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Potential of probing the neutron star composition in accreting x-ray binaries

Transiently accreting low-mass x-ray binaries have the potential to probe the core composition of their neutron stars via deep crustal heating caused by nuclear reactions. We statistically assess this deep crustal heating scenario, taking into account the various microphysical and astrophysical uncertainties. We find that despite the sizable uncertainties, there is a chance to discriminate different compositional scenarios. Several observed sources statistically challenge a minimal hadronic matter composition, where cooling proceeds exclusively via slow modified Urca reactions. Considering here two exemplary extended uniform compositions, namely ultradense hadronic matter with direct Urca emission and ungapped quark matter, we find that they are even within uncertainties distinguishable. We show that although exotic forms of matter are generally only expected in an inner core, which could in principle have any size, sufficiently large astrophysical datasets nonetheless have the potential to statistically discriminate compositional scenarios, in particular when further mass measurements become available.

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