Secondly, Wolfenstein misinterprets this as merely being anti-Soviet policy. This contention is as fallacious as it is obnoxious. Even a cursory look at the names of the people involved will show that these supporters span the entire political spectrum.

Individual scientists in the US and Canada stood firm on principle last summer after the infamous Soviet show trials. They reacted because the Soviet government forced them to. They focused on the Soviets because their violations of the rights of scientists were the most flagrant and repugnant. They focused on the Soviets because the Soviets had indeed signed numerous international agreements (not the least of which was the Helsinki Agreement) whose letter and intend they were now violating. And all this was happening at a time when the Soviets were urging more joint cooperative efforts in order to reap the benefits of *our* science and technology.

Yes, scientists every where should protest human-rights violations around the world and support organization such as Amnesty International. But in human rights as in physics, just as we need generalists we need specialists to help focus our attention on problem areas.

MOREY SCHAPIRA
4/30/79 *Sunnyvale, California*

THE AUTHOR COMMENTS: My letter was in no way meant to imply that supporters of Scientists for Orlov and Scharansky were politically motivated. Many of these scientists are my friends, and I admire and share their commitment to human rights. Also, I did not mean to oppose the setting up of an organization by scientists specifically designed to defend the freedom of fellow scientists. I do feel that it is inappropriate and in the long run ineffective to set up an organization directed solely towards human-rights violations in the Soviet Union and ignoring violations in other countries.

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Jupiter bewilderment

In recent televised and reported interviews, members of the science team observing the data being received from Voyager 1 as it encounters Jupiter report being "happily bewildered." Specifically, they refer to the apparent atmospheric phenomena in the region of the "giant red" and other spots.

The high-resolution visual images of these features (which were, incidentally, taken through optical systems designed by the author of this letter while he was employed by the Jet Propulsion Laboratory) reveal these spots to appear to be swirling vortices of immiscible liquids. Since the members of the science team state that they are bewildered, I would like to propose an electromagnetic hypothesis to explain the phenomena.

Jupiter is known to have powerful magnetic fields around it. Just north and south of the Red Spot are bands that are revealed, by successive images, to be moving in opposite directions. Assuming these bands are somewhat conductive, they would develop large electric currents of opposite polarity. Highly charged particles in a magnetic field travel in a spiral track, and large numbers of them would appear to swirl in a vortex pattern. Furthermore, assuming different ionic species with different electromagnetic properties, there might be some bunching of these species as in a mass spectrometer, and if these species also have different optical characteristics, they might appear to behave separately—as would immiscible liquids.

LEONARD LARKS
3/1/79 *West Covina, California*

More on energy conservation

The comment made by Willem Van Gool in March (page 9) was useful in pointing out common glosses in the initial thinking of physicists approaching the energy problem. I would like to offer a couple of addenda, one on the restricted subject and one on the wider context of those comments, which suggest that the initial thinking is not that far off.

Van Gool uses the thermodynamics of irreversible processes to argue that higher-efficiency thermal processes require lower processing density and hence larger investment in energy and money for capital equipment providing a given production rate. This is a reasonable argument on the trade-offs available within a fixed technology, but not in the presence of a growing technology associated with an active scientific community. The reason for this is that the thermodynamics of irreversible processes involves "phenomenological coefficients" which, aside from symmetry conditions, must be supplied from outside the theory, that is, from technology. The prime example of technology widening the choices in energy trade-offs is the heat pipe. Invented a few decades ago, it allowed power-conversion machinery to be made smaller and more efficient and more productive all at once. The waves from this invention are still building.

The energy problem is not an energy shortage; there is far more power incident on our planet and streaming near by it than we can want to use in the near future.[1] The problem is the cost of the machinery to concentrate, transport and convert this power to the form and den-

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sity that we need. The major challenge to science and technology is not to improve efficiency at greater capital cost, but to reduce capital cost per watt/m^2 of power delivery in the desired form. The range of technological options so far employed for this purpose is small. We typically use the cheapest working substances, like water vapor, for our heat engines and find that we are priced out of the solar energy market by the cost of the small high-pressure, and large low-pressure, boxes required to house it. We have hardly begun to use solids as the working substances in heat engines,[2] though they hold potential for high-density power conversion without high pressure. Spending more on the working substance may lead to lower total capital cost per watt and open a vast power resource currently outside our economic reach.

References

1. J. E. Drummond, R. N. Drummond, "Solar Power Satellites Revisited," Proceedings of the Energy Technology V Conference, (1978); page 495.
2. J. E. Drummond, "Miniature Solar-Electric Power System," Proceedings of the 12th Intersociety Energy Conservation Engineering Conference (August 1977).

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4/8/79

Roads to greatness

In his editorial (March, page 144), John Wheeler has given us deep insights into Albert Einstein the thinker. However, his advice to our aspiring young friends appears to be violated by Einstein himself. Following the example of Einstein, a young aspirant would:

- drop out of high school
- skip many classes in college
- apply for graduate studies and fail to get an assistantship
- submit his own research without a thesis advisor and without taking any graduate courses or passing a qualifying examination. (Einstein did receive his PhD from Zurich. I wonder if this can be done today at any US university.)
- work on a great variety of research problems. (Today, a research program involving relativity, Brownian motion and photoelectric effect simultaneously may indeed be judged as incoherent.)

May I also mention that Einstein was not an isolated example among the great scientists. Following Willard Gibbs, a young aspirant would be designing gear teeth before carrying out any research in physics. Following Michael Faraday, he or she would spend many years in bookbinding. Following Gregor Mendel, he or she would be a monk! Among our contemporaries, Eugene Wigner studied chemical engineering and John Bardeen worked as a geophysicist in the petroleum industry.

The only obvious conclusion is, there is plenty of variation. Not all great scientists follow the stereotyped storybook career of quick transition from high-school valedictorian to renowned physics professor.

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4/16/79

More English vs. metric

I was very much surprised when I read the letter from William Abler on "English versus metric" (May, page 15). In this letter he mentions the following reasons which, he says, are usually given for the superiority of the metric system over the English, and states his reasons for preferring the English system.

- "The units can be recovered if they are lost, because they are based on the circumference of the earth." He says that this is a weak argument because other units might be devised which would be equally recoverable. Of course other such units might be devised, but does that fact affect the superiority of the meter over the foot? Later in his letter Abler suggests that if we were to adopt a new unit, it should be based on the nautical mile because "that really will never change." Any unit whatever could be defined, as the meter now is, in terms of the wavelength of a particular color of light. This is not a reasonable ground for choosing any particular unit of length.
- "Metric arithmetic is easy because units are related by integral multiples of ten." He admits this is an advantage but comments—as he did for the previous point—that other systems could be devised that would have the same advantage. Again, this is no argument against the metric system but it is a powerful argument against the English system. Consider, for example, how many square feet there are in an acre.
- "The European Common Market uses the metric system." This, he says, "is purely economic and may explain why US industry has been more hospitable to metrication than the general public. But it is not the reason that responsible scientists will want to promote." Why not? If something that is good for science (and the metric system would not be so universally used in scientific work if it were not) is also good for world trade, is that an argument against it? A footnote by the editor (page 108) points out that the metric system has been adopted not only by the Common Market nations but by the entire world, with the exception of Brunei, Burma, Liberia and Yemen. Abler would have us join these more backward nations in this respect.
- "The English system is messy." Everyone can agree with that! But, says Abler, "Surely, the badness of one system is no argument in favor of some other." I say it *is* an argument in favor of one that isn't so "messy" or so hard to learn. He compares the size of the standard foot with the size of the human body and points out the same dimensions, such as height, may be approximated by a small integral number of feet, while the corresponding values in meters involve fractions. If you do consider this an advantage for English units, at least it is a very minor one.

Abler wants a system "that will serve people's needs and make them comfortable." It seems to me that the metric system will serve people's needs much better than the English system does. With inches, feet, yards, rods, furlongs, miles (both statute and nautical), acres, Avoirdupois and Troy weights, tons (long and short), quarts (dry and liquid), pints, gallons, pecks, bushels—can you imagine much greater confusion? These are things that children have been expected to learn in grammar school, in addition to grammar. How much simpler and more easily learned the metric units will be!

As for comfort, it is true that those of us who have been brought up on the English system will be uncomfortable with the metric units until we become familiar with them. Children now in school are already learning them.

It is also true that some expense will be involved in making the change, though I understand that those industries that have already begun the use of metric units have found it considerably less expensive than had been predicted.

I should like to make one comment not related to Abler's letter. The accepted pronunciation of "kilometer" places the principal accent on the first syllable, *kil*-o-meter. There are two good reasons for this: it is consistent with the pronunciation of other units such as centimeter, millimeter, kilocycle, megacycle, kilogram and so on; and words that are accented on the second syllable are names of *instruments*, such as thermometer, barometer, hygrometer, and so on. Query: How do you define "micrometer"? Here—unless you use the "micron" or change the name of the instrument—the context must dictate the accent.

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6/4/79

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William Abler thinks it is not sufficient reason (to use the metric system) "that everyone else is doing it." The reasons he gives for retaining the English system seem good to him because he is familiar with that system. But if we measured each quantity by a unit that gave "good