URSI - RCRS 2022, IIT (Indore), India, 1 - 4 December, 2022

A perceptive overview of nucleus-acoustic waves in degenerate quantum astroplasmas

Pralay Kumar Karmakar and Sayanti Dasgupta
Department of Physics, Tezpur University, Napaam-784028, Tezpur, Assam, India
E-mail: pkk@tezu.ernet.in

This contribution plans to present a theoretic model formalism meticulously developed to explore the stability behavioral dynamics of the nucleus-acoustic waves (NAWs) excitable in diversified astrophysical gyrogravitating degenerate quantum plasma fluids in the presence of realistic key influential factors. The complex quantum plasma model system consists of non-degenerate heavy nuclear species, lighter nuclear species, but both treated classically. It has quantum-mechanically treated degenerate electronic species. All the constitutive species are well attached conjointly via the long-range non-local gravito-electrostatic back-and-forth interactions through the Poisson differential formalisms [1-2]. It specifically considers the vigorous influences of the linear viscoelasticity and the nonlinear electrostatic confinement pressure (quadratic in density). Application of a standard normal spherical mode analysis is executed over the perturbed quantum plasma system to arrive at a generalized linear dispersion law (septic in analytic construct). It climaxes the dependency of various atypical plasma-parametric dispersion coefficients without any traditional quasi-classic guesstimate [3]. It is analytically revealed therefrom that the NAWs here are the propagatory longitudinal mechanical disturbances excited cooperatively due to the interplay between the nuclear inertia (by heavy nuclear species) and the thermal elasticity (by degenerate electronic species). The NAW proliferation is clearly amidst the combined action of the included dynamic factors in the model setup. It is perceived that the relative nuclear charge-mass coupling acts as a destabilizing agency to the NAW dynamics. The ratio of the charge density of the heavy-to-light nuclear species acts as a stabilizing agency in both the non- relativistic (NR) and ultra-relativistic (UR) regimes. It is conjectured that, in both the NR-UR domains, the rotational force plays a destabilizing role, and so forth. A comparative analysis of the findings goes in correlation and consistency with the varied earlier extrapolations seen in the literature [1-2]. We highlight the asteroseismic applicability of our analysis, essentially to comprehend diverse wave-instability activities seen in complex degenerate quantum plasmas. It clearly mirrors largely the intricate interiors of compact astrophysical objects alongside existent astronomic artworks of white dwarf family stars with diverse core configurations [1-3].

1. G. Manfredi, Field Inst. Commun. Ser. 46, 263 (2005).
2. D. Koester, Astron. Astrophys. Rev. 11, 33 (2002).
3. S. Dasgupta, P. K. Karmakar, Sci. Rep. 11, 19126 (2021).