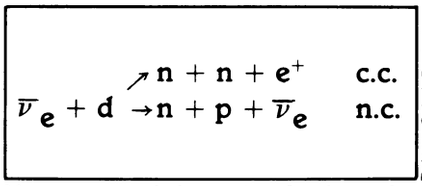
underlying waves. So what is ostensibly an electron neutrino when it comes out of the reactor can change itself to muon neutrino and back perhaps more than once on the way to the detector. (The tau neutrino, incidentally, does not seem to oscillate to an electron neutrino.)

There is a certain mass assocated with each of these underlying waves. There has to be. This is how the mass comes in. If it were not there, both waves would travel at the speed of light. They would be always in phase. There would be no interference, no oscillation in the superposition wave. There would in fact be no reason to talk of two underlying states, nor would there be



Reines, Sobel, Pasierb

Mene, mene, tekel *neutrino. Its charged current interactions did not weigh enough in the balance.*

neutrino oscillations. So the mass must be there. The experiment can calculate the mass *difference* between the two underlying states, which Reines calls "neutrettos." It comes to about one electron-volt. The masses of the observed neutrinos remain to be determined.

The neutrino having been weighed in the balance and found not wanting, the hand seems to be writing on the wall at high speed. Reines read to a press conference a telegram he had received from David Schramm and Gary Steigman, astrophysicists at the University of Chicago, who after congratulating him on his result go on to point out that a mass of 25 electron-volts for the observed neutrinos would provide enough mass in the form of neutrino haloes around galaxies to close the universe. The universe would then apparently oscillate from big-bang explosion to big-bang explosion. Reines rather chuckles at the theological implications of that.

Less cosmically this result could "solve" the problem of the solar neutrinos, or to be more exact, turn it into a different problem. The nuclear processes in the sun are supposed to produce a certain flux of neutrinos. Observations have failed to measure that flux. Physicists have suggested that something is wrong with the sun. It may have "turned off." Reines now says the problem could be oscillating neutrinos deceiving the detectors. The sun may still be on after all.

A fundamental implication of the result, Reines says, is that the "flavors" or the characteristics of being an electron neutrino, a muon neutrino or a tau neutrino may not be distinct. Distinctness of flavors —these and others—and parallels among them are basic to the unified field theory schemes that are now trying to compose a comprehensive description of physics. Will a confusion of flavors make tutti fruiti of their work? One might paraphrase I. I. Rabi's famous remark about the muon: Consider the neutrino. Who ever ordered it to behave like that? □

Fest for Sakharov; Message to Moscow

The case of Andrei D. Sakharov has stirred up the American physics community to the same or perhaps even a higher degree than that of Aleksandr Solzhenitsyn stirred up the American literary establishment. It is hardly surprising that in these cases of persecution by totalitarian governments people respond most vigorously to the situation of a colleague. They can understand the prohibitions and impositions in terms of their own activities. So the literati identified with Solzhenitsyn, and the scientific establishment, particularly the physics establishment, is holding rallies for Sakharov.

Sometimes the hero turns out to be a little difficult to identify with. Solzhenitsyn is quite right wing (so the American left cannot justify itself in his person). He is a fervent Russian nationalist (sponsored by an American intelligentsia that tends to think nationalism rather than Marxism is the source of the trouble in Russia). Mirabile dictu, he is something of a clericalist (in one essay he seemed to suggest turning over the government of Russia to the Orthodox bishops). Finally, like many Russian intellectuals, he is grumpy. So we now begin to hear murmurs that Solzhenitsyn is not the writer he was reputed to be.

In Sakharov's case the bond between the man and his western supporters seems stronger than ever. It may be that the physicists will not be disillusioned because they seem to know Sakharov better than the literati knew Solzhenitsyn. International physics is a more communal and closely knit world than the literary elite, in spite of the Iron Curtain.

Attempts to detract from Sakharov's professional character have not come from disgruntled acolytes in the West. They all come from the Soviet press. The content of these remarks is that Sakharov, having lost his talent for physics, went into politics in order to stay in the public eye. American physicists reacted with outrage to these "slanders" and organized a session at last week's APS meeting to refute them.

Chaired by the president of the APS, Herman Feshbach of Massachusetts Institute of Technology, the session was meant to reaffirm belief in Sakharov as a physicist and as a human being and to drum up support for his cause. Adherents to a moratorium on scientific contacts with the Soviet Union were solicited as were signatures on a telegram of support addressed to Sakharov.

The purpose of all this activity was to demonstrate to the Soviet authorities that Sakharov is not forgotten by his colleagues in the West. Edward Lozansky of the University of Rochester, executive director of the Sakharov International Committee and himself an emigré from the Soviet Union, remarked that the Soviet authorities are evidently hoping that the furor will die down, and then they can proceed with harsher measures unnoticed. That must not be allowed to happen, Lozansky says: "Sakharov's welfare is our welfare."

That identification was the keynote of the proceedings. The two scientific papers, on thermonuclear fusion by Melvin B. Gottlieb of Princeton University and on particle physics by Sheldon Lee Glashow of Harvard University, were intended to review branches of physics in which Sakharov had made contributions and mention his work by the way. Perhaps Sakharov's most widely known contribution was the invention (with Igor Tamm) of the tokamak, the controlled fusion device that many physicists believe will be the foundation of a successful fusion reactor. A particle physics example is his prediction of the masses of the charm particles. His was one of two successful attempts at this very difficult accomplishment. In 1966, long before this year's grand unified theories made it mandatory, he speculated that the proton might be subject to radioactive decay and drew a cosmological conclusion from that that explains the observed imbalance between matter and antimatter in the universe.

He has not lost interest, the participants in this meeting assert. He continues to write scientific papers alongside his political statements. As recently as six months ago he managed to publish a paper, an accomplishment that Lozansky attributes to the intervention of Pyotr Kapitsa, possibly the most renowned of living Russian physicists. More recently two papers dated Jan. 22 were "lost" on the way to publication. He has since reconstructed the work in a single paper and sent it by the hand of his wife directly to the president of the Soviet Academy of Sciences (which publishes the scientific journals).

Tributes to Sakharov's personal qualities were also numerous. They gave the meeting an air of solemnity and moral intensity. Gottlieb quoted Lev A. Artsimovich, who led the development of tokamaks at the Kurchatov Institute in Moscow, as saying of Sakharov: "The man is a saint." That seemed to embarrass some people a little. Certainly he is a kind of martyr, and for the people in the hall that night, a living symbol. The whole affair is a testimony that no longer can a government interfere with a citizen's freedom and expect it to remain an internal matter. □