Gluon matter under weak acceleration: lattice results

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Motivation

Effects of high temperatures, high densities, strong (electro)magnetic fields, vorticity on quark-gluon plasma have been intensively studied.

What is about acceleration?

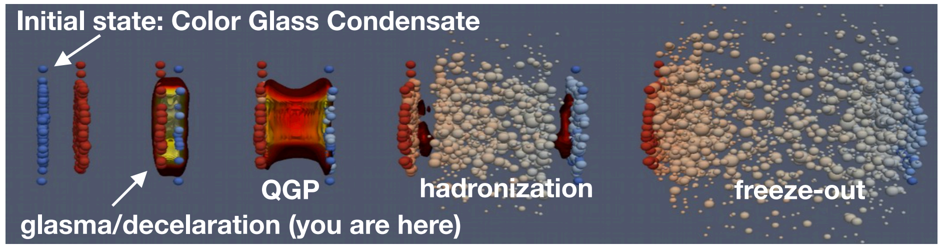
Relevant to early stages of heavy ion collisions, and presumably, extreme astrophysical environments (Early Universe?)

Uniformly accelerating fluid stays in thermal equilibrium and possesses an event horizon, similar to black holes.

→ Intriguing questions related to the Unruh temperature and the Hawking radiation.

Colliding relativistic ions: The intense interaction via chromoelectric fields causes their rapid deceleration.

→ High values of deceleration: $a \sim Q_s \sim 1\ \mathrm{GeV}$, of the order of the gluon saturation scale Q_s.



[adapted after MADAI collaboration, Hannah Petersen and Jonah Bernhard]

→ Rapid thermalization that can be interpreted as a result of tunneling through the event horizon and as a (color) Schwinger effect.

→ The Unruh temperature, $T_U = a/(2\pi) \simeq 200\ \mathrm{MeV}$ (QCD scale)

[D. Kharzeev, K. Tuchin, From Color Glass Condensate to Quark Gluon Plasma through the event horizon, Nucl. Phys. A753, 316 (2005)]

Question

What is the effect of acceleration on the phase diagram of hot gluon matter?

In other words: find a phase diagram in the $(T, a) =$ (Temperature, Acceleration) plane.

What other theories tell?

Comes from interacting fermion models:

Chiral symmetry in the broken phase of Nambu–Jona-Lasinio gets restored when acceleration reaches certain critical value.

[T. Ohsaku, Phys.Lett. B599 (2004) 102]

Could simplistically be anticipated from the Unruh result:

$$T_U = \frac{a}{2\pi}$$

that can naively be interpreted as "acceleration makes things hot"

(interpretation is not straightforwardly correct!)

Other models of quarks in QCD, interacting bosons and electroweak sector of the standard model, agree: there is a critical acceleration above which any spontaneously broken symmetry gets restored.

[D. Ebert and V. Ch. Zhukovsky, Phys. Lett. B 645, 267–274 (2007); P. Castorina and M. Finocchiaro, J. Mod. Phys. 3, 1703 (2012); A. Dobado, Phys. Rev. D 96, 085009 (2017); A. Casado-Turrión, A Dobado, Phys. Rev. D 99, 125018 (2019); W. Kou, X. Chen, arXiv:2405.18697; …]

But there are subtleties: [W. G. Unruh and N. Weiss, Phys. Rev. D 29, 1656 (1984)]

For a recent discussion of the subtleties, see: [D. G. Salluce, M. Pasini, A. Flachi, A. Pittelli, S. Ansoldi, JHEP 05, 218 (2024)]

Immediate suggestion

Acceleration generates a transition to the deconfinement (QGP) phase (?)

Our answer

No. (at least for small accelerations, $a \lesssim 27\ \mathrm{MeV}$)

A bit more detailed answer is given in the poster

We present first-principle numerical Monte-Carlo results for gluon SU(3) plasma under acceleration.

"Tom under acceleration"