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Scalarized neutron stars in massive scalar-tensor gravity: X-ray pulsars and tidal deformability

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We investigated neutron stars (NSs) in scalar-tensor theories of gravity with spontaneous scalarization, exploring three classes of massive scalar-tensor theories and obtaining numerical solutions for slowly rotating NSs. These solutions were used to construct X-ray pulse profiles of hot spots on the surface of NSs, and we also calculated the tidal deformability for NSs with spontaneous scalarization, which was done for the first time with a massive scalar field. Our findings suggest that the I-Love universal relation between the moment of inertia and the tidal deformability deviates from that in GR, serving as a powerful test of GR. The class of scalar-tensor theories with the scalar field coupling to the Gauss-Bonnet invariant has drawn great interest since solutions of spontaneous scalarization were found for black holes in these theories. We studied rotating and tidally-deformed NSs in the scalar Gauss-Bonnet theory and found that while the mass, radius, and moment of inertia of spontaneously scalarized NSs show very moderate deviations from those of NSs in GR, the tidal deformability exhibits significant differences between the solutions in GR, and the I-Love universal relation breaks down in this theory.

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