NEUTRINO MASS LIMITS AND DARK HALOS

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Lower mass limits for particles constituting the dark matter in galaxy halos can be derived from considerations of the initial and final phase space distribution. In the case of massive neutrinos, Tremaine and Gunn (1979) pointed out that the initial fine-grained occupation number of cosmological neutrinos and therefore the final coarse-grained phase space occupation, is less than 0.5. From this they were able to show that if the final neutrino distribution is an isothermal sphere, one can put lower limits on the neutrino mass from assumptions about the core radius of the neutrino sphere.

There is, however, no reason to believe that the final neutrino distribution should be an isothermal sphere. If more efficient packing in phase space takes place, halos may be made of neutrinos less massive than would be predicted from the isothermality assumption. A firm lower mass limit for an isotropic velocity distribution was derived by Madsen and Epstein (1984) based on the existence of a maximally compact sphere constructed from a cloud of primordial neutrinos.

But even limits based on isotropy may be misleading. The effects of velocity anisotropies were investigated by Madsen and Epstein (1985). If transverse velocity dispersion dominates in the outer parts of the halo, neutrino mass limits are increased relative to results in the isotropic case, but if radial velocity dispersion dominates, limits are weakened.

Velocity anisotropies can be described by the parameter α, where $\langle v_\theta^2 \rangle = \langle v_\phi^2 \rangle = (1-\alpha)\langle v_r^2 \rangle$. From a sample of well observed galaxies we conclude that $m_\nu > 35\ h^{1/2}$eV if $\alpha \leq 0$, $m_\nu > 29\ h^{1/2}$eV if $\alpha \leq 0.4$, and $m_\nu > 25\ h^{1/2}$eV if $\alpha \leq 0.8$ (h is the Hubble parameter in units of 100 km $s^{-1}Mpc^{-1}$).

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