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CP Violation in Rare B Decays as a Window to New Physics

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In the pursuit of physics beyond the Standard Model, a promising path is the study of exclusive B-meson decays caused by the transition $b \rightarrow s \ell^+ \ell^-$. A key observable in such decays is the ratio R_K , which measures electron-muon universality in $B \rightarrow K \mu^+ \mu^- / e^+ e^-$. At first sight, the recent LHCb measurement of $R_K \sim 1$ may seem to largely constrain deviations from universality in these decays. However, this is actually not the case: new sources of CP violation allow for universality violation consistent with $R_K = 1$ [2303.08764]. Another central observable is the branching ratio of the semileptonic decay $B \rightarrow K \mu^+ \mu^-$, which shows a $\sim 4\sigma$ tension between experiment and theory. New physics causing this tension is customarily encoded in the Wilson coefficients C_9 and C_{10} . We discuss a new way to extract CP-violating phases in these coefficients [2212.09575]. We also discuss CP violation in the leptonic decay $B_s \rightarrow \mu^+ \mu^-$, which complements semileptonic decays through its outstanding sensitivity to scalar and pseudoscalar physics. These studies provide exciting new opportunities to search for new physics in rare B-meson decays.

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