Temperature-dependent oscillation modes in rotating superfluid neutron stars

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According to the standard r-mode theory, hot and rapidly rotating neutron stars (NSs) in low-mass X-ray binaries (LMXBs) should be CFS-unstable with respect to emission of gravitational waves [1, 2]. As a consequence, the probability to observe them should be very small, but this conclusion contradicts observations [3]. To resolve the paradox, in the series of papers [4–8], we introduced a new scenario, in which the finite-temperature effects in the superfluid core of an NS lead to resonance coupling and enhanced damping (and hence stability) of oscillation modes at certain "resonance" stellar temperatures. We demonstrated that NSs in LMXBs with high spin frequency may spend a substantial amount of time at these resonance temperatures, so their interpretation does not constitute a problem.

The scenario of Refs. [4–8] was based on a simplified phenomenological model (in particular, resonance temperatures have never been calculated explicitly). In this work we put it on a more solid ground by considering realistic NS models. Moreover, to find the resonance temperatures (and hence to verify the scenario) we perform extensive calculations of oscillation spectra for *rotating* NSs, accounting for the effects of nucleon superfluidity, finite-temperatures, and multilayer structure of NS cores with different particle compositions. Our work provides a new method to quantitatively constrain the properties of superdense matter by comparing the observed temperatures of NSs in LMXBs with the theoretically calculated resonance temperatures in their oscillation spectra.

References

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