Astrophysical Limits on Superluminal Electron and Neutrino Velocities

FLOYD STECKER, NASA Goddard Space Flight Center — The observation of two PeV-scale neutrino events reported by Ice Cube allows one to place constraints on Lorentz invariance violation (LIV) in the neutrino sector. First, I derive an upper limit for the difference between putative superluminal neutrino and electron velocities of $< \sim 5.6 \times 10^{-19}$ in units where $c = 1$. I then derive a new, strong constraint on superluminal electron velocity $\delta_e < 5 \times 10^{-21}$. One then obtains an upper limit on the superluminal neutrino velocity alone of $\delta \nu < 5.6 \times 10^{-19}$, many orders of magnitude better than the time-of-flight constraint from the SN1987A neutrino burst. However, if the electrons are subluminal the constraint on $|\delta_e| < 8 \times 10^{-17}$, obtained from the Crab Nebula $\gamma$-ray spectrum, places a weaker constraint on superluminal neutrino velocity of $< 8 \times 10^{-17}$. 

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