Susceptibilities from a Black Hole Engineered EoS with a Critical Point

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Exploring The QCD Phase Diagram

Study possible signatures of the location of the QCD critical point (CP) using a black hole engineered holographic model.

Lattice QCD:

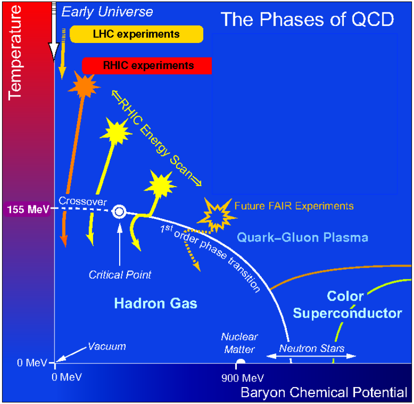
Perform calculations at $\mu_B = 0$, extrapolate via Taylor expansion to finite μ_B.

Holographic Black Hole Engineering:

Based on lattice data at $\mu_B = 0$, allows us to calculate observables at finite density.

Susceptibilities of Conserved Charges:

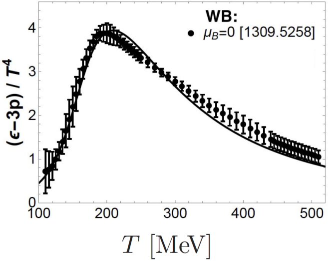
Provide information about the effective degrees of freedom. Sensitive to the CP.

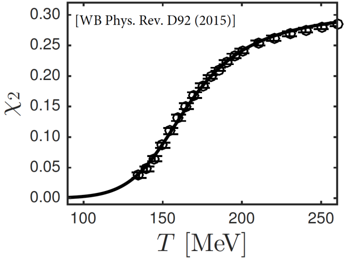


Holographic Black Hole Engineering

Non-conformal holographic gravity dual in 5 dimensions $\Longrightarrow$ Black Hole Solution

$$\mathcal{S} = \frac{1}{16\pi G_5}\int \mathrm{d}x^5\sqrt{-g}\,\Big[\mathcal{R} - \frac{1}{2}(\partial_M\phi)^2 - \underbrace{V(\phi)}_{\text{nonconformal}} - \frac{1}{4}\underbrace{f(\phi)F_{MN}^2}_{\mu_B\neq 0}\Big]$$



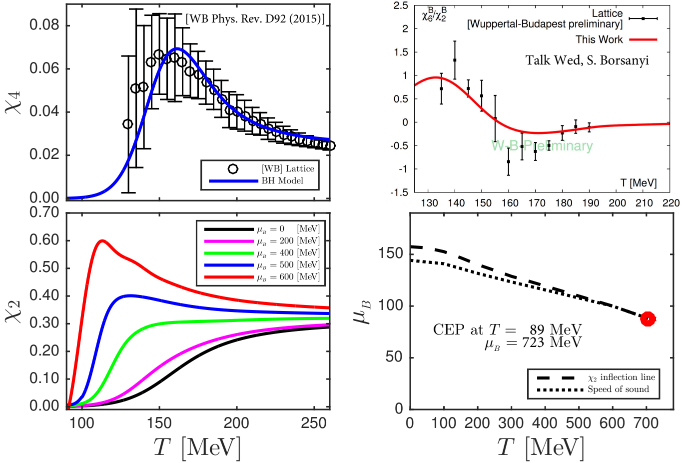


- Input parameters are fixed by lattice QCD results at $\mu_B = 0$
- Finite T and $\mu_B \rightarrow$ Predictions

O DeWolfe, S S Gubser, and C Rosen, Phys. Rev. D **83**, (2011)
R Rougemont, A Ficnar, S Finazzo and J Noronha, JHEP (2016) **102**.

Results for Baryon Susceptibilities $\chi_i = \frac{\partial^i}{\partial(\mu_B/T)^i}\left(\frac{P}{T^4}\right)$

- The model predicts the right behavior for χ_4 and χ_6

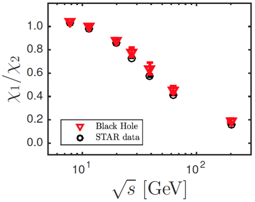


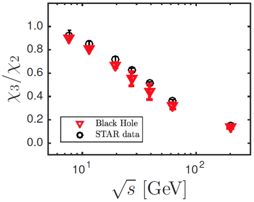
- The model has a CP at $T = 89$ MeV and $\mu_B = 723$ MeV

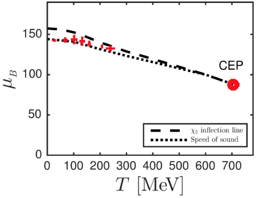
Connection to Experiment

- Freeze-out parameters are extracted by fitting the experimental values for χ_1/χ_2 and χ_3/χ_2

$\chi_1/\chi_2 \rightarrow M/\sigma^2$ $\chi_3/\chi_2 \rightarrow S\sigma$







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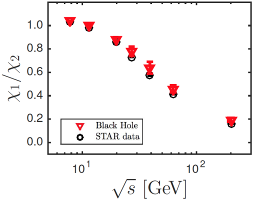
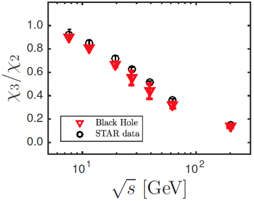
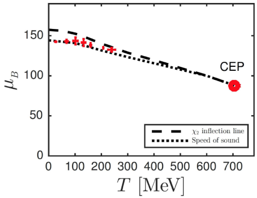
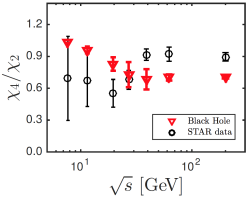






$\chi_4/\chi_2 \rightarrow \kappa\sigma^2$



- Freeze-out points far from CP
- χ_4/χ_2 predicted at freeze-out points
- Non-monotonic region near crossover line

[STAR] Phys. Rev. Lett. **112** (2014)