Anisotropic Flow Decorrelation in Heavy-Ion Collisions at RHIC-BES Energies with 3D Event-by-Event Viscous Hydrodynamics

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References: Phys. Rev. C 103, 034902 (2021) and arXiv:2104.08022 (to appear in PRC)

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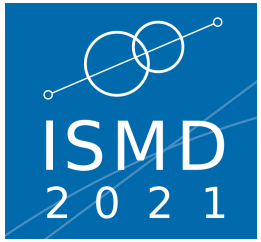


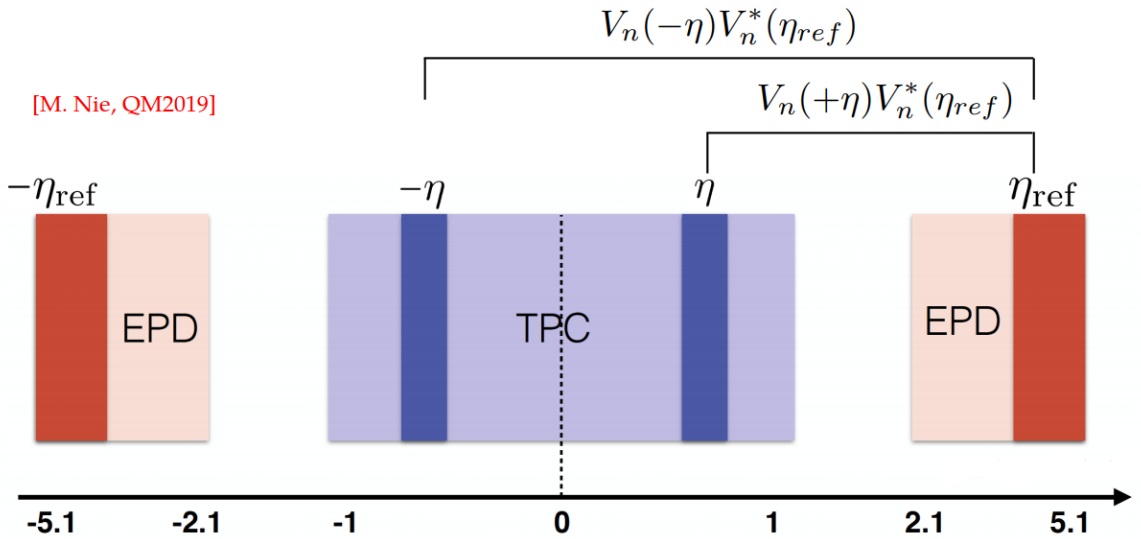
Introduction

- Longitudinal structure of anisotropic flows brings additional constraints on the initial state and/or transport coefficients of the QGP
- At RHIC-BES energies, flow decorrelation is just starting to be researched
- So far, there are only preliminary results from STAR at $\sqrt{s_{\mathrm{NN}}} = 27$ and 200 GeV [Nucl. Phys. A 982, 403 (2019), Nucl. Phys. A 1005, 121783 (2021)]
- Model: 3D initial state (GLISSANDO2 and UrQMD) $\Rightarrow$ vHLLE $\Rightarrow$ Cooper-Frye $\Rightarrow$ UrQMD cascade for rescatterings and resonance decays
- There is a finite baryon and electric charge density at all stages
- We simulated Au+Au collisions at energies $\sqrt{s_{\mathrm{NN}}} = 27$ and 200 GeV

Decorrelation

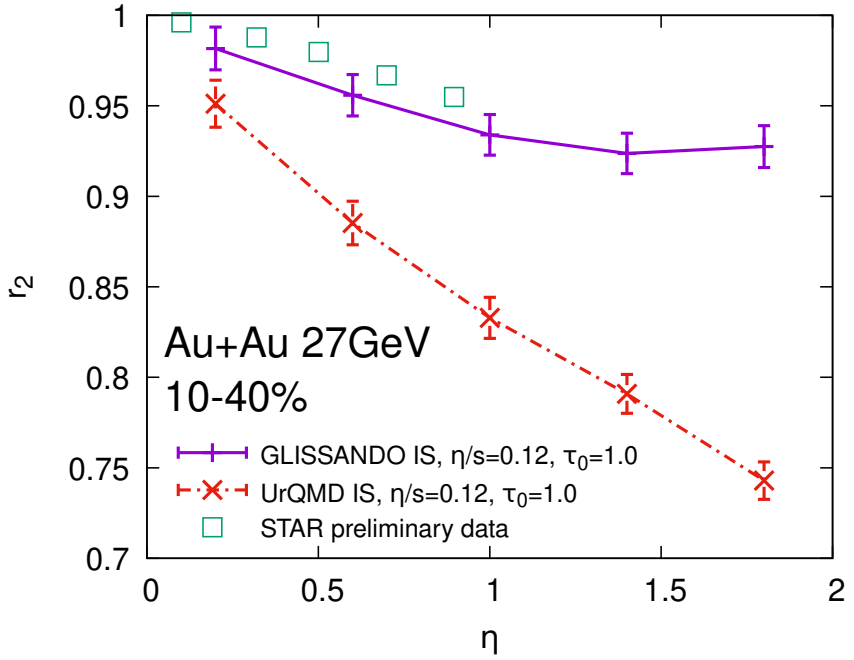
- Longitudinal fluctuations can lead to decorrelations of anisotropic flows along the pseudorapidity direction
- We use flow vector $\mathbf{V}_n = v_n e^{in\Psi_n}$ to calculate factorisation ratio
- The factorisation ratio is the defined

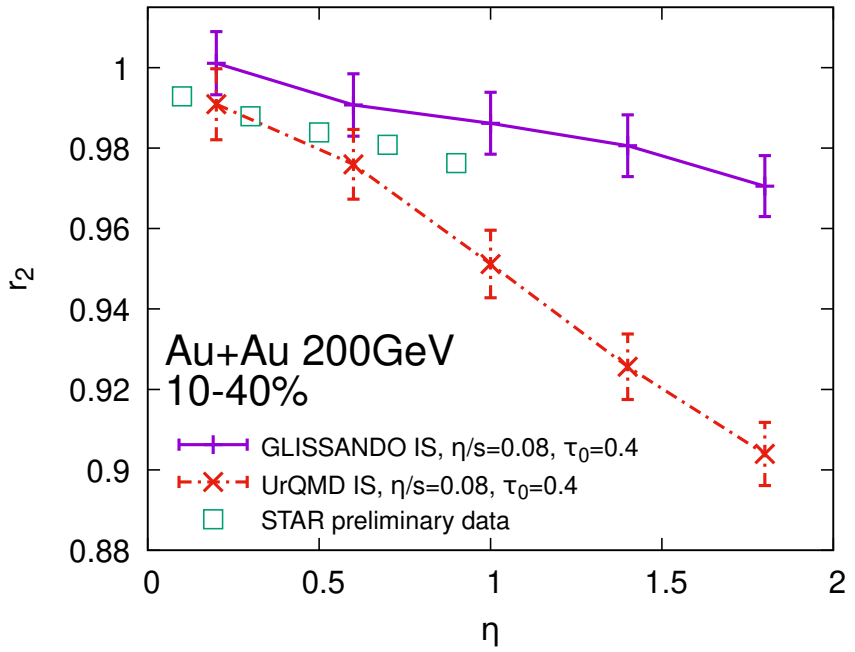
$$r_n(\eta, \eta_{ref}) = \frac{\langle \mathbf{V}_n(-\eta)\mathbf{V}_n^*(\eta_{ref})\rangle}{\langle \mathbf{V}_n(+\eta)\mathbf{V}_n^*(\eta_{ref})\rangle} = \frac{\langle v_n(-\eta)v_n(\eta_{ref})\cos n(\Psi_n(-\eta) - \Psi_n(\eta_{ref}))\rangle}{\langle v_n(+\eta)v_n(\eta_{ref})\cos n(\Psi_n(+\eta) - \Psi_n(\eta_{ref}))\rangle}$$



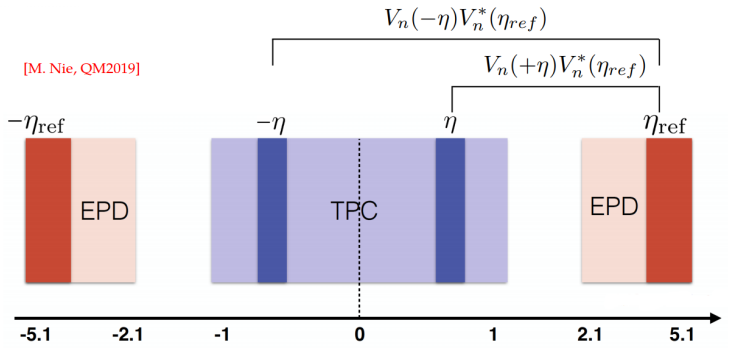
- $r_n(\eta) = 1 \Rightarrow$ no decorrelation
- $r_n(\eta) < 1 \Rightarrow$ decorrelation

Results of Flow Decorrelation

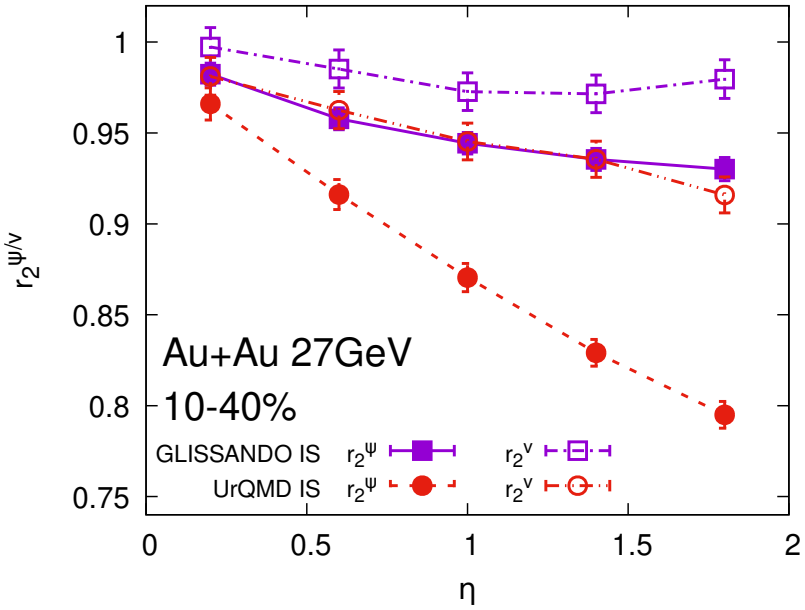


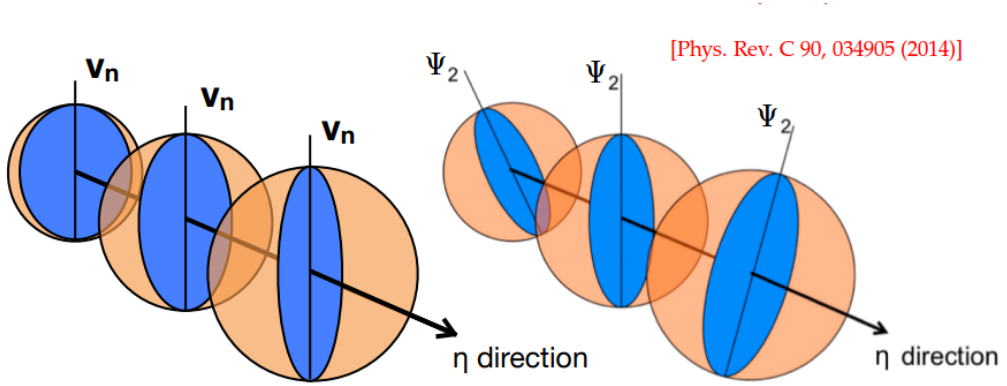


- UrQMD IS results in significantly stronger decorrelation



Angle and Magnitude Decorrelation





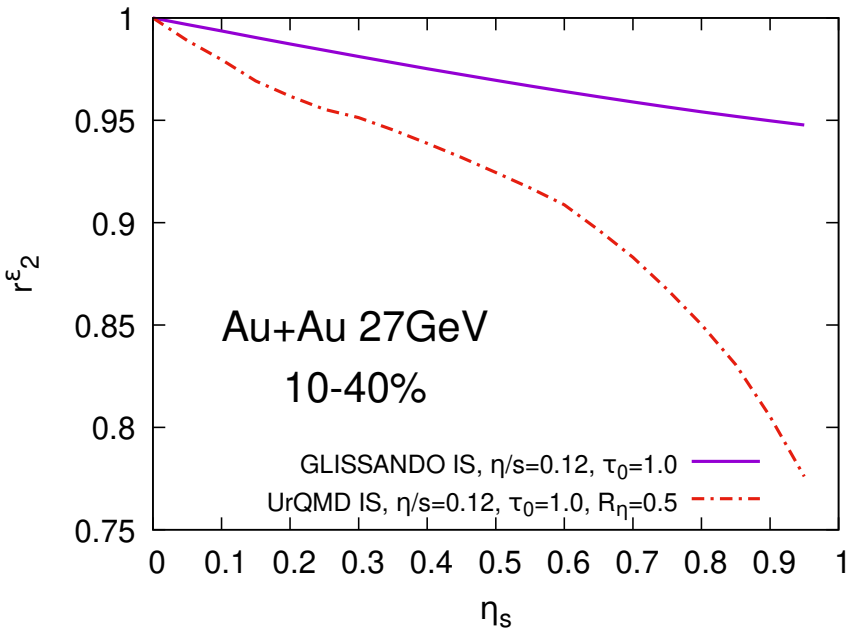
- The flow decorrelation is mainly caused by flow angle decorrelation

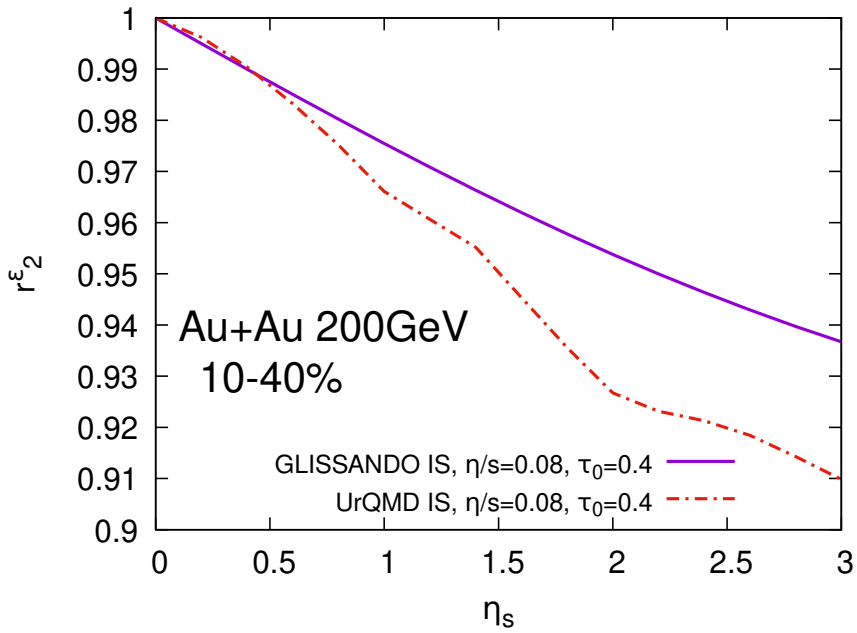
Initial State Eccentricity Decorrelation

- Analogously, we can define decorrelation of initial state spatial eccentricity

$$r_n^{\epsilon}(\eta_s) = \frac{\langle \epsilon_n(-\eta_s)\epsilon_n(\eta_{s,\mathrm{ref}}) \cos[n\,(\Psi_n(-\eta_s) - \Psi_n(\eta_{s,\mathrm{ref}}))]\rangle}{\langle \epsilon_n(\eta_s)\epsilon_n(\eta_{s,\mathrm{ref}}) \cos[n\,(\Psi_n(\eta_s) - \Psi_n(\eta_{s,\mathrm{ref}}))]\rangle}$$

  - where $\epsilon_n e^{in\Psi_n} = \frac{\int e^{in\phi} r^n \rho(\vec{r}) d\phi\, r\, dr}{\int r^n \rho(\vec{r}) d\phi\, r\, dr}$





Summary

- We presented the flow decorrelation in Au-Au collisions at $\sqrt{s_{\mathrm{NN}}} =$ 27 and 200 GeV in 3-dimensional viscous hydrodynamic model with UrQMD and 3D GLISSANDO initial states
- Flow decorrelation at $\sqrt{s_{\mathrm{NN}}} = 27$ GeV is a first calculation of a kind in a hydrodynamic model
- We observe that the flow decorrelation is mainly caused by flow angle decorrelation, which is in agreement with other studies [Phys. Rev. C 98, 024913 (2018), Phys. Rev. C 97, 034913 (2018)]
- The model with UrQMD IS overestimates the decorrelation, which is rooted in much stronger decorrelation of initial state eccentricity
- References: Phys. Rev. C 103, 034902 (2021) and arXiv:2104.08022 (to appear in PRC)

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