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New SUSY parameter constraints from $b ightarrow s \gamma$

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New SUSY parameter constraints from $b \rightarrow s\gamma$

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Activities				

▶ New SUSY parameter constraints from $b \rightarrow s\gamma$

- Phenomenology of QCD: Higgs background
- SUSY: phenomenological calculations, constraints on the supersymmetric parameters, spin measurements...
- Collider signals of extra-dimensions

► B-physics

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Introduction $\circ \bullet$	Theoretical framework	Experimental limits and data	Results 0000000	Conclusion 0

- A good strategy to find the information on SUSY particles would be
 - ▶ to look at where the SM contributions are vanishlingly small,
 - to study processes for which QCD corrections are known with high accuracy
 - and branching ratios can be measured at LHC even at low luminosity.
- ▶ b → d, s transitions (FCNC) are forbidden at the tree level in SM and can only be induced via loop diagrams ("penguin" and "box" topologies)
- \Rightarrow Rare B decays are IDEAL CHOICES for that!

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Effective Hamiltonian				

Effective Hamiltonian

The idea of $B \longrightarrow X_s \gamma$ decay begins with introducing an effective Hamiltonian:

$$\mathcal{H}_{eff} = -rac{4G_F}{\sqrt{2}}V_{ts}^*V_{tb}\sum_{i=1}^8C_i(\mu)O_i(\mu)$$

$$O_{1} = (\bar{s}_{L}\gamma_{\mu}T^{a}c_{L})(\bar{c}_{L}\gamma^{\mu}T^{a}b_{L}) \qquad O_{2} = (\bar{s}_{L}\gamma_{\mu}c_{L})(\bar{c}_{L}\gamma^{\mu}b_{L})$$

$$O_{3} = (\bar{s}_{L}\gamma_{\mu}b_{L})\sum_{q}(\bar{q}\gamma^{\mu}q) \qquad O_{4} = (\bar{s}_{L}\gamma_{\mu}T^{a}b_{L})\sum_{q}(\bar{q}\gamma^{\mu}T^{a}q)$$

$$O_{5} = (\bar{s}_{L}\gamma_{\mu_{1}}\gamma_{\mu_{2}}\gamma_{\mu_{3}}b_{L})\sum_{q}(\bar{q}\gamma^{\mu_{1}}\gamma^{\mu_{2}}\gamma^{\mu_{3}}q)$$

$$O_{6} = (\bar{s}_{L}\gamma_{\mu_{1}}\gamma_{\mu_{2}}\gamma_{\mu_{3}}T^{a}b_{L})\sum_{q}(\bar{q}\gamma^{\mu_{1}}\gamma^{\mu_{2}}\gamma^{\mu_{3}}T^{a}q)$$

$$O_{7} = \frac{e}{16\pi^{2}}m_{b}(\bar{s}_{L}\sigma^{\mu\nu}b_{R})F_{\mu\nu} \qquad O_{8} = \frac{g}{16\pi^{2}}m_{b}(\bar{s}_{L}\sigma^{\mu\nu}T^{a}b_{R})G_{\mu\nu}^{a}$$

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Effective Hamiltonian				

Wilson Coefficients

$$C_i^{eff}(\mu) = C_i^{(0)eff}(\mu) + \frac{\alpha_s(\mu)}{4\pi} C_i^{(1)eff}(\mu) + \cdots$$

The effective coefficients evolve according to their RGE:

$$\mu \frac{d}{d\mu} C_i^{\text{eff}}(\mu) = C_j^{\text{eff}}(\mu) \gamma_{ji}^{\text{eff}}(\mu)$$

driven by the anomalous dimension matrix $\hat{\gamma}^{eff}(\mu)$:

$$\hat{\gamma}^{\text{eff}}(\mu) = \frac{\alpha_s(\mu)}{4\pi} \hat{\gamma}^{(0)\text{eff}} + \frac{\alpha_s^2(\mu)}{(4\pi)^2} \hat{\gamma}^{(1)\text{eff}} + \cdots$$

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Effective Hamiltonian				

Contribution to Isospin Asymmetry

 $b O_3 O_6 S$ $\overline{q} \overline{q}$



QCD penguin operators

Electro- and chromo-magnetic operators

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	Theoretical framework	Experimental limits and data		Conclusion	
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Supersymmetric contributions					

Supersymmetric contributions

MSSM with minimal flavor violation (MFV) \hookrightarrow no more flavor/CP violation than in SM



Calculation of the coefficients at $\mu = M_W$:

$$C_i(\mu) = C_i^{W^{\pm}}(\mu) + C_i^{H^{\pm}}(\mu) + C_i^{\chi^{\pm}}(\mu)$$

Gómez et al. Phys. Rev. D74, 015015 (2006) Degrassi et al. JHEP 12, 009 (2000) Ciuchini et al. Nucl. Phys. B 534, 3 (1998) Ciuchini et al. Nucl. Phys. B 527, 21 (1998)

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Isospin Asymmetry				

Isospin Asymmetry

$$\begin{split} \Delta_{0-} &\equiv \frac{\Gamma(\bar{B}^0 \to \bar{K}^{*0}\gamma) - \Gamma(B^- \to K^{*-}\gamma)}{\Gamma(\bar{B}^0 \to \bar{K}^{*0}\gamma) + \Gamma(B^- \to K^{*-}\gamma)} \\ \Delta_{0-} &= \operatorname{Re}(b_d - b_u) \,. \\ b_q &= \frac{12\pi^2 f_B \, Q_q}{m_b \, T_1^{B \to K^*} a_7^c} \left(\frac{f_{K^*}^{\perp}}{m_b} \, K_1 + \frac{f_{K^*} m_{K^*}}{6\lambda_B m_B} \, K_2\right) \\ a_7^c &= C_7 + \frac{\alpha_s(\mu) C_F}{4\pi} \Big(C_1(\mu) G_1(s_p) + C_8(\mu) G_8 \Big) + \frac{\alpha_s(\mu_h) C_F}{4\pi} \Big(C_1(\mu_h) H_1(s_p) + C_8(\mu_h) H_8 \Big) \end{split}$$

In the Standard Model: $\Delta_{0-}\simeq 8\%$

Kagan and Neubert, Phys. Lett. B 539, 227 (2002) Bosch and Buchalla, Nucl. Phys. B 621, 459 (2002)

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Experimental data

$\frac{\text{BABAR}}{\Delta_{0-}} = -0.006 \pm 0.058(\textit{stat}) \pm 0.009(\textit{syst}) \pm 0.024(\textit{R}^{+/0})$

Aubert et al. (BABAR Collaboration) Phys. Rev. D72 (2005)

$\frac{\text{BELLE}}{\Delta_{0+}} = +0.012 \pm 0.044(\textit{stat}) \pm 0.026(\textit{syst})$

Nakao et al. (BELLE Collaboration) Phys. Rev. D69 (2004)

Allowed Region: $-0.047 < \Delta_{0-} < 0.093$

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Experimental limits

Lower bounds on sparticle masses in GeV:

Particle	h ⁰	χ_1^0	Ĩ _R	$\tilde{\nu}_{e,\mu}$	χ_1^{\pm}	\tilde{t}_1	ĝ	\tilde{b}_1	$\tilde{\tau}_1$	<i>q̃</i> _R
Lower bound	111	46	88	43.7	67.7	92.6	195	89	81.9	250

Yao et al. J. Phys. G33 (2006)

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Ahmady & Mahmoudi, Phys. Rev. D75 (2007)

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Ahmady & Mahmoudi, Phys. Rev. D75 (2007)

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Image: A matrix

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Ahmady & Mahmoudi, Phys. Rev. D75 (2007)

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Image: A matrix

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Results: AMSB



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Results: AMSB



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Results:

mSUGRA



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Results:

mSUGRA





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Results: Isospin asymmetry vs. Charged Higgs (mSUGRA)



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Results: Isospin asymmetry vs. Charged Higgs (mSUGRA)



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SuperIso v1.0

A public program for calculating isospin asymmetry of $B\to K^*\gamma$ in supersymmetry.

- calculation of isospin asymmetry and inclusive branching ratio,
- reads Les Houches Accord files,
- interface with Softsusy and Isajet,
- automatic calculation in mSUGRA, AMSB ans GMSB scenarios.

Can be downloaded from:

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http://www.isv.uu.se/~nazila/superiso/
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Conclusion

Very tight constraints on the mSUGRA parameter space, better than the inclusive branching ratio

Can be applied to other models

 Isospin asymmetry seems to be an important observable in the precision test of the SM and in constraining new physics parameters

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