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The Peculiar Thermal Relaxation of Neutron Stars

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The peculiar thermal relaxation property of neutron stars is characterized by significantly prolonged thermal relaxation time. By combining neutron star cooling simulations, we propose a simple analytical model to explain the peculiar thermal relaxation. We find that the introduction of neutron 3P_2 superfluidity and the dUrca process lead to these peculiar thermal relaxations. The former originates from the re-coupling of the neutron star's core and crust following the PBF process, while the latter results from the delayed thermal coupling between the neutron star's inner core and outer crust. The peculiar thermal relaxation properties of neutron stars can be used to constrain the internal physics of neutron stars, particularly the superfluid properties.

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