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Novel features of super strong magnetic field in magnetars

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Magnetic field quantization is an important issue for degenerate environments such as neutron stars, radio pulsars and magnetars etc., due to the fact that these stars have a magnetic field higher than the quantum critical field strength of the order of 4.4 × 10*13 G, accordingly, the cyclotron energy may be equal to or even may be more than the Fermi energy of degenerate particles. We shall formulate here the exotic physics of strongly magnetized neutron stars, known as magnetars, specifically focusing on the outcomes of the quantized magnetic pressure.

In this scenario, while following the modified quantum hydrodynamic model, we shall investigate both linear and nonlinear fast magneto sonic waves in a strongly magnetized, weakly ionized degenerate plasma consisting of neutrons and electron–ions in the atmosphere of a magnetar pulsar. Here, linear analysis depicts that sufficiently long, fast magneto sonic waves may exist in a weakly dispersive pulsar having finite phase speed at cutoff.

To investigate one dimensional nonlinear fast magneto sonic waves, a neutron density expression as a function of both the electron magnetic and neutron degenerate pressures, is derived with the aid of Riemann's wave solution. The obtained neutron density expressions correspond to two different type of KDV equations, having coefficients which are strong function of both quantized magnetic pressures and neutron density concentration. Consequently, a modified Korteweg–de Vries equation is derived, having a refractive solitary wave solution.

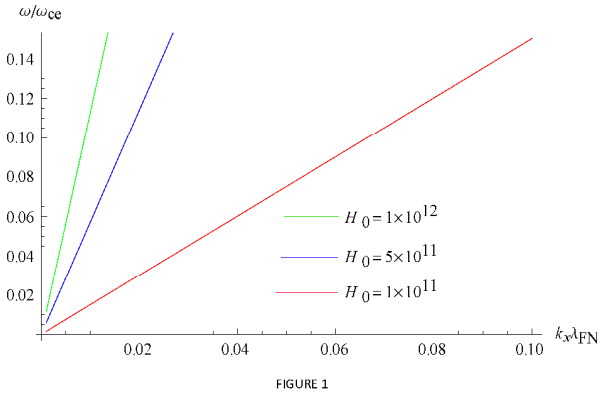

Figure 1. Normalized angular frequency (ω) of fast, degenerate, neutron magnetosonic waves is plotted against the wave number while assuming n0e =10^{22}cm^{-3} and n0N=10^{30}cm^{-3}

It is found that the basic properties such as amplitude, width and phase speed of the fast magneto acoustic waves are significantly altered by the electron magnetic and the neutron degenerate pressures.

The results of this theoretical investigation may be useful for understanding the formation and features of the solitary structures in astrophysical compact objects such as pulsars, magentas and white dwarfs etc

We have displayed Fig.1 to show that angular frequency (ω) of fast magneto sonic wave increases by increasing the strength of magnetic field H₀..

The impact of quantized magnetic field on the dispersive properties of solitons is displayed in Fig. 3(a)

.References

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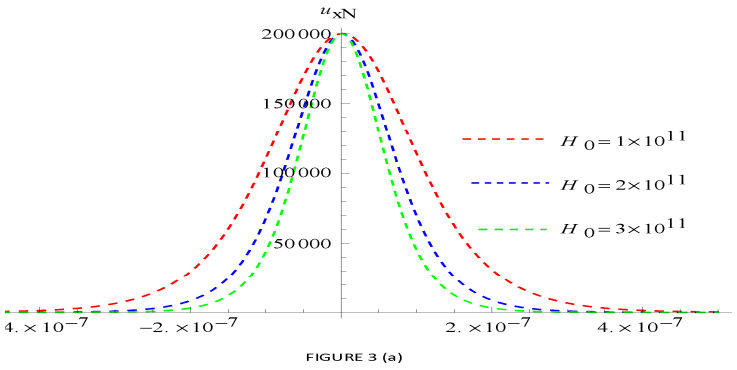

Figure 3(a). The -x dimensional neutron velocity (u_{xN}) of fast magneto sonic neutron waves is plotted against the x-coordinate for different values of magnetic field.