

Holographic phase transitions

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Abstract

We study holographically theories with thermal phase transition and obtain new qualitative insights possibly relevant for QCD. Our studies are motivated by the extensive experimental efforts devoted to the search of the conjectured critical point in the QCD phase diagram. The dual gravitational theory is Einstein-scalar in asymptotically AdS_5 , with a non-zero scalar potential. This potential is chosen such that a phase transition in terms of black brane configurations exists and corresponds to a thermal phase transition in the boundary theory. Choosing appropriate initial data, we can explore the spinodal instability of the strongly coupled gauge theory, as well as heavy ion collisions modeled by propagating shockwaves in the bulk. We find that near a second order phase transition almost all the energy of the projectiles is deposited into a long-lived, quasi-static blob of energy. Moreover, hydrodynamics describes this blob only if we consider a formulation different from the Muller-Israel-Stewart formulation that is almost universally used in the numerical codes describing the quark-gluon plasma formed at RHIC and LHC.

References

- [1] Maximilian Attems et al. “Holographic Collisions across a Phase Transition”. In: *Phys. Rev. Lett.* 121.26 (2018), p. 261601. DOI: 10.1103/PhysRevLett.121.261601. arXiv: 1807.05175 [hep-th].
- [2] Maximilian Attems et al. “Phase Transitions, Inhomogeneous Horizons and Second-Order Hydrodynamics”. In: *JHEP* 06 (2017), p. 129. DOI: 10.1007/JHEP06(2017)129. arXiv: 1703.02948 [hep-th].