Good to the last drop: fully utilizing a pp collision's correlated information with the QCD power spectrum

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For LHC proton physics, the ever-increasing beam luminosity L is a blessing and a curse. Each unprecedented achievement ($L_{\max} \approx 2 \times 10^{34}\,\mathrm{cm}^{-2}$ in 2018) creates even more noise (on average, $\sim$40 soft "pileup" interactions contaminate each hard scatter). The resulting hierarchy — *local*, collimated jets emerging from *global*, diffuse pileup — frustrates prevailing jet reconstruction techniques, which tend to bundle energy into jets via a rather local evolution. Removing pileup from these jets requires sophisticated techniques which inevitably discard information about the soft and long-distance physics of the hard scatter.

We attempt a more global approach to QCD jets by revisiting the QCD power spectrum (a.k.a. the Fox-Wolfram moments). This observable utilizes every inter-particle correlation seen in the detector. We extend Fox and Wolfram's original scheme by introducing particle "shape functions," which codify both (i) the angular uncertainty of each detector object (e.g., tracks and calorimeter towers) and (ii) the collective angular resolution of the final state as a whole. Our initial application of this framework, the "power jets" model, simultaneously fits QCD jets and pileup to the observed power spectrum, resulting in an accurate reconstruction of event kinematics. We conclude by noting that the QCD power spectrum is in many ways *better* suited for the study of nuclear collisions, where the dominant effect is *global* — the remnants of a thermalized ensemble.

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