The 2007 Outburst of GW Librae

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What is a Dwarf Nova?

Cataclysmic variables are a type of close binary system consisting of a primary white dwarf star that accretes hydrogen-rich material from a secondary star that overflows its Roche lobe. In a dwarf nova system, material builds up in the white dwarf, eventually triggering thermonuclear runaway, which leads to a nova explosion. There is a certain class of dwarf novae that experiences a high amplitude frequency signal known as the "superhump." It is caused by perturbations in the accretion disk of the primary star due to the gravitational influence of the secondary. The primary star experiences a precession and the secondary transits to the line of apsides with a longer period than the orbital period. This longer period is the superhump period.

Energetics

Analysis of the light during outburst produced the following values for parameters of the system:

Parameter	Value
q	0.068(5)
M_{sec}	$0.057(5) M_\odot$
M_{wd}	$0.84\ M_\odot$
R_{wd}	6×10^8 cm
L_{bol}	$8(\pm 2) \times 10^{31}$ erg s^{-1}
M_{dot}	$1.3(\pm 0.3) \times 10^{-11}\ M_\odot\ yr^{-1}$

The Eruption of GW Lib

In April of 2007, GW Lib entered its second known eruption. The light curve shot upward on JD 2454203 at an incredible rate of 10 mag/day. This outburst attracted many observers around the world. The Center for Backyard Astrophysics (CBA) accumulated over 90 nights worth of data. The observations by the CBA were taken in several different locations across the globe using amateur telescopes and CCD photometers taking long time series.

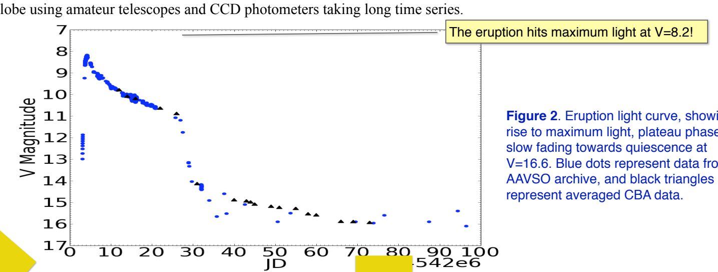


Figure 2. Eruption light curve, showing the rise to maximum light, plateau phase, and slow fading towards quiescence at V=16.6. Blue dots represent data from the AAVSO archive, and black triangles represent averaged CBA data.

Conclusions

- The expected orbital signal was seen in the early days of the outburst.
- Superhumps appeared on the 10th day of the outburst and remained throughout the fall to quiescence.
- The periodic wave became complex during the fall off the "plateau phase" until the light stabilized.
- The 2007 observing campaign marked the greatest data coverage of a GW Lib outburst. Further analysis of this data can and will be used to ascertain many physical parameters of the system including mass transfer rate and energy loss.

The First 10 Days…

During the first 6 days of the eruption, the most prominent signal found was one near the orbital frequency (18.76 cycles/day). (**Fig. 3**) This indicated the presence of the so-called "outburst orbital hump."

JD 2454203-9 Power Spectrum

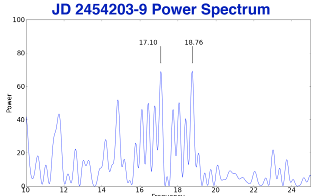


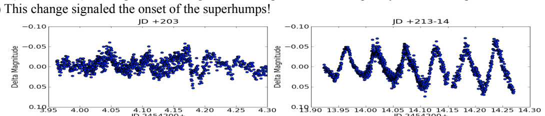
Figure 3. Power spectrum of a 6-day splice of the data from early on in the outburst. A signal near the orbital frequency is clearly present, plus a strange signal at a frequency of no clear importance.

A nearly equi-amplitude signal at 17.10 was also present. However, we were able to determine that this signal is an alias signal, and may be disregarded (for now).

The Superhumps Arrive!

Finally, on the 10th day of the eruption (JD 2454213), the light curves began oscillating at a lower frequency, and the amplitude of the oscillations grew tremendously. (**Fig. 4**) This change signaled the onset of the superhumps!

Figure 4. Light curves from days 203 and 213-4, showing the onset of the superhumps. The clear periodic, high-amplitude oscillations are typical of superhumping dwarf novae.



These high-amplitude superhumps were strongly present throughout the "plateau" phase of the outburst, and persisted for at least 100 days after the initial outburst.

JD 2454213-9 Power Spectrum

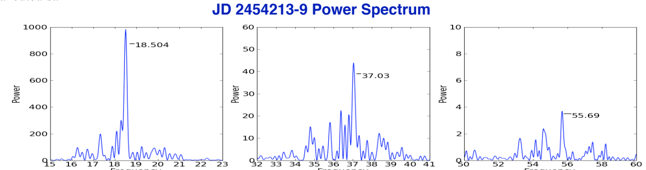


Figure 5. Power spectrum of a 6-day splice of data during the plateau phase. The primary superhump signal at 18.504 cycles/day is clear, as well as the first and second harmonics.

The Descent into Quiescence…

By JD 2454228, the light had begun to fade rapidly. During this time, power spectra of 2-day spliced light curves found our superhump signal significantly weakened, and daily power spectra showed that the signal was not steady, but wandering. (**fig.6, left**) This is most likely due to a transition to a lower light phase.

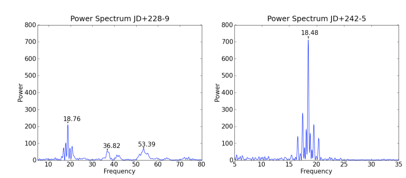


Figure 6.
Power spectrum spliced data during the fall from the "plateau phase," and during the fade to quiescence.

Once the light settled into a slow decline, the superhump signal returned to its rightful place and stayed there for at least 90 more days. This long descent began around JD +230. The mean power spectrum from days 242-245 is shown in the right panel of figure 6.