MEAN FIRST-PASSAGE TIME DYNAMIC ENTROPY USED FOR THE ANALYSIS OF ACTIVE BROWNIAN MOTION IN SMALL SYSTEMS OF INTERACTING PARTICLES

X. Koss,[1,2] O. Petrov,[1,2] K. Statsenko,[1,2] M. Vasiliev[1,2]

[1] *JIHT RAS, Moscow, Russian Federation*
[2] *MIPT, Moscow, Russian Federation*

Nowadays, systems consisting of active Brownian particles, i.e. particles that are able to transform an external energy into the kinetic energy of their motion, arouse great interest as rapidly evolving and perspective interdisciplinary field of science. These objects are widespread in living nature (motile cells of living organisms, insects, etc) and created artificially for the purposes of medical industry and technology A study of phase transitions in these open systems is a selected and actual problem.

Within the frames of present work, we study the dynamical properties of small structures of active Brownian particles, consisting of 7 grains. We have used the metal-coated dusty particles 10 μm in diameter, levitating in RF-discharge plasma [1]. The external laser radiation, acting on the metal surface, induces the radiometric force [2]. Its direction is determined by the Brownian rotation of the particle, i.e. chaotic. So, the metal-coated plastic particles in gas-discharge plasma act like active Brownian agents, transforming the energy of laser radiation into the kinetic energy of their motion. As the power of laser radiation grows, the kinetic energy of particles increases.

To describe the structure characteristics of experimentally created systems, we have used the approach of mean first-passage time dynamic entropy [3] – a simple approximation of Kolmogorov-Sinai entropy [4]. Within this framework we have analyzed the fractal dimension of trajectories of particles and the size of their localization area. Three states of the system are distinguished: crystal-like, liquid-like and transitional.

References

[1] O. Petrov et al. EPL 111, 45002 (2015)

[2] O. Jovanovic. Journal of Quantitative Spectroscopy & Radiative Transfer, 110:889–901, 2009

[3] K. Koss, O. Petrov, M. Myasnikov, K. Statsenko, M. Vasiliev. Phase transitions and dynamic entropy in small two-dimensional systems: Experiment and numerical simulation. Journal of Experimental and Theoretical Physics, 123(1):98-107, 2016

[4] P. Gaspard and X.-J. Wang, Phys. Rep. 235, 291 (1993)