Looking forward to new lattice inputs for flavour phenomenology

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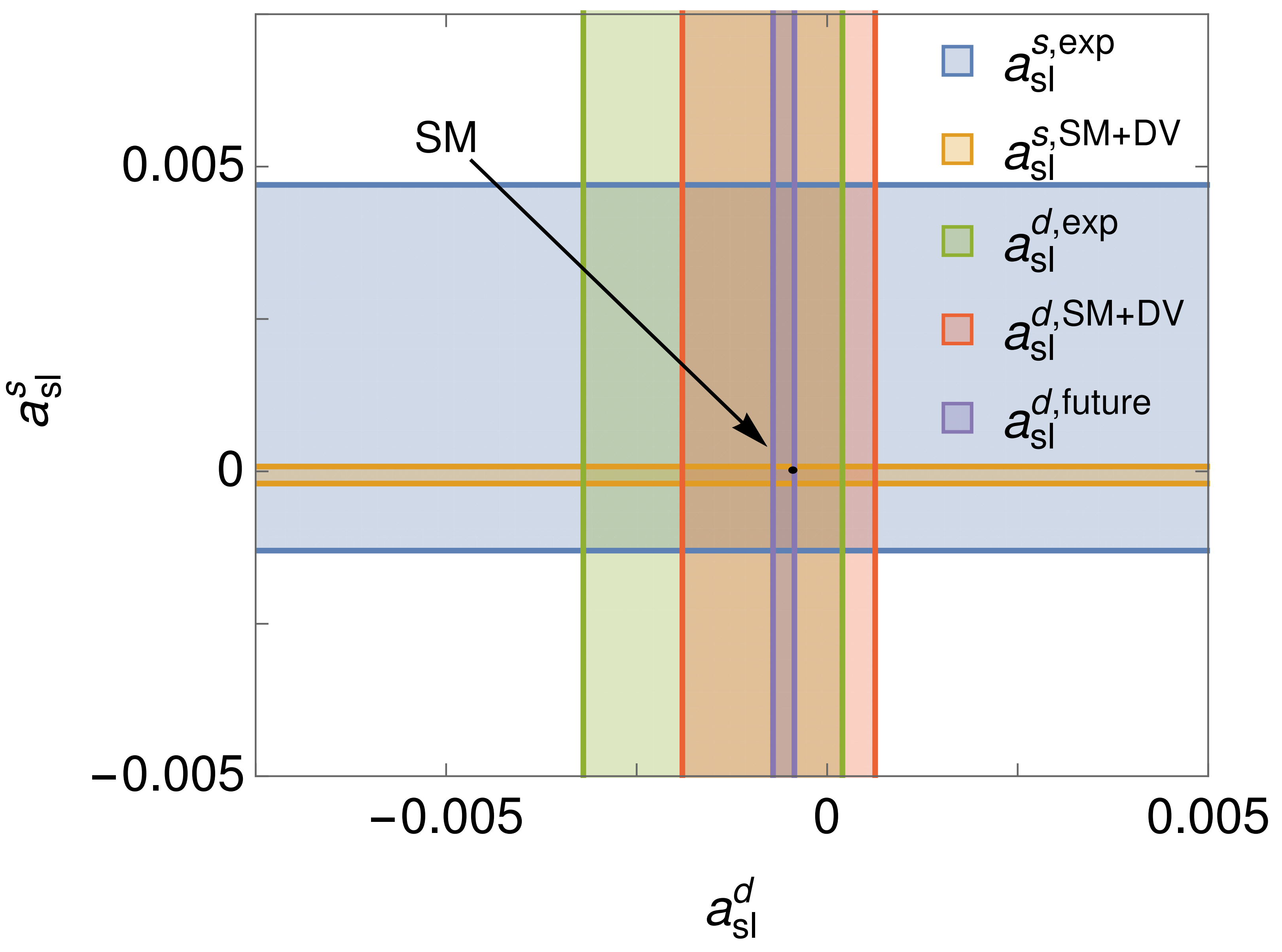
Duality Violation

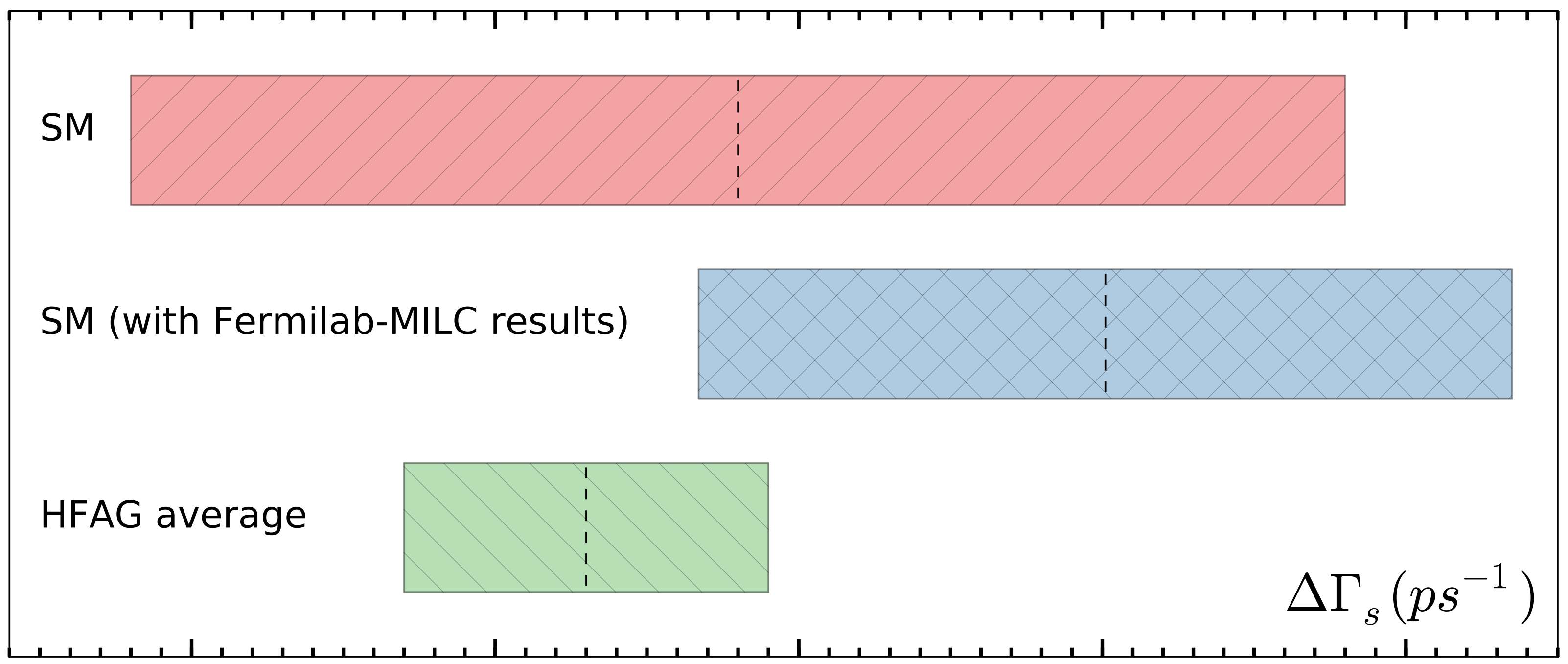
Current results from theory and experiment (ATLAS, CMS, LHCb) on $\Delta\Gamma_{\mathrm{s}}$ constrain quark-hadron duality violation to around 30% [1]. From this result, we can quantify whether deviations of a_{sl} from theory could be explained by duality violation, or whether they would be unambiguous signs of NP.



The future scenarios assume a reduction in the theory error – we need lattice contributions for dimension-6 and dimension-7 operators (some in progress – see talk by M. Wingate at Heavy Flavour 2016, Lattice 2016).

Improved dimension-6 operators

Most recent lattice calculation from earlier this year [3]. As an example, look at $\Delta\Gamma_{\mathrm{s}}$



Lattice has allowed us to reduce the theory error by around 1/3 – but the central value has shifted away from experiment. Calculations by more lattice groups essential for assessing this.

B Meson Lifetime Ratio

Very strong NP bounds can be obtained using the lifetime ratio $\tau(\mathrm{B_s})/\tau(\mathrm{B_d})$, as there is strong cancellation in the SM calculation. The most recent theory calculation of $\tau(\mathrm{B_s})/\tau(\mathrm{B})$ is 1.00050 ± 0.00108. Around 80% of this error comes from lattice calculation of colour-suppressed bag parameters $\epsilon_{1,2}$.

$$\left\langle B \,\middle|\, (\bar{\mathrm{b}}\gamma_\mu(1-\gamma^5)T^a q) \otimes (\bar{q}\gamma^\mu(1-\gamma^5)T^a \mathrm{b}) \,\middle|\, B \right\rangle = f_{\mathrm{B}}^2 M_{\mathrm{B}}^2 \epsilon_1$$

$$\left\langle B \,\middle|\, (\bar{\mathrm{b}}(1-\gamma^5)T^a q) \otimes (\bar{q}(1-\gamma^5)T^a \mathrm{b}) \,\middle|\, B \right\rangle = f_{\mathrm{B}}^2 M_{\mathrm{B}}^2 \epsilon_2$$

Last result comes from 2001 proceedings [2]:

$$\epsilon_1 = -0.02 \pm 0.02 \qquad \epsilon_2 = 0.03 \pm 0.01$$

New results for these parameters are urgently needed.

Charm Lifetimes

The status of the Heavy Quark Expansion (HQE) in charm sector is almost unknown – an ideal testing ground is charm meson lifetimes. The most recent results are very promising [4]

$$\left.\frac{\tau(\mathrm{D}^+)}{\tau(\mathrm{D}^0)}\right|_{\text{HQE}} = 2.2 \pm 1.7 \qquad \left.\frac{\tau(\mathrm{D}^+)}{\tau(\mathrm{D}^0)}\right|_{\text{exp.}} = 2.536 \pm 0.019$$

No lattice calculations of the lifetime matrix elements are available, leading to huge hadronic uncertainties seen above. Some work has been done for charm mixing matrix elements [5] – however calculation of lifetime matrix elements is crucial for precision tests of the HQE.

References

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