Eyepiece Views: March, 2006

E Y E P I E C E V I E W S #313

March, 2006

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1. INTRODUCTION

Spring is around the corner... Almost! For the AAVSO, quite a bit is in store. First, there is the spring meeting in Rockford, Illinois (May 4-6, 2006). We have many interesting events planned for this meeting. For more detailed information, please visit the URL below:

http://www.aavso.org/aavso/meetings/spring06.shtml

Arne has a full schedule this spring/summer. He is scheduled to give a talk at the British Astronomical Association (BAA)'s annual meeting in May. He is giving another talk in New Plymouth, New Zealand, in June at the Royal Astronomical Society of New Zealand's annual conference. August was not going to be left without a meeting, so Arne decided to fly to Prague, Czech Republic, for the International Astronomical Union (IAU) General Assembly! On that trip he will also get together with Hungarian amateur astronomers.

This issue also stands out for the guest authors it welcomes. You will enjoy reading Dr. Matthew Templeton's contribution, "Astrophysics from Visual Observations" while appreciating the wonderful piece from our avid contributor Mike Simonsen, "Recurrent Novae". Approximately 150 years 3 months ago, U Gem was discovered! In U Gem's honor, we are including a memorable article from our observer Haldun Menali to emphasize the fact that you can participate in science through variable star observing. You will read a little write up regarding the most recent status of the translations of our Visual Observing Manual.

Until next timeÉ

Thanks and good observing!

Gamze Menali, AAVSO Technical Assistant (MGQ)

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2. RECURRENT NOVAE - Mike Simonsen

With the recent outburst of RS Ophiuchi still underway, now is a great time to discuss recurrent novae. These cataclysmic variables grab our attention and spark our imaginations because of the incredible amplitude of their outbursts, typically 8-12 magnitudes, and the rarity of these spectacular events. Many of these outbursts are once-in-a-lifetime events. Like an apparition of Halley's comet, witnessing an outburst of T CrB twice in a lifetime would be a matter of uncommon luck, longevity or both.

In the General Catalog of Variable Stars (GCVS) recurrent novae are included in the same category as novae, with the main distinction being the features of their light curves.

"According to the features of their light variations, novae are subdivided into fast (NA), slow (NB), very slow (NC), and recurrent (NR) categories.

NR Recurrent novae, which differ from typical novae by the fact that two or more outbursts (instead of a single one) separated by 10-80 years have been observed (T CrB)."

This implies that the outburst mechanism, orbital periods, spectra and the nature of the components of these close binaries are the same or very similar. To understand recurrent novae we need to understand novae first, and then make distinctions.

Novae are close binary systems with orbital periods from 0.05 to 230 days. The primary of the system is a hot white dwarf star while the cooler secondary components may be giants, subgiants, or dwarfs of K-M type.

Although few novae have been caught in the very act of rising to eruption, it is generally accepted that the time it takes to go from restless quiescence to full max is 1- 3 days. The same is probably true for recurrent novae.

The cause of a nova eruption is a thermonuclear reaction on the surface of the white dwarf. After years of mass exchange between the binary pair, temperature and pressure at the surface of the white dwarf build sufficiently to cause the layer of accreted material to explode like a hydrogen bomb. This bomb, however, can have the mass of 30 Earths! Once the temperature becomes high enough, this layer begins to expand. Minutes into the process the shell can be radiating at 100,000 solar luminosities and expanding outwards at 3000 km/s. Eventually the shell envelopes the entire binary and the orbital motion of the pair acts like a propeller to whip things up. After 1000 days or so the envelope expands to the point it can be seen as nebulosity surrounding the pair. Over hundreds of years the shell dissipates into the interstellar medium.

Most novae probably erupt more than once in their lifetime, with the mass of the white dwarf determining the amount of accreted material that needs to accumulate before triggering on outburst. Systems with a white dwarf of 0.6 solar masses might take as long as 5 million years between eruptions. A system with a 1.3 solar mass white dwarf might only take 30,000 years between eruptions.

So are recurrent novae simply the same type systems with even more massive white dwarfs? The accretion rate of a system with a 1.4 solar mass white dwarf could have a recurrence time of less than 100 years. T Pyx may be one such system, but it is unclear at present if the outburst mechanism for all recurrent novae is the same as novae, or if some are the result of accretion by Roche-lobe overflow or stellar winds, or a result of disc instabilities.

Even more interesting is the possibility that recurrent novae may actually be progenitors of Type Ia supernovae. Observations of novae eruptions and the resulting nebulae indicate the mixing of the accreted layer with the outer layers of the white dwarf may cause the white dwarfs to lose mass over time and repeated eruptions. The heaviest white dwarfs, with their higher accretion rates, may actually gain mass over time! Although a large part of the envelope mass is blown away in the wind, these primaries may retain a substantial part of the envelope mass after hydrogen burning ends. The white dwarfs in some recurrent novae have now grown up to near the Chandrasekhar mass limit and might soon explode as a Type Ia supernova.

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.

Finding the stamina and determination to follow such stars is no small task. Even Leslie Peltier, one of the greatest AAVSO observers of all time, had an "unhappy affair" with T CrB that can serve as a lesson to us all. In 'Starlight Nights' he writes:

"From 1920 on I watched it closely at every opportunity. For more than twenty-five years I looked in on it from night to night as it tossed and turned in fitful slumber. Then one night in February 1946 it stirred, slowly opened its eyes, then quickly threw aside the draperies of its couch and rose!
Full eighty years had passed since the star had shattered the symmetry of the Northern Crown. And where was I, its self-appointed guardian on that once-in-a-lifetime night when it awoke? I was asleep!"

Peltier had set the alarm for 2:30 AM to observe morning variables. When he got up the sky was clear and the stars were shining, but feeling he might have a cold coming on he decided to go back to bed. He goes on to describe his personal relationship with the star, one that many of us feel for our favorite variables, and how it changed after that.

"I alone am to blame for being remiss in my duties, nevertheless, I still have the feeling that T could have shown me more consideration. We had been friends for many years; on thousands of nights I had watched over it as it slept and then, it arose in my hour of weakness as I nodded at my post. I still am watching it, but now it is with wary eye. There is no warmth between us any more."

In more recent times, CI Aql had been suspected of being a recurrent nova even though only one recorded outburst had occurred in 1917. As such it was included in the BAAVSS Recurrent Objects Programme for many years. For reasons he still will not discuss with even the best of friends, Gary Poyner, coordinator of the program, decided to drop CI Aql from the list in 2000; literally weeks before it erupted again for the first time in over 80 years! Sorry Gary, but its just too good a story not to recount.

Below is a table of known recurrent novae.
Try not to sleep through the next eruption of any of these unpredictable stars.

Name
RA/Dec (2000)
Magnitude range
Years of known outbursts
Chart availability

T Pyx
09 04 41.53 ?32 22 47.2
6.5 v - 15.3 v
Outbursts in 1890, 1902, 1920, 1944 and 1966
AAVSO charts

IM Nor
15 39 26.47 ?52 19 18.0
7.8 V - 22.0 j
Outbursts in 1920 and 2002
AAVSO charts

T CrB
15 59 30.19 +25 55 12.1
2.0 p - 11.3 p
Outbursts in 1866 and 1946
AAVSO charts

U Sco
16 22 30.80 ?17 52 44.0
8.8 V - 19.5 V
Outbursts in 1863 and 1999
AAVSO charts

RS Oph
17 50 13.12 ?06 42 28.2
4.3 v - 12.5 v
Outbursts in 1898, 1933, 1958, 1967, 1985, 2006
AAVSO charts

V745 Sco
17 55 22.27 ?33 14 58.5
11.2 p - 21 j
Outbursts in 1937 and 1989
No AAVSO charts

V394 CrA
18 00 25.97 ?39 00 35.1
7.2 V - 18.8 V
Outbursts in 1949 and 1987
No AAVSO charts

V3890 Sgr
18 30 43.32 ?24 01 08.6
8.4 p - 17.2 p
Outbursts in 1962 and 1990
Very poor AAVSO chart; lettered sequence only

CI Aql
18 52 03.57 ?01 28 39.4
8.8 V - 15.6 p
Outbursts in 1917 and 2000

AAVSO charts

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3. ASTROPHYSICS FROM VISUAL OBSERVATIONS - Matthew Templeton

The primary way we come to understand the physical world is through observation. We tie together many different pieces of methodically gathered and analyzed evidence to build a coherent picture of the nature of things. In astronomy, we're mostly limited to gathering light from the objects under study, but light can provide lots of clues into the nature of our universe. With light, we can take the temperatures of stars, and measure their chemical makeup. By looking at the properties of stars in clusters -- all born at almost the same time -- we gain some insight into the lives of stars, the workings of stellar evolution, and even the age of the universe. But there is a limit to how much we can learn from measuring the behavior of things at a given moment in time.

One of the reasons why variable stars make such excellent subjects for study is because we often learn by studying how things *change* over time. Physics is partly the study of the dynamics of systems, and we can learn about what goes on in the universe in the same way that we study the behavior of things here on Earth. However, the time-scales for evolutionary changes in stars and galaxies is much, much longer than a human lifetime, so we have to look to variable stars as objects that can change on observably short time-scales.

When observers estimate the brightnesses of stars, they're really quantifying a physical change in the star they're looking at, as manifested in the light that's given off. And there's a lot we can learn just by studying changes in light. For example, by measuring the depths of and times between eclipses in eclipsing binary stars, we can determine the orbital period of the binary, and begin matching physical models of the component stars to what we see. Or when we measure the changes in light of a pulsating variable star like a Mira or an RR Lyrae, we can measure the pulsation period (which tells us something about the star's physical size) and the overall change in brightness and the shape of the light curve (which tells us about the changes in radius, temperature, atmospheric structure, and on and on).

What makes the observational records of the AAVSO archive so valuable is that they often extend for decades, even a century in a few cases. This is important because with variable stars, we sometimes get to study the way a star that changes... changes! We try to understand variable stars in terms of easily measurable quantities, the most obvious being the time-scale on which the star varies (i.e. the period). Although most stars in the universe evolve on time-scales longer than we can observe, some of them can undergo measureable changes on human time-scales. In some cases, these changes are very subtle, and can only be seen through very careful measurements undertaken for decades at a time. For example, the periods of many pulsating stars like Cepheids and RR Lyrae stars do actually change with time. By measuring the moment at which these stars reach maximum brightness and comparing these times to those predicted by a previous ephemeris, we can sometimes see trends emerge. Sometimes these trends are well-behaved and well-understood, such as the very slow, steady period changes seen in Cepheids as they evolve through the Cepheid instability strip. In other cases, the period changes have strange glitches in rate and direction, indicating something other than evolutionary changes are going on. Such changes are sometimes observed in RR Lyrae and delta Scuti stars.

Recently, I worked with Lee Anne Willson of Iowa State University to study period changes in another class of star -- the Mira variables. The AAVSO has an enormous amount of data obtained by our observers for much of the last century, giving us a very clear record of the behavior of these stars for all that time. As a result of monitoring by variable star astronomers, it's well-known that Miras don't have well-behaved periods, but instead have periods that wander a few percent up and down over the years. What we went looking for were the stars that underwent big changes -- those that changed by tens of percent over the course of the observational record. A few Mira stars, like T Ursae Minoris and LX Cygni, have changed their periods by several tens of days over the last three or four decades, changes well-documented by the work of the observational community. What we think is happening is that deep inside the star, the dense shell of helium surrounding the carbon-oxygen core undergoes an episode of rapid thermonuclear burning, known as a thermal pulse, that then changes the interior structure of the star. These structural changes manifest themselves as a change in period that lasts for a few thousand years. After the heat generated by the thermal pulse is dissipated, the star returns to its equilibrium state and resumes more regular pulsations. Thermal pulses were predicted by theoretical and computational models of stars and stellar evolution, and these period changes are a good confirmation that this process is actively happening in some Mira stars. And it's a confirmation that comes directly from observations by amateur observers; without data archives such as those of the AAVSO and other variable star organizations around the world, such studies would be nearly impossible.

Binaries, too, can undergo changes over time. The dwarf novae are well known to undergo outbursts over irregular intervals having varying durations. Monitoring of these systems can tell us quite a lot about the physics of accretion disks; often, amateur observations of these systems are used to trigger professional observations with larger ground-based or space-based observatories that can measure these systems over the entire spectrum of light they emit, telling us even more about their underlying physics.

Amateur monitoring of eclipsing binaries has also been important over the years. Like the pulsating stars, we can measure the times of eclipse minima over many thousands of cycles and compare the observed times with those predicted by ephemerides. Often, we see strange changes in the orbital period -- something rather strange for things as large as stars to do! Such changes often indicate there are unseen physical processes at work, including magnetic fields, stellar winds, and even gravitational radiation. Sometimes these changes only become apparent after many years of observations, and it is in large part due to the observational community that our knowledge of the physics of such binaries has grown.

I've only mentioned a few different types of variable star in this article -- dozens of different classes have been described in the GCVS, and an uncountable number exist in our galaxy alone. But in large part, our understanding of these stars has advanced *only* through the work of the amateur community, including those whose equipment consists of their own eyes. Observations of variable stars have a long and important history in variable star astronomy, and the contributions of visual observers to the science of astronomy have been invaluable. They will remain so for the foreseeable future.

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4. MANUAL FOR VISUAL OBSERVING OF VARIABLE STARS - NEW TRANSLATIONS UNDERWAY!

As most of you may already know, we have currently launched a project to translate our Visual Observing Manual into other languages. The French translation is already done.

http://www.aavso.org/publications/manual/#french

We have received most of the chapters in Spanish and in Turkish and are currently finalizing the translations in both languages.

Other volunteers are working passionately to send us chapters in Russian, Greek and hopefully in Hungarian.

As you can see, thanks to the assistance of several ambitious AAVSO volunteers in various countries, the project is well on its way.

Hopefully our efforts to make the AAVSO Manual more useful to our members and observers world-wide will show some results to get more people interested in variable star observing.

The AAVSO Manual for Visual Observing of Variable Stars is a valuable and comprehensive guide to variable star observing for observers of all skill levels. This manual provides up-to-date information for making variable star observations and reporting them to the AAVSO. The most recent revision occurred in January, 2005.

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5. A DATE WITH U GEM – AN AMATEUR'S HUMBLE CONTRIBUTION TO SCIENCE - Haldun Menali

(Originally published in Turkish in Cumhuriyet Bilim Teknik on December 22, 1990)

Have you ever dreamt for years wishing that something special happened to you? Most probably you had. Everybody has some dreams in their life to make it more joyful.

As an amateur astronomer, I had a dream since the day I started observing the skies. To observe a special celestial event that no one has ever witnessed that day (rather, that night!). My astronomical observing endeavor I have been carrying on for eleven years has been focused on variable stars since 1983 (I have been observing the heavens for more than 21 years in 2000). After having started to estimate their ever-changing brightness using a pair of 8x30 binoculars and currently observing with a homebuilt 8" reflector, more than 1000 of my variable star observations have been published by several astronomical organizations around the world (As of January 2000 they reached 2000 too!). Even though I was aware that my observation results contributed to a rich database accessed by numerous professional astronomers, I wanted to get something more tangible out of my observations. I have waited with patience for so many years. Until that night...

My luck turned around when my phone rang on the night of November 23rd (1990). When I answered I recognized the voice of Janet Akyuz Mattei, the long-time Director of the American Association of Variable Star Observers (AAVSO) located in Cambridge, MA, the clearinghouse for the variable star observations of amateurs around the world. Janet told me that the cataclysmic star U Geminorum was in outburst for a couple of nights already. These kinds of events are the most interesting ones for astrophysicists who want to unveil the mysteries of stellar evolution. They try to observe these enigmatic stars on the whole electromagnetic spectrum during their outbursts (or minima) to find answers to their questions. Visual amateur observers who closely monitor these stars issue warnings when something unexpected happens. Janet explained that US scientists were planning to observe U Gem in the ultraviolet using the International Ultraviolet Explorer (IUE) satellite.

The variable had been observed at visual magnitude 9.7 from the US the previous morning. The observing prerequisite for the IUE was that the variable should have been brighter than magnitude 10.5. We had about three hours before the start of an IUE observing session that night. It would have been impossible for the satellite to observe the variable if there weren't any observation to confirm its brightness within this time frame.

I was the only one among 500 or so AAVSO observers in 40 countries around the globe, geographically the best located to observe the star within that tight time frame. It was just after civil twilight in Turkey and the star had already started to rise over the northeastern horizon. The observers in the Far East missed that opportunity as the morning was getting near there. Telling to Janet that the skies were clear and I could observe the variable, I jotted down the phone number of the astronomer who would make the ultraviolet observing in California (He was Dr. Chris Mauche whom I met in person at the AAVSO Second European Meeting in Sion, Switzerland in May 1997 and presented him with a signed copy of my original article).

Within the next half hour after Janet's call I was ready to observe. Having bundled up against the cold weather, I grabbed my reflector, eyepieces, sky charts, red flashlight and 7x50 binoculars and went out into the backyard. I was deeply disappointed to see that the sky, which was clear half an hour ago, was covered with a thick layer of haze and clouds. We the amateur astronomers are ready to face this kind of annoying and unexpected surprises. So I set up my telescope and started to wait for the sky to be cleared up.

Almost two hours had already fled and I was still waiting outside. I was exhausted standing up and started shivering because of the decreasing temperature. There was no sign of a clearing up.

When a police patrol car stopped by the backyard gate "Yeah, that was the perfect timing" I mumbled! Another common issue for the amateur astronomers is their weird working hours. Because the darkness of the night makes it almost impossible to distinguish between a bazooka and a telescope! Despite the suspicious ski mask I put on to stay warm, I would have been so convincing to the police officers that they left at last, by wishing me good luck and with a grin on their face! (They must have thought I was the crazy ONE in the neighborhood!)

Yet the clouds stayed where they were!

Waiting for that special moment in my life after so many years and hours, it was really saddening not to realize it. But I started to dissassemble my instruments by uttering to myself "don't worry, next time".

Oh my goodness! Were stars really getting brighter or was it just my imagination because of cold and fatigue? I swept the sky with my binoculars at once. Boy, I was right! The haze and clouds were almost completely dissipated!

The telescope and other stuff had been set up again in a matter of minutes, ten times faster than dissassembled! Another 30 seconds and there it was! 15 more seconds and I was estimating U Gem's magnitude as 9.7. As soon as I made my estimation I rushed inside the house to the phone. At the other end of the line in California was Dr. Mauche who thanked and told me that they were waiting for my call and they will be ready to start observing in half an hour.

When I returned to the backyard to take my instruments back inside I looked up to the sky. I was thinking about the IUE satellite. I was imagining the satellite, up there somewhere in the orbit, to be oriented toward U Gem. I was happier than ever, because I had realized my long-time dream; and because amateurs had proved their contribution to astronomy once again!

I have another dream these days... To be one of these amateurs to see a nova or a comet for the first time and become its only discoverer! Maybe, one night, you never know...

(I am getting there step by step! I was one of the just ten observers around the world (2) confirming the discovery of Nova Aquilae 1999 Number 2 on December 1, 1999; and one of the seven observers worldwide confirming the discovery of Nova Ophiuchi 2003 on July 18, 2003. I keep looking up...)

Notes:

(1) My location as of December 1990.
(2) Based on observations published in the related AAVSO Newsflashes.

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Good observing!

Gamze Menali,AAVSO Technical Assistant (MGQ)
Aaron Price, AAVSO Technical Assistant (PAH)
Mike Simonsen, AAVSO Observer (SXN)

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
25 Birch Street, Cambridge, MA 02138 USA
Tel. 617-354-0484 Fax 617-354-0665
http://www.aavso.org
