

Physics monitor

Stable neutrinos

The 'solar neutrino puzzle' – the large difference between the calculated neutrino power pumped out by the sun and the signal detected on earth – is one continuing neutrino enigma.

One possible explanation, not even ruled out by the new neutrino data from last year's supernova – much more distant than the sun – is that some neutrinos could disintegrate on the way between the sun and the earth.

The possibility of neutrinos disintegrating to give photons has now been ruled out by a small team from the French Saclay Laboratory. The very simple experiment used a photomultiplier monitoring the core of a fission reactor (a strong source of antineutrinos), to look for photons with an energy of 1-3 eV which might result from neutrino disintegration. A few days of measurement were enough to discount the idea, and the solar neutrino puzzle lives on.

NEUTRINOS Oscillations come and go

The Moriond Workshop on Neutrinos and Exotic Phenomena held recently at Les Arcs in the French Alps highlighted again the fascination of this volatile area of particle physics.

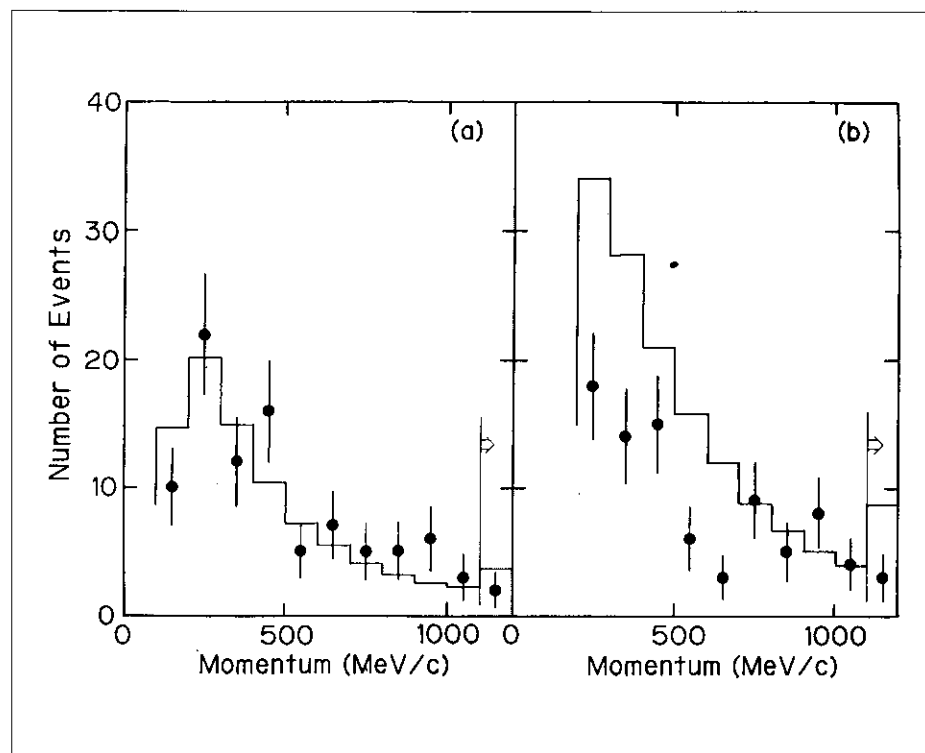
One important recent discovery

is double beta decay (see January/February issue, page 32), with two nuclear neutrons of selenium transforming into protons, giving krypton, and emitting two neutrinos. The halflife of the reaction is 10^{20} years, in good accord with geochemical estimates. Progress in the underlying theory of double beta decay, both with neutrino emission, and the as yet unseen neutrinoless variety, was summarized by P. Vogel.

Experiments using neutrinos from fission reactors have been looking for signs of possible switching between neutrino types (neutrino oscillations). Now the results from the group using the Bugey (France) reactor are consistent with those obtained by the group working at Goesgen (Switzerland), with no evidence any more for neutrino oscillations.

S.T. Petcov and S. Toshev cov-

Momentum spectra of atmospheric electron-like (a) and muon-like (b) neutrinos from the Kamiokande underground detector in Japan, compared to the expected signals (histograms), showing an interesting suppression in the muon-like case. This could have important implications for neutrino behaviour.

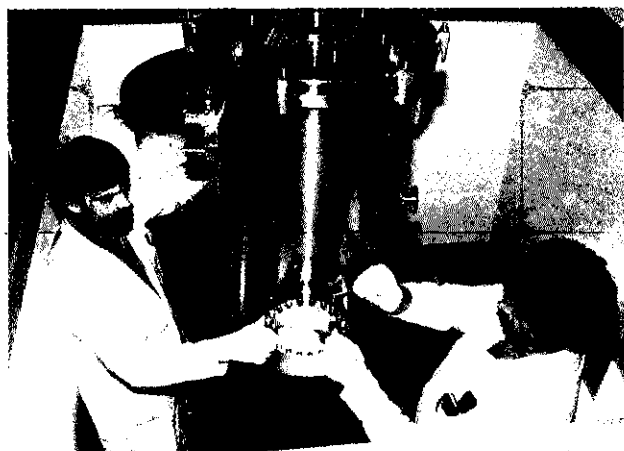


ered the propagation of neutrinos in dense matter, where delicate resonance (MSW) effects could explain the longstanding disagreement between the predicted and detected levels of neutrinos from the sun. New results simplify considerably the necessary calculations.

The valuable neutrino signals picked up from last year's supernova provide astrophysicists with a new window on cosmic processes and particle physicists with new information on neutrinos.

One of the experiments detecting these supernova neutrinos was the Kamiokande underground study in Japan, where nearly a thousand specially developed large (20 inch) photomultiplier tubes monitor the Cherenkov light produced by particles captured in 2000 tons of water. Based on 220 days of running, this experiment also looked at the

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Mounting a lead-optical fibre block in the calorimeter developed for the Omega spectrometer at CERN. On the left are the light guides. In four years, this module has served seven physics experiments.

(Photo CERN X503.5.86)

angular correlation of neutrino hits to detect particles from the sun (solar neutrinos). The upper limit of the signal is below the figure from confident calculations of solar neutrino emission, underlining for the first time the 'solar neutrino problem' identified in the classic studies by Ray Davis. The directional real time information from the Kamiokande experiment is especially valuable.

M. Koshiya of the Kamiokande collaboration was also able to report that, based on a sample of 277 captured neutrinos, the level of atmospheric electron-type neutrinos is as expected, but muon-type neutrinos appear to be suppressed by about 40 per cent. (Identification uses the distribution of photoelectrons in the single Cherenkov rings in 190 of the 277 neutrino events.) At face value, this decreased muon-like signal hints at neutrino oscillations, and is supported by a corresponding suppression of electrons characteristic of those from muon decay.

The corresponding measurement from the Frejus underground experiment near the French-Italian frontier still has large uncertainties, and the result hangs in the balance.

DETECTORS

Scintillating developments

To meet the stringent demands of today's experiments, detector specialists are looking to improve the performance of photon and electron detectors beyond the traditional solution using alternating plates of lead and plastic scintillator. Although robust and inexpensive, this technique has poor posi-

tion resolution because of its coarse granularity, and gives irregular response.

One solution proposed by P. Sonderegger (CERN) and D. Perrin (then at Neuchatel) was to use scintillating optical fibres instead of scintillator plates. The fibres were developed by J.C. Thevenin at the French Saclay Laboratory, and a prototype using two-thirds of lead by volume with 1 millimetre diameter fibres was tested by a CERN/Lisbon/Neuchatel/Saclay team in 1982-3 using an electron beam (achieving an energy resolution of 7.8 % divided by the square root of the energy).

When the big Omega spectrometer at CERN had to be equipped for a new experiment with a forward photon calorimeter, it needed only the first six months of 1984 to design, develop and build a new unit and record the first photons from neutral pion decays. The lead-covered fibres, corrugated to ensure that even photons hitting a fibre end-on would eventually meet some lead absorber, are read by 169 downstream phototubes.

Covering a 42 centimetre square area, the 350 kg unit cost the same as a lead-glass scintillator in a conventional calorimeter, while coping better with ambient radiation. In four years, this detector has operated satisfactorily for a series of seven physics experiments.

Meanwhile other lead/fibre solutions have been developed. The new UA2 vertex detector provides increased electron identification (see June 1987 issue, page 9), while the Small Angle Tagger developed by Bergen for the Delphi experiment at CERN's LEP electron-positron collider will measure photons and electrons emerging close to the beam pipe.

A Clermont-Ferrand group, with help from CERN, developed a dense electromagnetic calorimeter (twice as much lead as fibre) for the NA38 experiment to measure transverse energy in heavy ion collisions. The suppressed signal from the J/psi resonance is a possible indicator for a new kind of quark matter (see April issue, page 5). The intense radiation levels at-

