Typicality, stochastic dynamics and generalized statistical mechanics

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The concept of typicality has not been yet explored for systems/processes with exploding or shrinking phase spaces, or processes displaying path dependent dynamics or subject to emergent internal constraints and correlations. The properties of the typical set --roughly speaking, the region of the phase space effectively occupied by a physical process--, are direct consequence of the microscopic stochastic rules underlying the system. And, interestingly, its characterization involves the entropy functional, which, consistently, arises naturally from the underlying dynamics. Therefore, the typical set connects (i) the microscopic dynamics of the system, (ii) the phase space occupancy and (iii) the entropy without imposing anything to the later. In addition, the existence of the typical set and, in consequence, typical macroscopic properties, is key for the existence of the thermodynamic limit. However, given its central role underlying the emergence of stable, almost deterministic macroscopic patterns, a question arises whether typical sets exist in much more general scenarios. In my talk I will show that the typical set can be defined and characterized from general forms of entropy for a much wider class of stochastic processes than was previously thought. This includes processes showing arbitrary path dependence, long range correlations or dynamic sampling spaces, suggesting that typicality is a generic property of stochastic processes, regardless of their complexity. Moreover, other quantities, like generalized free energies and the associated duality relations, arise from the existence of typical sets. With that, we provide a microscopic ground to the emergence of generalized entropies.