Potts model on complex networks

M. Krasnytska[a], B. Berche[b], and Yu. Holovatch[c]

[a] *Ivan Franko National University of Lviv, Department of Theoretical Physics, 79005, Lviv, Ukraine, E–mail: krasnytska@i.ua*

[b] *Institut Jean Lamour, Nancy Université, F-54506 Vandœuvre les Nancy, France, E–mail: berche@ijl.nancy-universite.fr*

[c] *Institute for Condensed Matter Physics, National Academy of Sciences of Ukraine, 79011, Lviv, Ukraine, E–mail: hol@icmp.lviv.ua*

Potts model is one of the most popular spin models of statistical physics. It has been the subject various analytical and numerical treatments [1]. Opposite to the prevailing majority of work done so far, where lattice versions of the model were considered, the goal of our study is to get more insight about the q-state Potts model on complex network [2], when the interacting particles are located on nodes of a random graph.

Current interest in critical behaviour of spin models on complex networks is caused both by their unusually rich behavior as well as by possible applications that range from nano- to sociophysics. We consider the scale-free network for which the node-degree distribution manifests a power-law decay governed by the exponent λ. In the frames of the mean-filed approximation (mfa) we obtain thermodynamic functions and analyze the phase diagram of the model in different regions of the $q - \lambda$ plane. Whereas for the d-dimensional systems the mfa is asymptotically correct only above the upper critical dimension, for the systems on random uncorrelated scale-free networks (where the very notion of space dimension is ill-defined) this method is known to give asymtotically exact results. Depending on particular values of q and λ one observes either the first-order or the second-order phase transition [2]. In the latter case we also display the scaling functions for different observables in an explicit form. Moreover, we consider also the case when degree-degree correlations between different network nodes are present [3] and discuss possible impact of these correlations on the phase transitions in the Potts model.

[1]. F.Y. Wu. Rev. Mod. Phys. **54** (1982) 235.
[2]. F. Iglói, L. Turban. Phys. Rev. E **66** (2002) 036140.
[3]. L.K. Gallos, C. Song, H.A. Makse. Phys. Rev. Lett. **100** (2008) 248701.