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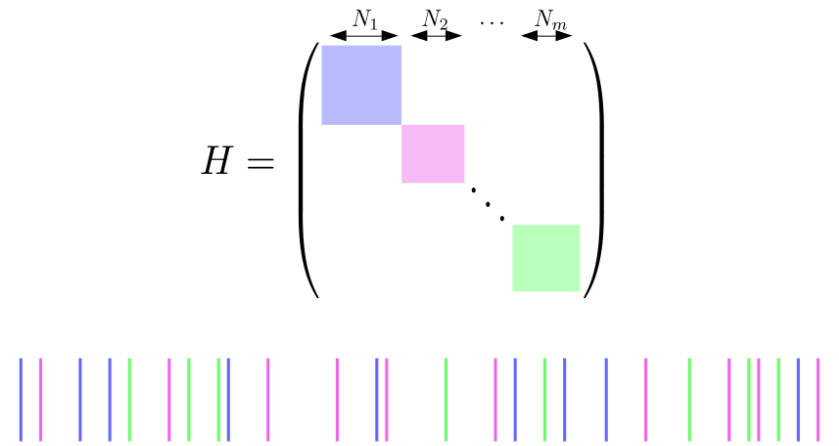

PROBING SYMMETRIES OF QUANTUM MANY-BODY SYSTEMS THROUGH GAP RATIO STATISTICS

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The idea of describing properties of complicated systems, such as complex atomic nuclei, using random numbers dates back to the 1950s. One application is in quantum mechanics, where random numbers are a tool for making accurate predictions about the statistics of discrete energy levels a system can assume. More precisely, the statistical distribution of the spacings between successive energy levels can be compared with distributions from random matrices, which provides a signature of whether the system behaves in a regular or a chaotic way. Random matrix theory (RMT) has since grown into an active branch between mathematics and physics, and has found applications in many branches of physics but also in biology or finance.

Analyzing universal statistical properties of a spectrum requires unfolding. Unfortunately, this can lead to spurious results: for many-body systems, the density of states is generically far from being uniform, which makes the use of the unfolding procedure rather inaccurate. This is why in recent years the focus has shifted away from the statistics of energy spacings to the statistics of ratios between successive spacings. This ratio statistics is by now a widely used tool of quantum chaos, that allows to compare experimental or numerical observations with theoretical predictions.

However, extra symmetries of the system, which may be hidden, can split the spectrum into independent random blocks, and thus modify these statistics. We show that it is possible to extend the theory of spacing ratio statistics to account for the presence of additional symmetries. Our results allow to probe for the existence of symmetries if they were unknown. We derive analytical surmises for random matrices with independent block structure, and illustrate our approach on a number of applications from many-body physics. This provides a tool not only to get a signature of chaos or regularity in systems with symmetries, but also to uncover these symmetries if they were previously unnoticed.