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Longitudinal-transverse double-spin asymmetry with a $\cos \phi_S$ modulation in SIDIS

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We study the double-spin asymmetry $A_{LT}^{\cos \phi_S}$ in semi-inclusive DIS for charged and neutral pions production by scattering a longitudinal polarized beam off a transversely polarized proton target. Within the collinear framework, in which the transverse momentum of the final state hadron is integrated out, we predict the asymmetries for three pion productions at the kinematics of CLAS12 and future Electron Ion Collider. There are two sources contributed to the corresponding asymmetry, one is from the convolution of the twist-3 distribution function $g_T(x)$ and the unpolarized fragmentation function $D_1(z)$, the other is from the coupling of the transversity distribution function $h_1(x)$ and the collinear twist-3 fragmentation function $\tilde{E}(z)$. Our numerical results show that the $\cos \phi_S$ asymmetry of pion production at CLAS12 is sizable, and the fragmentation function $\tilde{E}(z)$ plays an important role in the large- z region. The asymmetries at EIC are much smaller than those at CLAS12 due to the suppression in the large- Q region.

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