

# PHASE TRANSITIONS IN THE SELF ORGANIZATION OF HIERARCHICAL SOCIETY

R. Fujie and T. Odagaki

Department of Physics, Kyushu University  
6-10-1 Hakozaki Higashi-ku Fukuoka, Fukuoka 812-8581, Japan  
r.fujie@cmt.phys.kyushu-u.ac.jp

It is common to see self organization of social hierarchies in societies of human beings and animals. Since emergence of social hierarchies is shown as a result of simple random process by Bonabeau et al., the studies of structure and emerging mechanism of hierarchy have also been conducted by applying methods of statistical physics [1].

Bonabeau et al. introduced an agent based model, where each agent assumed to has its own wealth as an internal state. The basic processes in their model are random walk, fighting when two agents meet, and relaxation of the wealth. They showed that hierarchy can self organize when the density exceeds a critical value.

Hierarchical society can be self organized even in societies where random walk of agents is irrelevant. For example, winner and losers exist in economic competitions and in scientist communities. Therefore, the universal mechanism to explain the self organization of hierarchy should not rely on the random walk of agents.

We introduce a model where fighting among agents and relaxation of their wealth are the essential dynamics, and generalize it to handle the fight among  $n$  agents and to handle the problem of distribution of wealth by introducing the concept of cost. This generalized model can be applied to a wide range of economic and social competitions (e.g. firms in competitive market, competing educational institutions, competing scientists for scientific research fund, workpeople under challenge again program, etc.). We present the results for several cases described by the generalized model.

## Keywords

hierarchy, self-organization, phase transition

## References

[1] E. Bonabeau, G. Theraulaz and J.-L. Deneubourg, "Phase diagram of a model of self-organizing hierarchies", *Physica A*, v. 217, p. 373-392, 1995.