Fluctuation Theorems and Thermodynamics

D.J. Evans [C, S] and S.R. Williams
Research School of Chemistry, Australian National University, Canberra, ACT, Australia

D.J. Searles
Nanoscale Science and Technology Centre, School of Biomolecular and Physical Sciences, Griffith University, Brisbane, QLD, Australia

We discuss the Evans Searles Fluctuation Theorem[1] and its implications: the Second Law Inequality, the NonEquilibrium Partition Identity, the Dissipation Theorem[2] and the Relaxation Theorem[3]. It turns out that the subject of the Fluctuation Theorem, namely the dissipation function is also the central function for nonlinear response theory as summarized in the Dissipation Theorem. The Second Law Inequality leads to a mathematical proof of the relaxation to equilibrium under widely satisfied conditions. This proof, namely the Relaxation Theorem, thus provides for systems of arbitrary density and arbitrarily far from equilibrium, an analog of the Boltzmann H-theorem. However, unlike the Boltzmann H-theorem the Relation Theorem utilizes only time reversible equations of motion.

[1] D.J. Evans and D.J. Searles, *Phys. Rev. E* **50**, 1645(1994), *Adv. In Phys.*, **51**, 1529(2002).
[2] D.J. Evans, D.J. Searles and S. R.Williams, *J. Chem. Phys.* **128**, 014504 (2008), *ibid* **128**, 249901(2008).
[3] D.J. Evans, D.J. Searles and S. R.Williams, arXiv:0811.2248.