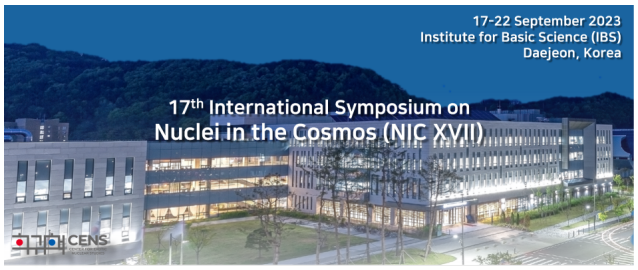

Contribution ID: **47** Type: **Poster**

Full 3D Fluid Simulations of the Convective Urca Process in a Simmering White Dwarf Star

Tuesday, 19 September 2023 17:00 (5 minutes)

Type Ia supernovae are extremely bright thermonuclear events and have been very well studied by numerous observations. However, there remain many open questions about the progenitor system for these explosive events. In the single-degenerate progenitor model, in which a white dwarf accretes mass from a stellar companion, a phase of simmering occurs where carbon burning drives core convection prior to the thermonuclear explosion. A poorly understood aspect of this simmering phase is the convective Urca process, a linking of convection and weak nuclear reactions. We present full 3D fluid simulations of the A=23 convective Urca process in a simmering white dwarf using the MAESTROeX low-Mach hydrodynamic software. This enables us to model both the slow moving convection and weak nuclear reactions. We characterize the extent of mixing across the Urca shell, the convective velocity, and the energy losses due to neutrino emissions. These results can inform 1D stellar evolution models which track the longer timescale evolution of the carbon simmering phase. This research was supported in part by the US Department of Energy (DOE) under grant DE-FG02-87ER40317.

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Session Classification: Poster session (Stellar modelling)

Track Classification: Stellar modelling