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Exposing Dark Sector with Future Z-Factories

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We investigate the prospects of searching dark sector models via exotic Z-boson decay at future e^+e^- colliders with Giga Z and Tera Z options. Four general categories of dark sector models: Higgs portal dark matter, vector portal dark matter, inelastic dark matter and axion-like particles, are considered. Focusing on channels motivated by the dark sector models, we carry out a model independent study of the sensitivities of Z-factories in probing exotic decays. The limits on branching ratios of the exotic Z decay are typically $O(10^{-6} - 10^{-8.5})$ for the Giga Z and $O(10^{-7.5} - 10^{-11})$ for the Tera Z, and they are compared with the projection for the high luminosity LHC. We demonstrate that future Z-factories can provide its unique and leading sensitivity, and highlight the complementarity with other experiments, including the indirect and direct dark matter search limits, and the existing collider limits. Future Z factories will play a leading role to uncover the hidden sector of the universe in the future.

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