Path-length dependence of jet-energy loss*

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Jet-quenching observables are considered to be significant probes of the medium evolution during a heavy-ion collision. We performed a systematic study on the jet-energy loss [1] based on a generic energy loss model [1, 2] that can interpolate between a pQCD-based and an AdS/CFT-inspired jet-energy loss prescription. The results were compared to the measured nuclear modification factor R_{AA} and the high-p_T elliptic flow [3] to study the jet-medium coupling κ and the impact of the jet path-length dependence.

The generic energy-loss model

The generic energy-loss model [1, 2] parametrizes the energy loss via

$$\frac{dE}{dx} = \frac{dE}{d\tau}(\vec{x}_0, \phi, \tau) = -\kappa(T) E^a(\tau)\, \tau^z\, T^{c=2+z-a}\, \zeta_q \, .$$

Here, the jet-energy dependence, the path-length dependence, the temperature dependence, and the jet-energy loss fluctuations are characterized by the exponents (a, z, c, q). The jet-energy loss fluctuations are distributed via $f_q(\zeta_q) = \frac{(1+q)}{(q+2)^{1+q}}(q+2-\zeta_q)^q$, allowing for an easy interpolation between non-fluctuating ($q=-1$, $\zeta_{-1}=1$) and fluctuating ($\zeta_q < 1$ for $q > -1$) distributions.

The jets are distributed according to a transverse initial profile specified by the QGP expansion of VISH2+1 [4].

Results

Below we consider an exponentially falling ansatz for the jet-medium coupling, $\kappa(T) = \kappa_1 e^{-b(T-T_1)}$, assuming that the coupling is zero below a certain temperature T_1, representing the freeze-out, where the coupling peaks at a value of κ_1 and falls off for larger temperatures to a value of $1/e$ at a temperature T_e.

Fig. 1 shows the result for the nuclear modification factor and the high-p_T elliptic flow both at RHIC and at LHC energies with and without additional jet-energy loss fluctuations. Given the space-time uncertainties of the hydrodynamic evolution (for details see Ref. [1]), such a temperature-dependent jet-medium coupling represents a decent fit to the measured data.

Conclusions

Performing a systematic study on the jet-energy loss [1] we found (see Table 2 of Ref. [1]) that a pQCD-like energy loss with a temperature running coupling appears to be favored (see Fig. 1). Besides that, a realistic QGP expansion is essential to account for the dependence of the data on transverse momentum p_T, azimuth ϕ, impact parameter b, and collision energy $\sqrt{s}$.

References

[1] B. Betz and M. Gyulassy, JHEP **1408**, 090 (2014) [Erratum-ibid. **1410**, 043 (2014)].

[2] B. Betz and M. Gyulassy, Phys. Rev. C **86**, 024903 (2012).

[3] A. Adare *et al.*, Phys. Rev. C **87**, 034911 (2013); B. Abelev *et al.*, Phys. Lett. B **720**, 52 (2013) and Phys. Lett. B **719**, 18 (2013); S. Chatrchyan *et al.*, Eur. Phys. J. C **72**, 1945 (2012) and Phys. Rev. Lett. **110**, 042301 (2013); G. Aad *et al.*, Phys. Rev. C **86**, 014907 (2012) and Phys. Lett. B **707**, 330 (2012).

[4] H. Song and U. W. Heinz, Phys. Rev. C **77**, 064901 (2008); Z. Qiu, C. Shen and U. Heinz, Phys. Lett. B **707**, 151 (2012).

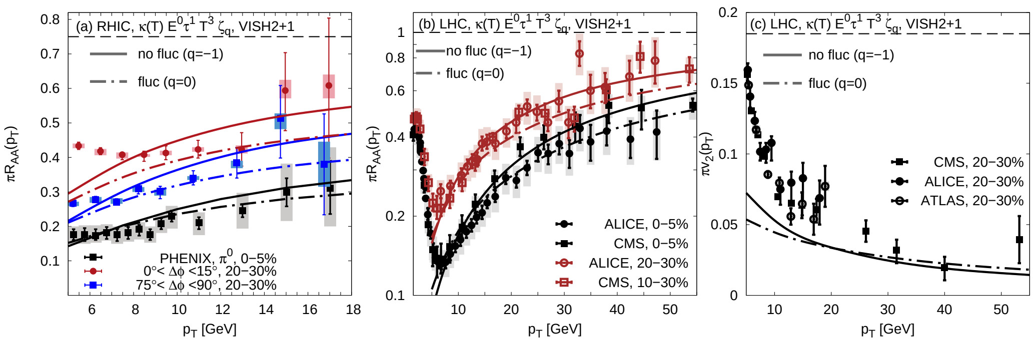

Figure 1: Azimuthal jet tomography at RHIC and LHC for a pQCD-like ansatz (see text for details) [1].

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