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This report covers the period from 1998 April 01 through 1999 March 31, while the publications are for the calendar year 1998.

1. MANDATE

The National Research Council (NRC) has the Parliamentary mandate to operate and administer any astronomical observatories established by the Government of Canada. NRC exercises this mandate through its Herzberg Institute of Astrophysics (HIA), which provides astronomical facilities, research, and infrastructure to university scientists and their students. Later sections of this report describe the Optical Astronomy Program at the Dominion Astrophysical Observatory in Victoria, BC, the JCMT Group at the same location, and the radio-astronomy projects at the Dominion Radio Astrophysical Observatory near Penticton, BC.

2. INTERNATIONAL COLLABORATION

HIA is responsible for Canada's participation in three major ground-based facilities - the 3.6-m Canada-France-Hawaii Telescope (CFHT) and the 15-m James Clerk Maxwell Telescope (JCMT) on Mauna Kea, and the Gemini 8-m telescopes under construction on Mauna Kea and Cerro Pachon in Chile. Donald Morton represents NRC on the Gemini Board and the JCMT Board, while Vice President Jacques Lyrette and James Hesser are the NRC members of the CFHT Board. The Office of the Director General coordinates the assignment of Canadian time on the CFHT and JCMT. Jacques Vallée is the Technical Secretary of both committees and is assisted by Brenda Parrish. During 1998 the Canadian Time Assignment Committee for the CFHT consisted of D. Bohlender (HIA), R. Carlberg (U. Toronto), P. Hickson (UBC), T. Davidge (HIA), G. Fontaine (U. Montréal), and M. West (St. Mary's U.), while the Time Allocation Group for the JCMT comprised J. MacLeod (HIA), M. Fich (U. Waterloo), D. Naylor (U. Lethbridge), R. Pudritz (McMaster), and D. Scott (UBC). Vallée is also Secretary to the Canadian National Committee for URSI.

3. STAFF CHANGES

Graham Knox and Roxanne Ewing joined the Central Services staff, and Bill Mackwood was hired to a short term contract during the review period. Ron Davison retired in August after 31 years with NRC.

4. RESEARCH

Morton has continued his efforts to tabulate the most reliable wavelengths and *f*- values for analyzing astronomical spectra. He chaired the Local Organizing Committee for the 6th International Colloquium on Atomic Spectra and Oscillator Strengths, which was held in Victoria, B.C., August 9-13, 1998. With Biémont (Liège) and Quinet (Mons), he published theoretical *f* -values for Ge II, As II, and Se II. He has updated his resonance-line computation for the lighter elements in an appendix to a paper on 23 Ori in collaboration with Welty and York (U. Chicago) and is preparing a new compilation of atomic data for the stable elements heavier than gallium.

Vallée published a review of the observations of magnetic fields inside and outside the Solar System, notably on planets, stars, masers, pulsars, and starforming regions less than 1 parsec in extent. Vallée, Bastien (U. Montréal) and Greaves (JAC) have a program to detect the presence of magnetism in molecular cloudlets using the JCMT polarimeter with SCUBA. Measurement of the polarization in these elongated clouds should determine the geometry of the magnetic field (at least for the tangential component). Vallée and Greaves also are studying gas globules (Boks) for turbulence, using the JCMT at 345 GHz. Vallée and Henriksen (Queen's U.) are studying cloud collision and rotation in CO lines.

5. CANADIAN GEMINI PROJECT OFFICE

During 1998 the Canadian Gemini Project Office began to emphasize p reparations for Gemini observations, which are to begin in 2000, with the first proposal deadline at the end of 1999. In recognition of this, the name will change to ''Canadian Gemini Office.'' HIA held a competition to select two astronomers to support Canadian scientists with Gemini operations, and appointed Tim Davidge and Stéphanie Côté. Both took up their positions around the end of 1998. Davidge has seven years experience in the CGPO in term positions supporting Gemini construction, and now takes up an ongoing position for Gemini operations. Côté was most recently a Research Associate at HIA, and has previous experience in the ESO User Support Group. Davidge worked with NOAO and with the CADC to develop a Web-based tool for handling Gemini Phase 1 proposals, and prepared the initial Canadian Gemini Web pages. Côté has now taken over responsibility for these. Woodsworth has accepted additional responsibilities in High-Performance Computing (HPC) for NRC, and he served on the Executive Committee of C3.ca, a national organization to promote and coordinate HPC in Canada. With the sponsorship of NRC's Vice-Presidents, he developed a proposal for how NRC would provide a national coordinating office for C3. Woodsworth acted as Chairman of the Gemini Operations Forum, which coordinates efforts of the Gemini partners in supporting their national scientific communities. He also represented HIA on the Gemini Instrumentation Forum and he led the development of a joint proposal for Canada and Chile to develop a Science Archive for Gemini. Bob Wooff, as manager of the Gemini Enclosure Control System, completed and delivered this project to Gemini. It is now in use at the summit. Work

continued on development of the Gemini Multi-Object Spectrographs, in collaboration with the UK Astronomy Technology Centre and Durham University. The HIA team brought Altair, the Gemini adaptive optics system, through a successful Critical Design Review and fabrication of this effort has begun. Finally, the CADC completed work on the Gemini Data Handling System, which very recently has been accepted by Gemini. Jean-René Roy of Université Laval continued as a member of the CGPO in the capacity of Canadian Gemini Scientist. He also acted as Chairman of the Gemini Board. Davidge continued near-infrared photometric studies of globular clusters at low latitudes. Using data obtained with the CTIO CIRIM imager and the CFHT AOB+KIR, Davidge investigated the colour-magnitude diagram and K luminosity function of the very metal-poor globular cluster NGC 6287, which is only 1.6 kpc from the Galactic Center. These data indicate that NGC 6287 is not significantly older than the metal-poor halo cluster M92. Moreover, the temperature distribution of horizontal branch stars in NGC 6287 is very different from that in M92, suggesting that the second-parameter effect may also occur among globular clusters in the inner Galaxy, contrary to what was previously thought. Davidge also used the CFHT AOB to obtain broad- and narrow-band near-infrared images of the central regions of a number of nearby galaxies. The central regions of the Sb galaxy M81 were investigated in collaboration with Stéphane Courtéau (HIA). These data reveal that within a few tenths of an arcsec of the galaxy center the light near 2 microns contains a significant contribution from hot ($T \sim 1000K$) dust. The spatial distribution of globular clusters in the inner regions of M81 is also not significantly different from that in the Milky Way, including a dearth of clusters within a few hundred parsecs of the galaxy center.

6. FUTURE RADIO ASTRONOMY INITIATIVES

Peter E. Dewdney is the Co-ordinator of Future Radio Astronomy Intitiatives for the Herzberg Institute. He is assisted by B.G. Veidt, B.R. Carlson, and J. Fitzsimmons who came to NRC in March, 1998. Dewdney and Veidt have been active in developing strategies for Canadian participation in the Atacama Large Millimeter Array (ALMA). This large international project has received funding in several countries, and is seen as the most important initiative in the field of mm/submm astronomy in the coming decade. Plans are being developed to participate through the contribution of correlator and receiver work at NRC, and through industrial contracts in the areas of antenna construction and the design of cryogenic equipment. Work has also begun to understand issues related to the design of precise antennas for ALMA. Dewdney has also been active with university and international colleagues in promoting the Square Kilometer Array (SKA) in the international arena, and in developing the Large Adaptive Reflector (LAR) as potential technology for the SKA. The SKA is now seen in many countries as the next generation cm/dm wave radio telescope. Two international SKA meetings were held, one in July, 1998 in Calgary, Alberta, and the other in Green Bank, West Virginia. The Calgary meeting, organized jointly with Prof. A. R. Taylor at the University of Calgary, was the first to concentrate in detail on matching the scientific priorities of the SKA with technical specifications. As a result, and with subsequent work by international colleagues, the first full edition of a scientific case has been published (Taylor, A.R., and Braun, R., 1999, Science with the Square Kilometre Array). With partial funding from the National Research Council, Prof. Taylor has been appointed as SKA International Project Scientist. Recently the SKA science case has been presented to the Canadian Long Range Planning Panel and the Radio Panel of the US Decade Review. The Canadian technical contribution to the SKA is research on the Large Adaptive Reflector (LAR), a potential solution to the cost and performance barrier needed to enable its eventual construction. The LAR is a long focal-length paraboloid which requires an air-borne platform with variable-length tethers to support the focal package, but does not require mechanical tilting of the reflector as in more traditional reflector designs. As a result of a special grant from the National Research Council of Canada, research and development work on the Large Adaptive Reflector (LAR) has involved about 26 people in Canadian universities and industry, including seven graduate students. The researchers are organized into strategic groups. The feed group, led by Veidt, has completed a study of the full range of feed options, and mapped out further development strategies. The antenna group at the University of Manitoba led by Prof. Shafai is examining some of these options in detail, including a Cassegrain option, which could be important for deep-space communications and radar applications. As part of the receiver development, the cryogenics group led by Prof. Luc Bauwens of the University of Calgary is developing pulse-tube-cooling technology for cooling the low-noise amplifiers in the feeds, funded by a $275K NSERC grant. The aerodynamics group of Fitzsimmons and Prof. M. Nahon at the University of Victoria have completed steady-state studies of the aerodynamic stability of the multi-tethered aerostat system. The results of three independent models of steady-state behaviour agree, including the earliest calculations by Veidt, and preliminary models of dynamical behaviour in turbulent air indicate that the stability goals can be achieved. The structures group, led by Prof. Stiemer of the University of B.C. and D. Halliday of AGRA-Coast, has completed a preliminary design of the 200-m LAR reflector, including panels, support structure, and main and secondary actuators (with contributions from Carlson). Optimization of the structure is continuing to lower the cost. The controls group is dispersed, with laboratory experiments conducted by Prof. Meng's group of the University of Alberta, and theoretical work being carried out at the University of Victoria. Meng's group has built up a laboratory setup to study the behaviour of a multi-tethered system similar to the one needed for the LAR. The laboratory setup is complete, and tests are to begin shortly. This group will also be designing a control system for the position of the reflector surface. The measurements group is also multi-pronged. Prof's E. Cannon and G. Lachapelle of the University of Calgary have completed a study of the 3-D position-measurement system for the airborne feed. Carlson has completed an analysis of a photogrammetry method for measuring the positions of the panels of the reflector surface.

Landecker and his student are constructing at NRC a demonstration microwave system for determining the distance from the center of the reflector to the focus with submm accuracy. Current estimates indicate that the cost-goal of 400-600 $US per square meter for the SKA is within reach with the LAR technology. Results of this work have been reported at international meetings as part of the international agreement, ''Technology Study Program Leading to a Future Very Large Radio Telescope,'' signed by HIA last year on behalf of NRC. Some of the technical reports and other information can be accessed on the World-wide Web at http://drao.nrc.ca/ska/ska.html.

7. SOLAR TERRESTRIAL PHYSICS

In Ottawa Vic Gaizauskas continued his collaboration with members of the PROM (Prominence Research: Observations and Modeling) team on the general topics of the formation, support, and destabilization of solar prominences and solar filament channels. These topics are fundamental to the understanding of mechanisms behind mass ejections from the Sun; they have a practical relevance to the triggering of major geomagnetic storms. The film archive of large-scale solar images acquired at the Ottawa River Solar Observatory 1973 - 1992 provided most of the data analyzed in the publications listed below. Donald McDiarmid, in Ottawa used CANOPUS magnetometer and radar data from the ground to investigate an auroral MHD feature which occurs past midnight and is characterized by auroral bands taking the form of a capital omega concurrent with a very long period magnetic pulsation. McDiarmid also is the science policy consultant for the Canadian Association of Physicists and is its Director of Professional Affairs. David Anglin in Ottawa, has used HIA's High flux Telescope on the Ulysses spacecraft to measure convective flows in Jupiter's magnetosphere using anisotropies in the energetic particle flux. Collisions between neutrals and ions in Jupiter's ionosphere produce a potential field, which drives a Birkeland current system in the magnetosphere. As a result, the magnetospheric plasma and particles are forced into quasi-rigid rotation with the planet. However, the capability of Birkeland currents to maintain this flow is limited by the ionospheric Pedersen conductivity. Rigid rotation was predicted to breakdown around 20 Rj. In order to search for this breakdown, Anglin extended his previous anisotropy analysis using the High Flux Telescope out to greater radial distances. On the duskside, an oscillatory behaviour was observed in the flow. Near 15 and 20 Rj, the flow appears to be super-rotational. The Ulysses magnetometer observed leading signatures at these distances, indicating that the plasma was pushing the field into the tail of Jupiter's magnetosphere. The origin of these super rotational flows is not understood, but they might be due to the solar wind's interaction with the magnetosphere. Anglin, with Hargrove (Carleton U.), has performed modelling for the design of a Lead Astrophysical Neutrino Detector (LAND) in order to determine the optimal geometric configuration and the relative amounts of lead, moderator and neutron counters in this configuration. The goal is to develop a low-cost detector for astrophysical neutrinos produced in supernova explosions. Andrew Yau, who is now based at the University of Calgary, successfully completed the tenth year of continuous operation of the Suprathermal Mass Spectrometer (SMS) instrument on the EXOS-D (Akebono) spacecraft in March 1999. The extended science data base, which will cover a full 11-year solar cycle by March 2000, will be a unique base for the study of ionospheric ion composition and outflow. Yau also completed the development of the Thermal Plasma Analyzer for the Japanese PLANET-B mission to Mars and delivered the instrument to ISAS in Japan in May 1998 for final integration and testing. It was launched on the Nozomi spacecraft on July 4, 1998, and is presently en route to Mars. Yau has commenced the development of the Thermal Suprathermal Analyzer instrument for the SS520-2 sounding rocket to be launched November 2000 from Spitzbergen, Norway. This instrument is an advanced version of Mars analyser with improved ion optics and more than a 10-fold increase in measurement speed. All of Yau's projects are supported by the Canadian Space Agency.

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