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Hydrodynamic response to jets with a source based on causal diffusion

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We present a systematic study of the hydrodynamic medium response to jet shower propagation, based on a strongly-coupled description of the Quark-Gluon Plasma (QGP). A causal formulation for the space-time profile of energy-momentum source terms is incorporated with a multi-stage jet evolution and (3+1)-D viscous hydrodynamics within the JETSCAPE 2.0 framework. In this work, we employ a causal relativistic diffusion equation to model the evolution of the localized energy and momentum depositions by jet partons before injection into the QGP fluid. This formulation provides the source terms with a space-time profile that naturally preserves causality. The diffusion coefficient and the relaxation time used in this model are directly connected to the transport properties of the QGP, such as its specific shear viscosity, and determine the size and shape of the source-term profile.

Utilizing this new framework, we quantify the effects of the hydrodynamic response of a strongly-coupled medium on jet substructures (e.g. jet shape and jet fragmentation functions), by comparing with results for a weakly-coupled QGP where the medium response is modeled with recoil partons. Furthermore, we explore the dependence on the diffusion coefficient and the relaxation time in the diffusion of the sources to show how the transport properties of the QGP manifest themselves in the medium response to jet propagation.

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