LETTERS

Another Approach to Introductory Physics: Focus on Unifying Micro- and Macrophysics

The diverse comments expressed in "Letters" (April, page 15) regarding Joseph Amato's article in your December 1996 issue reflect the difficulties and frustrations encountered in attempting to develop a satisfactory new approach to the introductory physics course while maintaining an organization that follows classical macrophysics rather than building the course around the fundamental concepts of microphysics.

The problem appears because the empirical evolution of classical macrophysics was based on sensorial experiences, which resulted in well-defined branches associated with those experiences (that is, mechanics, heat, sound and optics). Then more branches—not directly related to macroscopic sensorial experience, electromagnetism and "modern" physics—were tacked on at a later date. This approach, even when each classical branch is looked at from a modern point of view, is not amenable to the unifying story line advocated by many educators. The result is that students are left with the feeling that physics is an aggregate of disconnected, disjointed and apparently unrelated sciences.

In our opinion, the only way to show students that physics has a unifying story line is by making them aware—from the very beginning—that the current model of the physical universe is based on the following six assumptions: (1) the universe is composed of distinct entities, or particles, each with well-defined properties; (2) anything that happens in the universe is the result of interactions among the particles; (3) there are only a few distinct fundamental interactions; (4) interactions are described in terms of fields, which are generally time dependent and propagate as waves with finite velocities; (5) in all interactions, certain quantities are conserved; and (6) the conservation principles are related to certain symmetries observed in the universe.

Obviously, one is not going to throw all the above ideas to the student on the first day of the course. As with all stories, these ideas, which constitute the substratum, or essence, of physics, have to be gradually brought to the student's attention as the course progresses. At each stage of the course, these fundamental

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ideas should be used to explain the diverse phenomenology associated with macroscopic empirical physics in a more unified and coherent way, thus dressing up the story line. For example, one can show that the properties of systems composed of a very large number of particles are made manifest macroscopically as the phenomenology known as heat; the notion of waves serves to explain the phenomenology associated with acoustics and optics; and, above all, electromagnetic interactions between fundamental particles serve to explain most of the macroscopic properties of matter. It is this connection between micro- and macroscopic physics that gives students a unifying view of the physical universe.

One final, very strong opinion: All courses are composed of lectures and laboratory. The lectures are needed to develop the story line, and the laboratory helps students develop other skills, as well as affirm specific physical facts. There is no need to maintain a close connection between the two as the course evolves, but they must complement each other as much as possible.

We have been using this approach since 1967 with satisfactory results and have refined it in our latest book,[1] which incidentally is mentioned in Amato's article. Our experience has been that students acquire a much better understanding of the physical universe when presented with such a story line and become enthusiastic about physics as a result.

Reference

1. M. Alonso, E. J. Finn, *Physics*, Addison-Wesley, Wokingham, England (1992).

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Keeping Scientist from Cuba Out of US Was Right Thing to Do

Some comments on the story about scientific exchanges with Cuba, published in your July issue (page 55):

The Cuban regime is a dictatorship. Many people don't understand the meaning of living under such circumstances because it is outside of their personal experiences. I was a kid when Fidel Castro took the power in my country. On behalf of a false patriotism, we were nurtured to support and even to participate in acts of injustice, repression, abuse, insult and humiliation.

In 1992, 18 Cuban professionals (engineers, professors, scientists) signed and sent a letter to the Cuban government demanding official respect for human rights in Cuba. The answer was quick and harsh: All of us were fired from our jobs at universities and research centers. According to the official explanation, we were traitors, mercenaries, agents of imperialism. We embarked on a long, hard struggle just to keep our dignity.

I don't know whether any American scientists condemned this injustice. Maybe they were too busy working in their labs and exchanging scientific information. But real life in my country is so crude that scientific commitment, in one sense or another, runs beyond the labs. Probably, the kind of scientific information that would have been acquired by the University of Havana's Luis Montero Cabrera, had he been allowed into the US, would not have threatened US security. But whatever that information would have been, I suspect he would have put it in the hands of the Cuban dictator without hesitation. The price for his refusal would have been too high. I know it, he knows it, every Cuban knows it.

I can understand why Cornell University's Andrew Albrecht found Montero's exclusion "horribly disappointing." However, I would like him to realize that the more than one million Cubans (including many scientists) who are forced to live in exile continue to be horrified by the violation of the human rights of the more than ten million people living in Cuba.

Castro once said, "For us, everything is politics." In my opinion, Montero's trip would have been, at least, yet another excuse to perpetuate the Castro dictatorship.

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California Traffic Has Been Making Kinematic Waves since Fifties

In his letter to PHYSICS TODAY (April, page 96), Michael Thusen proposes that a model for traffic flow on California freeways be developed, if it has not been done already. He can rest assured that it has been done; such a model was developed more than 40 years ago, when freeways were still