THE ELECTRON NEUTRINO MASS

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These limits apply to ν_1, the primary mass eigenstate in ν_e. They would also apply to any other ν_j which mixes strongly in ν_e and has sufficiently small mass that it can be emitted in the respective decay. (Note that the reactor $\overline{\nu}_e$ disappearance experiments show that the electron neutrino is not strongly coupled ($\sin^2 2\theta \lesssim 0.1$) to any other neutrino for $\Delta m^2 \gtrsim 10^{-3}$ eV^2.) The neutrino mass may be of a Dirac or Majorana type; the former conserves total lepton number while the latter violates it. Either could violate lepton family number, since the neutrino mass eigenstates do not need to coincide with the neutrino interaction eigenstates. For limits on a Majorana ν_e mass, see the section on "Searches for Massive Neutrinos and Lepton Mixing," part (C), entitled "Searches for Neutrinoless Double-β Decay."

The square of the neutrino mass, $m^2_{\nu_e} = \sum |U_{ej}|^2 m^2_{\nu_j}$, where the sum is over the kinematically allowed range of the neutrino masses m_{ν_j}, is measured in beta decay experiments by fitting the shape of the beta spectrum near the endpoint; results are given in one of the tables in this section. Low-energy tritium beta decays, delivering a high number of events near the kinematically interesting endpoint, are studied in a number of careful experiments. The most sensitive of these are reported in LOBASHEV 99 and WEINHEIMER 99. They both find that unknown effects cause an accumulation of events near the endpoint of the electron spectrum. If the fitting hypothesis or data selection does not account for this, unphysical negative values of $m^2_{\nu_e}$ are obtained. In WEINHEIMER 99, two analyses which exclude the spectral anomaly result in an acceptable $m^2_{\nu_e}$ and a mass limit of better than 3 eV. In LOBASHEV 99, the resulting mass limit is also less that 3 eV when the analysis includes an *a priori* form for the anomalous events near the endpoint. We take $m_{\nu_e} < 3$ eV as our evaluation.

The spread of arrival times of the neutrinos from SN1987A, coupled with the measured neutrino energies, provides a simple time-of-flight limit on m_{ν_e}. This statement, clothed in various degrees of sophistication, has been the basis for a very large number of papers. The LOREDO 89 limit (23 eV) is among the most conservative and involves few assumptions; as such, it can be regarded as a safe limit.