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LETTERS (continued from page 15)

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 pa-

triotism, 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

free from congestion.¹

The traffic-generated waves Thusen mentions are kinematic waves described by the equation

$$\frac{\partial Q}{\partial t} + C \frac{\partial Q}{\partial x} = B,$$

in which Q represents a volume flux, C the speed of the wave and B a local production term, and t and x denote time and distance, respectively. These waves are essentially different from dynamic waves, such as waves on the ocean surface. Newton's equations of motion do not play a role in kinematic waves (other than, perhaps, by linking the wave speed to the volume flux), as they do in dynamic waves, which exist because of the inertia terms in the equations of motion. Rather, kinematic waves owe their existence to the conservation of volume or mass, when a relation exists between the discharge, concentration and position.

Kinematic wave theory has been used to describe traffic flow on long crowded roads, as well as to characterize flood waves traveling downstream on long rivers and to model the response of glaciers to changes in surface accumulation.

On California freeways and highways elsewhere, kinematic waves are generated by drivers, especially aggressive ones, as they weave in and out of traffic, annoying and cutting off other drivers and thus aggravating unsuspecting people farther back who have to suddenly slow down for no apparent reason. Because the wave velocity is somewhat less than the mean speed of cars, these people can accelerate only gradually as they make their way through the kinematic wave.

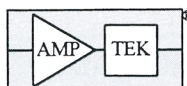
Reference

1. M. J. Lighthill, G. B. Whitham, Proc. R. Soc. London Ser. A, **229**, 317 (1955).

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Earth Science Beckons to Physicists Taking Quantitative Approach

In his review of two books on planetary volcanism (PHYSICS TODAY, March, page 77), Don Anderson is absolutely correct in pointing out that much fascinating and important work remains to be done, and that the field "is ripe for exploitation by physicists." Their abilities and interests would greatly compliment the valuable but often relatively nonquantitative contri-



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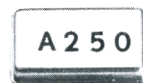
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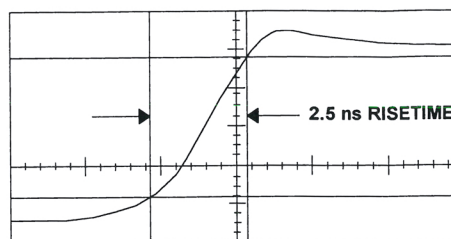
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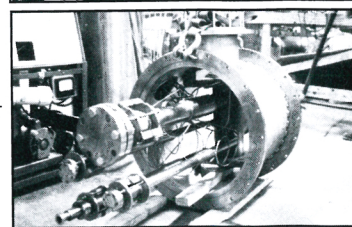
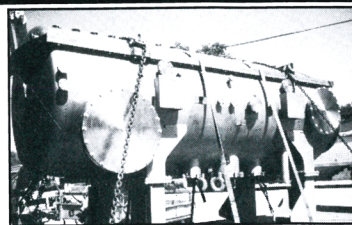
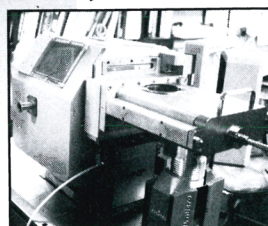
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