# How to learn about fundamental physics from fast rotating neutron stars: Spectra, Stability and Universal Relations

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We study rapidly rotating relativistic stars which are present in various astrophysical systems such as in binary systems involving neutron stars or in the aftermath of a supernova core collapse. First, we study their oscillations and instabilities by taking into account the contribution of a dynamic space-time. This part of the study is based on the linearised version of Einstein's equations and via this approach the oscillation frequencies as well as the critical values for the onset of a secular instability are determined. We show asteroseismological relations for the fundamental eigenfrequency which are crucial for tackling the so-called "inverse problem". Further, we provide universal relations that allow to estimate the moment of inertia (and other bulk quantities) of a rotating star from the knowledge of the triple mass, radius and moment of inertia of an associated non-rotating star. The proposed universal relations facilitate computationally cheap EOS inference codes that permit the inclusion of observations of rotating neutron stars. As a demonstration, we deploy them into a Bayesian framework for equation of state parameter estimation that is now valid for arbitrary, uniform rotation. The results are important for all stages of a neutron star's life but particularly interesting in pre- and post-merger cases.