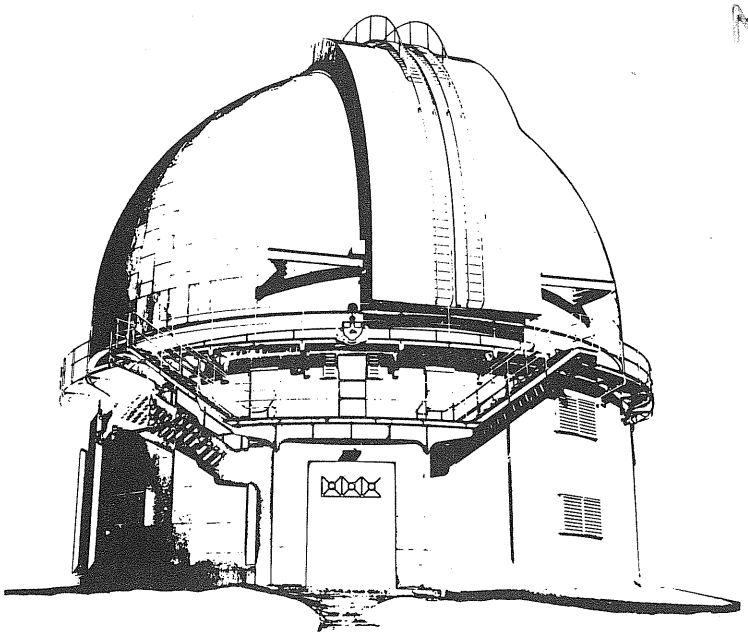
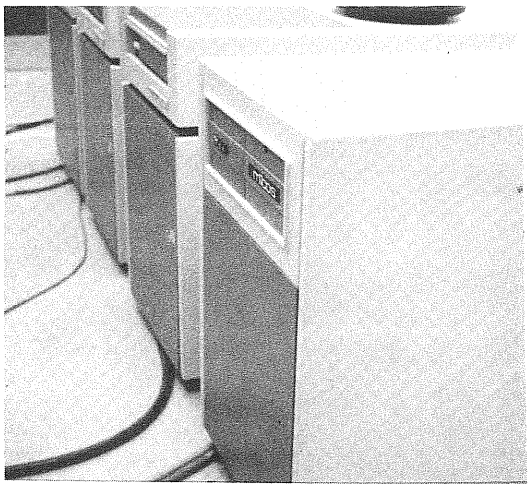
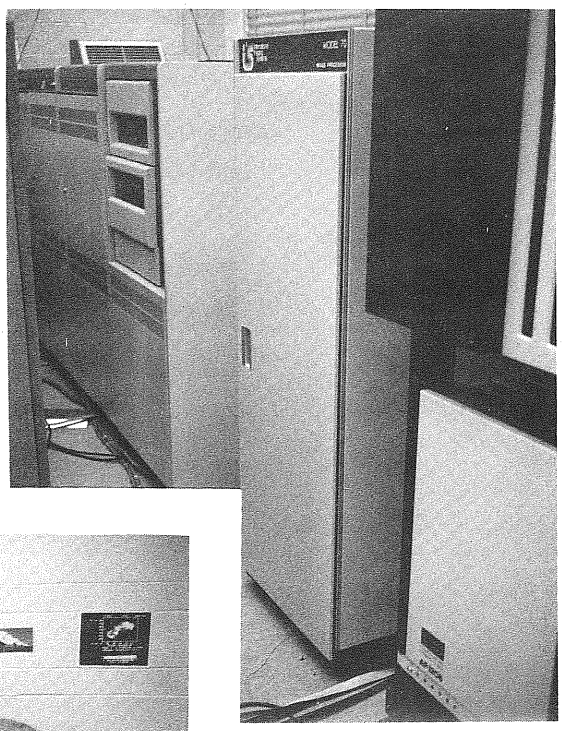
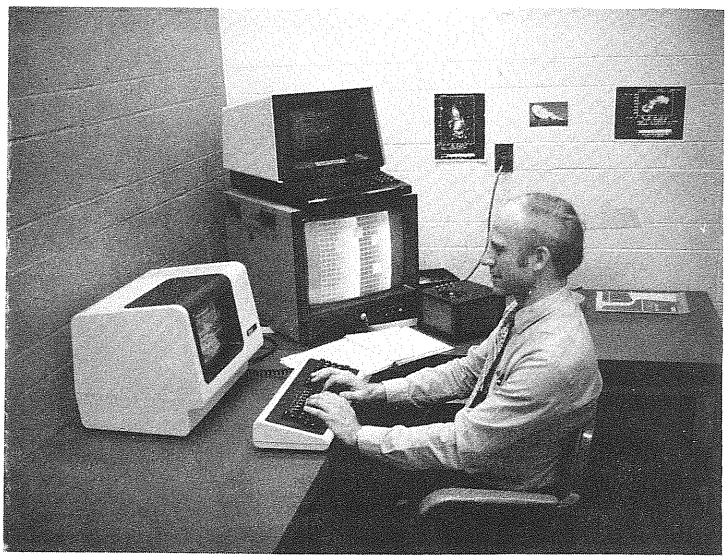


THE DAVID DUNLAP DOINGS

Vol. 15, No. 4 May 3, 1982







Cover Story p.3

THE AIPS WORK STATION IN THE ALCOVE OF ROOM 1405

Above left, the 675 Mbyte disk and above right, the I^2S and the array processor (foreground) beside the VAX on the 8th floor.

C O N G R A T U L A T I O N S

They arrived!

First, COURTNEY SULLIVAN, *at 8 lbs. 7 oz., on Thursday April 15 at the Toronto General Hospital, a sister for Todd Alan*

and, but one day later, VICTOR WONG, *at 7 lbs. 8 oz., on Friday April 16 at Branson Hospital.*

Congratulations to Pamela and Alan Sullivan and to Maria and Stephen Wong.

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Cover Story

The Image Processing and Display System - I

by Philipp Kronberg

We now have at U. of T. the first fully equipped VLA post-processing terminal outside the U.S. Indeed, the combination of display hardware and associated computer power in the VAX room is still only one of a handful of such "stations" fully duplicating the VAX-based hardware combination which NRAO has set up at the VLA site and at the Charlottesville headquarters. The display equipment, which many of you have doubtless noticed in the alcove off room 1405 (see cover photo), is just the tip of the iceberg: the bulk of the equipment, identified in the other photos, shares the company of the 2 VAX 11/780 computers on the 8th floor of the Physics Tower. The complete VLA post-processing terminal consists of:

(i) an *array processor* (Floating Point Systems Inc. Model 120-B),

(ii) an International Imaging Systems (I^2S) image computer, with *four* 512^2x8 bits deep *image planes, four graphics overlay planes,* and *arithmetic logic unit* (ALU), and I^2S *Model F12 Pipeline Display Processor* plus a few other less interesting components, all of which are housed in the I^2S cabinet in the VAX room. The two remaining components of the image computer are the *track ball controller* and the *high resolution Mitsubishi colour monitor.* These 2 units, together with a *VT100 terminal* plus additional *screen for task logging* comprise the user's terminal (see photo),

(iii) the biggest disk you can find - in this case a *CDC 675 Mbyte fixed head disk* also in the VAX room,

(iv) last, but not least, of course, the Physics/Astronomy VAX-1 computer.

The acquisition of the vital components, apart from the VAX, began in May 1980 when Physics Prof. Chris Chapman and I, after obtaining a matching subsidy from the Chairman of Physics, purchased the FPS 120-B array processor. Then together with Ernie Seaquist and Barry Madore, in the Autumn of 1980 I applied for, and received an equipment grant which paid for most of the I^2S image computer. It soon became painfully clear that the gridding, sorting, mapping, and storing of VLA uv and map plane data, all require enormous quantities of disk space. It turned out that Jim Prentice and his colleagues in the High Energy Physics group also needed a similar disk storage capacity. As a result, Jim Prentice and I jointly purchased the 675 Mbyte disk, close to the largest currently available on the market. This, the final crucial component, arrived in February of this year. The approximate costs of these items, for anyone interested are: $70,000 for the array processor, $70,000 for the I^2S, not counting terminals and some other extras, and $42,000 for the dual-ported (to VAX 1 and VAX 2) version of the 675 Mbyte disk.

The software is an equally important part of the system. It was developed by a team of programmers and astronomers at NRAO. The system was recently christened AIPS for "Astronomical Image Processing System". Some of the NRAO staff involved in writing AIPS software are Ed Fomalont, Eric Greisen, Bill Cotton, Tim Cornwell, Arnold Rots, Garry Fickling, Fred Schwab and Walter Jaffe. Also Don Wells, formerly of KPNO, has recently joined the AIPS group. Stuart Button has spent time with the AIPS team at NRAO, and has written some AIPS software. This makes the University of Toronto a direct contributor to AIPS.

With this introduction to the Image Processing and Display System, you may well be asking what it can do. That makes for a very long story which would take more than my fair share of valuable DDD space to describe in detail here. I shall therefore be brief, but will tell this story at greater length in installment II to appear at a later date.

The AIPS system accepts VLA data on tape in a prescribed format known as "FITS", and performs a very wide range of operations on the data, the end result being a radio map. In this case the input data is "uv"; in other words it corresponds to the Fourier transform of the actual image in the sky. One main function of the array processor is to do the Fourier transform of the input data. This can be performed 10 or more times faster than in the VAX CPU (in this way AIPS also, of course, saves a lot of CPU time).

Alternatively AIPS can perform many operations in the sky plane such as convolving, integrating, beam fitting, cleaning, position measurements etc. In this mode of operation it can work equally well with any non-VLA radio data, or digitized optical or X-ray pictures. All that matters is that the data be in FITS format. Finally I should mention that software for VLBI reduction is also being written. The data are accepted in a format analogous to VLA data. This means that we shall very soon have a VLBI post-processing station, using the same combination of computer hardware which we have installed.

G.A.S.A. *Gossip*

The Night of the Living Grad

by Ctn

As I touch the up button, all four elevators leave for the 14th floor without me. Could this be an omen? I am about to enter a world unknown to those who inhabit DA from 9 to 5. The sun has set and even Maurice will have put on his coat and fled the department. This is the world of the graduate student, populated by zombies wandering aimlessly about the darkened corridors as they try to remember the significance of names like Wilson and Bappu; do they have something to do with spectral lines or do they play on a line for the Boston Bruins?

My elevator stops and the door opens. Warned by the sound of Beethoven's 9th symphony being whistled backwards, I leap out of the way just in time as Louis streaks by and crashes through the closing door. Moving to 1405, I answer the phone. Before the caller can speak, I inform him that Doug Gies (pronounced Gees) is not is his office at the moment, take the message and deposit it atop the pile on Doug's desk. As I do this, I pass by Neb who is quietly reading today's issue of Pravda while waiting for his programme to run on the VAX. Just as I'm about to sit down at my desk, the caretakers arrive and order me out of the office so that they can wax the floor. I move back into the hallway passing 1408 where Doug Welch is telling his VDT to eat flaming death. I assume he is working on his solar model again and move on. I am attracted to 1416 by the shouts emanating from the latest friendly discussion between Ed and Fred but before I get there I am accosted by Al who is hustling Ping Pong. I can see he's serious about playing as he already has the cover off his paddle. I consent to the game since the caretakers are now piling furniture on top of my desk. On reaching the 15th floor, we are momentarily startled by the presence of Dieter sitting in the dark. After being trounced again, I return to the 14th and decide to try the reference room while my office floor dries. I am startled once more, this time by Louis who is asleep on the couch. The journal I'm looking for is missing so, finally allowed to return to my desk, I put on my coat and make my way home after a good night's work.

Geoff Clayton is President of G.A.S.A.

The New PDS Radial Velocity Program at DDO

By Tom Bolton

The PDS microdensitometer has been routinely used as a radial velocity measuring engine since 1976. The standard program for determining radial velocities from microdensitometer scans has been known as PLVEL or PLVELL and is now called STARVE because I could never learn to pronounce all of those L's. It determines line positions by fitting either a parabola or a Gaussian to a portion of each line profile to be measured. The user may specify the functions to be used and the wavelength interval to be fit for each line. The first STARVE measurement of the spectrum of a particular star takes a bit of time to ensure that the wavelength intervals used for the profile fits have been properly chosen, but subsequent measures of the spectra of the same star proceed very rapidly because STARVE operates on the unprocessed microdensitometer scan data.

The accuracy of the PDS and STARVE for radial velocity work have been carefully checked by measures of spectrograms of stars with a wide variety of spectral types which have also been measured on the Grant or Zeiss measuring engines. These tests have invariably shown that the STARVE/PDS measures have no significant systematic errors and tend to have smaller internal errors (i.e., greater accuracy per spectrogram) than those made with the other measuring engines. However, STARVE does not perform well when the S/N of the line profiles is small (e.g. weak exposures or broad, shallow lines), and we have not yet found an algorithm that will allow it to cope with the complex problems associated with measuring the spectra of double-line binaries.

These shortcomings can be overcome to a great extent if line positions are determined by cross-correlation with a spectrum with a known velocity. This is the numerical version of the process that is done electro-mechanically by CORAVEL and the Griffin radial velocity spectrometer. It doesn't have the speed of those instruments, because the spectrum must still be recorded element by element with some detector, but it is more flexible because single lines can be measured, it is easy to match the standard and unknown spectra, and it is easy to create special purpose correlation masks. This technique was originally developed here by Gerry Grieve for his M.Sc. thesis. Ron Lyons has improved and extensively rewritten Gerry's original software, and this package, called ACOR, has been available on the PDS system since last summer. The operation of this program and the results of some of the tests of it are described in the following paragraphs.

The microdensitometer scans must be processed by REDUCT to rectify the continuum before they are measured with ACOR. If they are not, the correlation functions will be distorted by continuum slopes. "Continuum" slopes could be a problem in rectified spectra in situations where lines are blended, such as metallic lines in the wings of hydrogen lines. ACOR has a feature which allows the user to perform local rectification of the "continuum" before measuring such lines.

The choice of correlation standards or masks depends a great deal on the problem under investigation. If absolute velocities are required, the unknown spectra must be correlated with a spectrum whose radial velocity shift is known. It is relatively easy to find a star of a given spectral type whose radial velocity is known with high precision, but it is much more difficult to be sure that the standard spectrum of this obtained with your instrument has the same radial velocity shift. This uncertainty propagates through the velocity determination and can significantly reduce the accuracy attainable. This can be overcome by using correlation measures

of standard velocity star spectrograms to determine the shift of the correlation standard or by constructing correlation standards from high accuracy spectrophotometric atlases of the sun and stars. We have not yet had occasion to test these techniques.

ACOR has been used primarily for work on binary and variable stars where the user wants to measure velocity variations with high accuracy but has no need for accurate absolute velocities. In this case, one of the spectra of the program star can be used as the correlation standard. Since this process omits the conversion of each velocity measure to the absolute system and the errors associated therewith, the velocity differences between the standard spectrum, which is assumed to have radial velocity equal to zero kilometers per second (or any other convenient arbitrary value) with no error, should be a factor $\sqrt{2}$ more accurate than those computed from STARVE velocities. The tests performed this past summer by Alex Fullerton confirmed that this is the case.

ACOR has a number of other nice features which are useful in special situations. First the cross-correlation algorithm is much more sensitive to weak signal to noise lines than the profile fitting technique. For example, Alex Fullerton's tests on weakly exposed plates of a broad-lined star found that ACOR could detect and reliably measure anywhere from 13 to 22 lines in spectra where STARVE could find no more than 4 and in some cases could find none.

Second, ACOR can be readily adapted to measure features that are heavily blended due to high line density and low resolution or blending with another star. The former case is handled by correlating sections of the spectrum against the standard analogously to the way measures are made with a spectrum comparator. There is no need to worry about effective wavelengths as would be required with STARVE. There are two situations that may arise. If the spectra of the two stars are similar (the most common case) a single-line spectrum (i.e. one taken at one of the conjunctions) can usually be used as a correlation standard. If pair-blending is a problem in the double-line spectrum, this can be reduced by correlating the blue wing of the blue line with the corresponding wing of the line in the standard spectrum and the red wing of the red line with its corresponding wing in the standard spectrum. Furthermore, the standard spectrum can be used to create pair-blends with known separations, and these can be used to derive empirical corrections for the pair-blending effect. (cf. Grieve's M.Sc. thesis).

If the spectra of the binary components are very different, it will be necessary to use the spectra of standard stars for the correlation masks. However, some tests by Nancy Evans have shown that it is possible to get very reliable results in such a situation even if the secondary spectrum is heavily blended with the primary, is much fainter than the primary, and where the data are noisy. She found that ACOR could detect the secondary spectrum in normal signal to noise photographic data when it contributed as little as one seventh of the signal. The secondary was also detected in data with S/N $\simeq$ 2-3 when it contributed one fifth of the signal. There is some loss of accuracy at the extreme light and S/N ratios, but it would not be possible to detect the secondary at all, let alone measure it with the classical techniques.

Further information on ACOR can be obtained from Ron Lyons, and full documentation is included with the documentation of the rest of the PDS software.

CONTEST RESULTS

The Winner of the 1981 Observers Handbook in the race to correctly identify "I" as Kim Innanen (Ph.D. 1964) is Dieter Brückner (who incidently is the only person whose observing initials contain an umlaut). An Honourable Mention goes to Barry Madore who in desperation suggested UBVR I. Another goes to Hy for the entry from the greatest distance - Dick Henry's welcome postcard from Baltimore reached us as this issue goes to press.

Operational Status of 1.88 m Telescope

The 1.88 m telescope has been the centre of a great deal of engineering activity since the accident to the cassegrain spectrograph (cf. previous DDD) substantially reduced the operational capabilities of the telescope. We have tried to make the best possible use of our bad luck by moving previously scheduled preventative maintenance and repairs up in order to minimize the engineering downtime that will be required once the spectrograph is fully operational.

By the end of April, the telescope drive train, the right ascension slew assembly, the declination slow motion assembly, and the cassegrain secondary mirror assembly had been variously dismantled, cleaned, repaired, modified, lubricated, and reassembled. The shop crew has also carried out some preventative maintenance on the dome, which we hope will stop small chunks of metal from falling onto the observing floor from on high. The last major job to be undertaken at this time, preventative maintenance and repair of the declination slew assembly, will begin on Monday, May 3 and should be completed within a week to ten days. Two other major jobs will have to wait. More tests are required before we can complete the repairs to the clock drive, and the primary mirror cell cannot be refurbished until the primary is aluminized, which will probably be done sometime in June.

Meanwhile, Karl Kamper has been working on several fronts to get the spectrograph back into full operation. He has explored two possibilities for obtaining a new corrector plate and some more exotic possibilities for doing without. He found that the latter would not prove satisfactory, so we are ordering a replacement from Applied Physics Specialties. Work should be underway on it by the time you read this, and it should be delivered by July 1. In the meantime, Karl has refigured the old collimator (pre mid-1978) from the spectrograph to work without the corrector plate. This has been successful in the sense that this system cancels the spherical aberration, but the coma is unacceptable outside the central 20-30 mm of the field. This system can be used with the reticon, which will soon be installed for testing, or for photographic spectrophotometry in the coma free field. Karl is exploring some additional posssibilities for temporary improvement, but it is likely that there will be no further improvement until the new corrector plate becomes available.

The telescope has not been completely idle since the accident. Chris Corbally used the new Garrison spectrograph at the Newtonian focus for four nights, and Ron Lyons has used a number of nights to obtain 8 Å mm^{-1} spectrograms of HR 5110 and radial velocity standards with the cassegrain spectrograph. The latter observations have shown that the spectrograph can be used for radial velocity work without the corrector plate in spite of the severe spherical aberration in the images provided

great care is exercised. There have been no tests of the 12 Å mm^{-1} grating, but we have no reason to think that it will not yield comparable results. The resolution of the spectrograph without the corrector plate is substantially lower than usual because of the spherical aberration, and plates obtained with this configuration probably should not be used for spectrophotometry.

There will be an informal observing schedule for the 1.88 m telescope beginning about May 10. This will be continued until the new corrector plate is installed or the reticon becomes operational. Please contact me if you are interested in using the telescope in its present configuration.

Tom Bolton (Bln)

An ISSN for the Doings!

Readers may have noticed on the verso of the title page of this month's issue of the DDO Doings a strange 8 digit number with the acronym ISSN preceding it. This is the International Standard Serial Number, a unique code used in the identification of serial publications world-wide. The DDO Doings is now registered with the International Serials Data System in Paris, France, a division of UNESCO'S world science information programme.

Lynda Colbeck (LaC)

DEAN-ELECT VISITS D.A.

In place of the regular staff-meeting on Wednesday April 28th, the Department was host to Robin Armstrong, soon to become the new Dean of the Faculty of Arts & Science. His visit was a part of an effort to contact all 29 departments before the end of term and before shouldering his duties on July 1.

Robin hardly needed to be briefed about the Department of Astronomy, since his association with us and the Department of Physics ranges all the way from undergraduate student (B.A. 1958) to Chairman of Physics (1974-1982). Principally he expressed an interest in knowing astronomy's hopes and priorities for the future. He stressed the importance of planning on the Faculty level and the necessity of proceding in a logical manner in going after support of new major projects. In connection with the latter he congratulated the astronomers (all of us in Canada, of course) in the way they had succeeded in presenting their cases, in recent years, for CFHT, CLBA, and now CITA, at the national level.

There was also some discussion of the role of private funding where the Department and Observatory feels there has been confusion and unnecessary restriction, and where advice could soon be most helpful. The Dean-to-be cited examples of confusion and inefficiencies in this area in his own experience.

No one would suggest that our department can look for any special consideration from the new Dean, but it is gratifying to know that he will have an understanding of our historical role and our place and importance at present, both locally and nationally. We wish him well in his new position.

1982 H.L. WELCH LECTURES IN PHYSICS

General Lectures in Medical Sciences Auditorium

Monday, May 17 *1:45 P.M.*	*R.R. Wilson, Columbia University,* *"Art, Architecture and Physics at Fermi Lab"*
Monday, May 17 *3:45 P.M.*	*Carl Sagan, Cornell University,* *"Organic Matter in the Outer Solar System"*
Tuesday, May 18 *11:00 A.M.*	*D.G. King-Hele, Royal Aircraft Establishment, Farnborough,* *"Geophysical Results from Artificial Satellite Orbits"*
Tuesday, May 18 *1:45 P.M.*	*R.R. Wilson, Columbia University,* *"Personal Perspective of Particle Physics: Where, When, What and Why?*
Tuesday, May 18 *3:45 P.M.*	*D.G. King-Hele, Royal Aircraft Establishment, Farnborough,* *"Erasmus Darwin - Man of Many Talents"*

There will be a General Lecture in Convocation Hall on Tuesday, May 18 at 8:00 P.M. by Carl Sagan on "The Search for Extraterrestrial Intelligence". In addition each of the speakers will give a specialized lecture on Wednesday, May 19, in the McLennan Physical Laboratories.

Revisionist's Corner

... In the discovery of pulsars a noble price was awarded to Hewish and chairperson at the Cambridge University...

Q: Where would you look to see Vega in the late evening sky in July?

A: South of Polaris

Q: What is the reason we give the names we do to the various meteor showers?

A: The various meteor showers are come from a various region in the sky, so we name them by the apparently constellation appears in that region of the sun.

To diffentiate them from other occurances in space and also because the don't really harm us as other large meteorite mite do if the fall on earth.

Q: Distinguish clearly between ... etc.

A: Rotate is the things it turn arounding by itself.

Revolve is the things which turning arounding, surrounding something.

Q: Define ...

A: The plane of the ecliptic is the horizontal earthbound that observer can easily seen the sun.

P O T P O U R R I

John Percy attended the spring meeting of the AAVSO in Milwaukee, Wisconsin, and presented a paper on "An International Photometric Campaign on Be Stars".

Bob Garrison was at Smithsonian Astrophysical Observatory in Cambridge, Mass. from 2-5 April working with Rudy Schild on a joint project involving new eclipsing variables and a new cataclysmic variable.

Word comes from Bjarne (Ph.D. 1979) and Carol Everson in Colorado of the birth of a daughter Sonja Elizabeth (7 lb. 10 oz) on Easter Sunday.

COMINGS AND GOINGS

Welcome to Jacqueline Patasar, our new secretary at DA, who is filling in while Pamela and Maria are on maternity leave.

COLLOQUIA*

April 13	Dr. T.T. Chia, Dalhousie University, "The Evolution of Close Binary Systems due to Mass Exchange and the Emission of Gravitational Radiation"
May 5	Doug Welch and Ed Zukowski, University of Toronto G2000 Current Literature Seminar
May 11 Tuesday+	Prof. Wen-Rui Hu, Academia Sinica, Peking, and High Altitude Observatory, "On Galactic Shock Waves"
May 12	Dr. J. Gallagher, University of Illinois, TBA
May 13 Thursday'	Dr. Donald Lynden-Bell, University of Cambridge, "The Mass and Dynamical Age of the Local Group"

*Unless otherwise noted, colloquia are held on Wednesdays at 4:00 P.M. in Room MP 137 with TEA at 3:45 in the Reference Room, MP 1404.

+Institute for Aerospace Studies, Staff Lounge, 11:00 A.M.

'McLennan Physical Laboratories, Room MP 134 at 4:10 P.M. with TEA in Room MP 1404 at 3:30 P.M.

PAPERS SUBMITTED

E.R. Seaquist *W.S. Gilmore* *K.J. Johnston* *J.E. Grindlay*	*Simultaneous Radio and X-ray Activity in SS 433*
Ray Skinner *Raymond Rusk*	*Generalized Hamiltonian Dynamics I: Formulation on T*Q⊕TQ*
Ray Skinner *Raymond Rusk*	*Generalized Hamiltonian Dynamics II: Gauge Transformations*

I.R. POUNDER

Professor I.R. Pounder died last month at the age of 91, ending a long career devoted to the teaching of mathematics at two universities in Toronto. He took a degree in mathematics in 1912 from U. of T. after starting out in 1906 in the School of Practical Science, now the Faculty of Applied Science & Engineering. Rejected from army service in the First World War because of what was obviously a minor heart defect, he joined the Department of Mathematics and taught here for over 40 years. His retirement coinciding with the beginning of York University, he then transferred to York's staff and taught there for another 14 years. The Department of Astronomy has special reasons to be grateful to I.R. Pounder and to note his passing, though most of us never knew him. A few years ago Professor Pounder was a beneficiary in the will of his brother, John A. Pounder whose career was in the Canadian Geodetic Survey. In his brother's memory, Professor Pounder established the several John Pounder Awards in Astronomy in various undergraduate astronomy courses at all three campuses of this university. Then, in December 1981, Professor Pounder himself made a benefaction to the Department of Astronomy, of $3000 to be used for graduate research work in the Department of Astronomy, and he indicated there would be a second gift from his estate.

I was one of Pounder's students when he taught a formal course in Integral Calculus in the late 30's. What I remember most about his class-room presence was that he was determined to make all statements with great care. I began to realize that mathematical proofs were things that required intense concentration and attention to details, and that their proper presentation involved strenuous effort on the part of the teacher, no less than by the student. Seeing Professor Pounder work so hard for the sake of clarity and rigor engendered a sympathetic and co-operative frame of mind in the students and we all developed an enthusiasm and understanding which helped greatly to carry us along in the course. Other students of Professor Pounder's over his particularly lengthy years of service must certainly have benefitted in the same way.

MR