Publications

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E Y E P I E C E V I E W S #321

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1. INTRODUCTION — OUR BIRTHDAY

Time flies... The first issue of Eyepiece Views was published 6 years ago, July 2001! We took a break between November 2002 and June 2005 to enable the AAVSO validation project to move fast with full staff participation.

In the first issue, we stated that we anticipated some tweaking and minor changes over the first few issues, and yes, that was 6 years ago! Although our format in general has stayed the same, we have tried to implement your suggestions and requests wherever we could.

We always welcome and appreciate suggestions, comments, feedback, and contributions from observers as we strive to make this publication your observing aid.

Thank you to all our contributors and readers for being part of this fun journey and for allowing us to bring Eyepiece Views to you. From Europe to Asia to Australia to Africa to the Americas... Thank you very much from our hearts to yours.

Next time you are observing a variable star for the AAVSO, please know that your contributions, your observations, and your participation mean the world to us.

Thanks and good observing!
Gamze Menali, AAVSO Technical Assistant (MGQ)

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2. A DIFFERENT VIEW OF RV TAURI STARS - Eric Broens

During the summer of 1986 I made my very first visual magnitude estimate. I picked R Scuti for this first observation, probably not knowing what type it was and probably not even having heard about RV Tauri stars at that time. Ever since then I like to observe R Scuti. It shows nice variations and is located in a nice part of the sky near the open cluster M11. It is best observed using binoculars since it varies roughly between 5th and 9th magnitude.

Most books on variable stars give only some very concise information on RV Tauri stars. Often only the definition from the GCVS is given. One might ask what the reason is - are these stars relatively unstudied? Eager to know more on these fascinating stars, I started to look for more information. I found that during the last decade quite a lot of research has been done on RV Tauri stars. I mainly read the papers on their post-AGB membership rather than the papers on the pulsational aspects and their stellar evolution, although there is very interesting information on these topics, too.

RV Tauri, the prototype of the class, was discovered in March 1905 by Mrs. Lydia Ceraski on plates taken by Sergey Nikolaevich Blazhko. The discovery was announced by her husband, Prof. Witold Karlovich Ceraski, in Astronomische Nachrichten [1]. Seares and Hayens noticed in 1908 that the minima were not of equal depth and the light curve resembled that of Beta Lyrae [2]. They noticed that the maximum and minimum magnitude varied from cycle to cycle, and furthermore that there was a secondary variation which is perhaps irregular and quite different in period from the "Beta Lyrae variation".

The GCVS defines the RV Tauri stars as "radially pulsating supergiants with light curves showing alternating deep and shallow minima with periods in the range from 30 to 150 days between deep minima" [3]. These alternating deep and shallow minima are what Seares and Hayens described as Beta Lyrae variation. The GCVS divides the RV Tauri stars into 2 subtypes: RVa stars don't vary in mean magnitude, while RVb stars vary in mean magnitude with periods from 600 to 1500 days and amplitudes up to 2 magnitudes in V. It is this long-term variation that Seares and Hayes refer to as secondary variation. The third criterion in the GCVS is the spectral type: F-G at maximum light and K-M at minimum.

In the early 1970's it was discovered that many RV Tauri stars show a large IR excess, i.e., the stars radiate more energy in the infrared than expected [4]. This excess is caused by circumstellar dust. The dust absorbs the radiation at shorter wavelengths, mainly UV, and re-radiates it at the IR wavelengths. Based on IRAS observations Jura concluded in 1986 that RV Tauri stars are post-AGB stars, stars in transition from the asymptotic giant branch (AGB) to white dwarfs [5]. The post-AGB phase is a very short phase, lasting only a few thousand years. There are only about 220 post-AGB stars known in our galaxy [6]. The GCVS lists 137 RV Tauri stars, but for 49 of them the classification is uncertain. It is known that stars while evolving on the AGB are subject to heavy mass loss. Once they evolve off the AGB the mass loss ceases. Jura mentioned that most of the RV Tauri stars might be progenitors of planetary nebulae.

Not surprisingly, the research of RV Tauri stars benefits from the research done on post-AGB stars and vice versa. Until the mid-1990's little work had been done toward determining the chemical composition of RV Tauri stars. The studies showed that the stars were metal-poor, leading to the conclusion that these stars belonged to the old disk or halo population. By the early 1990's five post-AGB stars were found showing chemical anomalies: the iron abundances were very low while the abundances for other elements like carbon, nitrogen, oxygen, and sulphur were quite normal. It was unclear whether the low iron content is primordial and the C, N, O, and S abundances are the result of stellar evolution, or whether something else was going on. In the case of the iron abundance being primordial, these stars would be very old stars. It was noticed that there are similarities between the observed abundance anomalies and the gas phase of the interstellar medium. This led to the hypothesis that the elements with a high condensation temperature, like iron, were condensed into dust while the volatile elements like C, N, O, and S remained in the gas phase [7].

In 1992 Van Winckel and collaborators discovered that HD 52961 showed a similar peculiar chemical composition but that zinc was overabundant with respect to iron [8]. Since zinc and iron have a similar nucleosynthetic history, their abundances cannot reflect the initial composition of the gas cloud from which the star was formed. Since zinc has a low condensation temperature this detection supported that hypothesis. Thus, somehow the elements with a high condensation temperature condense into dust while only the gas is re-accreted into the star's photosphere. This depletion process occurs most probably in a disc but is poorly understood [9]. In post-AGB stars a disc is probably present only if the star is a binary system. In that case the disc is a circumbinary disk. And indeed, the radial velocity measurements of those five post-AGB stars showed that they are all binaries with orbital periods in the order of one to a few years [10]. One of these binaries is the central star of the Red Rectangle nebula (HD 44179 nebula). The dust disc is "seen" on HST images as a dark band across the central star.

What has this all to do with the RV Tauri stars? Similar abundance anomalies have also been observed in RV

Tauri stars, however, they are less severe than in the above-mentioned post-AGB stars [e.g. 11]. The question naturally arises whether these stars are also binaries, and if so, are they surrounded by a circumbinary disc? The answer to the first question might be given by radial velocity measurements. The strong pulsations of the RV Tauri stars which vary from cycle to cycle and shockwaves disturbing the spectra make the detection of an orbital motion difficult. For a few RV Tauri stars however the orbital elements could be determined, i.e., U Mon, AC Her, EN TrA (in the GCVS classified as CEP:), and SX Cen, and orbital motion has been detected for IW Car, EP Lyr, and RU Cen [12]. Whether these stars have a circumbinary disc or not is even harder to answer. Only indirect indications based on spectral and photometric information exists. It has been suggested that the long-term RVb variations might be caused by periodic obscuration of the star by the dust disc [e.g., 13, 14]. Of the above-mentioned RV Tauri stars, U Mon, SX Cen, IW Car, and EP Lyr are classified as RVb stars in the GCVS and AC Her as an RVa star. For the two others, EN TrA and RU Cen, the ASAS data suggest that RU Cen is a RVa star and EN TrA a RVb star with a very small amplitude. The short-term amplitude for EN TrA is about 0.5 magnitude while the long-term amplitude is about 1 magnitude.

The AAVSO light curve generator shows a limited number of observations for RU Cen, while for EN TrA no observations are available. For the northern hemisphere observers I would like to point to RS Sge. RS Sge is classified in the GCVS as RVB+EA. It is the only RV Tauri star in the GCVS which is indicated being also an eclipsing binary. The GCVS mentions that two Algol-like fadings were observed at JD 2444837.22 (20 Aug. 1981) and 2444865.17 (17 Sep. 1981). The reference points to a publication in Peremennye Zvezdy [15]. Unfortunately the paper is not available online so it is unclear to me how these "Algol-like" fadings looked. The time interval between the two fadings is much shorter than the orbital periods of the above-mentioned binaries. According to the AAVSO light curve generator, RS Sge varies roughly between 11th and 14th magnitude but the observations are rather sparse. It is definitely worthwhile to put this and other RV Tauri stars on your observing program.

I would like to thank Patrick Wils for some useful hints.

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3. BOOK REVIEW - Kate Hutton The Cambridge Encyclopedia of Stars, by James B. Kaler, Cambridge University Press.

At my house, where you find a particular book says everything about its quality. The books on the living room bookshelves are either classics (such as Waldon Pond) or they have been read and deemed good enough to keep, having thus escaped a trip to Goodwill. Slightly above the living room books in quality are those found at someone else's house, as these were considered at least good enough to lend out. (Those that don't come back are perhaps slightly higher still, or maybe they are lower, if the friend or relative to whom they were lent has not got around to them yet.) Those in the bathroom have an excellent position, sharing space with Sky & Telescope and various mail order catalogs. They constitute light reading, in the active state. The books on the bookshelves in the bedroom are waiting their turn, so although they may be good, they don't have an initial strong attraction. Those piled on furniture such as bureaus are also in line, but in a more advanced position, equivalent to the bathroom books, but are expected to be slightly more weighty reading. The best books, the ones that are the most active ones in the house, are piled up on the bedside table. Here we find some light reading, but also an embarrassingly large collection of astrophysics books.

I'd like to comment on one of those: James Kaler's newly published The Cambridge Encyclopedia of Stars. I've never met one of Kaler's books that I didn't like (Extreme Stars and Stars and their Spectra having their places among the classics in the living room), so I was not hesitant to put this one on pre-order with www.amazon.com. A cursory glance at the actual book, however, almost put it on the bedroom bookshelf. It is large (enough to hurt if you fall asleep reading it), glossy, and full of color pictures and diagrams. Low-level stuff, I thought, but on that I was wrong.

As his web site will attest, Kaler is a man joyfully immersed in any amount of trivia involving stars. He explains in the preface to the Encyclopedia, how he wrote his first astronomy book Things That I Know About Stars at the age of eight. It included worthwhile information such as "there are two kinds of stars (giants and dwarfs)". He claims the current volume to be an advanced edition of this early book.

The Encyclopedia contains mathematics, but "except in the section on stellar structure", not calculus. The myriad explanations of astronomical phenomena, however, make the methods and results discussed absolutely clear.

Here is an example of Kaler's graphic and entertaining style: "At the brightest end [of the main sequence], mass loss is so great that stars not only do not make it to the M supergiant range, but never go past late class B, staying as blue supergiants before they make the turnaround. The effect is illustrated by the Humphreys-Davidson (HD) limit of the observed HR diagram. There are very few stars to the red of a sloping line in early class B that goes from high-mass limit to around 50 [solar masses] (Fig. 14.3). Below the HD limit, stars slide most or all the way across the HR diagram as they evolve. Above it, they hit the limit and bounce back to the blue side. The effect is apparently related to the Eddington limit, the luminosity at which radiation pressure acting on electrons effectively balances the inward gravitational pull. Here is the domain of the "luminous blue variables," the LBV's, stars that are so unstable that they can erupt huge quantities of matter, as exemplified by P Cygni and Eta Carinae. As massive stars loop back across the main sequence, they have lost so much matter that the by-products of nuclear burning become visible, creating first the nitrogen-rich WN version of the Wolf-Rayet stars and then the carbon WC stars (though the actual progression is argued), the lower-mass version making the B[e] stars."

I have learned several interesting things reading the Encyclopedia. For example, I had not realized that the fundamental astrometric reference frame (ICRS - International Celestial Reference System) is now-days based more on radio astronomy (very long baseline interferometry) of distant quasars, and less on optical observations. Also, I also came to realize that behind the press coverage of the Hubble, Chandra, and Spitzer Space Telescopes, there are a number of "unsung" astronomical satellites. One is Hipparcos, which measured over 100,000 parallaxes and proper motions. Our knowledge of the entire universe depends so heavily on "the distance ladder", and the distance ladder depends on parallax.

The Encyclopedia shares with Stars and their Spectra Kaler's incredibly detailed HR diagrams, which one almost needs a magnifier to read, as most stars mentioned by name in the books are included by name. Perhaps the author should publish these in poster form, for the benefit of middle-aged readers.

For the serious amateur astronomer who wants to seriously delve into how we know what we know about stars, but would rather not bother with calculus, The Cambridge Encyclopedia of Stars would be an excellent place to start. In fact, when I finished reading it, I started right over at the beginning, as there is much more information there than can be easily absorbed in one pass. For a reader who would want to employ calculus, each particular section of The Encyclopedia could still make good background reading, before a dive into a weightier textbook which may not give as clear a descriptive explanation.

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4. TRANSIENT AND CAMPAIGN OBJECT UPDATE - Dr. Arne Henden, AAVSO

Below is from a message Arne sent to AAVSO Discussion Group on June 21, 2007 with the subject line 'Transient and campaign object update':

Here are some recent updates on interesting objects:

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=15.5, 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.

V2467 Cyg
The nova peaked around V=7.5, faded smoothly to about JD2454205, had a sharp 0.3mag drop, rose back, and then underwent two more similar "eclipses" in the ensuing weeks. It is currently about V=12.4. Keep watching this star to see if other fading events occur.

V390 Nor
Bill Liller has discovered another nova (see Alert Notice 352). It is about 9th magnitude and a nice Winter object for southern observers. Based on the other novae listed in this email, you tell me what the light curve for V390 Nor is going to look like!

V2615 Oph
This nova reached a peak around V=9.0 on March 20, and has been fading since, though with some bumps and wiggles. Its current magnitude is V=13.5 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 a previous update 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.

V5558 Sgr
This slow nova appears to have topped out for the most part at V=8.39, but further increases are not out of the question. It is bright enough to be a binocular variable, and may suddenly fade - we just don't know. Monitor it closely! Watch for the 12th magnitude companion to the northwest as the star fades.

V1280 Sco
This was a fast nova, reaching a maximum around V=3.5, bottomed out at V=14.7, rose back to V=14.3 on JD 2454245, and now has continued its decline (currently about V=14.6). There is a fainter red companion about 8arcsec to the SSW, and a fainter blue companion about 6arcsec to the NNW. While the nova is still brighter than either of these two stars, they are influencing the photometry and will cause the "star" to bottom out shortly for many observers.

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 inbetween these two objects, but fainter. The nova is currently around V=14.6, 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=15.8 and the superhumps have vanished. 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.

ASAS182612
This eclipsing typeII Cepheid that Antipin, Sokolovsky and Ignatieva discovered (astro-ph/07050605), is now a campaign object for the AAVSO (Alert Notice 351). It just passed through secondary minimum and is rising back to "maximum" (the binary light curve looks like a W UMa star with period 51days). The next primary minimum will take place about July 9, though these eclipses are many days wide.

GJ436
As announced in Alert Notice 350, we are running a campaign for Greg Laughlin to monitor this new exoplanet transiting system. The transiting planet is about the mass of Neptune, and the transit depth is only 0.6percent, only visible at all because this is a red dwarf star. The planet orbit is eccentric, so other planets may be present in the system. Monitor it in and out of "eclipse" to look for other events and to time the known transit. A very tough observing project, only for the strong-willed folk, but with likely valuable scientific return.

Z UMi
You want another challenge? Z UMi, a nice circumpolar star for almost all northern observers, is an RCB type. It undergoes fading events as carbon soot is formed in its atmosphere and then gets burned off. These fades occur about once per year, but the current one is particularly deep. If you use the light curve generator, you will

see that the visual observers did a nice job down to about mag15 on this fade, and then all that is left are "fainter thans", plus a couple of CCD V-magnitude datapoints. The current brightness is about V=18, so getting a good measure is tough with most amateur telescopes, but if you have a Big Gun, see what you can do during this fading event.

We have a new campaign on Blazars just about ready to go, and a major announcement for all observers in the next couple of days. Keep tuned; we want to make your summer one to remember!

Arne

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5. A SUPERNOVA IN THE MAKING - Dr. Matthew Templeton, AAVSO

This time of the year is a great time for astronomy, since these months bring into view the densest star fields of the Milky Way. Southern hemisphere observers are treated to the awesome view of the Galactic bulge, while northern observers get lovely Cygnus all evening long. Cygnus has some remarkable objects for variable star observing, including the high-amplitude Mira variables Chi, R, and U Cyg that all come close to naked eye visibility during maxima, and the famous long-period Cepheid X Cyg. Another bright variable in Cygnus is only modestly variable today, but will one day -- some day -- put on a show seconded only by our own Sun.

P Cygni is a supermassive star, freshly-born from one of the many star-forming regions in Cygnus. At a modest apparent magnitude of 4.5, it appears somewhat nondescript, but this hides the fact that it's one of the most luminous stars in our Galaxy. It was first discovered as an apparent Nova in 1600 by Blaeu, and remained visible for nearly a quarter of a century -- much longer than any "novae" we know today. It returned later in the seventeenth century and has varied between 4.5 and 5.5 since then. We now know that it isn't a traditional nova, but a Luminous Blue Variable (LBV). These are the most massive stars known, doomed to live for just a few million years before their nuclear fuel runs out, and they die spectacular deaths as supernovae.

Supermassive stars are super-rare; only a handful exist in any star-forming galaxy at a given moment in time, and they're *only* found in galaxies currently forming stars. Their lives are so short that they come and go only during active star formation. The brightest (by far) in Earth's skies is the great eta Carinae, and its famous "homunculus" nebula was created by its own huge wind. P Cygni also has a wind, and the spectroscopic nebular line feature of blue-shifted absorption tails with red-shifted emission are given the name "P Cygni profiles" for the phenomenon first discovered in P Cygni.

P Cygni is currently (as of June 19, 2007) around m(vis) of 4.8, and it has varied by about half a magnitude around that value for the past several decades. Arne Henden released a Special Notice (#47, 2007 May 19) requesting monitoring of P Cygni, and visual observations are certainly welcome as always. It's a treat within the rich star fields of the July Milky Way, but don't expect it to vary by much over the observing season. But who knows -- if you're lucky, you might just be the first person to catch the first light of a Galactic supernova in nearly 400 years.

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