Despite 50 years of intense research on pulsars, their nature still remains largely unexplained. We know that pulsars are created as a result of a supernova explosion and emit a wide range of electromagnetic radiation as well as gravitational waves. The main goal of our project is to understand the nature of the radio emission of pulsars, which are strongly magnetized, fast-rotating neutron stars. The neutron stars are extremely fascinating compact objects of our Universe and are excellent laboratories of extreme physics. Size of a neutron star is about 20 km, while their mass is about one solar mass. The physical processes of how the emission activity of pulsars arise are still a mystery. The neutron stars are the last stage of evolution of some class of massive stars, thus, it should be a 'dead' star. However, some of them emit enormous amount of energy, sometimes their luminosity exceeds that of the Sun by several orders of magnitude. They emit a wide spectra of electromagnetic radiation, started from radio waves up to very high energy gamma-photons.

The main goal of our project is to understand the nature of the radio emission of pulsars. At the same time we also focus on studying their X-ray properties. It is widely accepted that radio waves are emitted by means of the coherent curvature radiation in a relativistic magnetospheric plasma. The plasma moves along a bundle of open dipole magnetic field lines originated from the polar cap region. Charged particles experience initial acceleration just above the polar cap in the so-called inner accelerating region, i.e. the polar gap. In our research, we adopt the Partially Screened Gap (PSG) model proposed by the members of the research team of this project. Particles accelerated in the direction of the magnetosphere generate an electron-positron plasma, while the particles accelerated towards the star cause heating of the polar cap which is the source of thermal X-ray. Their observations allow to determine both the temperature and size of the polar cap. Analysis of such data is a great tool for testing predictions of the polar gap model. The only source of pulsar radiation energy is the kinetic energy of the rotation of the star. Therefore, there should be some relationships between the properties of thermal and coherent radiation and the rate of loss of rotational energy.

The dependencies found by us opened a new chapter in the study of the internal acceleration region. In our project we intend to plan and perform pulsar radio observations from almost all the modern facilities worldwide. As a result, we will extend the current databases of pulsars showing some specific behaviors in their radio emission pattern. We also plan to perform X-ray observations simultaneously to the radio observations. Any kind of correlation would be very helpful in understanding the pulsar nature.