Gravitational waves from oscillating rotating neutron stars to probe their inner structure

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Any relativistic object whose internal motions are not too simple emits gravitational waves (GWs). Among the potential astrophysical sources, oscillating neutron stars (NSs) are strong candidates, whose GW emission could be detected in the future by GW telescopes such as VIRGO and LIGO. Yet, not all oscillatory modes are relevant from the GW point of view, since the possibility to observe them depends for instance on their damping time and their emissivity. Thus, the so called r-modes (axial inertial modes) of rotating NSs started to be considered as very interesting when it was proven that they are generically driven to instability by their coupling to the gravitational field, whatever the angular velocity of the star. After a short review of GWs and of rotating NS oscillations (with more details on inertial modes), a fully relativistic numerical study of r-modes will be presented (Villain, Bonazzola & Haensel, 2005, to be published in PRD). Through 3D time evolutions of the relativistic Euler equation done with a spectral code, the influence of a trying-to-be realistic description of the microphysics on the main properties of the modes was investigated.