Giovedì
17 settembre
Aula A, ore 15:00

INFN PERUGIA

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DIPARTIMENTO DI FISICA E GEOLOGIA

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The Cosmic Origin of Heavy Elements: From Neutron Star Mergers to Collapsing White Dwarfs

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Half of the nuclei heavier than iron are thought to be synthesized through rapid neutron-capture (r-process) nucleosynthesis in some of the most extreme environments in the Universe. The discovery of a kilonova accompanying the gravitational-wave event GW170817—the first observed merger of two neutron stars—provided the first direct confirmation that neutron-star mergers are a site of r-process nucleosynthesis. Yet despite the recognition of neutron-star mergers as a key source of r-process material, the astrophysical origin of the heaviest elements remains far from settled, with growing indications that an important piece of the puzzle is still missing.

In this seminar I will review our current understanding of heavy-element production in explosive astrophysical environments, focusing on the physical conditions required for r-process nucleosynthesis and the observational clues that constrain its origin. I will then present recent results identifying accretion-induced collapse (AIC) of white dwarfs as a promising source of heavy nuclei. Using multidimensional general-relativistic magnetohydrodynamic simulations coupled with nucleosynthesis and radiative-transfer calculations, we find that rapidly rotating, strongly magnetized AIC events can eject neutron-rich matter capable of producing heavy r-process nuclei while powering kilonova emission observable at extragalactic distances. I will discuss the implications of these results for the origin of heavy elements, kilonova observations, and the role of white-dwarf collapse in multimessenger astronomy.