Application of MaxEnt to Steady-State Flow Systems (and Extremum Entropy Production Principles)

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15 April 2011

Abstract

Recently, the author gave a MaxEnt-based analysis of steady-state flow systems, using an entropy defined on the set of instantaneous fluxes through an infinitesimal fluid element [1,2]. The formulation is analogous to Gibbs' formulation of equilibrium thermodynamics [3], which expresses the effect of changes in entropy within and outside a system, but is here applied to the steady state of a non-equilibrium flow system. The analysis yields a potential function (negative Massieu function, analogous to a free energy) to be minimised; this in turn can be *approximated* by a maximum or minimum entropy production (MaxEP or MinEP) principle in different circumstances. In this seminar, a generic version of the derivation is first provided, encompassing three seemingly disparate formulations of equilibrium thermodynamics [3], local steady-state flow [1-2] and global steady-state flow [4-5]. The mathematical structure of the analysis, in consequence of Jaynes' framework [6], is first examined, leading into a discussion of the possibility and implications of a scale invariance condition for the application of MaxEnt to flow systems. The consequences of the analysis for several systems are also considered, including (i) the transition between laminar and turbulent flow in a pipe, and (ii) the modelling of planetary climate systems, including solar and extrasolar planets.

References:

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Key Words: MaxEnt, non-equilibrium system, entropy production, steady state, fluid flow, heat flow