Entropy augmentation through subadditive excess: a sane introduction of irreversibility into micro-dynamics

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For irreversible thermodynamic processes there is a disparity between the increase of thermodynamic entropy and the conservation of Shannon-von Neumann entropy in the microscopic dynamics. The higher value of thermodynamic entropy reflects the fact that thermodynamic variables are insufficient probes for microscopic information. Instead of either defining macrostates as regions in phase space or imposing an increase of Shannon-von Neumann entropy by coarse-graining, a third approach is developed. Information theory, in particular the consideration of mutual information, is used to define an alternative approach leading to increasing entropy and equilibration. The salient point can already be found (*in nuce*) in the Boltzmann equation, when it is viewed through the lens of information theory rather than scattering theory. Applying information theoretic tools not only to states, but to processes, an entire class of Boltzmann-inspired effective dynamics is constructed from arbitrary (quantum or classical) Liouville equations under the principle of entropy augmentation through subadditive excess (EASE). The resulting equations display both entropy production and relaxation towards thermal stationary states like the Boltzmann equation. While still microscopic, the solution of these equations is within the reach of current numerical methods.