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Why the x_E distribution triggered by a leading particle does not measure the fragmentation function but does measure the ratio of the transverse momenta of the away-side jet to the trigger-side jet.

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Hard-scattering of point-like constituents (or partons) in p-p collisions was discovered at the CERN-ISR in 1972 by measurements utilizing inclusive single or pairs of hadrons with large transverse momentum (p_T). Due to the steeply falling power-law p_T spectrum of the hard-scattered partons, the inclusive single particle (e.g. π^0) p_{T_t} spectrum from parton fragmentation to a jet is dominated by trigger fragments with large $\langle z_t \rangle \sim 0.7 - 0.8$, where $z_t = p_{T_t}/p_{T\text{jet}}$ is the fragmentation variable. It was generally assumed, following Feynman, Field and Fox [1], as shown by data from the CERN-ISR experiments, that the p_{T_a} distribution of away side hadrons from a single particle trigger [with p_{T_t}], corrected for $\langle z_t \rangle$, would be the same as that from a jet-trigger and follow the same fragmentation function as observed in e^+e^- or DIS. PHENIX [2] attempted to measure the fragmentation function from the away side $x_E \sim p_{T_a}/p_{T_t}$ distribution of charged particles triggered by a π^0 in p-p collisions and showed by explicit calculation that the x_E distribution is actually quite insensitive to the fragmentation function. Illustrations of the original arguments and ISR results will be presented. Then the lack of sensitivity to the fragmentation function will be explained, and an analytic formula for the x_E distribution given, in terms of incomplete Gamma functions, for the case where the fragmentation function is exponential. The away-side distribution in this formulation has the nice property that it both exhibits x_E scaling and is directly sensitive to the ratio of the away jet $\hat{p}_{T_a}$ to that of the trigger jet, $\hat{p}_{T_t}$, and thus can be used, for example, to measure the relative energy loss of the two jets from a hard-scattering which escape from the medium in A+A collisions. Comparisons of the analytical formula to RHIC measurements will be presented, including data from STAR [3] and PHENIX [4], leading to some interesting conclusions.

References

[1] R. P. Feynman, R. D. Field, and G. C. Fox, *Nuclear Physics* **B**, v. 128, p. 1-65, 1977.
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[3] J. Adams, et al., STAR Collaboration, *Physical Review Letters*, v. 95, p. 152301, 2005. J. Adams, et al., STAR Collaboration, preprint `nucl-ex/0604018`, submitted to *Physical Review Letters*.
[4] S. S. Adler, et al., PHENIX Collaboration, *Physical Review* **C**, v. 73, p. 054903, 2006.