Teaching Philosophy (Shardha Jogee)

Astronomy, the quest for understanding the Universe, takes us on a scientific exploration, which spans thirteen billions years and scales ranging from the infinitesimal to the grandest. As a discipline, it lies at the core of who we are as a civilization, and has the ability to engage and inspire our imagination boundlessly. I believe that my responsibility as a scientist is to share the goals, scientific inquiries, and advances in astronomy to the general public and students at all levels, thereby preparing the next generation of scientists. My philosophy is that scientific progress stems from the concurrent advancement of discovery and understanding, while promoting teaching, inquiry and learning. I have therefore adopted a holistic approach to research, teaching, and education outreach.

Using an inquiry-based approach in the classroom: I have taught a range of classes at UT, including classes for non-science majors (e.g., AST 301 Introduction to Astronomy), lower division (e.g., AST 104 Undergraduate Seminar) and upper-division courses for science majors (e.g., AST 358 Galaxies and Cosmology), and graduate courses (e.g., AST 381 Gravitational Dynamics; AST 386s Graduate Seminar in Extragalactic Astronomy). Faced with a wide range in class sizes (from 18 to 230 students), I use different techniques to set an interactive tone, including one-to-one discussions in smaller classes, group presentations and activities in larger classes, and oral quizzes. When teaching introductory astronomy to non-science majors with varying backgrounds in math and science, I spend considerable effort in trying to make scientific principles easy for students by using analogies and making students express formulae into words and figures. I have found that it is not 'the math', which is the stumbling block, but rather, the difficulty of students in understanding the physical principle or concept behind a formula. In undergraduate and graduate classes alike, my working philosophy has been to go beyond the textbook material and try to engage students by conveying the excitement of astronomy and sharing the results of ongoing research. Rather than presenting results as a 'fait accompli', I have tried to foster an inquiry-based approach, where I encourage students to use the process of scientific reasoning to reach some of the conclusions reached by astronomers, and to question existing paradigms. The best students enjoyed the challenges of being pushed outside their comfort zone, and having to think 'outside the box'. In fact, two of my best UG advisees signed up for research projects after taking AST 358.

Using instructional technology in the classroom: Astronomical research in my area of expertise, namely the field of galaxy evolution, has been profoundly transformed in the last five years by the advent of very large multi-wavelength galaxy surveys. Such surveys have been conducted by international science collaborations and made possible through technological advances on NASA's space facilities, such as the Hubble Space Telescope (HST). I have found myself right in the midst of these developments as I am part of five international science collaborations, While pushing the field forward in previously unparalleled ways, the scope of these large surveys has challenged us to find new effective ways to allow students to take part in such explorations. In order to facilitate the active exploration of data from large surveys, I have used grants from NSF, NASA, and UT's Division of Instructional Innovation and Assessment (DIIA) to develop the Galaxies and Cosmos Explorer Tool (GCET; http://www.as.utexas.edu/gcet). GCET is an online instructional technology tool, which allows students to access Hubble images

of over 8,000 galaxies, over a time interval equal to half the age of the Universe. Students can measure the size, determine the lookback time, perform morphological classification on images in two rest-frame wavelengths, and gauge the different stellar populations present. Users can record their measurements, as well as reference information, such as coordinates and redshift, into Excel spreadsheets for further analysis. Other scaffolding activities have been created to help students build their understanding of galaxies in order to use the GCET tool. The development of GCET was an interdisciplinary effort where I worked with senior graduate students from computer science (Achal Augustine) and DIIA (Aaron Smith), undergraduate (UG) astronomy student (Sarah Miller), and an astronomy educator (Dr. Mary Kay Hemenway). GCET can be used at three levels: by the public and 9-12 students; in introductory undergraduate astronomy classes for non-science majors; and in upper level classes for astronomy majors, when combined with programming exercises. Furthermore, Google Earth and Sky have approached us in order to make activities with GCET available to Google users.

Engaging students into research: Research is critical for our UGs to develop a deeper understanding of the field outside the classroom, and be competitive for science-related careers. During the period (2005–present) when I acted as adviser for 72 Astronomy UGs as well as Dean's Scholars in Astronomy, I have strived to make involvement in research be a cornerstone of our program. After I realized that it was hard for students to locate projects, I set up an online system (http://www.as.utexas.edu/astronomy/education/ug-research/) to match research skills and projects. The enthusiastic participation of the astronomy faculty and research staff in offering projects on this site has been invaluable. However, many students still lack basic skills for research and the large time-investment required of faculty often deters many of us from offering more projects. In order to address this long-standing problem, I am finalizing a new course entitled 'A Practical Introduction to Research in Astronomy' for 2009, whose goal is to better prepare undergraduates for research and equip them with some of the pre-requisites (e.g., introduction to basic astronomical softwares used for data manipulation; elements of programming and statistics; hands-on exercises covering a range of astrophysical areas; paper writing and oral presentations, etc). Furthermore, with the help of McDonald Observatory donors, we also secured new funds, which support travel, board, and lodging for UGs traveling to McDonald Observatory for research. Several UGs have traveled to the observatory, and considered it one of their most enriching experiences at UT.

Student mentorship and research supervision: At UT, I have supervised the research projects of five UGs, as well as those of three graduate students and two postdoctoral fellows in my research group. It is particularly enjoyable to work with talented UGs as they first encounter the beauty and challenges of astronomical research. I try to allocate projects of different scopes to students, according to what I gauge their skills, motivation, and potential to be. In the case of the two UG Dean's scholars (Sarah Miller and Kyle Penner) who excelled in the first or first two semesters of work, I invited them on challenging projects, which involve some of our large galaxy surveys and cutting-edge data. They presented their work at the CNS research forum (where they won the best oral presentations and best posters), as well as in several national astronomy conferences, where they contributed first-author articles. Sarah Miller was awarded one of the 32 national Rhodes Scholarship in 2008, selected from 764 applicants. She will join Oxford University to pursue a D.Phil in astrophysics in Fall 2008. Kyle Penner will join the University of Arizona

graduate program in Astrophysics, one of the top 10 programs in the country.

With my graduate students, I generally start with focused projects, and stress the mastery of astrophysical principles, critical analysis, and back of the envelope calculations. I hold weekly meetings with students to discuss recent papers in the field, brainstorm, and discuss progress on their research. Those involved in projects conducted within large international science collaborations participate in monthly telecons to discuss their work and in the initial phases work closely with me, before developing their own wings after the first project is over. Two of them have participated in team meetings in Europe, where they gave oral presentations on their work, alongside other students, postdocs, and faculty members. I send all of them to 1–2 conferences yearly, as participation in such events is crucial for giving them more breadth and maturity. One of the graduate students (Irina Marinova) won one of the two 2008 Frank N. Edmonds, Jr. Memorial Fellowship given to junior students who show promise in research, and was one of a handful of students to give a talk at a conference on galaxy dynamics in Italy in August 2008.

Rewarding excellence and attracting underrepresented groups: I believe in rewarding excellence and broadening the participation of underrepresented groups in the physical sciences. To this effect, I initiated as of 2006 the Astronomy Freshman Prize for Excellence, to support the best entering student in Astronomy. Pushing this effort further, I worked with Computer Sciences, Math, and Physics, as a co-I on a STEM proposal (DUE-0807140) to help 1st/2nd year undergraduates achieve long term success in the STEM fields of Astronomy, Computer Sciences, Math and Physics, where women and minorities are under-represented . The proposal was just awarded $600,000 by NSF in 2008.

Education outreach at the national and international level: In the last five years, we have made giant strides in the observational exploration of the cosmos, and can now witness the assembly of galaxies at epochs when the Universe was a mere five percent of its present age. In the face of such advances, it behooves us as scientists to share the fruits of this progress with students and the public at large. The broad dissemination of such results is part of the core strategy of NSF and NASA to promote progress in science. Motivated by this philosophy, I have been the PI of of three NSF and NASA Education and Public Outreach (EPO) grants since 2004. In particular, I was both a science team member and the PI of the US-led EPO program for Hubble Treasury Survey of the Coma cluster of galaxies. Treasury surveys are among the largest decadal surveys conducted with the Hubble Space telescope and are meant to provide a lasting scientific and EPO legacy for the field of astronomy. Working with Sandi Preston and other experts from the Astronomy Department and McDonald observatory, I have produced 5 Stardate and 5 Universo radio programs on the Coma cluster. These aired in 2008 to a weekly audience of over ten million people. We have also produced the StarDate and Universo Teacher's Guide, which are being distributed to thousands of teachers nationally Furthermore, the Coma radio programs and HST images are being used in a ViewSpace program that will be broadcast in museums nationwide as of Fall 2008. It will also be featured in the McDonald Observatory visitor center, which attracts over 100,000 visitors annually.