Smallest eigenvalue density for Wishart-Laguerre ensemble and entanglement in coupled kicked tops

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The statistical behavior of the smallest eigenvalue has important implications for systems which can be modeled using Wishart-Laguerre ensemble, the regular one or the fixed trace one. For example, the density of the smallest eigenvalue of Wishart-Laguerre ensemble plays a crucial role in characterizing multiple channel telecommunication systems. Similarly, in the quantum entanglement problem the smallest eigenvalue of fixed trace Wishart-Laguerre ensemble carries information regarding nature of entanglement.

For the case of real matrices there exists an elegant recurrence scheme suggested by Edelman to obtain exact expressions for the smallest eigenvalue density. However, for the complex case, which is relevant to the above mentioned and other problems, only results based on determinants are available which become difficult to handle with increasing dimensionality or rectangularity of the matrices. We provide a recurrence scheme for the complex case which is analogous to that of Edelman's for the real case. This is used to obtain exact results for the smallest eigenvalue density as well as moments for both regular, and the fixed trace complex Wishart-Laguerre ensembles. We validate our analytical results using Monte Carlo simulations, and eventually apply them to investigate the behavior of the smallest eigenvalue in the paradigmatic system of coupled kicked tops.