Effective Theories for Hydrodynamics

Paolo Glorioso (Chicago U.), Natalia Pinzani Fokeeva (KU Leuven)

Abstract

In these lectures we describe a first principle formulation of hydrodynamics where, to incorporate effects of dissipation and fluctuations, the Schwinger-Keldysh formalism plays a crucial role. Using an effective field theory approach we first establish what are the necessary low-energy degrees of freedom and the symmetries that a Schwinger-Keldysh effective action should have to describe hydrodynamic behaviour. Subsequently, we show how this formalism can be efficiently implemented using superspace techniques to obtain simple effective actions. Finally, we give a derivation of the local second law of thermodynamics by applying a Noether-like procedure to the effective action.

The main references will be [1]–[4]. See also [5]–[7] and references therein.

References

[1] M. Crossley, P. Glorioso and H. Liu, "Effective field theory of dissipative fluids," JHEP **1709**, 095 (2017) doi:10.1007/JHEP09(2017)095 [arXiv:1511.03646 [hep-th]].

[2] P. Glorioso and H. Liu, "The second law of thermodynamics from symmetry and unitarity," arXiv:1612.07705 [hep-th].

[3] K. Jensen, N. Pinzani-Fokeeva and A. Yarom, "Dissipative hydrodynamics in superspace," arXiv:1701.07436 [hep-th].

[4] P. Glorioso, M. Crossley and H. Liu, "Effective field theory of dissipative fluids (II): classical limit, dynamical KMS symmetry and entropy current," JHEP **1709**, 096 (2017) doi:10.1007/JHEP09(2017)096 [arXiv:1701.07817 [hep-th]].

[5] F. M. Haehl, R. Loganayagam and M. Rangamani, "Schwinger-Keldysh formalism. Part I: BRST symmetries and superspace," JHEP **1706**, 069 (2017) doi:10.1007/JHEP06(2017)069 [arXiv:1610.01940 [hep-th]].

[6] F. M. Haehl, R. Loganayagam and M. Rangamani, "Schwinger-Keldysh formalism. Part II: thermal equivariant cohomology," JHEP **1706**, 070 (2017) doi:10.1007/JHEP06(2017)070 [arXiv:1610.01941 [hep-th]].

[7] P. Gao and H. Liu, "Emergent Supersymmetry in Local Equilibrium Systems," arXiv:1701.07445 [hep-th].