

Gluonic structure of nucleon and nuclei at RHIC and its implication at the EIC

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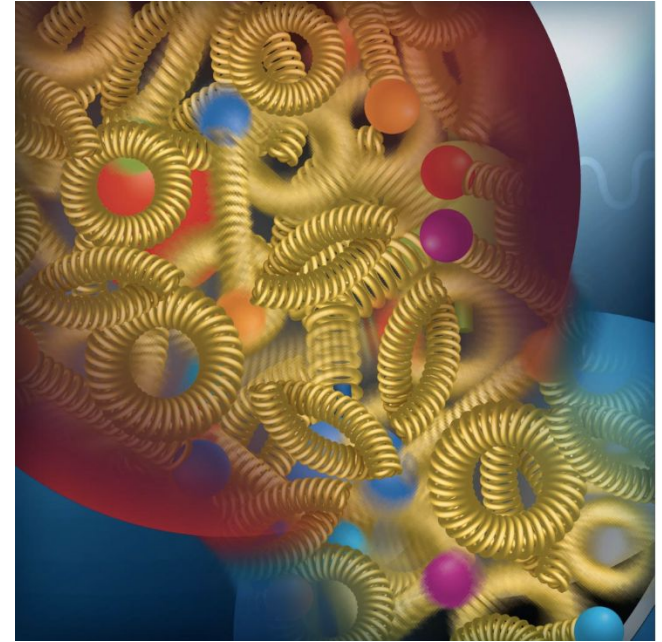
Gluons in nucleon/nuclei at high energy

The big questions:

- What role does gluon play in nuclear structure at high energy?
- What can gluonic structure of nucleon/nuclei tell us about *confinement*?

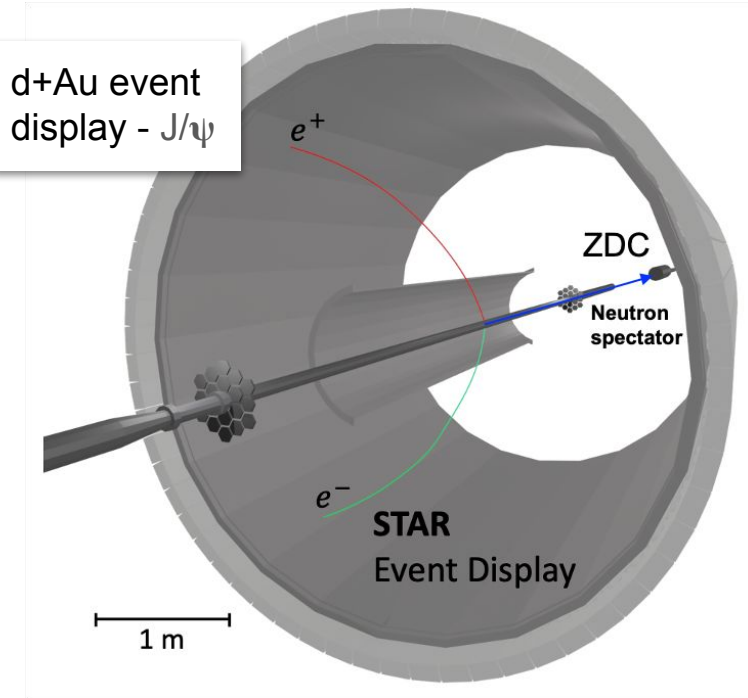
Specific questions and directions:

- What is the gluon spatial distribution in nuclei?
- What is the correct or most relevant paradigm in describing the gluon density from low to high energy? Saturation or shadowing?
- Origin of mass?



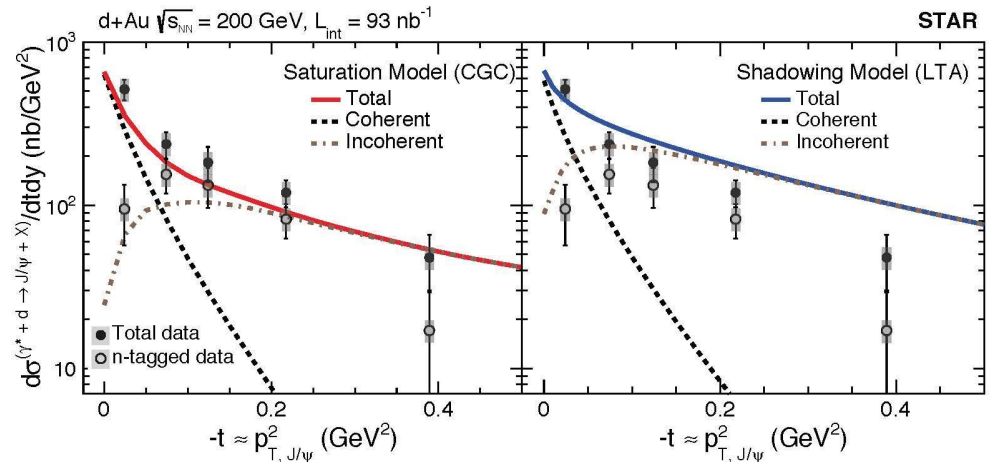
The glue that binds us all

Unique capability of ultra-peripheral collisions at RHIC



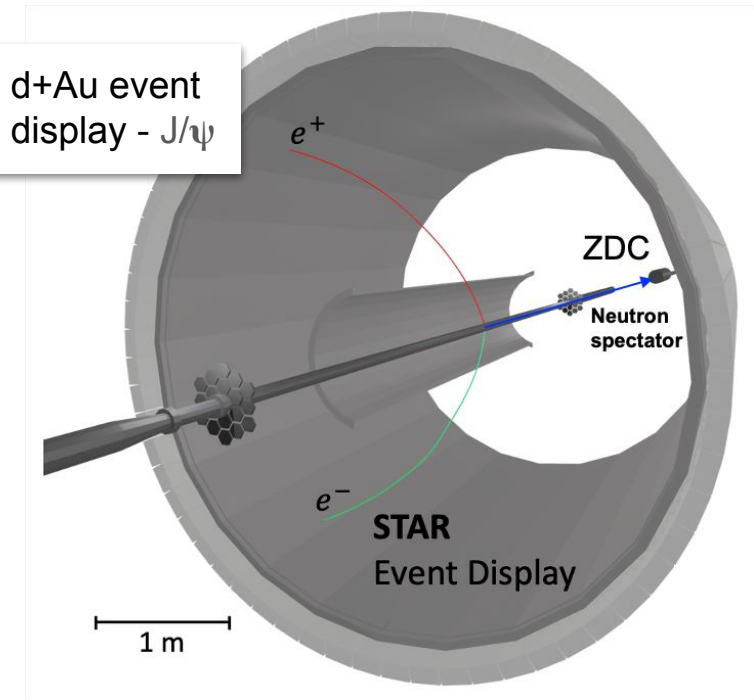
- **Systems:** pp, pAu, dAu, RuRu, ZrZr, AuAu collisions at their top RHIC energies.
- **Vector-Meson:** ρ , J/ψ , and possibly ϕ .
- **Polarizations:** proton beam.
- **Forward detectors:** ZDC, RPs(?) for pAu pp runs.

$$\gamma + p/A \rightarrow VM + p/A/X$$

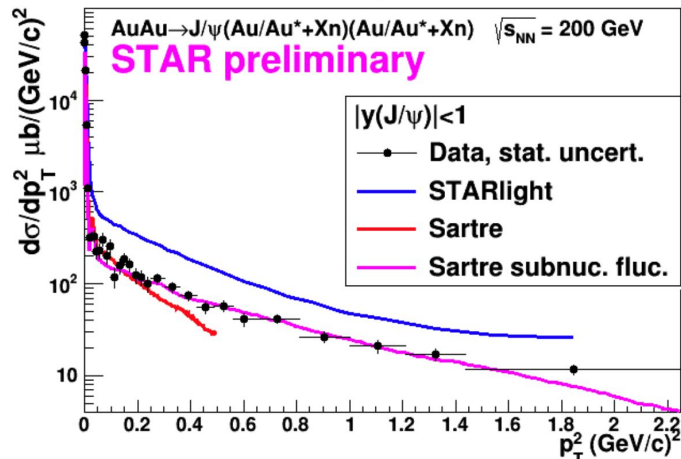


Gluon distributions measured in deuteron
 [Phys.Rev.Lett. 128 (2022) 12, 122303]

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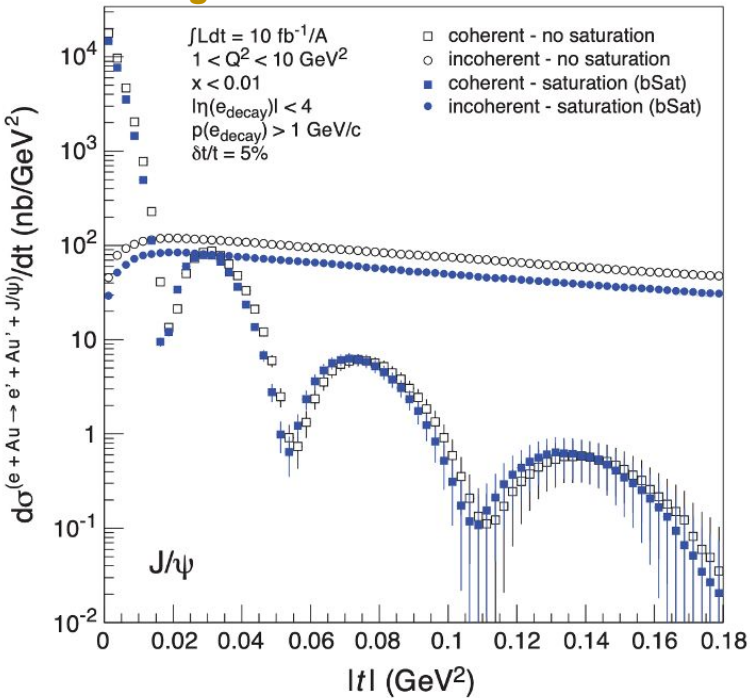
Au nucleus:
first-time
measurement from
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Coherent & incoherent production \rightarrow gluon spatial distributions and nucleon fluctuations

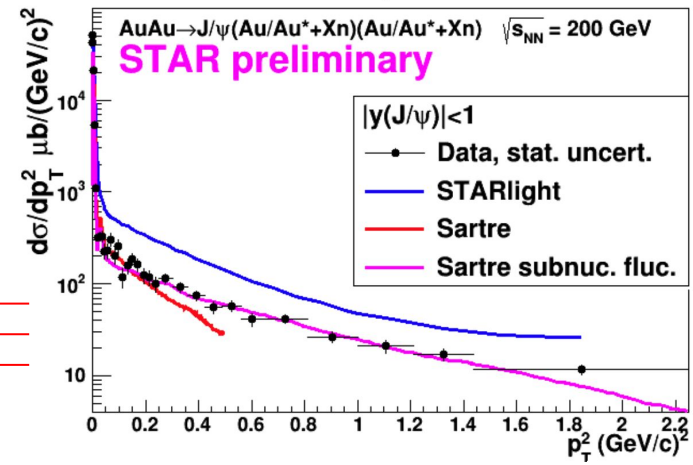
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EIC golden measurement



Understand RHIC data is the key!

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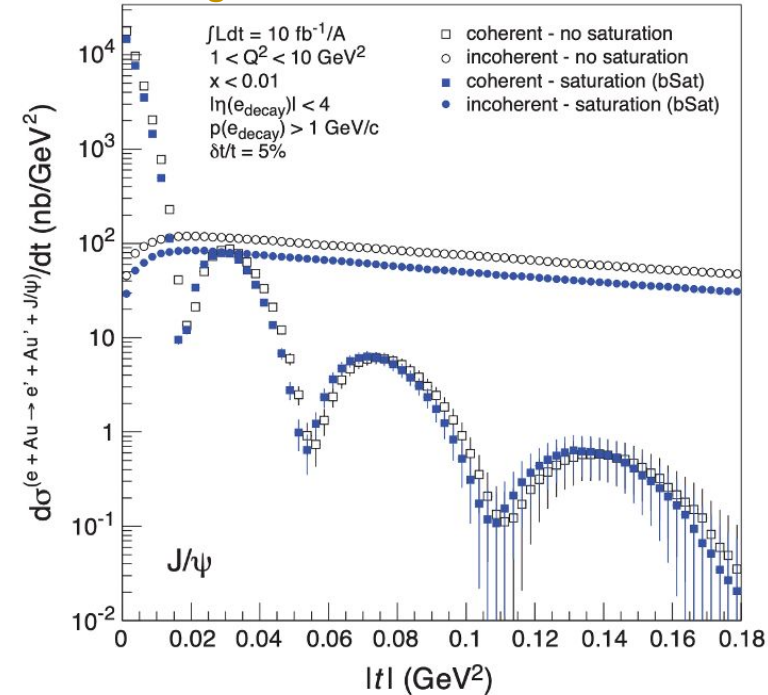


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Tools:

- System/target dependence, VM species dependence, polarization dependence, separation of coh/incoh., etc.

Goal:

- An **unified picture** of the gluonic structure from nucleon to heavy nuclei at RHIC energies, **refined models** to projections at the EIC based on RHIC data, and (clearly identify) **challenges/opportunities** for the EIC

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Plans

Must-haves:

- High-luminosity AuAu, pAu, and pp runs for Run 23-25 - as scheduled.
- Forward capabilities of STAR, dedicated triggers, etc.
- People-power, software support, etc for analyzing the data.
- **Training next-generation scientists for the EIC physics based on RHIC data.**

Directions:

1. J/ψ photoproduction in Au and proton, compared with inclusive jet photoproduction in Au and p;
2. J/ψ near-threshold and/or sub-threshold production in p and Au;
3. J/ψ photoproduction in polarized proton;
4. **Exploratory study, photoproduction of ϕ , which is difficult at the EIC;**
5. ...

EIC will extend in detector coverages, kinematic phase spaces, precisions, etc.
Both RHIC & EIC are necessary to understand the big questions.