Latest results from the Mainz Neutrino Mass Experiment

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The β spectrum from a frozen, molecular tritium source is investigated close to its end-point, in order to extract the rest mass of the electron antineutrino. The measurements are performed with a MAC-E-filter, combining Magnetic Adiabatic Collimation and an Electrostatic high pass filter at a filter width of $\Delta E = 4.8$ eV. Our spectrometer accepts a solid angle of $\Delta\Omega/4\pi = 0.25$ from a source area of 1 cm^2.
After an improvement programme in 1997 we have been taken data for running periods of 3 to 4 months per year. Combining data from 1998, 1999 [1] and 2001 the result is: m_ν^2 = -1.2 $\pm$ 2.2 $\pm$ 2.1 eV^2/c^4 corresponding to $m_\nu \leq$ 2.2 eV/c^2 (95 % C.L.).
For this analysis only the last 70 eV of the β spectrum have been taken into account. For such an interval the sum of statistical and systematic uncertainties of the result obtains a minimum.
A significant step like anomaly in the integral β spectrum close to the endpoint, the so called "Troitsk anomaly" [2], has been observed only in one out of 12 data sets. Thus the effect is likely to be an instrumental artefact, rather than a physics phenomenon.
To clarify the nature of the effect it was decided to run the spectrometers in Troitsk and Mainz in parallel. In 2000 and 2001 the Mainz spectrometer was operated for about 2 months each year but due to technical problems in Troitsk the overlap was only 2 weeks in december 2000. Step like anomalies showed up in the Troitsk data but clearly not in the Mainz data. Due to fluctuating background the Mainz data from 2000 do not improve the limit on m_ν. The sensitivity limit for the Mainz experiment of 2 eV/c^2 is almost reached. This value is very similar to the limit for hot dark matter in the universe obtained by comparing the models for structure formation with matter distribution in the universe [3]. To investigate further the mass range of interest for the cosmology and to set the mass scale of the neutrino, a new larger experiment KATRIN [4] is proposed.
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References

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