Controlling Collective Behavior of Active Colloids through a Dipole-Quadrupole Transition

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Understanding transport properties of colloid under various external fields is a fundamental classical problem in soft matter physics and their fluctuating dynamics is still a central topic in non-equilibrium statistical mechanics. Recently, we studied on non-trivial dynamics and self-organization of active colloids. By fabricating Janus particles with their half hemisphere covered with gold, we realized self-propelled motion under AC electric field. Asymmetric surface flow around the particle caused a self-propulsive ballistic motion. We have succeeded to control interaction between colloidal particles with changing salt condition and frequency of electric filed. Interaction between particles changed from repulsive to attractive resulting in formation of chains which swim, oscillate, and rotate under steady uniform electric fields. The mechanism of changing interactions is attributed to a dipole-quadrupole transition of Janus particle due to the response to the AC electric field. I will discuss on the mechanism of these nontrivial behaviors.