

Nuclear Signatures from Binary Stars

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Like nuclear physicists, the most interesting stars like to get together and interact: many are found in binary, or higher-order multiple, systems. In binaries, nuclear physics shapes the yields and observable signatures. In this talk I will explore how binary interaction alters stellar nucleosynthesis, and how we model these processes today, from research codes to the classroom.

I will begin with accreting compact binaries. X-ray bursts on neutron stars and novae on white dwarfs are classic sites of rare-isotope production, seen both in their spectra and in presolar grains, and they provide excellent constraints on reaction rates in extreme conditions. In stellar astrophysics we aim to predict event rates, light curves and detailed isotopic yields of these events. I will discuss the computational tools we use, and how sensitive the results are to uncertainties in stellar evolution and nuclear physics.

I will then turn to thermally-pulsing AGB stars that merge with a companion during binary evolution. We recently found that such mergers can greatly alter the temperature and luminosity of these stars, and the number of thermal pulses they undergo, changing how much nuclear-processed material they eject. They may then be important sources of stable isotopes such as C12 and N14, and of radioactive species such as Al26. Finally, I will ask what happens when we combine the two scenarios: when a neutron star merges with a red giant, the result may be a Thorne–Żytkow object. TŻOs make heavy elements with no other known astrophysical production site: we just need to find them.