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Multiplicity distributions in QCD jets and jet topics

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We present a comprehensive study of multiplicity distributions in QCD jets at the LHC. Our analysis combines pQCD calculations within the Double Logarithmic Approximation (DLA) and modified DLA (MDLA), together with comparisons to ATLAS data and PYTHIA simulations. We provide the first direct verification of KNO scaling for both quark- and gluon-initiated jets within the DLA framework by computing parton multiplicity distributions across the LHC p_T range. By incorporating energy conservation, the MDLA yields scaling functions that differ significantly from the pure DLA predictions. The MDLA framework provides a quantitatively accurate description of the inclusive charged-particle multiplicity distributions of the two leading jets in pp collisions at $\sqrt{s} = 13$ TeV, as measured by ATLAS over the range of p_T from 0.1 to 2.5 TeV, and shows good agreement with PYTHIA simulations. These findings are further supported by comparisons with quark- and gluon-initiated jet distributions obtained through jet topic modeling. The multiplicity distributions of quark and gluon jets, obtained by applying the method to ATLAS jet samples, are consistent with our MDLA predictions.

[1] X.-P. Duan, L. Chen, G.-L. Ma, C. A. Salgado, and B. Wu, arXiv:2503.24200.
[2] X.-P. Duan, L. Chen, G.-L. Ma, C. A. Salgado, and B. Wu, arXiv:2509.06158.

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