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A Sliver Anniversary of sorts



Neptune and Triton

(Image courtesy: JPL/NASA)

At 0356 UT on August 25, 25 years ago, Voyager 2 flew 3,000 miles over the north pole of Neptune, identifying its magnetic pole and recording auroral emissions. On a course that deflected it ‘down’ from the ecliptic at an angle of about 48° to achieve an encounter with Neptune’s largest moon Triton 5 hours later, Voyager 2 went on to record Triton occulting the star Gomeisa (β Canis Minoris, Procyon’s sidekick) and then our own Sun.

[Voyager 2 flew past Triton](#) at a distance of about 24,000 miles and generated a mosaic of its surface. 79 hours after its closest approach to Neptune, its camera was turned back on the pair to record the above crescents. It was the Grand Tour’s last work of art.

Neptune can never show a crescent phase to sunward Earth. Voyager’s unusual vantage point also robs Neptune of its familiar blue hue, as the sunlight seen is scattered forward, reddening it. For a journey back in time to JPL on that August 25, read Bob Veilleux’s personal account in the [September 2013 edition of Observer](#) (page 6).

President's Message



Recently I've been reading a book called "Tracks" by Robyn Davidson, who trekked solo across 1,700 miles of Australian outback in 1977 with four camels and her dog Diggity.

Learning about the harsh environment was a matter of survival for her, but Robyn acknowledges that the learning happened in many different ways. At one point she writes: *"My environment began to teach me about itself without my full awareness of the process."* I'm sure many of us have recognized a similar feeling as we stood outside contemplating the night sky. The author continues: *"Having been taught some rudimentary knowledge of the pattern of things at the beginning of the trip, I now had enough to provide a structure in which I could learn to learn."*

Upon first joining our club you may have felt overwhelmed by the amount of knowledge that exists out there about your new hobby. Don't get discouraged! Think of each new bit of knowledge as part of the structure you are building which will hold all the new knowledge you gain. Eventually the connections will become more apparent, and new facts and ideas will fit right in. Enjoy the journey!

Clear skies,

Ted Blank
NHAS President

"Particle Fever" at Red River Theatre, Concord NH, August 14

This Thursday evening screening of the film in Concord featured a Q&A session with director **Mark Levinson** as the epilogue. NHAS members attending were **Ted Blank, David Getman, Andy Jaffe** and his wife, **Larry LaForge**, his wife and daughter **Ally, "Rags"** and **Nori**, and **Curtiss Rude** and his wife.

Reactions were much the same across the board. While Ted was entertained by the parts where the director explained how he got access to the "inner sanctum" of the accelerator areas, Larry enjoyed the personal insights of the physicists involved and really, really wants one of their T-shirts.

"Rags" seconded both sentiments:

Nori and I totally loved the entire thing. Sadly we missed the first few minutes and wound up sitting on the stairs in the pretty much packed house, but it was quite delightful. I particularly liked how it followed people at different levels of the project, not just the physicists but the people "in the trenches" that built and maintain the gargantuan machinery. The Q&A afterwards was definitely the icing on the cake, the audio and video worked beautifully, and we will be ordering at least one T-shirt...

Andy Jaffe went with a more personal outlook:

It is a great film outlining science as the people who push the frontiers forward, featuring four physicists to help tell the story of the discovery of the Higgs particle. When filming of "Particle Fever" started, before the Large Hadron Collider (LHC) was even operational, there was no guarantee that it would end on such a high note. The film is a well told story from both a people and a science standpoint. The director is unusual in having a PhD in particle physics from UC, Berkeley. Additional scenes, such as the visit to a sculpture garden and the making of coffee, in stark contrast to conventional notions of "doing science," help to underline points in the film.

*I have known **Mark Levinson** from college and our conversations are far more mundane than the excellent discussion after the film. While hearing the audience questions, I think I spent far too much time checking whether Mark had gotten any sleep, made his connections, or had had anything to eat. I sat back and listened to the audience question him as a director. His depth of knowledge and skill and his truly down-to-earth attitude were wonderful to see come through on the large screen. The fault-free Skype connection was a big help.*

I encourage everyone in the club to consider seeing this film on Netflix if they can't get to a screening (I have no connection with either the film or Netflix).

Rey Center (again), Waterville Valley NH, August 23

This monthly event is rarely talked about at club gatherings and business meetings, but for the third month in a row this summer we have a report on what really transpired up there under the dark skies.

Ken Charles filed this report:

*The event took place on Saturday, August 23rd, as scheduled from 9pm to 11pm. We had very dark skies, with occasional clouds passing overhead during the last hour. About 25 people showed up, including 5 or 6 children with their parents. I gave a talk for each object I was showing. Also showing up as the Rey Center representatives were NHAS members **Al Larsson** and his wife **Dottie**, with Al's Meade LX-90.*

Early on both Al and I were showing Saturn, and I also showed some attendees a quick view of Mars before it dropped down behind the trees. I then went higher in the sky and showed M13, M92 and M57, while Al showed Alberio. As the clouds moved across overhead, I showed the Blue Snowball followed by M31 until the clouds forced me to M81 and M82.

*I finished the night with carbon star T Lyrae, which had a nice red color to it this evening. As **Paul Winalski** once taught me "no skywatch is complete until you show a carbon star for color effect."*

All attendees seemed to have a good time and thanked us profusely for doing the skywatch.

Return to Star Island, August 23-24



The Fabulous Four (Sandra, Jason, Rags and Nori) at the bow (above left) of the ferry Thomas Laighton (top right), disembarking at Star Island (bottom right).

It was a bright and sunny Saturday in Portsmouth NH as **Nori** and I waited for the *Thomas Laighton* to dock. Soon **Jason Paul** and **Sandra Koski** showed up and we took up a place at the bow for the crossing. It was smooth sailing of about an hour to Star Island to be welcomed by Pelicans, their chant ending with a hearty "you *did* come back!"

Jason and Sandra had a C9.25 on a Mini Tower Pro and a C6 on a Mini Tower, while I brought my "Grab and Go Newt" – a 13.1" Coulter Odyssey. Star Island owns two telescopes and their 10" (or so) hand-built Newtonian was on-site as well. We made sure all of them were in Stone Village by the time when they have their social hour.

A number of people wandered by as we set them up, some of whom knew about the skywatch and some who didn't; they were encouraged to return later. One little girl named Allison was fascinated with the GaG Newt. Since it was still light, I targeted a seagull on the chapel roof and showed her how the image was upside down and backwards; she found that delightful. Her father was also interested in how the telescope worked.



The Arsenal at the ready (left). Allison examines herself in the Coulter's primary (center), and then has a good look at the seagull's very odd looking image (right). (All Photos: Nori Odoi)

We began the skywatch by showing people Mars and Saturn, very close to each other and easy to find even in twilight. I put mine on Mars and used the smaller aperture (but much crisper image) of the Star Island telescope to showcase Saturn. It got the breathless "Wow!" it typically does. I told a few people to feel free to try to keep it in the eyepiece by just grabbing the end and moving it. They're always amazed at how simple it is, and how hard it is – simple that one just moves it around, hard that the image never goes in the expected direction. (grin)

I had perhaps eight to ten people at the two telescopes I was manning at the start of the skywatch. Once things got underway by 9pm, it seemed I rarely had less than four or more than ten waiting, but the people present changed with some regularity, some returning multiple times. **Nori** helped make sure they safely navigated the rocky terrain to and from the telescopes, and she also fielded questions when I was busy until well after midnight. I estimate I had 70 people look through my scope, ranging in age from 5 to 90, including many who had never looked through a telescope before, and one whole Girl Scout Troop. One woman could barely see but patiently and persistently looked at each object I presented, listening to my description until she was sure she'd seen as much as she was able to; another nearly burst into tears at how beautiful she found the Double Cluster to be.

Whenever I looked over at Jason and Sandra manning their two telescopes I saw a knot of people in the dark. Nori said they were both engaged the entire time, with Sandra doing a lot of the talking late into the night. One of their telescope mounts had failed along the way, so Sandra answered questions while Jason operated the working scope.

I cycled through the Ring Nebula, Alberio, M13, the Andromeda Galaxy, the Double Cluster, and the Lagoon Nebula. I always have a frightful time finding M81 and M82, and this night was no different. I tried for the duo once for maybe 5 minutes and kept them out of the rotation, even though they should have been visible. The Star Island telescope was kept mainly on Saturn while it was visible, but once it was fully dark and there were many people about, I didn't have time to keep both telescopes pointed at something. So I used just the Coulter.

A good part of the time was also spent talking to people about astronomy in general – on galaxy formation, globular clusters, double stars, and nebulae. One couple was totally amazed when they asked how many galaxies there were and I told them about the two Hubble Deep Field images. Another guy (named Dusty) seemed to know a lot about astronomy and stuck around for a very long time as others came and went. This was nice because he'd prompt me to say more about something by asking questions, and I came to realize as time went on that he usually already knew the answers to his questions. (grin) Thanks Dusty!

Whereas loading the gear for the return trip was a little more chaotic than I'd prefer, everything got on board without a hitch and it was again smooth sailing back to the mainland, the Pelicans' chant of "you **will** come back!" echoing in our ears.

Dang straight I'll do that.

- **“Rags”**

[If you consider the notion of pelicans chanting in English a bit too fanciful, you would be right. “Pelicans” in this context refers to the summer workers at the hotel on Star Island (often high school or college students) who look after visitors, greet them at the dock on arrival and bid them farewell at departure. –Ed.]



The Sun sets for the skywatch and then it rises (above), marking time for a hearty breakfast. As visitors relax after the repast, a resident enjoys a last morsel (below).



Madison Old Home Week, Silver Lake NH, August 7

A yearly favorite of hardy souls who dare venture into the dark abyss of deepest Madison, the forecast for the event was grim, the venue was changed, and to further complicate matters, the date was muddled in the program.

Ken McKenzie, Keith Garret and I showed up with 3 scopes between us and a small and attentive group came to see what was up. Saturn and Mars peeked out for a while and the group of knowledgeable youngsters seemed to have a lot of fun with them. But the greatest enthusiasm came from some more mature sisters who were thrilled to see Saturn's rings. We stayed until it was totally overcast, and lingered even later fixing a Dob.

- *Marc Stowbridge*

Nesmith Library, Windham NH, August 11

About 20 Library patrons attended the presentation given by **Steve Rand**. NHAS members **John Bishop, Ted Blank, Herb Bubert, Gardner Gerry, Steve Pearsall** and **Ed Ting** set up scopes and showed Saturn, Mars and a few summer deep sky objects, as well as the Moon one day past being Full. I also showed M13, M57, Alberio, the Double Double and Izar.

- *Gardner Gerry*

Hi Gardner and friends,

I just wanted to send you guys a big "thank you." Everyone had a great time last night and several people have asked us to host another one of these soon. Your expertise and enthusiasm is very much appreciated!

*Thanks again,
Sylvie Brikiatis, MLS
Young Adult Librarian
President of Young Adult Library
Services, a section of NHLA
Nesmith Library*

Whipple Free Library, New Boston NH, August 14

About 15-20 people showed up for my indoor talk. NHAS members manning telescopes were **John Bishop, Gardner Gerry, Linda and Larry Lopez, and Ed Ting**. We had clear, dark skies and there were a few spectacular Perseid meteors during the event.

- *Paul Winalski*

Goffstown Public Library, Goffstown NH, August 18

We had clear, if somewhat hazy, skies for this event attended by about 30 of the public. Other NHAS members setting up scopes were **John Bishop, Herb Bubert, Jeffrey Dionne, Gardner Gerry, Elaine Grantham-Buckley, Steve Rand** and **Ed Ting**. The proximity-activated floodlights on the Waterworks building weren't turned off, but it was still a very dark site by public observing standards.

I showed Saturn and Titan, Mizar, Albireo, 61 Cygni, Gamma Delphini, V Aquilae, M57, Swan Nebula, M31 and M32, and (by borrowing Herb's 13mm Ethos EP) a spectacular view of M13.

- *Paul Winalski*

Pease Public Library, Plymouth NH, August 19

We had 15-20 of the public show up. NHAS was well represented,

with 4 scopes in service. **Gardner Gerry** spent much of the evening helping the library staff operate their library telescope. He even found the current bright telescopic comet (**C2014/E2 Jacques**) in the library telescope! Quite an accomplishment for a mag. 9 object. Gardner later helped me find this comet in my 14" TScope. It is currently close to the double cluster in Perseus and was easily visible in the Orion 9x50 RACI finder. In the main scope it looked like a dim or distant globular cluster – a fuzzy ball of light.

The public was treated to both an Iridium flare and a very nice pass of the International Space Station (ending with it fading out as it passed into the Earth's shadow). Skies here are impressively dark, given that we were in the center of a town. Objects that I showed in the 14" reflector: Mizar, Albireo, 61 Cygni, Gamma Delphinus, M57, M81 and M82, the carbon star V Aquilae, M11, M17 and NGC 457.

- *Paul Winalski*

Aaron Cutler Memorial Library, Litchfield NH, August 26



Rich DM and his Obby (Photo: Ed Ting)

The event took place under clear skies. **Steve Rand** gave the indoor presentation to about 30 people. Unfortunately we were unable to get any of the floodlights on the school or

in the parking lot turned off, so star-hopping was sometimes a struggle. Other NHAS members present were **Rich DeMidio, Joe Derek, Gardner Gerry, Elaine Grantham-Buckley, Ed Ting** and **Bob Veilleux**. The library's LTP telescope was also in use.

We all started with Mars and Saturn (with 2, possibly 3 moons visible). Given the artificial light problem, I concentrated mainly on double stars: Mizar, Albireo, Polaris, 61 Cygni and Cor Caroli; I also managed to show M13, M3, M11 and NGC 457. Just before packing up I managed to split Antares at 330X with the aid of a green filter and Gardner got a very good view of comet *C/2014 E2 Jacques*.

- **Paul Winalski**

Hooksett Library, Hooksett NH, August 27 and 28

*[This event was postponed from the primary date of August 27 based on weather forecast, which turned out to be less than accurate. **Bob Veilleux** went to the site on the primary date for a skywatch and returned the next day to do the indoor presentation, followed by another skywatch, thus scoring probably the first tripecta in NHAS history. It could also be said that if the **Daniel Webster College** event in Nashua on October 29 last year was a double skywatch separated in space, this one was a double skywatch separated in time. - Ed.]*

I had four people show up and we set up two telescopes and got some nice views of a 48 hour crescent moon, Saturn, Mars, M-13 and M-57. I was glad to engage these people who did not get word on the change of date.

- **Bob Veilleux**

It was breezy on the 28th and cooled off nicely, with excellent transparency when the clouds did clear out. But there was an accident on Rt. 3 just south of the library which probably kept a few folks from getting to the skywatch, though the local police were detouring traffic around it on the back roads.

Something always seems to happen when we visit this library – there was an earthquake in the region the last time we were on site!

Other NHAS members present were **Rich DeMidio, Ed Ting, Bob Veilleux** and **Paul Winalski**. We observed M57, Alberio, M13, M31 and M32, the Swan Nebula, M11, T Lyrae, V Aquilae and *Comet Jacques*, which has moved significantly over the course of the week and a half we have been showing it to the public.

- **Gardner Gerry**

This was a really fine observing event, although the attendance was down due to the accident that Gardner mentioned above.

Threatening clouds around sunset moved on and we were left with hazy and somewhat turbulent, but clear, skies for the whole evening. Our host was able to turn off ALL of the external lighting in the parking lot and on the library building, which was a big plus for our observing. The library sits on a hill that offers excellent panoramic observing to the west and south – really good this time of year, since that's where the Milky Way is.

The Hooksett Library's own LTP telescope was on the field and we helped out by finding objects for the public to observe through a telescope that they could check out themselves.

I showed the Moon (beautiful crescent, marred only by turbulent and hazy horizon skies), Saturn (three moons visible), Mars, Mizar, Albireo, 61 Cygni, WZ Cassiopeiae, T Lyrae, and V Aquilae, for individual and double stars.

Rich DeMidio let me borrow his 13mm Ethos and we got spectacular views of M13, M92, and M3. That was a real treat! Other deep-sky objects that I showed in Mr. T. were: NGC 457, M11, M31/M32, and M8 (both with and without a narrow band O-III filter).

Bob Veilleux and Ed Ting were also able to help a person sort out problems with his 6" Celestron Schmidt-Cassegrain. The images wouldn't come to focus because the scope had been cranked to one end of its very long focal range. Ed knew enough to crank it back enough the other way, and voila! Beautiful images were at hand.

There was another couple present who were planning a tour around the USA and wanted a recommendation for a telescope to take with them. I recommended the Orion Classic XT-8 or XT-6, whichever they had room for (preferably the larger scope).

- **Paul Winalski**

*[Both the **First Friday** skywatch at MSDC on August 1 and the **Sidewalk Astronomy** session at Portsmouth the next day were cancelled due to bad weather, as was skywatch scheduled for the **Hill Library, Center Strafford NH** on August 16. -Ed.]*

M22 – Globular Cluster in Sagittarius

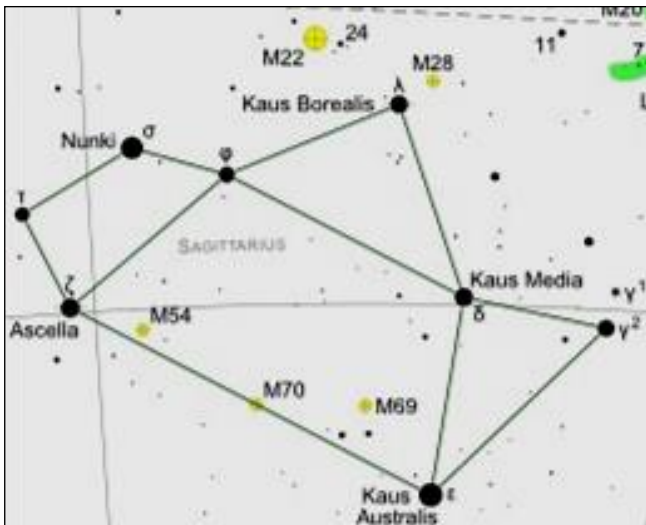
by Glenn Chaple

On early evenings in September, the constellation Sagittarius arches above the southern horizon, its rich deep-sky treasures accessible to those of us who inhabit mid-northern latitudes. One of the more spectacular of these cosmic splendors is the globular cluster M22. Its discovery is attributed to the German astronomer Abraham Ihle, who came across it on August 26, 1665 while observing Saturn.

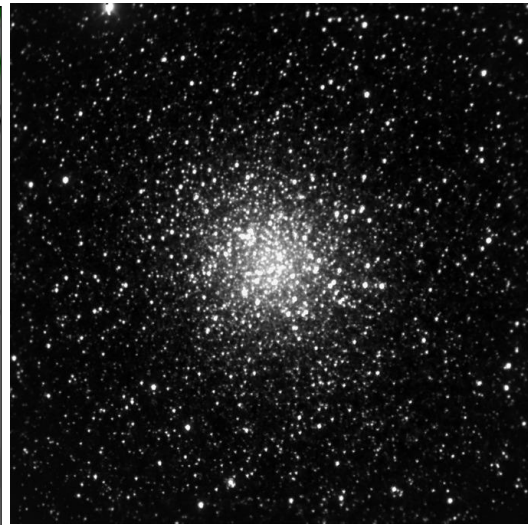
Among globular clusters, M22 is exceeded in brightness and apparent size only by omega Centauri and 47 Tucanae. Much of its grandeur results from its nearness to the Earth. At a distance of 10,500 light years, it is at less than half the distance to the much-heralded M13. In reality, M13 is half again as large and contains several hundred thousand stars, compared to M22's estimated 70,000.

I've always been a proponent of small telescopes for backyard astronomy, but had to admit that large aperture scopes are the way to go should you want to resolve the stars in a globular cluster. M22 is an exception. I've resolved it quite nicely with a 4-inch f/4 RFT (an Edmund Astroscan) and a magnifying power of just 74X. Naturally, to view M22 in all its glory you'll want to use a large instrument and 2 or 3 times that magnification.

M22 is relatively easy to locate if you use the "Teapot" of Sagittarius as a guide. In binoculars and finderscopes, it appears as a 5th magnitude smudge just 2 ½ degrees northeast of Kaus Borealis (Lambda [λ] Sagittarii) - a 3rd magnitude star that forms the top of the Teapot's lid. Next time you're visiting M13, drop southward and give M22 a look-see. Which do you prefer?



(courtesy: freestarcharts.com)



(Image: Mario Motta, MD)



A year ago, **Gary Duranko** bought a Canon EOS DSLR off of Gardner Gerry and stepped over to the dark side. His initial attempts at imaging DSOs were featured in the [August 2013 edition of *Observer*](#).

This time around he imaged μ *Cephei* (*Herschel's Garnet Star*) alongside comet *Jacques* (*C/2014 E2*) in a one-minute exposure at ISO 1600 on August 30, which has managed, to quote **Dave Weaver**, a cool juxtaposition of color.

Dave himself imaged the comet thrice in five days with his EOS 7D at prime focus on the Takahashi TOA-130 with field flattener, as shown below:



120 sec ISO 1600, August 25, 10:14pm



30 sec ISO 6400, August 26, 10:12pm



60 sec ISO 6400, August 30, 12:26am

Imaging the Sun in X-rays

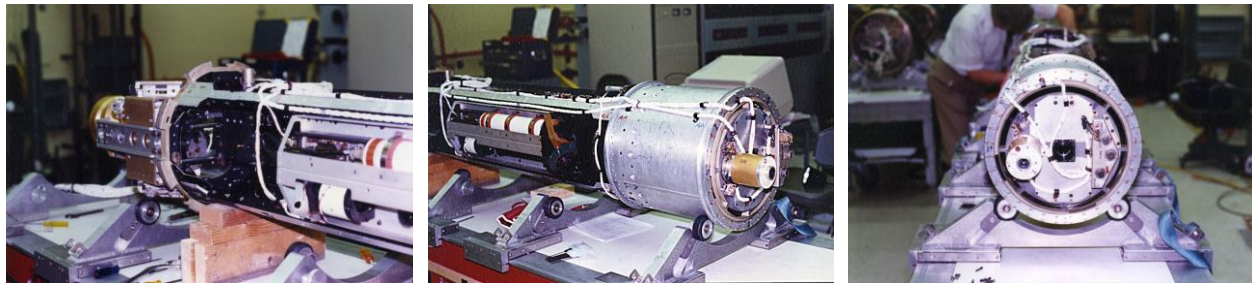
It was a crisp December day at the White Sands Missile Range in New Mexico. The NASA mission about to launch was tasked with imaging the Sun in X-rays with a special telescope carried well clear of Earth's atmosphere. In typical NASA-speak, the mission was designated *Rocket Launch 36.038CS*, and it went on to capture the finest detail of the Sun in the X-ray band seen up to that time.

I was the payload specialist on the team headed by **Dan Moses**, the Principal Investigator; **Frank Hills** and **Roger Eng** were the engineers, while **Earl Smith** and **John Davis** were part of the rocketry crew. I was responsible for the cryogenic and vacuum systems, and for the calibration of the X-ray film.

The experiment payload was developed by American Science and Engineering (AS&E). The Wolter X-ray telescope with a focal length of 54 inches was coupled with the first CCD camera flown in space (made by EV Products), with the trusty Kodak SO-212 film as backup. An H-alpha camera (with 0.1 Å bandwidth) made by Daystar was part of the SPARCS S19 pointing system responsible for precise guidance as the two-stage Sounding Rocket propelled the payload. The rocket's first stage was a Terrier booster, coupled with a Black Brant sustainer stage.

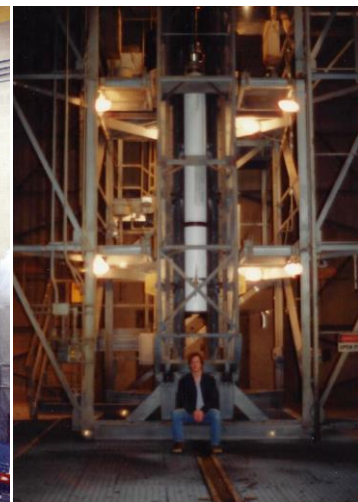
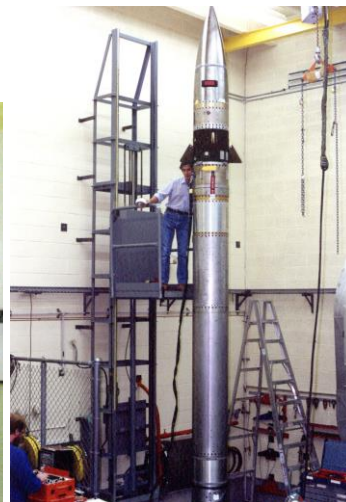


Frank Hills and Roger Eng (in the blue shirt) work in the integration facility on the experiment's telemetry and guidance components.



The experiment payload on rollers (and odd bits of 2x4): The pointed end (left), the pointing mechanism (the S19 with the gold-plated small cylinder at the end) and the mirror cell (center), and the business end of the mirror cell seen face-on (right). (All photos: Rich Schueller)

The payload underwent endless checks (below left) before being fitted with the nose-cone (right) and moved to the gantry ready for launch, with yours truly seated at the base to provide scale (far right).

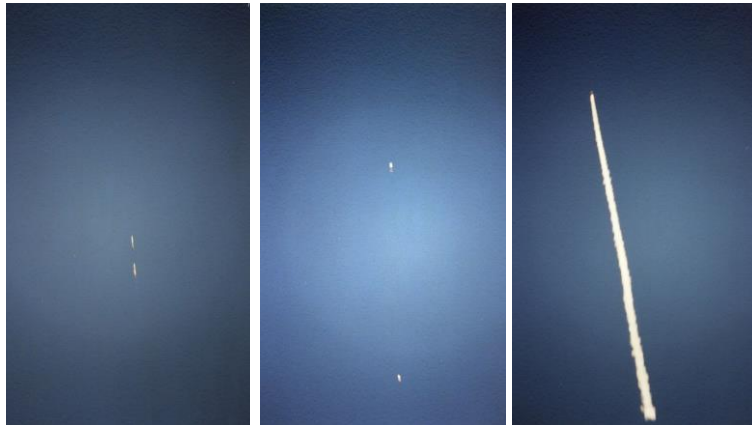




The 3-2-1 launch sequence was captured by an Olympus OM-2 with an auto-winder operating at 3fps. These are the first 3 shots in the sequence. The Terrier can certainly motor!



“The two pins holding the stages together were no larger than a pinkie!”



4.3 seconds into the mission and stage separation occurs. The first stage drops off before the second one ignites to propel the payload straight up, some 275 miles above White Sands. Yes, it did go that far up!

A NASA commendation was awarded to Dan Moses in recognition of this achievement, and he graciously crossed out his name on the certificate and wrote in the team’s names.

X-ray mirrors will work only if the angle from the plane of reflection is very low (10 arc-minutes to 2 degrees), else the rays will be transmitted or absorbed, not reflected. These are called grazing incidence mirrors. **Hans Wolter** showed in 1952 that by using two such mirrors an [X-ray telescope](#) with a fairly wide field of view can be built.

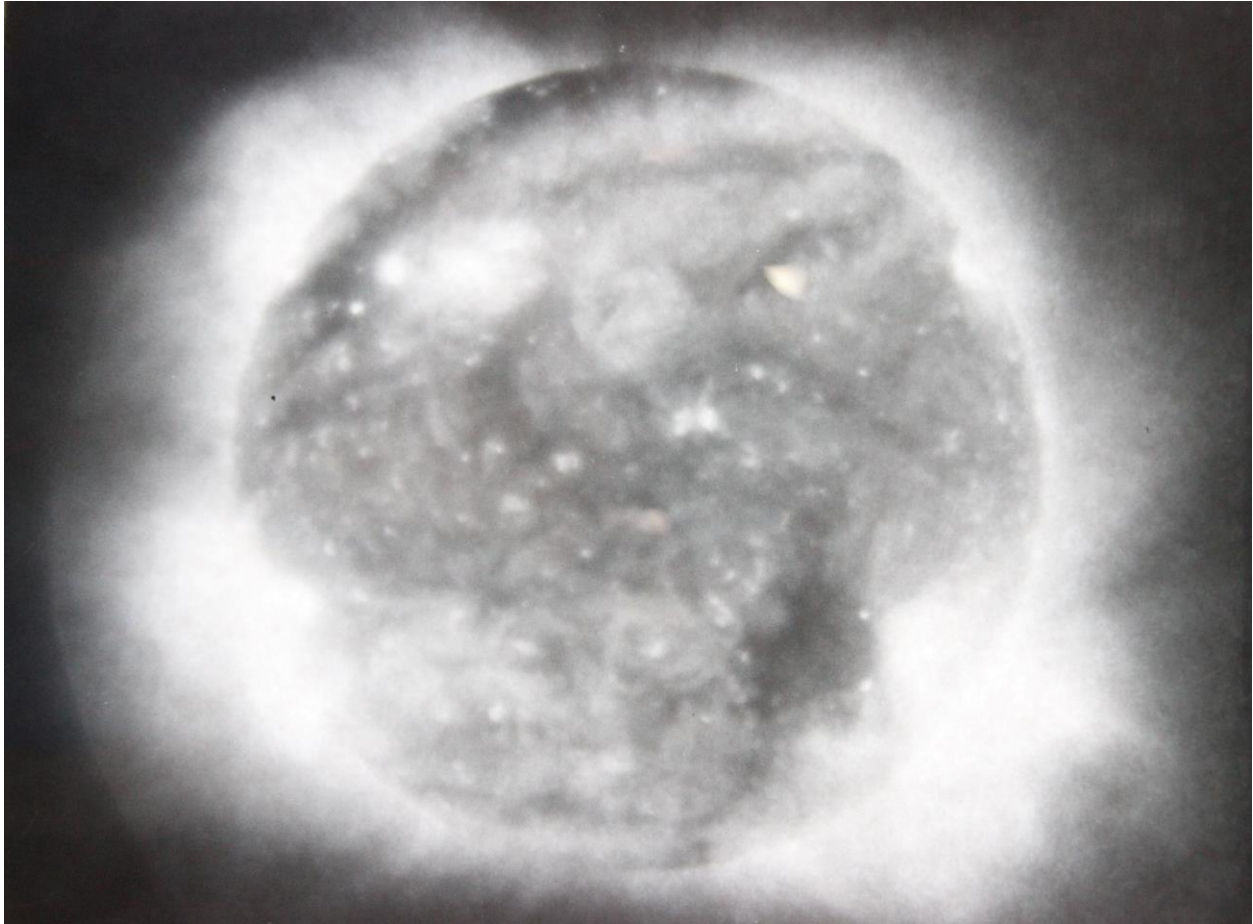
Launch and Recovery

The launch was a breathtakingly swift affair, with the Terrier booster propelling all that was above it for just 4.3 seconds. The 2 stages were held together by a pair of small pins with palm-sized drag plates at a 90° angle. These were not exploding pins that caused stage separation; they were a passive system without mechanical constraints in the axial direction, and separation occurred due to drag differential accelerations between the booster and the sustainer.

The sustainer stage ignited after separation and soon the payload was above the 400,000 feet altitude at which it was to operate. With the rocket traveling at speeds of up to 7700 ft/sec (5250mph), the excellent engineering of the S19 aiming mechanism kept the telescope pointed in the correct direction.

The imaging session occurred over the next 30 minutes. Then the capsule re-entered the atmosphere and was parachuted down for recovery in the hilly terrain of Organ Mountains, some 15 miles due west of White Sands. The Sounding Rocket system did not really perform a sub-orbital flight; the payload went almost straight up and when it floated down, the rotation of the Earth below took it westward. The payload was tracked on both ascent and descent phases by telemetry.

The end-result was a 60 second exposure of the Sun through a 1 micrometer layer of aluminized polypropylene (shown overleaf), the best X-ray image of the Sun generated up to that point.



The Sun in all its glory, sporting a somewhat different look in X-rays. The solar disk is discernable and the corona is obvious, There are some dark areas as well – these are called corona holes. The dark spot (near the 9 o'clock position) is a speck of dust on the Kodak film, which was developed by yours truly.

- *Rich Schueller*



A couple of prized mementoes of X-ray photography of the Sun and stars.



The prototype of the first X-ray telescope to image the Sun in October 1963 atop an Aerobee sounding rocket (top) and four pieces of the waste cutoff of the Wolter type I mirror on-board the Einstein Observatory launched in 1978 (bottom). Its 3 years of operation led to major insights into X-ray astronomy.



Tom Cocchiario and Rich Schueller ponder finer points of X-ray astronomy.

Ptolemy and Copernicus

You might remember learning about Copernicus and how his heliocentric system replaced the old Ptolemaic system. If you recall the details, it is probably that Ptolemy's system was wrong and overly complicated, while Copernicus's was correct and simple. You might well have been told that Ptolemy's system put Earth at the center of the universe out of religious considerations or self-importance, and that by putting the Sun in the center, Copernicus was meritoriously taking our pride down a notch. In short, Ptolemy was not doing science and Copernicus was.

Most of what has been said in the paragraph above is wrong. It wasn't that simple.

To begin with, the old system you were told about is likely to have been Hipparchus's, not Ptolemy's. It was Copernicus's system that was more complicated and wrong, while it was Ptolemy's which was simpler and correct. Hipparchus's system was simpler still, and almost as correct as Ptolemy's.

The question you should ask yourself when someone says "more correct" or "better" is: "better for what?" A solar system model could be trying to accomplish one of two very different objectives. It could be a calculation method to allow you to predict the location of the visible planets in the sky for a given date, or it could be a model of what is really going on. A very good model for calculation methods might be a bad representation of reality, and a very good model for reality might not lend itself well to calculations.

As an example in another area, maps using the Mercator projection are very good for navigating ships in the days of sail, but bad for estimating land areas. It's silly to complain that they do a bad job in presenting land areas; that's not what their designers meant by "better."

Let us cast our minds back to the times of Copernicus and think of what the life of an astronomer would be like. This was a time when most astronomers were "Court Astronomers" that lived in court or near the King or Emperor, worked for the Emperor and were paid by the Emperor.

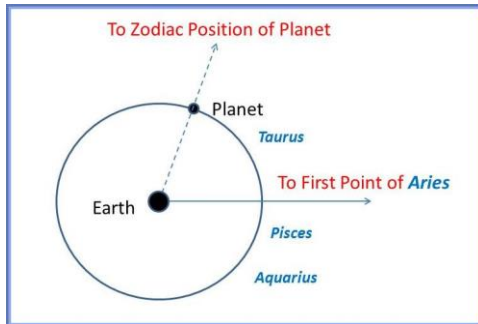
Court Astronomers

A Court Astronomer's position is a very comfortable one: you have a steady and respectable income; you have high status in society because you work for royalty; you have ample time to observe the skies and to correspond in Latin with scholars around Europe. You might even be allowed to marry – though your knowledge of Latin will make most people assume you are at least in minor orders and have taken a vow of celibacy, even if you are not a priest.

On the other hand, you might well be the only scholar within a hundred miles, and your primary job is to cast horoscopes. The King or Emperor believes in horoscopes, whether you do or do not, and so do all other members of the court. When the Emperor or a high noble is considering a bride for his son, an alliance, or a war, he will want you to cast a horoscope based on birth dates. The predictions in your horoscopes will influence his decision, so you have some political power as well as an income. Other members of the court want influence too, and some of them will put pressure on you to slant the horoscopes one way or the other. Bribes and death threats come with the job, as do poison and accusations of witchcraft. "Court Astronomer" is a title that carries a lot of weight if you are dealing with merchants and peasants, but it ranks far below a Duke or a Prince; worse yet, they have armed servants and you do not.

Of course the Emperor doesn't know anything about the position of the planets twenty years ago. You could just make stuff up. But not for long! "Court Astronomer" is a cushy job and there are plenty of people who would be willing to explain to the Emperor just how wrong a horoscope was, so that they could have your job. And if a Duke doesn't like you, he can easily find a candidate astronomer who is hungry for the job and the patronage. So you can't fake it; you really have to calculate where the planets were. Therefore ease of calculation and correctness of the result (in terms of where Mars was in March and so on) were what made a solar system model "good." Being a proper representation of physical reality was not a consideration at all.

Now, if all the astronomers in Europe had been organized and were cooperative, it would have been easy to ask them to record the position of the planets each night and circulate the results. After a century, life would be easy. No calculations would be necessary unless all of Europe had been clouded out on the day you cared about. As you might guess, that didn't happen. Court astronomers weren't cooperative and they didn't create such a record.



Step 1: Locate the orbiting planet in a constellation of the zodiac.

So astronomers had to be able to calculate the locations of the visible planets for a given date (and often a given hour) in the past. Today we can use computer programs; thirty years ago we used an ephemeris – a book full of tables calculated at great effort by people or, in more recent times, by computers. In the days of Copernicus, and even a bit later, there was no such help; astronomers used a combination of analog and digital methods.

The analog part was often done with charcoal on a big table or even on a whitewashed wall because paper was expensive and a larger diagram meant more accuracy. They did the calculation in Earth-relative terms because what they wanted to wind up with was an Earth-relative celestial longitude. In other words, you started with a date and wound up with a location along the zodiac for each planet, essentially its “Right Ascension.”

The Hipparchus method

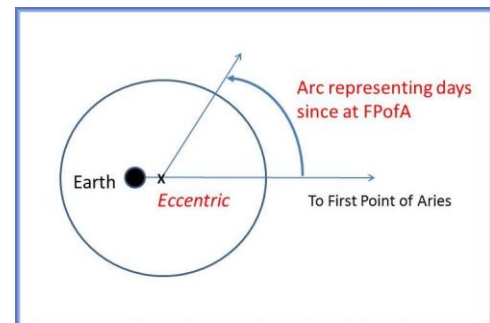
The Hipparchus method worked like this: you had a book (typically Ptolemy's *Almagest*). For each planet, you looked up **1**) its apparent (earth-relative) period and **2**) a known date in the past on which it was at a known celestial longitude. This known longitude was probably *The First Point of Aries* where the ecliptic crosses the celestial equator, the spot where the Sun is located at the Spring Equinox.

Using these two items and **3**) the current date and **4**) the known length of the year in days and fractions of a day, you can calculate how many full orbits around the Earth the planet had made, and thus know how many days had elapsed since the last time the planet had last been at the *First Point of Aries*. You divide that "left over" number of days by the full period, and then multiply that fraction by 360° to turn it into an angle.

Now you go to your wall. You use a large straight-edge to draw a horizontal line about half-way up. You make a mark on the horizontal line to be the center of your diagram. This is called the *eccentric*. You now take a big compass (the drawing device, not the one that points north) and make a large circle centered on the eccentric mark. The radius of the circle is as large as you can make it and still have some space left over for the epicycle circle you'll draw later.

A bit off to the left side of the eccentric you make a mark on that line which will represent the Earth. The book tells you what fraction of the radius of your big circle that distance should be. The line to the right of the Earth mark represents the direction of the *First Point of Aries* and angles are measured from that point going counter-clockwise. The circle represents the celestial equator.

Using the previously calculated angle and some standard geometric tricks (or a pre-calculated protractor) to turn that angle into a line in the diagram, you measure up along the circle to that angle, make a mark and draw a line from the eccentric mark. If the planet moved in a uniform way, this line would tell you the celestial longitude of the planet on the given date.



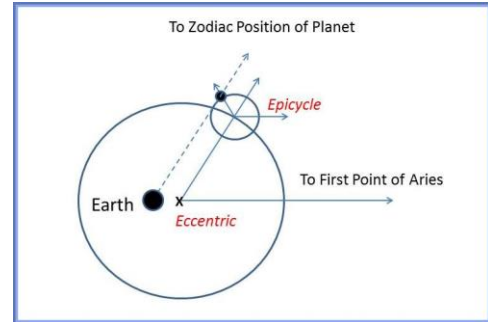
Step 2: Mark the eccentric and use the arc of residual days to compute the celestial longitude.

But planets don't move in a uniform way.

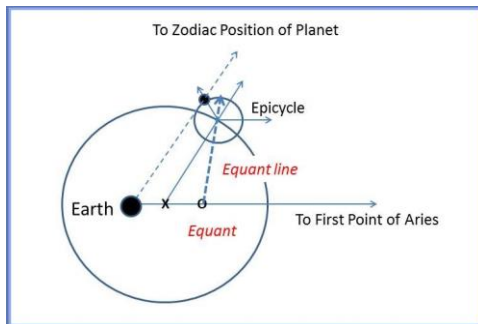
You have to go back to the book and look up the relative size of the epicycle radius relative to the orbit radius. You set your compass to draw a circle of the correct size relative to the first circle, and then draw a smaller "epicycle" circle around the point where the angled line intersects the big circle. You then draw a horizontal line through the center of the epicycle circle.

Once more back to the book, where you look up the period of the epicycle and a known starting point on the epicycle. Again you calculate the residual days after all the full periods are removed and draw an angle line from the center of the epicycle (angled relative to a local horizontal, of course). Where that second angle line crosses the epicycle circle you make a mark. This is the planet mark.

With the long straight edge you then draw a line from the Earth mark to the planet mark. The angle that line makes with the original horizontal line is the celestial longitude of the planet on the specified date. You're done! All you had to do was draw two circles and five lines, do some easy math and some easy geometrical constructions.



Step 3: Introduce the Epicycle.



Step 4: Introduce the Equant.

Ptolemy's refinement

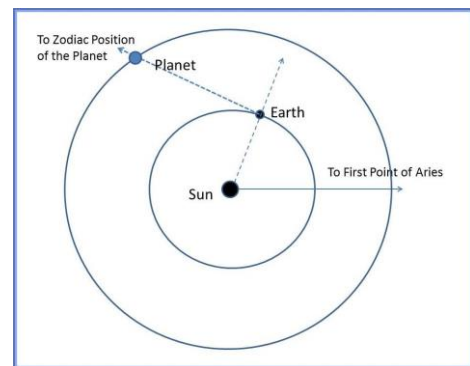
The Hipparchus method gives pretty good answers but it's sometimes off enough, especially for Mars. Ptolemy added some extra steps to get a more accurate result -- "accurate" as in "keep my job" accurate!

The first extra step is to make a mark on the initial horizontal line on the other side of the *eccentric* from the Earth mark and just as far away. This is the *equant* mark. The second extra step is that when you draw the angle representing the "leftover" days from the planet's earth-relative period, you draw it from the *equant* mark, not from the *eccentric* mark.

With Ptolemy's extra steps the predictions are very good. They aren't more than a degree off for any planet except Mars, and are always within three degrees of Mars's true position. Even with the extra steps, this was a fast method of getting accurate longitudes for the horoscopes. And more to the point, all the astronomers are agreed that this was a good method, so if you used it, you won't be shown to be wrong by a rival!

The Copernican way

Now let us consider Copernicus's method. You start with a Sun mark on horizontal line and a circle for the Earth's orbit. You take the number of days since the last spring equinox and divide it by the length of a solar year. This gives you an angle and you plot an Earth mark on the big circle. You look up the orbital radius of the planet you are interested in and draw a planet circle of the correct relative size – you'll need a really big wall if you are plotting Saturn's orbit! Now you look up the Sun-relative orbital period of the planet and again turn the residual days (relative to the solar period of the planet) into an angle so you that can draw a Saturn mark. Now you draw the straight line through the Earth and Saturn marks, extend it to the initial horizontal line, measure the angle and get your longitude. Voila! That was easy.



The Copernican way

Unfortunately while it was easy, it's going to be **very** wrong, because there is no element in this process which adjusts for the actual orbits being elliptical (no one knows about that, and Copernicus, like Ptolemy, believes in circular orbits for all planets).

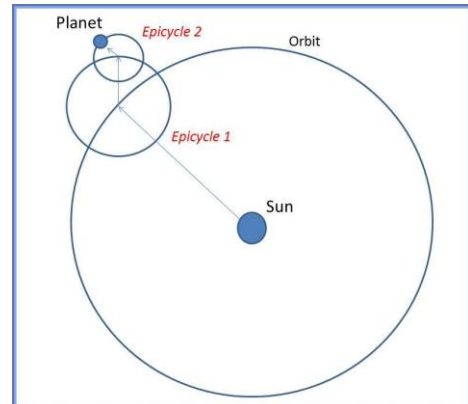
So Copernicus adds an epicycle to fix this. It is still a bit off, so in the Copernican system, there's an epicycle on top of the epicycle! That one works. It gives the same answers as the older Ptolemaic system (Kepler calculated that they differed at most by two arc-minutes).

But the bottom line is that Ptolemy's system is both faster and simpler. All other astronomers use Ptolemy's system, which has fewer steps and leads to fewer errors along the way, and everyone will get the same answers with it. If you don't get the same answers as other astronomers, you'll lose your job. If you lose your job, it could be worse than just going without the next pay-check.

You're working for the Emperor and giving him wrong answers is treason. Treason is punishable by painful death.

So for the Court Astronomers of the past, Ptolemy's system was better. It was simple and correct, while Copernicus's system was complex and wrong. And that's the other side of that story!

- [John Bishop](#)



Copernican construct of epicycle on epicycle

Editor's note: The March of Time

This issue marks the end of the first year on the job for me.

Reflecting on the year gone by, I can remember many peaks and some valleys, even a particularly deep one. I am often asked how much time I devote to an issue and my answer would be: not a minute more than required!

But sometimes one does get carried away, as with the John Dobson article in January. It became a true reporting experience as I tried to fix the date of the *Making of the Mirror*. When I think of the 4 or 5 hours spent at the Manchester City Library (site of EOC meetings) whizzing through microfiche spools of the *Union Leader* looking for a specific photograph by **Bob LaPree**, well, that was a touch of madness. It all came to nothing; then **Marion Hochuli** found the printed one-page edition of the September 1996 **Observer** and voila! The quest was over.

And yet, to me the best work in that January 2014 issue is represented by the *Cleaning Eyepieces* article (featuring **Gardner Gerry**). Thinking about it now, I am reminded of the scene from season 1 of *LOST* where John Locke is silently contemplating the cover of the hatch. He talks to Boone about how Michelangelo would stare at a block of marble for weeks, trying to see the statue within. I am not comparing myself to Michelangelo, and I certainly did not have weeks at my disposal, but I did stare at the video from **Tom Cocchiaro** and **Ted Blank's** still images for a couple of days, trying to come up with an approach. And then something clicked, and I was done in a matter of 3-4 hours. It was, as **Michael Deneen** might put it, a sublime moment. In the end, I suppose, that's what we all live for.

- [Ramaswamy](#)

NHAS August 2014 Business Meeting Report

The monthly business meeting was held at MSDC, Concord NH on August 8th, with our President **Ted Blank** presiding. The Treasurer's report by "**Rags**" follows on the next page. This was also the first meeting to be webcast, with about half a dozen members attending online.

President's Report

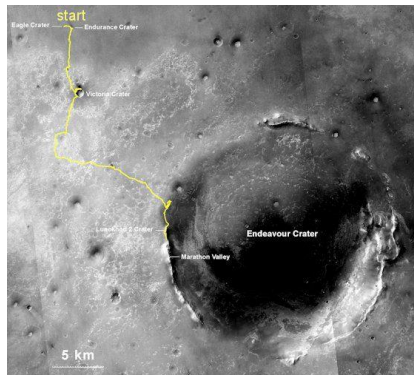
Recent public out-reach events were reviewed, including Skywatches.

Members were reminded once again that on August 14, the Red River Theatre in Concord NH will screen **Mark Levinson's** film "*Particle Fever*" – it documents the discovery of the Higgs Particle at the Large Hadron Collider. Mark will be available by Skype to answer questions after the film.

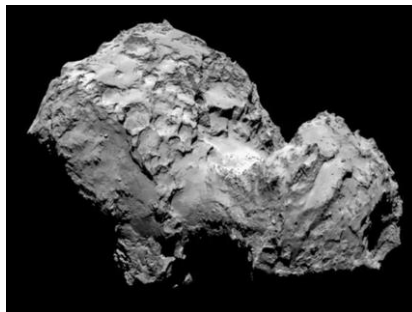
Ken Charles spoke about programs available via Astronomical League, [for which he has created a Forum entry](#). He also presented an AL certificate to **Ed Ting** for successful completion of observing 70 Messier objects (in May). [Ed's observing log](#) is also available online.

The Top 3 News items of the past month, in reverse order:

* Mars rover *Opportunity* has set an off-world driving record (over 25 miles on Mars). The next milestone will be the completion of a marathon, at Marathon Valley (see below):



* *New Horizons* is less than a year away from its rendezvous with Pluto.



* *Rosetta* has arrived at Comet [67P/Churyumov-Gerasimenko](#) to find a strange looking object.

Dwight Lanpher of PVSG (and NHAS) was in attendance to remind people of the upcoming Acadia Night Star Festival (September 25-29) near Bar Harbor, Maine. He also handed out brochures detailing the activities.

Astronomy Shorts

Paul Winalski reported about a conjunction of Mercury and Jupiter caught on the SOHO LASCO C-3 coronagraph.

Rich Schueller thanked [Andy Jaffe](#) for explaining the strange moment on TV during live coverage of the Apollo 11 landing: the sight of 2 Armstrongs stepping off 2 landers on 2 Moons!

Marc Stowbridge went to Barrington NH to fix their library scope, which just needed batteries and some minor adjustments.

John Rose has extra copies of *Starry Nights* to give away, and will also be turning over the money collected at Stellafane swap table.

The Evening Presentations



Rich Schueller making a point the old fashioned way. He later switched to the use of a red laser.

Before the break, **Rich Schueller** traveled down memory lane to give a 15-minute talk about the day in 1987 when a rocket launch generated the best view then available of the Sun in X-rays. Film and story on [page 10](#).



After the break, **Steve Conard** of the Johns Hopkins Applied Physics Laboratory talked about the 20cm Ritchey-Chretien telescope aboard the *New Horizons* spacecraft on its way to image Pluto and its environs.

Dubbed **LORRI** (Long Range Reconnaissance Imager), it'll obtain early long-range images of the Pluto/Charon system, and later provide high resolution panchromatic images at closest approach, with an expected resolution of 100 meters.

NHAS Treasurer's Report*(as of August 7, 2014)*

Starting Checking Balance:	\$10,160.15	Membership:	141
Deposits:		Single + Family	
Membership	60.00	Cash Renewals:	0x30.00+0x10.00 0.00
Donations	75.00	Cash New Members	2x30.00+0x10.00 60.00
Interest	0.37	PayPal Renewals:	0x28.83+0x 9.61 0.00
Total:	\$135.37	PayPal New Members:	0x28.83+0x 9.61 0.00
		Total:	2 \$60.00
Expenses Paid:		Current Members:	143
United Site Services (porta potty)	56.45	New Members:	
Kelly Beatty (Starblast for LTP)	100.00	Michael Clancey	Gardner MA
Marc Stowbridge (LTP accessor.)	250.00	William Lincoln	Nashua NH
Herb Bubert (AAS registration)	50.00	Donations:	
Gardner Gerry (AAS registration)	50.00	Portsmouth Sidewalk Astronomy	GEN 75.00
Rackspace Cloud (web site)	22.60	Total:	\$75.00
Total:	\$529.05		
Current Checking Balance:	\$ 9,766.47		
Petty Cash:	\$100.00		
Current Cash Balance:	\$9,866.47		
EOC Share:	\$6,183.02		

Contact InformationHow to join NHAS

Write to us: **NHAS**
P. O. Box 5823
Manchester, NH 03108-5823

Send Email to: info@nhastro.com

Visit our web site: <http://www.nhastro.com>

How to contribute to the Observer

Email articles and snapshots to the Editor:

ramax.astro@yahoo.com

NHAS Officers:

President: [Ted Blank](#)
Vice-President: [Tom Cocchiaro](#)
Secretary: [Paul Winalski](#)
Treasurer: [David "Rags" Gilmore](#)

Board of Directors:

[Ken Charles](#)
[Pete Smith](#)
[Steve Rand](#)



Orion XT6 – 6” Newtonian on a Dobson mount
 (custodian: Ted Blank contact: tedblank@gmail.com)

Equipped with:

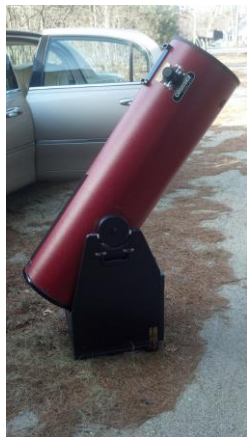
- Telrad finder with a dew shield
- 32mm, 25mm and 10mm Plössl EPs in a case
- A Planisphere, a Moon map, and a red light
- Richard Berry’s “Discover the Stars”
- Orion XT6 user manual



Meade 8” Newtonian on a Dobson mount
 (custodian: Ken Charles contact: starnek2550@gmail.com)

Equipped with:

- Telrad finder with a dew shield
- 25mm and 10mm EPs
- Custom-built base (a Joe Derek/Chase McNiss original)



Coulter Odyssey 10” Newtonian on a Dobson mount
 (custodian: “Rags” Gilmore contact: nhas@ragnorok.net)

Equipped with:

- Telrad finder with a dew shield
- 26mm TeleVue Plössl and 15mm Celestron Plössl in a case
- A Planisphere and a Moon map
- Richard Berry’s “Discover the Stars”

Also available on loan, independent of the telescope, and in a separate slip-case:

- Sky Atlas 2000.0 by Wil Tirion and Roger Sinnott
- Sky Atlas 2000.0 Companion by Robert Strong and Roger Sinnott



Orion XT10 on a Dobson mount
 (custodian: Pete Smith contact: psastro60@gmail.com)

Equipped with:

- Telrad finder (replacing the original finderscope)
- Assorted EPs: 35mm, 25mm wide-angle, 17mm and 10mm.
- An EP case will be available in the near future.

Regional Astronomy Clubs

New Hampshire Astronomical Society
[NHAS] *Skywatches around the State*
Sidewalk Astronomy in Portsmouth
www.nhastro.com

Amateur Astronomical Society of Rhode Island (North Scituate, RI)
www.theskyscrapers.org

Amateur Telescope Makers of Boston
(Westford, Mass.)
www.atmob.org

Astronomy Society of Northern New England (Kennebunk, Maine)
www.asne.org

Gloucester Area Astronomy Club
(Gloucester, Mass.)
www.gaac.us

McAuliffe-Shepard Discovery Center
[MSDC] (Concord, NH)
First Friday Observing Event
www.starhop.com

Northeast Kingdom Astronomy Foundation (Peacham, VT)
www.nkaf.org

North Shore Astronomy Club
(Groveland, Mass.)
www.nsaac.org

Penobscot Valley Star Gazers
(Bangor, Maine)
www.gazers.org

Online Live Observatories

Astronomy Live (broadcasts)
www.astronomylive.com

SLOOH (Tenerife, Canary Is.)
www.slooh.com/about.php

Worldwide Telescope
www.worldwidetelescope.org

Magazines

Astronomy
www.astronomy.com

Sky & Telescope
www.skyandtelescope.com

Astronomy Gear

Agena AstroProducts
www.agenaaastro.com

Astromart
(Used equipment and advice)
www.astromart.com

Astronomy-Shoppe
(in Plaistow, NH 03865)
www.astronomy-shoppe.com

Celestron
www.celestron.com

Cloudynights
(Used equipment, Articles, Forums and Reviews)
www.cloudynights.com

Explore Scientific
www.explorescientific.com

High Point Scientific
www.highpointscientific.com

Kendrick Astro Instruments
www.kendrickastro.com

Lunt Solar Systems
www.luntsolarsystems.com

Meade Instruments
www.meade.com

Oceanside Photo & Telescope
www.optcorp.com

Orion Telescopes
www.telescope.com

ScopeStuff
www.scopestuff.com

TeleVue
www.televue.com

Vixen Optics
www.vixenoptics.com

William Optics
www.williamoptics.com

Sky at Night
www.skyatnightmagazine.com

Astronomy Web Sites

CalSky
(Sky Calendar to plan Observing)
www.calsky.com

Free Star Charts
(Star Charts for MM, Planets etc.)
www.freestarcharts.com

Heavens Above
(on Satellites, Spacecraft, Planets)
www.heavens-above.com

NASA
www.nasa.gov

Dark skies Observing Sites
(Horizons and Clear Sky information)
www.observingsites.com

ScopeReviews
(Reviews by Ed Ting, NHAS)
www.scopereviews.com

Sloan Digital Sky Survey DR10
<http://skyserver.sdss3.org/>

SpaceWeather
(Solar activity, Asteroid passes)
www.spaceweather.com

Computer Software

Cartes du Ciel (*aka Skychart*) (Free)
www.ap-i.net/skychart/

Celestia
www.shatters.net/celestia

Computer Aided Astronomy (Free)
www.astrosurf.com/c2a/english/

Earth Sky Tonight
www.earthsky.org/tonight

SkyMap Online
www.skymaponline.net

Starry Night
(many versions, Novice to Expert)
www.starrynight.com

Stellarium (Free)
www.stellarium.org









WinStars (Free)
www.winstars.net/english/

Upcoming Events

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Event	Date	Time	Location
West Manchester Community Library Skywatch	Wednesday, September 3	7:00pm	76 North Main St, Manchester NH
First Friday Skywatch for MSDC	Friday, September 5	7:00pm	MSDC, Concord NH
Sidewalk Astronomy Skywatch	Saturday, September 6	6:00pm	Market Square, Portsmouth NH
Owls Landing Campground Skywatch	Saturday, September 6	7:00pm	245 US 3, Holderness NH
West Manchester Community Library Skywatch (backup date)	Wednesday, September 10	7:00pm	76 North Main St, Manchester NH
EOC Meeting	Thursday, September 11	6:30pm	Manchester City Library, Manchester NH
Franconia Notch State Park Skywatch	Thursday, September 11	8:00pm	Lafayette Campground, 260 Tramway Dr, Franconia NH
NHAS Business Meeting	Friday, September 12	7:30pm	St. Anselm, Manchester NH
Owls Landing Campground Skywatch (backup date)	Saturday, September 13	7:00pm	245 US 3, Holderness NH
Gordon-Nash Library Skywatch	Sunday, September 14	7:30pm	New Hampton School, New Hampton NH
J A Tarbell Library Skywatch	Thursday, September 18	6:30pm	Citizen Hall, Lyndeborough NH
NHAS Fall Messier Marathon	Friday, September 19	3:00pm	The Wickett Residence
Gordon-Nash Library Skywatch (backup date)	Friday, September 19	7:30pm	Pinnacle Hill, New Hampton NH (note the difference in location)
Fall Messier Marathon (first backup date)	Saturday, September 20	3:00pm	The Wickett Residence
Septemberfest Camp Runels Skywatch	Saturday, September 20	4:15pm	Camp Runels, Pelham NH
LTP Modification Party	Sunday, September 21	11:30am	MSDC, Concord NH
J A Tarbell Library Skywatch (backup date)	Thursday, September 25	6:30pm	Citizen Hall, Lyndeborough NH
Kensington Library Skywatch	Friday, September 26	7:00pm	Kensington School playground or Sawyer Park, Kensington NH
Coffee House Night at YFOS	Saturday, September 27	5:00pm	YFOS
Rey Center Skywatch	Saturday, September 27	8:00pm	Waterville Valley NH
Kensington Public Library Skywatch (backup date)	Sunday, September 28	7:00pm	Kensington School playground or Sawyer Park, Kensington NH
North Hampton Public Library Skywatch	Wednesday, October 1	7:30pm	237a Atlantic Avenue, North Hampton NH
Franconia Notch State Park Skywatch (backup date)	Thursday, October 2	8:00pm	Lafayette Campground, 260 Tramway Dr, Franconia NH
First Friday Skywatch for MSDC	Friday, October 3	7:00pm	MSDC, Concord NH
Sidewalk Astronomy Skywatch	Saturday, October 4	6:00pm	Market Square, Portsmouth NH
EOC Meeting	Thursday, October 9	6:30pm	Manchester City Library, Manchester NH
NHAS Business Meeting	Friday, October 10	7:30pm	MSDC, Concord NH
Center for Conscious Studies Skywatch	Saturday, October 11	6:00pm	Stratham NH (see Calendar entry)
Center for Conscious Studies Skywatch (backup date)	Sunday, October 12	6:00pm	Stratham NH (see Calendar entry)
Hopkinton Town Library Skywatch	Thursday, October 16	7:00pm	Houston Drive, Hopkinton NH
NEFAF Skywatch	Friday, October 17	6:00pm	UNHO, Spinney Lane, Durham NH
NEFAF Skywatch	Saturday, October 18	10:00am	UNHO, Spinney Lane, Durham NH
Hopkinton Town Library Skywatch (backup date)	Monday, October 20	7:00pm	Houston Drive, Hopkinton NH

Note: Please check [Calendar] at www.nhastro.com for up-to-date information on upcoming events.

Date	Lunar Phase
Tuesday, September 2	 First quarter 11:11am
Tuesday, September 9	 Full moon 1:38am
Tuesday, September 16	 Last quarter 2:05am
Wednesday, September 24	 New moon 6:14am
Wednesday, October 1	 First quarter 7:33pm
Wednesday, October 8	 Full moon 10:51am
Wednesday, October 15	 Last quarter 7:12pm
Thursday, October 23	 New moon 9:57pm

Credits

Contributors to this month's **Observer:**

John Bishop, Ted Blank, *Sylvie Brikiatis*, *Glenn Chaple*, Ken Charles, Gary Duranko, Gardner Gerry, "Rags" Gilmore, Andy Jaffe, Larry LaForge, Nori Odoi, Steve Rand, Rich Schueller, Marc Stowbridge, Ed Ting, Bob Veilleux, Dave Weaver and Paul Winalski.