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Phenomenology: Anisotropic Neutron Stars: Exploring Quasinormal Modes in Full General Relativity

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The discovery of the Hulse Taylor pulsar gave indirect evidence of gravitational waves, but recent groundbreaking direct detection of gravitational waves by LIGO-VIRGO collaboration opened a new window to look at the celestial entities and cosmos. In this work we focus on exploring the impact of local anisotropic pressure on the quasinormal modes of neutron stars in the framework of general relativity. Prior research has been conducted in this particular area; however, all previous studies have either relied on a Newtonian framework or utilized the Cowling approximation, in which metric perturbations are assumed to be negligible. These considerations, however, do not provide a complete picture of the oscillation characteristics of anisotropic compact stars, as the general relativistic framework also allows us to obtain the damping time of the oscillation, which is crucial for understanding the gravitational waves that the anisotropic compact stars emit. According to theoretical research, anisotropy can develop in neutron stars as a result of a number of circumstances, including high density, the presence of a magnetic field, superfluidity, pion condensation, and a number of others. The discovery of both high-mass and low-mass stars in recent findings further strengthens the supporting evidence regarding the existence of anisotropy in neutron stars. This study focuses on deriving the governing equations for metric perturbations and fluid perturbations from the linearized Einstein equations and conservation of energy-momentum tensor. Specifically, we have employed the Regge-Wheeler gauge to derive the equations for the polar mode of oscillations, while also considering the anisotropy present in neutron stars. In conducting this study, we have incorporated realistic equation of states and utilized an ansatz that accounts for anisotropy with astrophysical significance. We have demonstrated how the mode frequencies and damping times vary with changes in the strength of anisotropy within the system, taking into account observables such as the total mass of the star and the gravitational redshift. This analysis provides a distinctive approach to detect and characterize anisotropy in compact stars, offering valuable insights into the nature of these celestial objects. We have also explored the influence of the equation of state's stiffness on the quasinormal modes of neutron stars in the presence of anisotropy.

Presenter: MONDAL, Sushovan (The Institute of Mathematical Sciences, Chennai, India)

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