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Abstract of the PhD dissertation "Models of accretion disks thermal oscillations in applications to systems with black holes"

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In compact objects huge amount of mass is concentrated in a small volume. Those objects are reservoirs of the gravitational energy, which can be transformed into radiation under proper physical conditions. The stellar and galaxy evolution determines the formation of objects known as white dwarfs, neutron stars and black holes. In those objects, the hot matter, seen by the X-ray observatories, accretes onto the compact object.

The behaviour of that matter is driven by non-linear processes, determined by the equations of hydrodynamics. It implies different complicated patterns of the temporal variability. The dynamics of inflowing matter, leads in some cases to unstable behaviour. The thermal-viscous instability, accompanied with global stabilizing mechanism like advection of heat, may result in limit-cycle oscillations. The observed oscillation patterns can be splitted over many different timescales.

General theory of the accretion disks was presented in 1973 by Shakura and Sunyaev. Their α disk theory still remains dominant effective large-scale theory of the accretion disks, albeit the mechanism of heat production is still unknown. The aim of this thesis is to study variable X-ray sources at different black hole mass scales and verify the existence of the radiation pressure instability, which drives the thermo-viscous oscillations in black hole accretion disks. In this thesis I confront the α -disk model with some recent observational results (2011 IGR J17091-3624 heartbeat state and 2009-2014 HLX-1 lightcurve). I also verify the hypothesis about the stabilizing role of the Iron Opacity Bump in AGNs. Finally I discuss physical scenarios within the framework of this model. I present the general model and apply it to some observations. The resulting lightcurve properties (period and amplitude) are confronted with accretion scenario parameters. These estimations help in determination of the black hole mass and Eddington ratio, being an alternative method in comparison to spectral modeling. It is used to determine the black hole mass of HLX-1 and can be applied to other X-ray sources with periodic thermal variability. The model is extended by the effective prescription for the wind ejection. For AGNs it is supplemented by the atomic opacities. I show that both these effects can have influence on the variability patterns and disk instability.

The thesis is organized as follows: In the Introduction the basic physical foundations of black holes and accretion physics are presented. In Chapter 2, I derive the equations for the accretion disks structure and dynamics. In Chapter 3, I focus on the example of microquasar IGR J17091-3624, and anticorrelation between the wind outflow and time variability. In Chapter 4 I present the general model of modi#ed viscosity in accretion disks and method for estimation of masses and other parameters of the sources from the X-ray lightcurves. In Chapter 5, I apply the results from 4 to the newly discovered source HLX-1 and measure its mass and accretion rate. In Chapter 6, I propose the extension of the model from Chapter 4, including the effects coming from the atomic processes inside the plasma, which can moderate the variability of the disk around the supermassive black holes.