

Intersection of nuclear structure and high-energy nuclear collisions 2027

post-QM2027 satellite meeting, Mar 29 - April 1, 2027, Daejeon, Korea

Organizing Committee

<https://indico.cern.ch/event/1686349/>

5th edition

2023(Seattle,INT)

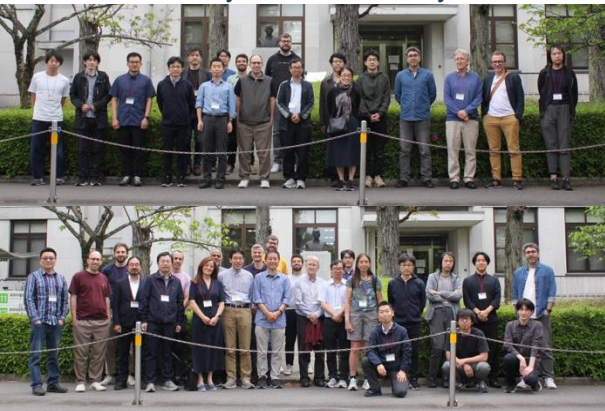
2024(Beijing)

2025(Shanghai)

2026(Kyoto)

2027(Daejeon)

Picture from Kyoto edition this year



Yongsun Kim (Co-Chair, Sejong, Korea)

Sunghoon (Tony) Ahn (CENS/IBS, Korea)

Taeksu Shin (IRIS/IBS, Korea)

Masakiyo Kitzawa (Kyoto, Japan)

Takayuki Miyagi (Tsukuba, Japan)

Chunjian Zhang (Fudan, China)

Jiangyong Jia (Co-Chair, StonyBrook, US)

Dean Lee (FRIB, US)

Giuliano Giacalone (CERN, Switzerland)

Dongjo Kim (University of Jyväskylä, Finland)

You Zhou (Aarhus, Denmark)



We already have 24 confirmed + 12 potential speakers

Confirmed Speakers

Name	Institute	Country	Expertise
Thomas Duguet	CEA Paris-Saclay, IRFU/DPhN	France	Low-energy
Benjamin Bally	Technische Universität Darmstadt, Institut für Kernphysik	Germany	Low-energy
Ulf-G. Meißner	University of Bonn / Forschungszentrum Jülich	Germany	Low-energy
Gaute Hagen	Oak Ridge National Laboratory	USA	Low-energy
Jiangming Yao	Sun Yat-sen University	China	Low-energy
Pengwei Zhao	Peking University	China	Low-energy
Takaharu Otsuka	The University of Tokyo	Japan	Low-energy
Jason D. Holt	TRIUMF	Canada	Low-energy
Bo Zhou	Fudan University	China	Low-energy
Shinsuke Ota	The University of Osaka, RCNP	Japan	Low-energy
Tadaaki Isobe	RIKEN Nishina Center	Japan	Low-energy
Paul Garrett	University of Guelph	Canada	Low-energy
Jung Keun Ahn	Korea University	Republic of Korea	Low-energy
Hao-Jie Xu	Huzhou University	China	High-energy
Huichao Song	Peking University	China	High-energy
Longgang Pang	Central China Normal University	China	High-energy
Weiyao Ke	Central China Normal University	China	High-energy
João Barata	CERN	Switzerland	High-energy
Matthew Luzum	University of São Paulo	Brazil	High-energy
Yugang Ma	East China Normal University / Fudan University	China	High-energy
Yen-Jie Lee	Massachusetts Institute of Technology	USA	High-energy
Zaining Wang	Fudan University / Stony Brook University	China	High-energy
Reyes Alemany Fernández	CERN	Switzerland	High-energy



Contact one of us if you are interested



EMMI Workshop: Light-ion collisions 2026

Heidelberg September 21-25 2026

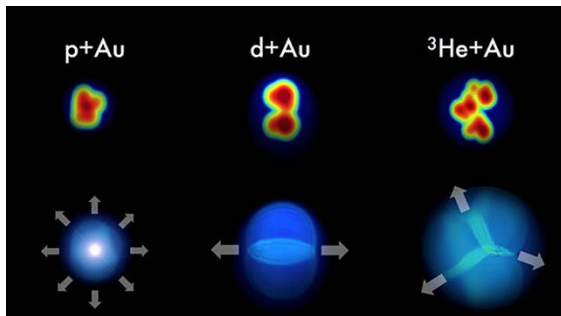
Engineering QGP droplets with STAR light-ion collisions

Jiangyong Jia

Chunjian Zhang can't come due to visa-related cancellation

Based on STAR paper arXiv: 2510.19645

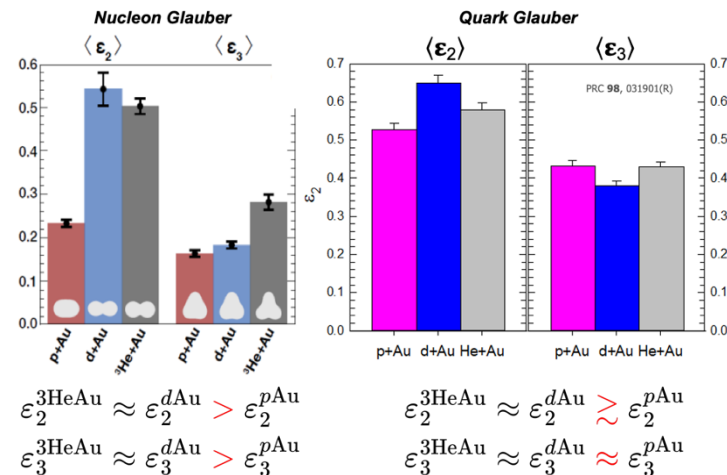
The challenge: connect nuclear geometry to flow



Geometry scan via asymmetric systems

p+Au, d+Au, ^3He +Au

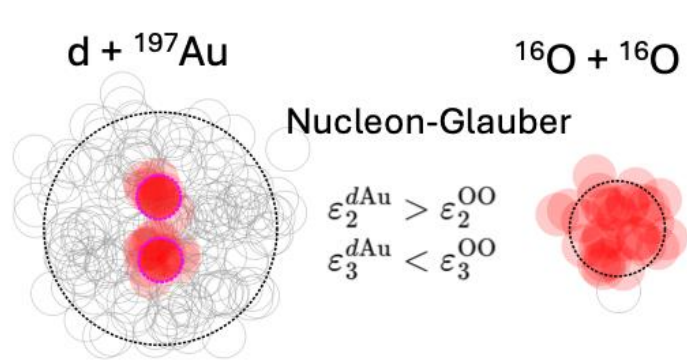
1805.02973, 2210.11352, 2312.07464



- Substructure influences ϵ_n .
- Acceptance-dependent longitudinal decorrelations

O+O provides a symmetric reference with a large geometry contrast to asymmetric d+Au, and connects RHIC with the LHC
 → A stronger test of geometry-driven response.

A large geometry contrast: central d+Au and O+O

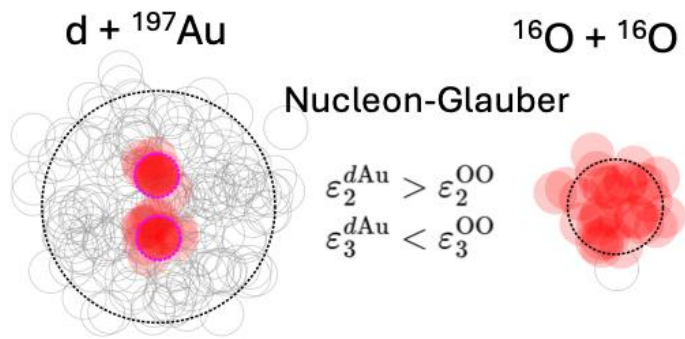


ϵ_2 in dAu: large ellipticity with smaller relative fluctuations
narrow $p(\epsilon_2) \rightarrow \epsilon_2\{4\} \approx \epsilon_2\{2\}$

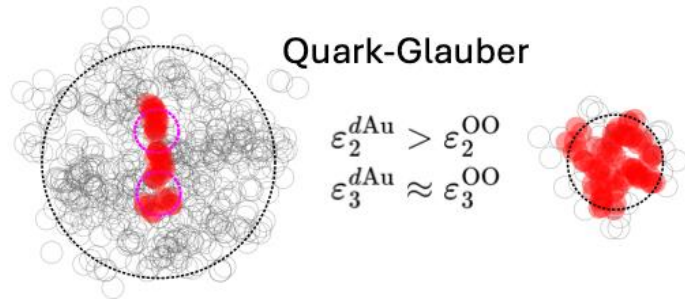
ϵ_2 in OO: fluctuation-driven

ϵ_3 in both: fluctuation-driven
 $\rightarrow$ sensitive to structure inside nucleons.

A large geometry contrast: central d+Au and O+O



S. Huang, C. Zhang, J. Jia 2507.16162



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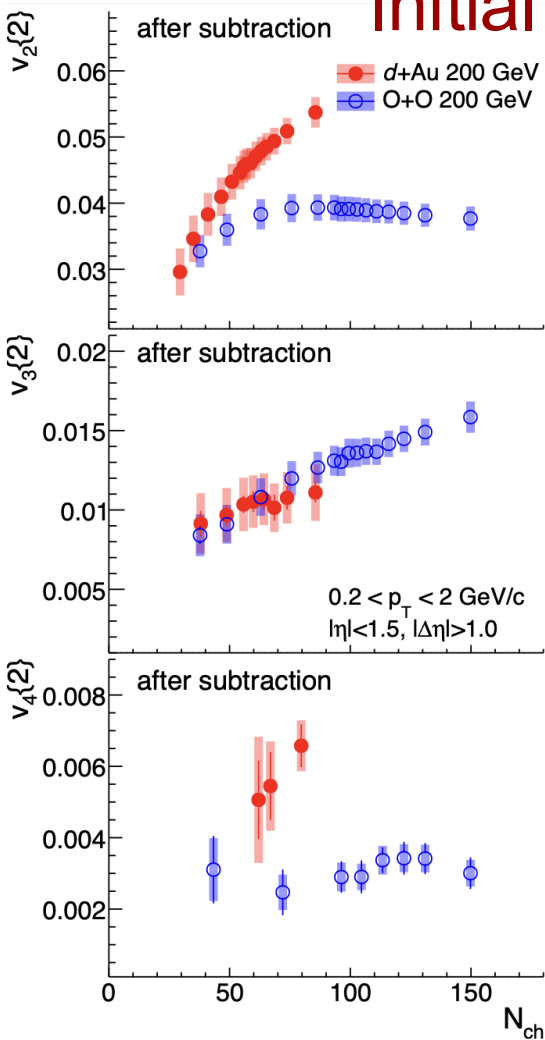
$v_4 \propto \epsilon_2^2 \propto v_2^2$: dominated by nonlinear response
 $\rightarrow$ enhanced in d+Au due to its larger v_2

At matched multiplicity, d+Au is more compact
 $\rightarrow$ more **radial flow**, influence v_n - p_T correlation

A wide range of tests for collectivity:

Flow is geometry-driven $\rightarrow$ substructure is important $\rightarrow \sqrt{s}$ -indep. of initial geometry

Initial geometry survives in final-state flow



$v_2^{dAu} \simeq 1.4 v_2^{OO}$ in the high-multiplicity N_{ch} region.

v_2 follows the robust ordering of ε_2 , independent of details of **experimental analysis** and **initial geometry**.

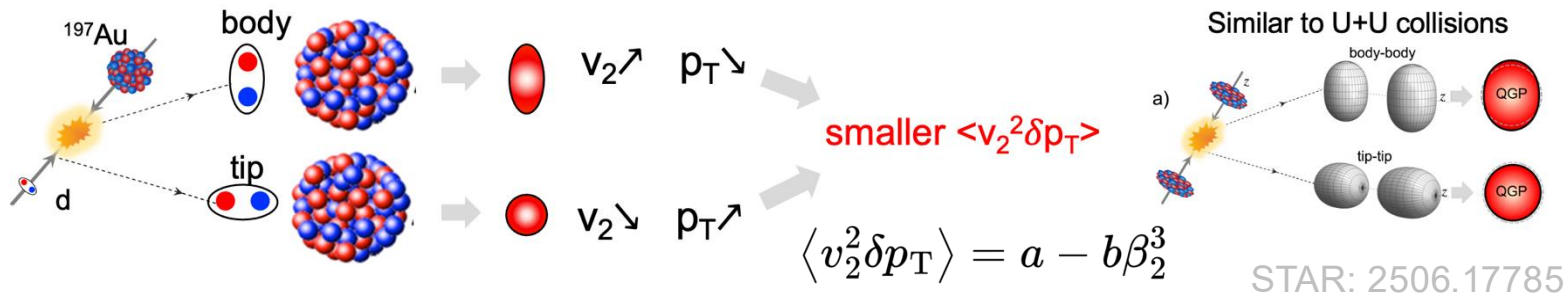
v_3 is nearly equal between dAu and OO

v_4 is also larger in dAu consistent with nonlinear coupling to its larger v_2 : $v_4 \propto v_2^2$

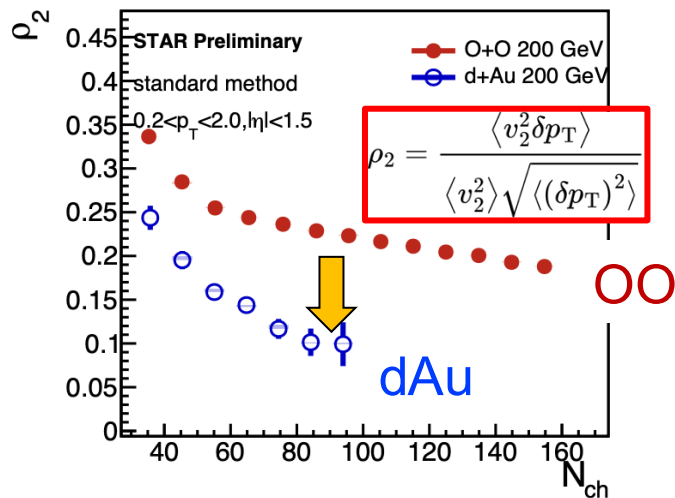
Together, these results provide a distinctive and robust imprint of the initial geometry

Flow is final-state response to initial geometry

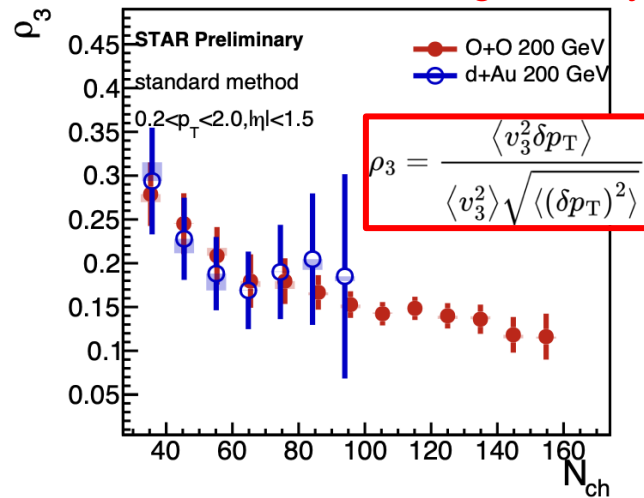
Initial geometry impacts v_n^2 - p_T correlations



Behavior of $\langle v_2^2 \delta p_T \rangle$ consistent with QGP response to the prolate shape of deuteron



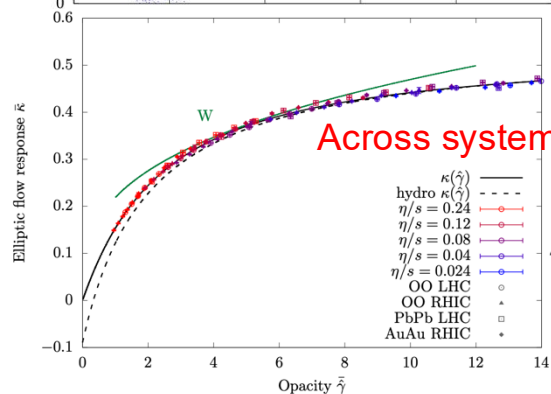
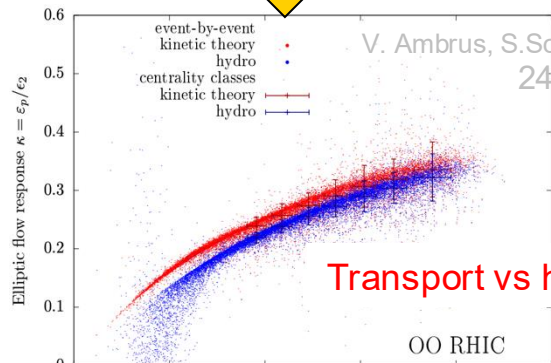
Behavior of $\langle v_3^2 \delta p_T \rangle$ consistent with fluctuation-driven geometry



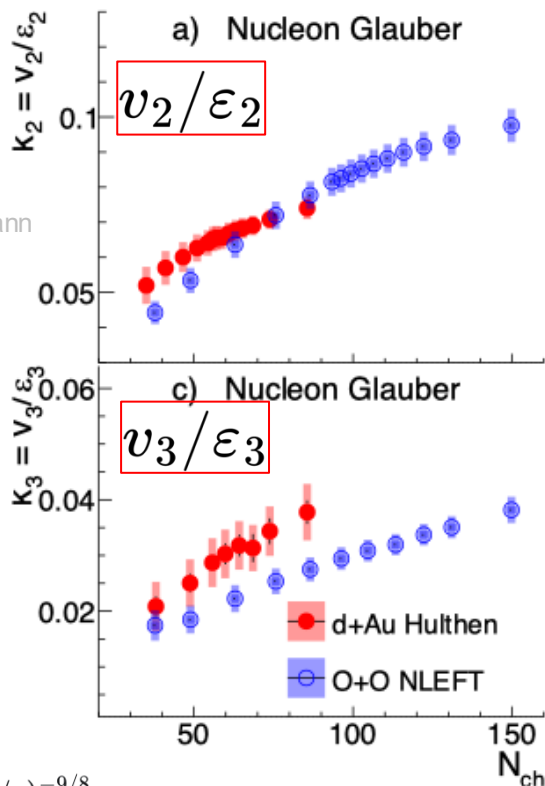
Flow is final-state response to initial geometry

Testing a common final-state response: $\kappa_n = v_n\{2\}/\varepsilon_n\{2\}$

Theory: approximate response scaling at matched multiplicity

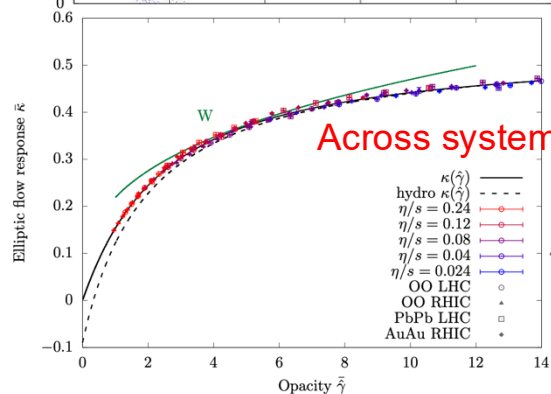
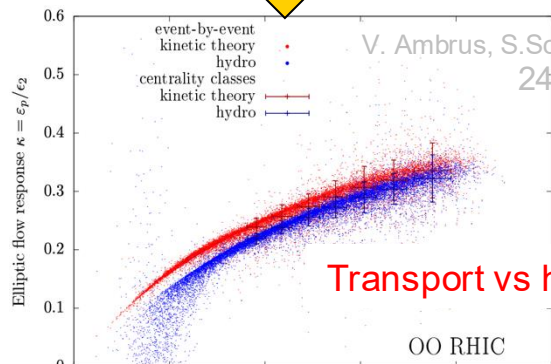


$$\hat{\gamma} \propto \left(\frac{dN_{ch}}{d\eta} \right)^{3/8} (\eta/s)^{-9/8}$$

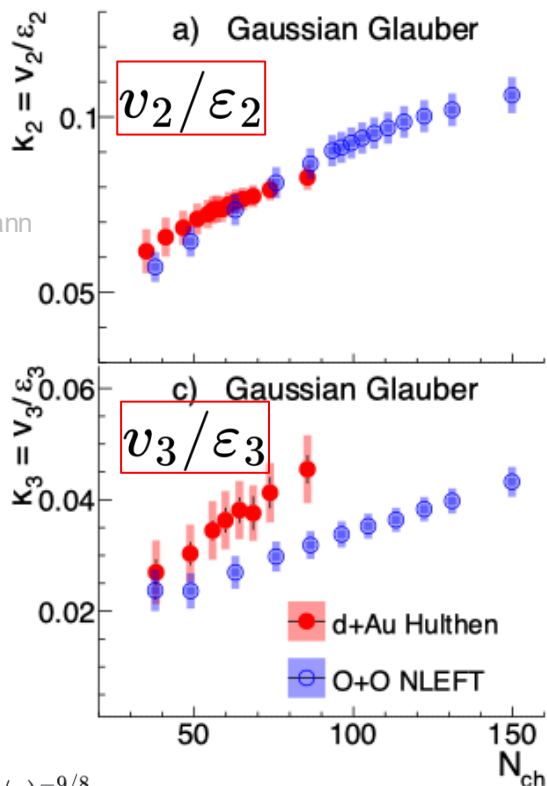


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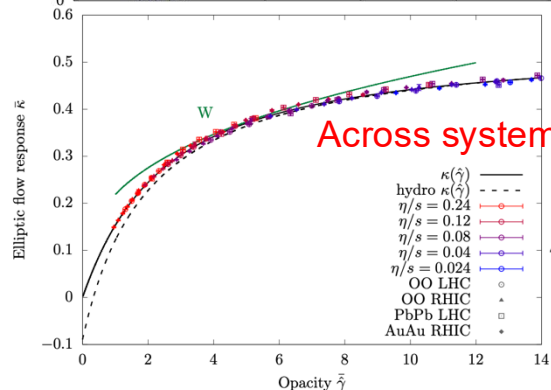
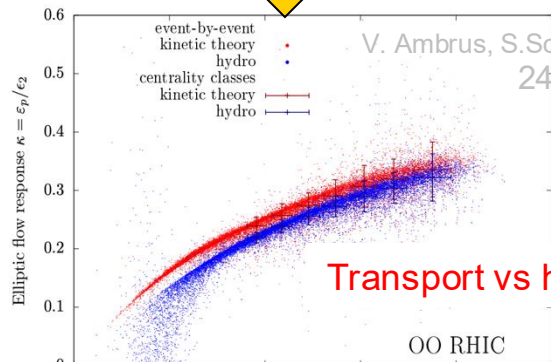


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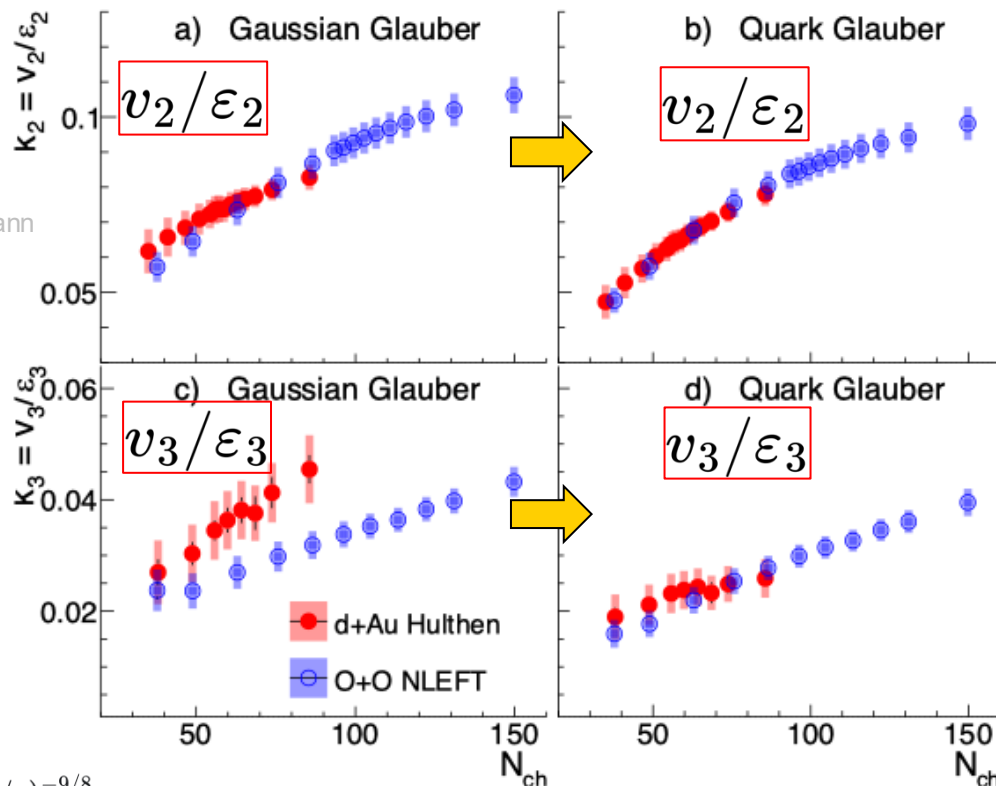
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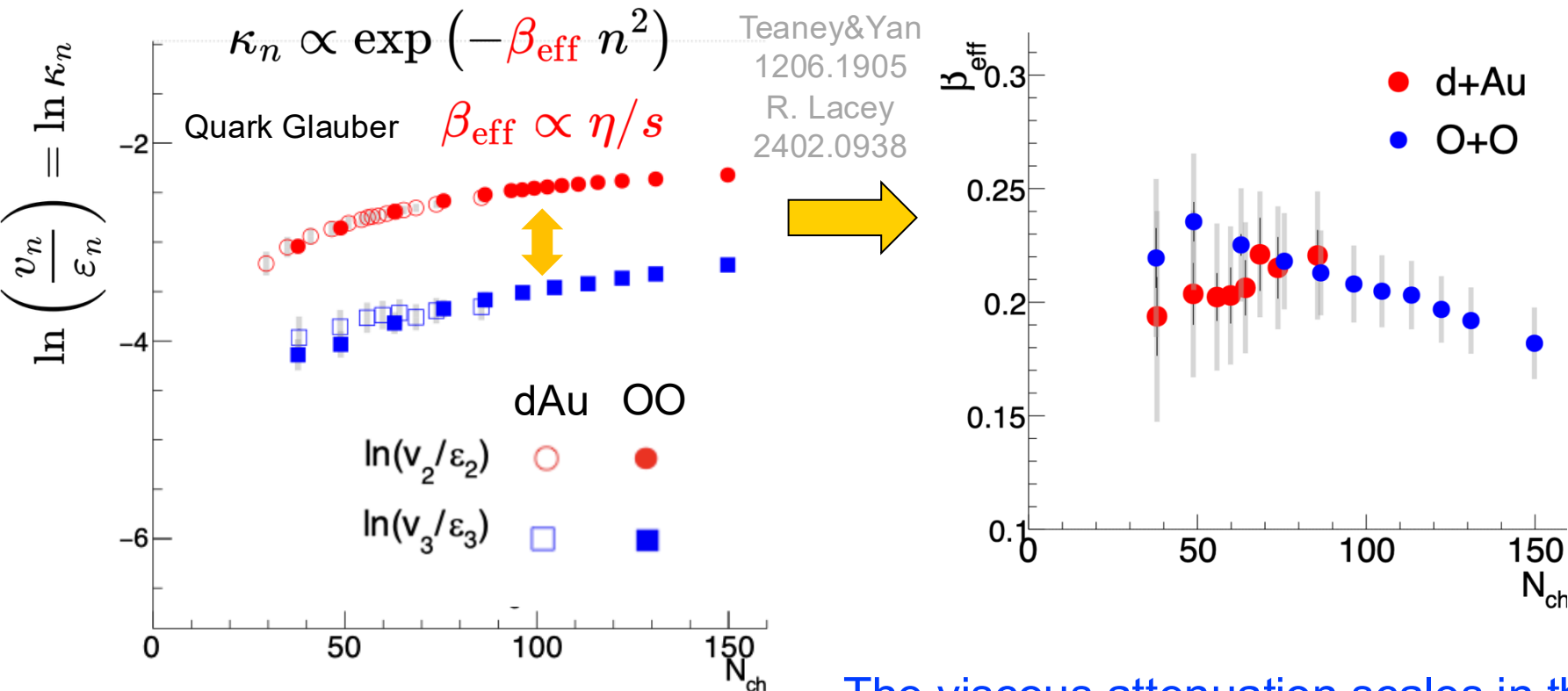
$$\hat{\gamma} \propto \left(\frac{dN_{ch}}{d\eta} \right)^{3/8} (\eta/s)^{-9/8}$$

1908.02866



universality restored only by including nucleon substructures

Constraining the final-state response



β_{eff} : slope of $-\ln(v_n/\epsilon_n)$ vs. n^2

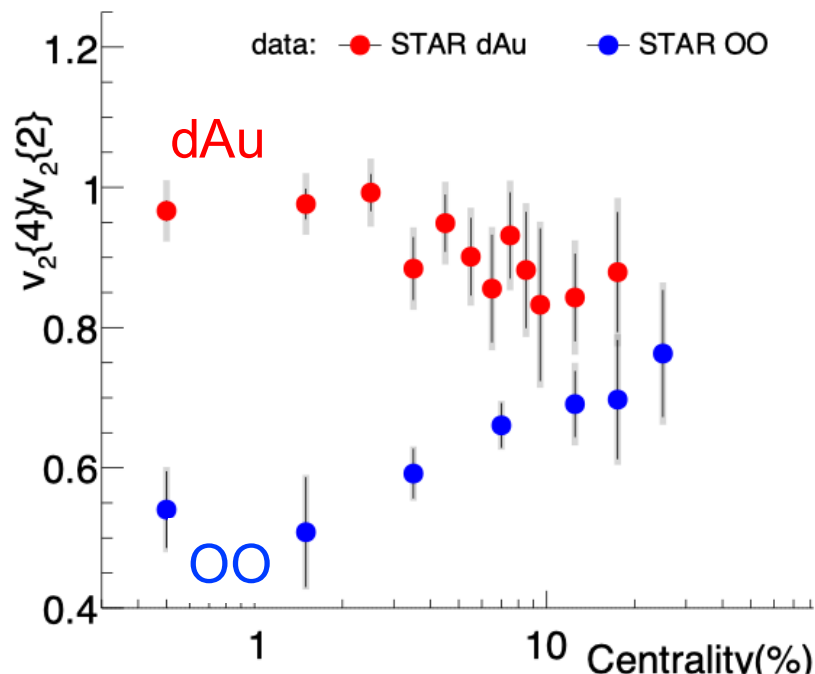
$$\beta_{eff} = -d \ln k_n / d(n^2) = \frac{\ln \kappa_2 - \ln \kappa_3}{5}$$

The viscous attenuation scales in the two systems and decreases with N_{ch}
 → weaker damping at higher N_{ch}

Elliptic-flow fluctuations

$$\left[\frac{v_2\{4\}}{v_2\{2\}} \right]^4 = 1 - \frac{\text{Var}(v_2^2)}{\langle v_2^2 \rangle^2}$$

closer to unity $\rightarrow$ smaller relative fluctuations



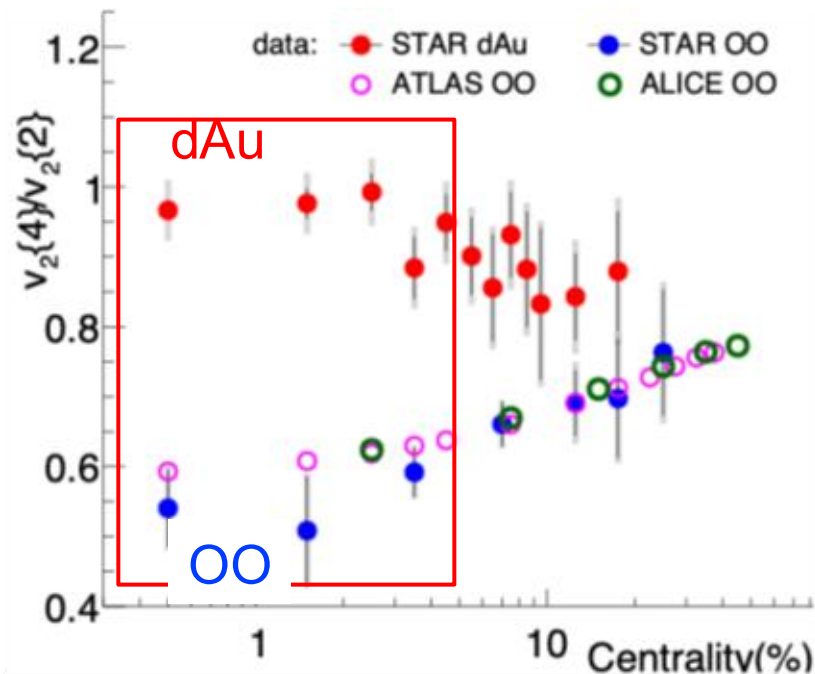
d+Au: ratio ~ 0.9 , small fluctuations

O+O: ratio 0.5-0.8, large fluctuations

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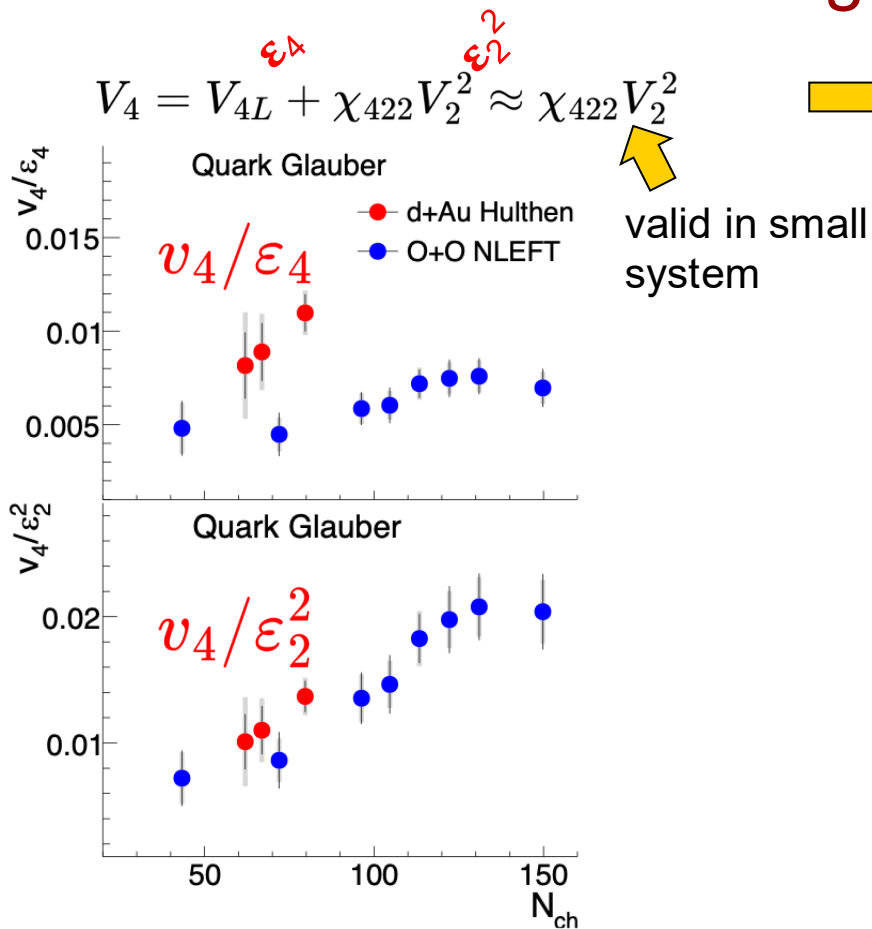
O+O: ratio 0.5-0.8, large fluctuations

$$\frac{v_2\{4\}}{v_2\{2\}} = \frac{\varepsilon_2\{4\}}{\varepsilon_2\{2\}} \rightarrow \text{The overall response cancels separately at each energy}$$

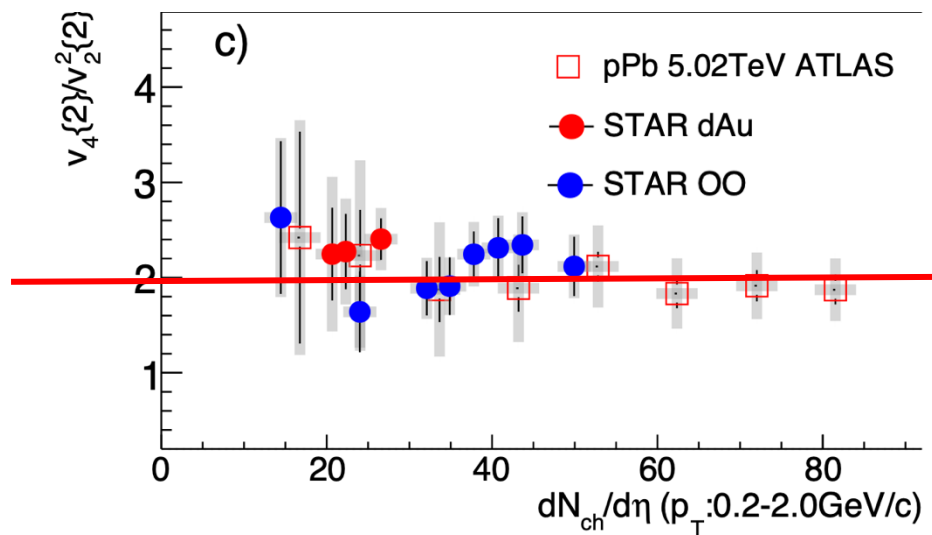
200 GeV $\rightarrow$ 5.36 TeV, x 27

Relative v_2 fluctuations support that the initial geometry is approximately $\sqrt{s}$ -independent.

Nonlinear flow: connecting v_4 to v_2



$$\frac{v_4\{2\}}{v_2\{2\}^2} \approx \chi_{422} \frac{\sqrt{\langle v_4^2 \rangle}}{\langle v_2^2 \rangle} \approx \chi_{422} \frac{\sqrt{\langle \varepsilon_4^2 \rangle}}{\langle \varepsilon_2^2 \rangle}$$



Similar nonlinear-flow ratios across systems and $\sqrt{s} \rightarrow$ consistent with geometry-driven interpretation

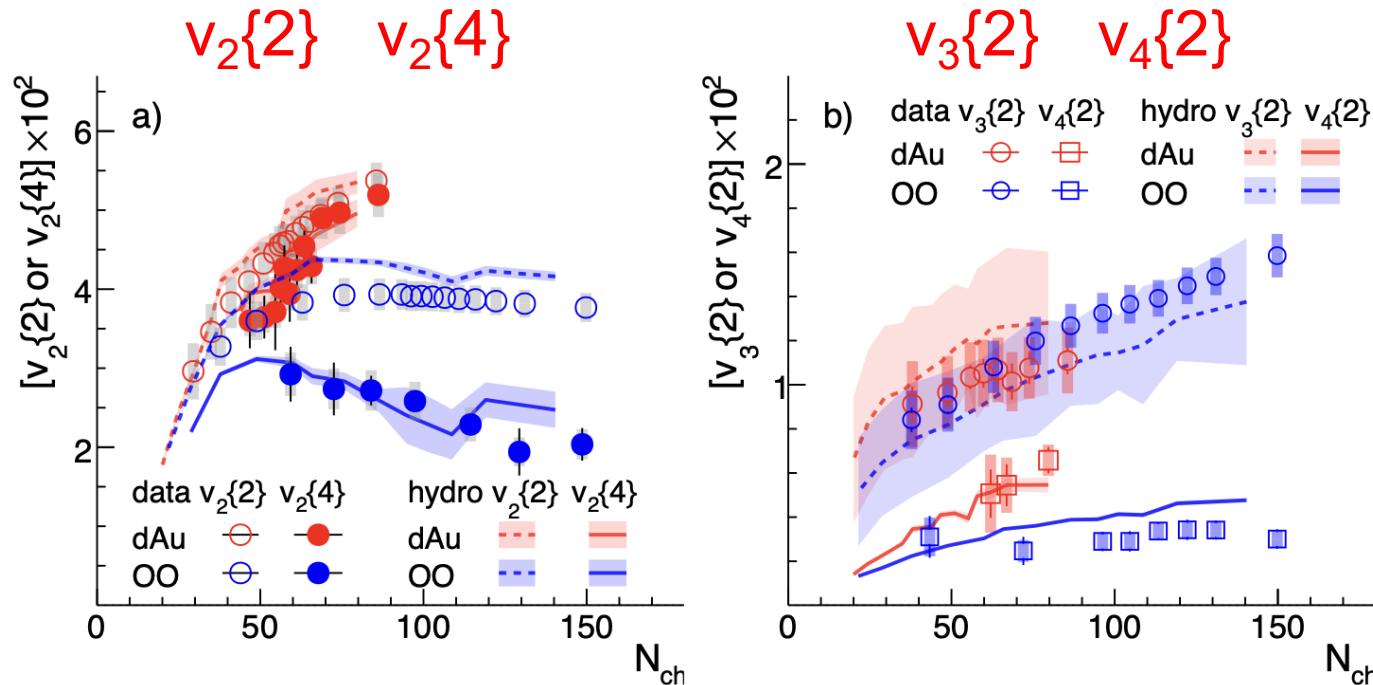
Viscous hydrodynamics describes the pattern

Medium parameters constrained by Au+Au data

3D-Glauber+MUSIC+UrQMD

S. Jahan,
H. Roch,
C. Shen

2507.11394



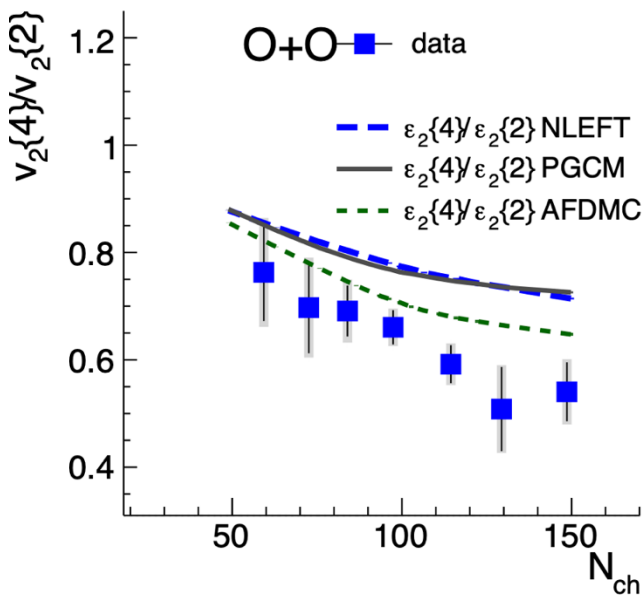
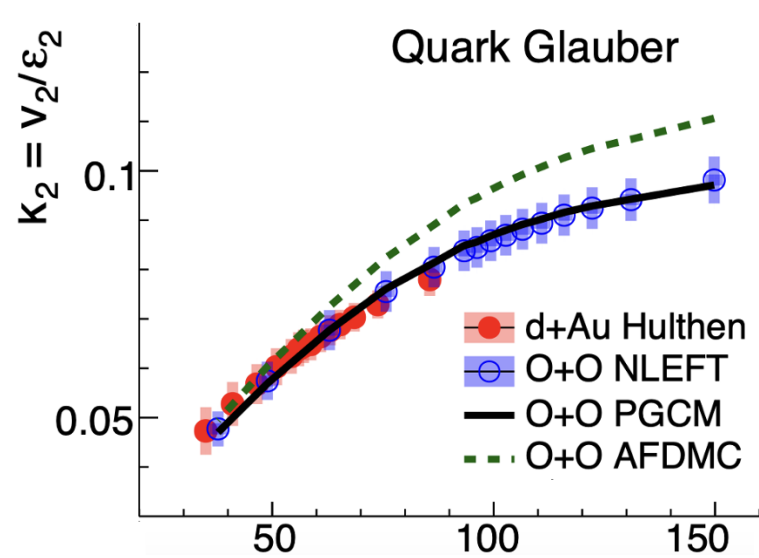
Four observables in two systems are jointly described,
consistent with QGP formation

From collective flow to oxygen structure

The data show sensitivity to oxygen structure

AFDMC: poorer inter-system k_2 agreement

But eccentricity ratio closer to flow ratio



$V_n = \kappa_n \mathcal{E}_n + \xi_n$ beyond leading ϵ_n : radial modes, nonlinear terms, momentum/stress

Including these modes can improve estimator & geometry-to-flow mapping.

J. Sousa, J. Noronha, M. Luzum 2405.13600

Better geometry estimators needed to probe subtle structural details, such as alpha clustering

Summary: four tests of geometry-driven collectivity

O+O adds a large geometry contrast to the asymmetric scans, e.g. d+Au

1. **Nuclear geometry:** dAu larger v_2 with smaller fluctuations, suppressed v_2 - p_T ; similar v_3 and v_3 - p_T between the two systems.
2. **Nucleon substructure:** improved v_2/ϵ_2 , v_3/ϵ_3 scaling within tested models.
3. **Nonlinearity in v_4 :** large v_2 in dAu also enhances its v_4 compared to OO
4. **$\sqrt{s}$ -dep. RHIC vs LHC:** similar v_2 fluctuations & nonlinear contribution to v_4 , support an $\sim \sqrt{s}$ -independent initial geometry.

A broad, coherent body of evidence for geometry-driven collective flow in small systems.