PROPOSAL TITLE: Photmetric Study of an Eclipsing Binary Star.

ABSTRACT:

The sabbatical leave will afford the opportunity for personal and professional growth through scientific research, specifically the study of an eclipsing binary star. Doing science benefits teaching science because it keeps me interested, and thus benefits students. The primary outcome will be the publication of a computer model of an eclipsing binary star. Staying active in research will improve my ability to convey to students how science is done. Data collected and the astrophysical parameters determined by the model will be available for anyone to examine, and may be presented in a flex workshop. Students will gain exposure to someone who actually does science, and might get an opportunity themselves for a little taste of the excitement of probing the unknown, and that is a benefit. The department, college and district get a teacher, who is engaged in the scientific process, stays energized by it, hopefully infects a few students with the same love for it, and is available to assist other faculty with similar interests.

Proposal:

Need for Sabbatical

1. How does your proposed activity meet the need for professional and personal growth?

I am a scientist. To me, that means doing science. Not teaching it, or reading about it, or working problems in a textbook. To me being a scientist means making a contribution to the fund of scientific knowledge by doing research and publishing it. Nothing is more important to me personally or professionally. Research collaboration with astronomers at SDSU is the primary aim of the sabbatical proposed here.

2. How does your proposed activity benefit (please address at least three of the following):
   a. the students

      From studies I have read, no convincing link has been found between research activity and teaching quality. In my personal experience, there is one question that students often ask that I am sure I answer better as a current researcher than otherwise, and that is, How do they know? For example how do astronomers "know" the temperature at the center of the Sun or stars? That is a question about modeling. My research publications have been in the areas of modeling eclipsing binary stars, from observations, and modeling chemical reaction dynamics from first principles, i.e., *ab initio*. I would be much less effective at explaining to students how science is done and how scientists "know" things, if I had no research experience. Continuing

to do research as I am able will clearly benefit the students. I have a paper almost ready to submit for publication right now, and I want to do much more.

Research also keeps me EXCITED about science. My enthusiasm for Astronomy comes through to my students. They frequently mention it in student evaluations comments, and appreciate it. It has been noted in my peer review evaluations. Most of us have had to sit through lectures from instructors who just don't care, and it's tough to pay attention to that, let alone learn anything.

b. the institution

Faculty active in research benefit the institution in part by benefitting the students. Students ask questions about research, which can be better answered by a researcher. Students ask questions about graduate school and careers in research, which can be better answered by a researcher. The institution gets a faculty member who stays alive and engaged and enthused about science. This is repetitive, but given the warning in the proposal instructions, there is no choice.

Besides the benefit to the students, having an active researcher around may benefit other faculty. For example, a full time physicist from Grossmont assisted me in starting my own research program in an area of astronomy I had never considered: astrometry. Moreover, I learned how he was teaching Grossmont students to do this same research, earn Honors Program credit for it, and get a publication in a peer reviewed journal that they can cite on their resume. I would like to do the same for Cuyamaca students. I am on a task force currently that seeks to start an honors program at Cuyamaca. I would not be on that task force if it were not for my physics mentor at Grossmont.

The relationships I develop in the SDSU astronomy department could benefit Cuyamaca. The Cuyamaca science department chair and I would like to create a Life in the Universe course that would be transferable to SDSU. The Grossmont physicist I mention above has already designed such a course and pitched it to the SDSU Astronomy department. No dice. They will not accept the course. The Grossmont professor is very capable, and made sure his course had everything Southwestern's Life in the Universe has. Southwestern's course is accepted by SDSU. Too bad, so sad. NO DICE. SDSU Astronomy will not give a good reason for turning down Grossmont's course, except to say that they can accept or reject any course for any reasons they want. The Southwestern astronomers are SDSU Astronomy insiders. For a time they were both adjuncts there (adjunct at SDSU does not mean paid instructor). I have a plan within a plan. As an RA, who already has a Ph.D. and is

willing to work for nothing, I will collaborate with someone on a research project, and in the meantime ingratiate myself with the department. I sincerely want to do research with them, but the collaboration will also serve as a means to turn my trench coat collar up and infiltrate their department. When the time is right, I will pitch the Cuyamaca Life in the Universe course, but unlike the Grossmont prof, I will have become an "insider." If I succeed in getting their ok on our course, I think Life in the Universe would be a very popular course at Cuyamaca.

c. the community

The community gets a better scientist if I continue to pursue research. Pure science has unpredictable benefits to society.

d. The discipline/contribution to scholarship

Well, this one's tough. It seems to me research is the best example of scholarship. It's tough to find a sentence that contains one of the words, without the other. Outstanding scholars contribute original research. I can't think of any more to say.

3. Describe the relevancy of your activity to your current/new assignment and the improvement of student learning.

As previously discussed, I am a scientist. My current assignment at Cuyamaca is Astronomy Professor. The activity I want to do is astronomical research, so the relevance to my current assignment I would say is self-evident. Regarding student learning, once again, an active researcher can better explain to students how science is done than someone not in the game. Someone with research experience can also advise students interested in a research career, and even provide interested students with a chance to contribute to research. Co-authorship on a publication looks good on the resume. I'll say it again, research keeps ME excited about science, and the students benefit from that.

Description of Overall Activity

4. Please provide a brief description and purpose of the proposed sabbatical leave activity.

The primary purpose of the sabbatical is to provide time for eclipsing binary star research. As it stands, I currently have a paper almost ready for submission to a top astronomical journal. I am currently incorporating into the paper some suggestions from my collaborator. But part time research is slow going. The sabbatical will give me time to get more done. A secondary research program will be astrometry of non-eclipsing binaries. I have enough data to begin writing an astrometry paper, and the sabbatical will give me time to get that published.

Specifically, for the primary project, I want to observe light from two stars orbiting one another, and alternately eclipsing one another ("eclipsing binaries"). The light will be observed through several passbands. This type of observational work is called "photometry." Computer software will be used to "model" the system, providing a wealth of information about the individual stars, and even interactions (if any) between them.

The secondary project, the astrometry project, involves measuring the positions of individual stars as they orbit one another. In this type of work, you have to be able to see both stars. The stars in eclipsing binaries are so close together, the stars cannot be seen separately.

All of this work will be published in peer-reviewed astronomical journals.

5. Please provide a clearly defined set of objectives and the course of action to achieve those objectives that are consistent with the purpose and nature of the proposed leave.

For the eclipsing binary project, the first objective will be finding a collaborator at SDSU. A collaborator is desirable for three reasons. 1.) Though I have written a Master's thesis in the form of an eclipsing binary study (incidentally that work appears in E.F. Milone's book, *Light Curve Modeling of Eclipsing Binary Stars*), I want to learn much more about modeling eclipsing binaries, from professionals who do this all the time. SDSU Astronomy specializes in this business. 2.) I want to learn the use of the latest, most powerful computer codes for modeling eclipsing binaries. SDSU Astronomers have the codes and can teach me. It would be incredibly good luck if they offered their Binary Star graduate course during the sabbatical, but I'm not counting on that. 3.) Page charges are very expensive. If I have an SDSU co-author on the paper, the SDSU Astronomy department will pay for the publication. A willing research assistant with a Ph.D. already in hand, who works for free, I am hoping will be enough to interest someone in collaborating with me. An SDSU Astronomer gets his name on a publication, while I do most of the dirty work.

The second objective can be pursued in parallel with the first. The second objective will be choosing a suitable eclipsing binary for observation. This requires a literature search, which is well under way. Ideally, to get enough data for the computer modeling project, the object will not require more observation time than the length of the sabbatical. The chosen object must be bright enough given the observational tools available, some on my own property, some at SDSU's Mount Laguna Observatory. There is much to be considered in choosing an appropriate object; far too involved a problem to delve into here.

The third objective will be to submit to SDSU's Astronomy department a proposal for observing time on one of their telescopes. This may not be necessary if the object is bright enough that good data can be obtained using my own equipment on my home property.

The fourth objective will be to collect data by observing the object through filters of various passbands, in other words, photometry, as introduced above. In parallel, I would be learning the use of the powerful computer codes mentioned in objective 1.), above.

The fifth objective will be to use the observational data to model the eclipsing binary system. This does not happen overnight. Computer modeling is not "plug and play."

The sixth objective will be to write up the project and submit the paper to an Astronomical journal for publication. The sabbatical will be long over before the paper appears in print.

For the astrometry project, the first objective is: keep going until there is enough data for a paper. I have about reached that point. The second objective is to write up the paper. That will not take long. This is simple work. The third objective is to submit the paper to the Journal of Double Star Observations. The Journal of Double Star Observations is one source of data for the Washington Double Star Catalog, maintained by the United States Naval Observatory. It is the world's principal database of astrometric double and multiple star information. There I will take my place alongside one of Astronomy's greatest: William Herschel, a prolific contributor of double star measures.

6. Please address the feasibility of the activity by discussing:
    a. A proposed timeline that is appropriate to the activity
    b. The availability of appropriate resources

If my sabbatical is granted, the search for an SDSU collaborator will commence immediately, and the literature search for a suitable target will continue. I am sure by the time the sabbatical starts, a suitable eclipsing binary will have been targeted, and perhaps observations will already have begun. I can't be sure that all the data needed will be acquired during one season, but the sabbatical will greatly speed up the process. If all the data is acquired during the sabbatical leave, I would estimate about six months of additional work before a paper could be submitted for publication. An awful lot depends on the complexity of the system and difficulty in modeling it.

Resources I have, in spades. I am an experienced observer at Mount Laguna Observatory, and I am sure I can get time on those telescopes. In addition, I have a research grade telescope and all the required auxiliary equipment at home. It's a MONSTER telescope, permanently mounted in concrete and housed in an observatory dome. Bigger than the huge one I've been seen carting to campus in my hatchback. I live at moderately high altitude and under moderately dark skies, conditions that are not as good as at Mt. Laguna Observatory, but pretty good. It is possible I won't need Mt. Laguna Observatory at all.

Outcomes

7. Clearly describe the expected outcomes of your activity.

Early on, data. A "light curve" of the system, going through its full cycle of eclipses, observed through several passbands, will be generated through photometric observations.

Later, a computer model of the various parameters of the system. I could list them, but it would be very technical and I don't think very useful here.

Eventually, a publication in a peer-reviewed astronomical journal. But that cannot be expected to be realized by the end of the sabbatical period.

8. What evidence will you submit to demonstrate the achievement of your outcomes?

Data, and plenty of it. Graphs of light curves. Intermediate results of the computer model, or perhaps the finished model. Again, I won't have a paper out by this time next year. If so desired, I will present my research at a flex week workshop or to the Governing Board (I'm sure they'd be fascinated.).