

# CASSIOPEIA

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Nova



Canadian Astronomical Society /

Société Canadienne d'Astronomie

## FROM THE EDITORS

We go to press with mixed feelings about this first issue of Cassiopeia. The spontaneous response to our July 10 request for news items was not overwhelming, and much of what appears here is a result of subsequent inquiry on our part. We know that there have been interesting items of news over the past three months that have been missed.

Our next issue is slated for the Winter Solstice, and, since that brings us close to Christmas holidays and mail rush, we hope to get our mailing out early in December. Therefore please note on your calendar now the deadline of November 15 for news items, brief articles, comments, etc., to be mailed to David Dupuy, Burke-Gaffney Observatory, St. Mary's University, Halifax, N. S. Our budget does not permit a special reminder letter to all members.

We hope that Cassiopeia can develop into an interesting and valuable medium for communication among Canadian astronomers. In years to come these early issues, despite their shortcomings, will constitute an important record of what we were all doing in 1973.

J. F. H. and D. L. D.

Applications are invited for a postdoctoral project scientist position for work on radiative transfer in molecular atmospheres using computer-oriented synthetic spectral methods. Candidates should have a good knowledge of molecular spectroscopy and radiative transfer theory and be experienced in programming and the use of computers.

Applicants should send a curriculum vitae and the names and addresses of at least two referees to Professor R. W. Nicholls, Director, Centre for Research in Experimental Space Science, York University, 4700 Keele St., Downsview, Ontario M3J 1P3, from whom more information may be obtained.

## NEW FACULTY MEMBERS & STAFF

University of Waterloo - Dr. Donald R. Rayburn has recently joined the Astronomy Programme, Department of Physics, as an Assistant Professor. Donald obtained his Ph.D. at Queen's University in 1971 and has since been doing Postdoctoral Research at the Institute of Theoretical Astronomy in Cambridge, and at the Department of Astrophysics at Cal Tech, under sponsorship of NRC. His research interests include relativistic magnetohydro-dynamics and the theory of pulsars and thermal and dynamical processes in the interstellar medium. Donald is married and has one child.

DAO - Mike Marlborough has arrived for a sabbatical year, from Univ. of Western Ontario.

University of Western Ontario - Dr. Conrad Sturch, previously at the University of Rochester, will take Mike Marlborough's place this year.

Romas Mitalas will return in September from a sabbatical leave spent at Yale University.

## NOTES FROM CRESS

Kim Innanen was recently promoted to full Professor and was in Australia attending the I.A.U.

Chris Purton and Paul Feldman have had considerable success recently in observing radio emission from a number of early type emission line objects. Details of these objects have been given in a recent series of I.A.U. Circulars. Dr. Purton was following up these discoveries in Australia towards the end of August.

A. Sanyal, formerly a Post Doctoral Fellow at the University of Toronto, has spent the summer months collaborating with Stanley Jeffers and Bill Weller working on short-term spectrum variable stars.

Stanley Jeffers was recently promoted to Associate Professor with tenure.

## VISITORS TO UNIVERSITY OF WESTERN ONTARIO

Dr. John Rice of Brandon University spent the month of August at Western. He and Bill Wehlau have been observing several peculiar A stars that are spectrum variables.

In early August, Bill Webster from the Manitoba Museum of Man and Nature, in Winnipeg, visited briefly for discussion of work he is engaged in with Mr. Moorhead.

Serge Demers of the Institute for Astronomy, Laurentian University, Sudbury, spent a week at the Astronomy Department working on the iris diaphragm photometer and discussing some problems in photometry with Amelia Wehlau.

#### X-RAY ASTRONOMY AT U OF C

A Black Brant rocket (APF-IV B-30) was launched from Kauai, Hawaii at 00 30 local time on June 21, 1973. This is part of the NRC Sounding Rocket Program for Upper Atmosphere Studies. The rocket carried scientific experiments from the University of Calgary and Simon Fraser University.

The U of C experiment had two detectors for detecting cosmic x-rays, which were designed, developed and fabricated in the Physics Department at U of C under the direction of Dr. D. Venkatesan. The technical team consisted of C. Hansen and Z. Spivak of U of C and D. Will and T. Lamont, now at the Southern Alberta Institute of Technology in Calgary.

The detectors were the so called "Wall-less counters" viz., multi-layer proportional counters, filled with P-10 gas. One detector with a suitable aluminized mylar window was designed to measure hard x-rays in the range 2-20 Kev. The other was operated in cooperation with Simon Fraser University. Its sensitivity was centered around 0.6 Kev.

Data were obtained during the 850 second flight of the rocket, which attained an altitude of about 440 miles. Analysis will be carried out in the months to come.

#### SAINT MARY'S UNIVERSITY

The University has approved a plan for a Master's Degree Program in Astronomy, which may begin as early as 1974/75. Gerald Diamond, a fourth year Physics student at SMU, has spent the summer at DAO as a Student Assistant. During its first year of operation, the new Burke-Gaffney Observatory attracted almost 5000 visitors. Photoelectric and photographic photometry is under way for a study of several young clusters.

#### Astronomer on Royal Guest Lists

Helen Hogg, first CAS President, has probably shattered the record for royal guest listing as far as Canadian astronomers are concerned. On June 26 she was a guest of the Government of Ontario at the State Banquet tendered in Toronto for Queen Elizabeth and Prince Philip and on August 1 she was a guest of the Prime Minister and Mrs. Trudeau at a reception in Ottawa for the same royal personages.

## Astronomy at Canadian Universities

In an effort to get a general picture of the scope of the teaching of astronomy in Canadian Universities, I recently sent out a brief questionnaire to members of CAS at twenty Universities where astronomy is taught. The results, tabulated below, should be of interest and value.

It was suggested to me that brief statements from those universities which have well-developed astronomy graduate programs would also be of particular value to prospective graduate students and their advisors. Such statements were requested and those which have been received are presented on the following pages.

We will gladly correct any errors and print any late reports in a subsequent issue.

J. F. H.

University	No. of Courses Offered			U-g. Spec. Prog.	Grad. Progs.		Research Telescope
	Undergrad.		Grad.		M.Sc.	Ph.D.	
	Intro.	Adv.					
Saint Mary's	2	2 x ½	-	No	(Yes)	No	16"
Laval	2	-	-	No	No	No	16"
Montreal	-	3	5	?	Yes	Yes	-
McGill	½	½	-	No	No	No	-
Queen's	2	1	10	No	Yes	Yes	60' radio, 16"
Toronto	8	7	16	Yes	Yes	Yes	74", 2 x 24", 19" 16", 60' radio
York	2	2	6	No	Yes	Yes	24"
Waterloo	4 x ½	5 x ½	7 x ½	Yes	Yes	Yes	12"
Guelph	2	-	-	No	(Yes)	No	12½"
Western Ontario	2	3	15	Yes	Yes	Yes	48", 12" 8"
Laurentian	2	2½	-	(No)	No	No	-
Lakehead	1	-	-	No	(Yes)	No	-
Manitoba	2	1	-	No	No	No	-
Saskatchewan	2	-	-	No	No	No	-
Lethbridge	1	2	-	No	No	No	-
Alberta	2	1	3 x ½	No	Yes	(Yes)	12"
Calgary	1	2	5	Yes	Yes	Yes	16"
British Columbia	2	5	10	Yes	Yes	Yes	12", 15' radio
Simon Fraser	-	1	-	No	No	No	-
Victoria	6 altogether		5	Yes	Yes	Yes	-

Notes: Brackets indicate that the reply was qualified. U. of T. courses include those offered at Scarborough and Erindale. All graduate courses are usually not offered every year.

C F H T

By Donald A. MacRae

It takes time to record a star deflection, cook a hamburger, or build a telescope. In the case of the Canada-France-Hawaii Telescope the French have given the project a head start and everyone is anxious to keep up the momentum. For a time, walls of protocol seemed to be holding back progress but a substantial breaching occurred in July with an exchange of diplomatic notes as a formal prelude to the official signing of the Memorandum of Understanding by the three agencies (NRC, CNRS and U. Hawaii). (It had already been initialled last May.) This step will make possible the immediate establishment of a Canadian Project Office to handle the parts of the job which are to be our responsibility, principally the optical work on the mirror and the design and construction of dome and associated buildings.

Even a few days before the diplomatic notes were exchanged, the Cervit mirror in its 15-foot packing crate was removed from its idyllic setting in the Meudon park, beside la grande coupole of the Observatory, and sent on its way to equally idyllic surroundings in Victoria B.C. The boat trip, via Antwerp, began on July 13 and it is probable that the mirror will have arrived in the west by this time. The optical craftsmen at DAO are anxious to begin their work, as they have been for too many years.

The design of a modern dome is no mean task for Canadian engineering. I think most astronomers will agree that it is essential that there be astronomical input, too, to avoid inconvenience, clutter, inadequacies and errors. Members of the Canadian Astronomical Society, especially those who have had experience with domes, are urged to send suggestions to one or the other Canadian members of the Scientific Advisory Council. They are David Crampton, René Racine, Gordon Walker and Bill Wehlau.

Suggestions about the optical facilities and instrumentation for the telescope itself are also welcome, and should be supplied to the same individuals. Responsibility for the construction of the telescope lies with the French. Also the chief Project Office will be in Paris, but with the signing of the Memorandum of Understanding a Canadian contingent of engineers can be placed there and will participate in the work. Graham Odgers will be Associate Project Officer.

Meanwhile the University of Hawaii, with state funds, is proceeding with its task of providing living accomodation at mid-level on Mauna Kea, and roads, power, etc., to the top.

Although it is too early to forecast a date when the telescope will become available for use, it is not too early to

C F H T - cont'd.

consider how it will be staffed and operated, to plan for appropriate instrumentation, and to prepare observational programs of significance which are appropriate to the instrument and site.

#### U. of T. Astronomers in Chile

Bob Garrison has been spending this summer (or winter if you like) in Chile, giving a course on spectral classification at the University and observing both at the Las Campanas Observatory and at Cerro Tololo. He reports that with his portable classification spectrograph (112A/mm) and associated image tube on the 60-inch CT telescope he has been able to get a good 0.6 mm wide spectrogram of a 16.5 mag. star in three hours. Nolan Walborn's image-tube eyepiece makes such faint stars easily visible on the slit.

Christine Coutts returned in July from a four-week observing run on the 24-inch Las Campanas telescope which netted about 150 photographs of globular clusters on her own and Helen Hogg's programs, even in the poor winter observing conditions (about 65% clear).

There has been a change of observing assistants at Las Campanas: Rick Salmon has resigned to accept a senior observing-assistant post at Cerro Tololo effective Sept. 15, and Chris Smith, a recent astronomy graduate at U. of T. has taken over the Las Campanas job.

Nolan Walborn, until recently a post-doc at the DDO, has taken up his new post as Assistant Astronomer at Cerro Tololo as of Sept. 1.

Canadian astronomers are reminded that the Las Campanas 24-inch telescope with front-rank photometric, photographic and spectrographic equipment is available to qualified astronomers for suitable programs. Applications for time requested along with a brief description of the programs should be made to the Director of the DDO.

## NOTES FROM THE ASTROPHYSICS BRANCH, N.R.C., OTTAWA.

John MacLeod has returned to Ottawa after a ten-month stay at the D.R.A.O., Penticton, B.C. While at D.R.A.O. he conducted a search for absorption in the radio spectrum of the quasar 3C455 caused by an intervening galaxy.

Bruce McIntosh of the Astrophysics Branch is spending four months in Czechoslovakia from June to September. He is working with Czech colleagues at the Ondrejov Observatory near Prague and the Astronomical Institute of the Slovak Academy of Sciences in Bratislava.

The Astrophysics Branch of N.R.C. in Ottawa was represented at the I.A.U. meetings in Sydney by Jack Locke and Peter Millman.

### MARIE LITCHINSKY BEREAVED

It is with deep regret we report the death of Mr. Sam Litchinsky of Calgary on July 31. Mr. Litchinsky served for many years on the local and national councils of the R.A.S.C. In 1972 he married Marie Fidler, well known to both amateur and professional astronomers across Canada as the Executive-Secretary of the R.A.S.C. On behalf of its members, the Canadian Astronomical Society extends its sincere sympathy to Mrs. Litchinsky.

### COPERNICUS COMMEMORATED IN OTTAWA

A major exhibit on the life and work of Copernicus, in honour of the 500th anniversary of his birth, was viewed by many thousands of visitors at the National Museum of Science and Technology in Ottawa from July 19 to 31. The exhibit featured the old astronomical instruments, mainly from the 15th century, which belong to the Jagellonian University of Cracow, where Copernicus received the first of his several degrees. It included two astrolabes, one an 11th century Arabic instrument, a celestial globe, an elegant torquetum for obtaining ecliptic coordinates and a terrestrial globe made in 1510, probably the first to show the newly discovered lands of America. In addition to portraits, university maces, copies of documents and woodcuts from Poland the exhibition included a large display on the life and teaching of Copernicus assembled by IBM in New York.

The Royal Society of Canada will sponsor a one-day Copernicus celebration in Ottawa on November 28, 1973, under the title "On a Disquieting Earth". The event coincides with the opening of a Copernicus exhibition at the National Library and the invited speakers will be Dr. C. E. Dolman of U.B.C., Dr. Northrop Frye of the University of Toronto, Dr. Jean-Paul Audet of the University of Montreal and Dr. J. M. Harrison, now with UNESCO in Paris. Both the Governor General and the Prime Minister have been invited to attend. In the evening a concert at the National Arts Centre will include the premiere performance of a musical work called "Copernicus", commissioned for the occasion and composed by Tadeusz Baird in Warsaw.

## DAO REPRESENTATIVES TO IAU

Dr. Ken Wright, Director of the Dominion Astrophysical Observatory since 1966, received an honorary doctorate from the Nicolaus Copernicus University in Torun, Poland. The degree was conferred at a special convocation held on September 7 in connection with the Extraordinary General Assembly of the I.A.U. and the celebration of the quincentenary of Copernicus' birth.

Dr. Wright also attended the regular XV General Assembly of the I.A.U. in Sydney, Australia. As chairman of the National Committee, he was Canada's official delegate. Also going to Sydney were Graham Odgers, Alan Batten, Graham Hill, and John Hutchings (who was returning from a working visit to South Africa). Wright and Hutchings attended I.A.U. Symposium No. 59 in Canberra (Stellar Instability and Evolution) gave brief papers there. Odgers presented a paper to Commission 9 (Instruments) by Richardson and himself on telescope arrays. Batten is Secretary of Commission 30 (Radial Velocities) and on the Organizing Committee of Commission 42 (Photometric Double Stars). Smolinski, Climenhaga, and Wright presented a paper on line blanketing to Commission 29 (Stellar Spectra).

### DAO Instrumentation

Although a formal agreement has not yet been signed between Canada and France for the 3.6-metre CFH telescope, some interim appointments have been made. Graham Odgers is Associate Project Director, and has spent several weeks at the Project Office in Meudon, France, since last May. David Crampton is a member of the Scientific Advisory Committee which held a meeting in Paris, during July. The WESTAR 150-inch grinding machine is nearly ready to take the 3.6-metre mirror blank when it arrives in Victoria.

Three orders have been received for a new spectrograph designed by Harvey Richardson. These spectrographs are destined for the Nicolaus Copernicus Observatory, Torun, the Athens Observatory, and the 16-inch telescope on Mt. Kobou. The optical parts will be made at the D.A.O., and the mechanical parts by firms in Victoria and Vancouver.

A new spur-gear drive was installed on the 48-inch telescope in March. It was designed by Dittmar Associates, and is similar to the drive on the McDonald 107-inch telescope. The performance of the new drive is very satisfactory.

## U. of T. Brief Notes

Donald MacRae, as Chairman of the Board of Trustees of the Universities Space Research Association attended meetings in New York on June 7 and Chicago on June 11. He also gave a talk on "Since Copernicus" at the Symposium on Copernicus conducted by the Canadian Society for the Study of the History and Philosophy of Science in Kingston on June 8. On July 17-20 he attended a meeting of the Provisional Board of Directors of the CFHT Project.

Rene Racine, along with other Canadian members of the Scientific Advisory Committee for the Canada-France-Hawaii Telescope Project, namely David Crampton, Gordon Walker and Bill Wehlau, met with their French and Hawaiian counterparts in Paris June 18-20 to discuss planning details.

Don Fernie organized and chaired a symposium on "Chemical Evolution of the Elements" at the June Meeting of the Royal Society of Canada in Kingston. At the same meeting Jack Heard was elected convener of the Interdisciplinary Subject Division and Sidney van den Bergh the Society's representative on the NRC Associate Committee on Astronomy for the coming triennium.

Post-doc Brent Tully gave a colloquium at the DDO on "The Whirlpool Galaxy" on July 17.

Grad student John Roger completed his Master's program this summer and left for Nigeria for a two-year stint with CUSO.

The following were expecting to attend the IAU Assemblies: in Sydney, Maurice Clement, Don Fernie, Bob Garrison, Don MacRae, Sidney van den Bergh, Nolan Walborn; in Poland: Jack Heard, Helen Hogg, Phil Kronberg, Robert Roeder.

Grad student Austin Gulliver has recently visited the DAO and the University of Michigan searching plate files and borrowing spectrograms which relate to the active phases of shell stars for material for his Ph.D. project.

In June Tom Bolton visited Warner and Swasey Observatory and the University of Michigan conferring and giving talks on Cygnus X-1. At the Columbus AAS meeting he attended the Council meeting as a "young astronomer" and gave a paper on Cygnus X-1.

## R Aquarii a Radio Source

Ernie Seaquist of U. of T. and Phil Gregory, now at U.B.C., had observed in April and May, at ARO, signals at 2.8 cm apparently emanating from the peculiar symbiotic star R Aqr. In June, observing the region again with the Green Bank radio interferometer at 3.7 and 11 cm, Dr. Seaquist was able to confirm the association of the radio signals with R Aqr. The star has long been known to be surrounded by faint filamentary structure, and it is this which is presumed to give rise to the radio emission.

UNIVERSITÉ de MONTREAL

Trois étudiants de l'Université de Montréal recevront un Ph.D. en astrophysique cet été, soient Gilles Aubin, Héléna Dédic et Monique Tassoul. Gilles Aubin ira enseigner au Sénégal, Héléna Dédic prendra un congé de maternité et Monique Tassoul retournera en Europe l'an prochain. Trois nouveaux étudiants ont été acceptés au niveau maîtrise pour l'automne qui vient.

Au cours de l'été, il y a eu pas mal de va et vient au département. D'abord, au mois de mai, Gilles Beaudet et Morris Aizenman participèrent au Congrès annuel de la Société Canadienne d'Astronomie. A la même période, Georges Michaud faisait un séjour d'un mois à Meudon et Nice. A la fin mai, le Dr. Philippe Goret de Saclay, France, fit un stage d'un mois et demi à l'Université.

A la fin juin, lors du Congrès de l'Association Canadienne des Physiciens, plusieurs personnes ayant des intérêts en astrophysique dont le Dr. Jack Locke et E. Vogt sont passés par le département. En juillet nous avons reçu la visite du Prof. E.E. Salpeter de l'Université Cornell. Morris Aizenman nous quittait pour accepter un poste à Boulder. Le Prof. Hubert Reeves et René Racine ont passé la majeure partie du mois d'août au département, et le 8 août le Prof. Y. Terzian s'est joint au groupe comme professeur invité. Il demeurera avec nous jusqu'à la fin janvier et donnera un cours en radio-astronomie à l'automne. En septembre aussi, le Dr. Gilles Fontaine de l'Université de Rochester, boursier de la Province de Québec fera ses études post-doctorales au département. Enfin, le Prof. Georges Michaud présentera une communication lors du Congrès IAU à Sydney, et Gilles Beaudet participera au Congrès extraordinaire de l'IAU en Pologne en septembre.

### Toronto's vdB Travels Widely

Sidney van den Bergh will have covered a fair part of the earth on astronomical business before the summer is over. After a May observing session at Cerro Tololo he had a five-night session with the 40-inch telescope of the Wise Observatory in the Negev Desert, Israel, visiting also Tel-Aviv University at Ramat-Aviv where he talked on "Supernovae". Returning via Europe he visited the Italian Institute for Space Research at Frascati where he gave talks on "Differences between Galaxies", attended the inauguration of the new Italian 72-inch telescope in Asiago on June 16, gave a talk on "Galaxy Evolution" on June 18 to the Italian Centre for Nuclear Research at Frascati. At the Cambridge Institute of Astronomy he gave talks on "Old Stellar Populations and Galaxy Evolution", "Differences between Galaxies" and "The Supernovae of the Second Millenium A.D.". At Ruhr University in Bochum and at the Kapteyn Astronomical Laboratory in Groningen he also gave his talk on "The Supernovae of the Second Millenium A.D.".

In the latter part of August he had a total of 13 nights on the 48-inch and 200-inch telescopes at Palomar. With the 200-inch he was able to complete the resolution of the three dwarf-spheroidal companions to M31 which he had discovered in 1972, the magnitude level of resolution being similar to that of the Population II stars in the Andromeda nebula. Using the Toronto SII interference filter on a 200-minute exposure with the 200-inch telescope he was able to identify the remnant of Cas A as an almost complete shell.

In August Dr. van den Bergh will attend the IAU General Assembly in Sydney and give an invited talk on "Differences between Galaxies" to IAU Symposium No. 58 at Canberra and an invited paper on "Remnants of Supernovae" at the joint Discussion on Novae and Supernovae in Sydney.

### Seventh Annual June Institute

Staff and students of the Department of Astronomy at U. of T. and about 44 visitors enjoyed the 1973 four-day June Institute on June 12-15 organized by René Racine. The emphasis this year was shared between galactic structure and astrophysics. Dr. Bart Bok of the Steward Observatory gave four talks on the structure of the galaxy as revealed by photography, and Dr. Gerrit Verschuur of NRAO four equally fascinating presentations on the structure as revealed by hydrogen clouds. The sometimes divergent views of the two speakers were highly stimulating. Dr. Dimitri Mihalas of Boulder gave four talks on new theoretical interpretations of the details of early-type stars, and Dr. Olin Wilson of the Hale Observatories gave a four-session account of his long-continued studies of stellar chromospheres.

J. S. Plaskett and the Shape of the Galaxy\*

by Donald A. MacRae

"The Rumford Premium has been awarded to Dr. Plaskett. This gold medal, given at irregular intervals by the American Academy of Arts and Science, Boston, for researches in heat and light, is the highest honour the academy can give. Dr. Plaskett will be in Boston early in April and will receive the medal in person".

- from *J. Roy. Astr. Soc. Can.* 24, p. 146,  
March 1930.

The medal was duly presented to J.S. Plaskett at the 1181st meeting of the Academy on the ninth of April 1930 beginning at 8:38 P.M., with all the pomp and ceremony appropriate to the era and the occasion. Dr. Plaskett was invited to address the 41 members of the Academy and 12 guests who had assembled for the event. He had chosen for his title "The gases of interstellar space" and in it he described how the recent observations at Victoria had proved that the interstellar material partakes in the differential rotation of the Galaxy.

At the conclusion of his address, Dr. Plaskett agreed to the Chairman's request that he answer a few questions from the floor, but the audience felt restrained by the importance of the occasion, the eminence of the recipient of the medal, or the breadth of the subject on which he had spoken. Finally a gentleman who had been sitting in the front row rose to his feet. Several persons in the audience who knew of his ideosyncrasies caught their breath. "Thank you, Dr. Plaskett, for your very fine address ", he said, " We now know not only that the Earth is flat but that the Galaxy is flat as well" , and he sat down. The meeting, according to the Academy's Proceedings, vol. 64, p. 490, "was dissolved at 9:54 P.M."

\* *Inspired by an eyewitness account by B. J. Bok*

Editors' Note: We hope to institute a "department" for Canadian historical notes and anecdotes relating to astronomy. Have you any to submit?

Titles of some recent theses are:

UNIVERSITY OF ALBERTA

Research and graduate work in Astronomy and related fields is carried out in the departments of Physics and Electrical Engineering. Areas of research and staff members involved include galactic structure, binary and variable stars (Dr. D.P. Hube); gravitational collapse and cosmology (Dr. W. Israel); atomic transitions and laboratory astrophysics and others, Electrical Engineering). Experimental work related to nucleogenesis is conducted by members of the Nuclear Research Centre. Research facilities include an IBM 360/67 computer with terminal facilities in the Physics Building; a 12-inch reflecting telescope equipped with a single channel photometer and a wide variety of filter systems; a 3-meter spectrograph, 1-meter and 3/4-meter vacuum spectroscopy and forbidden atomic transitions studies. Interested students should write to Dr. E.R. Kanasevich, Assistant Chairman, Department of Physics, University of Alberta.

UNIVERSITY OF BRITISH COLUMBIA

Research in astronomy is carried out in the geophysics and astronomy, physics, electrical engineering, mechanical engineering and mathematics departments, and is coordinated through the Institute of Astronomy and Space Science. Graduate programs leading to the M.Sc. and Ph.D. degrees in astronomy or astrophysics are offered by both the geophysics and astronomy and the physics departments. Previous course work in astronomy is not necessary but a good background of physics and/or mathematics is essential. Courses cover such topics as the techniques of radio and optical astronomy, celestial mechanics, interstellar matter, stellar structure, modern astronomy and space dynamics.

Most of the observations by faculty and graduate students are made with the facilities of the Penticon and Algonquin Park Radio Observatories, the Dominion Astrophysical Observatory in Victoria, the Kitt Peak National Observatory in Arizona and the Cerro Tololo Inter-American Observatory in Chile. A 15-foot radio telescope for use in the millimetre-wave region is in operation on campus. A fully-digitized Joyce-Loebl microdensitometer is in operation for the reduction of astronomical spectra. Systems for the direct digitization of astronomical spectra, using low-light-level television cameras and a small computer have been built and extensively used; further development of sophisticated optical receivers is continuing. Research is also carried on in the field of laboratory astrophysics, including the analysis of astrophysically-important spectra, light-supported shock fronts, and the behaviour of plasmas. Experiments for the detection of infra-red spectra are flown in rockets launched from the Churchill Rocket Range.

J. Byl (M.W. Ovenden): Time-dependence of the Local Stellar Velocity Distribution.

I. Easson (M.H.L. Pryce): Calculated Potential Energy Curves of Hydroxyl.

B.A. Goldberg (G.A.H. Walker): Development of LLTV techniques for detection/analysis of spectra with application to B Cephei stars and other objects.

V.R. Venugopal (W.H.L. Shuter): Study of the 21-cm line in the Solar Neighbourhood.

A booklet describing awards and financial assistance is available from the office of the Registrar. Correspondence, and requests for information, application forms, etc., should be addressed to:

Dr. G. A. H. Walker, Director  
Institute of Astronomy & Space Science  
The University of British Columbia  
Vancouver 8, B.C.

UNIVERSITY OF CALGARY

The graduate programme at Calgary is directed towards a balanced training in astronomy and astrophysics. Facilities exist for work both in theoretical as well as observational astronomy and astrophysics. The astrophysics group is part of a larger space science group which has had a successful graduate programme since 1958.

Formal course work is kept to a minimum of two courses in the MSC as well as the Ph.D programmes (with a further minimum of two courses). No predefined courses are listed except for a course on stellar structure and evolution and one on solar terrestrial physics. Each year graduate courses are given tailored to suit the needs of current students. An interesting aspect of astrophysics at Calgary is that made possible by active research projects in X-ray (D. Venkatesan); Ultra-violet (E.F. Milone); Optical (E.F. Milone); and infrared astronomy (T.A. Clark) as well as theoretical astrophysics (S.R. Sreenivasan).

Observational X-ray astronomy using rocket-borne multi-anode, multi-layer proportional counters is in progress. Cosmic X-ray spectral measurements are planned and a sky-survey project in the far infrared is under development, using balloon payloads.

The nature of the variability in X-ray, optical, infrared and radio sources is pursued through spectroscopy, high-precision broad-and narrow-band photometric observation of light variations. Classes of objects studied include pulsating, eclipsing, and erratic variables. Particular programs include photoelectric monitoring of the optical and radio variable synchrotron source BL Lacertae, the light curve study and analysis of binaries in the mass-exchange phases of evolution, an infrared excess study to determine the existence of circumstellar shells in those binaries, and a program to measure the motion of the line of apsides in selected binary systems, and an ongoing study of the ultraviolet radiation from the sun.

Theoretical studies relate particularly to stellar evolutionary models of massive stars beyond the main sequence, mass-loss effects on evolution and realistic mass exchange mechanisms including radiation pressure in close binary systems. Solar work concentrates on the structure and beating of the solar atmosphere, dynamics of solar activity and the solar wind. Work is also being carried out on the structure, dynamics and stability of force-free magnetic fields and their role in solar, stellar and galactic phenomena.

Further information may be sought by writing either to the Department Head (Dr. H.R. Krouse) of the Chairman of Graduate Affairs (Dr. S. R. Sreenivasan).

UNIVERSITÉ DE MONTRÉAL

Il existe trois orientati ons distinctes de la recherche astro-physique actuellement à l'Université de Montréal, centrées autour des professeurs G. Michaud, J.L. Tassoul et G. Beaudet. Les cours gradués sont évidemment choisis en conséquence de ces programmes de recherche, exceptés peut-être pour les premiers cours de maîtrise. Le Dr. G. Michaud s'occupe actuellement des problèmes de diffusion dans les étoiles Ap, dans le but d'expliquer les abondances nucléaires anormales de ce type d'étoile. Comme deuxième point d'intérêt, il a l'astrophysique nucléaire dans le calcul des sections efficaces de réactions. L'hydrodynamique et la mécanique des fluides servent d'instruments de base au Dr. J.L. Tassoul dans l'application aussi bien à la fission possible d'une masse gazeuse, qu'à l'étude de la stabilité des étoiles. Des considérations analogues peuvent aussi s'appliquer à des masses plus importantes ou la théorie générale de la relativité devient importante. L'évolution des étoiles demeure l'apanage du Dr. G. Beaudet. Les problèmes concernant les produits de réactions nucléaires à l'intérieur des étoiles sont étudiés en détail pour les étoiles peu massives. Les diverses réactions nucléaires à partir des interactions fortes aux interactions faibles sont considérées.

QUEEN'S UNIVERSITY

Graduate courses offered at Queen's include: Galactic Astronomy, Extragalactic Astronomy, Stellar Structure and Evolution, Cosmic Gas

Dynamics, Gravitation and Cosmology, Classical Electrodynamics, and Advanced Radio Astronomy.

Editors' note: because of a misunderstanding of what we were asking for, a description of the Graduate program in astronomy at Queen's has not been included here; we plan to print it in a subsequent issue.

UNIVERSITY OF TORONTO

The Department of Astronomy offers programs of study and research leading to the M.Sc. and Ph.D. degrees. The Master's program generally takes 12-15 months but can involve a longer period in some cases. A student in such a program takes three to five courses depending on his astronomy background and whether he completes a thesis or a smaller research project. If admitted to a Ph.D. program, a student must pass some additional courses as well as submitting a thesis involving original research.

Research can be undertaken in any of the three broad areas of optical, radio, or theoretical astronomy. Current work includes the study of galaxies, star clusters, galactic structure, variable stars, binary stars, stellar structure, and cosmology. The David Dunlap Observatory, sixteen miles north of Toronto, provides the major instrumentation for optical work. There is a 74-inch, 24-inch, and a 19 inch reflector, all equipped with accessory instrumentation. The Department also operates a 24-inch telescope in Chile to take advantage of the great opportunities for discovery in the Southern Hemisphere. Students also have access to the 150-foot paraboloid of the Algonquin Radio Observatory which is operated by The National Research Council. At this observatory, the University of Toronto is completing its own 60-foot dish. For theoretical work and data analysis, The University of Toronto Computer Centre operates a network of IBM computers including a 370/165, a 360/65, and a 7094 together with peripheral equipment such as display units, platters, and remote terminals.

For further information, contact the graduate Secretary, Department of Astronomy, University of Toronto, Toronto, Ontario M5S 1A7.

UNIVERSITY OF VICTORIA

Astronomy at the University of Victoria is offered within the Physics Department. Both M.Sc. and Ph.D. degrees may be obtained. Information may be obtained by writing to:

Chairman, Graduate Committee,  
Department of Physics  
University of Victoria

Each program requires a thesis, though the thesis may be replaced by four additional courses for an M.Sc. candidate. The areas of research include Galactic Clusters (G.A. Bakos), Galactic Structure (M.P. FitzGerald), H II regions (D.L. Roberts) and Relativistic Gas Dynamics (D.R. Rayburn). Other areas of current research include the interstellar medium (MPF and DRR), variable stars (GAB), V1016 Cygni (MPF), Pulsars (DRR), the Galactic Centre (DRR), binary stars (GAB) and MPF, and stellar spectroscopy (GAB and MPF). Recent M.Sc. theses in these areas have included space density analyses in the southern Milky Way MPF: (W.J.F. Wilson, J.M. Moore, K. Kirton, J. Stegman), Model Atmospheres of early type stars GAB: (E. Mautser), ratio of total to selective absorption MPF: (R.A. Bell), visual binaries GAB: (C. Doucet), HII regions DLR: (J. Sipe), and image orthicon photometry GAB: (S.E. Kim).

The facilities available include a 12-inch telescope, a 360-75 computer, an HP 9830 departmental computer equipped for photoelectric photometry. An up to date and complete library and astronomy exchange library, a two co-ordinate measuring machine, an astrophotometer, and a microdensitometer. Extensive use of the Cerro Tololo Inter-American Observatory and the Las Cruces telescope of the Dearborn Observatory has also been made, as have the facilities of the David Dunlap Observatory, thanks to the courtesy of the Director. Further information may be obtained by writing to Professor G.A. Bakos, or to Professor N.R. Isenor, Chairman of the Graduate Committee, Department of Physics, University of Waterloo.

UNIVERSITY OF WESTERN ONTARIO

Graduate programs leading to the Ph.D. and M.Sc. degrees in Astronomy are offered by the Astronomy Department of the University of Western Ontario. There are seven faculty members in the Department, with primary interests in optical astronomy and theoretical work. Graduate courses, seminars and colloquia cover the major areas of astronomy with emphasis on those actively pursued here. Examples of recent theses are:

**Ph.D.:** A search for Weak Longitudinal Magnetic Fields in Bright Stars by E. Borra ( now Carnegie Post-Doctoral Fellow at Hale Observatories ) supervised by J.D. Landstreet.

**M.Sc.:** Photographic Photometry with the 48-inch Telescope by W. Webster (now at the Manitoba Museum for Man and Nature), supervised by J.M. Moorhead.

Research is being carried on in stellar spectroscopy, stellar atmospheres, spectrophotometry, optical instrumentation, stellar interiors, polarimetry, stellar magnetism, variable and peculiar stars, photometry of clusters, radiation transfer, stellar evolution and galaxies. Studies in gas dynamics, magnetohydrodynamics, physical processes and data are conducted in cooperation with the Applied Mathematics and Physics Departments.

**Astronomy Faculty:** J.A. Burke  
J.L. Climenhaga  
F.D.A. Hartwick  
C.D. Scarfe  
J.B. Tatum  
F.I. Cooperstock

Fields of research are: stellar and laboratory molecular spectroscopy, binary stars, interstellar medium, and evolution of stars and galaxies, and general relativity. Often there is cooperation with astronomers at the nearby Dominion Astrophysical Observatory.

Research equipment may include access to the 48-inch and 72-inch telescopes at the D.A.O. in addition to a 12-inch telescope with pulse counting photometer on the campus. Measuring equipment at the university includes a microphotometer, iris photometer, bif microscope, several measuring engines and a laboratory spectrograph.

Some recent theses:

**Ph.D.** "On the 1 to 8 A Soft X-ray Emission during Solar Flares"  
M.N. Anandaram. Supervisor: J.B. Tatum.

"On the Theoretical Evolution of Horizontal Branch Stars in Globular Clusters" P.G. Laskarides.  
Supervisor: F.D.A. Hartwick.

**M.Sc.** "Curve of Growth Analysis of a Bootis and 31 Cygni A"  
D.A. Vanden Berg. Supervisors: J.L. Climenhaga and K.O. Wright(D.A.O.).

"Observations Relevant to Mass Transfer in the Eclipsing Binary U Cephei" B. Baldwin. Supervisors:  
A.H. Batten and J.A. Burke.

"The Scuti Star 20 CVn" J.E. Penfold. Supervisor:  
C.D. Scarfe.

UNIVERSITY OF WATERLOO

The Astronomy graduate program at Waterloo is an integral part of the Physics graduate programs. However this does not detract from its comprehensiveness in Astronomy. On the M.Sc. level, which is well developed, students are required to take one of Quantum Mechanics 1, Electromagnetic Theory, or Statistical Mechanics, and three other courses. In Astronomy these would usually consist of Galactic Structure and Astrophysics and one other course. On the doctoral level all of the above physics courses are taken, with the total number of post-B.Sc. courses required being 9. All courses are 3 hours per week, one-term.

Facilities include a 48-inch Ritchey-Chretien reflector on the observatory 15 miles north of the campus. A horizontal coude spectrograph provides dispersions of 14 and 4 A/mm for photographic spectroscopy and 1 A/mm for the photo-electric spectrum scanner and polarimetry. Other ancillary instruments are a direct camera providing a field of 1.3 degrees at the Cassegrain focus, a Cassegrain spectrograph giving dispersions of 40, 62 and 345 A/mm, a 16 channel photometer, a Cassegrain polarimeter for circular and linear polarization, a single channel filter photometer and an image intensifier for direct photography and spectroscopy. A high dispersion Cassegrain echelle spectrograph for spectroscopy and polarimetry and an image intensifier - image dissector system with digital output are under construction.

The Cronyn Observatory contains the 10-inch refractor with the 12-inch reflector and 8-inch Schmidt camera and the instrument and electronic shops operated by the technical staff. Plate measuring engines, a microphotometer, a blink comparator, a spectra-comparator, student-faculty shop and dark rooms are located with the office.

Computing facilities include use of the CDC Cyber 73 and DEC PDP10.

For information on admission and financial assistance in the form of scholarships, bursaries and assistantships, write to:

Dr. W.H. Wenhau, Head,  
Department of Astronomy,  
University of Western Ontario,  
London, Ontario, N6A 3K7

YORK UNIVERSITY

Astronomical research and graduate work at York University is performed in The Centre for Research in Experimental Space Science (CRESS) in which a broad research programme in Astronomy and Astrophysics, Astronomy and Atmospheric Science, Chemical Physics, Earth Science, Lasers and Laser Applications, Rocket and Satellite Research, and Remote Sensing of Earth Resources is in progress. Observational, Experimental and Theoretical work is done in all of these areas. N.Sc and Ph.D. degrees are awarded in either the Physics of the CRESS graduate programmes depending upon the selection of graduate courses. About 40 faculty members, 20 postdoctoral fellows and 60 research students are involved in the work.

The main lines of current Astronomical Research are:

- Radio Astronomy (Observational) - Dr. C.R. Purton
- High Energy Astrophysics (Theoretical) - Dr. P. Feldman
- Galactic Structure (Theoretical) - Professor K.A. Innanen
- Stellar Spectroscopy using image tube techniques (Observational) - Dr. S. Jeffers

Laboratory Astrophysics (Experimental and Theoretical) - Professor R.W. Nicholls, Professor G.R. Herbert, Dr. W.M. Duley, Dr. F.J. Morgan  
Rocket spectroscopy of solar eclipses in the vacuum ultraviolet (Observational) - Professor R.W. Nicholls, Dr. F.J. Morgan.

The titles of typical recent Ph.D Theses are:

Numerical Investigation of Stellar Motions (1972) - Franklin House: A shock tube determination of the CN ground state dissociation energy and the electronic transition moments for the CN Violet and Red Band systems (1972) - James O. Arnold: A spectroscopic study of a quiescent solar prominence in the vacuum ultraviolet from rocket observations during the March 1970 eclipse (1973) - Chao Yuan Yang.

A two dome observatory containing 24" and 12" cassegrain telescopes are part of the Petrie Science building. CRESS also has very well equipped research laboratories and measuring equipment. CRESS astronomers regularly use the Algonquin Radio Observatory, Greenbank and a number of optical observatories. They also use the Churchill Research Rocket Range.

For more information including a 40 page brochure which describes the research programme in detail, please write to Professor R. W. Nicholls, Director, Centre for Research in Experimental Space Science, York University 4700 Keele St. Downsview M3J 1P3, Ontario.