# Probing the Evolution of Accreting Binary Stars

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## Abstract

The objective of this research project was to use an astronomical observation trip to test a method for directly observing a white dwarf star (an Earth sized star and the end of its life) in a binary star system. (See Fig.1 for example)

## Binary Stars

It has been estimated that 5-10% of all stars are in a binary system, therefore the study of these objects is important in astrophysics. These star systems are some of the brightest in the sky. This is mainly due to mass being accelerated to high speed and glowing by the process of accretion between the stars. If the rate of mass transfer changes the brightness of the star also changes as seen in Fig. 2. Accretion can only occur when the two stars are close enough together so that the system evolves as one.

## Cataclysmic Variables

The stars considered for this project belong to a group called Cataclysmic Variables (CV) stars. These are so called due to the fact that their brightness changes as the rate of accretion changes. Eventually the situation may arise when enough material has transferred such that one star becomes a brown dwarf (a star in which fusion cannot continue).

## Technique

My supervisor Prof. Tom Marsh used this trip to test a new technique to gather information on binary stars. This involved using magnesium (Mg) absorption lines to try to observe the white dwarf in a binary star system. This hasn't been previously possible due to the overwhelming brightness of the accretion disk. This method meant that the stars observed needed to be accreting Mg, however this wasn't always visible due to small amounts of the metal thought to make up these stars. An example spectra of GW Lib is shown in Fig. 4.

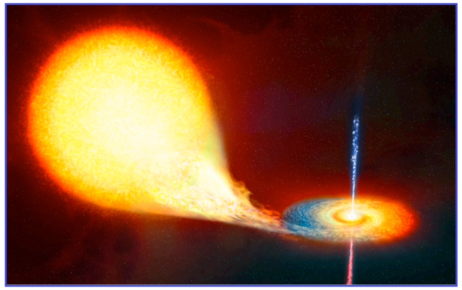

**Figure 1**: An artist's impression of a binary star system. The white dwarf is the smaller star surrounded by an accretion disc.

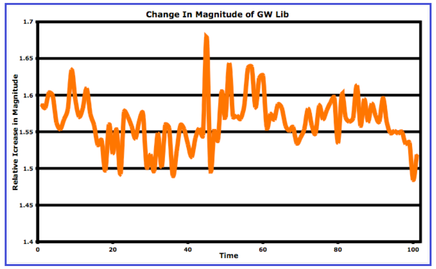


**Figure 2**: The change in brightness of GW Lib over the course of an observation run.

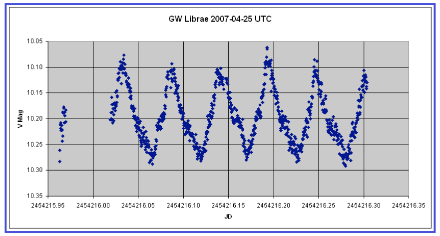


**Figure 3**: GW Lib becomes brighter by almost 10 times during an outburst cycle in April this year. It was observed in July in a quiescent state.

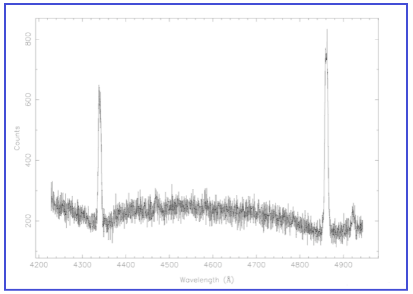

**Figure 4**: A spectrum in blue of GW Lib. The two peaks refer to hydrogen emission which is prevalent in accretion disks.

## Observation Information

The telescope used for this trip was the 4.2m William Herschel Telescope in La Palma, Spain. Over the course of four nights data was taken on seven stars. All of these star systems were thought to be accreting Mg.

## Data Reduction

The process of data reduction removes all effects from the camera, optical imperfections and the sky. The difficulty in this process arises from the need to try to preserve as much possible information from the star as possible. This is the process that my research project mainly concentrated on.

## Conclusion

The mass of the system and also the period of the orbit (Fig. 5) could be found by tracking the movement of the hot spot on the accreting star (Fig. 1). This is the spot from which material is irradiated from the donor star, an image of this can be created using Doppler Tomography (Fig. 6). However, it was not possible to see any Mg lines but for the first time the star was imaged directly.

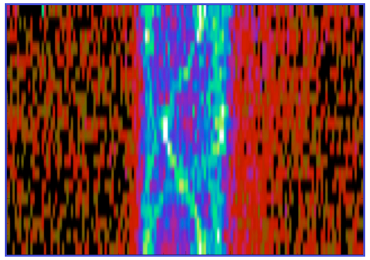

**Figure 5**: A trail of GW Lib, the brighter sinusoidal wave tracks the movement of the companion star, while the fainter wave depicts the irradiation of material. The ratio of the periods of the stars can give the mass ratio.

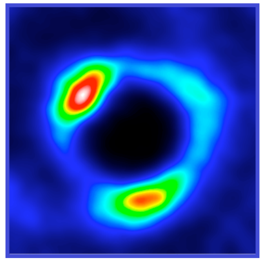

**Figure 6**: A velocity map of the accretion disk of another star; WZ Sge which clearly shows two hotspots. The star cannot be seen on this diagram as it is too faint. The cause of the lower hotspot is a mystery.

## Acknowledgements

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