Beam energy dependence of squeeze-out effect on anisotropic flow at high baryon density[1]

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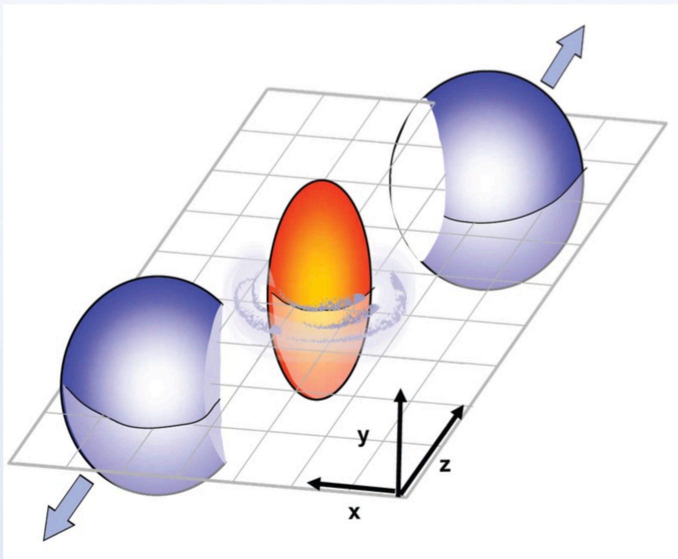
Abstract

The STAR experiment has published the energy dependence of the directed flow (v_1) of identified particles, such as proton, charged kaons and pions[2] . A clear sign change is observed in excitation function of the proton v_1 slope, which could be an indication of the softening of the equation of state (EoS) due to first order phase transition. In this poster, we will present a detailed analysis of the beam energy dependence of directed and elliptic flows in Au+Au collisions focusing on the role of hadronic rescattering and spectator shadowing within a microscopic transport model JAM with different equation of state. A systematic study of the energy dependence is performed for Au+Au collisions at $2 \le \sqrt{s_{NN}} \le 62.4$ GeV .

Introduction



- The anisotropic flows are defined by the Fourier coefficients of the expansion of particles azimuthal distribution :
  $E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}[1 + 2\sum_{i=0}^{n} v_n \cos n[(\phi - \Psi_{RP})]]$
- Directed flow is defined as the first Fourier coefficient v_1, while v_2 referred to as elliptic flow, are used as probes to study the medium properties.
- A microscopic transport model JAM as well as several setups were utilized to study the squeeze-out effect on anisotropic flow at high baryon density.

JAM Model and setup

A Microscopic Transport model JAM[3]

- Resonance model N*, D*, string pQCD,PYTHIA6.1 .

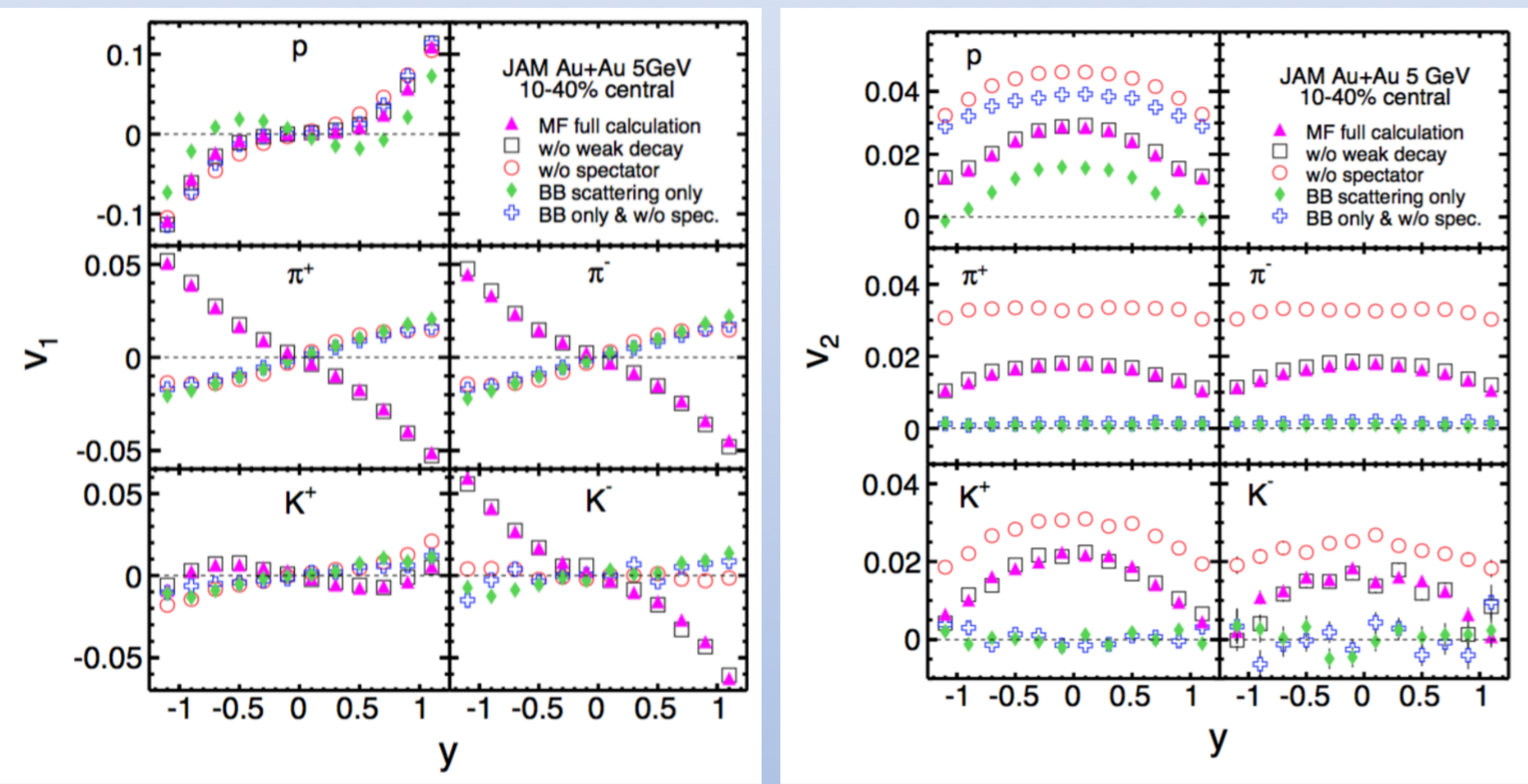
Nuclear Mean-Field effect(MF)

- Implemented alone the lines of RQMD/S.
- Skyrme-type density dependent
  + Lorentzian-type momentum dependent mean-field potential [4] .

1OPT: simulate softening of equation of state[5]

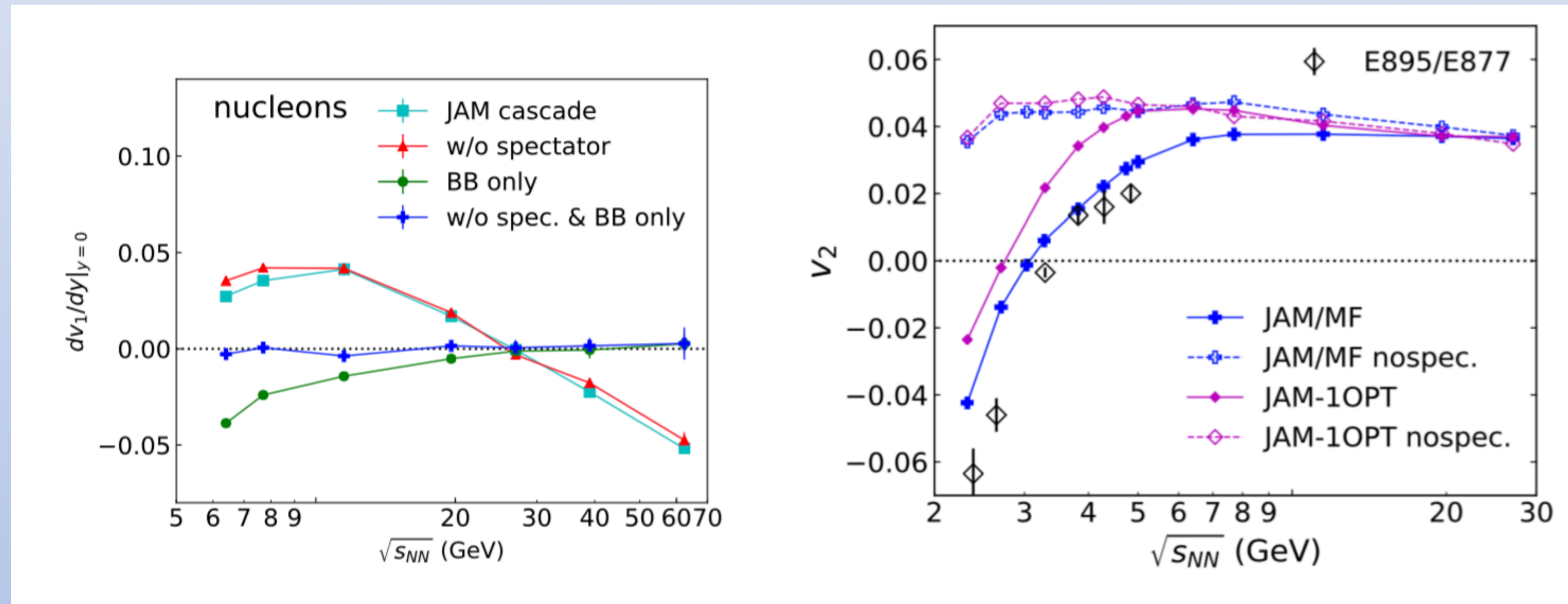
- This mode is realized by selecting azimuthal angle in the two-body scattering process according to the constraint :
  $\Delta P = \frac{\rho}{3(\delta\tau_i + \delta\tau_j)}(p_i' - p_i)(r_i - r_j)$; here ρ is the local particle density.

Squeeze-out effect (1)



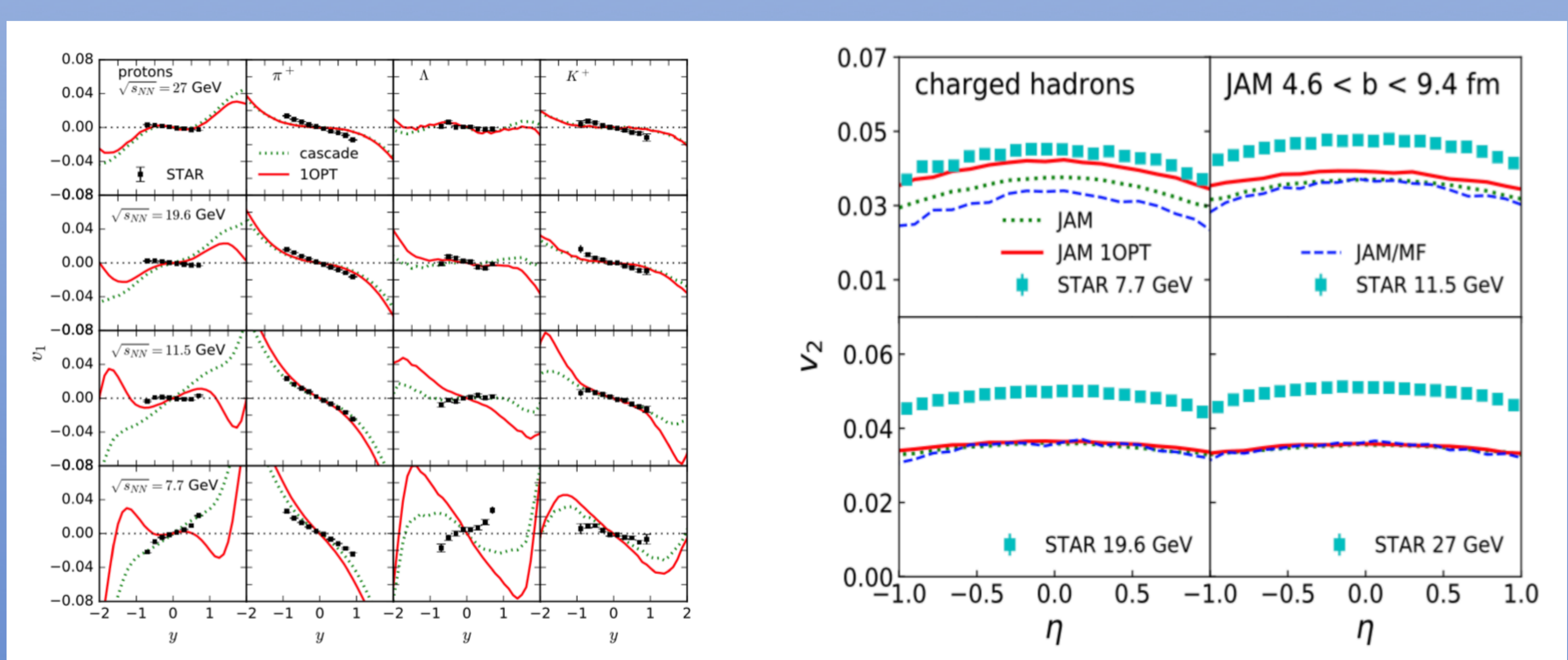
- Negative nucleon v_1 in the BB(baryon-baryon collision only) scattering simulation is due to the squeeze-out effect by the spectator matter, negative v_1 for pion is introduced by the interaction between spectator nucleons and pions.
- Nucleon v_2 is reduced about 20% in BB scattering, squeeze-out effect suppresses the elliptic flow for all particles.

Squeeze-out effect (2)



- In RHIC-BES energy, BB scattering introduce negative directed flow below 30 GeV (green), MB(Meson-Baryon) and MM(Meson-meson)scattering effects to the slope of nucleon directed flow is opposite at low and high energies.
- For elliptic flow, squeeze-out effect exits up to 10 GeV in MF, on the other hand, it disappears around 5GeV in 1OPT mode due to strong softening effect.

Comparing with data



- Due to the lack of partonic phase, the same behavior of p and Λ directed flow cannot be accounted for within our model simulation, the negative pion and kaon directed flow are consistant with the data.
- The 1OPT scenario elliptic flow in JAM seems to be consistent with STAR data at 7.7GeV, at higher energies, due to the lack of partonic phase, the JAM simulations predict less than data.

Summary

- Due to the squeeze-out effect, initial nucleon-nucleon collisions introduce negative nucleon directed flow, and the effect decrease with increase energy.
- The role of final state interactions (mostly MB and MM scattering in our case) to the slope of nucleon directed flow is opposite at low and high energies. Thus the dynamical origin of directed flow changes at 30 GeV.
- Squeeze-out effect by the spectator to the elliptic flow becomes negligible at above 10 GeV.

References

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