

# The Spectrogram

Newsletter for the Society of Telescopy,  
Astronomy and Radio

April 2009

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S\*T\*A\*R

P.O. Box 863

Red Bank, NJ 07701

On the web at:

<http://www.starastronomy.org>

Edited by: Ahmad & Hanna Jrad

## April's Meeting

The next meeting of S\*T\*A\*R will be on Thursday, April 2. Our program will be "*Solar Telescopes*" with guest speaker Alan Traino of Lunt Solar Systems. All are welcome. The meeting will begin promptly at 8:00pm at the Monmouth Museum on the Brookdale Community College campus.

## Editor's Corner

Many thanks to Gavin Warnes, Allen Malsbury, Barlow Bob & Randy Walton for contributing to this month's Spectrogram.

Reminder to pay membership dues \$25/individual, \$35/family. Donations are appreciated. Make payments to our treasurer Rob Nunn at the April meeting or mail a check payable to S\*T\*A\*R Astronomy Society Inc to:

**S\*T\*A\*R Astronomy Society**

**P.O. Box 863**

**Red Bank, NJ 07701**

## May Issue

**Please submit articles and contributions for the next *Spectrogram* by April 25.**

Please email to [stargaze07@verizon.net](mailto:stargaze07@verizon.net).

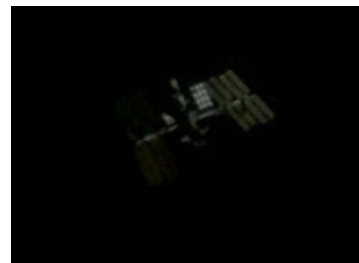


A Close-up of M3. (Scope: Takahashi TSA 102 Camera: Canon EOS 350 D)

Credit: Peter Muks

## Calendar

- ❖ Sep 4, 2008 – "*Past Saturn and 7 More Years to Pluto:*" New Horizons Mission, Michael Lewis, NASA Solar System Ambassador
- ❖ Oct 2, 2008 – "*An Idea That Would Not Die*" by Robert Zimmerman
- ❖ Nov 6, 2008 – "*Tour of Monmouth Museum & Demonstration of Planetarium*" by S\*T\*A\*R's own Dennis O'Leary
- ❖ Dec 4, 2008 – "*Why does the sun shine for billions of years?*" by S\*T\*A\*R's own Arturo Cisneros
- ❖ Jan 8, 2009 - "*Celestial Navigation*" by Justin Dimmell, Island School, Eleuthera, Bahamas
- ❖ Feb 5, 2009 - "*ATM Night*" S\*T\*A\*R Members will bring and talk about their home made telescopes
- ❖ Mar 5, 2009 - "*Solar Telescopes*" by Alan Traino of Lunt Solar Systems
- ❖ Apr 2, 2009 – "*The Origin of Star Names*" S\*T\*A\*R's own Ahmad Jrad will talk about how the stars got their names
- ❖ May 7, 2009 – "*Mars Science Laboratory*" by DJ Byrne of JPL
- ❖ Jun 4, 2009 – AGM



ISS & Discovery

By: Janusz Krysiak, Synta 12", Canon 400d

## President's Corner

By Gavin Warnes

Welcome to spring galaxy season! Now is the time of year to look millions of light years into the past and explore the Virgo super cluster. I'm really glad that the 25" telescope made the first outing of the year to BWII last week. Thank you very much to Dan Pontone for organizing this and getting the monster scope ready for action, I'm sorry I missed it but let's make this the first of many trips this year.

Just a reminder that the NEAF show is just around the corner on April 18th and 19th. This is a great opportunity to check out the latest Astor gear just 60 miles away from home in Suffern, NY. Hopefully a group of members will get together for a day out. This year I will be an exhibitor so I'll see you there.

Also later this month on Sunday 26th is the Earth Day event at Bayonet Farm in Holmdel. This is a great opportunity to publicize the club in our back yard. Hopefully the weather will be kind to us and we will be able to do some solar observing. If it is a nice day hundreds of people will show up so please volunteer to help out! If you have a solar scope, please bring it along. We can also do planet walks, show off our telescopes and generally try to get the public interested in our hobby and the club. I'll post details on the discussion board closer to the day.

At last month's meeting we had a good discussion about the feasibility of a club library. Randy made the excellent suggestion that we could offer to loan books we own to other members. I don't know about you but I have a bunch of books that mostly collect dust and would be useful to new members. I'll post a list of books I would be willing to loan and encourage you to do the same.

As I write this I've just heard from Mike Kozic that the bus trip to New York City went off very well on Saturday 28th. I hope you all had a great time. We owe Mike a big thank you for all the work he did towards this – it wasn't easy but it worked out great in the end.

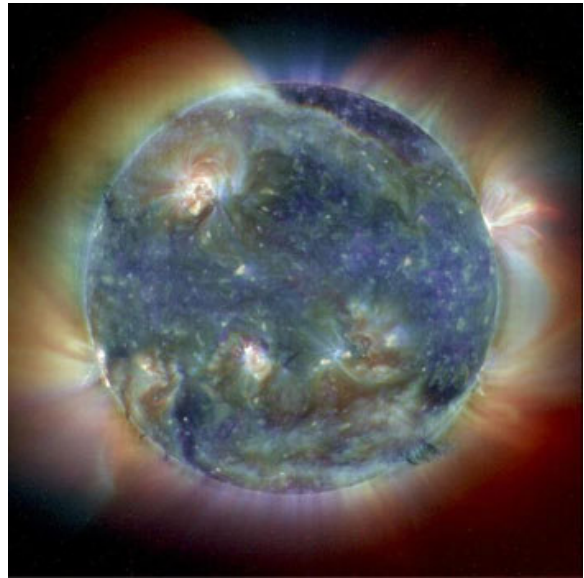
After some soul searching I have decided that I will not seek re-election as S\*T\*A\*R President next year. I've had a lot of fun doing it but I think it is time to step aside. I've started putting programs together next year to give whoever follows me a helping hand. I'll still remain an active member of the club. If you would like to stand for President, please contact Frank Loso at flnjus@yahoo.com.

Keep looking up!

Gavin

## Spectroscopy History

Compiled and Edited By Barlow Bob



The Sun in X-Ray (from [ESA/NASA/SOHO](http://esa.nasa/soho))

The English philosopher [Roger Bacon](#) (1214 – 1294) was the first person to recognize that sunlight passing through a glass of water could be split into colors.

Nearly four centuries later, Sir [Isaac Newton](#) coined the term “[spectrum](#)” to describe the rainbow of colors produced by sending sunlight through a prism. In 1666, he directed a beam of sunlight through a glass prism and noted the light from the [Sun](#) was composed of a continuous spectrum of colors. Newton was not equipped to study the spectrum and was unable to observe the spectrum in more detail. Later, using a telescope and prism, Newton viewed the light from [Venus](#). Again, he noted the light contained a continuous spectrum. Newton's work with spectral light was not broadly recognized, and little additional work on the nature of spectra was done for 150 years.

However, two noteworthy spectral discoveries did take place during that period. In 1800, [William Herschel](#) tested the heating power of the colors of the solar spectrum. He placed sensitive thermometers at various locations in the spectrum. Herschel found that the maximum heating effect took place outside the red end of the visible spectrum. He discovered infrared (IR) light. The following year, [J.W. Ritter](#) was testing the effect of the solar spectrum on various chemicals. His experiment involved a quartz prism placed in an open window. Ritter placed paper that was coated with different chemicals in the spectrum. He found that silver chloride

blackened when placed at a point beyond the violet end of the spectrum. Ritter discovered ultraviolet (UV) light.

[William Hyde Wollaston](#) (1766 – 1828) was an English chemist and physicist. In 1802, in what was to later lead to some of the more important advances in solar physics, he discovered the spectrum of sunlight is crossed by a number of dark lines. This is considered to be “A Great Moment in the History of Solar Physics” since it was the birth of Solar Spectroscopy.

In the early 19<sup>th</sup> century, Europe was in the midst of the [Napoleonic Wars](#) and military needs were driving many technologies, as they have often done before and since. In 1801, the French military government in Bavaria was having a great deal of difficulty making a survey of Napoleon’s new conquests because of the poor quality of the lenses available for surveyor’s transits. Farsighted businessmen bought an abandoned monastery, called [Benediktbeuern](#), near Munich. There they set up a company to improve the quality of glass. Glassmakers had to find ways of making sure that when they melted a mixture of quartz, lime and soda in their furnaces, the materials really mixed together uniformly. The inability to solve this problem caused windows in old buildings to produce distorted, wavy images of outside objects. You can imagine what it did to a telescope lens.

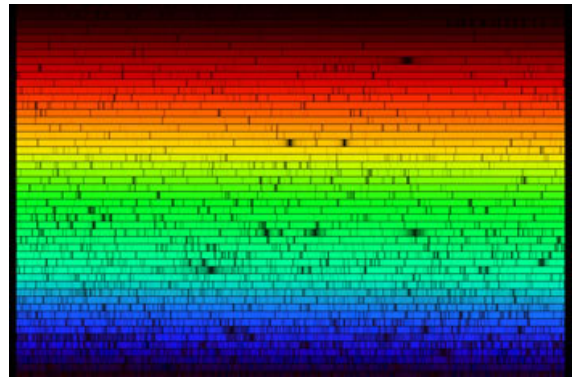
The smartest thing the company owners did was to hire a journeyman glassworker by the name of [Joseph von Fraunhofer](#). Orphaned as a young boy, Fraunhofer had been apprenticed to a glass cutter. One day while working, the building he was in collapsed around him trapping him inside and, apparently, turning him into something of a public hero in Bavaria as rescue workers struggled to dig him out. The Elector of Bavaria gave him 18 Ducats, which allowed Fraunhofer to buy out his apprentice’s contract and acquire enough tools to set himself up in business. By 1813 he was in charge of the whole operation at Benediktbeuern. Over the years, he improved the quality of the glass produced by his factory, producing the best optical equipment to be found anywhere in the world. This gave Fraunhofer a new problem. There was not a way that he could measure small differences in the composition of his glass from one melt to another.

To see why this might be important, think about a simple optical instrument, such as a prism. When white light comes into the prism, the different wavelengths are bent through different angles, resulting in a spread of colors. Prisms made of slightly different pieces of glass, however, will bend the same wavelength of light through slightly different angles. What was needed was some sort of calibration standard, some fixed wavelength of light that all laboratories could run through their prisms to compare the way the instruments

worked. Today, there are many such standards available. In Fraunhofer’s time, there was nothing.

He turned to a discovery that had been made in 1802. If you pass sunlight through a prism of sufficiently high quality, you notice a series of dark bands superimposed at regular intervals over the colored spectrum of light. No one at the time, including Fraunhofer, had any idea what these lines were. He realized that whether he understood them or not, they could be used to solve his calibration problem.

The same Sun shines on London and Berlin. Laboratories in these two cities carefully measure the wavelengths of the dark bands. They could compare their prisms, by looking at how much they each bent a specific wavelength. Like most high-tech entrepreneurs, Fraunhofer was not slow to exploit his new idea. In 1814, he rediscovered the dark lines in the solar spectrum noted by William Hyde Wollaston and determined their position with improved precision. In the 1820’s, he had made careful measurements of no fewer than 574 dark lines in the Sun’s spectrum. He provided a detailed road map for other investigators to follow. As far as we can tell, he never tried to find out what the lines were or where they came from. For him, they were useful markers that made his work as an equipment manufacturer easier. Today, we honor his careful benchmark investigations by referring to dark lines of this type as “[Fraunhofer lines](#).”



**The solar spectrum and its Fraunhofer Lines**

In 1849, [Leon Foucault](#) noticed that Fraunhofer’s D line in the Sun corresponded with the bright yellow-orange line in lamps. To show that the two lines matched, he passed sunlight through the arc of a lamp in order to view the superimposed spectra. To his surprise, he found that the absorption lines in the solar spectrum became stronger. Additional experiments using carbon arc lamps showed that a given medium could produce either emission or absorption lines. The results of these and earlier experiments were fundamental to the development of [Kirchoff’s Laws](#).

# Apollo Upgrade

The flight computer onboard the Lunar Excursion Module, which landed on the Moon during the Apollo program, had a whopping 4 kilobytes of RAM and a 74-kilobyte “hard drive.” In places, the craft’s outer skin was as thin as two sheets of aluminum foil.

few days, astronauts will be living on the Moon’s surface for months on end. Protecting astronauts from harsh radiation at the Moon’s surface for such a long time will require much better radiation shielding than just a few layers of foil. And rather than relying on food and water brought from Earth and jettisoning urine and other wastes, new life support systems will be needed that can recycle as much water as possible, scrub carbon dioxide from the air without depending on disposable filters, and perhaps grow a steady supply of food—far more than Apollo life-support systems could handle.



*The Chariot Lunar Truck is one idea for a vehicle equal to the lunar terrain. Each of the six wheels pivot in any direction, and two turrets allow the astronauts to rotate 360°.*

It worked well enough for Apollo. Back then, astronauts needed to stay on the Moon for only a few days at a time. But when NASA once again sends people to the Moon starting around 2020, the plan will be much more ambitious—and the hardware is going to need a major upgrade.

“Doing all the things we want to do using systems from Apollo would be very risky and perhaps not even possible,” says Frank Peri, director of NASA’s Exploration Technology Development Program.

So the program is designing new, more capable hardware and software to meet the demands of NASA’s plan to return humans to the moon. Instead of staying for just a

Next-generation lunar explorers will perform a much wider variety of scientific research, so they’ll need vehicles that can carry them farther across the lunar surface. ETDG is building a new lunar rover that outclasses the Apollo-era moon buggy by carrying two astronauts in a pressurized cabin. “This vehicle is like our SUV for the Moon,” Peri says.

The Exploration Technology Development Program is also designing robots to help astronauts maintain their lunar outpost and perform science reconnaissance. Making the robots smart enough to take simple verbal orders from the astronauts and carry out their tasks semi-autonomously requires vastly more powerful computer

brains than those on Apollo; four kilobytes of RAM just won't cut it.

The list goes on: New rockets to carry a larger lunar lander, spacesuits that can cope with abrasive moon dust, techniques for converting lunar soil into building materials or breathable oxygen. NASA's ambitions for the Moon have been upgraded. By tapping into 21st century technology, this program will ensure that astronauts have the tools they need to turn those ambitions into reality.

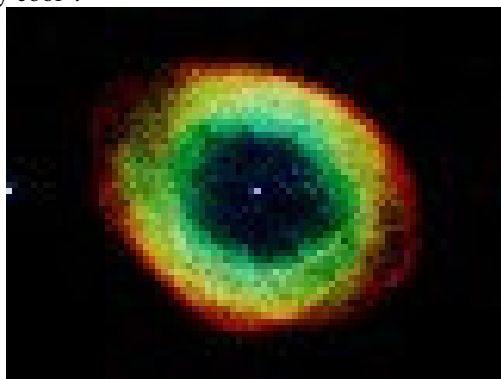
Learn more about the Exploration Technology Development Program at [www.nasa.gov/directorates/esmd/aboutesmd/acd/technology\\_dev.html](http://www.nasa.gov/directorates/esmd/aboutesmd/acd/technology_dev.html). Kids can build their own Moon habitat at [spaceplace.nasa.gov/en/kids/exploration/habitat](http://spaceplace.nasa.gov/en/kids/exploration/habitat).

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

## Sketching: Always an Option

By Allen Malsbury

In this age of eye opening Hubble photographs, why would anyone want to sketch what they see in the eyepiece? Current astro-photographic methods, stacking, extended period data collection and/or integration with high-tech post processing produces some amazing photo's of those faint objects we can't see, even with the biggest telescope we can fit in the back of the SUV. These photos often reveal hidden features, colors and structure the eye just can not perceive. There is no question about it. Astrophotography is "way cool".



However, there is also something special about looking through that piece of highly engineered glass and mirrors and letting your brain record, interpret and integrate what you see.

Although I am just a beginner and learning, little by little, I am getting better at observing. It seems to me the more time I spend with an object, the more I see. Even if I go back a

night later, or a month later, I usually get a different impression of an object than last time I looked at it. Most experienced observers say "slow down" for a reason. Good advice. Try to look longer. Be patient. Slow down. Then look again.

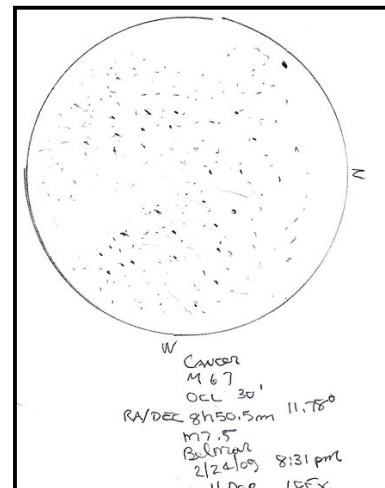
Sketching is a great way to slow down. When you sketch you must look, then sketch. Then look again, and sketch some more, and so on. Sketching helps me remember what I saw. It is not a photograph. It is more of an impression, a memory jogger. Not a scientific record, but rather a memory aid.

I recently found that with a little high-tech computer "photo-shopping" even the crudest field scribbles and notations can become a keepsake summary of what I saw. I started using a method I found on the internet that lets me convert those penciled sketches into photo-like images. This is how it works.

The first step is making the original sketch. Draw a circle on a piece of white unlined paper. I like to fold the paper in half twice making space for four sketches per page.

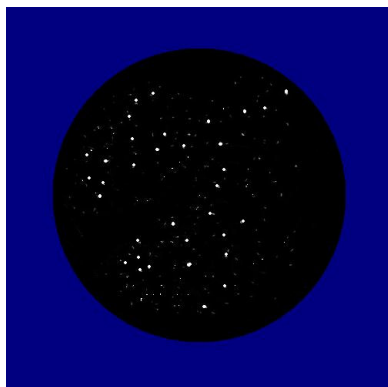
After finding the object I want, I observe which direction the object drifts in the eyepiece. (If you have a tracking mount, turn it off for a minute or two.) The direction the object moves to is to the West. Make a mental note of that and mark a "W" outside the circle you drew. If you have a tracking mount, turn your drive on again and re-center the object. If you are like me, push your Dob a little to re-center.

Next start to locate the brightest stars first. Make a pencil mark for each. Try to place them within the circle as accurately as you can. Remember you are working black on white while sketching. Later those dark marks will be converted to white on a black background. The darker you make a mark during this step the whiter it will end up at the end. Make a note of each star's color along the margins outside the circle. Next start adding the fainter stars. Use the brighter ones as a reference. The color of the fainter stars is less important, generally, faint means you will not be seeing much color. If there are galaxies, nebulas and/or other features now is the time to add them. These usually are not as bright as stars in the same field, so sketch lightly. Often a faint fuzzy will have some structure. Many times a star cluster will have a patchy background. Since you are working with a

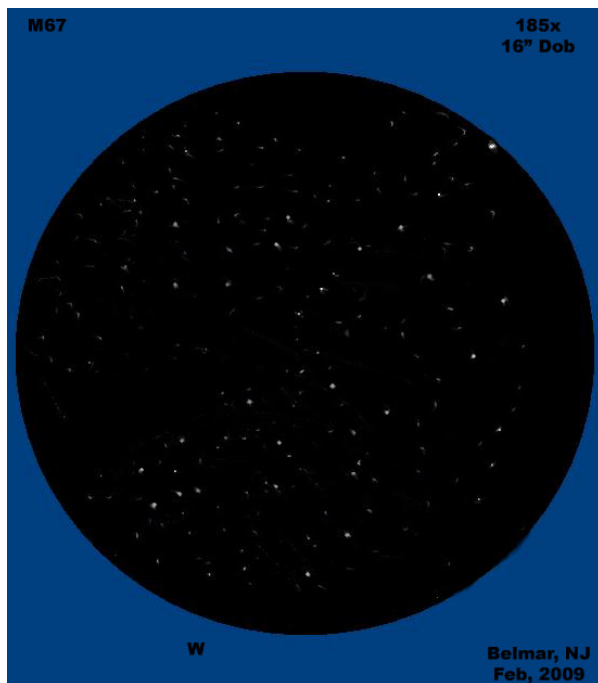


pencil don't be afraid to erase areas you don't like. Don't try to get it perfect in the field, instead make notes and fix it during the "photo-shopping" session later. I like to make a note of the date, time, location, type of telescope and magnification I observed at.

The next step is to scan your sketch using a computer scanner. I have a low cost, 3 in 1 printer/fax/scanner. It works fine for this. See my example M67 field sketch after scanning.



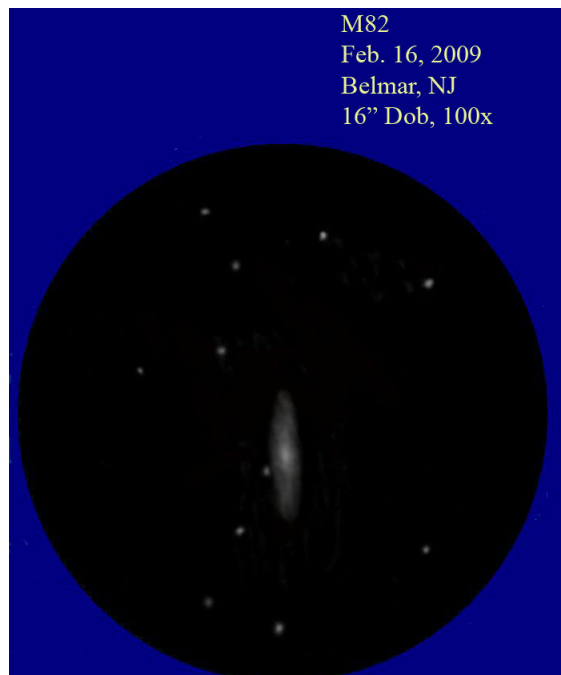
After scanning, I use Microsoft Paint to clean up the scanned image. I erase stray pencil marks, all my notes, even the W mark and the penciled circle. [I still have the original to refer to for the notes.] I replace the original circle with a nice new pure black one. I fill the entire area outside the new black circle with black. Then I invert the image, a negative of it. Inverting turns all the white to black and all the pencil marks and that new black border to white. I refill the entire border, inverted back to white, with a color I like and it is time to save this image and exit Paint.



Now the magic begins. I reopen the file using Photoshop. I use the blur tool to soften the edges of all the stars, bright and faint ones. I add color highlights to some of the bright stars per my field notes. Often this requires re-blurring to

mix in the color added. Faint fuzzy objects take longer to get right. I have found that drawing very thin black lines on top of an object like a galaxy then "blurring" and/or "smudging" them gives a nice appearance of structure. Be patient with yourself and the image. It may take time to get it close to what you saw. Stars are easy, comets and galaxies take more trial and error attempts to get right. Save your work often, you don't need to get it done in one sitting.

Here is an example of a galaxy, M82, after the "photo-shopping" magic.



The method I use is described in more detail at the following website.

<http://www.perezmedia.net/beltofvenus/archives/000577.html>

These folks really do some great sketches. Check out the Lunar sketches there too. Maybe someday I'll be able to do that.

I also found that Cloudynights has a very active forum dedicated to sketching, another source for good information and examples at this website:

<http://www.cloudynights.com/ubbthreads/postlist.php/Cat/0/Board/Sketching>

So far, each sketch I have completed has been a learning experience. Sketching helps me slow down. I look longer and am improving my observing technique. They help me remember what I saw. So far, I only have a small collection of keepsake images. I am planning to do more. Sketching is always an option for me now.

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

S\*T\*A\*R is the proud owner of a **monstrous 25" Dobsonian Obsession reflector** – which members can gain access to!

Meetings are the first Thursday of each month, except July and August, at 8:00 PM at the Monmouth Museum on the Brookdale Community College campus. Meetings generally consist of lectures and discussions by members or guest speakers on a variety of interesting astronomical topics. S\*T\*A\*R is a member of United Astronomy Clubs of New Jersey (UACNJ), the Astronomical League (AL), and the International Dark Sky Association (IDA).

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

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Make checks payable to: S\*T\*A\*R Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701



## 2009 April Celestial Events

Supplied by J. Randolph Walton (Randy)

Day	Date	Time (EDT)	Event
Thu	2	10:34	<b>First Quarter Moon</b>
		11:46	Moon Rise
Sat	4	04:30	Jupiter Rises
		05:37	Venus Rises
		05:40	Mars Rises
		05:50	Saturn Sets
		06:39	Sunrise
		14:13	Moon Rise
		19:28	Sunset
		19:55	Mercury Sets
Mon	6	05:59	Jupiter's Io occults half of Ganymede
Thu	9	10:56	<b>Full Moon</b>
		20:01	Moon Rise
Sat	11	04:05	Jupiter Rises
		05:10	Venus Rises
		05:20	Saturn Sets
		05:25	Mars Rises
		19:35	Sunset
		20:40	Mercury Sets
		22:14	Moon Rise
Fri	17	09:36	<b>Last Quarter Moon</b>
		12:05	Moon Set
Sat	18	03:40	Jupiter Rises
		04:50	Venus Rises
		04:55	Saturn Sets
		05:10	Mars Rises
		06:17	Sunrise
		13:07	Moon Set
		19:42	Sunset
		21:20	Mercury Sets
Wed	22	06:00	Lyrid meteors peak (ZHR=20)
Fri	24	19:42	Moon Set
		23:23	<b>New Moon</b>
Sat	25	03:10	Jupiter Rises
		04:25	Saturn Sets
		04:35	Venus Rises
		04:55	Mars Rises
		06:08	Sunrise
		19:49	Sunset
		20:57	Moon Set
		21:37	Mercury Sets
<b>Fri</b>	5/1	12:05	Moon Rise
		16:44	<b>First Quarter Moon</b>
<b>Sat</b>	5/2	02:50	Jupiter Rises
		03:55	Saturn Sets
		04:20	Venus Rises
		04:40	Mars Rises
		05:59	Sunrise
		13:17	Moon Rise
		19:56	Sunset

## In the Eyepiece

Here is a list of objects for this month. This is reproduced from [www.skyhound.com](http://www.skyhound.com) with the kind permission of its creator and author of SkyTools Greg Crinklaw.

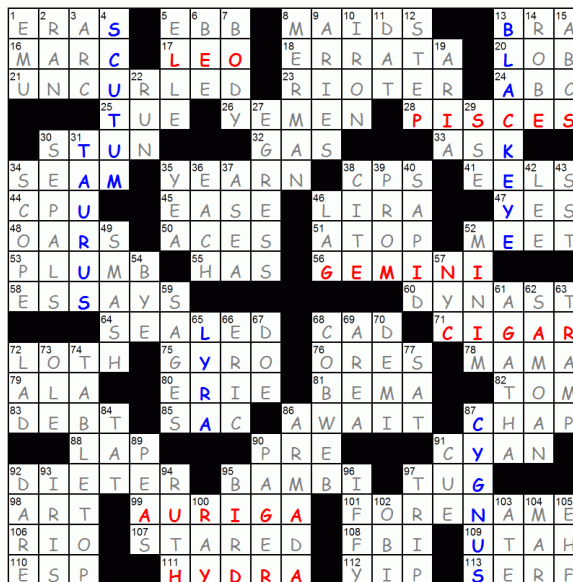
Object(s)	Class	Con	RA	Dec	Mag
<a href="#">M 81 &amp; M 82</a>	Galaxies	Ursa Major	09h55m34.1s	+69°03'59"	7.8
<a href="#">NGC 3511</a>	Galaxy	Crater	11h03m23.7s	-23°05'11"	11.5
<a href="#">Spindle</a>	Galaxy	Sextans	10h05m14.1s	-07°43'07"	10.1
<a href="#">Ghost of Jupiter/Eye</a>	Planetary Nebula	Hydra	10h24m46.1s	-18°38'32"	8.6
<a href="#">NGC 2903</a>	Galaxy	Leo	09h32m09.7s	+21°30'03"	9.6
<a href="#">M 95</a>	Galaxy	Leo	10h44m00.0s	+11°41'57"	10.5
<a href="#">M 96</a>	Galaxy	Leo	10h46m48.1s	+11°48'54"	10.1
<a href="#">The Leo I Dwarf</a>	Galaxy	Leo	10h08m30.6s	+12°18'07"	11.2
<a href="#">Markarian 421</a>	Galaxy	Ursa Major	11h04m27.4s	+38°12'34"	14.8
<a href="#">NGC 3395</a>	Galaxy	Leo Minor	10h49m52.4s	+32°58'35"	12.4
<a href="#">NGC 2818/A</a>	Planetary Nebula in Open Cluster	Pyxis	09h16m01.5s	-36°36'37"	13.0
<a href="#">PHL 1811</a>	Quasar	Cap	21h55m01.6s	-09°22'24"	13.8?
<a href="#">Focus On the Twin Quasar</a>	Quasar	Ursa Major	10h01m20.8s	+55°53'54"	17.0
<a href="#">Hickson 44</a>	Galaxy Group	Leo	10h18m00.4s	+21°48'44"	10.0
<a href="#">Abell 33</a>	Planetary Nebula	Hydra	09h39m09.2s	-02°48'35"	13.4
<a href="#">H 3-75</a>	Planetary Nebula	Orion	05h40m44.8s	+12°21'16"	13.9
<a href="#">Black Eye</a>	Galaxy	Coma Berenices	12h56m43.9s	+21°41'00"	9.3
<a href="#">Sombrero</a>	Galaxy	Virgo	12h39m59.3s	-11°37'22"	9.1
<a href="#">M 106</a>	Galaxy	Canes Venatici	12h18m57.5s	+47°18'14"	9.1
<a href="#">M 108</a>	Galaxy	Ursa Major	11h11m31.3s	+55°40'31"	10.9
<a href="#">M65</a>	Galaxy	Leo	11h18m55.8s	+13°05'32"	10.2
<a href="#">M 66</a>	Galaxy	Leo	11h20m15.1s	+12°59'22"	9.6
<a href="#">Owl</a>	Planetary Nebula	Ursa Major	11h14m46.1s	+55°01'07"	12.0



## Moon Phases

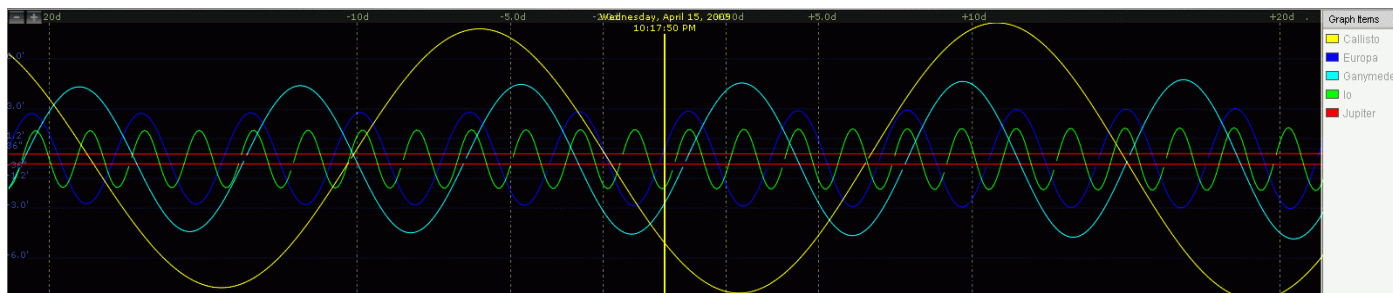


## AstroPuzzle Solution for March 2009



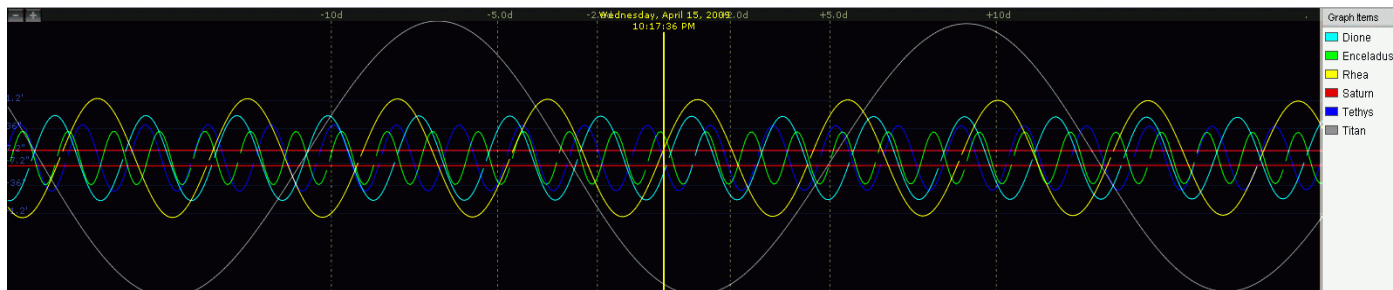
## Jupiter Moon Calendar

Here is a graphical depiction of the visible moons of Jupiter for the month of April 2009.

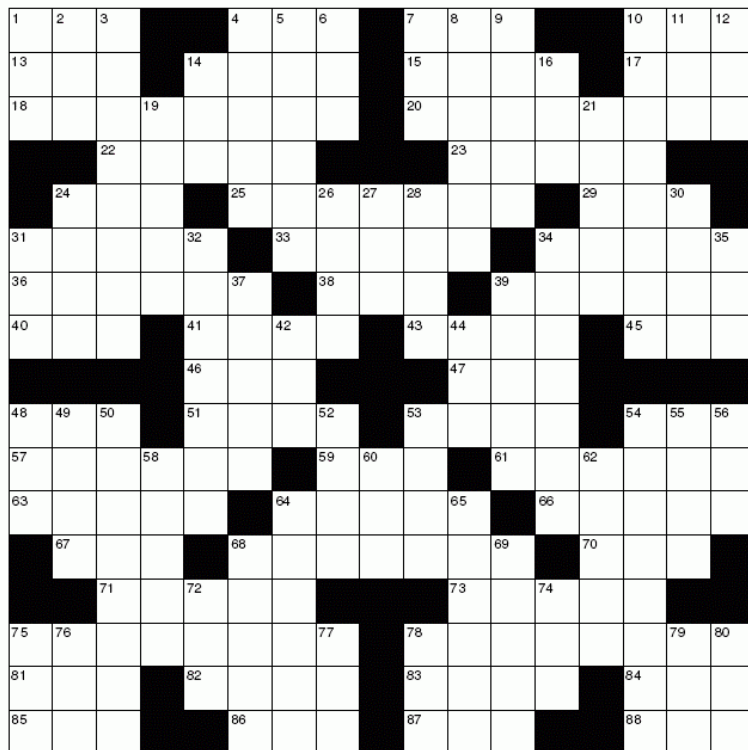


## Saturn Moon Calendar

Here is a graphical depiction of the visible moons of Saturn for the month of April 2009.



# April 2009 – Constellations



www.CrosswordWeaver.com

## ACROSS

- 1 Affirmative  
 4 Poisonous snake  
 7 Resort hotel  
 10 Most basic  
 13 Lawyer's title  
 14 Ca. University  
 15 Nimbus  
 17 Doze  
 18 **The sculptor (originally his studio)**  
 20 Roofs  
 22 Fable writer  
 23 Keno  
 24 Undergarment  
 25 Annuls  
 29 Failure  
 31 Suppress  
 33 **The dragon**  
 34 Having a secret meaning  
 36 Dishevel  
 38 **The altar**  
 39 **The fish**  
 40 Abdominal muscles (abbr.)  
 41 Pretentious  
 43 Dawdle  
 45 Eastern Standard Time

- 46 Second day of the wk.  
 47 Boxer Muhammad  
 48 Headed  
 51 Chilled  
 53 Old  
 54 Fleece  
 57 Erring  
 59 Representative  
 61 Part of a shirt  
 63 Great ape  
 64 **The wolf**  
 66 Asian country  
 67 Goof  
 68 **The winged horse**  
 70 Dashed  
 71 Student's class records  
 73 Unembellished  
 75 Gray nature  
 78 Hotly  
 81 Electroencephalograph (abbr.)  
 82 Star \_\_\_  
 83 Canal  
 84 Leer  
 85 Evening  
 86 \_\_\_ Lanka  
 87 Compass point  
 88 Fox hole

## DOWN

- 1 Okay  
 2 Escudo  
 3 **The water carrier**  
 4 Performing artist  
 5 Tilted  
 6 Standard or average  
 7 Pocket  
 8 S. W. Indian tribe  
 9 **The ram**  
 10 Herald  
 11 Pouch  
 12 Hertz  
 14 Delivery service  
 16 Wing  
 19 Pencil tips  
 21 **The (American) Indian**  
 24 Spot  
 26 Address God  
 27 Serving of corn  
 28 Academy (abbr.)  
 30 Expires  
 31 Estimated time of arrival  
 32 Exciting  
 34 Unyieldingly  
 35 Clock time  
 37 Burp  
 39 Whitens  
 42 Ball holder  
 44 Scrap  
 48 **The lion**  
 49 Goofs  
 50 Runoff  
 52 Medicine  
 53 **The bird of paradise**  
 54 Immured  
 55 Kitchen appliance  
 56 TV lawyer Matlock  
 58 Irritate  
 60 Government agency  
 62 Uncanny  
 64 Minor  
 65 First-rate  
 68 Equals  
 69 Killed  
 72 Trinitrotoluene  
 74 Dined  
 75 "To the right!"  
 76 Pastor (abbr.)  
 77 Slide on snow  
 78 Carve  
 79 Caustic substance  
 80 Shekel

Note: All clues in bold (11 total) are Related to and/or derived from the 88 Constellations.