SARA OBSERVATORY NEWSLETTER

Volume 4, Issue 1 *July 2000*

Florida Tech | East Tennessee State | Florida International
University of Georgia | Valdosta State | Clemson

Contents

The SARA telescope waiting for action.
Photo courtesy of Michael Bradshaw.

The SARA back stairs, making quick escapes safer and easier.
Photo courtesy of Jim Webb (the original escapee).

The Editor Speaks

Michael Bradshaw, FIU

First off, I would like to introduce myself. My name is Michael Bradshaw, and I am the newest SARA member at Florida International University. I am also the new editor of the recently revived SARA Observatory Newsletter. This newsletter should become a bi-annual event, with all of the fanfare that accompanies such an occasion.

The SARA group has grown greatly since the last newsletter, and this publication should reflect that growth. There are articles on the new members, the new equipment, and the new REU students. There is a new design for the newsletter, and a new collection of people in charge.

You will find some information on the observatory equipment that has changes, and this should be considered a source of tech data that should be kept. I'm going to try to implement a "tech-section" to the newsletter, probably based on relevant posts to the SARA mail server. The updated SARA Observer's Guide is the next project, and any constructive replies from this newsletter will be incorporated into the Guide.

Besides the SARA Newsletter editor, I am the Astronomy Laboratory Supervisor at FIU. I have my MS in Physics from DePaul University in Chicago, and a BS in Astronomy from University of Illinois. I have experience in the design, construction and maintenance of telescope and observatory systems, and have been an amateur astronomer and astroimager for about a decade. Here at FIU, I am working on redesigning the Astronomy lab program, as well as assisting in various SARA projects. I have scattered some images taken with the SARA telescope and the new SITe CCD (more information is available on page 8) around the newsletter, to show the "artistic" side of SARA.

Since the SARA REU program is too dynamic to capture in print, there are several web pages with images and commentary. You should look at the following pages to appreciate the 2000 REU students at their best…

- http://www.fiu.edu/~bradshaw/sarastuff/images.html
- http://astro.fit.edu/sara-reu/sara-reu.html

From the Director's Chair

James Webb, FIU

The past year has brought about tremendous progress at the SARA Observatory. Among the successes were: successful remote observing becoming the norm, new equipment purchases such as the new Apogee/SITe CCD, and acquisition of equipment to take us closer to robotic operation. The most significant change is the addition of Clemson University to our consortium.

Along with the successes, there have also been problems and disappointments. The problems include the occasional tracking/ balance problems, image quality problems, and more recently problems with the old CCD booster box and the lower dome shutter. When all is said and done, however, last year was probably the most productive year research-wise for the observatory, mainly due to remote observing. Being located in the Southeastern US and working at more teaching intensive institutions, our major problem was finding money for travel to the observatory and time to go out. Since becoming remote, the SARA observers scheduled 92 nights for research observations. Nineteen nights were scheduled for engineering runs. The months of May, June and July are fully scheduled due to the summer REU program. We fully expect that in the future, most if not all of the available nights will be scheduled and used for research and education. The primary restriction of scheduling remote observations is the availability of a remote observing assistant. We have now increased the number of remotely accessible nights with the addition of Elaine Halbedel as a second Remote Observing Assistant.

Eight nights were lost to mirror realuminization, and nearly a week was lost to problems with the booster box on the primary imaging CCD. The most serious time loss, however, was due to the lower shutter problem. The lower shutter was blown off of the dome in a windstorm and cost us about one month of observations. On February 17, 2000 Elaine Halbedel noticed the lower portion of the dome shutter was missing! A quick look around the site indicated that it was laying down the hill in the scrub after having been blown off the dome. Thanks to Elaine's diligence in looking after the observatory, she averted an impending disaster. With the help of her husband Hal, they successfully retrieved the damaged lower shutter section, hoisted it up to its proper position with ropes and secured it before poor weather rolled in. Their hard work and effort saved the observatory from severe weather damage, especially the newly realuminized mirror. We are all grateful for their hard and timely work in protecting our investment. ACE retrofitted the lower shutter with a mechanism that folds out upon opening and therefore will alleviate the need to repeatedly open and close the dome to gain access to the zenith or horizon.

ACE handled the mirror realuminization for us in October 1999. The realuminization went smoothly in one sense, but not in another. The mirror removal, transport, stripping and realuminization were textbook. Careful examination of the stripped mirror revealed a myriad of tiny scratches. Rumor at the mirror lab has it that in the mirror's murky past, some less-than-adept astronomer attempted to clean the mirror with a rough cloth and scratched the surface. When SARA was given the mirror, these scratches were already there and this is a source of scattered light and part of our optical problems. The only solution is to re-polish the entire primary.

The large 2kx2k Apogee CCD purchased with a grant from The Research Corporation is nearly 6 years old but is still functioning well. We recently experienced problems with the booster box and are in the process of diagnosing these problems. In addition to the 2kx2k CCD, SARA recently purchased a brand-new CCD from Axiom, the AP-7, which has a smaller chip (6 arc min x 6 arc min) but much higher sensitivity, especially in the blue. Coupled with the much higher quantum efficiency is the ultra-fast readout time and low dark current. Thus we will have two imaging instruments to choose from, one large field, the other blue sensitive and high QE. The new CCD has been in use for nearly a month and has had rave reviews from the FIU group. The new camera operates under Maxim-DL software. This new software system is more versatile than CAMERA and is supported by Apogee, but unfortunately runs only on a Windows machine. ACE is working with Maxim DL to try and make ACE talk to Maxim DL so the camera control can be built into the robotic system.

Drs. Mike Castelez and Martha Leake have installed a low-resolution spectrograph that is remotely accessible on one of the free SARA ports. This instrument will be used in their research projects.

As observatory director, I would like to welcome Clemson University to SARA and the observatory. The addition of Clemson to our consortium has helped our consortium scientifically as well as financially (see the article on Clemson in this newsletter).

With the addition of Clemson University, and the dramatic increase in available capital, we should be able to improve the observatory facilities and move into robotic mode. I anticipate about 80% remote observing through the next year, with a few observing trips and REU visits, then moving into robotic mode as ACE finishes the robotic package. MaxIm DL is the new camera control software.

I have had several other groups contact me about the SARA observatory, indicating they are interested on how we run SARA so they can form their own consortiums. I have a feeling we are projected as the leaders in the field of small telescope consortia. Others are now fully recognizing the work we have done and if our publication rate picks up as the data collection rate has, we should remain there for a while. With a new imaging CCD, an autoguider, and a permanent spectrograph, our observing options are greater than ever before.

Spring 2000 Board Meeting

Gary Henson, ETSU

The Sara Board of Directors met at Clemson University on 7 April 2000. This was the first meeting to be held on the campus of the newest SARA member institution. The Observatory Director, Jim Webb of FIU, gave a very positive report on the status of the observatory. He noted how successful remote observing has been even with the inevitable problems that occur with such technical enterprises. Plans were made to seek out more observing assistants and to begin trial operation in robotic mode with control software from Astronomical Consultants & Equipment Inc. (ACE) as soon as possible.

The increase in available funds, due to the recent addition of Clemson to the consortium, gave the budget discussion a whole new atmosphere. All budget items necessary for operation of the observatory can now be funded. This includes upgrades to instruments, computers, and software (like the robotic package for example). In addition, some long-standing construction needs were addressed. Safety concerns led to the Board voting to construct stairs from the lower outside door to the lower parking area. However, the Board voted against completing the kitchen/bathroom area of the observatory. It was decided the cost outweighed the need for this improvement at this time. The SARA account now has a healthy reserve fund that the Board would like to see maintained.

Plans for the summer 2000 REU program were also discussed. Board chairperson, Matt Wood of FIT, commented on the need for standardized application dates. Although many mentors were getting the students they wanted, some were having difficulty with students who applied to several programs with different deadline dates. The dates and locations for the group meetings were set for the summer.

The discussion on telescope time allocation centered on making the most of remote observing. The Board discussed how to make the most efficient use of the two remote observing assistants (ROA) and how best to schedule remote observations. Some of the on-site REU student observing runs were scheduled and all observers were made aware of the potential to perform backup observations for a Hubble Space Telescope campaign in late spring.

This Board meeting was among the shortest and smoothest of all that have been held. Future meetings should also go as smoothly with the observatory operating routinely in remote mode and a healthy budget now in place. The Board's final action, before adjourning, was to set the meeting site for fall 2000 as Florida International University.

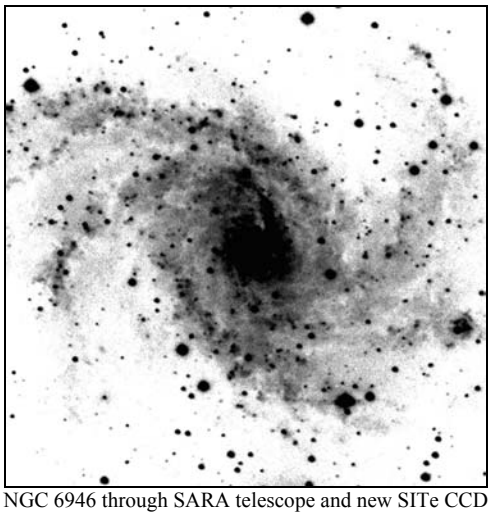
Astronomy Grows at ETSU

Gary Henson, ETSU

ETSU has recently renamed the physics department and acquired new facilities and faculty. The Department of Physics at ETSU has been renamed the Department of Physics & Astronomy. This change reflects the emphasis in the field of astronomy which the department has seen increase since ETSU joined SARA in 1989.

The Harry D. Powell Observatory had its official dedication ceremony in fall 1999. This state of the art campus observatory has been in use since spring 1998. It has permanent outside mounts for eight 8-inch Meade telescopes and a 14-inch Celestron telescope under a dome roof. All telescopes can be computer controlled and are equipped with CCD cameras. The observatory serves numerous astronomy lab students, faculty research, and the general public through regularly held star parties.

The department has just added two new astronomy faculty members to its ranks. An opening for one assistant professor position was filled by Dr. Beverly Smith whose husband, Dr. Mark Giroux, also happens to be a Ph.D. astronomer. Dr. Smith (Ph.D. 1989, Univ. of Massachusetts) joined the department in fall 1999 as a tenure-track, assistant professor. Her major research interest is multi-wavelength extragalactic astronomy. She uses a multi-wavelength approach to investigate the nature of the interstellar medium in galaxies and has already made several optical wavelength observations using the SARA observatory. Dr. Giroux (Ph.D. 1992, Univ. of Texas) joined the department in fall 1999 as an adjunct professor. His research interests include the thermodynamics of the intergalactic medium and quasar absorption line systems, the large-scale structure of the universe, and theory of galaxy formation. The addition of both an observational and a theoretical astronomer working in the extragalactic field will be an excellent complement to the concentration in stellar astronomy the department already has.



NGC 6946 through SARA telescope and new SITe CCD
Courtesy of Michael Bradshaw

Clemson, The Newest SARA School

Mark Leising, CU

The astrophysics group at Clemson University joined SARA in 1999. Nuclear and Gamma-Ray Astrophysics is the guiding theme of this research group, covering topics from Big Bang nucleosynthesis, stellar evolution, novae and supernovae, to meteoritics and gamma-ray bursts. To provide faculty and students access to an optical research telescope the Clemson group joined the SARA consortium, and plans to use the 0.9m telescope for observations of supernova light curves, gamma-ray burst (GRB) afterglows, star clusters, quasars, and whatever might excite their current and future students. Here is a little recent history of Clemson astronomy.

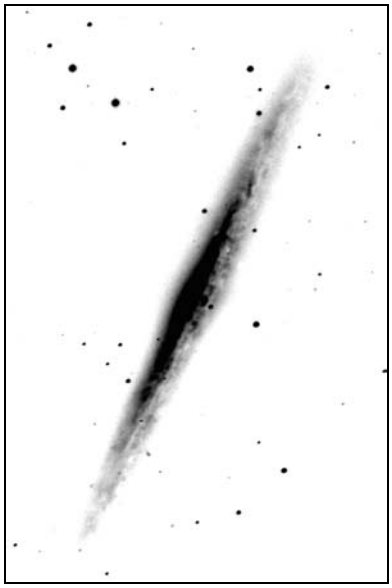
Phil Flower was the only active astronomer at Clemson University in 1989 when Donald Clayton moved to the Department of Physics and Astronomy from Rice University. Clayton was a Co-Investigator on one of the Compton Gamma Ray Observatory's four instruments, the Oriented Scintillation Spectrometer Experiment (OSSE). His efforts were supported by Research Associate Dr. Lih Sin The, an experienced gamma-ray astronomer whose background was in transport theory and N-body simulations. Within two years three new astronomy faculty were hired. They were Dieter Hartmann, Mark Leising and Brad Meyer. Each was thoroughly grounded in the science of nuclear astrophysics, so that the Clemson program became known as "Nuclear and Gamma Ray Astrophysics" to highlight this cultural unity. In April 1991 CGRO was launched, with Clemson as one of the OSSE teams with special responsibility for nuclear gamma ray lines from exploding objects. The effort also expanded into the hard X-ray continuum of various sources (supernovae, novae, stellar-mass black holes). Joint research with Roland Diehl (MPE) and the CGRO/COMPTEL instrument team became a parallel theme. Hartmann's research on GRBs connected to many groups, but the most intense collaborative effort developed with the CGRO/BATSE Team at MSFC in Huntsville, AL. Much of the research activity at Clemson was supported by NRL and NASA's guest investigator program for the Compton Gamma Ray Observatory.
Three PhD's and numerous MS degrees and senior theses resulted from this program. This Great Observatory was destroyed by NASA on 3 June 2000. An era has come to an end, but Clemson's program will remain active in this field as new missions such as HETE 2, SWIFT, GLAST, INTEGRAL, and others will continue to explore the high-energy universe.

In parallel, a second major Clemson thrust was initiated, the study of astronomy in the isotopic patterns in solid samples from meteorites, especially those within the presolar grains that had been identified in 1987. In 1990 Clemson University began the first of (so far) ten annual Workshops on Isotopic Anomalies, organized jointly with Robert M. Walker's laboratory at Washington University in St. Louis. The first NASA Workshop in the new Origins of Solar Systems Program was held at Clemson in 1990 to kick off this thrust. NASA and NSF grants support Clemson's major effort to discern the meaning of the incredible isotopic patterns that are found in the presolar grains. These have revealed nucleosynthesis processes recorded at their stellar sources. Three graduate students and one Clemson senior physics major now do research in this program, which recently awarded its first PhD degree.

Clemson's research program has also greatly benefited from an ongoing collaboration with Prof. Mounib El Eid (AUB). After many years at the Observatory of Gottingen University, his path led to the American University of Beirut, where he teaches introductory and advanced physics courses, and carries out stellar evolution studies of massive stars. El Eid makes extended annual visits to Clemson, to carry out a stellar evolution program. This effort now involves several faculty and an advanced graduate student.

Hartmann and student Grant Williams are members of the LOTIS collaboration, headed by Hye-Sook Park of LLNL. Williams' thesis is on the search for prompt optical emission from GRBs. The next generation GRB telescope, Super-LOTIS, is a 0.6m Boller-Chivens f/3.5 reflector. This automated telescope has just been moved to the Steward Observatory CTI site on Kitt Peak, making SLOTIS a neighbor of SARA. Hopefully, some GRB afterglows will be jointly observed with both instruments. Grant Williams will fill a postdoctoral position with Steward Observatory in August 2000, so SARAns could get a guided tour of the SLOTIS facilities if they run into him on the mountain.

Clemson's first SARA telescope observations were carried out in April 2000, and the first Clemson SARA-REU students arrived in May.



NGC 5907 mosaic, made with MaxIm DL and SARA equipment
Courtesy of Michael Bradshaw

NGC 4410 Galaxy Interactions

Beverly Smith, ETSU

The large radio lobes of radio galaxies both affect, and are affected by, their environment. There are numerous examples of radio galaxies with bent and distorted radio lobes; these peculiarities are clearly caused by something external to the central engine that produces the jets.

Traditionally, it was believed that bends in radio lobes are caused by ram pressure due to motion through a hot intracluster medium (e.g., Miley et al. 1972). However, in recent years, there is more and more evidence that in some cases interstellar matter, rather than intracluster matter, could be responsible for these peculiarities. For example, Stocke et al. (1985) identified a number of `Dog Leg' Radio Galaxies---systems with abrupt bends in their radio lobes. These bends were sometimes coincident with companion galaxies, suggesting that the jets were being deflected by the interstellar medium in the companion.

Bending of jets due to impacts with interstellar matter may be especially important during gravitational interactions of the radio galaxy with a companion. The motion of the interstellar matter in the companion during a galaxy-galaxy interaction may provide sufficient ram pressure to strongly distort a radio lobe. This has been strikingly demonstrated by Borne and Colina (1993) for the 3C 278 system. Borne and Colina used a previous numerical simulation of the gravitational interaction between the 3C 278 host galaxy and its companion NGC 4783, and added ram pressure from the interstellar matter in the companion. With this model, they were able to successfully reproduce the observed 70 degree bend in the 3C 278 jet.

To better understand the interplay between radio lobes and the interstellar medium in radio galaxies, detailed studies of the interstellar matter in nearby radio galaxies are essential. To this end, I have been conducting a multi-wavelength study of the nearby low luminosity radio galaxy NGC 4410A and the group in which it resides (Smith 2000). The NGC 4410A group is remarkable in both its complex optical morphology, indicating multiple gravitational interactions between the galaxies in the group, and the unusual distorted radio morphology of NGC 4410A. My study suggests that these peculiarities may be related, in that the gravitational interaction between the galaxies may have disturbed the interstellar matter in the system, which in turn disrupted the radio lobes.

As part of this study, I used the SARA 0.9 meter telescope to obtain deep optical images of the inner part of the NGC 4410 group (see Figure 1a, 1b). These show that NGC 4410A has a prominent bulge surrounded by an extended ring or loop-like structure. NGC 4410A is strongly interacting with the nearby galaxy NGC 4410B. These two galaxies are part of a sparse group containing at least a dozen galaxies which lies behind the Virgo cluster. The inner 9 arcmin diameter of this group contains five of these galaxies, at least four of which are strongly interacting. NGC 4410A+B appears to be connected by a stellar bridge to the S0 galaxy NGC 4410C (IC 790), which in turn is connected to the SBa galaxy NGC 4410D (VCC 934). In addition to the possible bridge to NGC 4410C, NGC 4410A+B has a long (2 arcmin=55 kpc) tail to the southeast and another extension to the northwest.

With the NRAO Very Large Array (VLA), I obtained radio continuum and 21 cm HI maps of this group. I also used the NRAO 12 meter telescope to obtain CO (1-0) data for this system. My radio continuum maps show a very asymmetric double-lobed structure, with a high surface brightness lobe extending 3.6 arcmin (100 kpc) to the southeast and a 6.2 (180 kpc) low surface brightness feature in the northwest (Figure 2). Higher resolution VLA maps (Hummel et al. 1986) show an abrupt 70 degree bend in the southeastern lobe. Molecular gas is abundant in NGC 4410A, with $M_{H2} = 4 \times 10^9 M_{sun}$ (using the standard Galactic conversion factor), but is undetected in NGC 4410B. HI is less abundant, with $M_{HI} = 10^9 M_{sun}$ for the pair. The HI map shows an HI tail extending 1.7 arcmin (50 kpc) to the southeast of the pair, coincident with a faint optical tail and partially overlapping with the southeastern radio lobe (Figure 3).

To investigate the question of intracluster gas in this group, I utilized an archival ROSAT X-ray map. Surprisingly, I found a possible 2 arcmin (56 kpc) long X-ray tail extending from the NGC 4410A+B system, anti-coincident with the HI tail (Figure 4). This X-ray structure is aligned with the stellar bridge that connects the pair to NGC 4410C. If this X-ray emission is indeed associated with the group, I infer $(3–8)\times10^8 M_{sun}$ of hot gas in this feature, similar to the amount of HI in the other tail. This X-ray emitting gas may be either intracluster gas or shocked gas associated with the bridge.

The detection of abundant interstellar gas in this pair, including an HI-rich tidal tail near the southeastern radio lobe, suggests that the observed distortions in this lobe may have been caused by the interstellar medium in this system. The gravitational interaction of the two galaxies and the subsequent motion of the interstellar medium in the system relative to the jet may have produced sufficient ram pressure to bend and distort the radio jet. An alternative hypothesis is that the jet was distorted by ram pressure due to an intracluster medium, although the small radial velocity of NGC 4410A relative to the group and the lack of diffuse X-ray emission in the group makes this less likely unless the group is not virialized or is in the process of merging with another group.

Borne, K. D., and Colina, L. 1993, ApJ, 416, 157
Hummel, E., Kotanyi, C. G., and van Gorkom, J. H. 1986, A&A, 155, 161
Miley, G. K., Perola, G. C., van der Kruit, P. C., and van der Laan, H. 1972, Nature, 237, 269
Smith, B. J. 200, ApJ, in press.
Stocke, J. T., and Burns, J. O. 1987, ApJ, 319, 671

NGC 4410 Galaxy Interactions

Images and Figures

Original Images: www.etsu.edu/physics/bsmith/research/n4410.html

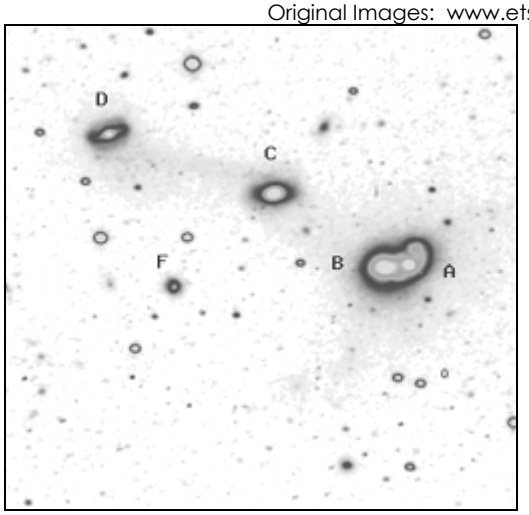


Figure 1a
Optical Image of the NGC 4410 Group

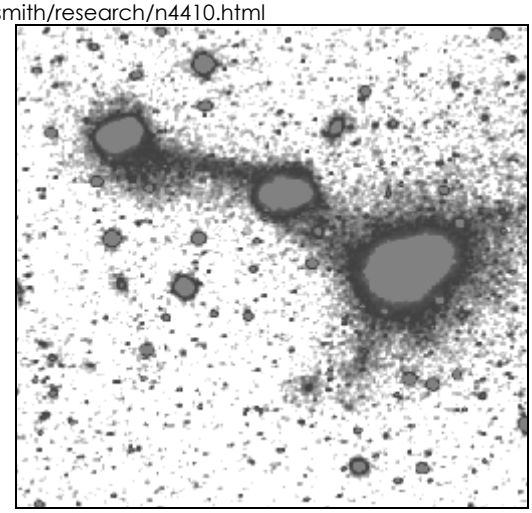


Figure 1b
Deep Optical Image of NGC 4410 Group

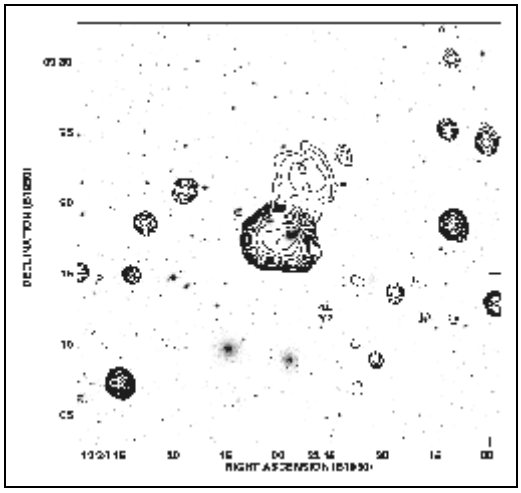


Figure 2
Radio Continuum Map of the Region

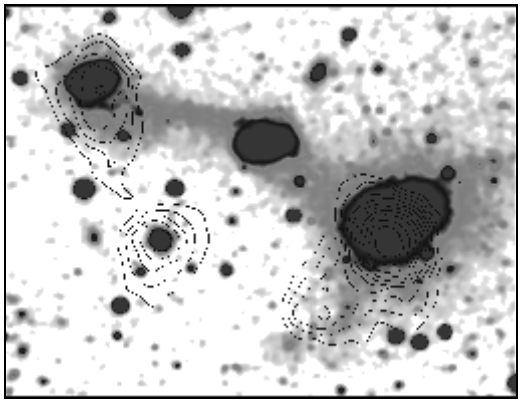


Figure 3
HI Map Overlaid on Optical Image

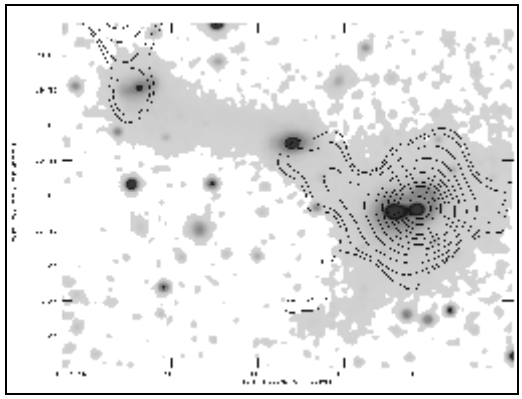


Figure 4
ROSAT X-Ray Map Overlaid on Optical Image

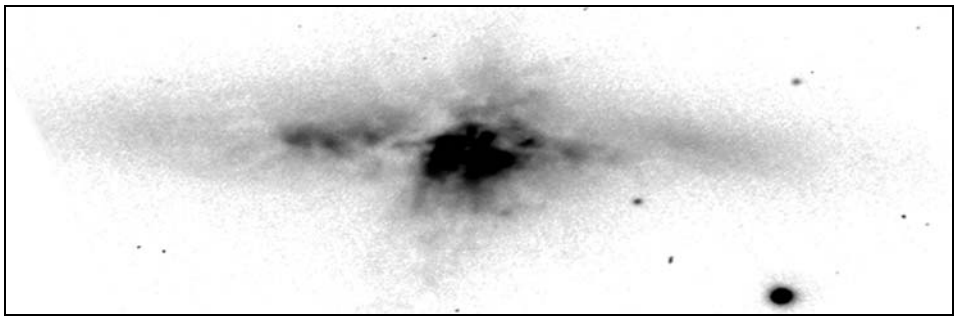
2000 SARA-REU Students

Here is a list of the REU students for Summer 2000:

Name	Home Institution	REU Institution	REU Advisor	REU Project
Larry Arbuckle	Florida Tech	VSU	Dennis Marks	Relativistic Quantum Dynamics in 2 and 4 Dimensions
Martha Boyer	University of Minnesota	UGA	Scott Shaw	Search for Variable Stars in Open Cluster NGC 6811
Andrea Clemons	Pomona College	ETSU	Mike Castelaz	Astrobiology of the Galilean Moons
Ansley Collins	Birmingham-Southern College	FIT	Mark Moldwin	The Search for Pc3 Waves
Amy Forestell	University of Virginia	CU	Mark Leising Varsha Kulkarni	Cosmic Chemical Evolution: Comparing Analytical Models
Nick Gothard	Bob Jones University	FIU	Walter van Hamme	Light Curves for the Eclipsing Binaries EF Boo and CN And
Kyle Jones	Furman University	FIT	Matt Wood	IDL Visualization of Q=0.075 SU UMa Dwarf Novae
JP Nogues	Yale University	VSU	Martha Leake	The Challenge of C Asteroid Spectroscopy
Marie Rinkoski	Oberlin College	ETSU	Mike Castelaz	Phase Dependant Spectroscopy of the Mira Variable R Leo
Erin Ryan	University of Arizona	FIU	James Webb	Verification of the Dual Jet Model of Quasar Emission
Troy Swift	Case Western Reserve University	CU	Brad Meyer	Overproduction of Light p-Process Isotopes in Freezeouts

And here are updates from some SARA-REU alumni:

- Adina Alpert is working on her PhD. with Dr. Jay Melosh at The University of Arizona Lunar and Planetary Laboratory. She worked with Martha Leake at VSU on Asteroid Spectroscopy in 1997. She graduated from University of Pennsylvania with a BS in Astronomy.
- Rupal Amin is at the University of Florida, working on graduate Physics. After working with Mark Moldwin and Hamid Rassoul on the Characteristics of Biteouts on 1998, he graduated from Florida Tech.
- Jonathan Hargis is now at Eastern College, studying eclipsing variable stars, after graduating from Villanova University. He worked with Caroline Simpson at FIU on interacting galaxies in 1999.
- Emily Howard is working on her PhD in Physics at Florida International, where she did her REU research in 1996 with James Webb. She previously graduated from Denver University with a degree in Physics.
- Diane Paulson (nee Lofland) finished her undergraduate work at Texas A&M after working with Gary Henson on Mira Variables in 1998, and is now at the University of Texas. She is working with Bill Cochran and Artie Hates on low mass planetary companions in the Hyades cluster. She is also working on planetary formation processes.
- Brian Rebel is working on his PhD. at Indiana University. He passed his qualifying exams, and is working in Astrophysics. He is working on the MINOS detector and neutrino oscillations.



M82 in Hα light, from the SARA Observatory
Courtesy of Michael Bradshaw

Observatory Information

Michael Bradshaw, FIU

The SARA observatory has recently been outfitted with many new goodies:

Stairs

The new rear stairs allow safe and convenient access to the outside world, without stumbling around the dome floor. They lead all of the way to the lower parking area, and give an excellent view of the western sky. A big improvement over the old wooden "monster". The new stairs can be seen in the photo on the first page of the newsletter.

Lower Dome Shutter

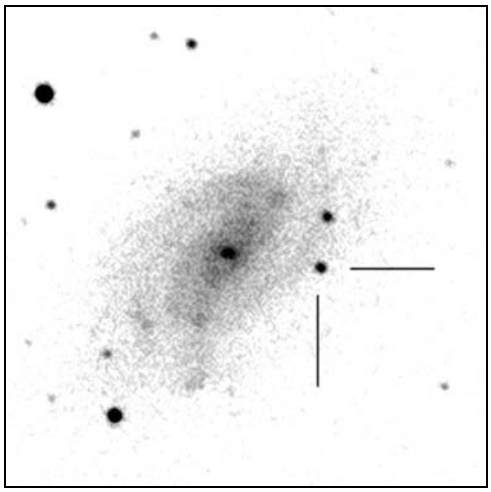
ACE updated the lower dome shutter after the damage from the windstorm. Now, the shutter can open independently of the upper shutter, and folds out, rather than riding up the slit as before. This allows an observer to keep the shutter closed for high altitude viewing, keeping the horizon glow to a minimum, or open the shutter for low altitude imaging. Also, an observer doesn't need to close the upper shutter to change the position of the lower shutter, as was necessary before.

CCD Camera

The new CCD camera is an Apogee AP-7 model, with the SITe 512x512 back-illuminated chip. This camera has high sensitivity across the entire visual spectrum, allowing faint imaging in the "B" and "U" bands, something that the previous camera was not able to do. The chip is square, with 24μ pixels, giving an image scale of just under one arcsecond per pixel. Combining the larger pixel size, deeper well size, very low dark noise, extreme cooling capabilities and back-illumination allows this chip to image several times faster than the old camera. The only disadvantage is the 6.3x6.3 arcminute image size, somewhat smaller than the other camera. The original camera is still mounted on the telescope, if the larger image scale is needed. Specific information can be found at the Apogee web site: http://www.apogee-ccd.com/astronomical_imaging.htm

Camera Software

The new camera control software is MaxIm DL, V2.0. This is a Windows based program that runs the camera, and can do basic image reduction. It has a simple user interface, potentially can control the filter wheels, and has lots of functions built in that observers use. Testing is ongoing at FIU to determine if the image reduction is scientifically rigorous (i.e. if it is comparable to IRAF). If so, then the on-site observer can reduce all of their data *in situ*, making for less data transfer back to their home institution. MaxIm has a photometry function, but they are explicit in stating that it is NOT scientifically rigorous. It could, however, be used in the field to give some rough estimates. The images scattered throughout the newsletter are there to show some of MaxIm's capabilities.



Supernova SN2000cb in IC 1158
Approximate m_r of 18
Courtesy of Michael Bradshaw

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Michael Bradshaw, Editor

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This newsletter is available as an electronic PDF file

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