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Bayesian inference of the critical end point in a (2 + 1)-flavor system from holographic QCD

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We present a Bayesian holographic model constructed by integrating the equation of state and baryon number susceptibility at zero chemical potential from lattice QCD. The model incorporates error estimates derived from lattice data. With this model, we systematically investigate the thermodynamic properties of the 2+1-flavor QCD system. Using Bayesian Inference, we perform precise calibration of the model parameters and determined the critical endpoint (CEP) position under the maximum a posterior (MAP) estimation to be $(T^c, \mu_B^c) = (0.0859\ \mathrm{GeV}, 0.742\ \mathrm{GeV})$. Additionally, we predict the CEP positions within 68% and 95% confidence levels, yielding $(T^c,\ \mu_B^c)_{68\%}$=$(0.0820\text{–}0.0889, 0.71\text{–}0.77)$ GeV and $(T^c,\ \mu_B^c)_{95\%}$=$(0.0816\text{–}0.0898,\ 0.71\text{–}0.79)$ GeV, respectively. Moreover, to validate the reliability and predictive power of our approach, we conduct a comprehensive comparison between our predictions and potential CEP locations proposed by other theoretical models. This work not only establishes a novel Bayesian framework for holographic modeling but also provides valuable insights and theoretical support for exploring phase transitions in strongly-interacting matter under extreme conditions.

Primary author: 朱, 力强 (Central China Normal University)

Presenter: 朱, 力强 (Central China Normal University)

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