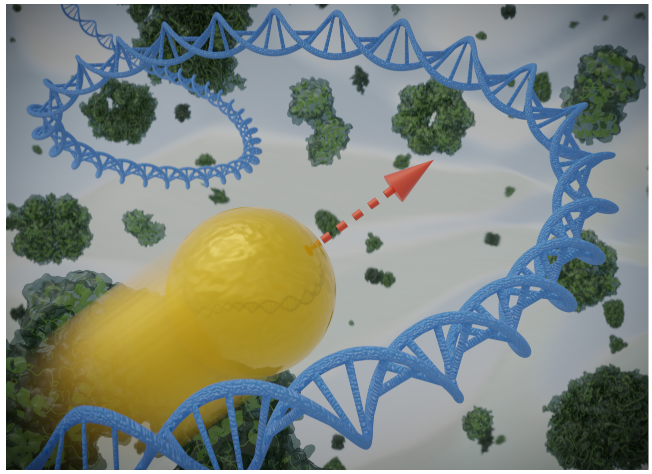
Observation of the motion of a body gives information about the moving body itself and its environment as well. Additionally, the knowledge about the mechanisms of motion enables predicting of body behaviour in different situations. It also allows one to infer about the body environment, facilitate to design the system and thus delivers technological development.



The above general rule also applies to the motion of a minute (much smaller than a hair thickness) particle in water. Suppose that such a particle is a protein, which is still much larger than a water molecule. The protein constantly collides with surrounding water molecules. The amount of collisions per second is enormous. They cause unpredictable in practice and complicated motion of the protein.

However, after an appropriately long time during which a sufficient amount of collisions occur and the particle changes its velocity many times - an astonishing regularity emerges from these chaotic collisions. The motion no longer poses the Newtonian character, where acceleration, mass and force determine its trajectory. Under these conditions, the movement is called diffusion. Observed under a microscope, the particle undergoing diffusion jiggles constantly.

Albert Einstein and Marian Smoluchowski introduced the theory of diffusion. In this very description, the regularity emerges from chaos, as mentioned above. The fundamental quantity in their approach is the particle diffusion coefficient. Its simplicity manifests itself by the fact that only the fluid temperature and its viscosity determine the diffusivity of the particle. Thus, only two fluid's parameters are sufficient to take into account the effects of multiple collisions of the diffusing particle with surrounding molecules.

However, for about 70 years, there has been another question that bothers scientists. In many biological fluids, there are plenty of proteins or larger macromolecules, instead of a single diffusing particle. A naive application of Einstein formula leads in this case to discrepancies described even by a factor of 10 000. Therefore, in this situation, there is a question as to how to describe diffusion. Many scientific works have focused on diffusion, unfortunately, in particular complex systems.

But is it possible to describe diffusion in complex fluids like in Einstein approach? Can the diffusivity be related to simple properties of the complex liquid, without referring to its specific structure?

The goal of the project is to answer the above questions. In particular, its main task is to show in practice - by the joint theoretical and experimental study - how to describe diffusion in complex liquids. We will focus on the diffusion of DNA fragments and flexible polymers in complex fluids. As a result, the project should deliver a tool for interpretation of experiments in such industrial fluids as polymer solutions and in biological liquids, e.g. cell cytoplasm. It will thus help to design complex liquids and identify biological mechanisms important for life processes.

The project will be performed in collaboration with John F. Brady from California Institute of Technology and Stewart A. Mallory from Pennsylvania State University in the United States.