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Unveiling the jet angular broadening with photon-tagged jets in high-energy nuclear collisions

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The medium modification of jet substructure in hot and dense nuclear matter has garnered significant interest from the heavy-ion physics community in recent years. Measurements of inclusive jets show an angular narrowing in nucleus-nucleus collisions, while recent CMS results for photon-tagged jets (γ+jets) suggest evidence of broadening. In this study, we conduct a theoretical analysis of the angular structure of inclusive jets and γ+jets using a transport approach that accounts for jet energy loss and the medium response in the quark-gluon plasma. We examine the girth modification of γ+jets in $0-30\%$ PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, achieving satisfactory agreement with recent CMS measurements. We explore the relationship between selection bias and jet kinematics by varying the threshold for $x_{j\gamma} = p_T^{\rm jet}/p_T^{\gamma}$. Notably, we quantitatively demonstrate that γ+jets significantly reduce selection bias and can effectively select jets that have been sufficiently quenched in PbPb collisions, which is crucial for capture the jet angular broadening. Additionally, we estimate the contributions of medium-induced gluon radiation and the medium response to the broadening of the jet angular substructure. Lastly, we analyze the modification patterns of jet R_g and $\Delta R_{\rm axis}$ in PbPb collisions, which indicate slight broadening for γ+jets and noticeable narrowing for inclusive jets compared to pp collisions.

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