SARA OBSERVATORY NEWSLETTER

Issue #6 *Autumn 2002*

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

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The 2002 CUR National Conference was held on the beautiful campus of Connecticut College. *(Photo by Ken Rumstay)*

Astronomers in attendance at the CUR Meeting. Seated in the front row are Mary Crone (Skidmore College), Terry Oswalt (FIT), and Tom Balonek (Colgate University). Standing in the back row are Larry Marschall (Gettysburg College), Ken Rumstay (VSU), and Leslie Brown (Connecticut College). *(Photo by Ken Rumstay)*

The Summer 2002 CUR National Meeting

K.S. Rumstay, VSU

The Council on Undergraduate Research is a national organization whose mission is "to support and promote high-quality undergraduate student-faculty collaborative research and scholarship". Its leadership works with a variety of agencies and foundations to enhance research opportunities for faculty and students, placing special emphasis on primarily undergraduate institutions of higher learning. Through a series of publications and outreach activities CUR shares successful models and strategies for establishing and institutionalizing undergraduate research programs.

The CUR membership is organized into a divisional structure that includes biology, chemistry, geosciences, mathematics and computer science, physics and astronomy, psychology, social sciences, and an at-large division that serves administrators and other disciplines. The over 3000 members (representing over 870 institutions) members of CUR benefit from a range of services designed to have a positive impact on undergraduate research programs.

The Physics and Astronomy Division of CUR currently has a roster of two dozen councilors, and only two of them are astronomers: Terry Oswalt (SARA's Chairman of the Board) and myself! While it is gratifying to see SARA so well represented in CUR, we would like to see a better representation for astronomy. If you are an astronomer and a faculty member at an institution of higher education, I would encourage you to join CUR and to consider running for a place on the Council. Further information is available at the CUR website (http://www.cur.org/), or feel free to contact me at krumstay@valdosta.edu.

The ninth CUR National Conference was held June 19th through the 23rd on the campus of Connecticut College in New London. With hundreds of attendants and dozens of workshops it was a great success! One highlight of the meeting was an observatory open house conducted by Dr. Leslie Brown and her astronomy students, which include 2001 SARA REU alumnus Doug Gobeille On Friday morning Terry and I (along with Dr. Larry Marschall) conducted a workshop on "Fostering Undergraduate Research in Astronomy across Campuses and Between Institutions". We all had a great time, and I would like to thank Leslie and Doug for their hospitality!

Observatory Director's Report

James Webb, FIU

I. Introduction

This has been another excellent six months for the SARA Observatory. Every SARA school has utilized the telescope both on-site and remotely, both for research and teaching. The on-site observations generally were part of the SARA REU program, and I am very pleased that the telescope worked very well during this time period. There were some problems, mostly associated with control system upgrades and dome failure, but by and large every observer was able to take data. The network has been much slower lately, even for those of us on Internet 2, which is worrisome to say the least. We are just now encountering problems with staffing ROA positions, and this will be an action item for us. With most of the projects we had planned completed, we can now move on to more advanced problems. One of these will involve switching to new IDE cards instead of the current old-tech ISA cards. This is a necessary step and will no doubt be accompanied by problems during the switch. A major problem we are encountering is delay in delivery of new CCD cameras which we have purchased. This is discussed below and represents another obstacle in the coming months.

II. Research at SARA

This has been an excellent year for research at SARA. Targets ranged from gamma-ray optical afterglows to asteroids, from time series analysis of super-humping variables to blazar microvariability, from light curves of binary stars to white dwarfs. At least six publications have been submitted to major journals in 2002. This number is based on data taken in the past year. The REU projects reflected the diversity of SARA faculty interests and most of the results will eventually find their way into print as well. Recent SARA-related publications are listed on our website at http://saraobservatory.org/sara_pub.html. This page is updated by Bev Smith of ETSU whenever SARA members send publication information to her. Another gauge of activity at the SARA Observatory is the facts that all six schools routinely present papers utilizing SARA data at meetings of the American Astronomical Society.

Although image quality hampers us from doing high quality imaging, and the CCD noise (we thermoelectrically cool the CCD's instead of utilizing liquid nitrogen due to the remote access) hampers our attempts to observe as faint as we would like, we still routinely obtain high quality photometric data and low resolution spectra.

III. Telescope Usage.

Although the usage statistics were not available when I finished the report, it is clear from the nightly reports that every school used its allotment of time. There were several nights claimed, but not used, due to the lack of ROA's. I think the telescope is at the "oversubscribed" stage now, which is exactly where we want to be!

IV. Telescope Problems

A detailed look at the SARA observer reports show that many of problems we encountered with the telescope were related to the new ACE versions ("growing pains"). Problems such as "Emergency stops" when turning dome lights on, incorrect filter wheel readouts, and dome opening/closing problems were reported several times; the latter problem was especially prevalent after the August shutdown. Minor annoyances like the ACE tof files not saving and loading properly were also reported. Access to the weather station also caused problems after the summer shutdown. Most of these problems are now history. According to Peter Mack's report on 09/20/02 and the observer reports since that time, the Smartdome problems are now fixed.

The pointing model has also been installed and works in a limited fashion. Data for the pointing model was collected for the eastern part of the sky, but not yet for the western sky. The pointing model will be revised by adding denser sampling and a least-squares procedure. These changes will be implemented shortly to improve its accuracy. Bugs were also fixed in the telescope offset routines, focus routine, and the video switcher. The second dual filter box has been fixed and the "emergency stop" problem has been corrected. Routines have been written to attempt correction for periodic worm error, but it may not help us since the WIYN 0.9-meter telescope did not benefit from this routine.

The telescope still suffers from tracking problems in the western portion of the sky. In all probability the tracking will not substantially improve until we get the autoguider. It is not clear that polar alignment is responsible for all of the problem, it could easily be differential weighting or a host of other things contributing to the tracking problems.

The dome tracking bug has finally been squashed and the problems in opening and closing the dome in Smartdome have also been fixed. On resuming operations in September, the dome failed to respond. Peter Mack visited the SARA dome and found that a critical RS232 circuit board and LCD display had been destroyed, apparently from lightning. These parts were replaced and the telescope was functioning the following night. With the Smartdome bugs fixed, the dome should be in great shape.

We also had roll-down storm doors installed on the dome doors. This project was spearheaded by Gary Henson of ETSU, and he did an excellent job with it. At first, the company failed to properly install the door facings flush with the curved, corrugated dome wall, but Gary spoke with the company and they have apparently corrected the situation. The storm doors were initially keyed, and we actually lost a few observing nights since the ROA's did not have access to the keys, but the key locks were replaced so access is no longer a problem.

ACE has performed routine maintenance such as

changing gearbox oil, greasing DEC drive, adjustment of the worm gear engagement, repairing damaged cables, etc. They also replaced the telephone fuses so we once again have telephone access to the dome.

V. Instrumentation

Cameras

The small format AP7 Apogee camera shutter problems were fixed, but it developed horizontal lines in the images. These lines were correctly diagnosed by Apogee engineers as being an improperly set priority in Maxim Dl. This problem has now been corrected.

The older, large format Apogee AP4 CCD is still in service. The decision to purchase a new large-format CCD camera was made and the order was sent, but the camera has yet to be delivered. It is nearly three months overdue at this time. This is one of the problems that we are currently trying to resolve. The old AP4 is still usable, but we should consider revamping it so it will work with Maxim DL for future use.

Computing facilities

The crash of SARACAM resulted in its being sent to FIU for analysis and restoration. Eric Johnson (FIU) found the mother board had crashed; it had not been hacked as we had suspected, but it was irreparable. Eric built us a new computer with parts around his lab (since it required old-style boards) and we shipped it to SARA. It is apparently working well. We had to replace the UPS batteries as they were not holding charge properly. The enhanced mountain computer security has not affected VNC or our ability to access the telescope and CCD computers.

Weather Station

The weather station has now been incorporated into the ACE system. Peter custom programmed it for us and it was ready by September 23, four days before the promised date. We are now awaiting calibration of the cloud sensor and lightning sensor.

Autoguider

We purchased a new CCD camera for the autoguider, after Apogee was not able to deliver the Lisaa camera. After several delays, Finger Lakes delivered the new camera. Unfortunately, ACE detected a shutter defect which had been built into the CCD's and the camera had to be repaired before it could be incorporated into the autoguider system. An oversight during the summer shutdown resulted in its not being sent back to Finger Lakes in a timely fashion. Once the oversight was detected, it was immediately shipped back to the factory. Apparently, the factory is so backed up that it will be months before they can get to it. Thus, we are still without an autoguider. Peter Mack of ACE has sent them a memo expressing his (and our) concerns over this very slow service.

Robotic System

ACE has apparently now received information from Maxim-DL which will allow direct integration of the telescope information into the FITS image headers. This is a feature we have all been wanting to see for a number of years. A beta release will be scheduled in October, so perhaps it will be possible for us to test it at SARA with a Beta release version next month. Thus we are incrementally closer to a true robotic system. The full robotic package has yet to be tested by SARA and we have not purchased it yet. This purchase will be discussed at the upcoming board meeting.

ISTeC

The ISTeC web site is maintained by Gary Henson of ETSU. The last “update” date still reads May 15, 2000, although I am fairly sure it has been updated since that time. This page needs to be updated soon to keep it current and useful. Some links are out of date and some are broken, but most functioned properly.

REU Program

The 2002 REU program was a resounding success! The students were great, the projects were all excellent and of such high quality that this might qualify as the best year yet. The student reviews were excellent. A brief look at the observing reports during the REU visits showed that technical problems were at a minimum. Credit should be given to Peter and ACE for responding to our pleas of correcting a number of pre-REU problems that worried us tremendously. The main problem the REU faculty encountered was clouds in the later part of July. Once again we need to thank Matt Wood for an excellent job, and to the Valdosta people for hosting the final meeting (which I am sorry to have missed).

Remote Observing Assistants

Our current group of ROA's have been exceptional! Adam Block, Elaine Halbedal, and Mike Bradshaw have all been very professional, extremely helpful, and respond immediately and effectively to problems. I wish to thank them for their excellent work. Both Adam and Mike are not going to be able to continue at their current rate since their jobs or schedules have changed. We need to locate, train and establish some new ROA's to make up the lack of coverage we will experience in upcoming months. SARA is essentially oversubscribed and would be used every available night if we had enough ROA's, so we need to make an effort to find more. This is a very high priority for us at this time.

Summer Shutdown

Our progress during summer shutdown was minimal. This was in part due to ACE being heavily committed during that time, due to an injury of critical ACE personal, and due to the Finger Lakes problem. Without the CCD camera, no progress could be made on the autoguider. Data was taken for the pointing model and dome maintenance was done on schedule. Most of the projects we had hoped would be completed during summer shutdown (with the exception of the autoguider) were actually completed in the

last few days before this report was prepared.

VI. The Future

Here is a list (in order of urgency) of important action items which I feel we need to address.

1. ROA staff
Probably the most critical and immediate problem is the ROA staff. With Adam and Mike playing a lesser role in covering nights, we need to find and train new ROA's.

2. Finger Lakes CCD Cameras
We need to help ACE encourage FLI to deliver the CCD's we have purchased. Some science projects require the large format CCD which is at least three months past due, and nearly all projects need the autoguider (and the corrected CCD camera we purchased for that purpose).

3. Dome Control Upgrade
In his report Peter Mack has strongly recommended that we upgrade the dome control hardware and software to include a ramp-up/ramp-down procedure. This should significantly reduce dome wear and tear, and will even increase the dome speed on long moves. This may also have an effect on limiting the "post move" vibrations which we currently experience in the telescope. I think this is a great idea and we should do it as soon as possible.

4. Telescope Control System
We need to change the telescope control system from the ISA version of ACE to the new PCI system. This new system is in operation at the WIYN 0.9 meter telescope. Peter has promised an estimate of the cost of this switchover for discussion at the board meeting.

5. Image Quality Improvements
Someone needs to seriously investigate ways to improve our image quality, including the possible fabrication of a new secondary mirror. We need to decide whether we want to pay for this out of SARA funds or to write a grant proposal soliciting outside funding. Any volunteers?

VII. SUMMARY

Our observatory is now completely subscribed, and operates well enough that observers routinely get publishable data remotely. Our most critical problem is that some of our wonderful remote observing assistants are reducing their availability, so we desperately need to find more ROA's. Although we still occasionally suffer technical problems, the telescope has been very productive in its mission as a research instrument and a teaching observatory. Improvements are continuing to be made, but not at the expense of collecting data. New cameras, an autoguider, and upgrades to the control system are all necessary and will continue to be high priority items. Improvements such as optics and cooling problems, both for the CCD's and the telescope tube and dome, are also important. Most of the faculty from each SARA institution have been contributing to the operation of the observatory and we appreciate all of their efforts. Peter Mack and ACE have been working very hard for us and we appreciate their efforts. I want to remind everyone that a remotely accessible research facility is not a plug-and-play system and that during times of change there will be problems. I think that during the past six months our consortium and its partners have shown their commitment to make SARA a model research and teaching facility.

Submitted 2002 September 27

SARA: A Node in The Whole Earth Telescope and Delta Scuti Networks

Matt A. Wood, FIT

Most astronomical objects are constant in luminosity over a human lifetime - their brightnesses and spectra don't change significantly from year to year. For these objects, we need only measure them once and we don't need to revisit them until instrumental improvements let us significantly improve our measurements.

About one star out of every 3000 exhibits cyclical brightness variations which result from pulsation of the star. The best-known class of pulsators are the Cepheid variables, which are bright enough to be visible in galaxies several Megaparsecs away, and which have a calibrated period-luminosity relationship - the brighter the star, the longer the pulsation period. Measure the period and you know the intrinsic brightness of the star; that combined with the apparent brightness yields the distance to the star - or of the galaxy to which it belongs.

Just as a bell rings at certain frequencies that depend on the size of the bell, the details of its shape, the type of metal from which it’s made, and so on, so too the frequencies at which a star pulsates depend on the details of the mass and structure of the star. You could for example record a bell ringing behind a curtain and analyze carefully the waveform. Using an analytical tool called a Fourier transform, you could determine the harmonic structure of the waveform, including all the frequencies of oscillation and their relative phases. Then you could build a computer model of a bell, and "ring" it to see what frequencies it oscillates at. By changing the parameters of your computer model - the shape, the wall thickness, the metal, etc. - you could come closer and closer to matching the oscillation frequencies, amplitudes and phases of the bell behind the curtain. When you finally match them as closely as you can, you'd remove the curtain and would likely find that your computer model was very, very close to the real thing. You could even figure out if the bell was spinning while suspended from a string!

Seismology is the branch of geology which uses this technique to probe the internal structure of the Earth, and *asteroseismology* is the branch of astrophysics which applies this techniques to pulsating stars. We collect time-series data on the pulsator, see what frequencies are present,

build numerical models of stars and then analyze these models to determine what the oscillation frequencies would be, changing the parameters of the models (stellar mass, surface temperature, chemical composition, evolutionary state, etc.) until our model results match the observations.

While simple in principle, the process is difficult in practice. The difficulties begin with the acquisition of time-series data of sufficient quality and density to identify unambiguously the frequencies present. The white dwarf stars we study have pulsation periods ranging from two to ten minutes or so, requiring us to sample the brightness at least twice a minute or faster. They also typically have 10 to 100 frequencies present, which means that we need to observe them continuously for a couple of weeks in order to determine accurately which frequencies are present.

The first problem we run into is that any given star is only visible for about 8 hours out of 24 on average; for the rest of the day it's either too low in the sky to get good measurements or the Sun is up. Ed Nather, Don Winget (both at the University of Texas), and their collaborators realized that what was needed was a collaborative network of observers around the globe that could come together for a 2-3 week period once or twice a year to observe stars of interest to everyone in the network. The result was the founding of *The Whole Earth Telescope*, or WET (wet.iitap.iastate.edu). The WET has collaborating observers on all continents save Antarctica, so a given target can usually be observed continuously with only small data gaps caused by clouds.

Figure 1 shows how gaps in the data affect the Fourier transform of a single, noise-free sine curve sampled as indicated at the top of each panel (from Nather *et al.* 1990, *Ap.J*, **361**, 309). In the left hand panel, we see "alias" patterns typical of single site data, and in the right hand panel is the pattern obtained if the daytime gaps are not present. If for example there are 172 cycles per day (frequency of 2000 microhertz, as shown), then sampled as in the left-hand panel 172 cycles per day gives the best fit to the solution, but 171 and 173 cycles are nearly as good, 170 and 174 cycles slightly worse, etc. The fact is that if we have no data, we don't *know* how many cycles we missed, and that is reflected in the Fourier transform as alias peaks. Now imagine that you have three closely spaced peaks with overlapping alias patterns - there's no way to figure out which frequencies are the real pulsation frequencies.

We use the SARA observatory at Kitt Peak as one of the nodes in the WET as well as for the Delta Scuti Network (www.deltascuti.net), which is primarily concerned with the study of pulsating stars near the main sequence. The pulsation periods are longer, but the techniques of asteroseismology are the same.

A recent success was a study headed up by Gerard Vauclair (Obs Midi-Pyrenees) entitled *Asteroseismology of RXJ 2117+3412, the hottest pulsating PG 1159 star*. In this work, we were able to determine that there are 37 independent pulsation frequencies detected. These allow the determination of the star's rotational period (1.16 days), the conclusion that the star does not rotate as a solid body, the mass of the star (0.56 M_{sun}), and the mass of a surface helium layer (0.013 to 0.078 M_{star}). The luminosity derived from asteroseismology is about 10,000 L_{sun} and the distance is approximately 760 pc.

While the trend in telescope design has been to collect as large a reflecting area as possible in one location (for example the 10-m Keck telescopes), our approach, driven by our science, has been to distribute our telescope in longitude so we can observe targets continuously. Global international collaborations have proven to be extremely useful and productive, and have shown conclusively that small telescopes can produce big science, especially when they band together!

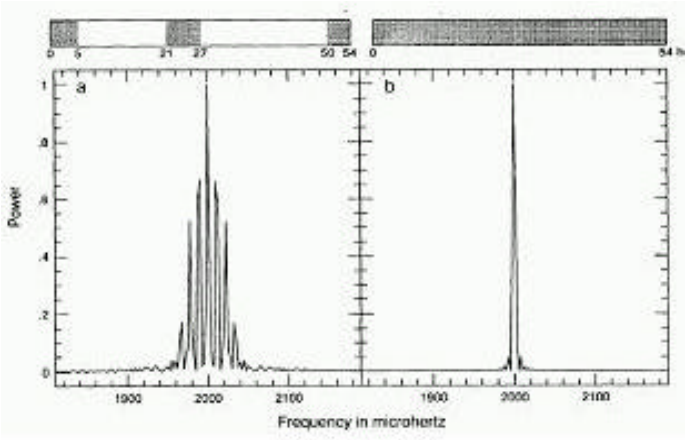


Figure 1: Plot showing the Fourier transform of a noise-free sinusoid sampled as indicated at the top of each panel. Data gaps lead to aliases in the Fourier transform.

Figure 2: Map of current WET observing nodes.

The Summer 2002 REU Program

Ken Rumstay, VSU

This summer's REU program was perhaps our most successful ever! *Every* student finished the summer with publishable results, and a record 91% of our students will present these at the January meeting of the American Astronomical Society in Seattle. And (very gratifyingly) the program evaluations completed by the participants were overwhelmingly favorable.

As in previous years our project director Matt Wood sent over 3000 flyers to virtually every college and university science department in the country. This resulted in over 120 applications to our program; from these eleven highly gifted students were selected. As the table on the next page shows, these young astronomers conducted a wide variety of research projects at the five participating SARA schools.

Our program began with a group Workshop held on May 31st and June 1st at the Florida Tech campus. This provided an opportunity for everyone to become acquainted, and for the faculty mentors to provide brief overviews of their various research areas. A wonderful session on Scientific Ethics was led by FIT Professor of Humanities Gordon Patterson, students agreed that this was a high point of the workshop! And we enjoyed a variety of social events, including dinner Friday night at the Lone Cabbage Fish Camp, a beach party Saturday afternoon, and a party at the home of Terry and Barb Oswalt.

Of course, most of each student's waking hours during the summer were devoted to research, working closely with his or her faculty mentor. Every student, regardless of whether his project was observational or theoretical in nature, traveled to Kitt Peak to gain experience in astronomical observation with the SARA 0.9-m telescope. This trip is invariably the highlight of the program for our students, many of whom have never experienced a dark sky!

The second Workshop was held August 2nd and 3rd on the campus of Valdosta State University. Each student presented his research in two formats, representative of the ways in which research is presented at professional scientific meetings. On Friday each student gave a fifteen minute oral presentation. Saturday morning was devoted to a poster session. The posters this year were of outstanding quality, ready to be presented at an American Astronomical Society (as most will be)! The meeting ended with a barbecue and party at the home of Ken and Sue Ellen Rumstay.

As previously mentioned, ten of our students will present the results of their summer research at the January AAS meeting in Seattle. If you plan to attend that meeting, we cordially invite you to stop by and meet our students at their posters (sessions 4.01U, 11.14U, 13.05U, 45.04U, 48.01U, 87.09U, 116.02U, 117.09U, 119.01U, and 120.05U)!

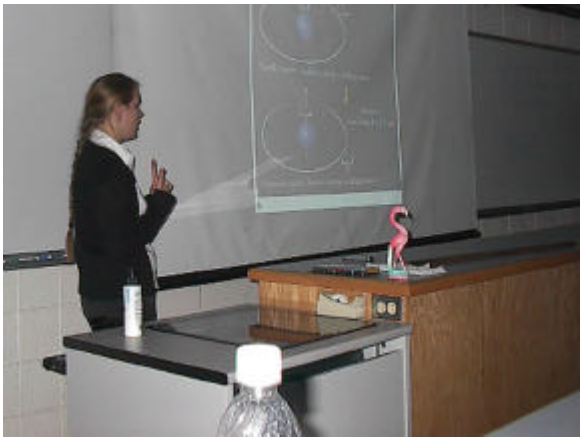
The Summer 2002 REU participants. Standing in the front row are (left to right) Juli Stoltz and Shannon Wells. In the second row are Sarah McGregor, Vanessa Wilkat, Martha Leake, Caroline Simpson, Wes Ryle, Justin Schaefer, and Derek Lamb. In row three are Roger Cohen, Elizabeth Jefferey, Jennifer Reiff, and Terry Oswalt. Finally, in the back row are Walter Van Hamme, Ken Rumstay, Matt Wood, Randall Perrine, Gary Henson, and Mark Leising. Not pictured are mentors Mike Hickey, Beverly Smith, and Jim Webb. *(Photo by Thressea Boyd)*

2002 SARA-REU Students

Name	Home Institution	REU Institution	REU Advisor	REU Project
Roger Cohen	Wesleyan University	FIU	Walter van Hamme	Light Curve Variability in W Corvi
Elizabeth Jeffery	Brigham Young University	VSU	Martha A. Leake	A Photometric Survey to Determine Rotation Rates of Primitive Asteroids
Derek Lamb	Drake University	CU	Mike Hickey	Ion-Drag effects on Gravity Wave Heating and Cooling in Jupiter's Thermosphere
Sarah McGregor	Saint Michaels College	VSU	Kenneth S. Rumstay	A Multicolor Photometric Study of Three Type 1 Seyfert Galaxies
Randall Perrine	Vassar College	FIT	Matthew A. Wood	Parallelizing an SPH Cataclysmic Variable Code
Jennifer Reiff	Otterbein College	ETSU	Gary D. Henson	Microvariability in Mira Variables
Wes Ryle	Western Kentucky University	CU	Mark Leising	X-ray Studies of Radioactivity in the Tycho and Cas A SNR
Justin Schaefer	University of Wyoming	FIT	Terry D. Oswalt	The Search for Cool Blue White Dwarf Variables
Juli Stoltz	Montclair State University	ETSU	Beverly Smith	Optical Imaging of Interacting Galaxies
Shannon Wells	Columbus State University	FIU	Caroline Simpson	A 21-cm Neutral Hydrogen Study of Arp 213
Vanessa Wilkat	Florida Institute of Technology	FIU	James R. Webb	Time Series Analysis of Microvariability in Blazars

Students meet for the first workshop at FIT. *(Photo by Ken Rumstay)*

An airboat ride on the Indian River. *(Photo by Ken Rumstay)*

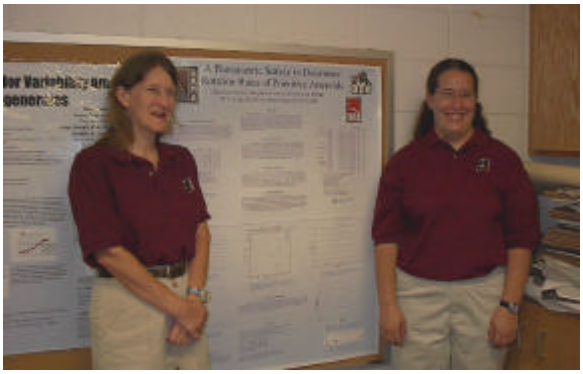


Shannon Wells describes 21-cm radiation. *(Photo by Ken Rumstay)*

Jennifer and Julie enjoy a tasty confection. *(Photo by Ken Rumstay)*

Sarah McGregor, after being asked to re-reduce the Akn 564 data "just one more time"! *(Photo by Ken Rumstay)*

Lunch in the President's Dining Room. *(Photo by Ken Rumstay)*



Elizabeth Jeffery (right) presents her work on asteroid light curves, as mentor Martha Leake stands by. *(Photo by Ken Rumstay)*

News from our Alumni

Chris Burke

Ever since my first astronomy research experience during the '97 SARA REU program, I've continued to pursue a career in astronomy. After graduating from Yale University in '99, I entered the astronomy graduate program at The Ohio State University and am currently starting my fourth year, one year into my Ph.D. thesis work. For my thesis I have undertaken an intense photometric monitoring campaign of open clusters to find extrasolar planets through the transit technique. The 19 night observation of the open cluster NGC 1245 last fall has not yielded any planet discoveries, however, this null result rules out >5% of the stars in NGC 1245 having close-in Jupiter-sized planets. I am actually writing this letter from MDM observatory where I am halfway through a 30 night monitoring of the open cluster NGC 2099 (M37). By concentrating the search for extrasolar planets in several clusters of known (and varied) age, metallicity, and stellar density, I hope to gain insight in to how these various properties affect planet formation, migration, and survival. If you're interested in more details of the Survey for Transiting Extrasolar Planets in Stellar Systems (STEPSS) see astro-ph/0208305. Finally, I want to thank all of you involved in the SARA REU program. Your program deserves a lot of credit for providing an excellent head start for me in astronomy.

Yale undergraduate Chris Burke worked with mentor Matt Wood during the summer of 1997. *(Photo by Chris Burke)*

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Issue #6 Autumn 2002
Kenneth S. Rumstay, Editor

The SARA web page is www.saraobservatory.org
This newsletter is available as an electronic PDF file

For paper copies, comments, questions or contributions,
Please contact the editor at krumstay@valdosta.edu