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Where are we with the understanding of a collective dynamics of quasi-periodically perturbed particles?

Monday, 4 September 2017 17:00 (30 minutes)

Marian Smoluchowski provided an explanation of the Brownian motion of particles. The equation for a particle's displacement in space that he proposed in 1906 provided an important basis for the theory of stochastic processes. This initiated the whole new field of stochastic dynamics that blossomed during the last century. In this talk we will discuss what happens to the particles if external deterministic forces are continuously imposed on them, and how a collective dynamics emerges to describe particles under external forcing.

The time-varying, non-autonomous, dynamics that emerges under external forcing has been detected in living, as well as man-made, systems. Currently, however, non-autonomous dynamics is commonly considered easy to deal with - either by transforming it into autonomous dynamics, for which an abundance of tractable analytic tools is available, or by considering it as belonging to the class of stochastic systems where, again, numerous analytic approaches exist.

In the talk, we will argue that there is a need for a theory of a new class of non-autonomous systems with time-varying dynamics due to external forcing. We will first present examples of non-autonomous dynamics measured from biological cells, the cardiovascular system and the brain, as well as from experiments with electrons on the surface of liquid helium.

Then, we will review briefly the existing numerical methods for the detection and analysis of non-autonomous dynamics from data. In the third part of the talk, we will summarise our current work on non-autonomous dynamics when the external perturbation is of quasi-periodic origin, arguing that most of the challenging problems still remain unsolved and that our better understanding of non-autonomous, finite-time dynamics could make a similarly significant contribution to that of Smoluchowski more than 100 years ago, thereby advancing our understanding of nature in general.

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