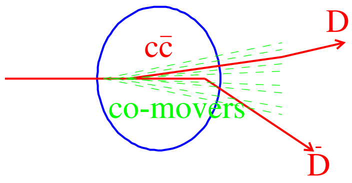
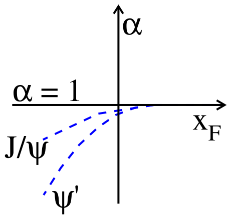
Issues in J/ψ Production from Nuclei

- Nuclear & Comover absorption $\qquad \sigma_A = \sigma_N A^{\alpha}$



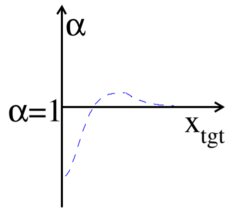


  - fast (large x_F) J/ψ (or ψ') are formed as a small $c\bar{c}$ pair and hadronize well outside nucleus
  - slow (small or negative x_F) $c\bar{c}$ may become *physical* J/ψ's (or ψ''s) and have strong absorption

Meson	Radius	$B.E.$
J/ψ	.29 Fm	$\sim$ 640 MeV
ψ'	.56 Fm	$\sim$ 52 MeV
Υ	.13 Fm	$\sim$ 1.1 GeV

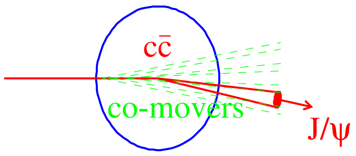
  - depends critically on production mechanism
    - color-singlet: small weakly interacting $c\bar{c}$
    - color-octet: larger absorption *(Braaten,Fleming,Yaun)*
    - or coherence length of hybrid states *(B. Kopeliovich)*
  - open charm (D meson) is not strongly suppressed in nuclei - so absorption of J/ψ must be mainly from final state

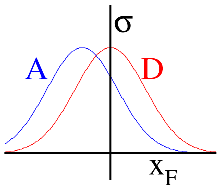
- Shadowing (e.g. *Eskola, Kolhinen, Ruuskanen)*

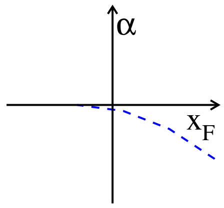


  - gluon fusion dominates J/ψ production at moderate x_F ($x_F < .65$)
  - but gluon shadowing not as well understood as quark shadowing

- Energy loss & Multiple scattering







  - Multiple scattering broadens p_T
  - Drell-Yan influenced by energy loss in initial-state but not in final-state
  - *Gavin & Milana*: $\Delta x_1 = -\kappa_1 x_1 \cdot A^{1/3}$
  - *Brodsky & Hoyer*: $\Delta x_1 \approx -\kappa_2 / s \cdot A^{1/3}$
  - *Baier et al.*: $\Delta x_1 \approx -\kappa_3 / s \cdot A^{2/3}$
    and $-dE/dz = 3/4 \cdot \alpha_s \cdot \Delta < p_T^2 >$

- J/ψ suppression in A-A collisions
  - signature of QGP - color screening *(Matsui & Satz)*
  - anomolous J/ψ absorption in NA50?
  - interpretation *relies* on a thorough understanding of "cold" nuclear matter effects
  - comovers more numerous in A-A collisions $\rightarrow$ more absorption
  - shadowing very important in RHIC collider kinematics