Causal second-order magnetohydrodynamics from kinetic theory using RTA approximation

BY: ANKIT KUMAR PANDA, NISER (INDIA)
COLLABORATORS: Dr. Ashutosh Dash, Dr. Victor Roy, Rajesh Biswas
QGP AND MAGNETIC FIELD PRODUCTION

$\nu_2$ VARIATION WITH MAGNETIC-FIELD AND $b$

MAGNETIC FIELD MAGNITUDE COMPARISON

- Earth's magnetic field $\sim 5 \times 10^{-5}$ T
- MRI $\sim 1$ T
- Strongest laboratory fields $\sim 1.2 \times 10^5$ T
- Magnetar (static) $\sim 10^{11}$ T
- Heavy Ion Collisions (transient) $\sim 10^{14}$ T

MAGNETIC-FIELD VARIATION WITH $b$


https://doi.org/10.1140/epjc/s10052-020-7847-4
FORMALISM

MICROSCOPIC THEORY

BOLTZMANN EQUATION

\[ p^\mu \partial_\mu f + q F^{\mu \nu} p_\nu \frac{\partial}{\partial p^\mu} f = C[f] \]

KINETIC THEORY

\[ f = \sum_{n=0}^{\infty} (-1)^n \left( \frac{\tau_c}{u.p} \right)^n \left( p^\mu \partial_\mu + q F^{\mu \nu} p_\nu \frac{\partial}{\partial p^\mu} \right)^n f_0 \]

RELATIVISTIC MAGNETOHYDRODYNAMICS EQUATIONS

\[ \partial_\mu T^{\mu \nu}_f = F^{\nu \lambda} J_\lambda f \quad \partial_\mu J^\mu_f = 0. \]

\[ \partial_t F^{\mu \nu} = J^\mu \quad F^{\mu \nu} = E^{\mu \nu} \cdot u^\nu - E^{\nu \mu} \cdot u^\mu + \epsilon^{\mu \nu \alpha \beta} u_\alpha B_\beta. \]

MACROSCOPIC THEORY

➢ NO POLARISATION
➢ NO MAGNETISATION

CALCULATE : \( \dot{\alpha}, \dot{\beta}, \dot{u}^\mu \)

EQUATION OF MOTION

FINDING EVOLUTION EQUATION FOR DISSIPATIVE STRESSES (\( \pi^{\mu \nu}, V^\mu, \Pi \))

DOI: "10.1103/PhysRevD.104.054004" and DOI: "10.1007/JHEP03(2021)216"
We Found out the 2\textsuperscript{nd}-ORDER evolution equations of viscous stresses.

All the Transport coefficients pertaining to this study have been evaluated.

The anisotropic transport coefficients of shear, diffusion stresses and for the electrical conductivities have also been evaluated in the presence of external electromagnetic field.

From kinetic theory perspective we have found out the small corrections to equilibrium distribution function which can be readily used in the cooper-frey formula to find out different flow harmonics.

THANK YOU