

Spectral and spectropolarimetric studies of Be/X-ray binaries

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In this thesis the results of our study of spectral and spectropolarimetric observation of Be/X-ray binaries are presented. The thesis is divided into five chapters with an appendix and a bibliography. In Chapter 1 brief introduction, motivation and the main aims are discussed. In Chapter 2 the interstellar extinctions toward 9 Be/X-ray binaries and one possibly related system using equivalent width of KI $\lambda = 7699 \text{ \AA}$ and equivalent width of Diffuse Interstellar Bands (DIBs): DIB $\lambda = 6613 \text{ \AA}$; DIB $\lambda = 5797 \text{ \AA}$ and DIB $\lambda = 5780 \text{ \AA}$ are estimated. In most cases the results are in agreement with published values which means that the applied technique is relevant and the measured extinction should provide useful input for theoretical modeling. The main results of this study are published in Nikolov et al. (2017).

From the spectroscopic observations of the three Be/ γ -ray binaries, obtained with the fibre-fed Echelle spectrograph *ESpeRo* attached to the 2.0 m telescope of the Bulgarian Rozhen National Astronomical Observatory, we deduce that in LSI+61⁰303 the neutron star crosses the outer parts of the circumstellar disc at periastron, in MWC 148 the compact object passes deeply through the disc during the periastron passage, and in MWC 656 the black hole is accreting from the outer parts of the circumstellar disc during the entire orbital cycle. We estimated the circumstellar disc size, compared it with separation between the components, and discussed the disc truncation. The histograms in all three stars show that the disc size clusters at specific levels, indicating the circumstellar disc is truncated by the orbiting compact object. The main results of this study are published in Zamanov et al. (2016).

The Two Channel Focal Reducer RoReRo2 in spectropolarimetric mode of observation is discussed in Chapter 4. I describe the instruments and its possibilities in spectropolarimetric mode of observation as I give examples with observations of spectropolarimetric standard stars (with high and zero degree of polarisation); HMXB star Cyg X-1 and symbiotic star RS Oph. Data reduction of X Per is described in the appendix.

In Chapter 5 optical spectropolarimetric observation of MWC 148; LSI+61⁰303; MWC 656; LSI + 5979 and X Per are presented. Spectropolarimetric observations of the Be/X-ray binaries were secured with the 2-Channel-Focal-Reducer Rozhen (FoReRo2) attached to the Cassegrain focus of the 2.0m RCC telescope of the Bulgarian Rozhen National Astronomical Observatory. The polarized light coming from astronomical objects brings important information for their geometry. The degree of intrinsic optical linear polarisation of X-ray binaries can be up to a few percents.

When unpolarized light undergoes scattering (Thompson scattering) in the circumstellar disc around the Be- star, the scattered light is linearly polarized. The degree of polarisation depends on factors such as the density of circumstellar disc around mass donor star and its inclination to the line of sight. On the other hand the dynamics of the processes occurring due to the interaction between the different components of this object are such that we expect changes in the measured Stokes parameters Q and U. Optical spectropolarimetric observations can give us important information about the physical and geometrical properties of the Be/X-ray binaries.

The observed polarisation in the astrophysical objects is usually sum of two components, the intrinsic polarisation, produced in the object and the polarisation arising from the foreground interstellar matter between the object and the observer. For estimation of interstellar polarisation toward LSI +5979 and MWC 656 field star method and correlation between E(B-V) and degree of polarisation was used, Fosalba et al. (2002). The conclusions of spectropolarimetric observations of Be/X-ray binaries are summarised below:

- Dominant component of observed polarisation of LSI + 5979 represents interstellar polarisation.
- For MWC 656 we observed variation of intrinsic polarisation, depends of orbital phase of the system.
- For MWC 148 we observed for the first time depolarisation effect across H_α emission line, that indicates intrinsic polarisation of this object. Our values of observed degree of polarisation and position angle are very close to those, obtained by Yudin et al. (2017).
- The values of observed and intrinsic polarisation of LSI+61⁰303 are close to those obtained by Nagae et al. (2009).
- X Per was observed at the recent disk loss phase. The observations indicate linear correlation between equivalent width of H_α emission line and degree of intrinsic polarisation.

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