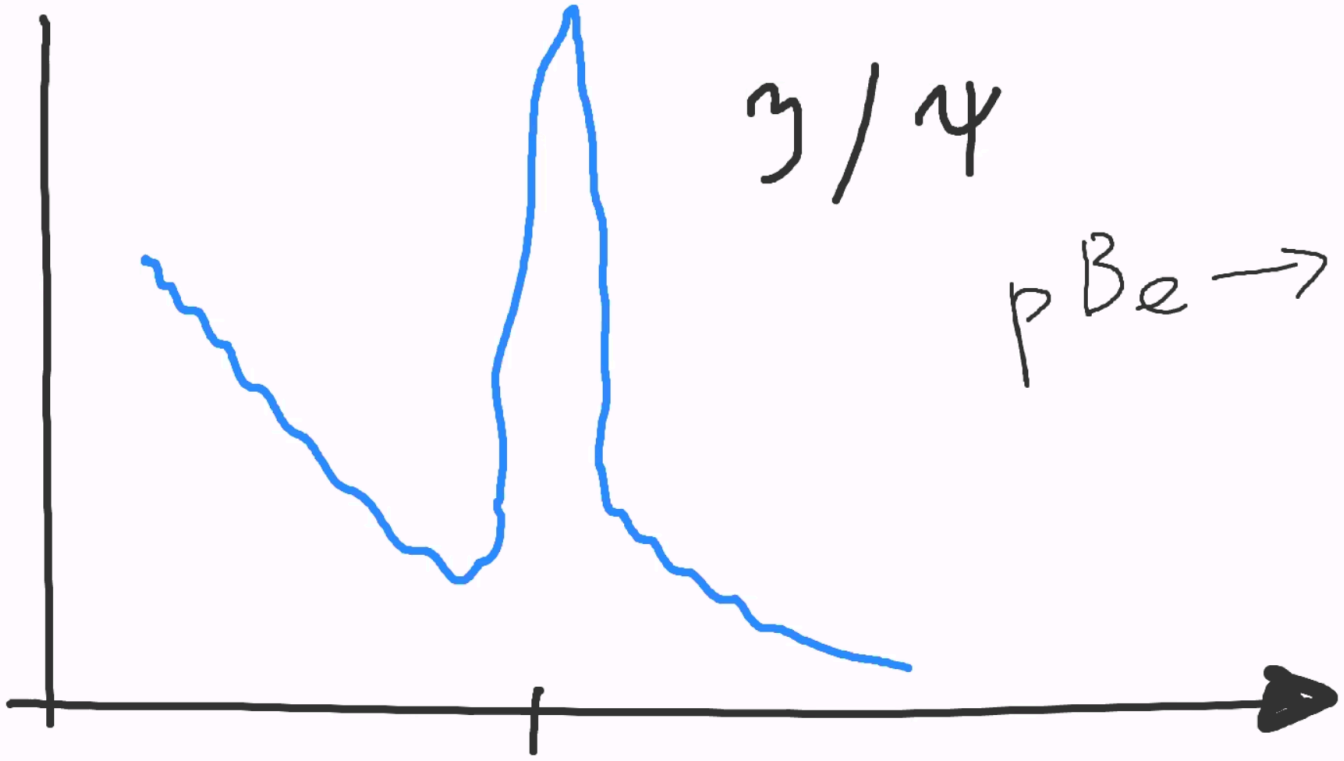
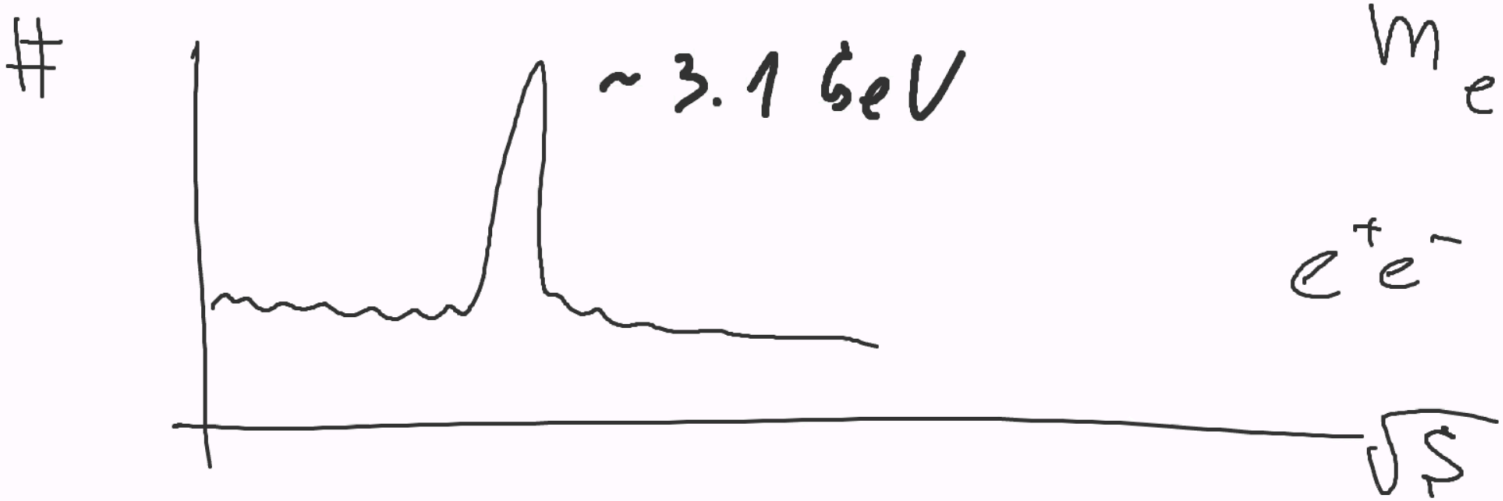
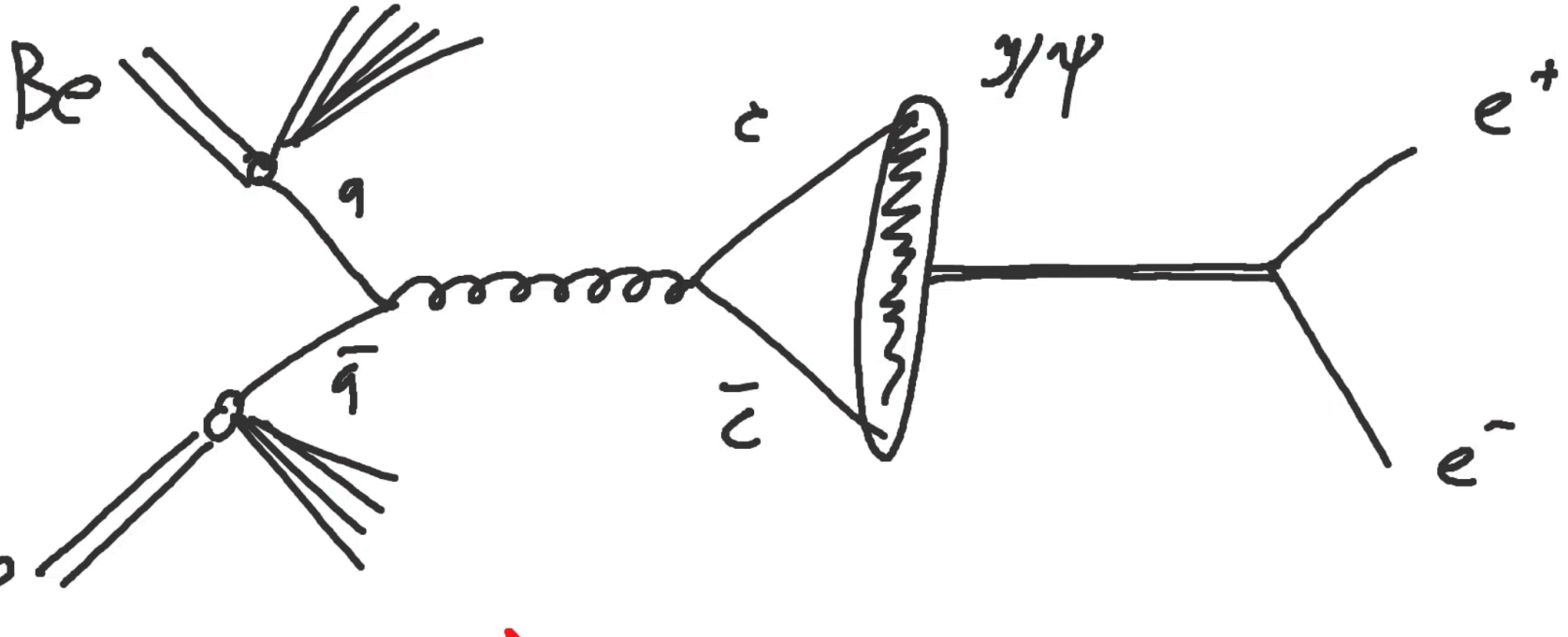


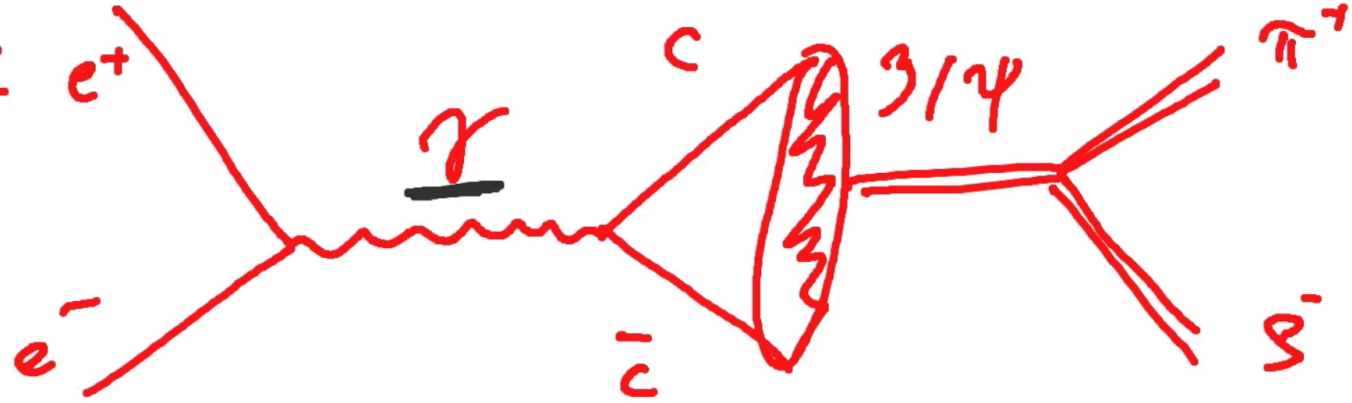
$p\,Be \rightarrow e^+e^- + X$



pBe: BNL



e^+e^- ... SLAC

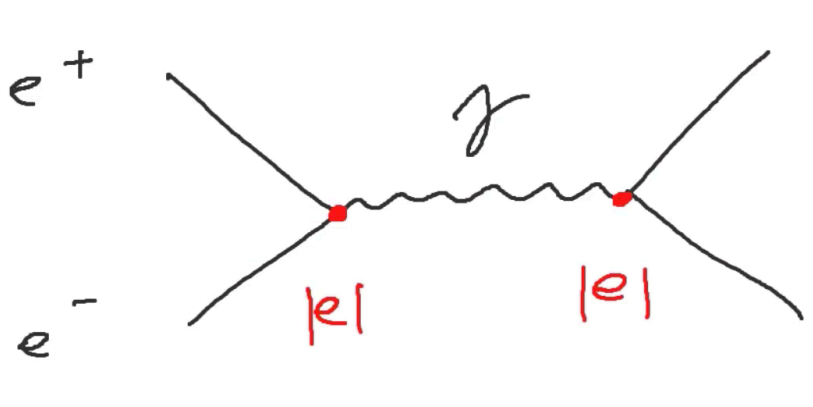


$J/\psi \not\to \gamma\gamma$

$J/\psi \not\to D^0\bar{D}^0$ $\quad m_{J/\psi} < 2m_{D^0}$

$$R = \frac{\#\, e^+e^- \to \text{hadr.}}{\#\, e^-e^+ \to \mu^-\mu^+} \quad \text{... for E sufficiently}$$

$$= \frac{\sigma(e^+e^- \to \text{hadr.})}{\sigma(e^+e^- \to \mu^-\mu^+)}$$



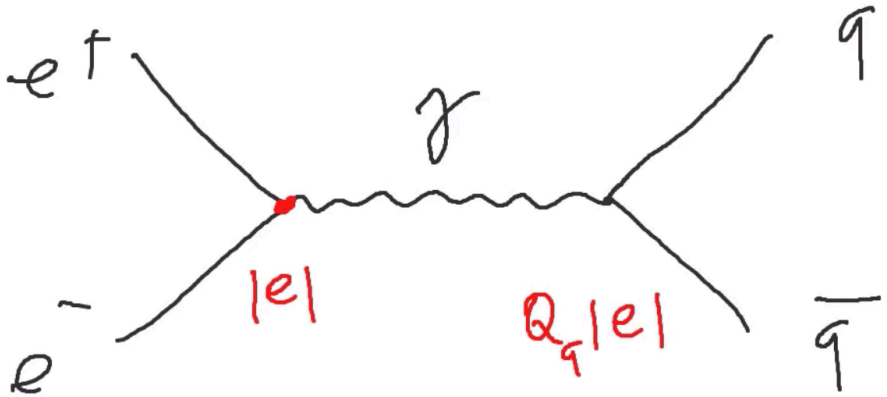
QED

$$\mu^- \sim \mathcal{A}_{\mu\mu} \sim |e|^2 \sim \alpha$$

$$\sigma_{e^+e^- \to \mu^+\mu^-} \sim |\mathcal{A}_{\mu\mu}|^2 \sim |e|^4 \sim \alpha^2$$

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c} \sim \frac{1}{137}$$

$e^+e^- \to$ hadr.



$q = u, d, s, c, b$

die energie e^+e^- erreicht

$$\mathcal{A}_{q\bar{q}} \sim Q_q |e|^2 \sim Q_q \alpha$$

$$\sigma_{q\bar{q}} \sim Q_q^2 |e|^4 \sim Q_q^2 \alpha^2$$

$$\sigma_{e^+e^- \to \text{hadr}} = \sum_{\substack{q: \\ 2m_q > E_{\text{Collision}}}} \sigma_{q\bar{q}}$$

$$\sigma_{qq} \doteq Q_q^2 \cdot \sigma_{\mu\mu} \qquad m_q \approx m_\mu \approx 0 \quad \text{approx.}$$

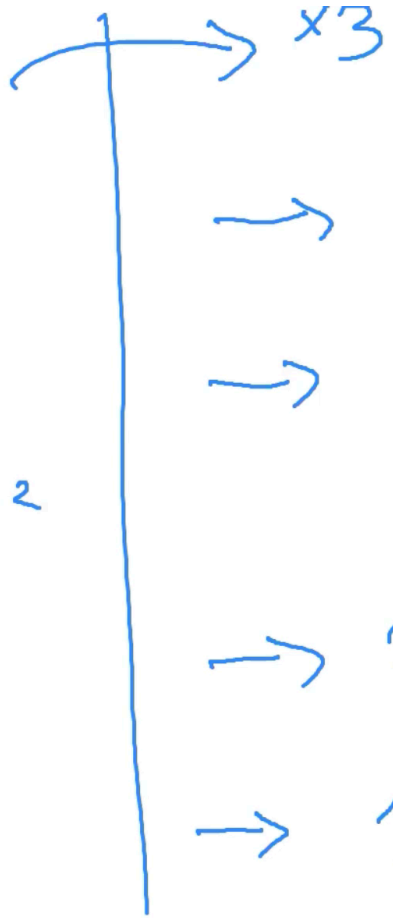
$$\Rightarrow \quad R = \frac{\sum_q \sigma_{qq}}{\sigma_{\mu\mu}} \simeq \sum_q Q_q^2$$

E: skáìnn:

u, d: $\quad R = \left(\frac{2}{3}\right)^2 + \left(\frac{1}{3}\right)^2 = \frac{5}{2}$

u, d, s:

Expt: $R = \sum Q_q^2$



$u\,d$ $\quad R = \left(\frac{2}{3}\right)^2 + \left(\frac{1}{3}\right)^2 = \frac{5}{9}$ $\rightarrow \frac{5}{3}$

u,d,s $\quad R = \left(\frac{2}{3}\right)^2 + 2\left(\frac{1}{3}\right)^2 = \frac{2}{3}$ $\rightarrow 2$

u,d,s,c $\quad R = \left(\frac{2}{3}\right)^2 \cdot 2 + 2 \cdot \left(\frac{1}{3}\right)^2 = \frac{10}{9}$ $\rightarrow \frac{10}{3}$

$u,d,s,c,b = \frac{11}{9}$ $\rightarrow \frac{11}{3}$

$\simeq$ ✓ kvp. ☺ :-)

Ale: 9 ... 3 x barevných variant
... "nábojé"

$\Delta^{++} \equiv (u_\uparrow u_\uparrow u_\uparrow)$ Pauliho princip $\Rightarrow$ barva

$S = 3/2$

Barva: "silný náboj"

q ... 3 barvy

$\bar{q}$ ... 3 antibarvy

$(q\bar{q})$ ... mezony

$(qq'q'')$ ... baryony

| — hadrony ... bezbarvé

$q\bar{q}$ ... barva + antibarva

qqq : $\sum_{i,j,k=1}^{3} q_i\, q'_j\, q''_k\, \varepsilon_{ijk}$ ... antisym.