

The origin of relativistic particles in cosmic space is one of the basic problems of modern astrophysics. These particles are likely to be accelerated in compact cosmic sources which are characterised by extreme conditions still impossible to reproduce in laboratories on the Earth. Processes related to the acceleration, propagation and radiation of these energetic particles at the source can be studied by investigating the features of produced by them neutral radiation such as gamma-rays and neutrinos. Confrontation of observations of this radiation with the analysis of physical processes within the source (i.e. models of specific sources) allow us to obtain information on the behaviour of matter in extreme conditions characterised by enormous energy release, relativistic velocities of plasma, strong gravitational and radiation fields. In this project we aim to investigate advanced models for the high energy phenomena in a few types of cosmic sources. We concentrate on the models which take into account complicated, three-dimensional structure of these sources (inhomogeneous sources) and also inter-dependence between processes occurring in different parts of these sources (their non-locality). Due to these two effects, the physical processes often become non-linear, i.e. processes in specific region effect processes in other regions and in reverse. Therefore, advanced numerical models of these sources have to be elaborated. We concentrate on two general types of sources, i.e. those in which important role is played by relativistic jets (e.g. active galaxies, micro-quasars, gamma-ray bursts) and by strong winds (e.g. strong winds produced in globular clusters by mixing millisecond pulsar winds with the winds of red giant stars). These types of sources has been already discovered to emit gamma-rays which has to be produced by energetic non-thermal particles. The predictions of developed in this project advanced models, for the high energy radiation from these sources, will be confronted with their modern observations by the satellite and ground-based telescopes.