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E Y E P I E C E V I E W S #320

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1. INTRODUCTION

Greetings All,

Together with the warm weather's arrival in the northern hemisphere, the AAVSO Spring meeting is approaching once again. Time flies indeed. This year's meeting will be part of "ASTRONOMY ROUNDUP 2007" in Calgary, Alberta, Canada, June 28 – July 3. We encourage you to visit the URL below for more information:

http://www.aavso.org/aavso/meetings/spring07.shtml

Here at Headquarters we expect a wonderful summer and hopefully a productive one as well.

We are grateful to all our contributors. We would welcome your contributions, too. As always, please send us your comments and questions.

Have a wonderful summer or winter!

Thanks and good observing!

Gamze Menali, AAVSO Technical Assistant

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2. LEGACY VARIABLE STARS Part 2 – Cataclysmic Variables - Mike Simonsen

In the March 2007 issue we discussed 'Legacy Variables' and their importance in variable star astronomy.

"Legacy Variables are stars that have been observed for decades and whose data can be plotted as light curves describing the behavior of the star over extended periods. Some of them have been observed for over one hundred years! In some cases, it has taken decades to demonstrate the behavior scientists are interested in studying. Legacy Stars will never go out of style, and it is precisely the long time line of visual observations that makes many of them important or of particular interest.

Many of these stars are among the first variable stars to be discovered, so they tend to be bright and have large enough amplitudes to be observed visually. Many of them are the prototypes of their particular class of variable stars, being the first to be explained or the first to be discovered as such. By contributing to the body of historical observations you are sustaining the legacy of these distinguished stars."

Part one focused on Miras, R CrB and symbiotic variables. Part two will be devoted to cataclysmic variables.

There are four types of non-magnetic cataclysmic variables: novae, recurrent novae, dwarf novae and nova-like objects.

Novae tend to be relatively short lived, transient events, so they are not usually studied on time-scales of decades. There are exceptions, and we will touch on one or two before we are done here.

Recurrent novae, characterized by decades long periods of inactivity, require observation over very long periods of time to be recognized for what they are. All recurrent novae should be considered 'legacy variables'. With so few known examples and the rarity of these events it is no wonder that recurrent novae eruptions are extremely interesting to astronomers. Monitoring these stars for outbursts over decades of relative inactivity is still one of the extremely valuable contributions visual observers can provide to science.

RS Oph- 17 50 13.20 -06 42 28.5 (2000) Judging by the number of observations in the AAVSO International Database since 1918, RS Oph is one of the most observed stars of its class. RS Oph varies in visual magnitude from 12.5 at minimum to a maximum of 4.8. This magnificent star erupts to naked eye visibility every twenty to thirty years! Over a century of observations shows that the variable has undergone 6 recorded outbursts with very irregular frequency: 1898, 1933, 1958, 1967, 1985 and the most recent in one in 2006. Two other notable recurrent novae that may be overdue for an outburst any day now are T Coronae Borealis and T Pyxidis.
A more detailed accounting of recurrent novae and their properties can be found in the March 2006 issue of Eyepiece Views. http://www.aavso.org/publications/eyepieceviews/0306.shtml

Dwarf novae are divided into four sub types in the GCVS (UG, UGSS, UGSU and UGZ), primarily on the characteristics of their light curves.

U Gem- 07 55 05.20 +22 00 04.0 (2000) The prototypical star of the class of dwarf novae (DN). Most DN are referred to as UGs or U Gems, unless they belong to a specific sub group of DN. Ranging from 14th magnitude to 8th magnitude in outburst, U Gem can be followed throughout its cycle with modest telescopes. The 'mean cycle' or average time between outbursts is approximately 105 days, but this has been known to vary from 33 to 256 days. The AAVSO archival data goes back to 1908. Historical observations exist in the BAAVSS archives dating back to the 1860's, including its discovery in 1855 by J.R. Hind.

The AAVSO has participated in many observing campaigns on U Gem over the decades, in support of ground-based, satellite, and even space shuttle observations. U Gem continues to garner interest from professional astronomers due to its proximity, apparent magnitude, grazing eclipses and the long observational time line.

SS Cyg- 21 42 42.80 +43 35 09.9 (2000) Discovered in 1896 by Louisa D. Wells of the Harvard College Observatory, SS Cygni is the prototypical star of the UGSS sub-type of dwarf novae. As defined by the General Catalog of Variable Stars, SS Cygni-type variables increase in brightness by 2-6 mag in V in 1-2 days and in several subsequent days return to their original brightness. The values of the cycle are in the range 10 days to several thousand.

SS Cyg has a visual range of 12.2 at minimum to 8.3 at maximum. Outbursts can be expected every 4-10 weeks, with a 1-2 week duration. At a distance of 90 to 100 light years SS Cyg is fairly close. This combination of relative apparent brightness, frequent activity and proximity has made SS Cyg one of the most observed variable stars in the night sky. Observers have followed this star so intensely for over a century that not one outburst has ever been missed in that time. That is quite a legacy!

SU UMa- 08 12 28.20 +62 36 22.6 (2000) Discovered in 1908 by L. Ceraski of Moscow, the variable SU Ursae Majoris is the prototype for variables belonging to the UGSU subtype of dwarf novae. These are characterized by the presence of two types of outbursts, "normal" and "superoutbursts". Normal, short outbursts are similar to those of UGSS stars, while superoutbursts are brighter, last more than five times longer, and occur much less frequently. During superoutbursts, the light curves show "superhumps", periodic oscillations with amplitudes of approximately 0.2-0.3V. While superhumps are generally observed with sensitive equipment capable of measuring minute changes in light output, like CCDs, they can be observed visually in UGSUs that get as bright as SU UMa.
The range of variation is typically from a minimum of ~15V to a maximum of 10.8 or so at superoutburst. SU UMa's normal outbursts occur every 11 to 17 days and superoutbursts every 153 to 260 days. Being circumpolar, SU UMa can be observed year round in the Northern Hemisphere with a moderate-size telescope. As with SS Cygni, brightness and frequent activity have made this variable a favorite with AAVSO observers since 1935.

VW Hyi- 04 09 11.34 -71 17 41.1 (2000) VW Hydri could be considered the southern sky equivalent to SU UMa in many ways. Due to its brightness and frequent activity many studies have been undertaken to analyze every aspect of this star and its behavior. The average time between two normal outbursts is 27.3 days, while for superoutbursts it is 179 days. Normal outbursts last for 1.4 days, while super-outbursts last 12.6 days on average. During quiescence, VW Hyi can be seen around magnitude 14.4. Super-outbursts are observed to be around 8.4, and normal outbursts attain mag 9.0. VW Hyi has been in the AAVSO observing program since 1958, and as an important star in the historical development of our understanding of dwarf novae, deserves a place amongst the 'legacy cataclysmic variables'.

Z Cam- 08 25 13.20 +73 06 39.2 (2000) Z Camelopardalis is the prototype star of a subclass of dwarf nova-type cataclysmic variables especially known for their random standstills. UGZ type stars show cyclic outbursts, but differ from UGSS variables by the fact that sometimes after an outburst they do not return to minimum, but stall at a point between maximum and minimum, remaining there for days weeks or months at a time. These 'standstills' are the predominant characteristic of UGZ systems. Outburst cycles are typically from 10 to 40 days, while light amplitudes are from 2 to 5 mag in V. Z Cam is another bright, active, circumpolar variable that has been monitored by AAVSO observers since 1963, and continues to surprise and intrigue us to this day.

WZ Sge- 20 07 36.53 +17 42 15.3 (2000) Originally thought to be a 7th magnitude nova from its discovery on photographic plates, WZ Sge was dubbed "Nova Sge 1913". It erupted again in 1946, again reaching 7th magnitude. At this point WZ Sge was suspected of being a recurrent nova with an outburst cycle of about 33 years. Close watch was kept as the 33-year time elapsed, and in 1978, nearly on cue, WZ Sge went into outburst again. Photometric studies conducted during the quiescence revealed an orbital period of 81 minutes and 38 seconds, a short orbital period that is not usually seen in recurrent nova. In addition, spectra showed a mostly featureless continuum at maximum similar to dwarf novae, instead of broad emission bands and P Cyg absorption lines that are typical of recurrent novae. Observations of the 1978 outburst also revealed superhumps, the defining characteristics of SU UMa type dwarf novae; thus WZ Sge is now considered the prototype for a subset of the SU UMa class. These objects were deemed TOADs (tremendous outburst amplitude dwarf novae) early on, but are now more typically referred to as WZ Sge types, UGWZ or UGSU(WZ).
The primary factor determining the long super-cycle interval appears to be a very low mass-transfer rate. Given this slow rate of mass-transfer, it takes decades to accumulate enough material for a super-outburst. The puzzle of these stars, however, is why they show few or no normal outbursts during this interval. Even with a low mass-transfer rate, material should accumulate, drifting viscously into the inner disc, and trigger an outburst. One suggestion for why this does not occur is that the disk viscosity is very low. The material would then remain in the

outer disc, where much more can be stored before an outburst is triggered. The problem with this idea, however, is to explain the extremely low viscosity level. Another possible explanation involves the removal of the inner disc, to prevent outbursts starting there. This could occur through siphons or because of a magnetic field on the white dwarf.

Like recurrent novae, all WZ Sge type variables should be considered ‘legacy stars’. WZ Sge’s most recent outburst in July 2001 may have been the most widely covered outburst of the century, with observations being made from all over the world and space in multiple wavelengths. Other UGWZ stars include AL Com and EG Cnc, which have super-outburst intervals of approximately 20 years.

ER UMa- 09 47 11.83 +51 54 09.0 (2000) On the other end of the super-cycle spectrum is ER UMa, the prototype of a variety of UGSU in which the interval between superoutbursts is unusually short. ER UMa stars typically spend a third to a half their time in super-outburst, with a super-cycle of only 20 to 50 days. When not in super-outburst these stars show frequent normal outbursts, about one every 4 days. Although ER UMa and her brethren have not been recognized as an official sub-type of UG, references are typically made to UGSU(ER) type systems in the literature. ER UMa is quite typical of this kind of CV and is relatively bright, ranging from 15.2-12.4, making it a regular target of most CV observers.

AM Her- 18 16 13.33 +49 52 04.2 (2000) Discovered in 1923 by M. Wolf in Heidelberg, Germany during a routine search for variable stars AM Her was initially described as an irregular variable with a range of 12th to 14th magnitude. It wasn’t until the late 1970’s that the more complex and interesting nature of AM Her came to light.

AM Her is the prototype of its class of magnetic variables. Unlike dwarf novae, the AM Her stars (or polars) have such strong magnetic fields that accretion disks cannot form. Mass exchange occurs along magnetic field lines and the accreted matter slams into the white dwarf at the poles. Most of these systems are in synchronous rotation, the white dwarf spinning at the same rate as the two components orbit each other.

Of course, none of this can be observed, visually or directly, but there is plenty of action to keep observers interested. AM Her exhibits periods of activity, or high states, where it dances about the 13th magnitude mark, and periods of inactivity, or low states, where it is relatively quiet near 15th magnitude, waiting to surprise us again with a totally unpredictable flare up of activity.

GK Per- 03 31 11.82 +43 54 16.8 (2000) Originally discovered as an extremely bright, naked eye, nova in 1901, GK Per (Nova Persei 1901) reached magnitude 0.2 before beginning to fade. Nova Per 1901 behaved very much like most fast novae (Na), falling to fourth magnitude in about four weeks. At this point, fluctuations of about 1.5 magnitudes with a period of roughly four days set in as the nova continued to fade. It wasn’t until 1912 that GK Per finally reached its pre-outburst state at 13th magnitude.

GK Per became part of the AAVSO observing program in 1920, and from then until 1966 it fluctuated from 12.5 to 13.5 quite irregularly. In August 1966, GK Per rose suddenly to 11th magnitude, and from that time until now has exhibited dwarf novae-like outbursts of three magnitudes every three years or so.

It wasn’t until 1980 that the magnetic nature of GK Per was discovered. It is now classified as an intermediate polar, or DQ Her star. These magnetic systems have magnetic fields less intense than polars, so an accretion disk is able to form to a certain degree. However, it is disrupted well above the surface of the white dwarf, and accreted material must travel along magnetic field lines before crashing into the white dwarf surface near the poles.

The irregular fluctuations and unpredictability of this star’s behavior, coupled with the fact that it is relatively bright, make it another well-observed legacy variable star.

There are no doubt several more CVs that could be included in the list of legacy variables, and we haven’t even touched on Cepheids, RR Lyrae, eclipsing binaries and several other well-studied types of variables. Perhaps there is a part three to this article. What do you think? Write me at mikesimonsen at mindspring.com, and let me know your suggestions?

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3. TRANSIENT OBJECT UPDATE – Dr. Arne Henden, AAVSO

In case our readers missed it, below is from a message Arne sent to AAVSO Discussion Group on Wednesday, May 09, 2007 with the subject line ‘transient object update’:

V5558 Sgr
This slow nova continues to brighten, increasing by 0.7mag in the past two weeks to its current V=9.1 value. I would not be surprised to see it brighten even more, so keep monitoring this one.

V2615 Oph
This nova reached a peak around V=9.7 on March 20, and has been fading since, though with a lot of bumps and wiggles. Its current magnitude is V=11.2 and is fading about 0.1mag/day.

It is really interesting to see the difference between all of the novae currently visible - no two are alike. The dramatic fade indicated in my previous update about a month ago turned out to be an isolated event. The star recovered from a sharp 1-magnitude decrease and then resumed its 0.1mag/day fading rate.

V2467 Cyg
The nova peaked arount V=7.5, faded smoothly to about JD2454205, had a sharp 0.3mag drop, rose back and now continues its slow asymptotic decline, about V=11.3 right now. There is no indication of a close companion, so the smooth decline seems to be intrinsic.

V2362 Cyg
This old nova (April 2006) faded dramatically in December after its second peak, and since about January 2007, has been declining steadily though slowly. It is currently at V=14.7, but has a long way to go before it reaches its expected quiescent level of V=20. The 4arcsec companion to the west is now brighter than the variable.

V1280 Sco
This was a fast nova, reaching a maximum around V=3.5, bottomed out at V=14.7, and now has risen back to V=14.3. There is a fainter red companion about 8arcsec to the SSW, and a fainter blue companion about 6arcsec to the NNW.

V1281 Sco
This nova is now fainter than the companion star about 15arcsec to the NW, so be careful what you measure. There is a third star that falls in between these two objects, but fainter. The nova is currently around V=13.6, with a separation between the visual and CCD observers.

GW Lib
This WZ Sge type of CV peaked around V=8.8, and then slowly declined. After superhumps were detected around April 16, they grew in amplitude to about 0.3mag, and then slowly decreased in amplitude. About May 7 the star went into sudden decrease, and is now about V=14.3.

The quiescent level is V=17, so it still has some fading to go, and WZ Sge cataclysmic variables often have echo outbursts. Keep watching this one - it will continue to surprise us for a while.

Did I forget any novae? Surely there must have been a couple more! Another really interesting star is the eclipsing typeII Cepheid that Antipin, Sokolovsky and Ignatieva discovered (astro-ph/07050605), which we will have a campaign on in a few days. The new planet-transiting star, XO-2b, is pretty cool too. Lots of fun stuff up there these nights!

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4. TRIAL BY FORWARD SCATTER - G.M. Ross

Being the Second Greatest Observer in Michigan offers one the opportunity to confront Nature -- and learn the hard way. So it was yet again at the Veen Observatory on 30 January *instant*. The crisp twilight was a gift of the north-westerly breeze which kept Lake Michigan's clouds to the west, at least temporarily. In spite of the cold wave my feet hastened to the Observatory. Surprisingly, the car made it all the way up, although the issue was in doubt. Whenever contemplating astronomy in western Michigan, oceanfront at the Doral looks pretty good.

Very nearly full, the Moon took the high ground in Gemini, more or less R.A. 6h 30m, Dec. 27 [deg.] 44 m, approximately 48 degrees in elevation at the start of observing. Even with a miserable seven per-cent albedo, she turned the scene into an alien world, which will never cease to captivate. Rather than do the obvious like exploring the waxing terminator, against all reason I decided to observe variable stars. But then one who finds himself in a purgatorial observatory tower cannot be deemed entirely reasonable.

AH Eri and CN Ori seemed good targets, and the former, a U Gem object, is always fun to monitor. AH is not too far south to observe from 43 N., although I have never with any telescope seen it at minimum. CN is a quirky periodic thing with an irritating "preliminary" chart, which is another story. The Grand Rapids Association's mighty Boor Telescope is an f/10 Schmidt-Cass. with the finest eyepieces available to amateurs. Even so, the drowned sky presented a problem that close to "second quarter" Moon. Viewing AH was not easy, but came in at a workmanlike (13.5. Then I swung the leviathan to the left and up into eastern Orion. CN is due east of the "sword" – significantly moonward. What a chore observing that star! I thought I was going to mutate my ocular orb permanently, since it was impossible to make out much even in a 12mm eyepiece. With equal measures of eye strain, extrapolation, and poetic imagination I put down (13.1, of marginal utility).

The point of this morality tale is proximity to the Moon. CN Ori was at greater elevation, true, but the advantage was cancelled out by "scattered light". AH Eri was ~50[degrees] away whilst CN was ~ 35[degrees], distances derived not with a computer cursor, but by scaling them off a Rand McNally Celestial Globe (simple methods for a simple fellow). The Rayleigh scattering at our modest elevation can be considerable for observing. Angular separation from the bright source was everything here.

Rayleigh intensity is [1 + cos^]. Isolating all other effects, the ratio of intensities at the two separations is:
[1+ cos ^2 (35degrees)] / [1 + cos^2 (50degrees)] ~ 1.2. Hence the sky background for the Orion star was 20 per-cent brighter than for AH Eri, approximately 0.2 mag. That difference is not what I observed, although the CN magnitude was a swan dive, *supra*. Nonetheless, those cosines go up mighty fast as the light source is approached.

A sidebar issue inspired Beethoven's best loved non-symphonic work, why all proposals of marriage should be reserved for broad daylight. Scattering intensity is proportional to [1 over Lambda to the 4th power], where [Lambda] is the wavelength of the light. The sky of 18 January at least appeared blue, even though our satellite is decidedly not, because the scattering intensity is larger for blue light. Regarding such situations Mark John Christensen, old friend and drinking buddy, would cite the immortal Helmholtz: "We live in a logarithmic universe." I must check next January to see if any of this holds true, scattering intensity and sky hue, because one cannot be too careful even in an a *priori* science. (*See* Edmund Husserl's "Philosophie als strenge Wissenschraft" [1910], preferably in the original German.)

Sure that the Rayleigh scatter by going up -- practically on top of the Moon -- to observe CZ Orionis would make one quit astronomy forever, I turned the "glass" to see Aristarchus . . . just before she disappeared into the upper reaches of the dome. It was too frozen to adjust. Then, chastened, back to the farm in retreat although declaring victory for the press. True to the prediction of a television meteorologist, the breeze shifted to westerly and lake clouds slowly rolled in, another triumph for empirical science.

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5. CAMPAIGN UPDATES – Dr. Matthew Templeton, AAVSO

In last month's issue of Eyepiece Views, I talked at some length about the importance of visual observations to many of the AAVSO's past alerts and observing campaigns. I won't go on as long as last issue (phew!) but thought I should give a quick update on happenings at AAVSO HQ on that topic (and perhaps a bit more).

In Alert Notices 345 and 348 we requested observations for a number of CVs on behalf of a group of radio astronomers attempting to observe a CV right at the beginning of an outburst. Given how quickly CVs can rise to maximum light, that's no small feat, but observers worldwide (AAVSO-affiliated and not) helped to make it happen. Radio observations of SS Cygni commenced on April 26, and have continued intermittently since; every indication is that something new has been observed. All observers -- visual and CCD – have contributed important data, but it was a visual observer who gave us the first "heads up" that SS Cyg was up to something.

Visual observers still amaze me, not least because I find it so hard to do, personally! The amount of valuable visual data that gets submitted every year is phenomenal, and still -- in the age of computers and CCD cameras and go-to telescopes -- has great, great scientific value. At the moment, three of the half-dozen or so research projects on my desk involve visual data, either as part of a larger effort, or as the sole basis for the research. For one of them, alternating minima in W Virginis, my jaw dropped when I made the first phase diagram, proving that some of W Vir's long-term visual observers were seeing "something interesting" that hadn't yet been formally described in literature -- without even realizing they were doing it! It was definitely proof of the concept of "report what you see, not what you expect", and remarkable given the subtlety of the effect we were looking for. (The paper should be submitted in a few weeks; we presented a first draft at the American Astronomical Society meeting in January.)

As I'm writing this I'm reminded of an interesting talk I watched recently. A few months ago I was digitally mastering some video of Robert Evans' keynote at the 1983 Annual Meeting as part of an archiving project here at HQ. A few of you readers were there, and may remember it as the first of Evans' many Supernova Awards since. Every single one of his 40 supernovae (to date) was discovered by eye, with the help of a good telescope and a good visual memory. His continuing work and that of the many other recipients of the Supernova Award over the years-- also highlights the fact that there is a lot of science still to be done with visual data.

You should always use the right tool for the right job, and sometimes your eye is just right.

Clear skies, & good observing!

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Good observing!

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