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**STEM Faculty Fellows Program 2009-2010 Proposal**

## **Enhancing K12 Physics and Astronomy Teaching and Learning**

### MOTIVATION

High school teachers of physics and astronomy (taught as a component of earth science) are often poorly prepared in terms of content knowledge and understanding, for a number of reasons. Most K12 science teachers majored in life science and took relatively few courses in physics; some schools do not need a full-time dedicated physics teacher and so teachers rotate into physics as needed; and, on the supply side, relatively few physics majors choose K12 teaching as a career. I propose to use 3 units of assigned time to develop NSF proposals aimed at creating a real and online community to support K12 science teachers and to prepare more physics majors for K12 education careers.

This project builds on two existing strengths. First, I led the development of a teacher preparation concentration within the physics major at CSUS. I am currently mentoring the first two students who entered this concentration, and am actively recruiting more. Students work in high school or at Sac State physics classrooms weekly, report on their experiences, and culminate the semester by teaching one class. Second, I like to lead teacher workshops as part of the Science in the River City (SIRC) program run by CSUS. These experiences, while successful individually, demonstrate the need for a more ambitious program which integrates teacher preparation and continuing education, and provides more all-around support to more teachers in ways that they find more useful.

### PROJEC DESCRIPTION AND SCOPE

The monthly workshops, while useful (a comment found on a recent evaluation form: "I FINALLY understand physics!"), attract only those teachers with the dedication and wherewithal to attend in person. Furthermore, workshops can't be finely tuned in advance to the needs of individual teachers. What is required is a community on which teachers can rely for support as needed. This community must include a substantial online component, so that teachers can turn to it 24/7 and access a rich variety of materials including text, graphics, and videos; but it must also have a local, personal component so that it is not merely another website in a long list of Google search results.

As part of the personal component, I will integrate the physics majors who are concentrating in teacher preparation. They are in the classrooms regularly and have direct contact with any issues or difficulties experienced by the teacher. Students in the teacher preparation concentration can help develop teacher workshop materials to address the difficulties they personally see. For example, Newton realized that the Moon, like a falling apple, is in free fall, but this remains a difficult concept to explain. Understanding the motion of the moon requires integrating several concepts including angular momentum, uniform

circular motion, and gravity. Developing effective ways to explain this cluster of concepts would be a suitable special (PHYS 199) or senior (PHYS 191) project. It could culminate in a teacher workshop, but would also include short videos so that teachers anywhere can access it online.

Integration of teacher preparation with teacher continuing education will be just one component of this community. I will further propose to record video of the SIRC physics and astronomy workshops and make them available online, to serve teachers who could not attend, or teachers who did attend but wish to review it later. This concept could be extended to other sciences represented in the SIRC workshops as desired.

Furthermore, I will propose to build an online video library of physics demonstrations. This will be useful in two ways. First, it will give teachers ideas for demos they wish to do in class; and second, it will provide a way to show students demos that may otherwise be too dangerous. For example, Newton's third law can be demonstrated in a fascinating way by mounting a small rocket on a skateboard, but this is inadvisable in a high school classroom.

Currently, one can find free online videos of physics demos (often inadvertent, as in the case of the skateboard-mounted rocket!) IF one knows exactly what to look for, and searches patiently. The proposed community would build a video library both by making its own videos, and by maintaining a organized list of external videos found most useful by the community.

Finally, the community will be tied together by a moderated mailing list and a website. The mailing list will begin with only local people, to encourage the offline interaction and networking which is really necessary to build a community. However, as national and international teachers discover the website, they will also be encouraged to join the mailing list to add their unique perspectives.

This proposal is suitable for more than one NSF call, as listed below. I will use the 3 units of assigned time to work with the STEM center to fine-tune these ideas for each call, and to write proposals aimed at those calls deemed most promising.

#### POTENTIAL FUNDING SOURCES AND DUE DATES

- NSF/CCLI: Jan. 13, 2010
- NSF/ALT (Advanced Learning Technologies): not yet announced for 2010, likely to be due in April
- NSF/NSDL (National STEM Education Distributed Learning): not yet announced for 2010, likely to be due in April