SkyWAAtch

Transit of Mercury

Bob Kelly took this image of the Transit of Mercury from Ardsley, NY. He used a Canon SX camera at prime focus of his 8-inch f/6 dobsonian reflecting telescope with a 2x Barlow. (Exposure 1/125 seconds, ISO-400 with a white light solar filter).

The Transit occurred on May 9th when Mercury passed directly between the Sun and Earth, partially obscuring the solar disk. Mercury transits occur in May and November, with the next such transit slated for November 2019.

In This Issue . . .

Events for June

WAA June Lecture

" How to Observe the 2017 Great American Total Solar Eclipse "
Friday June 3rd, 7:30pm
Leinhard Lecture Hall,
Pace University, Pleasantville, NY

Mr. Charles Fulco's talk will focus on important facts one needs to know in order to safely observe, record and appreciate the 2017 U.S. Total Solar Eclipse. Beginning with basic knowledge of why eclipses happen, he will explore the role of these phenomena throughout history, explain what makes totality the most amazing spectacle one can witness in a lifetime and why a person needs to be "in the path" on Aug. 21 next year!

Charles Fulco is a science consultant and curriculum writer with BOCES and the former Planetarium Director at Port Chester Middle School, Port Chester, NY. He participates in many astronomy events through NASA's Solar System Ambassador program. An avid eclipse chaser, Charles was just appointed Education Chair of the AAS 2017 Total Solar Eclipse Task Force, and is involved with national educational and public outreach for next year's total solar eclipse. He enjoys astronomical and terrestrial photography, promoting environmental activities and traveling anywhere. Free and open to the public. Directions.

Upcoming Lectures

Pace University, Pleasantville, NY

There will be no lectures for the months of July and August. Lectures resume on September 16th.

Starway to Heaven

Saturday June 25th, Dusk.
Ward Pound Ridge Reservation,
Cross River, NY

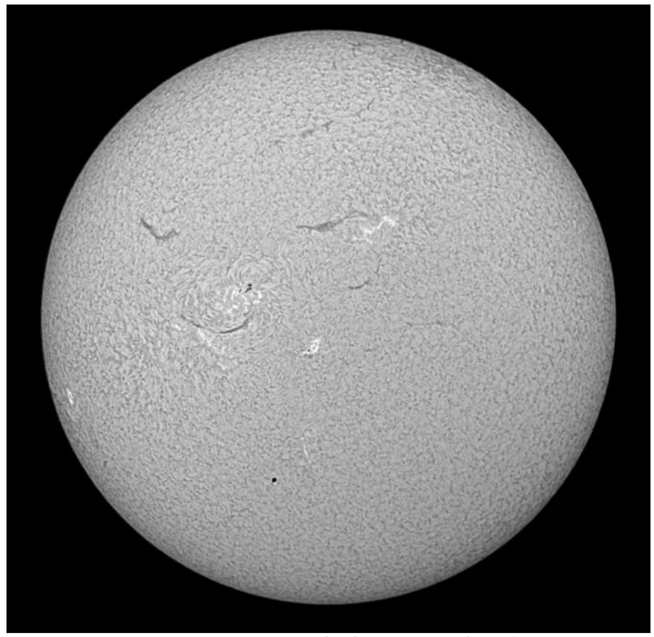
This is our scheduled Starway to Heaven observing date for June, weather permitting. Free and open to the public. The rain/cloud date is July 2nd. **Important Note**: By attending our star parties you are subject to our rules and expectations as described here. Directions and Map.

New Members. . .

Beth Propper and Ava Rubin - Irvington
Joseph Zeiden - Ossining
Luisa Thayer - North Salem

Renewing Members. . .

Walter Chadwick - Scarsdale
Barbara Matthews-Hancock - Greenwich
Arun Goyal - Katonah
Red Scully - Cortlandt Manor
Jordan Webber - Rye Brook
Jonathan Williams - New Rochelle
Arthur Linker -Scarsdale
Dante Torrese - Ardsley
Robert Brownell - Peekskill
Arumugam Manoharan - Yonkers
Donna Cincotta - Yonkers
Ernest Wieting - Cortlandt Manor
Jeffrey Jacobs - Rye



Larry Faltz also captured the Transit of Mercury. The above H-alpha image was made with a Lunt 60 double-stacked with a Mallincam M3 focal reducer to get the full-frame image, Celestron Skyris 445 camera (monochrome), best 200 of 2000 images, stacked in Autostakkaert, gentle wavelets in Registax 6.1 and final contrast balancing in Photoshop Elements.

Call: 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to visit the WAA website.

Almanac
For June 2016 by Bob Kelly

Jun 4 Jun 12 Jun 20 Jun 27

June is the time to make the most of the shortest nights of the year! We get only 4 ½ hours of astronomical darkness on the shortest night of the longest day. Fortunately, we can get a head start on the night if you can find Jupiter while the sky is still bright. Mars and Saturn are at their closest for the year, but we need to be patient for them to get above the trees in full leaf.

Mercury and Venus will be hiding in the Sun's glare in June. If you have an open eastern horizon and a clear sky, you might spy the innermost planet as it hangs out only seven degrees above the horizon in bright twilight 30 minutes before sunrise. That's challenging. Venus is still out in back of the Sun. You can track it on the SOHO C3 camera, except when Venus is too close to the Sun even for SOHO. Venus will be directly behind the Sun for forty-five hours around Superior Conjunction on June 6th - the reverse of the Transit of Venus across the Sun four years ago. Wait patiently for late July, when Venus will blaze in the post-sunset sky for the rest of the year.

Catch Jupiter early in the evening for the best views of this amazing sight, as Jupiter will be sinking lower into the western sky after sunset. Check Sky and Telescope or other predictions on when the Great Red Spot will be facing Earth. The GRS is still small, but it has been bright red. Watch for a star posing as a fifth bright moon of Jupiter around the 10th.

When Mars and Saturn, with Antares, get well above the horizon, they will be hard to miss. Even after our closest approach to Mars on May 30th, in June Mars will still appear larger than anytime during its previous opposition in 2014. So, every time you get the chance this month, Mars will be worth lots of good, long looks. The disks of Saturn and Mars are about the same size, but Mars will seem smaller, since Saturn's rings impair the comparison. If you see a whitish area on Mars, it's likely to be the giant Hellas basin, not a polar cap. Neither Martian pole is significantly tipped toward Earth this time, as Mars' equinox is in early July (on our calendar). Watch for gray areas of volcanic rock not covered by reddish dust. Mars starts out the month as bright as Jupiter, but Mars will fade rapidly from magnitude minus 2.0 to minus 1.4 this month, while Jupiter only fades by 0.2 magnitudes. Jupiter appears twice as large as Mars (and Saturn), even though Mars continues to be the closest planet to Earth through late August.

Despite Saturn being closely associated with Scorpius this summer, it's actually in the boundaries of Ophiuchus, a sprawling constellation that impinges on the path of the Sun and planets. At a dark sky summer star party, look for Ophiuchus holding Serpens above Mars and Saturn. We make our closest approach to Saturn on the 2nd. The rings are wide open, remaining tilted about 26 degrees toward us, making it harder to find faint Saturian satellites. Titan should be findable at magnitude +8.4, and perhaps Rhea, closer in and at magnitude +9.7. Iapetus ranges further out to the west (ahead of Saturn's apparent motion as the Earth rotates), brightening to +10.2.

While you're in the neighborhood of Ophiuchus, can you find Comet 252P/LINEAR? It's running about magnitude +10, but it's fuzzy, so may be harder to find to the right of the top of the snake-handler. And try for C/2014 S2 (PANSTARRS) under the paws of Ursa Major, moving into Hercules this month at magnitude +11.

The summer stars are rising higher in the sky. Despite being low down, Scorpius will get lots of attention, followed by Sagittarius, the archer that looks more like a teapot. Did Scorpius have surgery centuries ago? In pre-history, Libra may have been Scorpius' claws, but became known as its own constellation.

The darkest of the summer night is a good time to find galaxies M51, M81 and M82 near the Dipper. The star cluster M4 hides near the glare of Antares, but M3 and M5 try to hide in plain sight in large gaps between bright stars, making for large star hops to find them.

Once you sight the keystone of Hercules approaching the zenith, remember which side of that quadrilateral M13 is located. This month it's on the western or leading edge; the side nearest the zenith. Lyra and Cygnus herald the coming return of the Milky Way to our skies. Mars' north pole points to an area near the tail of Cygnus. We look straight 'down' into Vega's putative planetary system, so any planets whose poles point the same direction as their "sun's (like Jupiter's poles in our system) are using our Sun as a magnitude +4.3 pole star.

The Wonderful Whirlpool

Larry Faltz

M51 by the Hubble Space Telescope

It is only recently, within the last 100 years, that we have come to understand the structure and dimensions of the cosmos. Until Galileo turned his primitive telescope on the heavens, there were only the stars and planets in their fixed spheres, accompanied by occasional comets and meteors, both thought to be atmospheric phenomena and therefore closer than the orbit of the moon.[1] Until the 19th century, glass lenses in refractors could not be made larger than about 4 inches and reflecting telescopes used speculum metal mirrors, limiting resolution and preventing faint objects from being viewed. Speculum metal, a mixture of 2/3 copper and 1/3 tin, could be ground into a parabolic figure but could only be polished to about 66% reflectivity. Speculum metal tarnished easily, further reducing its performance. Although seemingly handicapped by inferior technology, astronomers in the first 240 years of the science as we now know it detected many moderately faint objects that were clearly not stars or planets. Because they did not move in the sky, they were obviously not comets.

Charles Messier's famous enumeration of faint non-stellar objects was made to keep comet hunters from being fooled into having erroneous "eureka" moments. Messier used many telescopes in compiling his catalogues, later merged into the single listing that we use today. His refractors had apertures no larger than 3½ inches and the reflectors topped out at about 8 inches. The quality of the optics and reflecting surfaces was far poorer that the telescopes owned by WAA members today, but of course his skies were darker and, being a professional astronomer, he had more time to devote to viewing. He had the added stimulation, perhaps, of not knowing what he was looking for.

Messier first observed the object we now know as M51 on October 13, 1773. In his second (1780) catalogue, which included the original 45 objects plus 23 more, he provided the first description of this object.

> Very faint nebula, without stars, near the eye of the Northern Greyhound [Cor Caroli in Canes Venatici], below the star Eta of 2nd magnitude of the tail of Ursa Major…. One cannot see this nebula without difficulties with an ordinary telescope of 3.5 foot [focal length]: Near it is a star of 8th magnitude…. It is double, each has a bright center, which are separated 4'35". The two "atmospheres" touch each other, the one is even fainter than the other. Re-observed several times.

Messier's friend and fellow astronomer Pierre Méchain distinguished the companion we now call NGC 5195 on March 21, 1781. We know this from a handwritten annotation appended to the above text by Messier in his own copy of the 1780 catalogue.

The great observer William Herschel made four entries about M51 in his notes, observing through several speculum metal reflectors, the largest of which was 18.7 inches in diameter (20-foot focal length).

> 1783, Sept. 17. 7 feet, 57. Two nebulae joined together; both suspected of being stars. Of the most north [H I.186, NGC 5195] I have hardly any doubt. 7 feet, about 150. A strong suspicion next to a certainty of being stars. I make no doubt the 20 ft. will resolve them clearly, as they want light and prevent my using a higher power with this instrument.

> 1783, Sept. 20. 20 ft., 200. Most difficult to resolve, yet I do no longer doubt it. In the southern nebula [M51, NGC 5194] I saw several stars by various glimpses, in the northern [NGC 5195] also three or four in the thickest part of it, but never very distinctly. Evening very bad.

> 1787, May 12. Bright, a very uncommon object, nebulosity in the center with a nucleus surrounded by detached nebulosity in the form of a circle, of unequal brightness in three or four places, forming altogether a most curious object. [H] I.186 [NGC 5195] B. R. S. vgbM. [bright, round, small, very gradually brighter to the middle] just north of the former.

> 1788, April 29. vB. L. [very bright, large], surrounded with a beautiful glory of milky nebulosity with here and

[1] For a fine book on how the universe was measured, see John Gribbin's *The Birth of Time* (Phoenix Books, 1999)

> there small interruptions that seem to show through the glory at a distance. [H] I.186 [NGC 5195] cB. pL., a little E. [considerably bright, pretty large, a little elongated], about 3' p. [preceding, W] Mess. 51 and about 2' more north.

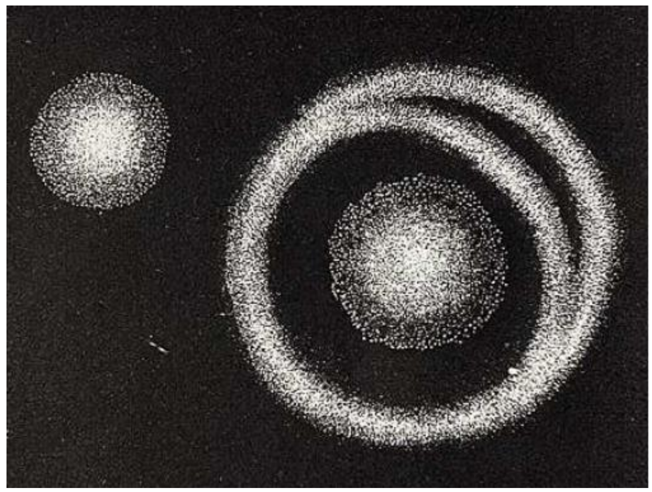
Herschel did not view the galaxy with his largest instrument, the famous “40-foot” telescope. Had he done so, he might have made out the spiral structure that is so familiar to us today and made sense of the “unequal brightness” he perceived in 1787 and the “small interruptions” that he noticed in 1788. The enormous “40-foot” instrument (that’s the focal length; the mirror diameter was 48 inches), financed by King George III, was actually so difficult to use that it contributed little to his observing program. It was dismantled in 1839. The only remaining piece of it, a ten-foot section of the tube, is on display at the Royal Greenwich Observatory near London.

Elyse with the remnant of Herschel’s 40-foot (focal length) telescope at the Royal Greenwich Observatory, June 2015

Herschel’s son John, as accomplished an observer as his father, got a glimpse in 1833 of what appeared to be a ring structure, most probably using a telescope with a 22-inch diameter mirror, but he was also unable to appreciate the spiral nature of the “nebula” as it was called, for no one knew yet about galaxies. John Herschel wrote:

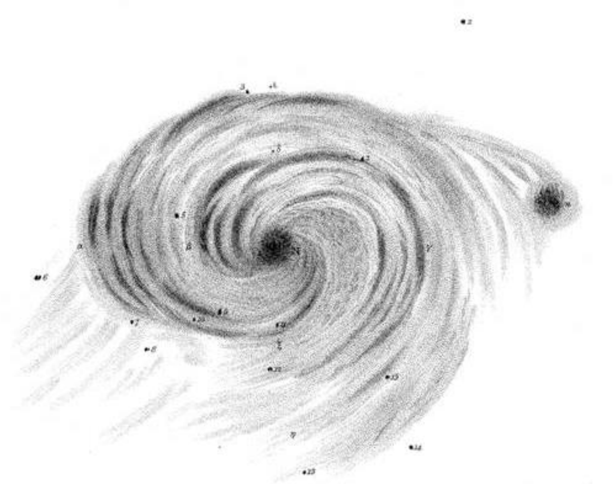
> Were it not for the subdivision of the ring, the most obvious analogy would be that of the system of Saturn, and the ideas of Laplace respecting the formation of that system would be powerfully re-called for that object.

John Herschel was referring to the Laplace/Kant “nebular hypothesis” of solar system formation, in which rotation played a major role. Since the Milky Way was thought by most astronomers to be the entire universe, M51 and other spirals found later were taken to be nascent solar systems. It wasn’t until 1923 that the true distance to galaxies was determined. Presciently but with no real evidence, William Henry Smyth, after observing M51 in 1836 with a 5.9” refractor, catching a vague glimpse of the spiral arms, wrote that the nebula must be “a stellar universe, similar to that which to which we belong, whose vast amplitudes are in no doubt peopled with countless numbers of percipient beings.”



John Herschel’s 1833 drawing of M51

It was left to William Parsons, better known as Lord Rosse, to detect the spiral arms of M51 using his 72-inch (1.8 meter) “Leviathan of Parsonstown,” the largest speculum metal telescope ever built. He drew the object twice, once in 1845 and again in 1850, the same year that he was the first observer to glimpse spiral structure in the larger and brighter Andromeda nebula, M31. In his sketches there is no mistaking the spiral nature of M51. The 3-ton mirror of Parson’s telescope was a slow f/9, but it was reputed to have an excellent figure. The light path was Herschelian, meaning that mirror was tilted so that the observer’s head at the focus did not block the incoming light. Since secondaries also had to be made of speculum metal, they were to be avoided if possible. The intensity of light bouncing off two metal mirrors would be reduced by at least 57%. The Leviathan was in use for more than 30 years. Parsons discovered 226 objects that were included in the New General Catalog (NGC), published in 1888. Between 1848 and 1861, no fewer than 67 true spiral galaxies were identified by observers using the Leviathan.



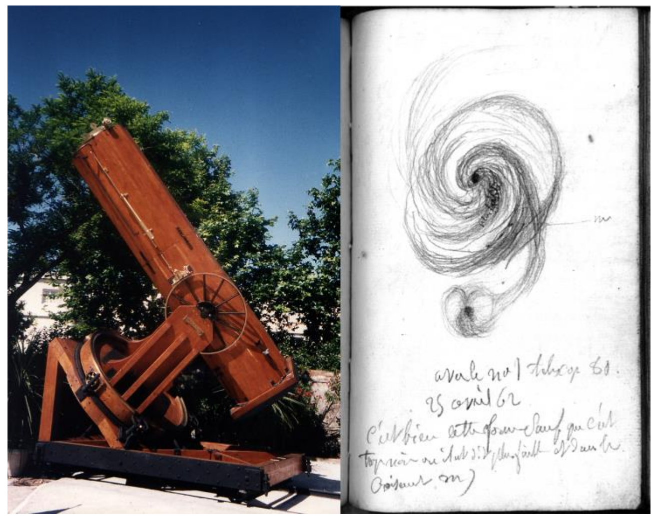
Lord Rosse's 1845 drawing of M51

In the late 1850's, Leon Foucault invented the metallized glass mirror, putting an end to the speculum metal era that had lasted almost 200 years. His largest telescope was a beautiful 0.8 meter reflector on an equatorial fork mount that is still in existence at the Marseilles Observatory. A number of important observations were made with this instrument, including confirmation of the companion of Sirius and a shadow transit of Titan across the face of Saturn.

In 1862, astronomer Jean Chacornac sketched M51 using this telescope shortly after it was delivered to the Paris Observatory. The sketch was recently discovered in the Observatory's archives and was the subject of an interesting article[2], in the obscure peer-reviewed Journal of Astronomical History and Heritage, available on line. The publication, which has three issues per year, was started by two Australian astronomers in 1998 and is published by the National Astronomical Research Institute of Thailand.

Chacornac's observations were rather informal, and sketches were captured *carnets*, literally "notebooks," in which Chacornac also jotted down a plethora of non-astronomic information: train schedules, gossip and even lists of interesting books. His drawings were not artworks, but relatively quick sketches of what he saw through the eyepiece. Chacornac had only a brief career, running afoul of observatory director Urbain LeVerrier (the man who calculated the exact position of the then-undiscovered planet Neptune in 1845) and then having an apparent nervous breakdown in 1863. He retired shortly thereafter.

Chacornac annotated his sketch "avec le No 1 télescope 80. 25 Avril 62. C'est bien cette forme sauf que c'est trop noir où il est dit plus faible et dans le croisement m." This note explains that the spiral arm emanating just to the right of center was actually fainter than the drawing suggests ("trop noir", "too black" in the negative drawing), as was the intensity at the "crossover," marked as "m" on the drawing.



Foucault's telescope and Chacornac's 1862 drawing of M51

Tobin and Holberg's article goes on to discuss in great detail the relative merits of the Leviathan telescope in comparison with the newer coated glass reflectors that followed it in the mid-1800's. They gathered sketches made by mid-century astronomers as well as early and recent photographs, normalized their sizes and presented them all as negatives (black on white) to show how the observers' perceptions of M51 varied and to compare the accuracy of the observations. Although Foucault himself was unimpressed by the Leviathan when he visited in 1857 ("Lord Rosse's telescope is a joke," he commented), Tobin and Holberg suggest that the images it gave were of high quality even if there was a significant diminution of light intensity due to the speculum metal surface. But they conclude that the 80 cm Foucault telescope was clearly a better and more useful instrument. In addition to its reflective superiority, it undoubtedly had a better figure and it was equatorially mounted, enhancing its utility to track and provide all-sky coverage. Unlike the Leviathan, it could be moved, as it was to Marseilles shortly after Chacornac's work with it. It continued making observations for 100 years.

[2] Tobin, W, Holberg, JB, A newly-discovered accurate early drawing of M51, The Whirlpool Nebula, *Journal of Astronomical History and Heritage*, 11(2), 107-115 (2008)

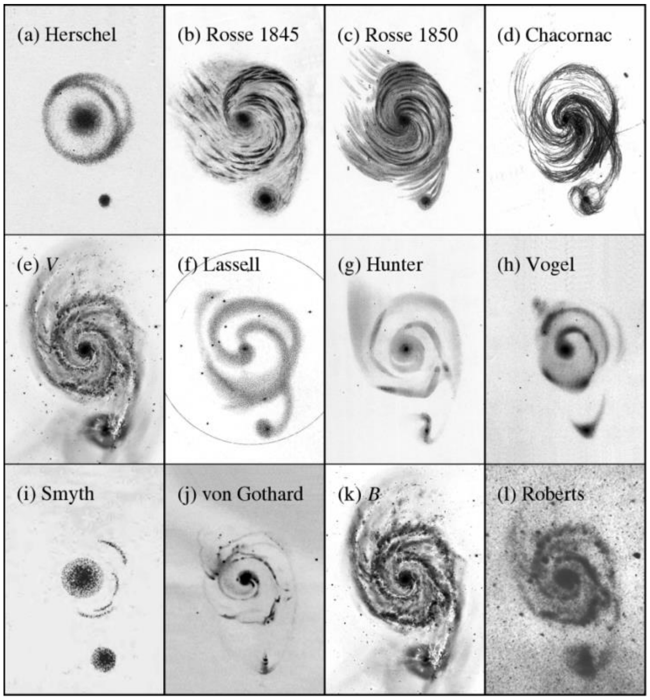
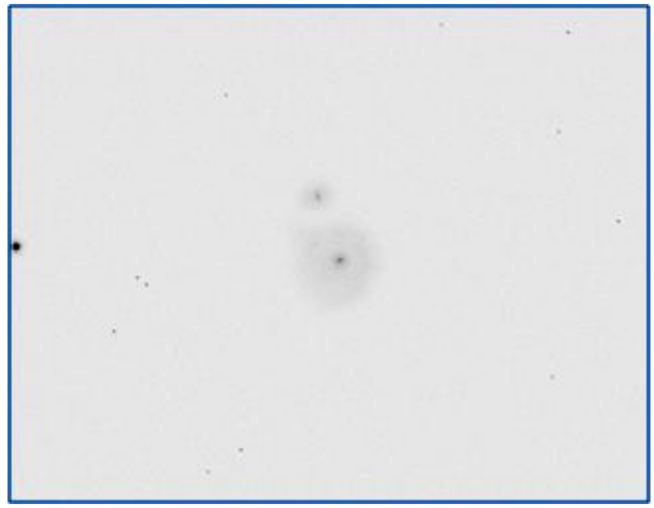


Fig 3 from Tobin & Holberg's paper. "Twelve images of M51 plotted with the same orientation and scale. South is upwards and east to the right. The separation between the nuclei of the two nebulae is 4.6 arc minutes. (a) John Herschel's drawing of 1833. (b) Rosse's drawing of 1845, as given by Nichol (reproduced in negative). (c) Rosse's drawing of 1850. (d) Chacornac's drawing of April 1862. (e) Modern CCD image in the V band captured with the CFH12K camera on the Canada-France-Hawaii Telescope. (f) Lassell's drawing of June 1862. (g) Hunter's drawing of 1864, published in 1879. (h) Vogel's drawing of 1884. (i) Smyth's drawing published in 1890 (reproduced in negative). (j) Widt's drawing of von Gothard's photograph of 1888. (k) CFH12K CCD image in the B band. (l) Roberts' photograph from 1889 (reproduced in negative)."

Viewing M51 from our light-polluted Westchester skies is difficult. Most reasonably-sized scopes can show the nuclei, but it takes substantial aperture or an imaging chip to see the spiral arms. From Camp Hale at 9,200 feet in Colorado, under exceptionally dark skies, I could make out the body of the galaxy with an 80mm refractor and with averted vision I could faintly resolve the spiral arms with a 6" f/5 reflector. They were visible but not well-resolved in a 16" Dobsonian I observed with at the Lowell Observatory in Flagstaff, Arizona in 2011, but the grounds were very illuminated and Mars Hill, the site of Lowell, is only six-tenths of a mile from downtown Flagstaff. The galaxy is magnitude 8.4 with a surface brightness of 12.9, about the same as M82. About 1/3 the diameter of the moon, it's high in the sky during evenings in the spring and summer, keeping it out of the "soup" near the horizon, helping the viewing somewhat.



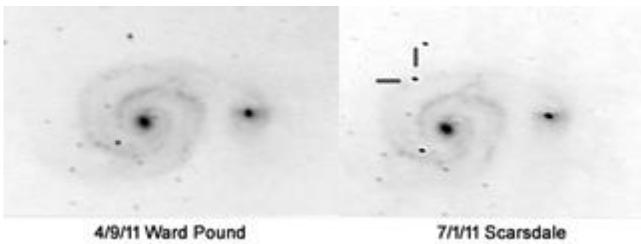
On a very good night at Ward Pound you might see this view with an 8" telescope (in negative).

Under average conditions at Ward Pound my 8" SCT and Mallincam video camera easily shows M51's spiral arms and the connection to its companion, NGC 5195. Under darker skies and with larger aperture, the video device shows much greater detail. Through a C11, the smear of stars ejected from NGC 5195 can be seen as a faint haze in an image taken through WAA member Mike Cefola's C11 in Springfield, VT on July 30, 2011.

28-second Mallincam image through a Celestron C11. \

We piggybacked my Stellarvue SVR-105 triplet refractor onto Mike's C11 for a wider field view. In these images, supernova 2011dh is visible. I made a comparison of images taken at Ward Pound in April 2011 and from light-polluted Scarsdale in July 2011 to show the supernova.

Stellarvue 105mm refractor, f/4, Vermont



Mallincam images showing the appearance of supernova 2011dh.

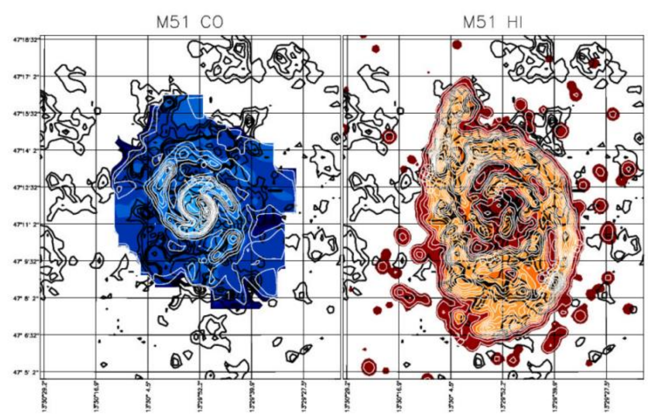
Of course, M51 is a major target for CCD imagers, who can bring out much more detail than the Mallincam. In 2012 Australian astrophotographer Martin Pugh won the Astronomy Photographer of the Year competition, held at the Royal Greenwich Observatory near London, with a spectacular image of M51.

Martin Pugh's image of M51. Besides winning Astronomy Photographer of the Year in 2012, it was NASA's Astronomy Picture of the Day on May 2, 2015.

The companion galaxy NGC 5195, sometimes called M51b, appears to be slightly more distant than NGC 5194 (M51a), which is estimated to be about 25-30 million light years from us. This is evident from images that show a dust lane from the main galaxy in front of the companion. Tidal disruption of M51b from the more massive (160 billion solar masses) M51a has flung out stars into a cloud surrounding it and extending as a tail far to the northwest, as seen in Pugh's image. The most likely interaction scenario is that M51b started behind M51a, crossed it about 600 million years ago and then crossed back behind it about 75 million years ago. The richness and definition of the spiral arms in M51a is a result of tidal forces as well.

Star formation is still occurring in M51. Star formation depends on many factors, among them the density and temperature of atomic and molecular gas as well as interstellar dust. Tidal forces at work compress the gas and dust in the center of the galaxy and along the arms.

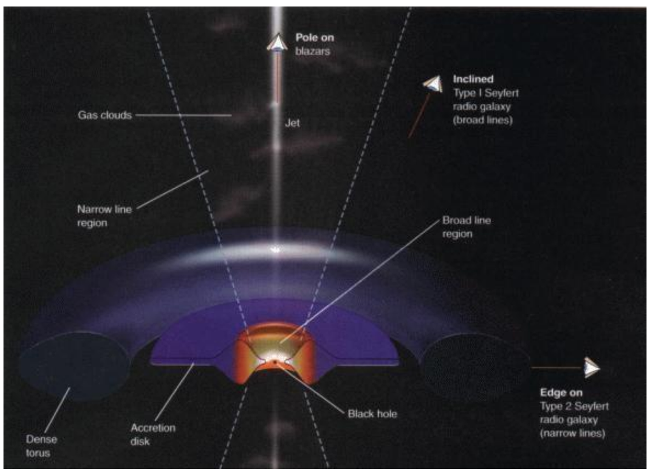
In a study released in March 2016, a multinational collaboration of 12 astronomers used the James Clerk Maxwell submillimeter telescope on Mauna Kea to map emissions from molecular clouds at a wavelength of 1.1 millimeters. The authors determined a number of complex parameters of gas distribution and dynamics, and showed that the molecular gas is being depleted from the center of the galaxy outward as star formation peaks.



Gas distribution in M51 (arXiv:1603.07736)

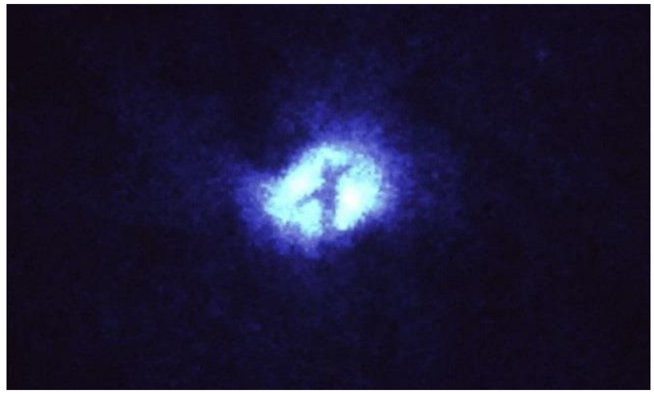
M51a is a Seyfert galaxy, named for astronomer Carl Seyfert, who described them in 1943. Seyferts are spirals with active nuclei, thought to be closer versions of quasars. It is estimated that 10% of all galaxies meet criteria to be called Seyferts. They are characterized by luminous central cores with strong emission lines from ionized gas. Type 1 Seyfert galaxies have broad lines, suggested very high velocities of the gas near their cores, while Type 2 Seyferts have narrower lines.

All active galactic nuclei appear to have a common structure. At the center is a supermassive black hole, surrounded by its accretion disk, radiating copious amounts of X–rays. About 100 light-days out from the black hole is the "broad line" region of highly ionized gas, and then 100 light years out is a torus of cooler molecular gas, which, depending on the inclination of the galaxy to our line of sight may or may not obscure emissions from the galaxy's core. Surrounding the torus is a region of rarefied gas at lower velocity that emits narrow spectral lines. Some of these are "forbidden" lines from electron orbital transitions that are suppressed when gas density is high enough (as explained in the article on planetary nebula in the October 2015 Sky*WAA*tch newsletter). Depending on the angle we view the AGN, they can appear as Type 1, Type 2 or as intermediate forms, depending on how much the torus is inclined to our line of sight.



Seyfert galaxy structure

One would think that M51's central torus should orthogonal to our line of sight since the galaxy is face-on and everything would be expected to rotate in the same plane, so we should see the broad line emissions of a Type 1 Seyfert. But it's not: M51a is a type 2. The Hubble Space Telescope imaged the core in 1997 and found an unusual cross overlying the nucleus, thought to reflect intersecting or overlying dust lanes. A study in the *Astrophysical Journal* in January 2015[3] mapped molecular densities in the center of M51, and the authors determined that there is dense molecular gas obscuring radiation from the core, which must be rotating at right angles to the face of the galaxy as evidenced by a bow shock to the south caused by a strong radio jet emitted from the black hole along its rotational axis.



Hubble image of the core of M51, showing the cross of obscuring dust.

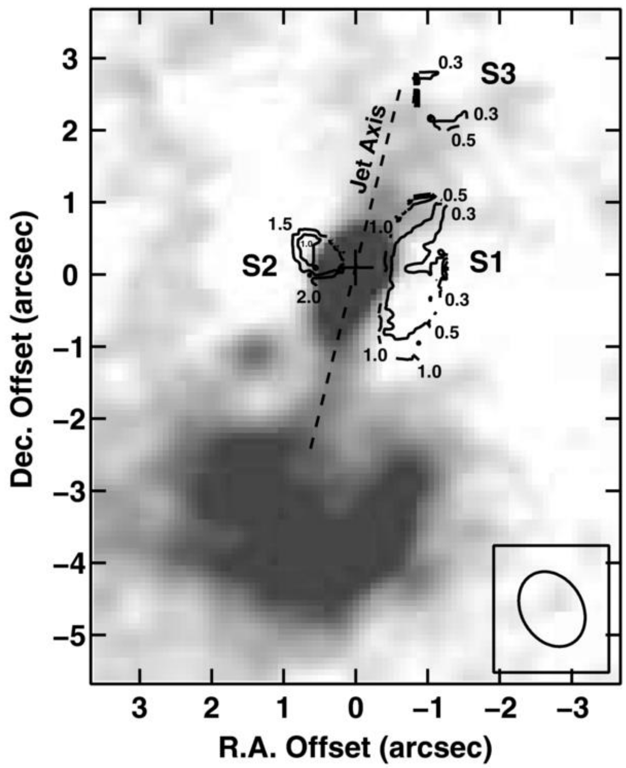


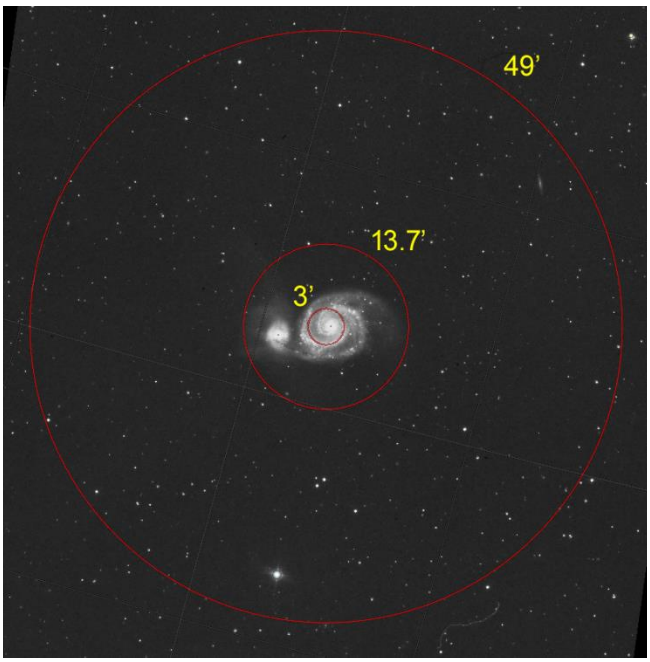
Fig 5 from Matsushita et. al., showing the distribution of gas at the center of M51. Note the emission from the bow shock in the lower part of the image.

The term "whirlpool" was initially used by John Herschel and others as an analogy for the phenomenon of nebular condensation as developed by Laplace and Kant, with the expectation that the objects were in motion, not as the name of an object or class of objects. There were two contending ideas about nebular structure, divided between those who thought that they were gaseous and those who believed that they

[3] Matsushita, S, Trung, D, Boone, F, et. al., resolving the bright HCN(1−0) emission toward the Seyfert 2 nucleus of M51: Shock enhancement by radio jets and weak masing by infrared pumping? *Astrophysical Journal*, 799:26 (2015)

would be resolved into stars given enough technology and skill in observing. In the latter camp was a friend of Lord Rosse's, the Reverend Thomas Romney Robinson, Director of the Armagh Observatory in Ireland. A frequent visitor to Birr Castle, the site of Rosse's observatory, he observed M51 with Rosse on April 11, 1844 through a 36-inch telescope, predecessor to the Leviathan.

Using the Leviathan wasn't easy. It had no finder, and the lowest power available was with a 46 mm eyepiece giving 360x and a field of view of 13.7 minutes of arc. Observations were carried out at 560x and 1280x. Atmospheric disturbances, narrow field of view and manual tracking must have made observing a real trial.



Fields of view for an 8" f/10 SCT with a 32 mm (52° apparent field) Plossl eyepiece (63x, 49' FOV), the Leviathan with its "finder" eyepiece (360x, 13.7' FOV) and with its high-power eyepiece (1280x, 3' FOV). Made with Cartes du Ciel, true-size image from Sloane Digital Sky Survey.

Observing in rare fine weather April 1845, Rosse and Robinson, along with double star expert James South, examined 43 nebulas. Robinson claimed that all were "resolved" (into stars) while South claimed only some were clearly stellar. Robinson also viewed M51 that spring, and claimed to have resolved it into stars as well. In this, South concurred. However, neither observer mentions anything about the spiral nature of the object. They compared it to M13, the great globular cluster in Hercules. A short time later, observing alone, Rosse noted the spiral form of the nebula. He never claimed it could be resolved into stars. Of course we know now that all galaxies are made up of stars, but the Leviathan would have been incapable of resolving those distant stars.

In another thoroughly researched article about M51 and the Leviathan in the Journal of Astronomical History and Heritage[4], German astronomer Wolfgang Steinicke comments that Robinson's religious views may have driven his perception that the nebulas had been resolved. "In his static system of the world," writes Steinicke, "God had created the stars, and there was no room for nebulous matter and evolution. To prove his view, as many nebulae as possible had to be resolved." Robinson never gave up his assertion that he could see stars in all of these objects, and he seems to have convinced some others that he was correct. It may be that the mind has more resolving power than the eye.

Lord Rosse's first drawing was published in 1847. In 1848, American astronomer Ormsby Mitchel published a paper, "Lord Rosse's Whirlpool Nebula," in the magazine *Sidereal Messenger*, but his meaning may have been generic. It does not appear that the name "Whirlpool" was uniquely applied to M51 until after galaxies were recognized as objects far outside the Milky Way in the 1920's. The appellation was not used in the description of M51 (nor was its Messier designation even referenced) in either Camille Flammarion's *Astronomy for Amateurs* (1904) or Cecil Dolmage's *Astronomy of Today* (1910), popular works of their time, both of which show illustrations of the Whirlpool Galaxy but describe it merely as a "spiral nebula." ■

Combined Chandra X-ray/Hubble visible light image of M51 (NASA).

[4] Steinicke, W, The M51 mystery: Lord Rosse, Robinson, South and the discovery of spiral structure in 1845, *Journal of Astronomical History and Heritage*, 15: 19-29 (2012)

NOAA's Joint Polar Satellite System (JPSS) to Revolutionize Earth-watching

Ethan Siegel

If you want to collect data with a variety of instruments over an entire planet as quickly as possible, there are two trade-offs you have to consider: how far away you are from the world in question, and what orientation and direction you choose to orbit it. For a single satellite, the best of all worlds comes from a low-Earth polar orbit, which does all of the following:

- orbits the Earth very quickly: once every 101 minutes,
- is close enough at 824 km high to take incredibly high-resolution imagery,
- has five separate instruments each probing various weather and climate phenomena,
- and is capable of obtaining full-planet coverage every 12 hours.

The type of data this new satellite – the Joint Polar Satellite System-1 (JPSS-1) -- will take will be essential to extreme weather prediction and in early warning systems, which could have severely mitigated the impact of natural disasters like Hurricane Katrina. Each of the five instruments on board are fundamentally different and complementary to one another. They are:

1. The Cross-track Infrared Sounder (CrIS), which will measure the 3D structure of the atmosphere, water vapor and temperature in over 1,000 infrared spectral channels. This instrument is vital for weather forecasting up to seven days in advance of major weather events.
2. The Advanced Technology Microwave Sounder (ATMS), which assists CrIS by adding 22 microwave channels to improve temperature and moisture readings down to 1 Kelvin accuracy for tropospheric layers.
3. The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument, which takes visible and infrared pictures at a resolution of just 400 meters (1312 feet), enables us to track not just weather patterns but fires, sea temperatures, nighttime light pollution as well as ocean-color observations.
4. The Ozone Mapping and Profiler Suite (OMPS), which measures how the ozone concentration varies with altitude and in time over every location on Earth's surface. This instrument is a vital tool for understanding how effectively ultraviolet light penetrates the atmosphere.
5. Finally, the Clouds and the Earth's Radiant System (CERES) will help understand the effect of clouds on Earth's energy balance, presently one of the largest sources of uncertainty in climate modeling.

The JPSS-1 satellite is a sophisticated weather monitoring tool, and paves the way for its' sister satellites JPSS-2, 3 and 4. It promises to not only provide early and detailed warnings for disasters like hurricanes, volcanoes and storms, but for longer-term effects like droughts and climate changes. Emergency responders, airline pilots, cargo ships, farmers and coastal residents all rely on NOAA and the National Weather Service for informative short-and-long-term data. The JPSS constellation of satellites will extend and enhance our monitoring capabilities far into the future.

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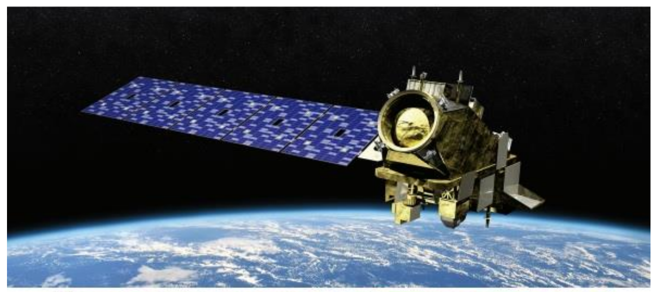

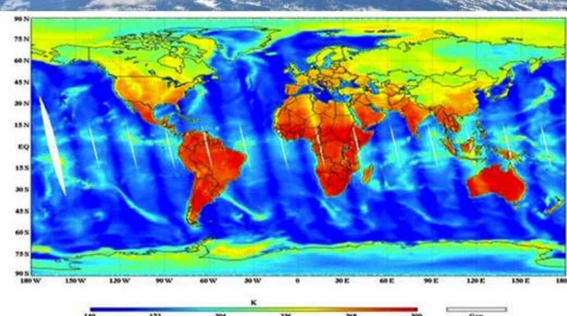

Images credit: an artist's concept of the JPSS-2 Satellite for NOAA and NASA by Orbital ATK (top); complete temperature map of the world from NOAA's National Weather Service (bottom).

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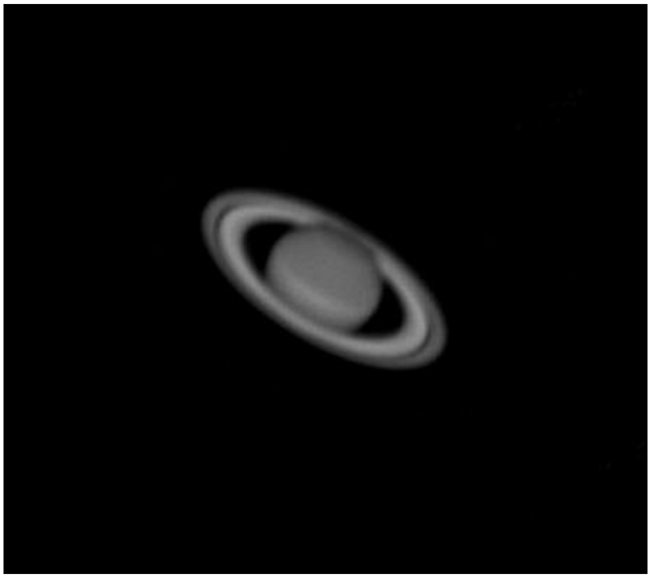
Astrophotos



Planetary Tour

Courtesy of John Paladini are these planetary images taken through his C9.25 Schmidt-Cassegrain telescope using a ZWO ASI MC camera for Jupiter (middle image) and a ZWO MM (mono) camera for Mars (top image) and Saturn (bottom image).