

Partonic Critical Opalescence & 'Jet' Quenching



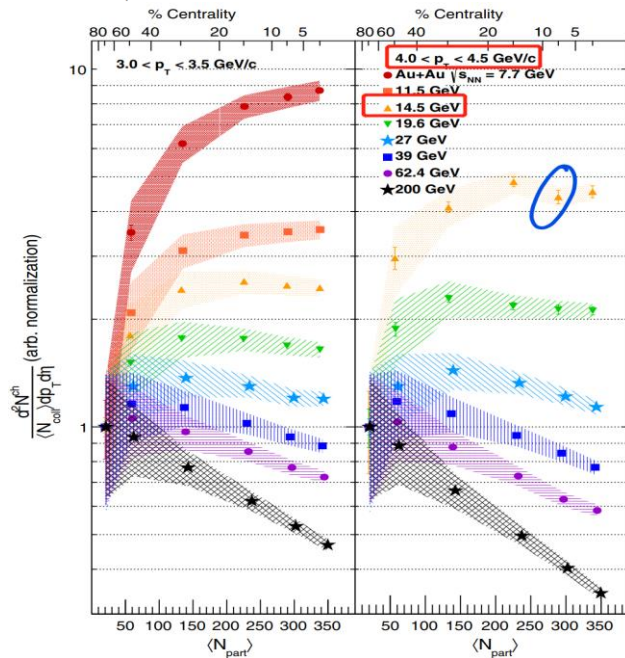
arXiv:2208.14297

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'Jets' in BES exp.

PHYSICAL REVIEW LETTERS 121, 032301 (2018)

Beam Energy Dependence of Jet-Quenching Effects in Au + Au Collisions at $\sqrt{s_{NN}} = 7.7, 11.5, 14.5, 19.6, 27, 39, \text{ and } 62.4 \text{ GeV}$



'Jets' as CEP probe

- Affected directly by CEP
- Jet-hadron interaction is negligible

Jet-quenching parameter

$$(q+k)^2 = q^2 = 0$$

$$\rightarrow k^2 < 0$$

$$\hat{q} \equiv \sum_k \frac{\vec{k}_\perp^2}{t} \sum_{X,M} \rho(M) |\langle q, M | U_I(t) | q+k, X \rangle|^2$$

$$U_I(t) = T e^{-i \int_0^t d\bar{t} H_I(\bar{t})}$$

A. Majumder, PRC87, 034905 (2013)

Quark Meson Model:

- Mesonic field in place of gluon
- Chiral phase transition & CEP embedded
- Applicable for $0.5 \sim 1.5 T_{pc}$
- $H_I = g \int d^3 \vec{x} \bar{q} (\sigma' + i \gamma_5 \vec{\pi} \cdot \vec{\tau}) q$

$$\hat{q} = \hat{q}_\sigma + \hat{q}_\pi$$

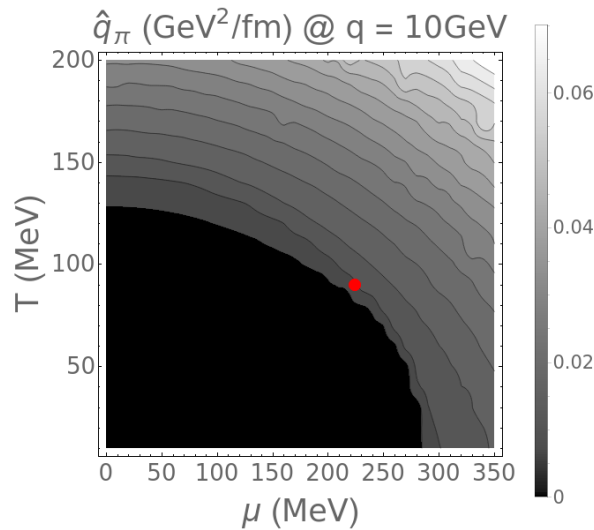
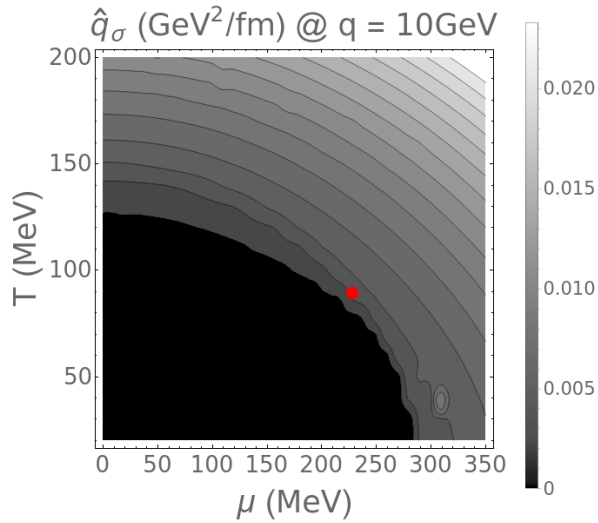
$$\hat{q}_{\sigma/\pi} = \frac{g^2}{N_c N_F} \int \frac{d^3 \vec{k}}{q E_{q+k}} \vec{k}_\perp^2 q \cdot (q+k) \tilde{G}_{\sigma/\pi}(k^0, \vec{k})$$

$$k^0 = -q + |\vec{q} + \vec{k}|$$

$$\tilde{G}_\sigma(k) = \int d^4 x \langle \sigma'(0) \sigma'(x) \rangle e^{ik \cdot x}$$

$$\tilde{G}_\pi(k) = \int d^4 x \langle \vec{\pi}(0) \cdot \vec{\pi}(x) \rangle e^{ik \cdot x}$$

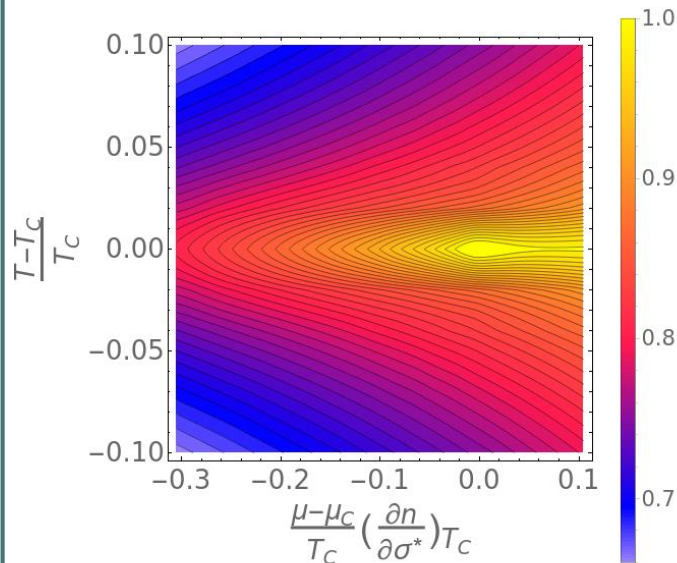
\hat{q} from p-Calcul. up to 1-loop



$$\begin{aligned} \hat{q}_\pi &\sim 0.35 n_{parton} \\ \hat{q}_\sigma &\sim 0.12 n_{parton} \\ \hat{q} &\sim 0.47 n_{parton} \end{aligned}$$

No special behavior observed around CEP, due to the failure of perturbative treatment.

Partonic critical opalescence



Map between QCD & Ising model

M.Martinez, etc., PRD 100, 074017(2019)

$$\begin{pmatrix} \delta e \\ \delta n / \sigma' \end{pmatrix}_{QCD} = \begin{bmatrix} 0 & 1 \\ -\frac{1}{2} & 0 \end{bmatrix} \begin{pmatrix} \delta \epsilon \\ \delta \psi \end{pmatrix}_{Ising} \rightarrow \rho_{n/\sigma}^{QCD} \propto \rho_\epsilon^{Ising} \propto \rho_{\psi^2}^{Ising}$$

$$\frac{\hat{q}_\sigma}{\hat{q}_{\sigma C}} \rho_{\psi^2}(k) = 4 \text{Im} \left[\int \frac{d^4 \bar{k}}{(2\pi)^4} \Delta_S \left(\frac{k}{2} + \bar{k} \right) \Delta_R \left(\frac{k}{2} - \bar{k} \right) \right]$$

$$\Delta_S(k) = \coth \frac{k^0}{2T} \text{Im} \Delta_R; \quad \Delta_R = \frac{\chi_k(\xi) \Gamma_k(\xi)}{\Gamma_k(\xi) - ik^0}$$