Jet fragmentation via recombination of parton showers in vacuum

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We have devised a model to hadronize perturbative parton showers in jets based on quark recombination [1]. This is achieved by turning perturbative parton showers into showers of constituent quarks and antiquarks by gluon decay, and then applying Monte Carlo methods to recombine quarks and antiquarks using probabilities given by the overlap integrals of their Gaussian wave packets with meson and baryon Wigner functions [2]. For remnant quarks and antiquarks that are not used for recombination, they are connected to form short strings and subjected to the usual string fragmentation procedure in PYTHIA [3]. As an example, we have studied hadron production from e^++e^- collisions at center of mass energy of 200 GeV using shower partons generated from PYTHIA. Fig. 1 shows the longitudinal (through the momentum fraction z of the jet) and transverse momentum spectrum p_T of pions, kaons, protons, and Lambdas obtained from recombination, remnant fragmentation, and their sum. For the

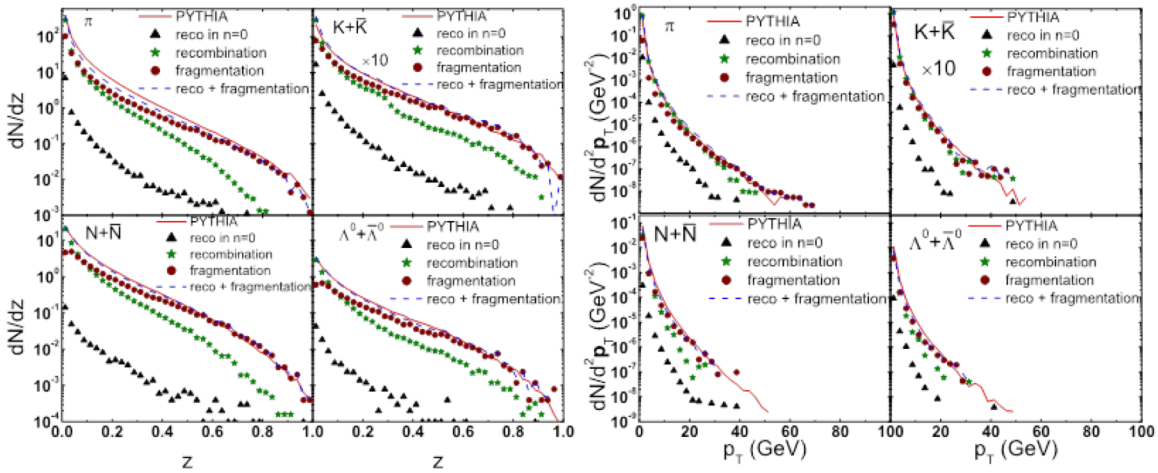

FIG 1. Longitudinal momentum fraction dN/dz (left window) and transverse momentum pT spectrum (right window) of pions (upper left panel), kaons (upper right panel), nucleons and antinucleons (lower left panel), and Lambdas and antilambdas (lower right panel) from the recombination of shower partons (stars), fragmentation of remnant partons (circles), and their sum (dashed lines), compared with results from PYTHIA string fragmentation (solid lines) for jets produced in e^++e^- collisions at center of mass energy of 200 GeV.

recombination contribution, we fix the cutoff parameters in meson and baryon Wigner functions by the charge radii of pion, kaon, and proton, and also include decays of excited states from recombination. It is seen that low momentum hadrons are mainly produced from recombination while high momentum ones are dominated by string fragmentation of remnant partons, reflecting the decreasing recombination probability of shower partons with their momentum. The sum of the recombination and short-string fragmentation qualitatively reproduces the results from PYTHIA string fragmentation of original parton showers. Our study differs from early works using quark recombination for hadronization of jets [4] in that parton showers in our study are obtained from the sophisticated parton Monte Carlos available today instead of from fitting to data or from specific models. In addition, earlier works used event-averaged spectra, ignoring fluctuations coming from the small number of partons in each jet. Work is in progress to

generalize present approach to include partons from an ambient medium such as the quark-gluon plasma (QGP) produced in relativistic heavy ion collisions by allowing shower partons to recombine with thermal partons at phase transition temperature.

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