Nanoscale physics

Collective motion of rotationally driven nanoparticles of concave shape

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Today nanoscience is increasingly considering the study of so-called active nanoparticles. By the latter we mean particles that can transform different types of the energy into motion. Examples include nanoobjects of both the biological (bacteria, macromolecules, viruses) and physical nature (gold nanoparticles heated by laser radiation). Thus great practical importance is got by the methods that allow describing the types of the motion of such nanoparticles and the critical phenomena occurring during of their movement.

In the paper [1] the collective phenomena of rotationally driven active particles of concave shape were investigated on the basis of Langevin equations for translation and rotation. However, using this approach, the problem is solved only numerically.

We have built a self-consistent theory describing the transition in an ensemble of driven nanoparticles based on synergetic Lorenz equations. The role of the order parameter, which differ the directional and the rotational motion of the particles, plays by the translational velocity. The conjugate field is given by an external force, and the control parameter – by a torque of particles. As a result of solving the system of three differential equations within the adiabatic approximation we have obtained an effective potential, which had two equilibrium states. The first corresponds to zero velocity of the translational movement and thus describes rotational movement of nanoparticles, the second specifies the non-zero velocity, defined by external parameters of the system, and corresponds to the translational motion of the active particles. As a result, it turned out that the main parameter affecting the behavior of the system is a torque of nanoparticles.

1. *Nguyen H., Klotsa D., Engel M., Glotzer S.* Emergent Collective Phenomena in a Mixture of Hard Shapes through Active Rotation // PRL-2014.**-112.-**P. 075701(1-5).