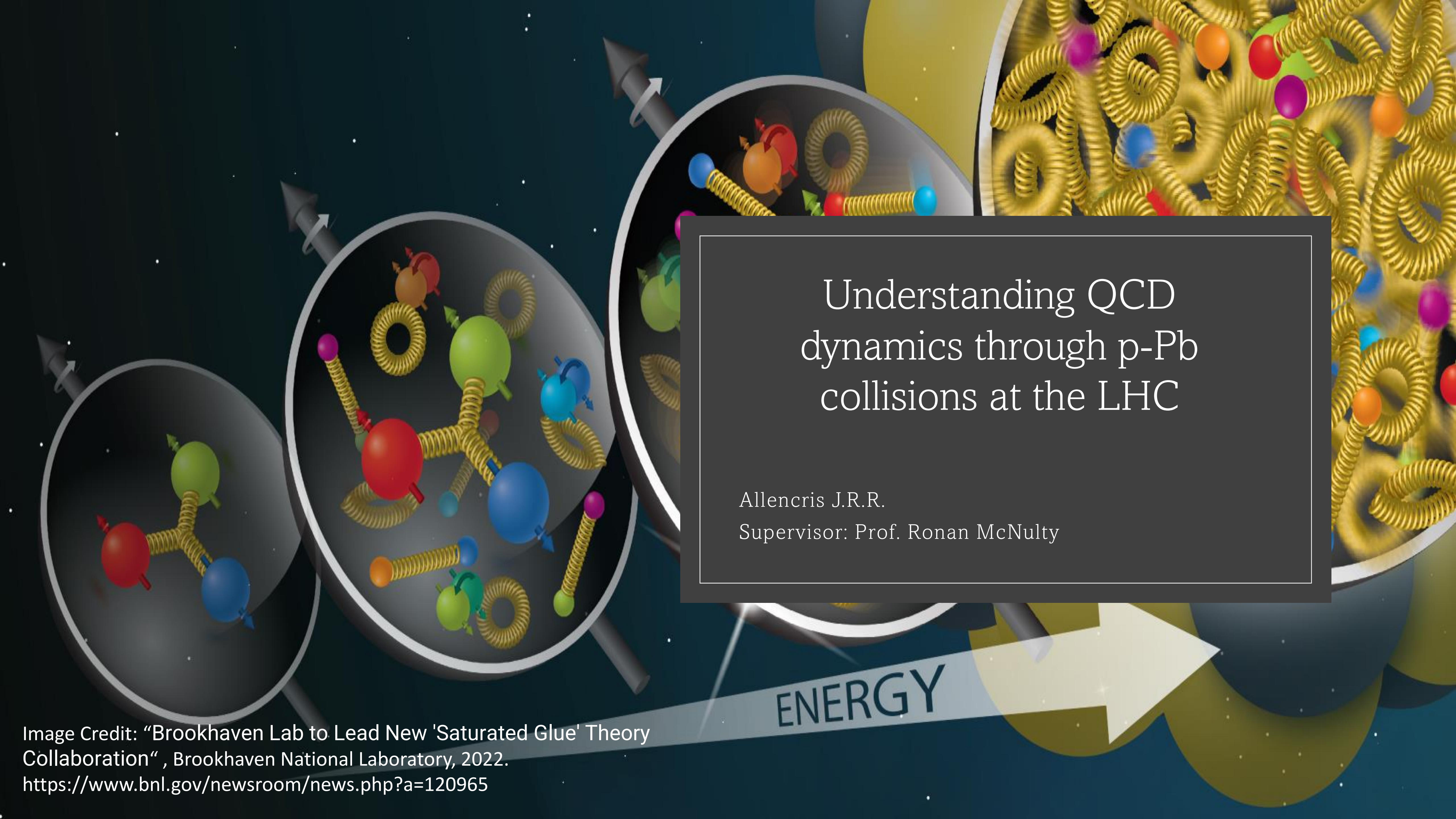

Understanding QCD dynamics through p-Pb collisions at the LHC

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Image Credit: “Brookhaven Lab to Lead New 'Saturated Glue' Theory Collaboration“ , Brookhaven National Laboratory, 2022. https://www.bnl.gov/newsroom/news.php?a=120965

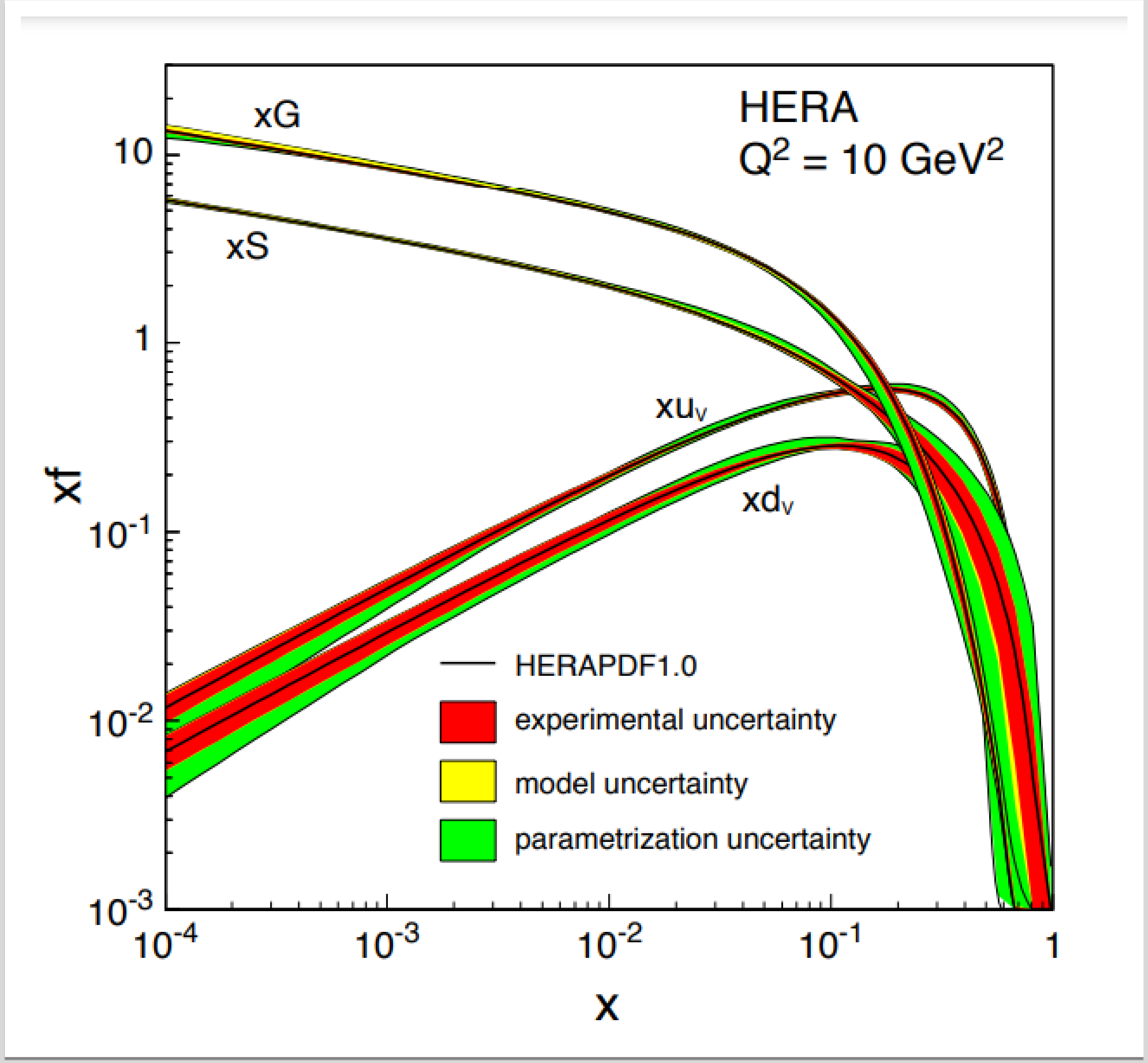


Fig1. Proton parton distribution functions plotted as a function of Bjorken x

(Acardi et al., 2012)

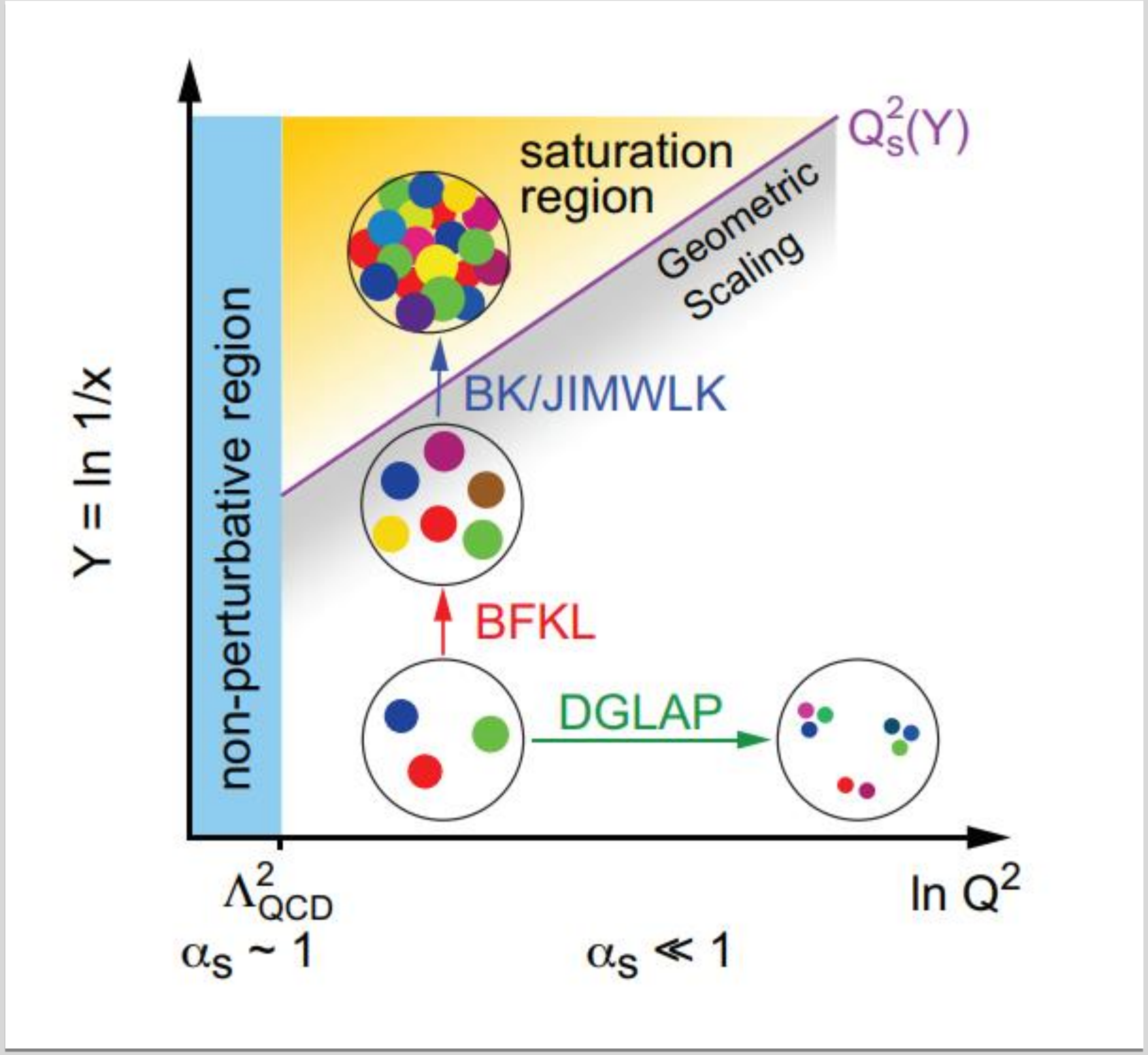


Fig2. A map plotting the log of $\frac{1}{x}$ against Q^2. Different Evolution equations govern different regimes

(Acardi et al., 2012)

Introduction

Cross-section: Probability that a given process takes place

Vector Mesons: Bound states of $q\bar{q}$ with the quantum numbers $J^P = 1^-$

Central Exclusive Production: Class of reactions $A + B \rightarrow A + X + B$ A & B remain intact. X is fully measured

Rapidity (y) : Measure of particle angle with respect to beam axis

$y \approx \eta$ for UR

Pseudorapidity (η) : Rapidity but easier to measure

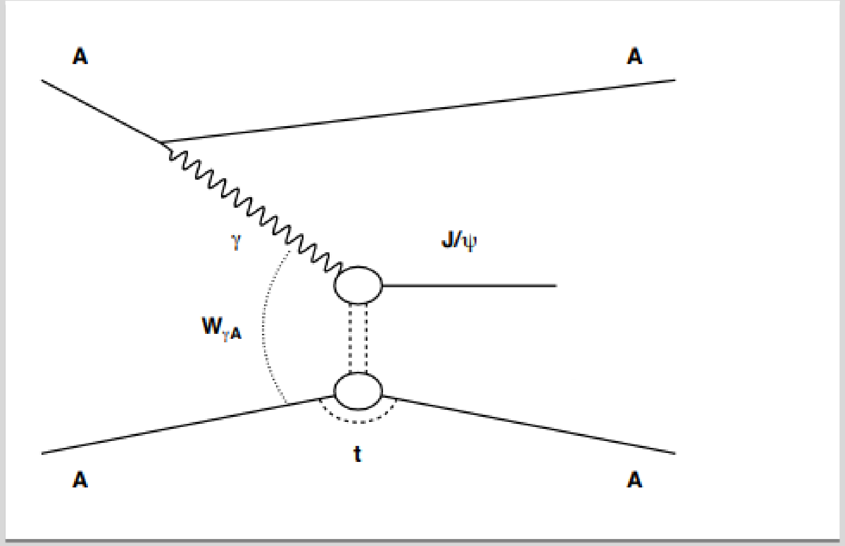


Fig3. CEP of the J/Ψ meson in an ion-ion collision. Phys. Rev. C97 (2018) 024901

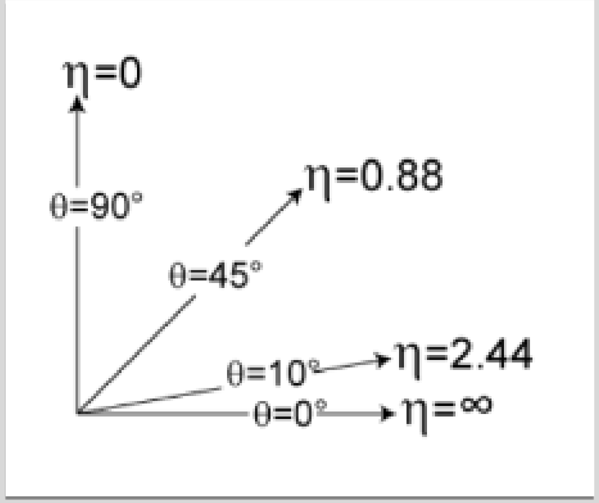


Fig4. Pseudorapidity range

(Albrow et al, 2010)

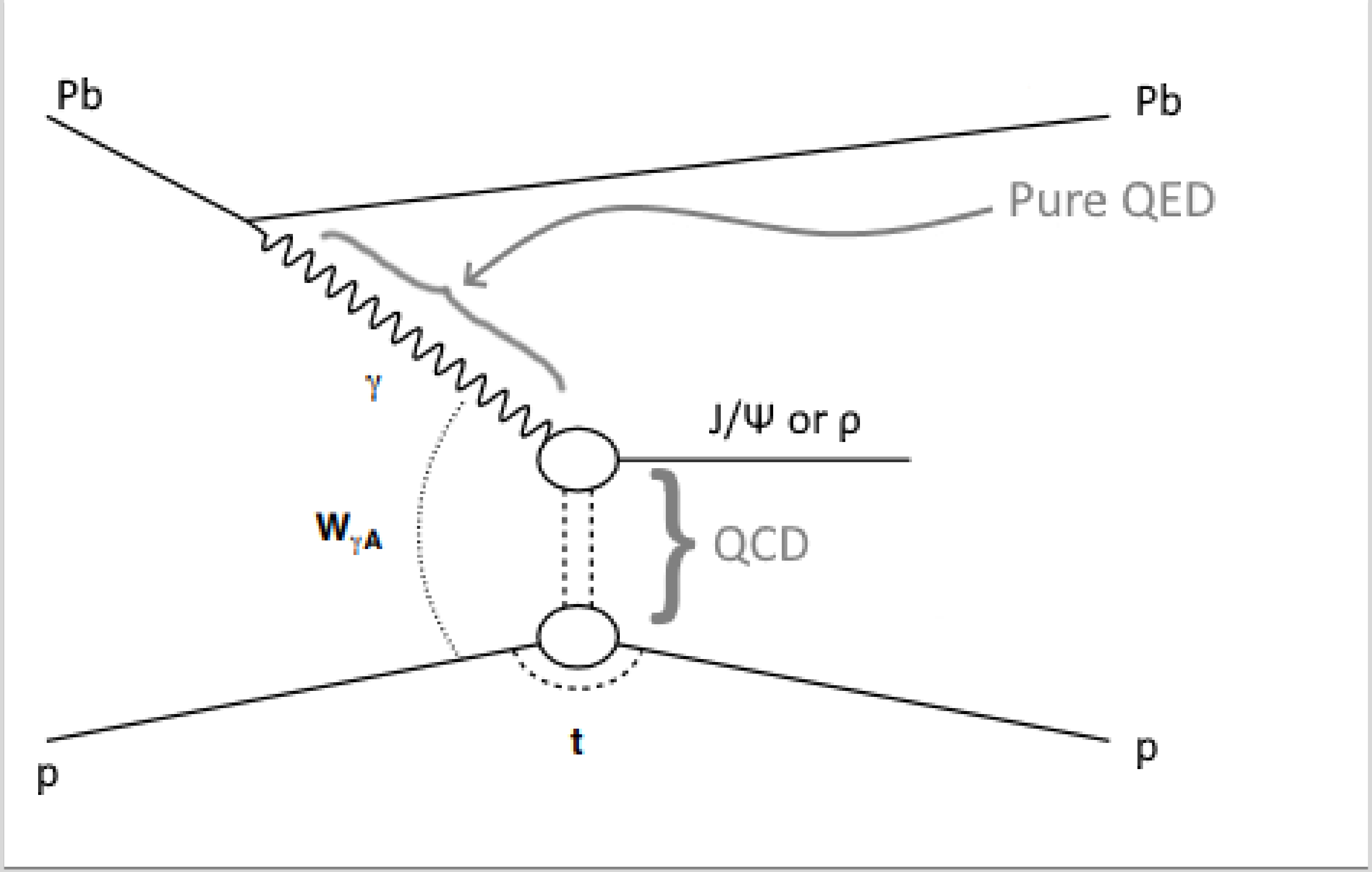


Fig5. The particular process(es) we're interested in.

Overview of Project Goals

Weizsacker-Williams Approximation

Equivalent photon spectrum

$$\sigma(h_1 + h_2 \rightarrow h_1 \otimes V \otimes h_2) = \int d\omega \frac{n_{h1}(\omega)}{\omega} \sigma_{\gamma h_2 \rightarrow V \otimes h_2}(W^2_{\gamma h_2}) + \int d\omega \frac{n_{h2}(\omega)}{\omega} \sigma_{\gamma h_1 \rightarrow V \otimes h_1}(W^2_{\gamma h_1})$$

Photoproduction cross-section

Color-dipole formalism

(Goncalves et al, 2017)

Equivalent Photon Approximation (EPA)

1. Compute E-field of A_1 in rest frame of A_2
2. Fourier transform $E(t) \rightarrow E(\omega)$
3. $P_1 \rightarrow E_2$ and $P_2 \rightarrow E_1$
4. Integrate $P = P_1 + P_2$ over impact parameter b to get $n_A(\omega)$

$$n_A(\omega) = \frac{2Z_A^2\alpha_{EM}}{\pi}[\zeta K_0(\zeta)K_1(\zeta) - \frac{\zeta^2}{2}(K_1^2(\zeta) - K_0^2(\zeta)]$$

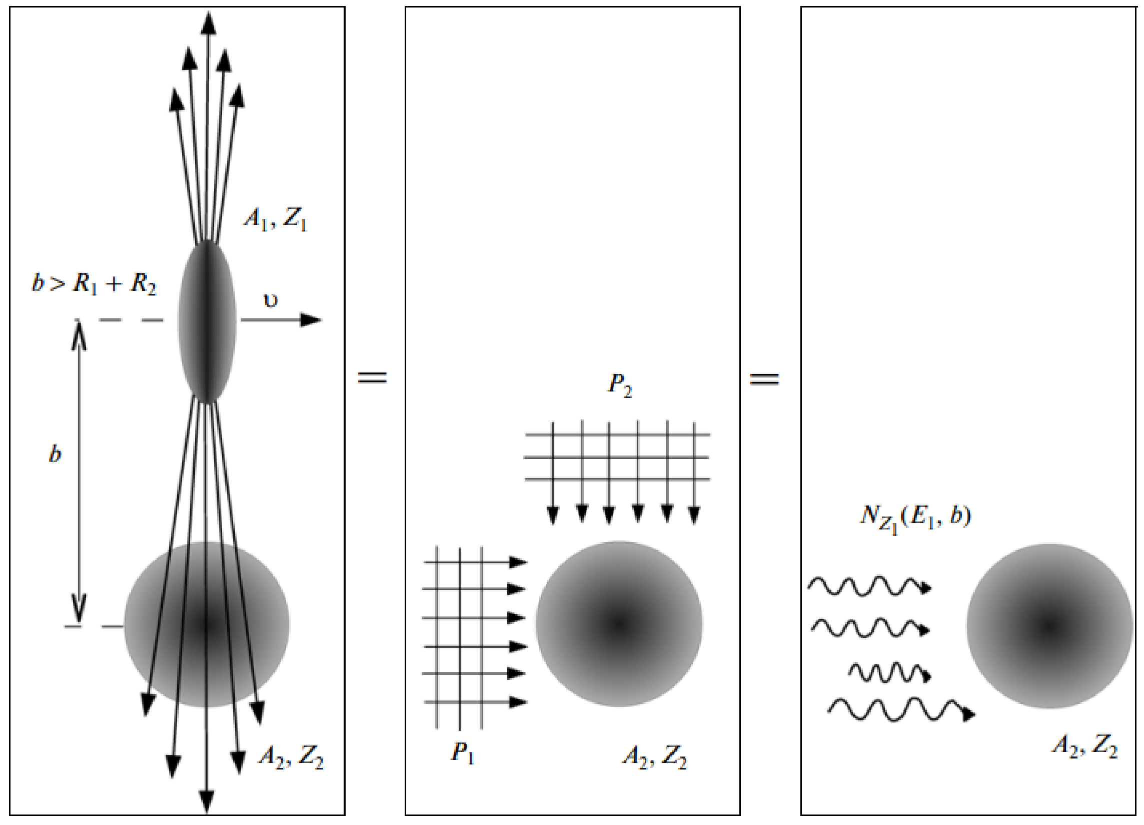
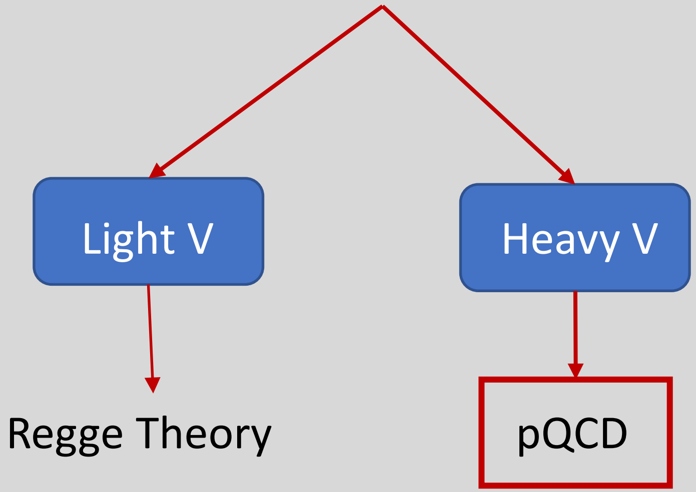


Fig6. Diagram showing equivalence of the E-field and a flux of photons

(Pshenichnov, 2011)
(Fermi, 1924)
(Williams, 1935)

Photoproduction cross-section

- Photon fluctuates into q$\bar{q}$
- q$\bar{q}$ interacts with particle through 2 gluons (unusual because colorless)



$$\frac{d\sigma(\gamma A\to J/\Psi)}{dt}\Big|_{t=0} = \frac{\pi^3\Gamma_{ee}M^3_{J/\Psi}}{48\alpha}\frac{\alpha_S^2\overline{(Q^2)}}{\bar{Q}^8}\times\left[xG_A(x,\bar{Q}^2)\right]^2$$

$$\sigma(\gamma A\to J/\Psi) = \frac{d\sigma(\gamma A\to J/\Psi)}{dt}\Big|_{t=0}\int_{t_{min}}^{\infty} dt\,|F(t)|^2$$

- Then creates/ moves off as V

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