“Joint Institute for Power and Nuclear Research - Sosny”

Event-by-Event multiplicity fluctuations in Monte-Carlo simulations of Heavy Ion Collisions

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Y.A. Rusak

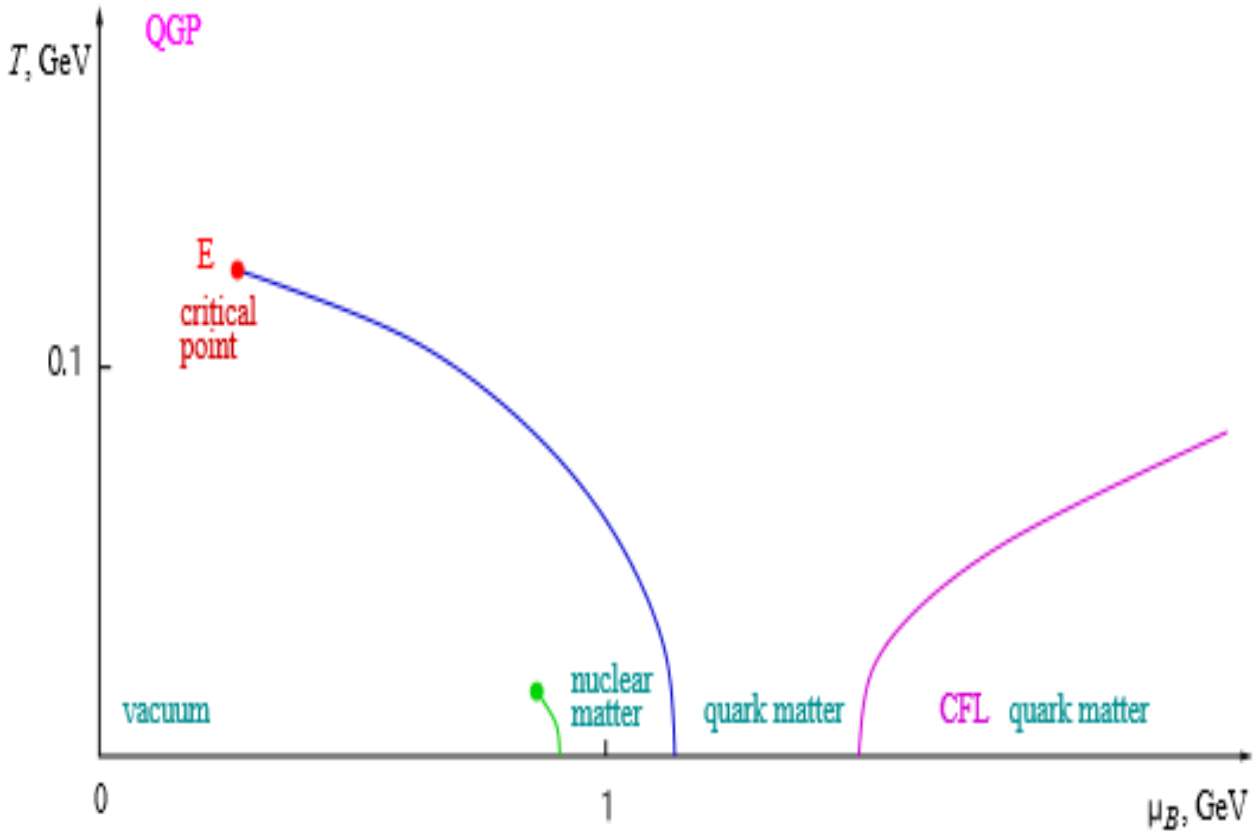
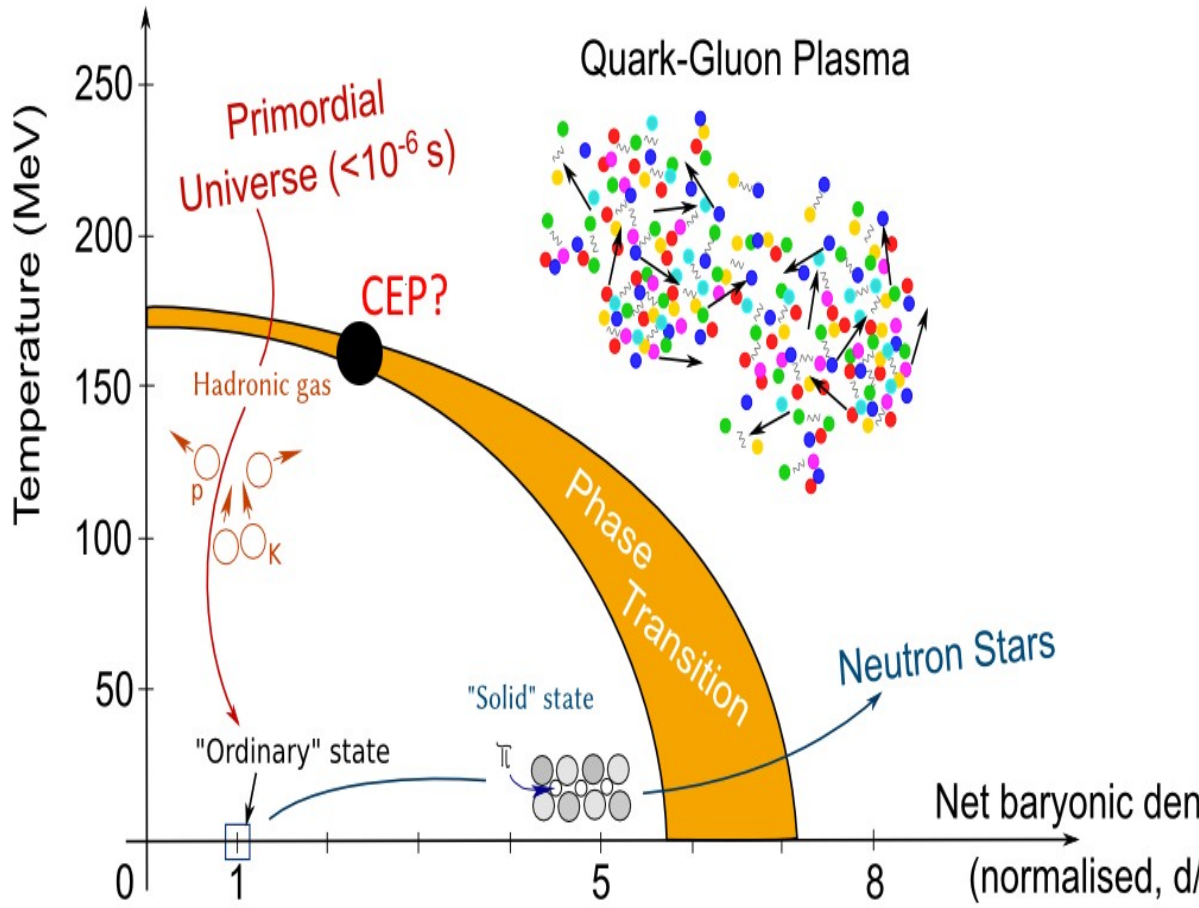
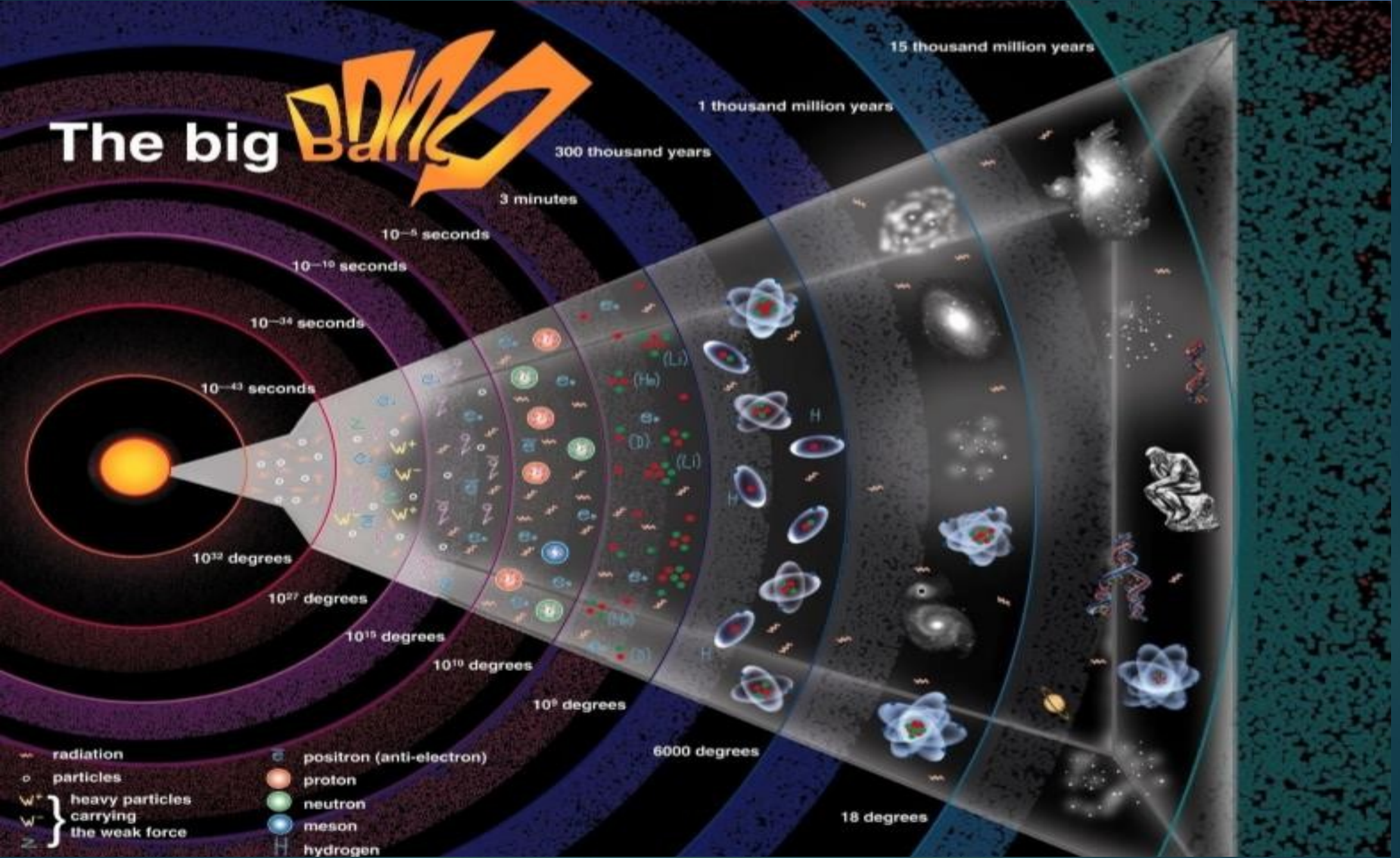


Fig. 1. QCD phase diagram

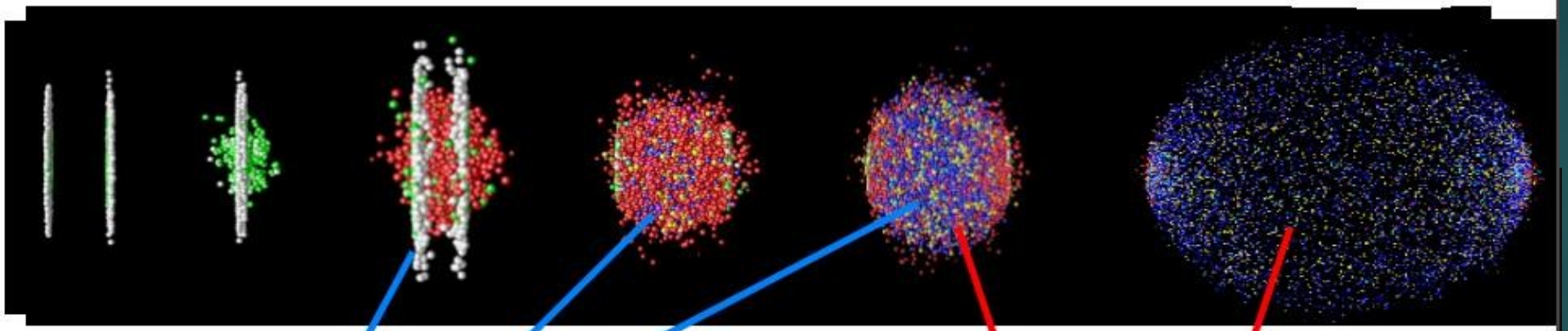


"QCD Phase Diagram and the Critical Point"
M. Stephanov
[arXiv:hep-ph:0402115v1 27.03.2006]

A commonly conjectured form of the phase diagram.


The big Bang
15 thousand million years
1 thousand million years
300 thousand years
3 minutes
10^{-5} seconds
10^{-10} seconds
10^{-34} seconds
10^{-43} seconds
10^{32} degrees
10^{27} degrees
10^{15} degrees
10^{10} degrees
10^{9} degrees
6000 degrees
18 degrees
radiation
particles
heavy particles carrying the weak force
positron (anti-electron)
proton
neutron
meson
hydrogen

Pre-equilibrium Thermalization QGP phase? Mixed phase Hadronization (Freeze-out)+ Expansion

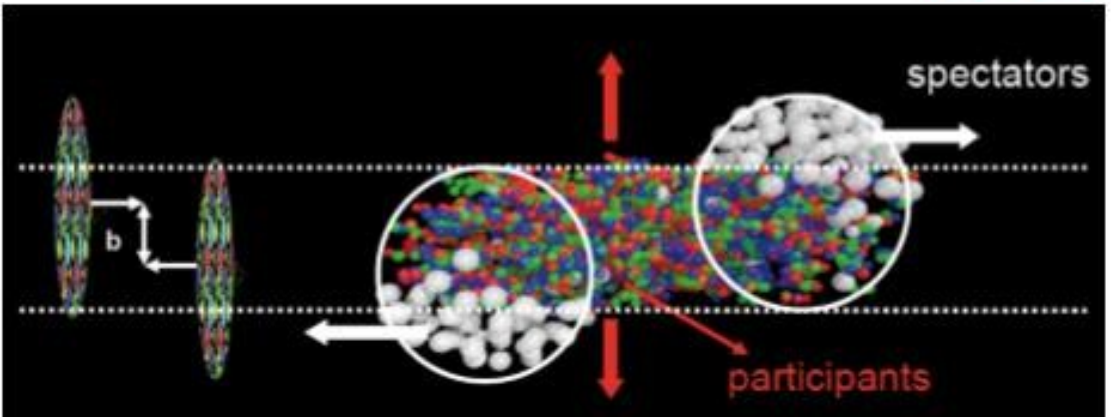


$\gamma, \gamma^* \rightarrow e^+e^-, \mu^+\mu^-$

π, **K**, **p**, **n**, ϕ, Λ, Δ, Ξ, Ω, **d**,…

Hard processes (early stages): Real and virtual photons, high p_T particles.

Soft hadrons reflect medium properties when inelastic collisions stop (chemical freeze-out).



$$\varepsilon_{Bj}^{Pb+Pb@158GeV} = 3.2GeV / fm^3 (NA49)$$

$$\varepsilon_{Bj}^{Pb+Pb@2.75TeV} = 16GeV / fm^3 (ALICE)$$

Fluctuations

1. H. Heiselberg, Physics Reports 351 (2001) 161.
2. 2. M.M. Aggarwal et al., (WA98 Collaboration), Phys. Rev. C65, (2002) 054912.

Event-by-Event fluctuations in HIC:

- Multiplicity fluctuations;
- Net charge fluctuations;
- Fluctuations of particle ratio;
- <Pt> fluctuations;

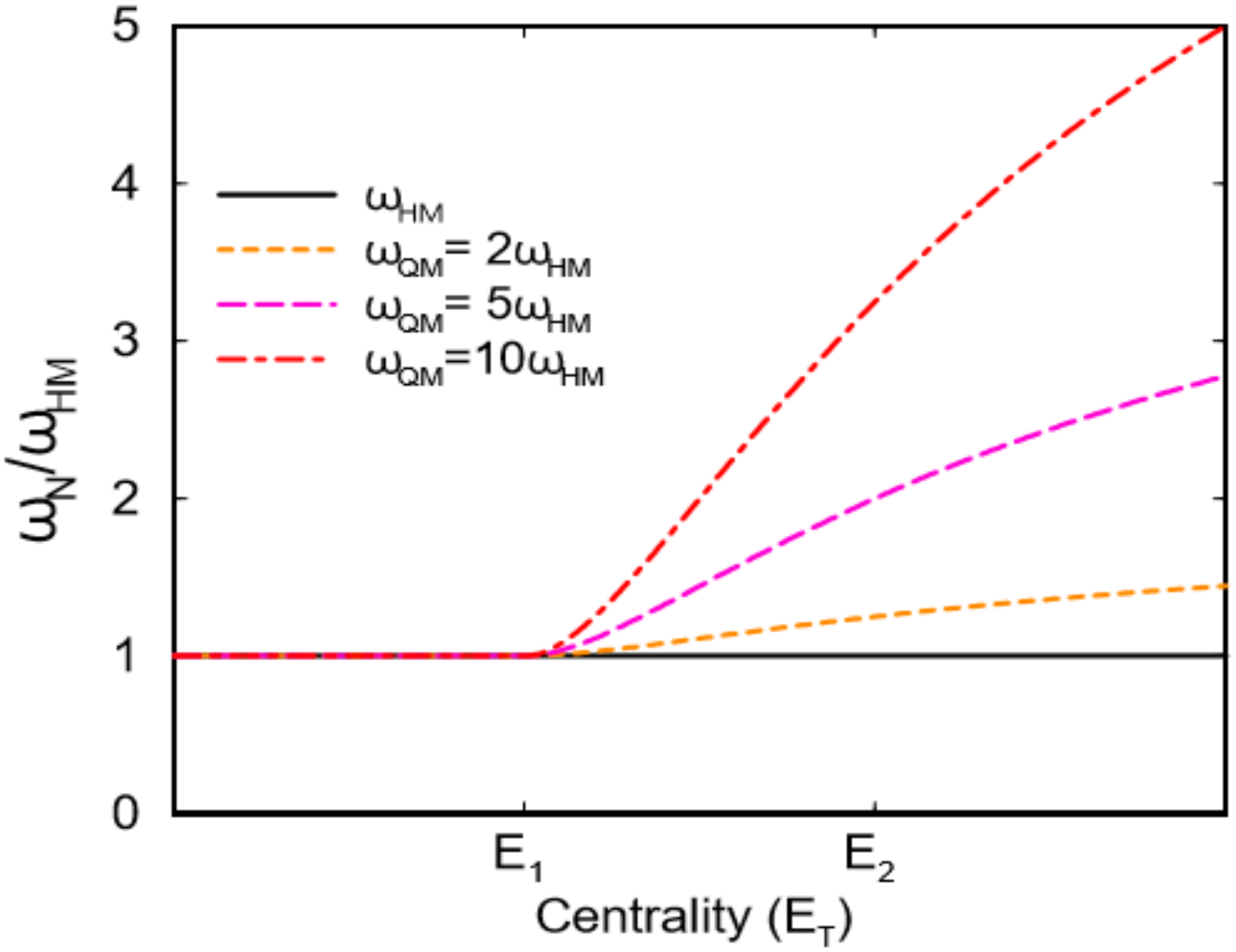


Fig. 3 Qualitative picture of multiplicity fluctuations vs. centrality (total multiplicity or E_T). Anomalous fluctuations appear when a transition to a new state of matter (QM) starts at centrality E_1 (see text). Curves for different ratios of the fluctuations characterizing the two states of matter are shown.

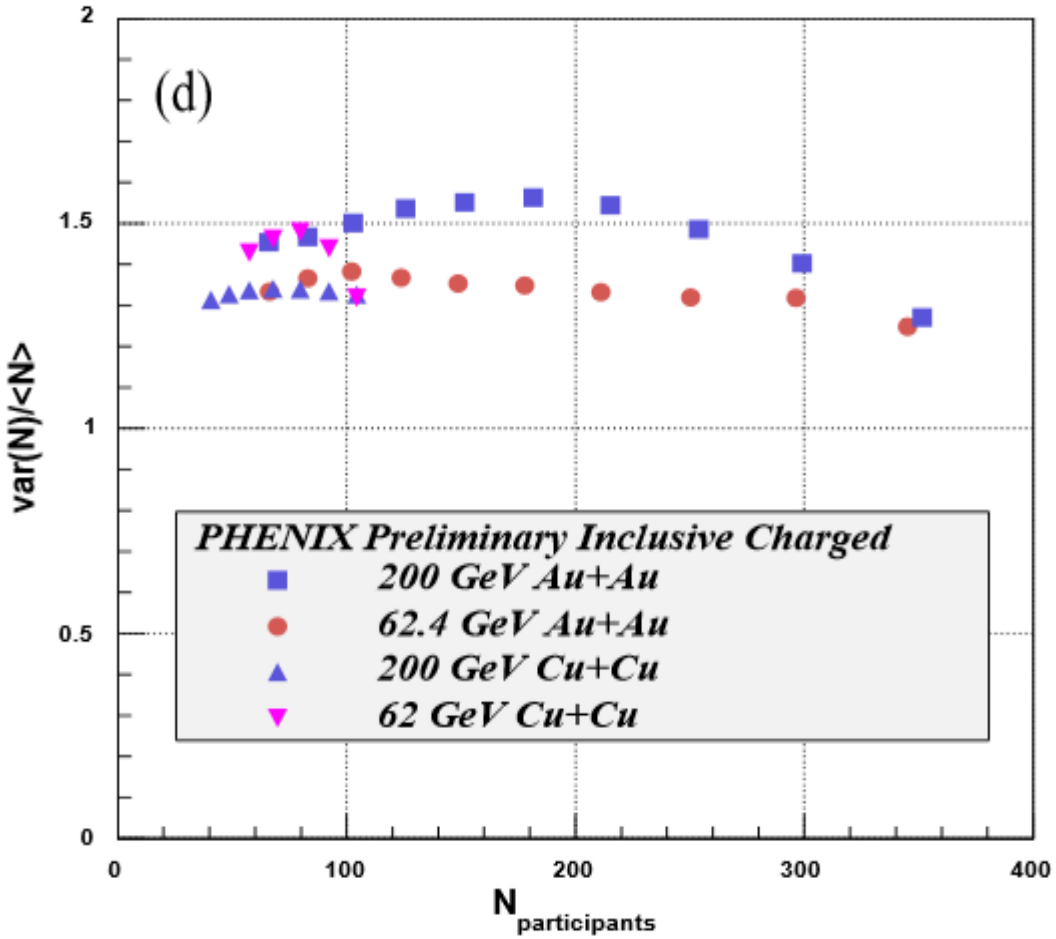
"Event-by-Event Physics in Relativistic Heavy-Ion

H. Heiselberg [arXiv:nucl-ph:0003046v5]

HIJING = Pythia+JETSET+FRITIOF

Description of HIC:

1. Two beam particles are coming in towards each other;
2. Initial state shower built by parton initiator;
3. Hard process;
4. Production of short-living resonances;
5. Parton branching, final state showers;
6. Semihard interactions between other partons;
7. QCD confiment mechanism fragmentates quarks and gluons (by JETSET);
8. Hadrons decay further;



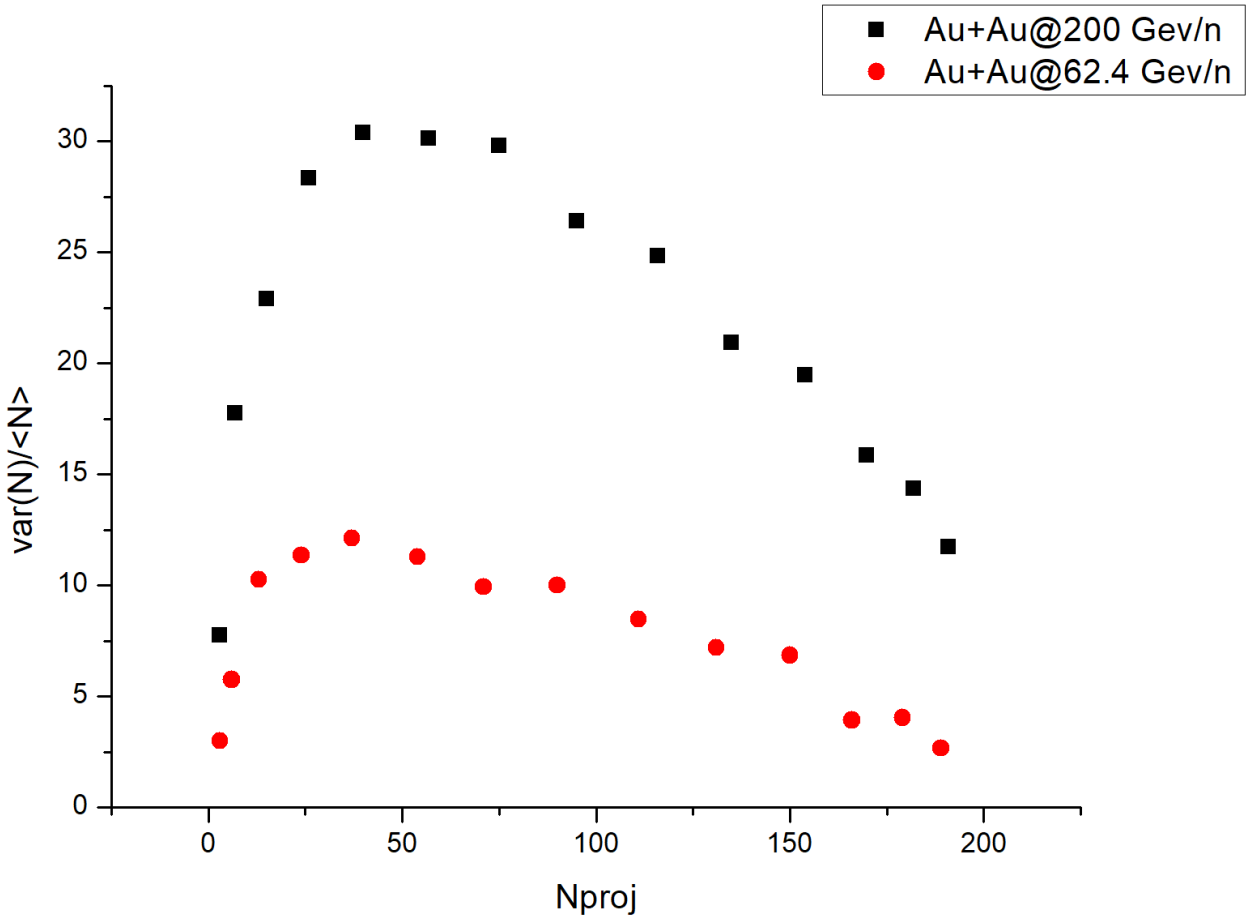
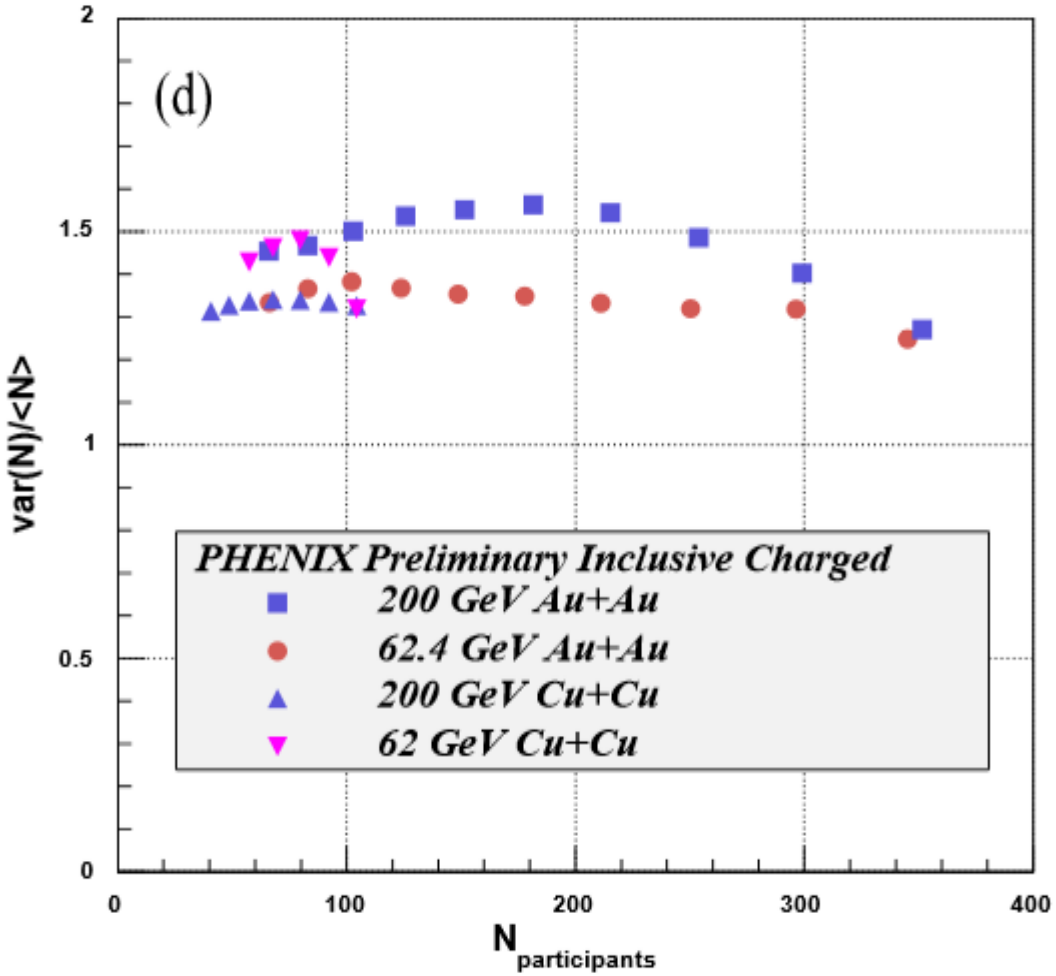


Fig 4. Multiplicity fluctuations at RHIC energies. Left – experiment, right – HIJING modelling



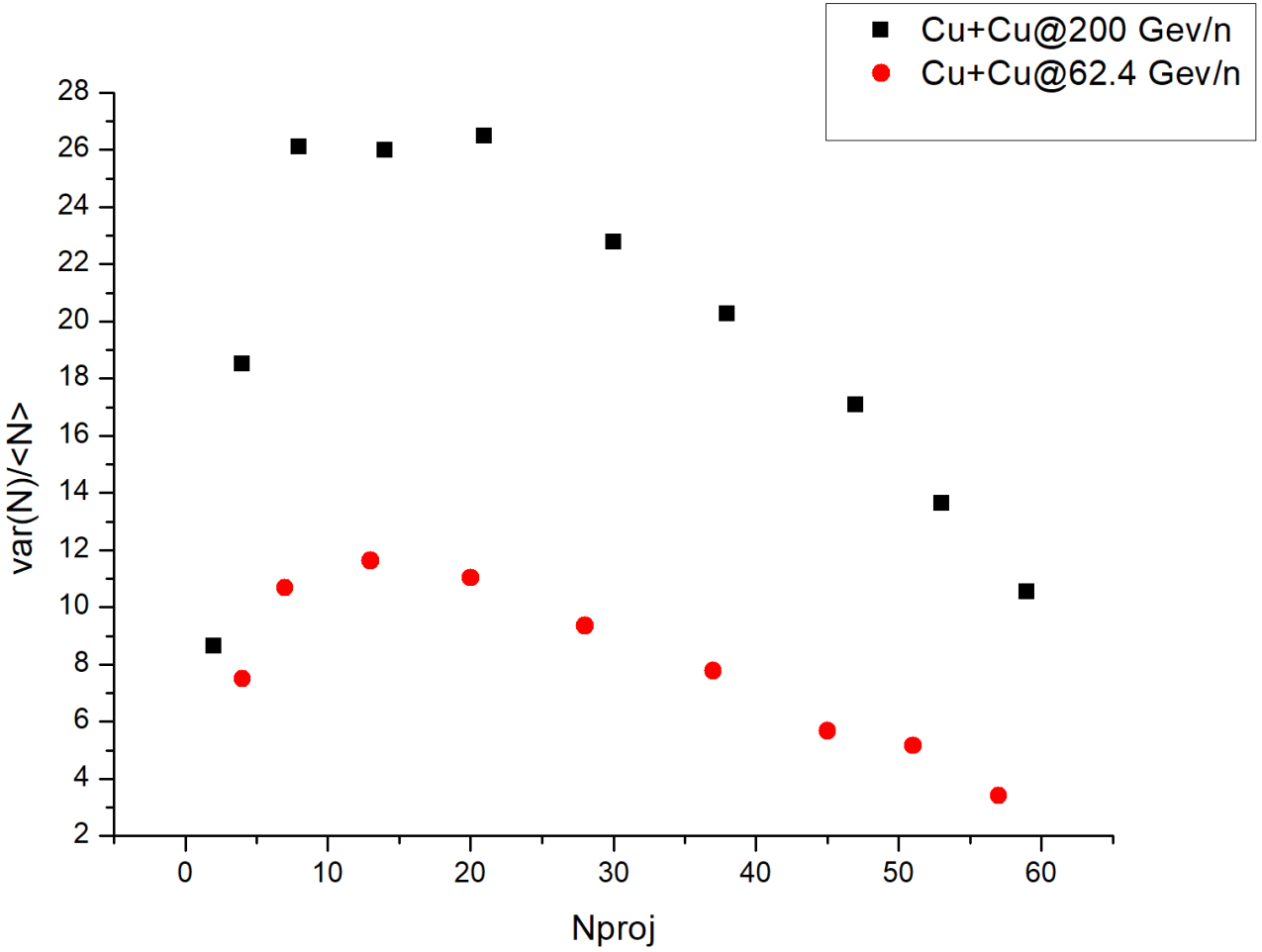
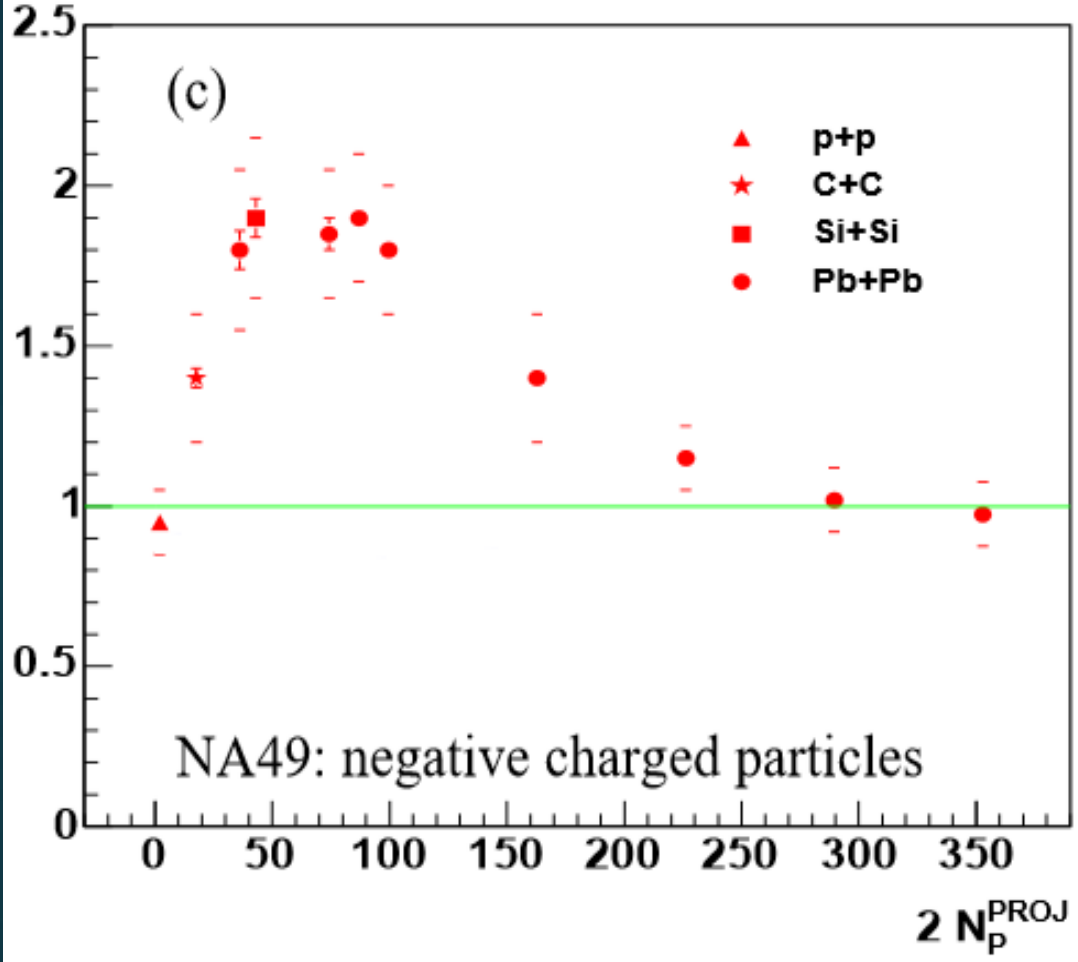


Fig 5. Multiplicity fluctuations at RHIC energies. Left - experiment, right – HIJING modelling



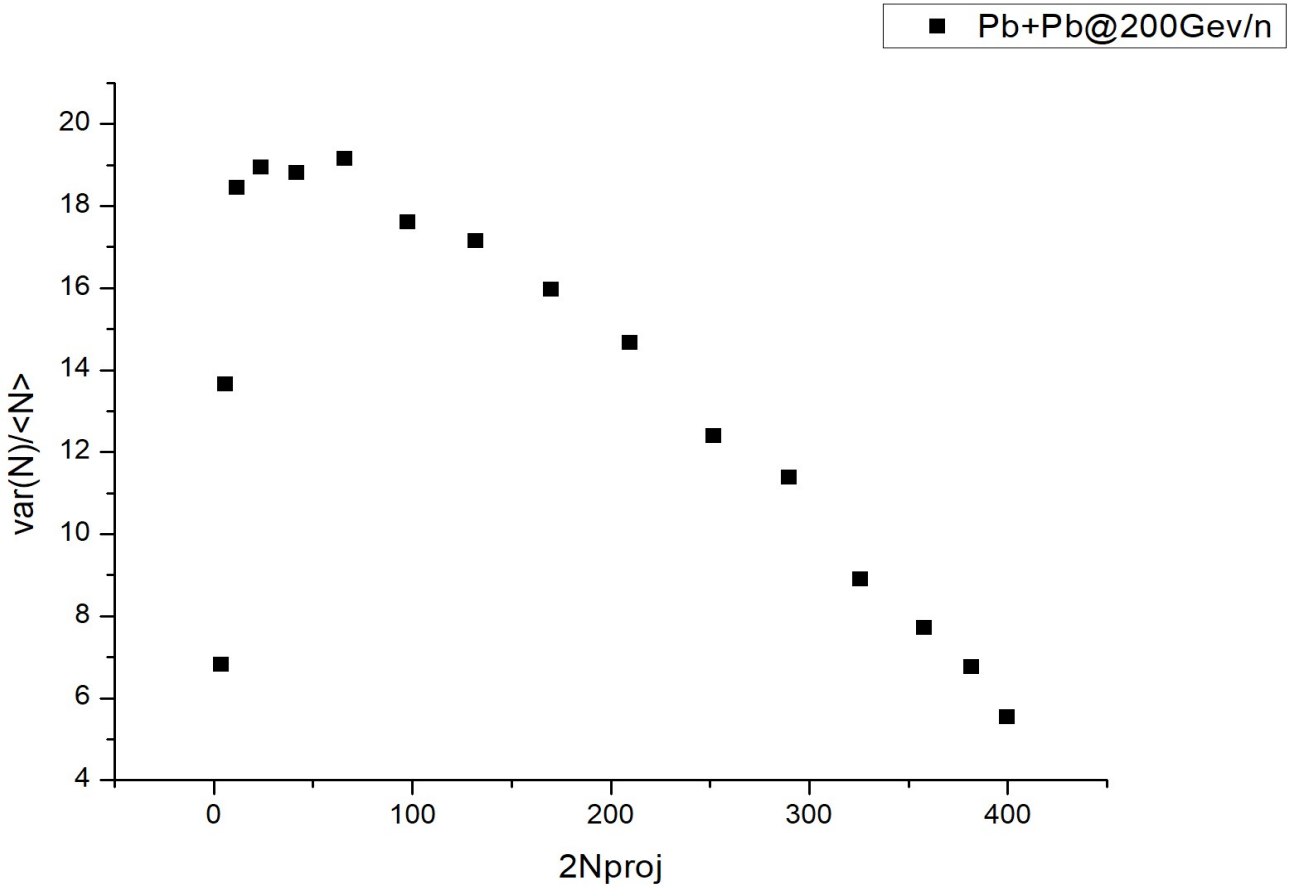


Fig 6. Multiplicity fluctuations at SPS energies. Left – experiment, right – HIJING modelling

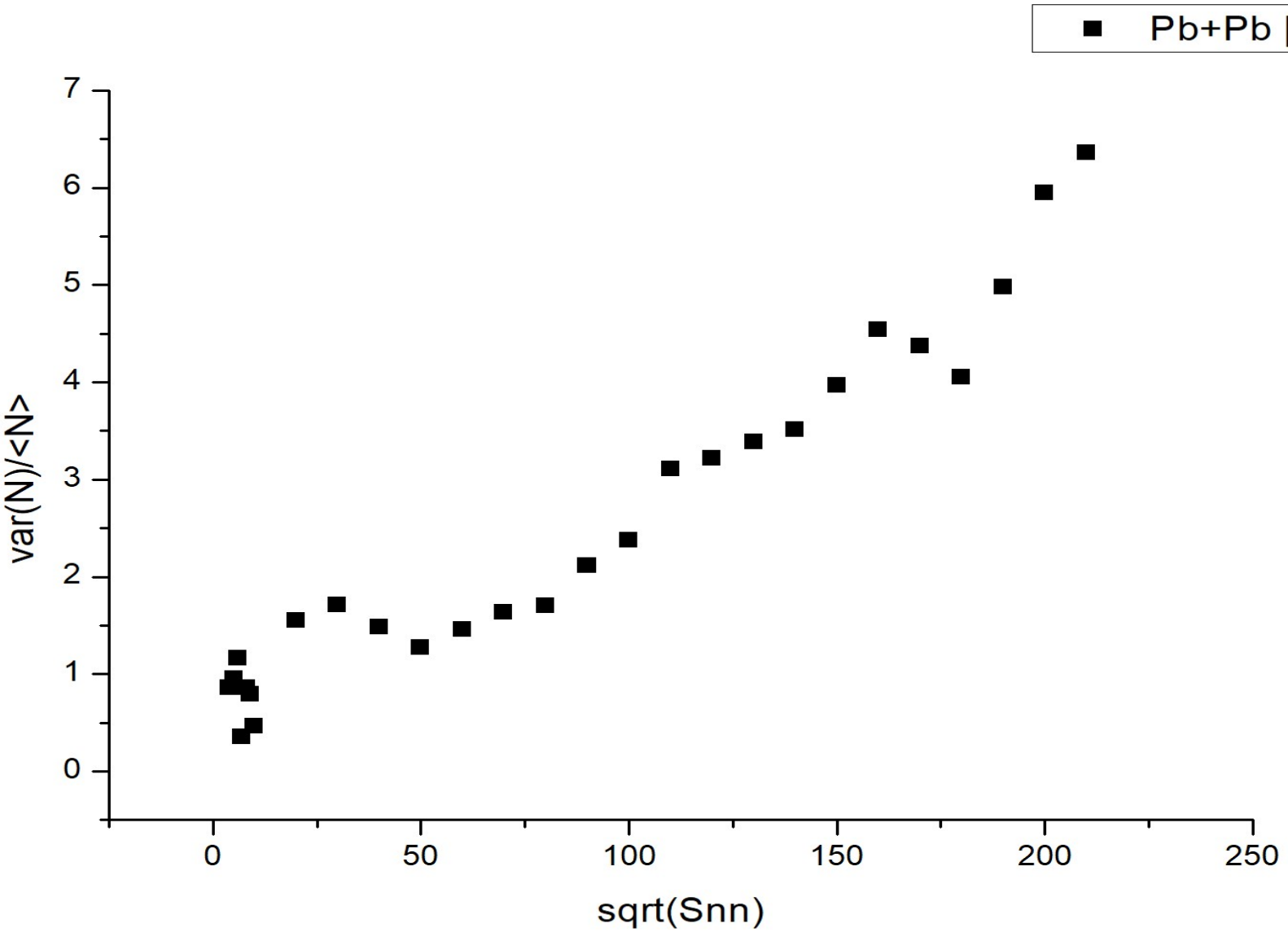


Fig. 7 Multiplicity fluctuations vs collision energy.