Flavor-changing hyperon decays with invisible scalars

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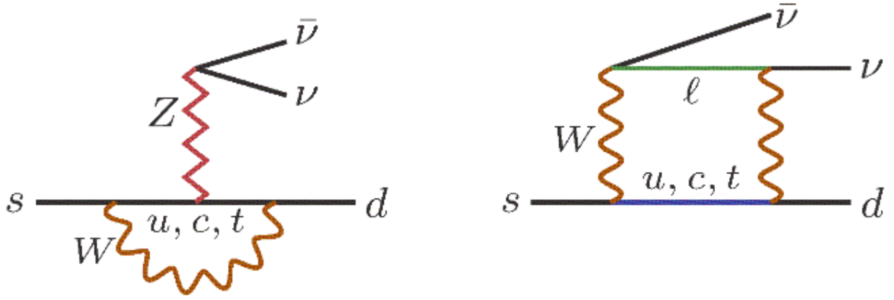
Based on G Li, JY S, J Tandean, Phys. Rev. D 100,no.7, 075003
(arXiv:1905.08759)

Outline

- Introduction
  - Strangeness Hadron decays with missing energy
- New ds quark interactions with invisible scalar bosons in kaon & hyperon decays
- Comparison with invisible fermions
- Conclusion

- In the standard model (SM) the strangeness-changing neutral current decays of hadrons with missing energy ($\not{E}$) arise mainly from the loop-induced quark transition $s \to d\nu\bar{\nu}$



- Such decays are highly suppressed in the SM, with branching fractions of order 10^{-10} or less
  - E.g. SM perdictions $\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu}) = (8.5^{+1.0}_{-1.2}) \times 10^{-11}$

$$\mathcal{B}(K_L \to \pi^0\nu\bar{\nu}) = (3.2^{+1.1}_{-0.7}) \times 10^{-11}$$

Bobeth & Buras, 2018

- The modifications due to new physics (NP) may translate into effects big enough to be discoverable.

K meson decay with missing energy

- Measurements:

$\mathcal{B}(K^+ \to \pi^+ \nu\bar{\nu}) = 1.7(1.1) \times 10^{-10}$ PDG, 2019

$\mathcal{B}(K_L \to \pi^0 \nu\bar{\nu}) < 3.0 \times 10^{-9}$ KOTO, 2019

$\mathcal{B}(K^- \to \pi^0 \pi^- \nu\bar{\nu}) < 4.3 \times 10^{-5}$ E787, 2001

$\mathcal{B}(K_L \to \pi^0 \pi^0 \nu\bar{\nu}) < 8.1 \times 10^{-7}$ E391a, 2011

- Extracting from existing data:

$\mathcal{B}(K_L \to \not{E}) < 6.3 \times 10^{-4}$, $\mathcal{B}(K_S \to \not{E}) < 1.1 \times 10^{-4}$ Gninenko, 2015

- SM predictions:

$\mathcal{B}(K^+ \to \pi^+ \nu\nu) = (8.5^{+1.0}_{-1.2}) \times 10^{-11}$

$\mathcal{B}(K_L \to \pi^0 \nu\bar{\nu}) = (3.2^{+1.1}_{-0.7}) \times 10^{-11}$

Bobeth & Buras, 2018

$\mathcal{B}(K^- \to \pi^0 \pi^- \nu\bar{\nu}) \sim 10^{-14}$

$\mathcal{B}(K_L \to \pi^0 \pi^0 \nu\bar{\nu}) \sim 10^{-13}$

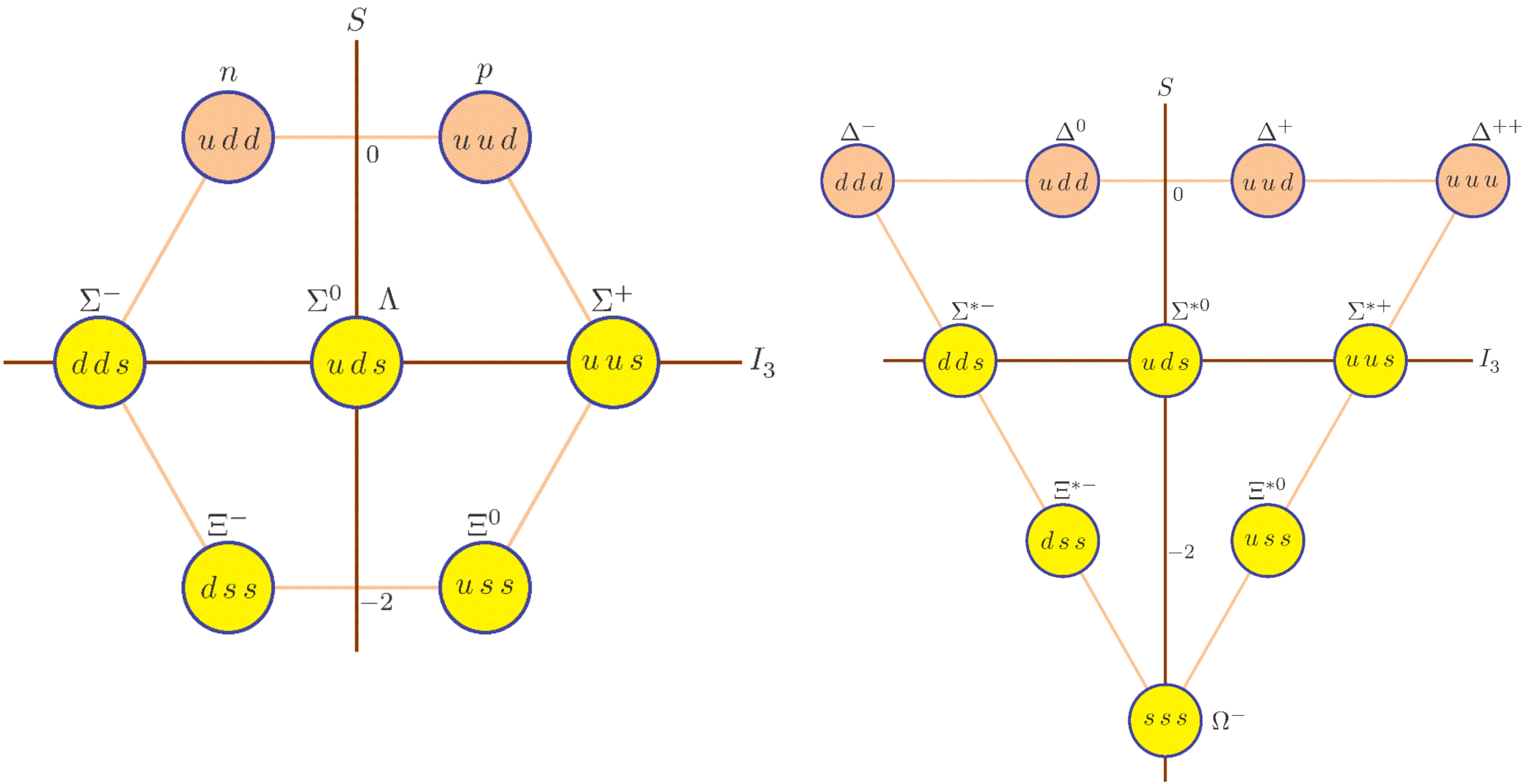
Littenberg & Valencia, 1996
Chiang & Gilman, 2000
Kamenik & Smith, 2012

$\mathcal{B}(K_L \to \nu\bar{\nu}) \lesssim 1 \times 10^{-10}$

$\mathcal{B}(K_S \to \nu\bar{\nu}) \lesssim 2 \times 10^{-14}$

Gninenko, 2015
JT, 1901.10447

Flavor SU(3) octet of spin-1/2 baryons & decuplet of spin-3/2 baryons



Contribution of invisible spin-0 bosons

- Effective Lagrangian for $sd\phi\bar{\phi}$ interactions at low energies

$$-\mathcal{L}_{\rm NP} \supset \left(c_\phi^{\rm V}\,\overline{d}\gamma^\eta s + c_\phi^{\rm A}\overline{d}\gamma^\eta\gamma_5 s\right) i\left(\phi^\dagger\partial_\eta\phi - \partial_\eta\phi^\dagger\phi\right) + \left(c_\phi^{\rm S}\,\overline{d}s + c_\phi^{\rm P}\overline{d}\gamma_5 s\right)\phi^\dagger\phi + H.c.$$

ϕ represents an electrically neutral, colorless, invisible, spin-0 particle.
Model-independently $c_\phi^{\rm V,A,S,P}$ are generally complex free parameters.

- It contributes to $|\Delta S| = 1$ kaon and hyperon decays with missing energy
  - $K \to \phi\bar{\phi}$
  - $K \to \pi\phi\bar{\phi}$
  - $K \to \pi\pi\phi\bar{\phi}$
  - $\mathfrak{B} \to \mathfrak{B}'\phi\bar{\phi},\ \mathfrak{B}\mathfrak{B}' = \Lambda n, \Sigma^+ p, \Xi^0\Lambda, \Xi^0\Sigma^0$
  - $\Omega^- \to \Xi^-\phi\bar{\phi}$

- Mesonic matrix elements

$$\langle 0|\bar{d}\gamma^\eta\gamma_5 s|\overline{K}^0\rangle = \langle 0|\bar{s}\gamma^\eta\gamma_5 d|K^0\rangle = -if_K p_K^\eta, \qquad \langle 0|\bar{d}\gamma_5 s|\overline{K}^0\rangle = \langle 0|\bar{s}\gamma_5 d|K^0\rangle = iB_0 f_K$$

$$\langle 0|\bar{d}(\gamma^\eta, 1)s|\overline{K}^0\rangle = \langle 0|\bar{s}(\gamma^\eta, 1)d|K^0\rangle = (0,0)$$

$$\langle\pi^-|\bar{d}\gamma^\eta s|K^-\rangle = -\langle\pi^+|\bar{s}\gamma^\eta d|K^+\rangle = \left(p_K^\eta + p_\pi^\eta\right)f_+ + \left(f_0 - f_+\right)q_{K\pi}^\eta \frac{m_K^2 - m_\pi^2}{q_{K\pi}^2}$$

$$\langle\pi^-|\bar{d}s|K^-\rangle = \langle\pi^+|\bar{s}d|K^+\rangle = B_0 f_0\,, \qquad B_0 = \frac{m_K^2}{\hat{m} + m_s}, \qquad q_{K\pi} = p_K - p_\pi$$

$$\langle\pi^-|\bar{d}(\gamma^\eta, 1)\gamma_5 s|K^-\rangle = \langle\pi^+|\bar{s}(\gamma^\eta, 1)\gamma_5 d|K^+\rangle = (0,0)$$

$$\left\langle\pi^0(p_0)\,\pi^-(p_-)\middle|\bar{d}\left(\gamma^\eta, 1\right)\gamma_5 s\middle|K^-\right\rangle = \frac{i\sqrt{2}}{f_K}\left[\left(p_0^\eta - p_-^\eta, 0\right) + \frac{(p_0 - p_-)\cdot\tilde{q}}{m_K^2 - \tilde{q}^2}\left(\tilde{q}^\eta, -B_0\right)\right]$$

$$\left\langle\pi^0(p_1)\,\pi^0(p_2)\middle|\bar{d}\left(\gamma^\eta, 1\right)\gamma_5 s\middle|\overline{K}^0\right\rangle = \frac{i}{f_K}\left[\left(p_1^\eta + p_2^\eta, 0\right) + \frac{(p_1 + p_2)\cdot\tilde{q}}{m_K^2 - \tilde{q}^2}\left(\tilde{q}^\eta, -B_0\right)\right]$$

f_K is the kaon decay constant, $f_{+,0}$ represent form factors depending on $q_{K\pi}^2$

$\tilde{q} = p_{K^-} - p_0 - p_- = p_{\bar{K}^0} - p_1 - p_2$

Hadronic matrix elements

- Baryonic matrix elements are estimated with aid of chiral perturbation theory at leading order:

$$\langle \mathfrak{B}' | \bar{d}\gamma^\eta s | \mathfrak{B} \rangle = \mathcal{V}_{\mathfrak{B}'\mathfrak{B}} \bar{u}_{\mathfrak{B}'} \gamma^\eta u_{\mathfrak{B}}, \qquad \langle \mathfrak{B}' | \bar{d}\gamma^\eta \gamma_5 s | \mathfrak{B} \rangle = \bar{u}_{\mathfrak{B}'} \left(\gamma^\eta \mathcal{A}_{\mathfrak{B}'\mathfrak{B}} - \frac{\mathcal{P}_{\mathfrak{B}'\mathfrak{B}}}{B_0} \mathrm{Q}^\eta \right) \gamma_5 u_{\mathfrak{B}},$$

$$\langle \mathfrak{B}' | \bar{d} s | \mathfrak{B} \rangle = \mathcal{S}_{\mathfrak{B}'\mathfrak{B}} \bar{u}_{\mathfrak{B}'} u_{\mathfrak{B}}, \qquad \langle \mathfrak{B}' | \bar{d}\gamma_5 s | \mathfrak{B} \rangle = \mathcal{P}_{\mathfrak{B}'\mathfrak{B}} \bar{u}_{\mathfrak{B}'} \gamma_5 u_{\mathfrak{B}}, \qquad \mathrm{Q} = p_{\mathfrak{B}} - p_{\mathfrak{B}'}$$

$\mathfrak{B}'\mathfrak{B}$	$n\Lambda$	$p\Sigma^+$	$\Lambda\Xi^0$	$\Sigma^0\Xi^0$	$\Sigma^-\Xi^-$
$\mathcal{V}_{\mathfrak{B}'\mathfrak{B}}$	$-\sqrt{\frac{3}{2}}$	-1	$\sqrt{\frac{3}{2}}$	$\frac{-1}{\sqrt{2}}$	1
$\mathcal{A}_{\mathfrak{B}'\mathfrak{B}}$	$\frac{-1}{\sqrt{6}}(D+3F)$	$D-F$	$\frac{-1}{\sqrt{6}}(D-3F)$	$\frac{-1}{\sqrt{2}}(D+F)$	$D+F$

$$\mathcal{S}_{\mathfrak{B}'\mathfrak{B}} = \frac{m_{\mathfrak{B}} - m_{\mathfrak{B}'}}{m_s - \hat{m}} \mathcal{V}_{\mathfrak{B}'\mathfrak{B}}\,, \qquad \mathcal{P}_{\mathfrak{B}'\mathfrak{B}} = \mathcal{A}_{\mathfrak{B}'\mathfrak{B}} B_0 \frac{m_{\mathfrak{B}'} + m_{\mathfrak{B}}}{m_K^2 - \mathrm{Q}^2}$$

$$\langle \Xi^- | \bar{d}\gamma^\eta \gamma_5 s | \Omega^- \rangle = \mathcal{C}\, \bar{u}_\Xi \left(u_\Omega^\eta + \frac{\tilde{\mathrm{Q}}^\eta \tilde{\mathrm{Q}}_\kappa}{m_K^2 - \tilde{\mathrm{Q}}^2} u_\Omega^\kappa \right), \qquad \langle \Xi^- | \bar{d}\gamma_5 s | \Omega^- \rangle = \frac{B_0\, \mathcal{C}\, \tilde{\mathrm{Q}}_\kappa}{\tilde{\mathrm{Q}}^2 - m_K^2} \bar{u}_\Xi u_\Omega^\kappa$$

$$\langle \Xi^- | \bar{d}\gamma^\eta s | \Omega^- \rangle = \langle \Xi^- | \bar{d} s | \Omega^- \rangle = 0\,, \qquad \tilde{\mathrm{Q}} = p_{\Omega^-} - p_{\Xi^-}$$

Contributions of couplings to kaon and hyperon modes

$$-\mathcal{L}_{\rm NP} \supset \left(c^{V}_{\phi}\,\overline{d}\gamma^{\eta}s + c^{A}_{\phi}\overline{d}\gamma^{\eta}\gamma_5 s\right) i\left(\phi^{\dagger}\partial_{\eta}\phi - \partial_{\eta}\phi^{\dagger}\phi\right)$$
$$+\left(c^{S}_{\phi}\,\overline{d}s + c^{P}_{\phi}\overline{d}\gamma_5 s\right)\phi^{\dagger}\phi + H.c.$$

Decay mode	$K \to \phi\bar{\phi}$	$K \to \pi\phi\bar{\phi}$	$K \to \pi\pi'\phi\bar{\phi}$	$\mathfrak{B} \to \mathfrak{B}'\phi\bar{\phi}$	$\Omega^- \to \Xi^-\phi\bar{\phi}$
Couplings	c^{P}_{ϕ}	$c^{V}_{\phi},\ c^{S}_{\phi}$	$c^{A}_{\phi},\ c^{P}_{\phi}$	$c^{V}_{\phi},\ c^{A}_{\phi},\ c^{S}_{\phi},\ c^{P}_{\phi}$	$c^{A}_{\phi},\ c^{P}_{\phi}$

NP couplings affecting FCNC kaon & hyperon decays with missing energy carried by spin-0 bosons $\phi\bar{\phi}$

Kaon sector as constraints

- $K \to \not{E}$

$\mathcal{B}(K_L \to \not{E}) < 6.3 \times 10^{-4}\,,\quad \mathcal{B}(K_S \to \not{E}) < 1.1 \times 10^{-4}$ Gninenko, 2015

$\mathcal{B}(K_L \to \nu\bar{\nu}) \lesssim 1 \times 10^{-10}\,,\quad \mathcal{B}(K_S \to \nu\bar{\nu}) \lesssim 2 \times 10^{-14}$ Gninenko, 2015; JT, 1901.10447

- $K \to \pi\not{E}$

$\mathcal{B}(K^+ \to \pi^+\nu\nu) = 1.7(1.1) \times 10^{-10}$ PDG, 2019

$\mathcal{B}(K_L \to \pi^0\nu\bar{\nu}) < 3.0 \times 10^{-9}$ KOTO, 2019

$\mathcal{B}(K^+ \to \pi^+\nu\nu) = (8.5^{+1.0}_{-1.2}) \times 10^{-11}$

$\mathcal{B}(K_L \to \pi^0\nu\bar{\nu}) = (3.2^{+1.1}_{-0.7}) \times 10^{-11}$ Bobeth & Buras, 2018

- $K \to \pi\pi\not{E}$

$\mathcal{B}(K^- \to \pi^0\pi^-\nu\bar{\nu}) < 4.3 \times 10^{-5}$ E787, 2001

$\mathcal{B}(K_L \to \pi^0\pi^0\nu\bar{\nu}) < 8.1 \times 10^{-7}$ E391a, 2011

$\mathcal{B}(K^- \to \pi^0\pi^-\nu\bar{\nu}) \sim 10^{-14}$

$\mathcal{B}(K_L \to \pi^0\pi^0\nu\bar{\nu}) \sim 10^{-13}$

Littenberg & Valencia, 1996; Chiang & Gilman, 2000; Kamenik & Smith, 2012

Decay mode	$K \to \phi\bar{\phi}$	$K \to \pi\phi\bar{\phi}$	$K \to \pi\pi'\phi\bar{\phi}$	$\mathfrak{B} \to \mathfrak{B}'\phi\bar{\phi}$	$\Omega^- \to \Xi^-\phi\bar{\phi}$
Couplings	c_ϕ^P	$c_\phi^V,\ c_\phi^S$	$c_\phi^A,\ c_\phi^P$	$c_\phi^V,\ c_\phi^A,\ c_\phi^S,\ c_\phi^P$	$c_\phi^A,\ c_\phi^P$

$K \to \not{E}$ & $K \to \pi\pi\not{E}$ has weaker constraint from experiment

- NP contributing only through operators with pseudoscalar ds part

$$-\mathcal{L}_{\rm NP} \supset c_\phi^{\rm P} \overline{d} \gamma_5 s\, \phi^\dagger \phi + H.c.$$

- The constraints come mainly from $K \to \not{E}$ and lead to

$$\left|c_\phi^{\rm P}\right|^2 < 1.1 \times 10^{-16}\ {\rm GeV}^{-2}$$

- Obtaining

$$\mathcal{B}(\Lambda \to n\phi\bar{\phi}) < 1.3 \times 10^{-7}\,, \quad \mathcal{B}(\Sigma^+ \to p\phi\bar{\phi}) < 3.7 \times 10^{-8}\,,$$
$$\mathcal{B}(\Xi^0 \to \Lambda\phi\bar{\phi}) < 1.9 \times 10^{-8}\,, \quad \mathcal{B}(\Xi^0 \to \Sigma^0\phi\bar{\phi}) < 2.5 \times 10^{-8}\,,$$
$$\mathcal{B}(\Omega^- \to \Xi^-\phi\bar{\phi}) < 1.6 \times 10^{-6}\,.$$

- The upper values of these limits is close to the BESIII sensitivity levels.

Estimated BESIII sensitivity for branching fractions Li, 2017

$\Lambda \to n\nu\bar{\nu}$	$\Sigma^+ \to p\nu\bar{\nu}$	$\Xi^0 \to \Lambda\nu\bar{\nu}$	$\Xi^0 \to \Sigma^0\nu\bar{\nu}$	$\Omega^- \to \Xi^-\nu\bar{\nu}$
3×10^{-7}	4×10^{-7}	8×10^{-7}	9×10^{-7}	2.6×10^{-5}

NP-enhanced hyperon rates ($m_\phi = 0$)

- NP contributing only through operators with axial-vector ds part

$$-\mathcal{L}_{\rm NP} \supset c_\phi^{A} \bar{d}\gamma^\eta\gamma_5 s\, i(\phi^\dagger\partial_\eta\phi - \partial_\eta\phi^\dagger\phi) + H.c.$$

- The constraints come mainly from $K_L \to \pi^0\pi^0 \not{E}$ and lead to

$$\left(\mathrm{Re}\, c_\phi^{A}\right)^2 < 3.8 \times 10^{-13}\ \mathrm{GeV}^{-4}$$

- This translate into

$$\mathcal{B}(\Lambda \to n\phi\bar{\phi}) < 6.6 \times 10^{-6}, \quad \mathcal{B}(\Sigma^+ \to p\phi\bar{\phi}) < 1.7 \times 10^{-6},$$
$$\mathcal{B}(\Xi^0 \to \Lambda\phi\bar{\phi}) < 9.4 \times 10^{-7}, \quad \mathcal{B}(\Xi^0 \to \Sigma^0\phi\bar{\phi}) < 1.3 \times 10^{-6},$$
$$\mathcal{B}(\Omega^- \to \Xi^-\phi\bar{\phi}) < 7.5 \times 10^{-5}.$$

- The upper values of these limits exceed the BESIII sensitivity levels.

Estimated BESIII sensitivity for branching fractions — Li, 2017

$\Lambda \to n\nu\bar{\nu}$	$\Sigma^+ \to p\nu\bar{\nu}$	$\Xi^0 \to \Lambda\nu\bar{\nu}$	$\Xi^0 \to \Sigma^0\nu\bar{\nu}$	$\Omega^- \to \Xi^-\nu\bar{\nu}$
3×10^{-7}	4×10^{-7}	8×10^{-7}	9×10^{-7}	2.6×10^{-5}

NP-enhanced hyperon rates ($m_\phi > 0$)

- With $m_\phi > 0$, maximal branching fractions of hyperon modes can be higher

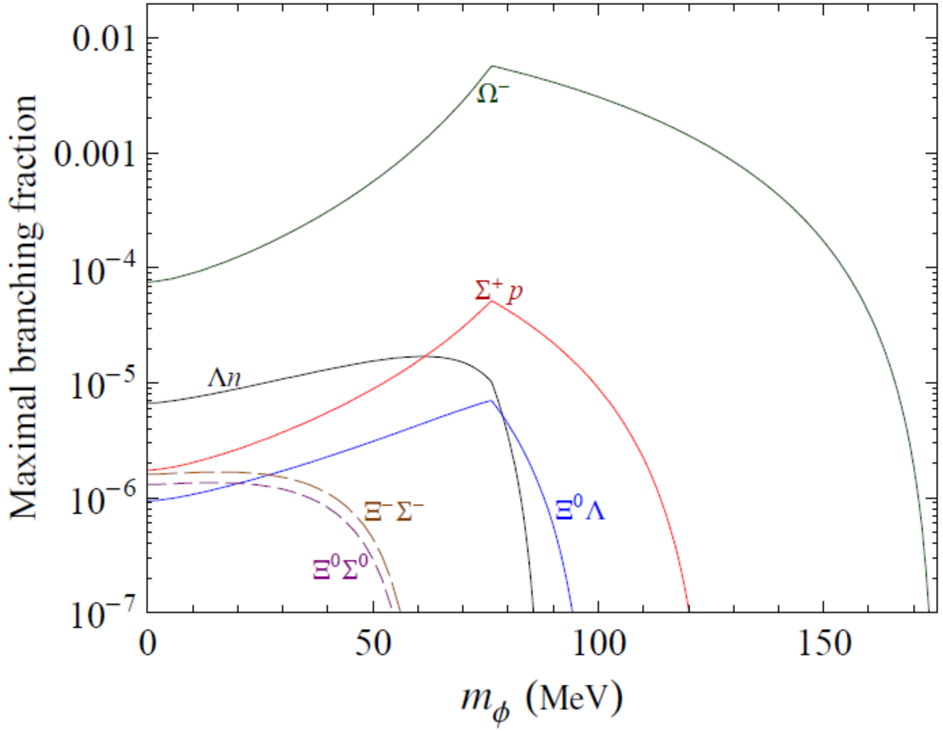


FIG. 1: The maximal branching fractions of $\mathfrak{B} \to \mathfrak{B}'\phi\bar{\phi}$ with $\mathfrak{B}\mathfrak{B}' = \Lambda n, \Sigma^+ p, \Xi^0\Lambda, \Xi^0\Sigma^0, \Xi^-\Sigma^-$ and of $\Omega^- \to \Xi^-\phi\bar{\phi}$, indicated on the plot by the $\mathfrak{B}\mathfrak{B}'$ and Ω^- labels, respectively, versus m_ϕ, induced by the contribution of $\mathrm{Re}\, \mathsf{c}_\phi^{\mathsf{A}}$ alone, subject to the $K_L \to \pi^0\pi^0 \not{E}$ constraint and the perturbativity requirement for $m_\phi > 76$ MeV as explained in the text.

Invisible fermions as contribution to FCNC

- Effective Lagrangian for $sd\mathtt{f}\bar{\mathtt{f}}$ interactions at low energies

$$\mathcal{L}_{\mathtt{f}} = -\Big[\overline{d}\gamma^\eta s\ \overline{\mathtt{f}}\gamma_\eta\big(\mathrm{C}^{\mathrm{V}}_{\mathtt{f}} + \gamma_5\mathrm{C}^{\mathrm{A}}_{\mathtt{f}}\big)\mathtt{f} + \overline{d}\gamma^\eta\gamma_5 s\ \overline{\mathtt{f}}\gamma_\eta\big(\tilde{\mathrm{c}}^{\mathrm{V}}_{\mathtt{f}} + \gamma_5\tilde{\mathrm{c}}^{\mathrm{A}}_{\mathtt{f}}\big)\mathtt{f}$$
$$+ \overline{d}s\ \overline{\mathtt{f}}\big(\mathrm{C}^{\mathrm{S}}_{\mathtt{f}} + \gamma_5\mathrm{C}^{\mathrm{P}}_{\mathtt{f}}\big)\mathtt{f} + \overline{d}\gamma_5 s\ \overline{\mathtt{f}}\big(\tilde{\mathrm{c}}^{\mathrm{S}}_{\mathtt{f}} + \gamma_5\tilde{\mathrm{c}}^{\mathrm{P}}_{\mathtt{f}}\big)\mathtt{f}\Big] + \mathrm{H.c.}$$

JT, 1901.10447

- It contributes to $|\Delta S| = 1$ kaon and hyperon decays with missing energy.
  - $K \to \pi\mathtt{f}\bar{\mathtt{f}}$
  - $K \to \pi\pi'\mathtt{f}\bar{\mathtt{f}}$
  - $K \to \mathtt{f}\bar{\mathtt{f}}$
  - $\mathfrak{B} \to \mathfrak{B}'\mathtt{f}\bar{\mathtt{f}}$, $\mathfrak{B}\mathfrak{B}' = \Lambda n, \Sigma^+ p, \Xi^0\Lambda, \Xi^0\Sigma^0$
  - $\Omega^- \to \Xi^-\mathtt{f}\bar{\mathtt{f}}$

NP-enhanced hyperon rates ($m_f = 0$)

- NP contributing only through operators with pseudoscalar ds part

$$\mathcal{L}_f \supset -\overline{d}\gamma_5 s\, \overline{f}\left(\tilde{c}_f^{S} + \gamma_5 \tilde{c}_f^{P}\right) f + \text{H.c.}$$

- The constraints come mainly from $K \to \not{E}$ and lead to

$$\left|\tilde{c}_f^{S}\right|^2 + \left|\tilde{c}_f^{P}\right|^2 < 2.2 \times 10^{-16}\ \text{GeV}^{-4}$$

- Obtaining

$$\mathcal{B}(\Lambda \to n f \bar{f}) < 5.0 \times 10^{-9}, \quad \mathcal{B}(\Sigma^+ \to p f \bar{f}) < 3.0 \times 10^{-9},$$
$$\mathcal{B}(\Xi^0 \to \Lambda f \bar{f}) < 9.4 \times 10^{-10}, \quad \mathcal{B}(\Xi^0 \to \Sigma^0 f \bar{f}) < 4.4 \times 10^{-10},$$
$$\mathcal{B}(\Omega^- \to \Xi^- f \bar{f}) < 3.0 \times 10^{-7}.$$

JT, 1901.10447

Estimated BESIII sensitivity for branching fractions

Li, 2017

$\Lambda \to n\nu\bar{\nu}$	$\Sigma^+ \to p\nu\bar{\nu}$	$\Xi^0 \to \Lambda\nu\bar{\nu}$	$\Xi^0 \to \Sigma^0\nu\bar{\nu}$	$\Omega^- \to \Xi^-\nu\bar{\nu}$
3×10^{-7}	4×10^{-7}	8×10^{-7}	9×10^{-7}	2.6×10^{-5}

NP-enhanced hyperon rates ($m_f = 0$)

- NP contributing only through operators with axial-vector ds part

$$\mathcal{L}_f \supset -\bar{d}\gamma^\eta\gamma_5 s\, \bar{f}\gamma_\eta\left(\tilde{c}_f^V + \gamma_5\tilde{c}_f^A\right)f + \text{H.c.}$$

- The constraints come mainly from $K_L \to \pi^0\pi^0 \not{E}$ and lead to

$$\left(\text{Re}\,\tilde{c}_f^V\right)^2 + \left(\text{Re}\,\tilde{c}_f^A\right)^2 < 9.4\times10^{-14}\,\text{GeV}^{-4}$$

- This translate into

$$\mathcal{B}\left(\Lambda\to nf\bar{f}\right) < 6.6\times10^{-6}, \qquad \mathcal{B}\left(\Sigma^+\to pf\bar{f}\right) < 1.7\times10^{-6}$$

$$\mathcal{B}\left(\Xi^0\to\Lambda f\bar{f}\right) < 9.4\times10^{-7}, \qquad \mathcal{B}\left(\Xi^0\to\Sigma^0 f\bar{f}\right) < 1.3\times10^{-6}$$

$$\mathcal{B}\left(\Omega^-\to\Xi^- f\bar{f}\right) < 7.5\times10^{-5}$$

JT, 1901.10447

- The upper values of these limits exceed the BESIII sensitivity levels.

Estimated BESIII sensitivity for branching fractions   Li, 2017

$\Lambda\to n\nu\bar{\nu}$	$\Sigma^+\to p\nu\bar{\nu}$	$\Xi^0\to\Lambda\nu\bar{\nu}$	$\Xi^0\to\Sigma^0\nu\bar{\nu}$	$\Omega^-\to\Xi^-\nu\bar{\nu}$
3×10^{-7}	4×10^{-7}	8×10^{-7}	9×10^{-7}	2.6×10^{-5}

Comparison with invisible fermions

Decay mode	$\Lambda \to n \not{E}$	$\Sigma^+ \to p \not{E}$	$\Xi^0 \to \Lambda \not{E}$	$\Xi^0 \to \Sigma^0 \not{E}$	$\Omega^- \to \Xi^- \not{E}$
Expected BESIII sensitivity	3×10^{-7}	4×10^{-7}	8×10^{-7}	9×10^{-7}	2.6×10^{-5}
ds$\phi\bar{\phi}$ pseudoscalar	1.3×10^{-7}	3.7×10^{-8}	1.9×10^{-8}	2.5×10^{-8}	1.6×10^{-6}
ds$\phi\bar{\phi}$ axial vector	6.6×10^{-6}	1.7×10^{-6}	9.4×10^{-7}	1.3×10^{-6}	7.5×10^{-5}
ds$f\bar{f}$ pseudoscalar	5.0×10^{-9}	3.0×10^{-9}	9.4×10^{-10}	4.4×10^{-10}	3.0×10^{-7}
ds$f\bar{f}$ axial vector	6.6×10^{-6}	1.7×10^{-6}	9.4×10^{-7}	1.3×10^{-6}	7.5×10^{-5}

Conclusions

- FCNC hyperon & kaon decays with missing energy are potentially sensitive to physics beyond the SM, while they have different set of underlying NP operators.
- Ongoing & future experiments on the hyperon ones can provide access to possible NP effects which is complementary to that from the kaon sectors.
- NP with invisible scalars is more detectable for future experiments.

Thank You!