

The main objective of the project is the production of the first in Poland and in Central-Eastern Europe quantum degenerate gas of fermionic potassium sympathetically cooled with a bosonic isotope.

The light, including laser light, typically is associated with a heat source. It might be a surprise to many, but it is lasers that are often used to decrease the kinetic energy of atoms and therefore lower their temperature. Via absorption of photons from a laser beam followed by a subsequent re-emission it is possible to transfer momentum to atoms which results in them slowing down. This enables trapping of atoms in the so called magneto-optical traps. However, this method quickly reaches its limits and in order to cool down even further one needs to employ evaporative cooling, a process very similar in its core to the cooling down of a soup when the air is blown on it – by evaporating we get rid of the most energetic particles and what is left reaches a new thermal equilibrium corresponding to a lower temperature.

When the atomic cloud is sufficiently dense and cold it is possible to create so called Bose-Einstein condensates or fermionic quantum gases. Such systems can be described exceptionally well by quantum mechanics and thanks to their low temperatures they can be very precisely controlled.

The research conducted within the scope of this project will lead to the creation of such unusual quantum gases in the laboratories of the Faculty of Physics of the University of Warsaw. As it turns out the behavior of such atoms under certain circumstances can be exploited for simulation of other, more complex system like for example crystals.

Ultracold fermionic atoms can be confined in specially oriented laser beams forming optical lattices that resemble crystals. By looking at their behavior of these atoms under external perturbations we can make analogies to the motion of electrons in real solids – which in the future might help us understand intriguing phenomena like high temperature superconductivity.