Colloidal Transport and Dynamics over Periodic Potentials

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Energy landscape is an important concept in science, which has been widely used in many areas of physics, chemistry, biology and materials science. Applications of the energy landscape concept can be found in the calculation and measurement of the chemical reaction rate, lifetime of single molecular bonds, folding kinetics of proteins, and phase diagram of complex materials. Our general understanding of this type of problem is through the well-known Arrhenius-Kramers equation, which was obtained under an idealized condition for a single energy barrier. For many practical applications, however, one often encounters complex energy landscapes. There are few experimental systems in which one can actually visualize the energy landscape, and thus much of the work done so far is through computer simulations. A physical model system in which one can directly measure the energy landscape and track individual particle trajectories would be extremely valuable in testing different theoretical ideas. In this talk I will present our recent efforts in developing a two-layer colloidal system to study colloidal transport and dynamics over periodic potentials [1-3]. This work opens up a whole new realm of investigation at the single-particle level for a range of interesting problems associated with the diffusive and forced barrier-crossing dynamics over complex energy landscapes. Examples of applications of this system will be discussed.

[1] “Colloidal diffusion over a periodic energy landscape,” X.-G. Ma, P.-Y. Lai, and P. Tong, Soft Matter 9, 8775 (2013) (featured on the cover page of the issue).

[2] “Colloidal transport and diffusion over a tilted periodic potential: dynamics of individual particles,” X.-G. Ma, P.-Y. Lai, B. J. Ackerson, and P. Tong, Soft Matter, 11, 1182 (2015).

[3] “Colloidal dynamics over a tilted periodic potential: non-equilibrium steady-state distributions,” X.-G. Ma, P.-Y. Lai, B. J. Ackerson, and P. Tong, Phys. Rev. E 91, 042306 (2015) [editor’s suggestion].

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