# Skylights

Newsletter of the Astronomical Society of Northern New England

MAR 2015

Member of NASA's

Astronomical League

**ASNNE MISSION**

**ASNNE is an incorporated, non-profit, scientific and educational organization with three primary goals:**

***1) To have fun sharing our knowledge and interest with others.***

***2) To provide basic education in astronomy and related sciences to all who are interested.***

***3) To promote the science of Astronomy.***

## What's Up In March

*By Bernie Reim*

The month of March is named after the Roman god of war, Mars. It also used to be the first month of the year. For us in the northern hemisphere March always marks the beginning of spring. This year that will happen exactly at 6: 45 p.m. on Friday the 20th.

That important moment can be further defined by the sun on the ecliptic crossing over the celestial equator on an upward path. That is also called the vernal equinox. That word means "equal night", which is when the days and nights are both equal to 12 hours. That day actually happens two days before the equinox, on the 18th, because the earth orbits the sun in ellipses and not perfect circles.

The vernal and autumnal equinoxes are the only two days each year that the sun rises due east and sets due west for everyone on Earth except for the North and South Pole. Near the equator, within the region of the tropics that reaches up to 23 and a half degrees north and south of the equator, the days are always about 12 hours long, not just during the equinoxes.

So those two configurations at the equinoxes can be seen as a unifying principle of experience for the nearly 7.3 billion people that now share this fragile planet with each other.

The earth will have to warm up a little this month as it slowly tilts back towards the sun again. There will be several interesting highlights to see as more people venture outside again after a long, cold, and snowy winter. Jupiter will still be close to its best, more mutual occultations and eclipses of Jupiter's four large Galilean moons, Venus and Mars slowly drift apart again, nice conjunctions of crescent moons with Mars and the Venus, Saturn rising around midnight, and a challenge to see the famous white dwarf star which is the companion star for Sirius. If you are willing to travel a little, there is even a total solar eclipse coming up in the North Atlantic just 12 hours before spring starts.

Jupiter is still close to its best and brightest for the year. It rises around one hour before sunset and will reach its highest point in the sky, which is defined as transiting the meridian around 10:30 pm starting this month. Notice that the king of the planets is still in retrograde motion westward towards the Beehive Star cluster in Cancer, but it will not reach it before it returns to its normal eastward or prograde motion again next month. A nearly full moon will pass just to the right of Jupiter on the evening of Monday the second.

There are many more mutual occultations and eclipses happening between the four large Galilean Moons of Jupiter happening every single night this month. Check out a detailed schedule if you would like to observe some of them through a telescope to attain a better understanding of how this miniature solar system really works.

Our two nearest planetary neighbors, Venus and Mars are slowly drifting apart again after a close conjunction last month. Notice that Venus is just over 5 magnitudes, or 100 times brighter than orange Mars. Venus keeps rising higher and setting later. It will not set until after 9 pm by the end of this month.

***"Continued on page 2"***

***TRIVIA: Boomerang Nebula** is the coldest natural known place in the universe, 1kelvin above absolute zero.*

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**What's Up "*Continued from page 1*"**

Mars is doing just the opposite, setting earlier and slowly sinking out of view by the end of the month after it had matched our rate of revolution around the sun at one constellation per month for the last half year. The net result was that Mars always set at about the same time, a few hours after sunset.

If you have a good pair of binoculars or a telescope you can spot a much fainter planet that has been hanging out near the pair for a month or so. Uranus is closest to Venus on March 4th, less than one tenth of a degree away. Notice that it will be fully 10 magnitudes, or 10,000 times fainter than Venus. On March 11th, Uranus will pass less than one third of a degree below Mars. Since its discovery on March 13 of 1781 by Sir William Hershel, Uranus has not even completed 3 of its 84-year orbits around the sun.

The gap between Mars and Venus will be increasing at the rate of about half a degree per day. By March 21st, right after spring starts, they will be about 12 degrees apart, which can be measured in the sky by just over one fist at arm's length. That is also the distance that the moon moves each day. It moves eastward its own width, which is half a degree, each hour against the fixed background of stars. On the evening of Saturday the 21st, the slender waxing crescent moon, only about a day and a half old after creating a total solar eclipse over the North Atlantic by having its shadow cone sweep over a small part of the earth, will be less than half a degree to the left of Mars. The very next evening, the moon will appear 7% larger and about one degree to the left of Venus.

Saturn is getting a little closer and brighter each night and will be rising a little earlier. The ringed planet will end its eastward motion on March 14 this year, which also happens to be Albert Einstein's birthday. Then it will reach opposition on May 22nd and end its retrograde motion about two months after that.

The brightest star in our sky is named Sirius and can easily be seen in the constellation of Canis Major. It also has a companion star called Sirius B which is a white dwarf. It makes an elliptical orbit around Sirius every 50 years. The last time it was as far away from Sirius as it is now was back in 1979. It will not reach its maximum separation of 11.3 arc seconds until 2022, but now it is already separated by 10.7 arc seconds, which means it should be possible to see it in a good telescope.

March 5. Full moon is at 1:05 p.m. EST. This is also called the Sap, Crow, Worm, or Lenten Moon

March 6. The Dawn spacecraft is scheduled to arrive at Ceres, our largest asteroid, today.

March 8. Daylight-saving time starts at 2 am this morning.

March 12. The waning gibbous moon is just 3 degrees from Saturn and 9 degrees from Antares in Scorpius this morning.

March 13. On this day in 1781 William Herschel discovered the planet Uranus. Last quarter moon is at 1:48 p.m. EDT.

March 14. Albert Einstein was born on this day in 1879. His general theory of relativity, published in 1915, completed redefined gravity as simply the curvature of the fourth dimensional space-time continuum.

March 20. New moon is at 5:36 a.m. There will be a total solar eclipse over the Faroe Islands and parts of the North Atlantic today. A partial solar eclipse will be seen over a much larger part of the world, but not for us here on the East coast of the U.S. Spring starts at 6:45 p.m. EDT.

March 21. The waxing crescent moon is near Mars tonight.

March 22. On this day in 1997, Comet Hale-Bopp made its closest approach to Earth. This was a once-in-a-lifetime comet whose distinct double tail stretched over 20 degrees through the sky for over a month. It sparked a serious interest in astronomy for thousands of people on Earth.

March 24. The moon crosses over the Hyades star cluster this evening and occults Aldebaran in Taurus for observers in Alaska and northwestern Canada.

March 25. On this day in 1655, Christian Huygens discovered Titan, the largest moon of Saturn.

March 27. First quarter moon is at 3:43 a.m. EDT.

## Moon Phases

**Mar 5**
Full

**Mar 13**
Last Quarter

**Mar 20**
New

**Mar 27**
First Quarter

## Moon Data

**Mar 3**
Jupiter 5° north of Moon

**Mar 5**
Moon at apogee

**Mar 12**
Saturn 2° south of Moon

**Mar 18**
Neptune 4° south of Moon

**Mar 19**
Mercury 5° south of Moon

Moon at perigee

**Mar 21**
Uranus 0.9° south of Moon

Mars 1° south of Moon

**Mar 22**
Venus 2° south of Moon

**Mar 25**
Aldebaran 0.9° south of Moon

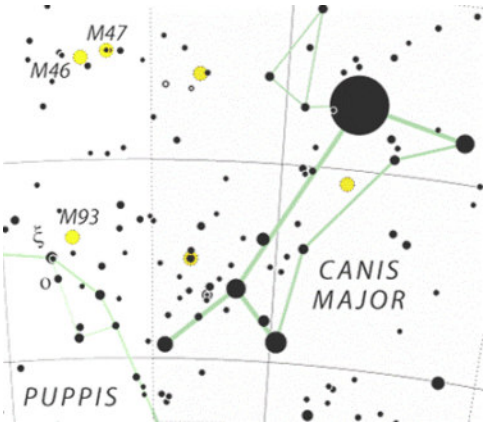
## Sky Object of the Month – March 2015
## Messier 47 (NGC 2422) – Open Cluster in Puppisby
## Glenn Chaple

Last March, we explored the open star cluster Messier 46 in Puppis. This time around, we turn our telescopes 1 ½ degrees westward to another Puppis cluster – M47. For nearly two centuries, this was one of Messier's "missing" objects. It was originally discovered by the Italian astronomer Giovanni Battista Hodierna – a forerunner of Messier. Hodierna reported it in a treatise on comets and "admirable objects of the sky," published in 1654. Hodierna's work was unknown to Messier who independently discovered the cluster on February 19, 1771. Messier made an error in plotting its position, and the mistake wasn't rectified until the mid 1900s.

At magnitude 4.4 and having the apparent width of a full moon, M47 is visible to the unaided eye under dark-sky conditions. It's a fine sight in binoculars and rich-field scopes, which capture M46 as well. While the latter appears as a hazy patch, M47 has an almost Pleiades-like look. Even a small scope will pick up several dozen cluster members.

Like M46, which houses the planetary nebula NGC 2438, M47 is home to a deep-sky delight of its own. Near its center is the pretty double star Struve (STF) 1121 – a pair of white magnitude 7.0 and 7.3 stars separated by 7.4 arc-seconds. STF 1121 is well resolved when M47 is viewed with magnifications of 50X and up.

M 47 is approximately 1600 light-years away and has a true diameter of 12 light-years.




www.constellation-guide.com
(IAU and *Sky and Telescope*)

Messier 47 (4.5-inch f/8 reflector at 33X)
North is up in this 1.3 degree field. Arrow shows location of STF 1121. Sketch by author

## Principal Meteor Showers in 2015

**January 4**
Quadrantids

**April 22**
Lyrids

**May 6**
Eta Aquarids

**July 30**
Delta Aquarids

**August 12**
Perseids

**October 9**
Draconid

**October 21**
Orionids

**November 9**
Taurids

**November 18**
Leonids

**November 26**
Andromedids

**December 14**
Geminids

**December 22**
Ursids

*Note: Dates are for maximum*

**New Activity on the SciJinks Web Site: Lightning Detection**

Why would we want a tool to detect lightning? It's pretty hard to miss, isn't it? Well, it turns out there are different kinds of lightning, and detecting some kinds early can help meteorologists predict when a storm will get worse. Read the latest SciJinks article to learn about the history, use, and future of lightning detection. **http://scijinks.gov/lightning-detection**. SciJinks is a joint NOAA and NASA educational website about weather and other Earth science topics. It targets middle- and high-school aged students.

**The latest issue of the Space Place Newsletter: News and Notes for Formal and Informal Educators can be found at: http://spaceplace.nasa.gov/en/educators .**

**Check out our great sites for kids:**

The Space Place website (http://spaceplace.nasa.gov)

The *SciJinks Weather Laboratory* at http://**scijinks.gov**

*NASA Climate Kids* at http://**climate.nasa.gov/kids**

## Our club has merchandise for sale at:

**www.cafepress.com/asnne**



**All money raised goes to our operating fund.**
**Any design can be put on any item.**

# The heavyweight champion of the Cosmos

By Dr. Ethan Siegel

As crazy as it once seemed, we once assumed that the Earth was the largest thing in all the universe. 2,500 years ago, the Greek philosopher Anaxagoras was ridiculed for suggesting that the Sun might be even larger than the Peloponnesus peninsula, about 16% of modern-day Greece. Today, we know that planets are dwarfed by stars, which themselves are bound together by the billions or even trillions into galaxies.

But gravitationally bound structures extend far beyond galaxies, which themselves can bind together into massive clusters across the cosmos. While dark energy may be driving most galaxy clusters apart from one another, preventing our local group from falling into the Virgo Cluster, for example, on occasion, huge galaxy clusters can merge, forming the largest gravitationally bound structures in the universe.

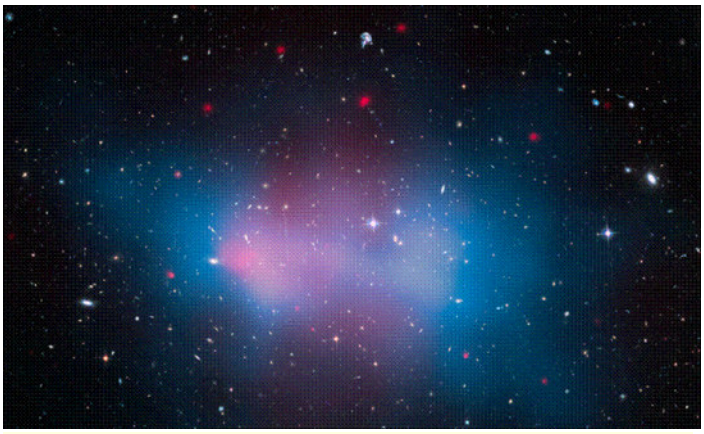
Take the "El Gordo" galaxy cluster, catalogued as ACT-CL J0102-4915. It's the largest known galaxy cluster in the distant universe. A galaxy like the Milky Way might contain a few hundred billion stars and up to just over a trillion ($10^{12}$) solar masses worth of matter, the El Gordo cluster has an estimated mass of $3 \times 10^{15}$ solar masses, or 3,000 times as much as our own galaxy! The way we've figured this out is fascinating. By seeing how the shapes of background galaxies are distorted into more elliptical-than-average shapes along a particular set of axes, we can reconstruct how much mass is present in the cluster: a phenomenon known as weak gravitational lensing.

That reconstruction is shown in blue, but doesn't match up with where the X-rays are, which are shown in pink! This is because, when galaxy clusters collide, the neutral gas inside heats up to emit X-rays, but the individual galaxies (mostly) and dark matter (completely) pass through one another, resulting in a displacement of the cluster's mass from its center. This has been observed before in objects like the Bullet Cluster, but El Gordo is much younger and farther away. At 10 billion light-years distant, the light reaching us now was emitted more than 7 billion years ago, when the universe was less than half its present age.

It's a good thing, too, because about 6 billion years ago, the universe began accelerating, meaning that El Gordo just might be the largest cosmic heavyweight of all. There's still more universe left to explore, but for right now, this is the heavyweight champion of the distant universe!

*Learn more about "El Gordo" here: [http://www.nasa.gov/press/2014/april/nasa-hubble-team-finds-monster-el-gordo-galaxy-cluster-bigger-than-thought/](http://www.nasa.gov/press/2014/april/nasa-hubble-team-finds-monster-el-gordo-galaxy-cluster-bigger-than-thought/)*

*El Gordo is certainly huge, but what about really tiny galaxies? Kids can learn about satellite galaxies at NASA's Space Place [http://spaceplace.nasa.gov/satellite-galaxies/](http://spaceplace.nasa.gov/satellite-galaxies/).*



**Caption:**

*Image credit: NASA, ESA, J. Jee (UC Davis), J. Hughes (Rutgers U.), F. Menanteau (Rutgers U. and UIUC), C. Sifon (Leiden Observatory), R. Mandelbum (Carnegie Mellon U.), L. Barrientos (Universidad Catolica de Chile), and K. Ng (UC Davis). X-rays are shown in pink from Chandra; the overall matter density is shown in blue, from lensing derived from the Hubble space telescope. 10 billion light-years distant, El Gordo is the most massive galaxy cluster ever found.*


The University of California High-Performance AstroComputing Center

## Without a Trace—Almost

It was a classic case of serendipity.

While investigating how supermassive black holes formed in the early universe, UC Santa Cruz postdoctoral researcher Ke-Jung Chen stumbled on the unanticipated discovery that some primordial supermassive stars could explode without leaving *any* black hole or other stellar remnant behind.

Chen had been fascinated by supermassive black holes since grad school at the University of Minnesota. Every big galaxy has one of these voracious monsters at its center: a black hole millions or even billions of times more massive than the sun.

The big mystery long puzzling astrophysicists is: how did supermassive black holes form? The ones that exist at the centers of some very ancient galaxies that shine brightly as quasars formed when the universe was less than 800 million years old. But no ordinary-sized stellar-mass black holes could have grown that gigantic that fast.

So the conclusion seemed inescapable: supermassive black holes had to have started life already monstrous at cosmic dawn. But how?

### Monster stars

Just as ordinary black holes are the stellar remnants left by supernova explosions of stars more than 20 solar masses, supermassive black holes could have originated from supernova explosions of supermassive stars—ones having *tens of thousands* of solar masses.

Today, the highest-mass stars top out at about 100 solar masses (Eta Carinae, one of the most massive stars in our Milky Way galaxy, is about 90). But recent cosmological simulations suggest the possibility that in the early universe truly gargantuan stars could exist. So Chen began exploring this with two different computational simulations, called KEPLER and CASTRO, using resources at the National Energy Research Scientific Computing center (NERSC) at Lawrence Berkeley National Laboratory.

KEPLER is 1-dimensional (meaning it assumes that stars are spherical, so physical quantities such as temperature or density can depend only on radius). KEPLER follows how gas turns into stars and how supernovae feed back energy into surrounding gas; it also traces how convection—movement of gas inside a star—affects mixing and nuclear burning. CASTRO allows more complexity: it recreates a multidimensional section through a star, modeling internal gravitational forces and tracking the masses of specific atomic elements that are synthesized from nuclear fusion.

Most importantly, both simulations were run at high spatial resolution to explore fine details of an explosion. The supermassive star Chen modeled had a radius of about 103 million miles—about 10% larger than Earth's orbit—with a resolution of 30,000 miles, only 0.03% of the radius.

***"Continued on page 7"***

***Without a Trace—Almost***
***"Continued from page 6"***

**Live fast, die young…leave no corpse**

The simulations revealed that a supermassive star burns hydrogen at a furious rate for under 2 million years—a mere blink of a cosmic eye (the Sun is about 5 *billion* years old) before beginning to collapse. Then what happens internally depends critically on its mass. If it is less than 55,000 or more than 56,000 solar masses, the supermassive star explodes and leaves behind a supermassive black hole.

But if it is between those masses—say, 55,500 solar masses—special processes in the star's ultrahot low-density core trigger a general relativity instability that triggers an explosion so violent that it "completely unbinds the star and leaves no compact remnant," write Chen and his five coauthors in *Astrophysical Journal.* Indeed, the explosion "at ~9 x $10^{54}$ erg is the most energetic thermonuclear SN [super-nova] known."

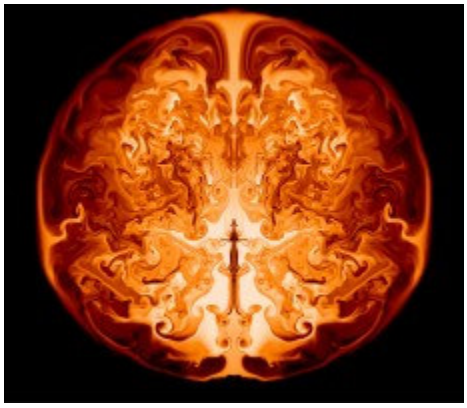
Okay, that's what the simulations predict. Did such exotic primordial explosions happen in the real Universe? Future wide-field infrared telescopes in orbit—such as the proposed Wide Field InfraRed Survey Telescope (WFIRST)—might be able to directly detect such explosions at the very edge of the universe a few hundred million years after the Big Bang.

Moreover, the volume of "metals"—chemical elements heavier than helium—that a general-relativity–instability supernova explosion (GSNe) expels into space would be 100 times greater than that from a regular supernova. But it would have a different chemical composition, consisting only of lighter elements from carbon to silicon rather than heavier ones such as iron. "Traces of GSNe might therefore be found in early galaxies that are $^{56}$Fe [iron] deficient but enhanced with $^{12}$C [carbon] and $^{16}$O [oxygen]," Chen and his coauthors conclude.

Stay tuned! *–Trudy E. Bell, M.A.*

***Further reading:*** The paper "The General Relativistic Instability Supernova of a Supermassive Population III Star" in the August 1, 2014 issue of *Astrophysical Journal* by Ke-Jung Chen et al is at http://iopscience.iop.org/0004-637X/790/2/162/. See also the press release "Simulations Reveal Unusual Death for Ancient Stars" at http://www.nersc.gov/news-publications/news/science-news/2014/simulations-reveal-unusual-death-for-ancient-stars/ and http://news.ucsc.edu/2014/09/unusual-supernova.html, and the Astrobites story "A New Way to Die: What Happens to Supermassive Stars?" at http://astrobites.org/2014/03/21/a-new-way-to-die-what-happens-to-supermassive-stars/.

The University of California High-Performance AstroComputing Center (UC-HIPACC), based at the University of California, Santa Cruz, is a consortium of nine University of California campuses and three Department of Energy laboratories (Lawrence Berkeley Laboratory, Lawrence Livermore Laboratory, and Los Alamos National Laboratory). UC-HiPACC fosters collaborations among researchers at the various sites by offering travel and other grants, co-sponsoring conferences, and drawing attention to the world-class resources for computational astronomy within the University of California system. More information appears at http://hipacc.ucsc.edu .



*This image is a slice through the interior of a supermassive star of 55,500 solar masses along the axis of symmetry. It shows the inner helium core in which nuclear burning is converting helium to oxygen, powering various fluid instabilities (swirling lines). This snapshot shows a moment one day after the onset of the explosion, when the radius of the outer circle would be slightly larger than that of the orbit of the Earth around the sun.*

*Credit: Ken Chen, UC Santa Cruz*

## Club Meeting & Star Party Dates

| Date | Subject | Location |
|---|---|---|
| Mar 6th | **ASNNE Club Meeting:**<br><br>**6:45-7:30PM:** Joan's Beginner Astronomy Class (Public walk-ins welcome).<br>**7:30-9:30PM:** Club Meeting<br><br>**Meeting Agenda**<br><br>**Guest Speaker:** TBD<br><br>Bernie Reim - What's UP<br>Astro Shorts: (news, stories, jokes, reports, questions, observations etc.)<br>Where's Pluto - Update on the New Horizons Mission and "Planet" status. | The New School, Kennebunk, Me. |
| Mar 20th | Club/Public Star Party<br>(*Visit website for updates and or cancellations*) | Starfield Observatory,<br>West Kennebunk, Me. |

## Directions to ASNNE event locations

**Directions to The New School in Kennebunck** [38 York Street (Rt1) Kennebunk, ME]

For directions to The New School you can use this link to the ASNNE NSN page and then click on "get directions" from the meeting location. Enter your starting location to generate a road map with complete directions. It works great. http://nightsky.jpl.nasa.gov/club-view.cfm?Club_ID=137

**Directions to Starfield Observatory** [Alewive Road, Kennebunk, ME]

**From North:**
Get off turnpike at exit 32, (Biddeford) turn right on Rt 111. Go 5 miles and turn left on Rt 35. Go 2 miles on Rt 35 over Kennebunk River to very sharp 90 degree left turn. The entrance to the Starfield Observatory site is at the telephone pole at the beginning of the large field on the left. Look for the ASNNE sign on the pole.

**From South:**
Get off the turnpike at exit 25 in Kennebunk. After toll both turn right on Rt 35. Go up over the turnpike and immediately turn right on Rt 35. About 4 miles along you will crest a hill and see a large field on your right. Continue until you reach the end of the field. Turn right into the Starfield Observatory site at the last telephone pole along the field. Look for the ASNNE sign on the pole. If you come to a very sharp 90 degree right turn you have just passed the field.

To join **ASNNE**, please fill out the below membership form. *Checks should be made payable to: Astronomical Society of Northern New England (A.S.N.N.E).* For more details, please visit our website: **http://www.asnne.org**

Astronomical Society of Northern New England
P.O. Box 1338
Kennebunk, ME 04043-1338

**2015 Membership Registration Form**

(Print, fill out and mail to address above)

Name(s for family): _____

Address: _____
City/State: _____ Zip code: _____

Telephone # _____

E-mail: _____

Membership (check one):
Individual $35 _____ Family $ 40 _____ Student under 21 years of age $10 _____ Donation_____

Total Enclosed_____

Tell us about yourself:
1. Experience level: Beginner____ Some Experience ____ Advanced_____

2. Do you own any equipment? (Y/N) And if so, what types?

_____
3. Do you have any special interests in Astronomy?

_____
4. What do you hope to gain by joining ASNNE?

_____
5. How could ASNNE best help you pursue your interest in Astronomy?

_____
6. ASNNE's principal mission is public education. We hold many star parties for schools and the general public for which we need volunteers for a variety of tasks, from operating telescopes to registering guests to parking cars. Would you be interested in helping?
Yes_____ No_____

7. ASNNE maintains a members-only section of its web site for names, addresses and interests of members as a way for members to contact each other. Your information will not be used for any other purpose. Can we add your information to that portion of our web site?

Yes_____ No_____