M. G. Shchepkin. *Majorana neutrino and double beta decay.* The question of the neutrino mass and its possible manifestations is now being widely discussed. In the last few years, of the order of 100 experiments in which processes which are sensitive to nonzero neutrino mass have been performed, and the number of theoretical works is significantly higher than the number of experimental works.

What explains this unusual interest in this question? What is the role of processes in which the leptonic charge is not conserved in the phenomena studied? Is there any basis for doubting the exactness of the law of conservation of leptons, taking into account the fact that the well-known experimental facts are in agreement with the conservation of L ? From the standpoint of the theory, the problem of neutrino mass and conservation of L is linked with the problem of unification of the strong and electroweak interactions. If the unified description of interactions is based on a gauge theory, then at low energies the symmetry corresponding to conservation of L must be a spontaneously broken local symmetry. Otherwise it is impossible to solve the problem of leptonic photons, whose nonexistence has been verified experimentally with high accuracy. From the standpoint of the most popular models, the spontaneous breaking of L symmetry means that the neutrino is a majorana particle with nonzero mass. We note that in such theories the smallness of the neutrino mass compared with the masses of the charged leptons and quarks is explained in a natural manner.

The arguments presented in support of the existence of the neutrino rest mass are not absolutely exact. Models in which the L symmetry is global, like, for example, in SU(5), are discussed in the literature. In such theories the spontaneous breakdown of the conservation of leptonic charge is accompanied by the appearance of a massless Goldstone boson, capable of a virtual transition into a neutrino or antineutrino pair.

It is not easy to observe experimentally the consequences of spontaneous breaking of L symmetry. The problem is that the amplitudes of the processes in which the L charge is not conserved are small because of the so-called chiral exclusion rule. The search for neutrinoless double beta decay is apparently a more effective method for checking L conservation. It is now known that the period of $2\beta(0\nu)$-decay is not less than 10^{21}–10^{23} years, whence it is possible to obtain a limit on the Majorana mass of the electron neutrino. Based on estimates by different authors, it ranges from several eV to tens of eV. Unfortunately the accuracy of the calculation of the nuclear amplitudes is low, so that more precise estimates of the upper limits on the neutrino mass apparently cannot be obtained from double beta decay experiments. The same data imply that the amplitude of the admixture of the right-hand currents to the Lagrangian of the weak interactions does not exceed 10^{-5}–10^{-6}.

It is interesting to compare the limits on the neutrino mass from double beta decay with the results of measurements of the beta spectrum of tritium. Experiments performed at the Institute of Theoretical and Experimental Physics[1] were interpreted as an indication of the existence of a neutrino rest mass $m_\nu > 20$ eV. Recent results obtained at SINP (Switzerland) show that $m_\nu < 18$ eV.[2] There are reasons for expecting that in the near future the situation with tritium will be clarified. There is no doubt that these data are a kind of landmark in investigations of double beta processes, in spite of the fact that there may not be a unique relationship between these phenomena. In principle, it has not been excluded that the neutrino mass is a Dirac mass and that there are no processes which are forbidden by the law of conservation of leptonic charge. There is a large number of investigations on the comparison of different processes sensitive to the neutrino masses. On the phenomenological level, however, the problem is solved relatively simply by studying the properties of the neutrino mixing matrix.

A number of new experiments on the study of double beta processes, including K capture with the emission of a positron, are now being planned. Together with the search for neutrinoless 2β transitions, attempts are being made to observe two-neutrino decay modes, $2\beta(2\nu)$ decay is allowed by the conservation laws, and there is no doubt that it does occur. Comparison of the theoretical predictions of the probability of $2\beta(2\nu)$ decay with experiment will make it possible to select the best approach to the calculation of the nuclear amplitudes of double beta transitions.

A detailed discussion of the problem of the neutrino mass and leptonic charge conservation is given in Ref. 3; a comparatively complete list of original works is also presented there.

[1]S. D. Boris, A. I. Golutvin, L. P. Laptin *et al.*, Pis'ma Zh. Eksp. Teor. Fiz. **42**, 107 (1985) [JETP Lett. **42**, 130 (1985)].

[2]M. Fritschi, E. Holzschuh, W. Kundig *et al.*, SIN Preprint (1986); Proceedings of the 6th Moriond Workshop on Massive Neutrinos in Particle Physics and Astrophysics, Tignes, France (1986).

[3]S. M. Bilenky and B. Pontecorvo, Phys. Rep. **41**, 225 (1978); M. G. Schepkin, Sup. Fiz. Nauk **143**, 513 (1984) [Sov. Phys. Usp. **27**, 555 (1984)]; M. Doi, Preprint OS-GE 85-03 (1985); J. D. Vergados, Phys. Rep. **133**, 2 (1986).