Ion Coulomb Crystals - from Nanofriction to Optical Clock Operation

Tanja E. Mehlstäubler

Leibniz Universität Hannover, 30167 Hannover
PTB, Bundesallee 100, 38116 Braunschweig

Laser-cooled ions in Paul traps allow for a high degree of control of atomic quantum systems. They are the basis for modern atomic clocks, quantum computers and quantum simulators. Our research aims to use ion Coulomb crystals, i.e. many-body systems with complex dynamics, for precision spectroscopy. This paves the way to novel optical frequency standards for applications such as relativistic geodesy. At the same time, we can use them as quantum simulators in which their complex dynamics becomes accessible with atomic resolution.

The self-organized Coulomb crystals give a fascinating insight into the non-equilibrium dynamics of many-body systems with long-range interactions, displaying atomic friction and symmetry-breaking phase transitions. In the first part of the presentation, we discuss the creation of topological defects in 2D crystals and the study of tribology and transport mediated by the topological defect, in classical and quantum regimes. In the second part, we focus on the precision spectroscopy for clock operation and tests of general relativity.