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Challenges in Nuclear Astrophysics: nucleosynthesis in novae, x-ray bursts and type Ia supernovae

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Many stars form binary or multiple systems, with a fraction hosting one or two degenerate objects (white dwarfs and/or neutron stars) in short-period orbits, such that mass transfer episodes onto the degenerate component ensue. This scenario is the framework for a suite of violent stellar events, such as type Ia supernovae (SNIa), classical novae (CNe) or type I X-ray bursts (XRBs).
The expected nucleosynthesis accompanying these cataclysmic events is very rich: CNe are driven by proton-capture reactions in competition with beta-decays, proceeding close to the valley of stability, up to Ca. XRBs are powered by a suite of nuclear processes, including the rp-process (rapid p-captures and beta-decays), the 3alpha-reaction, and the alpha-p-process (a sequence of (alpha,p) and (p,gamma) reactions); here, the nuclear flow proceeds far away from the valley of stability, merging with the proton drip-line beyond A = 38, and reaching eventually the SnSbTe-mass region,
or beyond. In SNIa, the detailed abundances of the freshly synthesized elements depend on the peak temperature reached and on the excess of neutrons and protons (which depend in turn on the metallicity of the white dwarf progenitor as well as on the density at which the thermonuclear runaway occurs); they constitute the major factory of Fe-peak elements in the Galaxy, and roughly speaking, the abundance pattern of their ejecta is the result of four different burning regimes: NSE and incomplete Si-, O-, and C-Ne-burning.

In this talk, I'm going to address recent progress in the modeling of these astrophysical scenarios, with emphasis on the nuclear processes involved and on their associated uncertainties. Sensitivity studies aimed at identifying key reactions that deserve to be (experimentally) improved will be presented as well.

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