Written by Roger Boston

## RICE

## **Educational Aspects of Proposed Program - Rice University**

Rice University will monitor the behavior of cataclysmic variables, blazars, quasars, active galactic nuclei, and faint long-period variables in U, B, V, R & I wavelengths. We also will conduct minor planet, supernova and gamma ray optical afterglow searches. We will be working with the Minor Planet Center to determine minor planet light curves. The hands-on observation experience increases the students interest in the field. By gaining experience interpreting data, they will be more inclined to pursue continued observation studies.

Rice students are currently exposed to observational astronomy through: Astronomy 201/202 (introductory courses for non-majors and academes with approximately 100 students per semester) and view objects through a 16-inch telescope on campus. This program will enable them to observe deep-sky objects with a larger telescope at a darker site. Students in Astronomy 221 labs will now be able to learn constellations and how to use a computerized telescope at a darker site than ever possible on campus. Students in Astronomy 230 labs will be able to obtain research-quality imagery and spectroscopy of fainter objects than possible on campus for use in learning IRAF data analysis techniques as the final research projects in the lab. Juniors and seniors will now have research quality observatory equipment at a sufficiently dark site to pursue publishable research projects as part of their junior and senior research required for the B.S. degree in astrophysics at Rice.

## Spectroscopy

Dr. Reggie Dufour, Professor of Physics and Astronomy at William March Rice University, will serve as the lead researcher in this area. Dr. Dufour has successfully served as PI on 23 and Co-PI on 19 NSF and NASA grants. Dr. Dufour served as PI on 19 IUE and HST observing programs between 1980 and 2005. He has also authored and co-authored over 121 refereed publications on UV-optical NIR spectroscopy, nebular astrophysics, and star-forming galaxies.

Dr. Dufour is an expert in nebular and emission-line diagnostic astrophysics. He proposes a spectroscopic monitoring program of the spectra of symbiotic stars, which are mass-exchanging binaries with one companion being so very hot that part of the surrounding medium is ionized and shows a nebular-like spectrum that usually varies in time over periods of weeks. Students

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will take low dispersion spectra over a 6-8 month time span to map out variations in various emission lines (both HI and HeI recombination and collisionally excited ionic species such as [OII], [OIII], [SII], [NII] to derive changes in the gas ionization, temperature, and density for purposes of modeling the systems. Approximately 30 symbiotic star systems exist brighter than  $V=12^{th}$  magnitude which could be reached with a 24-inch telescope and our SGS spectrograph (compared to about a V~9 limit for the current Rice on-campus 16 inch).

The program will provide at Rice University undergraduates and graduate students with training in doing spectroscopy and imagery of stars and nebulae at a darker site than the campus observatory which they can utilize in later research at major observatories. The program will enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships by providing a quality observatory viewing experience in a darker site. Rice University undergraduate and graduate students will be able to utilize the remote observatory, which will be more similar in operation to major observatory telescopes than the Rice campus observatory 16 inch, and, more significantly, the larger aperture, better mount, and darker site of the HCC observatory will enable Rice students to observe object 2-3 magnitudes fainter than possible at their campus observatory. This increases more than hundred-fold the number of astronomical targets for which quality observations will be possible.

Rice graduate students go to major observatories each year to do thesis observations and this facility will enable them to learn the basic observational techniques preliminary observations of their research targets without travel. Graduate students will also be able to salvage their research programs using the TORRE telescope if they get clouded out during their (usually limited) observing sessions at the major observatories.

Rice University astronomy course offerings include:

**ASTR 201** - STARS, GALAXIES, AND THE UNIVERSE: formation, evolution, and death of stars; composition and evolution of galaxies; structure and evolution of the universe.

**ASTR 202** - EXPLORATION OF THE SOLAR SYSTEM: surveying the sun, planetary motions, interplanetary fields and plasmas, the planets, their satellites and rings, and comets. The

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purposes and methods of solar system exploration are discussed.

**ASTR 221** - OBSERVING THE NIGHT SKY: Use of small telescopes to study constellations, bright stars, planets and the sun at the campus observatory and at dark-sky sites. Modern analog and digital techniques will be used along with direct visual observation.

**ASTR 230** - ASTRONOMY LAB: A hands-on introduction to modern techniques of observational astronomy. Students use telescopes, CCDs, and computers to obtain and analyze their own images of solar system, galactic, and extragalactic objects. This course involves field trips to dark sky observing sites such as George Observatory and makes extensive use of state-of-the-art data analysis software.

**PHYS 491/492** - UNDERGRADUATE RESEARCH: Research projects conducted under supervision of departmentally approved faculty.

**PHYS 493/494** - UNDERGRADUATE RESEARCH SEMINAR: Weekly seminar for juniors and seniors in which presentation on research topics and/or topics in the scientific literature will be given.