DESCRIPTION FOR THE GENERAL PUBLIC:

The Sun that we see every day on the sky hides from us many mysteries. The Sun consists of its interior and atmosphere. The central part of the interior is called the core in which nuclear reactions generate gamma photons. The core is capped by the radiation zone in which these gamma rays try to penetrate the medium, making their effort to reach laying above the convection zone. In this region transport of energy is dominated by upwelling parcels of hot plasma and descending cold gas. The lowest layer of the solar atmosphere is called the photosphere – only 500 km thick region which emits the light we see. Temperature of this layer is only about 5600 K, in comparison to 15 MK hot solar core. Just above the photosphere plasma temperature drops to 4300K, but surprisingly enough higher up, temperature rises, first slowly in the chromosphere and then suddenly at the transition region above, were it reaches on average 2-3 MK in the corona. One of the most important open questions is the chromospheric and coronal heating paradox; these atmospheric layers have temperatures much higher than the photosphere that is laying below. Current computer models as well as analytical and observational efforts cannot explain the cause of this paradox and its solution on the basis of the magnetohydrodynamics - the simplest conceivable model of plasma - does not seem to be possible.

Because of low computing power until recently, numerical simulations with the use of two-fluid models developed for ions+electrons and neutrals have been difficult to perform. However, due to the technological development duration of numerical simulations have been shortened and it is now possible to elaborate more complex numerical models. The Lunar cluster which is available at UMCS allows us to perform modern, realistic but formidable numerical simulations with the use of numerical code JOANNA, describing by so-called two-fluid evolution equations interaction of ionized and neutral atoms.

The goal of this project is to simulate for the first time two-fluid solar convection and study the behavior of waves and other dynamic events which are associated with this convection. This goal will be realized with the use oh the JOANNA code. It is believed that these waves play an important role in formation and dynamics of the solar atmosphere contributing to atmospheric heating and solar wind generation. Due to the fact that JOANNA is a parallel code we will be able to make simulations with the use of hundreds of processors which will let us to perform challenging calculations even in three spatial dimensions.
Simulations of this type will be pioneering in the field of solar physics and will allow us to understand the way in which ions and neutral atoms affect the behavior of the solar granulation and associated with it waves and jets. These phenomena can contribute to the solution of two major problems of heliophysics, the coronal heating paradox as well as solar wind generation.