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Heavy Nucleus Acoustic Periodic Waves in a Degenerate Relativistic Quantum Plasma

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There has been a great interest in studying the relativistic degenerate dense plasmas due to its existence in interstellar compact objects (white dwarfs [1], neutron stars [2] etc.). It is notable that the basic constituents of white dwarfs are mainly positively and negatively charged heavy elements like carbon, oxygen, helium with an envelope of hydrogen gas. The existence of heavy elements (positively and negatively) is found to form in a prestellar stage of the evolution of the universe, when whole matter was compressed to extremely high densities. The degeneracy of the plasma species arises due to Heisenberg's uncertainty principle, and that the uncertainty in the momenta of highly compressed plasma species (which are confined in an extremely small space) is infinitely large. This means that the degenerate plasma species (even though they are extremely cold) must move very fast yielding to a very high pressure, called "degenerate pressure". It is observed that the degenerate pressure exerted by electrons (light nuclei/ions) depends only on the electron (light nucleus/ion) number density, but not on the electron (light nucleus/ion) temperature. The inter-particle distance in such space and laboratory degenerate relativistic quantum plasma (DRQP) systems is of the order of (or smaller than) the de Broglie wavelength of light plasma particle species, and the relativistic parameters of the light plasma particle species acquire very large values. This means that the quantum as well as relativistic effects become important. We have investigated heavy nucleus-acoustic (HNA) periodic and solitary waves in a degenerate relativistic magneto-rotating quantum plasma (DRMQP) system containing relativistically degenerate electrons and light nuclei, and non-degenerate mobile heavy nuclei. Only positive potential HNA periodic waves and solitons have been found in consonance with the satellite observations [3]. It is shown that the combined effects of external magnetic field strength, rotational frequency and obliqueness significantly modify the propagation properties of the HNA periodic waves and solitons. The results of this investigation may be useful in understanding the shock waves and solitons in astrophysical compact objects especially white dwarfs and neutron stars.

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