Hydrodynamical Study of Jet Energy Loss

B. Betz\textsuperscript{a,b}, K. Paech\textsuperscript{c}, D. H. Rischke\textsuperscript{a,d}, H. Stöcker\textsuperscript{a,d}

\textsuperscript{a} Institute for Theoretical Physics, Johann Wolfgang Goethe-University, Frankfurt, \textsuperscript{b} Helmholtz Graduate School, GSI & Frankfurt, \textsuperscript{c} Department of Physics and Astronomy, Michigan State University, Michigan, \textsuperscript{d} Frankfurt Institute for Advanced Studies (FIAS), Frankfurt

Motivation

- Jet quenching occurs in a hot and dense medium [1].
- RHIC experimental data show anomalous behaviour of angular distribution in particle multiplicity [2].
- Study jet quenching in a spherically symmetric expanding medium within (3+1)d ideal hydrodynamics.

Jets in Nuclear Collisions

- In high-energy collisions, hard scattering of quarks and gluons early in the collision leads to jet production.
- Jets serve as a probe for the matter created in the collision.

Jet suppression

- The away-side jet in Au+Au collisions
  - for high-$p_T$ particles ($p_T(assoc)>2$ GeV/c, $4<p_T(\text{trigger})<6$ GeV/c)
  - with pseudo-rapidity $|\eta|<0.7$
  - is suppressed [2],
- whereas the away-side jet in p+p collisions is not suppressed.
- This is commonly interpreted as parton-energy loss (jet quenching):
  - One jet escapes but the other jet deposits a large fraction of energy into the dense medium.

(3+1)d hydrodynamical approach

- We use the (3+1)d ideal hydrodynamics and an ultrarelativistic ideal gas EoS.
- employ the (3+1)d SHASTA (SHarp And Smooth Transport Algorithm) [3]
- and implement a jet that deposits its energy and momentum completely during a very short time in a small spatial volume.
- The medium has an initial energy density of $\varepsilon = 11.5$ GeV/fm$^3$,
- the jet deposits in a volume of $V^4 = 1.6 \times 10^{-2}$ fm$^4$ and has extra energy density of $\varepsilon = 5$ GeV/fm$^3$ and initial velocity in $x$ direction of $v_x = 0.9$ c.

Jet Orientation Dependence

- In order to study the influence of a different jet orientation, we shift the jet parallel to the $y$-axis.

Influence of EoS

- Equation of State with phase transition to the quark-gluon plasma.
- Contour plot of the laboratory energy density for $t = 0$ fm/c and $t = 6.4$ fm/c.

References