

## A New Strong Urca Pair $^{63}\text{Fe}$ - $^{63}\text{Mn}$ and its Impact on the Thermal Evolution and Superburst Ignition of Neutron Star

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The cooling effect of  $^{63}\text{Fe}$ - $^{63}\text{Mn}$  Urca pair on the neutron star surface has been evaluated based on the state-of-the-art shell model calculations which reproduced the experimental spectroscopy results in the neutron-rich  $N \sim 40$  region. It is concluded that  $^{63}\text{Fe}$ - $^{63}\text{Mn}$  could be among the strongest Urca pairs in the neutron star crust. This pair has been identified as the primary contributor to the cooling of neutron stars after type-I X-ray bursts, as demonstrated by crust cooling models. When considering this pair, carbon ignition is expected to occur at a deeper shell, potentially facilitating superburst ignition with X-ray burst residues. Consideration of  $^{63}\text{Fe}$ - $^{63}\text{Mn}$  also improves the constraints that can be made on past surface nuclear burning on accreting neutron stars with observed quiescent cooling light curves.

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