von Neumann entropy in classical statistical mechanics

Roman Krcmar*†[1], Andrej Gendiar[1], and Tomotoshi Nishino[2]

[1]Research Center for Quantum Information (RCQI) – Institute of Physics, Slovak Academy of Sciences
Dúbravská cesta 9, 84511 Bratislava, Slovakia, Slovakia
[2]Kobe University – 1-1 Rokkodai-cho, Nada-ku, Kobe 657-8501, Japan, Japan

Abstract

Entanglement is a property of the quantum system. It expresses correlations between various parts of the quantum system. For the bipartite division von Neumann entropy can be used as a measure of the entanglement. Correlations are enhanced in the vicinity of the phase transition point and therefore von Neumann entropy can be used for detection of quantum phase transitions. It has logarithmic divergences around them [1]. Using Suzuki-Trotter transformation we can map the one-dimensional quantum model to the two-dimensional classical statistical model. Using this mapping we can define classical analogue of von Neumann entropy. Expecting the same singular behavior we can use this quantity for detecting the positions of the phase transition. This approach has several advantages. Firstly it can be used for the inspection of the new model with very little knowledge about it. Secondly it can be used to obtain the central charge of the critical model and enhance the knowledge of the criticality. Corner transfer matrix renormalization group (CTMRG) [2] method is a great framework in which to define classical von Neumann entropy. We will present results from our study of various models. Toy model based on the truncated tetrahedron [3]. Generalized Widom-Rowlinson model [4]. Eight-vertex model in a field [5] the 6-clock model [6]. [1] T. J. Osborne and M. A. Nielsen, Phys. Rev. A 66, 032110 (2002).
G. Vidal, J. I. Latorre, E. Rico, and A. Kitaev, Phys. Rev. Lett. 90, 227902 (2003).
F. Franchini, A.R. Its, B-Q. Jin, and V.E. Korepin, J. Phys. A 40 8467 (2007).
T. Nishino and K. Okunishi, J. Phys. Soc. Jpn. 65, 891 (1996).
T. Nishino and K. Okunishi, J. Phys. Soc. Jpn. 66, 3040 (1997).
Krcmar R., Gendiar A., Nishino T., Phys. Rev. E 94 022134 (2016).
Krcmar R. and Samaj L., Phys. Rev. E 92 052103 (2015).
Krcmar R. and Samaj L., EPL, 115 56001 (2016).
Krcmar R., Gendiar A. and Nishino T., in preparation

*Speaker
†Corresponding author: krcmar.roman@gmail.com