Gaia22yj Intermediate Polar mCV

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Chapter 1

Introduction

Cataclysmic variables (CVs) are binary systems of stars composed of a white dwarf known as a primary and the companion star called a secondary, which through its roche lobe mass flow to the primary starRobinson [1976]. Magnetic cataclysmic variables (mCV) are evolved semidetached interacting binaries containing a magnetic white dwarf (WD), which accretes material from a Roche lobe-filling red dwarf star. Three categories of mCVs; Polars usually show synchronous rotation of the magnetized white dwarf with the orbital motion of the binary system and have a magnetic field greater than or equal to 10GLittlefield et al. [2023]. This high magnetic field strength causes the accretion stream to flow along the magnetic field lines to its poles, hence no formation of the accretion disk, leading to a synchronous motion. Intermediate polars have less magnetic field(between 1G and 10G, which necessitates the formation of the accretion disc by the mass flow from the companion star, resulting in assynchronous rotation with the orbital period.

Furthermore, intermediate polars emit radiation across X-ray, ultraviolet (UV), and optical wavelengths, with each type of emission arising from distinct physical processes. X-rays are produced by shock heating when high-velocity particles in the accretion flow collide with the white dwarf's surface near its magnetic poles. In contrast, the UV and optical emissions originate from cyclotron radiation, which is generated as a result of the white dwarf's intense magnetic fieldWickramasinghe et al. [1991].

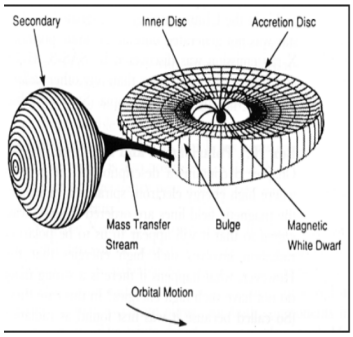

Figure 1.1: Intermediate Polar mCVs

Gaia22yj is a transient magnetic cataclysmic variable discovered in 2022, at a distance approximately 2.5kpc from its parallax of w = 0.34 + or - 0.22 masRodriguez et al. [2025]. It has period of 9.36 minutes. In this project data collected on 15 May 2023 and on 16 May 2023 will be analysed using a software called period04 so as to categorise Gaia22yj as polar magnetic cataclismic (mCV) or intermediate polar (mCV) or eclipsing magnetic cataclysmic variables.

Chapter 2

Results

2.1 Phase diagrams or light curves

To get the phase diagrams of the data provided period04 was used. The data was import to the software separately and the range of frequency of the data was selected depending on nyquist value. On average the range was 0 to 900Hz. The software was run, and the phase diagrams for independent data respective of when it were collected and for the combined as well. At frequency; 154.038416Hz,153.780366Hz and 153.881688Hz for separate data and later combined. The light curves seem to be taking a sunosoidal shape exhibiting a cycle in Julian date.

2.2 Fourier Transform

Fourier transform is a mathematical technique that is used to analyze the dominant periods and frequencies of a signal. In the event that two or periodic signals with different frequencies are present in an astronomical system, spin and orbital frequency may be deduced the same with the spin period and orbital period. From the Fuorier transform plots, considering the frequency of peaks exhibited by the plot period, we can calculate the formula Period =(1 / frequency)(24 *60) hence at frequency 154.038416Hz,153.780366Hz and 153.881688Hz the period is 9.3483 minutes, 9.364 minutes and 9.35784 minutes respectively. Whether the value found is spin period or orbital period is justified in the discussion.

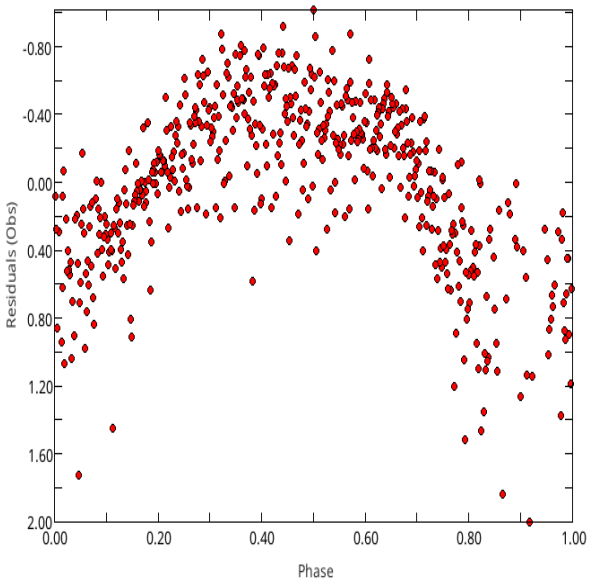

Figure 2.1: light curve of Gaia22jy system using the dat collected on 15 May 2023

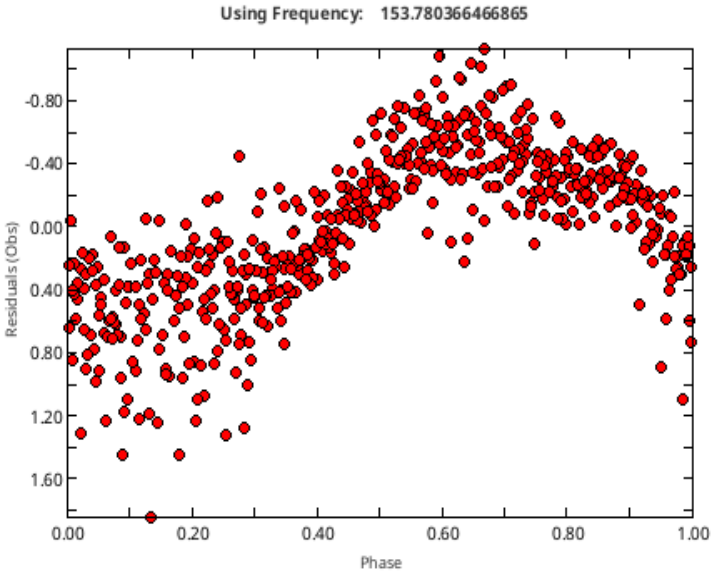

Figure 2.2: light curve of Gaia22jy system using the dat collected on 16 May 2023

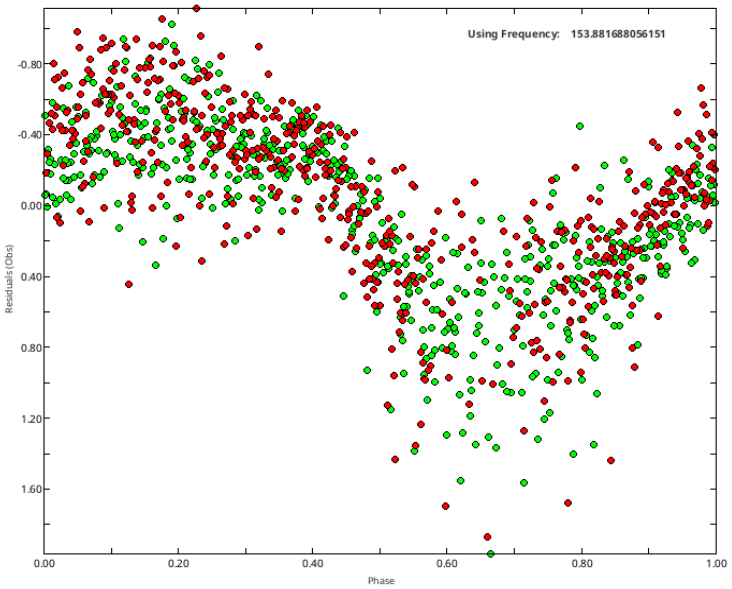

Figure 2.3: light curve of Gaia22jy system using the dat collected on both 15 and 16 May 2023

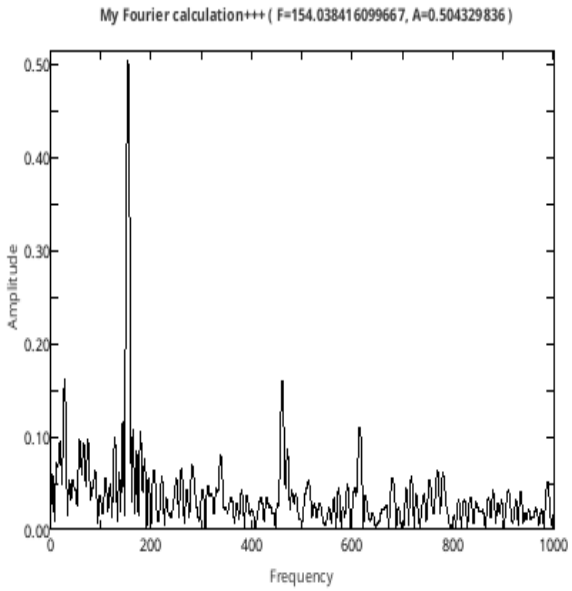

Figure 2.4: Fuorier Transform of Gaia22jy system using the dat collected on 15 May 2023

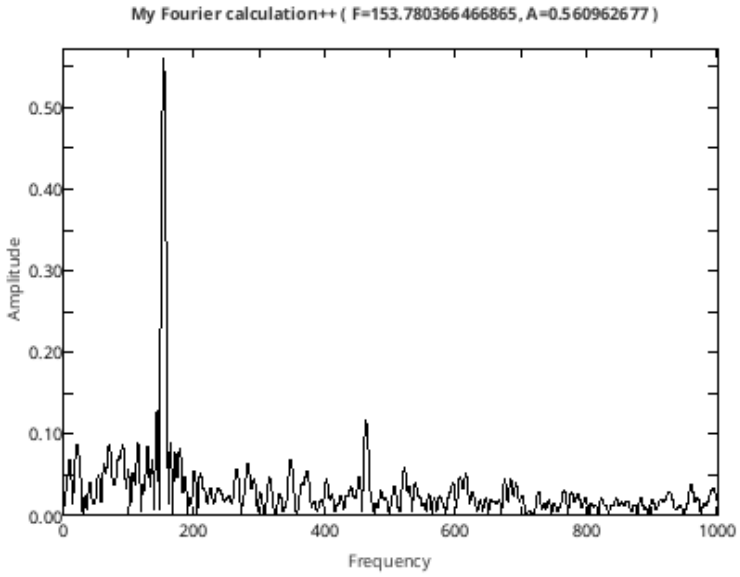

Figure 2.5: Fuorier Transform of Gaia22jy system using the dat collected on 16 May 2023

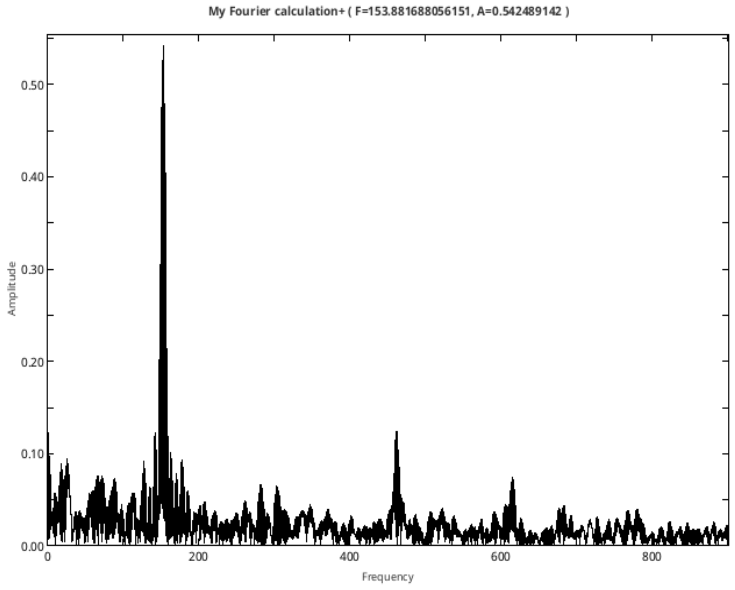

Figure 2.6: Fuorier Transform of Gaia22jy system using the dat collected on both 15 and 16 May 2023

Chapter 3

Discussion of Results

Looking carefully in the three phase diagrams (light curves) of the signal under discussion shows clearly sinusoidal kind of a wave this indicates that this is a binary system of stars with a white dwarf and a companion star but what remains is to characterize it under the magnetic cataclysimic variables(mCVs)Kato [2022].

Criteria for categorizing an mCV to be a polar, intermediate polar, or eclipsing. Polar, the spin period should be equal to orbital period, magnetic field should be greater than or equal to 10MG. Intermediate polar, the orbital period should be greater than spin period but less than 16 minutes, and the magnetic field should be greater than 1MG and less than 10MG. The eclipse of the magnetic field should be less than 1MG, with an orbital period greater than 16 minutes. However, this report does much on the period comparison as a tool to determine that the system is polar, intermediate, or eclipsing; this is so because that is the period04 can manage to analyse.

Literature has it that the mCV under discussion is an interpolar mCv with the spin period 9.36 minutes, and the orbital period is constraint to be within the range of 3.5 to 5.2 hours, on the period of the orbit there is no accurate data to supportRodriguez et al. [2025]. This means that beat frequency can not be deduced. This project has also found that the spin period is the same 9.36 minutes at a frequency of 153.71, this is cross cutting interms of whether the data was analysed separatery or combined. Other parameters were not tested cause the method and approach taken favours only properties (periodicity, phase, frequecies) of how the data behave when plotted or unde goes fuorier analysis.

Chapter 4

Conclusion

The core purpose of the project was to categorise the kind of the system to be polar , intermediate or eclipsing magnetic cataclysmic variables(mCVs). From the introduction where the brief description of mCVs are given then the results where the phase and fuorier transform are shown with high peaks where the frequency for calculating the period are taken. The interesting and unique thing in the fuorier transform diagram the peaks all occur at the same frequency regardless of which data are being used whether independent or combined. The spin period is 9.36 minutes which agrees with the one in the literature. Since the spin period is less than orbital period which is constrained in the range of 3.5 to 5.2 hours then Gaia22jy system is an inter polar magnetic cataclysmic variable.

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