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Polarization observables in chi_c to J/psi+mu+mu Dalitz decays at the LHC

Polarization observables play prominent role in modern physics and can provide unique and crucial information on the interaction dynamics. Our present note is devoted to a theoretical analysis of the decays of χ_{c1} and χ_{c2} mesons produced in high energy hadronic collisions:
$pp \to \chi_{cJ} + X;\ \chi_{cJ} \to J/\psi + l^+l^-;\ J/\psi \to l^+l^-$.
This study was inspired by a distinctive identification of χ_{c1} and χ_{c1} Dalitz decays at the LHCb collaboration at CERN.

In the context of χ_{cJ} Dalitz decays, we consider three sets of polarization obervables. First, is the polarization of the original χ_{cJ} mesons that can be seen in the angular distributions of the resulting J/ψ mesons and virtual photons. Second, is the polarization of the daughter J/ψ's that manifests in the angular distributions of the decay leptons. Third, is the polarization of the virtual photon that can be seen in the angular distributions of the other lepton pair.

Our calculations are performed in the k_t-factorization approach and rely on the standard QCD perturbation theory and nonrelativistic bound state formalism. The Leading Order contribution is represented by a $2 \to 1$ gluon-gluon fusion partonic subprocess $g^* + g^* \to \chi_{cJ}, \quad J = 0, 1, 2$, where the initial gluons are off-shell, have nonzero transverse momentum and nonzero longitudinal component in their polarization vector. The subsequent decays of χ_{cJ} mesons are assumed to be dominated by electric dipole (E1) transitions.

We make numerical predictions for 'helicity' and Collins-Soper frames. We find that the polarization of χ_{cJ} and J/ψ mesons is large and possesses nontrivial behavior as a function of χ_{cJ} transverse momentum. Our predictions provide the necessary theoretical grounds for a comparison with forthcoming experiments.

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