

TMDs, PDFs, and multiparton distributions of spin-1 hadrons and their relations

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There are new polarized structure functions, which do not exist for the spin-1/2 nucleons, in a spin-1 hadron such as the deuteron. In the near future, we expect that physics of spin-1 hadrons will become a popular topic, since there are experimental projects to investigate spin structure of the spin-1 deuteron at the Jefferson Laboratory, the Fermilab, the NICA, the LHCspin, and the electron-ion colliders in US and China in 2020's and 2030's.

We explain possible transverse-momentum-dependent parton distribution functions (TMDs) for spin-1 hadrons up to twist 4 by decomposing a quark correlation function with the conditions of the Hermiticity and parity invariance [1]. We found 30 new structure functions in the twist 3 and 4 in our work. In addition, we indicated that new fragmentation functions exist in tensor-polarized spin-1 hadrons. Integrating the TMDs over the transverse momentum, we found new collinear PDFs for spin-1 hadrons. For these PDFs, we showed that a twist-2 relation and a sum rule exist for the tensor-polarized parton distribution functions f_{1LL} and f_{LT} [2]. We also indicated that four twist-3 multiparton distribution functions F_{LT} , G_{LT} , $H_{LL}^\perp$, and H_{TT} exist for tensor-polarized spin-1 hadrons. Furthermore, we showed relations among the collinear parton- and multiparton-distribution functions for the spin-1 hadrons by using the equation of motion for quarks [3]. Useful relations were obtained (1) for the twist-3 PDF f_{LT} , the transverse-momentum moment PDF $f_{1LT}^{(1)}$, and the multiparton distribution functions $F_{G,LT}$ and $G_{G,LT}$; (2) for the twist-3 PDF e_{LL} , the twist-2 PDF f_{1LL} , and the multiparton distribution function $H_{G,LL}^\perp$. In addition, so called a Lorentz-invariance relation was obtained for $f_{1LT}^{(1)}$, f_{1LL} , f_{LT} , and $F_{G,LT}$. These relations are useful in future experimental investigations on the spin-1 structure functions.

[1] S. Kumano and Qin-Tao Song, Phys. Rev. D 103 (2021) 014025.

[2] S. Kumano and Qin-Tao Song, JHEP 09 (2021) 141.

[3] S. Kumano and Qin-Tao Song, Phys. Lett. B 826 (2022) 136908.

Submitted on behalf of a Collaboration?

Yes

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