not for the purpose of purchase but to represent its holder's success, security, prestige, power and importance. So it is with the arms race. Some of our own weapons are more of a threat to us than the USSR, and if security is the goal, they make no sense. But security is not the goal, arms are.

▶ As scientists we understand earthquakes, eclipses and the like in terms of natural laws. But neither primitive nor modern peoples think this way. For them, things must be personalized. Why is there an earthquake? The gods are angry. Why is there evil in the world, why are there social problems and unpleasant changes? Because of the devil, the Jews, multinational corporations, the Soviet Union. Of course there is evil in the Soviet system, and it aggravates many problems. But if everything is blamed on the USSR, what is the chance of our policies bringing us closer to peace, and what is the chance they will make things worse?

▶ The Russians have 984 missiles and we have only 897. We're behind! One might think that, considering the differences in the two nations' security needs and arms stockpiles, it would be impossible to judge requirements by elementary means, by simple arithmetic. But rational decisions are difficult; simple numerical comparisons are easier. What is the chance of simple arithmetic giving wise decisions? Thinking is hard, which is why we have developed so many ways to avoid it.

These are the problems facing the US, the USSR and every one of us. Human irrationalities create and define the scientific problems, which are difficult, as many scientific problems are. Our responsibility is to find the means of overcoming them, to solve the problems and to keep the human race (and the rest of the Earth's biosphere) in existence. What should be done? For a scientist the first step is obvious: strive to understand.

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10/84

Nuclear spin waves

When several of our fellow scientists read your news item entitled "Nuclear spin waves seen in dilute polarized gases" (June, page 19), they asked me something like "I thought you just observed spin waves in He^3/He^4 mixtures—why haven't they mentioned your work?" I could only reply that the news was mostly about observations in *dilute, nondegenerate systems* and that our work was on concentrated, degenerate solutions at temperatures far below the Fermi temperature. However, when one considers the final paragraph or two of the report, my excuse seems somewhat lame. It is not clear why the experiments done in Jülich (Phys. Rev. Lett. **51**, 2120 [1983]) were ignored, despite the clear demonstration of spin waves in the helium mixtures ("the degenerate case") and the excellent fit of the data to the appropriate theory (Platzmann and Wolff, Phys. Rev. Lett. **18**, 280 [1967]). It is even less understandable when one realizes that our work should have been known to Bertram Schwarzschild; it was described by one of us in an invited talk at the same Washington APS meeting to which he refers in his report.

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Clarify the language of science

In your September editorial (page 144) you point out that to improve science education in high schools and colleges, we need to first increase public appreciation and acceptance of science.

I suggest that one of the factors that has prevented many nonscientists from pursuing an interest in science is inherent in its very language. By this I am not referring to the technical vocabulary, intimidating as that may be, but to the many common words that have been appropriated into different areas of science with highly specific meanings. Such terms constitute "paradoxical jargon" in that they are part of the specialized language of science, and yet, because of their common meanings, may not be recognized as such.[1]

The possibility that multiple meanings confuse science students was mentioned in a letter by Francis Throw in your July 1983 issue (page 96), but he concluded that there is no real problem because the particular meaning is clear from context. I suggest that this is often not the case. To illustrate my point, I once overheard a college counselor trying to explain specific gravity to a first-year physics student. If the student wasn't confused after hearing about "particular" or "unambiguous" gravity, I certainly was. It is not easy to apply the concept of specific gravity without realizing that the "specific" in this case means "compared to water" and not "particular." In addition, some words have different meanings in different areas of science. "Plasma" in biology is entirely different from "plasma" in physics. Something "radical" in government has little to do with either a methyl "radical" or a square root "radical." Such multiplicity of meanings can easily result in radical

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(extreme) confusion.

Although to the science-oriented individual the specific (particular) meanings of such words are obvious and may be determined readily from context, people who are not science-oriented may fail to understand what they are reading or hearing simply because they don't realize the words are being used in any sense other than the common ones. Because they are not understanding what appears to be ordinary English, they assume they can't possibly understand science, and we are on our way to reinforcing the alienation from the scientific and technological fields that has developed over the past decade.

As scientists and educators we have an obligation to do what we can to reverse this alienation. One step is to recognize jargon when we use it in the classroom or community, and a second is to be sure our listeners realize that such words are indeed technical terms. Science teachers in college and high school should not assume that discussing or illustrating technical concepts is sufficient. The best explanation of potential difference will not be successful if the student is thinking "possible" or "different ability" rather than "voltage." The whole concept of ideal gas behavior is lost if "ideal gas" is assumed to be the brand of gasoline that gives the best mileage.

Admittedly, this awareness will not in itself make the public more supportive of science education; but if those who are not science-oriented become more comfortable with the language itself, then they might find that science is not quite so strange and intimidating after all. And that would be a beginning.

Reference

1. P. A. Gowaty, Animal Behav. **30**, 630 (1982).

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Identifying the Higgs boson

In the article entitled "Has the Higgs boson been seen in the Crystal Ball?" (October, page 18), there is a common misconception that your readers should be alerted to in case other small, narrow resonances are discovered in the $c\bar{c}$, $b\bar{b}$ or $t\bar{t}$ resonance regions.

You state that a normal $b\bar{b}$ resonance "would obey e–μ–τ 'universality.' That is to say, because it couples to lepton pairs only by way of an intermediate virtual-photon state, a decaying heavy meson would have roughly equal branching fractions to e^+e^-, $\mu^+\mu^-$ and $\tau^+\tau^-$." The statement is true for the example you use, the upsilon (9.46 GeV), but many other $b\bar{b}$ states decay to lepton pairs in a "universality"-violating way. Consider, for example, the $^1S_0$ state of a bound $b\bar{b}$ system. The lepton-pair decay modes of this pseudoscalar meson strongly favor the $\tau^+\tau^-$ channel. As a matter of fact, the decay width is proportional to the square of the lepton mass just as it is for the Higgs—but, at first sight, for an entirely different reason: helicity suppression. Vector (and pseudovector) couplings prefer to conserve helicity. Vertices that involve helicity flip pay a penalty depending on the lepton mass. This argument is familiar to many particle physicists as the explanation for the π meson's preference to decay to $\mu\nu$ rather than $e\nu$.

In the case of the Higgs decay, there is no vector coupling. The reason the Higgs prefers to decay to the heaviest possible lepton pair is linked to its role as generator of mass. The cancellation of ultraviolet divergences in the $SU(2)\times U(1)$ gauge-field theory depends on the mass dependence of the Higgs coupling to leptons being the same as the mass dependence of helicity-suppressed decays. So it is no accident that the Higgs and $^1S_0$ mesons decay to lepton pairs in the same way.

I have attempted to calculate the decay rate for all $b\bar{b}$ states into lepton pairs. Those that violate e–μ–τ "universality" also tend to have exceedingly small decay widths, even to $\tau^+\tau^-$; these widths are much smaller than those that a Higgs in the 10-GeV mass region would exhibit. (These calculations have very large uncertainties, however.)

In conclusion, if a narrow resonance is found in the mass region of the $c\bar{c}$, $b\bar{b}$, or $t\bar{t}$ mesons, whose decay rate to a lepton pair is proportional to the square of the mass of the lepton, it is not necessarily the Higgs. It might be one of the many meson resonances that must decay to leptons of equal helicity.

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The gyroscope experiment

The article by Barbara Levi (May, page 20) on the "Orbiting test of general relativity" is misleading in several respects. A subsequent letter by C. W. F. Everitt (August, page 84) partially clarified the situation in one respect but then confused it in other ways.

Referring to the work of B. M. Barker (University of Alabama) and myself, Everitt quoted a 1974 paper of mine, completely ignoring many relevant subsequent contributions. In addition,