Springer Proceedings in Physics 265

Soumitra Sengupta · Samrat Dey · Saurya Das · Dhruba J. Saikia · Sudhakar Panda · Ramakrishna Podila *Editors*

Selected Progresses in Modern Physics

Proceedings of TiMP 2021

Springer

Springer Proceedings in Physics

Volume 265

Indexed by Scopus

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ISSN 0930-8989 ISSN 1867-4941 (electronic)
Springer Proceedings in Physics
ISBN 978-981-16-5140-3 ISBN 978-981-16-5141-0 (eBook)
https://doi.org/10.1007/978-981-16-5141-0

Contents

Chapter 43
Transport Coefficients of Dense Stellar Plasma in Strong Magnetic Field

Soma Mandal

Abstract Following an exact relativistic formalism (Ghosh et al. in Ann Phys 312, 398 (2004) [1]), we study the transport properties of dense stellar electron-proton plasma in a strong quantizing magnetic field. The transport coefficients, namely the coefficients of shear and bulk viscosities as well as thermal and electrical conductivities are obtained from the relativistic version of Boltzmann kinetic equation by linearizing the distribution function and using relaxation time approximation. The dependence of the kinetic coefficients on the strength of the magnetic field is discussed. The variation of these coefficients with magnetic fields are found to be insensitive for the field strengths $\leq 10^{17}$G beyond which decreases with magnetic field. As a consequence, in presence of ultra-strong magnetic field, the electron-proton plasma behaves like a superfluid insulator. Since the electrical conductivity of the medium becomes extremely low (almost zero) in presence of ultra-strong magnetic field, the magnetic field at the core region must, therefore, decay very quickly. Hence, strong magnetic field can not exist at the core of magnetars.

43.1 Introduction

The study of the transport properties of hot and dense matter has sharply been increased in the context of heavy ion collision physics. Knowledge of various transport coefficients is also required in astrophysical problems such as for the description of various phenomena in supernova and neutron stars [2, 3]. It is, therefore, worthwhile that these transport coefficients be understood and derived rigorously within a microscopic theory.

There have been a lot of attempts to estimate the transport coefficients involving different approximation schemes, e.g., relaxation time approximation [4–6], Green-Kubo formalism [7], Chapman-Enskog formalism [8], weak coupling QCD [9] etc. Method for the calculation of transport coefficients were probed in description of

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S. Sengupta et al. (eds.), *Selected Progresses in Modern Physics*, Springer Proceedings in Physics 265, https://doi.org/10.1007/978-981-16-5141-0_43