From full stopping to transparency

Towards more realistic holographic models of heavy-ion collisions

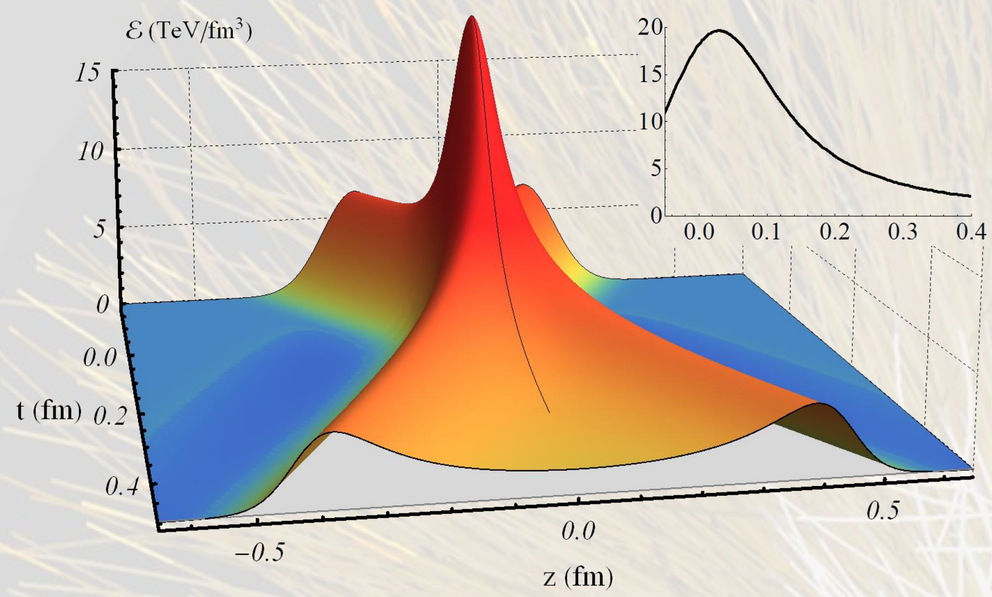
Wilke van der Schee, advisors Gleb Arutyunov and Thomas Peitzmann

Utrecht University

Based on work with Michal Heller, David Mateos, Jorge Casalderrey, Paul Romatschke and Scott Pratt

Homogeneous thermalisation

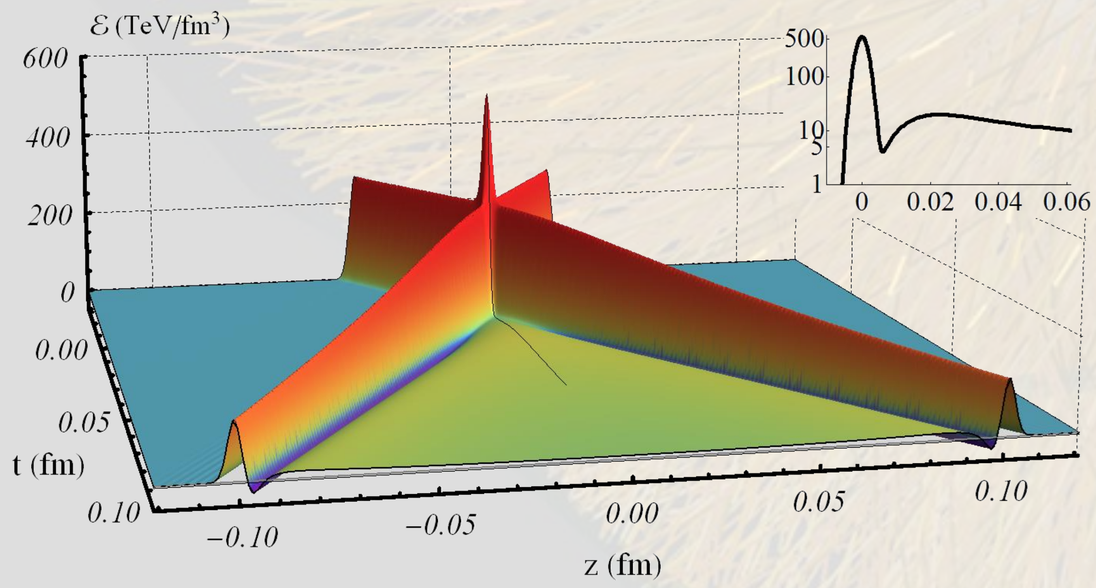
Colliding wide shocks – full stopping [1]



Energy density during collision, similar to low-energy collisions

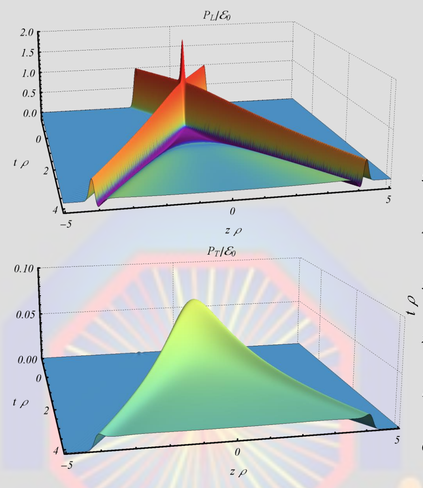
- Total energy matches Pb-Pb at LHC
- Piling up of energy
- Hydro applies @ t ≈ 0
  - Hydrodynamic expansion → speed maxima ~0.9

Narrow shocks – transparency

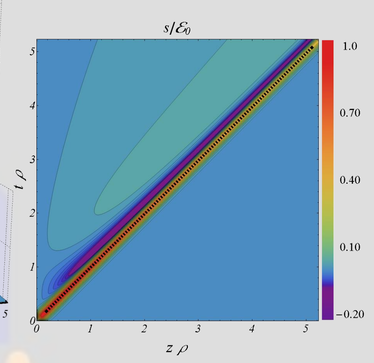


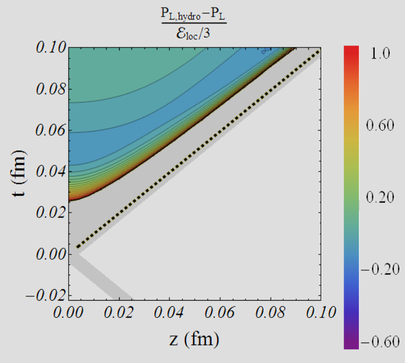
Energy density during collision, “almost like a real collision”

- Shock pass through unperturbed, later plasma
  - Trail of negative energy density
- Hydro applies @ τ ≈ 0.05 fm
  - Local temperature provides thermalisation timescale



Pressures, flux and hydro mismatch



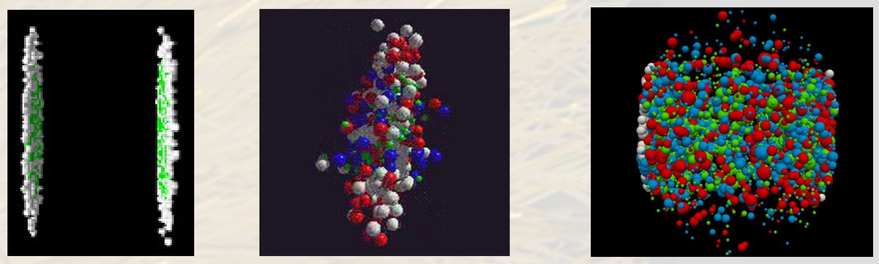


Strong coupling ≠ Full stopping

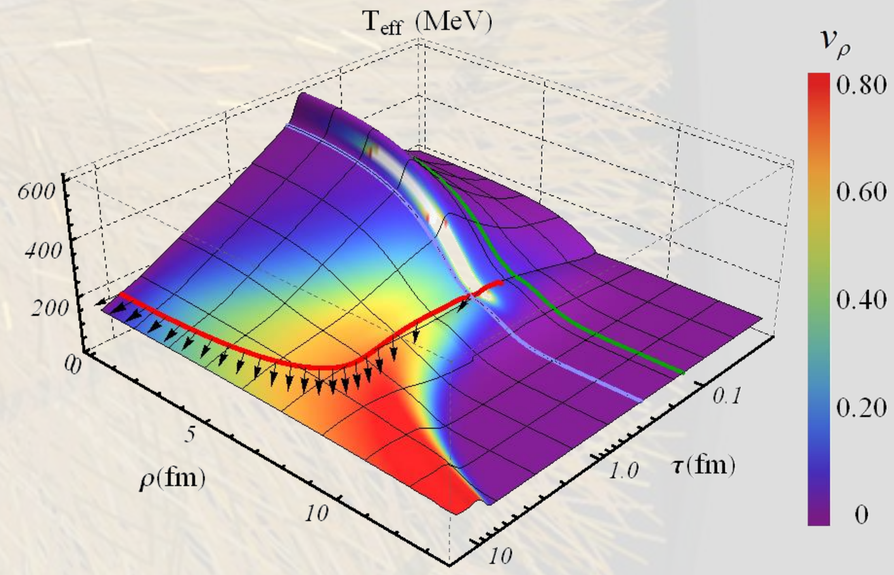
Thermalisation with radial flow

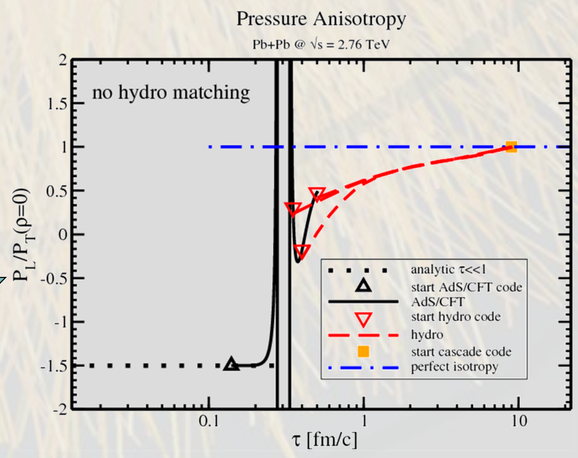
Four stages:

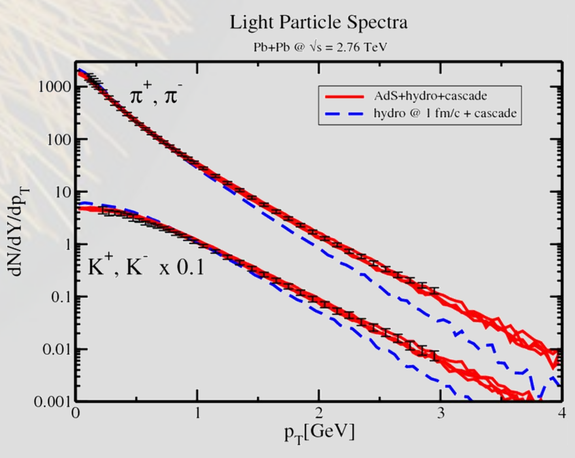
1. **The collision [2]:** solve central shockwave collision as small *t* near-boundary expansion
2. **Evolve numerically [3]:** solve boost-invariant gravity numerically, extra bulk parameter
3. **Viscous hydrodynamics:** after thermalisation use hydro until fluid hadronises
4. **Hadronic cascade:** apply kinetic theory until particles stop interacting, obtain spectra



Result – comparison with data







→ “pre-flow” + anisotropy gives excellent match!

Discussion

- Holography models only at strong coupling
- Most interesting correlations have less symmetry
- Still a long way from realistic QCD dual … !

[1] P. Chesler and L. Yaffe, Holography and colliding gravitational shock waves in AdS_5 (2010)
[2] P. Romatschke and D. Grumiller, On the collision of two shock waves in AdS_5 (2008)
[3] WS, Holographic thermalization with radial flow (2012)