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Probing the mass effect of heavy quark jets in high-energy nuclear collisions

The production of heavy quark (HQ) jets provides a new arena to address the mass effect of jet quenching in heavy-ion physics. This paper presents a theoretical study of HQ jet yield suppression in Pb+Pb collisions at the LHC and focuses on the energy loss of HQ jets produced by different mechanisms. The p+p baseline is carried out by the SHERPA generator, and the jet-medium interactions are described by the SHELL transport model, which considers the elastic and inelastic partonic energy loss in the quark-gluon plasma (QGP). In p+p collisions, our numerical results indicate that the HQ jets from gluon splitting ($g \to Q$-jet) give the dominant contribution at high p_T, and it shows more dispersive structures than the HQ-initiated one ($Q \to Q$-jet). In nucleus-nucleus collisions, our calculations are consistent the inclusive and b-jet R_{AA} recently measured by the ATLAS collaboration, which suggests a remarkable manifestation of the mass effect of jet energy loss. As a result of the dispersive substructure, the $g \to Q$-jet will lose more energy than the $Q \to Q$-jet in the QGP. Due to the significant contribution of $g \to c$-jet, the R_{AA} of c-jet will be comparable or even smaller than that of inclusive jet. To experimentally distinguish the $g \to Q$-jet and $Q \to Q$-jet, we propose the event selection strategies based on their topological features and test the performances. By isolating the $c \to c$-jet and $b \to b$-jet, the jets initiated by heavy quarks, we predict that the order of their R_{AA} are in line with the mass hierarchy of energy loss. Future measurements on the R_{AA} of $Q \to Q$-jet and $g \to Q$-jet will provide a unique chance to test the flavour/mass dependence of energy loss at the jet level.

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