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First Demonstration that Quark-Gluon Plasma has a Nonzero Resolution Length

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We begin by using Hybrid Model calculations to reproduce experimental results published by ATLAS in 2023 on R_{AA} for $R = 1$ jets in Pb+Pb collisions. These jets are identified by first reconstructing anti-k_t $R = 0.2$ subjets and then re-clustering them. Following ATLAS, we investigate how R_{AA} for these jets depends on the angle between the two subjets involved in the final clustering step of the $R = 1$ jet. We also study the dependence of R_{AA} for these jets on the resolution length of quark-gluon plasma (QGP), defined such that the QGP-medium can only resolve partons in a jet shower that are separated by more than this length. We demonstrate that this measurement pioneered by ATLAS rules out any picture in which an entire parton shower loses energy coherently as a single entity.

We further use this setup of $R = 1$ jets reclustered from $R = 0.2$ skinny subjets to evaluate the soft drop angle, notated as dR_{12}, using all charged-particle tracks that are associated with each $R = 1$ jet. Following another ATLAS measurement published in 2025, we use Hybrid Model calculations to investigate the dependence of $R = 1$ jet R_{AA} on the soft drop angle dR_{12}. We demonstrate that this new measurement from ATLAS rules out any picture in which all partons in a shower lose energy fully incoherently. Therefore, our analysis demonstrates, for the first time, that the QGP has a finite nonzero resolution length.

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