Henning Gerber

Research Training Group: Strong and Weak Interactions - from Hadrons to Dark Matter

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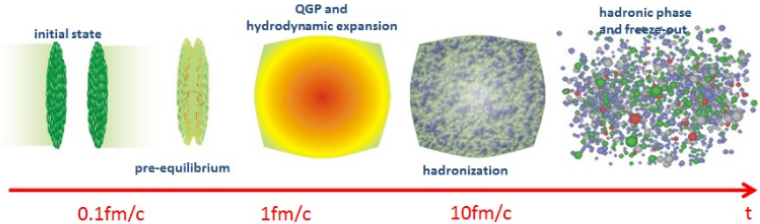
- Bielefeld:
  - 2009: Abitur (Fr.- v. Bodelschwingh Gymnasium)
  - 2009-2010: Civil Service at Boysenhaus, Bielefeld (Nursing home for the elderly)
  - 2010-2013: B. Sc. in Physics at Bielefeld University
    - Thesis: Topological insulator in a Zeeman-field
  - 2013-2015: M. Sc. in Physics at Bielefeld University
- Stays abroad:
  - 2006-2007: New Mexico, USA: High school exchange (10 month)
  - 2013-2014: King's College, London, UK (one academic year, ERASMUS)
- Münster:
  - 01.11.15: Ph.D. student at Uni Münster
  - Group of Prof. Dr. Münster: Non perturbative QFT on the lattice

Gravity-improved hydrodynamics of heavy ion collisions



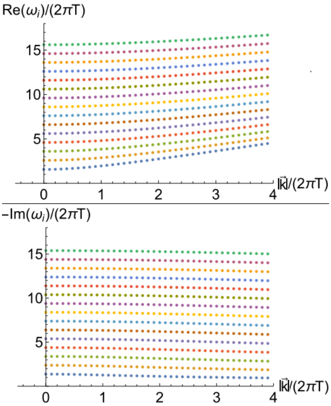
G. Qin - Anisotropic Flow and Jet Quenching in Relativistic Nuclear Collisions

- Ideal relativistic hydrodynamics works well after $\approx 1\frac{\text{fm}}{c}$, breaks down for earlier times
  $\Rightarrow$ Non-hydrodynamic modes
- AdS/CFT correspondence provides toy model of strongly interacting theory: $\mathcal{N} = 4$ SYM

$$\boxed{\{\mathcal{N}{=}4\ \mathrm{SU}(N)\} \equiv \{\text{Type IIB String Theory in } AdS_5 \times S_5\}}$$

- For $\lambda = gN \gg 1$ IIB string theory simplifies to classical supergravity
- SYM at finite temperature T - Collapse a black hole of Hawking temperature T in AdS_5
- $\mathcal{T}^{\mu\nu} \cong g^{\mu\nu}$
  $\Rightarrow$ Can use Einstein equations to calculate excitations of stress energy
  - Vanishing boundary condition at $r \to \infty$
  - incoming boundary condition at the black hole horizon
  - Quasinormal modes ω_i

- Simplifications
  - keep only lowest mode for hydro
  - ω is independent of $\vec{k}$
- $\langle \mathcal{T}^{\mu\nu} \rangle$ formally satisfies the differential equation of a damped harmonic oscillator



$$\left(\frac{1}{T}\frac{\partial}{\partial t}\right)^2 \langle \mathcal{T}^{\mu\nu} \rangle + 2\omega_I \frac{1}{T}\frac{\partial}{\partial t} \langle \mathcal{T}^{\mu\nu} \rangle + |\omega|^2 \langle \mathcal{T}^{\mu\nu} \rangle = 0$$

Relativistic Hydrodynamics:

$$\begin{aligned} \mathcal{T}^{\mu\nu} &= \mathcal{T}^{\mu\nu}_{\text{ideal}} + \Pi^{\mu\nu}_{\text{MIS}} + \Pi^{\mu\nu}_{\text{QNM}} \\ 0 &= \nabla_\mu \mathcal{T}^{\mu\nu} \end{aligned}$$

+ Müller-Israel-Stewart

$$\left(\tau_\pi \frac{1}{T}\mathcal{D} + 1\right) \Pi^{\mu\nu}_{\text{MIS}} = -\eta\sigma^{\mu\nu}$$

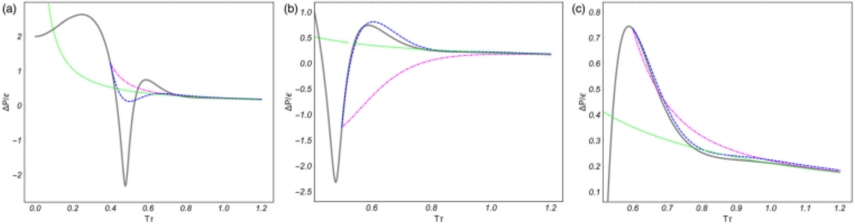
+ QNMs

$$0 = \left(\frac{1}{T}\mathcal{D}\right)^2 \Pi^{\mu\nu}_{\text{QNM}} + 2\omega_I \frac{1}{T}\mathcal{D}\Pi^{\mu\nu}_{\text{QNM}} + |\omega|^2\, \Pi^{\mu\nu}_{\text{QNM}}$$

Bjorken Flow

Bjorken flow: $u(x) = \frac{z}{t}$

Pressure anisotropy $\Delta P = P_{\text{tangential}} - P_{\text{longitudinal}}$



Heller, Janik, Spalinski, Witaszczyik (2014)

Gray: numerical AdS/CFT, Blue: improved Müller-Israel-Stewart, Magenta: Müller-Israel-Stewart, Green: ideal hydrodynamics

- AdS/CFT: Non-hydrodynamic modes should be included for the description of early times
- For better precision would need to include higher QNMs
- A dual theory for QCD has not been found, yet

- Group of Prof. Dr. Münster
- Second supervisor: Prof. Dr. Wulkenhaar
- $\mathcal{N} = 1$ Super Yang-Mills theory with gauge group SU(2) ⇒ SU(3)
- Technicolor models
- Data analysis
- Implementation of new observables