres*
- B. S. Ryden (Ph.D. Princeton 1987) - *Cosmology, Large Scale Structure, Galactic Structure*
- P. Saha‡, (D.Phil. Oxford 1989) - *Stellar and solar system dynamics*
- G. D. Starkman‡, (Ph.D. Stanford 1988) - *Cosmology, Nucleosynthesis, Dark Matter, Cosmic Strings, Exotic Particles, Particle Astrophysics*
- C. Thompson, (Ph.D. Princeton 1988) - *Pulsars, Plasma Physics, Supernovae, Astrophysical Dynamos, Neutrino Astrophysics, Cosmic Gamma Ray Bursts, Cosmic Rays, Large Scale Structure, Microwave Background Radiation, Cosmic Strings*
- P. C. Tribble†, (D.Phil. Oxford 1989) - *Clusters of Galaxies, Cooling Flows, Magnetic Fields, Extragalactic Radio Sources*
- R. van de Weygaert‡, (Ph.D. Leiden 1991) - *Cosmology, Large-scale Structure*
- J. C. L. Wang, (Ph.D. Cornell 1988) - *Gamma-Ray Bursts, Particle Acceleration, Radiative Transfer, Accretion Disks, Jets, Extragalactic Radio Sources*
- M. J. West†, (Ph.D. Yale 1987) - *Cosmology, Clusters of Galaxies, Large-scale Structure, Galaxy Formation*
- G. Yepes, (Ph.D. Univ. Autónoma Madrid 1989) - *Cosmology, Large-scale Structure, Galaxy Formation, Clusters of Galaxies*
- L. M. Widrow, (Ph.D. University of Chicago 1988) - *The Early Universe: Inflation, Baryogenesis, Topological Defects, Structure Formation*

‡ *Has joined CITA since June 1991*

† *Has left CITA since June 1991*

Although the bulk of the support for CITA's research

staff comes from our NSERC Special National Program grant and from the operating grants to individual faculty members, our research fellows successfully attracted substantial support from other sources including an NSERC Postdoctoral Fellowship (Quinlan), 2 NSERC International Fellowships (Meiksin, van de Weygaert), 3 NSERC University Research Fellowships (Binette, Boothroyd, Webster), the Spanish Ministry of Education (Yepes), and the Canadian Institute for Advanced Research (Klypin, Kofman).

National Fellows 1991

A program started in 1988 solicits nominations from universities across Canada for "CITA National Fellows". These are research fellows who are jointly supported by CITA and the nominating university; although they work primarily at the nominating university, visits to CITA and collaboration with CITA staff are encouraged. CITA Council awards these fellowships using the same selection criteria as those for CITA research fellowships. The National Fellows in 1991 were:

- J.-P. Arcoragi (Ph.D. Université de Montréal 1986) held at Université de Montréal (1989-1991)
- A. Barvinsky (Ph.D. Moscow State University) held at the University of Alberta (1991-1993)
- M. Morris (Ph.D. Caltech 1988), held at the University of Waterloo (1990-1992)
- Kevin Volk (Ph.D. University of Calgary 1986), held at the University of Calgary (1989-1991)
- Laurentius B. F. M. Waters (Ph.D. University of Utrecht 1987) held at the University of Western Ontario (1989-1991)

CITA Visitors

CITA has a vigorous visitors program bringing a number of Astronomy and Physics faculty members from other Canadian universities and from abroad for both extended stays and shorter visits.

Visitors to CITA included:

- T. L. Ainsworth, Texas A & M
- S. Balbus, University of Virginia
- J. Barnes, University of Hawaii
- L. Bildsten, Cornell University
- R. Blandford, California Institute of Technology
- R. Bucher, University of Florida
- M. Butler, Queen's University
- A. Campos-Aguilar, Univ. Complutense de Madrid
- S. Carroll, Harvard University
- D. Clarke, National Center for Supercomputing Applications
- R. Corrigan, Institute of Astronomy, Cambridge University
- H. Couchman, University of Western Ontario
- R. Daly, Princeton University
- A. Doroshkevich, Institute for Applied Mathematics, Moscow
- D. Crabtree, Dominion Astrophysical Observatory
- D. Durand, Dominion Astrophysical Observatory
- G. Evrard, University of Michigan
- L. Fang, Princeton University
- G. Ferland, Ohio State University
- M. Fich, University of Waterloo
- G. J. Fishman, NASA Marshall Space Flight Center
- J. Frieman, NASA/Fermilab Astrophysics Group
- C. Gammie, Princeton University Observatory
- K. Glazebrook, Durham University
- D. Goldwirth, Harvard-Smithsonian Center for Astrophysics
- J. Goodman, Princeton University
- A. Hassam, University of Maryland
- R. Henriksen, Queen's University
- P. Hewett, Institute of Astronomy, Cambridge University
- P. Hickson, University of British Columbia
- P. Infante, Universidad Catolica de Chile
- C. Kochanek, University of California, Berkeley
- R. Laflamme, Institute of Astronomy, Cambridge University
- J. Lattanzio, Monash University
- A. Linde, Stanford University
- J. Lissauer, SUNY Stony Brook
- A. Loeb, Institute for Advanced Study, Princeton
- P. Lubin, University of California, Santa Barbara
- D. Lynden-Bell, Institute of Astronomy, Cambridge University
- A. MacDonald, Queen's University
- J. McDowell, NASA Marshall Space Flight Center
- V. F. Mukhanov, Brown University and Institute for Nuclear Research, Moscow
- H. Muriel, Observatorio Astronomico, Universidad Nacional de Cordoba, Argentina
- R. Narayan, Harvard University
- J. Narlikar, IUCAA, Puna, India
- P. Nicholson, Cornell University
- A. Olinto, University of Chicago
- J. Peacock, Royal Observatory Edinburgh
- T. Piran, Harvard-Smithsonan Center for Astrophysics
- M. Portilla, Universidad de Valencia
- W. Press, Harvard University
- R. Pudritz, McMaster University
- T. Pyne, Harvard University
- G. Rhee, New Mexico State University
- A. Riera, Universidad de Barcelona
- L. S. Sparke, University of Wisconsin
- J. Stone, University of Illinois
- B. Tully, University of Hawaii
- D. van Buren, IPAC, Pasadena
- S. van den Bergh, Dominion Astrophysical Observatory
- J. Villumsen, Ohio State University
- K. Volk, University of Calgary
- D. Vollick, University of British Columbia

- I. Wasserman, Cornell University
- R. Watkins, University of Chicago
- D. Whittet, Rensselaer Polytechnic Institute

CIAR and CITA

The Canadian Institute for Advanced Research supports a number of Programs chosen for their high intellectual promise and interdisciplinary character. The CIAR Cosmology Program has nodes at UBC (Director and Fellow Bill Unruh, Fellow Ian Affleck), the University of Alberta (Fellows Werner Israel and Don Page) and at CITA, where Dick Bond and Nick Kaiser are CIAR Fellows. The CIAR also collaborated with CITA in 1991 to help support CIAR Visiting Associates Anatoly Klypin and Lev Kofman, and CITA visitor Andrei Doroshkevich. The intellectual interaction between CIAR Fellows and other CITA visitors and researchers, and the administrative cooperation between CITA and CIAR in attracting excellent cosmologists, has led to an inflationary increase in the level of activity in theoretical cosmology in Toronto and Canada. The Cosmology Program was renewed for a second five year term which began July 1, 1991.

Facilities

CITA occupies the entire 12th floor of the McLennan Physical Laboratories at the downtown campus of the University of Toronto. In 1991 we further expanded our network of UNIX workstations. We now have 18 diskless Sun 3/50 computers, networked with a Silicon Graphics 4D/280 (8 processors, 256MB). Four additional Sun Sparcstations, which provide substantially more desktop computing power than the Sun 3/50s, have been acquired, bringing the total to seven. We continue to own a three-eighths share of the 4D/280 (the remainder is divided between Astronomy and Physics). With the acquisition of one SGI Indigo (the newest Personal IRIS), the number of Personal Iris workstations have been expanded to nine, so that research activity demanding 3–D scientific visualization can be supported; in addition, three of the older, slower 4D/20 Personal IRISes have been upgraded to the substantially faster 4D/35 model. The disk capacity available to the network now exceeds 12 GB.

CITA Council

CITA is both an Institute within the School of Graduate Studies of the University of Toronto, and a non-profit corporation (CITA, Inc.). Relations between the two CITAs are governed by a Letter of Agreement between CITA Inc. and the University of Toronto that was signed in late 1989. The CITA Council consists of seven members, five selected from the CITA Inc. membership in co-operation with the Canadian Astronomical Society (of which they must also be members), and two *ex officio*: the Director of CITA and the Dean of the School of Graduate Studies of the University of Toronto or his designate. George Mitchell (St. Mary's University) and Don Vandenberg (University of Victoria) finished their term on the council in March 1991.

Members of CITA Council for the second half of 1991 were:

- Richard Henriksen, Queen's University
- Kim Innanen, York University
- Werner Israel, University of Alberta
- Rika Maniates, Acting Assistant Dean, School of Graduate Studies, University of Toronto
- Lorne Nelson, Bishop's University
- Peter Sutherland, McMaster University, Chair
- Scott Tremaine, CITA, Director

Conferences Supported by CITA

CITA supports scientific workshops and meetings in Canada on subjects of interest to theoretical astrophysics. Meetings supported by CITA in 1991 were:

- "Fourth Canadian Conference on General Relativity and Relativistic Astrophysics", May 16–18, Winnipeg, organizers J. Gegenberg, D. Vincent (Winnipeg), J. Williams (Brandon).
- "Two Black Hole Problem in Numerical Relativity", May 29–30, University of Toronto, organizer M. Choptuik (CITA).
- "McMaster–Montréal Graduate Workshop on Star Formation", August 14–16, Montréal, organizers R. Pudritz (McMaster) and P. Bastien (Montréal).
- "Kingston Meeting", October 10–12, Kingston, organizers M. Duncan and R. N. Henriksen (Queen's). Topic: "Star and Planet Formation".

Scientific Accomplishments 1991

Research at CITA covers a broad range of fields in astrophysical theory. In 1991 the areas of study included: general relativity (numerical black hole formation); cosmology (inflation, dark matter, cosmological defects, neutrino astrophysics, large-scale structure, microwave background anisotropies, gravitational lensing); intergalactic and interstellar medium (cooling flows, magnetic fields, dust physics, molecular cloud chemistry, star-forming regions, jets and outflows); dynamics (galactic disk/dark matter halo interactions, distribution functions); stellar physics (neutron stars and γ-ray bursts, carbon stars, planetary nebulae, pulsation); solar system astrophysics (planetary rings, planetary accretion, orbit evolution). A more detailed description of the work for this year follows.

Choptuik continued a detailed study of the non-linear dynamics of a collapsing massless scalar field which is coupled to the gravitational field in spherical symmetry. This model has turned out to exhibit intriguing

behaviour in the non-linear, strong-field regime where black holes form or "almost" form.

Starkman has reexamined the possibilities of neutrino degeneracy and/or variations in G_N in standard big bang nucleosynthesis. This work shows that the primordial abundances can be reproduced with a large variety of values of Ω_B including $\Omega_B = 1$, if sufficiently large neutrino chemical potentials ($\sim (1-10)T$) are introduced for both the electron and mu or tau-neutrinos.

Yepes and his collaborators have made an exhaustive computational analysis of Primordial Nucleosynthesis in cósmological models of the Brans-Dicke Scalar-Tensor theory of Gravitation. They have found that the cosmological models where $\dot{\phi}R^3 \rightarrow C \neq 0$ when $R \rightarrow 0$ are ruled out.

Widrow and his collaborators are currently studying the electroweak phase transition in models with an extended Higgs sector. They are investigating the rather unusual possibility that the electroweak symmetry remained spontaneously broken at temperatures well above the weak scale.

Feldman and his collaborators have investigated the theory of linear gravitational perturbations in a manifestly gauge invariant form. Issues discussed are temperature anisotropies in the cosmic microwave background radiation, the generation and evolution of gravitational waves, the analysis of entropy perturbations and non-scale invariant spectra in inflationary Universe models, and statistical fluctuations.

Bond is developing statistical tests to analyze the 1991 multiwavelength South Pole observations of cosmic background anisotropy with the view to constraining models of cosmic structure that evolves from Gaussian perturbations. Preliminary results reported by Bond at the Caltech Large Scale Structure Symposium in September show that, when combined with the earlier South Pole data described last year and the OVRO data, the 95% credible limits on the biasing parameter that defines the amplitude of the CDM theory is in excess of unity.

West has found tentative evidence of superclustering at high redshifts ($z \geq 0.5$). By examining the observed radio emission from distant quasars and radio galaxies he found a significant tendency for their radio major axes to be oriented in the direction toward other neighbouring quasars within $\sim 45\,h^{-1}$ Mpc of the radio source. These result may provide the first evidence of the existence of a well-developed pattern of superclustering in the early universe.

van de Weygaert and collaborators studied the structure and evolution of underdense regions in gravitational instability scenarios in Einstein-de Sitter Universes. It turns out that there is a clear distinction between the structure of voids in different scenarios. Voids in CDM are clearly defined, with a large coherent, relatively flat low-density central region surrounded by high-density, coherent ridges.

Babul and collaborators explored the possibility that the apparent large-scale structure in the galaxies is a consequence of the suppression of galaxies near quasars. If the influence of a quasar can extend out to 20 Mpc, the modulations caused by the observed quasar population can reconcile the CDM model with the recent measurements of the large-scale structure. In such a model, the observed voids ought to contain failed galaxies and galaxy clusters.

Kaiser has pursued a number of statistical studies of large-scale structure using galaxy redshift surveys. A preliminary estimate of the power spectrum of galaxy clustering has been obtained from the IRAS-QDOT survey. This provides a rather direct quantitative measure of the 'extra' large-scale power found in this survey.

Bond and Myers are further developing the Hierarchical Peaks method as a means for simulating the distribution of rich clusters and groups of galaxies and as a framework within which to describe the role of initial conditions on the final state of the collapsed structures. They are also are studying the detailed dynamical evolution of collapsing dark matter halos defined by the 'peaks' description. The first object calculated in detail was a Coma-like cluster of galaxies.

Cosmological mass functions that give the abundance of virialized objects as a function of mass are extremely useful for estimating abundances in a wide variety of cosmological problems, *e.g.*, quasars, X-ray clusters, primeval galaxies, dark gravitational lenses, *etc.* Bond and Kaiser, and their collaborators, "legitimized" the most widely used approach to cosmic mass functions, the Press-Schechter function. They showed by numerical and analytic calculations that general filters lead to mass functions quite different in shape than the Press-Schechter one. However, within the accuracy of multiplicity functions deduced for groups found in N-body studies of power law fluctuation models, they showed the correlated and uncorrelated formulae work reasonably well.

Kofman has analytically calculated the probability distribution functions (PDFs) for the density and velocity fields of large scale structure in the Zel'dovich approximation. Kofman and collaborators found good agreement between the analytic PDFs and those computed in cosmological N-body simulations. The first comparison between theoretical PDFs with the IRAS and POTENT observed data has lead to the conclusion that the statistics of the initial inhomogeneities are consistent with Gaussian statistics.

Klypin and his collaborators made a review of results and prospects to detect the anisotropy of the microwave background at large angular scales. Estimates of the expected contamination from galactic sources were made, which show that the contamination will be the main obstacle in detecting the anisotropy.

Kaiser has made predictions for the distortions of distant galaxies by gravitational lensing which provides a potentially useful probe of large-scale structure. The analysis generalises previous work by incorporating a realistic redshift distribution for the background galaxies and the possibility of evolution of clustering. As well as providing statistical relations between faint galaxy ellipticities and mass fluctuations, the analysis also yields a new technique for mapping the dark matter distribution in clusters of galaxies.

Merrifield has been investigating the hypothesis advanced by Vietri and Ostriker that some BL Lac objects may arise from the lensing of quasars by foreground galaxies. Most BL Lac objects are found to lie exactly centered on their host/lensing galaxies, and this observation is found to be inconsistent with both macrolensing by the overall potential of foreground galaxies and microlensing by individual compact objects.

Wang and collaborators have developed a theory of intrinsically asymmetric jets. The jets are electrodynamic and originate from a large scale ordered disk magnetic field that is asymmetric about the disk midplane. One motivation for this study is to explain the lopsided distribution of lobe brightnesses in the Fanaroff-Riley type II radio sources.

Binette and collaborators re-analysed the archived 79 IUE spectra of the Seyfert galaxy Fairall 9 to find patterns of change in the variation of the weak emission lines. A statistical study of an AGN population reveals that the degree of variation in the line equivalent widths also appear inversely correlated with the ionization potential.

Latter and collaborators studied the time-dependent chemical evolution of planetary nebulae. This project involves the integration of a complex chemical network throughout the lifetime of a simulated nebula. Latter also carried out a systematic study of near-IR spectra ($\lambda\lambda 0.875 - 1.330$ μm) of planetary and proto-planetary nebulae. Fich and collaborators continued their investigation of the millimeter and sub-millimeter continuum emission from dust in elliptical galaxies. Observations of the local group elliptical NGC 205 obtained at the JCMT were analyzed.

Boothroyd, Martin, Keogh, and Peterson are working on a theoretical determination of the cross sections for collisional excitation and dissociation of H_2 colliding with H_2. Collision rates in giant molecular clouds (GMCs) are so low that the forbidden infrared (quadrupole) emission of rotationally and vibrationally excited H_2 molecules can induce highly non-thermal distributions over the internal state of H_2.

Martin and collaborators made new observations of the wavelength dependence of interstellar linear polarization ($p(\lambda)$) to investigate the influence of the environment on the effective size distribution of the aligned polarizing particles. Mandy and Martin have investigated excitation and dissociation of interstellar H_2 by collisions with H atoms, using quasi-classical trajectory calculations on the H_3 potential energy surface to produce cross sections as a function of energy. Schwarz and Martin are calculating the steady state rates of cooling, dissociation, and ortho-para conversion as a function of temperature and density.

Feldman and Raga have simulated images of stellar jets. In particular, they have simulated a string of linearly aligned emitting knots that emerges from a stratified medium. For this configuration, they compute the single scattering of photons in order to obtain intensity maps of the scattered + direct light that reaches the observer. Kofman and Raga have suggested an analytic model of the knots travelling down a stellar jet from a source with a time-dependent ejection velocity. For supersonic jets the global structure of shock waves is modelled by the viscous Burgers equation.

Quinlan and Tremaine have been studying the theory of numerical integrations of the gravitational N-body problem. They have shown that shadow orbits exist in typical N-body integrations for many crossing times, thus substantially enhancing the justification for our belief that N-body integrations model real stellar systems.

Ryden has studied the three-dimensional structure of elliptical galaxies from their projected properties. A model galaxy in which the isoluminosity surfaces are triaxial ellipsoids with smoothly varying axis ratios can show large isophote twists from some viewing angles and tiny twists from other viewing angles.

West and collaborators have examined the frequency of bar formation in spiral galaxies as a function of local galaxy density, in order to test theories that bar formation may be induced by tidal interactions with neighbouring galaxies or stripping of dark matter halos in dense environments.

Kuijken and Tremaine have analyzed the evidence for large-scale deviations from axisymmetry or other oscillations in the Galaxy. The relevant data include the vertex deviation and velocity ellipsoid axis ratios in the solar neighbourhood, the mean velocity of tracers near the Galactic centre (OH/IR stars, planetary nebulae, the 2 pc gas ring, etc.), Oort's K constant, the HI terminal velocity curve, globular cluster, HII region, and carbon star kinematics, etc. They find no consistent evidence for any coherent large-scale deviation from axisymmetry.

Merrifield has developed a new technique for obtaining the rotation curve of the Milky Way. This method assumes that the thickness of the HI layer in the disk of the Galaxy has a thickness which is constant with azimuth and that the gas is on circular orbits. With these assumptions, it is possible to solve simultaneously for the rotation curve and the flaring of the HI layer with radius. This rotation curve is consistent with other constraints if $\Theta_0 = 200\ km\ s^{-1}$ and $R_0 = 8\ kpc$.

Application of hydrostatic equilibrium to the derived thickness of the HI layer implies that the exponential scale-length of the galactic disk is 4 *kpc*.

Malaney and Butler (Queen's) have pursued the fact that introduction of a Dirac–Majorana mass term in the neutrino Lagrangian generally leads to the possibility of oscillations into sterile states. In such circumstances a mixture of active $\rightarrow$ active and active $\rightarrow$ sterile oscillations could occur with important implications for solar neutrino observations by neutral–current detectors, such as the Sudbury Neutrino Observatory.

Wang and collaborators have developed a semi-analytic, physically motivated model for the formation of cyclotron lines in moderately thick scattering media. The main contribution here is the semi-analytic modeling of the multiple resonant scatters that form the cyclotron fundamental.

Blaes and collaborators have continued to investigate the fate of old, "dead" neutron stars which accrete material very slowly from the interstellar medium. New calculations of the pycnonuclear light element reaction rates imply that the accreted material will eventually be converted to ^{16}O at high densities. Blaes and collaborators have combined the known geography of the local interstellar medium with the dynamics of the Galactic neutron star population to see whether accreting neutron stars are actually observable with ROSAT, GRO, and EUVE. Results for both transient and quiescent UV and X-ray emission are promising.

Quinlan has studied the role of chaos in determining the general characteristics of our solar system. A numerical study of about 50 solar systems similar to our own showed that chaos is a common feature of planetary systems, even when the planets are started on orbits that are well separated. Saha and Tremaine have investigated new integration algorithms suitable for studying long term solar system dynamics. The key element of these algorithms is that they follow the orbital motion using action-angle variables rather than Cartesian coordinates, so that unperturbed Kepler motion is linear in time and therefore trivial to follow accurately.

Dones and Tremaine have determined the rates at which a planet embedded in a disk of particles accretes mass and angular momentum. The solutions are given in terms of two dimensionless parameters – r, which measures the importance of the planet's gravity on incoming trajectories, and s, the velocity dispersion of the disk.

ROBERT MALANE
LARRY WIDROW

INSTITUTE FOR SPACE AND TERRESTRIAL SCIENCE (ISTS)
JOB ANNOUNCEMENT
RESEARCH ASTRONOMER
SPACE ASTROPHYSICS LABORATORY

Key Responsibilities: conduct scientific research involving the reduction and analysis of planetary observations obtained with the Hubble Space Telescope. Most of the data will involve spectroscopic observations, particularly of outer solar system objects, with a minority of data related to extra-solar planets. Interaction with NASA deep-space missions, such as Galileo and Cassini, is an important aspect of the work.

Qualifications: A recent Ph.D degree or its equivalent in astronomy, astrophysics or planetary science; familiarity of all aspects of planetary science; demonstrated interest and record of accomplishment in the study of other planets is required; fluency and competence with modern computing systems; a working knowledge of SUN 4/UNIX and peripherals would be an advantage; demonstrated ability to conduct independent research.

This position is available starting September 1, 1992. We have an excellent benefits package. Starting salary will be approximately $36,500 per annum depending on qualifications. Interested applicants should forward their curriculum vitae to the Director of Human Resources, Institute for Space and Terrestrial Science, 4850 Keele Street, Second Floor, North York, Ontario M3J 3K1 by August 7, 1992. Please quote reference number SAL-9206.

In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

ISTS is committed to Employment Equity.

THE JOINT SUB-COMMITTEE FOR SPACE ASTRONOMY (JSSA).

I. The JSSA and the Astronomical Community

The Joint Sub-committee for Space Astronomy was formed to provide a single forum in which the astronomical community could develop a viable space astronomy program. The JSSA is a committee of CASCA and a sub-committee of the former NRC Associate Committee on Astronomy, now the Advisory Board for HIA (HIAAB). In these roles, JSSA provides advice on general policy issues and, from time to time, on particular issues referred to it. However, the principal function of JSSA is to serve as the Advisory Committee for Astronomy under the Space Science Program of the Canadian Space Agency (CSA).

The membership of JSSA is approved by the CASCA Board and, beginning in 1989, members are appointed to three year terms, staggered to ensure a degree of continuity. Current practice is for terms to begin on September 1 of the year of appointment with candidate members submitted to the CASCA Board meeting held during the summer AGM. The CSA has requested that JSSA be limited to a total of 6 regular members, including the Chair; a number consistent with the membership of the other Advisory Committees sponsored by the Agency. The JSSA will meet this target beginning September, 1992. In addition to the regular members, the Space Science Program Development manager, Gerry Atkinson, represents the CSA in an ex-officio capacity. Other ex-officio members include the Director General of HIA (Don Morton), the CASCA President and the Chair of the NRC HIAAB. In addition, the past-Chair of the JSSA has also participated, as needed, in an ex-officio capacity.

The JSSA normally meets twice a year, in the spring and fall. One of the meetings is traditionally held in Ottawa and the other has traveled to different sites. Travel costs to attend these meetings are paid for by the CSA. In brief, the business at the JSSA meetings is directed toward providing advice to the CSA on all aspects of the space astronomy program, including recommendations for new starts. In addition, the JSSA acts as an advisory board to the Canadian Astronomy Data Center (CADC) and receives regular reports on its activities.

II The CSA Space Science Program

The Canadian Space Agency was created (Bill C-16, 1989) to bring most of the Canadian space activities under a single administrative structure. The objectives set out in the Bill are: (1) to promote the peaceful use and development of space (2) to advance the knowledge of space through science and (3) to ensure that space science and technology provide social and economic benefits for Canadians. The CSA is a very large enterprise and, objective (2) notwithstanding, the Space Science Program is but a small piece; it represents about 7% of the total expenditures. The Space Science Program was created by a transfer of people and budgets from other agencies, NRC in particular. The Program is still housed in the NRC building at 100 Sussex Drive, Ottawa.

The CSA has recently completed preparation of a Long Term Space Plan (LTSP), to cover the period from 1993 to 2020. All aspects of the CSA are considered, including the Space Science Program. A working group which included representatives from all supported science activities (Space Life Sciences, Materials in Microgravity, Astronomy and Astrophysics, Plasma and Solar-Terrestrial Relationships, and the Atmospheric sciences) has made a series of recommendations concerning the Space Science Program which, if implemented, would see the CSA become much more involved with the direct support of scientific research. However, this plan is under internal review by the CSA management and must ultimately be approved by the Government. Realistically, it may be some time yet before any significant changes are realized.

At the present time, the operation of the Space Science Program may be characterized in the following way:

(1) The primary goal of the program is to support Canadian industry through participation in high quality research activities in space. This is accomplished through contractual arrangements between industry and the CSA to design and build specific components for its supported projects. An essential point is that the CSA budget must be spent in Canada - it is not possible to simply transfer funds abroad to 'buy' into a project. Note that the CSA retains complete control over management and cash flow. The PI's do not receive 'grants' or similar funds from the CSA.

(2) Scientific research activities associated with a space mission are not directly supported. This means, e.g., that a PI could not hire a PDF with CSA funds to assist with the reduction and analysis of the science data, etc. In short, activities which would normally be covered by an NSERC grant are not supported by the CSA.

(3) The CSA has no launch capability. In general, this implies that mission opportunities are defined by those with the launch capability. The Canadian scientists interested in a mission must approach the CSA (usually through the appropriate Advisory Committee; in our case the JSSA) with an 'unsolicited' proposal to participate.

(4) The CSA itself does not issue 'Announcements of Opportunity' (AOs) since it has no way of scheduling flight opportunities. As an alternative, the Space Science Program has partitioned its budget into funding envelopes for the different disciplines. The Astronomy envelope was set at $4 M pa. It is very important to

recognize that this sum is not a 'bankable' commodity. Recommendations from the Advisory Committees (eg, JSSA) are 'charged' against the envelope taking into account current commitments and the projected cash flow requirements. These envelopes must be averaged over some suitably long time, say 5+ years (the system has not been functioning long enough to be confident about this number). The real difficulty is that costs tend to escalate as the project time line slips. Hence the 'available' funds are never well known at any particular time.

III. Space Astronomy Proposals and Evaluation

Perhaps the most important function of the JSSA is to make recommendations to the CSA concerning participation in space projects. The above sections provide the context in which JSSA operates. The following remarks are intended as a guide to the factors considered by JSSA in project evaluation:

(1) The project must have clearly stated scientific goals which are shown to be attainable through the proposed activities. The necessity of the space mission for achieving the stated science goals is a paramount consideration.

In the usual case of foreign-led missions, specific Canadian interests should be identified. High leverage situations, where a relatively small Canadian contribution may have a disproportionate impact on the achievement of the scientific goals are of particular interest.

Projects which essentially involve only technology development (eg., a generic detector for the uv) or 'proof of concept' projects have been referred to the JSSA in the past. Such proposals will not normally be recommended for funding under the space astronomy envelope.

(2) The project must have clearly apparent leadership (a 'champion') from an established scientist or a small group. The overall responsibilities of those involved should be made as clear as possible; this is particularly important when the design and development of instruments or other space craft elements is specifically proposed.

(3) That part of the Canadian community to be served by the project must be identified and the likely impact of the project on that community described. Clearly, the JSSA will look for concrete evidence that this community has been consulted and supports the project. The size of the community and the impact of the science and of the technology development are important for assessing the level of Canadian participation in the mission.

It might be noted here that JSSA policy is to support projects on behalf of the astronomical community as a whole. Thus we do expect to see some discussion of how the community will interact and benefit from the mission.

(4) The feasibility of the project must be addressed. This requires a fair assessment of: the costs of the proposed activities, the material and human resources required to meet these commitments, and the schedule for both the mission and the proposed Canadian activities. One critical factor is the launch opportunity.

(5) The extent to which the project fits into the larger picture of other national and international activities in astronomy will be considered.

The JSSA will try to achieve a reasonable balance within the overall program. The factors weighed include the balance between sub-fields in astronomy, the size of the program (small and large projects), maintaining a diversity of international partners, competitive missions, possibilities for follow-on projects, etc.

IV Proposal Submission

The JSSA is certainly an advocate for space astronomy. However, it is up to members of the Astronomical community as a whole to find and 'promote' particular projects. The discovery of realistic opportunities arises through personal contacts, meetings, 'the grapevine', - whatever.

Within the general constraints imposed by CSA policies, several types of projects (as is suggested by our current program) are possible, including: (1) Providing an instrument for the science package. (2) Participation at the science level only. The CSA may 'buy' our way into a project (to secure observing time or access to data) by providing certain space craft subsystems. (eg., our participation in FUSE.) (3) Contribution to the ground segment of the mission (eg, our contribution to Radio Astron) (4) Some combination of the above.

Given that some opportunity becomes apparent, the first step toward seeking CSA support is to contact the JSSA and the CSA Program Development Manager, Gerry Atkinson. Depending on the state of the project, this initial contact may be a letter of intent (a proposal is planned) or, more likely, is a summary of the current status, maybe a request for advice, or, perhaps, something more specific, such as a request for assistance to attend a meeting or to hold a meeting between the Canadian and foreign side. The point is to let the people who will ultimately review a proposal know what is going on. Subsequent action depends on the particular details and may well lead to the preparation of a proposal.

The proposal should, of course, address the issues mentioned in the previous section. It need not be long or particularly elaborate. Generally, we expect that by the time an idea gets to the stage of a specific proposal, the background is well known to the JSSA and to the CSA through prior contacts. Nevertheless, the document should be reasonably self-contained and it must be specific enough to form the basis for negotiations between the CSA and the other parties involved.

There is no fixed format for a proposal; some common elements which should be present are:

(1) A summary; no more than a single page which can 'stand alone' as a description of what the proposal is.

(2) A section or series of sections which outline the science objectives, the instruments and the operational aspects of the mission. Canadian interests should be highlighted where appropriate.

(3) A specific proposal to the CSA regarding the overall level of participation (as a percentage of the mission science) and some details relating to how Canada can contribute to the mission. Anticipated costs, required resources, etc, should be discussed.

(4) Background material (letters of support, community responses, etc.)

The JSSA will try to deal with proposals in a timely manner and, in most cases, will invite the proposer to attend the corresponding JSSA meeting for a presentation and discussion of the proposal.

We invite comments on the policies and procedures outlined here. Please feel free to contact any of JSSA members listed below (Note that 4 members are retiring this year; a new Chairperson and two new members are to be appointed this year):

Tom Bolton (U. Toronto, 1991-94)
Nancy Evans (ISTS, 1990-93)
G. G.Fahlman (UBC, 1989-92); Chairman
Sun Kwok (U. Calgary, 1989-92)
Denis Leahy (U. Calgary, 1990-93)
Gordon Walker (UBC, 1989-92)
Francois Wesemael (U. Montreal, 1991-94)
Andy Woodsworth (HIA/DAO, 1989-92)

JSSA NOTES

The JSSA held a regular meeting in Ottawa April 26/27. Members attending were: Greg Fahlman (UBC, Chairman), Sun Kwok (UCal), Denis Leahy (UCal), Francois Wesemael (UMon), Nancy Evans (ISTS), Tom Bolton (UTor), and Andy Woodsworth (DAO). Gerry Atkinson (CSA) and Don Morton (HIA) attended in an ex-officio capacity. Peter Dewdney (DRAO) was an invited guest.

The principal item on the agenda was a proposal for Canadian participation in the astronomy side of the Swedish Odin Mission. The Proposal was prepared by Sun Kwok and Peter Dewdney together with Chris Rogers (DRAO), Slavek Rucinski (ISTS) George Mitchell (St. Mary's) and Michael Fich (Waterloo). A brief description of the mission can be found elsewhere in Cassiopeia. The JSSA recommendation to the CSA is as follows:

- That the CSA seek to negotiate a 20% share of the Odin mission for the benefit of the astronomical community in Canada.

- That the Canadian contribution include the development of hybrid digital spectrometers, as described in The Proposal.

- That the scientific participation of the community be implemented through an open solicitation of observing programs from Canadian astronomers.

It should be noted that:

(1) the Odin mission is nominally split 50-50 between aeronomy and astronomy observations. The 20% above refers to the whole mission and carries the implication that Canada may have up to 40% of the astronomy time. The split will be a matter for negotiation.

(2) the spectrometer development referred to above represents the first contribution from Canada to the science payload of an astronomy space mission. The JSSA considers this to be a vital part of The Proposal.

(3) the JSSA policy is to support missions on behalf of the community at large and the scientific opportunities engendered by Odin should be widely available.

In view of the JSSA policy statement which appears eleswhere in Cassiopeia, a few comments may be of interest. The potential for Canadian involvement in Odin became clear through independent Swedish contacts of Sun and Peter. At our previous (Oct '91) JSSA meeting, this potential was briefly discussed and the people involved were encouraged to pursue the matter. As a result, the CSA sponsored a meeting, held January '92 in Ottawa, at which the Swedish principals presented an overview of the mission (astronomy and aeronomy), the progress and status of the development and areas where Canada might contribute. The Proposal considered by the JSSA was a result of this meeting. It may be noted that the CSA has had two previous successful collaborations with Sweden, Viking and Freja, and hence the idea of Canadian participation in Odin was attractive and credible from the start. In addition, Sun canvassed the large Canadian community working in the general area of studies of the Interstellar Medium and recieved an enthusastic response. The rapid response was needed because the Swedes have completed Phase A studies and were seeking an international partner prior to their request to the Swedish National Space Board for Phase B funding. As a result of the JSSA recommendations, the CSA has 'officially' indicated a strong Canadian interest in participating in the project (a firm commitment must wait until the aeronomy community in Canada is consulted, through the STRAC, and certain budgetary issues involving other missions are clarified).

The Lyman/Fuse mission is entering Phase B studies which will lead to firm estimates of the costs associated with the areas of Canadian responsibilty. The Cana-

dian PI, John Hutchings, has suggested that the mission be reviewed when the Phase B results are known (about one year from now). The main issue to be addressed is the level of Canadian participation in relation to observing time. The JSSA had originally recommended participation leading to 7.5% of the observing time but since then, the British have withdrawn from the mission and, in the subsequent re-organization, the Canadian responsibilities have grown to an estimated 10% share of the mission. The SOIRA has been asked (through its Chairman, David Crampton) to conduct the scientific review of the mission and to pass a recommendation concerning the level of Canadian scientific participation to the JSSA. All members of CASCA are invited to make their views known to JSSA and/or SOIRA members.

The CSA has prepared a Long Term Space Plan for submission to Government. The LTSP contains a number of recommendations concerning space science and astronomy in particular. Perhaps the most significant feature of the LTSP (from our perspective) is the recognition that the CSA should assume financial responsibility for end-to-end mission support. This includes planning and science related costs and thus represents a major departure from the current, very restrictive, policy.

The LTSP includes a small, scientific satellite (SSAT) program which calls for a new supported mission at an interval of between 2 and 4 years. Should this program be approved, it opens the door to true announcements of opportunity for the scientific disciplines supported by the CSA. In anticipation of this program, the CSA has contracted with Bristol Aerospace to study the SSAT concept and to provide a report outlining the cost implications for three types of small satellites (the largest being about the size of ODIN; ie, about 225 kg.). Specifications appropriate to astronomy missions are included in the Bristol study; the results of which should be available soon.

Last December, the JSSA canvassed the community with a list of small satellite concepts which had been proposed to ESA. It must be stressed that ESA itself does not have a small satellite program - the idea was simply to gauge community interest. The JSSA received a number of responses to our mailing and it is clear that there is also a substantial level of interest here in such missions. We thank those who replied and urge individuals with specific interests to contact their European colleagues for futher details. Should Canada initiate a SSAT program, there may well be additional opportunities for collaborative development of some of these concepts.

G. G. *FAHLMAN*
Chairman, JSSA.

CANADIAN PARTICIPATION IN THE ODIN PROJECT

ODIN is a proposed Swedish satellite equipped with receivers at 5 mm/submm wavelengths to observe water, molecular oxygen, and several other important molecular species in the interstellar medium. The planned launch date is 1996. In the 2-year lifetime of the satellite, it is expected to survey molecular clouds, star formation regions, photodissociation regions, stellar envelopes, and galaxies for H2O and O2 emission. These molecular transitions have never been detected before, and their detection will have important implications in the cooling process of molecular gas and in the chemistry of the ISM.

In the January 27 meeting of the JSSA, a proposal on the Canadian participation in ODIN was presented by Sun Kwok and Peter Dewdney. The proposal suggests that Canada participates at the 20% level of the project, which includes the design and construction of the digital spectrometers for the satellite. This proposal was endorsed by the JSSA, and is now awaiting approval by the CSA. Since ODIN is also designed to carry out observations of the earth's atmosphere, the aeronomy community in Canada is also interested in in this project. If this is the case, then the total Canadian participation level may go as high as 40%.

Anyone who is interested in helping to make ODIN a success, please contact Sun Kwok (kwok@iras.ucalgary.ca) or Peter Dewdney (ped@ drao.nrc.ca). We will also try to keep the community informed in the progress of this mission in future issues of Cassiopeia.

SUN KWOK
PETER DEWDNEY

CASCA JOURNALS PROGRAMME

A major shipment was sent to Peru from Victoria early in the year, but we have not yet heard of its receipt. Another shipment is ready to be dispatched from Toronto as soon as we can be reasonably sure that it will arrive. A selection to Nigeria, and inquiries about sending this are being made by Paul Delaney. I received personal thanks in Argentina, last August, for a shipment of Monthly Notices that was sent there a few years ago.

In general, disposing of the material we have is slow, and storage is a problem. Inquiries are often not followed up by the originators. At times I wonder if we are in the business of "doing good" without really understanding the needs of the people we wish to help. People often ask for recent, or even current, journals. The kind of collection we all acquire over a normal working lifetime seems to be less valued than we think. On the other hand, some institutions have been very grateful. I think the programme is inevitably a low-key one.

A. H. *Batten*

THE HELEN SAWYER HOGG LECTURE

Speaker: Dr. Alan R. Hildebrand, Geological Survey of Canada, Ottawa
Title: "The Cretaceous/Tertiary Boundary Impact (or the Dinosaurs Didn't Have A Chance)"
Date: Thursday, July 2
Location: Pleiades Theatre, Alberta Science Centre 701-11th Street S.W., Calgary, Alberta
Admission is free!

Dr. Hildebrand will discuss the history of the Cretaceous/Tertiary Boundary debate and the clues which led to the discovery of the Chicxulub impact crater in Mexico. The environmental effects of this impact will be proposed as the extinction mechanisms which killed the dinosaurs and much of terrestrial life. The Chicxulub impact may have been the deadliest impact since life evolved on Earth because the impact targeted a thick sequence of carbonates and evaporites. The probability of recurrence of a disaster of this magnitude and lesser but still deadly impacts indicate that a measure of astronomical vigilance is required. For further background reading see the June 1, 1991 issue of Natural History, p. 47, for an article entitled "Cretaceous Ground Zero" by A. Hildebrand and W. Boynton.

The Helen Sawyer Hogg Lecture is jointly sponsored by the Royal Astronomical Society of Canada and the Canadian Astronomical Society. The lecture is named in honour of one of Canada's foremost astronomers, Dr. Helen Sawyer Hogg who is a past president of the R.A.S.C. and C.A.S.C.A. The two Societies would like to acknowledge the support of the Alberta Science Centre for helping make this public lecture possible. For more information please contact Don Hladiuk at 256-4480 or Walter Lindenbach at 253-5236.

A BRIEF VISIT TO THE BUCHAREST OBSERVATORY

Romanian astronomers have been quite isolated from the rest of the astronomical world, particularly the west, for more than a decade. Since the revolution in Romania, this situation has started to change, but the contacts are still quite limited. Romanian astronomers are anxious to participate more fully in the international astronomical community.

At IAU Colloquium 137 in Vienna in April I was fortunate to make the aquaintance of two astronomers from Bucharest. Doru Suran and Gabriele Oprescu are theoreticians with whom I share an interest in the properties of variable stars. Since I was going to Romania for a holiday following the meeting, they invited me to visit the Astronomical Institute of the Romanian Academy in Bucharest. We spent three days together - one day at the Observatory, the other two were holidays for the Romanian Orthodox Easter.

The earlist recorded astronomical observations in this part of Europe were made in the 15th century in Transylvania. The Observatory in Bucharest was founded in 1908 outside Bucharest. As with many such institutions, the city has grown out to surround the observatory. An additional limitation for observing is the typical central European climate. There are two other, smaller, astronomical stations in Romania where better observing conditions prevail: a 50 cm telescope at Cluj-Napoca, and a 40 cm one at Timisoara. The early history of the observatory was similar to that of other observatories of the time - concentration on astrometry, planetary motions, etc. Some of these traditions are being continued, but an astrophysical group and a solar group have been added.

The Director of the Astronomical Institute, Magda Stavinschi, arranged a tour of the observatory for me.

I was particularly impressed by two things: the enthusiasm of the staff for astronomy, and the great difficulties which they have to overcome to carry out astronomical research.

The difficulties under which they work can be illustrated by a couple of examples. Their subscription to the Astrophysical Journal ended in 1981; numerous other journals and books are lacking. The computational facilities of the Institute consist of one PC, a 386 machine. They have no printer, despite repeated efforts to obtain one. They do have some travel funds (which allowed Suran and Oprescu to attend the meeting in Vienna), but under certain bureaucratic rules (not unknown to the west), they may not use those funds for the purchase of equipment.

The Institute now has some limited cooperative arrangements with astronomical institutions in Europe. These allow some interaction, but they would like to expand that. Through such contacts and the generosity of some institutions and individuals, help has been obtained, particularly in some of the library acquisitions.

The Institute is working in a number of areas. I remember particularly the following ones

- theoretical astrophysics: stellar evolution, pulsation; large scale structure of the universe; etc.
- photoelectric photometry of eclipsing variables with the 40 cm Cassegrain telescope
- astrometry with the original meridian circle
- photographic astrometry
- solar studies: sunspots (Wolf number) and chromospheric activity; a radio telescope is under construction to monitor solar activity

By carefully choosing the projects on which they work, they are able to make useful contributions to astronomical research despite the limitations under which they work. With improved conditions, they will be able to do much more.

I cannot omit mentioning the wonderful hospitality extended to me while I was in Bucharest, and in other parts of Romania.

William Wehlau
Astronomy Department, University of Western Ontario

DEPARTMENT TECHNICIAN

The Astronomy Department anticipates that a full-time permanent position as Department Technician will become available within the coming few months. Although this position will be fully advertized when officially available, potential applicants may wish to insure consideration by contacting the Department in advance.

Major responsibilities will include maintenance of the 40-cm telescope at the Burke-Gaffney Observatory, and of other equipment in the Observatory and Astronomy Department. The position also involves instructing students in the use of equipment, organizing and conducting the Observatory tour program, and participating in a weekly seminar series. Preference will be given to applicants with an MSc or BSc in astronomy.

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CFHT SCIENTIFIC ADVISORY COUNCIL

The Scientific Advisory Council (SAC) of CFHT held its 41st meeting at the University of Victoria on May 7 and 8, 1992. Present were Chantal Balkowski (Chairman), Chris Pritchet (Vice-Chairman), Michael DeRobertis, Klaus-Werner Hodapp, Nicolas Mauron, Yannick Mellier, Daniel Nadeau, and Daniel Rouan; Harvey Richer and Ken Chambers were unable to attend. The Corporation was represented by its Directors, Guy Monnet and John Glaspey.

Much of the agenda of the SAC meeting centered around discussion of the CFHT Users' Meeting, a more detailed account of which will appear in the next *CFHT Information Bulletin*. The following is a brief account of some of the more important issues that arose at our meeting.

Technical Activities

Three instruments are being commissioned at CFHT in the next 6 months. These instruments are: *MOSSIS*, the new multiobject spectrograph, with an image stabilization port; *the Coudé f/4 camera*; and *Redeye*, an IR array detector built around a 256^2 HgCdTe detector. This engineering activity is placing quite a strain on the Corporation, and as a result work on the new Telescope Control System has been delayed.

Future of CFHT

Much of the discussion at the 3rd CFHT Users' Meeting focussed on the future of the CFH telescope on timescales of a decade or longer. The seriousness of such a discussion was highlighted in G. Walker's talk, in which it was pointed out that, in this decade

alone, more 8-10 metre class telescopes will be built than there are 4 metre telescopes now!

SAC discussed and agreed with the point of view that it will always be cheaper and faster to develop new instruments and try out new ideas with CFHT than with the new generation of 8 metre telescopes. The flexibility and versatility of CFHT will always enable us to react more quickly to new trends and discoveries, and this will remain a clear advantage of CFHT for several decades to come. Of course, this implies that visitor instruments will continue to be used heavily at CFHT. The Directors confirmed that, provided visitor instruments are carefully constructed to conform to CFHT standards and place minimal demands on the CFHT resources, visitor instruments will continue to be scheduled.

The other point of the SAC discussion on the future of CFHT centred on the number of foci that CFHT needs to support. On the one hand, the development of instruments such as MOS/SIS and the Adaptive Optics bonnette at the f/8 Cassegrain focus, and the engineering of an f/8 fibre feed for the Coudé spectrograph, imply that in a few years perhaps as much as 70% of the observing at CFHT could be carried out at the Cassegrain focus. Nevertheless, there will be a strong scientific need for observations at the other foci in the coming years, as was pointed out by J. Bergeron in her talk at the Users' Meeting. It was made clear that a single focus CFHT was not necessarily a desirable goal.

In terms of the future of CFHT, the importance of collaboration between scientists in Canada, France, and Hawaii was noted. Such collaboration could lead to more effective use of the telescope by avoiding the duplication of observing programmes. In addition, the collaborative development of instruments among the 3 agencies better exploits the talents of each group. SAC recommended that some form of joint participation at national meetings be encouraged among the CFH partners.

Adaptive Optics and High Resolution Imagery at CFHT

R. Arsenault presented a discussion of the CFHT Adaptive Optics (AO) Bonnette, a Corporation instrument presently under design and expected to be completed in about 3 years with an anticipated cost of approximately $1,000,000. This instrument will enable active correction of the pupil over a field of up to 1.5 arcmin, with a median Strehl angle of about 0.2 arcsec. It will also be possible to access the f/8 Cassegrain focus by simply removing two mirrors. The deformable mirror and control system for this instrument is being manufactured in France, and DAO is taking care of the mechanics and wavefront curvature sensor.

One important component of high resolution imagery is a programme to promote vigorous control of the thermal environment in and around the CFHT dome. Giant strides have been made in this direction over the past few years. SAC recommended that this work continue, and in particular, that further work be done on investigating means to provide better control of the thermal environment of the primary mirror.

SAC noted that the time is ripe to start thinking about instrumentation to be used behind the AO bonnette. It was also pointed out that the AO bonnette will be a very complicated instrument, and that planning should start for a simplified user interface to this instrument.

Wide Field Observations

A consensus emerged from the Users' Meeting that some form of imaging instrument was required to take better advantage of the wide-field capabilities of CFHT. SAC noted with interest, and endorsed, the proposed collaboration between Toulouse and DAO to build a 2×2 mosaic of 2048^2 CCDs on a time scale of 1–2 years. Such a device, equipped with Loral CCD's, would have an imaging field of about $13' \times 13'$ with sampling of 0.2 arcsec per pixel (at the prime focus). Although the scientific importance of drift-scanning was eloquently expressed at the Users' Meeting, it was clear from the discussion at the SAC Meeting that the (primarily manpower) resources do not exist at the present to implement drift scanning at CFHT.

Detector Development

A frequent subject of discussion at SAC meetings is CCD development, and this meeting was no exception. SAC again noted the lack of a thinned, high quantum efficiency 2048^2 CCD at CFHT, and recommended that CFHT do everything in its power to acquire such a device. Meanwhile, until such a device is acquired, it was acknowledged that implementation of the thinned 1024^2 STIS CCD (on loan from DAO) was of the highest importance. The STIS chip was described as being very close to being released for use on the telescope. In terms of longer-term priorities, SAC noted the importance of completing the two new IR array cameras (engineering time for which has already been scheduled), purchase and implementation of a thinned 2048^2 CCD, characterization of existing detectors, and development of CCD mosaics. The work of the engineer and technician that make up the CFHT detector group is clearly outstanding: SAC stressed the importance of expanding this small group.

Infrared Spectroscopy

There was a large amount of discussion at the Users' and SAC Meetings on infrared spectroscopy in the 1–2.5μm region. The simplest of these is the insertion of a grism in the dewars of the new IR camera, and the technical feasibility of such a project is now being assessed. Other projects discussed include Tiger-Pytheas IR (a cooled IR integral field spectrograph), Osiris (an IR module for MOS-SIS), use of the FTS with 2D IR

arrays, and an upgraded (cooled) FTS. SAC chose not to make a recommendation on these various projects, at least partly because some of these projects are not being funded by CFHT. SAC did however make it clear that IR spectroscopy was an important area of scientific interest in the next decade, and hopes to discuss these projects further at the next SAC Meeting.

Scheduling

A great deal of discussion took place at the Users' Meeting on future scheduling needs for the telescope. This discussion was prompted by the interest expressed by the community in some form of "Key Programme" announcement at CFHT, and by the concern about maximizing the efficiency of CFHT, given the fact that CFHT is so oversubscribed in both the Canadian and French communities.

There was considerable difference of opinion expressed among SAC members as to whether a new "Key Programme" initiative was needed. Many felt that a new initiative was not necessary, since CFHT has already implicitly supported such programmes in the past. It was also noted that the semester by semester review that a key programme would need (if handled by the present ad hoc method of review in which large programmes are subjected to the same review process as smaller programmes) is not altogether a bad idea; some form of ongoing review should be a key ingredient of a large programme, and there should be no "guarantees" of many semesters of telescope time. It was therefore decided that Key Programmes would, for the time being, continue to be considered on an ad hoc basis by the relevant Time Assignment Committees. A further discussion on Key Programmes will take place at the November meeting of SAC.

There was also an extensive discussion of queue scheduling and remote and service observing. Although the need for such services was clearly noted at the Users' Meeting, Monnet expressed several concerns related to the implications for such observing on CFHT personnel, specifically noting that it could be hard to honour a commitment to service observing if key personnel were lost on a short time scale. It was clear that a first step in this direction should be a very limited experiment with service observing in the next semester.

A queued approach to scheduling the telescope was discussed extensively at the Users' Meeting, and a number of clear advantages to such an approach were mentioned. Nevertheless it was clear that such an approach to scheduling would have to await the outcome of experiments in service and remote observing, which will hopefully be tried in the near future with MOS/SIS. Further discussions on remote observing, queue scheduling, and the treatment of similar or duplicate proposals in the Canadian and French communities, will be held at the November 1992 meeting of SAC.

SAC discussed the importance of the CFHT archive in improving the efficiency with which CFHT observations are used. An important part of the archive is some indicator of weather conditions at the time of observation, and a first step in this direction has been made with the acquisition of data from the new free standing weather tower; further work needs to be done on obtaining quantitative information on transparency and cloud cover.

CHRIS PRITCHET

HIGH-TECH APPROACHES TO BINARIES IN DIXIE

During the first full week of April my wife Ann and I had the pleasure of attending IAU Colloquium 135, which was devoted to the topic of "Complementary Approaches to Double and Multiple Star Research", and was sponsored by IAU Commission 26 (Double and Multiple Stars), with the co-sponsorship of Commissions 24 (Astrometry) and 30 (Radial Velocities). The Colloquium was attended by nearly 100 astronomers representing 21 countries, and was held at a delightful resort called Callaway Gardens, about 100 km southwest of Atlanta, Georgia. Our hosts were members of one of the most active and productive groups working in the field, the Center for High Angular Resolution Astronomy (CHARA) of Georgia State University. The local arrangements were ably looked after by a committee chaired by Bill Hartkopf, and the scientific program was arranged, as is usual for such meetings, by an international committee of which I was privileged to be a member. As is also usual, however, the lion's share of the latter committee's work was handled by its chairman, in this case Hal McAlister, founder and senior member of the CHARA group!

The choice of time for the meeting meant for me a splendid contrast with the tasks of lecturing, as it followed immediately after the end of our term. Of course the preparation of a paper for the meeting had made the previous few weeks a little more hectic than they might have been otherwise! But the real reasons for the choice were far better than such mundane considerations. April is a time of pleasant weather in Georgia, warm but not overpoweringly hot, a time when trees flower and the scenery is at its best. And Callaway Gardens include quite easily the most spectacular collection of azaleas I have ever had the pleasure of seeing. In full bloom, they really provided a powerful disincentive to attendance at sessions!

However, the program was full of interest, sufficient to lure one away from the azaleas MOST of the time! Among the highlights were descriptions of the fascinating results now coming from infrared speckle observations of very young objects. They are providing us with valuable insights into the formation of the majority of stars (binaries), as well as turning up a number of convincing cases of those elusive objects, brown dwarfs. Reviews were also presented of the large-scale spectroscopic surveys undertaken by the CORAVEL group in Geneva led by Michel Mayor, the Center for Astrophysics group led by David Latham, and by Roger Griffin in Cambridge. These are now at the stage where statistical results bearing on binary star evolution can be extracted from them, for example the age-dependence of the distribution of eccentricity as a function of period, important for understanding the efficiency of tidal circularization of orbits.

As would be expected from the fact that CHARA were our hosts, we had the pleasure of hearing much about speckle interferometry, which together with the long-term radial velocity work, has largely removed the observational selection gap in the period distribution of binary stars, although the fraction of spectroscopic binaries that are resolvable by that technique remains fairly modest. But we also learned about the results that are starting to flow from the new class of long-baseline interferometers, and of the construction of larger instruments of that type. Indeed for me the highlight of the whole Colloquium was the prospect that these instruments should soon permit most known spectroscopic binaries to be resolved. Of course one of the by-products of such resolution is the combination of angular and velocity data to yield accurate distances; the Colloquium resolved to propose to the IAU that the name orbital parallax be given to that method, which should soon become applicable to many more objects than it has hitherto. I suspect it may soon become the best method for finding the distance to such objects as the Hyades, with obvious consequences for the distances of objects that depend on the Hyades for calibration.

Many other notable pieces of work were also discussed briefly, or presented as posters. A very balanced review of precise radial velocities, written by Gordon Walker, a past-president of our Society, was read on his behalf by David Latham, since Gordon was unfortunately unable to attend because of illness. We were shown some preliminary results from Hipparcos, and a very few from the Hubble Space Telescope, two satellite observatories each operating with a handicap. In all, the wide range of studies, and the obvious enthusiasm of the young astronomers present, were convincing evidence that binary star astronomy has never been more flourishing in my recollection than it is today, and reflect the wisdom of the IAU Executive in permitting Commission 26 to continue in existence a few years ago when its fortunes were low. And one poster indicated how to build a speckle camera for $1000, a manageable cost for amateurs...or for undergraduate laboratories!

Finally it gives me the greatest of pleasure to let readers know that the Colloquium agreed unanimously to dedicate its Proceedings to a distinguished Canadian astronomer, Alan Batten, also a past-president of the C.A.S., in recognition of the many contributions he has made to astronomy as a whole and to binary star studies in particular, in his very productive career. (We made him work for the honour, however, as the concluding speaker, whose chore of bringing together all the week's ideas and discussions, always a difficult task, he accomplished with great skill and diplomacy, and even seasoned his remarks with a dash of humour!) In all it was an excellent Colloquium, another achievement to add to CHARA's growing list.

COLIN SCARFE

CANADIAN ASTRONOMY PUBLICATIONS
March 10 to June 8, 1992

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A. PREPRINTS OF RESEARCH PAPERS

The following is a list of preprints written by Canadian astronomers and received at the Astronomy library within the dates given above. The preprints are arranged in alphabetical order according to the surname of the first listed author. Originating institution and date of receipt at the library are given.

Babul, A., Starkman, G.D., *A quantitative measure of structure in the three dimensional galaxy distribution: sheets and filaments.* Canadian Institute for Theoretical Astrophysics, 11-May-1992.

Beech, M., Mitalas, R., *Mass-luminosity relation for Wolf-Rayet stars.* University of Western Ontario, 24-Apr-1992.

Bell, M.B., Feldman, P.A., Avery, L.W., *A sensitive search for rotational lines of vibrationally excited HC5N in IRC+10 216.* Herzberg Institute of Astrophysics, 30-Mar-1992.

Blaes, O.M., et al, *On the evolution of slowly accreting neutron stars.* Canadian Institute for Theoretical Astrophysics, 20-Mar-1992.

Blaes, O.M., Webster, R.L., *Using gamma-ray bursts to detect a cosmological density of compact objects.* Canadian Institute for Theoretical Astrophysics, 8-Apr-1992.

Butler, M.N., Malaney, R.A., *Gravitationally induced neutrino oscillations.* Queen's University, 18-Mar-1992.

Carlberg, R.G., Charlot, S., *Faint galaxy evolution.* Space Telescope Science Institute, 12-May-1992.

Clayton, M.A., Moffat, J.W., *Electroweak theory without a Higgs particle .* Physics, University of Toronto, 12-Mar-1992.

Davidge, T.J., Nieto, J.-L., *Asymptotic giant branch stars in the central regions of M32.* Canada-France-Hawaii Telescope, 27-Mar-1992.

Doyon, R., Puxley, P.J., Joseph, R.D., *The He I[lambda]2.06[mu]m/Br[gamma] ratio in starburst galaxies - an objective constraint on the upper mass limit to the initial mass function.* Obs. Mont Megantic, 15-Apr-1992.

Dubinski, J., *Cosmological tidal shear.* CfA, 27-Apr-1992.

Eales, S., *Direct construction of the galaxy luminosity function as a function of redshift.* David Dunlap Observatory, University of Toronto, 20-May-1992.

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Ivans, I., Percy, J.R., Zorgdrager, I., *Astronomy and astrophysics in your classroom.* David Dunlap Observatory, University of Toronto, 19-Mar-1992.

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Kallrath, J., Milone, E.F., Stagg, C.R., *Modeling of the eclipsing binaries in the globular cluster NGC 5466.* University of Calgary, 27-Apr-1992.

Kaspi, V.M., Stinebring, D.R., *Long term pulsar flux monitoring and refractive interstellar scintillation.* Princeton, 7-Apr-1992.

Leonard, P.J.T., Richer, H.B., Fahlman, G.G., *The mass and stellar content of the globular cluster M13.* Los Alamos Ntl. Lab., 20-Apr-1992.

Martin, P., Roy, J.-R., Belley, J., *Abundance gradients in barred spiral galaxies.* Obs. Mont Megantic, 19-May-1992.

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Milone, E.F., Stagg, C.R., Schiller, S.J., *Constraints on the cessation of eclipses in SS Lacertae and their implications for system evolution.* University of Calgary, 27-Apr-1992.

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Mitalas, R., Sills, K.R., *On the diffusion time scale for the sun.* University of Western Ontario, 24-Apr-1992.

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Neff, S.G., Hutchings, J.B., *Evolution of luminous IRAS sources: radio imaging.* Dominion Astrophysical Observatory, 25-Mar-1992.

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Pineault, S., *Cometary impact rates onto neutron stars and white dwarfs.* Obs. Mont Megantic, 15-Apr-1992.

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Quinlan, G.D., Tremaine, S., *On the reliability of gravitational N-body integrations.* Canadian Institute for Theoretical Astrophysics, 4-May-1992.

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Roy, J.-R., Belley, J., *The ionized gas in the center and in the bar of the spiral galaxy NGC 6946.* Obs. Mont Megantic, 19-May-1992.

Rucinski, S.M., *Spectral-line broadening functions of WUMa-type binaries. I. AW UMa.* Institute for Space and Terrestrial Sciences, York University, York University, 10-Apr-1992.

Saha, P., Tremaine, S., *Symplectic integrators for solar system dynamics .* Canadian Institute for Theoretical Astrophysics, 5-May-1992.

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Spence, I., Garrison, R.F., *A remarkable scatterplot.* David Dunlap Observatory, University of Toronto, 30-Mar-1992.

van den Bergh, S., Pierce, M.J., *The intrinsic colors of supernovae of type Ia.* Dominion Astrophysical Observatory, 25-Mar-1992.

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Williger, G.M., Babul, A., *Pressure-confined Ly [alpha] clouds: simulation results vs. observations.* Canadian Institute for Theoretical Astrophysics, 11-May-1992.

Young, A.T., Milone, E.F., *On improving IR photometric passbands.* University of Calgary, 27-Apr-1992.

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