



Newsletter of the SARA Robotic Observatory

Volume 1, Issue 1

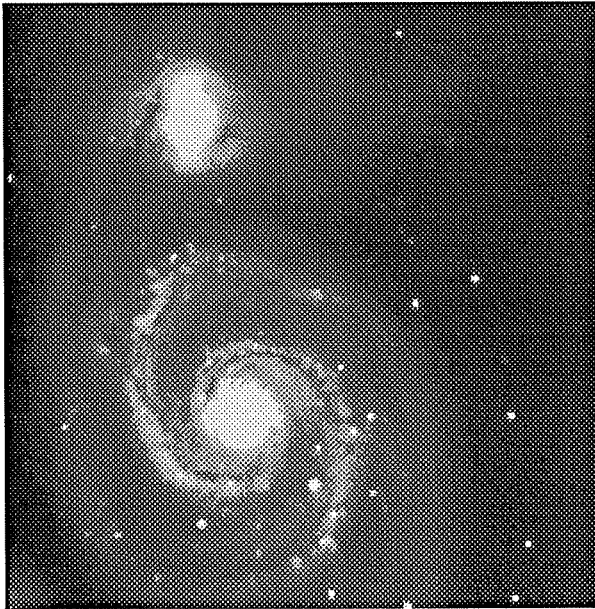
January 1996

M. A. Wood, Editor

FLORIDA TECH — EAST TENNESSEE STATE UNIV. — FLORIDA INTERNATIONAL UNIV. — UNIV. OF GEORGIA — VALDOSTA STATE UNIV.

INSIDE

Welcome	1
From the Director's Desk	2
The History of SARA	3
Dedication Highlights	3
Focus on SARA Science: Blazars	4
Grants/Awards to SARA Astronomers	5
The ACE Control System	6
The 1995 SARA-REU Program	7
The Axiom CCD Camera	9
Notes from the Board Meeting	10
SARA Observing Programs	10
Selected SARA Publications	11



An image of the Whirlpool Galaxy M51 taken with the SARA Telescope and the Axiom CCD Camera. The image resulted from the co-addition of 10 5-minute images.

Welcome

By Matt A. Wood, FIT

The Southeastern Association for Research in Astronomy (SARA) is a consortium of the five member institutions listed in the masthead above. With this, the first issue of the *Newsletter of the SARA Robotic Observatory*, we begin publication of a twice-yearly report of the status of the SARA observatory and of the science and educational accomplishments of note.

Regular columns in the Newsletter will include "From the Director's Desk," written by our Observatory Director Dr. Mike Castelaz (ETSU), and "Focus on SARA Science," which will be a brief introduction to some of the science projects we're involved in. In addition, we will include regular updates to the Grants & Awards received by and publications authored by SARA astronomers, and highlights from SARA Board Meetings. These regular columns are supplemented in this first issue with brief essays on the "History of the SARA Observatory" written by Dr. Kenneth Rumstay (VSU), "Dedication Highlights" by Dr. Matt A. Wood (FIT), "The Research Corporation CCD Grant" by Dr. James Webb (FIU), and "The ACE Control System" by Dr. Peter Mack (ACE, Inc.). In addition, Dr. Rumstay also has written a nice summary of the first SARA REU Site Program, held during the Summer of 1995—we think you'll find it entertaining reading. Finally, to entice you to at least open and scan the Newsletter when you receive it, we'll sprinkle interesting images taken with the SARA Telescope and CCD (like that at lower left), and will also include selections from the panel comic feature *The Borderline* by Gabe Martin.

For more timely updates on what's going on with SARA (and more images), please check our page on the world wide web at <http://pss.fit.edu/SARATelescope.html>. □

From the Director's Desk

By Mike Castelaz, ETSU

January 7, 1995, marked the Dedication of the SARA 0.9-m Observatory. Since that time observers have been steadily trekking their way across the country to use the facility. Although in use for less than a year, the observatory has already provided one of the SARA Consortium members with critical data. Observations made by Dr. Jim Webb of a blazar in outburst initiated a world-wide effort to observe the source. Also, the observatory was heavily used during the period June-July 1995 by students participating in the SARA REU program.

Currently, the telescope is under manual control using the observatory control system built by Astronomical Consultants & Equipment (ACE, Inc.). The system uses a Pentium CPU and Windows NT based software. Observatory control is being upgraded for remote use, which is expected to occur during the spring of 1996. This is a big step. In remote use, observers will not only be able to select which instruments to use, but also the configurations of the instruments, and will have the option of using both instruments in a co-temporal mode. Looking beyond remote use, the observatory will undergo the last phase of its development—robotic operation—by summer 1996. At that point, all hardware and software will be in place, and scheduling will become the focus of attention. Astronomers from at least five universities will submit their observation plans to the scheduler (Dr. Scott Shaw, UGA) who will organize the plans for most efficient use of instruments and time.

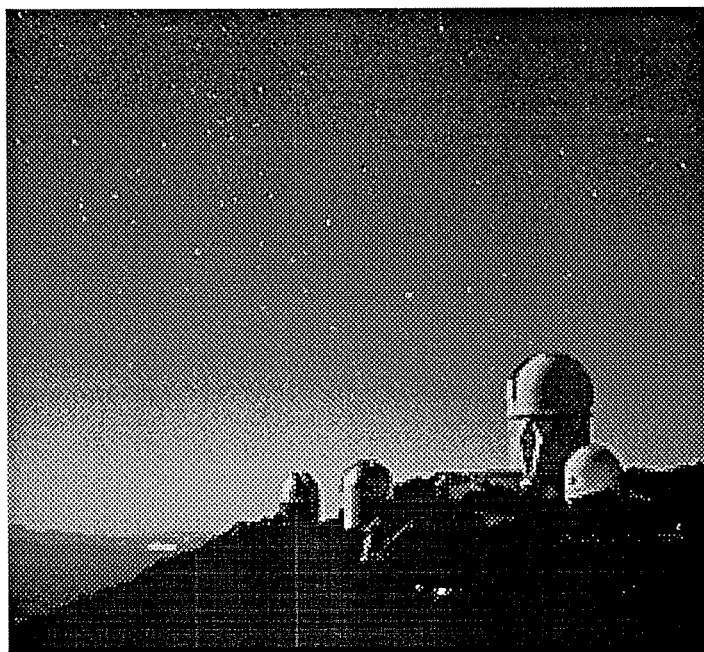
Two instruments are mounted on the 0.9-m telescope four-port instrument selector built by ACE. One port carries a 2048×2048 CCD camera and filters including *UBVRI*, $H\alpha$, $H\beta$, and red and blue nebular continuum filters. The camera, an Axiom AX-4, uses the Kodak KAF 4200 CCD sensor. It is free of point defects, column defects, and cluster defects. Digitization is 16-bit, the readout noise is 15 electrons rms, and dark count is about 3 to 5 electrons per minute at -35°C . The software allows for on-chip binning to 6×6 , as well as subframe imaging. Readout, download, and display occur at a rate of about 45,000 pixels per second. The chip has a 9 micron pixels providing field of view of 9.2 arcmin for the whole CCD sensor. A signal-to-noise ratio of 100 for a $V = 15$ star can be obtained in 120 seconds with the camera cooled to -20°C .

A second port carries a dual channel chopping photometer for photometric broadband and intermediate band color work. The light from a single star is beamsplit towards two different filter sets and photomultiplier tubes (PMTs).

Photon counts from the two PMTs are measured by two 32-bit counters. The filter wheels hold eight filters each. One filter wheel has *UBVR* and Stromgren *uvby*. The other filter wheel has a Bessell Set of *UBVRI*, and $H\beta$ narrow and $H\beta$ wide filters. The photometer is useful for absolute photometry, and also for observations of stellar colors on nights when the weather is not perfectly photometric. The photometer software was recently upgraded to a Windows based system. Over the next six months a chopping aperture feature will be added so sky measurements can be made simultaneously with point source measurements.

In addition to the photometer, ETSU has a low resolution ($120\text{\AA}/\text{mm}$) spectrograph and Axiom AX-1 CCD (768×512 , $9 \mu\text{m}$ pixels), which is used on a temporary basis on a third port of the instrument selector at the SARA Observatory. SARA astronomers and co-investigators are invited to use the instrument. This third instrument option provides the unique capability for co-temporal photometric and spectrophotometric observations.

SARA astronomers have worked hard to obtain grants for instrumentation and support of the SARA Observatory. These include the CCD camera (Dr. Jim Webb; RC grant), filters for the CCD camera (Dr. Ken Rumstay; AAS grant), the REU program (Dr. Bruce Rafert, Dr. Terry Oswalt; NSF) and the photometer and spectrograph (Dr. Mike Castelaz; NSF grants). Dr. Scott Shaw intends to submit a grant proposal to fund the purchase of software and hardware for dome control, as well as a grant to fully implement a data archive system. These and future efforts indicate that SARA astronomers will continue to have an excellent facility for their research efforts. \square



Kitt Peak at dusk.

The History of SARA

By Kenneth S. Rumstay, VSU

The southeastern United States has traditionally had little national representation in the astronomical community because the small number of astronomers at most institutions (typically two or three) have limited financial resources and are, for the most part, geographically isolated. In response to these challenges, the Southeastern Association for Research in Astronomy was chartered in 1989 to foster the growth of astronomical research in the Southeast. Representatives from the four charter institutions (FIT, ETSU, UGA, and VSU) first met on the FIT campus on March 24, 1989.

The formation of SARA was instigated by a letter issued to the astronomical community on April 9, 1988, by Dr. Sidney C. Wolff (Director of the National Optical Astronomy Observatories) and Dr. Goetz K. Oertel (President of the Association of Universities for Research in Astronomy, Inc.). As part of a comprehensive plan to address the financial crisis developing at the national observatories, a subcommittee of the National Science Foundation's Committee for Astronomical Sciences had recommended closure of one of two 0.9-meter telescopes at the Kitt Peak National Observatory. This telescope would be made available to the astronomical community under the proviso that it be moved from its site to make room for the planned 3.5-meter WIYN (Wisconsin-Indiana-Yale-NOAO) telescope. SARA was formed with the intent of acquiring this telescope to fulfill a collective need to (1) have access to a prime observing site; (2) pool institutional faculty and resources; (3) facilitate faculty and student research programs; and (4) acquire a test-bed for the development of new instrumentation. In September of 1989 SARA submitted a proposal to the NSF to relocate the telescope to a new site on Kitt Peak and to equip it for robotic observations. Approximately thirty competing proposals were submitted to the NSF by various individuals, institutions and consortia; the telescope was awarded to SARA in April 1990.

During the summer of 1990, following its disassembly and storage of the optics and mount, the structure housing the 0.9-meter telescope was demolished. A climatic and geological survey was simultaneously conducted to determine the optimum location for the new SARA observing facility. A location at Mercedes Point was eventually chosen (opposite the Burrell Schmidt telescope on Kitt Peak); at an altitude of 2100 meters this location offers stable seeing conditions and a fairly low horizon in all directions save for the northeast. A two-story structure for the SARA telescope was designed by the architectural firm of Stanly

Black of Boston, and construction was contracted to the firm of Kasper-Hall of Tucson. Construction began in late summer of 1992, and reassembly of the telescope began in February 1993. By the end of 1993 the telescope was fully capable of manual operation.

A fifth academic institution (Florida International University) joined SARA in April 1992, greatly increasing both the technical expertise and financial support available to SARA. One year later SARA cosponsored its first scientific conference: the SARA/Fairborn/IAPPP symposium "Robotic Telescopes, the First Decade" met April 9-10, 1993 at the Lazy K guest ranch in Tucson. In conjunction with the biennial meeting of the American Astronomical Society in Tucson a formal dedication for the SARA observing facility was held January 7, 1995. SARA's most recent endeavor, made possible through a two-year grant from the National Science Foundation, is the establishment of a summer Research Experience for Undergraduates program; during the summer of 1995 seven highly qualified students from around the eastern United States worked with SARA faculty members on a wide variety of observational research projects. □

Dedication Highlights

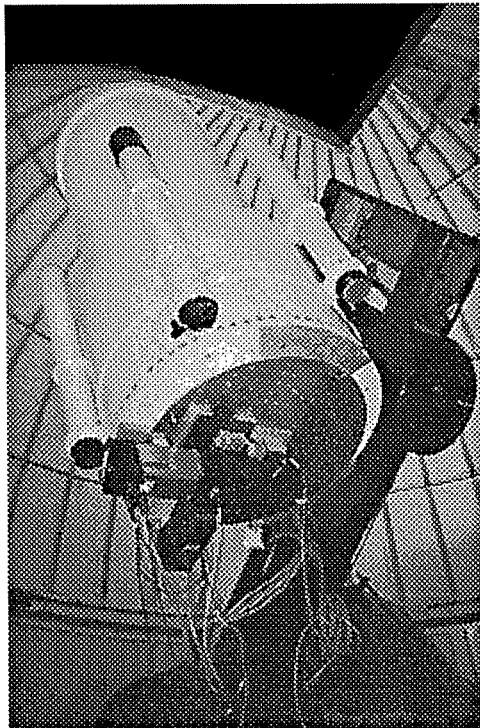
By Matt A. Wood, FIT

We dedicated the SARA Observatory on January 7, 1995. It was a beautiful day on the mountain, and we were pleased to have in attendance Dr. Caty A. Pilachowski, Interim Director of Kitt Peak National Observatory, Dr. James P. Wright, Director for Education and Human Resources and Special Programs at the National Science Foundation, and institutional representatives from the consortium schools: Dr. Norine Noonan, Florida Tech Vice President for Research and Dean of the Graduate School, Dr. Bruce Rafert, Florida Tech Professor of Physics and Space Sciences, Dr. Todd Baker, Chair of the UGA Physics and Astronomy Department, Dr. Harry D. Powell, ETSU Professor of Physics, and Dr. Kenneth Rumstay, VSU Associate Professor of Astronomy. Rounding out the list of speakers were the SARA Chairman of the Board, Dr. Terry Oswalt, the Observatory Director Dr. Mike Castelaz, Dr. Peter Mack of ACE, Inc, and the observatory Architect Mr. Stanly Black.

We began with a short dedication ceremony in the KPNO Visitors Center including short speeches by Drs. Oswalt, Pilachowski, Castelaz, and the institutional representatives. As a gesture of our gratitude to those most responsible for the timely completion of the observatory, Dr. Rafert presented plaques to Drs. Oswalt, Castelaz, Mack, and Mr. Smith.

We then walked to the observatory for the ribbon cutting ceremony. First, Dr. Pilachowski cut a ribbon as KPNO Interim Director, then the 5 institutional representatives cut a second ribbon. A Tribal Blessing by the Tohono O'odham Medicine Man William Antone had to be canceled because Mr. Antone was very ill with the flu.

After the ribbon cutting, those in attendance received a tour of the SARA facility and got to view the telescope in motion as it whirred quietly and quickly from one position to another, and even got to see the moon through the eyepiece. Following lunch, we concluded with a VIP tour of the mountaintop lead by Dr. Pilachowski, and later had a fine dinner at one of Tucson's best Mexican food restaurants, La Fuente. A great time was had by all! □



The SARA Telescope.

Focus on SARA Science: Blazar Variability

By James Webb, FIU

Blazars are a subclass of the active galactic nuclei (AGN). Our understanding of the physics of AGN is still incomplete, but we believe they are powered by accretion onto a supermassive central black hole, and usually contain a pair of relativistic jets. The blazars are observed to be highly variable optically, and we believe this is a result of the jet orientation in these objects—we are looking

directly down the axis of the blazar jets. The acquisition of the CCD makes the SARA 0.9-meter telescope sensitive enough to monitor most of the northern hemisphere blazars. Scientific contributions began immediately upon installation of the camera with two blazar observations.

First, during the initial installation trip to Kitt Peak in May of 1995, Mr. Thomas Barnello and Dr. James Webb decided to test the CCD on a field whose comparison stars were widely dispersed to confirm that at least two coma stars would be in the field of view with the blazar if the telescope were properly pointed. They noticed that the blazar, PKS 1156+295, was extremely bright and in the middle phase of an outburst. This outburst detection was transmitted to many other ground-based observers through E-mail and through an IAU circular (Webb et al. 1995, IAU circular #6168). Although the SARA CCD images were unfiltered and uncalibrated, the outburst detection enabled Webb to initiate a multifrequency campaign on this object which included observations in the radio, IR, and UV portions of the spectrum. The data resulting from the multifrequency campaign are now being analyzed and the results will be submitted for publication this year.

The second contribution came during a scheduled observing run in July, 1995. Days before leaving for the SARA observatory Dr. Webb received an E-mail about the detection of an obscure Blazar by the EGRET gamma-ray telescope on Compton Gamma Ray Observatory. Optical observations of this source from Germany revealed it to be extremely bright in the optical as well, indicating a possible gamma-ray/optical correlation. The German groups' telescope time ended halfway through the two week EGRET pointing, with the final week coinciding with the SARA telescope time. During the week of July 1-July 5, Webb, FIU graduate student Pamela Jenkins, Dr. Alberto Sadun, and NSF REU students Roy Kilgard, Tony Neal and Bryan Speck monitored the gamma-ray bright blazar, 1622-29 in *BVR* and *I*. These data were then reduced by Kilgard and Sadun. The immediate results were published in the IAU circulars along with the gamma-ray preliminary results (Mattox et al. 1995, IAU circular #6180). The light curves resulting from the German group's optical observations and the SARA observations are being combined into one paper scheduled for submission to *The Astrophysical Journal* (Wagner et al. 1995, in preparation), with a companion article detailing the gamma-ray results. Because variations in flux were seen in both the gamma-ray and the optical spectral regions, this is a great opportunity to study the variability correlations in these frequency bands.

In addition to the 1622-29 observations, over 75 CCD images of eight other blazars were taken as part of an ongoing monitoring program with the SARA telescope. Results of these images will be published at a later date. □

Grants & Awards

Castelaz Awarded NSF CAREER Grant

Dr. Mike Castelaz (ETSU) was recently awarded a prestigious Faculty Early Career Development (CAREER) grant from the National Science Foundation for his proposal titled "Career Development in Research and Education in Stellar Astronomy and Astrophysics." The award is for 3 years, and includes funds for summer support, travel expenses, page charges, and equipment funds to purchase a low resolution spectrograph and CCD camera.

The award will allow Castelaz to establish a balanced program of research and education in astronomy and astrophysics. He will establish a research program involving spectroscopy and photometry of late-type stars and establish an undergraduate education program to teach methodology in research using the late-type star research program. The research plan is to establish a program of frequent spectroscopic and photometric observations of long-period ("Mira") variables. The Mira variables undergo brightness variations of at least 2.5 magnitudes with a characteristic timescale of order 1 year, and their spectra vary in the strength of their absorption and emission features. The observations will provide important data needed to understand the relationship between the spectra and light curves of these stars, and ultimately, the physics of these envelope pulsations.

The CAREER program also includes a strong education component. Castelaz proposes to improve and develop courses and opportunities for students at ETSU using the available astronomical research facilities. The facilities include a new campus observatory housing a 0.35-m telescope, and of course the SARA 0.9-m telescope. The education plan includes a physics major senior project using research skills learned from assisting in the Mira star research. Dr. Castelaz will also develop an observational astronomy class which will be the equivalent of a sophomore/junior physics laboratory course.

SARA Awarded Research Corporation Grant

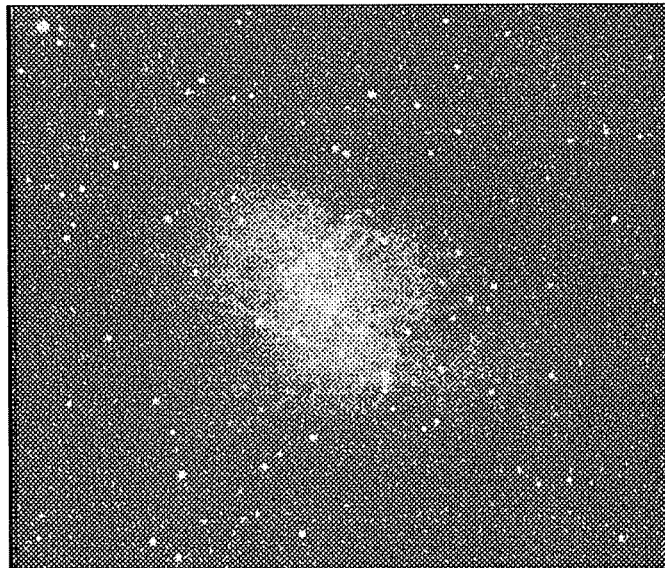
In autumn 1994 SARA was awarded \$60,000 by the Research Corporation of Tucson, Arizona, for the purchase of a research grade CCD camera. Principle Investigator for the grant was Dr. James R. Webb of FIU; co-PI's included the remaining SARA board members and Dr. Terry D. Oswalt, as Chairman of the Board. The funds were used to purchase an Axiom CCD camera with a 2048 × 2048 zero defect pixel array and also to construct a filter wheel assembly (see article on page 9).

Consortium Awarded NSF-REU Grant

In April 1995 SARA was notified that its proposal to operate a summer Research Experience for Undergraduates program was approved by the National Science Foundation. An award of \$52,011 was made for the first summer of operation. Principle Investigator for the grant was Dr. J. Bruce Rafert of Florida Tech; the remaining SARA board members and Dr. Terry D. Oswalt were co-PI's. During the summer of 1995, seven students selected from institutions located around the country participated in astronomical research projects at the five SARA schools. The 1995 SARA-REU program has been reviewed by Dr. James Wright of the NSF, and SARA has been approved to operate this program during the summer of 1996. Oswalt has taken over the job of PI of the REU Site Program following Rafert's departure for a department chairmanship in the Physics Department of Michigan Technological University.

Webb Receives IUE Observing Time and NASA Jove Grant

Dr. James R. Webb recently was awarded 160 hours of IUE time as part of the International Ultraviolet Explorer Key Observing Program. He is the PI of the program, entitled *Multifrequency Observations of Flaring Blazars*. Webb also recently received a NASA JOVE Augmentation Grant of \$20,000.



The Crab Nebula is the remnant of a supernova recorded by Chinese astronomers in 1054 AD. The image shown here was a 60-sec exposure obtained on 1995 September 27 by Christian Drouet D'Aubigny and Allyn Smith (FIT). As the image shows, the chip is cosmetically excellent.

Rumstay Awarded AAS Small Grant

In July 1995 SARA was awarded a grant of \$4000 by the American Astronomical Society for the purchase of interference filters to be used with the SARA telescope and CCD camera. Principle Investigator for this grant was Dr. Kenneth S. Rumstay of VSU; \$2650 of the award was used to obtain Balmer-line and continuum filters required for his program to map galactic HII regions. The remaining amount was used to purchase a three-filter subset of the Wing eight-filter photometric system. These filters will be used by ETSU astronomers; Drs. Powell, Henson, and Castelaz of ETSU were co-PI's for this grant.

Wood Awarded NASA Astrophysics Theory Program Grant

Dr. Matt A. Wood of Florida Tech was recently awarded a NASA Astrophysics Theory Program Grant for his research proposal "White Dwarf Astrophysics and the Age and Evolution of the Galaxy." The award is for 3 years and a total of \$173,000. Dr. Alexander G. Muslimov is Co-I on the grant, and will join Wood in Florida for 2 months for each of the next 2 summers. Funds will also support a graduate student, Mr. Robb David, for 3 years.

White dwarf stars, with their long cooling timescales and relatively homogeneous class properties, are ideal probes for a number of astrophysical problems. Wood and Muslimov will (i) improve the numerics of their evolutionary models and then to use these models (ii) to continue their work to determine the age and evolution of the Galaxy using the WD luminosity function, (iii) to provide lower limits to the ages of binary millisecond pulsars with WD companions, thus providing constraints to the magnetic decay models for the neutron stars in these systems, and (iv) to explore in detail the evolution of magnetic fields in the WD stars. In particular, Wood and Muslimov will attempt to understand the non-dipole magnetic field configurations observed in cool WDs. □



The ACE Control System

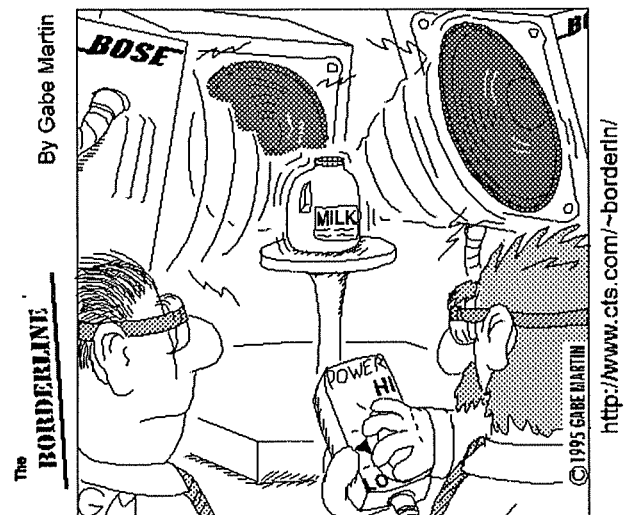
By Peter Mack, ACE, Inc.

The telescope control system has been operational since January, 1995. It has allowed on-site observers to use the facility. It is now being upgraded for remote operations under the Windows-NT operating system to provide complete control of the observatory.

Part of the upgrade includes a new set of control cards, optical shaft encoders on the right ascension and declination axes, and control of the instrument selector and dual-filter wheels. The system is highly intuitive and has two astronomer experience levels: novice and expert. In the novice mode, new astronomers are guided through the operations with additional messages in addition to the on-line help facility. The telescope has undergone an extensive overhaul since its acquisition by SARA, and it can now be smoothly slewed from horizon to horizon in just over one minute.

The ACE-Robotic Control System will be fully implemented by late January, and a remote demonstration is planned for that time.

For more information on the ACE-RCS contact Peter Mack at Astronomical Consultants & Equipment, Inc. (520 579 0698). □



Albert Einstein & Satyendra Bose's first attempt to produce the elusive fourth state of matter, the Bose-Einstein Milk Condensate, disappointingly ended with cottage cheese splattered all over the lab.

The Summer 1995 SARA REU Program¹

By Kenneth S. Rumstay, VSU

Introduction

During the summer of 1995 the Southeastern Association for Research in Astronomy operated a Research Experience for Undergraduates program. Sponsored by a grant from the National Science Foundation, this program allowed seven students from six institutions of higher education to engage in research projects under the tutelage of SARA faculty members. On April 26, 1995 the SARA consortium received word that its REU Site Program proposal had been selected for funding for 2 years. Recruitment of qualified applicants began immediately, and by the end of May seven students had been selected. Table 1 lists each student's home institution, the faculty mentor assigned to each student, and the title of each student's research project. The grant provided each student with a travel allowance (for travel to and from the SARA REU site and to visit the observatory at Kitt Peak), dormitory housing during the research period, and a stipend of \$250 per week. The REU students began their summer experience by joining their faculty mentors at an introductory group meeting on the campus of Valdosta State University. The students and mentors then returned to their respective SARA institutions for six weeks of intensive research activity, the results of which were presented at a final group meeting on the Florida Tech campus.

The First Group Meeting

The seven students and six faculty mentors gathered for dinner in Valdosta on Sunday afternoon, June 11th. Dr. Rafert welcomed one and all to the very first SARA summer REU program, and Dr. Dennis Marks, head of the VSU Department of Physics, Astronomy, and Geology, welcomed everyone to Valdosta State. Everyone got to know each other and the faculty mentors told war stories of meetings and events past—the first several of which were of great interest to the students.

The participants gathered the next morning in the VSU Astronomy Lab. After some introductory remarks from Dr. Rafert, Dr. Terry Oswalt presented a brief history of the SARA consortium to the students. Mr. J. Allyn Smith of FIT, the SARA Assistant Observatory Director, outlined the operation of the 0.9-m telescope and described the characteristics of the recently-acquired CCD camera.

Following lunch, the group reassembled at 1:30 for the first of three afternoon ethics workshops conducted by Dr. Doug Bailey of FIT. The NSF-sponsored REU programs are designed not only to involve undergraduates in the process of modern research, but also to expose them to some of the ethical and moral considerations with which professional scientists must grapple. The final event on the first day's agenda was a tour of the VSU observatory, planetarium, and computing facilities, followed by dinner at the author's home.

During the second and third days of this opening meeting the faculty mentors presented a series of "mini-courses" in a variety of topics: Fundamental Astronomy (Dr. Rumstay), CCD Cameras (Dr. Rafert), Photometric Reductions (Dr. Oswalt), IRAF Image Processing Software (Mr. Smith), Astronomical Polarimetry (Dr. Henson), Radio Astronomy (Dr. Magnani), and Space-Based Astronomy (Dr. Webb). It turned out that all seven of the first-year students were majoring in physics, astronomy, or some related field; nonetheless, their backgrounds varied substantially, and all found these discussions useful. That night, we met for an informal session at the VSU planetarium.

Wednesday brought another round of mini-courses, as the REU faculty struggled to compress all of observational astronomy into three half-day sessions. After dinner the group convened for the last event of the meeting, an observing session at the campus observatory atop Nevins Hall. Fortunately the skies were clear, and students were able to experiment with the 0.4-m Starliner reflector and SBIG ST-6 CCD camera; a number of smaller telescopes were used for visual observations. Drs. Rafert and Oswalt kindly attempted to improve the collimation of one of the 10-inch telescopes; the resulting damage has since been repaired, and the author bears no ill-will towards either individual!

Fun and Adventures at Kitt Peak

The students and mentors returned to their respective host institutions on Thursday, June 15th. Upon arrival, the students settled quickly into their dormitory accommodations, and eagerly began work on their research projects.

Dr. Oswalt and his student, Tom Ahrens, were slated to begin observing at Kitt Peak almost immediately. They enjoyed eight nights of near-perfect observing conditions and became the envy of the observing teams that followed. At first, only two other students were slated to observe at the SARA facility: Roy Kilgard (with Dr. Jim Webb) and Allison Morrill (with the author).

The desirability of giving all seven students an opportunity to use the facility quickly became apparent and, thanks to the willingness of these two faculty mentors to supervise additional students, and to some creative financial juggling on Dr. Rafert's part, this became possible.

¹Condensed from an article submitted to the I.A.P.P.P. Communications. Used with permission.

TABLE 1
THE SUMMER 1995 SARA-REU STUDENT PARTICIPANTS

Student	Faculty Mentor	
Thomas J. Ahrens University of Wisconsin	Terry D. Oswalt Florida Tech	A Survey of Common Proper Motion Binaries Containing White Dwarfs
J. Paul Douglas Florida Tech	Gary D. Henson UGA	Photometry of Long Period Late-Type Variable Stars
Roy E. Kilgard Valdosta State University	James R. Webb FIU	Target of Opportunity Blazar Observations
Allison L. Morrill Florida Tech	Kenneth S. Rumstay VSU	Monitoring Continuum Emission from Active Galactic Nuclei
Anthony J. Neal Cornell University	James B. Rafert Florida Tech	Computer Modeling of W Serpentis Type Binaries Through the use of Smoothed Particle Hydrodynamics
Bryan G. Speck Benedictine College	Loris A. Magnani UGA	A Survey of Molecular Gas at High Galactic Latitudes
Shane Zabel Carnegie Mellon University	James B. Rafert Florida Tech	Computer Modeling of W Serpentis Type Binaries Through the use of Smoothed Particle Hydrodynamics

Tony Neal and Bryan Speck joined Dr. Webb, Roy, and Pam Jenkins (a graduate student from FIU) in Tucson in late June. Watching five people squeeze themselves and their luggage into a subcompact car (reserved prior to the addition of two REU students to the roster) for the trip up the mountain was apparently a sight to behold, conjuring images of the clown cars often seen in circuses. With an occupancy of six people (including Allyn Smith), the observatory warm room quickly became a pretty darn hot room!

In addition to observing during the night, students had an opportunity to tour the other telescopes at Kitt Peak, and were also given the opportunity to assist in the routine maintenance of the SARA observatory. All of the students considered this to be the most rewarding experience of the REU program; consequently, SARA plans to offer all future REU participants a similar opportunity to visit the SARA facility or some other national observing facility.

The Final Group Meeting

After returning from Kitt Peak, the REU students spent between two to four weeks at their host institutions catching up on sleep, reducing and analyzing their data, and becoming familiar with all the subtle intricacies of IRAF. A final group meeting, scheduled for July 24th to 26th on

the FIT campus, gave them a chance to present their results and to compare experiences. The students also met in private with Dr. James Wright of the National Science Foundation, who was there to evaluate the SARA-REU program in its first year.

A large portion of the first two days of this meeting was devoted to presentations by the faculty mentors, who described the various types of astronomical research conducted at their respective institutions.

Students presented their project results in two formats—oral and poster sessions—in an attempt to simulate the most common presentation formats used at professional meetings. On Tuesday, each student gave a ten-minute oral summary of his or her work. In accordance with AAS format, students were encouraged to speak for five minutes and to allow five minutes for questions. While some were noticeably nervous, all agreed that it was a useful exercise. The poster session on Wednesday, however, was perhaps the high point of the meeting; with the “first-talk jitters” out of the way, all seven students succeeded in describing their projects clearly, succinctly, and enthusiastically while standing in front of posters worthy of any AAS meeting!

As with the opening meeting in Valdosta, this final group meeting was enlivened by a variety of social events.

On Tuesday the REU faculty and students were invited to join Dr. Lynn E. Weaver, President of FIT, for lunch and conversation. Also joining us were Dr. James Patterson, Head of the Department of Physics and Space Science, and Dr. Norine Noonan, Vice President for Research and Dean of the Graduate School. That night we were treated to a wonderful planetarium show at Brevard Community College. On Wednesday night, our last night together, Dr. Noonan treated us all to dinner at a local restaurant. We shall always remember her good-natured graciousness and generosity! On Thursday, July 27th, the Summer 1995 SARA-REU Program officially came to an end.

Conclusion

Although the SARA-REU students are once more scattered across the country, their involvement in this summer's program is not over. Each student who participated in the program was awarded approximately fourteen hours of observing time on the SARA telescope. This could be used after the telescope becomes capable of remote observation, or before, provided the student is able to arrange travel to Kitt Peak. Students maintain contact with their faculty mentors and each other via e-mail, fax, and telephone; many are writing up their project results for publication.

SARA has received NSF funding to continue this program during the summer of 1996, and is now soliciting applications from qualified students. Requests for information should be addressed to Dr. Terry D. Oswalt at Florida Tech (oswalt@tycho.pss.fit.edu). WWW users can access the SARA REU Home Page at http://pss.fit.edu/SARA_REU.html. □

The Axiom CCD Camera

By James R. Webb, FIU

Introduction and History

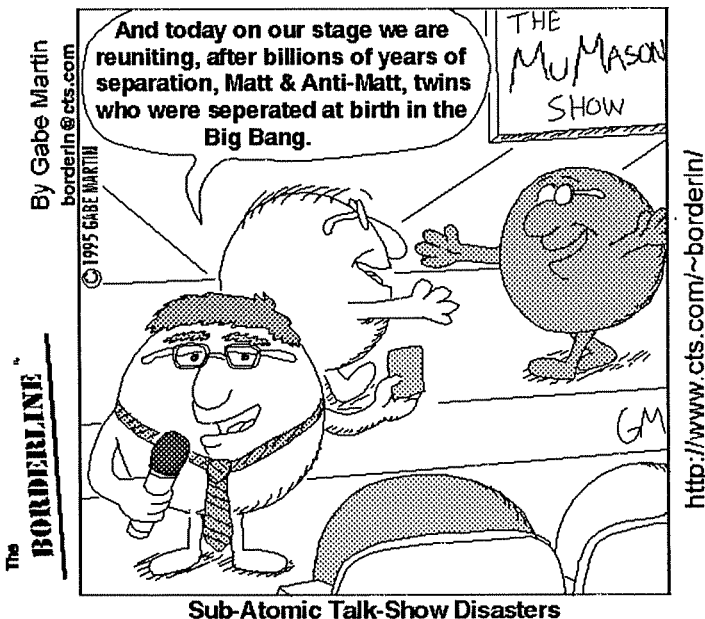
Following the acquisition of the 0.9-m telescope from NOAO, the next important step was to obtain instrumentation. A research-grade photoelectric photometer was designed and built with NSF funding by Mike Castelaz at East Tennessee State University. This instrument is of exceptional quality, but it could not support all of the research needs of SARA scientists. This need led to a proposal to the Research Corporation written by Dr. James R. Webb (PI) and Scott Shaw in an attempt to secure outside funding to purchase a Charge-Coupled Device (CCD) camera to be used as an imaging detector. The Research Corporation generously decided to fund the proposal in October of 1994 and \$60,000 was made available to the PI in late November of 1994—\$5,000 for travel and on-site support and \$55,000 for equipment.

CCD Evaluation and Purchase

After extensive consultations, we decided to evaluate just two CCDs "on-site" at the 0.9-meter telescope. Of primary concern were temperature control and interface with the telescope control system. We tested cameras made by Axiom and Photometrics. Rigorous testing indicated that the Axiom CCD camera was the one most suitable for our needs, both in quality and in compatibility with the automation system. The SARA Board approved the purchase of an Axiom AX-4 camera with a 2048×2048 Kodak Grade 1, lumigen-coated (UV sensitive) CCD chip. The AX-4 camera is a 16-bit camera with MPP electronics that has very low noise even when operated at higher temperatures. The higher temperature constraint is imposed by our planned robotic/remote operation. With nobody at the telescope, there will be no way of refilling a dewar with liquid nitrogen. Therefore we must rely upon a high-power thermoelectric cooler with a maximum capacity of 53°C below ambient—*i.e.*, a considerably higher operating temperature than typical for astronomical CCDs.

Additional Equipment

In addition to the CCD itself, several pieces of supporting equipment were needed to adapt the CCD to the telescope. Many of the items were custom-built by ACE, Inc., specifically for our telescope/CCD system. This includes the CCD collimation Jig, the Filter wheel, and the instrument selector box. The filters were purchased from Custom Scientific and the CCD computer is from Cornell Comput-



ers. The computer, a Pentium-based system, was specially ordered to efficiently operate the CCD using the Axiom data acquisition and reduction software, Mira.

The CCD Detector and Camera

We ordered the AX-4 CCD camera with a Kodak KAF-4200 2040×2048 chip, with each pixel being 9 microns square. The physical size of the chip is 18.4 x 18.4 mm and this corresponds to 9.2×9.2 arc minutes on the sky through the SARA f/7.5 Cassegrain focus. The chip was ordered as a grade 1 chip, which would allow up to 10 point defects but no column or row defects. We were pleasantly surprised to have a grade 0 chip delivered—no column or row defects, even after the application of the lumigen coating. Repeated use has also shown the chip to be stable and very flat, in many cases needing no flat fielding at all. *This cosmetically perfect detector is perhaps the highest quality CCD chip used for astronomical imaging on Kitt Peak at the present time.*

Summary

As can clearly be seen by the research already done with the CCD, the acquisition of the camera instantly made the SARA 0.9-meter a superb research and teaching telescope. As the telescope operating system is completed and refined, the CCD will become an even more valuable instrument. Future remote and robotic operation will rely on the CCD as a finder and centering instrument for the other instruments even when not being used as the primary detector. The sensitivity of the CCD allows the 0.9-meter telescope to observe sources previously too faint for a telescope of this size. Other narrow-band photometric filters are being purchased from other grant funds to be used with the CCD. This will allow us to carry out even more diverse research projects with this instrument. □

Notes from the Fall Board Meeting

By Gary Henson, ETSU

The SARA Board of Directors Fall meeting was held on September 22 at Florida International University. The meeting's day long agenda included discussions on everything from how to fix the observatory's leaky front door to establishing budget priorities for the coming fiscal year. The meeting began with the approval of two new Board members, Matt Wood (FIT) and Gary Henson (ETSU). Observatory Director, Mike Castelaz, and Peter Mack of ACE, Inc. reported to the Board on the status of the SARA Observatory and the successful use of the facil-

ity by numerous on-site observers, including faculty and students, over the past six months. A lengthy discussion on business and administrative matters was led by Board chairman, Terry Oswalt. Acknowledging that the current budget must be increased to meet the needs of SARA, the Board will intensify efforts to add a new member. Notable among other issues was the recognition of the creation of a very informative SARA homepage on the Worldwide Web by Matt Wood. With another productive Board meeting concluded, those present adjourned to dinner and entertainment hosted by Jim Webb, including a *memorable* sing-a-long session led by the musical talents of Jim Webb and Matt Wood on acoustic guitars—don't give up your day jobs, guys! □

SARA Observing Programs

By Mike Castelaz, ETSU

Observations recently completed and/or scheduled the next six months include:

- *Balmer Line Imaging of Selected Galactic HII Regions*, K.S. Rumstay (VSU), A.L. Morrill (FIT), CCD
- *SARA Photometry of Variable Stars*, Mike Castelaz and Mike Bales (ETSU) John Stein (Geneva College), photometer
- *The Rotation Periods of Slow Rotators in Young Clusters* J.-P. Caillault and Sangeeta Mysore (UGA), CCD
- *Target of Opportunity Observations & Regular Monitoring Observations of Blazars*, J.R. Webb, A. Sadun, P. Jenkins (FIU), R. Kilgard (VSU), CCD
- *Search for Close Binaries in Open Clusters*, J.S. Shaw (UGA), CCD
- *UBV Photometry of Peculiar A Stars*, Paul Douglas (FIT), Gary Henson (ETSU), CCD
- *White Dwarfs in Wide Binaries*, J. Allyn Smith, Terry D. Oswalt, Melanie Kaplan (FIT), CCD
- *Outer Galaxy Star Forming Regions*, Loris Magnani (UGA), Jan Brand (CNR), J.G.A. Wouterloot (MPI), photometer
- *Photometry of W Serpentis Stars*, Bruce Rafert (MTU), CCD

- *Spectrophotometry of Mira Stars*, Michael Castelaz (ETSU), Tim Persinger (Allegheny Observatory), spectrograph and photometer
- *Resolving the Gravitational Time-Delay Controversy in the Double Quasar 0957+561*, J.-P. Caillaud (UGA), John Stauffer and Rudy Schild (CfA), CCD).
- Whole Earth Telescope Observations of the Delta Scuti Star 4 CVn (M.A. Wood (FIT) and Michael Castelaz (ETSU), photometer).
- Target of Opportunity Multifrequency Observations of BL Lac and OJ 287., Webb, J. R., et al., Proceedings of the Oxford conference, 1995.
- IUE Observations of OJ 287 in November 1994, Pian, E., Treves, A., Webb, J., Kazanas, D., Maraschi, L., McCollum, B., Shrader, C., and Wamsteker, W., Proceedings of the Oxford Conference, 1995.
- “The δ Scuti star FG Vir. I. Multiple pulsation frequencies determined with a combined DSN/WET campaign” Breger, M.A. et al. (includes Wood, M.A.) 1995, A&A, 297, 473.

Selected SARA Publications

The following is an incomplete list of recent publications of SARA astronomers. We hope to provide a more representative sampling in future issues. [SARAnS: Please send current CVs — Ed.]

- “The VSU 16-inch Telescope: A SARA Training Ground”, K.S. Rumstay (1995). I.A.P.P.P. Communications (in press).
- “Progress Report on the SARA 0.9-m Telescope Project at Kitt Peak”, T.D. Oswalt, J.B. Rafert, H.D. Powell, J.S. Shaw, K.S. Rumstay, and J.R. Webb (1995). I.A.P.P.P. Communications (in press).
- “Long-Distance Astronomy: The SARA 0.9-m Telescope at Kitt Peak”, T.D. Oswalt, et al. (includes all SARA astronomers) (1994). Bull. American Astron. Soc. 26, 1321.
- “Ginga and ROSAT Observations of the Cataclysmic Variable S193”, Szkody, P., Garnavich, P., and Castelaz, M.W. 1994, PASP, 106, 616.
- “Computer Control of an Optec Photometer Viewer Mirror and Scale”, Castelaz, M. W., Powell, H. D., Henson, G., and Williams, J., 1994, I.A.P.P.P Communications, No. 57.
- “A Search for Companion Stars to the Mira Variables S Leonis and U Cancri”, Castelaz, M. W. and McCollum, B., 1994, Astronomical Journal, Jan. 1995.
- “The Beta Pictoris Phenomenon Among Herbig Ae/Be Stars. UV and Optical High Dispersion Spectra”, Grady, C., et al. (includes Castelaz, M.W.) submitted to A&A, August 1995.
- “Detection of High-Energy Gamma-Ray Emission From OJ 287 During A Major Optical Flare”, Shrader, C. R., Hartman, R. C., and Webb, J. R., Proceedings of the 3rd Compton Symposium.
- “Magnetic Field Evolution in White Dwarfs: Complexity of the Magnetic Field and Hall Effect” Muslimov, A.G., Van Horn, H.M., and Wood, M.A. 1994, ApJ, 442, 758.
- “Whole Earth Telescope Observations of the DAV White Dwarf G226-29” Kepler, S.O., et al. (includes Wood, M.A.) 1995, ApJ, 447, 874.
- “Classical Kinetic Theory Simulations Using Smoothed Particle Hydrodynamics” Simpson, J. C., & Wood, M. A. 1995, *Phys. Rev. E*, submitted.
- “New Limits on the Galactic Disk Age from the Luminosity Function of White Dwarfs in Wide Binaries” Oswalt, T.D., Smith, J.A., and Wood, M. A. 1995, *Nature*, submitted.
- “Theoretical White Dwarf Luminosity Functions: DA Models” Wood, M.A. 1995, in *Proceedings of the 9th European Workshop on White Dwarfs*, eds. D. Koester and K. Werner (Berlin: Springer-Verlag) p. 41.
- “A 3-D SPH Model of Helium Accretion Disks in the Interacting Binary White Dwarf Systems AM CVn and EC15330-1403” Wood, M. A., and Simpson, J. C. 1995, *Baltic Astronomy*, in press.

NEWSLETTER OF THE SARA ROBOTIC OBSERVATORY

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