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Towards the qualitative theory of large quantum coherent structures

The impossibility of an efficient simulation of large enough quantum coherent systems by classical means, independently recognized by Feynman and Manin in early 1980s, launched the development of quantum computing and, more generally, the Second Quantum Revolution. It also remains the major obstacle for the development of quantum technologies 2.0, since the multiqubit structures which are being designed and fabricated at the moment are already too big to allow an efficient classical simulation, characterization and optimization, but too small and imperfect to serve as quantum computers capable of performing such a task. The situation is somewhat reminiscent of the aircraft development in the 20th century prior to the creation of computers powerful enough to solve the equations of hydrodynamics in realistic cases. I will use the analogy to discuss a possible strategy for circumventing the roadblock, which is based on the conjecture that there exist qualitatively different regimes of operation of large quantum coherent structures governed by a set of universal dimensionless parameters.