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Quantum Many-body Scars seen through the lens of Entanglement Spectroscopy.

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According to the laws of thermodynamics, a closed many-body system is expected to follow a chaotic evolution and reach a state of thermal equilibrium. The issue arises when one asks for a quantum picture. Indeed quantum mechanics strictly prohibits chaotic dynamics, and some quantum systems have been discovered to resist thermalization.
To solve this paradox, entanglement is believed to be a key ingredient. We hope to adress these deep questions in the context of a phenomenon called "Quantum Many-body Scars" recently observed in trapped ions setup (Bernien et al., Nature 2017). In this experiment, starting from a very ordered unentangled state, strong local constraints give rise to a non-trivial quantum dynamics characterized by long-time oscillations and a very slow thermalization.
Using a simple model called PXP we are able to study this unusual dynamics at long times through the lens of entanglement. We use a random-matrix-based diagnosis of the entanglement structure called entanglement spectrum statistics which allows us to characterize both the scrambling and complexity underlying these quantum scars.

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