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Quantum features from classical entropies

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The scaling of local quantum entropies is of utmost interest for characterizing quantum fields, many-body systems and gravity. Despite their importance, being nonlinear functionals of the underlying quantum state often hinders their theoretical as well as experimental accessibility. Here, we show that suitably chosen classical entropies of standard measurement distributions capture the very same features as their quantum analogs. We demonstrate the presence of the celebrated area law for classical entropies for typical states such as ground and excited states of a scalar quantum field. Further, we consider the post-quench dynamics of a multi-well spin-1 Bose-Einstein condensate from an initial product state, in which case we observe the dynamical build-up of quantum correlations signaled by the area law, as well as local thermalization revealed by a transition to a volume law, both in regimes characterized by non-Gaussian quantum states and small sample numbers. arXiv:2404.12320, 2404.12321, 2404.12323

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