Don't judge matrices by their spectra

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Quantum mechanics is ruled by Hermitian generators inducing unitary propagation, nevertheless, when tracing out some degrees of freedom, or doing coarse graining, one can end up with non-Hermitian or, in general, non-normal operators. When dealing with Hermitian operators we often rely on spectral properties, e.g., relaxation time is given by the spectral gap of a Markovian matrix. However, with non-Hermitian matrices one has to be careful – our "Hermitian" intuition can completely fail. For instance, it can happen that the spectrum is irrelevant in the thermodynamic limit and one should rather look at the pseudospectrum [1]. I will present two examples of such behavior. One will deal with matrices with a spectrum on a unit circle, where one would naively expect dynamics with no growth in time, however, in reality one gets exponential growth [2]. The second example will be about entanglement dynamics in random circuits where the correct entanglement production rate is given by the pseudospectrum rather than the spectrum. The phenomenon can be also related to the non-Hermitian skin effect, which here emerges out of fully unitary dynamics [3,4].

References

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