

Studies of the accretion disk stability are one of the major problems of modern astronomy. Previous and current X-ray observations of low-mass X-ray binaries (LMXBs) taken with space telescopes such as Swift and XMM-Newton, enable us to study phenomena occurring in the vicinity of a compact object (black hole, neutron star or white dwarf) in low-mass X-ray binary and verify theoretical models of an accretion disk.

The low-mass X-ray binary is a binary system that consists a compact star and normal star, such as our Sun. In such a system, there is a mass-transfer from the normal star onto the compact object. The result of mass-transfer could be emission of X-rays. The most common type of mass-transfer is an accretion disk, in which matter spiral onto compact objects. In this project we consider only one type of compact object, a neutron star that is built up entirely with neutrons and electrons. The most important property of a neutron star is their density that in the center of a star is greater than the nuclear density. The typical neutron stars have a radius of about 10 kilometers and a mass of about 1.35 Solar masses. The spoon of neutron star matter would weigh as much as whole Earth.

The aim of the project is to study instabilities in the accretion disk in various regions and mechanisms, that cause oscillations of matter with different time scales. Study of the effects of the Einstein's General Theory of Relativity and the rapid rotation on the vicinity of neutron stars allows us to assess stability of particular regions of the accretion disk.

In addition, we plan to investigate the hydrogen ionization instability arising in accretion disks in the low-mass X-ray binaries. The mechanisms of the above-mentioned instabilities differ significantly from each other, however, study of these instabilities allows to give a general view on the stability of accretion disks.

Our plan is to perform numerical calculations of rapidly rotating neutron stars with a wide range of masses and rotation rates. The calculations will be done for several modern tabulated equations of state of dense matter that describe the interior of neutron stars. The obtained results could may help us to understand the effects of General Relativity and rotation on to certain frequencies that describe oscillations of matter in accretion disks.

Obtained results will be compared with the observational data of the high-frequency quasi-periodic oscillations (HF QPOs) It will be performed numerical modeling of hydrogen ionization instability in an accretion disk around neutron star in low-mass X-ray binary. These calculations will explain observed variability of X-ray radiation with time-scales of about days.

The studies will be based on numerical calculations and interpretation of observational X-ray data. Obtained results will allow for more accurate understanding of the stability of accretion disks in a neutron star low-mass X-ray binaries.

Another aspect, that makes the project more interesting, is ability of identification of certain properties that may give neutron star parameters such as mass and radius. Knowledge of the mass and radius of neutron stars may limit the equation of state of dense matter that describes the structure of their star.