

'Nonadiabatic' Solar- ν Solution's Significance

I enjoyed the lively update on solar neutrinos by Bertram Schwarzschild (October, page 17) except for one blemish. He did an excellent job of conveying the excitement of the latest experimental results and the implications for physics beyond the standard model, but he gave the impression that the significance of the "nonadiabatic" Mikheyev-Smirnov-Wolfenstein solution was only realized in the recent paper of John Bahcall and Hans Bethe. In fact it had been realized long before.

The different types of MSW solution to the solar neutrino problem are contained in the original papers of S. P. Mikheyev and A. Yu. Smirnov, but the detailed properties of the nonadiabatic solution were first elucidated in 1986 by James M. Gelb and myself¹ and independently by Edward W. Kolb, Michael S. Turner and Terence P. Walker.² In particular, it was stressed at that time that the nonadiabatic solution could lead to a very small signal in the gallium experiment, whereas the adiabatic solution always gives a gallium signal close to the predictions of the standard solar model.

In 1988 the Kamiokande II collaboration reported its initial findings at the Munich conference, and Gelb and I immediately realized that the central value of R , the ratio of the observed to the expected signal, fell within the narrow band predicted by the nonadiabatic solution and within the broader band of the "large-angle solution," but definitely outside the range of the adiabatic solution. Unfortunately, the errors at the time were too large to allow one to draw any definite conclusions. We did observe that "were the error on the preliminary value 15% instead of 30%, then the adiabatic solution could be excluded at the 2-sigma level," and we pointed out that the gallium experiment could be used to distinguish between the nonadiabatic and large-angle solutions.³

I repeated these remarks in January 1990 at the Moriond workshop and was emboldened to argue that the gallium signal should be well below the standard-model predictions. Subsequent events have borne out this picture far better than I could have hoped for. The latest result on R from the Kamiokande II collaboration maintains the same central value as in the original Munich report, but the error is now reduced by a factor of

two, and the preliminary SAGE result is, as the whole world knows, much smaller than expected. I, for one, most certainly hope that this trend continues in the future results of both SAGE and GALLEX.

The purely numerical analysis by Gelb and myself was put on a secure and relatively simple footing by Wick C. Haxton,⁴ Stephen J. Parke,⁵ and Arnon Dar, A. Mann, Y. Molina and D. Zaifman⁶ using the Landau-Zener approximation. Exact analytical results were subsequently derived by Dirk Notzold⁷ and P. Pizzochero.⁸ This work, together with our original observation that the mass difference factor times the mixing angle is roughly 3×10^{-8} eV², leads to a simple modification factor for the spectrum of electron neutrinos arriving at Earth, namely $\exp(-9/E)$, where E is in MeV.

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10/90

Public Sees Physicists in the Wrong Light

I enjoyed the November special issue of *PHYSICS TODAY* on communicating physics to the public, as the topic has been on my mind. Recently, a ninth-grader participating in a summer program in our laboratory had this to say after his first day with us: "You guys are scientists, right? But you don't look like scientists!" I asked him what he thought a scientist should look like. He said something about television and movies, and it was clear to me that the creatures he had imagined weren't exactly human. Since then, I've paid attention to how physicists and other scientists are presented and misrepresented in the media.

Take molecular-beam epitaxy machines. MBE machines are among the most visually dramatic (that is, large and expensive) of our high-

technology research tools, and photographs of them often appear in publicity pieces, news articles, annual reports and the like. Nine times out of ten, these photos feature a normal MBE scientist posed next to an expanse of stainless steel, bathed in blue, red and green light. The blue, red and green scientist looks otherworldly, bizarre and unnatural, and if I were a ninth-grader, I don't think I would aspire to be one. I know many MBE scientists, and none of them are blue, red or green. Moreover, only a few of them are otherworldly or bizarre.

Another typical photo of scientists at work that makes its way into the popular media shows multicolor lasers being meditated upon by one or more laser jocks. Fog and multiple exposures turn the invisible beams into brilliant swords of color. Somehow the laser jock is bathed in the same red, blue and green light that usually emanates from MBE machines. These images are only slightly more accurate than the MBE pictures. (Dye-laser jocks sometimes *are* red.) I'm sure that 90% of the population believes that laser beams actually glow as they propagate.

There is no reason to present ourselves and our everyday environments to the public this way. A commercial photographer who can't compose an interesting picture of an MBE machine without colored lights is more commercial than photographer. We should realize that since most commercial photographers have seen the same movies as the ninth-grader mentioned above, we may have to help them produce accurate images of us.

I urge readers of *PHYSICS TODAY* to consider carefully the images they present to the outside world. Make sure that scientists and engineers are depicted as men and women rather than as space aliens. Don't pose under colored lights!

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11/90

What Feminism Means for Physics

It is easy enough to be sympathetic to the two negative letters (December, page 93) reacting to Sidney Harris's cartoon in which a woman scientist says to her male colleague, "It's an excellent proof, but it lacks warmth and feeling." But it is also easy to be unsympathetic. Though the two letter writers complained about social prejudices that make science careers

hard for women, some feminists insist that women's thinking *does* have valuable qualities that are lacking in men and that these qualities produce results that male intellection cannot.

For example, Evelyn Fox Keller's biography of the geneticist Barbara McClintock (Freeman, New York, 1983) was given the title *A Feeling for the Organism* to emphasize these very qualities—and McClintock has already become a sort of culture hero. (If I used the word "heroine" someone would doubtless complain that it is a belittling sexist word, like "poetess," and if I used "hero," someone would complain that it is patriarchal. This is a problem entailing an infinite regress, confrontable by infinite chips on infinite shoulders.) *A Guide to MLA [Modern Language Association] Documentation* (Houghton Mifflin, Boston, 1989) uses McClintock's career as a theme for a sample research paper emphasizing her resistance to the male "detached 'scientific' perspective" and her own aim to "create a more personal relationship with her subject." This feminist viewpoint implicitly endorses the one expressed in Harris's cartoon. If the cartoon had expressed the letter writers' viewpoint, the McClintock camp would probably have protested.

Feminists indeed have plenty of legitimate complaints. But personal freedom depends on a certain amount of both suppression and toleration of individual points of view and feelings. To enjoy such freedom entails the risk of hurting other people as well as being hurt oneself. But it's better than totalitarian "protectedness."

Finally, all humor is a form of bigotry, since it depends on a narrow point of view, a *misunderstanding*. *Tout comprendre c'est tout pardonner*. To God, nothing would be funny. Shall we therefore don sackcloth and ashes?

HAROLD FROMM

1/91 North Barrington, Illinois

Bonnie Johnson and Dietrich Schroer should be applauded for their desire to be sensitive to the feelings of their colleagues. However, they need to lighten up! I found Sidney Harris's cartoon delightful and funny. First, Harris's intent (as he stated in his reply to Johnson and Schroer), that the uncertain male had been demonstrating his work to a woman who was at least his peer, was obvious. Second, the cartoon poked fun at the tendency for all scientists, male and female, to be a bit stiff about our work. Objectivity is important, but we aren't machines, we're humans, and humor and feeling have an appropriate place in

our work. After all, why did most of us become scientists? Not for money or glory, but for the passion (defined as "any powerful emotion . . . boundless enthusiasm" in the *American Heritage Dictionary*) of pursuing new knowledge.

In this regard, I found Leon Lederman's Reference Frame column of January 1990 (page 9) exceptionally refreshing, because for the most part we tend to suppress the passionate aspect of what it means to be a scientist, whereas he emphasized it. Indeed, I have used that column to great effect in an undergraduate class in which I talked about what it means to be a scientist. Students are wary of giving themselves over to pointless self-sacrifice. They sometimes perceive that science is like that when they see professors struggling to get funding and to balance teaching and research. But show them the joy of discovery, the sense of anticipation that many of us feel when approaching a problem (the knottier the better!), and they are irresistibly attracted. Think: Who are your favorite colleagues, those whom you spend the most time with and, consequently, from whom you learn the most? If you value your humanity, it's the ones who see the humor in all human endeavors, even science, and who turn the creativity of humor into the exploration of ideas.

As a woman scientist with a naturally ebullient nature, I struggled many years to keep my emotions "under control." Finally, I realized that my work would speak for itself and there was no need to fit myself into some preconceived mold, and my career was, if anything, enhanced. Warmth and feeling are important, and emotions the wellspring of creativity. We must never forget that humans, not robots, do good science.

JUDITH TOTMAN PARRISH

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2/91

I wish to respond to Bonnie Johnson's letter in which she took exception to Sidney Harris's "warmth and feeling" cartoon.

I strongly believe in feminism. But to me, that does not mean that women should strive to be more like men. We should indeed seek a society devoid of gender-based discrimination and unfair expectations, but we should not construct that society on a masculine basis. We would have a better society if we deemphasized masculine aggressiveness and linear hierarchy and gave more importance to feminine cooperation and, yes, emotion. Were I a woman, I would have felt complimented by Harris's cartoon, since it

implies that women can both logically evaluate a mathematical argument and acknowledge the importance of emotion in our lives. Scientists of both sexes should realize that logical, scientific thought processes and deep feelings can easily coexist in a human mind. The greater ease with which women express emotion should be emulated by men, whether scientists or not.

I am an astronomy student, and I too am distressed at the lack of women in the physical sciences. But the reason for this lack is not any mathematical inferiority. (At my undergraduate institution, Penn State, women are quite well represented in the math department.) Rather, the problem is with teachers, parents and male peers who consciously or otherwise discourage girls and young women who have an interest in astronomy and physics. That is a tragedy for us all.

DOUGLAS O'NEAL

12/90 Hurricane, West Virginia

After reading the letter from Bonnie Johnson, I feel compelled to offer the opposite, but equally justified, critique of Sidney Harris's cartoon. Drawn with glasses, a mustache and a gold watch chain draped across his vest, the chunky, older man in the cartoon is undesirably stereotyped as cold and unfeeling. In contrast, the higher human qualities of warmth and feeling are assigned to the younger woman.

It is unrepresentative to ascribe warmth and feeling only to women and to characterize all male scientists as cold and unfeeling. During my 28 years as a physicist, I have worked with a variety of male and female scientists from various countries and from a wide range of scientific disciplines. I find that compassion, sensitivity, warmth and feeling are as prevalent in the male population of scientists as in the female population. While objectivity is a necessary tool of scientists and managers, none could succeed without the motivating influence of human emotions.

Actually, when first seeing the cartoon in question, I chuckled over the surprising idea of looking for warmth and feeling in a mathematical proof. Typically, that is what makes a single-panel cartoon successful: an unexpected twist on the expected. Only after reading Johnson's letter did I start looking for *sexual* stereotyping. Sure enough, if one looks for it, there is stereotyping of *both* males and females! On further reflection, I realized that I consider some mathematical proofs elegant and beautiful,

while others strike me as clumsy and unappealing. Could it be that physics and mathematics are *not* totally cold and emotionless? Or have I simply been a physicist too long?

As an undergraduate, Johnson complains of having to continually prove her academic and intellectual skills to those around her (predominantly males). Developing these selling skills could, however, give her a long-term advantage. It is impossible to overemphasize the value of learning, early in a scientific career, how to promote your contribution. As successful physicists know, attracting funding requires skillful selling of the quality and importance of your work.

Most men and women do not choose careers in physics. Why? The answer to that question is simple: It is because they do not perceive physics to be interesting and lucrative.

How do you attract more men and women into physics? The answer to that question is not simple!

DALE GEDCKE

1/91

Oak Ridge, Tennessee

I spent a few minutes looking at Sidney Harris's cartoon in the April 1990 issue, trying to figure out why it was supposed to be amusing. Finally it occurred to me that the "humor" relies on the concept that women *must* show warmth and feeling even if it means not doing math properly.

And while I was distracted from reading science anyway, I decided to check what other subtle messages you give your women readers. What, for example, is the gender ratio in the ads? In the ads depicting persons whose gender was evident, only 11% of those people were women. Granted, this is better than the status quo, but my vision is that the scientific societies (at least the ones to which I belong) in this country should be encouraging women and minorities. (There were *no* people of color shown at all.) I am frankly disturbed by this. Women models cost no more than men, last I heard, so guidelines requiring 50% women and people of color on new ads wouldn't cost the advertisers money. And if they say, "But that's not realistic!" tell them that the times are changing and you want them still to be in business in ten years.

BETH HUFNAGEL

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9/90

Santa Cruz, California

APS Aid to Women and Minorities

The news story on APS outreach committees (May 1990, page 93)

amused me at first and then made me angry. The APS has committees on the "status of women in physics" and on "minorities in physics." I was amused at the silliness of these ventures. At first, it seemed to me that APS had merely succumbed to the pop sociology that saddles many American institutions with the useless (at best) counting of women and minorities in all occupations. Setting aside the serious issue of quotas, I could smile at my colleagues whose overstimulated consciences had overcome their common sense.

Then I read about the APS-administered scholarships for minorities. No Asians or white males need apply! Who are the sexists and racists here: the majority who would leave physics an open profession of choice or the conscience-stricken committees who would herd women, African-Americans, Hispanics and Native Americans into the physics corral until even the most sensitive sociologist would smile and say, "Now we are equal?"

N. C. NICHOLAS

5/90

Silver Spring, Maryland

THE 1990 PRESIDENT OF APS REPLIES: APS wants to leave physics an open profession of choice and has no desire to "herd" anyone into the "physics corral." If "choice" is to be more than an empty phrase, the options must not be constrained by obsolete hurdles, of whatever origin, that make our science distinctly less open to large segments of our society. The removal of these hurdles has been a goal proclaimed consistently for decades by the elected council of APS. It represents the consensus of an overwhelming majority of our membership, who see it as an enlightened policy not only rooted in elementary fairness but also contributing to the health of physics.

EUGEN MERZBACHER

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10/90

Chapel Hill

The Paradoxical 'Unities' of Physics

The introduction of special sessions on "The Unity of Physics" at meetings of The American Physical Society reflects a widely held concern that physics is being fractured into specialties, with insufficient communication among them.

The situation was highlighted by the following experience. The late Luis Alvarez was one of our most versatile and fruitful colleagues. He was one of the very few to show friendly interest in my own work on

the physics of wood energy and its application to domestic heating. I offered to come to Berkeley to give a seminar on my work, but Luis told me that "if you don't talk about quarks, you won't have an audience." I have been turning that remark over in my mind, and find that it reveals an interesting paradox about the unity of physics.

Interest in quarks, and in particle physics generally, is propelled most particularly by the quest for unity in physics—by the search for grand syntheses at the most fundamental level of knowledge. What Alvarez's remark brings home is that the quest for unity has become a specialty that narrows so intensely the intellectual focus of its devotees that they are unwilling to be interested in anything else in physics. Is that what we want to encourage when we speak of "the unity of physics"? Or does such "unity" condemn one to a snobbish isolation from the mainstream of scientific and human concerns?

I believe the traditionally held conception of the role of the physicist is that he is a generalist who can turn his physics training to use in the most diverse ways—for example, as a "consultant-entrepreneur" (see my Guest Comment in *PHYSICS TODAY*, June 1978, page 9). Or as has happened in many notable instances in the past, he can enrich other branches of science with his physics training and habits of mind. I believe it is just such diversity that is the actual goal being sought by those who talk of "the unity of physics."

Perhaps that goal is better expressed by our speaking of "the diversity of physics," or, reaching for a compromise, let us talk of "the diversity and unity of physics."

LAWRENCE CRANBERG

12/90

Austin, Texas

Pauling Biographer Rebuts Rigden

Although I appreciated John Rigden's kind comments (May 1990, page 81) on my book *Linus Pauling: A Man and His Science*, I must challenge some of his other claims. Particularly bizarre is Rigden's claim that "out of a total of 202 references in the book, only three cite primary literature and they concern vitamin C." This is not only false, but surrealistically false. In fact, there are over 500 references, and almost 200 references to primary sources. Such primary sources include letters, monographs and books, as well as political, philosophical and scientific documents written by Paul-