The Generalized Gibbs Ensenble in the Heisenberg spin chain: A Hilbert space Monte Carlo approach

Vincenzo Alba[1] and Maurizio Fagotti[2]

[1] *International School for Advanced Studies (SISSA), Via Bonomea 265, 34136, Trieste, Italy, INFN, Sezione di Trieste*
[2] *Département de Physique, Ecole normale superieure, CNRS, 24 rue Lhomond, 75005 Paris, France*

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I. INTRODUCTION

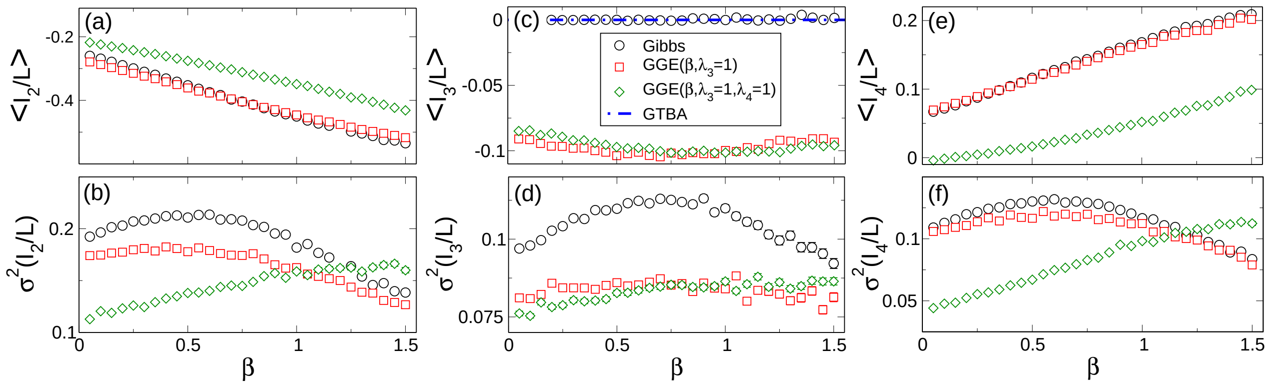

FIG. 1. The Generalized Gibbs Ensenble (GGE) for the finite-size Heisenberg spin chain with $L = 16$ sites. The GGE is constructed including the conserved charges I_2, I_3, I_4. The corresponding Lagrange multipliers are denoted as $\lambda_2, \lambda_3, \lambda_4$. Here I_2 is the Hamiltonian and $\lambda_2 \equiv \beta$ the inverse temperature. (a) The GGE average $\langle I_2/L\rangle$ of I_2/L plotted as a function of β. The data are obtained using the Hilbert space Monte Carlo approach described in the manuscript. The different symbols correspond to GGEs with different fixed values of λ_3 and λ_4. The circles correspond to the Gibbs ensemble. (b) The fluctuations $\sigma^2(I_2)/L \equiv \langle (I_2/L)^2\rangle - \langle I_2/L\rangle^2$ as function of $0 \leq \beta \leq 1.5$. (c)(d) and (e)(f): Same as in (a)(b) for I_3 and I_4, respectively. In all panels the dash-dotted lines are the analytical results obtained using the Generalized Thermodynamic Bethe Ansatz (GTBA) approach.

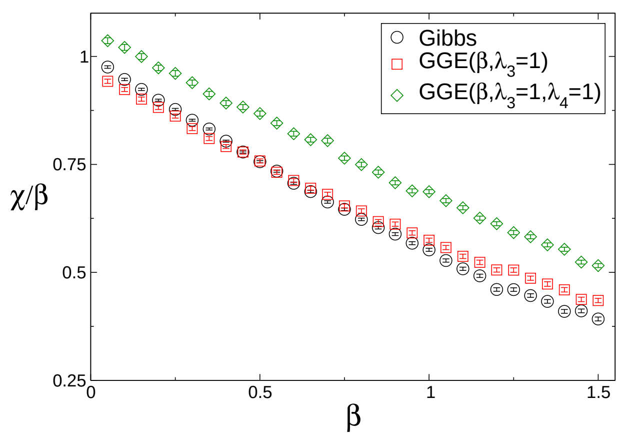

FIG. 2. The GGE average of the spin susceptibility χ in the Heisenberg chain with $L = 16$ sites: χ/β plotted versus the inverse temperature β. The GGE is constructed including the conserved charges I_2, I_3, I_4. The corresponding Lagrange multipliers are denoted as λ_2, λ_3, and λ_4. Here I_2 is the Hamiltonian and $\lambda_2 = \beta$. The different symbols are Monte Carlo data for GGEs with different values of λ_3, λ_4. Notice that the circles correspond to the Gibbs ensemble.

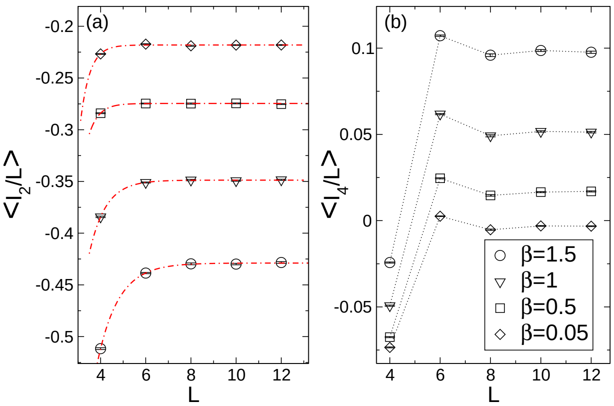

FIG. 3. Finite-size scaling of the GGE averages in the Heisenberg chain. Here the GGE is constructed using the conserved charges I_2, I_3, I_4, with associated Lagrange multipliers $\lambda_2, \lambda_3, \lambda_4$. I_2 is the Hamiltonian and $\lambda_2 \equiv \beta$ the inverse temperature. Here we fix $\lambda_3 = \lambda_4 = 1$. (a) The GGE average $\langle I_2/L \rangle$ (Monte Carlo data) plotted versus the chain size L. Different symbols correspond to different values of β. The dash-dotted lines are fits to an exponential behavior. (b) Same as in (a) for I_4.