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Chemically-Homogeneous Evolution's Impact on Stellar Populations and Compact Binary Mergers

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Compact binary mergers mark the final stage of a complex journey that begins with massive stellar binaries. These binary systems undergo complex processes throughout their lifetime, involving phenomena such as mass transfer and tidal interactions, and ultimately culminating in the formation of neutron star or black hole pairs. Among these binary processes, chemically-homogeneous evolution notably impacts the formation of compact binary mergers by inducing rapid spin increases and subsequent alterations in stellar properties and their evolution.

In my talk, I will present the effects of binary interactions and of chemically-homogeneous evolution both on observable stellar populations and the detectability of compact binary mergers using gravitational wave interferometers. My population-synthesis simulations reveal how chemically-homogeneous evolution alters the ratio of red supergiants to Wolf-Rayet stars, dramatically affecting stellar populations progenitors of gravitational wave sources that are potentially observable through electromagnetic surveys. Notably, Wolf-Rayet stars produced by chemically-homogeneous evolution are, on average, more massive, more numerous, and more luminous than Wolf-Rayet produced either via single or common binary evolution. The effects of chemically-homogeneous evolution are eventually inherited by the compact objects produced by these stellar progenitors: neutron star production is suppressed in favor of black holes, leading to an increased ratio of binaries composed of neutron stars and black holes or massive black holes. Conversely, chemically-homogeneous evolution strongly suppresses the production of compact binary mergers. These findings emphasize the intricate interplay between chemically-homogeneous evolution, stellar populations, and compact binary mergers.

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