Decay Constants of Heavy Pseudoscalar Mesons: Reconciling QCD Sum Rules and Lattice QCD

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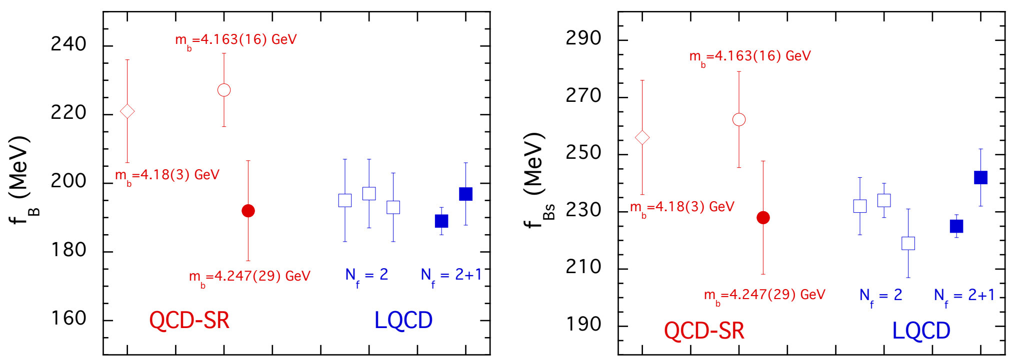
Exploiting recently proposed novel improvements of the techniques used for extracting from QCD sum rules pivotal hadron characteristics, including their systematic errors, we succeed to achieve a conspicuous agreement of the predictions of QCD sum rules (QCD-SR) for the decay constants f_B and f_{B_s} of the pseudoscalar mesons B and B_s, which before tended to be slightly too large, with the corresponding results of lattice-QCD (LQCD) computations for N_f dynamical sea-quark flavours: Adopting for the crucial b-quark mass $m_b \equiv \overline{m}_b(\overline{m}_b)$ defined in the $\overline{MS}$ renormalization scheme the value $m_b = (4.247 \pm 0.034)$ GeV, we get $f_B = (192.0 \pm 14.6)$ MeV and $f_{B_s} = (228.0 \pm 19.8)$ MeV; clearly, this may be also viewed as a determination of m_b from sufficiently precise decay constants.



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Introduction, Cursory Sketch of Basic Idea, Summary of Findings, and Conclusions

By simultaneous evaluation of vacuum expectation values of nonlocal products of interpolating quark currents at both QCD and hadron level, *QCD sum rules* relate measurable hadronic features to the fundamental parameters of QCD [1]. Wilson's operator product expansion enables us to express any such nonlocal product as a series of local operators. Our ignorance about higher resonances can be hidden by assuming *quark–hadron duality*: Beyond some effective threshold $s_{\rm eff}$ the perturbative QCD contributions are expected to counterbalance those of the hadronic excitations and continuum. Applying *Borel transformations* to Borel variables suppresses the impact of heavier hadronic states.

In order to improve the *accuracy* of sum-rule predictions and to estimate reliably the *systematic uncertainties*, we recently developed some modifications of the QCD sum-rule method [2] centered around the idea to allow $s_{\rm eff}$ to depend on the Borel variables [3]. This dependence of $s_{\rm eff}$ is found by minimizing, for polynomial ansätze for $s_{\rm eff}$, the deviation of the predicted meson mass squared from the true meson mass squared over the range of values allowed for the Borel variables. For the meson observable of interest, its systematic error due to the intrinsically limited accuracy of QCD sum-rule predictions is the spread of results derived for this observable using $s_{\rm eff}$ ansätze from linear to cubic.

Studying the bottom-meson system along this path [4], we note that expressing our sum rules in terms of the $\overline{MS}$ *running mass* of the heavy quark instead of its *pole mass* considerably improves the perturbative convergence of sum-rule findings [5] and that, contrary to the charmed-meson case [6], the decay constants $f_{B_{(s)}}$ of the $B_{(s)}$ mesons are very sensitive to the b-quark $\overline{\rm MS}$ mass $m_b \equiv \overline{m}_b(\overline{m}_b)$. Regarding this latter fact as serendipity, by choosing $m_b = (4.247 \pm 0.034)$ GeV our QCD sum rules entail $f_B = (192.0 \pm 14.3_{\rm QCD} \pm 3.0_{\rm syst})$ MeV and $f_{B_s} = (228.0 \pm 19.4_{\rm QCD} \pm 4_{\rm syst})$ MeV for the decay constants of the B and B_s mesons, which perfectly reproduces our averages $f_B = (191.5 \pm 7.3)$ MeV and $f_{B_s} = (228.8 \pm 6.9)$ MeV of several recent lattice-QCD evaluations [7] of these decay constants.

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