P.h.D. Thesis Review Report
PhD student Anastasiya Yilmaz

I carefully reviewed the Ph.D. thesis of Miss Anastasiya Yilmaz. The thesis is divided into two parts: the first part, which is the main focus of the thesis, is devoted to extensive and detailed modeling of the emission from the accretion disc of two X-ray binaries that host a black hole as the compact object. The second part involves identifying a transient ultra-luminous X-ray source candidate in M51.

This thesis contains substantial and original work by the candidate. The first part has already been published in a peer-reviewed journal, while the second part is expected to be published soon.

The primary goal of the thesis is to test and compare three different models of the accretion disk around a black hole. Two of these models are relativistic (KERBB and KYBB in XSPEC), and the third is a classical, widely-used model of an accreting multicolor disk around a Schwarzschild black hole (diskbb in XSPEC).

The sample used to test these models is a large collection of PCA/RXTE data from two types of BH-XRBs: GRO J1655-40 and LMC X-3. The first source is a classical transient LMXRB that has experienced several outbursts, covering all spectral states, while the second is a persistent HMXRB, always in the high soft state (HSS).

The accretion disk emission is thoroughly studied using an extensive set of PCA/RXTE archival data from the two BH-XRBs. The statistical methods used to test the models across this large dataset are rigorous and well-explained in the thesis. The results are presented with several plots, and the three different models are carefully compared, highlighting their similarities and differences.

The findings indicate that the KYNBB model can give back more accurate physical parameters such as the inner radius and can also minimize the deviation found in the relation between disk luminosity and disk temperature. Furthermore, the results highlight that KYNBB cannot recover the deviation in the relation between the color correction factor and the inner radius in the GRO J1655-40 spectra. This deviation can likely be attributed to general relativistic effects impacting the accretion disk.

The second part of the thesis focuses on the search for new transient ultra-luminous X-ray source candidates in M51, utilizing a long-term, multi-frequency observation campaign performed on M51 by XMM, Swift, Chandra, and HST. The data collected spans over 20 years, and a new ULX candidate has been identified. The outburst lasted 81 days, with the luminosity approaching nearly 10^39 erg s^-1. The data has been thoroughly analyzed to extract all possible information about the source. The study excludes the AGN nature of the source, and no pulsations have been detected. However, the limited data availability during the 81-day outburst does not allow for a definitive conclusion on whether the system harbors a neutron star or an intermediate-mass black hole.

The thesis is well-written, clear, concise, and easy to read. It discusses several topics in which the candidate skillfully demonstrates their expertise.

In particular, by analyzing such a large sample of spectra in both parts of the thesis, the candidate has gained extensive knowledge in data reduction from nearly all X-ray satellites of the past 20 years and has acquired significant experience in complex spectral modeling. Moreover, in the second part of the thesis, the candidate also focused on image and timing analysis. Based on this comprehensive data analysis, there is a deep understanding of accretion disk processes in various scenarios, also covering the super-Eddington condition in ULXs**.**

In summary, I believe that the findings presented in this thesis are both innovative and of significant scientific importance. The objectives outlined at the beginning of the research were successfully achieved, with the key outcomes being published in reputable peer-reviewed journals, and other publications are planned for submission in the coming months. In my view, this thesis meets the criteria necessary for the award of a Ph.D., and I fully support its submission for defense.

Certainly, in addition to the original and interesting scientific findings, the candidate has gained a valuable set of skills that will be instrumental in her future research career.

Corrections:

The thesis presents in some parts minor errors of latex (for example in section 1.1.4 all citations of the equations link to the same number.). Moreover, there are sometime some minor omissions in the introduction of both parts of the thesis (e.g. the lack of mention of relativistic ejections approaching the jet line in the Q-track diagram of the transient BH X-ray binaries). However, the significance of the thesis's scientific results remains unaffected by these small errors.

Questions:

1. **Study of relativistic and non-relativistic models**: *discuss the consequences at energies lower than the temperature of the seed photons of approximating the emission from the hot electron corona with a power law without cutoff at lower energies. Can this effect contribute to significantly to modify the values of the parameters especially the inner disk radius?*
2. **Identification of ULX* in M51:** *ascertained that pulsations are not detectable in M51 ULX*, is there a spectral or a timing signature that in principle could determine univocally the nature of the compact object in M51 ULX*?*