Inelastic J/ψ Photoproduction

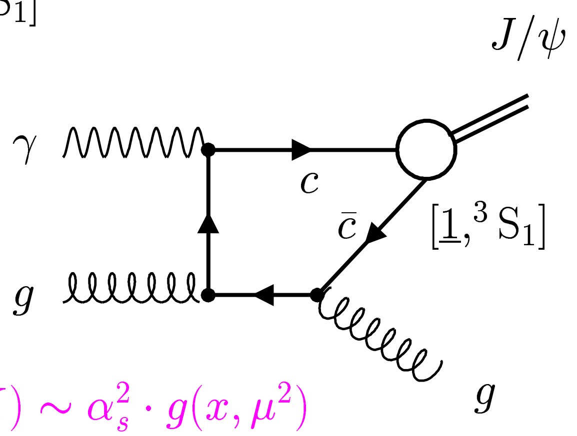
NRQCD factorization approach (Bodwin, Braaten, Lepage) :

$$\sigma(\gamma p \to J/\psi X) = \Sigma \langle \mathcal{O}[n] \rangle \cdot \hat{\sigma}(\gamma p \to c\bar{c}[n] X)$$

$\langle \mathcal{O}[n] \rangle$: NRQCD long distance matrix elements $\sim$ hadronization
$\hat{\sigma}$: short distance coefficients, calculable in pQCD
n : quantum numbers (colour state; ${}^{2S+1}L_J$)

Colour Singlet (CS) (Berger, Jones) : $[\underline{1}, {}^3\mathrm{S}_1]$

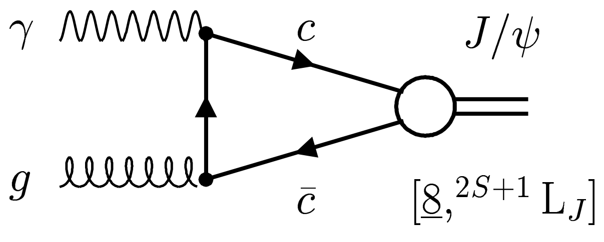
Colourless $c\bar{c}$ state formed by emission of hard gluon (g part of hard process)



- large NLO corrections (up to 50%)
- small relativistic corrections ($z < 0.9$)
- σ sensitive to $g(x, \mu)$: $\sigma(\gamma p \to J/\psi X) \sim \alpha_s^2 \cdot g(x, \mu^2)$

Colour Octet Contribution (CO) $[\underline{8}, {}^{2S+1}\mathrm{L}_J]$

J/ψ formed from colour octet $c\bar{c}$ pair by non-perturbative emission of gluons



- $\langle \mathcal{O}[8] \rangle$ determined from fit to Tevatron J/ψ data (${}^1S_0, {}^3P_J$)
- Test for colour octet contribution at HERA at $z < 0.9$

HERA data shown here for photoproduction at $z < 0.9$

Fragmentation, resolved γ, and b decays contribute little (in exp't)