The 1st International Workshop on Physics at High Baryon Density (PHD2024)

Rotating QCD matter

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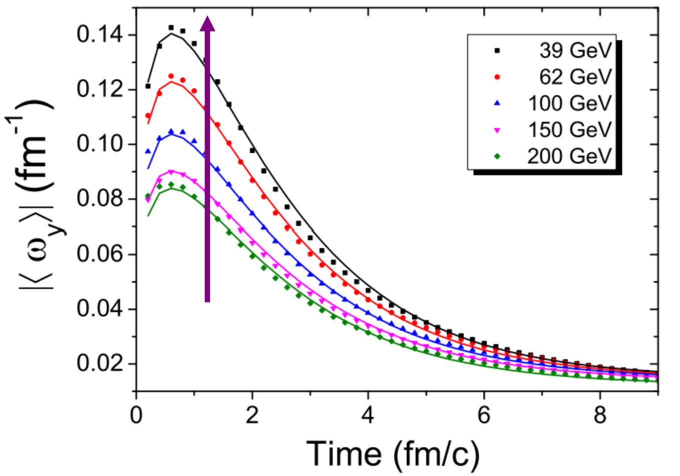
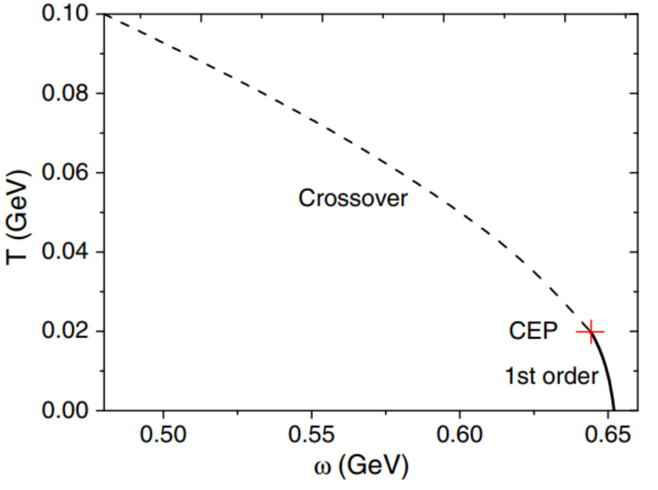
Lower energy, Higher density and Faster rotation

- Lower energy collision systems carries higher density and larger vorticity.
- Rotation speeds up the chiral restoration of the pure quark matter.
- Gluons suffer more polarization effect from rotation. What is the impact on phase transition?
- Model non-perturbative gluon contribution and couple it to quarks.



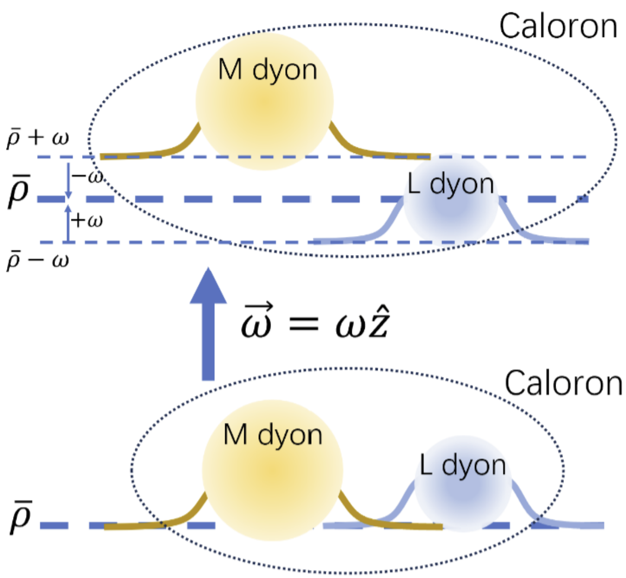
Y.Jiang, ZW. Lin, JF. Liao, PRC 94, 044910 (2016)



Y.Jiang, JF. Liao, PRL 117, 192302 (2016)

Dyon ensemble as the vacuum

- Modelling the vacuum of gluon matter with dyon solutions under rotation.



- On axis, rotation slows down the deconfinement and chiral restoration.

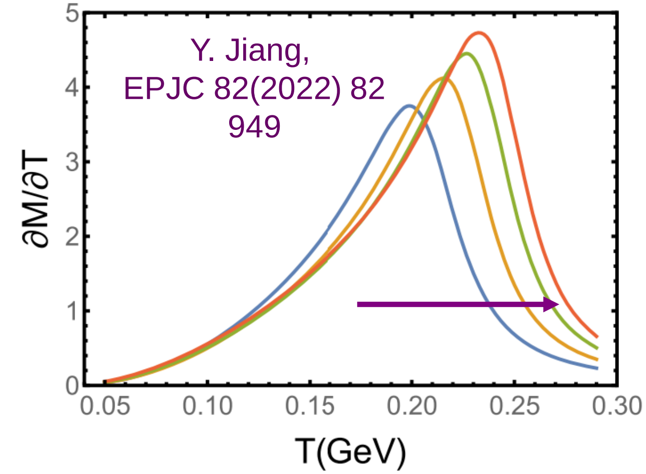
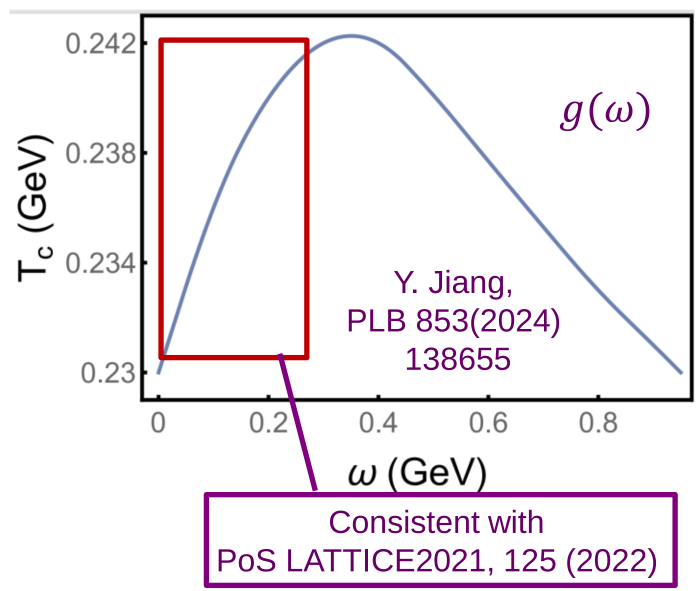


Fig. 3 Chiral susceptibility as functions of temperature at ω = 0.1, 0.2, 0.3, 0.4 GeV (from left to right)



Rotation induced inhomogenity

- Find off-axis dyon solution under rotation to construct local dyon ensembles.
  - Real rotation: the outer part is harder to deconfine.
  - Imaginary rotation: outer part is easier to deconfine.
  - Position dependence is consistent with lattice.

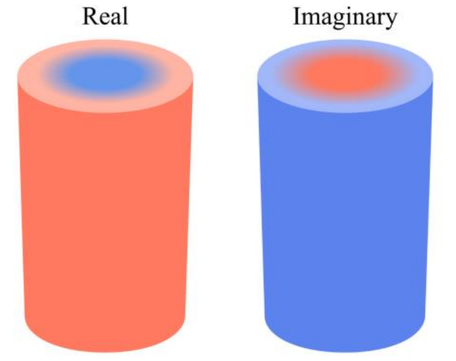


FIG. 1. The radial position dependence of the deconfinement temperature in both real (left) and imaginary (right) angular velocity cases. The critical temperature is higher in the red part.

Y. Jiang, PRD 110(2024) 054047

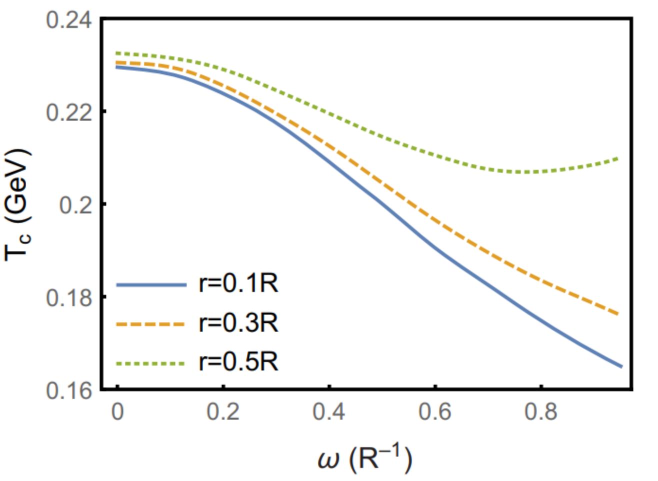
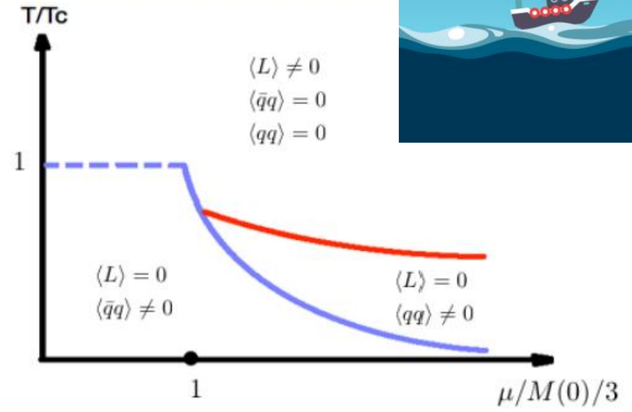


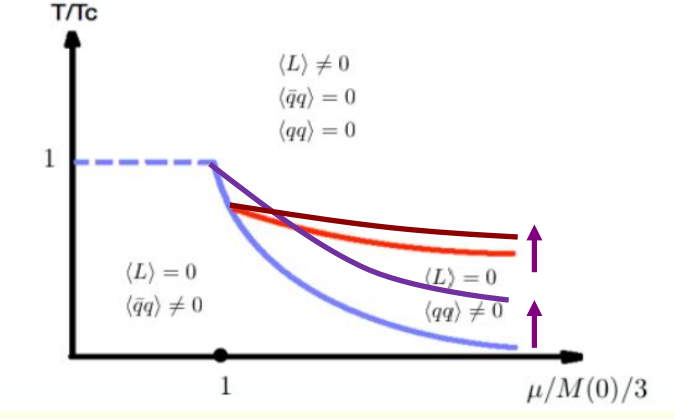
FIG. 2. The critical deconfinement temperature as a function of a real angular velocity at different radial positions.

Add quarks, finite baryon density

- In static case baryon chemical potential will reduce critical temperatures.
- Consider rotation-dependent coupling constant the rotation will slow down phase transitions.
- Because of causality, the global rotation can not be too fast, phase transition will happen eventually along chemical potential.



Y. Liu, E. Shuryak, and I. Zahed
PRD 94(2016), 105011



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Conclusion and Outlook

- Dyon is a good object for us to model the non-perturbative part of QCD around critical temperature.
- We may need to pay more attention on the gluon part even in the finite baryon density system because of nontrivial gluon profiles(color confinement).
- In non-central collisions at medium/low energy, faster rotation may induce more interesting physics relate to color confinement and chiral breaking.

Thank you for your attention!