ATELIER « SYSTÈMES DÉSORDONNÉS : VERRES DE SPIN »
8–13 JUIN 2009

WORKSHOP "DISORDERED SYSTEMS: SPIN GLASSES"
JUNE 8–13, 2009

Measuring ultrametricity and clustering properties of disordered systems

ALEXANDER HARTMANN

Institute for Physics
University of Oldenburg
Carl-von-Ossietzky Strasse 9-11
26111 Oldenburg
GERMANY

alexander.hartmann@uni-oldenburg.de

We present results [1] from Monte Carlo simulations to test for ultrametricity (UM) and clustering properties in spin-glass models. For this purpose, we introduce a different normalization of an UM measure, which allows to distinguish real UM from the spurious UM of the paramagnetic phase, in contrast to previous approaches. Furthermore, we extend a hierarchical clustering approach [2], resulting in displaying the hierarchical organization of a set of congurations via a dendogram and a grey scale picture of the matrix d of hamming distances. The extension allows to count the number of top-level clusters of the conguration space in a well defined way. These approaches are applicable to a wide range of models in disordered systems, like spin glasses [3] or combinatorial optimization problems [4], which are well known for their complex conguration landscapes.

By using a one-dimensional Ising spin glass with random power-law interactions [5], where the universality class of the model can be tuned by changing the power-law exponent, we find signatures of UM behavior both in the mean-field and non-mean-field universality classes for large linear system sizes. Furthermore, we confirm the existence of nontrivial connected components in phase space via a clustering analysis of configurations. Also selected results from applications of these methods to other models like the vertex-cover problem, the number-partitioning problem and the satisfiability problem are given.

[1] H. G. Katzgraber and A. K. Hartmann, Phys. **102** (2009) 037207.

[2] A. K. Jain and R. C. Dubes, *Algorithms for clustering data*, Prentice-Hall, Englewood Clis, USA, 1988.

[3] M. Mezard, G. Parisi, and M. A. Virasoro, *Spin glass theory and beyond*, World Scientic, Singapore, 1987.

[4] A. K. Hartmann and M. Weigt, *Phase transitions in combinatorial optimization problems*, Wiley-VCH, Berlin, 2005.

[5] G. Kotliar, P. W. Anderson, and D. L. Stein, Phys. Rev. B **27** (1983) R602.