Discussion: Transport coefficients

Topics for discussion:

- What transport coefficients do we need?
- What do we know?
- Important problems
- How to make transport coefficients easily accessible for a broad NS community: ideas, suggestions

• What transport coefficients do we need?

- Cooling of isolated NSs and X-ray transients → κ
- Oscillations of NSs → η, ξ
- Magnetic field evolution → D_{ij}, σ
- Vortex transport (glitches, inter-glitch dynamics)

transport coefficients describing vortex-particle interactions

- Dissipative effects during binary NS inspiral and post-merger phase (may affect GW signal) → ξ, η, κ
- …?

• What do we know?

Crust: • basic transport coefficients are rather well known κ, η, σ

(but not in the pasta phase)

Core: • As a rule, $npe\mu$ composition, no magnetic field, effects of superfluidity are partly taken into account ➡ $\kappa, \eta, \xi, \sigma$

D_{ij} • diffusion coefficients in the magnetic field are only well known for a simplified nonsuperfluid model of *Yakovlev & Shalybkov (1991)*

• vortex-related transport coefficients are poorly known and controversial. The reliable result: mutual friction coefficient describing scattering of electrons off the vortex magnetic field.

Important problems

- Thermal and electrical conductivity in the pasta phases: important, e.g., for explaining magnetars

- Calculate diffusion tensor D_{ij} with the updated microphysics

- Vortex transport

- Polarization properties of $npe\mu$-matter accounting for the Fermi-liquid effects and superfluidity/superconductivity (important for correctly describing the electron-electron and electron-proton scattering in dense Fermi-mixture).

- …?

- **How to make transport coefficients easily accessible for a broad NS community: ideas, suggestions**

- Fitting formulas

(example: fits from the review by *Schmitt & Shternin 2017*)

$$\eta_{e\mu} = 8.43 \times 10^{20} \left(\frac{n_{\rm B}}{n_0}\right)^{14/9} \left(\frac{T}{10^8\ {\rm K}}\right)^{-5/3} \frac{x_e^2 + x_\mu^2}{(x_e^{2/3} + x_\mu^{2/3} + x_p^{2/3})^{2/3}} \ \frac{\rm g}{\rm cm\ s}$$

$$\eta_n = 2.15 \times 10^{17} \left(\frac{n_n}{n_0}\right)^{5/3} \left(\frac{m_n^*}{m_N}\right)^{-2} \left(\frac{T}{10^8\ {\rm K}}\right)^{-2} \left[\left(\frac{m_n^*}{m_N}\right)^2 m_\pi^2 S_{\eta nn} + \left(\frac{m_p^*}{m_N}\right)^2 m_\pi^2 S_{\eta np}\right]^{-1} \ \frac{\rm g}{\rm cm\ s}$$

- Tables

- Publicly available codes (example: library of Alexander Potekhin)

  http://www.ioffe.ru/astro/conduct/index.html

- …?