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Semileptonic b Decays at Future Z Factories

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As one of the hypothetical principles in the Standard Model (SM), lepton flavor universality (LFU) should be measured with a precision as high as possible such that the physics violating this principle can be fully tested. The Z factories at the future e^-e^+ colliders provide a great opportunity to perform this task because of their large statistics and high reconstruction efficiencies for B mesons at Z pole. These advantages are further strengthened if τ leptons are produced via the B-meson decays as a third-generation flavor. In this paper, we present a systematic study on the LFU test in different operation scenarios of the future Z factories. The goal is two-fold. Firstly, we study the sensitivities of measuring the LFU-violating observables which have involved the $b \to c\tau\nu$ transitions, namely $R_{J/\psi}$, R_{D_s}, $R_{D_s^*}$ and R_{Λ_c}, using the mode of muonic τ decays. For this purpose, the strategies of event reconstruction are developed on the basis of the charged-track information. Secondly, we interpret the projected sensitivities in the SM effective field theory (with an assumption that the LFU-violating physics occurs to the third generation exclusively), by combining the LFU tests with $b \to c\tau\nu$ and the measurements of the $b \to s\tau^-\tau^+$ and $b \to s\nu\nu$ transitions. We show that the limits on the LFU-violating energy scale can be pushed up to ~ 10 TeV for $\sim \mathcal{O}(1)$ Wilson coefficients.

Category

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