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Young(?) and (Metal-)Rich: The Puzzling RR Lyrae Stars in the Galactic Disk

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RR Lyrae stars are a class of variable stars whose luminosity varies periodically, with periods ranging from 0.2 to 1 day. The shape and properties of their light curves correlate with intrinsic characteristics such as luminosity and metallicity (in astrophysics, “metals” refer to all elements heavier than helium). For this reason, RR Lyrae stars are considered standard candles and have been used for decades to measure distances within the Milky Way and its surroundings. They are among the most studied and well-known variable stars, formed from old (>10 Gyr), metal-poor, and low-mass progenitors. Indeed, they are abundant in the oldest structures of our Galaxy, including the stellar halo, the bulge, and globular clusters. However, it is well-established that metal-rich RR Lyrae stars (with metallicities up to solar values) also exist in the Solar neighbourhood. Recent results from the European satellite Gaia have revealed that these metal-rich RR Lyrae stars are distributed across all the Galactic disk, extending well beyond the Solar vicinity. Their kinematics suggest an association with an intermediate-age Milky Way disk population, with ages estimated between 2 and 8 Gyr. These relatively young ages challenge conventional scenarios for RR Lyrae formation, which posit that such stars should be among the oldest in our Galaxy or even too old to exist at higher metallicities. Resolving this conundrum requires exploring alternative formation channels for RR Lyrae stars. One promising alternative formation channel involves mass transfer in binary systems (i.e., systems of two stars gravitationally bound to one another). My primary research focus at the ICCUB is to investigate this alternative formation channel using binary evolution simulations. In this talk, I will present the current state of knowledge on this intriguing problem, share my efforts to address it, and highlight its importance in the broader context of our understanding of the Milky Way and the theories of stellar and binary evolution.

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