# Gluon Fragmentation Into Triply Heavy Baryons Considering Two Various Scenario

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# Outline

- Elementary particle physics
- Introduction
- Hadronization process
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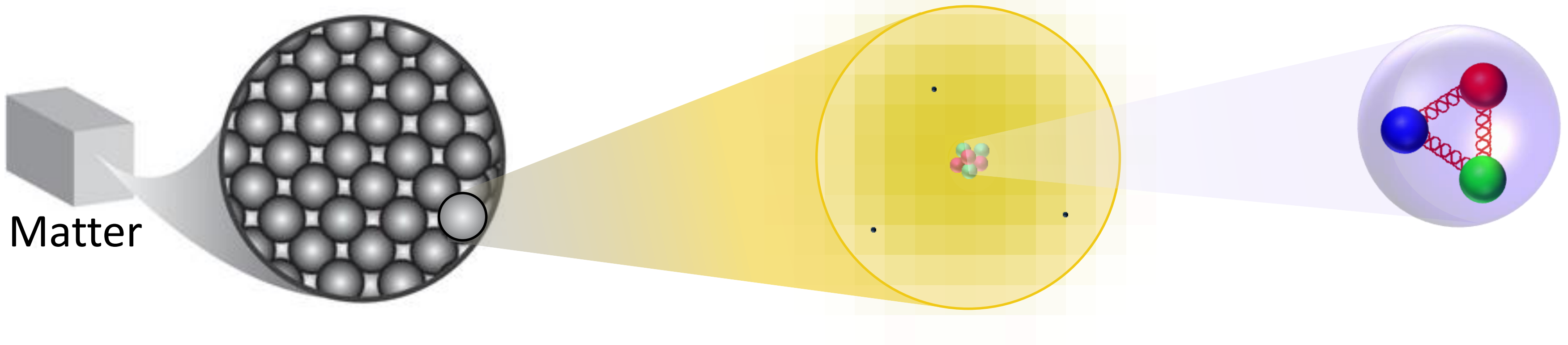
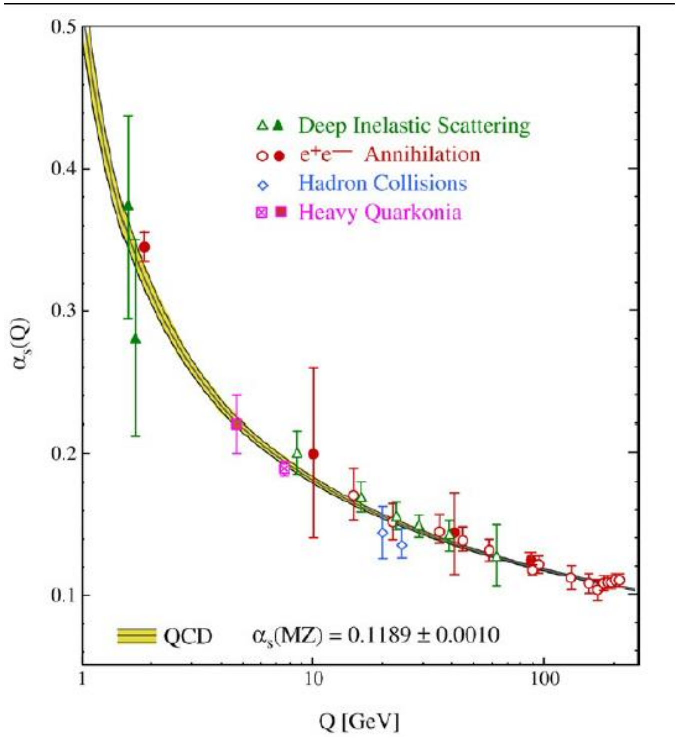
- Gluon into omega baryon
- Numerical
- Quark-Diquark Model
- Conclusion

# Elementary Particle Physics



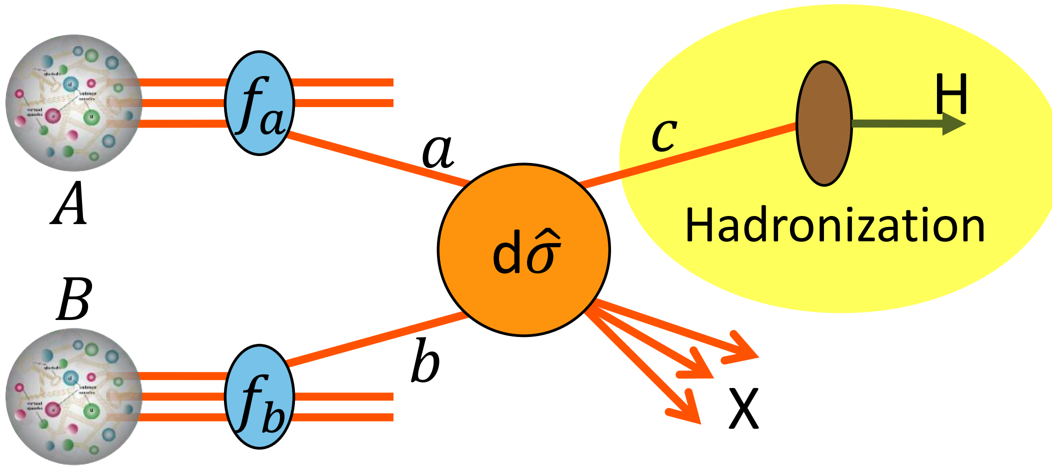





Quantum Chromodynamics:

the theory of the strong-interaction

# Introduction




$$Parton\ Distribution\ Function \otimes Hard\ Scattering \otimes Hadronization$$

$$d\sigma^{A+B\to H+X} = \sum_{a,b,c} f_a^A(x_a,\mu) \otimes f_b^B(x_b,\mu) \otimes d\hat{\sigma}^{a+b\to c+X} \otimes D_{c\to H}(z,\mu)$$

Parton Distribution Function → Long Distance

Partonic hard-scattering cross section → Short Distance

Fragmentation Function → Long Distance

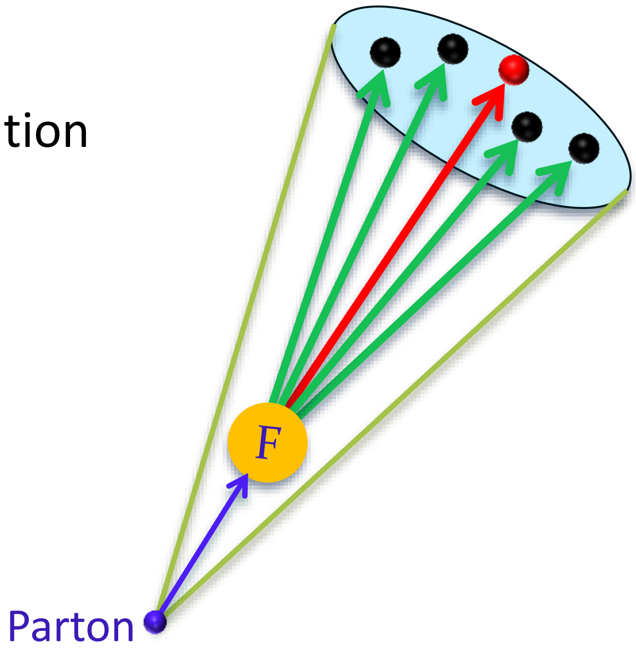
# Fragmentation Function

The probability densities for transition of initial parton into observed hadron

- $D_{c\longrightarrow H}(z,\mu)$ : Fragmentation function at the factorization scale $\mu$

- $D_{c\longrightarrow H}(z,\mu_0)$ : Fragmentation function at the initial scale of $\mu_0$

- Phenomenological determination
- Theoretical determination



# Theoretical determination of FFs

Non-perturbative QCD → (Heavy Hadron) → perturbative QCD $(\mu_0)$

Suzuki Model

Feynman diagram

Wave function of hadron

$$D_j^H(z,\mu_0) = \frac{1}{1+2S_j}\sum\int |T_B|^2 \delta^3\left(\sum_f \vec{p}_f - \vec{p}_i\right)\prod_i d^3\vec{p}_f$$

$$z = \frac{(E+p_L)_H}{(E+p_L)_j} \xrightarrow{\text{Infinite Momentum Frame}} z = \frac{E_H}{E_j}$$

Probability amplitude: Hard scattering amplitude + distribution amplitude

$$T_B = \int [dx_i] T_H(p_i, x_i) \Phi_B(x_i)$$

~~Fermi motion~~

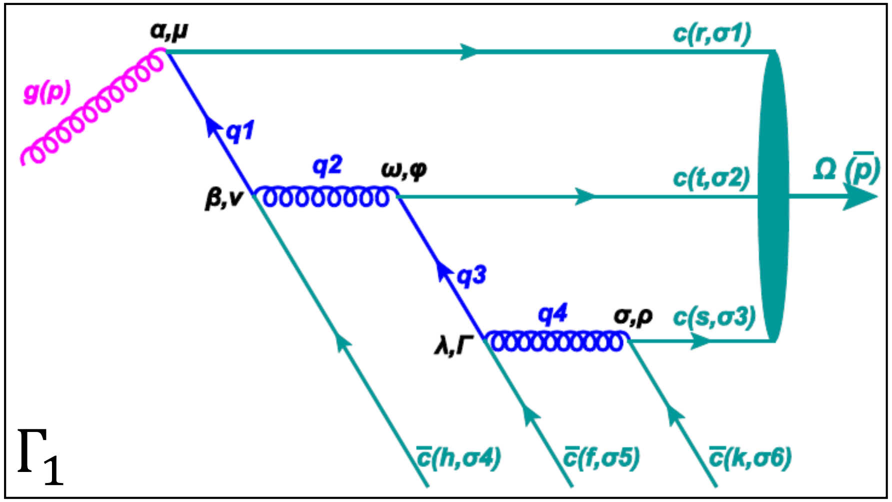
$$\Phi_B = f_B \delta\left\{x_i - \frac{m_i}{m_H}\right\}$$

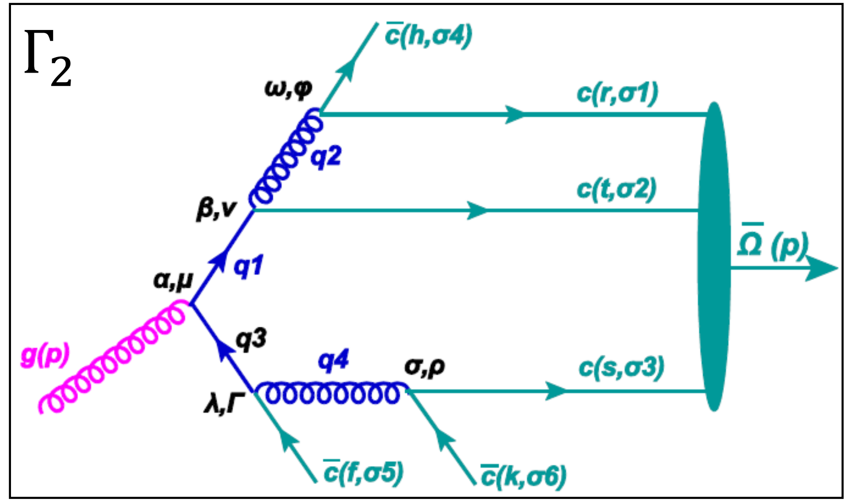
Decay constant of hadron

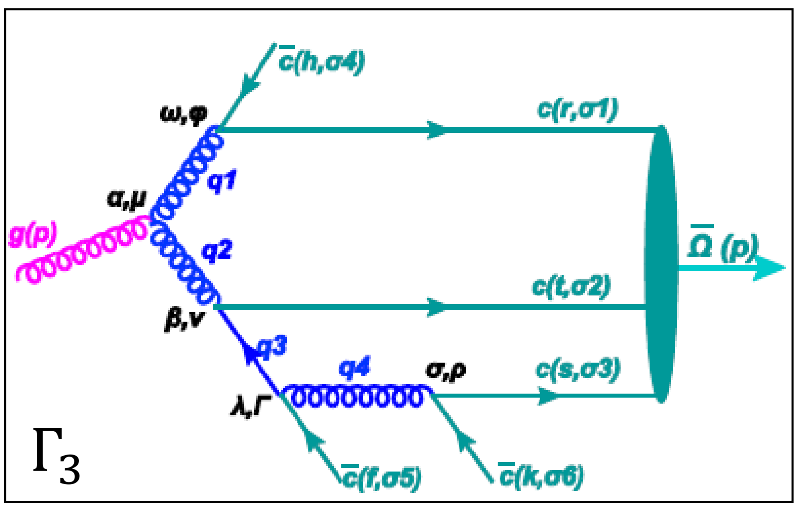
$$x_i = \frac{m_i}{m_H}$$

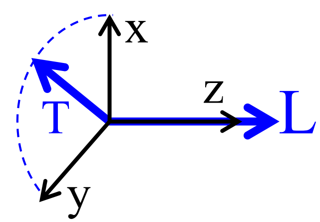
# Gluon into Omega(ccc)

$$g \longrightarrow \Omega_{ccc} + 3\bar{c}$$




$\Gamma_i$: quark propagator and the spinorial part

$$D_g^{\Omega}(z,\mu_0) = (128 m_c^{10} f_B^2 C_F^2 \pi^5 \alpha_s^5)\left[\frac{z(1-z)^2}{(9m_c^2 + z^2 p_T^2)^2}\sum|\Gamma|^2\right]_{p_T^2 \to <p_T^2>}$$

Initial scale: $\mu_0 = m_\Omega + 3m_{\bar{c}} \approx 6m_c$

$$\sum|\Gamma|^2 = \sum_{spin}(\Gamma_1\Gamma_1^* + \Gamma_2\Gamma_2^* + 2\Gamma_1\Gamma_2^*)$$

$$=6G_1^2(2+\kappa)^2(\kappa^3 + 6\kappa^2 + 14\kappa - 24) + G_2^2(2\kappa^5 + 13\kappa^4 + 40\kappa^3$$

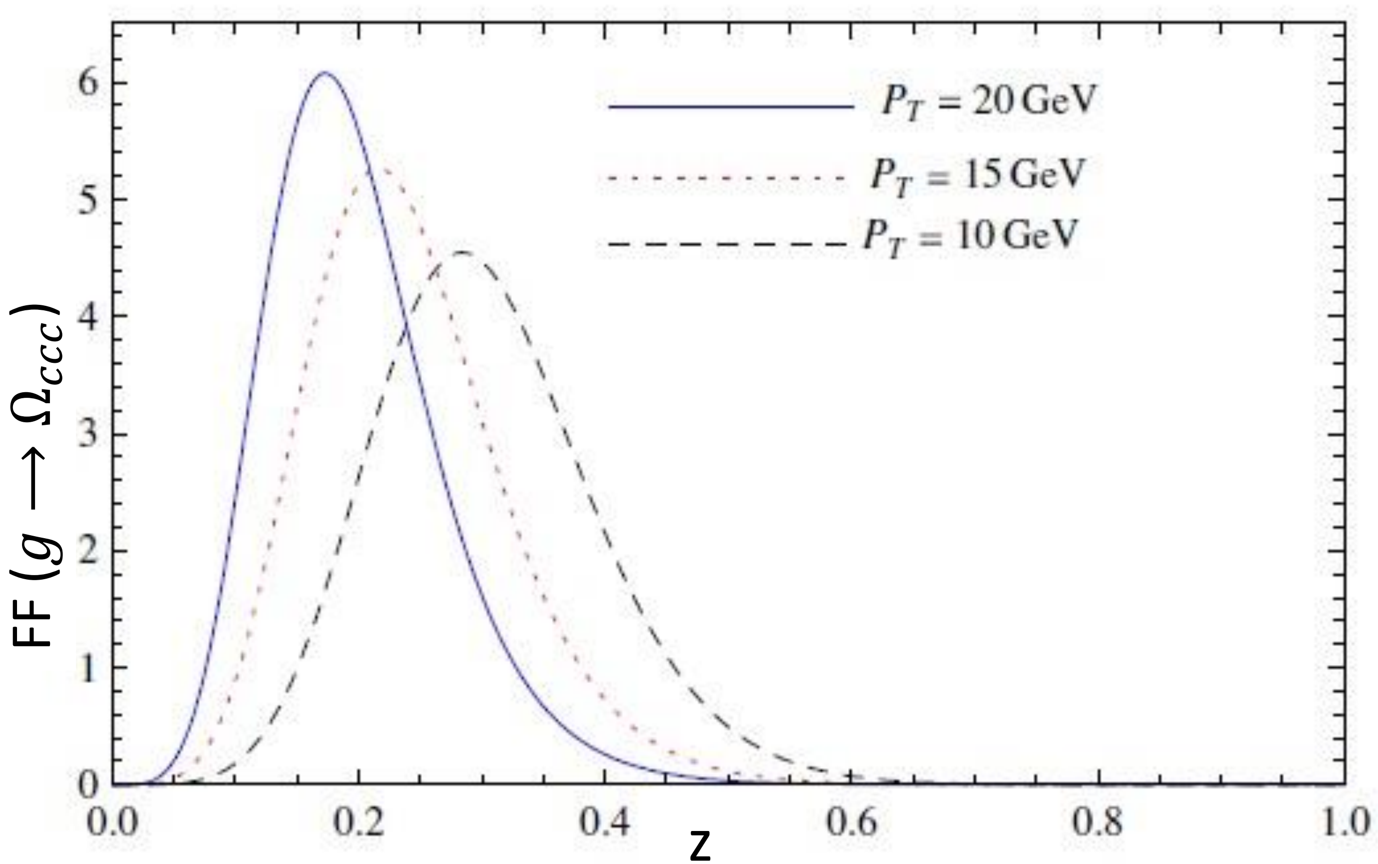
$$+84\kappa^2 + 88\kappa + 48) + 2G_1G_2(10\kappa^4 + 91\kappa^3 + 328\kappa^2 + 500\kappa + 265)$$

$$\eta(z) = \frac{z}{1-z}\left(m_c^2 + \frac{p_T^2}{9}\right) + \frac{(1-z)m_c^2}{z}$$

$$G_2 = 12G_1 = \frac{1}{2\eta^4(z)}$$

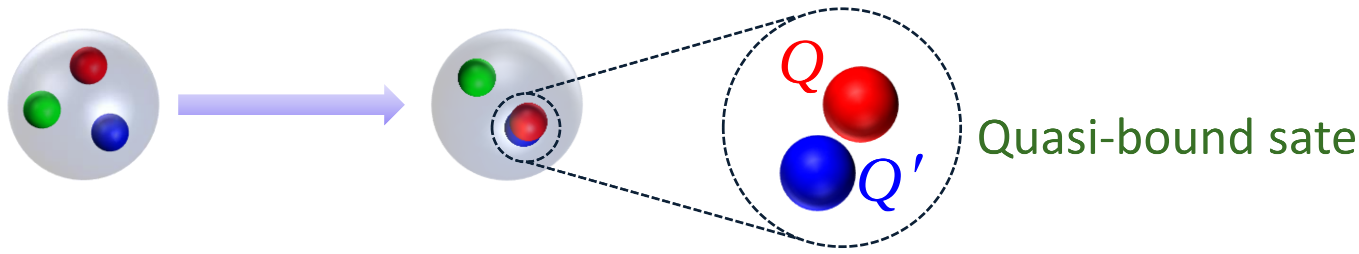
# Numerical Result

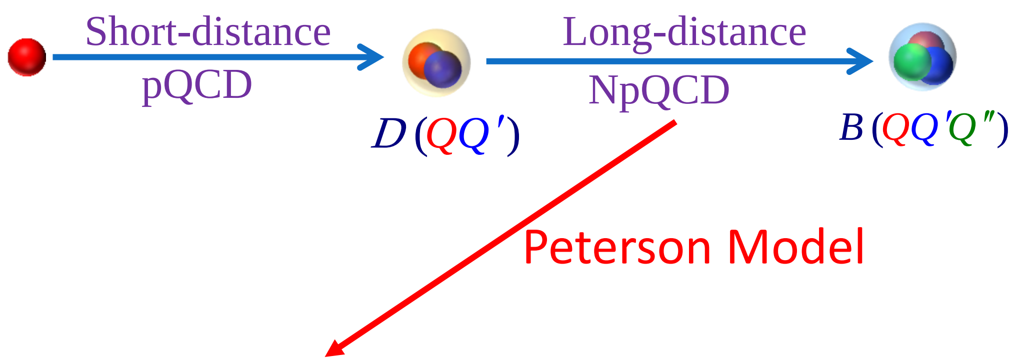
$m_c = 1.67\ GeV$ $f_B \approx 0.25$ GeV $\alpha_s = 0.26$ $C_F = \frac{7}{6}$




Gluon fragmentation function into triply heavy baryon $\Omega_{ccc}$ (Suzuki`s model)

# Quark-Diquark Approximation

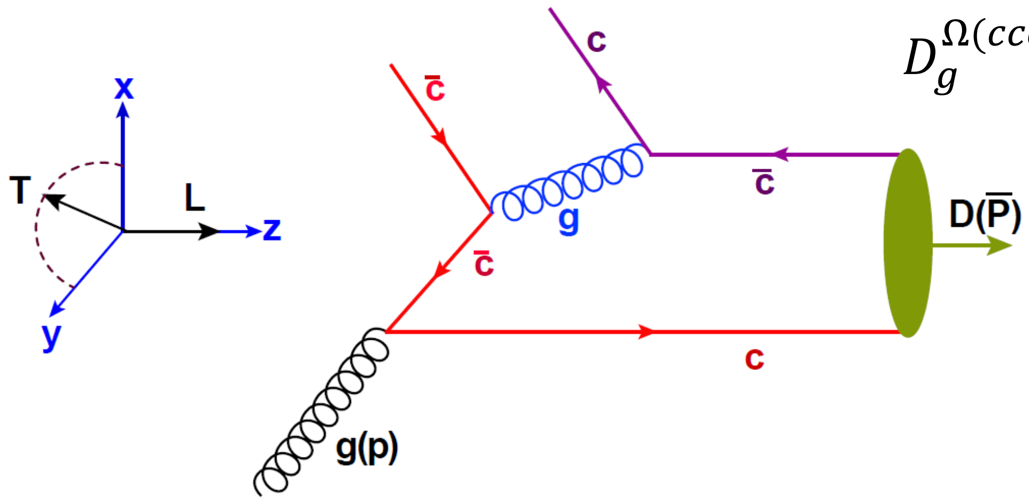



$$D_Q^H(z) = \frac{N}{z}\left[1 - \frac{1}{z} - \frac{\varepsilon_Q}{1-z}\right]^{-2} \qquad \epsilon_Q = \frac{m_Q^2}{(m_Q + m_{\overline{Q}})^2}$$

$$D_Q^B(z, \mu_0) = \int_z^1 \frac{dy}{y} D_Q^D\left(\frac{z}{y}\right) D_D^B(y) = \int_z^1 \frac{dy}{y} D_Q^{QQ'}\left(\frac{z}{y}\right) D_{\overline{Q}}^{\overline{Q}Q''}(y)$$

# FF Of Gluon Into Diquark




$$D_g^{\Omega(ccc)}(z,\mu_0) = \int_z^1 \frac{dy}{y} D_g^{D(cc)}\left(\frac{z}{y}\right) D_{\bar{c}}^{c\bar{c}}(y)$$

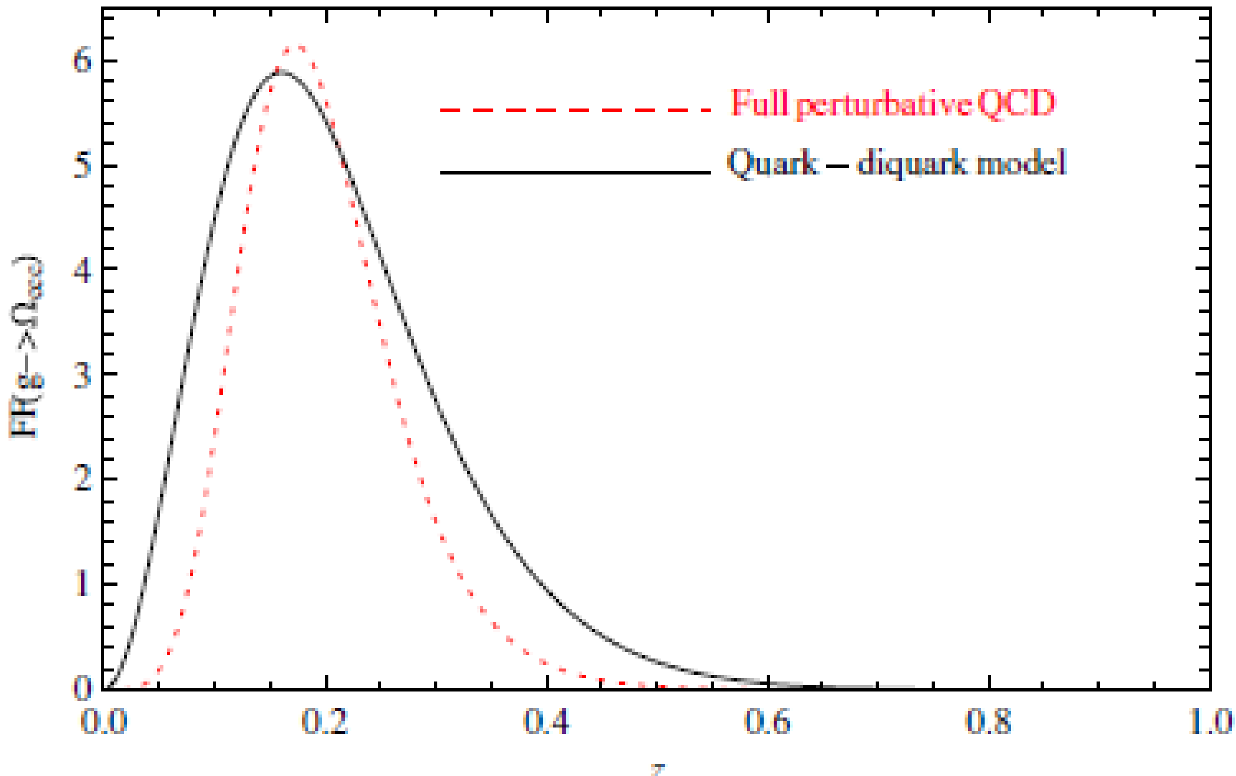
Peterson Model

$$\epsilon_Q = \frac{1}{4}$$

$$D_g^D(z,\mu_0) = N\frac{z^3(z-1)^2}{F(z,<p_T^2>)}\{(z^2<p_T^2>)^2 + 2z^2m_c^2<p_T^2>(4z^2-20z+17)$$
$$+8m_c^4(16z^2-32z+15)\}$$

$$F(z,<p_T^2>) = [4zm_c^2 + M^2(1-z) + z^2<p_T^2>]^2[4m_c^2 + z^2<p_T^2>]^3$$

# Conclusion




The $g \longrightarrow \Omega_{cc}$ FF obtained through quark-diquark model compared with that calculated in the pQCD approach

## HEP

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# Thank You