Muon g-2 and FCNC in Split-Family SUSY

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Discovery of Higgs boson

Higgs boson mass

$$m_{\rm Higgs} \simeq 125\,{\rm GeV}$$

ATLAS, CMS (2012)

Standard model is now complete!!

Muon g-2

Muon anomalous magnetic moment

Measured value deviates from SM prediction

$$\delta a_\mu \equiv a_\mu^{\rm exp} - a_\mu^{\rm SM} = (27.06 \pm 7.26) \times 10^{-10}$$

Muon g-2 collaboration (2006)
New Muon g-2 collaboration (2010)
Hagiwara *et.al*. (2011)
Nomura *et.al*. (2018)

3.7 σ deviation!!

Minimal Supersymmetric Standard Model

To obtain observed Higgs mass

$$m_{\rm stop} \simeq \mathcal{O}(10)\,{\rm TeV}$$

To explain muon g-2

$$m_{\rm smuon} \simeq \mathcal{O}(100)\,{\rm GeV}$$

Split-Family SUSY model

Ibe, Yokozaki, and Yanagida (2013)

Let us assume split sfermion masses

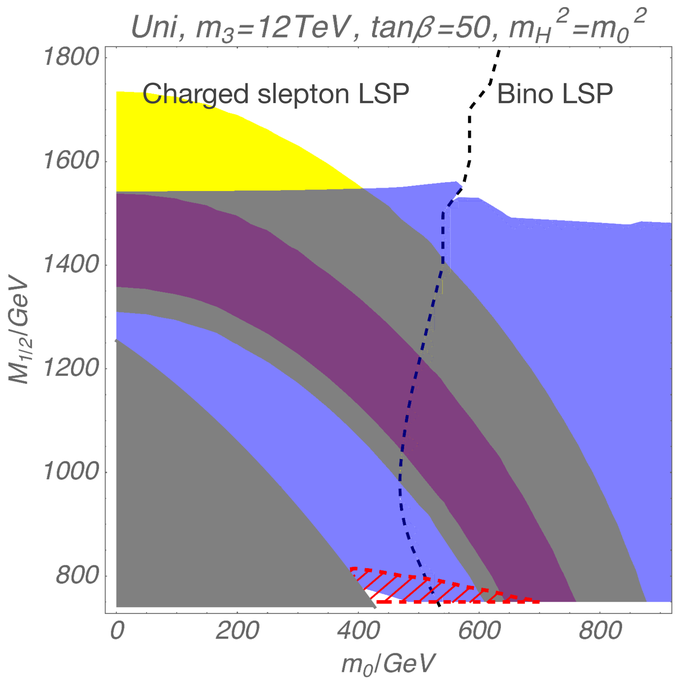
First two generation sfermons and third one are light and heavy, respectively

$$m^2_{\rm soft} = \begin{pmatrix} m_0^2 & 0 & 0 \\ 0 & m_0^2 & 0 \\ 0 & 0 & m_3^2 \end{pmatrix} \qquad \begin{aligned} m_0 &\simeq \mathcal{O}(100)\,{\rm GeV} \\ m_3 &\simeq \mathcal{O}(10)\,{\rm TeV} \end{aligned}$$

✔ Higgs boson mass and muon g-2

Split-Family SUSY model !!

Case I. Universal gaugino mass



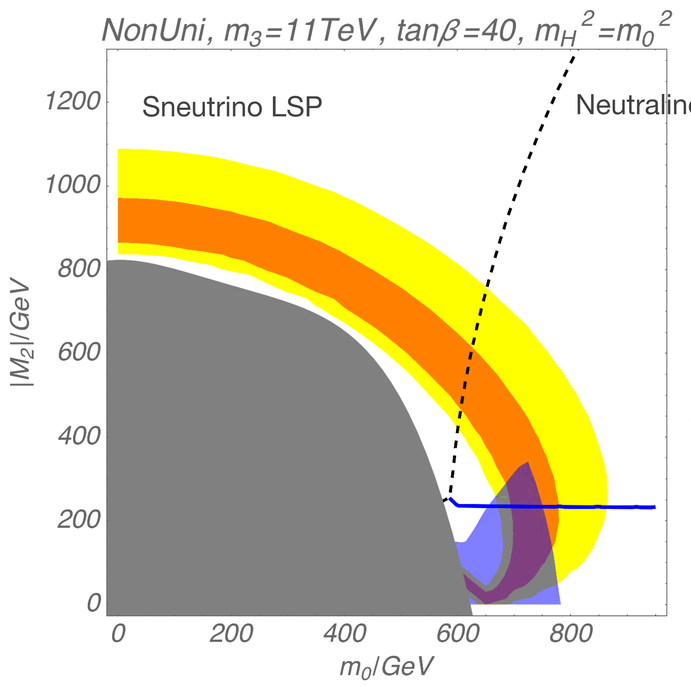
(GUT scale inputs)

Blue shaded region

Collider constraints ATLAS, CMS

$m_{\rm gluino},\ m_{\rm squark} \lesssim 2.6\,{\rm TeV}$

Case II. Non-universal gaugino masses



(GUT scale inputs)

$$M_3 = 2.6\,{\rm TeV}$$
$$M_2 = 1.8 M_1$$

Blue shaded region

Collider constraints ATLAS, CMS

$m_{\rm selectron},\ m_{\rm smuon} \lesssim 400\,{\rm GeV}$

Flavor Changing Neutral Current in Split-Family SUSY model

Light masses of first two generation sfermions

↓

Large FCNCs

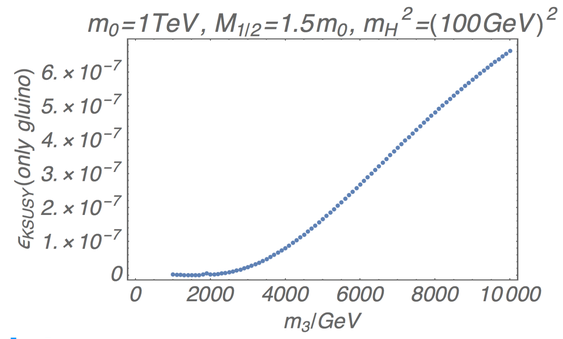
and

Large sfermion mass splitting

↓

Enhancement of FCNCs

e.g. εK: CP violating parameter in neutral kaon system



FCNC constraints

Lepton flavor mixings

Assuming CKM matrix like mixing for sleptons

$$(\sin\theta_{12}, \sin\theta_{13}, \sin\theta_{23}) = (\epsilon, \epsilon^3, \epsilon^3)$$
$$(\epsilon \simeq 0.2 \text{ for CKM})$$

Current limits

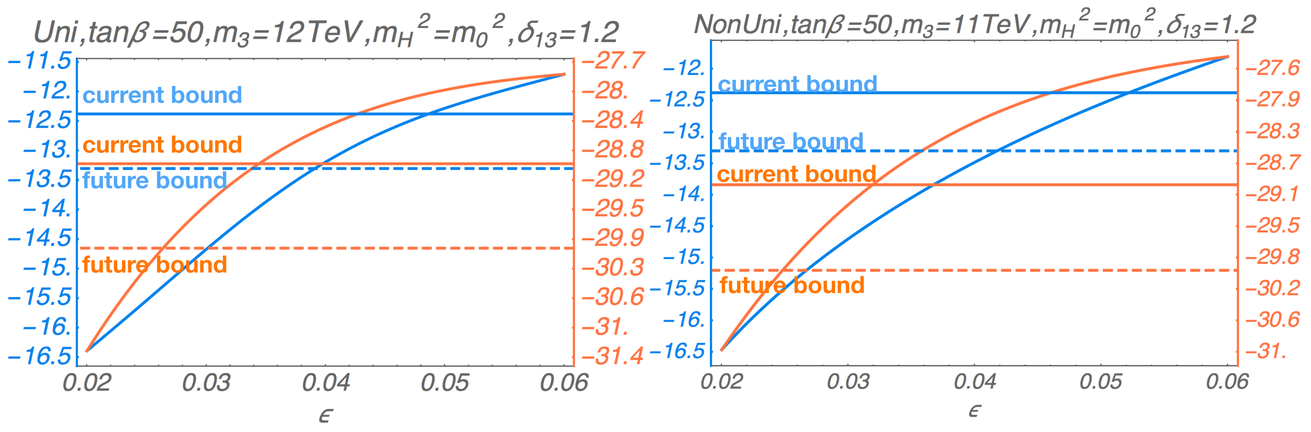
Blue $\mathcal{B}(\mu^+ \to e^+\gamma) < 4.2 \times 10^{-13}\ (90\%\ {\rm C.L.})$

MEG collaboration (2016)

Orange $|d_e| < 1.1 \times 10^{-29}\,{\rm e\,cm}\ (90\%\ {\rm C.L.})$

ACME collaboration (2018)

Constraint



Flavor mixing must be about 20-30% compared with CKM matrix

Quark flavor mixing

Assumption

CKM matrix in down-type quark sector and CKM-like mixings for right-handed squarks

Measurement and SM prediction

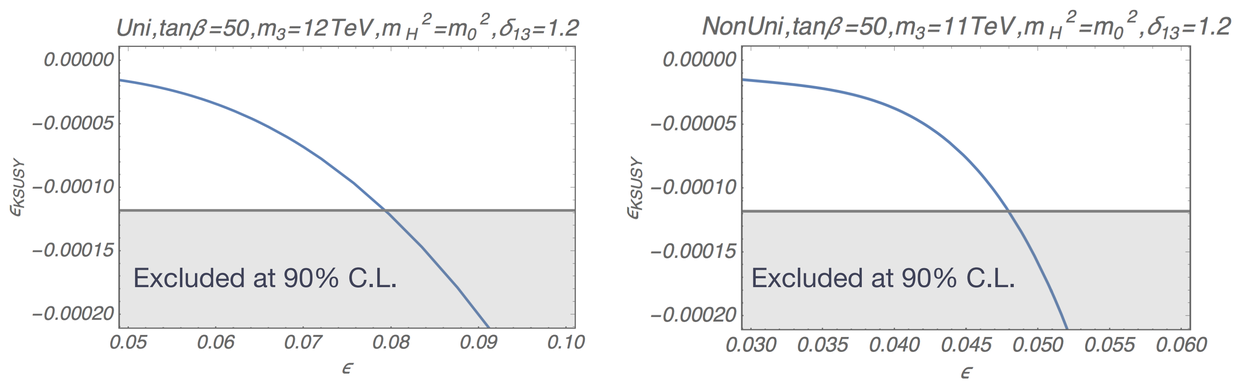
$$|\epsilon_K|^{\rm ex} = 2.228(11) \times 10^{-3}$$

SWME collaboration (2017)

$$|\epsilon_K|^{\rm SM,in} = 2.05(18) \times 10^{-3}$$

PDG (2018)

Constraint



Flavor mixing must be about 30-40% compared with CKM matrix