The proposal is directed towards comprehensive studies of complex dynamics in ionic systems on molecular (atomistic) level. The simplest example of ionic systems is ionic liquids in bulk and confinement. Ionic liquids are materials having melting point less than 100^{o}C and consisting of self-dissociated cations and anions (no solvent is needed). A more sophisticated example of ionic systems is so called nanofluids *i.e*. ionic liquids containing nanoobjects of different dimensionality and properties. Nanoparticles can be treated as zero-dimensional (0D) objects, nanotubes serve as one-dimensional (1D) objects, while graphene sheets (flakes) form two-dimensional (2D) nanoobjects. Because of the ionic nature dynamical properties of ions in such systems are significantly different from those of the 'conventional' molecular liquids. This is a general statement. We wish to go further and explain the reasons for a series of specific dynamical phenomena encountered in ionic systems under different conditions. This constitutes the first goal of the project – we wish to know why, for example, some ionic liquids entrapped in nanotubes diffuse much faster than in bulk, why nanofluids show specific rheological properties which can hardly be described by hydrodynamic rules or why in mixtures of ionic liquids the ionic conductivity does not reflect ionic diffusivity. We also ask questions of the type: is this possible that like-charged ions can form clusters – this concept is somewhat illusive. The answer to the questions lies in the dynamics of the individual ions, the level to which they movement is correlated and the way how the ions interact with each other and the neighboring surfaces. To "see" the ionic movement we apply a highly specific experimental method which is called Nuclear Magnetic Resonance Relaxometry. Very shortly – this method gives access to the time scale and the mechanism of ionic motion by investigating how fast magnetization of a sample placed in external magnetic field evolves when the field is changed.

Our society relies on electrical storage devices, from smartphones and laptops to vehicles and to wider industrial applications. The development of energy storage systems is a vital goal of material science, as this is a key to the technology enabling the shift from fossil to renewable energies. With increased production of sustainable energy from renewable sources (solar, wind), the need for efficient energy storage systems has stimulated intense research interest in the area of batteries and supercapacitors. Majority of the studies is devoted to synthesis of new compounds for electrolytes and electrodes and to their electrochemical characterization. There is, however, a growing awareness that further progress in the development of energy storage systems heavily rely on a thoroughgoing understanding of the mechanisms of ionic transport and interactions with surface of electrodes reached on molecular (ionic) level. Therefore the second goal of the project is related to application-oriented systems: more specifically – ionogels and membranes - for instance SiO_2 silica or polymeric networks containing ionic liquids and their mixtures with lithium salts. In analogy to the first part of the project, we again ask questions which need answers in order to improve the performance of electrolyte's – for instance what to do to preserve the liquid-like dynamics and conductivity characteristic of ionic liquids in bulk when they are entrapped in gels and membranes.