

Statistical ensembles without typicality

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Maximum-entropy ensembles are key primitives in statistical mechanics. Several approaches have been developed in order to justify the use of these ensembles in statistical descriptions. However, there is still no full consensus on the precise reasoning justifying the use of such ensembles. In this work, we provide an approach to derive maximum-entropy ensembles, taking a strictly operational perspective. We investigate the set of possible transitions that a system can undergo together with an environment, when one only has partial information about the system and its environment. The set of these transitions encodes thermodynamic laws and limitations on thermodynamic tasks as particular cases. Our main result is that the possible transitions are exactly those that are possible if both system and environment are assigned the maximum-entropy state compatible with the partial information. This justifies the overwhelming success of such ensembles and provides a derivation independent of typicality or information-theoretic measures [1].

[1] Boes, P. and Wilming, H. and Eisert, J. and Gallego, R., *Nature Communications*, **9**, 1022 (2018).