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 $\mu_B$.

**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

\[ S = \frac{1}{16\pi G_5} \int d^5 \sqrt{-g} [\mathcal{R} - \frac{1}{2} (\partial_\mu \phi)^2 - V(\phi) - \frac{1}{4} f(\phi) F_{MN}^2] \]

\[ \text{nonconformal} \quad \mu_B \neq 0 \]

\[ \Rightarrow \text{Black Hole Solution} \]

Input parameters are fixed by lattice QCD results at \( \mu_B = 0 \)

Finite \( T \) and \( \mu_B \rightarrow \) Predictions


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 \( \chi_4 \) and \( \chi_6 \)
- The model has a CP at \( T = 89 \text{ MeV} \) and \( \mu_B = 723 \text{ MeV} \)
Connection to Experiment

- Freeze-out parameters are extracted by fitting the experimental values for $\chi_1/\chi_2$ and $\chi_3/\chi_2$

\[ \chi_1/\chi_2 \rightarrow M/\sigma^2 \quad \chi_3/\chi_2 \rightarrow S\sigma \]
Freeze-out parameters are extracted by fitting the experimental values for $\frac{\chi_1}{\chi_2}$ and $\frac{\chi_3}{\chi_2}$

$$\frac{\chi_1}{\chi_2} \rightarrow \frac{M}{\sigma^2}$$

$$\frac{\chi_3}{\chi_2} \rightarrow S\sigma$$

Freeze-out points far from CP

$\frac{\chi_4}{\chi_2}$ predicted at freeze-out points

Non-monotonic region near crossover line