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12/88

Herman Feshbach and Victor F. Weisskopf seem to follow the textbook writer's maxim: "If my book cannot answer it, the question is foolish." But those of us who entered physics to satisfy our curiosity about nature continue to ask until we have answers.

I do not challenge the claims regarding the successes and range of validity of quantum theory. But I do challenge the implied notion that quantum mechanics explains all and it is a waste of time to search for something more complete and descriptive of nature. I cannot stop asking why charge exists but atoms are neutral, why electrons are so light compared with nucleons, why energy is proportional to frequency, why the velocity of light cannot be exceeded, why the Lorentz transformation holds or why time only advances. All of these questions relate to observed reality, and I was under the impression when I made my career decisions that physics existed to explain reality.

Defenders of an intellectually bankrupt theory inevitably fall back on the word "language." Mathematics is taught and used because it is more precise than any language, but transcends all languages. The question of whether a theoretical particle can or cannot have precise values of position and momentum depends on the mathematical meaning given to the particle. This very point is in fact one of the failures of quantum mechanics. According to the universally used Copenhagen interpretation, one must think of two entities, the wave and the corpuscle. After pretending through all the mathematical equations that the wave is the particle, we jump ship to the corpuscle before comparison with experiment. The probability relation between the two cannot be avoided, ever, if we are to be consistent. Perhaps if quantum theorists would decide just what a particle is, the popular press would stop playing games with the concepts.

There are many who regard quantum mechanics only as a steppingstone to the real truth of nature, and nature is surely never inconsistent. Future historians will no doubt marvel at our mastery of technology and empirical science, but regard us as hopelessly infantile in the realm of understanding. For the future of humanity on Earth, let us hope that not everyone stops asking foolish questions.

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10/88

FESHBACH AND WEISSKOPF REPLY: Most of the letters are based on a misunderstanding of what we meant by "an inappropriate question." It seems that the term "inappropriate" was inappropriate. What we meant was expressed in our column as follows: "Observations are formulated in the language of classical physics.... But classical physics concepts are not always appropriate for the description of atomic situations."

Any question that an experimental setup is supposed to answer is necessarily formulated in terms of a combination of classical concepts. If this combination is not appropriate to the quantum mechanical situation, quantum mechanics can only give probabilistic answers. This is due not to an intrinsic indeterminacy of the quantum world but to the limited applicability of classical concepts to microscopic objects. We definitely did not mean that such "inappropriate" questions should not be asked. They are justifiably asked in many important applications of quantum mechanics.

Certainly quantum mechanics is odd in many respects. The fact that classical concepts are not appropriate to atomic reality is odd in itself. Although the EPR experiment is based on rather elementary quantum relations, it surely contains odd features such as the nature of the correlation between measurements at two distinct locations, as David Mermin pointed out in his article in PHYSICS TODAY (April 1985, page 38). There is much more to say about quantum mechanics than we were able to cover in a short comment.

HERMAN FESHBACH
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1/89

SSC: Don't Name This One for the Gipper

I would like to express my worries regarding the politicization of the so-called Ronald Reagan Center for High Energy Physics.

What has happened to the space program over the last decade should be taken as a serious lesson by the high-energy physics community. After space scientists worked within political channels and with the military establishment, increased resources for basic space research seemed assured. Instead we have seen NASA slowly change from a high-quality, largely scientific agency that sent men to the Moon and uncovered the secrets of the solar system into an unreliable arm of the military. Low-cost, high-yield scientific missions meant to follow the incredibly successful planetary flybys of the 1970s have been canceled, mothballed or postponed in favor of incredibly expensive and questionable missions chosen by the politicians and the military—"Star Wars" tests, the space station and so on.

There are already three signals that suggest that the high-energy physics community will be taken down the same political primrose path. The first is the well-known interest by the Pentagon in particle beams for the SDI program. The second was the choice of the home state of the President-elect, Speaker of the House and chairman of the Senate Finance Committee over Illinois as the site of the SSC. The third is the naming of the SSC the Ronald Reagan Center for High Energy Physics.

This is not a question of Democrat versus Republican or increased versus decreased military spending. This is a question of how far scientists will allow the politicization and militarization of pure science. Let us not forget that Fermilab was named after a great physicist, engineered by great physicists and has produced great basic physics. Enough SSC deals have been cut. Let us have the moral courage to tell the politicians that the SSC will be called the Richard Feynman Center for High Energy Physics and run by scientists for science's sake, or it will not be built at all.

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1/89

Who Perceived the Perovskite?

In the *Physics News in 1987* article by Raymond Jeanloz (PHYSICS TODAY, January 1988, page S-45), it is claimed that "it was also in 1987 that perovskite-structured silicates were *found* to make up the bulk of our planet" (my italics), with reference given to work by Jeanloz and Elise Knittle.[1] In my view, this statement grossly distorts the facts. If the synthesis (or "discovery," as Jeanloz terms it) of high-T_c superconducting oxides began the "year of perovskite" in the physics community, the "year of silicate perovskites" began in 1974 and 1975 when I synthesized (Mg,Fe)SiO_3, (Mg,Fe,Al)(Al,Si)O_3 and $CaSiO_3$ perovskites.[2] If the year of silicate perovskites began when they were claimed "to make up the bulk of our planet," then the year should be 1982, when I concluded that "about half of the Earth, either by weight or volume, is composed of ferromagnesium silicate with the perovskite structure."[3] What Knittle and Jeanloz found is that "[$(Mg,Fe)SiO_3$] perovskite can exist throughout the pressure range of the lower mantle." This, however, does not warrant their claim of having *found* that silicate perovskites make up the bulk of our planet. One has to first show that the lower mantle is most likely to be composed of ferromagnesium silicates, as I did in 1982. The results of Knittle and Jeanloz merely support and confirm my 1982 claim.

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5/88

JEANLOZ REPLIES: Lin-gun Liu, one of the pioneers in the use of the laser-heated diamond cell, is the discoverer of the high-pressure silicate perovskite phase. He was the first to show that the dominant minerals of the Earth's upper mantle, olivine [$(Mg,Fe)_2SiO_4$], pyroxene ($MgSiO_3$ and $CaSiO_3$) and garnet ($Mg_3Al_2Si_3O_{12}$), all transform to the perovskite-rich assemblage at pressures of about 15–30 gigapascal. These conditions correspond to the top of the Earth's lower mantle, which spans pressures of 24–136 GPa. The importance of the work that Elise Knittle and I carried out was in demonstrating that the Mg-silicate perovskite phase is stable to pressures of 127 ± 10 GPa. That is, the perovskite is stable throughout the entire depth (pressure) range of the lower mantle, the largest region of our planet's interior ($>60\%$ on an atomic basis). As it has long been accepted that the deep mantle consists of Fe–Mg oxides and silicates,[1] our results imply that $(Mg,Fe)SiO_3$ perovskite is the single most abundant phase of the interior. The exceptional stability of the silicate perovskite is surprising, both on crystal-chemical grounds and given the phase equilibria observed among a wide variety of perovskites.[2] Because all of Liu's synthesis runs were at pressures estimated to be below 30 GPa and none of his experiments involved *in situ* analyses of samples at lower-mantle pressures (virtually all were quench-product studies), he had no basis either in experiment or in theory for concluding that the perovskite is stable throughout the deep mantle. Thus, our work documents that Liu's synthesis of silicate perovskite is one of the most significant mineralogical discoveries of the past 10–20 years.

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RAYMOND JEANLOZ

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The High Price of a Low Cost of Living

In the March 1988 issue (page 80) it was reported that an AIP survey indicated that physicists' median "cost of living adjusted" salaries are significantly higher in Albuquerque than in Philadelphia because a greater percentage of physicists in Philadelphia are employed at universities and because the cost of living is higher there. It is worth devoting some thought to what these numbers mean.

Although *median* university salaries are lower than those at government and industrial labs, the best-paid professors earn considerably more than the best-paid staffers at labs. Arguably this is because highly paid professors bring in large contracts and lead substantial research groups and therefore should be compared to lab managers and not staff. However, leading professors' "large" groups generally number fewer than 20 postdocs, students and technical aides, and their budgets are a few hundred thousand dollars. Lab managers who earn comparably high salaries are responsible for the expenditure of millions of dollars a year while their staffs number 50 and up. If we compare university physics departments with lab staff and *low-level* management, we find that the ratio of highest to lowest salary in a university physics department is roughly 3, while at an industrial or government lab it is about 2.

Although most full professors earn their keep, the effects of the wide salary distribution at universities are serious. At the low end are assistant professors who work hard, have no job security and spend their "vacations" trying to get a little research done. If fewer young people are considering academic physics as a career, is it any wonder? Low rewards at the high end in government and industrial labs are also a problem, forcing the most experienced staffers to give up research for management or to leave for academe to improve their financial status.

Turning to "cost of living adjusted" salaries, isn't the cost of living high in New York or Boston or California because many people like these places? Isn't it simply competition for desirable houses in desirable locations that drives up their price? Doubtless a house like mine would cost several times more in New York or La Jolla. But access to the Metropolitan Museum of Art or Lincoln Center or a first-class library or a good Italian restaurant just is not available here. Looking out over Albuquerque's arid west mesa, it is easy to imagine that you are at the beach. Unfortunately it's an 800-mile walk to the waves. Most people consider certain cultural or natural advantages important to their *standard* of living. What your news story blandly called the "cost of living" includes the price of these advantages. Sure my cost of living is lower in Albuquerque, but only until I want to go bodysurfing or look at a Picasso or see a Broadway show. For those of us who like living in the boondocks there is a financial advantage. But there is no reason to shed tears for those who want to be nearer to the action.

PETER FEIBELMAN

6/88 *Albuquerque, New Mexico*

Keep Colloquialisms Out of Colloquia

Communication, both written and oral, is a vital ingredient of scientific research. Many books have been published on teaching scientists better writing skills. As an expatriate American working in a country where English is not the native language, I am aware of a failure on the part of some native English speakers during oral presentations at international meetings. Granted, English is the accepted language of scientific discourse, and any competent scientist can read it and usually speak and understand it. But one should not assume that scientists whose native language is not English can understand a talk given in rapidly spoken English with colloquial and even slang expressions thrown in. Yet this is frequently how talks are given.

I encountered one particularly bla-