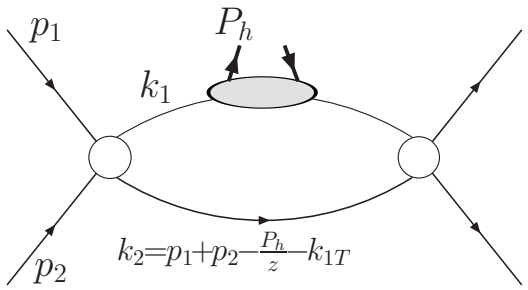

FIG. 1: *Generic Feynman diagrams to calculate the derivative term of the twist-three fragmentation function contributions to the single inclusive hadron production in pp scattering, $p^{\uparrow}p \to hX$: p_1 and p_2 are the two incident partons' momenta, k_1 and k_2 are the outgoing partons' momenta, where the quark k_1 fragments into final-state hadron P_h. The expansion of the scattering amplitude in terms of transverse momentum component of $k_1 = P_h/z + k_{1T}$ leads to the twist-three contributions from the fragmentation function $\hat{H}(z)$ defined in Eq. (3).*

this paper, we will report the derivative-term results, and carry out the numerical estimates for their contributions to the single spin asymmetries at RHIC. We will leave the detailed derivations, including the derivative and non-derivative terms in a future publication.

We follow the technique developed in the last few years [17–23] to derive the contributions from the twist-three fragmentation functions. First, we calculate the associated scattering amplitudes in terms of various twist-three matrix elements of hadrons. From diagrammatic point of view, these individual contributions are not in a gauge invariant way. However, the final results will be gauge invariant when we sum up all the contributions. In terms of twist-three operators, we have the contributions from the $\partial_T\psi$, A_T, and $\partial_T A^+$ ($\partial^+ A_T$). These contributions indeed will form the gauge invariant results in terms of $\hat{H}(z)$, $\hat{H}_F$ as defined above. In particular, $\partial_T\psi$ term corresponds to $\hat{H}(z)$ whereas A_T term corresponds to $\hat{H}_F$. Since the derivative terms are associated with the function $\hat{H}(z)$, we will need to calculate the contributions from the $\partial_T\psi$ part. In order to carry out this calculation, we have to perform the collinear expansion for the hard partonic part associated with this matrix element. In Fig. 1, we illustrate the generic Feynman diagrams contributing to the derivative terms. In this diagram, p_1 and p_2 are the two incoming partons' momenta from the polarized and unpolarized nucleons, respectively; k_1 and k_2 are the two outgoing partons' momenta where k_1 fragments into the final-state hadron P_h. The derivative terms come from the