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Hans A. Bethe Prize Talk: Nuclear and Neutrino Astrophysics: The Weak Interaction and the Origin of the Elements[1]

GEORGE FULLER, University of California, San Diego

The weak interaction has the unique ability to transmute neutrons into protons and *vice versa*. As a result, it plays a crucial role in the cosmos: enabling stars to shine for eons; refrigerating the cores of massive stars and setting them up for instability, leading to collapse and supernova explosions; and ultimately facilitating the assembly of nuclei in stars and in the early universe. In many cases the weakly interacting agents in these processes are the ghost-like neutrinos. Though much about these particles remains mysterious, spectacular recent advances in cosmological and laboratory probes have revealed a great deal about neutrino properties, *e.g.,* mass-squared differences and flavor mixing parameters. I will describe recent efforts to understand what these newly-revealed properties mean for how neutrinos transform their flavors in core collapse supernovae and, in turn, what flavor transformation might mean for the expected supernova neutrino burst signature and for the synthesis of the heaviest elements. I will also discuss how primordial nucleosynthesis considerations coupled with anticipated laboratory neutrino oscillation experiments and high-precision cosmic microwave background and large scale structure observations are setting up a nearly over-determined situation, one which can provide a probe of new beyond-standard -model neutrino physics.

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