

# The TQ4Q1.1 fragmentation functions: A case study for $T_{4Q}$ tetraquark production

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We investigate the core dynamics behind exotic matter formation via the TQ4Q1.1 set of collinear, variable-flavor-number-scheme fragmentation functions for fully charmed or bottomed tetraquarks in three quantum configurations: scalar ( $0^{++}$ ), axial vector ( $1^{+-}$ ), and tensor ( $2^{++}$ ). We adopt single-parton fragmentation at leading power and implement a nonrelativistic QCD factorization scheme tailored to tetraquark Fock-state configurations. Short-distance inputs at the initial scale are modeled using updated calculations for both gluon- and heavy-quark-initiated channels. A threshold-consistent DGLAP evolution is then applied via HF-NRevo. We provide the first systematic treatment of uncertainties propagated from the color-composite long-distance matrix elements that govern the nonperturbative hadronization of tetraquarks. Our analysis represents a further step toward bridging the domains of hadronic structure, precision QCD, and exotic matter.

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