

Broader Impact

Seventy-five high school teachers will immerse themselves in a deep 3-day/2night residential professional development workshop on Galaxies and the Cosmos. During this time they will eat meals with astronomers and learn about their research by visiting the domes in which they observe. Teachers will work in groups to practice galaxy activities that align with National Standards for Science Education that they can then take back to their classrooms and use with their students. They will receive DVDs containing all materials used in the workshop as well as recruitment materials to attract students into the astronomy field. Each teacher will reach 100 students and over 5 years this project will affect 22500 high school students and 75 teachers. Many of the students impacted will be minorities since Texas has the second fastest growing Hispanic demographic in the country. The proposed program uses both current research and technology. The benefit of this program to society is a better trained and competitive scientific and technological workforce.

EPO: EXPLORING GALAXIES AND THE COSMOS { A TEACHER PROFESSIONAL DEVELOPMENT WORKSHOP

I strongly believe in a holistic approach to research, teaching, and education / outreach. In

parallel with the scientific papers on the structural properties and merger history of galaxies, which

my research group and I have been leading and co-leading in several large science collaborations

(GEMS, STAGES, COMACS Treasury survey, and NICMOS-GOODS), we have also published for

astronomical education and public outreach effort. Such an effort is quite essential for sharing the

scientific legacy of these surveys with the next generation of young scientists, and stimulate an

inquiry-based approach.

As the PI of the US-based EPO program (HST-EO-10861.3.5-A; 2007-2009) for the HST ACS

Treasury Survey of the Coma cluster, I worked with the McDonald Observatory EPO team to

reach out to teachers, K-12 students, and the public at large, through HST archive *and 5 Universo* radio programs

on the Coma cluster, which aired on May 5 to 9, 2008, to a weekly audience of over ten million

people; the *StarDate and Universo Teacher's Guide*, which is being distributed in 2008 to thousands of teachers

nationally; and class activities focusing on galaxies in clusters. The Coma radio programs and

HST images are being adapted for use in a ViewSpace program that will be shown in museums

nationally.

From 2006 to 2008, as the PI of our outreach program entitled 'Building a Bridge to Texas

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High School Science Teachers and Students', I worked with our EPO team to develop and disseminate astronomy activities to high school students in Texas. This program was

sponsored

by a NASA EPO grant (NNG 06GB99G; 2006-2008) and an NSF grant (NSF AST-0607748).

I

extended this effort by using a FAST Tex (Faculty And Student Teams for Technology) grant for Instructional Innovation Techniques from UT to develop the Galaxies and Cosmos Explorer

Tool (GCET)¹, an online tool (<http://www.as.utexas.edu/gcet/>) to allow students to explore the evolution of galaxies over 8 billion years. The development of GCET was an interdisciplinary effort, where I worked with a computer science graduate student (Achal Augustine), a Division of Instructional Innovation and Assessment (DIAA) graduate student (Aaron Smith), undergraduate astronomy student (Sarah Miller { now a 2009 Rhodes scholar), astronomy educator Dr. Mary

Kay Hemenway, and Sandi Preston. GCET will be used in a research class I have developed for 2009.

From 2005 to the present, I acted as adviser for 72 Astronomy undergraduates and Dean's Scholars in Astronomy at UT Austin. As of 2006, I initiated a Freshman scholarship and mentorship program to support entering students in Astronomy. Pushing this effort further, I joined forces 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. For more advanced 3rd/4th year undergraduates, involvement in research has been a cornerstone of our program.

In addition to supervising the research of 5 undergraduates, I helped to set up an online system to match research skills and projects, and more recently am developing a new course entitled 'Practical Introduction to Research in Astronomy' whose goal is to better prepare undergraduates for research.

Building on our philosophy of integrating research, teaching, and education/outreach, we propose an EPO program that builds on our existing exciting body of legacy datasets, activities and educational tools:

Proposed program : A strong educational component is proposed in association with this research. We request funds to conduct 5 teacher professional development workshops focusing on

exploring galaxies and the cosmos for high school teachers at McDonald Observatory.

The goals of this five-year educational component are to (1) provide teacher professional development workshops for 75 teachers to offer them an experience to participate in galaxy activities in a classroom setting; (2) provide effective instructional activities on galaxies to high

school teachers to use with their students

In each of years one through five, we will conduct a residential 3-day/2-night teacher's workshop for 15 teachers at the Observatory. The PI will participate in the planning of the workshop and materials and will attend a portion of the workshop, either via videoconference or

in person, annually to present her research, answer questions, and interact with the participating

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Comment: That AISD workshop did not make so we did not use it.

¹ *The Galaxies and Cosmos Explorer Tool: Charting Galaxies over Cosmic Times in The Classroom* Shardha Jogee, M. K. Hemenway, S. Miller, A. Smith, A. Augustine, R. Worhatch, S. Preston, D. Lester, K. Fricke, BAAS 39, 738, 2007.

teachers.

Since 2001, McDonald Observatory has been presenting teacher professional development

workshops² during the summer in Fort Davis, Texas, the beautiful mountainous site where the telescopes are located. For example, in the summer of 2008, McDonald Observatory is offering

eight different professional development workshops. Typically, during a summer our workshops

will serve 120-150 teachers and we will have 80-100 teachers on a waiting list.

The workshops will align with the Texas Essential Knowledge and Skills² and the following National Science Education Standards³ for content: 9-12 Science as Inquiry (abilities necessary

to do scientific inquiry, understanding about scientific inquiry); History and Nature of Science (science as a human endeavor, historical perspectives, nature of scientific knowledge);

Physical

Science (interactions of energy and matter); Earth and Space Science (Origin and evolution of the

universe); Science and Technology (understanding of science and technology, abilities of technical design)

They PI has already developed a rich suite of educational activities related to her research on galaxy evolution to be used in the professional development workshops. The activities include:

© The Galaxy Cosmos Explorer Tool (GCET) an online web-based tool that encourages students to actively engage in quantitative analyses of Hubble Space Telescope (HST) images from the Galaxy Evolution from Morphology and SEDS (GEMS) survey. The tool allows users to surf the cosmos and access ACS images of over 8,000 galaxies. Users can measure the size, determine the look back 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. These include a Galaxy Classification Activity, a Multi-wave Length Astronomy Activity³, and a Lives of Stars Activity. A

short course workshop has already been developed about the GCET tool and delivered at the Conference for the Advancement of Science Teachers in 2008 so we have experience presenting these materials already.

© Activities based on the HST ACS Treasury Survey of the Coma Cluster are available in the

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Deleted: An example of our teacher professional development recruiting webpage and a selection of photos from 2007 workshops is available at <http://mcdonaldobservatory.org/teachers/profdev/>.

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² *Between the Stars: A Professional Development Workshop for Teachers*

Authors: Hemenway, Mary Kay; Redfield, S.

Publication:

BAAS 40, 236, 2008.

³ *Developing the "Multiwavelength Astronomy: Galaxies in a Different Light" Activity*

Authors:

Hemenway, M. K.; Jogee, S.; Fricke, K.; Worhatch, R.; Ruberg, L.

Publication:

EPO and a Changing World: Creating Linkages and Expanding Partnerships ASP Conference Series, Vol. 389, proceedings of the conference held 5-7 September 2007, in Chicago, Illinois, USA.

Edited by Catharine Garmany, Michael G. Gibbs, and J. Ward Moody. San Francisco: Astronomical Society of the Pacific, 2008., p.83

| *StarDate/Universo Teacher Guide*⁴ and online.

Their contents are derived from the PI's work with HST ACS Treasury Survey of the Coma Cluster. All activities have been extensively tested in the classroom.

Additionally, a new high school activity, that is under development and will be completed over the next year, will use content from the deep GOODS-NICMOS survey, where the PI is a

co-investigator.

²<http://www.tea.state.tx.us/teks/>

³<http://www.nap.edu/html/nses/>

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In addition to the classroom activities, the teachers will tour the observatory and share in the life of a research astronomer through mealtimes with the astronomers and tours of their telescope.

To meet our second goal of *providing* teachers with activities they can take back to the classroom, the new *StarDate/Universo Teacher Guide*, includes, among many activities, an activity on Stars and Galaxies and the PI has *StarDate* radio programs online that can be used in conjunction with the Teacher Guide. (These are associated with and tied to her research on the Coma Cluster research)

Other resources that will be produced over the next year that can easily be integrated into the workshop content and/or the materials that teachers take back to the classroom include a DVD on careers in astronomy and a ViewSpace museum show about the Coma Cluster research. Teachers will receive all activities presented in the workshop and expanded versions of those activities on a *CD-ROM* to take back to their classroom. And finally, we arm teachers

with materials they need to inspire their students to consider careers in science and technology

when they get back to the classroom. Teachers take back our Department of Astronomy's undergraduate brochures, and posters to encourage students in STEM careers. Teachers also become acquainted

with the 'What are Astronomers Doing?' website⁵

that describes all the projects going on at the telescopes each week.

Target Audience: The target audience for this proposal is 9 th to 12th grade science teachers who have traditionally underrepresented students. While we will recruit nationally for this workshop, it should be noted that the K -12 education population in Texas is inherently diverse.

In 2005 -6 (the most recent year for which Texas Education Agency has published statistics), 45 %

of Texas's 4.5 million students were Hispanic and 14.7% were Black. Almost 56 % of Texas's

students were economically disadvantaged. Texas has 1,227 school districts spread out in 7,956

campuses (including charter schools).

In Texas, the degree plans that most students will use, beginning with students who were *high school* freshmen in 2007-08 , will require four years of science, instead of the three previously required. At

the same time, by 2012-2013 , Integrated Physics and Chemistry (IPC) will be phased out of

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(<http://www.as.utexas.edu/astronomy/education/UG-Brochure-2007-1.pdf>)

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⁴ *The StarDate Universo Teacher Guide*, Johnson, R. editor, *The University of Texas McDonald Observatory*, pp. 30-37.

⁵ Hemenway, M. K.; Preston, S. L.; Johnson, R. A.; Young, C H.; Connor, P. S.; Summers, A. C.; Tykoski, M. J., "What Are Astronomers Doing?" at *McDonald Observatory: An Education/Public Outreach Website and Museum Kiosk*, *Bulletin American Astronomical Society* volume 36, page 809, 2004.

the Texas high-school curriculum. A new state-mandated Earth and Space System Science course will

be offered. In addition, fourth-year students have a state-approved course in Astronomy among those they can take. With these changes, Texas teachers and students will have a new need for access to standards-based content and to Astronomy experts, to help them effectively

deal with the new curriculum, and the PI can help fulfill this need.

Evaluation: *An outside evaluator, Dr. Cynthia Roberts-Gray with Third Coast Research and Development, will design and analyze the evaluation.* A process and outcome evaluation is planned. We plan both a formative and summative evaluation (Frechting & Sharp, 1997). The team will evaluate implementation to

insure that the project is being carried out according to the timeline, determine whether key milestones are being met, and reflect on accomplishments. *With the help of the evaluator, the team will formulate specific questions about outcomes achieved and lessons learned, and find appropriate methods to address*

these to serve both the needs of the project and NASA.

http://stardate.org/pdfs/teachers/StarDate_teacher_guide_2008.pdf

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Formative evaluation will consist of daily opportunities for open-ended discussion of the content and pedagogy delivered within the activities. At the conclusion of the workshops, focus

groups will form to reflect on the following themes:

• How do the activities and experiences at the workshop support the participants' learning?

• How do the activities and experiences at the workshop support teaching?

• Did the workshop provide an adequate range of resources to meet the needs of the participants?

Two months after the workshop, the participants will receive a questionnaire concerning their implementation of the workshop experience. Four months after the workshop, a sample of

participants will be interviewed concerning their impressions concerning the workshop and how

they have implemented the workshop experience into their classrooms.

8. PRIOR NSF SUPPORT & UNFUNDED COLLABORATIONS

The NSF Building a Bridge to Texas High School Teachers and Students supports the creation of a (check on this because it might be 2 activities. I no longer have a copy of the NSF proposal because you wanted me to dispose of it following Dan leaving it on the copy machine.) galaxy evolution activity using GEM data, presenting teacher professional development workshops at the Conference for the Advancement of Science Teaching to train teachers to use these activities, and conducting videoconferences with the classrooms of teachers who attend the professional development workshops. Additional funding from HST and FAST Tex have allowed us to create a total of five activities on galaxy evolution that can be used in a high school classroom over a one-week period. Each activity builds upon the knowledge gained in the previous activity. Advanced classes can enter into the five-step program at whatever knowledge level is appropriate.

The first of five activities focuses on the differences in galactic structures and how galaxies are classified. The second activity covers multiwavelength astronomy, Wien's Law, resolution, and the different galactic features that can be viewed in various wavelengths. The third activity covers stellar evolution, focusing on colors and masses of different stars. The fourth activity will address cosmology, red shift, and the expansion of the Universe.

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Letters of collaboration are included for unfunded collaborators (Rix, Brandt, Papovich, Peng, Shlosman), whose specific and reasonable contributions fall naturally within the science they are already doing, as outlined in x 2.0.

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The fifth activity provides instruction on how to use Galaxy & Cosmos Explorer Tool

The first three of five activities are complete. We are still in the early stages of planning how to bring cosmology, red shift and expansion of the universe into the fourth activity and use the Goods-NICMOS data. The fifth activity, a six-page student guide for using GCET has been created and field-tested with high-school teachers with positive results. It will be tested soon with students and then released for use.

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A short-course workshop on GCET was presented at the November 2007 CAST meeting in Austin, Texas. Another workshop will be presented at a mini-CAST in 2008-2009. The PI will do the videoconferences with the classrooms of the teachers that attend the mini-CAST during the International Year of Astronomy (2009). And finally, we are working with Google Earth and Sky to make GCET available to Google users.

Developing the "Multiwavelength Astronomy: Galaxies in a Different Light" Activity

Authors: Hemenway, M. K.; Jogee, S.; Fricke, K.; Worhatch, R.; Ruberg, L.

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