Spectral properties of bosonic and fermionic random matrix ensembles

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The Random Matrix Theory (RMT) with its unique feature of universality, is unanimously accepted worldwide and has ample applications in various Fields of physics, mathematics, statistics, etc. In particular, here it is used to study chaos in quantum many-particle systems. We have considered some Gaussian Orthogonal Embedded ensembles of bosons and fermions (with and without spin) and their spectral properties are studied using different parameters.

First we discuss about a system of m Finite spinless boson, wherein k body interaction persists [BEGOE(k)]. For such a system, the Hamiltonian is generated and the nature of state density with respect to the body rank (k) is studied. Also, here we analyze the nearest neighbour spacing distribution. The next section discusses a model of one plus two body embedded bosonic ensemble with Fictitious spin [BEGOE(1+2)-F]. For this, we study the average Fluctuation separation, the short and long range spacing statistics, 1/f noise as well as the nature of density for the two body part [BEGOE(2)-F]. The third model is again an one plus two body embedded bosonic ensemble, but now with spin one [BEGOE(1+2)-$S1$] where the method for constructing the ensemble has been developed. The analysis part covers the nature of state density for Fixed-(m, S), the behaviour of nearest neighbour spacing distribution and Fluctuations in energy centroids and spectral widths. Moreover, two types of pairing in BEGOE(1 + 2)-$S1$ space are introduced and some numerical results for ground state structure and pairing structure are presented.

Turning on to fermions, we study an embedded fermionic ensemble with three body interaction and a First analytical results are prepared. Such an ensemble was considered for one plus two body interaction, in past, and the present work serves as an extension to it. After constructing the method for constructing the ensemble for Fixed-(m, S), the result part consists of a study of spectral properties such as the nature of state density, average-Fluctuation separation in state density and the spacing statistics including NNSD and Dyson Mehta (Δ_3).

Thus the presented work is a kind of individual study of different models of bosons and fermions where one can understand the applicability of Random Matrix Theory to such generic systems, which proves to be an important tool to probe different spectral properties.

References

[1] V.K.B. Kota, *Lecture Notes in Physics 884, Embedded Random Matrix Ensembles in Quantum Physics*, Springer International Publishing Switzerland (2014).