Our interests in NICA

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NCBJ & UJK

Involvement in physics of high-energy nucleus-nucleus collisions

National Centre for Nuclear Research

Since 1970s experiments at Dubna, CERN, BNL

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Institute of Physics, Jan Kochanowski University

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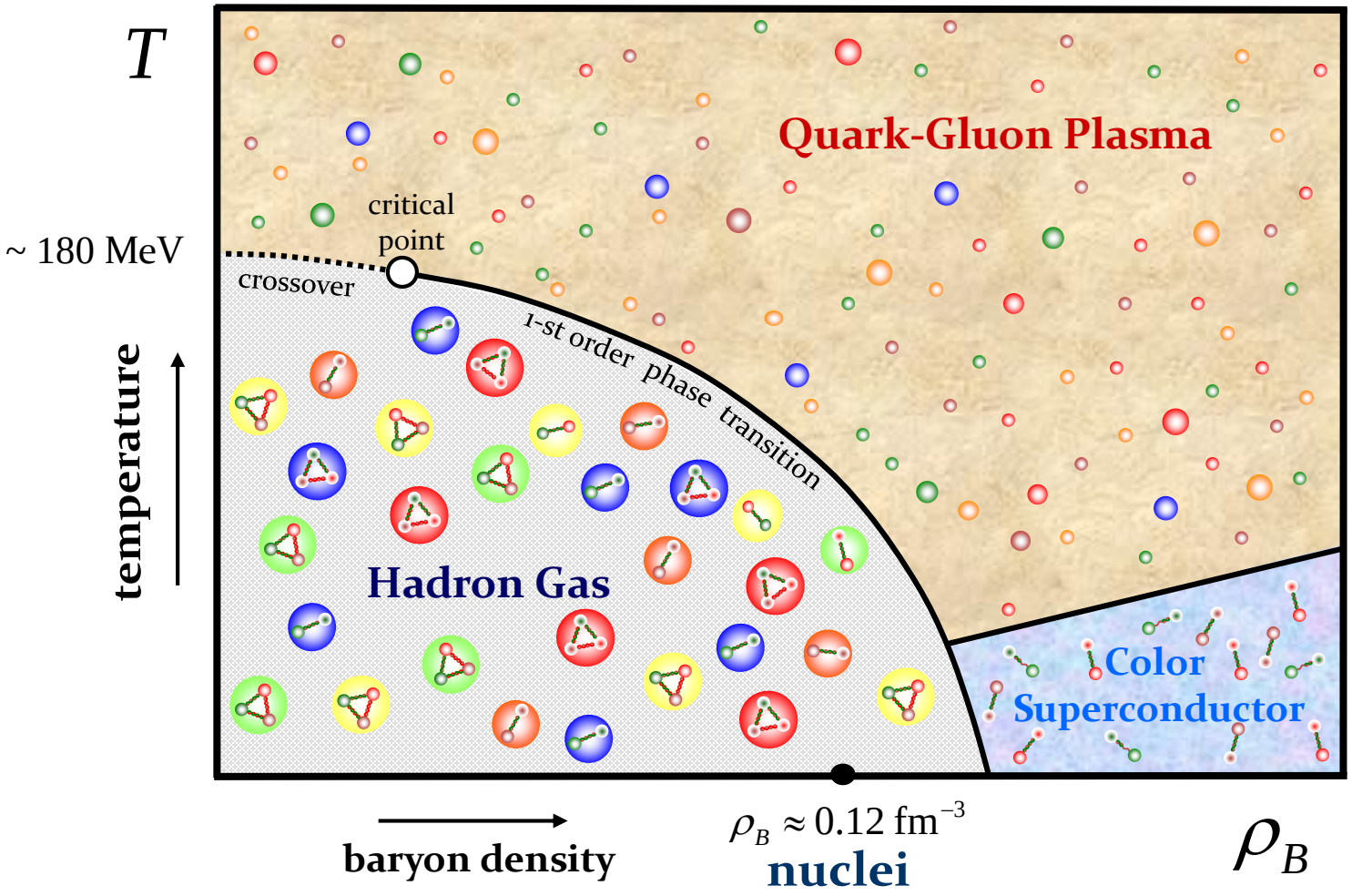
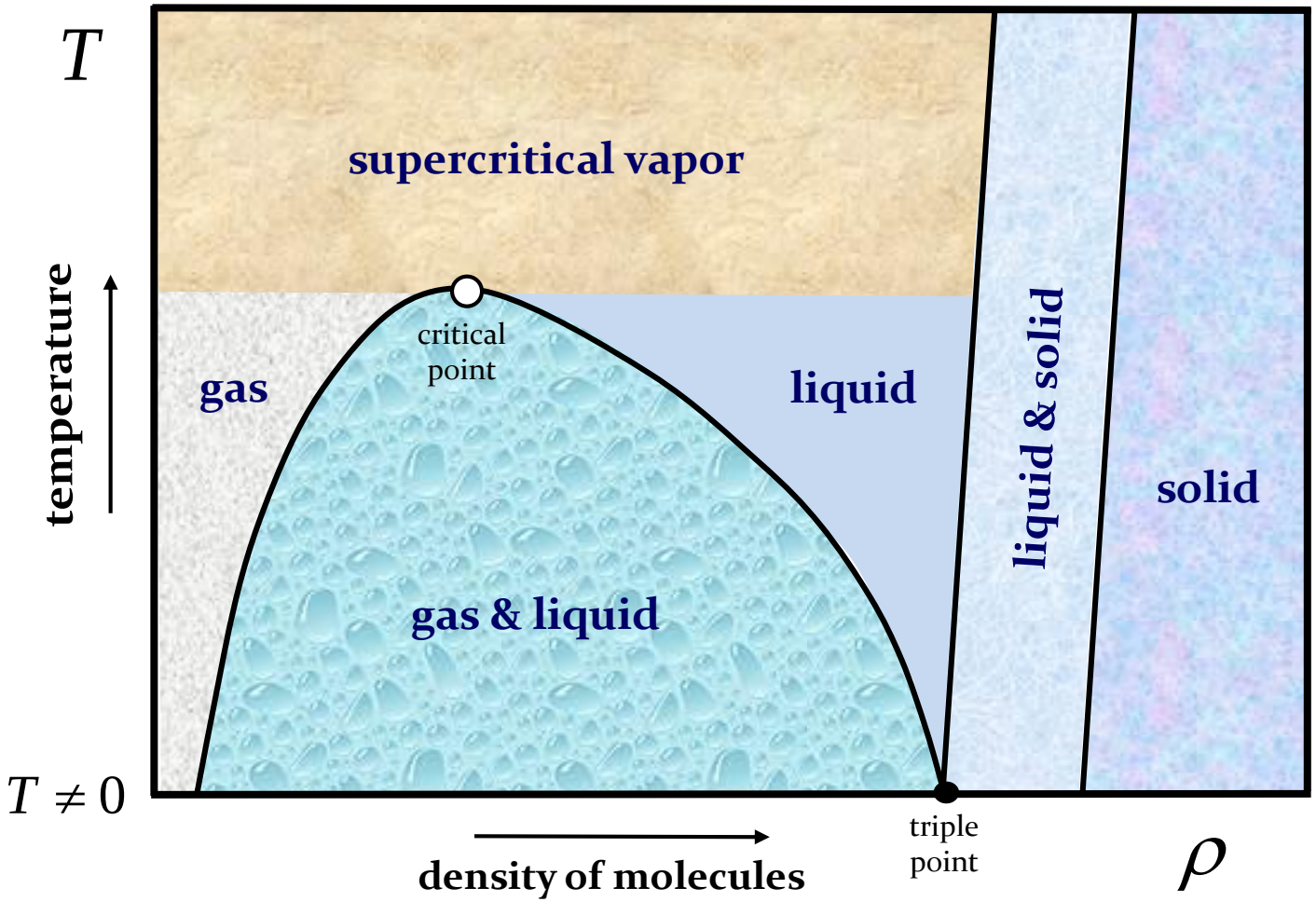
Phase diagram of strongly interacting matter



Schematic phase diagram of a simple fluid



Compressibility of strongly interacting matter

Isothermal compressibility

$$\beta_T \equiv -\frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_{T,\langle N\rangle} = \begin{cases} 0 & \text{incompressible fluid} \quad V = \text{const} \\ \dfrac{V}{T\langle N\rangle} & \text{ideal gas} \\ \infty & \text{phase coexistence} \quad p = \text{const} \end{cases}$$

$$\frac{\langle N^2\rangle - \langle N\rangle^2}{\langle N\rangle} = T\frac{\langle N\rangle}{V}\beta_T$$

Multiplicity fluctuations determine the isothermal compressibility.

St. Mrówczyński, Physics Letters **B430**, 9 (1998)

analysis of experimental data

M. Mukherjee, S. Basu, A. Chatterjee, S. Chatterjee, S.P. Adhya, S. Thakur, T.K. Nayak, arXiv:1708.08692

Multi-component system

$$\frac{\langle N^2 \rangle - \langle N \rangle^2}{\langle N \rangle} = T \frac{\langle N \rangle}{V} \beta_T$$

one-component system

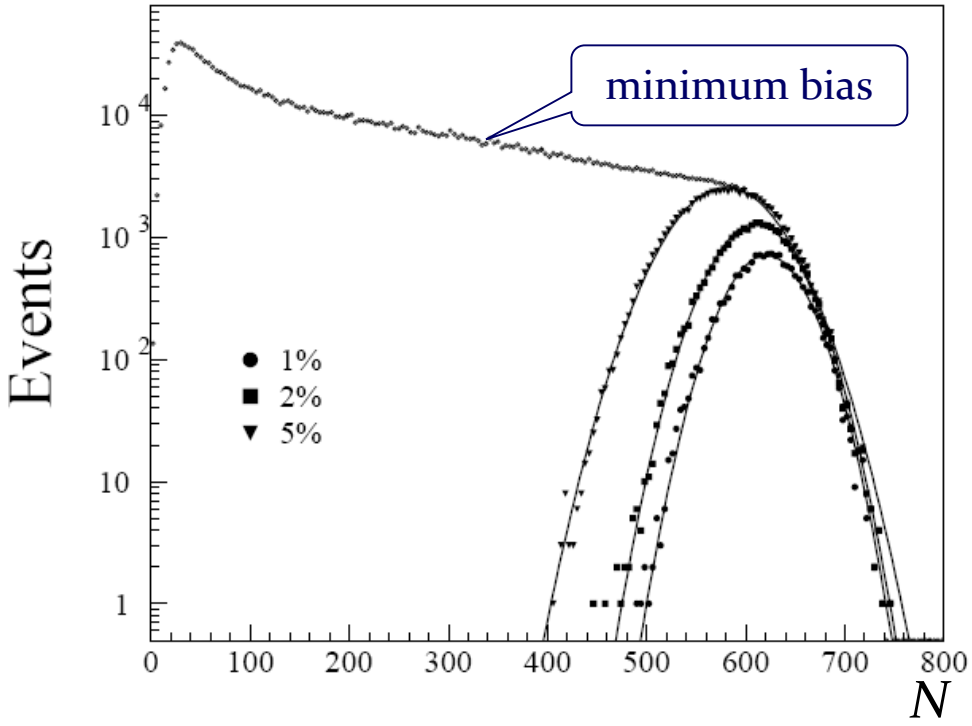
$$\sum_{i,j} \langle N_i \rangle \langle N_j \rangle M_{ij}^{-1} = \frac{V}{T \beta_T}$$

multi-component system

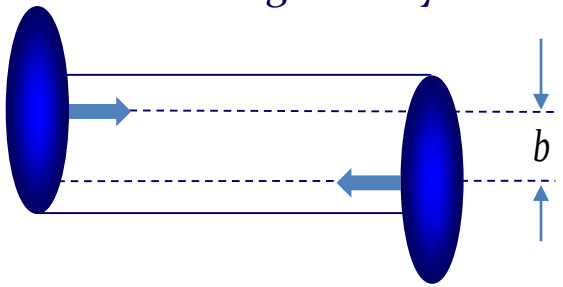
$$M_{ij} \equiv \left\langle \left(N_i - \langle N_i \rangle \right) \left(N_j - \langle N_j \rangle \right) \right\rangle$$

Multiplicity distribution

Pb-Pb @ 158 AGeV



collision geometry



$\langle N \rangle$ & Var(N) strongly depend on trigger conditions

M.M. Aggarwal et al. [WA98 Collaboration], Phys. Rev. **C65**, 054912 (2002)

How to eliminate trivial fluctuations?

Wounded nucleon model

N – number of particles produced in a nucleus-nucleus collision

N_W – number of wounded nucleons

n – number of particles coming from a single wounded nucleon

- $\langle N \rangle = \langle n \rangle \langle N_W \rangle$

- $\mathrm{Var}(N) = \mathrm{Var}(n)\langle N_W \rangle + \langle n \rangle^2 \mathrm{Var}(N_W)$

trivial fluctuations

variance

$$\mathrm{Var}(N) \equiv \langle N^2 \rangle - \langle N \rangle^2$$

$$\omega(N) = \omega(n) + \langle n \rangle \omega(N_W)$$

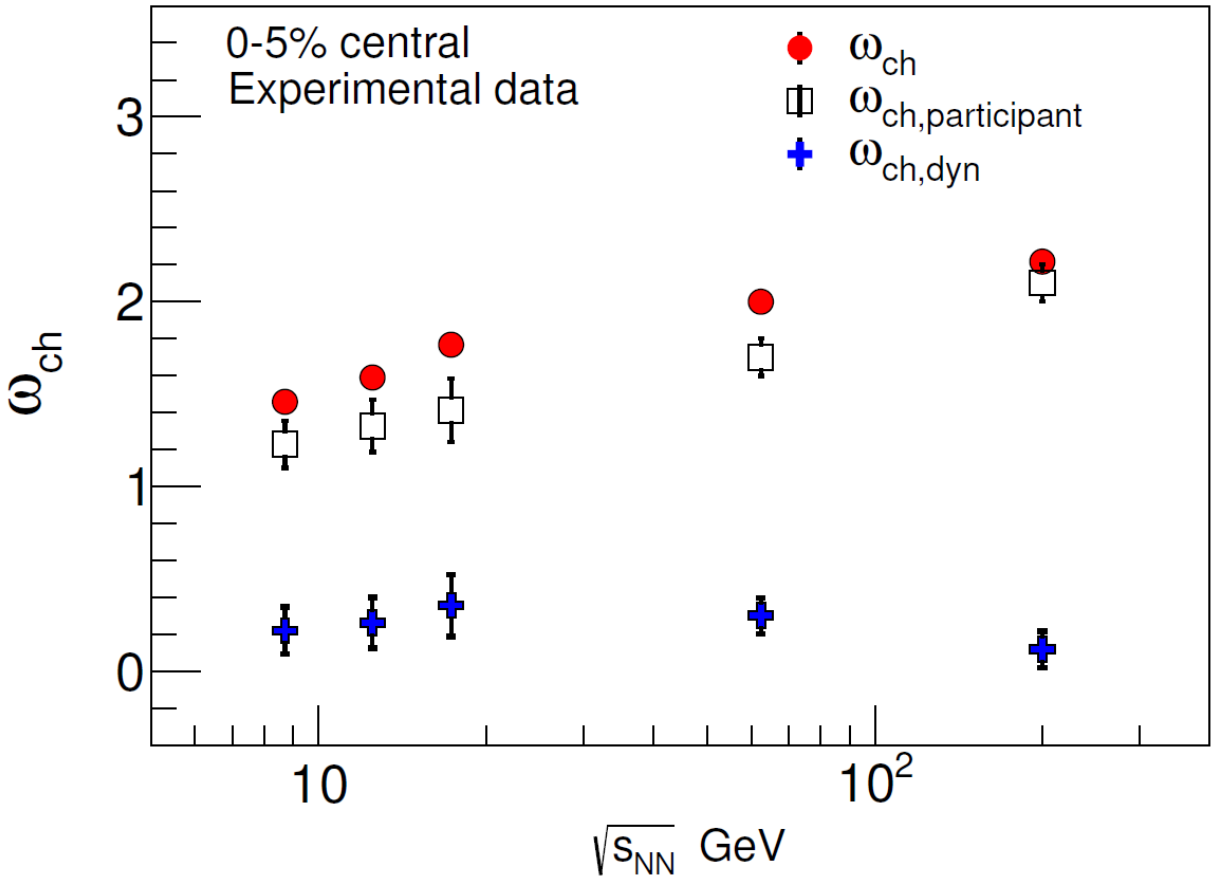
scaled variance

$$\omega(N) \equiv \frac{\mathrm{Var}(N)}{\langle N \rangle}$$

Trivial fluctuations can be measured

Dynamical fluctuations

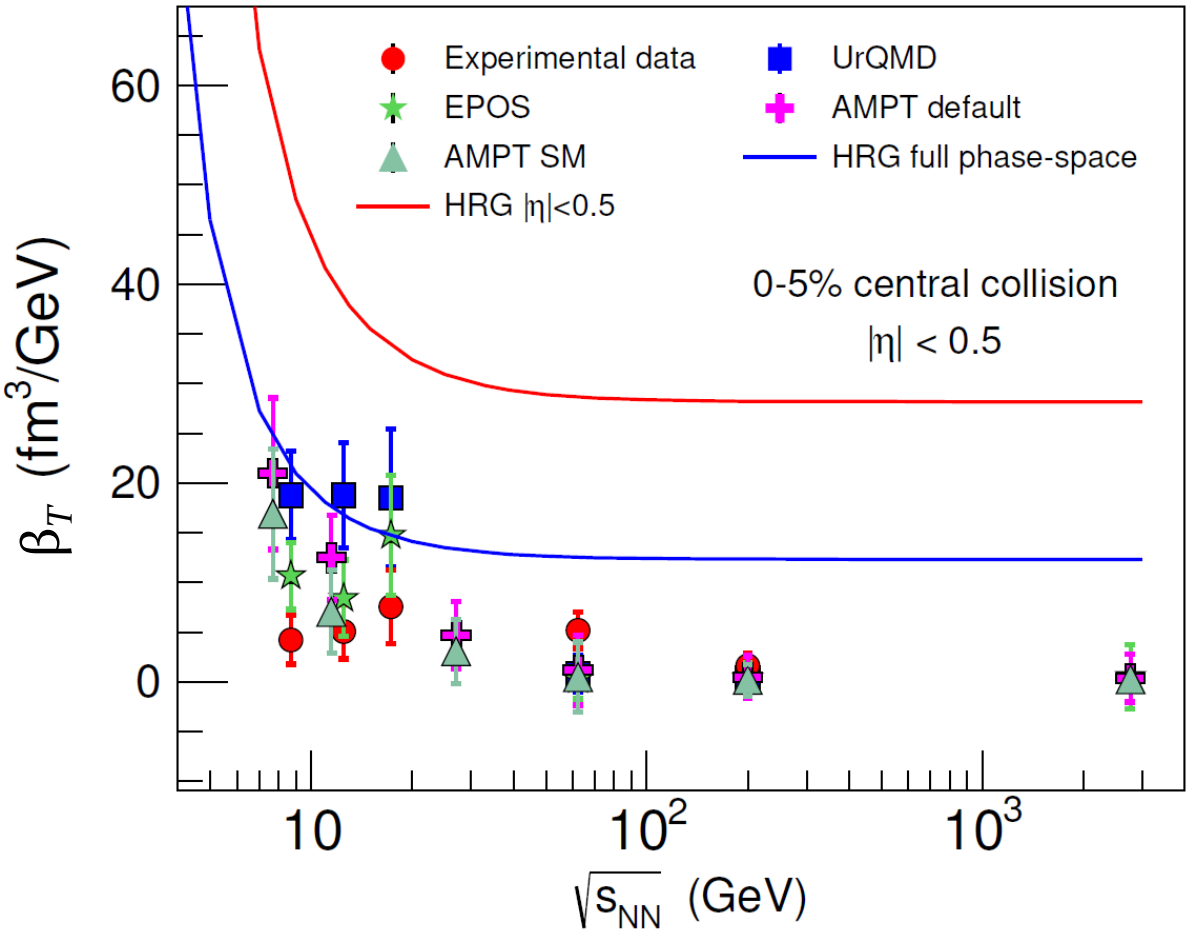
Scaled variance of multiplicity of charged particles $\omega_{ch} \equiv \frac{\mathrm{Var}(N_{ch})}{\langle N_{ch} \rangle}$



M. Mukherjee *et al.*, arXiv:1708.08692

Extracted compressibility

Very first results!



M. Mukherjee *et al.*, arXiv:1708.08692

Summary & Conclusions

- NCBJ & UJK are greatly interested in NICA.

- The isothermal compressibility
of strongly interacting matter is measurable.