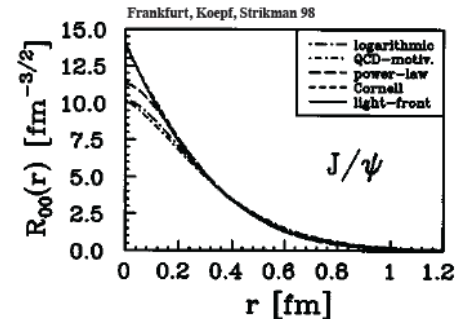


# J/ψ as a Unique Probe of Strong Color Fields in Nucleon

$$J/\psi(1S) : I^G (J^{PC}) = 0^- (1^{--}) \quad M_{J/\psi} \approx 3.097 \text{ GeV}$$

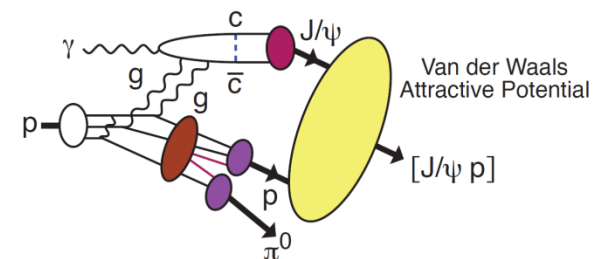
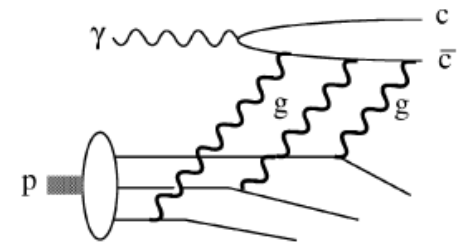
- **J/ψ is unique**

- charm-anticharm system, little (if not zero) common valence quark between J/ψ and nucleon
- Quark exchange interactions are strongly suppressed
- Pure gluonic interactions are dominant
- Heavy charm quark (1.3 GeV)  $\gg \Lambda_{\text{QCD}}$  (217 MeV)
- Typical size of J/ψ is 0.2-0.3 fm, pQCD at work



- **J/ψ is a probe**

- Probes strong gluonic interaction between two color neutral objects J/ψ and the nucleon at near Threshold
- QCD color Van der Waals force
- Possible J/ψ-Nuclei bound state
- Related to trace anomaly and proton mass structure



# J/ψ Near-threshold Production Related to Proton Mass Structure

$$H_{QCD} = H_q + H_m + H_g + H_a$$

$$H_a = \int d^3x \frac{9\alpha_s}{16\pi} (\mathbf{E}^2 + \mathbf{B}^2)$$

Trace of energy momentum tensor is a big part of proton mass

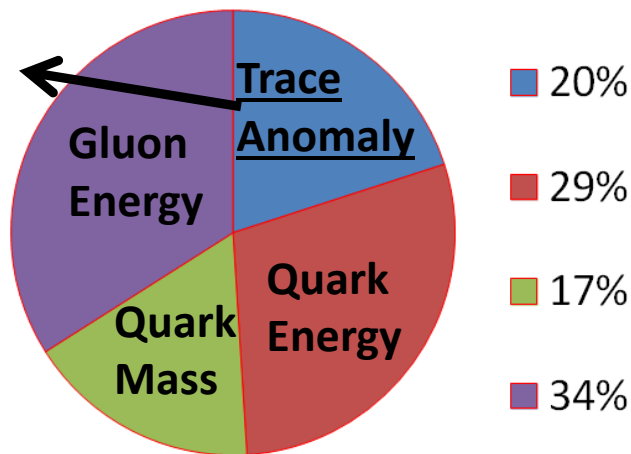
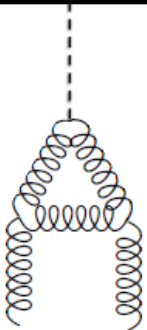
J/ψ near-threshold production amplitude:

**Imaginary part** is related to the total cross section through optical theorem

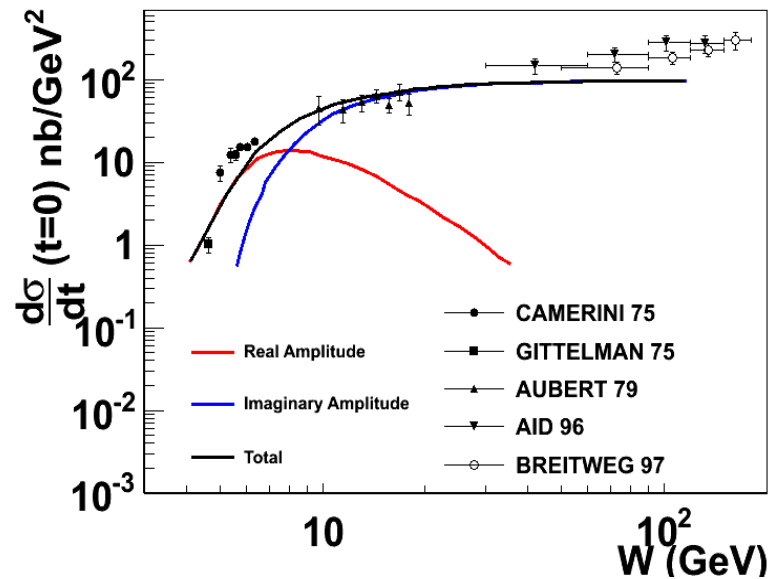
**Real part** contains the trace anomaly

## Proton Mass Budget

$$G^{\alpha\beta\gamma} G^{\gamma}_{\alpha\beta}$$

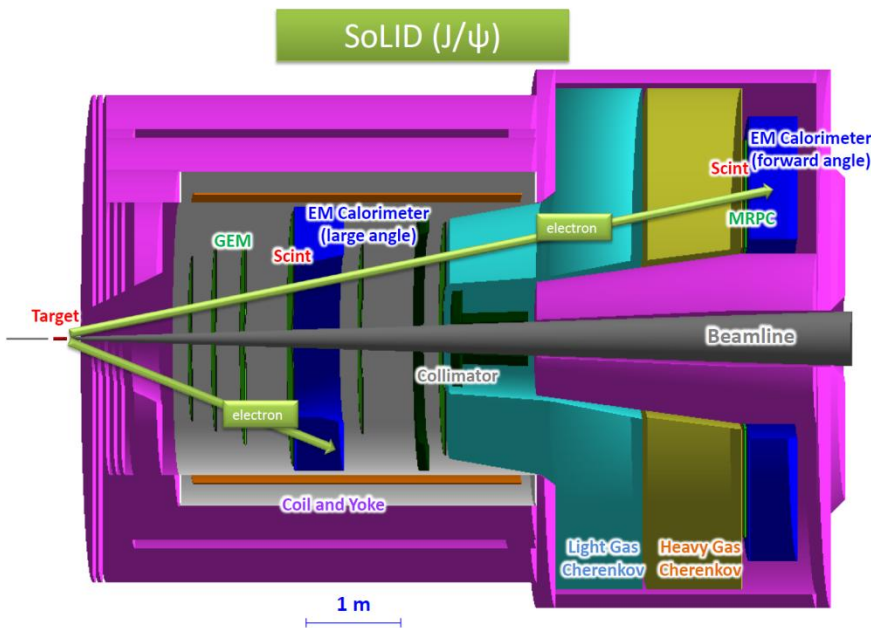


X. Ji PRL 74 1071 (1995)

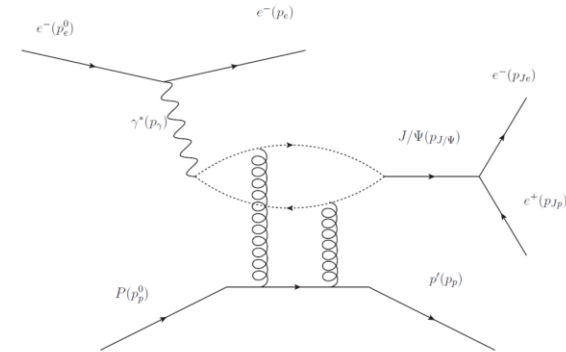


D. Kharzeev et al Eur.Phys.J. C9 459 (1999)

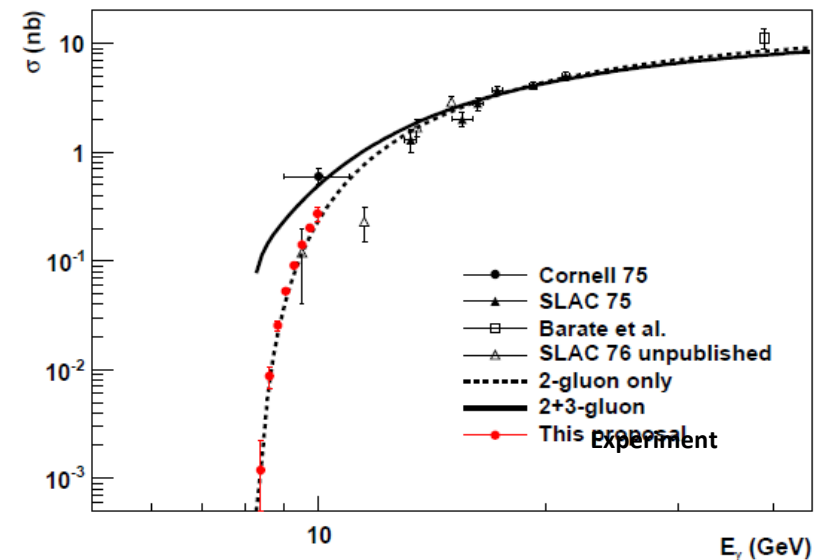
# Precise Measurement of $J/\psi$ Near-threshold Production with SoLID



$$\gamma^* + N \rightarrow N + J / \psi$$



$J/\psi$  Photoproduction Total Cross Section from nucleon



- The **high luminosity & large acceptance** capability of SoLID enables a **unique** “precision” measurement near threshold
- Shed light on the **low energy  $J/\psi$ -nucleon** interaction (**color Van der Waals force**)
- Shed light on the ‘conformal anomaly’ an important piece in the proton mass budget:
- **Models relate  $J/\psi$  enhancement to trace anomaly**