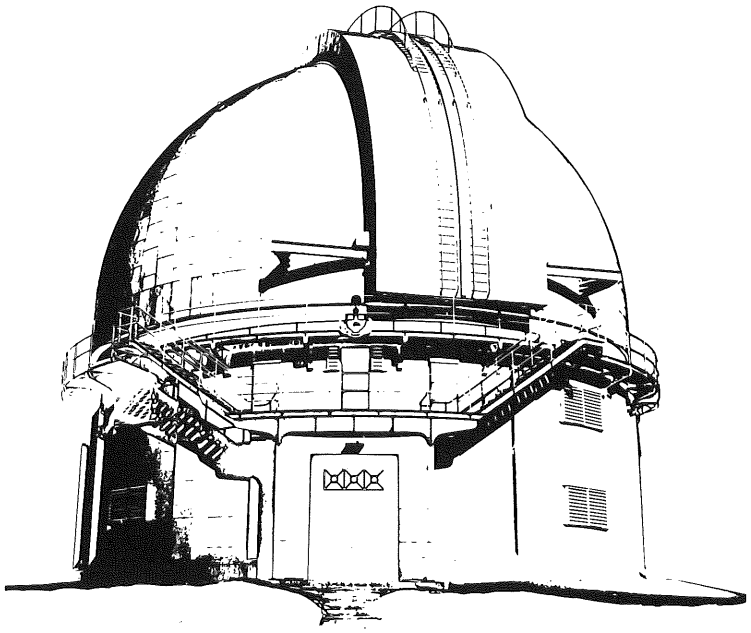
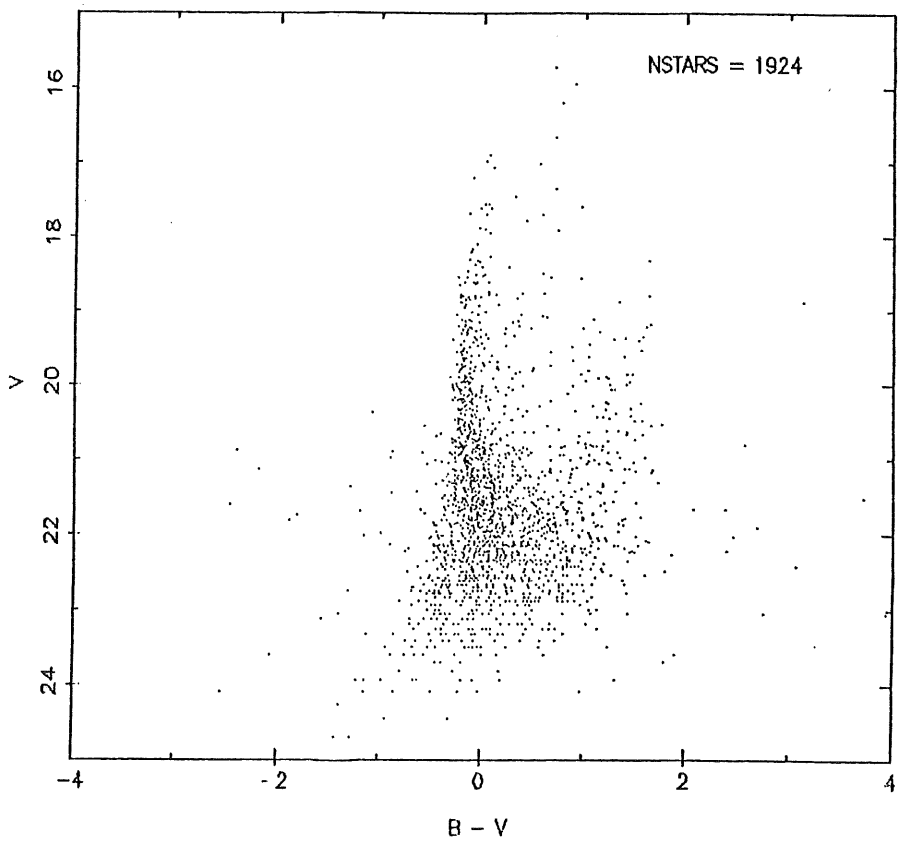


THE DAVID DUNLAP DOINGS

Vol. 17, No. 2 March 19, 1984

M33: COLOUR MAGNITUDE DIAGRAM (CCD DATA)



(Cover Story p.3)

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

To *Michael Bietenholz*, who completed his master's programme with the submission of his thesis entitled "An Investigation of the Polarization Properties of Extra-galactic Radio Sources of Different Morphologies and their Relation to Claimed Large Scale Anisotropies in the Universe". Michael was supervised by Phil Kronberg and is presently working for John Percy.

To *Alex Fullerton*, who supervised by Tom Bolton, completed his master's degree with the publication of his thesis on "The Early-Type Variable Star V986 Ophiuchi". Alex is continuing on at Toronto in the Ph.D. programme.

To *Michael Rensing*, who also finished his master's degree this spring. Michael's thesis, supervised by Stefan Mochnacki, is entitled "The Mass of AW Ursae Majoris". Michael recently returned to his home town in British Columbia.

To *Ann Rusk*, who finished a combined Chemistry-Astronomy master's degree entitled "A Study of the Dissociation of Molecular Hydrogen in Interstellar Shock Waves. Peter Martin acted as joint supervisor. Ann is now working for Maire Percy.

To *Fred Schmidt*, who submitted his master's thesis on "The Variable Star FO Virginis". Fred was supervised by Don Fernie and is continuing on in the Department's Ph.D. programme.

To *Doug Gies*, who has accepted a post-doctoral position at the other U of T (Texas, that is). His contact during the exciting negotiations was none other than Tom Barnes who finished his Ph.D. here in Toronto in 1970.

To *Wendy Freedman*, who has accepted a three-year Carnegie Fellowship at the Mount Wilson and Las Campanas Observatories in Pasadena, California. Wendy becomes the second woman to have gained entrance to this elite circle and follows René Racine who was Toronto's last Carnegie Fellow some 15 years ago.

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Editor: Barry F. Madore

COVER STORY

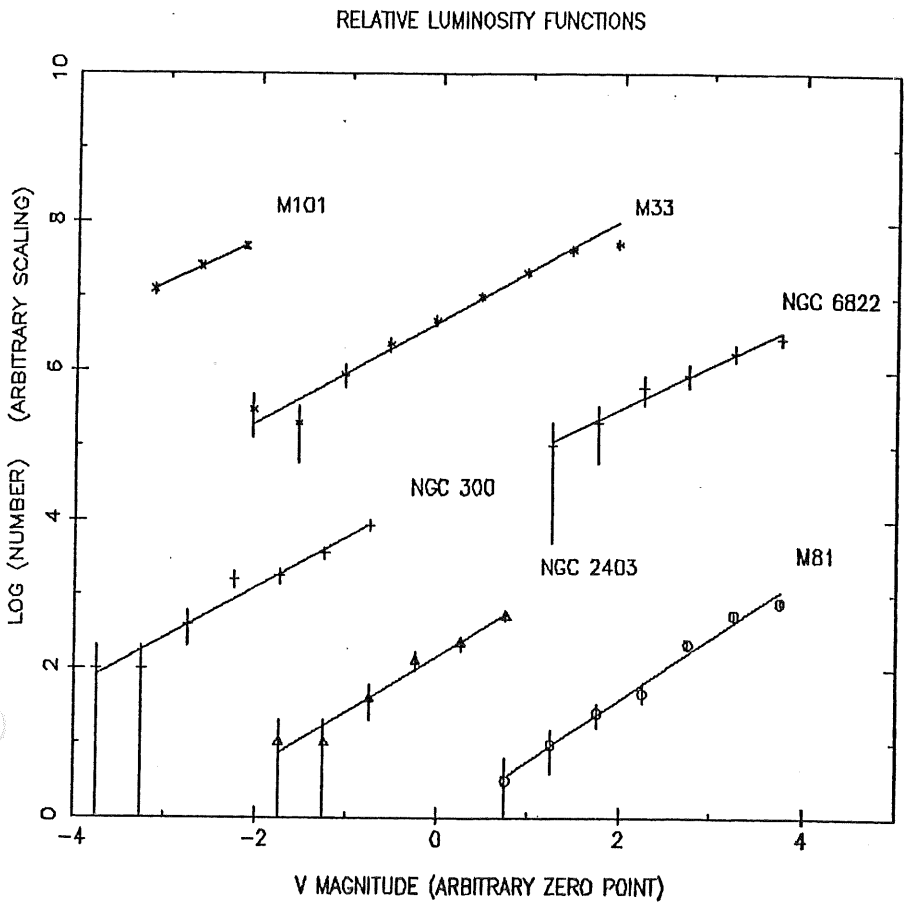
Luminosity Functions and CM Diagrams for Near-by Galaxies

The cover of the Doings is a colour-magnitude diagram of a field in M33 from CCD frames obtained at the prime focus of the Kitt Peak telescope this past September. The CCD data were obtained with two purposes in mind: first to study the cepheid in M33; a project in collaboration with Lindsey Davis, Chris McAlary and Barry Madore, and second to provide an external check on the photographic photometry obtained at the CFHT for my thesis. The CCD data (reduced using the Kitt Peak RICHFLD software for crowded field photometry) is in excellent agreement with the photographic data (reduced with the Automatic Plate Measuring (APM) facilities in Cambridge). The sample of galaxies for my thesis includes M33, NGC 300, NGC 2403, NGC 6822, M81 and M101.

One of the results from my thesis is shown in the plot below where the luminosity functions for the galaxies are all displayed on one plot with arbitrary log (number) and magnitude scales for comparison. What is immediately evident from this plot is the striking similarity of the slopes of the luminosity function for all of these galaxies. The slope of the upper end of the luminosity function appears to be universal.

This is an interesting result in the context of galaxy evolution. In models of galaxy evolution, the assumption is usually made the initial mass function is universal. Previous data in the literature on luminosity functions in external galaxies led to conflicting results, with some authors finding universality, other authors noting differences. The large numbers of stars measured with the APM however, has allowed statistically reliable slopes to be determined for a sample of galaxies.

CCD frames of several of these galaxies were obtained during a very successful run at the CFHT prime focus at the start of February. This should allow a further check of the results. My next step is to extend the sample to a wider variety of morphological types and to galaxies of different chemical compositions.



But first I have to finish my thesis ....

Wendy Freedman (Fre)

Tenure Announcement

I am happy to announce that Barry Madore's tenure committee met on March 2 and voted unanimously to recommend that Barry be awarded tenure with promotion to Associate Professor.

Barry's staff career here started off with a non-tenure-stream position, and only after two years of that did he win a tenure-stream position. Thus he has been an assistant professor longer than most, and tenure and promotion must be doubly welcome.

We offer him our congratulations and best wishes for a long and fruitful career in the Department.

Don Fernie

P O T P O U R R I

John Percy was back at Kitt Peak January 13-20, and is pleased to report that the weather was "almost average".

Phil Kronberg gave a colloquium to the physics department at the Université de Montreal on February 3rd, 1984 entitled: "M82: Laboratoire Extragalactique pour l'Etude des Etoiles Massives et Leurs Effets".

At the AAS meeting, Phil Kronberg described recent VLA results obtained with Dick Sramek at NRAO, in which they have detected variability on month- and year scale variability of the 30 new radio supernova and supernove remnant candidates discovered in M82 by Kronberg, Biermann and Schwab. One of these sources, 10 x as strong as Cassiopeia A in February 1981, has "turned off" within less than 13 months.

Louis Noreau, also at Las Vegas, presented the VLA 21cm. "cube" of the Arp 205 interacting galaxy system (part of a detailed radio-optical study with P. Kronberg, and F. Bertola, G. Galletta and D. Bettoni at Padua).

M.F. Bietenholz has just completed his M.Sc. thesis, which is entitled "An Investigation of the Polarization Properties of Extragalactic Radio Sources of Different Morphologies, and Their Relation to Claimed Large Scale Anisotropies in the Universe". This work has shown conclusively for the first time that the recently claimed evidence for such large scale anisotropies does not exist.

Life in the Wild Wild West

Laramie: Population 24410
Plus one
University town and railroad town
In one
Quiet, conservative
Cold and crisp
But friendly ...
Students
Cowboys
Antelope
Living in the valley
Amongst the mountains
One finds peace
Astronomer's paradise
Clear skies
Dry atmosphere
Far from the maddening crowds
To this place
I ran for rest
To rediscover the beauty of nature
And the beauty inside myself.

Mercedes Richards (Feb. 10, 1984)

From our Correspondent in Las Vegas

Starry-eyed Astronomers

Whenever I tell friends outside the Department of Astronomy that I'm going to some exotic location for a conference or observing trip, they invariably refuse to believe it. This is true even though I return within a week without having squeezed in any sightseeing. As a result, I have given up trying to defend myself when asked how it is that astronomers justify one of these faraway excursions. My standard reply has become: "Well, we aren't stupid, you know!!" I certainly made good use of it before this latest safari to sun and fun in Las Vegas, Nevada; i.e., Sin City, USA. Was it mere coincidence that six graduate students (Crw, Drc, Fre, Gis, Nru and Rsk) from our Department decided to go to the A.A.S. meeting there between January 8 and 11? We even took the same flight down, along with Martin Duncan, Kim Innanen (York) and Charles Hellaby (Queen's). You might imagine that a good time was had by all, and you would be absolutely right!

As we arrived in Vegas, we were astounded to discover that the Charter Air Terminal departure lounge was filled with slot machines! However, there was little time to waste, since the bus was ready to whisk us away to the Holiday Inn Center Strip (across from the infamous Caesar's Palace), where five of us were staying.

Doug and Louis shared one room, while Neb and Raymond shared another. I managed to get a room all to myself. Wendy stayed at the Continental along with what seemed like half the people attending the Meeting. After a brief rest, we all set off on foot for the University, thinking it was not too far away. After traipsing across the sands for almost an hour, we stumbled across an oasis which fortunately turned out to be our destination. No sooner had we registered when we ran into "Bwana" Bob Garrison and "Cosmic" Ray Carlberg, who both managed to find their way there independently. Later that evening there was a reception for the participants held in a large foyer beside a landmark known as "The Big Flashlight". Somehow this seemed appropriate for the City of Neon! There were many familiar faces at the Welcome Party, but they were hard to find because the room was packed. Several ex-Toronto grads were present, notably Chris McAlary, Dot Fraquelli and Joan Wrobel ... it was almost like Old Home Week. Lindsey Davis stayed behind in Arizona, which of course left Chris with enticing possibilities!

The conference itself was worthwhile from every standpoint. Wendy, Ray (Cbg) and Chris gave their talks during the first session on Monday morning, while Neb spoke Monday afternoon. Raymond (Rsk) and I were scheduled to talk on Tuesday, while Doug, Louis and Russ Taylor presented posters. All the "heavies" were in attendance at the Monday morning Galaxies session (Sandage, Dressler, Schmidt, Aaronson, Mould, van den Bergh and the Elmegreens, just to name a few). Wendy's talk was clearly a success (she has since been awarded a Carnegie Fellowship!), and Ray did a very good job also (although one person later asked us "Is he on something?"). Some of the other highlights included Alan Dressler's Pierce Prize Lecture on "Evolution of Galaxies in Clusters", Hjellming's talk on "Microcomputers in Astronomy" (or "How to Cure the Terminal Astronomer"), Irwin Shapiro's demonstrations of gravitational lens imaging (familiarity does not always breed contempt!), and a special tribute to Bart Bok delivered at the banquet by Frank Kerr.

There were many other worthwhile talks, but we couldn't hear them all because of the job interviews. This year, the Job Center was apparently busier than in other years. Those of us who were actively pursuing the market spent time talking to many people from different institutions. Neb was particularly busy - he arranged at least 10 interviews. Clearly it was worthwhile ... at least one of us (Fre) has a job already! After the interviews were finished, Alan Dressler of Carnegie remarked that this crop of students graduating from Toronto is the best group he has seen in a while! I guess we must be doing <u>something</u> right after all!

The conference organizers left us with a greal deal of time to explore the sights and sounds of Vegas, and naturally, we took advantage of that! Besides the banquet, the only other pre-arranged activity was a visit to the Nuclear Testing Site, which of course is off-limits to Canadian citizens. The six of us, along with Chris McAlary, Charles Hellaby and two students from Yale (Jim Schombert and Mike Gregg) cruised the local gambling establishments. It should be appreciated that this is no mean feat since there are at least fifty of them! Chris and Wendy quickly got hooked on electronic blackjack and each blew $10, even though they were beating the machines for awhile! They conspired to force me to try my hand as well; I was convinced by Wendy's inexorable logic: "Oh, come on Rick, you can give up your prunes for a week, can't you?" My luck was running high, but I didn't quit while I was ahead and lost $5 (cheapskate, you say?). Meanwhile, Louis was cleaning up on the slot machines ... the first three out of four times he tried playing, he hit the Jackpot. However, this newly-won prize quickly evaporated!

Everyone else at the conference was out on the town, also, so on two successive evenings, we ran into Frank Shu, and on another occasion, stumbled into Sun Kwok

trying to get lucky with the Roulette wheel. Hitting one place after another (MGM Grand, Barbary Coast, The Dunes), we finally found our way into Caesar's Palace. You have to see this place to believe it ... so lavish, gaudy and other-worldly that words failed even Louis! An entire gambling mall, complete with jewellery stores, steakhouses, nightclubs, and the Omnimax Theatre. It was pointed out that there were no clocks, watches or windows ... you could lose yourself in that maze and gamble away your life! (Is there an obvious analogy?) The outside is just as extravagant, with Roman statues (which Louis described to us thoroughly), lush fountains and glittering lights in the driveway. You could say it was American pop culture at its worst! Even after this experience, Chris and Wendy returned to the Continental and stayed up into the wee small hours attempting to improve on their gambling "expertise". As they left us outside Rick's Cafe, Louis turned to me and said "This could be the beginning of a beautiful friendship?" (Trivia Question: What movie is this line from?)

On our last night in Vegas, we decided to cash in our chips and treat ourselves to a real honest-to-goodness show. There was some debate as to which one to choose, but I was quite adamant about going to see Lola Falana at the Dunes and eventually this idea won out. It proved to be very entertaining and relatively inexpensive ($20 US for the show + 2 drinks), although if we had submitted to having our photographs taken, the cost would have been $10 more. Louis cut a very gentlemanly cloth by greeting the star in the French tradition, but Neb and I were a little more direct in our approach! It took us several days to deexcite from that experience!

In conclusion, let me list here a few quotable quotes from the trip:

Anonymous (Anon): After you've lived with someone for a while, you develop other interests.

Neb (Drc): I give my best talks during hangovers.

Louis (Nru): Sometimes English can be quite sweet.

Raymond (Rsk): I do have a tendency to use too many transparencies.

Wendy (Fre): Barry? Oh, he's ANCIENT!!

Wendy (Fre): (about her fellow graduate students, dressed up for dinner)
I don't recognize all these executives!

Wendy (Fre): (on hearing that astronomer have among the lowest suicide and divorce rates)
I don't believe that .... we must rank with travelling salesmen!!

Louis (Nru): (after the show by Ms. Falana)
I've just had a flash ... now I know how to solve that N-body problem!

and finally, Yours truly

Rick (Crw): (after Lee Oates makes another one of his patented comments)
I've just spent four days with Raymond, and now I have to put up with HIM?

Crw

The President of GASA Reports:

Skating and Bloodletting

Two major events were organized by GASA recently. On January 26th, a number of us gave blood at the Blood Donor Clinic being held in the Medical Sciences Building. For most, it was like the generals all over again but much less painful. Giving blood is a quasi-traditional GASA event and this year produced a record turnout with 9 students and 1 postdoc showing up. In alphabetical order, they are: Richard Crowe, Neb Duric, Dale Frail, Doug Gies, Brian Glendenning, Judith Irwin, Louis Noreau, Raymond Rusk, Fred Schmidt, Russ Taylor and Doug Welch. Of the 9 people who knew their blood type, 5 had RH^- (either A^- or O^-). It seems that astronomers are a strange lot, physiologically.

The second event took place on February 8th when we donned our skates and cruised Natham Phillips Square. This event was somewhat more popular than the first, with 15 participants. The degree of skating talent was varied, to be sure, from those who never skated before to the likes of Fred and Ed who showed amazing grace and balance and proved that Newton's laws don't always hold (I hear they're going for gold in Calgary /88). Everyone enjoyed the skate including Kamakaze Rick Crowe and Judith "the sprawler" Irwin.

The skate was followed by dinner at Sai Woo's which included free drinks for those who gave blood (curtesy of GASA). The evening featured a special dinner guest, Wendy Freedman, celebrating her Carnegie fellowship. Congratulations Wendy.

The evening was such a success that GASA (somewhat taken aback) is considering another such activity. If you have any good ideas let's try them out.

Drc (Neb)

P.S. Thanks to all those who showed up and especially those who gave the gift of life.

The following advertisement caught the eagle eye of our Professor Emeritus, Don MacRae who wondered in these were the type of jets that go 'Whooshoosh'. Ppperhaps.

Astrophysisical Jets

Proceedings of an International Workshop held in Torino, Italy, October 7–9, 1982

Edited by
A. FERRARI, *Università di Torino, Italy*
A. G. PACHOLCZYK, *University of Arizona, Tucson, U.S.A.*

1983, approx. xviii + 326 pp.
Cloth Dfl. 110,– / US $ 48.00
ASTROPHYSICS AND SPACE SCIENCE LIBRARY

Recent high-resolution observations at va
cases, active astrophysical objects
supersonic (eventually relat
ing 'jets', and suppo
for long lifet
are b

CENTENARY OF WOMEN AT UNIVERSITY OF TORONTO

The academic year of 1984-85 marks the centenary of women's admission into the University of Toronto. To celebrate this occasion, preparations are underway to produce a brief booklet on the history of women's efforts to be admitted to the University, including biographical information on some of our "firsts". Any relevant information or photographs that you may have to offer or loan to the project would be most welcomed. Please send to: Anne Rochon Ford, Rm 2030, Women's Studies, New College, University of Toronto, Toronto, Ontario M5S 1A1.

BALTIMORE MEETING CONTEST

In connection with the AAS meeting to be held in Baltimore in June 1984, Dick Henry is sponsoring a contest. Everyone is eligible. The prize, a bottle of J & B, will go to the best non-existent paper title and authors. Examples: "Astronomy for Young People," by Boyce and Gehrels. "The Origin and Fate of the Universe," by Beals and Endal. "Birth of the Stars," by Mumma and Popper. The only rule is that the "authors" must be real astronomers or physicists, living or dead. Deadline for entries in May 31, 1984. Send entries to Richard Henry, Physics Department, Johns Hopkins University, Baltimore, MD 21218.

(Dick Henry got his M.A. here in 1962. ed)

RECENT CORRESPONDENCE:

The following should have been received as a telex

31 Killdeer Crescent
Toronto, Ontario M4G 2W7
January 30, 1984

Dear Md,

I am very grateful to you for your piece on observing initials then and now. It made me less RETICENT to confess my confusion by acronyms and other mysterious ephemera.

Reading the Jan DDO Doings I found myself wondering if the WUPPE team had anything to do with the group who organized the WHOOPEE WILLY celebration. The GASA Gossip was almost a lost cause for anyone like me from the Pre-Ming Dynasty.

Though so few of those smiling faces (sic) on the cover would remember me, that I ought to include a CV, I hope you won't PURGE my name from the mailing list.

T.T.F.N.

Peter Broughton.

A VOICE FROM THE PAST

Below is an exerpt from a letter recently received after the publication of Wendy & Barry's results on computer modelling of acute chemical reactions.

February 18, 1984.

Drs. B.F. Madore and W.L. Freedman,

I am intrigued by your article in Science Volume 222, p.615, 1984 about modeling a patterned self-organizing process called the Belousov-Zhabotinsky reaction. Self-organizing assemblies and various degrees of orderely patterns in them seem rather ubiquitous in the scientific world of 1984. They make colleagues of chemists and astronomers even - not to mention biologists.

By way of personal introduction, I have been doing computer simulations and aggregation studies in colloid chemistry since about 1958 - sediment volumes, polymer dimensions in solution, packing in Gibbs monolayers, etc. I am now retired from teaching (since 1973) but still reasonably active in research. Incidentally, I have associations with your observatory. Reynold Kenneth Young, its Director for many years, was my father.

Sincerely yours,

Marjorie J. Vold
17465 Plaza Animado #144
San Diego, CA 92128

COLLOQUIA*

January 4	Dr. Ray Carlberg, University of Toronto, "The Difference Between Spiral and Elliptical Galaxies"
January 18	Dr. Stefan Mochnacki, University of Toronto, "Observational Evidence for Evolution in Contact Binary Stars"
January 25	Richard Crowe, University of Toronto, "Line Weakening in the Spectra of Southern Mira Variables"
February 1 (12 noon)	Dr. Don Penrod, University of California, ""Studies of Line Profile Variations in Early-Type Stars"
February 1	Prof. Ray G. McLenaghan, University of Waterloo, "Huygen's Principle for the Wave Equation on a Curved Space-Time"
February 15	Dr. Keith Horne, Cambridge University, England, "Eclipse Mapping of Accretion Disks in Close Binary Systems"
February 22 (1:10 p.m.)	Dr. Janet A. Mattei, Cambridge, Massachusetts, "The Work of the American Association of Variable Star Observers (AAVSO)"

February 22	Dr. J.C. Lo Presto, Edinboro State College, Pennsylvania, "The Variable Solar Rotation"
February 24 (Fri. 2 p.m.)	Dr. Lee Anne Willson, Iowa State University, "How to Model and Interpret Shock Waves in Stellar Atmospheres"
February 29 (4:10 p.m.)	Dr. Phil Gregory, University of British Columbia, "An Extraordinary Supernova Remnant"
March 7	Dr. W. Herbst, Van Vleck Observatory, "Irregular Variability of T Tauri Stars"
March 14	Dr. G. Michaud, Universite de Montreal, "Diffusion - Induced Hydrogen Burning in White Dwarf Stars"
March 21	Dr. H. Kuhr, Steward Observatory, "Compact Radio Sources"
March 28	Dr. Ron Webbink, University of Illinois, "Symbiotic Stars"
April 4	Dr. Len Cowie, Space Telescope Science Institite, Baltimore, "Gas Dynamics in Spiral Arms"
April 11	Dr. Steve Shore, Case Western Reserve, Ohio, "The Cosmic Scarsdale: A Quick Weight-Loss Cure for Massive Stars"

PAPERS SUBMITTED

K.W. Kamper *N.R. Evans* *R. Lyons*	*Confirmation of the Decreased Pulsational Amplitude of Polaris*
G. Grieve *B.F. Madore* *D.L. Welch*	*Leavitt Variables: The Brightest Known Cepheids and Their Implications for the Distance Scale*
P. Biermann *P.P. Kronberg*	*Hot Gas in Groups of Galaxies*
J.D. Fernie *R.F. Garrison*	*New Results for HD 161796*
A.R. Taylor *P.C. Gregory*	*Two Frequency Radio Spectra During an Outburst of the Periodic Radio Star LSI +61°303*
S.W. Mochnacki *W.G. Weller* *S. Chew*	*The DDO Data Network: Observing with a Remote Computer*
A. Wehlau *H.S. Hogg*	*Variable Stars in the Globular Cluster Messier 28*

THESES ABSTRACTS

An Investigation of the Polarization Properties of Extra-Galactic Radio Sources of Different Morphologies and Their Relation to Claimed Large Scale Anisotropies in the Universe

by Michael F. Bietenholz

The difference between the structural and the polarization position angles (Δ) has been determined for 277 extra-galactic radio sources. Most of the well determined Δ's tend to be near either $|\Delta|=0°$ or $90°$. The distribution of $|\Delta|$ is largely independent of the source morphology, z, the degree of polarization, the rotation measure or the flux ratio of the two components of the source. Birch (1982) claimed that Δ was dependent on the position of a source in a systematic way - i.e. a large scale anisotropy. It is shown that Birch's statistics are inadequate, as they treat Δ, which is a circular quantity, as a linear quantity; and adequate statistics are presented. The claimed anisotropy is not verified using my data, and it is shown that Δ does not depend on position in any significant way.

* * *

The Early Type Variable Star V986 Ophiuchi

by A.W. Fullerton

Spectroscopic and photometric results from the 1980 observing campaign, supplemented by spectroscopic results obtained from 1978 to 1983, are presented. Spectroscopic orbital elements are derived from nightly mean velocities. The orbital period is $25^d.56$. A sinusoidal variation with period $0^d.325$ and B amplitude $0^d.010$ is detected. A possibly significant radial velocity variation with period $0^d.2703$ and amplitude 3.1 km s^{-1} is detected in the entire velocity data set. No significant radial velocity variations are present in the seasonal velocity subsets. There is no significant photometric variation with the radial velocity period, and no significant velocity variation with the photometric period. The shape of the He I λ4471 line profile varies subtly. The variations are consistent with the changes expected from an $\ell=6$, $m=+6$ nonradial oscillation but this mode is incapable of producing the amplitudes of the observed velocity and light variations. This behaviour suggests that several modes of oscillation are excited simultaneously. Mode switching may account for the disagreement between photometric periods and amplitudes obtained at different epochs. The importance of tidal interaction with the companion as a mechanism for driving the oscillations is not clear. The status of V986 Ophiuchi as a β Cephei variable remains unresolved.

* * *

The Mass of AW Ursae Majoris

by Michael J. Rensing

The data from 22 spectra of AW Ursae Majoris obtained at the David Dunlap Observatory were analyzed. Radial velocities of the primary component were measured using Griffin-type cross-correlation techniques, and line profiles were modelled to account for radial velocity variations due to line blending and distortion effects.

The mass of AW Ursae Majoris was found to be $1.3 \pm 0.2\ M_{\odot}$, much smaller than the value found in previous studies. This agrees well with evolutionary theories of contact binaries if AW U Ma is a terminal age main sequence system.

The observed Hγ profile was observed to be narrower than the theoretical one, but this result depends on the uncertain definition of the continuum. The absolute magnitude M_V is $2^m.6$, 0.5 magnitudes brighter than inferred by Eggen from the common proper motion companion BD+30°2164.

* * *

A Study of the Dissociation of Molecular Hydrogen in Interstellar Shock Waves

by Ann Cornelia Margareth Rusk

Infrared emission from vibrationally and rotationally excited molecular hydrogen was first observed in the Orion region by Gautier (1976). We set out here to perform a master equation study of H_2 dissociation under interstellar conditions, using the available collisional and radiative transition probabilities. The simulation follows the changing energy level populations with time, allowing a more complete picture of the effect of added radiative transitions on the (collisional) relaxation and dissociation of H_2.

The dissociation rate coefficient, k_{diss} was found to fall off as density decreased, with dissociation occurring out of the ground vibration-rotation level at the low density limit. Comparison of observed and predicted H_2 infrared emission spectra (based on H_2/He collisions) suggest the temperature and density in Orion to be 2000 K and $n(He)=6.0 \times 10^5\ cm^{-3}$, which leads to an approximate H_2 number density of $4 \times 10^5\ cm^{-3}$.

* * *

The Variable Star FO Virginis

by Fred H. Schmidt

Photometric and spectroscopic observations of FO Vir (a suspected long period Delta Scuti variable) have shown this star to be an eclipsing-binary, probably of the β Lyrae variety.

Observational results and a period analysis are presented in chapters 2 and 3. Arguments for the eclipsing-binary nature of this star are given in chapter 3 and a preliminary discussion of the make up of the system is given in chapter 5. Possibilities for future work and the general conclusions are given in the last chapter.