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Random Matrices in Quantum Information: From Entanglement to Black Holes

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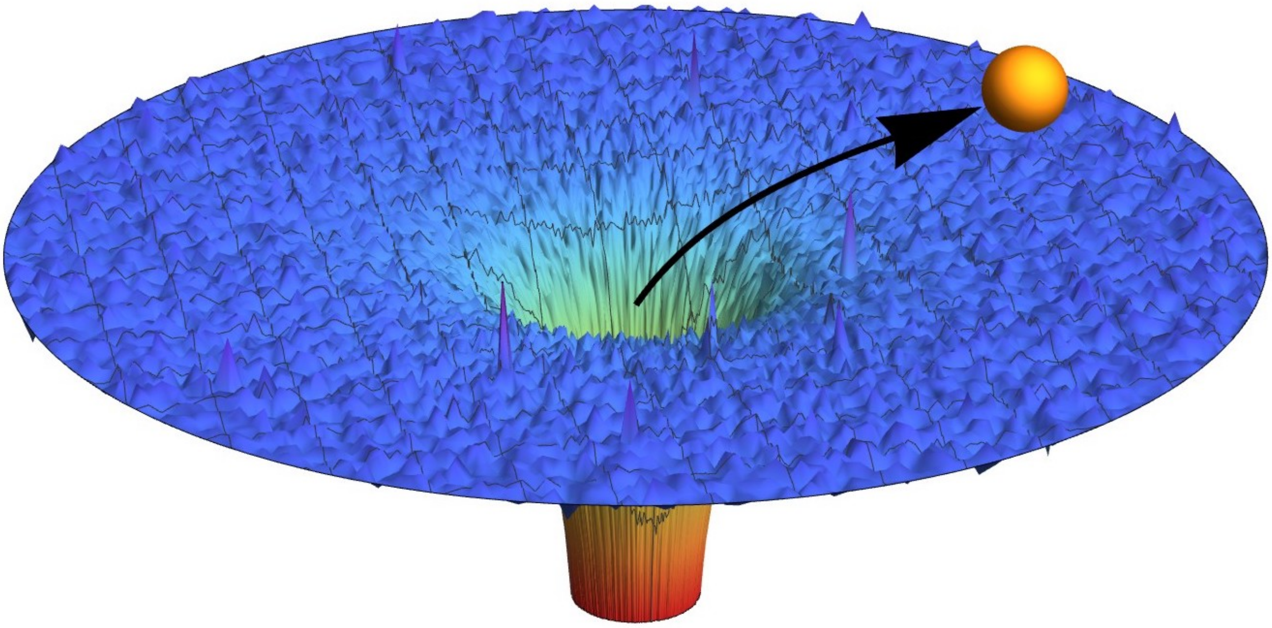

The information paradox of black holes has been a long standing problem in Physics. How can the black hole radiation be thermal while the evolution of a quantum system must be unitary? Page's idea of the solution of the problem is that the radiation only looks thermal because the quantum system of the particles that are sent out are in general entangled with the quantum system describing the black hole. Indeed, Page and several other authors have shown that in average the reduced density matrix of a uniformly distributed pure state is almost perfectly maximally mixed in average. In recent years, there has been some progress on how typical this situation is, and extended Page's result to systems of Gaussian quantum states with and without particle number conservation and for Fermions as well as Bosons. These models are effectively embedded random matrix ensembles. The analytic feasibility of the latter has allowed us to find not only the leading order but also several subleading order corrections of the mean and the variance of the entanglement entropy which seem to be universal. This has been corroborated by numerical simulations of chaotic quantum systems. In my talk, I will report on this progress and show you that thermal radiation of black holes must be also given for Gaussian quantum states.