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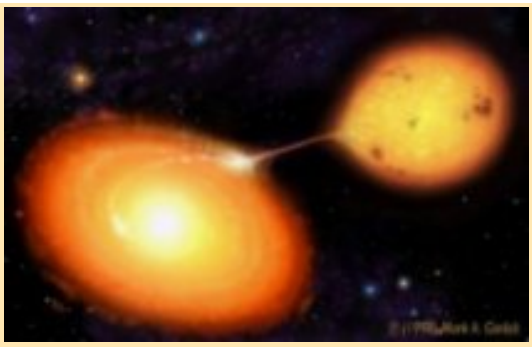
Variable Star Of The Month

November, 2002: VW Hydri

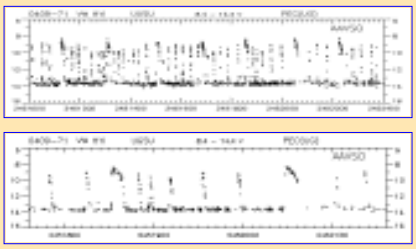
VW Hydri: Tops in the Dwarf Nova Superlatives



An artist's impression of a cataclysmic variable (CV) star. For a review of this type of variable, see one of our many CV features, including the prototype of the SU UMa class. Image credit: Mark A. Garlick

When one thinks of the dwarf nova subclass of cataclysmic variables, a number of familiar names come to mind: SS Cyg, U Gem, SU UMa, and Z Cam. To this list, VW Hyi should be no exception. While residing at a declination of -71°, VW Hyi is one of the most popular dwarf novae in the southern skies. More specifically, VW Hyi is one of the most favored SU UMa-type dwarf novae. The SU UMa class of dwarf novae is well known for their normal and superoutburst behavior. That is, in addition to the normal dwarf nova outburst, which consists of a rise from quiescence of 2-6 magnitudes and 1-3 day durations, the SU UMa variables also displays bouts of superoutbursts. As the name suggests, such outbursts are longer and brighter than the normal outbursts, though they occur less frequently. Superoutbursts may occur every 3-10 cycles, last for 10-18 days, and may rise in brightness by at least an additional magnitude. The light curves of such variables are also punctuated with an additional feauture whereby small-amplitude periodic modulations (variations) of several tenths of a magnitude are detected. This phenomenon, known as the superhump, is seen to occur with a period that is 2-3% longer than the period of the system. Therefore, by observing the superhumps, one can obtain the orbital period of the system. SU UMa-type stars have been found (in almost all cases) to have orbital periods of less than 2 hours!

Spotlight on VW Hydri



A portion of the VW Hyi light curve from the AAVSO International Database. The top panel shows the myriad of normal and superoutbursts that VW Hyi goes through in a course of several years. The bottom panel shows a closer view of these outbursts. Click on either image for an enlarged view.

While we now know generally about the SU UMa stars, what can we specifically say about VW Hyi? Numerous studies have been carried out to analyze as many properties of this popular star as possible. According to these studies (see Hack and la Dous 1993 and references therein) we know that the average time between two normal outbursts is 27.3 days, while for superoutbursts it is 179 days, and that the outbursts last for 1.4 and 12.6 days, respectively. During quiescence, VW Hyi can be seen around magnitude 14.4. The outbursts, however, can be seen around 8.4 for the superoutburst around 9.0 or so for the normal outburst. According to Smak (1985), the amplitude and width of a normal outburst are related to the length of the preceding cycle, but not the following cycle.

In all, between 3 to 8 normal outbursts occur between two consecutive supercycles--the name given to the time between two consecutive superoutbursts. In fact, two types of supercycles

are observed: a longer one, which is strong with the last two cycles having a duration of more than 60 days and a shorter one, where the outbursts are weak and last two cycles are less than 45 days (Smak 1985; Hack and la Dous 1993). The star then rises to and reaches superoutburst and the superhump appears when maximum light is achieved. Through 5-color photometry it has been found that the shape of the superhump is relatively the same with all filters, but that the amplitude of the superhump decreases with shorter wavelengths. Studies have shown that amplitudes in all colors decrease with time as the superoutburst progresses (van Amerongen et al. 1987; Hack and la Dous 1993). At the other extreme, during quiescence, VW Hyi shows a periodically repeating hump that reveals an orbital period of 0.07427111 days or 107 minutes (Vogt 1974)!

Congratulations on Collaborations

In addition to the HST, Astro-1 and -2 missions, VW Hyi has also been observed by an alphabet soup of satellites: IUE, HEAO-2, EXOSAT, ROSAT, GINGA, ASCA, and EUVE. The HST, pictured above, is probably the most famous of the bunch.

Professional astronomers have benefited greatly from the patience and enthusiasm of amateur astronomers time and time again. Due to time or financial restrictions, professional astronomers simply cannot carry out long-term, dedicated studies of objects that the amateurs can. In turn, they've looked to organizations such as the AAVSO for help from its hundreds of observers worldwide. Whether it is a correlation between data, or a trigger event where the astronomers need to know when a particular star will be in a specific state, amateur astronomers have heeded the call faultlessly. VW Hyi has been a component in the proud partnership that exists between these astronomers with a common goal: to further our understanding of variable stars.

For instance, studies of CVs, such as VW Hyi, in quiescence with the Hubble Space Telescope (HST) gave astronomers the opportunity to explore the interaction between accreting disk gas and the white dwarf surface layers. According to Sion (1996) and references therein, models predict the following parameters for white dwarf in the VW Hyi system: a minimum age since formation of ~ 50 million years; an effective photospheric temperature of 22,000 ± 2000 K; and a rotational velocity of V sin $i \approx 600$ km/s.

In addition to the parameters given above, studies with the HST also revealed: "(a) the first rotational velocities of for the underlying white dwarfs in cataclysmic variables; (b) the first white dwarf masses independent of disk emission lines; (c) the first chemical abundances for accreted atmospheres; (d) the first definitive evidence of white dwarf cooling in response to the dwarf nova accretion heating process in several systems" (Sion 1996).

On another front, again through collaborations between professional astronomers and amateur astronomers, researchers working with the Hopkins Ultraviolet Telescope (HUT) on Astro-1 and Astro-2 were able to monitor several dwarf novae--some through outburst, some through quiescence. The result yielded the first set of far ultraviolet spectra that provided good emission and absorption lines (Long 1995). From a researcher's point of view, obtaining such data is important as it can be used to put constraints on models of dwarf novae.

More recently, by combining the visual light curves of the AAVSO and VSS/RASNZ and the ultraviolet light curves from the EUV, Mauche et al. (2001) found the time delay between the optical and ultraviolet components of light curves for several dwarf novae, including VW Hyi.

Knowing this behavior, again, gives astronomers more clues about the nature of dwarf nova outbursts.

Through continued amateur support, professional astronomers will be able to piece more and more of the puzzle together to unlock the secrets of variable stars!

How Can I Observe VW Hydri?

Since the constellation of Hydrus (not to be confused with the constellation of Hydra) is unviewable from latitudes north of +32°, observers at southern latitudes and those near the equator are best suited for observing the dwarf nova VW Hyi. The variable itself can be found just over 3° northeast of the 3rd magnitude star gamma Hyi. Brightness estimates may then be made by using the 'b' and 'd' scale AAVSO charts.

The constellation of Hydrus was first published in Johann Bayer's *Uranometria* atlas. Bayer's *Uranometria* opened a new age in the history of celestial cartography, and was praised for the careful placement of star positions and brightnesses and for its attractive plates. Click on the above image for an enlarged view. Image credit: U.S. Naval Observatory Library

Those interested in adding VW Hyi to an observing program should plan to observe the variable every clear night, if possible. Superoutbursts should be monitored every 5 minutes for at least a 2-3 hour period (on a given night) for evidence of superhumps. Although such activity is best detected by equipment sensitive to small-amplitude variations, such as photoelectric photometers and CCDs, the visual observer might also try a hand at detecting the fluctuations. Observations of VW Hyi may then be submitted to the AAVSO for addition to the AAVSO International Database.

VW Hyi has been in the AAVSO observing program since 1958. In the past 40+ years, AAVSO observers have logged over 13,500 observations for this variable. The light curve from 1961 onward for this and other variables may be viewed by using the Light Curve Generator. If you are curious about the present activity of VW Hyi, visit the Quick Look file, or scan the most recent News Flashes for up-to-date information and reports on upcoming amateur-professional collaborations.

For More Information

- AAVSO 'b' & 'd' scales for 0409-71 VW Hydri
- AAVSO VSOTM for February 2000: SU Ursae Majoris
- Hack, M. and C. la Dous, eds. *Cataclysmic Variables and Related Objects*. Washington, DC: NASA Scientific and Technical Information Branch, 1993.
- Long, K.S. "The Hopkins Ultraviolet Telescope Observations of Dwarf Novae." *Journal of the AAVSO*, 23, 1995, 94-105.
- Mauche, C.W. has web page where he gives an excellent review of cataclysmic variables.
- Mauche, C.W., J. Mattei, and F. Bateson. "Optical and EUV Light Curves of Dwarf Novae Outbursts." In P. Podsiadlowski, S. Rappaport, A.R. King, F. D'Antona, and L. Burder, eds. *ASP Conference Series, Volume 229: Evolution of Binary and Multiple Star Systmes; A Meeting in Celebration of Peter Eggleton's 60th Birthday.* San Franciso: ASP, 2001, 367-371.

- Sion, E.M. "Hubble Space Telescope Studies of Exposed White Dwarfs in Dwarf Novae." *Journal of the AAVSO*, 24, 1996, 1-8.
- Smak, J. "Statistical Analysis of Outbursts and Superoutbursts of VW Hydri." *Acta Astronomica*, 35, 1985, 357-367.
- van Amerongen, S., H. Bovenschen, and J. van Paradijs. "Wavelength Dependence of Superhumps in VW Hydri." *Monthly Notices of the Royal Astronomical Society*, 229, 1987, 245-251.
- Vogt, N. "Photometric Study of the Dwarf Nova VW Hydri." *Astronomy & Astrophysics*, 36, 1974, 369-378.

This month's **Variable Star of the Month** *was prepared by Kerri Malatesta, AAVSO Technical Assistant.*

- Variable Star of the Month Archive