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Durham University

$B \to K^* \mu^+ \mu^-$: SM and Beyond

Aoife Bharucha with W. Altmannshofer, Patricia Ball, A.J. Buras, D. Straub and M. Wick (arXiv:0811.1214 [hep-ph])

IPPP/TU Munich

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Soon Launching Expedition to 14TeV

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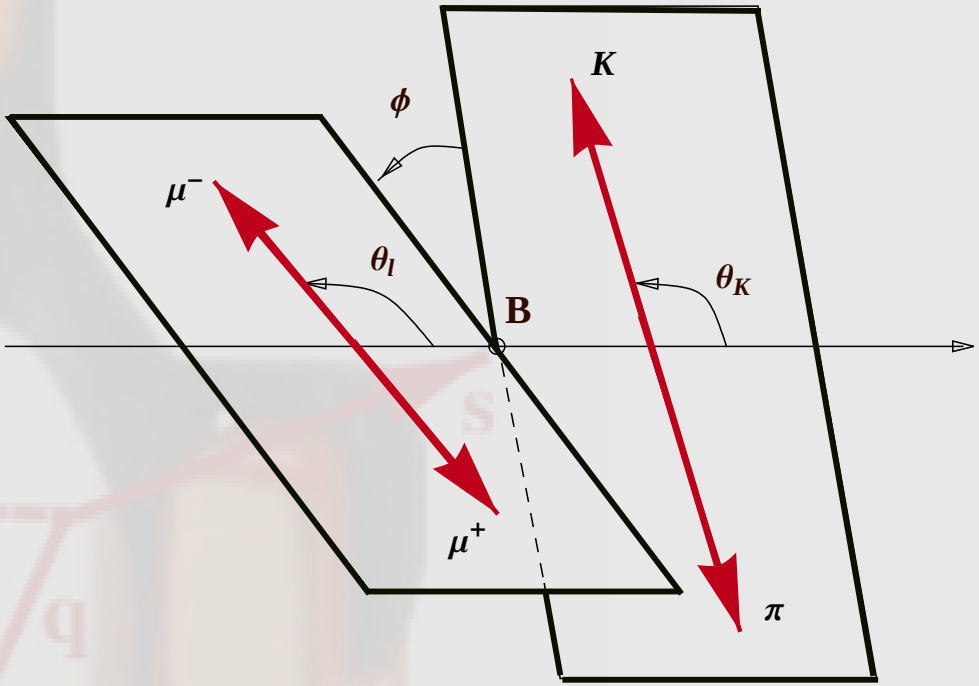
Some Structure

- Angular Observables via B Physics Tool Box
- Prospects at LHCb
- Categorising the NP contribution
- Some Concrete Examples-Distinguishing Features

Angular Observables

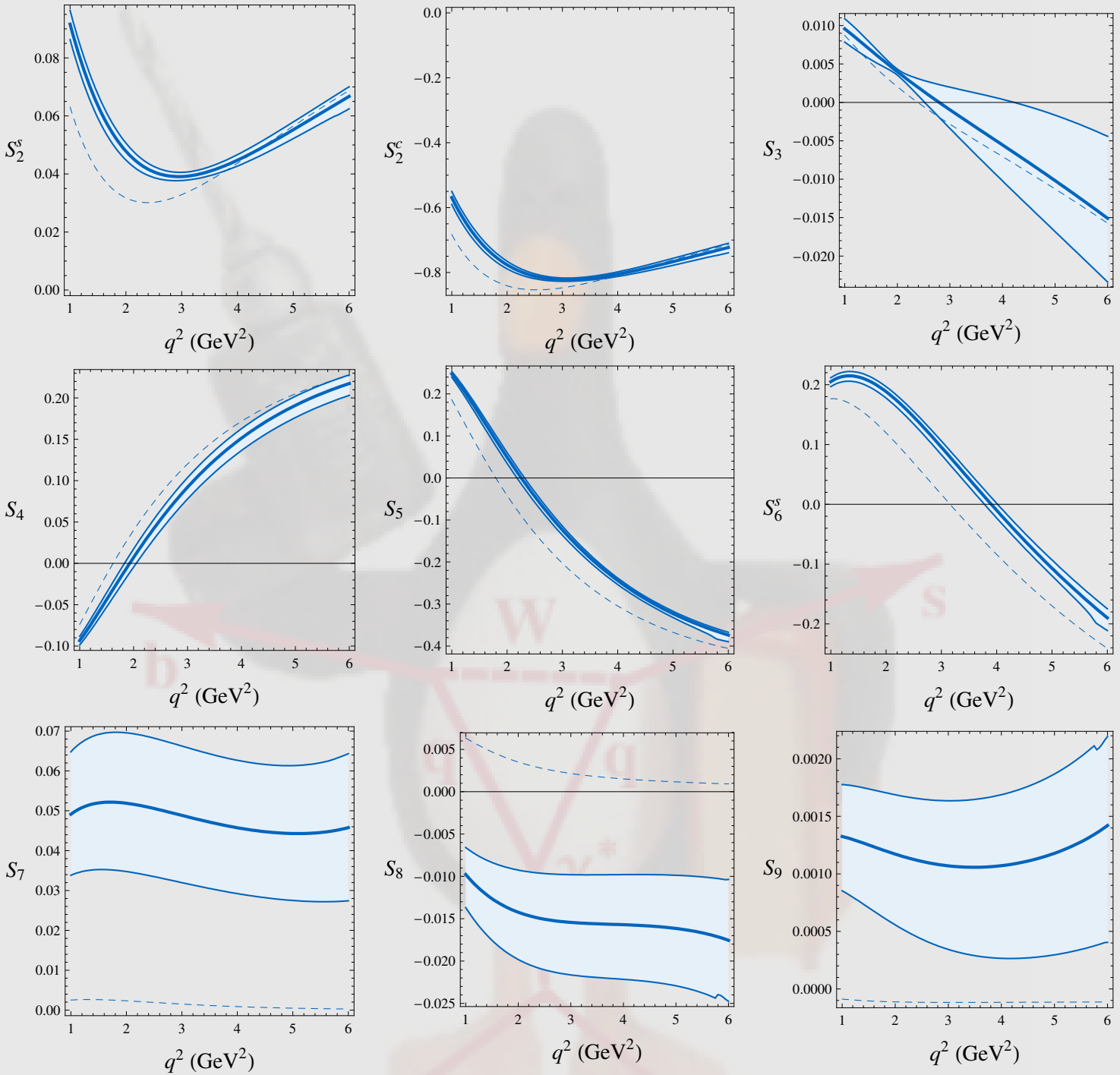
$$\frac{\mathrm{d}^4\Gamma}{\mathrm{d}q^2\mathrm{d}\Omega} = \frac{9}{32\pi} I(q^2, \theta_l, \theta_K, \phi)$$



..where $I(q^2, \theta_l, \theta_K, \phi) = \sum_{i=1}^{9} I_i^{(s/c)}(q^2)\, \omega_i(\theta_l, \theta_K, \phi)$

Emphasize CP Conserving Effects

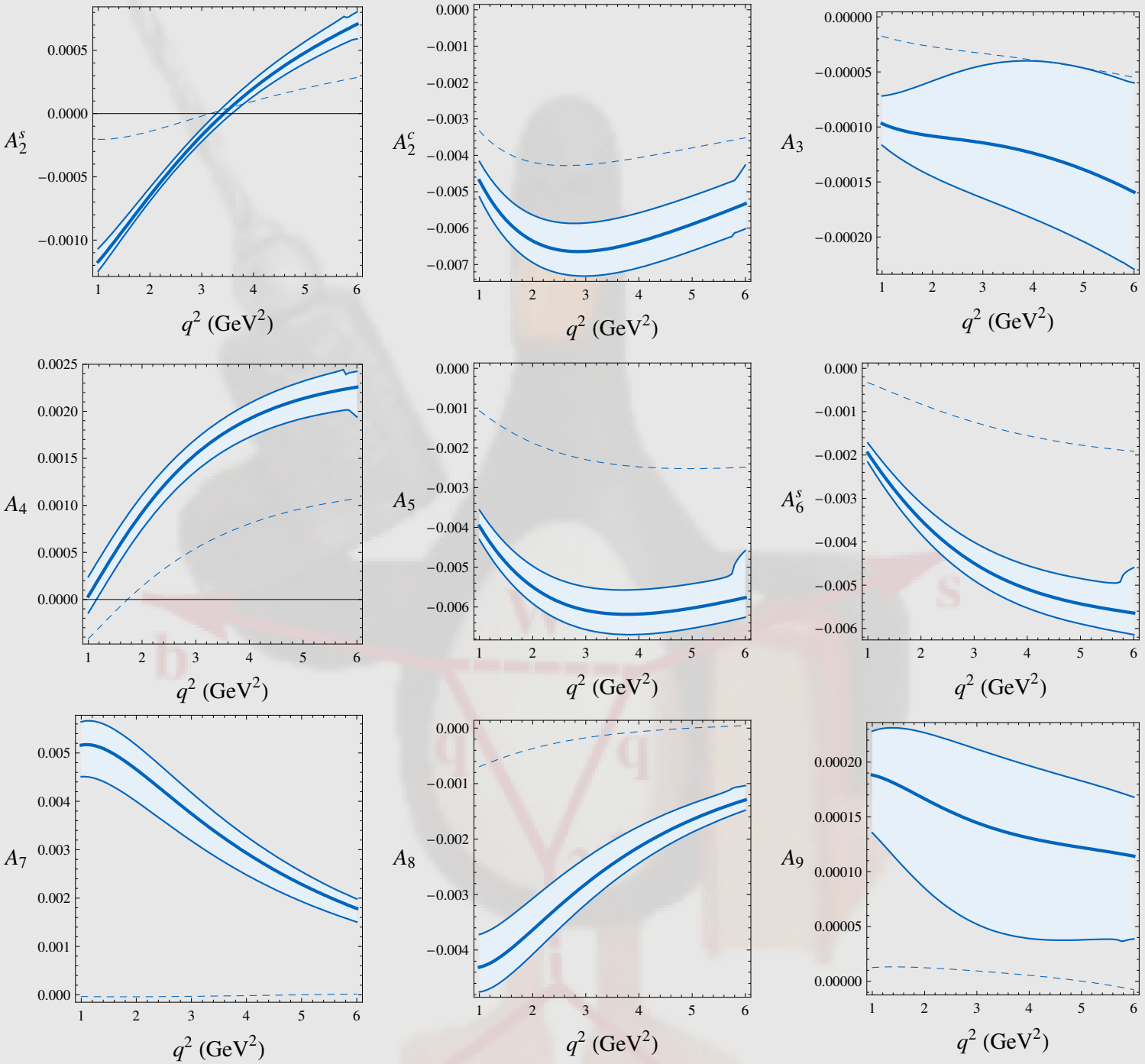
$$S_i^{(a)} = \frac{I_i^{(a)} + \bar{I}_i^{(a)}}{\mathrm{d}(\Gamma + \bar{\Gamma})/\mathrm{d}q^2}$$


S_2^s
S_2^c
S_3
S_4
S_5
S_6^s
S_7
S_8
S_9
q^2 (GeV^2)

Emphasize CP Violating Effects[1]

$$A_i^{(a)} = \frac{I_i^{(a)} - \bar{I}_i^{(a)}}{\mathrm{d}(\Gamma + \bar{\Gamma})/\mathrm{d}q^2}$$

[1] Also considered in C. Bobeth, G. Hiller and G. Piranishvili arXiv:0805.2525


A_2^s
A_2^c
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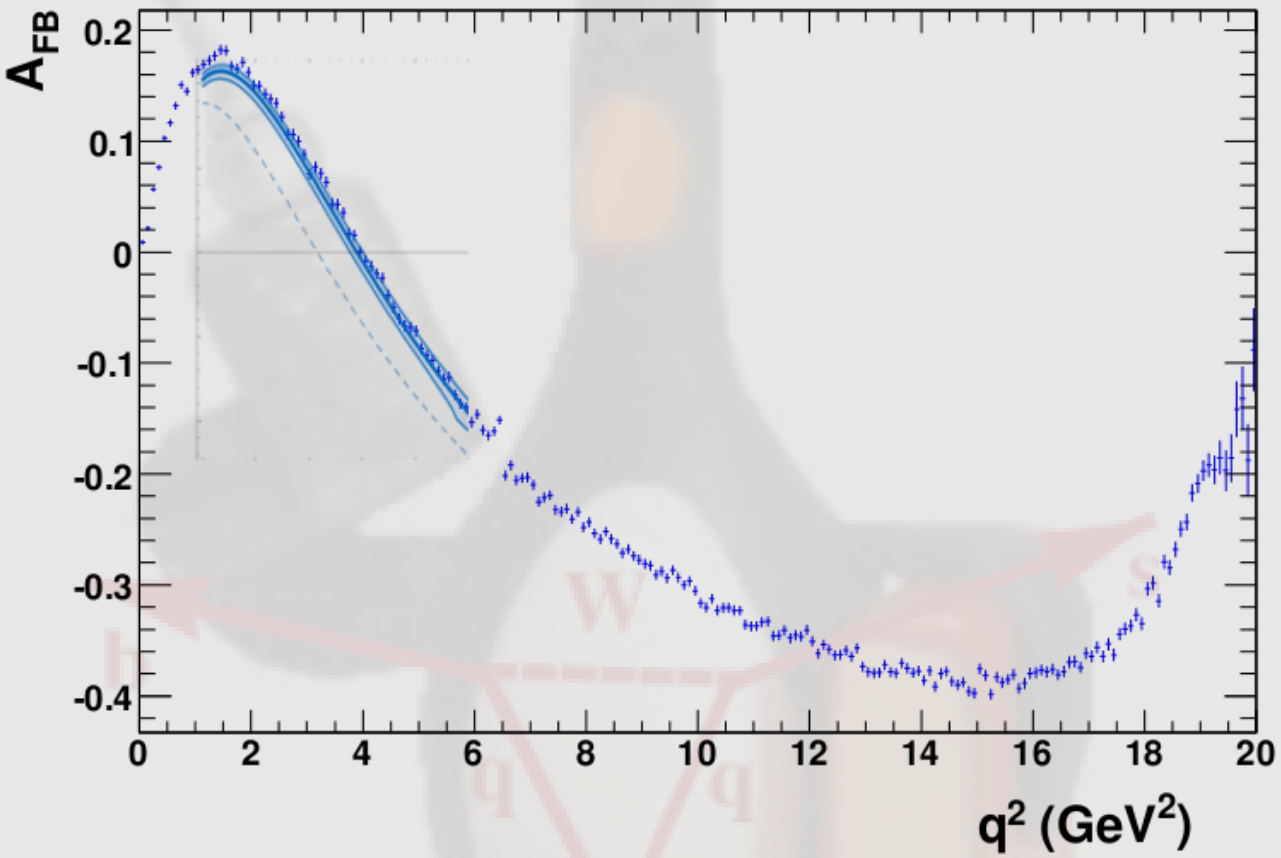
Prospects at LHCb



- Developing EvtGen Model (See Will Reece's talk)
- Focus on near future possibilities: S_3, S_5, S_6, A_7, A_9

Relating Observables to NP: EFTs

- Disentangle physics governed by different mass scales
- Write $\mathcal{L}$ in terms of **'Effective Operators'** and Effective Coupling Constants known as **'Wilson Coefficients'**

$$\mathcal{L} = \sum_i C_i O_i$$

For $B \to K^*(\to K^-\pi^+)\mu^+\mu^-$, important Operators are..

Electromagnetic Dipole O_7 Vector/Axial Current $O_{9(10)}$

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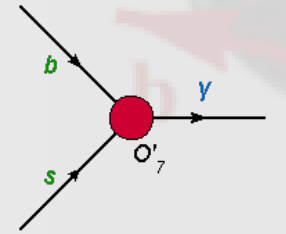
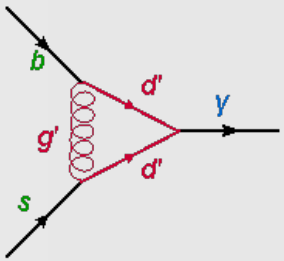
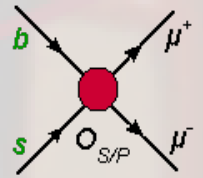
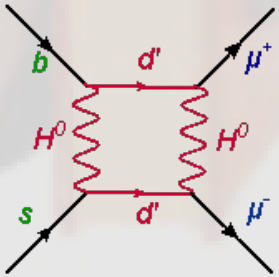
Spin-Flipped EM Dipole O'_7 Scalar/Pseudoscalar $O_{S(P)}$









What will the Flavour Telescope see?

Focus on Additional..

- **Operators** eg. Scalar
- **CP Violation**

Keeping in Mind Bounds from..

- $B_s \to \mu^+\mu^-$, $B \to X_s\gamma$, $B \to X_s\mu^+\mu^-$
- EDM's, CP Asymmetries....

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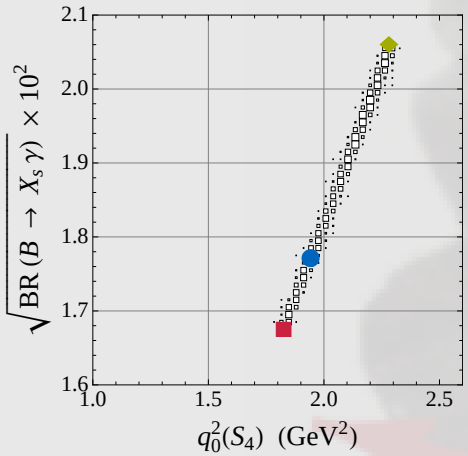
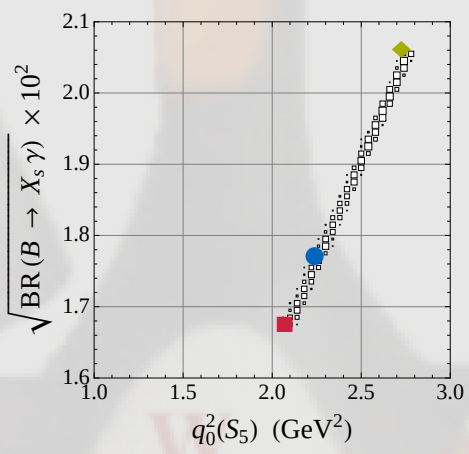
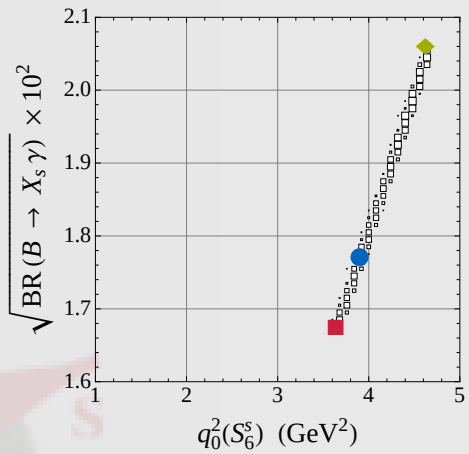
New Physics via Wilson Coefficients

Model	Additional Operators	CP/Flavour Violation
MFV MSSM	O_S, O_P	No
Flavour Blind MSSM	O_S, O_P	Yes/No
General MSSM	O_S, O_P, O'_7	Yes

MFV

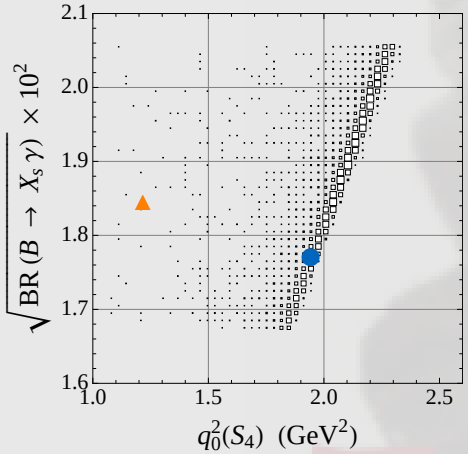


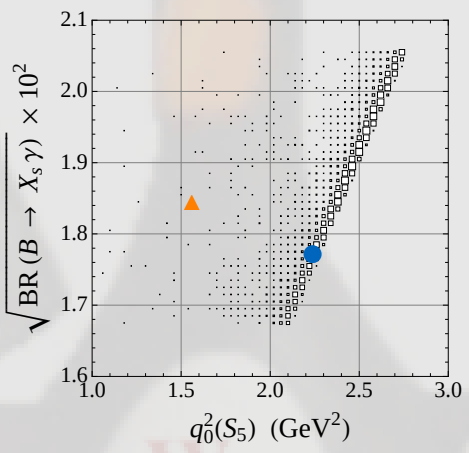


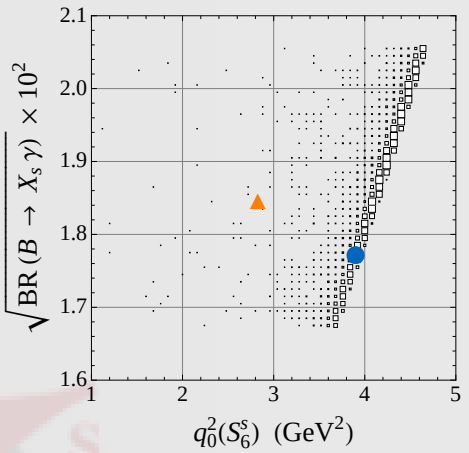


- Effects for CMFV at most 50%
- Correlate zeros of S_4, S_5, S_6^s with $B(b \to s\gamma)$

Flavour-Blind MSSM

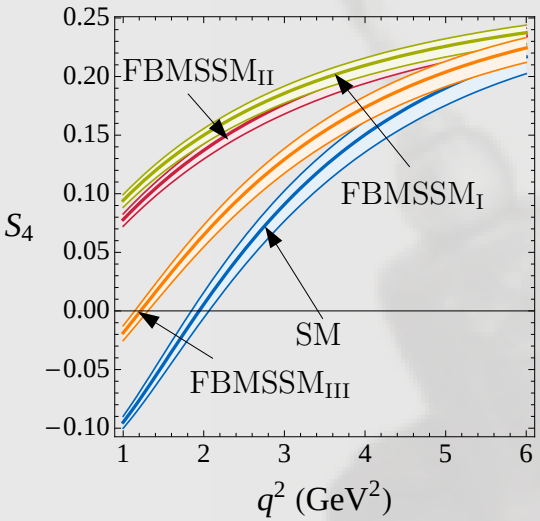


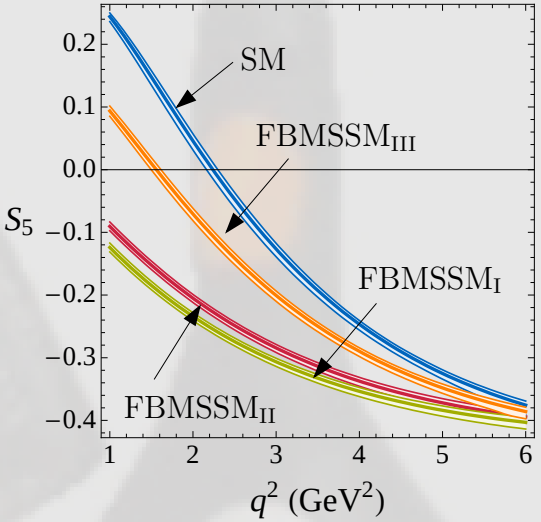


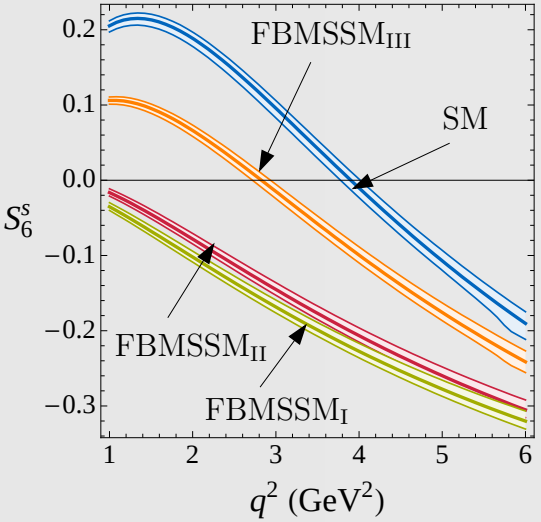


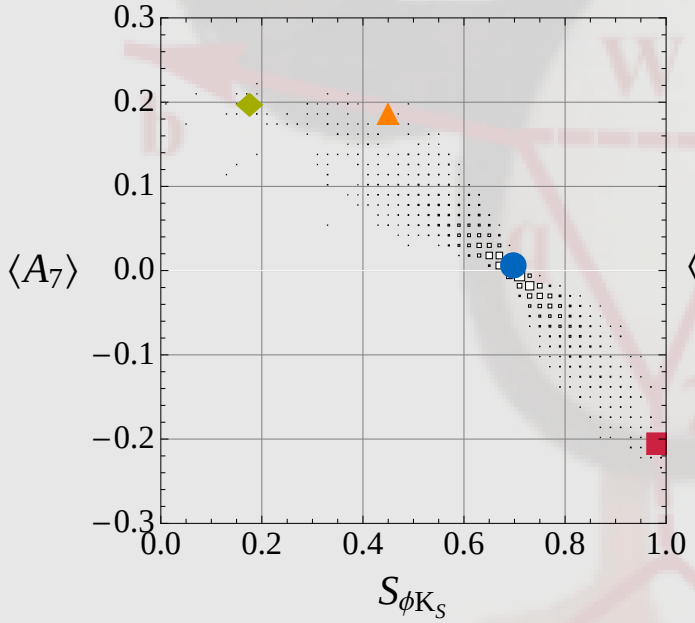
- Bound on C_7 from $b \to s\gamma$ weakened if complex FBMSSM has additional CP violating phases..
- Correlate zeros of S_4, S_5, S_6^s with $B(b \to s\gamma)$

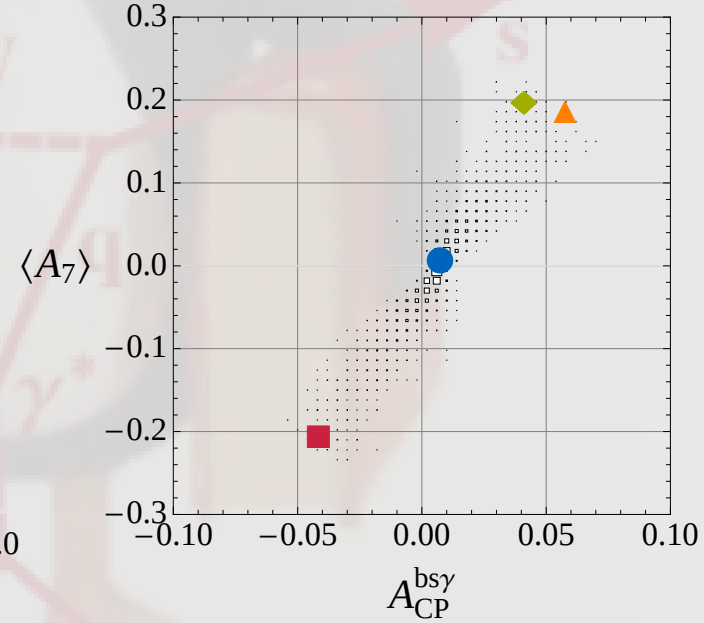
Flavour-Blind MSSM



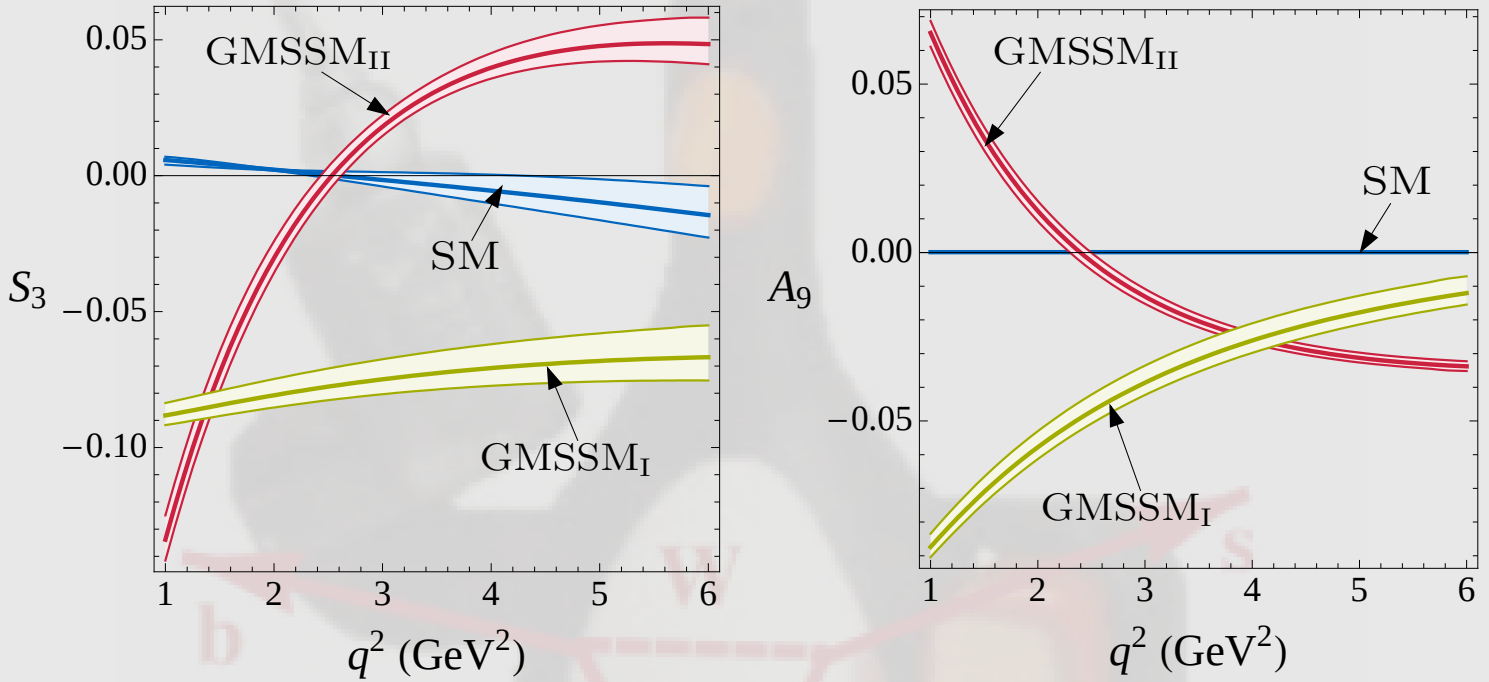








General MSSM



- Large no. of free parameters⇒Concentrate on complex C_7'
- Generate C_7' via down squark gluino loops
- Sizeable effects in $S_{4/5/6}^{(i)}$, $A_{7/8}$, and uniquely in S_3/A_9

Summary

- $\mathbf{B \to \bar{K}^* \mu^+ \mu^-}$ will provide a multitude of sensitive observables at the LHC

- **Visible effects at the LHC:** LHCb, ATLAS, CMS
  Full Angular Distribution will be measured, deviations from SM will be seen

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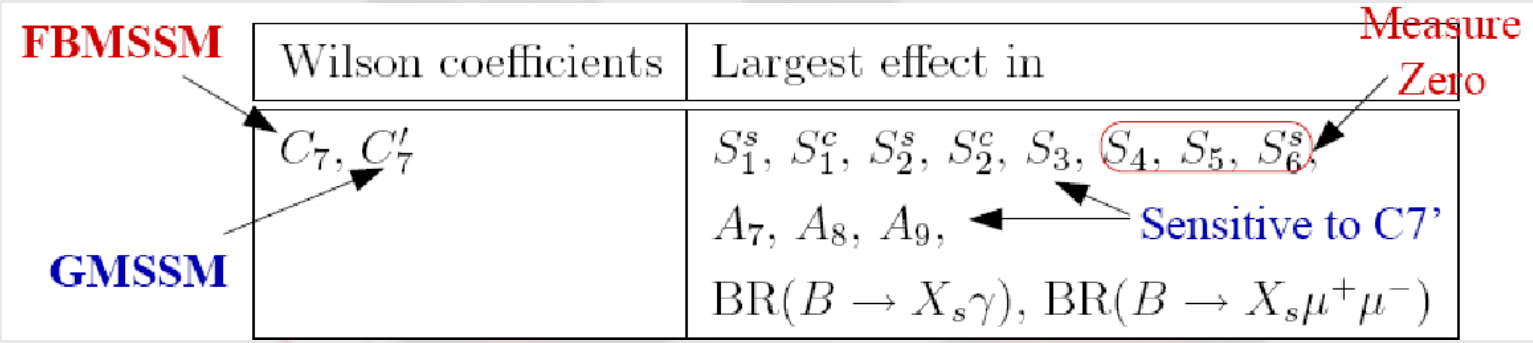

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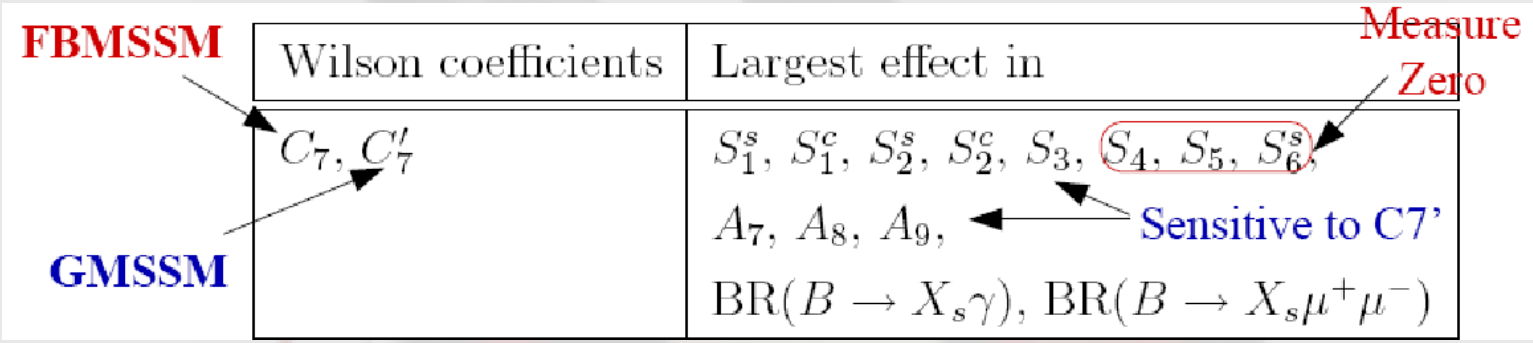

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