DESCRIPTION FOR THE GENERAL PUBLIC

The great progress of advanced experimental techniques has enabled studies of properties of atoms and molecules cooled down to very low temperatures close to absolute zero (0 kelvin), i.e., slightly above -273.15 degrees Celsius. In such conditions, the correct description of systems can only be obtained on the basis of quantum mechanics. The experimental realization of the Bose-Einstein condensate in 1995 referred as the fifth state of matter, which was predicted 70 years earlier by Satyendra Bose and Albert Einstein, was a breakthrough. In the experiment, the rubidium atoms were cooled down to a lower temperature than a millionth of a kelvin. E. Cornell, C. W. Ketterle and E. Wieman for unique research have been awarded the Nobel Prize in physics. Another milestone in research on cold matter was the molecular Bose-Einstein condensate made in 2003. The search for efficient cooling techniques and studies of quantum effects are constantly the subject of research both experimentalists and theoreticians.

The project focuses on the development of the adiabatic variational theory for cold collision experiments that was presented for the first time in 2015. The aim is to find out and understand the dominant quantum effects, the interaction properties, and the chemical reaction processes as a result of collisions between atoms and diatomic molecules at ultralow temperatures. An important characteristic of this theory will be its simple form involving techniques that are well-known by chemists and physicists. Moreover, the studies will allow on the one hand to verify existing experimental results and on the other hand to better control the collisions in new experiments. Understanding the collision processes at sub-kelvin temperatures is essential in the production of cold matter, which can be used in the near future to build a quantum simulator, components of a quantum computer and a new generation super-accurate optical clock.