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Nuclear Physics in Astrophysics - X

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Onset of pressure gradient on collective flow through balance and transition geometry

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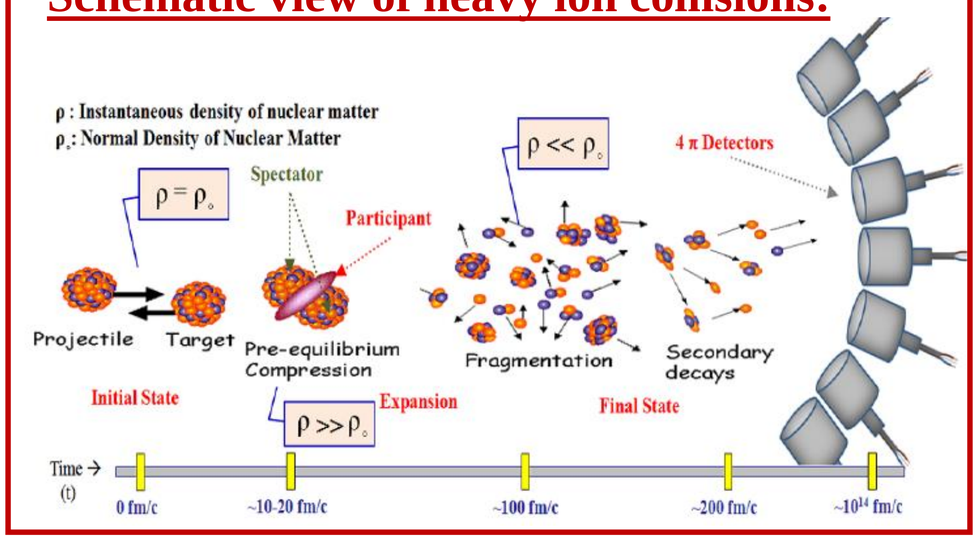
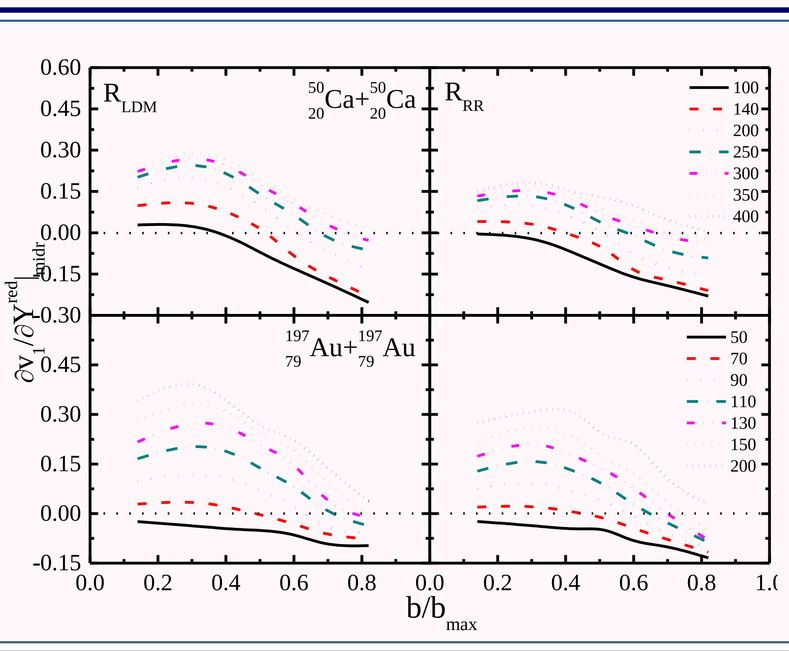
Abstract:

The impression of mean-field and spectator matter has been studied through the collision geometry dependence of reduced flow and elliptical flow in heavy-ion collisions (HICs) at intermediate energies using the Isospin-dependent Quantum Molecular Dynamics (IQMD) model for the reaction of $^{50}Ca+^{50}Ca$ and $^{197}Au+^{197}Au$ at incident energy between 50 MeV/nucleon and 450 MeV/nucleon. We observe that at particular incident energy, the magnitude of both types of flow changes their sign from positive to negative (or vice-versa) as the collision geometry increases. The impact parameter at which the reduced flow and elliptical flow change its sign is termed as balance geometry ($\hat{b}_{bal}$) and transition geometry ($\hat{b}_{trans}$) of flow, respectively. Our study reveals that $\hat{b}_{bal}$ and $\hat{b}_{trans}$ increases with an increase in incident energy. In addition, the effect of nuclear charge radius has also been studied by using the isospin-independent as well as using dependent nuclear charge radii parameterizations.

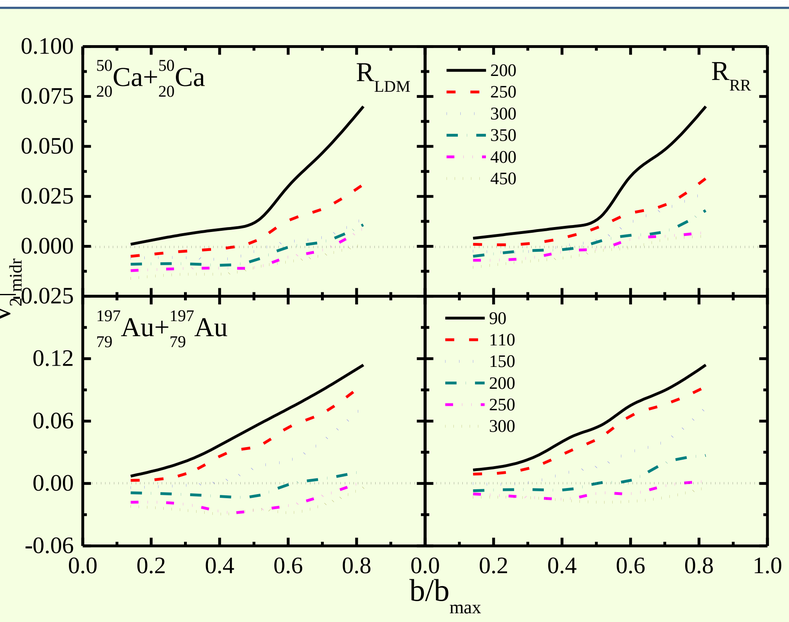
Schematic view of heavy ion collisions:





Introduction:

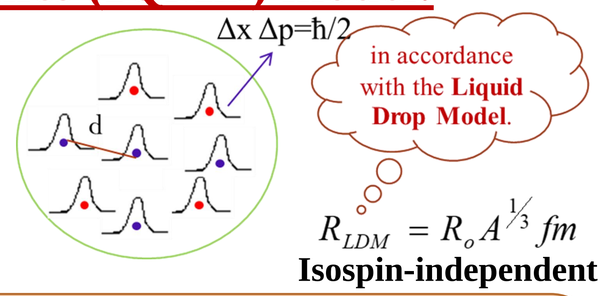
- The collective flow is a phenomenon that is related to the amount of momentum attained by the emitted particle and its direction of emission from the fireball. This, provide a clear vision of the thermodynamical state of the overlapping region of colliding nuclei.
- The directed flow referred to the preferential emission of particles in the reaction plane but in the sideward direction.
- The elliptical flow at mid-rapidity signifies the ellipsoidal distribution of emitted particles. Due to the variable size of the participant zone and shadowing of spectator matter, the strength of nucleon-nucleon collision differs with different reaction conditions.
- As the radius increases, the density of the nuclear matter will decrease which further affects the interaction range and thus the reaction dynamics.
- With the increase in impact parameter, the strength of repulsive nucleon-nucleon collision reduces as the participant matter decreases.



Isospin-dependent Quantum Molecular Dynamics (IQMD) model:

This model treats different charge states of nucleons, deltas and pions explicitly. In IQMD model, baryons are represented by Gaussian-shaped density distributions:

$$f_i(\vec{r},\vec{p},t) = \frac{1}{\pi^2\hbar^2} e^{-[\vec{r}-\vec{r}_i(t)]^2\frac{1}{2L}} e^{-[\vec{p}-\vec{p}_i(t)]^2\frac{2L}{\hbar^2}}$$



$$R_{LDM} = R_o A^{1/3} fm$$

Isospin-independent

The hadrons propagate using Hamilton equations of motion:

$$\frac{dr_i}{dt} = \frac{\partial\langle H\rangle}{\partial p_i}; \qquad \frac{dp_i}{dt} = -\frac{\partial\langle H\rangle}{\partial r_i}$$

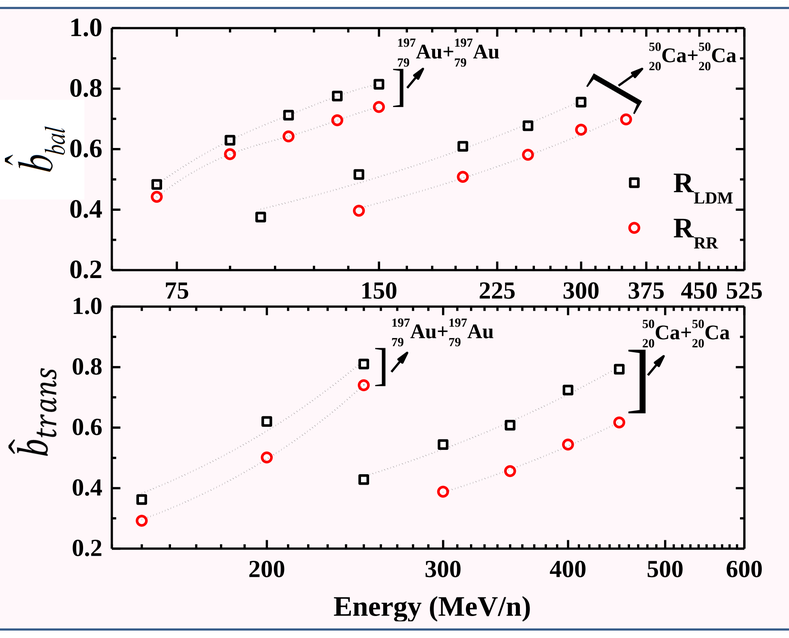
The baryon-baryon potential V^{ij}, in the above relation, reads as:

$$V^{ij}(r'-r) = V^{ij}_{Skyrme} + V^{ij}_{Yukawa} + V^{ij}_{Coul} + V^{ij}_{MDI} + V^{ij}_{Sym}$$

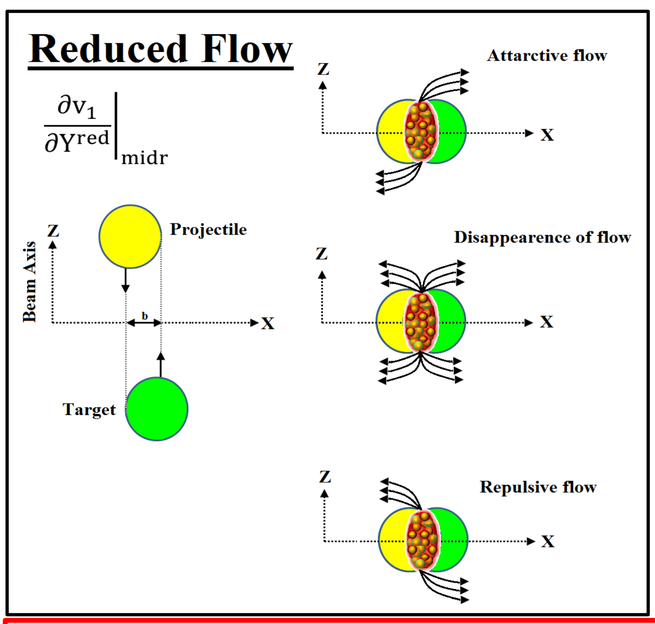
Isospin-dependent radii parameterization by Royer and Rousseau:

$$R_{RR} = 1.2332A^{1/3} + \frac{2.8961}{A^{2/3}} - 0.18688A^{1/3}I$$

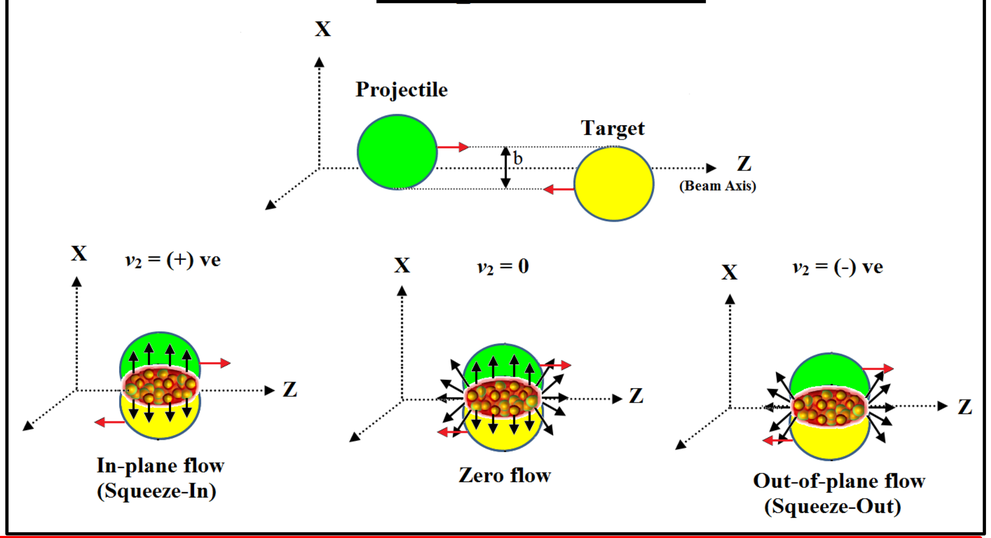
Isospin parameter: I=(N-Z)/A



Reduced Flow



Elliptical Flow



Conclusions:

- The role of nuclear charge radii parametrization is more for lighter colliding systems.
- Both $\hat{b}_{bal}$ and $\hat{b}_{trans}$ increases with increase in incident energy. Also, the influence of an increase in nuclear radius is more in $\hat{b}_{trans}$ compared to $\hat{b}_{bal}$, which proves elliptical flow to be more sensitive towards the choice of nuclear charge radii parametrization.
- The increase in nuclear charge radius reduces the magnitude of reduced flow and enhances the magnitude of elliptical flow.

References:

1. A. Bohr et al., Vol. 1, W. A. Benjamin Inc., New York, Amsterdam (1969).
2. G. Royer and R. Rousseau, Eur. Phys. J. A 42, 541 (2009).
3. C. Hartnack et al., Eur. Phys. J. A **1**, 151 (1998); C. Hartnack et al., Phys. Rep. **510**, 119 (2012).
4. Sangeeta, A. Jain and S. Kumar, Nucl. Phys. A **927**, 220-231 (2014).
5. Sangeeta, Acta Phys. Pol. B **47**, 991 (2016).
6. Sangeeta and V. Kaur, Acta Phys. Pol. B **48**, 623 (2017).
7. Sangeeta and V. Kaur, Nucl. Phys. A **966**, 20-33 (2017).

Acknowledgments:

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