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Universal features of quantum dynamics: quantum catastrophes

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Tracking the quantum dynamics following a quench of a range of simple many-body systems (e.g. the two and three site Bose-Hubbard models, particles on a ring), we find certain common structures with characteristic geometric shapes that occur in all the wave functions over time. What are these structures and why do they appear again and again? I will argue that they are quantum versions of the catastrophes described by catastrophe theory [R. Thom (1975), V.I. Arnol'd (1975)]. Quantum catastrophes occur in quantum fields: they are singular in the mean-field limit and require second-quantization to be well behaved, i.e. the essential discreteness of the excitations of the quantum field needs to be taken into account for a quantum catastrophe to be regularized. They are second quantized versions of more familiar catastrophes such as rainbows and the bright lines on the bottom of swimming pools (although the latter are rarely described in these terms!). Their universality stems from the fact that they are generic (need no symmetry) and structurally stable (immune to perturbations) as guaranteed by catastrophe theory.

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