NONEQUILIBRIUM THERMODYNAMICS AS A SYMPLECTO-CONTACT REDUCTION AND RELATIVE INFORMATION ENTROPY

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Abstract. Starting from Carathedory and Hermann, contact geometry is proposed as the correct geometric framework of thermodynamics, especially of its equilibrium thermodynamics. It has been observed in this formulation that the state of thermodynamic equilibrium can be interpreted as a Legendrian submanifold in thermodynamic phase space (TPS). In this lecture, we will explain the origin of aforementioned contact structure in TPS, in particular of its odd dimensionality, as a symplecto-contact reduction of the space of the probability distribution space of the statistical phase space (SPS) of many-body systems, which we call the kinetic theory phase space (KTPS). The relative information entropy associated to the probability distribution will be emphasized in this derivation: It plays the role of a generating function of thermodynamic equilbria as a Legendrian submanifold, after a collective symplectic reduction. This Legendrian submanifold is not necessarily graph-like. We then interpret the Maxwell construction in thermodynamics as the procedure of finding a continuous, not necessarily differentiable, thermodynamic potential and explain the associated phase transition. We identify the Maxwell construction with the algorithm of finding a graph selector in symplecto-contact geometry and in the Aubry-Mather theory of dynamical system. (This is based on a joint work with my student Jinwook Lim.)

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