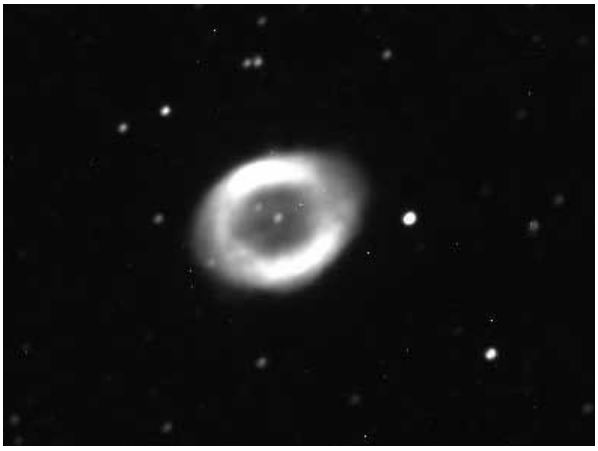
SARA OBSERVATORY NEWSLETTER

Issue #5 *Spring 2002*

Florida Institute of Technology | University of Georgia | Florida International University
East Tennessee State university | Valdosta State University | Clemson University

Contents



V image of the Ring Nebula (M57) in Lyra, obtained 2002 May 18 with the SARA 0.9-m telescope. *(Image by Ken Rumstay)*

SARA astronomers converse over beer during the January 2002 meeting of the American Astronomical Society in Washington. From left to right are Mike Castelaz, Matt Wood, Terry Oswalt, and 2001 REU student Marcus Woo. *(Photo by Ken Rumstay)*

From the Editor's Desk

Ken Rumstay, VSU

As I write this, SARA has just completed perhaps its most productive year in terms of astronomical research! The 0.9-m telescope at Kitt Peak is now completely subscribed (within the constraints imposed by availability of on-site assistants); astronomers at all six SARA schools routinely make astronomical observations from the comfort of their offices or homes! And, I am most pleased to announce that a record number of Summer 2001 REU interns presented their work at the January meeting of the American Astronomical Society in Washington. This biannual newsletter contains pictures and information regarding activities of the Southeastern Association for Research in Astronomy.

Since its founding in 1989, one of SARA's primary goals has been to foster astronomical research on the part of undergraduate students throughout the country. In early 2001 Dr. Terry Oswalt, Chairman of SARA's Board of Directors, was elected to a three-year term on the National Council (Physics and Astronomy Division) of the Council on Undergraduate Research. I'm happy to report that I will be joining Terry on the National Council this summer! We will be hosting a workshop on "Fostering Undergraduate Research in Astronomy" at the CUR National Conference in June, to be held on the campus of Connecticut College in New London. Highlights of that meeting will appear in our next Newsletter!

Astronomy magazine senior editor Richard Talcott and his lovely wife enjoy the banquet at the Washington AAS meeting. Richard was a graduate student at Ohio State University in the lat 1970's, so his association with SARAns Terry Oswalt and Ken Rumstay goes way back! *(Photo by Ken Rumstay)*

Notes from the Spring 2002 Meeting of the SARA Board of Directors

Ken Rumstay, VSU, and Gary Henson, ETSU

The Spring 2002 meeting of the SARA Board of Directors was held March 29th on the campus Clemson University. Board members from all six SARA institutions were present, as well as Chair Terry Oswalt (FIT) and Clemson University astronomer Mark Leising.

After the minutes of the September 28th board meeting were approved, Observatory Director Jim Webb (FIU) reported on the status of the 0.9-m telescope facility at Kitt Peak. His report is summarized on page three of this issue; we note with pleasure that the telescope is now nearly completely subscribed! The ensuing discussion centered on the usual telescope problems (notably the fact that we still don't have an operating autoguider). In addition, Gary Henson (ETSU) reported on possible solutions to the recurring water leakage at the base of the door on the telescope level. Architect Stanley Black, designer of the SARA observatory, suggested installation of exterior rolling shutters as the least costly fix.

Scott Shaw (UGA), Chair of the Telescope Allocation Committee, distributed preliminary observing schedules for the April through October 2002. As usual, from late May through mid-July the telescope will be devoted primarily to on-site observations by REU students and mentors. Remote observations can only be tentatively scheduled, since the schedules of our remote observing assistants is known at most only one month in advance.

SARA Chair Terry Oswalt distributed the current budget report, and much time was spent in identifying and prioritizing budget items for the coming six months. In general SARA is in good financial shape, and all high-priority items were approved for immediate purchase. Terry noted that the cost to SARA of operating the 0.9-m telescope at Kitt Peak is approximately $25,000 per year; this is only about 10% of the budget estimated by former NOAO director Sidney Wolff in 1989, when SARA applied to acquire the telescope!

SARA Board members discuss the coming semester's observatory budget. *(Photo by Dieter Hartmann)*

Terry announced that he would be representing SARA at the Kitt Peak tenant's meeting on April 22nd. No specific items to be presented at that meeting were suggested. The upcoming REU program was next discussed; information on that program may be found on page 6.

Next on the agenda was a discussion of the ISTeC (International Small Telescope Consortium) website maintained by Gary Henson. Terry described the Working Group on Amateur-Professional Collaboration (WGAPC), chaired by Dr. Janet Mattei of the Amercian Association of Variable Star Observers. Gary will investigate the benefits of future collaboration between ISTeC and WGAPC.

Terry then brought the board up to speed with regard to the new SARA video being produced by media students at FIT. Copies of the storyboard were distributed and found to be satisfactory; however, apparently little progress had been made in terms of actual production.

The final action item of the meeting was the reappointment of Jim Webb to another three-year term as Observatory Director. The autumn 2002 meeting was then scheduled for September 27th at Valdosta State University. *(Editor's note: During the summer the meeting location was changed to Florida Tech).*

SARA astronomers return from lunch, during the Spring 2002 meeting of the SARA Board of Directors at Clemson University. From left to right are Jim Webb, Matt Wood, Gary Henson, Terry Oswalt, Scott Shaw, Brad Meyer, Mark Leising, Ken Rumstay, and Dieter Hartmann. *(Photo by Dieter Hartmann)*

Observatory Director's Report

James Webb, FIU

I. Introduction

Once again I am very pleased to report that telescope time on SARA has been fully subscribed during the past six months. Science observations have been made routinely in remote mode, although occasionally SARA faculty used the telescope on-site. The current ROA's continue to be extremely helpful, and allow us to observe during a high percentage of the possible nights. The primary concern at this time is two fold, the reliability of the cameras and trouble-shooting telescope and equipment problems. As discussed in separate sections below, more than a few nights have been lost to equipment/computer failures and other problems. Recent tracking/pointing problems, discussed in more detail below, are a result of software upgrades and I consider them primarily growing pains. Our goal for the coming year, as it has been for the past year, is to upgrade the telescope operating systems to talk to the cameras and exchange information, to get the autoguider in place and working, and to look ahead to large projects like a new secondary to improve image quality.

II. Telescope Usage

All SARA schools are using the telescope regularly, both remotely and on-site. The statistics provided by Scott Shaw are as follows:

School	Nights used*	% of total	Previous %
FIT	42.0	34%	39%
VSU	25.5	21%	16%
ETSU	20.0	16%	16%
CU	15.7	13%	12%
FIU	12.5	10%	14%
UGA	7.0	6%	10%

**Based on submitted observing reports*

These statistics are based on the observing reports. Unfortunately, not everyone filled out an observing report, especially if they were either clouded out or the telescope was down for mechanical or instrumental problems. We lost at least one week of observing when both cameras were out of commission. Everyone is involved and observing!

III. Telescope Problems

For the most part the telescope has been operating tolerably. The tracking, especially west of the pier, is still somewhat erratic. In mid March, ACE installed the absolute encoders on the telescope, and that set off a host of problems. These problems, however, were not unexpected since the ACE code had been substantially rewritten. Peter attempted to minimize the impact on our observing by testing the new version on the other 0.9-meter at Kitt Peak, but alas some problems remained. Although Peter has not filed a report of the alterations/improvements he made to the telescope operating system, I believe that the bulk of the problems we have recently been encountering stem from the new absolute encoders. The new encoders were installed on the RA and DEC axis, as well as the dome. The upside of the new encoders is that now the telescope worm gear can be accurately mapped and the pointing tracking should take a quantum leap upward! The downside is that we are currently experiencing severe pointing problems. These problems are in the process of being fixed by ACE, but remote observations are dubious until they are fixed. The dome is also affected in some way, so the ROA's have to assist us in closing the dome at the end of the night. Unfortunately, with Peter Mack's heavy schedule and travel, the telescope has been seriously afflicted for several days. This brings back to mind the idea that we hire a "Tech person" for the SARA dome, who can help fix things when ACE cannot make it up there. This will be discussed again at the board meeting.

IV. Instrumentation

Cameras

The small format AP7 Apogee camera continues to have shutter problems. We have recently sent it back to Apogee and they replaced the shutter. Hopefully it is finally fixed. The older large format Apogee AP4 CCD is back in service now, but it was down after the cable was repaired due to the computer crash. The bottom line for this camera is that if it is to remain useful to use, we need to send it to Apogee and get it upgraded to work with MaximDL. Wayne Brown said it could be done, although it would require some down-time. This is a priority for me since I feel it is way too early to give up on a grade zero large format chip; although it is not as sensitive as newer chips, it is by far the cleanest chip we can afford. We are planning to purchase a new large format CCD. This purchase will be discussed at the board meeting.

Computing facilities

The UPS's are apparently working well now, and we haven't had problems in that area. However, we did have a massive computer failure that cost us several nights of observing. When the new AP7 was away to Apogee getting the shutter fixed, we were using the older AP4 as the primary camera. Unfortunately the computer which controlled it using the CAMERA program crashed. We were unable to communicate with it over the net and it lost some basic LINUX functions altogether. We shipped it back to Miami and Eric Johnson looked at it. He determined it was the motherboard, and had to re-place it. The unfortunate thing is that the older CCD controller board used connections that are not used in new computers, thus we could not simply replace the computer. Instead, Eric built one that would communicate with the controller board with spare parts and we sent it back to SARA. Apparently it works well now, but as mentioned under the camera section,

we need to get this CCD upgraded using a new controller board that will work with more modern computers. I consider this a priority.

We need to have a SARA faculty person look into computer security. There have been several changes to the security protocol on Kitt Peak and we now need to log into the saracam computer via secure shell. We need to make sure everyone can log into it and operate it properly. The enhanced security has not affected VNC though. It is not likely that the SARACAM computer was hacked, but it is a possibility.

Weather Station

We still need to connect and calibrate the cloud sensor and lightening detector. They are installed, but still not hooked into the weather station nor interfaced into the ACE software.

Auto guider

We purchased a new CCD for this system. After several delays it was finally delivered and is awaiting installation. Based on the amount of work ACE already has on its plate, I envision a tech person hired by SARA will be necessary to get this up and running.

Robotic System

The robotic module will be installed in the coming months and communication with the CCD will be possible in the very near future.

V. ISTeC and REU

The ISTeC web site is maintained by Gary Henson. The last "update" listed on the web page is May 15, 2000. This page needs to be updated soon to keep it current and useful.

The REU program is beginning with the selection process nearly complete. The applicants are outstanding, and most faculty are participating eagerly. We look forward to another successful year. Matt Wood's on-line application review process is still heralded amongst the mentors as an amazing time-saving feat! Great work again Matt.

VI. Future

For the future I want to stress a few things which we must address. They are listed in order of approximate urgency.

1) We need a local technical person to handle maintenance that does not require Peter's expertise. This person would not in any way replace Peter or ACE, nor would it have any effect on our financial commitment to ACE. Here are some of the projects this person could work on.

a) Map the telescope's worm gear, now that the absolute encoders are installed.
b) Troubleshoot camera problems on-site before observers run into them
c) Work on calibration of the lightening detector and cloud sensor.
d) Work on autoguider calibration and installation.

2) We need to look seriously look into ways to improve our image quality, including fabrication of a new secondary mirror. We need to decide whether we want to pay for these out of SARA funds or to write a grant proposal to seek additional funds.

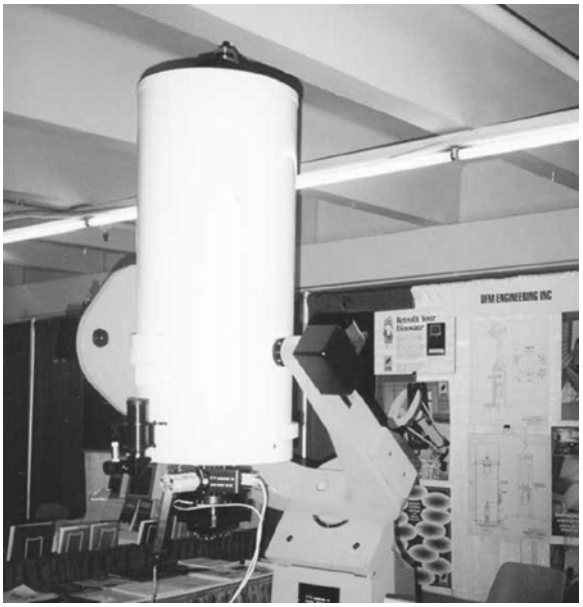
VII. Summary

In summary, it has definitely been another productive year in terms of research productivity! However, we have recently suffered some growing pains with problems caused by installation of the absolute encoders. This was not an unforeseen problem: we attempted to minimize these problems by letting Peter install them on the WIYN 0.9-meter telescope first, but not every problem can be foreseen. With installation of these encoders, we can now begin the critical projects that affect tracking and pointing, especially if we get a local tech person to help ACE with it. We then need to move on to the Robotic module, refit the old AP4 CDD, and purchase a new large format CCD. This, along with the purchase of spare computer equipment should get us to where we want to be in a short period of time.

News Notes from SARA Schools

Ken Rumstay, VSU

I'm pleased to report that, as a result of a years-end budget surplus, Valdosta State University will acquire a new 0.4-m telescope for its campus observatory! Manufactured by DFM Engineering, this instrument will replace the current Starliner telescope atop Nevins Hall. Installation of the new telescope will unfortunately be delayed until early 2004 while Nevins Hall undergoes extensive renovation.



DFM Engineering 0.4-meter telescope, on display at the Washington meeting of the American Astronomical Society. *(Photo by Ken Rumstay)*

SARA at the Washington AAS Meeting

Ken Rumstay, VSU

SARA's Summer 2001 REU program was particularly successful; we were fortunate to have attracted a truly outstanding group of young men and women! As testimony to the excellence of that group, eight of our eleven students presented their research at the 199th meeting of the American Astronomical Society, held January 6-10 2002 in Washington DC. Although we have sent some summer students to the January AAS meetings each year since the REU program's inception in 1995, I believe this is a record for us!

This was the first AAS meeting most of our students had attended, and by all accounts it was an eye-opener for them! Well over a thousand astronomers were in attendance, and our students had ample opportunity to meet future colleagues and to begin the "networking" which is such an important part of a young astronomer's career. And of course everyone was glad to be together again; since the program's end in August the students had been scattered across the country. A "reunion dinner" at a local Mexican restaurant on Tuesday evening provided a chance for everyone to become reacquainted.

Titles and abstract references for our students' papers appear below:

"The Photometric Analysis of Two New Eclipsing Binary Stars", M. La Vigne and J.S. Shaw, *B.A.A.S* **33**, 1313. (abstract 6.18)

"A Search for Variability Among Cool White Dwarf Stars", J. Bochanski, T. Oswalt, N. Silvestri, and G. Carlson, *B.A.A.S.* **33**, 1336. (abstract 17.08)

"Monitoring Select Mira Stars for Short-term Variability", H.D. Guenther and G.D. Henson, *B.A.A.S.* **33**, 1436. (abstract 90.07)

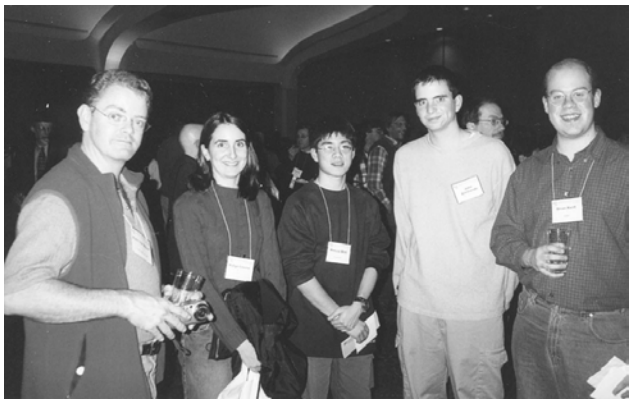
"Modeling Phase-resolved Spectra of Mira Variables", M.Y. Woo, A. Schweitzer, and M.W. Castelaz, *B.A.A.S.* **33**, 1436. (abstract 90.08)

"A Photometric Study of Selected Active Galactic Nuclei", R.D. Levine and K.S. Rumstay, *B.A.A.S.* **33**, 1517. (abstract 138.21)

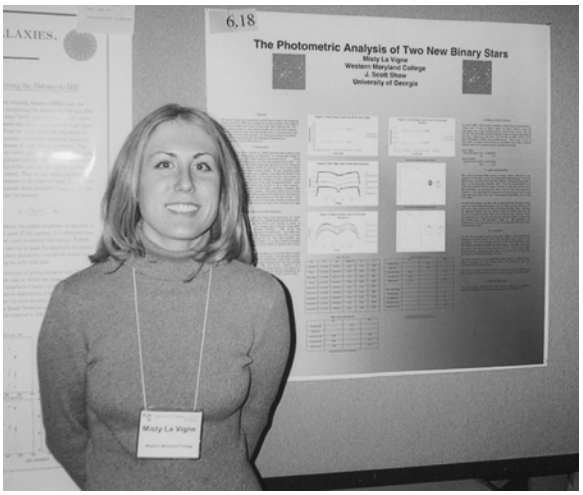
"Superhumps in the Helium Dwarf Nova KL Draconis", M.A. Wood, M.J. Casey, P.M. Garnavich, and B. Haag, *B.A.A.S.* **34**, 562. (abstract 155.08)

"Optical Observations of the Gamma-ray Blazar PKS 1622-297", B.R. Kent and J.R. Webb, *B.A.A.S.* **33**, 1453. (abstract 98.03).

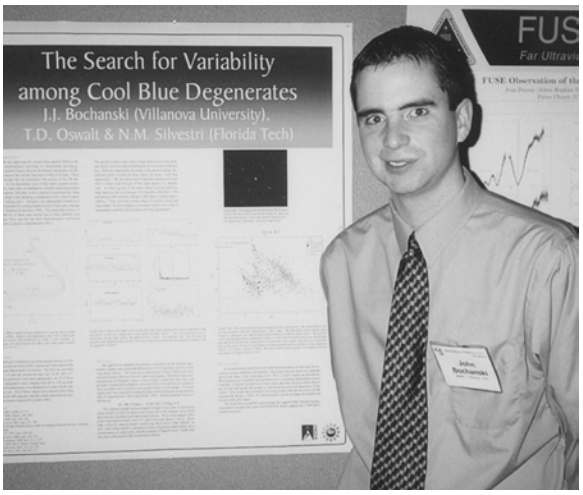
"Monte Carlo Simulations of the White Dwarf Populations in Open and Globular Clusters", D.B. Gobeille and M.A. Wood, *B.A.A.S.* **34**, 566. (abstract 157.08).



Summer 2002 REU students enjoy the reception on Sunday night. Left to right are project director Matt Wood, Robyn Levine, Marcus Woo, Jon Bochanski, and Brian Kent. *(Photo by Ken Rumstay)*

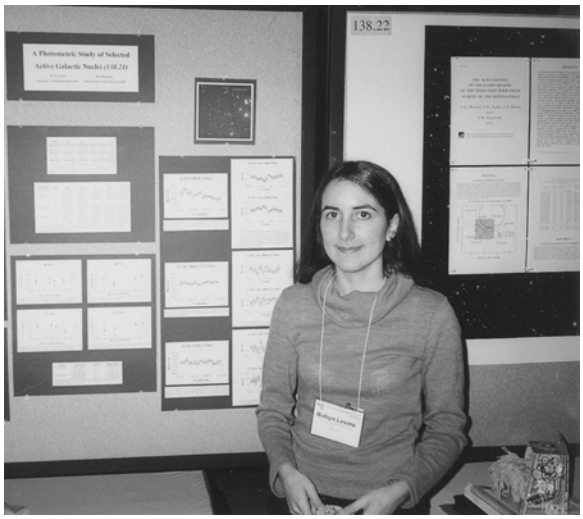


Misty La Vigne presents her photometric analysis of two binary stars. *(Photo by Ken Rumstay)*



John Bochanski presents his research on variability in cool blue degenerate stars. *(Photo by Ken Rumstay)*

For myself, the chance to meet up with students who have participated in this program in earlier years is highlight of these professional meetings. Many of our REU alumni have gone on to graduate programs in astronomy and physics, and some are already employed in the astronomical community. All speak fondly of the summer they spent with SARA!



Robyn Levine presents her photometric study of a sample of Seyfert Galaxies. *(Photo by Ken Rumstay)*

The Summer 2002 REU Program

Ken Rumstay, VSU

With the Washington AAS meeting behind us, our thoughts now turn to the coming summer and yet another Research Experiences for Undergraduates program! This year 127 undergraduate students applied to the SARA REU program, nearly all taking advantage of the Web-based application form effected by Project Director Matt Wood. As in previous years each mentor reviewed all applications, and each prepared a short list of candidates. By April 4th the eleven successful applicants had been selected. As the table below illustrates, once again our students will be drawn from a wide variety of educational institutions located all across the United States. We also have managed, as we have in all previous years, to obtain a nice gender balance! Unfortunately, once again we received very few applications from members of minority groups. Other summer research programs report the same experience; clearly we should be doing more to encourage minority applications.

We welcome Beverly Smith (ETSU) and Mike Hickey (CU) to our ranks; this will be their first time mentoring in our program. Our chosen students all have excellent credentials, and we look forward to a highly successful summer of research!

2002 SARA-REU Students

Name	Home Institution	REU Institution	REU Advisor	REU Project
Roger Cohen	Wesleyan University	FIU	Walter van Hamme	The Broken-Contact Binaries W Crv and EF Boo
Elizabeth Jeffery	Brigham Young University	VSU	Martha A. Leake	Water of Hydration on Primitive Asteroids
Derek Lamb	Drake University	CU	Mike Hickey	Acoustic-Gravity Waves in Jupiter's Upper Atmosphere
Sarah McGregor	Saint Michaels College	VSU	Kenneth S. Rumstay	Photometry of Selected Active Galactic Nuclei
Randall Perrine	Vassar College	FIT	Matthew A. Wood	Parallelizing a Smoothed Particle Hydrodynamics Code
Jennifer Reiff	Otterbein College	ETSU	Gary D. Henson	Characterizing Short-Term Variability in Select Mira Stars
Wes Ryle	Western Kentucky University	CU	Mark Leising	X-ray Line Studies of Supernova Radioactivity
Justin Schaefer	University of Wyoming	FIT	Terry D. Oswalt	A Search for Variability in Cool White Dwarf Stars
Juli Stoltz	Montclair State University	ETSU	Beverly Smith	Optical Imaging of Interacting Galaxies
Shannon Wells	Columbus State University	FIU	Caroline Simpson	Arp 213: A Spiral Galaxy With an Extensive Gas Disk
Vanessa Wilkat	Florida Institute of Technology	FIU	James R. Webb	Time Series Analysis of Blazar Microvariations

News from our Alumni
Rica Sirbaugh French

This summer SARA will offer its eighth NSF-sponsored Research Experiences for Undergraduates program. Since this program's origin in 1995 nearly seventy students from all parts of the country have participated. To the extent that we are able, SARA tries to maintain contact with all of its "alumni". We recently heard from Rica French (nee Sirbaugh), who worked with Oswalt's during our second year in 1996. She writes:

"What am I doing now? So much has happened since the glory days of white dwarfs, volleyball, and margaritas in Melbourne! But I'll try to hit the high points for you.

"As most of you know, I was married in August after returning from my ventures with SARA. No, we still don't have children (do you remember me at all??) but when I grow up we'd like to have a couple. The next summer (1997) I took off for another REU program with NOAO in Tucson. There I worked with Ken Mighell and Ata Sarajedini (now at the University of Florida) on the relative ages of populous clusters in the Magellanic Clouds from WFPC2 data using a novel technique that Ata helped develop. Upon returning from Arizona, my husband Galen and I jetted off for a week in Vienna, Austria, as I was one of four students selected to represent the United States at the 12th International Conference of Physics Students. And what a trip! The sights, people, culture, everything; it's really something to experience. Not a bad place to celebrate a first wedding anniversary, either.

"Spring 1998: Graduation is in sight. But before I could get to that light at the end of the tunnel, I was surprised with what I consider to be a great honor. My undergraduate institution (Middle Tennessee State University) had established some new annual awards. Not only was I selected as a finalist for the first President's Award, but I was the recipient of the University's first Provost's Award. Rather than shamelessly partying and celebrating my freedom from a physics degree, I was suddenly humbled and deeply honored to be the first to carry such an important torch. (Uh-oh. Now I'm recognized occasionally in town. Good thing I'm moving in a couple of months!)

"Moving?!?! Where, when?!" both my parents shriek, panic-stricken (yes, there is intelligent life outside of middle Tennessee). Good question. I'd been offered a job with the Space Telescope Science Institute in Baltimore, but I also had a few options for graduate school (much to my surprise). A tough decision, but Texas it was.

"As a member of the Astronomy Department at the University of Texas at Austin, I've worked on neutral material in planetary nebulae envelopes (for which I earned a Master's degree in December 2000), radial velocities of variable stars, and neutron-capture elements in metal-poor halo stars. My dissertation research is different: still investigating the intrinsic width of the main sequence, specifically in open clusters. Already it's fascinating – the perfect project for me. And with people like Ted von Hippel and the WOCS group (WIYN Open Cluster Study) behind me, I'd say I'm a pretty lucky duckling.

"Another of my true joys is sharing the skies with non-astronomers. So I'm naturally drawn to teaching and volunteer work. I've reworked the curriculum for our introductory observing course for non-science majors and have taught it for the past two years. I've also been involved in "Expanding Your Horizons in Science and Mathematics," a national program in which I also participated while in Tennessee. EYH, as it is known, seeks to encourage young women into scientific and technical fields. Specifically, it targets girls in the crucial middle school years where studies show they usually lose their self-confidence and interest in math and science. For three years, I have served as the Volunteer Coordinator of the program here in Austin where we reach about 600 girls annually.

"I must admit though, that with all the science, I was beginning to feel a little too "analytical" and creatively stifled. So last year I took an acting class (move over Julia Roberts) and what a blast it was! I got to play everything from a frightened and timid retail cashier to a retired "lady of the evening" thoughtfully describing how her man rescued her from her life of …well, you know. This time it's voice lessons (I'll send you my "Zombie" track after it's cut). I also play second base on a local softball team, enjoy volleyball, racquetball, and scuba diving every chance I get, and I can't wait for the next visit with my three year old nephew Shawn. Oh, and I've rediscovered what it is to read for pleasure. So between getting a life, my dissertation, and keeping the hubby in line (ha ha!), I'm keeping pretty busy.

"It seems like a lifetime ago, yet only a short 5-1/2 years since my SARA-summer. Indeed, I am a different person now: older (here's lookin' at the big 3-0 this year) but I dare not say more mature! I have a plan, but you know how those work out… or not. One thing I can say for certain: regardless of whatever else my life has been or will be, my interaction with the members of SARA remains one of the most positive and encouraging experiences I've ever had, astronomical or otherwise."

Rica poses in her academic regalia during commencement at Middle Tennessee State University. *(Photo by Rica French)*

Close Encounters of the "Famous Physicist" Kind

James Webb, FIU

The past six months has been very exciting for me professionally. I have enjoyed two close encounters of the "Great Physicist" kind. The first came about when our University president was instrumental in getting Dr., Murray Gell-Mann to our department for an extended visit. Dr. Gell-Mann won the Nobel prize in Physics in 1968 for the creation of the standard model of elementary particles, sometimes called the "Eight-fold Way" and elucidates the existence of quarks. Dr. Gell-Mann was a contemporary and sometimes rival of Richard Feynman.

Dr. Gell-Mann stayed with us for three weeks, giving seminars, meeting with physics faculty individually and as a group, meeting with students, and of course meeting with administrators. He delighted us all with stories of Richard Feynman, various presidents, crackpots, and other things. He inspired everyone he came into contact with. Although advanced in age, he is still sharper than anyone I have ever met. He spoke authoritatively on any topic from linguistics to physics, public advocacy to cosmology.

He mentioned several times that he wanted to speak to me about the latest supernova results and their cosmological implications. So I nervously went to work re-reading all of the papers on Universal acceleration and quintessence in preparation for our discussion. As we sat in my office discussing cosmology, I was doing well, not saying anything stupid or plainly wrong, until we started discussing tracker fields. I had just read two papers on them and to deflect my ignorance I referred to one of them so he could see for himself. Then he said, "What is that term in the Lagrangian?" That is where the house of cards fell at my feet. I had no idea! I mumbled something about kinetic energy or momentum but he had already figured it out! Anyway, it was stimulating, exciting, and gave everyone a fresh outlook on physics.

In late March, I received a call from a fellow graduate student from the University of Florida. Chris Vuille, a physics grad student working with Jim Ipser had befriended me since I was one of the only astronomy grad students to venture forth into the physics department for classes like General Relativity. Chris's advisor, Jim Ipser, was on my PhD committee and was a student of Kip Thorne at Cal Tech. I had stayed in contact with Jim Ipser through the years, and when Chris organized a special conference to honor his colleague and fellow relativist they invited Kip Thorne, and me??? How I snuck in I don't know, but the bottom line is that I attended the small conference with one of the world's most famous astrophysicists, Kip Thorne. I took three FIU grad students up and my talk was scheduled between Jim Ipser, Steve Detweiler, and Kip Thorne!

I prepared a special talk, "Quasars: Relativistic Astrophysics meets Observations." I started from the beginning, the First Texas Symposium on Relativistic Astrophysics where it all began, and outlined the progress that had been made and summarized the current state of Quasar theory, concentrating on the general relativistic aspects. Kip had attended the first Texas Symposium as a grad student, and had contributed greatly to the relativistic formulations of jet acceleration near massive rotating black holes, and also relativistic corrections to accretion disk theory. I was more than a little nervous, but my talk was apparently well received and I actually could answer some of his questions? Anyway, we had lunch together and hung out before his public lecture that evening which attracted over 400 people. So there was my second close encounter of the "great physicist" kind in the period of six months.

Dr. Murray Gell-Mann recently spent three weeks on the campus of Florida International University. *(Photo by Charles Abbott, copyright 1994; used with permission of the Santa Fe Instuitute)*

SARA Observatory Newsletter
Issue #5 Spring 2002
Kenneth S. Rumstay, Editor

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This newsletter is available as an electronic PDF file

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