

THE ^{DAVID} DUNLAP DOINGS

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Finding Chart p.3

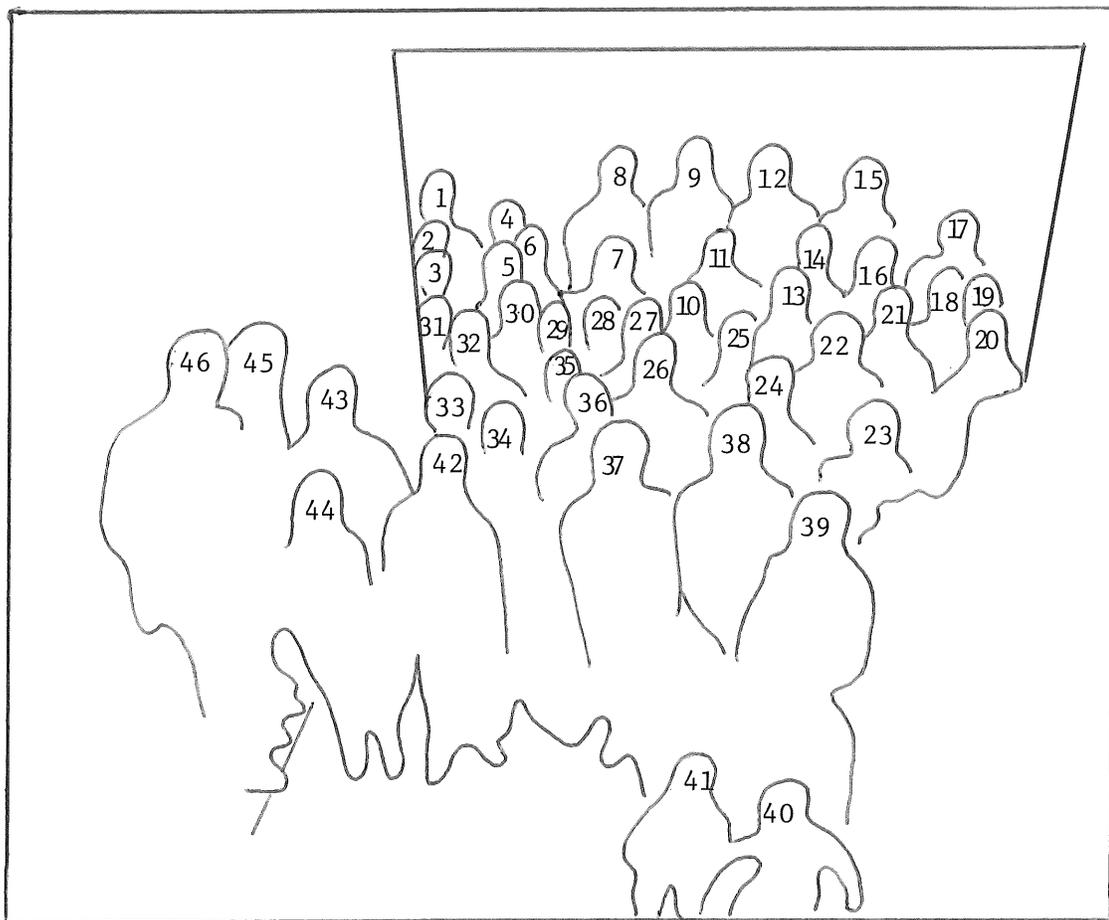
CONGRATULATIONS

To Doug Welch who successfully passed his general examination on Dec. 2.

On Nov. 2 Geoffrey Clayton successfully defended his Ph.D. thesis entitled "Interstellar Dust in the LMC" (supervisor P.G. Martin). Geoff is now at the Space Astronomy Laboratory at the University of Wisconsin, Madison, as a part of the WUPPE team.

APOLOGY

To Peter Leonard, who was inadvertently left off the list of new graduate students in the Department. Peter is working on his Master's Degree with Maurice Clement.



- | | | |
|-------------------|-----------------------|-----------------------|
| 1. Russ Taylor | 16. Alex Fullerton | 31. Tom Wells |
| 2. Jan Milligan | 17. Maurice Clement | 32. Don Fernie |
| 3. Kwang-Tai Kim | 18. Esther McCleary | 33. Lynda Colbeck |
| 4. Ernie Seaquist | 19. Fred Schmidt | 34. Gloria Seaquist |
| 5. Bill Weller | 20. Ray Carlberg | 35. Rosemary Diamond |
| 6. Neb Duric | 21. Mario Pedreros | 36. Michael Rensing |
| 7. Jim Thomson | 22. Barry Madore | 37. Louis Noreau |
| 8. Judith Irwin | 23. Wendy Freedman | 38. Ed Anderson |
| 9. Charles Dyer | 24. Doug Welch | 39. Mary Anderson |
| 10. Chris Stagg | 25. Stefan Mochnacki | 40. Timothy Anderson |
| 11. Tom Bolton | 26. Ed Zukowski | 41. Jennifer Anderson |
| 12. Martin Duncan | 27. Mercedes Richards | 42. Jonathan Seaquist |
| 13. Phil Kronberg | 28. Anne Creptak | 43. Helen Hogg |
| 14. Doug Gies | 29. John Percy | 44. Carolyn Seaquist |
| 15. Lee Oattes | 30. Rick Crowe | 45. Dave Earlam |
| | | 46. Archie Ridder |

WHOOPIING IT UP FOR WILLY

When an institution chalks up its 20th Nobel Prize there just has to be a celebration and it seems that Willy Fowler's jubilant friends and well-wishers at the Kellogg Radiation Laboratory of Caltech pulled out all the stops. Our correspondent, and alumna (Ph.D. 1968), Inge-Juliana Sackman sends us an account of the "phun and physics" at Kellogg at the end of October.

Fowler was in the east when the prize was announced, but on his first appearance on campus afterwards he was greeted with a real red carpet and garlands of roses and a huge sign saying "WHOOPEE WILLY". We think Inge had a hand in engineering the 27x16 ft (8.2x5.0 m) banner, made from no less than six king-size sheets sewn together and backed by sturdy steel rods, she says. The letters were 8 ft (let's see, that would be 2.4 m) high and from its location atop the Cal Tech library it could be seen all across the campus. One of Willy Fowler's weaknesses is a dedication to steam locomotive trains (he swears he'll use half of the \$190,000 cash award to travel in pursuit of his hobby) and at the party which ensued there was a cake (for 150 guests, and - get this - it was baked by his secretary) on the top of which was a toy train running on a circular track! Of course Willy was depicted as the engineer.

One of the songs at the party was "Willy at the throttle", sung to the tune of Casey Jones. Here's one of the verses

Back in the 'fifties, it came to the boil,
With Burbidge, Burbidge, Fowler, and Hoyle.
Willy and the rest, they all held forth,
About neutrons and protons and the rest, of course,
"Some I make fast, and some I make slow,
But old carbon-12, she just won't go."
Then Fred said to Willy, "I got a little trick,
And if its right, three alphas will stick."

CHORUS:

Willy Fowler - "You got a little trick?"
Willy Fowler - "Make them stick!"
Willy Fowler - "You got a little trick?"
"I hope it's right so carbon-12 will stick."

"This is an award for many people", Fowler is quoted as saying, "I'm lucky that the Nobel Prize can be awarded for a team effort". His admiring friends agreed with one who said "he's a beloved man who loves to laugh and has a million friends".

(By Editor Emeritus MR with thanks to correspondent Inge-Juliana Sackman Christy in Pasadena).

GASA GOSSIP

Vax Populi

It is late afternoon. It is the time when VAX CPU's crawl under the immense burden of astronomical research being foisted upon them. Throughout the Department and often at DDO, the sound of keys being punched fills the air. Rick Crowe, who first sat down at his terminal at 8am, is still attempting to log on. His LOGIN.COM is currently quizzing him about his 1981 Income Tax return. Neb Duric is still working on his program for producing CV's. He plans to market it under the name "VisiCV" and will extract a weighty fee for its use.

At the nearby graphics terminal, Wendy examines one of her 300 crowded fields in M33. She has been forbidden to print these out as the ribbon goes dry after every plot. Alex Fullerton is still trying to make sense out of his periodigram program. He writes his code in a version of FORTRAN last used during the Ming Dynasty. On the phone, Stefan tries once again to describe how to reset the GANDALF. Maria patiently sits in front of the DIABLO wondering how it has managed to print both backwards and upside-down.

With his briefcase at the ready, Raymond ponders how to best remove the structure found in his VLBI maps. Ray Carlberg displays the latest results from his N-body simulation. He has finally succeeded in having the PRINTRONIX puncture the paper where the star density is greatest. At the AIPS terminal, Louis has managed to squeeze 64 frames on one screen. He plans to market it as a chessboard surface for the Christmas season. Mike Rensing gives us a blow-by-blow commentary on his latest encounter with RETICENT. Ed Anderson stares intently at a screen containing either claw marks or galaxy orientation vectors. We'd rather not ask which. Barry edits one of his 900 peculiar galaxy files using an editor from the pre-Watergate era.

Perched high atop a stack of binders and chairs, Chris Stagg revels in the awesome power of the PURGE command. Peter Leonard clears his screen for the 43rd time and wonders what else the VAX is capable of. Bernard Bois is still logged-on despite the fact that he has left for the holidays. No doubt his directory will contain its own season's greetings when he returns. In a rare appearance downtown, Fred finally manages to use more than 100 blocks of his quota. Down on 13th floor, Peter Martin has successfully modified one of Martin Duncan's routines for his own use. He has managed to get 6 rabbits hopping across his screen simultaneously. Meanwhile, Dieter sits entranced by the beauty of the object file code scrolling across his screen.

Let us not forget those people with more modest computing goals: the ATLAS users, the OVERDRAWN, the huddled masses yearning to compile. They too have their purpose, and whether or not they are aware of it, the VERSATEC paper is unfolding as it should.

Doug Welch (Wch)

COLLOQUIA*

- November 2 Dr. J.S. Mathis, University of Wisconsin,
"What We Learn from Models of HII Regions"
- November 23 Dr. Jerry Sellwood, Cambridge University, England,
"Grand-Design Spirals: Transient or Mode?"
- December 7 Dr. Marc Gorenstein, Center for Astrophysics, Mass.,
"Looking Through a Gravitational Lens: High Resolution
Radio Observations of Q0957+561A,B"

*Unless otherwise noted, colloquia are held on Wednesdays at 4:00 P.M. in Room MP137 with TEA at 3:30 in the Reference Room MP1404.

P O T P O U R R I

Bob McLaren was in the Department for about a week at the beginning of December. Bob was back from Hawaii to be on Doug Welch's general examination committee. Bob flew over an instrumentation conference in the snowbound US midwest en route to Toronto.

Jerry Sellwood from the Institute of Astronomy Cambridge University was in town for about two weeks at the end of November. Jerry is collaborating with Ray Carlberg and Wendy Freedman on several aspects of the evolution of disk galaxies.

In mid-November Chip Arp from the Mount Wilson and Las Campanas Observatories was visiting Barry Madore putting more finishing touches on the two-volume "Catalogue of Southern Peculiar Galaxies and Associations"

Other visitors to the Department over the American Thanksgiving long weekend included Geoff Clayton and Nancy Evans.

John Percy was the speaker at the fall banquet of the Niagara Frontier Council of Amateur Astronomical Associations on November 5. Topic: "Two Hundred Years of Variable Star Observing".

John Percy addressed the Lunch and Learn Club (sponsored by the U. of T. School of Continuing Studies) on November 25, on "Scientist: Hero or Villain?" as part of a series on Science Issues and Ethics.

Ray Carlberg Reports

Jerry Sellwood, from the Institute of Astronomy in Cambridge, visited the Department for two weeks to give a seminar and to continue work with Ray Carlberg. Jerry came to us from Princeton, via MIT, Yale, and Columbia, and left for Michigan, DAO, Seattle, Berkeley and Caltech, then back to Toronto for the CITA meeting, followed by the return to England, via Cleveland and Boston.

Our current task was thrown down by Alar Toomre in a microconference on disk galaxies that he arranged in October. Where do the transient spirals that we observe in the N-body experiments come from? Are they no more than swing-amplified noise, which will become very small as N becomes large? To reassure the reader as to our perspicacity, such a thought had previously flitted through our minds. We do have part of the answer, but so far it appears to be more complicated than the question. At MIT we succeeded in obtaining the somewhat weak statement of agreement that the worst case scenario, all our results are figments of a large square root of N, is probably not true, on the basis of some current evidence.

The question can be further explored in the analytically tractable (just barely) Zang-Toomre disk, the constant circular velocity disk, which has been certified as having no growing modes in the linear theory. This is the no surprise disk; for a sufficiently large N, there should be no strong spirals to give heating of the disk. If there are strong spirals, much suspicion will be cast on numerical experiments.

Twelve days of heavy programming, 10 a.m. to 2 a.m., produced a set of initial orbits from the ZT distribution function, and then started to integrate them in a new disk code featuring a second order time step scheme, with arbitrary orbit substeps in time. A spirit of restraint on disk usage was encouraged by Peter Martin, which allowed a pool of 70,000 free blocks on the astro: disk to be filled and emptied several times with data from several N-body runs. At time of press a special quiet start disk with a very short time step had clocked up nearly five rotations. A statement on the results is expected soon.

The trip also featured a large number of trips to restaurants for various meals. Lunch was of course taken at the DA club, The Clarke Institute of Psychiatry cafeteria, which features reasonable food and reasonable prices and occasionally surprising behaviour in the elevator. Usually not from us. Dinners investigated a fair sample of the dozens of places within a few blocks of the University. Highlights and lowlights were the failed singing prawns, the Armadillo mandolin in La Bohemia, and Jerry's sudden addiction to Caesar Salad.

APPLICATIONS PACKAGE AVAILABLE

With so many students graduating this year, CV fever has hit the DA. In order to make the writing of a CV a little less tedious I wrote a program which formats the information in a standard way (according to the University and College Placement Association). Although I intended to use it specifically for my own purposes, I realize that the program could be generalized for anyone's needs. Rick Crowe and I proceeded to modify it with the result that it is now possible to produce standard CVs but with enough flexibility to allow specific formatting.

The program can be found in ASTRO:[NEB.CV] and can be run with a \$@[NEB.CV]CV command. If you would like to use it (it's very simple to run) see either Rick Crowe or myself and we'll get you started.

Neb Duric

LINE WEAKENING IN SOUTHERN HEMISPHERE MIRA VARIABLES

by Rick Crowe

Many of you will undoubtedly have noticed that I have been generating a large number of Versatec plots in the last few months; perhaps you will have also noticed that some of these show very clear trends, while others look more or less like scatter diagrams. The purpose of making so many plots is not to exhaust the supply of electrographic paper in Room 805, but rather to examine the behaviour of the spectral features of Mira variables as a function of phase or spectral type. The aim of the project is to try and use this empirical data provided by plates of 72 Southern Hemisphere Mira variables as a check on the hydrodynamical models of Willson and Hill, who have suggested that there are two shock waves operating simultaneously in the atmosphere of a Mira. The two-shock model provides a plausible explanation for the irregular cycle-to-cycle changes in the absorption-line strengths which were first pointed out by Merrill in 1940 in blue-visual spectra of Miras and which have defied a consistent interpretation since that time. The lines most affected by this so-called weakening are strong lines of neutral elements on the damping part of the curve of growth such as Ca I $\lambda 4226$ and Cr I $\lambda 4254$. In the model of Willson and Hill, the emission lines and the continuum originate in the lower shock, which is more regular in nature. This is supported by the consistency of the hydrogen emission in strength and phasing from one cycle to the next. The absorption lines, on the other hand, originate near the upper shock, persisting from a previous cycle, which is more likely to be aperiodic as successive shocks catch up to one another. It has been suggested that the aperiodic nature of the upper shock above a certain critical radius is responsible for the irregular changes in the absorption line strengths and velocities from one cycle to the next.

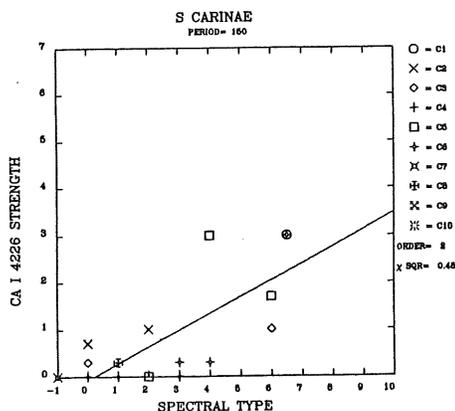
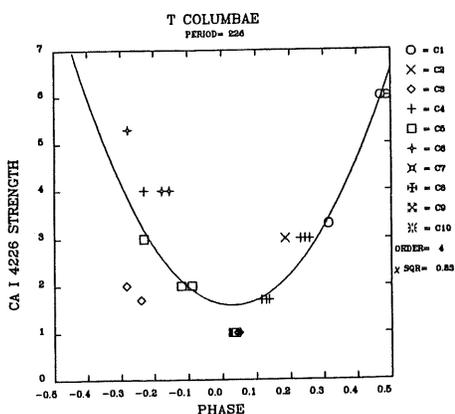
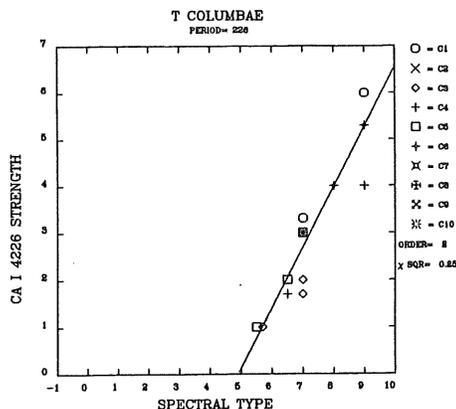
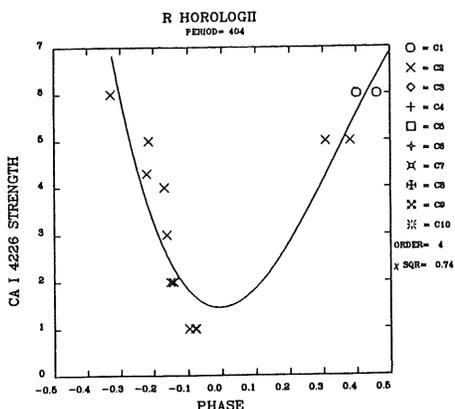
To illustrate some of these changes, I have prepared diagrams of Ca I, Cr I and Sr II line strength as a function of phase or spectral type for a few of the best-studied Miras in the Southern Hemisphere group. Each cycle is represented by a different plot symbol. The variation in Ca I $\lambda 4226$ strength as a function of phase is graphically demonstrated by R Horologii and T Columbae. The first of these shows a dramatic weakening between -87 days and -31 days, with the steepest decline at about -62 days (phase 0.85), which is approximately when the Balmer emission strengthens most rapidly. T Columbae also shows a sharp decrease in Ca I intensity through the maximum. Note that there is a wide cycle-to-cycle variation in strength before and not after maximum. It turns out that the run of the Ca strength with phase is skewed for the late-type Miras (particularly OH emission stars) and can therefore be better fit with a 4th-order polynomial than with a 3rd-order curve. Probably this reflects a shorter contraction time from minimum to maximum light, producing higher shock velocities and enhanced mass loss. I should point out that the curve-fitting routine was borrowed from Neb Duric and modified for use with my plot program.

We naturally expect the Ca I $\lambda 4226$ line strength to increase as a function of advancing spectral type within a cycle. When several cycles are considered, as for example in T Columbae (M5.5-M9), there may be significantly different Ca strengths for a given spectral type. Still, the Miras later than M5e at maximum light always show a fairly tight relationship between Ca strength and spectral type with a little scatter. For the Pop. II stars such as S Carinae (K7-M6.5), the trend of increasing Ca strength with advancing spectral type is much less obvious. The apparent scatter may be due to a change in atmospheric structure between early-type and late-type Miras, producing irregularities in the spectra of high-velocity stars with weakened atomic lines and bands. When we look at the behaviour of the Cr I $\lambda 4254$ feature with spectral

type, we see the same trends as with the Ca line, except that the scatter in all the plots is much larger. In fact, it is debatable whether we can say with certainty that Cr strength increases with advancing type for Miras earlier than M5e at maximum light. We may be seeing here the effects of the shock wave on the spectral features. The Ca I $\lambda 4226$ line may have a strong component which is formed in layers well above the shock wave, perhaps arising from the circumstellar envelope, so that the line profile doesn't always suffer from distortion introduced by the presence of the velocity gradient. The Cr I $\lambda 4254$ feature, on the other hand, is primarily formed in layers which are directly influenced by the passing shock wave, and hence the line strengths do not reproduce themselves so neatly from cycle to cycle. Why then should the early-type Miras show more irregularity in the Ca line than the late-type Miras? The answer could be that the Miras earlier than M5e at maximum light do not have a circumstellar component; hence, the Ca and Cr features are both formed in the same atmospheric layer and consequently show the same dependence on spectral type and the same irregularities. This hypothesis is also consistent with the behaviour of Ca and Cr in M standard stars. In non-variable M giants, the Ca strength reaches a minimum at M4 or M5, after which it increases steadily with advancing spectral type. The Cr line, on the other hand, levels off at M5 and shows no change in the cooler stars. This too may be due to the presence of an outlying atmospheric zone where a strong component of the Ca I $\lambda 4226$ line is formed.

The Sr II $\lambda 4077$ line is more unpredictable in its behaviour with spectral type than the resonance features of Ca and Cr. For a number of late-type Miras such as R Horologii, T Columbae, R Carinae and RS Scorpii, the Sr line clearly weakens with advancing type. However, there are other stars in the late-type group which do not show this trend at all; e.g., S Sculptoris, RR Scorpii and R Hydrae. As expected, the Sr II line strength in the early-type Miras does not follow any particular pattern. Again, we suggest here that the shock wave may be responsible for the irregularities in the line strength, but there is clearly no circumstellar component making a contribution to the Sr II profile. Pilachowski, Wallerstein and Willson (1980) have identified the location of the ionized lines as a region between two shock waves. Thus we might expect the Cr and Sr lines to be subject to more distortion from the shock wave than the Ca feature, which has a component arising from a more quiescent outer zone in the atmosphere. The Sr line may be more irregular from cycle to cycle because it is formed in a region closer to the upper shock.

Thus, it appears that although my data does not reveal anything which is unexpected, it does provide some support for the two-shock model of Willson and Hill. Using the brute force technique of plotting every parameter against every other parameter may use up a lot of paper, but it does tend to produce the desired results!



Richard Gray Reports

I spent most of the month of November using the Garrison spectrograph on the Las Campanas 24" telescope. I was obtaining spectra to fill out a three dimensional (temperature, luminosity, rotation velocity) grid of "normal" A-type stars with a view to improving the luminosity classification criteria of these stars. (I use normal in quotes as it is becoming increasingly clear that there is no such thing as normal in the realm of the A-type stars.) I also obtained spectra of most of the brighter stars of a little known open cluster in the direction of the LMC. The brightest stars in this cluster are evolved A-type stars. I had 21½ clear nights out of 25, but with a lower than average percentage of photometric nights, undoubtedly due to the lingering effects of El Niño.

El Niño manifested itself in other ways besides destroying photometric nights. The desert was abloom with a vast array of flowers, apparently surpassing similar displays in recent El Niño years. Accompanying this increased verdure was an increased population of insects, including the infamous vinchuca beetle, carrier of Chagas' disease. One small trantula (only the size of a teacup) wandered into Casa Canadiense, but both Bob Slawson and I felt that it was not significant enough to warrant the designation Toronto Trantula III.

Observing Initials, Now and Then

During my stay at the Institute of Astronomy in Cambridge this summer I was reminded of a DDO tradition that not everyone everywhere understands. So, for the latest recruits to the Department, I shall give a very terse history of the coded initials you will probably encounter from time to time, at the telescope, on memos and at the Xerox machine.

As I understand it, when observing at DDO was more of a departmental priority the many observers identified themselves in the log book, on the plate envelopes and even in their day-to-day discussions by a set of initials. This was rather avante gard, after all, today who has ever heard of International Business Machines, the International Grocers Association, Thompson, Ramo, Wooldridge, or a Virtual Access computer referred to by anything but their initials? The latter example, from the 8th floor of the Physics Building illustrates another point: observing initials were not necessarily your initials, they simply had to be unique. A single initial soon became insufficient when Frank and Helen Hogg joined the staff. And scientific notation had its debut with Robert Roeder who came to be known as R^2 ("R-squared"). Last names expanded into double and triple initials too, thus Don MacRae was MR and Sidney van den Bergh became known to one and all as vdB (lower case letters were already popular with the word processors of that day). It was all very confusing to a new graduate student (this author) fifteen years ago, but things have changed and first names are now as common as not.

The card box of names and initials is still up at DDO in JT's office if you need yet another identifier in your list of unique designations ranging from SIN(sic!) Numbers to ZIP codes. And then again you may find that your new name comes in handy. The Xerox book doesn't give you all that much room to sign your whole name and when you have to get a memo circularing quickly a couple of unique identifiers at the end of the note can save enormous amounts of time. But it can get you in trouble.

So back to Cambridge. One morning after having "signed out" many a book from the Institute Library I received the following note. Treat it as a warning.

Library 15th August 1983

Dear Dr. Madore

When you fill in a borrowing card please write out your surname normally. Many of the present Library users do not know "BFM*". Fame is very transitory, alas!

Yours sincerely,

Jean Sanders.

What more can I say? T.T.F.N.

Barry F. Madore.

*Ironically my official observing initials are Md.

THESIS ABSTRACT

Interstellar Dust in the Large Magellanic Cloud

by Geoffrey C. Clayton

This study attempts to attack the puzzle of interstellar dust by observing its properties in a different physical environment than the Galaxy, namely the Large Magellanic Cloud (LMC). A large body of observations have been gathered enabling a detailed comparison of interstellar extinction and polarization characteristics in the two galaxies.

Significantly reddened stars are rare in the LMC but extinction curves ranging from 0.13 to 2.2 μm were constructed for 12 stars. The wavelength dependence of interstellar polarization was studied from 0.35 to 0.84 μm for 18 stars.

The differences in the average extinction curves of the two galaxies, seen in the ultraviolet, are confirmed in the present study. In the visual and infrared the curves are very similar. The wavelength dependence of the polarization and the polarization efficiency, $p/E(B-V)$, are also comparable to Galactic values. Apparently the relevant variables, namely grain size, shape and composition, magnetic field strength, and gas density and temperature all conspire to make the grain alignment and polarization efficiency the same in these two quite different galaxies.

The dust to gas ratio, $E(B-V)/N_{\text{H}}$, in the LMC is several times lower than the Galactic value which could be interpreted as evidence of less efficient dust production in the LMC. However, the amount of dust produced is limited by the abundance of the condensable species. Taking into account the lower CNO abundances found for the LMC, the dust to gas ratio, $E(B-V)/N_{\text{CNO}}$, is the same within a factor of two. Therefore it can be concluded that the dust formation efficiency is rather similar in these two galaxies.

The extinction curves measured for individual lines of sight within the Galaxy are often quite different from the "average" curve. Average curves were calculated for 2 bins, inside and outside the 30 Dor region. The average extinction curves for the two bins are different. The 30 Dor bins has a smaller 2200 A bump and higher far-ultraviolet extinction. However, these differences are only marginally significant.

The similarities between the extinction and polarization properties of interstellar dust in the LMC and the Galaxy are more remarkable than the differences considering the large number of potentially free parameters involved in modelling the dust. The major factor involved in the observed differences may be the abundances of the elements used in dust formation.