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Shear viscosity and the nucleation of antikaon condensed matter in hot neutron stars

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The shear viscosity plays an important role in damping gravitational wave driven instabilities in old and accreting neutron stars. We discuss the shear viscosity in the presence of an antikaon condensate in neutron stars, using Boltzmann kinetic equation in the relaxation time approximation. The calculation of shear viscosity involves the equation of state (EoS) as an input, that we construct for antikaon condensed matter at finite temperature within the framework of relativistic field theoretical model. We consider a first order phase transition from charge neutral and beta-equilibrated nuclear matter to K- condensed phase in a hot neutron star after the emission of trapped neutrinos.

Antikaons, which form a s-wave (p = 0) condensation, do not take part in momentum transfer during collisions with other particles. However, with the onset of K- condensation, electrons and muons are rapidly replaced by them. This influences the proton fraction and EoS which, in turn, have important consequences for the electron, muon and proton shear viscosity. We find that the electron and muon shear viscosities drop steeply after the formation of the K- condensate in neutron stars. Hence, the total shear viscosity decreases in the K- condensed matter due to the sharp drop in the lepton shear viscosities. However, the proton shear viscosity whose contribution to the total shear viscosity was negligible compared to the leptonic contribution in nucleons only matter, now becomes significant in the presence of the K- condensate. The proton shear viscosity may even exceed the neutron as well lepton shear viscosities at higher densities.

Further the shear viscosity might control the nucleation rate of bubbles in first order phase transitions. The thermal nucleation time is inversely proportional to the shear viscosity. In this connection we discuss the effect of shear viscosity on the nucleation process of bubbles of K- condensed phase in neutron stars.

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