

A continuous wave window into neutron star structure

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Every rapidly spinning neutron star with slight asymmetry would broadcast a continuous hum of gravitational waves (GW). None of these signals has been detected yet, but the silence itself is measurable: searches now set upper limits on the GW amplitude of dozens of known pulsars, and for a growing subset those limits dig below the energy budget available from the stars' own spin-down. We ask what this kind of data, can say about the interior of a neutron star. The amplitude of the continuous signal depends on how much matter the star carries in its deformation and how that matter is distributed, its moment of inertia, which in turn is fixed by the unknown equation of state of dense matter. This opens a route to the neutron star mass-radius relation that is fully independent of the X-ray pulse-profile and binary-merger measurements that anchor current constraints. We build a hierarchical Bayesian pipeline that propagates simulated amplitude limits, treated consistently as non-detections, through stellar-structure calculations to the mass-radius plane, marginalizing over the unknown deformations of the pulsar population. Rather than claiming a new measurement, we chart the sensitivity frontier: how deep continuous-wave searches must go before they begin to weigh in on dense matter on their own.

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