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Scaling properties of jets in high-energy proton-proton collisions

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Measurements of jet profiles in high-energy collisions are sensitive probes of QCD parton splitting and showering. Precise understanding of the jet structures are essential for setting the baseline not only for nuclear modification of jets in heavy-ion collisions, but also for possible semi-soft cold QCD effects such as multi-parton interactions (MPI) that may modify jets in high-multiplicity proton-proton collisions. We analyzed the jet radial profiles in simulations, and defined a multiplicity-dependent characteristic jet size that is universal in a broad range of model classes regardless of parton distributions and the presence or absence of MPI and color-reconnection [1].
In this contribution we demonstrate that the radial jet profiles in proton-proton collisions exhibit scaling properties with charged-hadron event multiplicity in the full experimentally accessible transverse-momentum range. Based on this we propose that the scaling behavior stems from fundamental statistical properties of jet fragmentation [2]. We also study the multiplicity distributions of events with hard jets and show that the charged-hadron multiplicity distributions scale with jet momentum. This suggests that the Koba–Nielsen–Olesen (KNO) scaling holds within a jet. The in-jet scaling is fulfilled without MPI, but breaks down in case of its presence without color reconnection. Our findings imply that KNO scaling is violated by parton shower or MPI in higher-energy collisions [3]. Besides these results, newest findings on the flavor-dependence of scaling properties will also be presented.

[1] Z.V., R.V., G.G.B., Adv. High Energy Phys. 2019 (2019), 6731362, arXiv:1805.03101.
[2] A.G., R.V., G. Papp, G.G.B., in Gribov-90 Memorial Volume: Algebraic Methods in QFT (2021), arXiv:2008.08500.
[3] R.V., A.G., G.G.B., Phys. Rev. D 103, L051503 (2021), arXiv:2012.01132.

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