Basic physics in heavy ion collision

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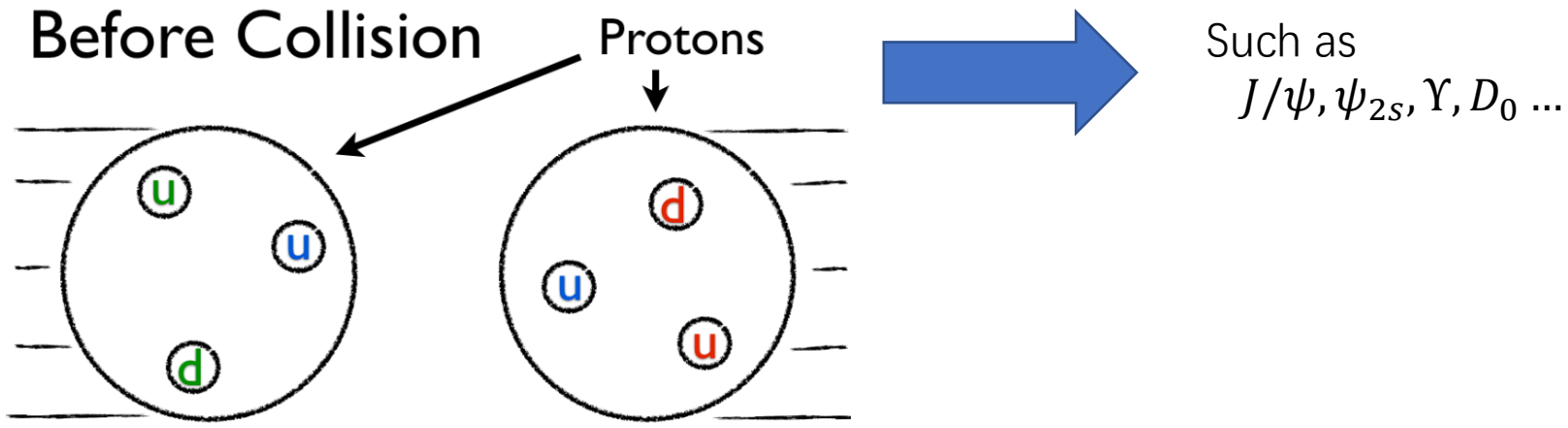
weekly meeting

Heavy flavour and quarkonium production in pp collisions

- Heavy flavour
- quarkonium



Such as
$J/\psi, \psi_{2s}, \Upsilon, D_0$ ...

Heavy flavour and quarkonium production in p-A collisions

$$R_{\mathrm{pA}}^{C} = \frac{N_{\mathrm{pA}}^{C}}{\langle T_{\mathrm{pA}} \rangle_{C}\, \sigma_{\mathrm{pp}}}.$$

Glauber model

In same center energy

Without a selection on centrality

$$R_{\mathrm{pA}} = \frac{\sigma_{\mathrm{pA}}}{A\, \sigma_{\mathrm{pp}}}.$$

Expect to be 1

In fact, is not!!

why ?

Differences in p-A vs pp:

- Depend on difference in A and p
  - Parton's distribution
  - Parton's dynamics
  - Nuclear matter effect

Cold nuclear matter effects

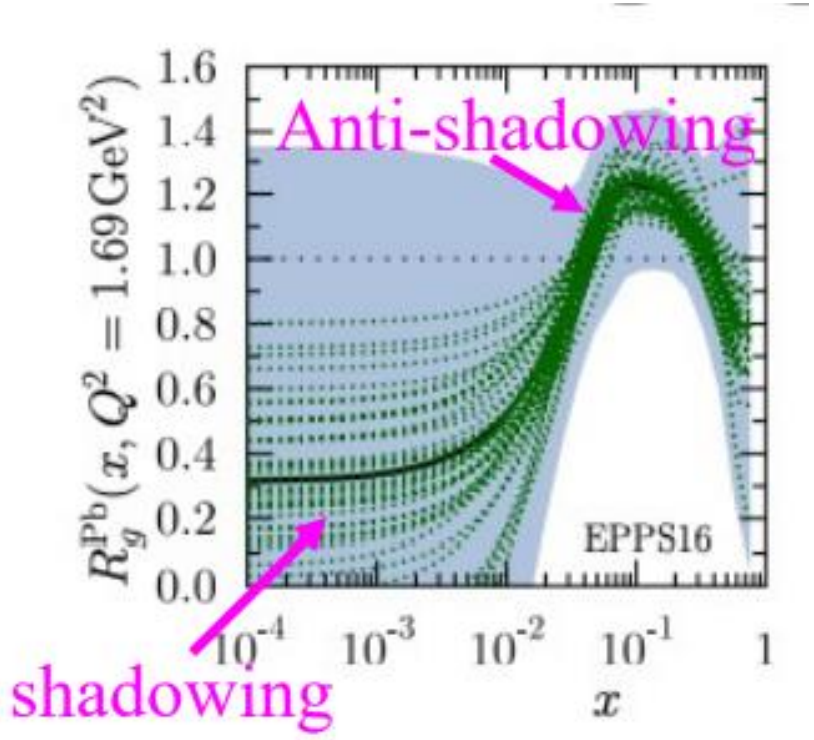
- nPDF
- Multiple scattering and energy loss
- Nuclear absorption
- Co-movers

nPDF

Nuclear PDF is different with proton

Cause suppression of production

What cause the nuclear PDF?



Multiple scattering and energy loss

Multiple scattering of partons

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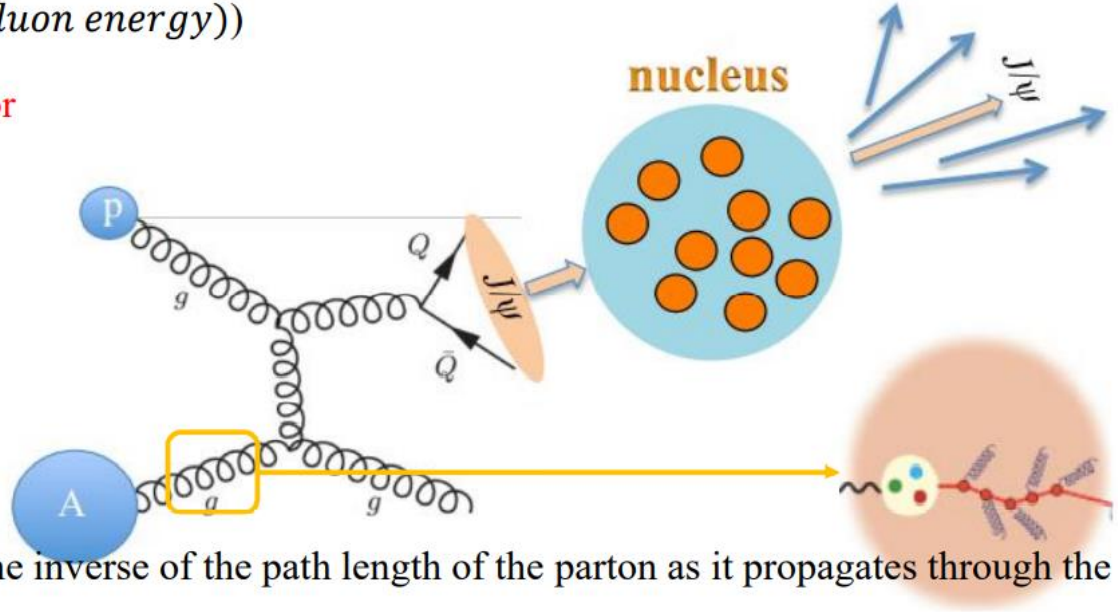
parton multiple scattering

- $Q\bar{Q}$ propagation in nuclei (LHC, the coherent time $\tau_c \gg R_A$), impact parameter dependence
- initial-and final-state energy loss (the transport properties of large nuclei for quarks and gluons, scattering or multiple scattering)
- coherent energy loss (medium-induced radiative, high-energy gluon cross a nuclear medium and being scattered to small angle, $\Delta E \propto E(gluon\ energy)$)

parton scattering from the medium

- coherent: lead to attenuation or shadowing
- incoherent: transverse momentum broadening, Cronin-like enhancement of the cross sections at intermediate pT ~ few GeV/c



longitudinal momentum transfer is small compared to the inverse of the path length of the parton as it propagates through the nucleus, the scattering becomes coherent

By Dr.Kaifeng

Nuclear absorption

The quarkonium nuclear absorption is characterized by an "effective" cross section $\sigma_{\rm abs}$.

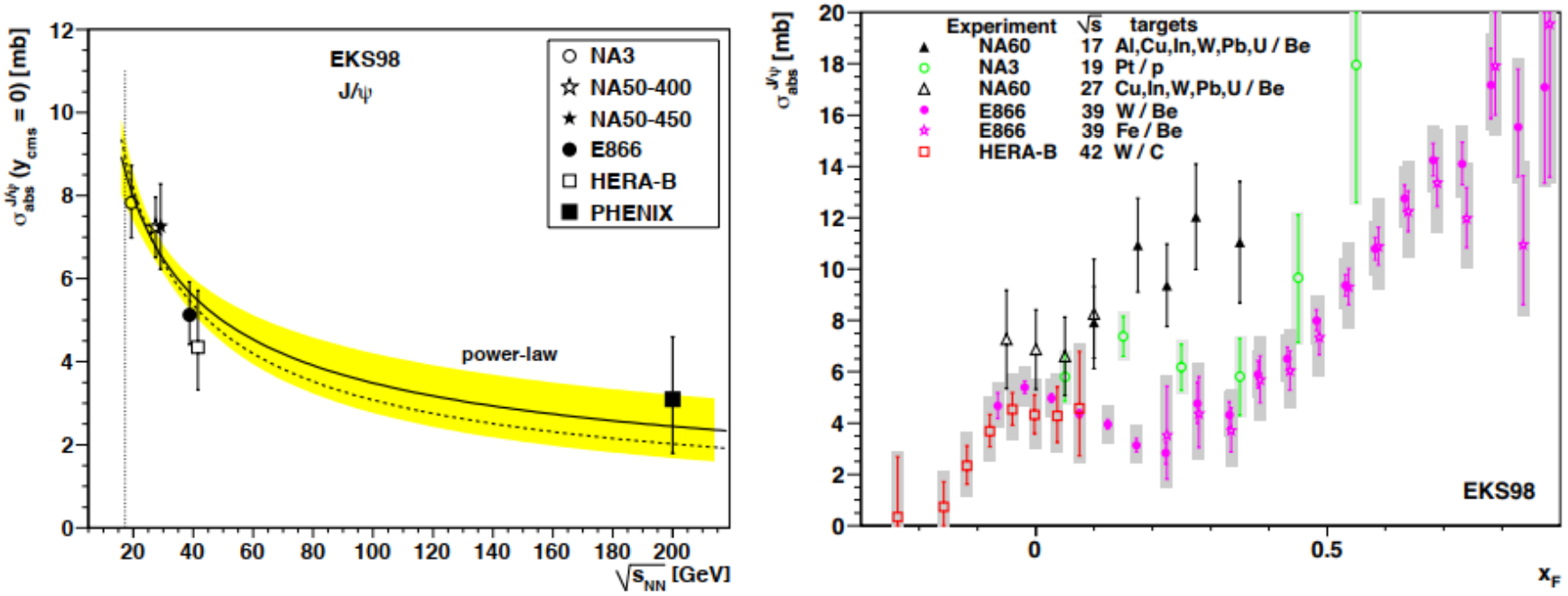
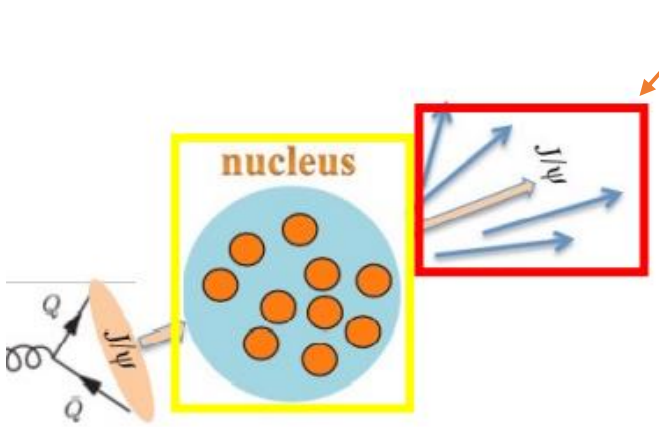


Figure 32: Left: Energy dependence of $\sigma_{\rm abs}^{J/\psi}$ at mid-rapidity [399] using the EKS98-CTEQ61L nPDFs [400–403]. Right: The $x_{\rm F}$ dependence of $\sigma_{\rm abs}^{J/\psi}$, determined [399] from fixed-target measurements and using the EKS98 nPDFs [400, 401].

Co-movers

Heavy quarkonium can be dissociated by co-movers (the partons or hadrons produced in the collision in the vicinity of the heavy-quarkonium state)



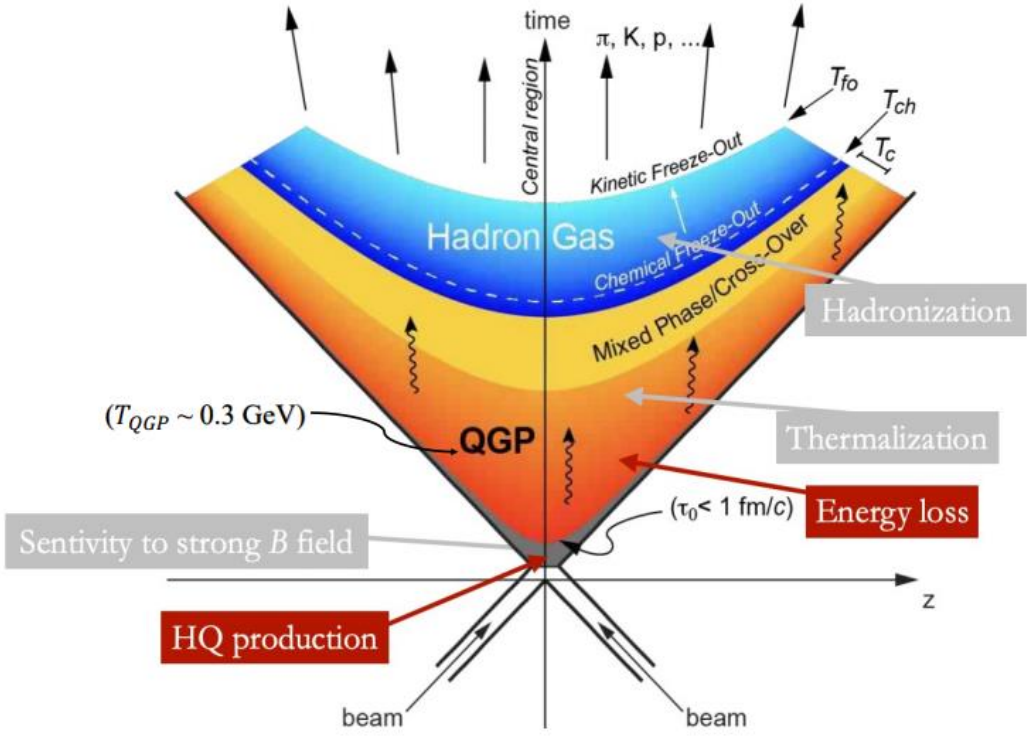
Cause the suppression of production

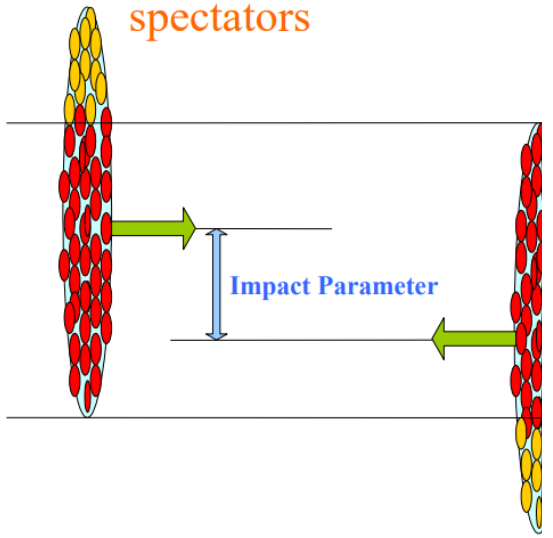
Creation of QGP in A-A collisions

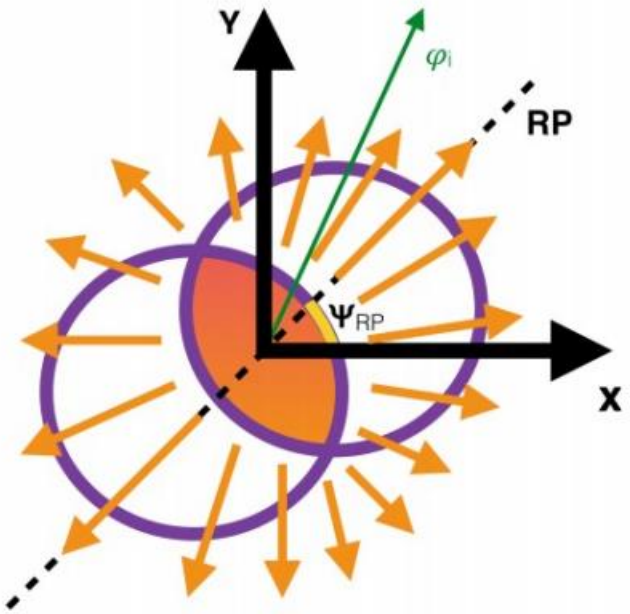
QGP's creation after primary hard QCD scattering

$T_{QGP} \approx 0.3GeV$

So heavy flavour hardon is a effective probe of QGP







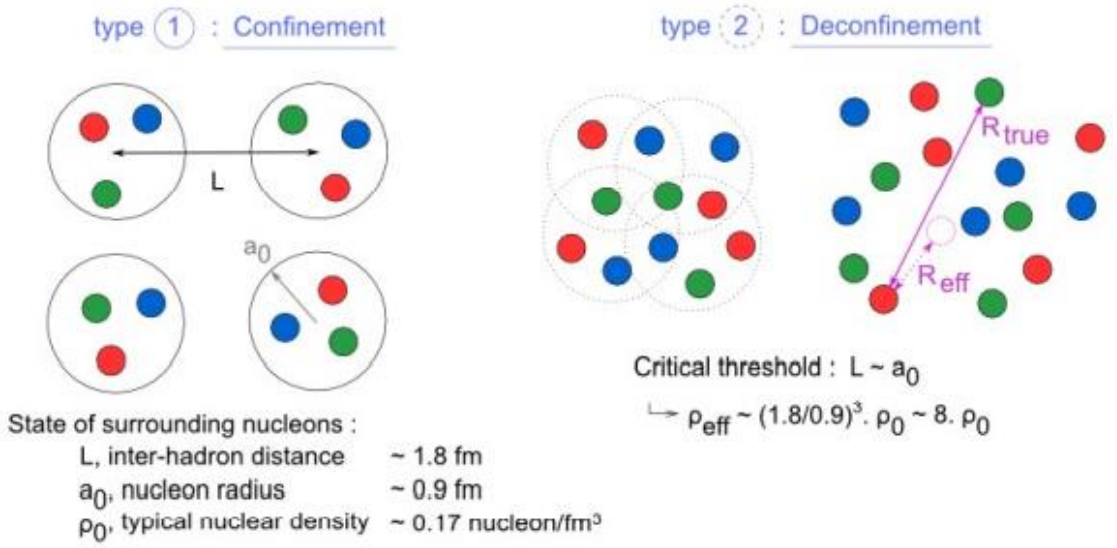
QGP effects in A-A collision

dissociation (static and dynamic) and regeneration

Because of Debye screening in QGP

$$R_{AA}(p_T) = \frac{1}{\langle T_{AA} \rangle} \cdot \frac{dN_{AA}/dp_T}{d\sigma_{pp}/dp_T}$$

Depend on CNM effects and QGP effects



thanks