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Naturalness scale inference in chiral perturbation theory and chiral logarithms

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Abstract

We use Bayesian techniques to infer a naturalness scale of chiral perturbation theory in the mesonic sector. We adjust the pointwise analysis technique, proposed by the BUQEYE collaboration, taking chiral logarithms that appear in the expansion of these quantities explicitly into account. To demonstrate our approach, we consider the chiral expansion of the pion decay constant F_π and the threshold and subthreshold parameters of $\pi\pi$ scattering. We find a strong observable dependence of the inferred naturalness scales, and show that they need not coincide with the pion mass at which the order-by-order hierarchy of the chiral expansion deteriorates. As an application, we discuss the requirements for lattice-QCD determinations of two O(p6) low-energy constants that in the current matching of Roy-equation analyses to chiral perturbation theory need to be estimated from resonance saturation, but could be extracted from the pion-mass dependence of $\pi\pi$ scattering parameters.

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