Jet Propagation and Mach Cones in (3+1)d Ideal Hydrodynamics

B. Betz[a], **M. Gyulassy**[b], **D. Rischke**[c], **H. Stöcker**[d] and **G. Torrieri**[e]

[a]Institut für Theoretische Physik, J.W. Goethe-Universität and
Helmholtz Research School, Universität Frankfurt, GSI and FIAS,
Frankfurt, 60438, Germany, *betz@th.physik.uni-frankfurt.de*

[b] Department of Physics, Columbia University,
New York, New York, 10027, USA, *gyulassy@phys.columbia.edu*

[c]Institut für Theoretische Physik, J.W. Goethe-Universität and
Frankfurt Institute for Advanced Studies (FIAS),
Frankfurt, 60438, Germany, *drischke@th.physik.uni-frankfurt.de*

[d]Gesellschaft für Schwerionenforschung, GSI
Darmstadt, 64291, Germany, and
Frankfurt Institute for Advanced Studies (FIAS),
Frankfurt, 60438, Germany, *stoecker@fias.uni-frankfurt.de*

[e]Institut für Theoretische Physik, J.W. Goethe-Universität
Frankfurt, 60438, Germany, *torrieri@th.physik.uni-frankfurt.de*

The observation of jet quenching and associated away–side Mach Cone–like correlations at RHIC provide powerful "external" probes of the sQGP produced in A+A reactions [1]. The nearly perfect bulk fluidity observed via elliptic flow suggests that Mach Cone–like correlations may also be due to rapid local equilibration in the wake of penetrating jets. Multi-particle correlations lend further support to this possibility [2]. However, the details of the fluid response to jets are shown to depend critically on the energy, longitudinal, and transverse momentum deposition mechanisms. We solve numerically covariant 3–dimensional hydrodynamics [3] to compute the flow correlation patterns resulting from a variety of possible energy-momentum deposition models. Mach Cone flow-field correlations generically do not survive the hydro decoupling freeze-out phase. Multi-hadron Mach Cone correlations only survive for a special limited class of energy–momentum loss models which assume significantly less longitudinal momentum loss than energy loss per unit length. We conclude that the correct interpretation of away–side jet correlations will require improved understanding and independent experimental constraints on the jet energy–momentum loss to fluid couplings.

References

[1] M. Gyulassy, P. Levai and I. Vitev, Nucl. Phys. B **594**, 371 (2001); H. Stöcker, Nucl. Phys. A **750** (2005) 121; F. Antinori and E. V. Shuryak, J. Phys. G **31**, L19 (2005); S. S. Adler *et al.* [PHENIX Collaboration], Phys. Rev. C **73** (2006) 054903; J. Adams et al. [STAR Collaboration], Phys. Rev. Lett. **95**, (2005) 152301.
[2] J. G. Ulery [for the STAR Collaboration], arXiv:0704.0224 [nucl-ex]; N. Grau [PHENIX Collaboration], arXiv:nucl-ex/0612019; N. N. Ajitanand [PHENIX Collaboration], Nucl. Phys. A **783**, 519 (2007).
[3] D. H. Rischke, Y. Pürsün, J. A. Maruhn, H. Stöcker and W. Greiner, Heavy Ion Phys. **1** (1995) 309.