

Polarization effects in the search for vector dark boson at e^+e^- colliders

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We argue that the search for vector dark boson through $e^+e^- \rightarrow Z'\gamma$ can determine the Lorentz structure of $Z'l^+l^-$ couplings with the detection of leptonic decays $Z' \rightarrow l^+l^-$. We assume a general framework that the vector dark boson interacts with ordinary fermions through vector and axial-vector couplings. As a consequence of Ward-Takahashi identity, Z' is transversely polarized in the limit $m_{Z'} \ll \sqrt{s}$ while all polarizations of Z' are produced for heavier Z' . Such polarization effects can be analyzed through the angular, or equivalently, energy distributions of final-state particles in Z' decays. Taking $l^\pm \equiv \mu^\pm$, we study the energy distributions of final-state muons that correspond to parent Z' s moving in either the forward or backward directions relative to the electron beam axis in the CM frame of e^+e^- pair. Such energy distributions can be used to probe the relative strengths of vector and axial-vector couplings between Z' and muons. We discuss such measurements in Belle II detector with appropriate acceptance cuts and various stages of integrated luminosities taken into account.

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