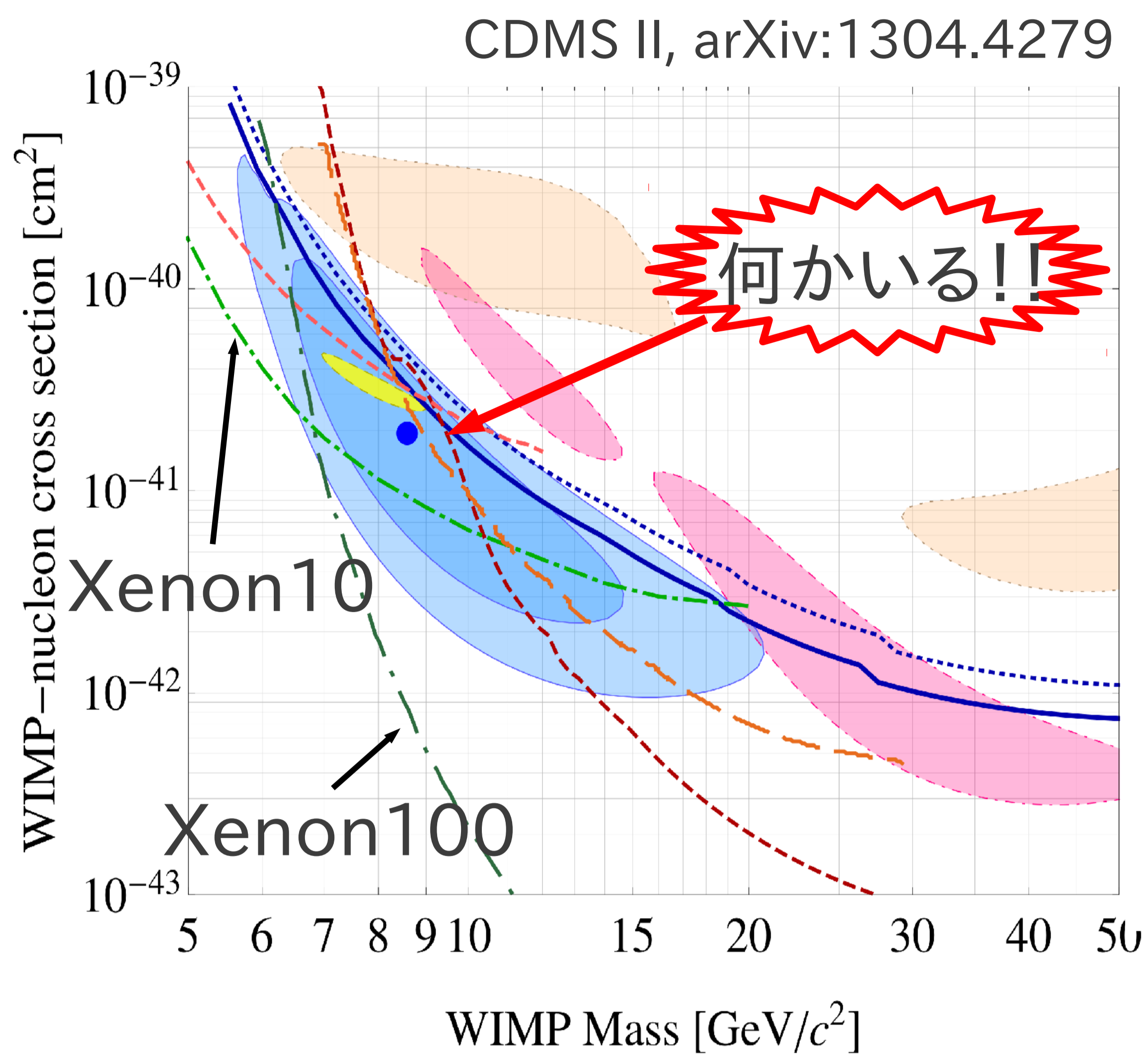


# Vector quarkを用いて軽い暗黒物質を説明する模型

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★ Xenonで排除されている?

→ Isospin violationで避ける。 Feng, et.al., arXiv:1102.4331

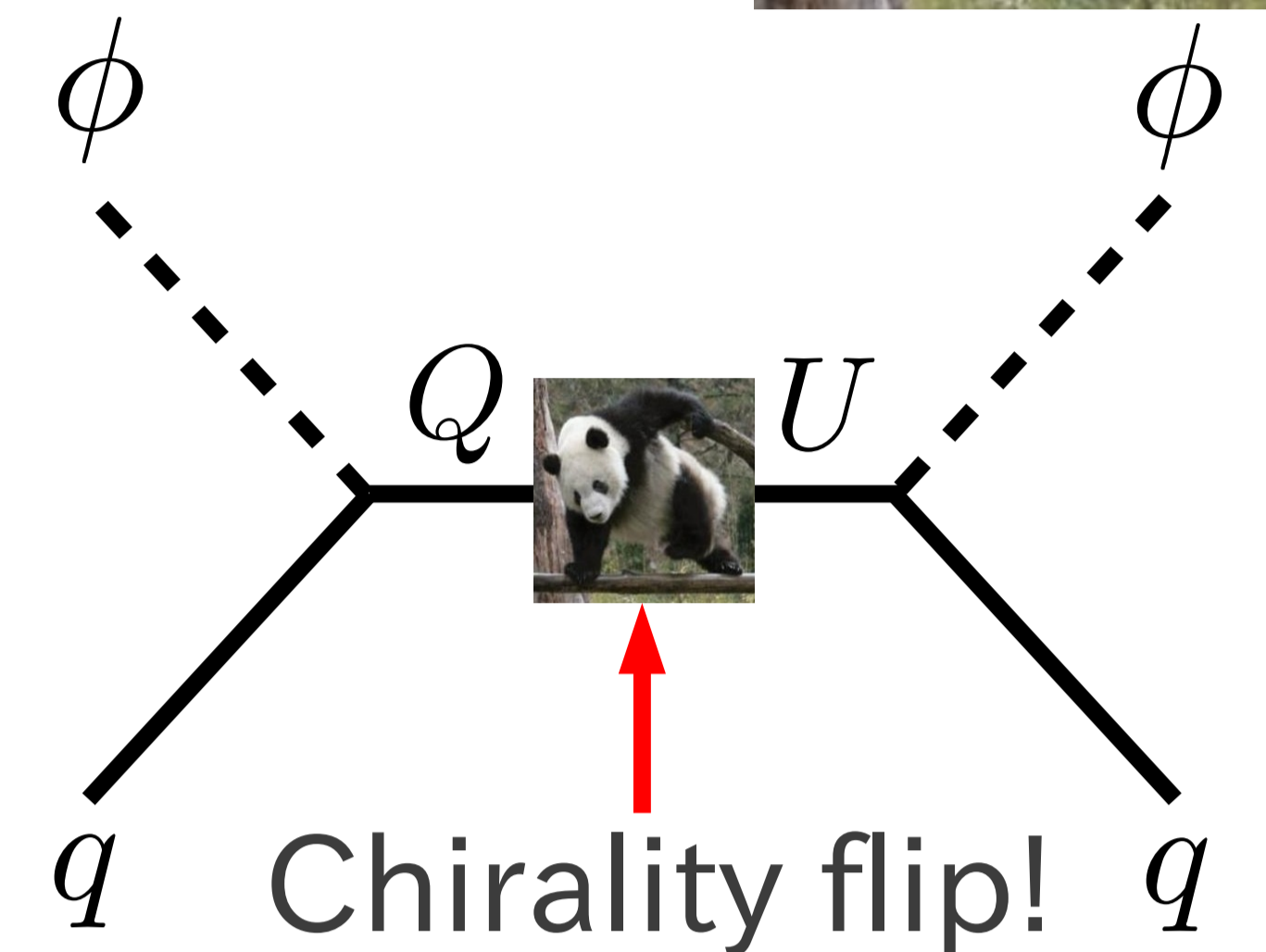
→ LHCのmono jet search で厳しい?

→ Scalar DM を考える。 Feng, et. al., arXiv:1306.2315

Effective theory やってる場合じゃねえ!!



	SU(3)	SU(2)	U(1)	mass
$Q_{L,R}$	□	□	1/6	$m_Q$
$U_{L,R}$	□	1	2/3	$m_U$
$D_{L,R}$	□	1	-1/3	$m_D$

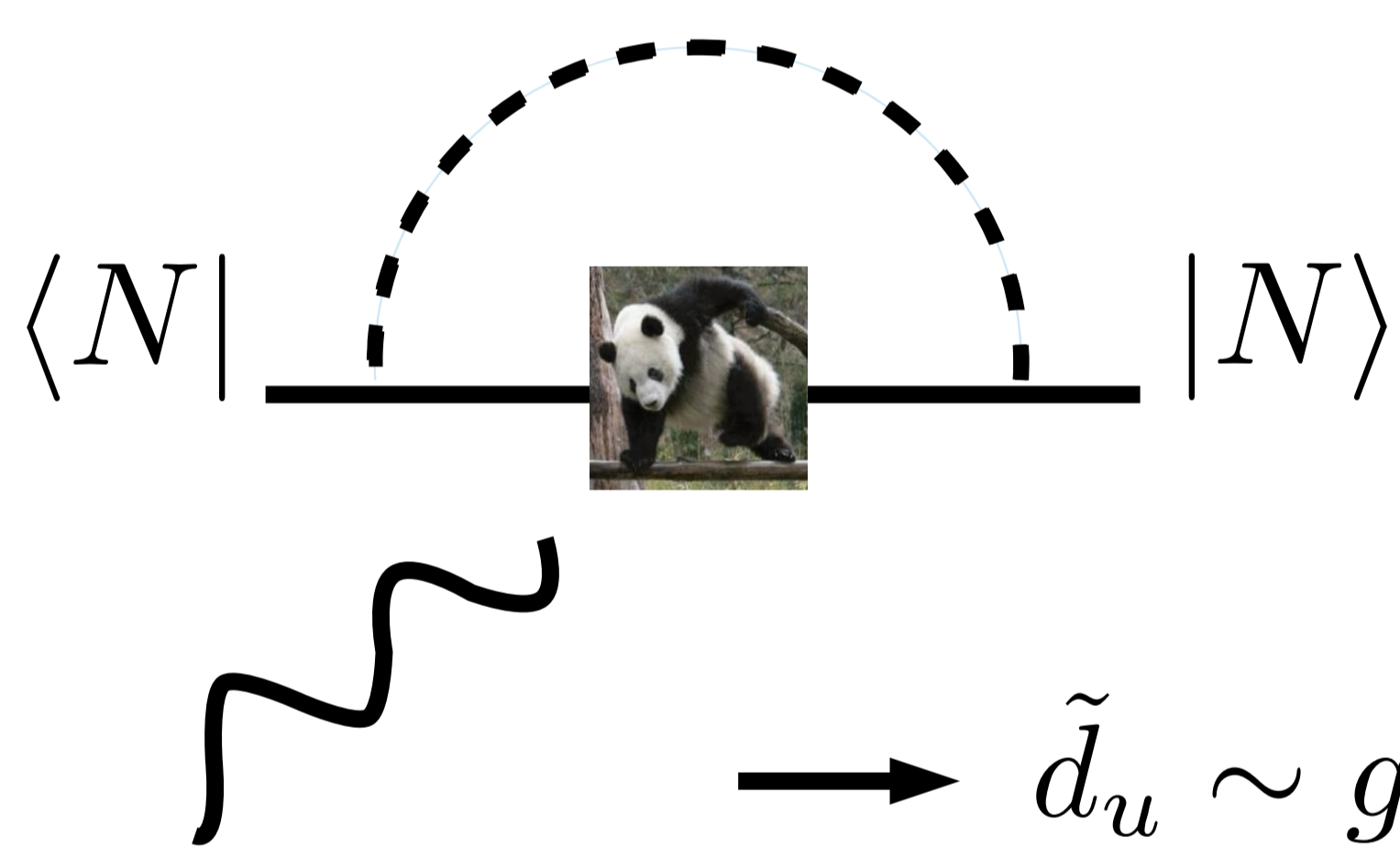


$$\mathcal{L}_Q \supset -y_{UL} e^{i\phi_{UL}} \bar{Q}_R U_L \tilde{H} - y_{DL} e^{i\phi_{DL}} \bar{Q}_R D_L H + (L \leftrightarrow R) \leftarrow \text{Heavy quark mixings (complex)}$$

$$-(y_q \bar{Q}_R Q_L + y_u \bar{U}_L u_R + y_d \bar{D}_L d_R + \dots) \phi + \text{H.c.} \leftarrow \text{あっちとこっちの架け橋 (1世代目とは real)}$$

$$\mathcal{L}_{\text{SI}} = \frac{y_q v}{\sqrt{2} m_Q} \frac{\phi^2}{2} \left( \frac{y_u y_{UR} \cos \phi_{UR}}{m_U} \bar{u} u + \frac{y_d y_{DR} \cos \phi_{DR}}{m_D} \bar{d} d \right) \rightarrow \begin{cases} m_U m_Q = 15 y_q y_u y_{UR} \cos \phi_{UR} [\text{TeV}^2] \\ m_D m_Q = 15 y_q y_d y_{DR} \cos \phi_{DR} [\text{TeV}^2] \end{cases}$$

## Neutron EDM



$$\mathcal{L}_{\text{nEDM}} = -\frac{i}{2} \sum_{q=u,d} \left( d_q \bar{q} (\sigma \cdot F) \gamma_5 q + g_s \tilde{d}_q \bar{q} (\sigma \cdot G) \gamma_5 q \right)$$

Hisano, et. al., arXiv:1204.2653

$$d_n = -0.12 d_u + 0.47 d_d - 0.18 e (\tilde{d}_u - \tilde{d}_d) < 2.9 \times 10^{-26} e \text{ cm}$$

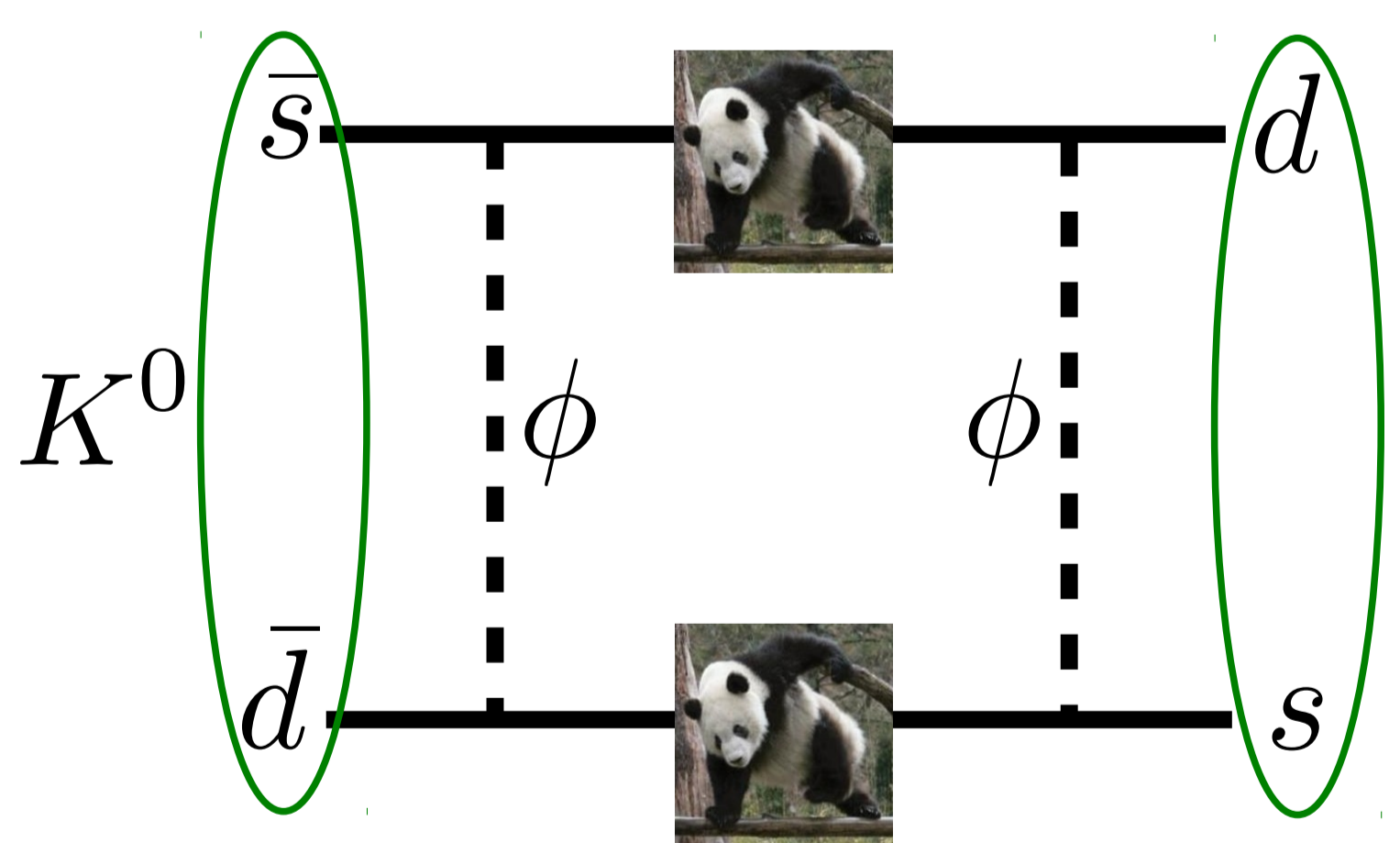
あれ?

$$\tilde{d}_u \sim g_s \frac{y_u y_q y_U \sin \phi_{UR} v}{\sqrt{2} (4\pi)^2 m_U m_Q} \rightarrow d_n = (7.4 \tan \phi_{UR} + 24 \tan \phi_{DR}) \times 10^{-23} e \text{ cm}$$

CPの不思議  $\phi_{UR} = \phi_{UL} = 0$  セーフ!!

## $K^0 - \bar{K}^0$ mixing

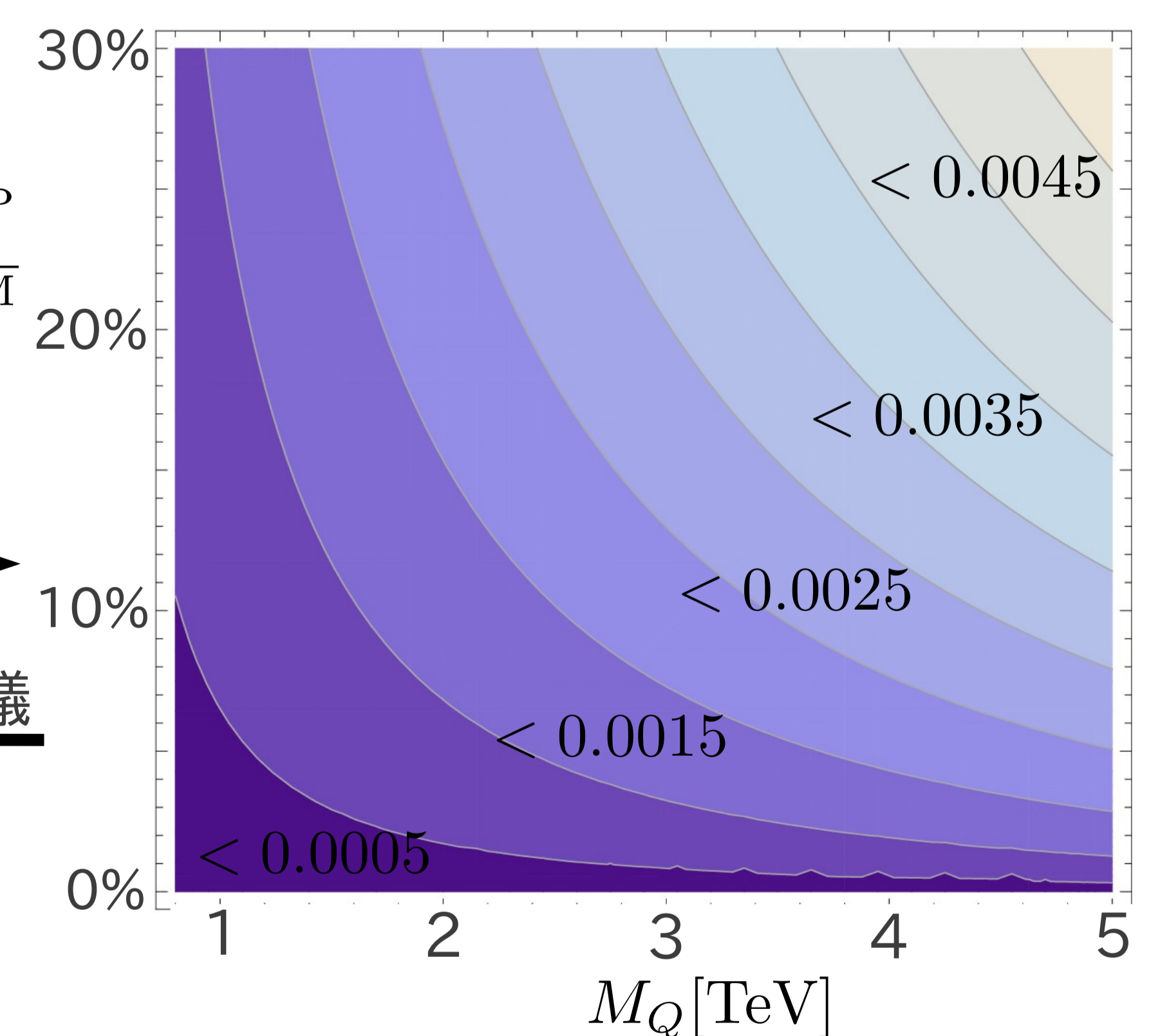
$$\mathcal{L}_K = \left( \frac{G_F m_W}{4\pi} \right)^2 \left( C_{LL}^S (\bar{s}_L d_R)^2 + C_{RR}^S (\bar{s}_R d_L)^2 + C_{LR}^S (\bar{s}_L d_R) (\bar{s}_R d_L) + \text{H.c.} \right)$$



$$C_{XY}^S \sim \frac{1}{\pi \alpha_W} \left( \frac{y_s y_d y_D v^2}{m_D m_Q} \right)^2$$

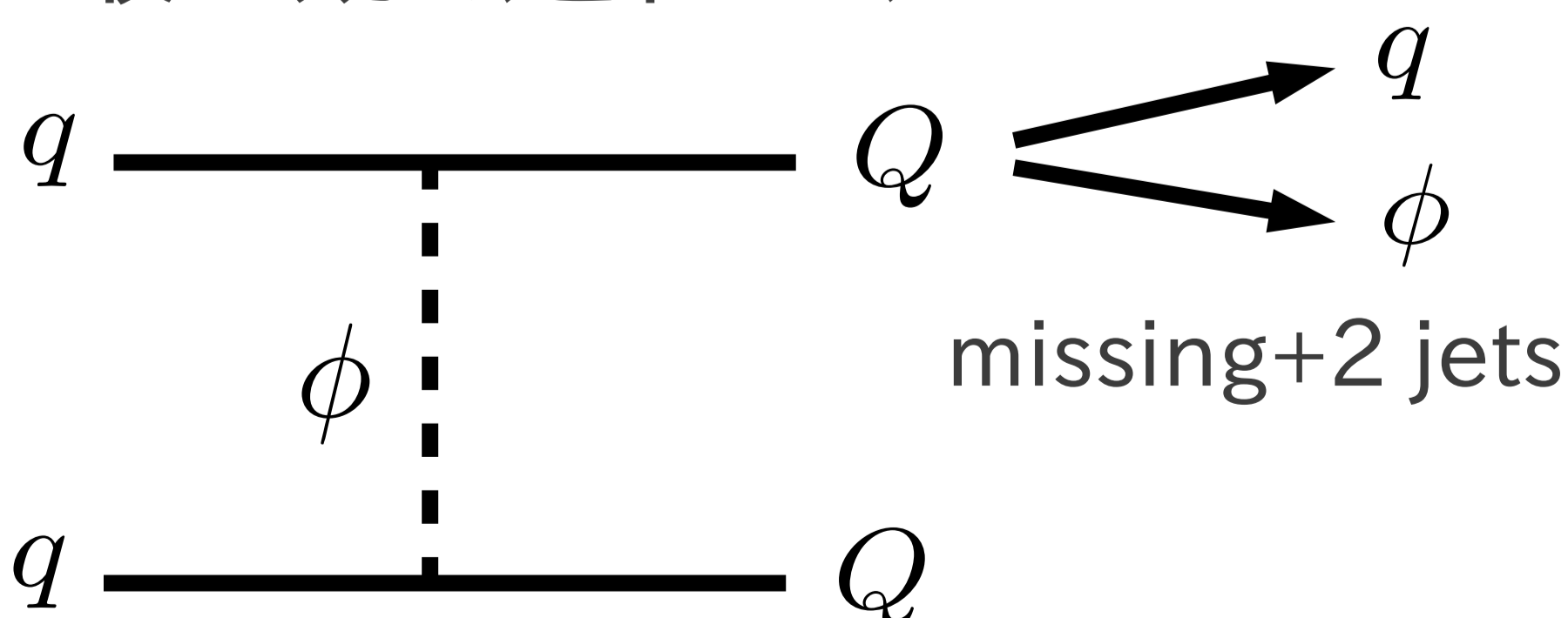
strange との結合に押し付けると

セーフ!! Flavor の不思議



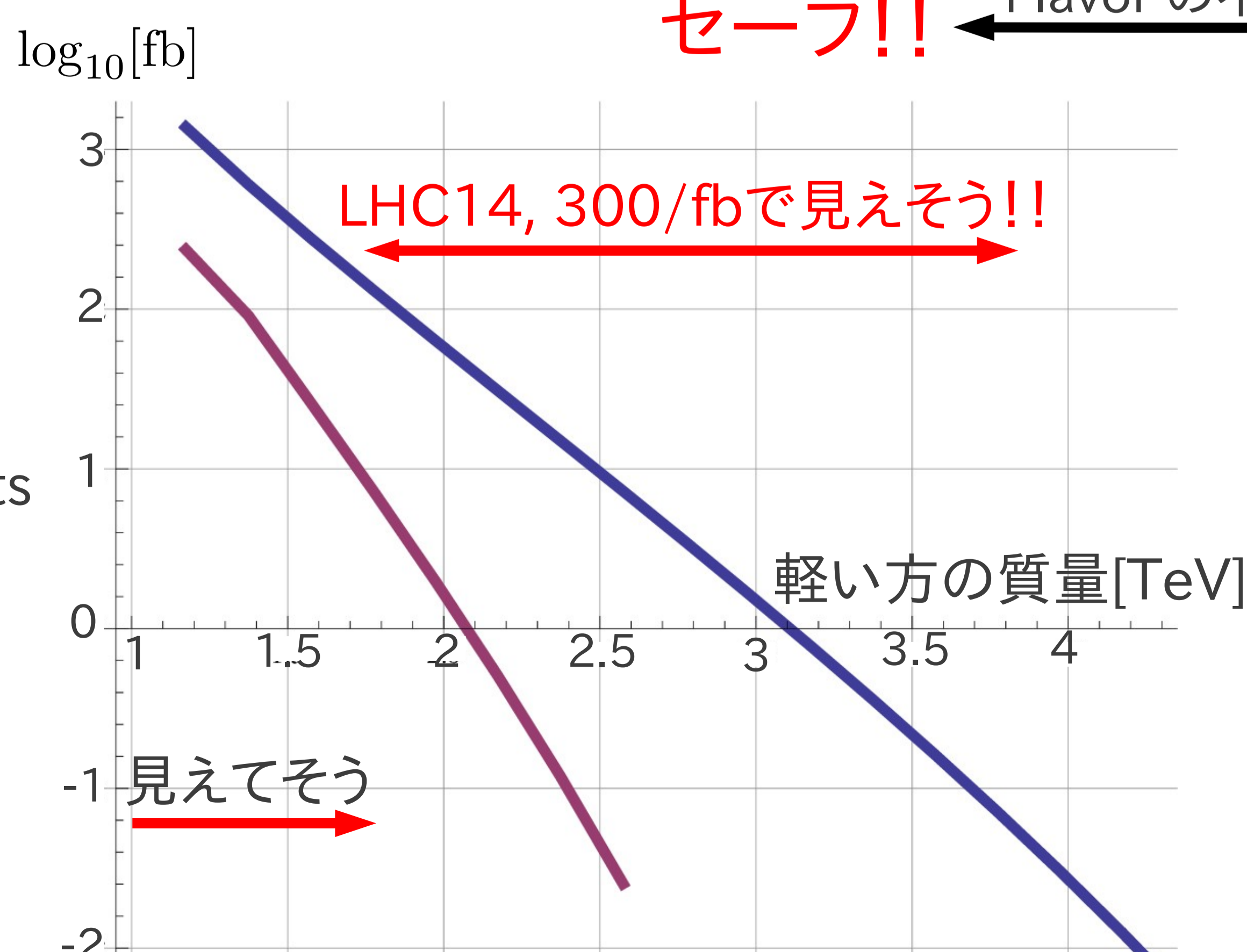
## Collider signals

最も効く過程は、



$$M_V = M_Q \pm 174 \text{ GeV}$$

→ 軽いUがdominant



## まとめ

軽い暗黒物質がありそう!!

重いquarkを探すことは重要!!

(今のところは...)