



Spectral Energy Distribution of Flares on the Variable Star WW Cnc

Sudum E*

Department of Physics, Rivers State University, Nigeria

***Corresponding authors:** Sudum Esaenwi, Department of Physics, Rivers State University, Port Harcourt, Nigeria

Research Article

Volume 4 Issue 2

Received Date: July 03, 2026

Published Date: October 26, 2026

DOI: [10.23880/oaja-16000173](https://doi.org/10.23880/oaja-16000173)

Abstract

Here we report on the flaring variable star WW Cnc which was observed with the 0.4m SBIG optical telescope from Las Cumbres Observatory Global Telescope Network remotely on 25/09/2022. The Spectrometry analysis was carried out with the SIMBAD Digital Sky Survey (DSS) menu from the Vizier GUI on the Aladin Software to obtain flux density, flare energy, flare wavelength and flare frequency. The light curve of WW Cnc shows that the source has a strong presence of flares. Hence, we estimated the flare energy, flare wavelength and flare frequency of WW Cnc at peak flares to deduce its spectral energy distribution. From the plot of flux density versus energy of the rotational variable binary star WW Cnc. A peak flare Energy of WW Cnc was measured at 5.66×10^{-1} eV, a flare flux density of 1.48×10^{-1} Jy, a flare energy flux density of 9.25×10^{-11} erg s $^{-1}$ cm $^{-2}$ μ m $^{-1}$ using Aladin software automatic energy generation tool. Similarly, we plotted the flux density versus wavelength of the flaring binary variable star WW Cnc. The source was identified as (V* B WW Cnc) Binary variable star belonging to the family of Rotational Variables with centre right ascension (RA) and declination (DE) for V* B WW Cnc as (090 09' 48.603", +300 25' 36.822") respectively, using a radius of 5 arcsec. From the graph it was deduced that the flare wavelength of WW Cnc was 3.23×10^{-1} μ m using Aladin automated wavelength generation tool. We also plotted a graph of flux density versus frequency of the Rotational Binary Variable Star WW Cnc. The flare frequency obtained for WW Cnc is 2.59×10^4 GHz.

Keywords: Spectroscopy; Flare Energy; Flare Frequency; Flare Wavelength

Abbreviations

LCOGT: Las Cumbres Observatory Global Telescope; CCD: Charged Coupled Device; CDS: Comprehensive Database Service; VLBOI: Very Long Baseline Optical Interferometry; INGOT: Isaac Newton Group of Telescopes; DSS: Digitized Sky Survey; SED: Spectral Energy Distribution; RA: Right Ascension; LCOGTN: Las Cumbres Observatory Global Telescope Network; UV: UltraViolet; IR: Infrared and MHD: Magnetohydrodynamic.

Introduction

The cataclysmic variable star called WW Cancrri or WW Cnc is found in the constellation Cancer. A white dwarf star and its closely orbiting red dwarf companion, make up this binary system. Due to the proximity of the two stars, the white dwarf is accreting matter from the companion star and developing an accretion disk around it. The variability of WW Cancrri makes it a fascinating object to study. It is categorized as a dwarf nova, a type of variable star that experiences irregular brightness outbursts that can last for

days to weeks. The accumulation of material in the accretion disk, which eventually leads to a thermonuclear explosion on the surface of the white dwarf, is thought to be the cause of these outbursts. Important new understandings about the characteristics of cataclysmic variable stars and the activities that take place in accretion disks have come from observations of WW Cancri. For instance, variations in the light curve of WW Cancri have been used to investigate the characteristics of the white dwarf, the structure and dynamics of the accretion disk, and the mechanisms underlying outbursts. During its outbursts, WW Cancri has additionally been observed at X-ray and extremely ultraviolet wavelengths and optically. These observations have identified emission from highly ionized species connected to the accretion process, including helium and nitrogen. In the field of cataclysmic variable stars, WW Cancri is a useful object for research and can shed light on the physical mechanisms that underlie variability in binary star systems.

Literature

Flux, Luminosity and the Inverse Square Law

The radiant flux received from a star, which is the total amount of light energy of all wavelengths that crosses a unit area (detector) oriented perpendicular to the direction of the light's travel per unit time, is how a star's "brightness" is measured in terms of physics. The radiant flux, F measured at a distance, r from the star's center is related to the intrinsic luminosity, L (the energy emitted by the star per unit time), using the equation known as the inverse square law for light, assuming that no light is absorbed on the way to the observer [1].

$$F = \frac{L}{4\pi r^2} \quad (1)$$

Each star is given an absolute magnitude (M), which is defined as the apparent magnitude a star would have if it were situated at 10pc, using equation 1. The flux ratio of two stars is given by equation 2 because, as captured in equation 2, a difference of 5 apparent magnitudes corresponds to a brightness difference of 100 as captured in equation 2.

$$\frac{F_1}{F_2} = 100^{\left(\frac{m_1 - m_2}{5}\right)} \quad (2)$$

Mixing equations 1 and 2 for the case of a single star seen from two different distances (10pc and D), one can easily do this

$$m - M = 5 \log_{10} \left(\frac{D}{10} \right) pc \quad (3)$$

According to Carroll and Ostlie [1], the equation connects the star's distance (D), apparent magnitude (m),

and absolute magnitude (M). This equation is known as the distance modulus equation.

Determination of Binary Star Temperature and Size

A star's surface temperature can be calculated by combining the results from two different filters from U (ultraviolet, 364 nm), B (blue, 442 nm), and V (visible, 540 nm) filters. Additionally, the temperature and surface area of a star are two of its attributes that are related to luminosity. The hotter star will emit more radiation if their surface areas are equal. The star with a larger surface area will radiate more energy than a star with a similar temperature [2]. A star's surface area is proportional to the square of its radius hence, equation 4 gives the star's luminance.

$$L = 4\pi R^2 \sigma T^4 \quad (4)$$

where T is the star's surface temperature in Kelvin, σ is the Stefan Boltzmann constant, R is the star's radius in meters, and L is its luminosity in watts. If we attempt to determine the ratio of another star's radius to that of our sun, the calculation becomes a little bit simpler. Assume that the sun's luminosity is LS , the AO Ser star's luminosity is L , the sun's temperature is TS , the WW Cnc star's temperature is T , the sun's radius is RS , and the WW Cnc star's radius is R . The ratio of their radius can then be expressed as described in equation 5 [2].

$$\frac{R1}{R2} = \frac{\left(\frac{T}{T_s}\right)^2}{\left(\frac{L}{L_s}\right)^{0.5}} \quad (5)$$

To find the ratio L/LS , we can make use of the absolute magnitudes of the star given by Chika et al., [2].

$$\frac{L}{L_s} = 2.51^{\Delta M} \quad (6)$$

where ΔM is absolute magnitude of the WW Cnc minus absolute magnitude of the sun ($M - MS$). Absolute magnitude is calculated using equation 7 [3].

$$M = (m + 5) - 5 \log \left(\frac{1}{p} \right) = (m + 5) - 5 \log d \quad (7)$$

where M is absolute magnitude, m is apparent magnitude and $d = 1/p$, and p is the star parallax in arcsec [4].

Stellar Flares

Stellar flares are brief bursts of light that are typically associated with stars. They can last anywhere from a few minutes to a few hours and have a dramatic increase in brightness over a wide spectrum of wavelengths, from X-rays

to radio waves. A slow decay that lasts anywhere between minutes and hours occurs after the brightness rises quickly [5]. Sun flares are brought on by energy released during the reconnection of magnetic field lines in the stellar core, which then convects into the outer atmosphere. These events cause the acceleration of energetic particles deeper into the atmosphere, which causes emission ranging from X-rays to radio waves [6].

According to Güdel and Nazé [7], flares in active M dwarfs are frequently 10-1000 times more energetic than solar flares and qualitatively distinct in several ways. Although our knowledge of these flares is very limited, it is believed that the underlying mechanism is very similar to that of the Sun. The average solar flare has an energy of around 10²⁹ erg, while the most powerful flares have an energy of around 10³¹ erg. The superflares' estimated energies fall between 10³⁵ and 10³⁹ erg. Super flares, according to Rubenstein and Schaefer [8], may result from magnetic reconnection in magnetic field lines that connect the star's atmosphere to its core. Ip, et al. [9]. Rubenstein close companion on nearby star activity has been discussed by Cuntz, et al. [10] and Lanza [11].

Materials

To conduct Spectro-Photometric study of the target variable stars, the following tools described below were used.

Telescope

The Las Cumbres Observatory Global 0.4m SBIG Optical Telescopes and the Las Cumbres Observatory Global Telescope (LCOGT) Observing portal are good tools for observing variable stars and gathering their photon counts for analysis because of their adequate aperture and magnification capability. The telescope, a very long baseline optical interferometer, has a steady motorized mount for accurate local and remote star tracking. The only access point for using the telescope is locally or remotely using a telescope's observing time which is very significant to the observer.

Charged Coupled Device (CCD) Camera

The primary purpose of this excellent, cooled camera, which is mounted on the LCOGT to work in synergy with the motorized mount is to take precise, high-definition images of the variable stars under consideration [12]. The camera has many pixels and a wide dynamic range, allowing it to capture the spectral data required for this study [13].

Filters: to isolate wavelengths and spectral bands for the spectro-photometry study of WW Cnc, the V and B-filters

are crucial filters [14]. This will help with the investigation of the flare behavior of the stars and the spectral energy distribution of the flares. Light pollution filters can help enhance the quality of observations by lessening the effect of light pollution on the data that is captured in areas where there is significant light pollution from background stars [15].

Computer and Software

Rivers State University's Department of Physics is equipped with a fast computer (HP Pavilion NB-0007 Intel-Iris Graphics/Core i5 Computer) and astronomical programs that can process and analyze images. These programs include the DS9 version 7.6, Aladdin version 11.0, IRIS version 5.59, Python version 3.9, Python Jupyter notebook, Astronomy Database Service (CDS) portal, VizieR portal, SIMBAD portal, and AAVSO portal. Software is required for accurately recording, processing, and analyzing the spectro-photometry data.

The VizieR Graphical User Interface Spectrograph:

This is required to break down light into its individual wavelengths and to collect precise data on Aladin's spectral energy distribution. The Aladin VizieR GUI spectrograph is the best option because it fits my research goal [16].

Methods/Observations

The data acquisition of WW Cancr was from the Las Cumbres Observatory Global Telescope Spectrometer and the Las Cumbres Observatory Global Telescope Photometer through direct and remote observations from University of Durban, South Africa and Rivers State University, Port Harcourt Nigeria. The data reduction and analysis were done using the Spectro-Photometric methods.

Stellar Identification

Stellar identification is a challenging but crucial task required to complete a successful observation project in optical astronomy among the billions of stars in a section of the sky surveyed for observation. This observation began with the determination of observable targets by using the professional Astronomy Comprehensive Database Service (CDS) and concentrating on three constellations, namely Serpente, Aquarius, and Cancer [17].

Google Chrome was used to access the query portal by going to the official CDS website. At no charge to the researcher, this database offers an exhaustive bibliography of the information gathered from various scientific publications and information on previously observed stars. The targets were chosen by searching the CDS portal's VizieR

catalog. The link can also be accessed directly or via the CDS portal by using a Google search, as have been done here. A specific observable variable star (WW Cnc) was selected for observation which forms the foundation and focus of this study (Wenge).

Stellar Address Identification

After confirming the target source's observability, the stellar addresses were identified by also querying the CDS database to learn more about the source's specifics; as a result, the following steps were taken for CDS search: To access the CDS database, the search engine Google Chrome was launched from where the target name was typed in its Astronomy Comprehensive Database Service. After that, the VizieR feature on the CDS portal was activated.

For stellar reference and comparison, it is necessary to compile a list of variable stars that have already been seen through optical telescopes throughout the Astronomy global family. In order to generate the target's correct coordinates (Right ascension, Declination, and Julian date, also known as stellar address), the target name was entered into the vizier catalogue in the "find catalogue among" search box. In order to search the catalog for the stellar parameters, I clicked the "Find" icon on the graphical user interface and furthermore entered the constraint (≥ 9 & ≤ 12.5) to get the target star's maximum brightness (Mag-Max) magnitude.

However, there is no need for a space between constraints. The required threshold for eclipse in binary stars, (≥ 0.8), was first entered without any space between the constraints to determine the depth of the stellar eclipse at primary minimum A1. To obtain the duration in hours, it is customary to calculate this duration quantitatively by multiplying the stellar phase obtained from observation by a factor of 1000, (the standard for the Las Cumbres Observatory Telescope). The target (WW Cnc) magnitude at maximum brightness (Mag-Max) was verified using the SIMBAD GUI from the CDS database to ensure that only light from stars within the variable domain are detected by the photometer and spectrometer.

To create an image of the variable star and its contrasting companions, the Aladin software was launched and its interactive tools used to run the analysis on the stellar data. However, because the field of view (FOV) will be over saturated by light from background sources, Aladin was seriously needed to check the target's observability to avoid over saturation. To query the CDS data base for the variable star WW Cancr under consideration, similar procedure was all adopted. Within the months of September to December 2022, these targets were all observed with the 0.4m LCOG Optical telescopes using a Very Long Baseline Optical

Interferometry (VLBOI) network in South Africa, which was remotely accessible from Nigeria afterwards. From the above procedure, the following properties were obtained and applied to the observation of all the variable stars [18].

WW Cancr (WW Cnc) Observation parameters

Observer: SUDUM ESAENWI

Target Name: WW Cancr

Period: 15.583 hours

Exposure time: 90s

Minimum number of images requested: 200 images, with a cadence of 45min

Number of images returned from ASTROLAB for V-Filter = 179

Number of failed images = 21

Number of images requested from ASTROLAB for B-Filter = 100

Number of images returned for B-Filter = 70

Number of failed images = 30

Telescope time allocated: 2hrs for V and B filter

Right Ascension (RA) = 137.45251176995

Declination (DEC) = 30.42689504164

No constraint with LCO telescopes because all constraints for eclipsing variables are already built into the telescope programming sensors.

Magnitude of star at maximum brightness: ≥ 9 & ≤ 12

Check for Target Visibility

The target query online calculator created by the Isaac Newton Group of Telescopes (INGOT) located in the Canary Islands of Spain was used to map the availability of the focus target in the night sky and its visibility free of atmospheric disturbances. This enabled the research to confirm that the focus target was observable. By inputting "catserver.ing.iac.es" into Google website, the visibility tool portal was accessed remotely. The two active modes for this target visibility are Staralt and Starobs. To request telescope observation time, the Staralt mode was used to determine whether the desired targets would be observable during the specified dates of observation. To ensure that the portal dialogue produced accurate results, a thorough check was performed to ensure that crucial parameters like the Moon position, Moon phase, and value of the airmass were properly inserted. Specifically, the Starobs mode was used to retrieve the target's maximum visibility for a period of six months (March 2022–September 2022) before using the 'Send' button on the Starobs interactive graphical user interface to create a plot of the visibility of all the targets being considered during this time of observation. The Las Cumbres Global Observatory Visibility tool, created by the LCOGT team and hosted on their telescope portal to improve easy usability of these robust-remote robotic telescopes, was activated to make sure that the target visibility prediction was extremely accurate.

Check for Target Field of View (FOV) Saturation

Tests for the brightness of the binary companions, comparative stars, or background stars were also carried out during observation to make sure that the chosen target is not over saturated by light from background stars. To make sure that the field of view is not oversaturated and that only light from the target object is being captured for the photometric and spectrometric analysis, the target source relative to all comparative stars were captured in the observation parameters. For each stellar measurement that is acceptable by the CDS database analysis standard, a minimum of 3 comparative stars were selected for WW Cnc, that are relatively close to these focus target. These comparison stars were chosen in consideration of the background stars that were present in our telescope's field of view (FOV) as seen in the image created by DS9 software during the photometric sky survey. The largest angular size that can be seen through an optical system is called the field of view (FOV).

Connecting with LCO Observation Portal

To automate the telescope for remote observation and data logging to our email, we first accessed the LCO's Observation Portal by typing LCO observation home Portal into Google website, which directed us there. A personal user account was created on the LCO portal using my information and a working email to ensure that data of all completed observation was sent to me directly. The LCO website GUI was carefully accessed by clicking on the sizable green "Register an Account" button and then filled out the registration form in accordance with the guidelines provided on the observing portal. Then click the "Register" icon after providing a username and password that were entered into the USERID header variable to allow access to any data that would be acquired for an approved proposal. My personal email address, which was entered on the registration page for the observation portal, then received confirmation. Additionally, a link to the LCO portal was sent to my email, where it was activated and made available for use.

Methods of Spectroscopy Using Aladin for Spectrum and Spectral Energy Distribution

Spectroscopic stellar identification of the binary star and that of the comparison stars were done with Aladin software to allow us to visualize the digitalized astronomical images

superimposed entries from astronomical catalogue in the database. The AstroLab computers with window version 11.0 of the Aladin Software was launched and the option 'File' was initiated to open the 'Load directory' URL of the Aladin GUI. The Digital Sky Survey (DSS) menu was activated from the Aladin GUI on the Left-hand side of the software pane view. The DSS pane on the European Space Observatory ESO platform for Garching/Deutschland-DSS.ESO was launched and the process adopted for WW Cnc.

For the digital stellar identification analysis, the target name e.g 'WW Cnc' was entered for all variable stars under consideration. The SIMBAD application for the digital sky survey on the RHS of the software pane view of the Aladin GUI was also launched to modify the radius as 15' followed by clicking on 'Display Filter'. The dialogue box 'Star' was activated because the analysis is specifically on stars and not any other source and finally the data was submitted.

The variable target star WW Cnc automatically popped-up. The data were automatically extracted and processed by Aladin.

Spectral Energy Distribution Analysis for Flare Energy, Flare Wavelength and Flare Frequency Production

For the Spectral Energy Distribution analysis, the VizieR GUI on the Aladin Software was activated to obtain flux density, energy density, Target Right Ascension (RA) and Declination (DE in Julian date, frequency, and wavelength of WW Cnc for further analysis [19]. The VizieR plot of the target was processed on the Aladin GUI to obtain the Spectral Energy Distribution (SED) data from the Aladin software which is a plot of brightness or flux density (power) against the frequency or wavelength from a target.

The light curves of the continuum flux of the star and the spectral signatures of the target produces all parametric information needed from the target. The astropy api codes in python program was written to run the spectral analysis of the source and produce the light curve and spectral stellar parameters for WW Cnc. Python version 2022 was used to generate the Spectral energy distribution curve and for the spectral analysis of the flare energy, wavelength and frequency for WW Cnc [20-23].

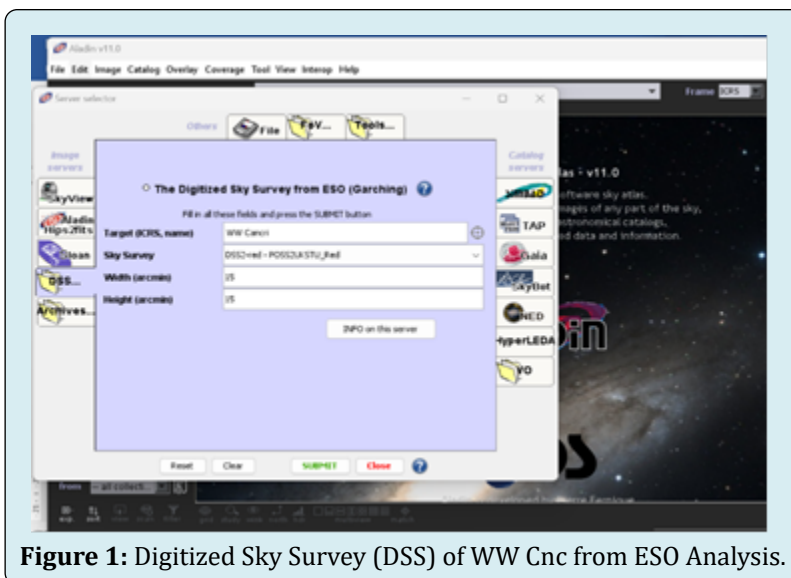


Figure 1: Digitized Sky Survey (DSS) of WW Cnc from ESO Analysis.

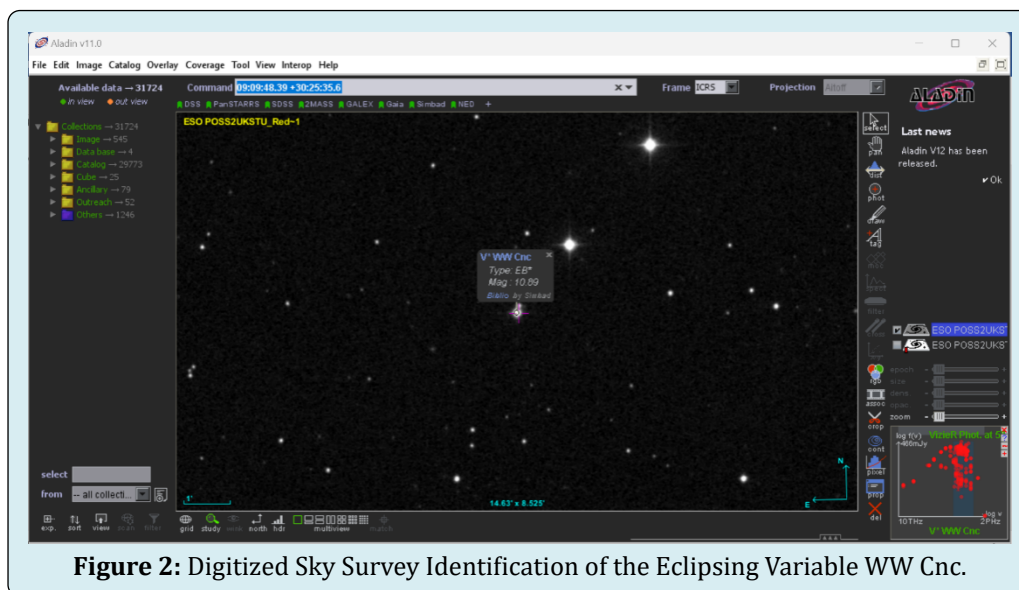


Figure 2: Digitized Sky Survey Identification of the Eclipsing Variable WW Cnc.

Results

Flare Energy, Flare Wavelength and Flare Frequency Production for WW Cnc

For WW Cnc, from our Vizier GUI on the Aladin Software data reduction, the flux density, energy density, Target Right Ascension RA and Declination DE in Julian date, frequency, and wavelength of WW Cnc were obtained. Table 1 shows an abstract of the data distribution collected from spectrometry database of Vizier observed by LCO. Column 1 is the right ascension of WW Cnc in Julian date, column 2 is the target declination in Julian date, column 3 is the spectral energy distribution frequency (GHz), column 4 is the target spectral wavelength (μm), column 5 is the target spectral energy

distribution flux density (Jy) and column 6 contains the spectral energy distribution flux-energy (Jy) [24].

From the Table 1, the plots are spectroscopic graph of flux density (Wm^{-2}) for WW Cnc against wavelength in micrometre μm -1, Flux density $F(\nu)$ Jy for WW Cnc vs Frequency GHz, and Flux Energy Density $F(\lambda)$ $\text{erg.s}^{-1}\text{cm}^{-2}$ μm^{-1} for WW Cnc Vs Flare Energy of WW Cnc, to deduce the values of the spectral energy distribution (SED) data of WW Cnc were obtained from the Aladin software which is a plot of brightness or flux density (power) against the frequency or wavelength from a target. The light curve of the continuum flux of the star and the spectral signatures of the target produces all parametric information needed from the target.

S/N	RA (deg)	DE (deg)	Sed_Freq (GHz)	Wavelength (μm)	Sed_Flux (Jy)	Sed_Eflux (Jy)
1	239.5769635	17.26954351	541.43e+3	5.54e-1	0.133	0.102
2	239.5769635	17.26954351	563.63e+3	5.32e-1	0.106	0.017
3	239.5769635	17.26954835	713.28e+3	4.20e-1	0.118	0.011
4	239.576975	17.269775	563.63e+3	5.32e-1	0.141	0.045
5	239.576975	17.269775	713.28e+3	4.20e-1	0.118	0.024
6	239.5767053	17.26944024	138.55e+3	2.16e+0	65.6e-3	1.1e-3
7	239.5767053	17.26942368	181.75e+3	1.65e+0	96.4e-3	2.1e-3
8	239.5767053	17.26944024	241.96e+3	1.24e+0	0.121	0.002
9	239.5767015	17.2694489	138.55e+3	2.16e+0	65.6e-3	0.008
10	239.5767015	17.2694489	1.82e+05	1.65e+0	96.4e-3	0.045
11	239.5767015	17.2694489	241.96e+3	1.24e+0	0.121	0.006
12	239.5767014	17.2694489	138.55e+3	2.16e+0	65.6e-3	0.445
13	239.5767014	17.2694489	181.75e+3	1.65e+0	96.4e-3	0.235
14	239.5767014	17.2694489	241.96e+3	1.24e+0	0.121	0.345
15	239.5767072	17.26943841	138.55e+3	2.16e+0	65.6e-3	1.1e-3
16	239.5767072	17.26943841	181.75e+3	1.65e+0	96.4e-3	2.10e-3
17	239.5767072	17.26943841	241.96e+3	1.24e+0	0.121	0.002
18	239.5767072	17.26943841	541.43e+3	5.54e-1	0.130	0.007
19	239.5767072	17.26943841	563.63e+3	5.32e-1	0.141	0.012

Table 1: Spectral Energy Distribution analyzed data of WW Cnc from VizieR.

The spectral energy distribution (SED) data of WW Cnc from the Aladin software which is a plot of brightness or flux density (power) against the frequency or wavelength from a target were all obtained. The light curve of the continuum flux of the star and the spectral signature of the target shows clearly all parameters information needed to understand WW Cnc [25].

Stellar Observations

The photometric and spectrometric results from observation and analysis of WW Cnc data was presented here. Figure 3 is an LCO observation portal for completed observation while Figure 4 is the stellar identification field of view with all three comparative stars needed for background separation.

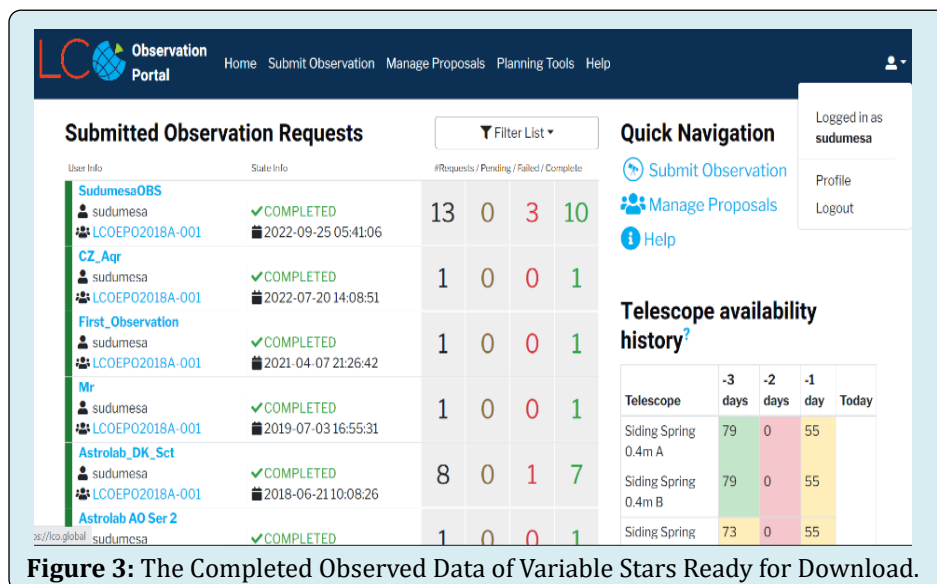


Figure 3: The Completed Observed Data of Variable Stars Ready for Download.

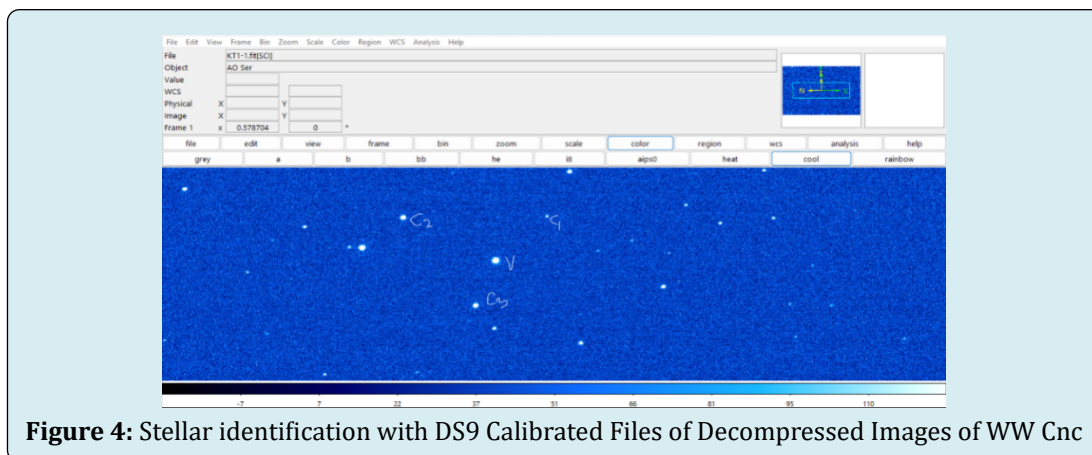


Figure 4: Stellar identification with DS9 Calibrated Files of Decompressed Images of WW Cnc

Discussion

Spectrum for Spectral Energy Distributions (SED)

The details of the spectrum of all observed variable stars are clearly shown in figure 5 -7 to estimate the amount of energy emitted by the star at different wavelengths of light. The SED was measured by analyzing the spectrum of the variable star, which shows the intensity of light at different wavelengths to deduce energy, wavelength and frequency of the flares emitted [26].

Spectral Energy Distribution of WW Cnc

Figure 5 is the plot of flux density versus energy of

the rotational variable binary star WW Cnc. A peak flare Energy of WW Cnc was measured at 5.66×10^{-1} eV, a flare flux density of 1.48×10^{-1} Jy, a flare energy flux density of 9.25×10^{-11} erg s $^{-1}$ cm $^{-2}$ μ m $^{-1}$ using Aladin software automatic energy generation tool. Figure 6 is the plot of flux density versus wavelength of the flaring binary variable star WW Cnc. The source was identified as (V* B WW Cnc) Binary variable star belonging to the family of Rotational Variables with centre right ascension (RA) and declination (DE) for V* B WW Cnc as (090 09' 48.603", +300 25' 36.822") respectively, using a radius of 5 arcsec. From the graph it was deduced that the flare wavelength of WW Cnc was 3.23×10^{-1} μ m using Aladin automated wavelength generation tool. Figure 7 is the plot of flux density versus frequency of the Rotational Binary Variable Star WW Cnc. The flare frequency obtained for WW Cnc is 2.59×10^4 GHz.

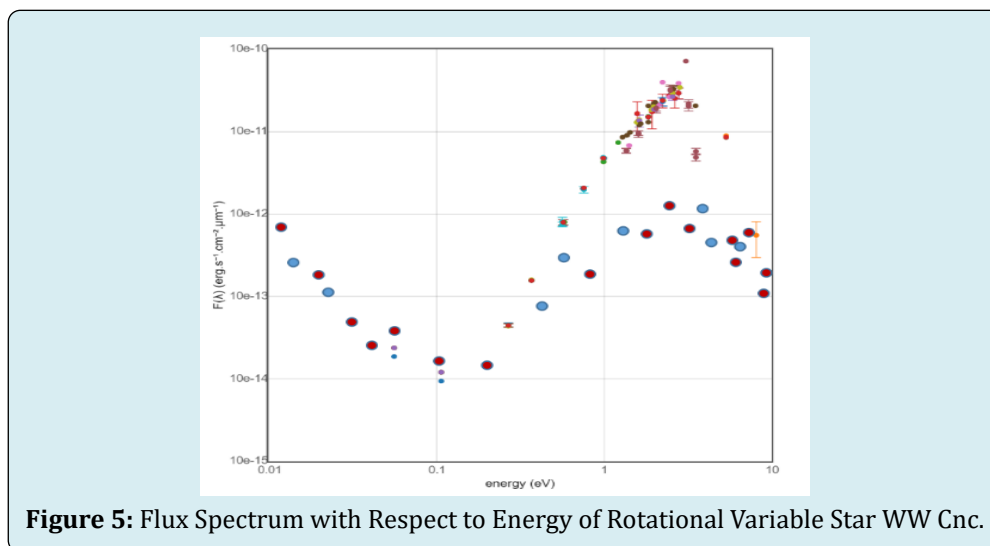


Figure 5: Flux Spectrum with Respect to Energy of Rotational Variable Star WW Cnc.

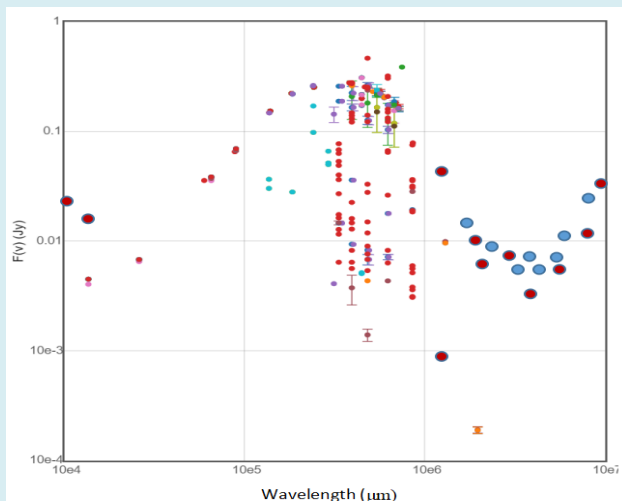


Figure 6: Flux Spectrum with Respect to Wavelength of Rotational Variable Star WW Cnc.

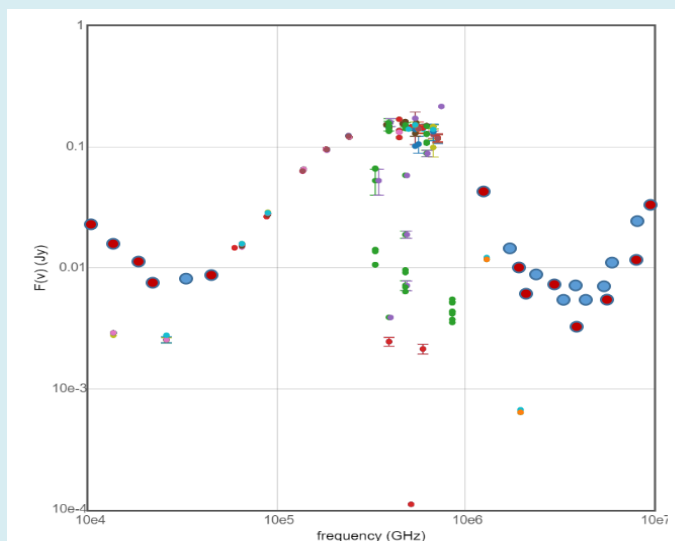


Figure 7: Flux Spectrum with Respect to Frequency of the Rotational Variable Star WW Cnc.

The analysis of the spectral energy distribution (SED) of the variable star WW Cnc has provided clear evidence that this system is highly active and magnetically dynamic. Observations made with the 0.4 m SBIG optical telescope of the Las Cumbres Observatory Global Telescope Network (LCOGTN) captured multiple flare events on the star's light curve, indicating strong variations in brightness caused by energetic outbursts. These flares are characteristic of rotational binary systems where close stellar companions interact magnetically, and they play a key role in shaping the observed SED of the star.

Through spectrometric analysis using SIMBAD DSS and Vizier tools in the Aladin software, we measured several physical parameters that describe the energy distribution of

WW Cnc. The peak flare energy of 5.66×10^{-1} eV, flare flux density of 1.48×10^{-1} Jy, and energy flux density of 9.25×10^{-11} erg s $^{-1}$ cm $^{-2}$ μm $^{-1}$ reveal that the star emits significant energy during flare peaks. These flares introduce strong and temporary enhancements in the star's total radiative output, which appear as spikes in its spectral energy curve.

When the flux density was plotted against wavelength, the flare wavelength of 3.23×10^{-1} μm was identified, placing the emission in the ultraviolet (UV) region of the electromagnetic spectrum. This suggests that the dominant energy output during flare activity occurs at relatively short wavelengths, which are associated with high temperatures and intense magnetic heating in the stellar atmosphere. The corresponding flare frequency of 2.59×10^4 GHz further

supports the presence of strong UV radiation and high-frequency emission components during active phases.

These results show that WW Cnc's SED is not static but rather fluctuates as flare events occur. The energy output shifts toward higher frequencies and shorter wavelengths during periods of magnetic activity, demonstrating how flaring significantly affects the star's overall spectral profile. The star's variability can therefore be understood as the result of periodic and impulsive magnetic reconnection events that heat plasma and emit radiation across a wide spectral range.

The consistency between our derived parameters and the catalogued data for variable star WW Cnc (RA 09h 09m 48.603s, Dec +30° 25' 36.822") validates both the observational methods and the computational tools used. The Aladin software's automated wavelength and energy generation functions proved effective in quantifying the SED changes that occur during flare activity. The findings are in line with what is known about rotationally modulated binary stars, which show energy redistribution caused by fast rotation, tidal effects, and magnetic coupling between the components.

In the broader astrophysical context, studying the SED of WW Cnc contributes to understanding how energy is released and distributed in magnetically active binaries. The data suggest that while WW Cnc is not among the most extreme "superflare" stars, it does experience repeated, moderate flares that significantly reshape its spectral output. These events likely play a continuous role in maintaining the system's energy balance and in influencing the structure of its outer atmosphere.

Overall, the results indicate that the spectral energy distribution of WW Cnc is dominated by variable flare emissions that peak in the ultraviolet region, with the optical and infrared contributions varying according to flare strength and duration. The balance between quiescent and flaring states defines the energy output of this binary system and reflects the operation of a strong magnetic dynamo mechanism driven by stellar rotation and binary interaction [27].

Conclusion

The study of the spectral energy distribution in the variable star WW Cnc has revealed that this system exhibits significant energy variation across wavelengths because of its magnetic activity and flare behavior. Using the Las Cumbres Observatory's 0.4 m SBIG optical telescope for observations and analysing the data through Aladin, SIMBAD DSS, and VizieR, we obtained quantitative information about how the

star's radiation changes with time and frequency.

The derived parameters including a peak flare energy of 5.66×10^{-1} eV, flare flux density of 1.48×10^{-1} Jy, flare energy flux density of 9.25×10^{-11} erg s⁻¹ cm⁻² μm⁻¹, flare wavelength of 3.23×10^{-1} μm, and flare frequency of 2.59×10^4 GHz clearly describe a system whose energy output increases sharply during flares, shifting toward higher frequencies and ultraviolet wavelengths. This behavior demonstrates that the SED of WW Cnc is heavily influenced by short-term magnetic activity, rather than steady-state radiation alone.

The variation of flux across wavelengths confirms that magnetic reconnection events are the main drivers of energy release in WW Cnc. Each flare temporarily alters the SED, producing intense radiation at shorter wavelengths before the system gradually returns to its quiescent state. Such energy redistribution patterns are typical of chromospherically active binary systems and help explain the photometric variability observed in this star.

This research shows that combining remote photometric observation with digital spectral analysis tools is a reliable way to map the spectral energy distribution of variable stars. It highlights how multi-wavelength data can uncover the connection between stellar magnetic processes and observable energy output.

In summary, the spectral energy distribution of WW Cnc reveals that its variability is driven by magnetic flaring activity that peaks in the ultraviolet region. The results confirm WW Cnc as a moderately energetic flaring binary star with strong but stable magnetic processes that shape its energy emission profile. Future studies that include long-term, multi-wavelength monitoring especially in ultraviolet and infrared bands—would help track how its SED evolves over time and provide deeper insight into the magnetic and thermal structure of similar variable stars.

Acknowledgements

I would like to express my deepest gratitude to the Las Cumbres Observatory Global Telescope Network (LCOGTN) for making it possible to observe the variable star WW Cnc remotely through their 0.4 m SBIG optical telescope. My sincere appreciation goes to the brilliant minds behind the Aladin Sky Atlas, SIMBAD, and VizieR databases. Their dedication to creating powerful, user-friendly tools allowed me to explore the spectral behavior of WW Cnc with precision and confidence. I also wish to thank the broader community of astronomers and data scientists who continually share their discoveries and expertise.

Recommendations

1. Extended Multi-Wavelength Monitoring

Future observations of WW Cnc should cover a broader wavelength range especially in the ultraviolet (UV) and infrared (IR) regions. Since the current analysis indicates that most flare activity peaks around $0.323\ \mu\text{m}$ (in the UV band), continuous UV and near-IR monitoring will help provide a more complete spectral energy distribution and reveal how energy shifts across different bands during both active and quiescent phases.

2. High-Cadence Photometric Observations

The variability of WW Cnc occurs on short timescales, suggesting that high-cadence photometric data (shorter exposure intervals) would capture the rapid rise and decay phases of flares more accurately. Instruments capable of millisecond-level time resolution should be employed in future campaigns to resolve the fine structure of flare events and improve SED modeling.

3. Modeling Magnetic Activity and Binary Interaction

Since WW Cnc is identified as a rotational binary variable, modeling of its magnetic field structure and binary orbital parameters should be pursued. Magnetohydrodynamic (MHD) simulations could provide insight into how the interaction between the two stellar components triggers flare activity and alters the observed SED.

References

- Carroll B, Ostlie D (2017) *An Introduction to Modern Astrophysics*. 2nd(Edn.), Cambridge University Press, UK 678.
- Chika CO, Michael CO, Frances NA (2022) Photometric Study of an Eclipsing Binary Star AO Serpentis. *Astronomical Society of Nigeria (PASN) 001*: 1-10.
- Torres G, Andersen J, Giménez A (2010) Accurate masses and radii of normal stars: modern results and applications. *The Astronomy and Astrophysics Review 18*(1-2): 67-126.
- Brown TM (2014) *An Introduction to Close Binary Stars*. Cambridge University Press, UK.
- Balona LA (2012) Kepler observations of flaring in A-F type stars. *Monthly Notices of the Royal Astronomical Society 423*(4): 3420-3429.
- Benz AO, Güdel M (2010) Physical Processes in Magnetically Driven Flares on the Sun, Stars, and Young Stellar Objects. *Annual Review of Astronomy and Astrophysics 48*: 241.
- Güdel M, Nazé Y (2009) X-ray spectroscopy of stars. *The Astronomy and Astrophysics Review 17*(3): 309-408.
- Rubenstein EP, Schaefer BE (2000) Superflares on Ordinary Solar-Type Stars. *Astrophysical Journals 529*(2): 1031.
- Ip Wing-Huen, Kopp A, Hu JH (2004) On the Star-Magnetosphere Interaction of Close-in Exoplanets. *Astrophysical Journal 602*(1): 53.
- Cuntz M, Saar SH, Musielak ZE (2000) On Stellar Activity Enhancement Due to Interactions with Extrasolar Giant Planets. *Astrophysical Journal ApJ 533*(2): 15.
- Lanza AF (2008) Hot Jupiters and stellar magnetic activity. *Astronomy and Astrophysics 487*(3): 1163-1170.
- Janesick JR (2001) *Scientific Charge-Coupled Devices* (SPIE Press). Comprehensive reference on CCD physics and performance.
- Howell SB (2006) *Handbook of CCD Astronomy*. 2nd(Edn.), Cambridge University Press, UK.
- Bessell MS (1990) UBVRI passbands. *Publications of the Astronomical Society of the Pacific 102*(656): 1181-1199.
- Fukugita M, Ichikawa T, Gunn JE, Doi M, Shimasaku K, et al. (1996) The Sloan Digital Sky Survey photometric system. *The Astronomical Journal 111*(4): 1748-1756.
- Ochsenbein F, Bauer P, Marcout J (2000) The VizieR database of astronomical catalogues. *Astronomy & Astrophysics Supplement Series 143*: 23-32.
- Brown AGA, Vallenari A, Prusti T, Bruijine de JHJ, Babusiaux C, et al. (2021) Gaia Early Data Release 3: Summary of the contents and survey properties. *Astronomy & Astrophysics 649*.
- Wenger M, Ochsenbein F, Egret D, Dubois P, Bonnarel F, et al. (2000) The SIMBAD astronomical database. *Astronomy & Astrophysics Supplement Series 143*(1): 9-11.
- Maehara H, Shibayama T, Notsu S, Yuta N, Takashi N, et al. (2012) Superflares on solar-type stars. *Nature 485*(7399): 478-481.
- Davenport JRA (2016) The Kepler catalog of stellar flares. *The Astrophysical Journal 829*(1): 23.
- Boch T, Fernique P (2014) The Aladin interactive sky atlas: visualizing and accessing astronomical data.

Astronomy & Astrophysics.

Pacific 125(931): 1031-1051.

22. Bayo A, Rodrigo C, Barrado y Navascués D, Solano E, et al. (2008) VOSA —the Virtual Observatory SED Analyzer: building and fitting spectral energy distributions using VO services. *Astronomy & Astrophysics* 492(1): 277-287.
23. Onuchukwu, CC, Umezuruike VA, Anekwe F (2021) Photometric study of an eclipsing binary star WW Cancr, pp: 1-11.
24. Brown TM, Baliber N, Bianco FB, Bowman M, Burleson B, et al. (2013) Las Cumbres Observatory Global Telescope Network. *Publications of the Astronomical Society of the Pacific* 125(931): 1031-1051.
25. Pickles A, Hjelstrom A, Boroson T, Burleson B, Conway P, et al. (2014) LCOGT network observatory operations. *SPIE* 9149.
26. Robitaille TP, Tollerud EJ, Perry G, Michael D, Erik B, et al. (2013) Astropy: a community Python package for astronomy. *Astronomy & Astrophysics* 558: A33.
27. Price-Whelan AM, Sipőcz BM, Günther HM, Lim PL, Crawford SM, et al. (2018) The Astropy Project: building an open-science project and status of the v2.0 core package. *The Astronomical Journal* 156(3): 123.