Numerical evidence of axial magnetic effect

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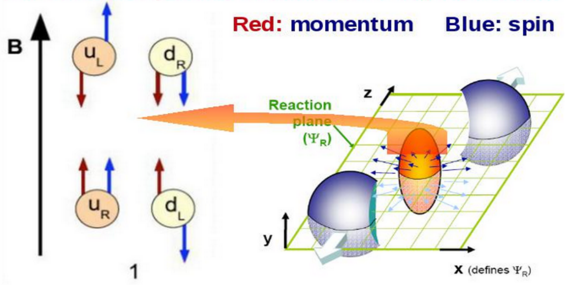
Outline:

- Introduction
- Axial magnetic effect in lattice QCD
- Conclusion



Chiral magnetic effect

- Topological charge($n_R \neq n_L$) + magnetic field ⇒ chiral magnetic effect
  (D. Kharzeev, L. McLerran, H. Warringa, NPA 803 ('08) 227)
- Related to axial anomaly
- $J_V = \sigma_{AV} H$ can be studied experimentaly
  (observed at RHIC and LHC, STAR Collaboration Phys.Rev.Lett. 103 (2009) 251601, ...)

Anomalous transport

- Chiral magnetic effect: $J_V = \sigma_{VV} H, \quad \sigma_{VV} = \frac{\mu_A}{2\pi^2}$
- Axial chiral magnetic effect: $J_A = \sigma_{AV} H, \quad \sigma_{AV} = \frac{\mu}{2\pi^2}$
- Chiral vortical effect: $J_V = \sigma_V \omega, \quad \sigma_V = \frac{\mu_A \mu}{2\pi^2}$
- Axial chiral vortical effect: $J_A = \sigma_A \omega, \quad \sigma_A = \frac{\mu^2 + \mu_A^2}{4\pi^2} + \frac{T^2}{12}$

Can be studied with the program which will be created in this project

Why anomalous transport phenomena are so interesting?

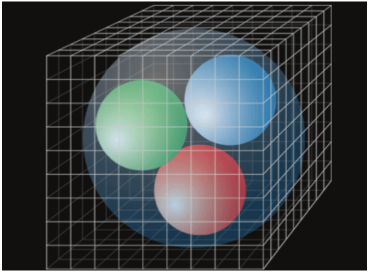
- Can be seen in current heavy ion collision experiments
- Related to the first principles of quantum field theory (anomalies)
- Non-dissipative phenomena

Axial chiral vortical effect:

Axial chiral vortical effect: $J_A = \sigma_A \omega, \quad \sigma_A = \frac{T^2}{12} \; (\mu = \mu_A = 0)$

Axial magnetic effect:

- $L = \bar{\psi}(\hat{\partial} - ig\hat{A}^a t^a - ie\gamma_5 \hat{A}_5)\psi$
- $J_\epsilon^i = \langle T^{0i} \rangle = \sigma H_5, \quad \sigma = \sigma_A = \frac{T^2}{12}$

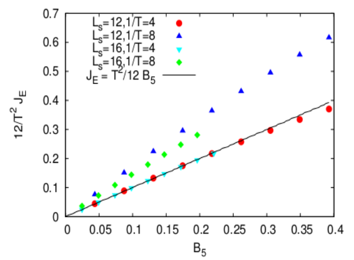


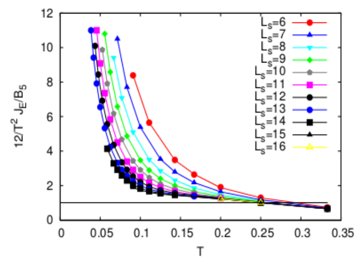
Lattice simulation of QCD

- Allows to study strongly interacting systems
- Based on the first principles of quantum field theory
- Acknowledged approach to study QCD
- Very powerful due to the development of computer systems

Aim: lattice study of axial magnetic effect

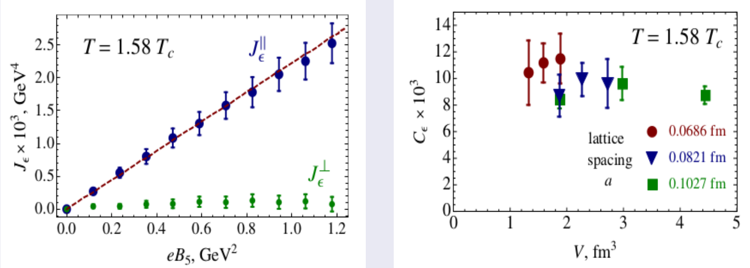
Free fermions (P. V. Buividovich, arXiv:1309.4966)





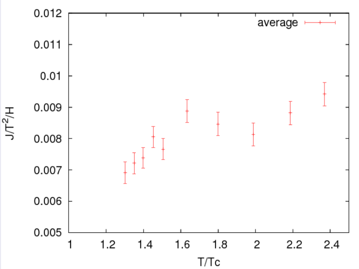
Theoretical result for free fermions can be reproduced in lattice QCD

Quarks in quenched SU(2) QCD (V. Braguta et. al., Phys.Rev. D88 (2013) 071501)



- First lattice observation of non-dissipative phenomenon
- $J_\epsilon \sim H_5$
- $\sigma_{lat}(T = 1.58 T_c) = 2.2 \times 10^{-3} GeV^2$
- $\sigma_{lat}(T = 1.58 T_c)$ is by an order of magnitude smaller than $\sigma_{th}(T = 1.58 T_c)$

Quarks in quenched SU(2) QCD (Preliminary results)



- $\sigma(T > T_c) > 0$
- $\sigma(T < T_c) = 0$

Clean signature of axial magnetic effect in experiments

Conclusion

- First lattice observation of non-dissipative phenomenon
- $\sigma_{lat}(T = 1.58T_c)$ is by an order of magnitude smaller than $\sigma_{th}(T = 1.58T_c)$
- Clean signature of axial magnetic effect in experiments

THANK YOU