Interference Fragmentation Functions

M. Radici
I.N.F.N. - Sezione di Pavia - Italy

Distribution functions (DF) describe the nonperturbative properties of partons when confined inside hadronic bound states at a low scale. Factorization theorems for hard processes, whenever available, ensure their universality. At leading order (LO), the state of a quark with respect to its longitudinal momentum and spin is parametrized by three functions: the momentum, the helicity and the spin-transverse distributions (or transversity). While the first two ones have been parametrized with high accuracy, the transversity is still unknown, because it is connected to soft nonperturbative processes that do not conserve the quark helicity. As such, the transversity is unaccessible in inclusive Deep Inelastic Scattering (DIS), at least at LO. Double Spin Asymmetries (DSA), such as Drell-Yan processes or productions of polarized Λ from polarized targets, represent an alternative tool. However, in both cases estimates of experimental rates are low and theoretical ambiguities have not yet been solved about the polarization transfer to the Λ particle not considered as a target. In fact, the nonperturbative behaviour of the parton content of hadrons, when not stable targets, is encoded in the fragmentation functions (FF), which represent an information complementary to DF but they require high-resolution measurements of semi-inclusive processes; as such, they are presently poorly known. Ongoing upgrades (HERMES) or new machines (COMPASS, eRHIC) will meet these requirements. In this case, Single Spin Asymmetries (SSA), like pion detection in DIS on transversely polarized targets, can give insight into the transversity through the socalled Collins effect. By relating the transverse polarization of the quark to the orbital angular momentum of the detected hadron around the jet axis, it is possible to extract the transversity at LO through a socalled interference fragmentation function (IFF), the Collins function, which is related to the quantum interference between different channels leading to the same observed final state. From the theoretical point of view, the Collins effect requires the complete knowledge of the kinematics of the detected hadron, including its transverse momentum. Further, it suffers from a suppression due to the Sudakov form factors, because the resummation of all the soft-gluon contributions does not cancel. Last, a possible modelling of the Collins function requires the ability of describing the microscopic residual interactions of the hadron with the unobserved jet.

For all these reasons, a better alternative could be the SSA with detection of two unpolarized leading hadrons inside the same jet. Assuming that the residual interactions between each leading hadron and the undetected jet is of higher order than the one between the two hadrons themselves, the transversity gets factorized at LO through a novel IFF, $H_1^{\sphericalangle}$, that relates the transverse polarization of the quark to the orbital angular momentum of the relative motion of the two detected hadrons. We call this the "bowling" effect. This new analyzing power, $H_1^{\sphericalangle}$, filters out the transversity in a very advantageous way, because collinear factorization holds and allows for a cancellation of the soft-gluon contributions and for a much easier LO evolution. Moreover, it is also easier to model the residual interaction between the two hadrons only. Therefore, we give a general leading-twist analysis of the IFF arising in this case and we calculate them in the spectator approximation but starting from the most general formalism. As such, we think that all this represents a substantial improvement with respect to the existing literature. Numerical estimates, in the case of emission of the (π^+,π^-) pair around the ρ resonance, show that the measurement is feasible at the aforementioned facilities.