Viewpoint...

LAPTAG—A Physics Outreach Program at UCLA

By Walter Gekelman

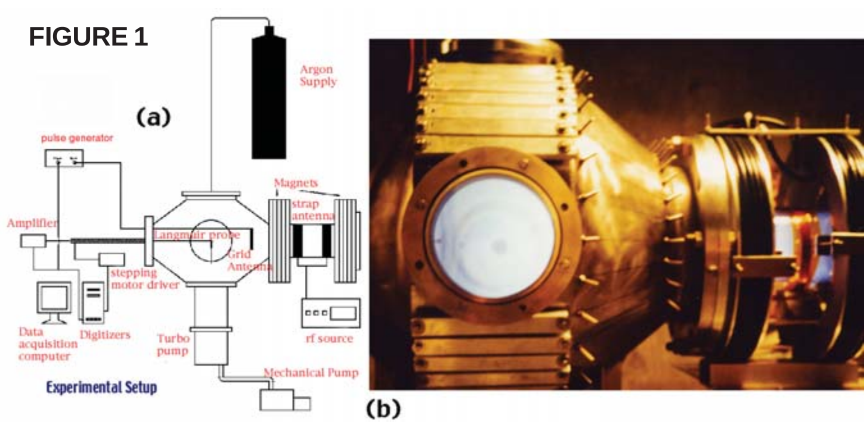
I have taught undergraduate physics courses at UCLA since the late 1970's. As the years rolled by it seemed, to me, that the incoming students' mathematical background and general science preparation eroded little by little. The natural thing to do was to blame the high schools that sent them to us on a wave of grade inflation.

In 1993, at the urging of one of my colleagues, I attended a meeting sponsored by the AAPT on encouraging the formation of alliances between universities and high schools. I went to the meeting under the assumption that it would lead nowhere and give me a perpetual right to gripe. There were several presentations about alliances (mostly involving several high schools and not universities), but what struck me was the great number of high school teachers present who were very interested in their craft: teaching. It was obvious that those present were dedicated and loved their work. In the afternoon we broke into groups based on physical proximity of schools and the group I was in decided to form an alliance which exists to this day. We called it LAPTAG (Los Angeles Physics Teachers Alliance Group).

At the outset most of our activities consisted of going on tours of many fascinating laboratories at UCLA and then expanding this with tours at USC, JPL, General Atomics fusion laboratory, and the Mount Wilson observatory. We also met on Saturdays and discussed education reform and classroom demonstrations. About ten other alliances formed the day of the meeting and we are the only one that survived. I believe the reason for this is the introduction of projects to our venue. We used one of the computers in my plasma physics laboratory as a web server and hosted a website for every school. In those days this meant teaching the high school teachers and their students how to write HTML and download pictures. Now most of the schools have servers of their own and some have sophisticated websites. We still host websites for about a dozen schools as well as the LAPTAG home page (http://coke.physics.ucla.edu/laptag).

The first substantial project was funded by the University of California Office of the President. It involved earthquake study (we have small temblors in Southern California nearly every day). We secured funding to buy 10 seismometers that interfaced with PC's and gave them to schools that were interested. Two of the LAPTAGer's were geologists and gave us lectures on what earthquakes were and how to bury the seismometers. We also had a series of lectures on ways to complement what they were learning in school. At this time we wrote a proposal to the NSF education division to substantially expand the project (we also had several hundred thousand dollars in matching equipment and software) but met with a great deal of frustration. We did not neatly fit into any of their programs and gave up after trying twice. Although several schools are still using the seismometers, a high point of that project was a presentation of six posters at the 1998 APS March meeting in Los Angeles. We brought a schoolbus full of high school students to the meeting and they had a wonderful and exciting time presenting the results.

FIGURE 1



(b)

Our next project was the construction of a plasma physics laboratory, which would be for the exclusive use of LAPTAG. I am a plasma physicist by trade and the Department of Energy (DOE) has now supplemented one of my grants three times in the past three years to help with the project. We used a surplus vacuum chamber and bought some refurbished pumps, gauges and so on. This was supplemented with "spare" equipment from my lab. The machine features a helicon source, which is safe and very easily run. The high school teachers and their students designed the antenna, solenoidal magnets, as well as the vacuum flanges with some help from one of my colleagues, Pat Pribyl, and myself. Ten additional LAPTAG students and teachers built the machine over the course of a summer. It has now been running for about three years. **Figure 1** shows the experiment and plasma.

In the past three years we have, with financial support from the DOE, added a computerized stepping motor control system (built and programmed by the students), 4 channels of 100 MHz digitizers, and soon an optical fiber based spectrum analyzer. Data is acquired using Labview software, and Visual Numerics has donated a copy of PVwave for data analysis. The high school students and their teachers use equipment and software similar to what we use in our research laboratory.

One of the experiments is on ion acoustic waves. The waves are launched by a grid antenna and detected by a Langmuir probe, which is moved with respect to the grid.

The propagation velocity of a toneburst is used to determine the plasma electron temperature (**Figure 2**). In a parallel experiment on sound waves in air the students measure the sound speed and air temperature. The speed of the two waves is compared. This is complemented by lectures and a lab manual (both on the website).

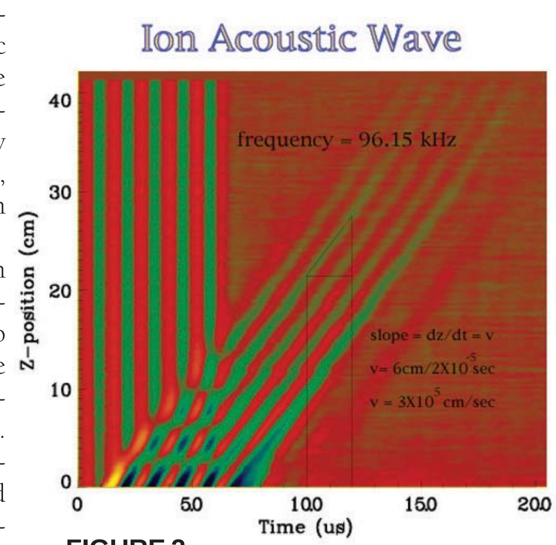


FIGURE 2

In some sense the tide of science education has turned towards large programs, sometimes involving many universities and still more high schools. It is a way to try and solve the problems that seem to plague our secondary school system, in one fell swoop. It is also heartening to see that other scientists working with middle and high schools. Perhaps one of these programs will work; time will tell. LAPTAG has not set out with any such ambition. It is a purely local attempt to have high schools benefit from the resources of a nearby University. Although the LAPTAG teachers have had many discussions about what a high school syllabus should be, and have followed and debated the content of the California and national standards with interest, we are savvy enough to know we can't change any of this. These are political decisions. From our experience with the NSF Division of Education we also realized that programs such as ours are not fundable from their point of view. We have no close connection to graduate schools of education and the vocabulary necessary to write a successful grant proposal, and from what we know now, no desire to administer

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We can summarize what we learned so far with the following points.

- Universities have a great deal to offer high schools.
- For an alliance to be successful it must have projects.
- The involved faculty in both high schools and universities must be committed.
- Expect no monetary resources — you must get them yourself.
- National aspiration will get in the way — it's all local.
- Don't expect quantitative outcomes.

LETTERS, *from page 4*

We Don't Mess Around in Texas

Last November *Physics Today* published a book review written by Hans Bethe — "*Edward Teller: A Long Look Back*," about the Teller "*Memoirs: A 20th Century Journey in Science and Politics*."

This review is just about what one would expect to see in *Physics Today*. It opens with the phrase "In his fascinating Memoirs..." and ends with "I strongly recommend the book."

A somewhat different review of "*Memoirs*" appears in a recent issue of *The Texas Observer* (7/5/02), by Anna Mayo. Its title is "And the Shark Has Pretty Teeth, Dear."

Since most APS members 1) have probably read Bethe's *Physics Today* review and 2) probably don't subscribe to *The Texas Observer*, I'll quote a bit more from the latter review. She begins as follows: "When the review copy arrived, I couldn't bring myself to touch it; a horrid thing, it gave off poisonous vapors — like an alchemist's toad. Finally, using tongs, I managed to get it up on the shelf alongside the autobiographies of Judas Iscariot, Dr. Strangelove, and Faust."

It goes on: "The toad-like book is the memoirs of Bohr's sometime pupil, the Hungarian-born physicist Edward Teller, who achieved worldwide fame as 1) Betrayer of J. Robert Oppenheimer, and 2) Father of the Hydrogen Bomb.

"Since our Dr. Faustus is ninety-something and in failing health, his book may be seen as a last effort to prove that he's not a heel."

Near the end: "But he is to be condemned not only for having played Judas to Oppenheimer, but for adhering to the belief, in the face of unchallengeable evidence to the contrary, that low-level radiation is a beneficial agent of evolution, that it weeds out the weak to produce a super race.

"Together with his sponsors in the military and industry, he is to be condemned for the deaths of uranium miners, of victims of the atomic tests in the Marshall Islands and Nevada and of persons living in the vicinity of nuclear power reactors; for promoting the Star Wars anti-missile system so favored by the present administration; for promulgating false studies to cover up these deeds against humanity; for having sanctioned the persecution of scientists such as Linus Pauling, Ernest Sternglass, and Teller's ultimate nemesis, John Gofman."

Obviously there are differences of opinion regarding Teller, his "*Memoirs*", and his work. As I said at the beginning, we don't mess around in Texas.

Robert A. Levy
Austin, Texas

Machines Can't Defy Entropy Either

In the August/September 2002 *APS News* I read that the APS Executive Board approved a resolution that calls claims of perpetual motion machines fraudulent. While I applaud the resolution, I believe that there is a more important need to also include "entropy-defying machines" into the ranks of fraudulent claims. Many proposers of such devices do not deny the existence of the second law of thermodynamics. They argue that entropy-decreasing systems are energetically possible, just unlikely. Then they argue that a clever scheme (machine) could be fabricated that would make it possible to overcome the thermodynamic () T/T) efficiency limit.

In my area of expertise, solar cells, the unfortunate situation has developed that solar cell device schemes have been proposed that promise unbelievably high conversion efficiencies (>70%) for two-terminal solar cell device structures converting the solar radiation spectrum into electricity. The high conversion efficiencies arise from concepts where it is suggested that the energy in excess of that required to excite an electron-hole pair to the "collection energy level" (*i.e.*, the semi- conductor band edges in a conventional semiconductor solar cell) would not be necessarily lost to thermalization. Such arguments, I believe, artificially separate the generation of carriers (electron-hole pairs) and the collection of such at the terminals of the device, thereby leading to the illusion that the thermodynamic limit could be overcome. Such schemes come from authors that are well respected in the field, and papers proposing such solar cell schemes have passed the muster of the review process in AIP journals.

Bolko Von Roedern
Golden, Colorado

BACHELORS *from page 1*

ity and magnetism, thermodynamics, and the other basics of physics to his students. He uses the equations of motion, light, and sound to design problems, experiments and demonstrations for his classes.

In one lab that White teaches, students watch a videotape of a NASCAR race. They use the speed of the car, given in the "in-car telemetry" on the tape, and the time it takes to reach the finish line to graph the motion of the car. White then has the students calculate the average acceleration from their graph, and determine the length of the straightway.

White has also developed a digital library of short physics video clips for his students. They include shots of skateboard crashes, skiing accidents, car wrecks, and bungee jumps, that he uses to spark class discussions on physics in real life.

"Students love them," says White. "Most of them are either amazing or funny, but they all demonstrate some concept in physics. This summer I carried a video camera around with me pretty much everywhere, and captured everything from rainbows to the inside of my lawnmower engine when I was working on it. It's a great way to get students interested in learning physics."

Wilkins uses the same equations of physics as an animator. It can be a lot more realistic to simulate the way dust swirls, a bridge sways, or clothing moves, using a computer than drawing it by hand, he says. The same equations of motion that govern how a ball falls and bounces in reality are used to create the effect on screen. The real challenge, according to Wilkins, is simplifying the equations without compromising the appearance of reality.

"The question is, how can we take a complex simulation that would take forever and pull out the time-consuming pieces that don't add to visual impression of accuracy? Sometimes, that can involve pushing things too far in that direction and then fixing them."

Wilkins says that the first few weeks of a shot are spent experimentally figuring out what parts of the simulation must stay, and what can go. "We constantly get funny results," he says, "like things interpenetrating each other. In *Shrek*, there were a lot of instances where the characters would walk away and leave clothing behind for an instant, before it caught up with them."

Both men agree that while some of the skills they use in their jobs, such as teaching techniques and computer programming, were gleaned outside of their physics education, studying physics gave them both a serious advantage.

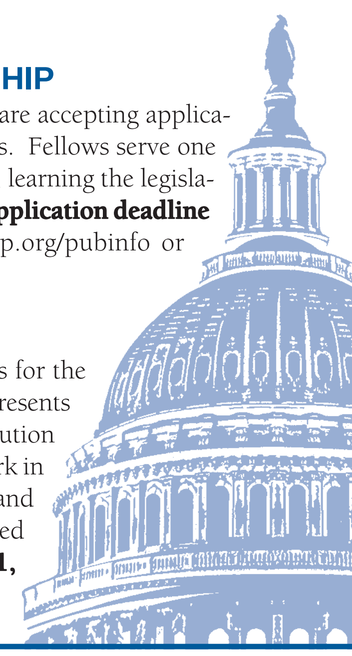
"Majoring in physics has absolutely given me advantages far beyond just learning the equations," says Wilkins. "It taught me analytical problem-solving skills – how to see each piece of the problem, and then rule out the part that troubles me to get to the solution."

White says for him, one of the best things about studying physics as an undergraduate was that it taught him how to be a student.

"I think that to teach effectively, I have to put myself in my students' shoes," says White, "and anticipate prior misconceptions about the subject. My physics major laid the foundation for me to be able to learn physics to a point beyond merely passing the exams and other requirements as an undergraduate; it gave me the ability to learn on my own to the point that I can always strive to be a more effective teacher by learning more about my subject."

ANNOUNCEMENTS

FELLOWSHIP PROGRAMS



APS/AIP CONGRESSIONAL SCIENCE FELLOWSHIP

The American Physical Society and the American Institute of Physics are accepting applications for their 2003-2004 Congressional Science Fellowship programs. Fellows serve one year on the staff of a Member of Congress or congressional committee, learning the legislative process while lending scientific expertise to public policy issues. **Application deadline is January 15, 2003.** For more information, visit: http://www.aip.org/pubinfo or http://www.aps.org/public_affairs/fellow/index.shtml

AIP STATE DEPARTMENT SCIENCE FELLOWSHIP

The American Institute of Physics (AIP) is now accepting applications for the AIP State Department Science Fellowship. This fellowship program represents an opportunity for scientists to make a unique and substantial contribution to the nation's foreign policy. Each year, AIP sponsors one fellow to work in a bureau or office of the US State Department, becoming actively and directly involved in the foreign policy process by providing much-needed scientific and technical expertise. **Application deadline is November 1, 2002.** For more information, visit: http://www.aip.org/mgr/sdf.html

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Wilcox is teaching English this semester in Hefei, China. She will start studying for her master's degree in physics at Brigham Young University when she returns.

Lauren Glas worked for the SPS national office at the American Center for Physics.

"I didn't have a typical science internship," Glas said, "but I had one that really fit my education. Coming here and getting a chance to go to the hill was amazing. I thought that there weren't a lot of people interested in changing science policy before I got here, but I realized that it's not that policy doesn't change and people don't care, but that the system is huge, and it takes a long time to change."

Glas worked on a project called the SPS Outreach Catalyst Kit (SOCK). The SOCK looks like a denim Christmas stocking and is filled with materials that can be used for SPS physics outreach programs. The SOCK Glas designed is called "Dimensions in Physics," and contains foam shapes that can be used for scaling exercises and rainbow glasses that demonstrate how light bends. They will be used by students of all ages.

The fifth intern, Jason Tabeling, also interned at the SPS national office. There, he created a website to help publicize the William F. and Edith R. Meggers Project Award, which has gotten few applicants over the past few years. He also helped Glas prepare the SOCK kit.

"I got pretty good at using a turkey carver to cut mattress foam for the shapes," he joked.

"There are a lot of people who think physics is hard to understand," Tabeling said. "The public perception isn't always positive. One question I tried to answer was, 'educating people about physics is difficult, so how can we make it easier?' "

Tabeling graduates this year with a double major in physics and math, and minors in astronomy and Spanish from Virginia Tech.

The interns' advisors were very excited about what the students accomplished over the summer.

"Katie's report will be required reading for engineers that are going back into solar mission research," said Fred Herrero, her advisor at NASA. "I'm very enthusiastic about the work that she has done."

The internship program began last summer with Mark Lentz, a physics major from the Northwestern State University SPS chapter. The internship, which pays a $2,500 stipend in addition to living and travel expenses, is accepting applications for next summer.

SPS members interested in applying should visit the SPS website at http://www.spsnational.org/programs/interns.htm to download the application form, or contact Liz Dart Caron at (301) 209-3034 for more information.

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and assess it, although we fully understand why program assessment is important to the NSF. Our tactic has been to utilize resources available at UCLA, spare equipment and small grants, to do what we can. Since UCLA is a large university and the **La**rge **P**lasma **D**evice (affectionately called the LAPD) Plasma Lab has resources as well, building the high school plasma lab was possible. One can't be as ambitious at a smaller college, but something always can be done. It all depends on a resource more precious, the dedication of a group of people[1].

Is LAPTAG a success? The participating teachers have certainly benefited and had a good time. They are involved in designing and teaching laboratory experiments using sophisticated equipment not available in their schools. In addition they and their students can relate measurements in the LAPTAG plasma lab to the physics and math they are teaching. I have had a good time working with the teachers and students and am happy to donate the necessary hours. As for the high school students it's hard to say. There was a tremendous variation in the students that have come through the plasma lab. Some were, in my opinion, good enough to skip whatever they had left in high school and directly come to UCLA or any other university. Others were there for the ride, sometimes accompanying friends. None of them seemed bored, some were downright enthusiastic. At the very least they completed the lab with a feeling about how science is done. Who knows, one or two one day may be first-class scientists. So is LAPTAG a success? Maybe.

Walter Gekelman is Professor of Physics at the University of California, Los Angeles. This article is based on his presentation at the Physics Department Chairs Conference at APS headquarters in June 2002.

1. When asked what the most valuable thing in the world was, a Chinese philosopher answered "The head of a dead cat, because no one can name the price." Perhaps our group is of equal value.

NSF BUDGET *from page 1*

major research equipment and facilities construction. How prospective projects under this account are evaluated and prioritized for funding has been the subject of congressional concern and several hearings.

In general, the National Science Board approves a list of projects for inclusion in future NSF budget requests, but those projects are not ranked in any priority order. However, both reauthorization bills would require the NSF Director to develop, for the Board's approval, "a list indicating by number the relative priority for funding under the Major Research Equipment and Facilities Construction account that the Director assigns to each project the Board has approved for inclusion in a future budget request."

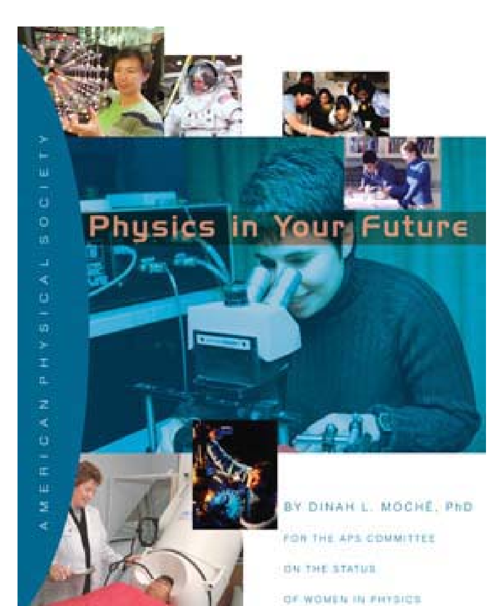
The Director would be required to report annually to Congress on the latest Board-approved priority list, the criteria used to develop the list, and "a description of the major factors" that determined each project's ranking on the list.

Among other provisions, the Senate bill would require the Board to "explicitly approve any project to be funded out of the major research equipment and facilities construction account before any funds may be obligated from such account for such project." It also calls for the Director to conduct an assessment of the needs for major research instrumentation by field of science and engineering and by type of institution.

The full text of both bills (S. 2817 and H.R. 4664) can be found on the Library of Congress web site at http://thomas.loc.gov.

—*Audrey T. Leath*

Physics In Your Future



At right is the redesigned cover of the booklet *Physics in Your Future*, which profiles seven young, female physicists, who have careers in industry, government labs, and academia. It was written by Dinah L. Moché, author of "Astronomy Today," and "Amazing Rockets," and produced with support from the APS, Bell Labs-Lucent Technologies, IBM, the Xerox Foundation, NEC, and GM.

The booklet is an updated version of one with the same title published in 1983. It is designed to show middle and high school girls the kinds of careers open to them if they study math and science before college.

The booklet is free to students, educators, guidance counselors and groups who work with young women. To order copies, please visit http://www.aps.org/educ/cswp/index.html.