Determination of Black Hole Masses in Galactic Black Hole Binaries using Scaling of Spectral and Variability Characteristics

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2.1 ICRANet participants

- Lev Titarchuk (George Mason University/Center for Earth Observing and Space Research, US Naval Research Laboratory; NASA/GSFC)

2.2 Ongoing collaborations

- Nickolai Shaposhnikov (CRESST/University of Maryland; NASA/GSFC)

3 Brief description

3.1 Collaboration with Byurakan Astrophysical Observatory in Armenia

The Byurakan Astrophysical Observatory (BAO) is one of the most important astronomical centers in the Eastern Europe and Middle East region, both by its scientific instruments and achievements. Byurakan Astrophysical Observatory (BAO) was founded in 1946 on the initiative of academician Victor Ambartsumian, who became the first director of the observatory. The Byurakan Astrophysical Observatory, or Byurakan Observatory is an astronomical observatory owned and operated by Armenian Academy of Sciences. It is located on the slope of Mount Aragats in the village of Byurakan in Armenia.

Now BAO continues to make a research on the following directions which can be interesting for Collaboration with ICRANET: Active Galactic Nuclei, Seyfet galaxies, Quasars, Extragalactic Supernovae, atmospheres of stars, white dwarfs and neutron stars, pulsars, compact cosmic objects including neutron stars and black holes.

Other interesting subject of investigation is the theoretical Astrophysics: radiative transfer theory, direct and inverse problems, mathematical physics and modeling. In BAO there are quite a few number of young scientist, grad and undergrad students of the department of Physics and Astronomy of Yerevan State University (YSU). These young talented people of BAO can be a big potential for collaboration with ICRANET if the appropriate guidance would be provided by ICRANET professors.

ICRANET can collaborate personally with:

- Dr. H. Harutyunian (cosmology, radiative transfer, QSOs)
- Dr. A. Michaelian (QSOs, X-ray and IR sources)
- Dr. G. Ter-Kazarian (superdense configurations, high energy Astrophysics)
- Dr. H. Pikichian (direct and inverse problems, radiative transfer)
- Prof. A Nikoghossian (radiative transfer, theory of the spectral formation in the compact objects)

- Dr. N. Melikian (polarimetry, optical observations of stars, H_α-stars and compact object sources).

3.2 Determination of Black Hole Masses in Galactic Black Hole Binaries using Scaling of Spectral and Variability Characteristics

We present a study of correlations between X-ray spectral of timing properties observed from a number of Galactic Black Hole (BH) binaries during hard-soft state spectral evolution. We analyze 17 transition episodes from 8 BH sources observed with *Rossi X-ray Timing Explorer* (*RXTE*). Our scaling technique for BH mass determination uses a correlation between spectral index and quasi-periodic oscillation (QPO) frequency. In addition, we use a correlation between index and the normalization of the disk "seed" component to estimate the distance to the source. While the index-QPO correlations for two given sources contain information on the ratio of the BH masses in those sources, the index-normalization correlations depend on the BH mass to distance ratios. The index-normalization correlation also helps us to establish the index-mass accretion saturation effect given that the normalization of disk "seed" photon supply is proportional to the disk mass accretion rate. We present arguments that this observationally established index saturation effect is a signature of the bulk motion (converging) flow into black hole which was early predicted by the dynamical Comptonization theory. We use GRO J1655-40 as a primary reference source for which the BH mass, distance and inclination angle are evaluated by dynamical measurements with unprecedented accuracy among other Galactic BH sources. We apply our scaling technique to determine BH masses and distances for Cygnus X-1, GX 339-4, 4U 1543-47, XTE J1550-564, XTE J1650-500, H 1743-322 and XTE J1859-226. A good agreement of our results for sources with known values of BH masses and distance provides an independent verification for our scaling technique.