PPARC Proposal, 30 January, 2002

Athanasios Dedes

University of Bonn, Germany

Footprints from Supersymmetry at B-factories and Colliders

1. Rare B-decays
2. Supersymmetry
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4. The strategy

Rare B-decays

- b-quark : an important laboratory for the exploration of the Standard Model and Beyond

  - Large mass and Long Lifetime
  - Large production cross section in e^+e^- and hadron collisions
  - The strong force binds b-quarks and d or s-antiquarks making B_d or B_s mesons
  - Huge data samples of B-meson decays $\rightarrow$ B-factories $\rightarrow$ CLEO, Belle, Babar
  - Huge data samples of B-meson decays are also expected at Tevatron and LHC

- Rare B-decays

  - They appear only at the Quantum Level in the SM
  - Flavour Changing Neutral Currents (FCNC) $b \rightarrow s, d$

Rare B-decays

- Limits on some Rare B-decays

Type	Channel	Expt.	Expt. value	SM prediction
Lepton Flavour	$B_d^0 \to e^\pm \mu^\mp$	CDF	$< 3.5 \times 10^{-6}$	0
	$B_s^0 \to e^\pm \mu^\mp$	CDF	$< 6.1 \times 10^{-6}$	0
FCNC	$B_d^0 \to \mu^+ \mu^-$	CDF	$< 8.6 \times 10^{-7}$	1.5×10^{-10}
	$B_s^0 \to \mu^+ \mu^-$	CDF	$< 2.0 \times 10^{-6}$	3.5×10^{-9}
	$B^+ \to K^+ \mu^+ \mu^-$	BaBar	$< 1.3 \times 10^{-6}$	0.4×10^{-6}
	$B^0 \to K^{*0} \mu^+ \mu^-$	Belle	$< 3.0 \times 10^{-6}$	1×10^{-6}
	$B^0 \to K l^+ l^-$	Belle	0.75×10^{-6}	0.35×10^{-6}
	$B^0 \to X_s \gamma$	CLEO	3.2×10^{-4}	3.4×10^{-4}

√ The difference between the experimental bounds and the SM prediction is a "Window" for Physics Beyond the SM

√ Example : $B_s \to \mu^+ \mu^-$ could be soon found at Tevatron

Question

Can Supersymmetry be revealed in such Rare B-meson decays?

Supersymmetry

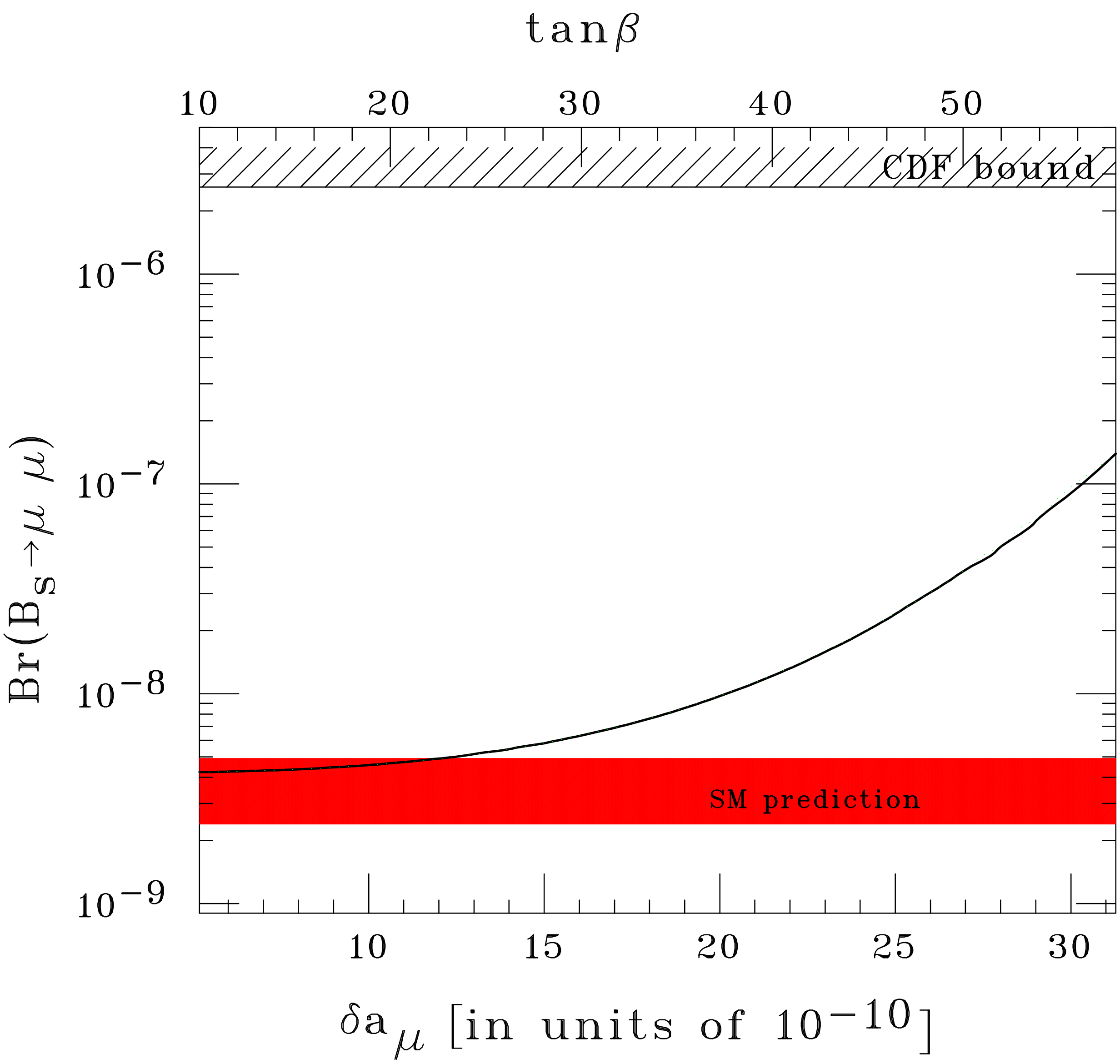
- Supersymmetry unites particles of different spin
  - has profound implications for fundamental physics
  - can be enlarged to include gravity
  - offers a hope of solving the hierarchy problem

- A minimal supersymmetric extension of the SM has been constructed, which is known as MSSM
  - unifies strong and electroweak forces
  - Gravity plays an essential role in supersymmetry breaking
  - offers a candidate particle to account for dark matter
  - predicts a light Higgs boson
  - predicts new particles-partners of the SM ones

$\longrightarrow$ Observables are affected

- Example : In MSSM the B-decay $B_s \to \mu^+\mu^-$ and the muon anomalous magnetic moment are enhanced with respect to the SM

The footprints



A. Dedes, H. K. Dreiner and U. Nierste, Phys. Rev. Lett. **87**, 251804 (2001)

√ Striking correlation of the Rare decay $B_s \to \mu^+\mu^-$ and the muon anomalous magnetic moment

√ More than 10 events can be seen at Tevatron/CDF

√ Crucial test for the SO(10) Grand Unified Models

The Strategy

- B-factories (CLEO, Babar, Belle)
  - Define the Rare B-decays which are affected by SUSY
  - Calculate quantum corrections for these decays
- Colliders (Tevatron)
  - Search for Rare B-decays at Tevatron
  - Search for direct evidence of supersymmetry
  - Make Monte-Carlo analysis
- B-factories and Colliders
  - Search for correlations between observables
  - Define or restrict the unknown parameters of SUSY
- Build a bridge between Cavendish and DAMTP!
  - Apply to Grand Unified and/or to Superstring Models