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Why the x_E distribution triggered by a π^0 does not measure the fragmentation function

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Abstract

At the previous Hard Probes 2004 conference, and at several other conferences the same year, I explained how "Almost everything you want to know about jets can be found using 2-particle correlations" in a talk which traced the development of hard-scattering in pp collisions from its discovery at the CERN-ISR in 1972—by measurements utilizing inclusive single or pairs of hadrons—to applications in Au+Au collisions at RHIC. Due to the steeply falling power-law transverse momentum spectrum of the scattered partons, the inclusive single particle (e.g. pizero) spectrum from jet fragmentation 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. However, it was generally assumed, following Feynman, Field and Fox, 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. An attempt by PHENIX 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 showed by explicit calculation that the x_E distribution was actually quite insensitive to the fragmentation function. Illustrations of the original arguments and ISR results will be given. 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 an incomplete Gamma function, for the case where the fragmentation function is exponential. The away-side distribution 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 to the relative energy loss of the two jets escaping from the medium in RHI collisions. Comparisons of the analytical formula to measurements from STAR [PRL **95**, 152301 (2005); `nucl-ex-0604018`] and PHENIX [`hep-ex/0605039`] will be presented, leading to some interesting conclusions.

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