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Probing the Path-Length Dependence of Parton Energy Loss in Quark-Gluon Plasma

The scaling property of large-$p_\perp$ hadron suppression, $R_{\rm AA}(p_\perp)$, measured in heavy ion collisions at RHIC and LHC allows for the determination of the average parton energy loss $\langle\epsilon\rangle$ in quark-gluon plasma produced in a variety of collision systems and centrality classes. Rescaling $\langle\epsilon\rangle$ by the particle density allows for the determination of the effective path length dependence of parton energy loss. We find that $\langle\epsilon\rangle \propto L^\beta$ with $\beta = 1.03\pm^{0.09}_{0.06}$, which is consistent with pQCD expectation of parton energy loss in a longitudinally expanding quark-gluon plasma. We demonstrate that the azimuthal anisotropy coefficient v_2 divided by the collision eccentricity follows the same scaling property as $R_{\rm AA}$, which is observed in data. Finally, a simply relation between $v_2(p_\perp)$ and $R_{\rm AA}(p_\perp)$ is found and confirmed by the correlation of the two independent measurements. This offers a new way to probe the L dependence of parton energy loss using high-statistics measurements from the coming LHC Run 3.

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