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From Core Burning to Collapse: Nuclear Physics Driving Nucleosynthesis and Neutrino Production in Massive Stars

Tuesday 19 August 2025 10:45 (25 minutes)

In this talk, I will highlight the critical role of nuclear reactions in massive and very massive stars and their significant impact on both nucleosynthesis and neutrino emission. As these stars evolve through successive burning stages such as carbon, neon, oxygen, and silicon burning, a complex network of nuclear processes governs the formation of intermediate and heavy elements. These reactions include alpha captures, neutron captures, proton captures, and photodisintegration, which together shape the elemental composition of the stellar core and contribute to the chemical enrichment of the universe. At the same time, weak interaction processes such as beta decay, electron capture, and thermal neutrino emission through pair production, photo processes, and plasma interactions become dominant sources of neutrinos. These neutrinos act as efficient carriers of energy, facilitating the cooling of stellar interiors and influencing the onset of core collapse. Accurate modeling of these phenomena depends on detailed nuclear physics inputs such as reaction rates, decay lifetimes, and cross sections. This presentation will examine how nuclear reaction networks in massive and very massive stars drive both nucleosynthetic yields and neutrino spectra, and how these processes connect to ongoing experimental efforts and future neutrino detection strategies.

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