QCD thermodynamics from Nuclear models

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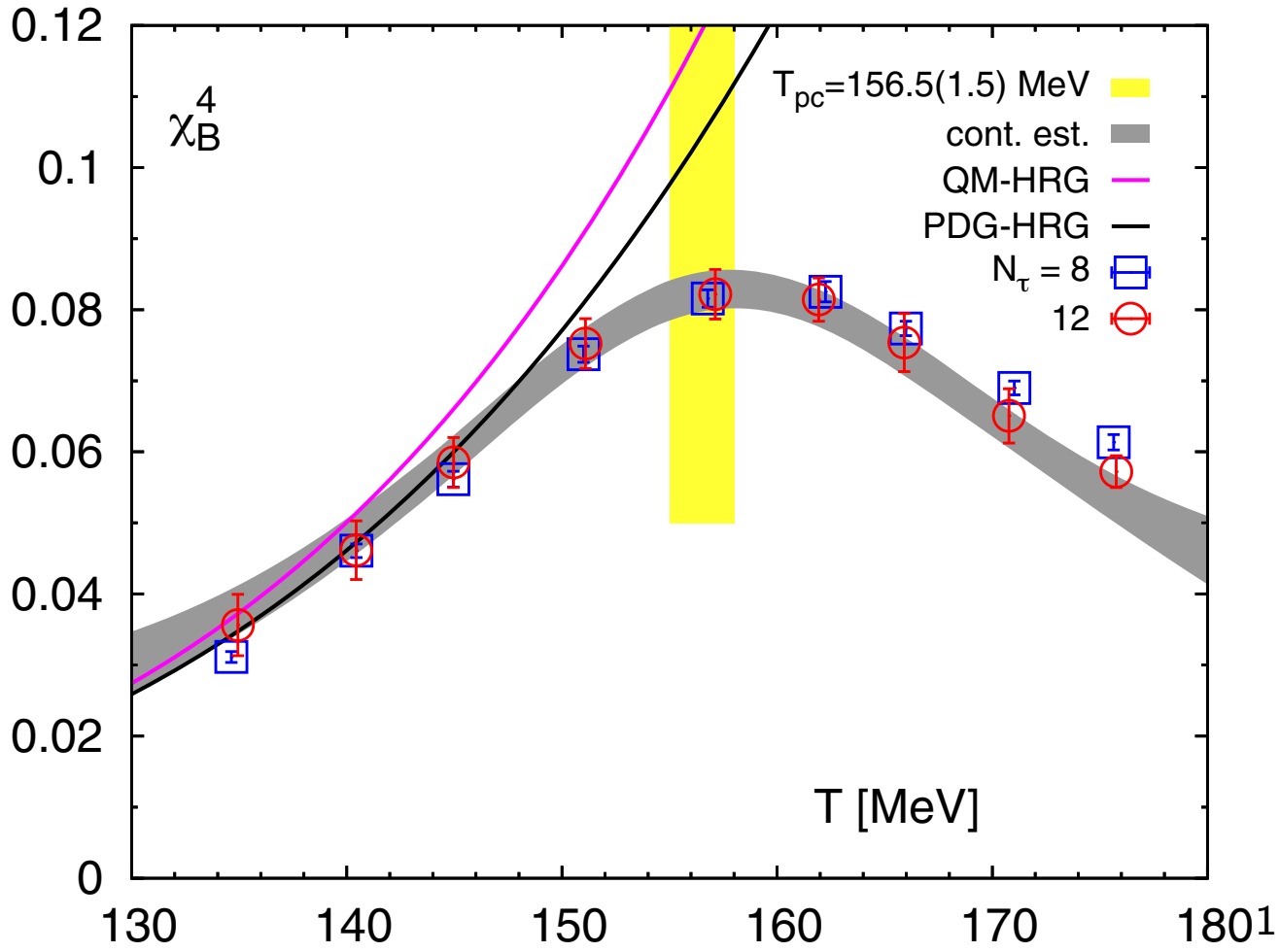
Outline

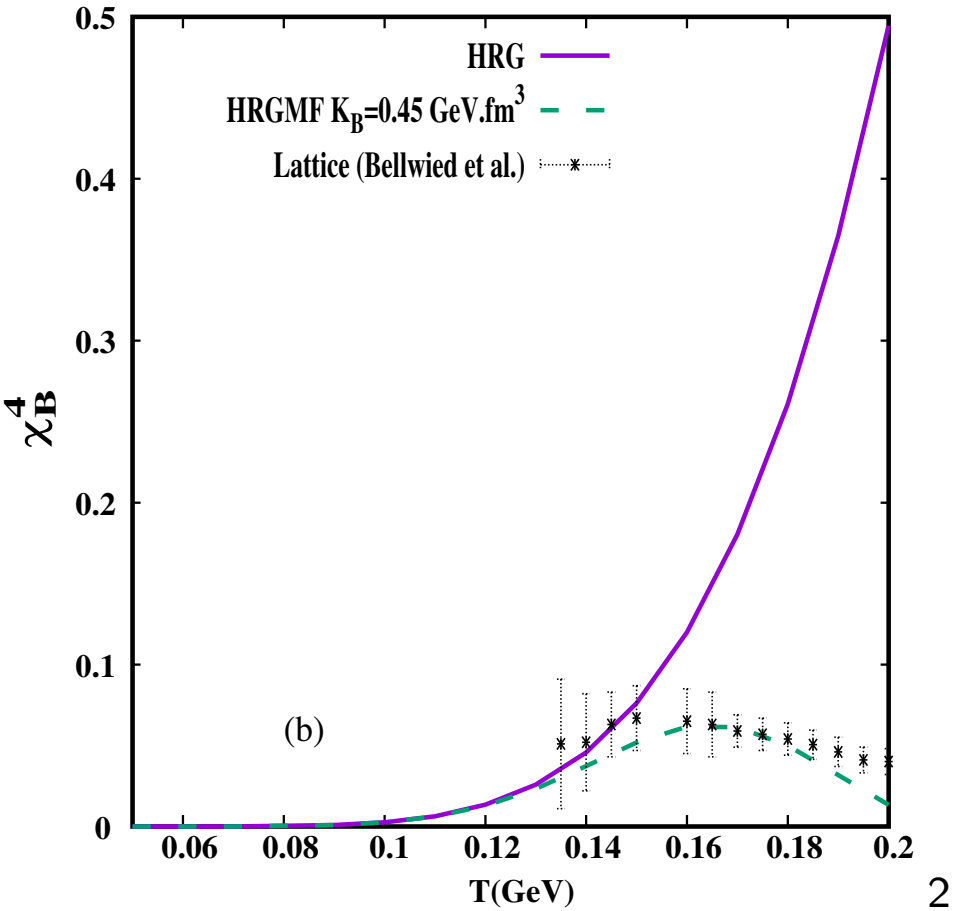
INTRODUCTION

χ_4^B in Lattice and IHRG



[1] PRD 101, 074502 (2020)

χ_4^B with repulsive interaction



[2]

[2] PRD 103, 054015 (2021)

Hadron Resonance Gas Models

- Hadron Resonance Gas(HRG) with interactions applied to higher densities
- Acausal at too low a density
- Carnahan-Sterling Modification Nuclear Model [3]
- Does not incorporate chiral symmetry restoration
- On cannot study the effect of critical modes

[3] PLB 835,137524(2022)

NUCLEAR MODELS

Nuclear Model[4]

$$\mathcal{L} = \bar{\psi}\left[\gamma_\mu(i\partial^\mu - g_\omega\omega^\mu) - (M - g_\sigma\sigma)\right]\psi$$

$$-\tfrac{1}{3}b_\sigma M(g_\sigma\sigma)^3 - \tfrac{1}{4}c_\sigma(g_\sigma\sigma)^4 + \tfrac{1}{4}b_\omega(g_\omega^2\omega_\mu\omega^\mu)^2 + \ldots$$

[4] PRC 70, 054309 (2004)

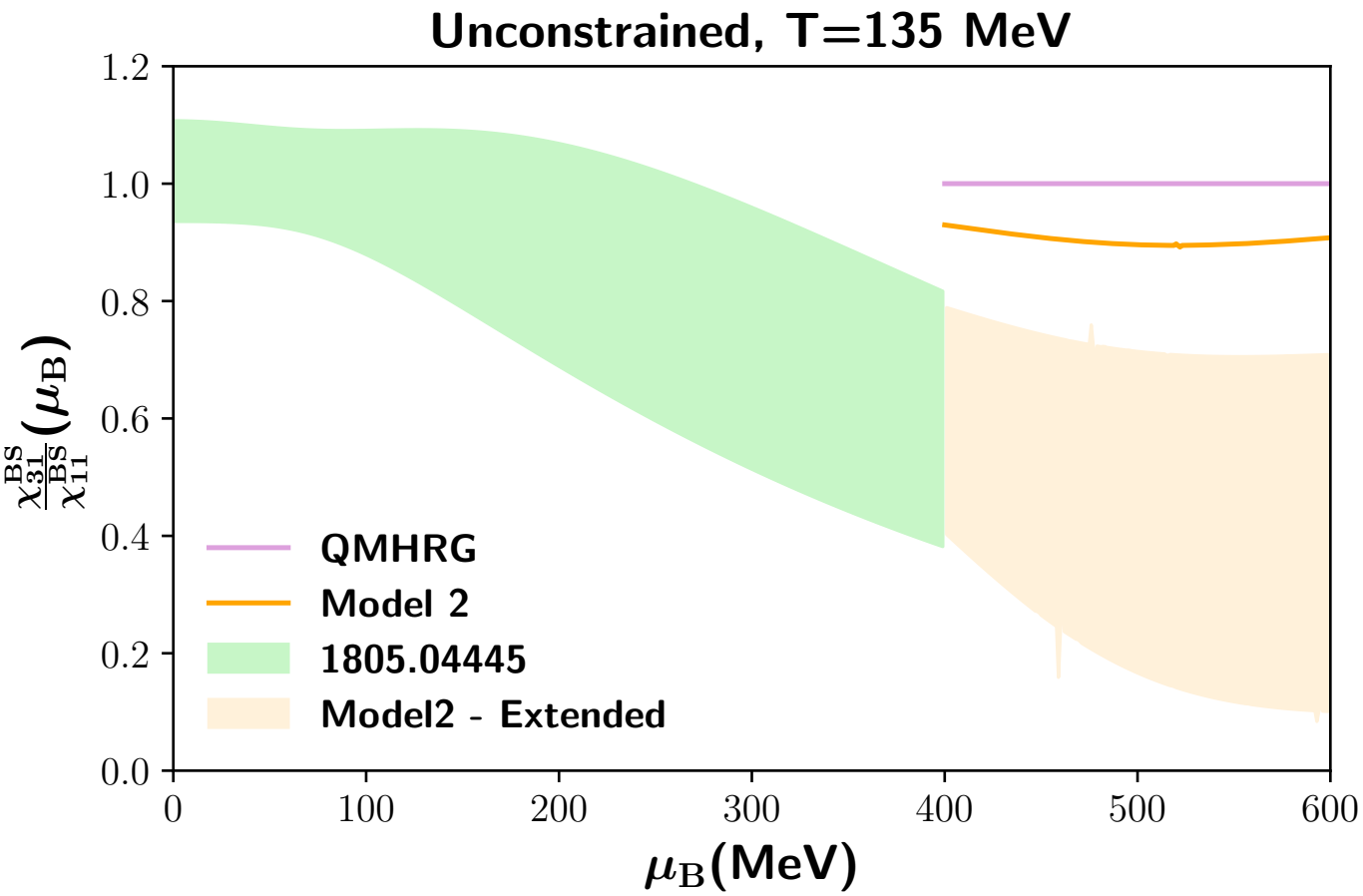
Nuclear Model(cont.)

- Nuclear Models work well at high densities
- Constrained[5] from experiments such as neutron skin depth, maximum mass of neutron star, nuclear saturation properties, etc.
- Consist of nucleons, hyperons interacting through sigma, omega, etc
- Have attractive and repulsive interactions built in

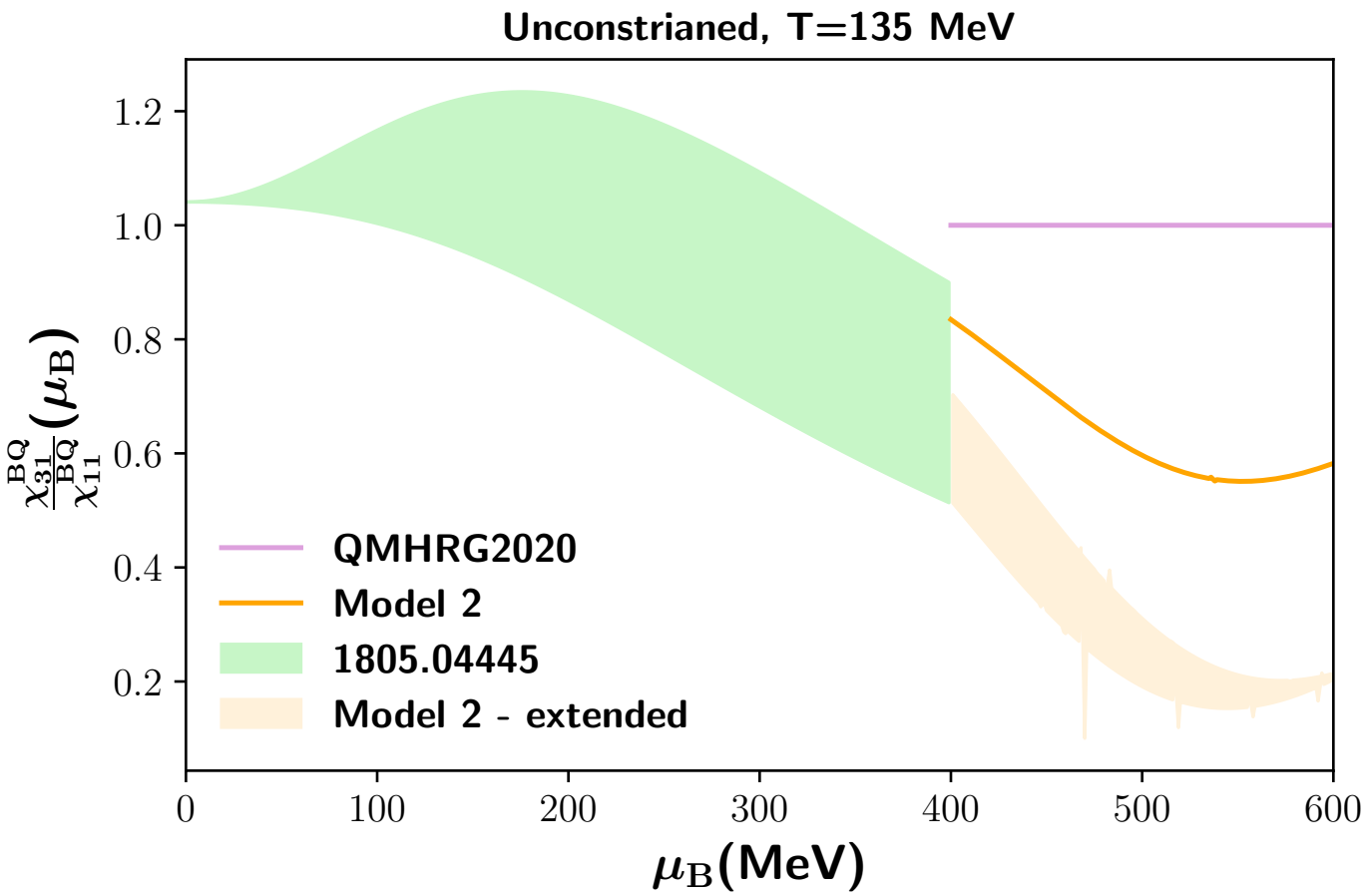
[5] R. Nandi and P. Char 2018 ApJ 857 12

RESULTS

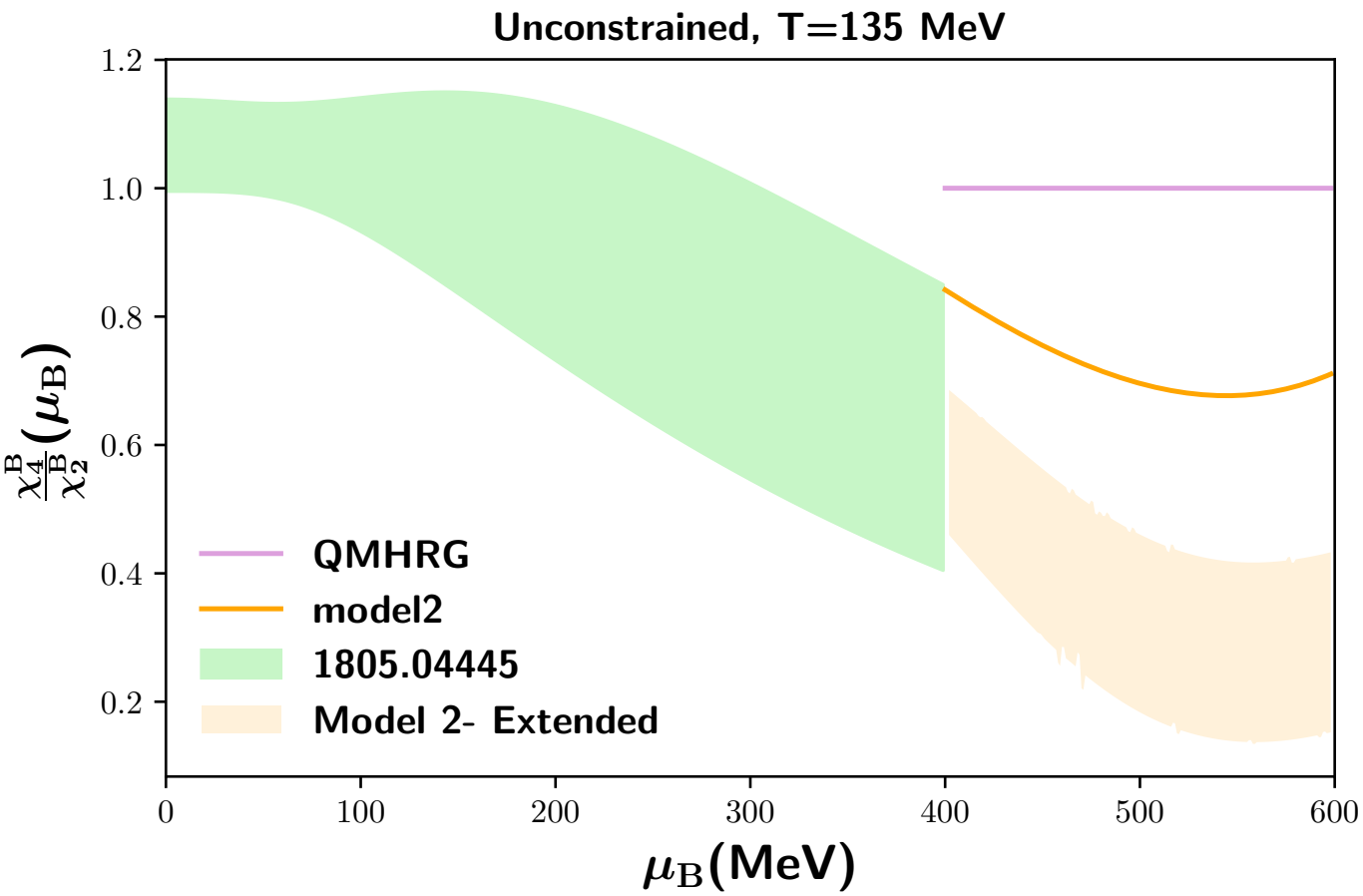
$\chi_{31}^{BS}/\chi_{11}^{BS}$



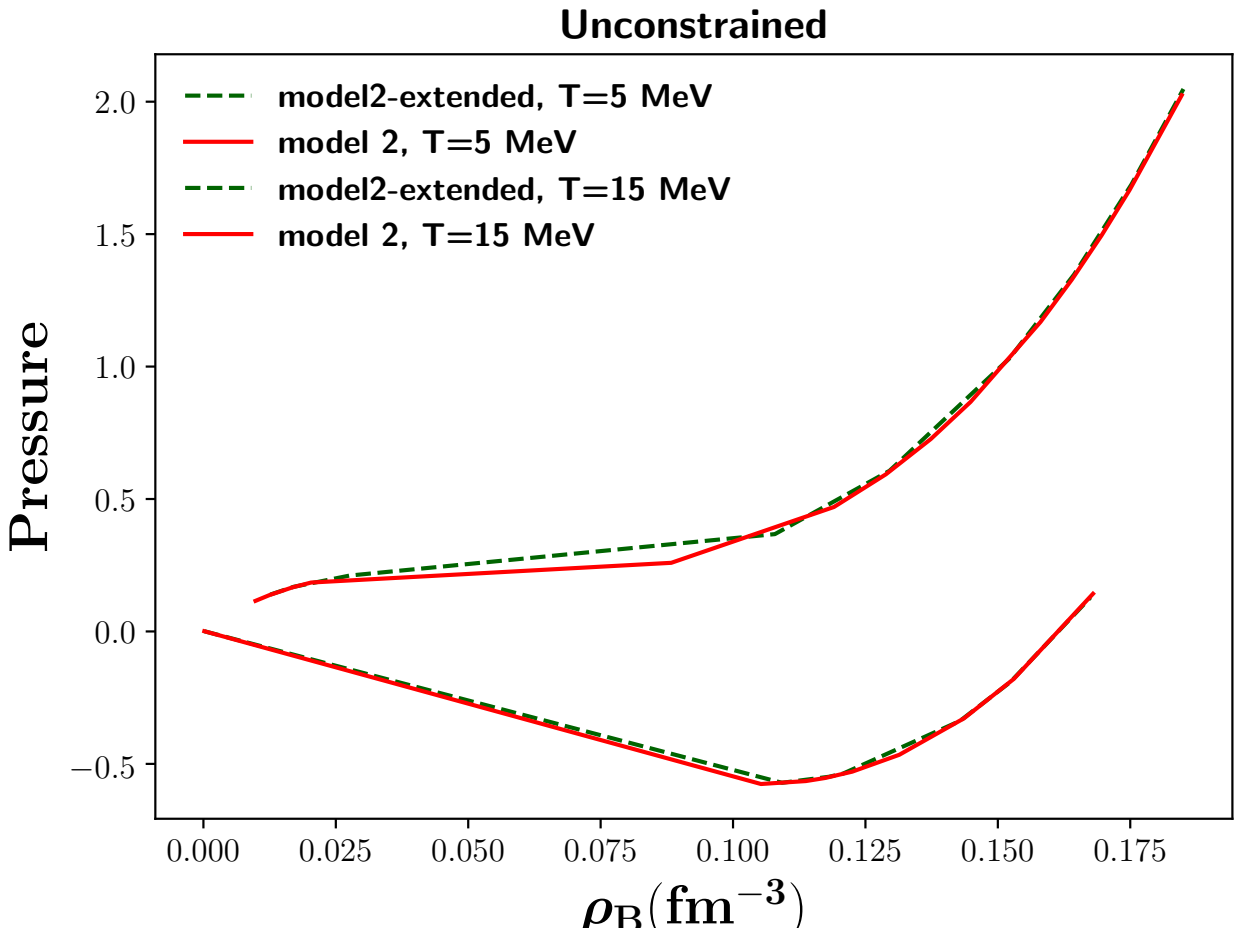
$\chi_{31}^{BQ}/\chi_{11}^{BQ}$



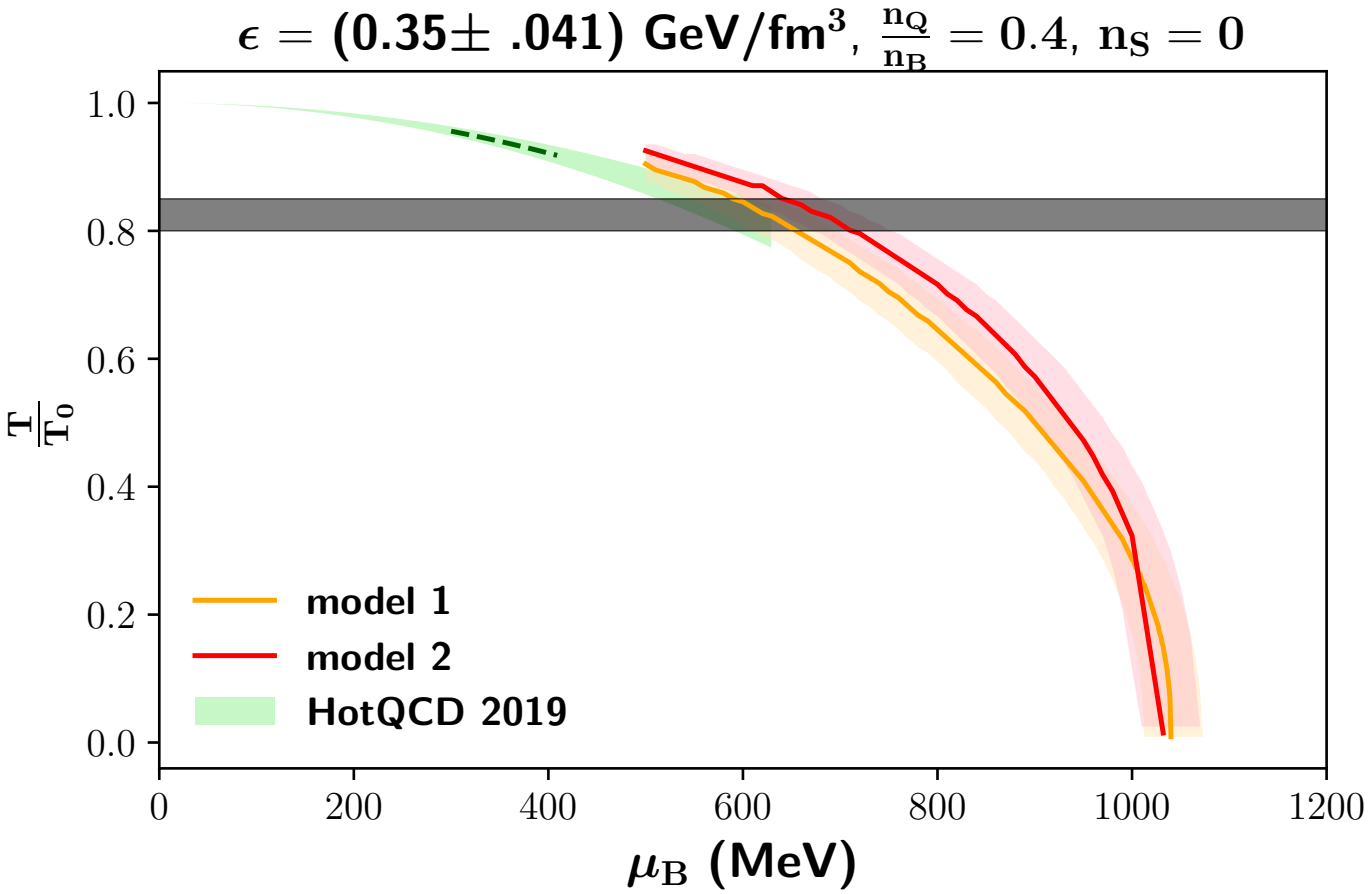
χ_4^B/χ_2^B


Unconstrained, T=135 MeV
1.2
1.0
0.8
0.6
0.4
0.2
$\frac{\chi_4^B}{\chi_2^B}(\mu_B)$
QMHRG
model2
1805.04445
Model 2- Extended
0
100
200
300
400
500
600
μ_B(MeV)

Effect of extra baryons



Constraining the location of critical end point



Conclusions of the study

- Comparision and extension of model give better estimates of susceptibility
- More precise lattice data in future can constrain nuclear models
- Model can be extended without upsetting the agreement with high density constraints
- A universal hadronic model can put constraint on high density nuclear models

Thank You!