NEWSLETTER OF THE BUFFALO ASTRONOMICAL ASSOCIATION INC.

The Spectrum

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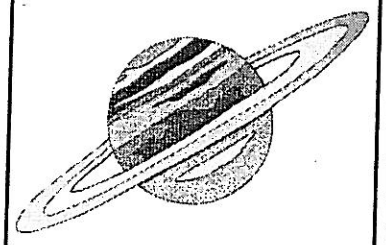
Table Of Contents



It's No Wonder ..... by Rowland A. Rupp

Its no wonder the public is often so uninformed about astronomy. Actually they're more likely misinformed. One of those "trailers" (or whatever they call those things that straggle along the bottom of the TV screen and are almost impossible to read if you're really trying to watch the program) highlighted the following for the night of December 31, 2001: Jupiter was to be at its closest to Earth, at its brightest, AND was to be "directly overhead". I assume the report emanated from the local channel. I can imagine an inexperienced observer looking for Jupiter at his or her zenith and wondering what happened to it. Fortunately, Buffalo's ever-present December cloud cover would have spared the viewer from that fate. Obviously, at our latitude Jupiter can never be directly overhead, the ecliptic just doesn't work that way. Even if we were at a latitude where Jupiter could be overhead, it would only be there for a brief time around midnight - Jupiter was near opposition on that night. I recall a newspaper report a couple of months before predicting the full moon would soon be at perigee and it too would directly overhead. Apparently the media cannot or will not differentiate between an object being close to Earth and being overhead.

I have maintained for a long time that generally whenever I read, see or hear a report on astronomy (or anything else I'm familiar with, for that matter) from the media, something, often lots of things, is wrong with it. The July 2002 issue of *Sky & Telescope* addressed this subject in their Focal Point editorial. Their finding entirely contradicts mine. They maintained that the accuracy of reports in magazines and newspapers was high, and the errors they found were all considered trivial. They claimed "experts" found no errors in 409 articles "that would seriously throw off a lay reader". It seems to me that being told something would be found overhead when it is not would throw off anyone.

The only explanations I can offer for this discrepancy are:

1. I'm too critical.
2. I'm the one that's got the facts wrong.
3. The S&T survey was flawed.
4. Local reporting is worse than most.

The first two prospects are too dreadful to contemplate; that leaves the last two. I'm doubtful about the survey. According to *S&T* the study was confined to articles on gamma-ray astronomy, supernovae and Martian geosciences - all pretty esoteric topics. I'd like to send its author some of the more mundane reports I've seen, like those above, and find out how he rates them. I suppose the last possibility is also a good one. After all, a community that can't win a Super Bowl, a Stanley Cup or balance it's budget is certainly a good candidate for getting celestial events wrong too.

Type-Ia Supernova by Bill Aquino

Supernovae are exploding stars that cause the observed brightness of the star to increase by as much as 21 magnitudes shortly after the explosion followed by a gradual fading over several months. These explosions release a tremendous amount of energy in the order of 10^{20} times as much energy as our Sun releases per second. The supernova event represents the final stages of evolution for certain types of stars. Astronomers began to catalogue and systematically study supernova phenomena in 1885 when a supernova was observed to occur in an area of the sky that we now know to be the nearby Andromeda galaxy. To date 2,046 supernovae have been discovered and catalogued. The year 2001 holds the yearly record for the greatest amount discovered with 238 so far, and still counting (as of 12/12/01 when this article was prepared).

These destructive stellar explosions are divided into two observational classifications either Type-I or Type-II based on the presence or absence of Balmer hydrogen lines in the spectra of the supernova when it is close to its maximum brightness. Type-I supernovae have no signs of hydrogen in their peak brightness spectra while in Type-II supernova hydrogen is detectable. For practical purposes the spectra of each newly discovered supernova is often taken within just a week or two of its discovery. This is because both types of supernova have a very rapid initial increase in brightness after the explosion takes place so are usually discovered just before or after maximum brightness has occurred. Within the type-I family there is a further subdivision into type-Ia, Ib, or Ic. Type-I supernovae that show ionized silicon in their spectra (at 6150 angstroms) are classified as type-Ia. If the type-I supernova lacks ionized silicon but shows neutral helium it's classified as type-Ib. And finally, if it lacks both ionized silicon and neutral helium it's classified as type-Ic. The difference between type-Ib and type-Ic is rather insignificant so some astronomers simplify things by classifying any type-I supernova that lacks the ionized silicon as type-Ibc.

All supernova except type-Ia are believed to occur when a massive star (at least 8 times the size of the Sun) eventually depletes its supply of nuclear fuel and the core collapses. This includes all of the type-II family (to be discussed in a future article) as well as both type-Ib and type-Ic which are thought to be massive stars with their outer layers stripped off by stellar winds (Wolf Rayet stars) or through binary interactions. Type-Ib having their hydrogen mantle removed while the type-Ic has both their hydrogen and underlying helium mantle's removed before the core collapse occurs. Type-II and type-Ibc supernovae have only been observed to occur in spiral and irregular galaxies and in areas of dense star formation (suggesting they are Population I stars). This evidence supports the theory that these types of supernovae are from young, quick-burning massive stars. On the other hand, the type-Ia supernova is suspected of being a completely different animal. They are thought to be the

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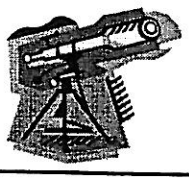


Astronomy Day

Astronomy Day Celebration Saturday, April 27

The BAA and the Buffalo Museum of Science will be teaming up for an Astronomy Day Celebration at the Museum on Saturday, April 27, from noon until 4:00 PM. The BAA will have the Cummings Room for telescope clinics, displays and demonstrations and the Auditorium is also ours for slide shows and short talks. The Walking Tour of the Solar System will wind its way around the Museum grounds as well. The Museum plans to have their Star Station 1 exhibit on display, and they'll be holding shows in the Starlab portable planetarium.

We need your help! Especially folks who'd like to run an activity or demonstration, or present a short talk. If you'd just like to show up and help people get their new, confusing telescope up and running, or just help greet people and introduce them to the BAA, that's great too!
C'mon down, it's sure to be a good time. The Museum will be advertising this in their "Collections" newsletter, and the weekend of 4/27-28 is the last weekend of the "Grossology" exhibit. They expect to have quite a crowd.

Planning is now underway and we're just starting to outline what types of talks and demonstrations the BAA will present. If you've got an idea, would like to help out, or would just like to make a suggestion, please give me a call or send me an e-mail.
Thanks!
Bob Titran

BAA Web Site

Tom Bemus and Bill Smith put together a club web site at :
http://members.aol.com/BuffAstro/

Meetings

BAA meetings are held on the 2nd Friday of the month from September to June in the New Science Building on the Buffalo State College Campus. Meetings start at 7:30 pm and all members and guest are encouraged to attend.

Observator News by Bill Aquino

Observatory News
There has not been much happening at the observatory since the last Spectrum issue. A lot of clouds, snow, and the cold tend to keep the observers away. The logbook shows a couple of entries on the few partly cloudy nights we have had. Things will pick-up again when the weather improves this spring.

Volunteers Needed
We are still looking for volunteer speakers for the 2002 Public Night season. If you are interested in volunteering please contact Bill Aquino at 731-9366. There are currently three confirmed speakers and many remaining dates to choose from. Dates are selected on a first-come first-serve basis, so if you are interested in a particular weekend, sign-up early. You can pick any "available" date from the list below that is convenient for you.

April 6 - **Bill Aquino**
April 20 - available

May 4 - available
May 18 - available

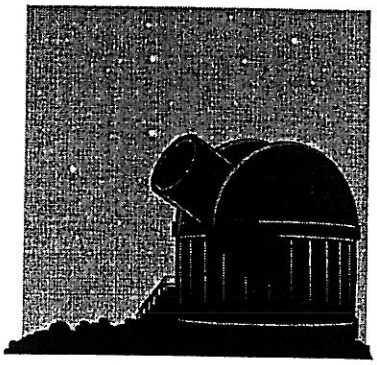
June 1 - available
June 15 - available

July 6 - **Ed Cersani**
July 20 - available

August 3 - available
August 17 - available

Sept 7 - available
Sept 21 - **Roland Rupp**

Oct 5 - available
Oct 19 - available



Note: If you will need any special assistance or AV materials for your talk let me know.
Thanks.

For Sale

Discovery 8" f/6 Dobsonian Telescope
1 Year Old
96% Enhanced Mirrors
Great Views, Like New
Cost $475 will sell for $325
Call Bud Abate at 773-3232

Meade Finderscope 6x30
Like New $35

Bushnell Binoculars 7x35
Like New $35

Call Ralph Green at 649-5911

(Continued from page 1)
explosion of an "overweight" white dwarf, one of the smallest stars known to exist. These stars are only about the size of the Earth.

When a moderate sized star (less than 8 solar masses) depletes its store of nuclear fuel there is not enough overlying mass to collapse the star. Instead, the outer layers are progressively sloughed-off in a much gentler manner and the star goes through the planetary nebula phase. This is suspected to take from 10,000 to 100,000 years and represents just a brief period in the life of a moderate sized star. What's left after this shedding process is the small, dense, and very hot, exposed core of the original star. We would expect this core to slowly cool over billions of years to a cold cinder, unless of course there is a nearby companion star. About half of the stars in existence are suspected of being in binary or multiple star systems. As a white dwarf and a companion lose angular momentum and move closer together the dense white dwarf begins to siphon material from the companion. The additional material causes the "overweight" condition that ultimately leads to the destruction of the white dwarf in the type-Ia supernova event. When the mass of the white dwarf increases to more than 1.44 times the mass of the sun (known as the Chandrasekhar limit) gravity overcomes quantum mechanics and the dwarf explodes violently. These explosions are the brightest in the universe and can even at times outshine the entire galaxy where they occurred.

Type-Ia supernova are observed to occur in stable areas of both spiral and irregular galaxies as well as in elliptical galaxies and are therefore thought to be older Population II stars. In addition, compact neutron stars have not been found in the remnants of type-Ia supernova, as they sometimes are in the remnants of the core collapse supernovae. There is also no known core collapse process able to explain the amount of energy released in a type-Ia supernova. All of the current supernova models indicate that too much of the explosive energy from the core collapse of a massive star would be absorbed by the overlying layers of material to account for the type-Ia's brightness. Instead something about the mass of the sun has to be completely destroyed, without absorption from overlying material, in order to explain the brightness of the type-Ia supernova. These findings point to the destruction of a white dwarf as a reasonable explanation. However, similar models of the type-Ia event are also used to explain the behavior of a classical nova. But in the classical novae explosion hydrogen is the dominant element detected in the spectra and the white dwarf is not destroyed. If the models of the type-Ia supernova and the classical nova are correct then it stands to reason that the two types of event are somehow related. Perhaps the classical nova is a precursor to the type-Ia supernova. It is theorized that all classical nova are actually recurrent nova but with periods so long that the relationship has not been verified. If so, a possible scenario might be that the white dwarf and companion start to draw closer, classical novae explosions begin to occur gradually (separated by thousands of years). As the distance continues to decrease between the stars the classical nova events increase in frequency. Essentially a recurrent nova develops followed by cataclysmic variability. This continues until the mass transfer is so great the white dwarf can no longer "blast-off" the additional material as it does in the classical nova event, and destruction results from a type-Ia supernova grand finale event. By the time of the type-Ia supernova event the outer hydrogen layers of the companion star are long since gone explaining the lack of hydrogen observed in the spectra of the type-Ia supernova.

Another interesting aspect of type-Ia supernova is their possible use as a standard distance indicator. A very good explanation of this potential was published by David H. White in an article titled "Supernova: Mileposts of the Universe" (Sky and Telescope, January 1985, page 18) where he explains;

"The spectra and light curves of type-II supernova show considerable variety, but those of type-Ia are remarkably uniform. According to Craig Wheeler (University of Texas), "You can lay the spectra [from different type-Ia supernova] down on top of each other, and, while the intensities may be slightly different, the same features are visible at the same time. The uniformity of type-Ia events is a consequence of the critical nature of white dwarf explosions. All white dwarfs that accrete sufficient material from a companion for their mass to exceed 1.4 Suns must have had essentially the same life history. Moreover, when they collapse and explode they all have *exactly* the same mass. This similarity is the secret of using type-Ia supernova as distance indicators. If their explosions are identical, then the only difference between two type-Ia events will be a consequence of their distances."

Although this is an idea with great promise there has developed some sticky difficulties. By measuring the peak brightness of a large number of observed type-Ia supernova astronomers have found a discrepancy exists in the "measured distance" between type-Ia supernova which occur in nearby galaxies and those that occur in more distant galaxies. If type-Ia supernovae are indeed standard distance indicators then this discrepancy should not exist. Professional astronomers have been working hard to resolve this problem. They have even used the Hubble Space Telescope extensively in a recent campaign (Sept. to Nov. 2001) in order to collect data to help resolve this issue. Hopefully, some positive results will come soon and we will have an additional distance yardstick to lay alongside the redshift yardstick in order to check its accuracy. I suspect we may find out some interesting things about redshift distance measurements if we only had something else reliable to compare against.

Another way of identifying supernovas is by plotting their light curves. The light curves of type-Ia supernova have a sharp initial maximum followed by a gradual smooth fading. The light curve of a typical type-Ia supernova is shown in figure 1. There is a very sharp rise in brightness followed by a gradual decline over several months. A great way to learn about and become comfortable with type-Ia supernovae is to observe one. To do a good job of this however, requires a good candidate to study. Thanks to the considerable efforts of both amateur and professional supernova hunters we have a large sampling of candidates each year to choose from. Those supernovae that are suitable for amateur study, I like to refer to as "campaign" supernova. Supernovae that fit into this category generate a lot of interest and observation from the amateur community. To qualify the supernova must be well placed for northern observers in the eastern sky in the early evening. This will allow the object to be studied over several months before disappearing into the Sun's glow. Evening observation is important because this is when most amateurs are available to observe. The supernova and host galaxy must be bright enough to observe with the typical amateur CCD system. This puts things in the 12th to 18th magnitude ranges. And finally, the supernova must be well placed within the host galaxy. If the supernova is too close to the host galaxies core or a bright HII region (knot) then differential photometry measurements become to difficult and the resultant light curves are overly distorted.

It just so happens that we had a really nice "campaign" quality type-Ia supernova candidate during this past year. It was SN2001V. Supernovae are named by the year of their discovery followed by a consecutive letter of the alphabet (double letters once all of the alphabet characters have been used). Therefore SN2001V was the 22nd supernova discovery in 2001. Professional astronomers from the Harvard-Smithsonian Center for Astrophysics Supernova Group discovered this supernova on February 19th, 2001 while they were performing routine spectral observations of potential supernova host galaxies. As luck would have it the discovery was made well before maximum brightness and the amateur community responded in earnest. During the roughly 4 month period from late February until early July several dozen amateur astronomers from around the world recorded almost 200 brightness estimates of SN2001V. The supernova was very well placed near the outskirts of the host galaxy NGC-3987 so the differential photometry estimates were less affected by the galaxies background brightness allowing for reasonably accurate estimates. At least as well as supernova estimates can go any ways. Supernovae are inherently difficult to estimate because they are often buried in so much background light from the host galaxy. SN2001V also had a generous collection of nearby reference stars to compare its light changes against. One of the images of SN2001V taken at the clubs Beaver Meadow Observatory (on May 9th, 2001) is shown in figure 2. You can see that the supernova is very well placed for study and the pretty edge-on host galaxy is reasonably bright (magnitude 13.89). The supernova was also easy to locate being about 9 degrees away from the bright star Deneb in the constellation Leo. The constellation of Leo is very well placed for northern observers during the evening in the spring and early summer.

Using all of the amateur observations I could get my hands on I decided to plot the light curve for this object. Observations were gleaned from the amateur databases of VS-Net (Japan), AUDE (France), The MI Group (Spain), and the AAVSO (USA). Simply taking the collected observations and plotting them out "as is" would create a horribly distorted light curve looking nothing like the typical example shown in figure 1. The reason for this is because the estimates come in basically six different flavors. All of the 200 or so estimates could be grouped into one of six category's with each category repre-

(Continued on page 4)

(Continued from page 3)

senting observations made with a detector, having a different sensitivity, than observations from the other groups. The six groups included observations made in the Johnson-Cousins photometric B, V, and R bands, also two distinct groups of unfiltered observations including those made using "R" band reference stars and those made using "V" band reference stars, and finally visual estimates. Yes, there are some amateur astronomers with the skill, dark skies, and large enough telescopes to make 14th and 15th magnitude estimates, its pretty impressive. Before plotting the light curve all of the estimates had to be "adjusted" to correct for the differences in sensitivity between them (this is called validating the observations). Once the adjustments were made the data was plotted and the light curve shown in figure 3 was produced. The sharp peaks and valleys in the curve are artifacts from the adjusting procedure as well as individual measurement scatter. Even the same observer measuring repeatedly will get small variations in the measured values, regardless of what is being measured. Also, the adjustment value used for each group of measurements was difficult to determine accurately and only a best guess on my part. Despite these anomalies the amateur light curve shown in figure 3 is remarkably similar to the typical curve shown in figure 1. There is a sharp initial rise in brightness (peak about 13 days after discovery) followed by a smooth gradual fading until the supernova dimmed below the range of amateur CCD systems at around magnitude 18.5. In all, 5 brightness estimates were contributed to the light curve from observations made at the clubs observatory (BMO) using the 12" CCD system and each is indicated on the curve.

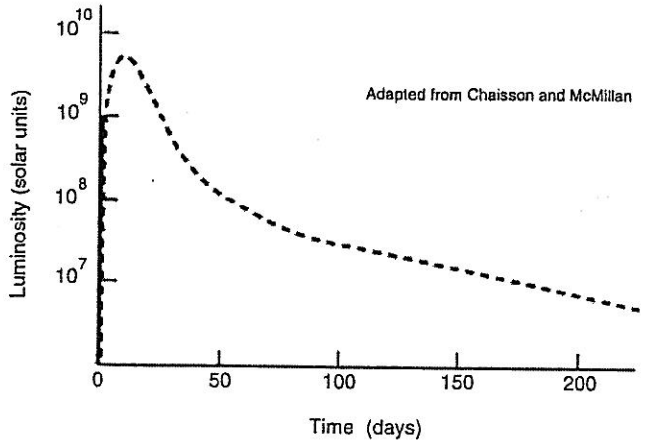


Figure 1: Typical type-Ia light curve.

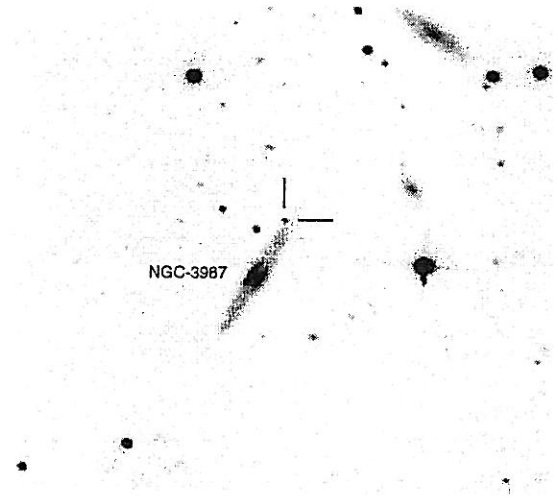


Figure 2: BMO image of SN2001V.

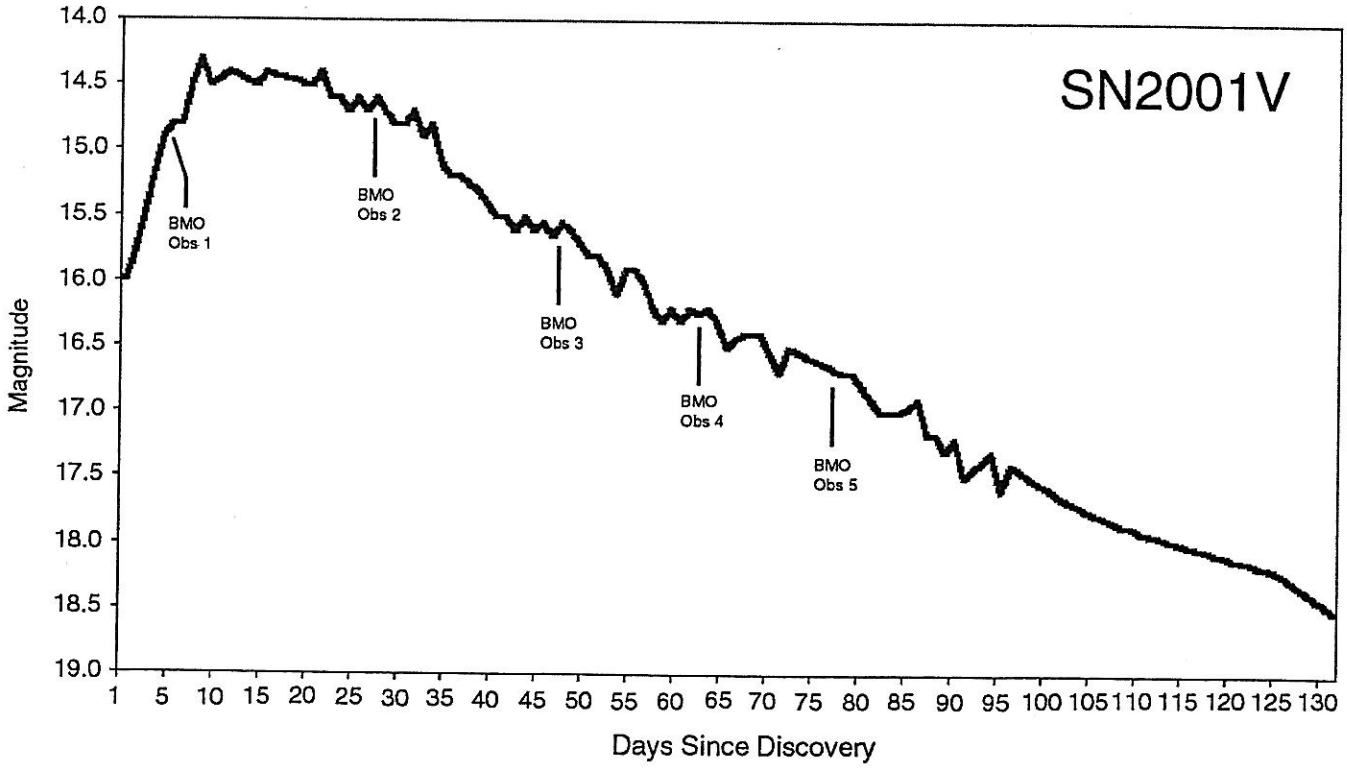


Figure 3: The amateur light curve of SN2001V.

BAA Annuals by Rowland A. Rupp

5 YEARS AGO - One of our best attended dinner meetings was held in March 1997 at Bullfeathers where Ivan Sememiuk was our speaker. His subject was Comet Hale-Bopp, a topic to which much of *The Spectrum* was devoted. In April we heard from Gene
Witkowski, who showed us his excellent video images of the moon and the planets.

Tom Bemus contributed an article to *The Spectrum* entitled "The 'Right' First Scope", a handy guide that beginners might
want to locate and read. "Barnard's Star" was the title of Leslie Martin's article that not only highlighted the history of this intriguing object, but also gave a brief biographical sketch of its famous discoverer. Paul Carroll added a few technical comments to augment those of Joe Orzechowski and Rowland Rupp in the preceding *Spectrum* pertaining to Allen Goodrich's articles on his views of the behavior of the universe. Thanks to Larry Carlino, we even had a stellar sonnet.

10 YEARS AGO - In March 1992 Fred Price entertained us with an unusual topic, "Astronomy on Cigarette Cards". Regrettably I missed this talk, but I believe that Fred described cards in cigarette packages he collected while living in England that highlighted astronomical objects. The next month Paul Mazierski, a geologist, spoke on "Volcanism in the Solar System". An NFCAAA meeting was to be held in Hamilton, Ontario in early May.

Edith Geiger wrote a biography of Vern Siegel, an accomplished electrical engineer, entrepreneur, radio operator and astronomer. Bill Smith wrote a primer on "Low Power Eyepieces" that is general enough to remain current. We had a couple of articles from members of other clubs, most notably from an old friend from Canada, Peter Jedicke, who wrote on Galileo.

15 YEARS AGO - Our March 1987 speaker was Jim Stegner who told us about his experiences while directing work on our first Orbiting Geophysical Observatory (OGO). John Croucher, spoke in April. As an ECC student in materials science, he won the Dow
Chemical Magnesium Design Contest for his low weight, low cost, portable telescope, which he described for us. The NFCAAA spring meeting was scheduled at the Corning Museum of Glass. For those who don't know, the NFCAAA is the Niagara Frontier Council of Amateur Astronomical Associations that was originally composed of about a dozen clubs, founded largely by the BAA's Ed Lindberg around thirty-five years ago. It still exists, but is much less active than in the past.
Rowland Rupp reported on a conference on creation at the University of Rochester. Speakers at the particular session he
attended were: Fred Hoyle, Robert Jastrow and Harlan Ellison. As might be expected, Hoyle championed his Steady State theory while Jastrow was more conventional. A brand new member, David Czuba, wrote a pair of articles for *The Spectrum*. One was inspired by Leslie Martin's earlier article on the anthropic principle, the other extended his views on the fallibility of human comprehension. A bit less esoteric was Carl Milazzo's article on the current achievements of amateur astronomers. Carl also provided the lone observation report.

Darwin Christy wrote a report on Japanese astronomer Shigeru Morikubo's book on micrometeorites. Darwin failed to mention that his own extensive research into micrometeorites played a prominent role in the book. That's all right, Edith Geiger set the matter straight in her "Spy & Tell". Darwin, ever prolific, also contributed notes on three southern constellations and the German astronomer Galle. Regrettably, Paul Noye's obituary appeared in this *Spectrum*.

25 YEARS AGO - George Keene gave a talk on astrophotography at our March 1977 meeting. George was employed by Eastman Kodak and was an expert in this field. At the next meeting Jack Mack told us about the "Search for the Missing Mass". As far as I know we're still searching. The Bob Kartyas Memorial reflector was displayed at the March meeting after Bob Mayer had refurbished it. It's still in service at BMO. The BAA was gearing up for a telescope and astrophotography exhibit at the ECC South Towns Campus planned for April.

Larry Carlino wrote an article on "Observing Jupiter". In it he described the planet's many features, and addressed which could be seen with different size telescopes. Carl Milazzo's article on precession noted not only the sequence of stars that would be the "North Star" over the 25,827-year cycle; he also listed which would be the "South Star". Right now its Sigma Octantis, a fifth magnitude star about one degree from the pole.

35 YEARS AGO - At our March 1967 meeting, Ray Manners discussed the Apollo program, emphasizing its lunar exploration phase. Ron Clippinger also spoke on "The Search for the Planet Vulcan". In April the BAA's Dr. Seville Chapman spoke on "The Ellipse" .

The Lunar, Observing, and Advanced Study Sections of the BAA were all active at this time; their meetings were reported in The *Spectrum*. Work was still going forward on the regional astronomy convention to be hosted by the BAA later in the year. On March 1, 1967, the Buffalo Museum of Science dedicated its new solar observatory. Cited for contributions to this effort were several BAA members including: Walt Semerau, Ed Lindberg, Dick Zygmunt and F. Shirley Jones.

Spy and Tell by Edith L. Geiger

Over the past 6 months, Tristan DiLapo has done some isometric measurements on 80 different asteroids. He has decided to sell the CCD he has used over the last couple years and get an even newer one that covers 3 times more area of the sky. It is called ST9, and is made by Santa Barbara Instruments. Gary Flagg has new night vision binoculars, good for Earth use as well as the night sky.

On January 21st, John Yerger, well-known artist, and former BAA member, was at the Partners in Art Studio, 83 Webster St, North Tonawanda, from 6:30 - 8:30 P.M. where he critiqued paintings of those who attended, evaluating and making suggestions and possible strategies.

On January 23rd, Darwin Christy was the speaker at the Lions Club meeting held at the Buffalo Launch Club on Grand Island. He spoke on "Comets, Origin and Destructive Power." He has been invited to speak in March at the Autumn View Health Care Facility on Southwestern Blvd. in Hamburg. Darwin is also busy working on his autobiography. To date, he has written 46 chapters.

Gerry Cook looks forward to winter snows, so she can enjoy invigorating snowmobiling.
Bob Hughes, along with many others, observed the breathtaking Leonid meteor shower from Beaver Meadow. He introduced an additional activity, that of naming the background constellations as seen through the spectacular shower.

Lynn Sigurdson and daughter, Hannah, performed in a figure skating exhibit at Buffalo First Night (New Years). Son, Ryan, may be going to the state hockey championship in March. He belongs to the North Buffalo Squirts II team.

Last year, Marilou Bebak received a grant from Cornell to write a high school biology lab book on the West Nile Virus. She has finished the book which will be presented to Cornell in July.

Steve Kramer will have a web page on the ancient Greek "Antikythera Mechanism."

Since her retirement from Williamsville High School in June, Jayne Mack has become
a member of a Bible group, "Women of the Word."

Carl Milazzo will be speaking on constellation hopping to the Boy Scouts in Algonquin on the weekend of March 8th.

Larry Carlino is in the process of compiling a book of his poems. Most of his poetry is written in sonnet form on subjects such as nature, death, and things like 9 -11. He also writes novels and short stories. We wish the best to this very accomplished and exceptionally talented human being.
Enjoy the sweet days of spring!

If You Were a Geek (Part 2) by Leslie Martin

Did you ever stop to think what you would know about astronomy if you lived in the past? In the May/June 2001 SPECTRUM we explored the progress of Greek astronomy up to the time of Aristotle, whose views on this subject, as well as many other sciences, were the last word well into the Renaissance. By the time we left off, Greek astronomers had discovered that the Earth was a sphere and the moon shined by reflected sunlight. Hence the cause of eclipses could be explained, but predictions of their occurrences could be made only by observing repetitive patterns. Though thwarted by retrograde motion, the early Greeks formulated various explanations of planetary motion, most with a stationary Earth, even one with a moving Earth, all leading up to the mechanical model proposed by Aristotle.

Aristotle's extension of the view originated by Eudoxus that the universe was composed of a series of rotating, concentric spheres to which were affixed the various celestial objects, all centered on the unmovable Earth, did not go unchallenged.

Heraclides, whose lifespan overlapped Aristotle's, is credited by some (but not by all) with initiating an approach, brought to fruition by Aristarchus, that refuted the immobility of the Earth. That Heraclides was the first to propose that day and night are caused by the rotation of the Earth about its axis is widely accepted. What is less certain, though probable, is that he originated the idea that the orbits of Mercury and Venus are centered on the sun. According to his view the sun still traveled around the Earth, but carried the inferior planets with it. In so doing, they were at times closer to Earth and hence brighter, while at other times they appeared dimmer because they were farther away, on the other side of the sun. This phenomenon resolved, at least for Mercury and Venus, the issue of how they could change in brightness, an impossibility if they traveled in perfect circles on perfect spheres centered on the Earth.

Aristarchus improved upon Heraclides's scheme by maintaining that all the planets revolved around the sun and, moreover, the Earth was one of them! This theory, dating from the middle of the third century BC, predated Copernicus's resurrection of it by about eighteen centuries. Not only did Earth rotate, but it also went around the sun in a circular orbit. To offset any criticism that if this was the case the stars ought to show parallax, Aristarchus asserted that the stars were so far away (not necessarily a new point of view) that any motion was

undetectable. So appalling was this hypocrisy that one Stoic philosopher and religious enthusiast, Cleanthes, suggested that Aristarchus be charged with impiety, somewhat reminiscent of the complaint lodged against Anaxagoras a couple of centuries earlier when he proposed that the sun was a red-hot stone larger than the peninsula on which Athens stood.

The size of celestial objects was one of the astronomical problems tackled by these later Greeks. Aristarchus addressed an

issue that plagued past astronomers - what was the size of the sun and the moon. Exactly what angular size he obtained for the sun is open to debate. In his own writings he stated the angular size of the sun is 1/15 of a zodiacal sign, which comes out to be two degrees, vastly more than its true size. Yet Archimedes, who was about 25 years younger than Aristarchus, credits him with finding the sun's diameter to be 1/720 of a full circle, half a degree, which is just about right. In either case Aristarchus surely must have been aware that the angular size of the moon was

nearly the same as the sun - how else could solar eclipses occur?

By assuming the sun was physically much larger than the Earth, Aristarchus appreciated that the shadow cast by the Earth was a cone having approximately the same angular diameter as the sun's disk. Observing a lunar eclipse, he concluded that the moon's disk filed about three-eighths of the Earth's shadow. Simple geometry led him to conclude that the moon's diameter was roughly one-fourth the Earth's and that its distance was around thirty times the Earth's diameter. Both of these conclusions are correct, the only problem was, nobody at the time knew the diameter of the Earth.

To the rescue came Eratosthenes, who lived later in the third century BC. He was the first to determine the true size of the Earth. His result was based on measuring the lengths of shadows cast by the sun at two locations at different latitudes which enabled him to find the angular difference between them. By knowing the length of the baseline between these two positions he calculated the circumference of the Earth within an accuracy of a couple of percent of the real value. This coupled with Aristarchus's relative sizes of the moon's diameter and distance at long last gave astronomers their first true dimensions of celestial objects. Aristarchus tried to extend his success by measuring the distance to the sun in the same relative way he did for the moon. He postulated correctly that if he could determine the exact point in the moon's orbit where it was in quadrature, that is, when it was exactly at quarter phase, and also determine the angle made between the moon and the sun at that time, he would know all the angles made by the triangle formed by the Earth, the moon and the sun. Since he knew the relative distance to the moon, he would be able to calculate very simply the relative distance to the sun. His conclusion was that the sun was nineteen times more distance than the moon. The real answer is about 400 times. This major error resulted not from any deficiency in the theory, but rather from the practical problem of determining exactly when the moon is at quarter phase.

This first effort to establish a sun centered universe and a mobile Earth met with little support, and it soon vanished from the astronomical scene. Replacing it were modifications of Aristotle's theory of spheres concentric with the Earth on which the sun, moon and planets traveled. Two mathematical hypotheses were formulated during the third and second centuries BC that yielded essentially identical results. One was the epicycle theory and the other the eccentric theory. In the former the Earth is at the center of a perfect circle, the deferment, located on a perfect sphere. The planet rides on an epicycle, another perfect circle on a perfect sphere whose center moves along the deferment. The rate at which the planet travels on the epicycle and the rate the center of the epicycle travels along the deferment can be adjusted to approximate the planet's motion on the sky, including retrograde motion. The two circles could be tilted with respect to the plane of the ecliptic and to each other to account for the fact that the planets have orbital planes that are inclined to the path of the sun.

In the eccentric construction the planets still travel around the Earth, but the center of the circle on which they move is displaced from it. This center for each planet's circle lies on the circumference of another circle centered on the Earth, and moves at the same angular rate as the sun. As before, the combination of rates of motion on these two circles can be made to match planetary motion closely. It has been shown that these two methods of accounting for planetary motion are equivalent. The center of the circle carrying the planet in the eccentric model originally was the sun, but in some later refinements this point was offset from the sun to accommodate observations. About eighteen hundred years later Tycho Brahe would present his system which is similar to this eccentric model.

Scholars are uncertain just who originated the idea of epicycles and eccentrics because often the seminal material is lost and much of what we know about the works of Greek astronomers is obtained from later writers who attributed certain discoveries to their predecessors. Heraclides is generally known as the originator of the epicycle hypothesis, at least for the two inferior planets. Apollonius, who lived in the latter half

of the third century BC contributed significantly to, or may have been the originator of, the theory of eccentrics. By the time of Hipparchus, around the middle of the next century, both theories were well developed. Hipparchus commented that it was worthy of investigation to determine how two different mathematical models could yield the same result. He, along with other Greek mathematicians, favored the epicycle theory which was more readily applicable to Mercury and Venus and was considered "more natural", but had to admit he could not tell which motion was real and which was apparent. Either way, his acceptance of a geocentric universe sealed the fate of Aristarchus's heliocentric hypothesis for nearly two millennia.

Hipparchus was one of the first Greek astronomers to make use of data and techniques obtained from Babylonian astronomers. He created his own star catalogs and, in the process, formulated the concept of precession. His estimate of its rate was short by about ten percent of the 50 seconds of arc per year we now know is true. He is believed to be the inventor of the astrolabe, an analog computer used before the birth of Christ, although none of his works on the subject survive. His six magnitudes of brightness for naked eye stars remain in effect today.

Much of what was achieved in Greek astronomy was documented by Ptolemy in the second century AD. His detractors contend that he merely summarized what others had learned before, but more often Ptolemy is recognized as an accomplished astronomer, mathematician, geographer and astrologer. His ancestry was Greek like many Egyptians in that era, Egypt having been conquered by Greece centuries before. His name was common in Egypt, but although he shared it with Egyptian kings, he was not a member of royalty. His great work, known today as *The Almagest,* was translated and re-translated during the "Dark Ages", first into Arabic, then into Latin, even into Sanskrit

(Continued on page 7)

(Continued from page 6)

where it ruled as the definitive work on astronomy until the time of Copernicus and, for some, beyond. Although Ptolemy's concept of the heavens was based on the Aristotelian model, much of his source material was obtained from the work of Hipparchus. He developed an arithmetical base, thanks to his Middle East resources, for his work which led to tables that facilitated finding solar, lunar and planetary positions, all based on the theory of epicycles, but with many embellishments of his own. His model for the motion of the planets included an idea developed by earlier theoreticians that the center of the deferent circle was offset from the Earth. Originally this innovation had the center of the epicycle moving along the deferent at a constant angular rate about the deferent's center, sometimes called an eccentric. Now he introduced a modification by having the angular rate at which the center of the epicycle moved on the deferment to be constant with respect to still another point, the equant. The equant was constrained to lie on an extension of the same straight line between the Earth and the center of the deferent on the opposite side of the deferent's center from the Earth, but at an equal distance from it. Ptolemy was often criticized for introducing the equant because it was regarded by some as a surreptitious way to circumvent the centuries old requirement for uniform, circular motion in the perfect heavens. All of this complexity was designed to provide additional degrees of freedom in determining the position of the planets before Copernicus and Kepler showed up to explain how things really were.

Ptolemy was the first to incorporate lunar parallax into his calculations, and was able to predict the occurrences of eclipses based on geometry rather than repetition of past eclipses. He was the first to introduce the concept of the "equation of time", a result of the eccentricity of the Earth's orbit and its axial inclination, into his calculations. His catalog of 1022 stars in 48 constellations was a standard reference for the next millennium and a half. And, showing the common heritage shared by astronomy and astrology, he wrote an extensive treatise on the latter subject, the *Tetrabiblous*, that enjoyed similar longevity.

At this point we will leave Greek astronomy. For the next fifteen hundred years Western astronomy progressed little, if any, beyond it. Fifteenth century university students studying the subject, which was regarded as an essential subject for an educated man, read the teachings of Aristotle and Ptolemy. Those who were gifted might be able to master the complex mathematics of epicycles, equants and eccentrics that enabled them to compute the positions of the planets. Those more gifted might refine Ptolemy's tables to account for discrepancies in these positions that accumulated as the centuries passed. The moon and the sun were still regarded as planets, and astronomers had the order of them just as wrong as they did in the era before Heraclides. They were ordered in progression of their periods: first the moon, then Mercury and Venus, next the sun, then Mars, Jupiter and Saturn. Beyond that was the sphere of the stars. The crystalline spheres of Aristotle were retained, until Tycho Brahe concluded that the comets were beyond the sphere of the moon and would go crashing through the planetary spheres if they really existed. Eclipses had become predictable, as had retrograde motion and precession, even if the physical causes of the latter two were not yet understood. What the planets, comets, meteors and stars really were remained a mystery for future astronomers and physicists to determine.

While we may chuckle at the some of these peculiar constructions and erroneous conclusions, they were laboriously obtained over centuries of observation and study, worked pretty well, and marked an intellectual achievement of high order. It was a form of science before modern science was invented.

Leslie Martin

Camping Under 6th Magnitude Stars by Carl Milazzo

I know of several club members, who enjoy camping, but would also like to combine it with outdoors Astronomy activities. Observing alone, sometimes can be spooky, and on a rare occasion, can be some what dangerous. It is safer and more fun as a group, weather with the family, friends, or with club members. The long drive back home after midnight, can be dangerous, from deer, fog, or from simply falling asleep at the wheel; all these problems can be solved by camping. If it suddenly clouds up, you can head back to your campsite, and make a campfire. If it clears up latter, set up your scope at a dark and open area like a baseball diamond, beach, or fishing spot along a lake or creek. Some scenic overlooks have treeless horizons, which are great for observing objects in Scorpious and Sagittarius.

Some campgrounds have too much light pollution, and too many trees to make observational astronomy, an activity at their location, but not all campsites.

The following are some of the best that I have found that are great for your outdoors astronomy activities, and in the day time, your family, friends, and other club members will find enjoyable too.

1. The Beaver Meadow Wilderness Campground 457-3101, one mile south of our club observatory.

2. Rock Point Provincial Park 905-774-6642, 35 miles west of Buffalo. Your south horizon is looking over the 30 mile wide Lake Erie, from it's sandy beach, which is open 24 hours for swimming. Some of it's camp sights are on the edge of the beach. Less than a mile off shore, is an island with a abandon lighthouse. This campground will even let you camp for free, if you give a talk on astronomy or nature, to the campers.

3. Lake Side Beach State Park 682-4888, 45 miles N.E. of Buffalo, on the shores of Lake Ontario, in Orleans County. A great place for watching aurora, and meteor showers, because of its dark zero degree northern horizon, overlooking 40 mile wide, 100 mile long light free Lake Ontario. Because there are none of the thousand of lights from cars, barns, roads, houses, stores, ect.

4. Fair Haven Beach State Park 315-947-5205 on Lake Ontario, 120 miles east of Buffalo, half way between Rochester and Syracuse, N.Y. .It has a wide sandy beach, a long concrete pier, camping on the summit of a hill that is 120 feet above the lake, with a cliff on the lake side. You will have a 360 zero degree horizon, which is great for sun sets, sun rises, the moon, aurora, ect. Even the Sterling Renaissance festivals, are only 3 miles away.

5. Ontario County Park 716-374-6250, 75 miles S.E. of Buffalo, and 6 miles north of Naples, N.Y., near Lake Canandaigua, one of the finger lakes. It is on the top of a hill, elevation 2,200 ft, which is largely treeless for a thousand feet in all directions. Seeing 6.5 to 7.0 magnitude star by eye is common. A mile south of the park is the Mees observatory of the University of Rochester, in which it's dome houses a 24 inch scope, that holds public nights. The park has a spectacular view called "The Jump-off", which drops vertically 1,200 ft, to the valley below.

6. Letchworth State Park 716-493-3600, 50 miles S.E. of Buffalo. Many of it's overlooks, have besides it's splendid earthly vistas, also dark zero degree horizons.

7. Allegany State Park (Quaker Section) 716-354-2182, 60 miles south of Buffalo. Near the dam is a dark parking-lot, with it's best horizon looking south over the lake, with a majestic view of the distance hills and valley.

8. Allegany National Forest of Pennsylvania (Tracy Ridge section) 10 miles past the New York State border, on Rt 321.One section has a large open field with great horizons and dark skies, elevation 2,200 ft.

BAA member, the late Ed Lindberg, started the N.F.C.A.A.A., which is a federation of local astronomy clubs that would get together at least one a year. In that kind of sprit, wouldn't be nice to get know our neighboring astronomy clubs a little better, by observing together from truly great locations.

MEETING CANCELLATION POLICY

If, for any reason, (most likely snow or ice storms), there might be cause for cancellation of the meetings of the B.A.A., tune your radio to either WBEN (930) or WGR (550). Also if Buffalo State College has been closed due to inclement weather, so will the meeting of the B.A.A be cancelled.

BEAVER MEADOW TELEPHONE

The telephone at Beaver Meadow, 716-457-3104, is for emergency use only at no cost. Local calls may be placed for a small charge - see the collection box by the phone. This phone cannot make long distance calls.

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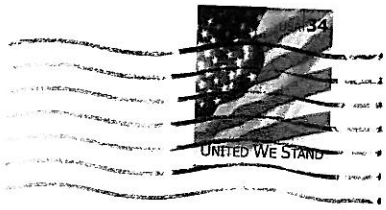

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