In- and out-of-equilibrium aspects of the Chiral Magnetic Effect from lattice QCD

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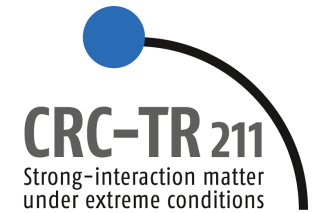


Introduction

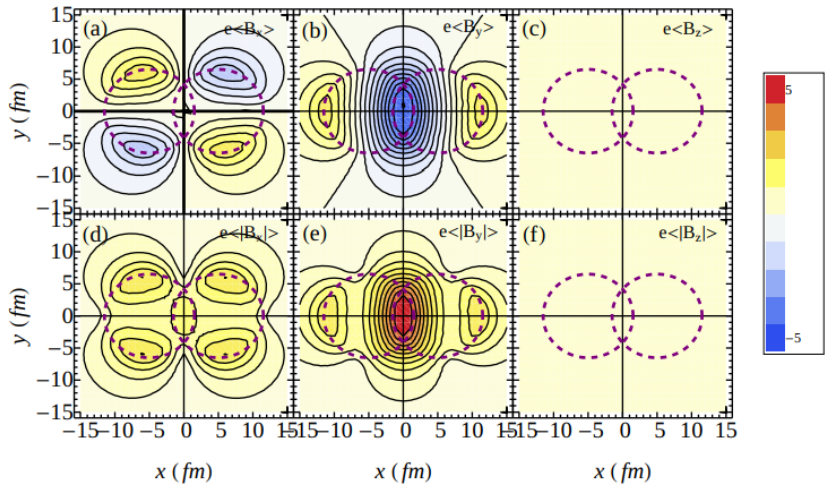
- Quantum anomalies + $\begin{matrix}\text{EM fields}\\ \text{Vorticity}\end{matrix}$ $\rightarrow$ **Anomalous transport phenomena**
- Examples:
  - Chiral Magnetic Effect (CME)
  - Chiral Separation Effect (CSE)
  - Chiral Vortical Effect (CVE)
  - ...
- Study the effect of strong interactions in the conductivities using **Lattice QCD**

CME: what can we do now?

In-equilibrium

- Magnetic fields in heavy-ion collisions are far from being uniform
- How is CME affected by an **inhomogenous** magnetic field?

Deng, Huang '12



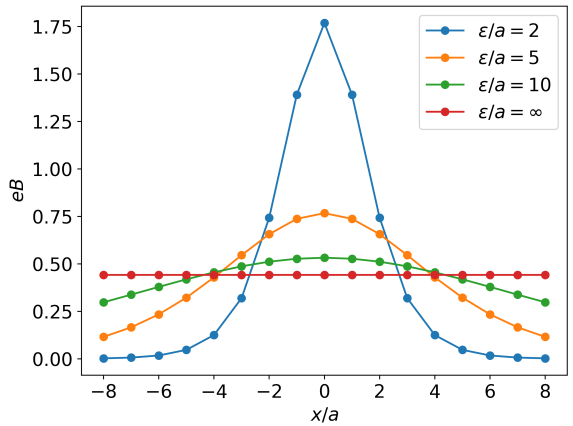
Out-of-equilibrium

- Linear response theory: perturbation $\delta\mu_5(t)$ with *homogeneous* B
- How does the system respond? $\rightarrow C_{\mathrm{CME}}^{\mathrm{neq}}$

Inhomogeneous magnetic field

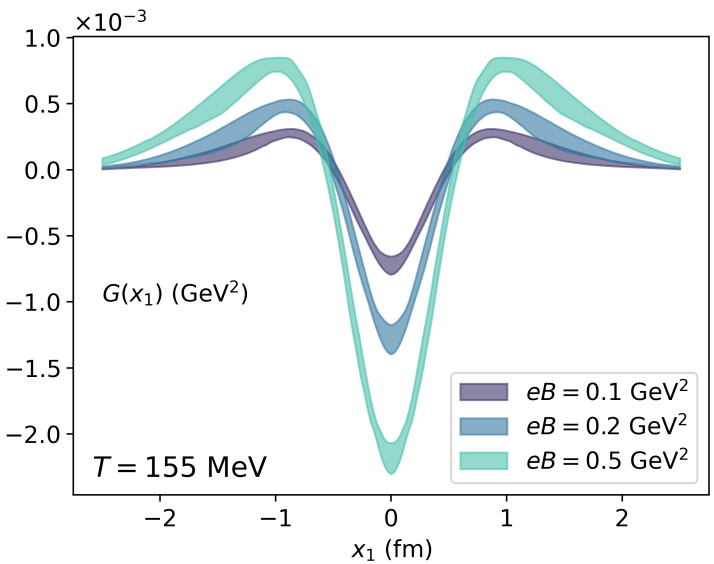
- Magnetic field profile:

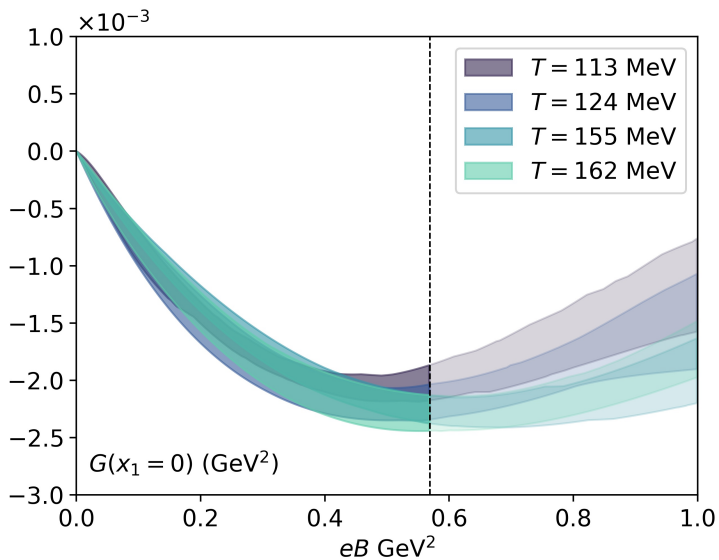
$$\vec{B}(x) = \frac{B}{\cosh^2\left(\frac{x_1}{\varepsilon}\right)}\,\hat{x}_3$$



- Non-trivial localized CME in QCD!

Brandt, Endrődi, EGV, Markó, Valois (in prep.)





Out-of-equilibrium

- Linear response to $\delta\mu_5(t)$ at finite B
- Kubo formula for $G_R(t) = i\theta(-t)\left\langle [j_{45}(t), j_3(0)] \right\rangle$

$$C_{\mathrm{CME}}^{\mathrm{neq}} \sim \frac{1}{eB} \lim_{\omega \to 0} \frac{\rho(\omega)}{\omega}$$

- Spectral representation of Euclidean correlators

$$G_E(\tau) = \int \mathrm{d}\omega \, \rho(\omega) \, K(\omega, \tau)$$

Lattice — Want — Known

- On the lattice: $N_t \sim$ 6-80 $\rightarrow$ ill-posed inverse problem
- Many methods on the market
- We use a simple method to get a first estimate of C_{CME}^{neq}