JETP LETTERS VOLUME 16, NUMBER 6 20 SEPTEMBER 1972

WHAT IS THE PENETRATING ABILITY OF THE NEUTRINO?

L.A. Mikaelyan

Submitted 24 July 1972
ZhETF Pis. Red. 16, No. 6, 313 - 314 (20 September 1972)

The absence of an observable effect from the solar neutrinos in the experiments by the Davis group [1] is beginning to cause concern. The models of the sun are being reviewed, and the hypothesis is being advanced that the neutrino is unstable and decays into two new particles, a boson and a fermion [2].

This raises the question whether the negative results of Davis' experiments might be attributed to the fact that the neutrino in solar matter loses an appreciable fraction of its energy, as a result of which the cross section of the reaction

$$\nu_e + Cl^{37} \to A^{37} + e^-$$

decreases by one order of magnitude or more.

It is customarily assumed that the neutrino mean free path is larger by many orders of magnitude than the thickness of matter [$(3 - 5) \times 10^{11}$ g/cm^2] that it must negotiate in its path from the center of the sun to its surface. Such an assumption is not based, however, on experimental facts.

To explain the results of the Davis group it must be assumed that the energy lost by a neutrino having an energy 10 MeV and produced in the decay of B^8 exceeds 50 or 40%, or $\sim 10^{-11}$ Mev-cm^{2}g^{-1}.

The presently available data concerning such an energy-loss mechanism, which is not predicted by the theory, have been obtained with the aid of various sources of antineutrinos ($\tilde{\nu}_e$), the most intense of which is a nuclear reactor. If the fraction of the energy lost by traversing a certain thickness of matter is the same for ν_e and $\tilde{\nu}_e$, and the energy is transferred to the electrons, then for the softer reactor spectrum the energy-loss region of interest begins in the vicinity of 5×10^{-13} Mev-g^{-1}cm^2 or

$$\sigma \sim \frac{10^{-30}}{\Delta\epsilon}\ \mathrm{cm^2/electron}$$

where σ is the cross section and $\Delta\varepsilon$ is the characteristic energy (in electron volts) transferred to the free electron in a single act of the hypothetical interaction.

The interpretation of the available data depends significantly on the value of the characteristic energy $\Delta\varepsilon$. A value $\Delta\varepsilon \gtrsim 10^5$ eV is excluded, with a large margin, by the results of the Reines group [3]. Attempts were made in earlier experiments to observe the ionization current [4] or the counts in a Geiger counter [5] induced by neutrino $\tilde{\nu}_e$ bombardment. The sensitivity of these experiments is close to that required from the point of view considered here. At the present state of the experimental art, this sensitivity can be increased by several orders of magnitude.

It might turn out, however, that the energy transferred in a single act of interaction between a neutrino and an electron is too low to cause ionization.