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Color-superconducting strange quark matter formation in compact stars

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An intriguing hypothesis states that ordinary hadronic matter in bulk is a metastable state (i.e., a local minimum) of strongly interacting matter, while strange quark matter (SQM) is absolutely stable (i.e., the global minimum) in bulk. A potential barrier that prevents a spontaneous deconfinement transition of ordinary hadronic matter into SQM would separate these two phases.
Our work aims to determine the conditions under which this barrier can be overcome and to assess whether such conditions may occur in high-energy astrophysical phenomena, such as core-collapse supernovae and binary compact star mergers. In these scenarios, the formation of a critical SQM seed could ultimately lead to the conversion of a hadronic star into a strange quark star.
It is usually assumed that the local flavor composition remains fixed during the initial formation of the SQM seed, given that the weak interactions are too slow to change it significantly. However, the composition fluctuates around its average equilibrium values at the typical temperatures of high-energy astrophysical processes. I will address this effect by considering the local thermal fluctuations of the hadronic composition, showing that they make the formation of SQM much easier. This result is also relevant in the standard one-family and twin-star scenarios, leading to a much smaller finite-size effect-mediated delay in the deconfinement than the ones estimated in previous works. Moreover, I will discuss the role of color-superconductivity in such a phenomenon. Finally, some possible associated phenomenology, such as the explosion of massive progenitor stars, will be presented.

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