continued from page 15
transfer from the collapsing bubble occurs very rapidly and with high efficiency.

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I Get No Thick from Champagne

The paper by Neil E. Shafer and Richard N. Zare (October 1991, page 48) was a pleasure for somebody like me, who has used for years examples from everyday life such as the formation of bubbles in beer to teach transport phenomena to engineering students. However, my pedagogical form of the problem is slightly different from the issues addressed by Shafer and Zare.

The question I ask my students to consider is the following: Why is the foam formed in a beer glass so stable that one may actually cut it with a knife, while the bubbles that form in a champagne glass result in a quickly subsiding foam? Champagne (one hopes) has a slightly higher alcohol content, but the strongest beers one may buy in Europe are right up there with the lightest champagnes. Thus the difference in alcohol content, though possibly significant for explaining the widespread preference for champagne over beer, cannot be invoked as the basic reason for the different foam behavior. Shafer and Zare's initial argument about the equilibrium between the gaseous CO_2 under the cap and the liquid being upset when a beer bottle is opened also doesn't furnish any clue. Granted, a champagne bottle gets flamboyantly uncorked rather than absentmindedly opened, but the physical effect is just the same: Pressure is suddenly relieved, as the fizz accompanying the beer bottle opening and the pop accompanying the champagne bottle uncorking reveal. The pop, of course, is much more spectacular than the fizz—but the difference in foam behavior is still left unexplained.

So wherein lies the difference? I use this problem to illustrate the fact that phenomena dominated by interfacial forces are tricky. The difference in foam behavior is related to the stability of the thin films between the bubbles in foam; unstable films collapse, the bubbles coalesce, and the foam subsides. Film stability is influenced by the Marangoni effect:[1] When mass transfer is taking place (in this case, when CO_2 is being desorbed to the gas phase), the thin films are or are not stable depending on the *sign* of the derivative of surface tension with respect to concentration. The thinnest regions of the films between adjacent bubbles are the ones with the lowest CO_2 concentration; hence if the derivative is positive, the surface tension is locally the lowest, resulting in an unstable film, and vice versa.

The sign of the derivative may well be influenced by the presence of trace components (for instance, proteins coming from the malted barley in beer, or even, God forbid, surfactants added to second-rate beers to increase head retention). Such trace components, to the general satisfaction of champagne drinkers and to the partial justification of the ethics of champagne manufacturers in establishing the prices of their wares, may indeed be as important to foam behavior as they are to taste.

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Textbook Authors, Rewrite Old Wrongs

Your special issue on pre-college education (September 1991) discusses many new programs for improving physics teaching but doesn't make much evaluation of the existing programs and how they can be improved within existing frameworks—for example, books distributed by major publishers.

The involvement of professional physicists and astronomers has led to great advances in junior high school science texts in recent years. As an astrophysicist, for example, I became involved a dozen years ago with *Scott, Foresman Physical Science* and *Scott, Foresman Earth Science* (the latter includes much astronomy). Though we professional scientists don't have free rein in determining the content of junior high texts, and overlapping state requirements must be met, we were able to make our books much more accurate, up to date and interesting than previous junior high texts in wide use. It was shocking how inaccurate and how badly explained much of the existing material I looked at was; the content of junior high books just shouldn't be left to junior high and high school teachers and to editors alone, since they apparently don't understand the material well enough to explain it clearly. The junior high books led to the elementary school series *Discover Science*, which is also much more interesting and accurate than previous texts on that level.

One mustn't ignore the mainstream just because some much smaller project may be flashier. I have done what I can to add clear explanations of interesting material to junior high texts, and I hope that many other scientists can join the good fight. Further, if we all pressured local and state school boards to make accuracy (instead of merely readability) a requirement, the next generation of texts would be helped.

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Let *PRL* Readers Review the Referees

Richard Greene (January, page 96) complains that the "uneven, subjective nature of the referee process" makes publication of a paper in *Physical Review Letters* an unreliable indicator of research quality. Since promotions and grants often depend on publication success in *PRL*, many authors feel cheated when their work is rejected by that journal while similar (or possibly inferior) work is accepted. Greene therefore proposes abolishing *PRL*, while the journal's editors respond that it serves its purpose. We believe both he and the editors have missed an obvious solution: Let the readers referee the referees!

A simple reader response page inserted into each issue would encourage feedback to the editors, referees and authors. Readers could rapidly check off "Yes" or "No" to three easy questions on each article: "Did you read this Letter?" "Was it of sufficient importance and quality to warrant rapid dissemination in *PRL*?"

"Is it relevant to your own research?"

The first two questions directly gauge interest and importance. The third addresses whether *PRL* is meeting its goal of informing researchers about results outside their own fields. Reader feedback would help the editors to evaluate their referees and the review process, diminish the apparent arbitrariness felt by contributors, and focus the journal on topics of broad interest to physicists.

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Big vs Little Science: A Lesson from Alvarez

The small science–big science debate can use the wisdom of the late, great Luis W. Alvarez. Luie started in the Radiation Laboratory at Berkeley when nuclear physics was small science. His first important work, the experimental proof of K capture, was done in the days of "love and string and sealing wax."[1] His later efforts and discoveries contributed to nuclear physics' growth from small science to big science. Here is what he had to say about entering big science as it is today:[1]

"There is no way a person with my personal qualities could go into either nuclear physics or particle physics at the present time. The table of contents of the latest issue of *Physical Review Letters* lists three particle physics papers with multiple authorships. The first two papers each have 72 coauthors, taking up fifteen lines—exactly the same names, in the same order—and the third paper lists 46 coauthors. I can't believe that I could ever have derived any satisfaction from being listed as the 37th in a group of 75, or as the 337th name on the list of 500 that will soon characterize the papers coming from the large European electron–positron colliding-beam accelerator near Geneva. I once saw a cartoon over the desk of a person working in one of these huge collaborations; it showed two men chained to a trireme oar, pulling as hard as they could. One said to the other, 'If it weren't for the honor of the thing, I'd rather do something else.'

". . . Most of us do physics because it's fun and because we gain a certain respect in the eyes of those who know what we've done. Both of those rewards seem to be missing in the huge collaborations that now infest the world of particle physics."

The men who have successful careers today in nuclear and particle physics are the power brokers, the managers, the administrators and the politicians of big science. Regardless of their limited technical contributions they have absolute power to approve publication of all papers from their laboratories. Luie conscientiously avoided a career as an administrator except for two years on the disastrous Materials Testing Accelerator. He said those years nearly did him in as a scientist.[1]

According to Luie,[1] only those with a herd mentality fit as willing cogs on the wheels of the bureaucratic machines of big science—among which I would count the Superconducting Super Collider, the space station, the Mars expedition and controlled (*sic*) thermonuclear power. None of these megaprograms addresses the needs of the taxpayers who are forced to support them. All four are in serious technical and engineering trouble. Aristotle warned about building pyramids that serve only the purposes of a priesthood and impoverish those who must pay for them.[2] (See my letter in PHYSICS TODAY, December 1988, page 129.)

Luie's career shows that the creative, nonconformist, inventive Alvarezes of the world in physics and other sciences could put the vast sums wasted on big engineering programs to much better use.

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Students and Teachers Need to Face Facts

A lot has been said recently about the number and quality of American science students. Many of these discussions fail to come to grips with the facts.

There is considerable confusion between quality and popularity of courses of study. A popular course need not be of high quality. A good teacher need not be a popular one. (The fallacious nature of student opinion polls is well known.[1]) Physics is harder to teach than most other subjects. Any campus-wide comparisons can only make us look bad. Students also need to understand that education is a job, not entertainment. It is the work everyone is expected to do prior to gaining admission to paid employment.

If students can no longer learn "first year" physics in two semesters, then we should require that they take three or four semesters. If we really believe all college graduates should know some physics, then it is up to accrediting agencies to demand that physics be required of all graduates. If all the students that need science were required to take (and learn) it, credit-hour production would be increased.

Since scientific knowledge has grown over the years, it is likely that four years is no longer adequate for an undergraduate degree. This time probably needs to be increased, with the added credit-hours going to required science and math courses.

There is, however, no reason to expect that we should train as many physicists as we do, say, business majors. Nor would one expect the costs to be identical. In fact, I would argue that the most important goal of physics education would be to offer training to the one or two Einsteins who come around every couple of generations. We don't create such people; we should simply be there to serve them. Nor can we expect them to find their way to the Harvards or Princetons. History shows us they don't necessarily choose such prestigious institutions.[2] Nor can they necessarily afford them.

We also must teach *facts*. You cannot teach a person "how to think" without first providing him or her with facts to think about. In reality, you can recognize an intelligent person by the insatiable appetite for more and more facts.

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A New Form of Nuclear Blackmail?

Unemployed scientists and new science graduates looking for work will be interested in a report in *The Los Angeles Times* (24 January 1992, pages A1 and A10) that the Bush Administration is preparing an initiative to ensure full employment for an estimated 2000 nuclear scientists in the former Soviet Union, including US-funded jobs and positions at uni-