ASTR 111L: Educational Research in Radio Astronomy (ERIRA)

ERIRA is a two-credit course designed to give undergraduates an exciting, hands-on introduction to the research process, and to radio astronomy. Although the course is administered in the fall semester, the bulk of the work takes place the summer before, during a one-week trip to the National Radio Astronomy Observatory (NRAO) in Green Bank, WV, where I have been granted exclusive access to their 40-foot diameter radio telescope for this program for the past 16 years. Dates for the trip are usually known by February 1st.

The number of students who can participate is limited by the number of beds that I can reserve at NRAO-Green Bank and by the fact that UNC-Chapel Hill is not the only school that participates in this program. Consequently, admission to the course is competitive and a short application is required: http://www.physics.unc.edu/~reichart/undergraduate.html. Admission is then by permission of the instructor. However, there are no other prerequisites and no background in astronomy is required: Majors, potential majors, and non-majors are equally encouraged to apply.

ERIRA is both an experiential-education course and a laboratory course. It may be used as a substitute for ASTR 101L.

Description of Summer Program

ERIRA began as a one-week summer program that I founded at NRAO-Green Bank in 1992 and have coordinated each year since. Participants begin the week by learning how to use the observatory's 40-foot diameter radio telescope. Then, working in five teams of three, they map most of our galaxy and a few extragalactic and solar system regions of interest, using the 40-foot and data acquisition software that I have written. This requires about three days of almost around-the-clock observing. Participants then learn how to produce false-color images of these regions, again using software that I have written. From these images, they "discover" supernova remnants, stellar nurseries, other galaxies, and quasars, as well as solar system objects like the sun, the moon, and Jupiter.

Meanwhile, the participants begin work on smaller, more research-oriented projects. These projects usually include:

- producing a "true-color" image of the Andromeda galaxy's disk and estimating its mass
- measuring and interpreting the changing fading rate of the supernova remnant Cassiopeia A
- detecting Jupiter and showing that it cannot be a thermal source
- constructing an antenna to detect Jupiter's moon Io crashing through Jupiter's magnetic field
- measuring the rotation curve and mass distribution of our galaxy using the 21-cm emission line of neutral hydrogen
- producing a "true-color" image of a portion of our galaxy and showing that it is warped
- measuring the surface temperature of the moon
- "deep" imaging of the Orion Nebula and the North Polar Spur
- using the 40-foot to predict sunspot numbers and other measures of solar activity
- constructing an antenna to predict sunspot numbers and other measures of solar activity
- constructing a 2-meter diameter radio telescope that is good enough to detect the sun

Typically, each participant selects two or three of these projects. Unlike the mapping project described above, participants are responsible for the design of these projects and their observations. However, typically six coordinators are on hand to help. All teams present their results in an informal, yet multimedia, setting on the final day.

Meanwhile, participants attend a crash course on radio astronomy, which I teach, as well as special interest talks (in past years, I have done the search for extra-terrestrial intelligence (SETI) and the archaeoastronomical properties of Stonehenge), research talks, and "Dan's Famous Backwards Walking Tour" of the observatory, which includes the Green Bank Telescope, the world's largest fully steerable telescope. Participants also have the opportunity to observe with optical telescopes on clear nights, before Green Bank's famous pea-soup-thick fog rolls in around 2 a.m., and remotely using telescopes that UNC-Chapel Hill has built in the Chilean Andes.

As you have probably guessed, the participants – as well as the coordinators – get very little sleep. This is particularly true the night before final presentations. However, this is completely voluntary and a reflection of the enthusiasm of our participants. As the week progresses, I often find participants sleeping in the lounge, which is where we do most of our work, instead of walking ten seconds down the hall to their beds. They tell me that they do not want to miss anything! Despite sleeping very little the last few nights of the program, nearly every participant can be found awake the final night of the program, after the program has officially ended. They will watch movies, play pool or ping pong or cards, or simply talk, most of them right up until they have to leave the following morning. On more than one occasion, I have had participants tell me that ERIRA was one of the best experiences (and in one case, THE best experience) of their life. Also on more than one occasion I have had participants pursue degrees in science after ERIRA when they had not planned to do so previously. As an educator, I cannot imagine a more rewarding experience than my one week at Green Bank each year.

Participants are selected on the basis of enthusiasm first, and background in astronomy and science second. This makes for a diverse and highly-motivated group. Typically, three fourths of the group consist of undergraduate astronomy and other science majors (recently, most from UNC-Chapel Hill) and one fourth of the group consists of non-science majors and very enthusiastic high school students. On occasion, we also accept very enthusiastic adults (i.e., people with real jobs). Participating institutions have included the University of North Carolina, the University of Chicago, the Ohio State University, the University of Wyoming, Fuhrman University, the Pennsylvania State University, the University of Pittsburgh at Bradford, and a variety of high schools, including Ridgewood High School (Norridge, IL) and Bradford Area High School (Bradford, PA).

Participants stay with the visiting astronomers in the observatory's residence hall, and they eat with the astronomers in the observatory's cafeteria. The rooms are air conditioned and very nice (sheets, blankets, pillows, towels, soap, etc. are provided). I assign each participant a roommate of the same gender, and if space is limited I may assign three to a room. (The number of participants that we can accept is set by the number of rooms the observatory has available.) Due to government subsidization of these facilities, room and board (and a trip to the gift shop) has cost no more than about $300 for the entire week, and recently I have been successful at winning grants to cover the expenses of the coordinators and the UNC-Chapel Hill students. Finally, to help with transportation I organize shuttles from and back to Chapel Hill and Chicago.

For more information: http://www.physics.unc.edu/~reichart/erira.html

Grades

50% of the grade will be for participation in the summer program, including final presentations at the end of the week. 25% of the grade will be for a approximately 10-page report on the mapping project carried out in the first half of the week. 25% of the grade will be for an approximately 10-page report on the smaller, more research-oriented project in which the participant is most involved. Reports will be due on October 15th and December 1st, respectively.