looking at the global picture in b➡s transitions

Ayan Paul

ERC Ideas: NPFlavour

INFN, Sezione di Roma. Roma, Italy.

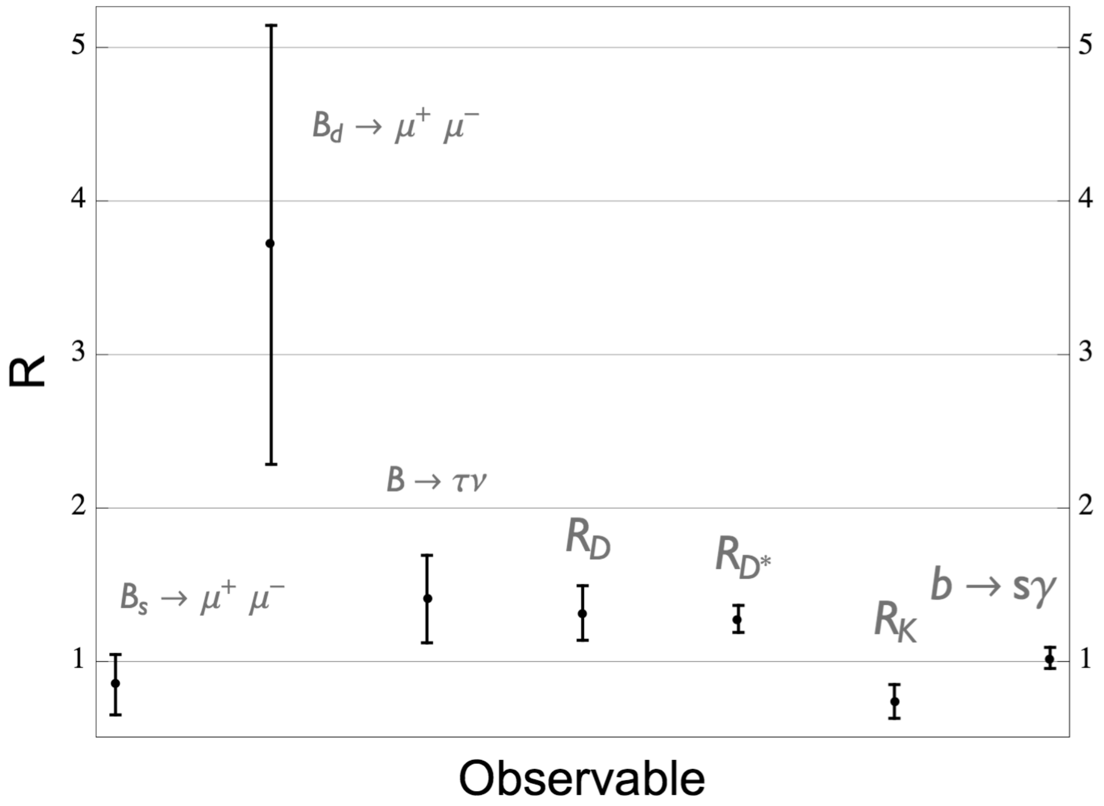
ICHEP 2016. August 6th 2016. Chicago, USA.

"I wanted to show that the women are not harvesting crops the way they had hoped. They're holding a bowl of dust, because this is what they're left with… <u>In other words, what we'd expect to see is not there.</u>"

-- Ashley Cecil

the brush strokes that have appeared

$$B_s \to \mu^+\mu^- \; : \; \downarrow \mathrm{SM}$$
$$B_d \to \mu^+\mu^- \; : \; \uparrow \mathrm{SM}$$
$$B \to \tau\nu \; : \; \uparrow \mathrm{SM}$$
$$R_D \; : \; \uparrow \mathrm{SM}$$
$$R_{D^*} \; : \; \uparrow \mathrm{SM}$$
$$R_K \; : \; \downarrow \mathrm{SM}$$
$$b \to s\gamma \; : \; \to \mathrm{SM} \leftarrow$$

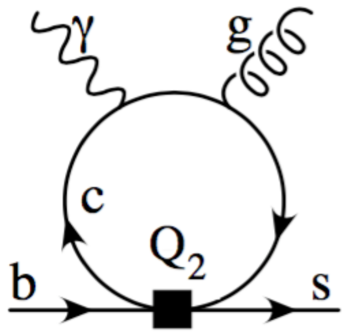


the story of the hadronic uncertainties

known:

- purely leptonic decays are theoretically clean and suffer from mostly parametric uncertainties
- Inclusive radiative decays suffer from a ~5% non-factorizable correction that cannot be reliably estimated

the hadronic uncertainties on-shell



Computation done with QCDF

A. Ali and A. Y. Parkhomenko, Eur. Phys. J. C **23** (2002) 89 [arXiv:hep-ph/0105302];
M. Beneke, T. Feldmann and D. Seidel, Eur. Phys. J. C **41** (2005) 173 [arXiv:hep-ph/0412400];
T. Becher, R. J. Hill and M. Neubert, Phys. Rev. D **72** (2005) 094017 [arXiv:hep-ph/0503263].

S. W. Bosch and G. Buchalla, Nucl. Phys. B **621** (2002) 459 [arXiv:hep-ph/0106081] and JHEP **0501** (2005) 035 [arXiv:hep-ph/0408231].

Computation done with QCD sum rules

P. Ball and R. Zwicky, Phys. Lett. **B642**, 478 (2006), arXiv:hep-ph/0609037 [hep-ph].
A. Khodjamirian, R. Ruckl, G. Stoll, and D. Wyler, Phys. Lett. **B402**, 167 (1997), arXiv:hep-ph/9702318 [hep-ph].
M. B. Voloshin, Phys. Lett. **B397**, 275 (1997), arXiv:hep-ph/9612483 [hep-ph].

Computation done with pQCD sum rules on the light cone

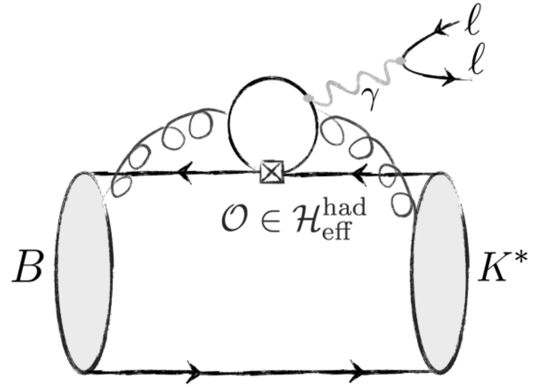
M. Matsumori and A. I. Sanda, Phys. Rev. **D73**, 114022 (2006), arXiv:hep-ph/0512175 [hep-ph].

estimate using SCET

B. Grinstein and D. Pirjol, Phys. Rev. **D73**, 014013 (2006), arXiv:hep-ph/0510104 [hep-ph].
B. Grinstein, Y. Grossman, Z. Ligeti, and D. Pirjol, Phys. Rev. **D71**, 011504 (2005), arXiv:hep-ph/0412019 [hep-ph]

the hadronic uncertainties off-shell

$$h_\lambda(q^2) = \frac{\epsilon^*_\mu(\lambda)}{m_B^2} \int d^4x e^{iqx} \langle \bar{K}^* | T\{j^\mu_{\rm em}(x) \mathcal{H}^{\rm had}_{\rm eff}(0)\} | \bar{B} \rangle$$
$$= h_\lambda^{(0)} + q^2 h_\lambda^{(1)} + q^4 h_\lambda^{(2)} \,,$$



- The weakest link in the analysis is the estimates of the non-factorizable part.
- However, the estimates of the angular observables in the SM depend heavily on the estimate of the non-factorizable part. (EVEN the "clean ones")
- The nonlinear dependence of the angular observables on the hadronic contribution means that the central value *and* the error in the prediction depends on the size of this estimate.
- The *only* theory estimate available in the literature (arXiv:1006:4945) takes into account only a part of the possible contribution (soft gluon contribution)
- Other contributing diagrams can possible bring about corrections to this estimate that are as large or larger than the current estimate depending on the kinematic region one considers.

A. Khodjamirian, T. Mannel, A. Pivovarov and Y.-M. Wang, *Charm-loop effect in $B \to K^{(*)}\ell^+\ell^-$ and $B \to K^*\gamma$*, JHEP **09** (2010) 089 [arXiv:1006.4945]

the key ingredients

$$H_V(\lambda) = -iN\left\{\underline{C_9^{\text{eff}}}\tilde{V}_{L\lambda} + \frac{m_B^2}{q^2}\left[\frac{2\hat{m}_b}{m_B}\underline{C_7^{\text{eff}}}\tilde{T}_{L\lambda} - 16\pi^2 h_\lambda\right]\right\},$$

$$H_A(\lambda) = -iN\underline{C_{10}}\tilde{V}_{L\lambda},$$

$$H_P = iN\frac{2m_l m_B^2}{q^2}\underline{C_{10}}\left(\tilde{S}_L - \frac{m_s}{m_B}\tilde{S}_R\right),$$

!! Simplified for SM, other operators play a role in NP

$$\begin{aligned}
V_\pm(q^2) &= \frac{1}{2}\left[\left(1+\frac{m_V}{m_B}\right)A_1(q^2) \mp \frac{\lambda^{1/2}}{m_B(m_B+m_V)}V(q^2)\right],\\
V_0(q^2) &= \frac{1}{2m_V\lambda^{1/2}(m_B+m_V)}\left[(m_B+m_V)^2(m_B^2-q^2-m_V^2)A_1(q^2) - \lambda A_2(q^2)\right]\\
T_\pm(q^2) &= \frac{m_B^2-m_V^2}{2m_B^2}T_2(q^2) \mp \frac{\lambda^{1/2}}{2m_B^2}T_1(q^2),\\
T_0(q^2) &= \frac{m_B}{2\,m_V\lambda^{1/2}}\left[(m_B^2+3m_V^2-q^2)T_2(q^2) - \frac{\lambda}{(m_B^2-m_V^2)}T_3(q^2)\right],\\
S(q^2) &= A_0(q^2),
\end{aligned}$$

$$\begin{aligned}
h_\lambda(q^2) &= \frac{\epsilon_\mu^*(\lambda)}{m_B^2}\int d^4x e^{iqx}\langle\bar{K}^*|T\{j^\mu_{\text{em}}(x)\mathcal{H}^{\text{had}}_{\text{eff}}(0)\}|\bar{B}\rangle\\
&= h_\lambda^{(0)} + q^2 h_\lambda^{(1)} + q^4 h_\lambda^{(2)},
\end{aligned}$$

LCSR at large recoil (low q^2) [hep-ph/0412079 and arXiv:1503.05534]

LCSR at large recoil (low q^2) [hep-ph/0611193] (larger errors)

Lattice at small recoil (high q^2) [arXiv:1501.00267]

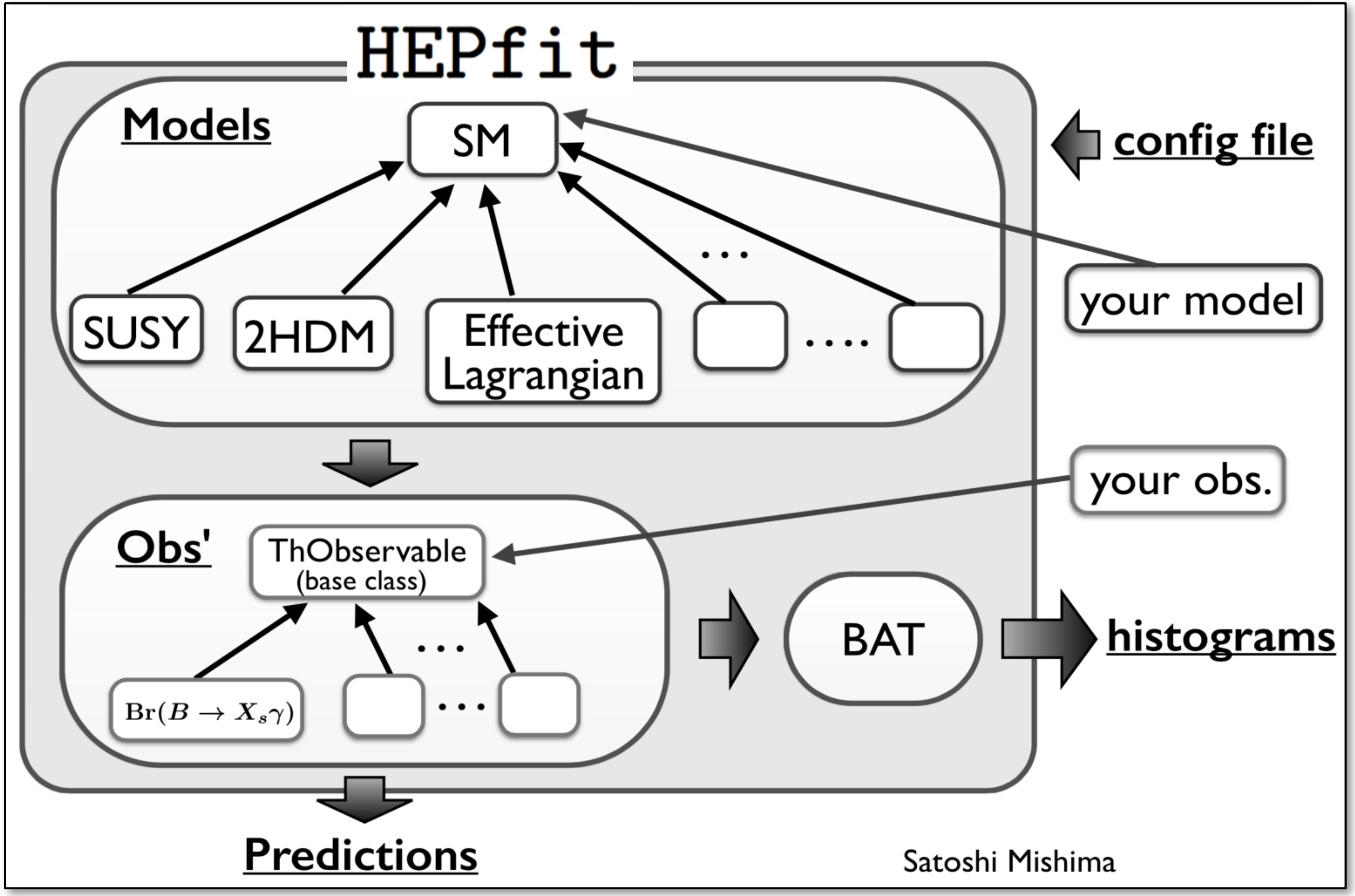
In the infinite mass limit ignoring α_s corrections the number of independent form factors = 2 (soft form factors)

The HEPfit story

$B \to K^* \ell^+ \ell^-$ decays at large recoil in the Standard Model: a theoretical reappraisal

Marco Ciuchini[a], Marco Fedele[b,c], Enrico Franco[c], Satoshi Mishima[d], Ayan Paul[c], Luca Silvestrini[c] and Mauro Valli[e,f]

[a] *INFN, Sezione di Roma Tre, Via della Vasca Navale 84, I-00146 Roma, Italy*
[b] *Dipartimento di Fisica, Università di Roma "La Sapienza", P.le A. Moro 2, I-00185 Roma, Italy*
[c] *INFN, Sezione di Roma, P.le A. Moro 2, I-00185 Roma, Italy*
[d] *Theory Center, IPNS, KEK, Tsukuba 305-0801, Japan*
[e] *SISSA, via Bonomea 265, I-34136 Trieste, Italy*
[f] *INFN, Sezione di Trieste, via Valerio 2, I-34127 Trieste, Italy*



an analysis toolkit for **electroweak**, **flavour** and **Higgs** observables based on BAT (https://www.mppmu.mpg.de/bat/)

HEPfit@ICHEP2016

Constraints on the Standard Model dimension 6 effective Lagrangian with HEPfit (15′ + 5′)

4 Aug 2016, 17:20
Chicago 10 ()

Oral Presentation | Higgs Physics | Higgs Physics

Speaker

Dr. Jorge de Blas (INFN Rome)

Electroweak precision observables in the Standard Model and beyond: present and future (15′ + 5′)

6 Aug 2016, 14:20
Chicago 9 ()

Oral Presentation | Top Quark and Electro... | Top Quark and Electrowe...

Speaker

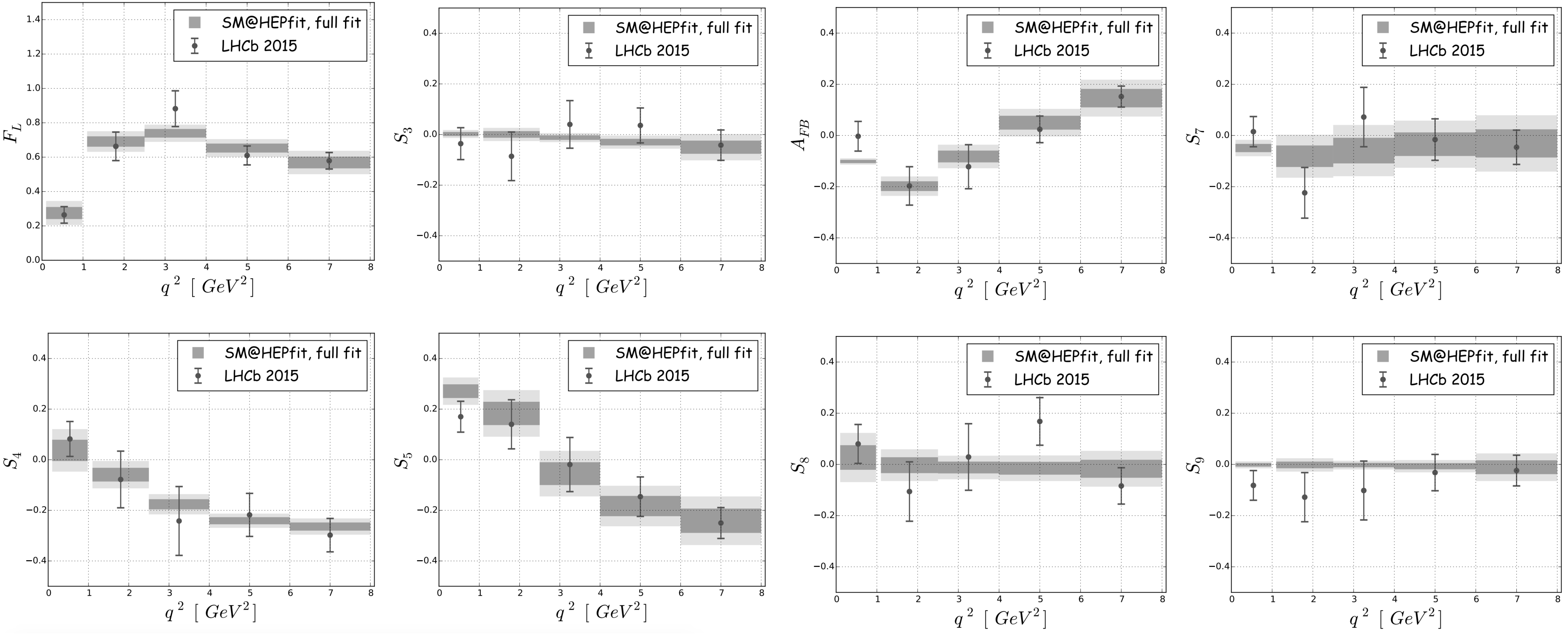
Dr. Jorge de Blas (INFN Rome)

q^2 bin [GeV^2]	Observable	measurement	full fit	prediction	p − value
[0.1, 0.98]	F_L	0.264 ± 0.048	0.275 ± 0.035	0.257 ± 0.035	0.13
	S_3	-0.036 ± 0.063	0.002 ± 0.008	0.002 ± 0.008	
	S_4	0.082 ± 0.069	0.037 ± 0.042	-0.025 ± 0.047	
	S_5	0.170 ± 0.061	0.271 ± 0.027	0.301 ± 0.024	
	A_{FB}	-0.003 ± 0.058	-0.102 ± 0.006	-0.104 ± 0.006	
	S_7	0.015 ± 0.059	-0.049 ± 0.016	-0.043 ± 0.017	
	S_8	0.080 ± 0.076	0.027 ± 0.048	-0.004 ± 0.046	
	S_9	-0.082 ± 0.058	-0.002 ± 0.007	-0.002 ± 0.007	
	P_5'	0.387 ± 0.142	0.774 ± 0.094	0.881 ± 0.082	0.0026
[1.1, 2.5]	F_L	0.663 ± 0.083	0.691 ± 0.030	0.688 ± 0.034	0.63
	S_3	-0.086 ± 0.096	0.000 ± 0.013	0.001 ± 0.013	
	S_4	-0.078 ± 0.112	-0.059 ± 0.027	-0.070 ± 0.032	
	S_5	0.140 ± 0.097	0.183 ± 0.046	0.208 ± 0.057	
	A_{FB}	-0.197 ± 0.075	-0.198 ± 0.019	-0.200 ± 0.022	
	S_7	-0.224 ± 0.099	-0.081 ± 0.042	-0.056 ± 0.049	
	S_8	-0.106 ± 0.116	-0.003 ± 0.031	-0.004 ± 0.033	
	S_9	-0.128 ± 0.096	-0.002 ± 0.013	0.002 ± 0.013	
	P_5'	0.298 ± 0.212	0.410 ± 0.099	0.460 ± 0.120	0.51
[2.5, 4]	F_L	0.882 ± 0.104	0.739 ± 0.025	0.729 ± 0.028	0.80
	S_3	0.040 ± 0.094	-0.012 ± 0.009	-0.014 ± 0.010	
	S_4	-0.242 ± 0.136	-0.176 ± 0.020	-0.179 ± 0.021	
	S_5	-0.019 ± 0.107	-0.055 ± 0.045	-0.055 ± 0.052	
	A_{FB}	-0.122 ± 0.086	-0.082 ± 0.023	-0.082 ± 0.025	
	S_7	0.072 ± 0.116	-0.059 ± 0.050	-0.080 ± 0.055	
	S_8	0.029 ± 0.130	-0.012 ± 0.023	-0.012 ± 0.023	
	S_9	-0.102 ± 0.115	-0.003 ± 0.009	-0.003 ± 0.009	
	P_5'	-0.077 ± 0.354	-0.130 ± 0.100	-0.130 ± 0.120	0.89
[4, 6]	F_L	0.610 ± 0.055	0.653 ± 0.026	0.661 ± 0.030	0.50
	S_3	0.036 ± 0.069	-0.030 ± 0.013	-0.030 ± 0.015	
	S_4	-0.218 ± 0.085	-0.241 ± 0.014	-0.239 ± 0.016	
	S_5	-0.146 ± 0.078	-0.183 ± 0.040	-0.205 ± 0.046	
	A_{FB}	0.024 ± 0.052	0.050 ± 0.027	0.067 ± 0.032	
	S_7	-0.016 ± 0.081	-0.034 ± 0.046	-0.037 ± 0.055	
	S_8	0.168 ± 0.093	-0.015 ± 0.025	-0.026 ± 0.026	
	S_9	-0.032 ± 0.071	-0.007 ± 0.012	-0.012 ± 0.014	
	P_5'	-0.301 ± 0.160	-0.388 ± 0.087	-0.440 ± 0.100	0.46
[6, 8]	F_L	0.579 ± 0.048	0.569 ± 0.034	0.517 ± 0.070	0.82
	S_3	-0.042 ± 0.060	-0.050 ± 0.026	-0.006 ± 0.054	
	S_4	-0.298 ± 0.066	-0.264 ± 0.016	-0.224 ± 0.037	
	S_5	-0.250 ± 0.061	-0.241 ± 0.048	-0.164 ± 0.100	
	A_{FB}	0.152 ± 0.041	0.146 ± 0.036	0.099 ± 0.077	
	S_7	-0.046 ± 0.067	-0.031 ± 0.055	0.010 ± 0.110	
	S_8	-0.084 ± 0.071	-0.017 ± 0.035	0.039 ± 0.055	
	S_9	-0.024 ± 0.060	-0.011 ± 0.027	0.018 ± 0.047	
	P_5'	-0.505 ± 0.124	-0.491 ± 0.098	-0.330 ± 0.200	0.46
[0.1, 2]	$\mathrm{BR} \cdot 10^7$	0.58 ± 0.09	0.65 ± 0.04	0.67 ± 0.04	0.36
[2, 4.3]		0.29 ± 0.05	0.33 ± 0.03	0.35 ± 0.04	0.35
[4.3, 8.68]		0.47 ± 0.07	0.45 ± 0.05	0.47 ± 0.11	1.0
	$\mathrm{BR}_{B \to K^* \gamma} \cdot 10^5$	4.33 ± 0.15	4.35 ± 0.14	4.61 ± 0.56	0.63

Observable	measurement	full fit	prediction	p-value
P_1	-0.23 ± 0.24	0.00 ± 0.01	0.00 ± 0.01	0.34
P_2	0.05 ± 0.09	-0.040 ± 0.00	-0.040 ± 0.00	0.32
P_3	-0.07 ± 0.11	0.00 ± 0.01	0.00 ± 0.01	0.53
F_L	0.16 ± 0.08	0.170 ± 0.04	0.18 ± 0.05	0.82
$\mathrm{BR} \cdot 10^7$	3.1 ± 1.0	1.4 ± 0.1	1.4 ± 0.1	0.06

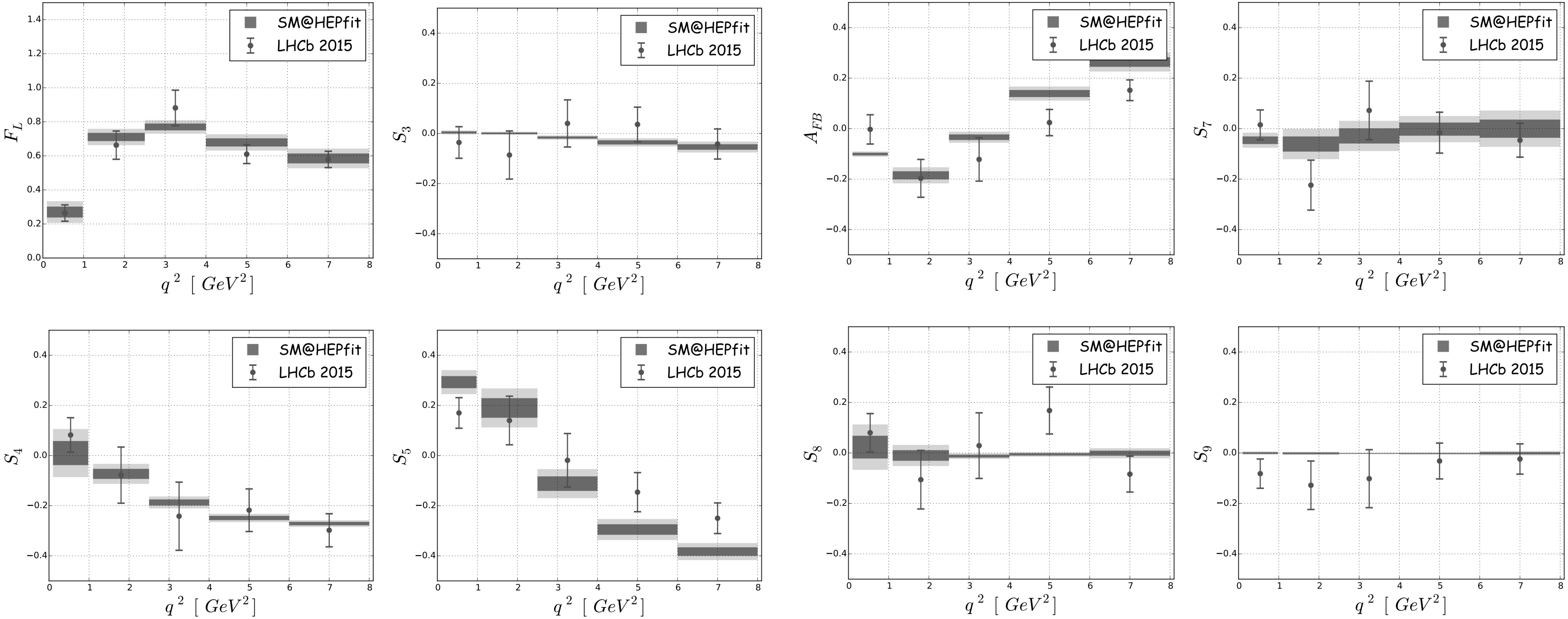
Parameter	Absolute value	Phase (rad)
$h_0^{(0)}$	$(5.7 \pm 2.0) \cdot 10^{-4}$	3.57 ± 0.55
$h_0^{(1)}$	$(2.3 \pm 1.6) \cdot 10^{-4}$	0.1 ± 1.1
$h_0^{(2)}$	$(2.8 \pm 2.1) \cdot 10^{-5}$	-0.2 ± 1.7
$h_+^{(0)}$	$(7.9 \pm 6.9) \cdot 10^{-6}$	0.1 ± 1.7
$h_+^{(1)}$	$(3.8 \pm 2.8) \cdot 10^{-5}$	-0.7 ± 1.9
$h_+^{(2)}$	$(1.4 \pm 1.0) \cdot 10^{-5}$	3.5 ± 1.6
$h_-^{(0)}$	$(5.4 \pm 2.2) \cdot 10^{-5}$	3.2 ± 1.4
$h_-^{(1)}$	$(5.2 \pm 3.8) \cdot 10^{-5}$	0.0 ± 1.7
$h_-^{(2)}$	$(2.5 \pm 1.0) \cdot 10^{-5}$	0.09 ± 0.77

fit using estimated charm loop contribution at low q^2



A. Khodjamirian, T. Mannel, A. Pivovarov and Y.-M. Wang, *Charm-loop effect in $B \to K^{(*)}\ell^+\ell^-$ and $B \to K^*\gamma$*, JHEP **09** (2010) 089 [arXiv:1006.4945]

fit using estimated charm loop contribution at all q^2



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the question of hadronic contribution

$$\Delta C_9^{(\bar{c}c, B\to K^*, \mathcal{M}_i)}(q^2) = (C_1 + 3C_2)\, g(m_c^2, q^2) + 2C_1 \widetilde{g}^{\,(\bar{c}c, B\to K^*, \mathcal{M}_i)}(q^2)$$

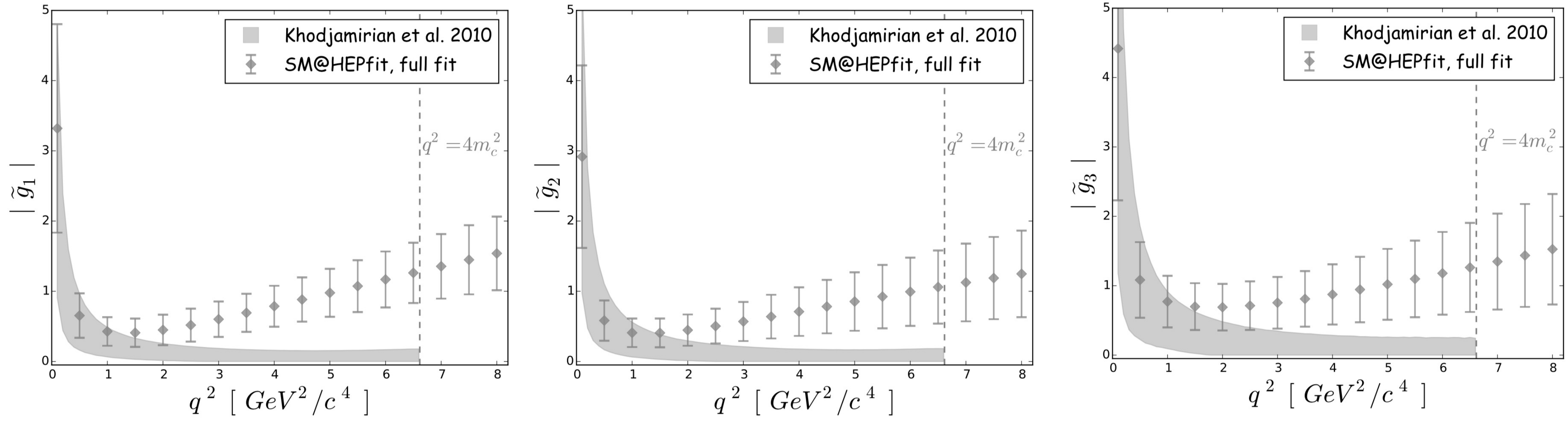
$$C_9^{\text{eff}}(q^2) = C_9^{\text{eff}} + Y(q^2)$$

- in the very low q^2 regime the hadronic contributions extracted from data and theory estimates seem to be compatible

- in the region closer to the resonance hadronic contributions extracted from data seem to be larger than theory estimates, as they should be

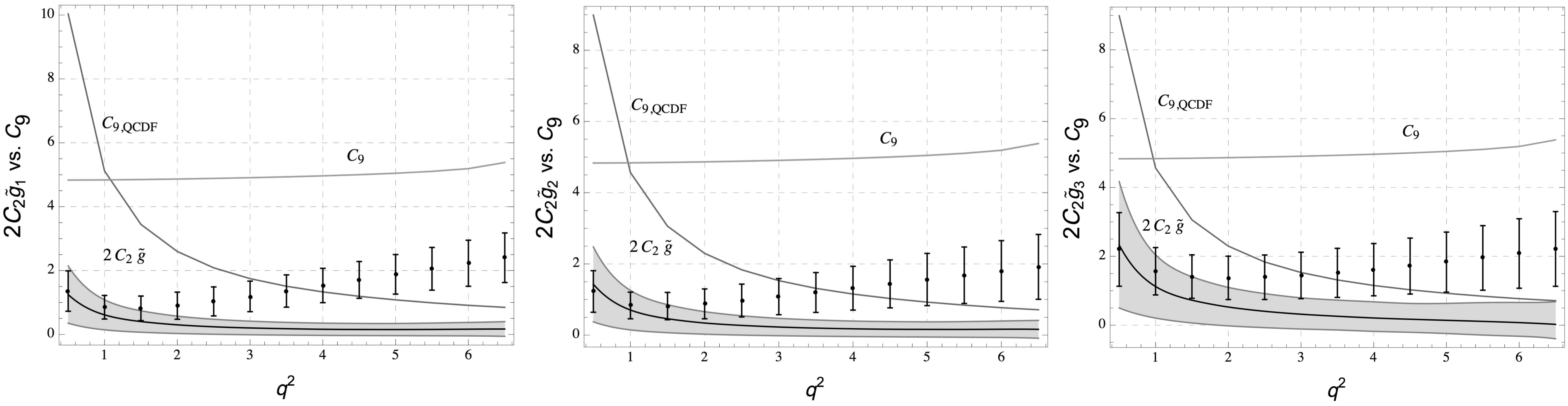
caveat: a ΔC_9 or ΔC_7 would have a similar effect on the observables.

However, a ΔC_9 or ΔC_7 cannot have a q^2 dependence!



A. Khodjamirian, T. Mannel, A. Pivovarov and Y.-M. Wang, *Charm-loop effect in $B \to K^{(*)}\ell^+\ell^-$ and $B \to K^*\gamma$*, JHEP **09** (2010) 089 [arXiv:1006.4945]

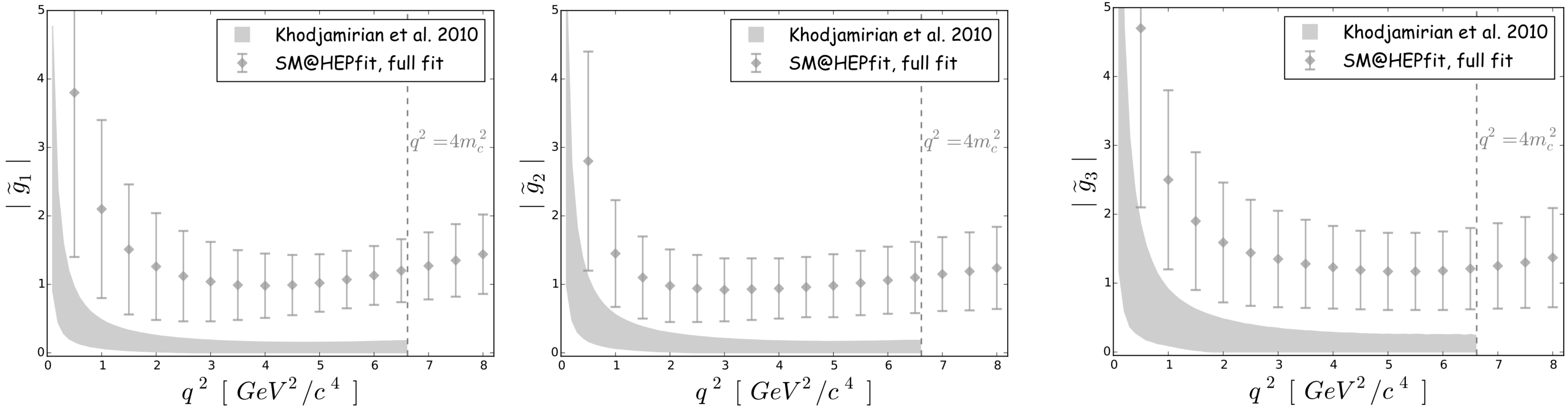
comparing the contributions



- ✓ C_9: the short distance contribution including the perturbative charm loop
- ✓ *QCDF*: the contribution from the charm look computed in QCDF (includes the pole at $q^2 = 0$)
- ✓ *gray band*: LCSR estimation of long distance contribution from Kodjamirian et. al. arXiv:1006.4945
- ✓ *black bars*: extraction of non-factorizable contributions extracted using **HEPfit** from $B \to K^*\ell^+\ell^-$ angular observables and branching fractions.

what data says about hadronic contribution

$$\Delta C_9^{(\bar{c}c,B\to K^*,\mathcal{M}_i)}(q^2) = (C_1 + 3C_2)\, g(m_c^2, q^2) + 2C_1 \widetilde{g}^{\,(\bar{c}c,B\to K^*,\mathcal{M}_i)}(q^2)$$



no theory input for fitting hadronic contribution

results from arXiV:1608.earlynextweek

Constraints on new physics from radiative B decays

Ayan Paul[a] and David M. Straub[b]

[a] INFN, Sezione di Roma, I-00185 Rome, Italy

[b] Excellence Cluster Universe, TUM, Boltzmannstr. 2, 85748 Garching, Germany

a step towards consistency in flavour physics computation

flavio BETA

A Python package for flavour physics phenomenology in the Standard Model and beyond

DOCS GET STARTED

View on GitHub

flavio is a Python 3 package to compute predictions for hundreds of observables in flavour physics, both in the Standard Model and for arbitrary new physics effects (parametrized as Wilson coefficients of dimension-6 operators). Additional features are in development.

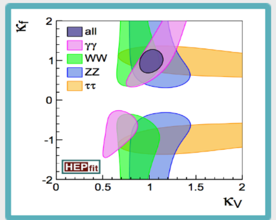
Main developer: David Straub

Please file bug reports and make feature requests over at Github

HEPfit

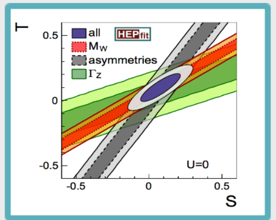
home developers samples documentation

HEPfit: a Code for the Combination of Indirect and Direct Constraints on High Energy Physics Models.



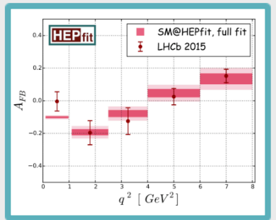
Higgs Physics

HEPfit can be used to study Higgs couplings and analyze data on signal strengths.



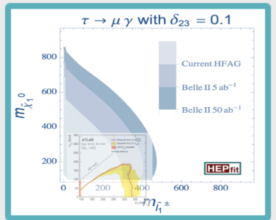
Precision Electroweak

Electroweak precision observables are included in HEPfit



Flavour Physics

The Flavour Physics menu in HEPfit includes both quark and lepton flavour dynamics.



BSM Physics

Dynamics beyond the Standard Model can be studied by adding models in HEPfit.

HEPfit COLLABORATION

our area of concern

$$\mathrm{BR}(B_q \to V\gamma) = \tau_{B_q} \frac{G_F^2 \alpha_{\mathrm{em}}^2 m_{B_q}^3 m_b^2}{32\pi^3} \left(1 - \frac{m_V^2}{m_B^2}\right)^3 |\lambda^t|^2 \left(|\mathcal{C}_7|^2 + |\mathcal{C}_7'|^2\right) T_1(0)$$

$$A_{\mathrm{CP}}(B_q(t) \to V\gamma) = \frac{\Gamma(\bar{B}_q(t) \to \bar{V}\gamma) - \Gamma(B_q(t) \to V\gamma)}{\Gamma(\bar{B}_q(t) \to \bar{V}\gamma) + \Gamma(B_q(t) \to V\gamma)}$$

$$= \frac{S(B_q \to V\gamma)\sin(\Delta M_q t) + A_{\mathrm{CP}}(B_q \to V\gamma)\cos(\Delta M_q t)}{\cosh(y_q t/\tau_{B_q}) - A_{\Delta\Gamma}(B_q \to V\gamma)\sinh(y_q t/\tau_{B_q})}$$

LCSR

$T_1(0) = 0.282 \pm 0.031$ for $B \to K^*\gamma$,

$T_1(0) = 0.309 \pm 0.027$ for $B_s \to \phi\gamma$,

LCSR + LQCD

$T_1(0) = 0.312 \pm 0.027$ for $B \to K^*\gamma$,

$T_1(0) = 0.299 \pm 0.012$ for $B_s \to \phi\gamma$.

SM

$$C_7^{\mathrm{eff}} = -0.2915$$

$$C_7' = \frac{m_s}{m_b} C_7$$

$$\mathrm{BR}(B_s(t) \to \phi\gamma) = \mathrm{BR}(B_s \to \phi\gamma)\, e^{-t/\tau_{B_s}} \left[\cosh\left(\frac{y_s t}{\tau_{B_s}}\right) - A_{\Delta\Gamma}(B_s \to \phi\gamma)\sinh\left(\frac{y_s t}{\tau_{B_s}}\right)\right]$$

$$y_q = \Delta\Gamma_q/(2\Gamma_q) = \tau_{B_q}\Delta\Gamma_q/2$$

$$\overline{\mathrm{BR}}(B_s \to \phi\gamma) = \left[\frac{1 - A_{\Delta\Gamma}(B_s \to \phi\gamma)\, y_s}{1 - y_s^2}\right] \mathrm{BR}(B_s \to \phi\gamma)$$

new physics sensitivity

$$S(B_s \to \phi\gamma) = \sin(2\chi)\ \sin(\phi_7 + \phi_7' - \phi_s^\Delta)\cos(\delta_7 - \delta_7')$$
$$A_{\Delta\Gamma}(B_s \to \phi\gamma) = \sin(2\chi)\ \cos(\phi_7 + \phi_7' - \phi_s^\Delta)\cos(\delta_7 - \delta_7')$$

$$S(B^0 \to K^*\gamma) = \sin(2\chi)\ \sin(\phi_7 + \phi_7' - 2\beta - \phi_d^\Delta - 2|\beta_s|)\cos(\delta_7 - \delta_7')$$

$$\tan\chi \equiv \left|\frac{\mathcal{C}_7'}{\mathcal{C}_7}\right|$$

complimentary

$B^0 \to K^{*0}(\to K\pi)e^+e^-$

$$P_1 = A_T^{(2)} = \frac{S_3}{2S_2^s},\ A_T^{(\mathrm{Im})} = \frac{A_9}{2S_2^s}$$
$$\lim_{q^2\to 0} P_1 = \sin(2\chi)\ \cos(\phi_7 - \phi_7')\cos(\delta_7 - \delta_7')$$
$$\lim_{q^2\to 0} A_T^{(\mathrm{Im})} = \sin(2\chi)\ \sin(\phi_7 - \phi_7')\cos(\delta_7 - \delta_7')$$

the hadronic uncertainties

Included in the analytic/numerical form

- ✓ vertex corrections involving matrix elements of current-current operators $Q_{1,2}$
- ✓ hard spectator scattering at leading order in Λ/m_b from QCD factorization
- ✓ weak annihilation at $O(\Lambda/m_b)$ from QCD Factorization

Treated as errors and included in the error budget

- × QCD power corrections to spectator scattering involving Q_8 that are end point divergent
- × Contributions to weak annihilation and spectator scattering beyond QCDF computed in LCSR
- × Soft gluon corrections, specially to the charm loop that are numerically significant

results assuming SM

Observable	SM prediction	Measurement
$10^4 \times \mathrm{BR}(B \to X_s\gamma)_{E_\gamma > 1.6\,\mathrm{GeV}}$	3.36 ± 0.23	3.43 ± 0.22
$10^5 \times \mathrm{BR}(B^+ \to K^*\gamma)$	3.43 ± 0.84	4.21 ± 0.18
$10^5 \times \mathrm{BR}(B^0 \to K^*\gamma)$	3.48 ± 0.81	4.33 ± 0.15
$10^5 \times \overline{\mathrm{BR}}(B_s \to \phi\gamma)$	4.31 ± 0.86	3.5 ± 0.4
$S(B^0 \to K^*\gamma)$	-0.023 ± 0.015	-0.16 ± 0.22
$A_{\Delta\Gamma}(B_s \to \phi\gamma)$	0.031 ± 0.021	?±?
$\langle P_1 \rangle (B^0 \to K^* e^+ e^-)_{[0.002,1.12]}$	0.04 ± 0.02	-0.23 ± 0.24
$\langle A_T^{\mathrm{Im}} \rangle (B^0 \to K^* e^+ e^-)_{[0.002,1.12]}$	0.0003 ± 0.0002	0.14 ± 0.23

LCSR

$T_1(0) = 0.282 \pm 0.031$ for $B \to K^*\gamma$,

$T_1(0) = 0.309 \pm 0.027$ for $B_s \to \phi\gamma$,

From a fit done assuming SM

$T_1(0) = 0.300 \pm 0.020$ for $B \to K^*\gamma$,

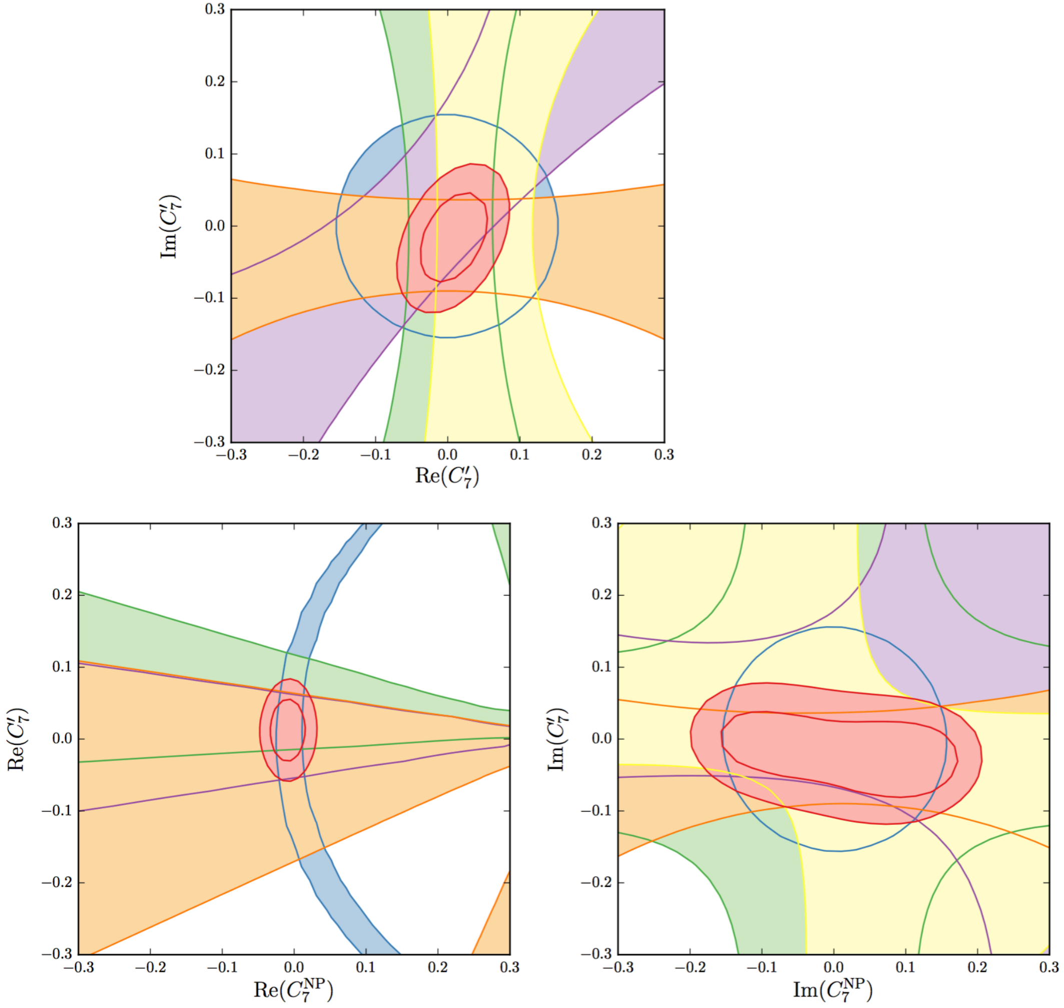
$T_1(0) = 0.264 \pm 0.022$ for $B_s \to \phi\gamma$.

LCSR + LQCD

$T_1(0) = 0.312 \pm 0.027$ for $B \to K^*\gamma$,

$T_1(0) = 0.299 \pm 0.012$ for $B_s \to \phi\gamma$.

results for NP



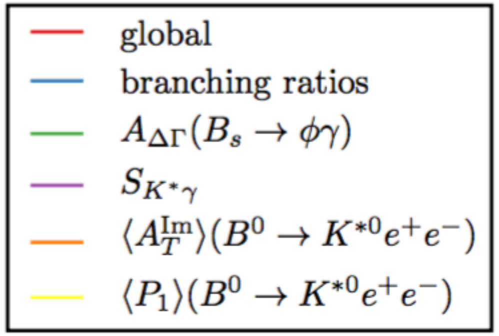
Assuming NP in *Re(C₇)* only:

$$C_7^{\rm NP} \in \begin{cases} [-0.023, 0.008] & @\ 68\%\ \text{C.L.} \\ [-0.037, 0.024] & @\ 95\%\ \text{C.L.} \end{cases}$$

Assuming *Im(C₇) ~ 0*:

$$\begin{pmatrix} \mathrm{Re}\, C_7^{\rm NP}(\mu_b) \\ \mathrm{Re}\, C_7^{\prime\,\rm NP}(\mu_b) \\ \mathrm{Im}\, C_7'(\mu_b) \end{pmatrix} = \begin{pmatrix} -0.007 \pm 0.016 \\ -0.003 \pm 0.039 \\ +0.024 \pm 0.070 \end{pmatrix} \quad \rho = \begin{pmatrix} 1 & 0.10 & 0.21 \\ 0.10 & 1 & 0.59 \\ 0.21 & 0.59 & 1 \end{pmatrix}$$

$$\mu_b = 4.8\ \text{GeV}$$



summary

Thank you…!!

To my Mother and Father, who showed me what I could do,

and to Ikaros, who showed me what I could not.

"To know what no one else does, what a pleasure it can be!"

– adopted from the words of

Eugene Wigner.