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Scaling properties of light and heavy-flavor jets in high-energy proton-proton collisions

Multiplicity distributions at different collision energies collapse to a single distribution using a simple scaling. This phenomenon, known as the Koba–Nielsen–Olesen (KNO) scaling, however, breaks down at higher collision energies. We studied the multiplicity distributions of events with hard jets and show that the charged-hadron multiplicity distributions scale with jet momentum. This suggests that the KNO scaling holds within a jet. The in-jet scaling is fulfilled without multiple-parton interactions (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 [1].
Furthermore, we investigated the scaling properties of heavy-flavor jets using Monte-Carlo simulations. We found that while jets from leading-order flavor-creation processes exhibit flavor-dependent patterns, heavy-flavor jets from production in parton showers follow inclusive-jet patterns. This suggests that KNO-like scaling is driven by initial hard parton production and not by processes in the later stages of the reaction. [2]

[1] Phys.Rev.D 103 (2021) 5, L051503
[2] Symmetry 14 (2022) 7, 1379

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