A measurement of intrinsic transverse momentum of parton \((k_T)\) from two particle correlations for pp collisions at RHIC

Mriganka Mouli Mondal\(^1\) and Subhasis Chattopadhyay\(^1\)

\(^1\)Variable Energy Cyclotron Centre, Kolkata-700064, India
(for STAR Collaboration)

**Introduction**

Partons are the constituents of nucleons which carry a fraction of the nucleon momentum described by parton distribution function [1]. 2\(\rightarrow\)2 partonic hard scattering processes are manifested as jets of particles back to back in azimuth. These processes are described well by QCD predictions but there are some difficulty in explaining the predictions of the cross sections at high \(p_T\) regions and the behavior of the scaling laws [2] and one needs to introduce an extra \(p_T\) kick to the scattered partons to explain the data. It is true that since partons are confined inside a hadron of finite dimension they have a certain amount of intrinsic motion [3]. This intrinsic motion gives rise to an effective transverse momentum vector \(k_T\) of each of the two colliding partons undergoing hard scattering in proton-proton collisions. \(k_T\) measurement have been performed by ISR [4, 5], CCOR [6], PHENIX [7] collaborations at various centre of mass energies and at various kinematic regions. The measurements contain the intrinsic \(k_T\) and the additional smearing of the partonic \(k_T\) that comes from initial and final state gluonic radiation.

**Analysis and results**

In the present analysis we have measured the \(k_T\) for pp collisions at \(\sqrt{s} = 200\) GeV in STAR from di-hadron correlation, the method of which is similar to PHENIX but in an extended kinematic region. We have used tracks form Time Projection Chamber (TPC) for associated particles \((p_{Ta})\) and neutral clusters from Barrel Electromagnetic Calorimeter (BEMC) as trigger particle \((p_{Tt})\) for getting \(\pi^0\)-charge correlation function. We have also used TPC only for getting charge-charge correlation function. Hence we have extracted \(k_T\) from \(\pi^0\)-charge and charge-charge azimuthal correlations. Each BEMC tower subtends 0.05 in \(\eta\) by 0.05 in \(\phi\) covering \(|\eta|\leq1\) in full azimuth. \(\pi^0\)'s are constructed from BEMC tower signal with no charge tracks falling in it.

Fig.1 shows the schematic where the average transverse momentum of particles in a jet relative to the jet axis \((j_T)\) is directly related to the measurement of \(k_T\) by correlation method, since \(p_{out}\) measured from the ex-
Experiment comprises the effect of both $j_T$ and $k_T$. We have the equations for finding $h_{j_T}^{2}$ and $h_{z_T}(k_T; x_h)$ which were used by PHENIX [7].

\[
\sqrt{\langle j_T^2 \rangle} = \sqrt{2} \frac{p_{T_a}p_{T_t}}{\sqrt{p_{T_a}^2 + p_{T_t}^2}} \sigma_N^2
\]

(1)

\[
\frac{\langle z_t(k_T, x_h) \rangle \sqrt{\langle k_T^2 \rangle}}{\tilde{x}_h(k_T, x_h)} = \frac{1}{x_h} \sqrt{\langle p_{out}^2 \rangle - \langle j_T^2 \rangle (1 + x_h^2)}
\]

(2)

Here $\langle z_t \rangle = \langle p_{T_t}/p_{T_a} \rangle$, $x_h = \langle p_{T_t}/p_{T_a} \rangle$, $p_{out} = p_{T_a} \sin \Delta \phi$, and $\sigma_N$ is the near side ($\Delta \phi = 0$) width of the correlation function (Fig.2).

We have calculated $j_T^2$ (Fig.3) and $\langle z_t(k_T, x_h) \rangle \sqrt{\langle k_T^2 \rangle}/\tilde{x}_h(k_T, x_h)$ (Fig.4 & 5) as a function of $p_{T_t}$ and $p_{T_a}$. The values of $\sqrt{\langle j_T^2 \rangle}$ is found to be independent of $p_{T_a}$ and $p_{T_t}$. On the other hand $\langle z_t(k_T, x_h) \rangle \sqrt{\langle k_T^2 \rangle}/\tilde{x}_h(k_T, x_h)$ is found to be strongly dependent on $p_{T_t}$ and $p_{T_a}$. It increases with $p_{T_t}$ while decreases with $p_{T_a}$. The factor, $\langle z_t(k_T, x_h) \rangle /\tilde{x}_h(k_T, x_h)$ can be calculated using PYTHIA which basically takes care of fragmentation of partons and one can finally have the value of $\sqrt{\langle k_T^2 \rangle}$ values and their $p_T$-factor dependence will be presented after obtaining the corrections from PYTHIA.

**References**