

# Six-dimensional light-front Wigner distributions of the proton

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Our study, rooted in hadron physics, addresses the incomplete information limitation of traditional parton distribution functions. We investigate the six-dimensional (6D) light-front Wigner distribution function of the proton (a spin-1/2 hadron) using the 6D light-front Wigner distribution framework constructed by our team.

At the leading twist, 16 independent distribution functions accounting for different polarizations are defined; their integration results carry specific physical meanings. The 6D light-front Wigner distribution features a quasi-probability nature: integration enables generation of known observables and definition of new low-dimensional distribution functions for exploring novel physical phenomena.

Employing the spectator model for proton Wigner distribution calculations, numerical results show the 6D Wigner distribution exhibits centrosymmetry or dipolar symmetry in specific planes, with function values generally increasing alongside relevant parameters. Qualitative analysis is also conducted on physical quantities like intrinsic orbital angular momentum.

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