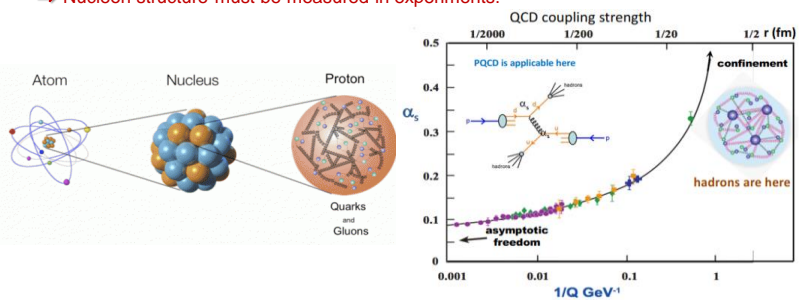


Strong Interaction at Low Energy

Nucleons are composite objects with inner structure, at low four-momentum transfer (Q), perturbative QCD could not work (expansion of α_s).

⇒ Nucleon structure must be measured in experiments!

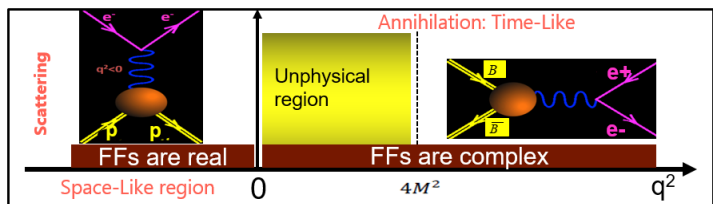


Electromagnetic Form Factors (FFs)

The nucleon electromagnetic vertex Γ_μ describing the hadron current:

$$\Gamma_\mu(p', p) = \gamma_\mu F_1(q^2) + \frac{i\sigma_{\mu\nu}q^\nu}{2m} F_2(q^2),$$

Sachs FFs: $G_E(q^2) = F_1(q^2) + (q^2/4m^2) \cdot F_2(q^2)$, $G_M(q^2) = F_1(q^2) + F_2(q^2)$.

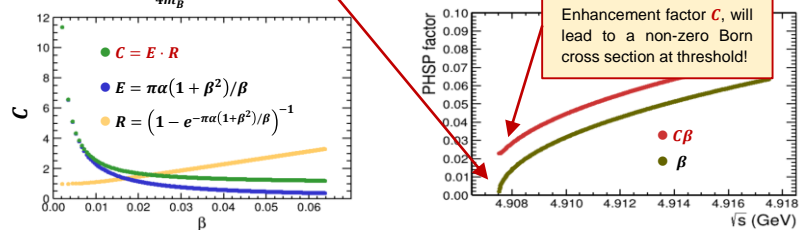


Baryon Pair Production

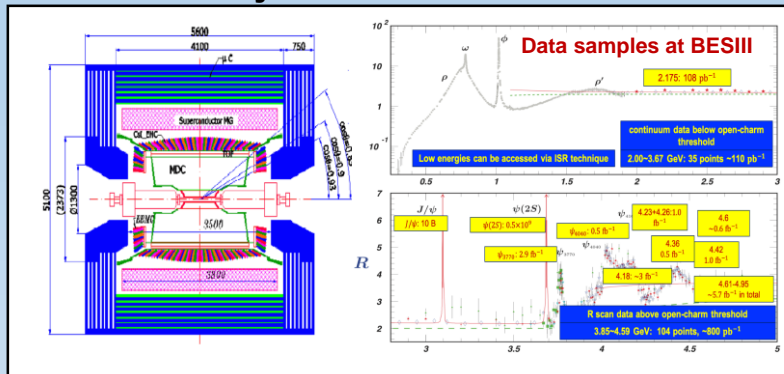
The Born cross section for $e^+e^- \rightarrow \gamma^* \rightarrow B\bar{B}$ (B is spin 1/2 baryon):

$$\sigma_{B\bar{B}}(q) = \frac{4\pi\alpha^2 C\beta}{3q^2} [|G_M(q)|^2 + \frac{1}{2\tau} |G_E(q)|^2]$$

At threshold, $\tau = \frac{s}{4m_B^2} = 1$, thus $\beta = \sqrt{1 - \tau} = 0$.

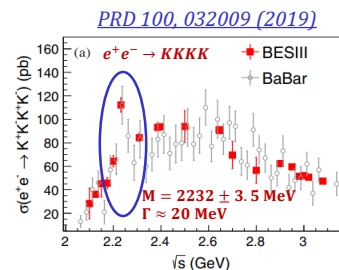
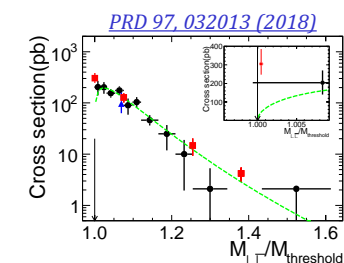


Study Time-like FFs at BESIII



Hyperon Production and FFs (Λ)

Non-zero cross section of $e^+e^- \rightarrow \Lambda\bar{\Lambda}$ at threshold is observed



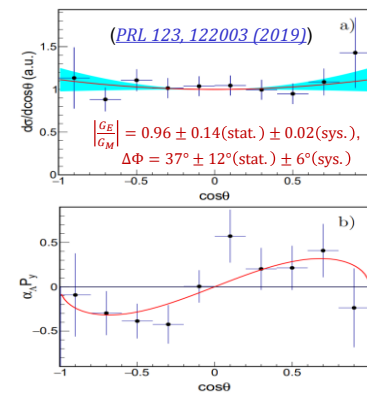
Complex form of FFs:

- $G_E = |G_E|e^{i\Phi_E}$, and $G_M = |G_M|e^{i\Phi_M}$
- Relative phase: $\Delta\Phi = \Phi_E - \Phi_M$

Non-zero phase will lead to polarization effect on the baryons: $P_y \propto \sin\Delta\Phi$

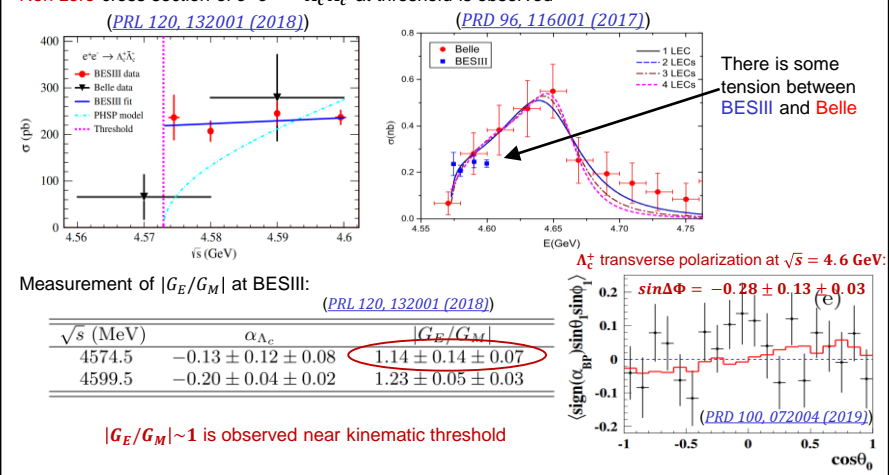
The angular distribution of daughter particle from hyperon weak decay:

- $d\sigma/d\Omega \propto 1 + \alpha_A P_y \cdot \hat{q}$
- α_A : asymmetry parameter
- \hat{q} : unit vector along the daughter particle in the Rest frame of hyperon.



Hyperon Production and FFs (Λ_c)

Non-zero cross section of $e^+e^- \rightarrow \Lambda_c^+\bar{\Lambda}_c^-$ at threshold is observed



Summary

