SARA OBSERVATORY NEWSLETTER

Issue #7 *Spring 2003*

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

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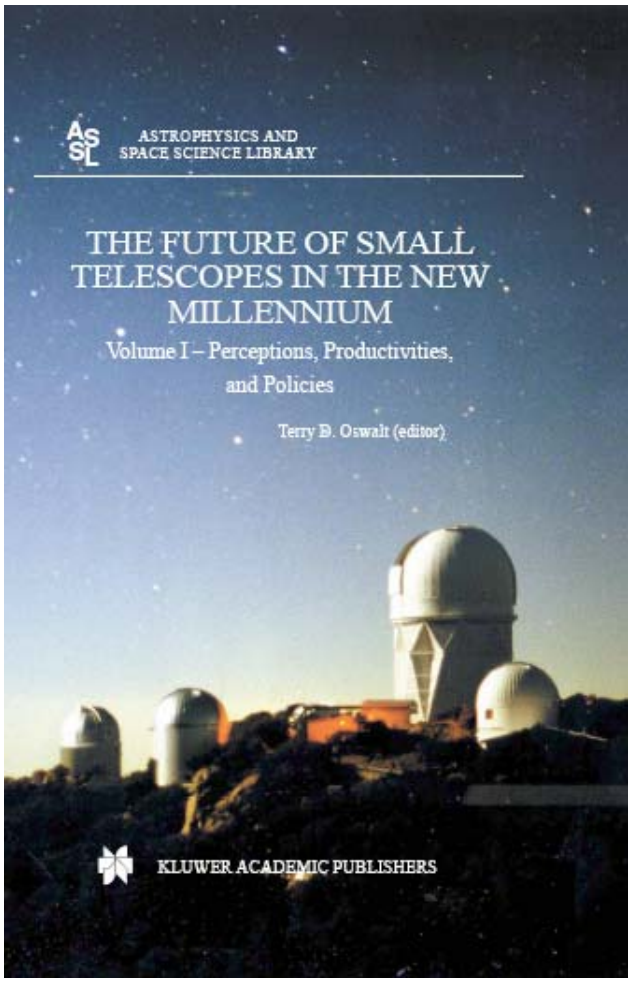


Kluwer Academic Publishers has just released a massive three-volume compendium entitled *The Future of Small Telescopes in the New Millennium*. Terry Oswalt, SARA's own Chairman of the Board, served as editor. The dome housing SARA's 0.9-m telescope appears on the cover, second from left. (*Photo by Kluwer Academic Press)*

From the Editor's Desk

K.S. Rumstay, VSU

Greetings once more to our regular readers! As I write this we are approaching the midpoint of what is proving, I fear, to be rather a tragic year. On January 18th much of the Mt. Stromlo Observatory in Australia was destroyed by wildfire. A tremendous loss has been dealt to observational astronomy in the southern hemisphere. Two weeks later the space shuttle *Columbia* disintegrated during reentry, with the loss of all seven crewmembers. Finally, March brought the start of war in Iraq.

The year began auspiciously for SARA, however. The American Astronomical Society held its winter meeting January 5-9 in Seattle, and we were certainly well-represented. *All* eleven of our summer 2002 REU students submitted abstracts; a new record! Our students' (and faculty members') research efforts were universally well-received; this marks perhaps the most successful year of our summer program.

Another highlight of the year has been the publication of *The Future of Small Telescopes in the New Millennium*, edited by our own Terry Oswalt. A chapter from that book which describes the SARA consortium is reproduced (with special permission of the publisher) in its entirety in this issue. Kudos to authors Terry Oswalt and Matt Wood!

A record number of SARA REU students attended the January 2003 meeting of the American Astronomical Society in Seattle! An account of the meeting appears on page 5. *(Photo by Ken Rumstay)*

SARA OBSERVATORY DIRECTOR'S REPORT

James Webb, FIU

I. Introduction

At the risk of sounding repetitive, we have had another good six months at SARA. One of the biggest problems we were having was ROA coverage. Fortunately, Adam Block helped us find two new ROA's who have helped increase access to SARA, even with Mike Bradshaw retiring from "ROA-dom". I would like to formally welcome Chuck Dugan, Jack Kennedy, and Roy Lorenz, our new ROA's at SARA. We are very pleased to be working with you and we hope you feel the same! As always, thank you Adam and Elaine for your continued great work; you are valued colleagues and the service you provide is vital to SARA. It is also nice to have Mike Castelaz working with us again, although just temporarily using SARA. Mike, one of the original and most colorful of the SARA members, was observatory director before I got saddled, I mean was elected to the job. Welcome back Mike!

I was asked to give a paper at the Joints-tech conference in Miami, the premier Internet II conference attended by literally hundreds of computer people and lasting nearly two weeks. After my talk on the SARA observatory, we were featured on the Internet II web site for a week! You can check out the article at: http://apps.internet2.edu/showcase-archive.html .

We are still struggling with taking delivery of CCD cameras. No problem buying them, just receiving them. In my last report I discussed problems with the delivery of a new large format CCD and the auto guider CCD. Although we are now in possession of the auto guider CCD, the large format camera has yet to be delivered. Matt Wood spoke to the manufacturer this week and received a delivery time estimate of 2 months. The only thing that makes it easier to take is that we are not alone, everyone seems to be encountering this problem.

The switch to the new IDE cards instead of the current old-tech ISA cards was postponed, but we will hopefully get this done during summer shutdown so we won't lose any valuable observing time. This is a necessary step and will no doubt be accompanied by problems during the switch. The ACE system is running brilliantly at present, and is giving us what we need to easily use SARA remotely. We are looking forward to many nights with our recently installed (last week) auto guider. Using the auto guider will allow us to do even more types of research projects at SARA. The next big improvement, besides changing i/o, is acquiring the ability to write telescope pointing information directly into the CCD image headers. This is coming soon to an observatory not necessarily near you but accessible over the internet!

II. Research at SARA

This year has been all about getting research-quality data. Any telescope improvements or enhancements were done such that the impact on gathering observations was minimized. I think our biggest problem during these past months was that data disks were filling up faster than we could FTP the data back to our home institutions. We were fully subscribed, and it seemed that everyone was getting and using as much time as they possible could. The next step of course is getting the data into the literature and the success of this aspect can be seen at the SARA publication page. SARA-Related astronomical publications are listed at: http://saraobservatory.org/sara_pub.html. This website page is updated by Beverly Smith of ETSU whenever SARA members send publication information to her. It is clear once again that SARA astronomers have not been religious about sending publication information to her and I implore everyone in SARA to send her this information ASAP! Others may look at this page and judge SARA's success on the basis of our publication record alone. If it is incomplete, it paints an unfinished picture of our observatory.

Going through the observatory reports, which are (or should be!) submitted by each observer immediately after their observing night, Peter Mack and I are able to keep track of problems at the observatory. I would like to encourage everyone to continue submitting these in a timely fashion. In looking at them, I noticed the incredible diversity of projects, from gamma-ray burst afterglows to fast-moving solar system objects and from super-humping variables to binary stars to Blazars. The SARA observatory participated in several multi-site campaigns as well. Everyone is doing research!

Another gauge of activity at the SARA Observatory is the number of papers using SARA data presented at meetings of the American Astronomical Society. Most of our six member institutions routinely have multiple papers at each AAS meeting, and the Seattle meeting was no exception. Many of our REU students contributed papers and they represented SARA, its research and teaching efforts, very well.

Our lack of a new large format camera has seriously hampered some research projects, especially those of Bev Smith at ETSU. The SARA board and observatory director are very conscious of this need, and hopefully we will take delivery of the new large format CCD very soon so that those projects can continue.

I wish to congratulate Matt Wood and Terry Oswalt of FIT for getting NSF research grants; hopefully mine will come through as well. These grants are based on SARA observations and thus are great for the research aspect.

III. Telescope Usage

The telescope is fully subscribed and the additional ROA's have helped the situation immensely. The weather during the past six months has been less than ideal, but

almost every clear night during which an ROA was available was used for research. Approximately 28 nights per month on average have been scheduled since September 2002. The telescope statistics are presented below. FIT was once again a major user, especially in February of this year when the Whole Earth Telescope campaign was going. The table below presents rough numbers (gleaned from the observing reports) describing clear observing hours, hours lost due to clouds, and hours lost due to equipment failure. Once again, not every observer filed a report for every night. Many cloudy nights were probably not accompanied by reports, these were therefore not included in these statistics. Also, observing hour estimates are approximate and are usually estimated at the end of the night.

Data from observing reports September 2002 to February 2003

Month	Hours Observed	Hours Lost (Weather)	Hours Lost (Equipment)
September	123.5	11	33#
October	138	19	38@
November	212	38.5	5.5
December	117	82	8
January	104.5	34	16
February	33	74	-

 # Hours lost due to Dome rotation failure.
@ Hours lost due to mirror pedal malfunction.

IV. Telescope Problems.

The problems dominating the observing reports last year have been wonderfully absent. Our biggest problems recently have been the occasional need to restart ACE when the focus motor fails, or other minor problems. Some observing time was lost due to a failure in the dome rotation motor, and on five occasions the mirror cover pedals failed. It is not clear what prompted the failure of the pedal segments, but the most likely theory is that buffeting by wind while they are open constantly weakens the pin in the hinge joint until it fails. ACE replaced the pin with a stronger one and the problem has not occurred since. The weather station does not record gust speeds, and it is possible that although one is observing within proper wind constraints an occasional high-velocity gust could stress the pedal joints, since they are perched precariously on the end of the telescope.

The telescope still suffers from tracking problems in the western portion of the sky. The tracking problems have not been completely diagnosed, but the recent delivery and installation of the auto guider should provide some relief, regardless of the cause of the problem. People have tailored their observing program to avoid sections of the sky where the tracking is worst, and we have become adept at changing the tracking rate to compensate for drift in right ascension and declination.

The Dome tracking operation, and the tracking itself, have been much improved since my last report. Very few if any dome-related problems have been mentioned lately in the observing reports.

The roll-down storm doors installed on the dome exterior doors have preformed very well for us, and are well worth the money we spent on them.

V. Instrumentation

Cameras

The small-format AP7 Apogee camera remains the workhorse of the observatory. The shutter problem reported earlier seems to be getting a little worse, especially during very short exposures, and has had a negative impact on some science observations.

The order (with a different manufacturer) for the new large-format CCD was placed nearly 9 months ago, but the camera has yet to be delivered. The current delivery time estimate is two months. The old AP4 is still usable if we can get its computer to run again, but we should consider revamping it so it will work with Maxim DL for future use.

Computing facilities

The SARACAM computer has once again failed. Peter Mack last reported that he was unable to get it started. This is a real problem, since it cannot easily be replaced and it is the only computer the large format CCD can speak to. My opinion is that we need to get it fixed if delivery of the new large-format CCD camera is months away.

Weather Station

The weather station is still working very well, and we are still awaiting calibration of the cloud sensor and lightning sensor.

Auto guider

The auto guider and the auto guider CCD are both at the observatory and , yes folks, on the telescope! It is not fully functional yet, but is very close (beta testing stage). We are all very excited at the prospect of being able to use it.

Robotic System

ACE has apparently now received information from Maxim-DL to allow direct integration of the telescope information into the FITS headers. This is a feature we have all been wanting to see for a number of years. As I understand it, we need to upgrade to the IDE ports to take advantage of the new ACE capabilities. The purchase of the complete robotic system will be discussed again at the upcoming board meeting.

ISTeC

The ISTeC web site is maintained by Gary Henson of ETSU. The last “update” was late last year. Gary has done a great job fixing or deleting broken links and there have been a handful of updates to the registry. Gary has been active in working with the AAS working group on Professional/ Amateur collaborations (WGPAC) which engaged in a telescope conference last December.

REU Program

The 2003 students have been selected, and it looks to be another great year for the SARA REU program. Great job Matt! Thanks for all of your hard work in putting the SARA-REU applications on-line for us.

ROAs

Our current group of ROA's have been exceptional! Led by Adam Block and Elaine Halbedel, new ROAs Chuck Dugan. Jack Kennedy, and Roy Lorenz fit in easily and seamlessly. We once again thank Mike Bradshaw for the work he did as an ROA.

Summer Shutdown

Josie and Peter Mack inquired about plans for summer shutdown. Peter suggested that we do the I/O conversion during summer shutdown to avoid impact on observing. We also discussed mirror re-aluminization; we concluded that we should start planning for it (possibly in 2004) but to not worry about it this year.

VI. The Future.

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

1. *New CCD Camera*

We need to help ACE encourage the manufacturer to deliver the CCD camera we have purchased. Some science projects require the large-format camera, whose delivery is now at least nine months past due.

2 *Telescope Control System*

We need to change the telescope control system from the ISA version of ACE to the newer system. This new system is in operation at the WIYN 0.9 meter telescope and we need to get current. Peter has promised an estimate of the cost of this switchover for discussion at the spring board meeting.

3. *Secondary mirror fabrication and other image-quality improvement measures*

Someone needs to seriously look into these things. We need to decide whether we want to pay for this out of SARA funds or to try and write a grant proposal for it. We need some new contributors. Any volunteers?

VII. SUMMARY

Our observatory is completely subscribed, and operates well enough that observers routinely get publishable data remotely. 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. A new large-format camera is necessary and will continue to be high priority items. The auto guider is here!! 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 University 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 during times of change, there will be problems. I think we are continuing to be *the* model of remotely operated research and teaching facilities.

Submitted 2003 March 27

At the January AAS meeting in Seattle Frank Melsheimer, president of DFM Engineering, demonstrated his company's latest product. This "periscope" eyepiece is easily accessible to all wheelchair-bound observers. Valdosta State University recently purchased a 0.4-meter telescope from Frank for its campus observatory. *(photo by Ken Rumstay)*

Melissa Williams, a senior astronomy student at Valdosta State University, spent last summer as a NASA intern through the Virginia Space Grant consortium. One highlight of her research experience was an opportunity to work at the Mt. Palomar Observatory in California! *(photo by Melissa Williams)*

SARA at the January 2003 AAS Meeting

K.S. Rumstay, VSU

The SARA REU program, now in its ninth year of operation, has been highly successful in granting students the opportunity to present their research projects at national meetings. At the 201st meeting of the American Astronomical Society, held January 5-9 in Seattle, we eclipsed all past records. All eleven students who participated during the summer of 2002 submitted abstracts based upon their work with SARA! For most of the students this was their first professional meeting, and as the pictures attest they appear to have enjoyed it thoroughly! Attendance at these meetings provides a crucial step in the networking process which will avail them as they pursue their career goals.

The 2003 SARA REU program was described in the previous issue of this newsletter (No. 6, Autumn 2002). The paper numbers and titles of the abstracts submitted by our students are reproduced below; the complete abstracts may be found in the *Bulletin of the American Astronomical Society*, volume 34, no. 4.

Justin Schaefer (University of Washington) discusses cool degenerate stars with Nicole Silvestri, former FIT graduate student. Both have enjoyed the privilege of having been mentored by Terry Oswalt! *(photo by Ken Rumstay)*

4.01 *Light Curve Asymmetry in W Corvi*, by R.E. Cohen and W. Van Hamme

11.14 *A Multicolor Photometric Study of Three Type I Seyfert Galaxies*, by S.L. McGregor and K.S. Rumstay

13.05 *A 21-cm Neutral Hydrogen Study of Arp 213*, by S.J. Wells and C. E. Simpson

45.04 *A Photometric Survey to Determine Rotation Rates of Primitive Asteroids*, by E. Jeffery and M.A. Leake

45.17 *Ion-Drag effects of Gravity-Wave Heating and Cooling in Jupiter's Thermosphere*, by D.A. Lamb and M.P. Hickey

48.01 *Time series Analysis of Microvariability in Blazars*, by V.L. Wilkat, J.R. Webb, S.D. Clements, and J.T. Pollock

87.09 *X-ray Studies of radioactivity in the Tycho and Cas A SNR*, by W.T. Ryle and M.D. Leising

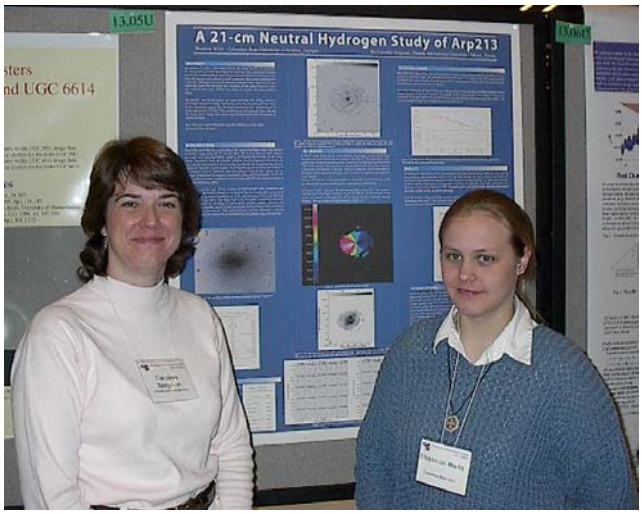
116.02 *Optical Imaging of Interacting Galaxies*, by J.M. Stoltz and B.J. Smith

117.09 *Monitoring of Select Mira-Type Stars for Microvariability*, by J.A. Reiff and G.D. Henson

119.01 *The Continuing Search for Variability Among Cool White Dwarfs*, by JJ. Scaefer, T.D. Oswalt, K.B. Johnston, M. Rudkin, and T. Heinz

120.05 *Parallelization of a Smoothed-Particle Hydrodynamic Cataclysmic Variable accretion Disk Simulation Code*, by R.P. Perrine and M.A. Wood

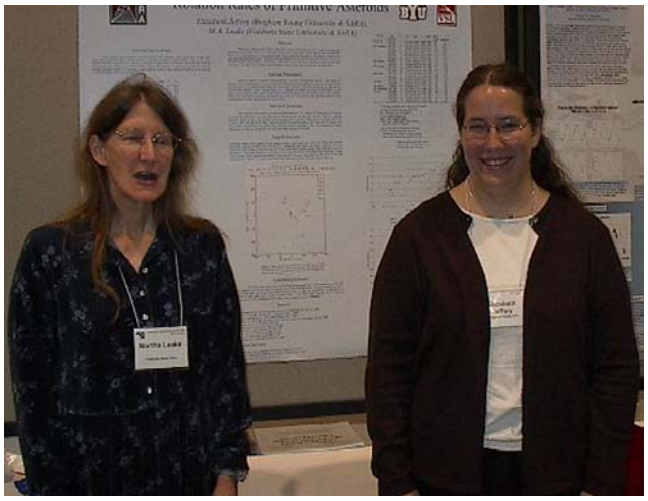
The SARA Summer 2002 REU students and mentors gather for dinner after a hard day at the meeting.. *(photo by Ken Rumstay)*



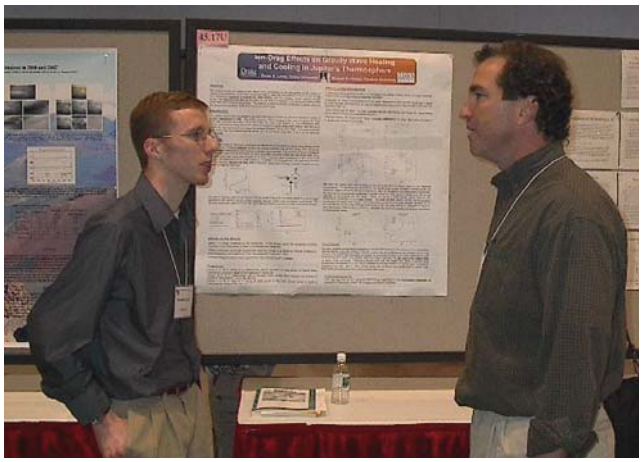
Shannon Wells (Columbus State University) and FIU mentor Caroline Simpson pose with their poster. *(photo by Ken Rumstay)*

Sarah McGregor (Saint Michaels College) displays her photometric study of Seyfert galaxies. *(photo by Ken Rumstay)*

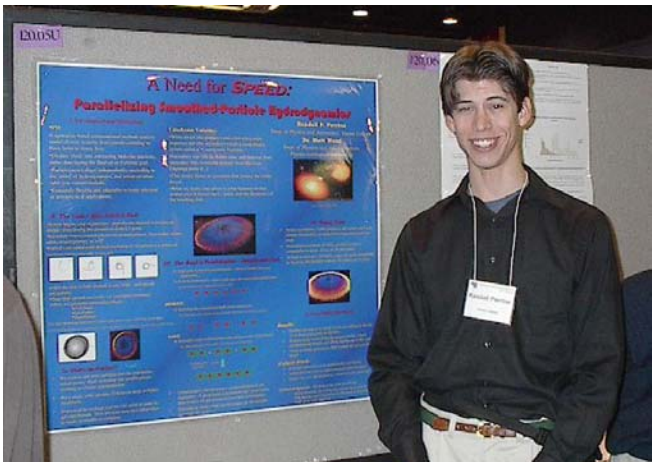
Jennifer Reiff (Otterbien College) spent the summer searching for evidence of microvariability in Mira stars. *(photo by Ken Rumstay)*



Martha Leake (VSU) and student Elizabeth Jeffery (Brigham Young University) determined asteroid light curves. *(photo by Ken Rumstay)*



Derek Lamb (Drake University) does some schmoozing in front of his poster during Tuesday's coffee break. *(photo by Ken Rumstay)*



Randall Perrine (Vassar College) spent last summer doing numerical simulations at FIT. *(photo by Ken Rumstay)*

Research in a Virtual Astronomy Department

The Southeastern Association for Research in Astronomy (SARA) and the Future of Small Telescope

Terry D. Oswalt and Matt A. Wood

The newly-released three-volume The Future of Small Telescopes in the New Millennium *(Kluwer Academic Publishers; see photo on page 1) summarizes the current status of astronomical research performed with relatively small apertures. The following article, comprising Chapter 17 of this work, describes the history and structure of the SARA consortium. It is reproduced here by permission of the publisher. This series of books is available for purchase at the Kluwer website (http://www.wkap.nl/journal/).*

1. A BIT OF HISTORY

In 1995 the Southeastern Association for Research in Astronomy (SARA) recommissioned a 0.9-m telescope formerly operated by the U.S. National Optical Astronomy Observatories (NOAO). The telescope was one of the first closed by NOAO in response to a decade of tightening budgets. The SARA consortium was awarded the telescope after a competitive review of proposals received from the astronomical community.

SARA chose a new site for the 0.9-m telescope on Kitt Peak near Mercedes Point (Figure 1). Key steps in its restoration included the design of a novel low-cost building to house the telescope and its automation to allow remote access operation. Oswalt *et al*. (1993) provide a summary of the construction history of the SARA observatory. This paper focuses on its current status and future, and how our approaches to such challenges as stable long-term funding, operational/technical needs, scheduling, and administration might be applied to other present and planned small telescopes. Current information about SARA can be found at our website (www.saraobservatory.org) .

2. THE SARA CONSORTIUM

The original partners in SARA included the Florida Institute of Technology, East Tennessee State University, The University of Georgia and Valdosta State University. Florida International University joined the SARA consortium in 1992 during the observatory's construction phase. The sixth member, Clemson University, joined in 1999 as remote operation over the Internet became routine.

2.1 Motivation

As other chapters in this book will attest, even though the total aperture area available to the astronomical community is increasing, the total amount of publicly-available observing time is not. Competitively awarded observing time at national facilities is becoming more difficult to obtain, especially for long-term or "risky" projects, or those that do not require large aperture telescopes. This traditional "propose and hope" cycle is becoming progressively more frustrating, especially for astronomers at smaller institutions that most depend upon public facilities.

The impetus for founding SARA in 1989 initially was the desire to acquire or build a research grade telescope at a prime astronomical site. The announcement of the closure of the No.1 0.9-m telescope at Kitt Peak National Observatory certainly brought this aspiration to a sharp focus. However, early in our collaboration it became clear that we also share a number of other motivations and strengths that have contributed to a productive and collegial long-term working relationship. Some of these approaches provide viable strategies not only for the preservation of other small observatories, but they also would improve the scientific productivity and cost-effectiveness of much larger facilities.

Pooling of Financial Resources— The size of a consortium should be an optimal compromise: large enough to be financially stable, yet small enough that each institution receives fair value for their investment in terms of telescope time per dollar. SARA seems to have achieved that balance. From the start, one of our most fundamental principles has been to depend upon only member institutions' financial commitments (~$10K/year per member) for basic operational costs. Our operational budget has averaged about $50K annually over the past ten years. All discretionary expenses for instrument upgrades, research and educational programs and technical improvements to the SARA observatory come from research grants.

Scientific Collaboration— The research projects conducted by nearly two dozen SARA astronomers are nearly as diverse as when the telescope was operated by NOAO. However, unlike publicly scheduled facilities, our observing schedule is quite flexible and web-based. It is relatively simple for us to collaborate on projects of mutual interest, spend partial nights on targets of opportunity such as gamma ray bursts, and to schedule collaborative campaigns such as the Whole Earth Telescope and the AGN Watch.

Instrumentation and Technical Expertise— It is unusual to find all necessary expertise for the operation of a remote observatory within one Physics and Astronomy department.

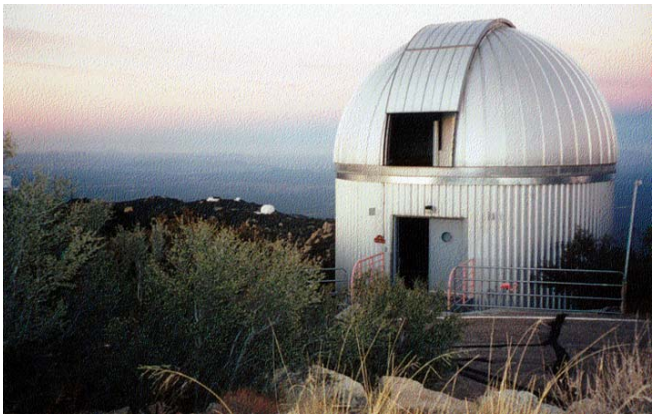


Figure 1. The SARA Observatory at Kitt Peak, looking southwest. (*Photo by Terry Oswalt)*

However, within the faculty of a six-university consortium all these bases can be covered. The financial stability provided by institutional commitments makes it possible to hire whatever expertise may be lacking, on an as-needed basis.

Student research— All of the SARA institutions have a long tradition of fostering undergraduate research, a key ingredient of a quality education. Four of the six have graduate programs in astronomy or related disciplines. The SARA 0.9-m telescope provides students with a hands-on experience doing everything that scientists do, from painting the dome to presenting scientific papers. The facility also benefits many students from around the U.S. Since 1995 SARA has administered one of the largest Research Experiences for Undergraduates (REU) programs funded by the U.S. National Science Foundation (NSF; see below).

Remote Access— Since the summer of 1998 the SARA telescope has been used primarily via remote access over the Internet. Little or no on-site human supervision is necessary on most nights. However, as a safety precaution, during remote observing sessions we require a Remote Observing Assistant (ROA). An ROA is ordinarily already on the mountain for other reasons and is able to respond quickly to any emergency that the observer may encounter or to enforce closure when adverse weather threatens. Automation and remote access observing are among the most significant ways to improve the cost-effectiveness of a telescope of any aperture. Our experience is outlined below.

National Voice— The Southeast has historically been underrepresented in astronomy. Partly, this is due to geographical isolation; the typical astronomer is alone in a Physics department. In addition, no major astronomical facilities are located in the Southeast. Nevertheless, a significant fraction of the astronomical community lives and works here. We believe that regional organizations like SARA can provide an important basis from which the majority of U.S. astronomers, who are at small institutions, can have a voice in setting astronomical priorities at the national planning committee and funding agency level.

Recruitment— Each of the six SARA institutions has hired 2-4 new astronomers since the consortium's inception about a decade ago. This constitutes about two percent of all faculty jobs in astronomy during that period (see Marvel 2002). The SARA Observatory continues to play a major role in student recruiting as well. For example, Florida Tech has over 100 undergraduate space sciences majors, the largest and oldest program in the U.S. Most of these students choose the Astronomy/Astrophysics track, which was created the same year the SARA Observatory became operational. Incoming students often mention the availability of the SARA Observatory as one of the factors that attracted them. In addition, several participants in our REU internships (or their friends) have chosen to do graduate work at the four SARA institutions with M.S. or Ph.D. programs.

2.2 A Virtual Astronomy Department

The structure of SARA is specified by a Consortium Agreement. It is loosely modeled after the original charter that governs NOAO facilities (Oertel 1989). The cognizant financial officer for each SARA university was required to commit in writing to an initial investment of $50K to $100K (most of which went into the original construction of the observatory) and annual dues of ~$10K to support the operational costs.

SARA is governed by a Board of Directors. Each is elected by his/her home institution for a three-year term. The Board comprises the decision-making body of the consortium. In addition, the Board includes three non-voting officers who serve at the discretion of the Board to execute and document its decisions. The Chair convenes the semi-annual Board meetings and is responsible for financial and business matters such as hiring contractors, purchasing equipment, representing SARA at Kitt Peak tenants' meetings, etc. The Observatory Director is responsible for the day-to-day operations and interacts directly with observers, on-site support personnel, ROAs, instrument vendors, etc. The Secretary is responsible for keeping a record of Board activities and commitments and assuring that it follows the Consortium Agreement. Each of the SARA faculty regularly assumes additional responsibilities such as evaluating new instrumentation options, scheduling the telescope, editing the SARA Newsletter, etc.

The SARA Board also serves as the Telescope Allocation Committee. Observing requests are submitted prior to each semi-annual Board meeting and reconciled at that meeting. The schedule that is posted on the SARA web-site is apportioned solely by the cumulative financial contributions of each institution. Faculty are responsible for allocating time within their respective institutional allocations. Once the schedule has been posted, individual members are free to claim any unassigned time, swap partial or full nights, share their time with outside colleagues, etc. The web-based schedule is updated as needed. Our scheduling procedure easily accommodates last-minute changes.

The governance of SARA is a no-frills structure that has worked well. In nearly a decade of semi-annual Board meetings nearly every major decision has resulted in a unanimous vote. This reflects the care with which potential SARA partners were originally selected. Our Consortium Agreement requires that admission of new institutional members be approved by a unanimous vote of the Board. It is expected that any prospective member must have essential attributes such as a new science focus, technical expertise, etc. Moreover, all astronomy faculty at that institution must be viewed as good colleagues who will contribute "sweat equity" to our ongoing activities. We seek no silent partners!

An e-mail list-server and occasional conference calls facilitate the day-to-day activities of the SARA consortium. Collectively, SARA involves over two dozen Ph.D. astronomers, comparable to a large astronomy department. Though separated by nearly 1000 miles across the southeastern U.S., it is not unusual for us to interact more often with each other in a given day than with our other local non-astronomy colleagues within our respective departments. In many respects, SARA is a "virtual" astronomy department.

3. THE TELESCOPE

The SARA 0.9-m telescope was the first research grade telescope installed at Kitt Peak (Federer 1960). Because the f/7.5-13.5 Ritchey-Crétien optics were originally optimized for spectrophotometry, it does not provide ideal images. We routinely achieve ~1.5" seeing with no significant changes to the original optics. Thermal control the dome is provided by a forced-air ventilation system that operates when the dome is closed, and passive ventilation system used when the dome is open.

The original mechanical drive system was replaced with high-torque stepper motors and absolute encoders in both axes. Astronomical Consultants and Equipment, Inc. (ACE) of Tucson designed and installed a new GUI-based control system, which controls the telescope, dome and monitors a local weather sensing station near the observatory. ACE continues to provide routine maintenance services for the SARA Observatory.

Mounted on the optical bench of the telescope is a 4-port instrument selector on which any one of four instruments can be mounted and accessed by simple rotation of a tertiary mirror (see Figure 2). For the past several years we have primarily used an Apogee AP7p 512x512 thermoelectrically cooled CCD as our primary detector. This detector provides a usable field of ~7x7 arc minutes at the telescope's image scale of ~30 arc seconds per millimeter. Other available detectors have included an Apogee 2x2K CCD of somewhat lower quantum efficiency but better cosmetics, a low-resolution spectrograph and a two-channel photopolarimeter. A full range of wide-, intermediate- and narrow-band filters are in two filter wheels.

The telescope drive system provides unguided exposure of up to ~15 minutes, depending upon sky position. An off-axis autoguider system is on order that will allow sky-limited integrations.

The observatory is equipped with two TV cameras from which both the telescope and dome positions can be monitored in real time from the downstairs control room, or over the Internet by remote observers.

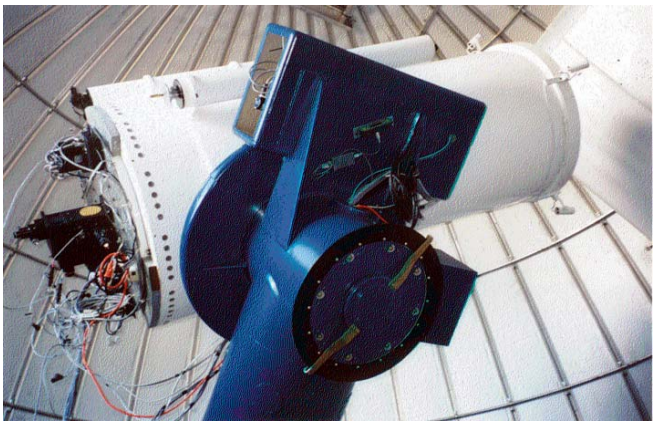


Figure 1. The SARA 0.9-m telescope. Note black 4-port instrument selector on tailpiece. (*Photo by Terry Oswalt)*

4. REMOTE ACCESS OBSERVING

In the summer of 1998 SARA began to experiment with remote access observing and it has evolved to become our primary mode of observing today. This, more than any other improvement, has contributed to the achievement of a subscription rate approaching 100% for the telescope, for it makes the telescope accessible to all of us from the comfort of our home institutions' offices, classrooms and labs. Prior to this, we seldom achieved more than ~60% utilization during the academic year (mostly dark to gray time) because of heavy teaching loads and the financial burden of cross-country travel. Now it is common for SARA observers to work from the comfort of their own home, providing they have a high-bandwidth cable modem or similar connection.

Because the SARA observatory computers are a mix of Windows™ and Linux™ platforms, for remote observing we chose to use VNCviewer , a readily available freeware utility for remote access and control of any host computer. SARA observers see on their local PC exactly the same telescope and camera control screens as on the monitors at the SARA Observatory. In addition to the convenience and enormous savings in travel expenses, this facilitates the training of new observers. It also opens up a host of possibilities for student research projects and classroom assignments. There is a downside: one still has classes to teach or attend when morning comes. It's also a little discomforting to be observing well after local sunrise or while a thunderstorm rages outside your local window!

The cost-effectiveness of remote observing is probably its single strongest benefit. Assuming ~$1000 cost for a five-night conventional observing run, we save ~$60,000 per year by remote access observing.

There are essentially no up-front expenses to remote observing, as no changes to the existing control or acquisition software are needed, and VNCviewer is free. There are some modest on-going expenses, however. SARA enlists Remote Observing Assistants (ROAs) who are routinely on the mountain for other reasons. Remote observing is not permitted unless an ROA has been scheduled. An ROA authorizes a remote observer to open the dome and usually verifies that the dome has properly closed at the end of a night. Other than this, an ROA is normally only on call in the event of adverse weather notification, equipment problems, or other emergency requiring local action. Total expenses for ROA services have averaged less than ~$5K per year—a small price to pay for piece of mind when remotely operating a facility valued at ~$1M.

SARA has become one of the largest users of the Kitt Peak Internet optical fiber link. Observers can easily accumulate ~1-Gb of data per night. Data is usually downloaded during the daytime to conserve nighttime bandwidth.

We operate the SARA Observatory for ~$45K per year—a small fraction of the annual operating expenses for the telescope when it was operated by NOAO (Wolff 1989). This figure includes our annual tenants' fee of ~$10K to NOAO, on-site routine maintenance services of ~$15K, utilities and all

other expenditures. Clearly other small facilities like ours, as well as much larger facilities, could be automated and operated for much less than conventional sites using such off-the-shelf technology and remote access observing schedules. So far, however, very few telescopes of any size are run this way.

5. RESEARCH

The research conducted with the SARA Observatory is very nearly as diverse as when it was operated by NOAO. The majority of SARA faculty specialize in stellar astronomy, and this is still the most frequent use for 1-m class telescopes, as is evident from the other articles in this volume. Projects in this field range from light curve studies of eclipsing binaries and cataclysmic variables to long-term photometry and spectroscopy of Mira variables, to photometry of the coolest white dwarf stars that set constraints on the age of the Galaxy. A growing component of the SARA research effort is devoted to multi-site campaigns on objects such as pulsating white dwarfs, subdwarf B stars, cataclysmic variables and δ Scuti stars.

SARA astronomers are also interested in minor planets. CCD-based BVRI photometry is used to determine rotation rates and taxonomic types for Near Earth Asteroids (NEAs). A spectrometric project is underway to identify the signatures of hydrates in several nearby minor planets.

Other SARA research focuses on the search for optical counterparts of gamma ray bursts (GRBs). This work is done in conjunction with the SuperLOTIS team (Park & Hartmann 2002). Our facility provides one of the potentially most efficient ways to fully document the optical afterglow of these transient outbursts. By agreement, GRB observations are allowed to interrupt regularly scheduled observations as outbursts are detected.

Another major collaborative effort that involves several SARA investigators is the long-term and multi-wavelength monitoring of active galactic nuclei (AGNs) and BL Lac objects. Several outbursts resulting in IAU circular announcements and the discovery of quasi-periodic variations have been direct results of work conducted at the SARA Observatory.

SARA can easily interrupt scheduled observing programs to participate in campaigns or to observe breaking astronomical events. It also provides ground-based support for spacecraft observations and multi-wavelength campaigns. Inquiries about such support services are always welcome.

Since the SARA Observatory became operational in 1995, observations conducted there have directly contributed to roughly 10 journal papers per year. In addition, roughly 20 non-refereed papers and meeting presentations per year from SARA faculty and their students are completed. The scientific productivity of the SARA Observatory compares very favorably with other observatories of its size (see Abt 2002). With a growing emphasis on remote access observing, we anticipate that this productivity will double or triple during the coming decade. Because the data are now coming in as fast as we can reduce and analyze them, our real challenge will be to keep up the pace.

6. EDUCATIONAL INITIATIVES

Since the first summer after its commissioning in 1995, SARA has hosted a Research Experiences for Undergraduates (REU) program funded by the U.S. National Science Foundation (NSF). To date, ~80 undergraduate interns have participated. At least ten students are selected each year from ~150 applicants from around the U.S. and its possessions. SARA pioneered the first multi-institution REU program. At least two summer students are hosted at each participating SARA institution. Unlike most other REU sites, each SARA intern works one-on-one with a full-time faculty mentor.

Our successful program differs from other summer programs in several other ways. In the application form, every student specifies one or more preferred research topic from those summarized by potential mentors. Nearly every mentor reviews every student application. Each compiles a short list from which a recruit is sought. Prior to these initial contacts, any overlap between mentors' short lists is resolved so that no student receives more than one invitation. The selection process yields a near perfect match between intern and mentor. The entire application and review process is web-based, greatly facilitating the application procedure, selection of candidates and record keeping for the program.

Because our program is distributed throughout a large area of the southeastern U.S., SARA hosts two workshops each summer which bring all mentors and students together. To minimize transportation expenses these two-day workshops are rotated between the three most centrally located institutions, Florida Tech, Valdosta State University and the University of Georgia. Thus, students are exposed to the several different environments and astronomy programs. The first workshop focuses on team-building and familiarizing interns with the details of the program (see Figure 3). SARA faculty deliver mini-colloquia on a wide variety of research topics. Interns also receive mini-workshops on science ethics, tips on giving talks, gender issues, and the history of SARA.

Figure 3. The 2001 SARA summer interns and their mentors at Melbourne, Florida. (*Photo by Terry Oswalt)*

A wide range of social events are integrated into both workshops, from air boating on the Florida swamps to witnessing a launch at the Kennedy Space Center.

All students plan and execute an observational research project even if their main research is primarily theoretical or computational. Teams of 2-3 observers travel to use the SARA Observatory at Kitt Peak throughout the summer. Students do everything their faculty mentors do, including routine maintenance of the observatory, from painting the dome, mopping the floors, to repairing and installing equipment. Many perform follow-up observations via remote access. Not surprisingly, the trip to the SARA Observatory is frequently cited by interns in their evaluations as the high point of their summer experience with us.

The 8-10 week summer program is concluded by a final workshop wherein each student presents his/her research results both as an oral presentation to the entire group, and via an AAS-style poster session. Students are also required to write a short research paper, which is published as a special proceedings issue of the IAPPP Communications, an international journal which specializes in fostering student-faculty-amateur research in astronomy. About half of the projects in a typical summer have advanced sufficiently to warrant having the student appear as a co-author in a conventional journal such as the Astrophysical Journal and/or to present their paper at the following January AAS meeting (see Figure 4). Thus, every SARA intern experiences the entire scientific process, from planning a research project, to presenting results to the scientific community.

7. SARA AND THE FUTURE OF SMALL TELESCOPES

The SARA consortium and the operation of the SARA Observatory provide valuable examples of ways telescopes of less than 4-m aperture can not only be preserved during the next decade, but also how larger and newer facilities might be operated. As smaller telescopes at public facilities become scarcer it will become even more important for academic institutions to contribute in innovative ways towards preserving and advancing access to small facilities.

In the era of 8-m telescopes, many more regional consortia like SARA need to be formed and linkages between them established. Many more telescopes need to be automated and made remotely accessible. Integration of research and education needs to become the norm, rather than the exception. More standardization of software and use of off-the-shelf instrumentation needs to be achieved.

Most importantly, users of small telescopes, whether individual or institutional, need to be more organized. SARA has taken an essential step in this direction by hosting the International Small Telescope Co-operative (ISTeC) , a web-based clearinghouse for small observatories around the world (see Henson 2002). Finally, there needs to be more cooperation between regional consortia, perhaps through a national organization such as the AAS, or internationally through the International Astronomical Union (IAU). Only then will the essential role of small telescopes be clearly and fairly represented in community-wide decade planning exercises. Only then will we revive the original spirit in which the U.S. national observatories were founded—a full suite of publicly owned and publicly accessible telescopes and instrumentation.

Figure 4. SARA REU interns talking with NSF Director Dr. Rita Colwell at the 2000 Atlanta AAS meeting. (*Photo by Terry Oswalt)*

8. ACKNOWLEDGMENTS

We thank the administrations of the Florida Institute of Technology, East Tennessee State University, the University of Georgia, Valdosta State University, Florida International University and Clemson University for their continued support of SARA. We also gratefully acknowledge the faith shown by the National Optical Astronomy Observatories in trusting the future of the 0.9-m telescope to us, and to the National Science Foundation, which supports the SARA REU program through grant AST-0097616.

9. REFERENCES

Abt, H. 2002, in volume 1 of this Kluwer series.

Federer, Jr., C.A. 1960, *Sky & Telescope* **19**, 392.

Henson, G. 2002, in volume 1 of this Kluwer series.

Marvel, K. 2002, Job Register Statistics, www.aas.org/career/JobRegisterStats.html

Oertel, G. 1989, private communication.

Oswalt, T.D. Rafert, J.B., Wood, M.A., Castelaz, M.W., Collins, L.F., Henson, G.D., Powell, H.D., Caillault, J.-P., Shaw, J.S., Magnani, L., Leake, M.A., Marks, D.W., Rumstay, K.R. 1992, in *Automated Telescopes for Photometry and Imaging*, ASP Conf. Ser. **28**, 111.

Park, H-S, Hartmann, D. 2002, in volume 3 of this Kluwer series.

Wolff, S. 1989, private communication.

The 2003 SARA REU Program

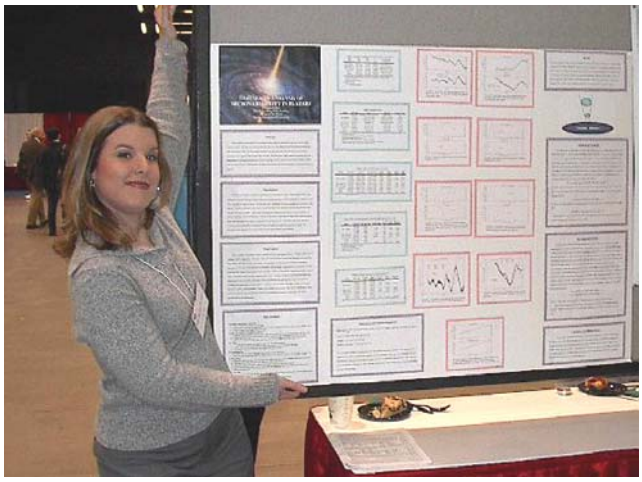
K.S. Rumstay, VSU

As of this writing all participants in the Summer 2003 SARA REU program have been selected. The process was, as always a difficult one, as we received well over a hundred applications form highly qualified and motivated students. We are pleased to welcome two new faculty mentors to our ranks: Cecilia Barnbaum of Valdosta State University and Jeremy King of Clemson University. We hope that their experience this summer is a pleasant one, so that they will wish to repeat it in future summers!

The 2003 SARA REU students are listed below, along with their home institutions and faculty mentors. We anticipate offering this program again during the summer of 2004; all undergraduates interested in applying (regardless of academic major!) are directed to our website (www.saraobservatory.org) for additional information. The SARA Research Experiences for Undergraduates program is supported by a grant from the National Science Foundation.

Student	Home Institution	Mentor
Roggie H. Boone	Valdosta State University	Cecilia Barnbaum (VSU)
Stephanie R. Cortes	Clemson University	Jeremy King (CU)
Sarah E. Eyermann	University of Missouri at Rolla	Ken Rumstay (VSU)
Cece H. Hendrick	University of Nebraska at Lincoln	Scott Shaw (UGA)
Leigh A. Korbel	Buffalo State College	Jim Webb (FIU)
Moshe Molcho	Los Angeles City College	Walter van Hamme (FIU)
John R. Robertson	Appalachian State University	Matt Wood (FIT)
Stuart J. Robbins	Case Western Reserve University	Brad Meyer (CU)
Twyla G. Smith	East Tennessee State University	Don Luttermoser (ETSU)
William K. Teets	Austin Peay State University	Gary Henson (ETSU)
Elizabeth A. Wennerstrom	Rhodes College	Terry Oswalt (FIT)

We conclude this issue of the *SARA Newsletter* with two more photos from the January AAS meeting in Seattle!



Vanessa Wilkat, a Space Sciences major at the Florida Institute of Technology, spent last summer in Miami studying blazers with Jim Webb. *(photo by Ken Rumstay)*

Juli Stoltz, from Montclair State University, worked with Dr. Beverly Smith (ETSU) last summer. She presented her poster on the final day of the Seattle AAS meeting. *(photo by Ken Rumstay)*

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Kenneth S. Rumstay, Editor

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

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