# The Spectrogram

*Newsletter for the Society of Telescopy, Astronomy, and Radio*

November 2005

## Inside this Issue




S*T*A*R
P.O. Box 863
Red Bank, NJ 07701
On the web at:
http://www.starastronomy.org


## November's Meeting

The next meeting of S*T*A*R will be Thursday November 3rd. Our program will be "How does Pluto fit into the scale of the Solar System?" by Jerry Vinski, Director of the RVCC Planetarium.

The meeting will begin promptly at 8:00pm at the King of Kings Lutheran Church, 250 Harmony Road, Middletown.

## Please Pay Your Annual Dues at November's Meeting

Membership fees for 2005-6 of $25 per individual and $35 per family were due in September. Please make payments to Paul Nadolny at the November meeting so we can collect them quickly. If you can't make the meeting, please mail a check made payable to STAR Astronomy Society Inc to:

STAR Astronomy Society
P.O. Box 863
Red Bank, NJ 07701

## A Big Thank You!

Thanks to everybody who sent in articles for the Spectrogram this month – Ernie Rossi, Frank Loso, Randy Walton, Steve Walters, Steve Fedor. The Spectrogram has been a little thin lately so thanks for answering my plea for contributions!

**The deadline for the next edition of the *Spectrogram* is Friday November 25th.** Please email any contributions to gwarnes1@comcast.net.

**Calendar**

Sep 1, 2005 – "***The Art and Science of Early Printed Star Atlases***" - Ray Harris, LVAAS

Oct 6, 2005 – ***"Searching for Earth-Like Planets: NASA's Terrestrial Planet Finder Space Telescope"*** by Dr. Robert Vanderbei, Princeton University

Nov 3, 2005 – ***"How does Pluto fit into the scale of the Solar System"*** by Jerry Vinski, RVCC Planetarium Director

Dec 1, 2005 – ***"Chandra's X-Ray View of Supernova Remnants"*** by Dr. John Hughes, Rutgers University

Jan 6, 2006 - ***"Ringed Basins on the Moon"*** by Charlie Byrne, S*T*A*R

Feb 2, 2006 - ***"Science and Art as Viewed Through the Lens of Astronomy"*** by Nick Lordi, S*T*A*R

Mar 2, 2006 - ***"An Empirical Determination of the Effect of Atmospheric Drag on Orbital Decay"*** by Daniel Handlin, S*T*A*R

Apr 6, 2006 – "***Cosmology***" by Dr. Joanna Dunkley, Princeton/Oxford

May 4, 2006 – TBA

Jun 1, 2006 – AGM

# President's Corner

*By Steve Walters*

This month, now that we did the "Fall Back" trick and are off daylight savings time, there is plenty of night for observing. So go out there and view some of the fall wonders. For one, be sure to look at Mars. Plenty of club members are reporting fantastic views of Mars. It's now viewable in early evening so you don't have to wait until 3 am to see it. This is the closest approach we'll have for a really long time. Besides Mars, the summer Milky Way is still viewable early and Andromeda is spectacular, even in our NJ skies. If you'll stay up later, you can start to catch some of the winter objects. So quit making excuses, drag your scope outside and take a look at these delights!

The Board has recently begun planning to have the mirrors in our 25" scope re-aluminized. Upon hearing this, our hero Ed Collett offered to pay for this somewhat expensive operation. So we are all indebted to Ed for his generosity. Thanks so much Ed! We all really appreciate you!

We do not yet have an exact schedule for this but it will probably be done during deep winter when the scope is less likely to be used. We also intend to have Waite Research LLC test the mirror and possibly re-figure it depending on the findings. This will be paid for by S*T*A*R. We are hoping to get a few members of the ATM group to build a shipping container for the mirror.

We also have two other donors to the 25" telescope. Gavin Warnes and I have joined forces to purchase a DSC system, the Sky Commander with 4096 step encoders. These are coming from Florida in a region that was hit by the hurricanes so it may be a while before we receive them. But we hope to add these while the mirror is being re-aluminized. We also plan to add a mounting for the 11x80 finder scope on the back of the mirror box to make it easy to point the scope in conjunction with the DSC system.

Lastly, if you haven't paid your dues yet, please get them in. Your S*T*A*R membership turns into a pumpkin on 11/30/2005, and you will be exorcised. Don't let this happen to you! We have a great club, get involved, get out and observe, come to the ATM or Imaging groups, continue to advance your knowledge of astronomy. And please pay your dues! Thanks in advance!

Steve

# October Meeting Notes

*By Steve Fedor*

The October 6th meeting of S*T*A*R Astronomy began at 8:08 pm. The meeting was attended by approximately 29 members and non-members. President Steve Walters began by welcoming four first time attendees and announcing that Treasurer Paul Nadolny would be collecting the annual dues.

The evening's lecture "Searching for Earth-Like Planets: NASA'a Terrestial Planet Finder" was presented by Dr. Robert Vanderbei of Princeton University. Dr. Vanderbei gave a fascinating discussion of how faint planets orbiting distant stars could be detected by utilizing telescopes with various aperture shapes. The lecture discussed the affects of aperture shapes on the Airy disk and how that allows for the detection of planets. The talk also included slides from the Princeton lab where the research is conducted. Dr. Vanderbei likened this research to the first telescopes detecting Jupiter or Saturn many years ago if successful. The talk concluded at 9:20.

Pres. Steve Walters announced the need for someone to present "Object of the Month."
Vice-Pres. Dennis O'Leary asked for ideas for "Scope and Tell." Dennis presented his experiences at Space Camp with pictures for this meeting's "Scope and Tell" during coffee break. At 9:51 the meeting resumed.

"Object of the Month" was presented by Steve Walters. The featured objects were M 13, 57, 31, 33 Mars and Uranus. Steve also reminded people new to the hobby to check-out the "S*T*A*R 30" observing list and earn an observing certificate.

Announcements:
Randy Walton announced: A.S.T.R.A. is still taking orders to achieve a group discount on The Observer's Handbook and calendars - A.S.T.R.A. will be holding a public observing session. Randy desires to use the S*T*A*R club's 25 inch Obsession and asked for Q.O.'s to volunteer.

Gavin Warnes announced he needs articles for publication in the Spectrogram. If you have anything of interest to your fellow astronomers, please help Gavin out by writing it down and sending it to him.

Larry Campbell announced upcoming star parties at Cliffwood Beach and Holmdel.

S.I.G. Reports
ATM – Gordon Waite announced the upcoming ATM meeting and invited everyone to join in the fun of building a telescope, grinding a mirror or working on any astronomy related work at his shop. The ATM group will also be refurbishing late S*T*A*R member Kay Sears' telescope.

Imaging – Steve Walters noted that Nick Lordi will circulate the "Celestia" disks which is a program similar to the "Digital Universe" lecture presented. Steve also invited those interested in learning imaging to attend this SIG.

Beginner's – Nancy McGuire indicated she would like to conduct a beginner's night, possibly at Burke Rd, if there were enough people to attend.

Observing. – No Report.

Dennis O'Leary announced the club's 25 inch Obsession will be upgraded over the winter and invited people to make use of it. At this time Steve Walters announced the big news of the evening. This was that Ed Collett graciously and generously offered to pay for the recoating of the 25 inch mirror. For this Ed received a round of applause.

The 50/50 was drawn for prize of $8.00. The meeting was adjourned.

# September Super Star Party

*By Ernie Rossi*

I was hoping this Star Party would be my best since this was going to be my final one at my dark site home. I have been hosting star parties since Sept. 2000 at my home which is located just passed the western edge of the Catskill mountains on almost 17 acres. The star party was set for Friday Sept 2, through Sunday Sept 4, However, I had someone come up on Sept 1, and some people stayed until Sept 6. It's rare that you get two clear nights back to back but it turned out we had a week of clear to mostly clear nights from just below average to excellent conditions. To get so many clear nights is just amazing. I figured I have had at least 30+ star parties at this site and more than 200 attendees, from beginners to avid observers.

The reason this was my last star party was that I was selling the place and the closing was just several weeks away. It was a decision that was difficult to make but it is that time in my life that I wanted to retire and move to a place that was less expensive and had many more options and things to do. For me this final star party with the selling of my home brings such sadness and yet so much joy because of the terrific memories of the past. I also feel blessed that I was able to give many observers from beginners to avid amateur a chance to see the sky without them having to travel great distances, spend a lot of money and have poor accommodations and not be around friends.

This is a very rural area at an elevation of 1800 to 2300 feet with large flat clearings and some forest. The area is only zoned for agriculture and surrounded by state forest and parks throughout. This is one of the closest and darkest sites in location to New Jersey. Under pristine sky conditions visual magnitude of close to 7 is possible.

My guests were Joe Marchelak, Neil Wendt, Bill Anthony, Dan Pontone, Doug Berger, Jeremy Carlo, Dave Nelson, Nancy McGuire, Jordan Fedor, Steve Feder, Mike Sullivan, Steve (scopehead), Ralph and Ron from the Princeton club, and Tim Tierney and his daughter. Joe Marchelak was the only observer that was at my first star party and my last.

Each time I observe from this location I always find new objects and old objects that look more awesome than ever. NGC 253, 891, and 246 were the best I've ever seen, and many other observers also agreed. I have seen these objects from Cherry Springs but through my 25" not even pictures looked as good. Stephan's Quintet all 5 galaxies at 363 x were not only visible but distinct shapes and arms were easy to see. Everyone mentioned some object they either saw for the first time or found objects with such detail they never thought possible with their particular telescope.

My guests came from four different clubs in New Jersey, AAi, NJAA, STAR and AAAP. Telescope sizes ranged from 4" to 25", some were refractors, SCT, and Newtonians. Everyone looked at their favorites, mine are M13, M27, M17, M8, M22 which just looked unbelievable in 3 D using the binoviewers in the 25" scope. Many observers would take a break at times just to look up and enjoy the sky naked eye.

Here are some of the comments from some of the observers that posted messages on the STAR bulletin board several days after the star party. Jordan Feder wrote, Not only was the 25" available but scopes of various sizes, observers at various stages of experience and with somewhat different observing lists for some extra objects to checkout. Musical background was provided by Jeremy and his radio and combo of classical music and BB King from Dan's system during setup on Sunday night, NWS forecast on Jeremy's receiver, stack of muffins by Nancy, birding with Neil and Bill, and target practice by Joe. Highlights for Jordan were NGC 246 in the 25" with and without a filter. Jordan writes, the bubble was well defined and with an 0111 filter had structure and varying wisps of thickness on the edge. NGC 891 in scopes 16" and larger all the experienced observers commented that was the brightest they have seen it, and it extended a bit further in the smaller scopes as well due to the very dark sky. The center of NGC 253 had lots of swirling detail with arms and dust lanes in the 25" scope. Other highlights were the Veil in all the scopes and NGC 7008 in Bill Anthony's 12" scope. Stephan's Quintet showed detail in the 25" as well as sizeable companion to NGC 7331, probably NGC 7335 at magnitude 13.4. All the objects in the 25" with or without the binoviewer were truly impressive like seeing the structure of M 11, and to see how wonderful globular cluster M 92 looks. Two dust lanes could easily be seen in the Andromeda galaxy and so many objects difficult to see were so bright and defined. This was just part of

Jordan's list and many of the other observers wrote about their wonderful experience and highlights of the star party. To write about everyone's experience and observing list would fill up a small book. Many of the advanced observers come to find those elusive objects not possible in New Jersey. You can only see these objects in a very dark pristine sky or with a long exposure photograph in brighter skies.

One of the pleasures in having your own dark sky home is all the amenities that comes with it, warm beds, a shower, toilet, kitchen, hot food, cold drinks, TV, and privacy of your own property. I will always cherish this place for its beauty, dark skies, comradeship, and most of all the wonderful memories and fun we all had. This was truly a Super Star Party.

# Revisiting the Leonids: Observations of the 2001-2004 Showers

*By Frank Loso*

Just a few years ago, with November approaching, the attention of both casual sky gazers and seasoned amateur astronomers alike was focused on the Leonids. The reason for all the interest in this normally average meteor shower was the possibility of witnessing a spectacular meteor storm like the one that occurred during the Leonids of 1966. Much has been written about this incredible shower, possibly the most intense meteor storm in history, where in the predawn hours of November 17, meteors were seen at rates of up to several hundred per minute with a peak rate of 40 per second. Several eyewitness accounts of the 1966 shower can be found at the NASA Leonid archive, http://leonid.arc.nasa.gov/1966.html and the American Meteor Society website at http://comets.amsmeteors.org/meteors/showers/leonidsrecoll.html and make interesting reading. Descriptions such as "awe inspiring" and even "life altering" are used. Several people describe the event as being similar to the sight of driving into a snowstorm. Now this would be something to see!

It was with such anticipation that I observed the Leonids for several clear Novembers beginning in 1998 until the perfect storm finally did occur in 2001 and 2002. I will describe my observations in this article, but before that, a bit of background material might be of interest.

Meteors are observed when the earth sweeps up bits of interplanetary debris during its orbit around the sun. This debris, mostly sand to pebble sized particles eroded from comets by the heat and radiation pressure of the sun, is burned by friction with the earth's atmosphere resulting in the glowing streaks seen in the night sky as 'shooting stars.' While sporadic meteors are seen randomly on any clear night, named meteor showers such as the Perseids and Leonids occur annually around fixed dates when the earth passes the point in its orbit where it intersects with the orbit of the parent comet for that particular meteor shower. In the case of the Leonids, the parent comet is 55P/ Tempel-Tuttle, a periodic comet with a 33 year orbit. Occurring annually in mid-November, the Leonids are known for bright swift meteors which often leave behind visible trails. Generally the Leonid shower displays an average of perhaps 10 to 15 meteors per hour, which is not particularly great compared to more active showers such as the Perseids or Geminids where rates of perhaps 100 per hour are typical. What makes the Leonids most noteworthy is their association with several meteor "storms" like the one of 1966. Besides the 1966 storm, the Leonid shower is known to have produced storms in 1799, 1833 and 1866 as well as several other spectacular displays that did not quite reach "storm" levels.

Of the earlier Leonid storms, the one of 1833, depicted above, is especially noteworthy. As with the 1966 storm, meteors were seen falling at a rate so great that the entire sky appeared to be covered with them at once, as if it were literally raining meteors. The fact that this display occurred before the widespread use of outdoor electric lighting must have made it even more spectacular. Aside from the visual spectacle, the Leonid shower of 1833 is important in that it led to an accurate modern understanding of meteors in general. Until this time, there was still speculation about the nature of meteors and whether they were meteorological or astronomical phenomena. The 1833 Leonids helped to answer this question, revealing that meteors, while appearing in the atmosphere, were the results of particles from space. It was also through observations of this shower that the first precise determination of a meteor shower's radiant (point in the sky from which the meteors appear to

originate) was made by Professor A.C. Twining of West Point, New York, and W.E. Aiken of Emmittsburg, Maryland. Perhaps even more interesting, is the fact that information compiled in the years following regarding past Leonid showers led to the determination, by Heinrich Wilhelm Matthias Olbers in 1837, that the Leonids possessed a period of about 33 years in which activity significantly increased. As a result, he predicted a return Leonid storm in 1867.

The expected storm occurred in 1866, as did strong displays in both 1867 through 1869. The year 1867 was another milestone in the increased understanding of meteors. In December the previous year, a faint comet was discovered near Beta Ursa Majoris by Ernst Tempel of Marseilles, France. The comet was also discovered independently in January 1867 by Horace Tuttle of the Harvard College Observatory, and was given the name of Tempel-Tuttle. This comet reached perihelion (the point where it is closest to the sun) on January 12, 1867 after which it quickly receded and faded from view. When its orbit was accurately computed, Tempel-Tuttle was determined to be a periodic comet that returned every 33.17 years. Shortly after this determination, the astronomer Urbain LeVerrier (who mathematically predicted the existence and position of the planet Neptune, leading directly to its discovery in 1847) was able to compute an accurate orbit for the parent meteoroid stream of the Leonids, noting a strong similarity with the orbit of comet Tempel-Tuttle. This connection was discovered independently by several others, including Giovanni Schiaparelli, of the Martian "canali" fame. And so, the connection between comets and meteors was first made.

With the comet/meteor connection having been made, the periodicity of Leonid activity made sense. As a comet orbits the sun, material in the form of gas and dust is eroded by solar heating and radiation pressure. Near perihelion, the rate of erosion greatly increases, forming a trail or "stream" of material that is pushed outward by the solar radiation pressure and follows the comet closely in a similar orbit. This debris is gradually spread over the comet's entire orbit like litter along a highway, but remains most dense close to the comet. Since there is some debris dispersed over the comet's entire orbital path, meteor activity is seen each year when the earth passes through the point in space where its orbit intersects that of the comet near the perihelion point. In years when the comet is nearby, however, the earth may pass through the dense area of the stream, and the meteor activity will be above average - hence, the relationship between the period of increased meteor activity with the period of the parent comet.

With the periodicity of the Leonids having been established in 1867, the world awaited the Leonids of 1899. Unfortunately, when this year finally came, the Leonids failed to deliver. While the shower of 1899 reached rates of about 40 meteors per hour, which was above average, it came nowhere close to the thousands per hour anticipated. The best showers in this time period were those of 1898 which reached rates of 100/hour, and 1901 which reached up to 400/hour. Another 33 years later, the Leonids around the years 1928-32 behaved similarly, reaching peak rates of about 100/hour in 1930 and 1931, but failing to reach storm levels. Leonid activity remained above average (about 40/hour) through 1939, before settling back to the more normal rates of 10-15 per hour. Finally, in 1966, the greatest meteor storm of all history broke loose.

From the historical record, the 33 year periodicity associated with the Leonids was clearly evident. It was also clear from the variation in the peak rates observed, however, that something still needed to be explained. It was in 1998 that the pieces began to really fall together. In this year, David Asher of Armagh Observatory in Northern Ireland, and Robert McNaught of the Australian National University and Siding Spring Observatory published a paper describing a model of how meteor streams, the dense trail of debris that closely follow comets, evolve. By understanding the structure and orbits of these streams, they were able to make predictions for the Leonid activity for the expected peak of 1999. At the same time, another team of astronomers, Esko Lyytinen of Finland, and Tom Van Flandern of Meta Research in Washington, D.C. developed their own meteor stream model which utilized a different methodology than Asher and McNaught, but which provided similar predictions.

In early 1998, Comet Tempel-Tuttle reappeared, reaching perihelion in February. While the world awaited the Leonid shower of that year, the meteor stream models were predicting increased activity in 1999 and 2000, and peak activity in 2001 and 2002. Sure enough, the 1998 Leonid activity was above average, up to a few hundred meteors per hour, and the 1999 shower resulted in rates of up to 1 meteor per second with a peak predicted by the Asher McNaught model to within 6 minutes. Unfortunately this peak was not visible in North America. As an aside, the 1998 shower was noteworthy in an unusually high percentage of bright fireballs over a period of about 18 hours. This was also ultimately explained by Asher/McNaught.

The 2000 Leonids occurred during a bright moon period, and no storm was observed. By this time the now-refined models were indicating that 2001 would be the year for a full blown Leonid storm. Asher/McNaught predicted two peaks for November 18, one at 1001 UT resulting from an encounter with a meteor stream originating from the 1767 apparition of Tempel-Tuttle, and a second at 1820 UT from the 1866 stream. The first peak was expected to result in a ZHR of up to 3000 meteors/hour, and the second a ZHR of over 9000 per hour.

And so, on the morning of November 18, 2001, I set my alarm clock early. At 0400 EST, I went outside. The sky was clear. Dressed warmly, I set up a lounge chair in my

backyard, and with a thermos of coffee and a notepad, sat down with a good view to the south and waited. By this time it was 4:15. By 4:21, I had seen 14 meteors. Clearly something exceptional was happening. I had planned to keep count, recording the number of meteors seen every 10 minutes, but since they were coming faster than I expected, I shortened the interval to around 5 minutes. My timer was a watch with no alarm, so my timings were based on periodic glances at the watch. Because of this, the interval strayed a bit. Also, I found that at times several meteors would appear at once, adding to some inaccuracies in my counting. In any event, the display that year was truly spectacular, with meteors visible at a rate I had never seen before, including multiple simultaneous bursts, some of which looked almost like spokes from an umbrella pointing back to the radiant point in Leo.

My observations for that morning are graphed in figure 1. The graph shows the number of meteors seen in each time period, which as noted above is somewhat variable from one sample to the next. Also shown is the cumulative number of meteors observed, and the calculated hourly rate, which is simply the number observed in each period extrapolated to 60 minutes. For example, 5 meteors observed over a 5 minute period (1/minute) correspond to a calculated rate of 60 per hour. The calculated rate is a raw rate, i.e., no corrections were made to convert to Zenithal Hourly Rate (ZHR), the number of meteors that would be seen if the radiant was overhead and the limiting magnitude 6.5. ZHR, the metric usually used to describe meteor activity, also includes correction factors for the percentage of sky observable, percentage of sky obscured by clouds, and "population index" (a correction factor based on the magnitude distribution of meteors for the particular shower).

As the graph shows, over 2 hours and 45 minutes of observing I counted 354 meteors for an average raw rate of 128 meteors per hour. My peak observed rate of 336 meteors per hour occurred between 0520 and 0540 EST. According to the results published in Sky and Telescope and on the International Meteor Organization (IMO) website (http://www.imo.net), the maximum rate for the 1767 stream was a twin peak with one maximum at 0539 EST and another at 0603 EST. Interestingly, my observation also indicates two peaks (at 0521 and 0532 EST), but since this separation is close to the five minute resolution of my recorded observations, I wouldn't speculate as to whether this is real or not. My observed peaks differ from the published results by 20 to 30 minutes. This could be due to a number of factors including the accuracy of my timing, i.e., an unsynchronized wristwatch, the less than ideal observing conditions of my light polluted back yard, or my less than ideal recording technique. Nevertheless, my observations did show a pronounced peak followed by a falloff that is at least generally consistent with the published results.

My original goal for this shower was to simply observe it, hoping to see a meteor storm, while maintaining an observing log. I hadn't intended to use the data for analysis, so my observations and data recording were pretty casual; however after plotting it, I thought it would be interesting to see how my observed maximum hourly rate of 336 compared with the ZHR of 1500 that was eventually published by the IMO based on worldwide observations. I located a formula for ZHR at http://skytour.homestead.com/zhr.html and http://www.namnmeteors.org/guidechap8.html.

ZHR = HR * F * ( r ^ (6.5-LM)) / Sin A

Where:
HR = hourly rate
F = correction factor for % of sky observable (e.g., F=2 for 50%)
LM = limiting magnitude at zenith
r = population index
A = altitude of the radiant

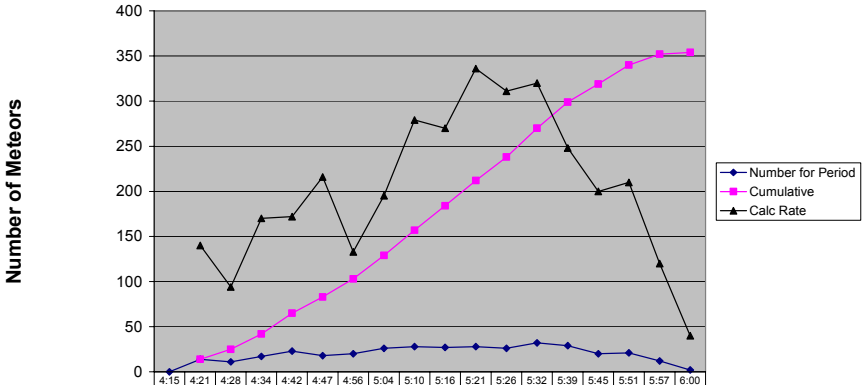
According to the IMO, a reasonable figure for the Leonid population index r=2. Values for the other parameters, from my observations, are HR = 336, LM = 4.5, A = 60 degrees (at 0420 EST), F = 2.

Using these figures, the resulting ZHR for my observations is 3104, which is a factor of two higher than the IMO value of 1500. Investigating sources for error, I found that relatively small variations in LM and F could account for the difference. I focused on these parameters since my estimates for both were really only "guestimates." If the value for limiting magnitude is increased to 5 (which is possible at the zenith from my location), and % of sky observable is increased to 75% (F= 1/0.75), which is also feasible, the new ZHR value becomes 1463 which agrees much more closely with the IMO value of 1500. And so, although my observations have a wide margin for error, it is reassuring to see that my results are at least generally consistent with other observations.

As the 2002 Leonids approached, predictions indicated excellent prospects for a repeat performance of 2001. The earth would once again intersect the 1767 and 1866 dust streams of Comet Tempel-Tuttle, resulting in two Leonid peaks, one of which would be well placed for North American observers. A ZHR of 2600 was predicted for about 0540 EST on November 19. Unfortunately, a full moon would make observing difficult, but having met with success in 2001, I decided to try again.

Sky Clear
Limiting Magnitude at least 4.5
No ZHR corrections

## Leonid Meteor Shower 11/18/01
## Aberdeen, New Jersey

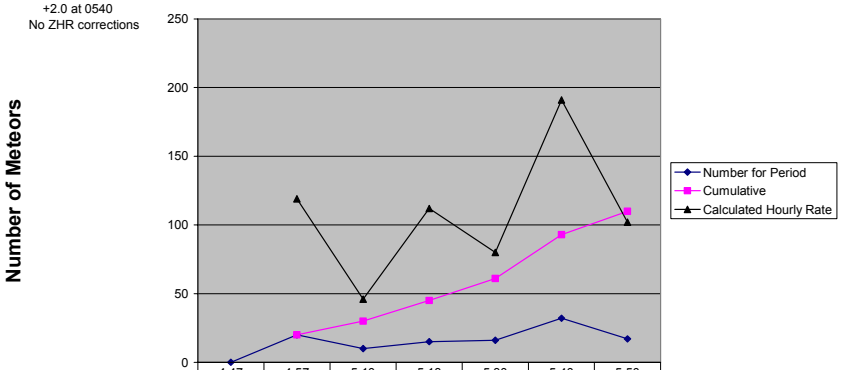



| | 4:15 | 4:21 | 4:28 | 4:34 | 4:42 | 4:47 | 4:56 | 5:04 | 5:10 | 5:16 | 5:21 | 5:26 | 5:32 | 5:39 | 5:45 | 5:51 | 5:57 | 6:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number for Period | 0 | 14 | 11 | 17 | 23 | 18 | 20 | 26 | 28 | 27 | 28 | 26 | 32 | 29 | 20 | 21 | 12 | 2 |
| Cumulative | | 14 | 25 | 42 | 65 | 83 | 103 | 129 | 157 | 184 | 212 | 238 | 270 | 299 | 319 | 340 | 352 | 354 |
| Calc Rate | | 140 | 94 | 170 | 172 | 216 | 133 | 195 | 279 | 270 | 336 | 311 | 320 | 248 | 200 | 210 | 120 | 40 |

Time (EST)

Cirrus Clouds throughout period
Moon 99% illuminated in SW sky
Limiting Mag:
+3.0 at 0520
+2.5 at 0527
+2.0 at 0540
No ZHR corrections

## Leonid Meteor Shower 11/19/02
## Aberdeen, New Jersey

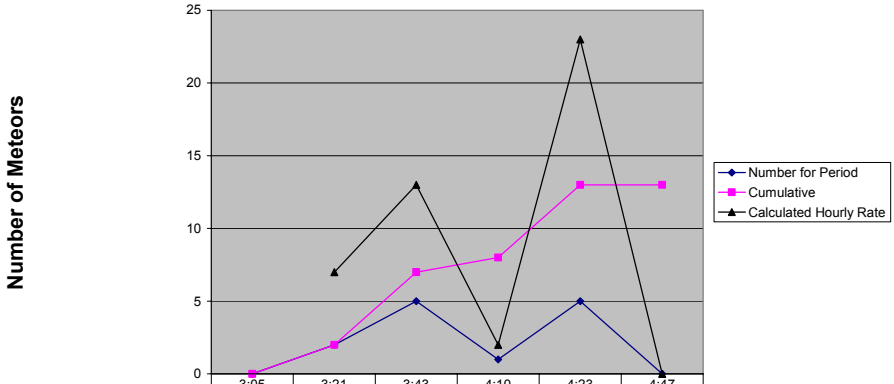



| | 4:47 | 4:57 | 5:10 | 5:18 | 5:30 | 5:40 | 5:50 |
|---|---|---|---|---|---|---|---|
| Number for Period | 0 | 20 | 10 | 15 | 16 | 32 | 17 |
| Cumulative | | 20 | 30 | 45 | 61 | 93 | 110 |
| Calculated Hourly Rate | | 119 | 46 | 112 | 80 | 191 | 102 |

Time (EST)

Temp 34 F
Sky Clear
Limiting Mag 4.5
No ZHR corrections

## Leonid Meteor Shower 11/17/04
## Aberdeen, New Jersey




| | 3:05 | 3:21 | 3:43 | 4:10 | 4:23 | 4:47 |
|---|---|---|---|---|---|---|
| Number for Period | 0 | 2 | 5 | 1 | 5 | 0 |
| Cumulative | 0 | 2 | 7 | 8 | 13 | 13 |
| Calculated Hourly Rate | | 7 | 13 | 2 | 23 | 0 |

Time (EST)

* Mag -5 fireball at 04:10

On the morning of November 19, in addition to the bright moon in the east, the sky was covered with a thin layer of cirrus which further reduced visibility. Nevertheless, I decided to observe. My observations are shown in figure 2. As in 2001, my recording intervals are variable, this time with a target window of ten minutes. From 0447 to 0550 EST I recorded 110 Leonids in spite of the moon and clouds which reduced the limiting magnitude to about 3.0. A surge of activity was seen around 0540 EST, in which I recorded 32 meteors in a ten minute period. Included in this window was a near simultaneous burst of five Leonids from the radiant at 0537. Without the interference from the moon and clouds, I am sure that this shower would have been as visually spectacular as the 2001 display - perhaps more so.

The results for 2002 reported by the IMO indicated a peak ZHR of 2660 around 0550 EST, just ten minutes later than my observed peak. My peak hourly observed rate was 191. Applying the corrections for ZHR, my peak observed rate corresponds to a ZHR of 7057 which exceeds the published value by about a factor of three. I can only explain this by speculating that my estimates for limiting magnitude and % obscuration were in error, as in 2001. The limiting magnitude was particularly hard to estimate due to the changeable sky conditions. Still, as in 2001, my observations appear to be at least in the right ballpark.

Looking beyond 2002, both the Asher/McNaught and Lyytinen models indicated no further good opportunities for Leonid storms. I was unable to observe in 2003, but conditions were good last year (2004) so I went out once again. The results of my observations as plotted in figure 3. show that the 2004 Leonids were somewhat more active than the normal 10 to 15 per hour, but not even close to the storm level activity of 2001-2002. The time for Leonid storms indeed appears to be over.

In summary, the Leonids of 2001 and 2002 delivered as advertised, producing meteor storms with rates of well over 1000 meteors per hour which were observed worldwide. Peak observed rates of over 300 meteors per hour were seen even from my light polluted backyard in New Jersey. I am pleased that my observations appear consistent with those from other parts of the world. Both showers were something that I will remember for a long time. While the showers of 2001/20002 failed to produce the phenomenal rate of meteors seen during the 1966 storm, the activity was fast and furious for short periods, giving a good hint at what it must have been like to witness that historic shower – unless one was observing from New Jersey, that is. One of the eyewitness accounts of the 1966 Leonids, from a gentleman named Forest Markowitz, is especially interesting for those of us in the Garden State.

"I was 16 and interested in astronomy. I lived in suburban New Jersey. In 1963 the Perseus shower was exceptionally good as the weather was quite cool and clear so I was really looking forward to the 1966 (Leonid) shower. Well, the night was cloudy as it had rained all day. The local 11 pm news on TV had radar and reported that the sky was clear south of New York City over the New Jersey coast. A friend of mine who was old enough to drive convinced his father to let us take the family 1959 Plymouth to a dark location along the Jersey Shore. We settled for a farmer's corn field in Holmdel, New Jersey, away from the city lights. Sure enough the sky was fair with some haze, not good but acceptable for all the effort. We were all set by 1:30am when two things happened; the local police came by to see what we were doing and then the clouds began to thicken. While the police cooperated, Mother Nature didn't and we were clouded out by 2am. We called it quits at 5:00 without seeing a single meteor! On the drive back it began to rain."

And so goes the story of astronomy in New Jersey.
In closing, one final note on the future deserves mention. According to information on the Armagh Observatory website (http://www.arm.ac.uk/leonid/dust2006.html) there is a possibility of one last outburst of Leonid activity next year (2006) due to an intersection with the 1936 Tempel-Tuttle stream. The current estimated time for the peak activity is 0445 UT on November 19 (1145 pm EST on November 18). A ZHR of about 100 is anticipated, with a geometry favoring observers in Western Europe. The radiant will be just below the horizon for observers on the east coast of North America during this period, so we will not be well placed for this event. Even so, the Leonids remain worth watching.

# A Wrinkle in Space Time

*By Trudy E. Bell*

When a massive star reaches the end of its life, it can explode into a supernova rivaling the brilliance of an entire galaxy. What's left of the star fades in weeks, but its outer layers expand through space as a turbulent cloud of gases. Astronomers see beautiful remnants from past supernovas all around the sky, one of the most famous being the Crab Nebula in Taurus.

When a star throws off nine-tenths of its mass in a supernova, however, it also throws off nine-tenths of its gravitational field.

Astronomers see the light from supernovas. Can they also somehow sense the sudden and dramatic change in the exploding star's gravitational field?

Yes, they believe they can. According to Einstein's general theory of relativity, changes in the star's gravitational field should propagate outward, just like light—indeed, at the speed of light.

Those propagating changes would be a gravitational wave.

Einstein said what we feel as a gravitational field arises from the fact that huge masses curve space and time. The more massive an object, the more it bends the three dimensions of

space and the fourth dimension of time. And if a massive object's gravitational field changes suddenly—say, when a star explodes—it should kink or wrinkle the very geometry of space-time. Moreover, that wrinkle should propagate outward like ripples radiating outward in a pond from a thrown stone.

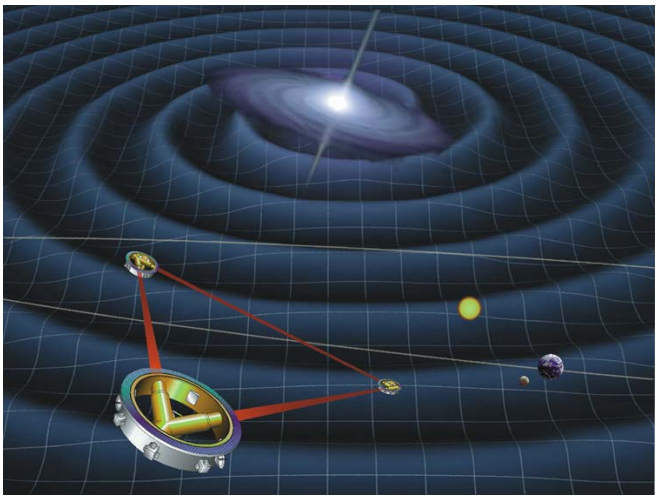
The frequency and timing of gravitational waves should reveal what's happening deep inside a supernova, in contrast to light, which is radiated from the surface. Thus, gravitational waves allow astronomers to peer inside the universe's most violent events—like doctors peer at patients' internal organs using CAT scans. The technique is not limited to supernovas: colliding neutron stars, black holes and other exotic objects may be revealed, too.

NASA and the European Space Agency are now building prototype equipment for the first space experiment to measure gravitational waves: the Laser Interferometer Space Antenna, or LISA.

LISA will look for patterns of compression and stretching in space-time that signal the passage of a gravitational wave. Three small spacecraft will fly in a triangular formation behind the Earth, each beaming a laser at the other two, continuously measuring their mutual separation. Although the three 'craft will be 5 million kilometers apart, they will monitor their separation to one billionth of a centimeter, smaller than an atom's diameter, which is the kind of precision needed to sense these elusive waves.

LISA is slated for launch around 2015.

To learn more about LISA, go to http://lisa.jpl.nasa.gov. Kids can learn about LISA and do a gravitational wave interactive crossword at http://spaceplace.nasa.gov/en/kids/lisaxword/lisaxword.shtml.



*LISA's three spacecraft will be positioned at the corners of a triangle 5 million kilometers on a side and will be able to detect gravitational wave induced changes in their separation distance of as little as one billionth of a centimeter*

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

## Moon Phases

**Nov 2** **Nov 9** **Nov 16** **Nov 23**

**Dec 1** **Dec 8** **Dec 15** **Dec 23**

## November Celestial Events

*By J. Randolph Walton (Randy)*

| Day | Date | Time (LMT) | Event |
|---|---|---|---|
| Tue | 1 | 16:37 | Moon Set |
| | | 20:25 | New Moon |
| Sat | 5 | 05:00 | S. Taurid meteor peak, ZHR 10 |
| | | 05:45 | Jupiter Rises |
| | | 06:34 | Sunrise |
| | | 16:53 | Sunset |
| | | 16:55 | Mars Rises |
| | | 19:22 | Venus Sets |
| | | 19:25 | Moon Set |
| | | 22:45 | Saturn Rises |
| Tue | 8 | 06:35 | Mars Sets |
| | | 20:57 | First Quarter Moon |
| | | 23:04 | Moon Set |
| Sat | 12 | 04:00 | N. Taurid meteor peak, ZHR 15 |
| | | 05:20 | Jupiter Rises |
| | | 06:15 | Mars Sets |
| | | 06:42 | Sunrise |
| | | 14:57 | Moon Rise |
| | | 16:46 | Sunset |
| | | 19:27 | Venus Sets |
| | | 22:20 | Saturn Rises |
| Tue | 15 | 02:00 | Mars 2.5 deg. S of Moon |
| | | 06:20 | Moon Set |
| | | 16:18 | Moon Rise |
| | | 19:57 | Full Moon |
| Thu | 17 | 10:00 | Leonid meteor peak, ZHR 15 |
| Sat | 19 | 16:41 | Sunset |
| | | 19:27 | Moon Rise |
| Wed | 23 | 17:11 | Last Quarter Moon |
| | | 23:36 | Moon Rise |
| Sat | 26 | 01:37 | Moon Rise |
| | | 04:37 | Jupiter Rises |
| | | 05:03 | Mars Sets |

| | | | |
|---|---|---|---|
| | | 06:58 | Sunrise |
| | | 13:53 | Moon Set |
| | | 16:37 | Sunset |
| | | 19:32 | Venus Sets |
| | | 21:25 | Saturn Rises |
| Sun | 27 | 02:39 | Moon Rise |
| Wed | 30 | 06:03 | Moon Rise |

# Are you a S*T*A*R Member?

S*T*A*R is a member of United Astronomy Clubs of New Jersey (UACNJ) and the International Dark Sky Association (IDA). Meetings are the first Thursday of each month, except July and August, at 8:00 PM at the King of Kings Lutheran Church, 250 Harmony Rd. in Middletown . Meeting generally consist of lectures and discussion by members or guest speakers on a variety of interesting astronomical topics.

Memberships: ( )Individual....$25
( ) Family...$35 ( ) Institutional $25

Name_____

Address_____

City_____State___Zip_____

Phone_____

Email_____
Make checks payable to: STAR Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701

# In the Eyepiece

Here is a list of objects for this month. This is reproduced from www.skyhound.com with the kind permission of its creator and author of SkyTools Greg Crinklaw.

| Object(s) | Class | Con | RA | Dec | Mag |
|---|---|---|---|---|---|
| Iota Cas | Multiple Star | Cassiopeia | 02h29m04.0s | +67°24'09" | 4.5 |
| 6 Tri | Multiple Star | Triangulum | 02h12m22.3s | +30°18'11" | 4.9 |
| Almaak | Multiple Star | Andromeda | 02h03m53.9s | +42°19'47" | 2.1 |
| h and Chi Perseus | Open Clusters | Perseus | 02h19m01.8s | +57°08'47" | 4.3 |
| NGC 1097 | Galaxy | Fornax | 02h46m18.9s | -30°16'21" | 10.2 |
| M 103 | Open Cluster | Cassiopeia | 01h33m13.8s | +60°42'23" | 6.9 |
| Little Dumbbell (M76) | Planetary Nebula | Perseus | 01h42m19.3s | +51°34'30" | 12.2 |
| NGC 891 | Galaxy | Andromeda | 02h22m32.9s | +42°20'46" | 10.8 |
| NGC 1023 | Galaxy | Perseus | 02h40m27.7s | +39°04'04" | 10.2 |
| AGC 347 | Galaxy Group | Andromeda | 02h25m48.0s | +41°52'00" | -- |
| IC 1747 | Planetary Nebula | Cassiopeia | 01h57m35.8s | +63°19'19" | 13.6 |
| NGC 470 & 474 | Interacting Galaxy Pair | Pisces | 01h19m44.9s | +03°24'35" | 12.6 |
| NGC 925 | Galaxy | Triangulum | 02h27m16.8s | +33°34'45" | 10.9 |
| NGC 784 | Galaxy | Triangulum | 02h01m16.8s | +28°50'14" | 12.5 |