Description of the project and obtained results

The aims of the project were to determine the optical polarisation of selected DC type white dwarfs and investigation of the changes of the optical polarisation of High Mass X–ray Binaries with Be stars (BeXBs) in order to determine their orbital parameters such as inclination, i.e. the viewing angle of the orbital plane.

To determine the strength of magnetic field the Zeeman effect is used very often. It is the effect of splitting a spectral line into several components in the presence of a static magnetic field. The spectral line separation is proportional to the magnetic field strength. In case of DC type white dwarfs it is hard to relay on Zeeman effect since its spectrum is continuous and does not show strong spectral lines. The other way would be the investigation of polarisation of their emitted optical radiation.

High Mass X–ray Binaries with Be stars (BeXBs) are binary systems with orbital periods of the order of 10 to 300 days. They consist of a neutron star and a Be type star companion. One of the characteristics of the binary systems is the change of polarisation depending on their orbital phase. The knowledge of such changes allows to determine orbital parameters such as eccentricity, inclination and ascending node, which in turn allow to determine the masses of both components. It is especially important in the case of neutron star since it can help to verify different equations–of–state. More specifically the equation–of–state is a thermodynamic equation describing the state of matter under a given set of physical conditions. A the moment there are many neutron star models and any restrictions put on their parameters can rule out incorrect ones.

To fulfil the goals fo the project we performed observations using two telescopes: 1.3 meter telescope in Skinakas Observatory on Crete (Greece) and 2 meter fully robotic telescope on La Palma (Spain). We were granted almost 90 hours of observing time to observe 76 white dwarfs and 5 BeXBs. Additionally many supporting observations were performed with telescopes located in Poland, Germany and Turkey.

Observations show that radiation coming from the selected sample of white dwarfs is unpolarised. This makes our targets good candidates to be zero–polarised standards which can be used to calibrate polarimeters and spectropolarimeters mounted on large optical telescopes.

In case of BeXBs we noted changes in polarisation degree with respect to orbital phase which allowed us to determine orbital parameters of the system. This part of the project is so interesting that the observations will be continued because we were granted an additional 20 hours of observations on the Liverpool Telescope on La Palma to perform more observations of other BeXBs.

Moreover we discovered the optical polarisation changes in the V 0332+53 that follow the X–ray flare observed in this system. The duration of position angle and polarisation degree changes is the same as the duration of the X–ray flare. However, the polarisation changes lag to the X–ray flare by 90 days. It is wort to mention that this target did not show any X–ray activity in more than last seven years. Such an behaviour has been never seen before and needs to be further investigated with respect to theoretical models.

An important side effect of our research is thorough analysis of three year worth of observations of polarimertic standards performed with the Liverpool Telescope. In close cooperation with scientific and technical teams we manage to successfully calibrate the telescope. As a result of the analysis of over hundred thousands photos the database of four polarisation standards polarimetric measurements was created. It has to be used to calibrate the observations so correct results can be obtained.