Early-Stage Shear Viscosity far from Equilibrium via Holography

Flash Talk

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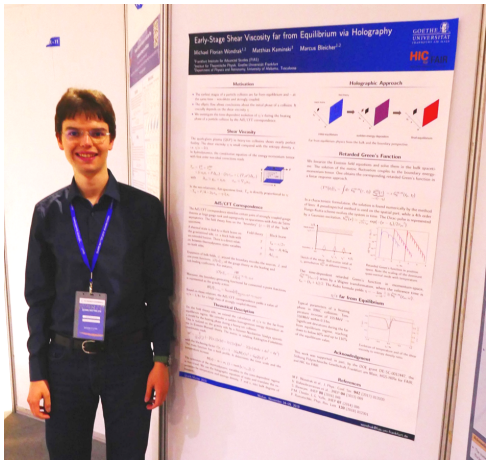


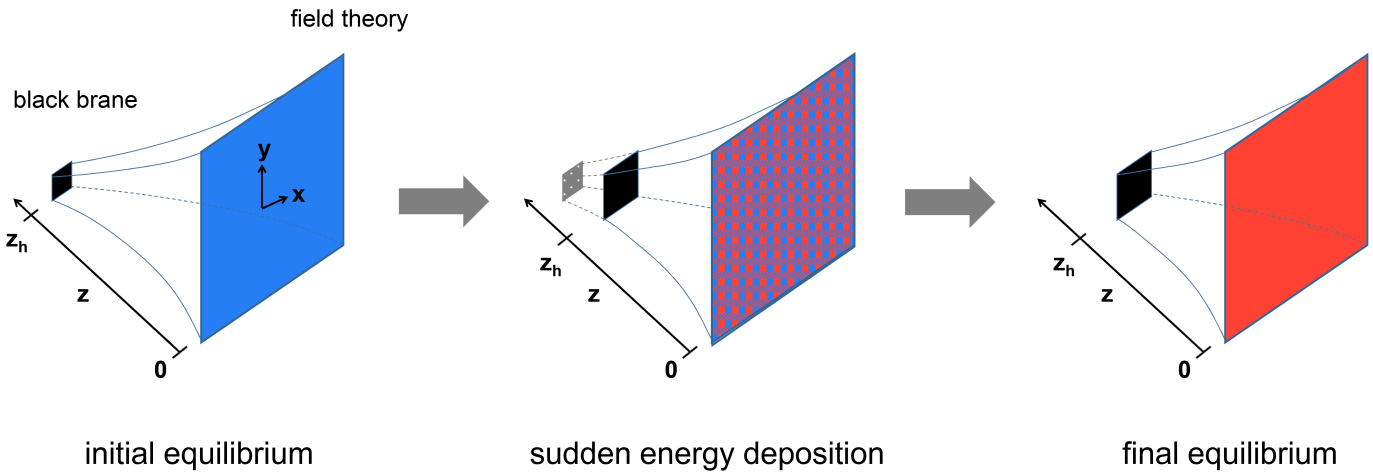
Quark Matter 2019, Wuhan, November 09, 2019

MFW, Kaminski, Nicolini, Bleicher, J. Phys.: Conf. Ser. **942** (2017) 012020

Far from Equilibrium in Bulk and Boundary $\rightarrow s$

- Viscosity: Crucial property of QCD matter.
- BUT: Off-equilibrium behavior differs from static one.

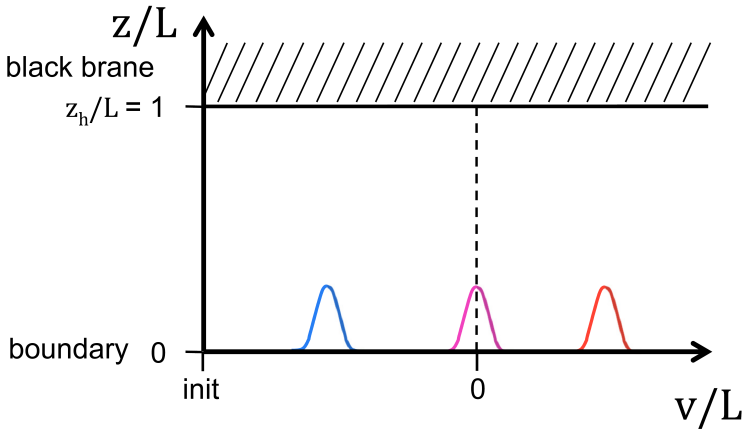
$\Rightarrow$ Calculate the effective η/s for non-equilibrium systems.

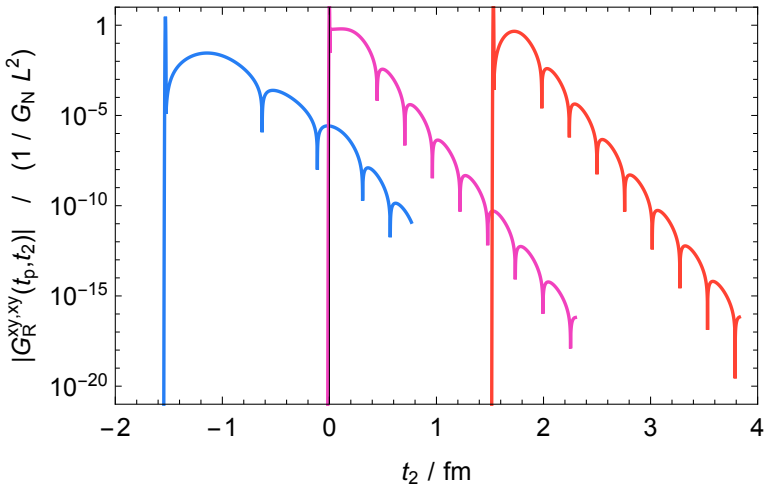


- Sudden energy deposition @ boundary
  $\leftrightarrow$ Rapid mass infall (Reissner-Nordström Vaidya spacetime).
- Holographic equation of state $\rightarrow$ time-dependent s.

System Response to Perturbations $\rightarrow \eta$

- Bulk: Evolution of the geometry perturbation h_{mn}.
  $\rightarrow$ Boundary: Damped oscillations of $\langle T^{\mu\nu} \rangle$.





- Linear response:

$$\langle T^{xy}(t_2)\rangle_h = \int \mathrm{d}\tau \; G_R^{xy,xy}(\tau,\, t_2) \underbrace{h_{xy}^{(0)}(\tau)}_{=\delta(\tau - t_p)} = G_R^{xy,xy}(t_p,\, t_2)$$

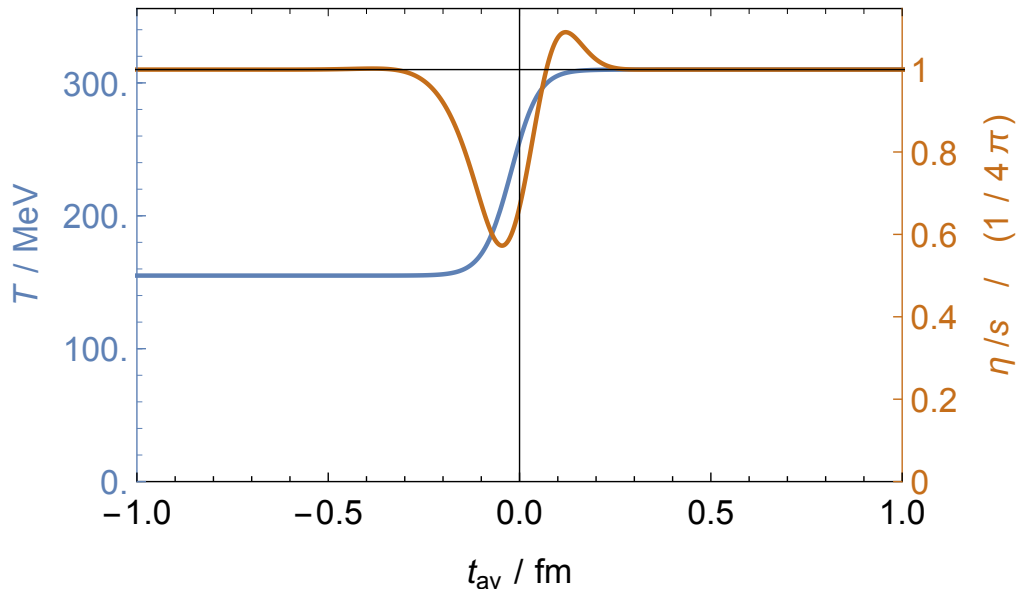
- Wigner transformation $\rightarrow$ Kubo formula $\rightarrow$ time-dependent η.

η/s far from Equilibrium

Initial stage modeled by temperature rise

($T = 155\,\mathrm{MeV}$ $\rightarrow\ T = 310\,\mathrm{MeV}$)

over $\Delta t = 0.3\,\mathrm{fm}$.



⇒ First holographic non-equilibrium calculation of η/s via the retarded Green's function.

⇒ Off-equilibrium effects drastically change the effective viscosity/entropy ratio in the early stage.

⇒ Impact on hydrodynamics and on the extraction of viscosity from data.