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MATINS: a new 3D code for the magnetothermal evolution of isolated neutron stars

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Isolated Neutron Stars (NS) are intriguing sources of continuous gravitational waves (GW) that have yet to be detected. To emit GWs, a star typically requires a mass-energy distribution that deviates from axial symmetry with respect to its rotational axis. This deviation often stems from the non-axisymmetric distribution of magnetic energy, which arises from the coupled magnetic and thermal evolution of the star. Understanding the magneto-thermal evolution of NSs over time is also crucial for comprehending their spectral and temporal properties and shedding light on the origins of different NS populations.

To achieve these goals, a comprehensive numerical study is necessary, involving the analysis of heat diffusion and magnetic evolution equations, as well as detailed calculations of the star's microphysical properties, such as neutrino emissivity, heat conductivity, and electric conductivity. Additionally, to account for non-axisymmetric effects, a 3D solution of the equations becomes essential. These effects are particularly significant as they contribute to the formation of a non-axisymmetric temperature distribution on the stellar surface, leaving an observable imprint on the object's light curve.

In this talk, I present the implementation of our new code, MATINS, a 3D magneto-thermal evolution code designed to solve the coupled magnetic and thermal evolution equations for isolated NSs with the most detailed microphysical description currently available.

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