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'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 myself[1] 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. Zaifman[6] using the Landau–Zener approximation. Exact analytical results were subsequently derived by Dirk Notzold[7] 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} eV^2, 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 *un*sympathetic. Though the two letter writers complained about social prejudices that make science careers