Notre Dame Science
Department of Physics

# EVIDENCE FOR AN INVERTED NEUTRINO HIERARCHY FROM NEUTRINO NUCLEOSYNTHESIS IN CORE COLLAPSE SUPERNOVAE, METEORITES AND NEW MEASUREMENTS OF THE $\Theta_{13}$ NEUTRINO MIXING ANGLE

Astrophysics Seminar


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**Tuesday, August 30, 2011**
**12:30 P.M. NSH 184**


Although it is now known that neutrinos have mass, the ordering of the mass eigenstates is not yet known. In this talk we describe a new possible solution to this mystery. Core collapse type-II supernovae emit copious neutrinos from the nascent neutron star. These neutrinos can induce nucleon emission reactions (the $\nu$-process) which can be the dominant source for the synthesis of several rare light and heavy nuclei. This process, however is complicated by the fact that the neutrino mass eigenstates oscillate as the neutrinos transport though the dense outer layers of the supernova. This mixing can affect the $\nu$-process nucleosynthesis. In particular, the synthesis of $^{11}$B and $^{7}$Li via the $\nu$-process is sensitive to the neutrino mass hierarchy for finite mixing $\sin^2 2\theta_{13} > 0.001$. This arises because the average electron neutrino energy for the charged-current neutrino reactions is larger for a normal mass hierarchy than for an inverted hierarchy when there is 13 mixing. This mixing occurs in the carbon shell, and hence, affects the nucleosynthesis of $^{11}$B and $^{7}$Li in the helium shell of core-collapse supernovae. Recent constraints on $\theta_{13}$ from the T2K and MINOS collaborations suggest that $\theta_{13} < 0.001$ is excluded at better than the 90% C.L. This means that there is sufficient mixing to affect Li and B nucleosynthesis. In this talk we point out that there is also a recent suggestion that some SiC X grains containing supernova material from the Murchison meteorite indicate the possible existence of $\nu$-process $^{11}$B encapsulated in the grains along with an upper limit on $\nu$-process $^{7}$Li. We show that these two new results hint at a marginal preference for an inverted neutrino mass hierarchy and we argue that the analysis of more X grains enriched in Li and B along with a firm lower limit to $\theta_{13}$ could reveal the true neutrino mass hierarchy.


All interested persons are cordially invited to attend.