Spring 2012
Issue 97

Quarterly

www.bpastro.org Bainbridge Island, WA

EVENTS CALENDAR

(unless otherwise noted, all events are at the Edwin Ritchie Observatory, Battle Point Park)

MARCH

MARCH 3 Mars at opposition in Leo

MARCH 5 Mercury at greatest elongation east
Comet Garradd closest to Earth (mag 6)

MARCH 6 Joseph Fraunhofer's 225th birthday

MARCH 8 ○

MARCH 10 7 p.m. Planetarium Show "Mars" and Stargazing

MARCH 11 Daylight "Saving" Time begins

MARCH 14 ◑

MARCH 19 Vernal Equinox (10:14 p.m. PDT)

MARCH 22 ●

MARCH 27 Venus at greatest evening elongation

MARCH 30 ◐

APRIL

APRIL 6 ○

APRIL 13 ◑

APRIL 14 7:30 p.m. Planetarium Show and Stargazing

APRIL 15 Saturn at opposition in Virgo

APRIL 19–22 Camp Delany Star Party

APRIL 21 ● Lyrid meteor shower peak

APRIL 28 Astronomy Day

APRIL 29 ◐

MAY

MAY 5 ○ Eta Aquarids meteor shower peak

MAY 12 8 p.m. Planetarium Show "Transit of Venus" and Stargazing (date subject to change)

MAY 20 ● Annular solar eclipse (Medford and beyond)

MAY 28 ◐

JUNE

JUNE 5 Transit of Venus

Transit of Venus June 5, 2012

On the north side of the island of Tahiti, some ten miles east of Papeete, is a small, often-visited monument at a site named Point Venus. This monument commemorates the observations made nearby by then-Lieutenant James Cook, astronomer Charles Green, and botanist Joseph Banks of the transit of Venus across the face of the Sun on June 3, 1769. Cook's famous name stands out but in fact, his expedition was only one of 77 commissioned by various governments and scientific societies to observe that transit from various parts of the world.

The centuries following Nicolaus Copernicus' publication in 1543 of his Sun-centered theory of the universe saw a great blossoming of astronomical science. The

Transit *con't page 3*

VERNAL PLEASURES

Mercury

CALENDAR NOTES: Please join me in extending sincere and warmest thanks to Diane Colvin for her many years of outstanding service as "Calendar Girl." I miss her work already! Under my watch there will be missteps; so please be gentle as you point out my predecessor's superiority. I will not take offense. I rationalize that my habit of long midnight walks under the influence of ancient starglow begs an occasional stumble.

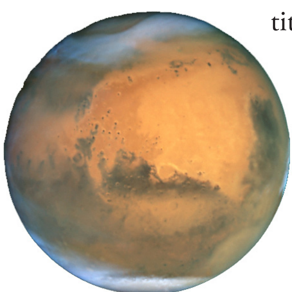
The purpose of this column is to magnify the necessarily brief notations on our Events Calendar. As telescopic observers quickly learn, a downside of magnification is restricted field of view. You will find herein no further coverage of such deserving springtime topics as the Coma-Virgo cluster, the Zodiacal Light, or the spectacular outlook for this year's Lyrids. These topics are well-covered elsewhere: remember that all Planetarium shows are well worth attending, open to the general public, and answer questions!

For "naked eye" observers, the question of which spring stars are best is superseded this year by events within our particular solar system. It's not just that vernal constellations lack the punch of winter's Orion or summer's Milky Way. All seven of the classical planets—Sol, Luna, Mercury, Venus, Mars, Jupiter, and Saturn—are each so extraordinarily compelling this spring that one understands why the Greeks endowed their planetary gods with pride and competition.

Pleasures *con't page 2*

Sol's closest planet, Mercury, puts on his finest evening show of the year during the first week of March. To my eyes his pinkness is inexplicably dignified. He is amazingly bright and unmistakable despite all the disheartening claims one hears of rarity and difficulty. Successful observation of the fleet-footed messenger of the gods mostly requires the right vantage—which, unfortunately, most of Bainbridge Island is not. Ideally one wants a clear western horizon; for us Puget Sound dwellers that generally means somewhere with a nice view of the Olympic Mountains. A public, easily accessible, west-facing Bainbridge Island beach would be perfect. If only. This is the rare case where an astronomical event is actually easier to see from Seattle. Shilshole gave me my first success. Waterfront Park, Discovery Park, and Alki are equally good choices. Even Colman Dock would work (but is certainly not recommended). For those who keep logs, the Olympics provide a nicely calibrated ruler for recording the azimuth of disappearance. I wonder where one must stand to watch Mercury deliver his divine message directly onto Mount Olympus?

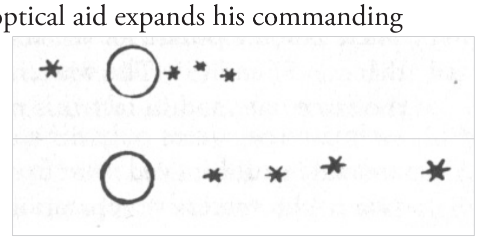
Planet number two, Venus, reaches maximum evening elevation a few weeks later. Wishing upon the goddess of love is one of my earliest memories. Even though I, like so many others, got it entirely wrong—thinking her a star—I remain forever grateful to my mother for encouraging me to look up, simply by teaching me the ditty, "Starlight, Star bright / First star I see tonight / I wish I may; I wish I might / Have this wish I wish tonight." After taking its great height, Venus plummets back towards a direct bull's-eye engagement with Sol. Their conjunction will be her command performance, and a solid claim on the title of this spring's "most spectacular." On her June 5th rendezvous, Venus transits directly across the face of Sol, an event that will not repeat for another 105 years! I fear that if I tell, my wish might not come true; but I'll hint that I plan to watch locally.



Mars

Mars' March 3rd opposition, though chronologically first amongst this quarter's events, is notable mostly for its poorness, his menacing disk never quite distending 14 arcseconds. That's enough to reveal the north polar ice cap even in modest one meter (long) Fraunhofer refractors like my own, but one shouldn't hold much hope of regaining Shiaparelli's *canali*. Nonetheless Mars will be stunning, bright red enough to immediately, viscerally explain how ancient man equated Mars with war. Wouldn't it be wonderful if, like Mars himself, war only came "close" once every other year?

Jupiter need prove nothing. He is king—even when not at opposition. Unlike the inferiors (who, to him, are not just Mercury and Venus; by most measures all planets pale before Jove), Jupiter can boast his brilliance all night long. Especially compelling is that even the most meager optical aid expands his commanding brilliance into the precision clockwork of the Galilean moon dance. Only one planet is more telescopically rewarding.



Galileo's drawings of Jupiter and its moons

After months lurking in those early hours I rarely wake for, Saturn finally reaches all night visibility on tax day, making the traditional association of Saturn with business (almost) amusingly appropriate. Regardless when one views, Saturn is the one object whose appearance through a telescope always exceeds expectation. If the ancients had known his rings Saturn would surely have dethroned Venus. The Evening Star may be romantic, but Saturn's gossamer rings ring all night long, of beauty, art, and maybe even love.

Often forgotten is that the ancients considered Sol and Luna planets too. In Greek, planet simply means wanderer. Since the paths of Sol and Luna convincingly mimic the ecliptic-constrained, wandering traverse of their orbiting brethren, calling them planets is entirely reasonable. That Sol and Luna were ultimately summarily dethroned may give despondent Pluto fans some consolation.

Luna's most compelling apparition this spring comes in conjunction with her "planetary" dance partner, big daddy Sol. This time the Sun wins. The Moon, only one day past apogee, will be too far away, too small to completely cover, leaving a fiery ring even more breathtaking than Saturn's. May 20th's annular eclipse will be well worth the trip south. I'm thinking Santa Fe; but even Medford should suffice—depending, of course, on the weather. This will be my first experience within the Moon's antumbral shadow, so I'm thoroughly excited. I'm bringing my primary solar observing tool, a three dollar, #14 welder's safety glass. Especially now that we are, finally, getting some evidence that solar cycle 24 lives, my welder's glass has reclaimed its favored status. I prefer simple tools. This unassuming 2" x 4" rectangle of glass should add delightful views of the eclipse and June's transit to its already impressive number of catches of "naked-eye" sunspots. (Repeating that term reminds me how annoyingly imprecise I find "naked eye." It's not whether or not it's hyphenated, it's do eyeglasses count? What about nebula filters, or sight tubes, or my #14? I propose "unmagnified" as the better term. But I don't think unmagnified will catch fire; nakedness has that perennial popularity.)

Winner of a different competition, Joseph Fraunhofer's upcoming 225th birthday is an ideal opportunity to fondly remember a man who may not be perennially popular, but gets my vote for single greatest astronomical equipment inventor of all time. Fraunhofer gave us the German equatorial mount, the achromatic doublet, and the spectroscope. Who even comes close? At least for this year, I'm naming my one meter achro by its optical prescription, Fraunhofer doublet.

So who wins the "most spectacular" title? Send in your votes!

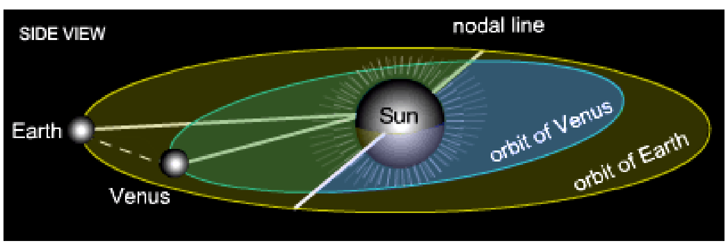
—*Cheth Rowe,* Calendar Editor

Transit *con't from page 1*
detailed planetary observations of Tycho Brahe later in the sixteenth century led, early in the seventeenth century, to Johannes Kepler's laws of planetary motions; his third law* has the consequence that if the distance of any one planet from the Sun (or from the Earth) is known, the distance of the Earth from the Sun (quite uncertain at the time) could be determined by a simple proportion.

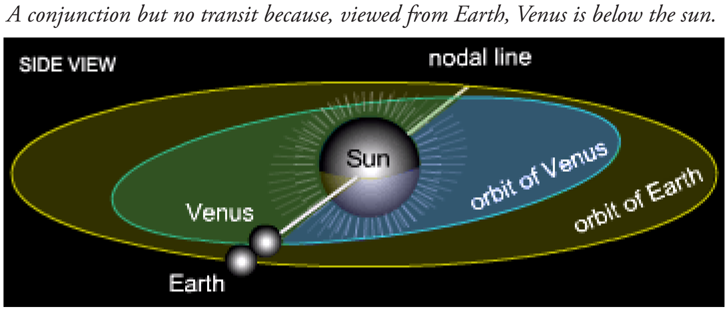
In 1691, Edmond Halley, employing Kepler's third law, suggested that transits of Venus measured from various places on the Earth could be used to determine the distance of Venus from the Earth. (the mathematically-minded can learn more at *www.exploratorium.edu/venus/P_question4.html*, and *www.phy6.org/stargaze/Svenus1.htm*)

In 1716, Halley presented a paper to the Royal Society of London outlining his proposal in more detail. (You can read this at *http://eclipse.gsfc.nasa.gov/transit/HalleyParallax.html.*) Although Halley died some nineteen years before the next transit in 1761, his paper drew so much attention to the then vexing problem of the Earth's distance from the Sun that, by 1761, governments and scientific societies all over the world joined together in what was probably the world's first great international scientific collaboration: 62 expeditions, which would travel to far-flung locations and coordinate their data. This world-wide scientific endeavor, reported widely in the popular press, sparked great public interest. It was this popular enthusiasm for a rare event (see below) that might answer a fundamental question (the size of the "universe," then thought to be the solar system), and engaged public figures, renowned scientists, and explorers, that made transits of Venus so significant. The actual results of the observations and measurements made were too uncertain and varied for reliable conclusions. Later and more precise calculations of the solar distance depended on other methods, aided by the invention of photography.

You may have noted that the date of Cook's expedition given in the first paragraph above is 1769, whereas that in the paragraph just above is 1761. Those dates refer to two successive transits. But the transit prior to that of 1761 occurred in 1639, and the one following 1769 did not happen until 1874, and then another eight years later. It is an odd sequence of spacings: 121.5 years, 8 years, 105.5 years and 8 years again. That sequence, repeated over and over, is a consequence of the fact that the plane of the orbit of Venus is tilted 3.39º from that of the Earth. On other passages of Venus between the Earth and the Sun, Venus goes above or below the Sun as seen from the Earth. In some cycles, the two transits with an eight year separation become one, but the last time that happened was in 1396 AD, and the next one will be in 3098 AD.



A conjunction but no transit because, viewed from Earth, Venus is below the sun.



Both a conjunction and a transit because the planets are lined up at a node.

The transit this year was preceded by one on June 8, 2004, but you would have seen that one (in the United States) only if you were east of a line roughly from central Montana to central Texas. The Sun had not yet risen for us westerners. And the one previous to that was in 1882. My parents did not have the opportunity to see even one transit in their long lives. Following this year's transit, there will not be another until 2117, and that will be in December so, even if you were to live here for another 105 years, the event would likely be hidden by clouds!

This year's transit will begin, for us, at 3:05:50 PM, June 5, when Venus first touches the Sun's disk. It will not pass completely over that edge until 3:23:24 PM, after which time it will appear about the size relative to the Sun of a black BB on a dinner plate. Using a telescope or binoculars with an appropriate solar filter, or focusing the Sun's image onto a sheet of paper held several feet from a telescope's eyepiece, look for the earliest hint of a silhouette near the edge of the Sun that is closest to our zenith. We will see most of the 6 hour and 20 minute transit, losing only the last bit after the Sun sets at 9:03 PM.

You may notice that Internet or magazine diagrams of the predicted path of Venus across the Sun show a perfectly straight line. That would be true if our observations were made from the center of the Earth. In fact, because of the rotation of our planet on its axis, the apparent path of Venus, for us, will be a very shallow inverted "S", certainly too shallow to notice except, perhaps, on time-lapse photographs. Other parts of the country, and the world, will see a slightly more pronounced hook shape.

If all of you, on the morning of June 5, think urgently,

"No clouds!

No clouds!"

perhaps we will have a clear view of this truly once-in-a-lifetime event.

—Verne Wade

* the ratio of the squares of the sidereal orbital periods of any two planets equals the ratio of the cubes of their mean distances from the Sun.

Steve Ruhl

President's Message

Introduction to Amateur Astronomy course

Dave Fong, BPAA Education Director, and I will be teaching this course again this spring. Last spring everyone seemed to have a great time, and we have had many requests for a repeat. We plan six classes, Thursdays at 7 P.M. at Ritchie Observatory beginning April 26, (no class May 10), last class June 7. Sign up through Bainbridge Island Parks and Rec: *http://www.biparks.org/* The course code is 131855-01 or search on "astronomy."

Topics include:

- Telescope basics—refractors, reflectors, magnification, light gathering power, resolution
- Finding your way around the night sky—constellations, asterisms, star sizes, North Star, Earth rotation, star trails, latitude, star hopping, spring constellations, circumpolar constellations, star charts and atlases, object designations (Messier, NGC, IC)
- The art of observing—averted vision, finer points of observing, round stars and collimation
- Motion of the Sun, Moon and planets, zodiac, constellations visible through the seasons (Earth orbit), precession, comets, meteor showers
- Telescopes (Part 2)—refractor (doublets and triplets), reflectors (Newtonian, Cassegrain and SCTs, coma-free designs), alt-az (Dobs), equatorial mounts (GEM and forks)
- Planets—planets visible at night/dawn/dusk, planets near the Sun, phases, retrograde motion, surface features, atmospheric features, moons, rings
- Eyepieces and filters
- Deep sky objects, stars, multiple stars, clusters, globular clusters, galaxies, Milky Way, nebula, supernova remnants, planetary nebula
- Light, CCDs, emission nebulas, filters, light pollution, star magnitudes.
- Telescope Buying Guide—Essential items you need for a basic setup, most bang for the buck, good intermediate scopes, and advanced scopes

Last year the class was full; so, if you're interested, sign up early.

Dark Skies and Legislation

The association has acquired the rights to show the award-winning documentary "Dark Skies". This movie looks at the social and health aspects of light pollution. We plan to screen it at several local venues in the future. The Bainbridge premier was at Ritchie Observatory earlier this month: Diane Colvin reviews it on page 6. Watch for it!.

For the second year in a row, legislation was introduced in Olympia (SB 5298 and HB 2336) to allow lighted off-premise billboards. This legislation is being pushed by the billboard industry. My representatives indicate that it will die this year but it is not certain. Be aware, and when it comes up again next year, please let your representatives know how you feel.

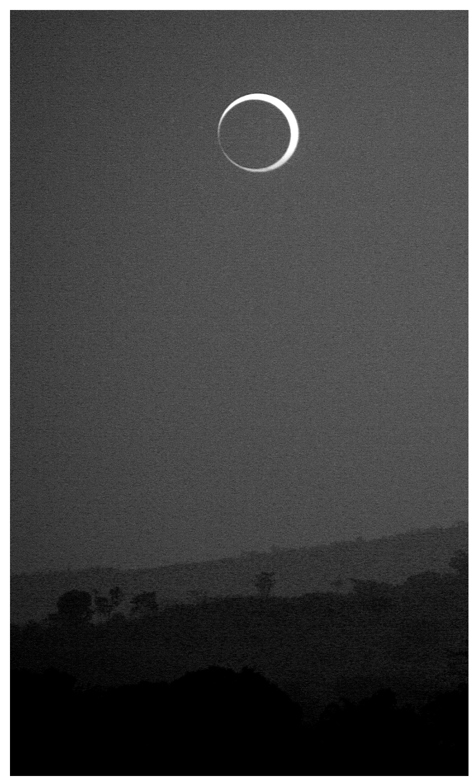
Upcoming Astronomical Events

Two significant solar events are coming soon. WARNING: DO NOT LOOK AT THE SUN DIRECTLY. You must have a proper filter or your retina will look like an overcooked chicken nugget.

An annular eclipse will occur on May 20th in southern Oregon and Northern California. The moon will be too far away from the earth to completely block out the sun; so, at the peak of the eclipse, a sliver of sun surrounds the moon. It is not as dramatic as a total eclipse but it should be a good show. About 83% of the sun will be blocked in this area but about 96% of the sun in the Eureka area.

The other event is the last transit of Venus during your lifetime (unless, of course, there are some really significant improvements in medical care). On June 5th, the planet Venus will be passing in front of the sun from about 3:40 pm until the sun sets. This occurred back in 2004 but because of the various orbits, it will not occur again until December 2117. (See Verne Wade's article, page 1)

I am sure we will be doing a few things surrounding these events, but I just wanted to let you know they are coming. Of course, the one I am waiting for is the total solar eclipse on August 20, 2017. This will run right through the middle of northern Oregon.



Annular solar eclipse (Bangui, Central African Republic, January 15, 2010), detail from photo by Tino Kreutzer

Take a Telescope Home
BPAA Free Telescope Loan Program

The BPAA has seventeen portable telescopes for members to borrow, including

- Six Dobsonian telescopes (4", 6", 8", 10", 16", and the new 20"),
- Schmidt-Cassegrain telescopes on fork and equatorial mounts
- A 6 inch Schmidt-Newtonian
- 90mm Meade ETX Maksutov/Cassegrain—a small and portable telescope.
- Two German equatorial mounts with motor drives that can be controlled by a laptop computer, on which various telescopes can be mounted.
- An Edmund Astroscan telescope with a table mount, very easy to use.

While a few of the more complex or valuable telescopes are reserved for the use of long-time BPAA members with substantial experience, most are available for loan to any member. To check out a telescope you must have been a member for at least six months. We will waive the six month requirement if you will leave us a refundable deposit. Before you check out any telescope, you must be trained on the use of that particular telescope by an experienced member/trainer. This usually takes 30 minutes to an hour, depending on the complexity of the telescope and your own level of experience. The trainer signs and dates the check out sheet. When you borrow a telescope we will include a selection of eyepieces and other accessories appropriate to the telescope. Telescopes and accessories may be checked out for 60 days and renewed subject to demand by others. Check out sheets are in a book in the telescope storage office at Ritchie Observatory. To make arrangements to borrow a telescope, contact our new Telescope Loan Manager Dave Janich at (206) 780-2357 or email *equipmentloan@bpastro.org*.

Dobsonian

Orion Refractor/Solar Telescope

8" Schmidt-Cassegrain

90 mm ETX Meade Maksutov/Cassegrain

8" Celestron SCT Motor Drive

Any member who is planning to observe can invite others to join in by sending an email to *bpaa@yahoogroups.com*. To join our email group, send an email with your name to *bpaa-owner@yahoogroups.com* and we can enroll you. If you want to have web access to the messages and files, you can join the Yahoo group by clicking the register link for new users on *http://groups.yahoo.com/*. Request to join at *http://groups.yahoo.com/group/bpaa/*. The system will send us a message, and we'll approve your request after we verify your membership.

A Bainbridge Premiere: *The City Dark*

A movie premiere on Bainbridge Island! Imagine that. It happened, thanks to the efforts of BPAA board member David Fong. On Saturday night, February 11, a capacity crowd at the Ritchie Observatory viewed the award-winning film *The City Dark:A Search for Night on a Planet that Never Sleeps*. The film, mostly set in one of the worst cities in the world for light pollution, New York City, graphically displays the horrors that electric lighting has wrought. Made you wish that god of Genesis had said, "let there be no light."

The City Dark dramatically demonstrates that the night sky is now pretty much invisible to city dwellers. I grew up on a farm in Iowa in the 40's and 50's. While much of my childhood has faded from memory, one thing I remember vividly is the Milky Way. It was always there on a clear night, big, bright and beautiful. Most kids now have never ever seen the Milky Way.

The film also demonstrates that light pollution has affected not just stargazers but animals as well. In Florida, hatching sea turtles can't find their way because condo lights outshine starlight and moonlight reflecting from the sea. Migrating birds smack into high rises in cities all over the world because they are similarly confused.

And there are health effects for humans, especially for shift workers. The film shows that unnatural light exposure can disturb the body's circadian rhythm and affect our health. We were made to go to bed when it's dark, get up when it's light. My grandparents probably did that, but no one I know does that anymore.

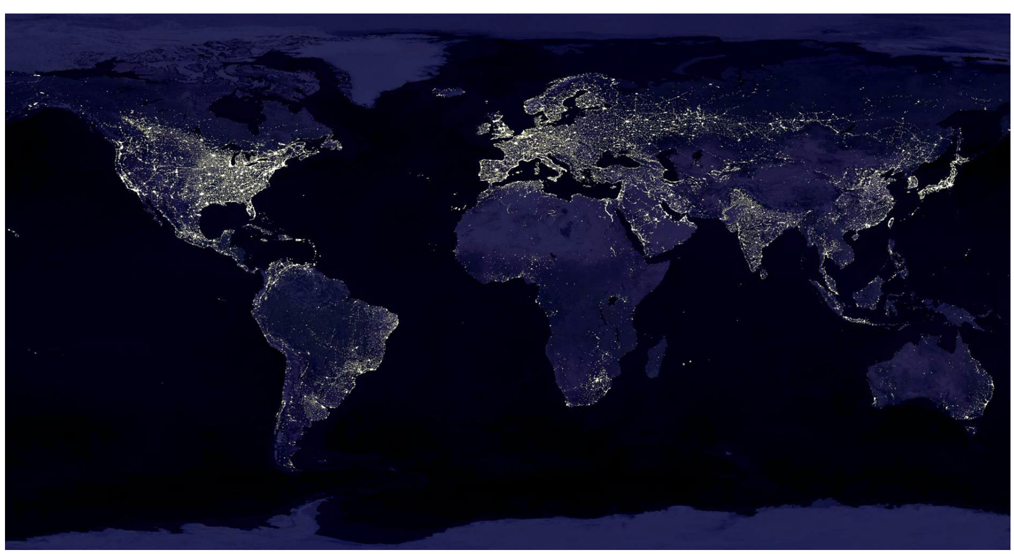
My spouse and I had the privilege of volunteering in the astronomy program at Bryce National Park in 2005. The supervisor of that program, Ranger Chad Moore, appears in *The City Dark*, all too briefly. Ranger Moore created the National Park Service's Night Sky Team in 1999. The team collected darkness measurements in parks all over the country in their effort to preserve the night skies in our national parks. In the western U.S., the darkest night skies are found in national parks like Bryce, Yellowstone, Glacier, Canyonlands and Death Valley. Many of these parks are threatened by a city that gives New York City a serious run for its money as a destroyer of night skies. That would be Las Vegas, of course, but don't get me started on that.

A film like *The City Dark* makes you think about what you can do to alleviate the problem of light pollution. I feel fortunate to live on an Island that has a lighting ordinance (enacted with the urging of BPAA members). Installing lighting on your property in compliance with the ordinance is a good first step. Another effective measure is supporting the International Dark-Sky Association. The association is doing much good work these days, encouraging not just the use of night sky friendly lighting for the benefit of amateur astronomers but educating the general public as well on the amount of energy that is wasted by misdirected light, on the fallacy of the belief that bright light leads to safety and security, and on the threats of bad lighting on wildlife. Get informed, and better yet, join up at *http://www.darksky.org* .

Finally, satellite images shown in *The City Dark* of the world at night make you think about the effects of population growth, especially now that the human population has topped seven billion. When I was looking at those dark skies in Iowa as a child, the world population had not yet reached three billion. Makes you wish that god of Genesis had never issued that directive to "be fruitful, and multiply."

For more information on *The City Dark* go to *www.thecitydark.com* and *www.thecitydark.com/#/Trailer.* BPAA plans to screen the film several more times around the Island.

—*Diane Colvin*



NASA satellite image of the world at night.


Hubble star field

Star Light, Star Bright

SEEING STARS **Astronomy 0.001**

Some years back, following an unusually disastrous spring season of floods, a group of villagers from southern Turkey loaded their truck with stones and headed for the capitol, Ankara. Their wish that night was to use the stones to attack the American Embassy. They believed that the US had poked holes in the sky with space robots which let all the water spill out, and they pointed to the stars to show the holes we'd made.

So, how *do* we know what a star is? We can't touch it, or smell it, or taste it. All we can do is look at it. Would you trust your judgment of the taste of a shiny black olive hanging on the tree only from seeing it? Until we actually got people on the Moon and sent robots to Mars, how could just looking tell us what is there, when everything we could tangibly, concretely measure was here?

Perhaps the first methods we used to understand the stars were to identify them by naming them, and then to measure their brightness and colors. We used numbers to sort them into groups according to how bright they looked. We still do. The lower the number the brighter the star. For instance, one of the brightest, Rigel, has an apparent brightness of 0.12, while dim Alcor, the companion of Mizar in the Big Dipper, has an apparent brightness of only 4. Six is about as faint as we can see with our naked eyes. Our Sun's apparent brightness is a high -27.6 —too bright to look at—and there are a lot more that we can see only with telescopes and whose numbers are higher than 6.

One of the next questions was their distance. Using parallax more than 2,000 years ago, the mathematician Erastosthenes estimated the distance between the Earth and the Sun. Even now, that distance is based on what we can measure from Earth and theories based on Earthly experience.[1]

We know that how bright a light appears to us here on Earth depends on its size, distance, and how bright it actually is. A star's apparent brightness (how bright it seems to be to our naked eyes) decreases inversely with the square of the distance between the observer and the object. To determine each star's absolute magnitude (how bright it really is), it needs to be measured on a scale that puts all stars at an equal distance from us. (The bigness doesn't matter here.) This can be done by first measuring the parallax of those stars that are relatively near us and then comparing each to its apparent magnitude. This gives our Sun an absolute magnitude of 4.8 (not even as bright as Alcor); on this scale Rigel has an absolute magnitude of -7.84. That's 85,000 times brighter than the Sun. The difference here is that while the Sun is about 8 light minutes away from us, Rigel is about 860 light years (ly) away, and its radius is about 71 times that of the Sun. So far the star with the highest known absolute magnitude is one in Sagittarius that is not visible to the naked eye: LBV1806-20, with an apparent magnitude of +35 and an absolute magnitude of -14.2.

Once we know any two of the three elements, 1) absolute magnitude, 2) distance from the Earth, and 3) apparent magnitude, we can find the third.[2] Double stars too far away to give us a parallax angle can be measured by the change in their brightness as they revolve around each other.

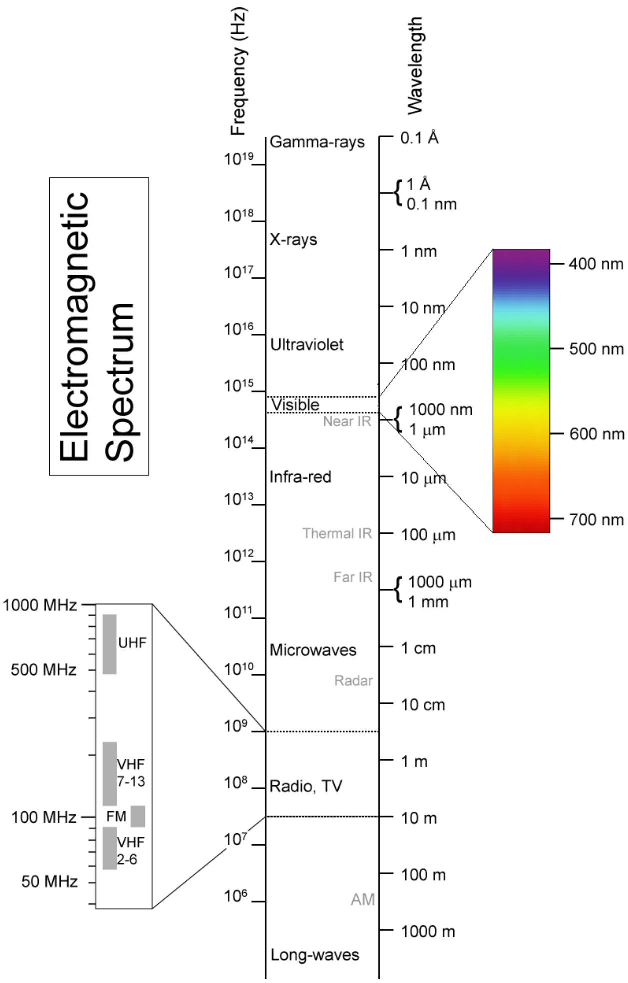
A star's size, that is, its mass, is important in determining its age and its probable life span.[3] For instance, the red giants, the heaviest and hottest of stars, will use up the helium in their cores in about ten million years, and blow apart as supernovae.

Astronomers also group the stars by color. The importance of their color increased when Sir Isaac Newton[4] passed the light of one star through a prism and showed that what we thought was pure white light was really a rainbow of colors. Then by passing that rainbow back through the prism he turned it into white again.

With more and more complicated tools (spectroscopes among them) the light of each star was resolved into distinct spectra showing patterns in the colors. Those patterns mimicked the patterns and the temperatures produced when we burn chemicals on Earth, and gave us information about the temperature, age, and the chemical composition of the surface of the stars. For instance, knowing that a star contains neutral helium means that its surface is about 27,000°K; on the other hand, a star that has strong neutral iron means its temperature is 4,500°K.[5]

The broader the spectral lines the faster the star is revolving. A combination of color and absolute magnitude show a general grouping of stars in a curving line (a main sequence). The line begins with those that are red and arches through orange, yellow, white and blue in what is called a Hertzsprung-Russell diagram. (You can find one at *en.wikipedia.org/wiki/Hertzsprung%E2%80%93Russell_diagram.)* The diagram also tells something about a star's life cycle, its beginning and its probable end. Our Sun falls about in the middle of the curve suggesting that its lifetime is about half spent, so we probably have another five billion years to be around.

Early in the 19th century William Herschel found that when he held a thermometer just beyond the red end of the visible spectrum it registered a slight rise in temperature: he thought that therefore some invisible energy must be acting on it. He didn't understand what it was, but we now accept this as infrared radiation. We also know a bit about the rest of the array of electromagnetic radiation that includes radio waves, microwaves, ultra-violet radiation, X-rays, and Gamma rays, as



well as visible light (which only takes up a small fraction of the electromagnetic spectrum).

In the 1920s Edwin Hubble discovered that the universe was not confined to our own galaxy. By using a comparison between the luminosity of nearby stars and those in galaxies so far away that we couldn't calculate their distance from parallax, he figured out the distances of nine of them. With the telescopes we have now we have found not only more stars, but also more than a hundred billion galaxies, each with a hundred billion stars, more or less. And no matter which direction we look, there seem to be the same number of stars. (How is this possible?) Of these, about five of them in our galaxy collapse as supernovae every five years, but none yet so close to us that they have threatened to condemn us to quick death by radiation and none that we have seen with the naked eye since Kepler's supernova in 1604. (Why haven't we seen any since?)

Those distant galaxies show several puzzles. One was a similarity in that almost all of their spectra were shifted toward the red side. As with the Doppler effect of sound that rises in pitch as it approaches and falls as it recedes, these red-shifting galaxies were all falling—moving away from us. In other words, it appeared that almost everything in our universe was getting relatively farther and farther away. The more distant, the more quickly it was moving off. Thus, it appears that our whole universe is expanding. But the theory is that the universe has no end. What can it expand into? Does this mean that the universe will go on expanding? Or reach a limit? Or maybe, a balance?

One of the answers to this last puzzle relates to the amount of light we see or don't see: Light is a measure of the amount of matter, or density of stuff, in the universe. The density controls the speed of expansion. But, the amount we are able to measure is not enough to explain the speed of the expansion. Thus we need to find a lot more "dark matter," or "anything matter," to hold everything together. Where? What? Which leads to the questions of how the universe got started in the first place, and what made it expand, and on what scale we measure time. And where we think we're going.

What do we see when we look at the stars? So far, their brightness, their color, their surface temperature, their distance from us, their chemical composition, their age, their mass, their similarities to other stars, their direction of movement, their revolutions, their electromagnetic radiation, that we're lucky to be where we are in relation to the Sun and the Moon…and… would any of this knowledge be likely to impress those villagers with their truck load of stones? Probably not as effectively as the armed gendarmes who interrupted their journey. But they would know from experience how a raw olive tastes: nothing like the way it looks.

—*Anna Edmonds*

Notes:

1. Theories are a means to understand, explain, and make predictions. But if a theory proves, through tests and observations, to be inaccurate, then new theories are needed.
2. The equation for this is $M = m -5 \log (d/10)$, in which M means absolute magnitude, m means apparent magnitude, d the star's distance from the earth in parsecs. Parsec is the distance of 3.26 light years, and *10* parsecs was determined to be the standard distance measurement with which to compare the stars' brightness. That is, if the Sun were moved off to 32.6 ly it would seem to us to be not quite as bright as Alcor.
3. Mass is the amount of material in an object, not its weight. (Weight varies with the pull of gravity, mass does not. So an astronaut can be weightless, but still have mass.)The easiest way to measure a star's mass is by applying Kepler's third law to double stars ($M1, M2$) using the orbital period in years (p) and the semimajor axis (a); $M1 + M2 = (a3/p2)$. Fortunately there are many double stars.
4. Newton also took Kepler's laws and applied them to all matter in the universe, thus laying the basis for today's astrophysics.
5. The ratio in magnitude difference in brightness of a star (approximate): 1 magnitude difference means the star is 2.5 times brighter, 2 magnitudes difference means the star is 6.3 times brighter, and so on; a difference of 4 is 40 ×; 10 is 10,000 ×.

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Annual Awards Dinner February 4

Diane receiving award, Russ and Jodie Heglund look on.

Celebrating Dark Skies, Proper Contracts, Accurate Calendars—Diane Colvin's Many Contributions to BPAA

Diane Colvin has done, and still does, much for BPAA, quietly. Most importantly, in May 2005, she led the defense of the starry skies of Battle Point Park, inspiring community members to speak out (see *http://tinyurl.com/7y7gmxd*) and prevent the installation of athletic field lights adjacent to the Observatory. The Parks board voted against the lights in July 2005.

A lawyer and former judge, Diane has helped BPAA frame bylaws and vet contracts. She has kept us on track for a decade by organizing and writing our calendar with wit and precision. As newsletter editor and publicist, I am forever grateful for her diligence (and her skill at proofreading). Diane served on the BPAA board for four years, from January 2002 to January 2006, as our Events Director. When she stepped down from the Board, she took on the role of Events Manager—and carries on proofreading, distributing posters, and lending a hand with contracts. BPAA is better and stronger because of her work. And we can still see the stars!

Vicki presents, George McCullough looks on.

— Vicki Saunders

New Calendar Guy, Cheth Rowe and former Calendar Girl.

A Narrow Entry

When you take a photograph of a faint nebulosity in the sky, you want to grab as many photons as you can. But you want the good photons. It is counter-intuitive that you would toss out about 99% of the photons but that is just what you do in narrow-band astrophotography. You just keep the good photons. Good photons are called signal; bad photons are called noise.

Narrow-band astrophotography looks at specific wavelengths of light emitted by certain elements instead of a broad spectrum—wavelengths emitted when electrons move between specific states. This specificity yields photons high in signal and low in noise (a high signal-to-noise ratio). The photographs released by the Hubble Space Telescope use narrow-band filters. Santa was very nice to me this year and brought me 3 narrow-band filters similar to Hubble's: Hydrogen-alpha, Sulfur-II, and Oxygen-III.

Hydrogen-alpha (Hα) emission has a wavelength of 656.28nm, and occurs when an electron transitions from level 3 to level 2 in a Hydrogen atom. This is a very red piece of light, at the edge of visibility for humans. Since hydrogen is the most common element in the universe, it is the brightest piece of the night sky. If something in the night sky is going to glow, it will glow this color. Unfortunately, most commercial cameras (DSLRs) filter out much of this frequency.

Sulfur-II (SII) is a double emission line at the wavelengths of 671.6 and 673.1 nm, slightly longer than Hα. It is also very red, and just barely visible to the human eye. It is frequently found in nebulae. As the ratio of SII/Hα increases, the intensity of the Hα emission decreases. Sulfur is present in nebulae where elements have cycled through several generations of stars, such as supernova remnants.

Oxygen-III (OIII) is the double ionized emission at 495.9 and 500.9 nm. This is located in the center of the visible electromagnetic spectrum, corresponding to green. It is commonly found in planetary nebula and supernova remnants, and used to visually observe faint nebulosity, such as the Veil Nebula.

Hubble Palette

Contrary to popular belief, many Hubble photographs of emission objects do not depict them as we would see them with our eyes. All of the emission lines above lie in the visible spectrum so they are referred to as "visible" as opposed to "infra-red" or "ultra-violet" but the Hubble photos show them in false color. The Hubble palette converts SII to red; Hα to green; OIII to blue. Hubble photos of objects with continuous spectra, such as galaxies, globular clusters, or reflection nebulae, are not suitable for narrow-band imaging and do not use this conversion.

A Narrow Entry *con't page 10*

Figure 1 Supernova remnant. Knowing the red is sulfur and green is hydrogen, you can observe all sorts of spiky formations as it transitions through red and yellow to green. These are called Rayleigh–Taylor instabilities. They occur when fluids of different densities interact. These instabilities are visible in narrow-band but not in a traditional visual view of the Crab. (All photos other than Figure 1 are taken from Bainbridge Island.)

Figure 2 A Hubble palette from my telescope. While not as detailed as the Hubble and highly magnified, it is a good representation of the object. The Crab is a relatively small object so this image is only a couple of hundred pixels across.

Figure 3 shows the appearance of the Crab Nebula made with the same equipment but with broad band filters. This image represents what the human eye would see if the object was bright enough so that our eyes could detect the colors. The detailed structure is just not there. But since the filters let in more light, more stars are visible with significantly less exposure time.

Comparison of Visual and Hubble Palette

Next we directly compare photos taken in the same session with narrow and broad band filters. The target is the big and bright Orion Nebula (M42). *Figure 4* presents what our eye would see if the image was bright enough that we could see the color. The red areas of the nebula are principally Hα emissions but the photo gives no insight into what else might be present.

Figure 5 shows the same object in the false color of the Hubble palette. Both photos show some of the wonderful detail in the object. The Hubble palette shows additional detail (particularly in yellow) in the nebula as the interstellar gasses interact. Knowing that Hα emission is green, SII emission is red, and OIII emission is blue tells me something about the composition of this nebula. The yellow is a mixture of glowing Hα and SII and white implies a mixture of all three elements. Further analysis could reveal the distribution of different elements in the nebula.

Mixing Filters

By playing with a few targets, I find that a mix of Hα with a blue and a green filter gives a good rendition of a subject that has a mix of features. *Figure 5* contains an emission nebula that really needs to be enhanced by a Hα filter, but several reflection nebulas are broad spectrum objects. Viewing these objects with narrow band filters would make them virtually disappear. By mixing narrow and broad band filters, I can represent the Hα of the emission in red and represent the reflection nebula fairly accurately with good signal to noise ratios.

Emission Nebula

Photographing a pure emission nebula I have found that many have zero or very little SII or OIII emission but huge quantities of Hα emission. If blue and green are photographed, I gain star color at the cost of fair amount of light (or moonlight) pollution. I have resorted to photographing emission nebulae in only Hα. When I process the image, the nebula is tinted an accurate red and the stars are tinted a generic white. This allows me to image on moonlit nights that would be otherwise unusable.

Narrow-band imaging rejects most light and only permits light from a specific frequency to pass. For objects that emit light at specific frequencies, narrow-band imaging can provide stunning images by boosting the signal from the image and blocking the noise. Good candidates for narrow-band imaging include emission nebulae, planetary nebulae, and supernova remnants.

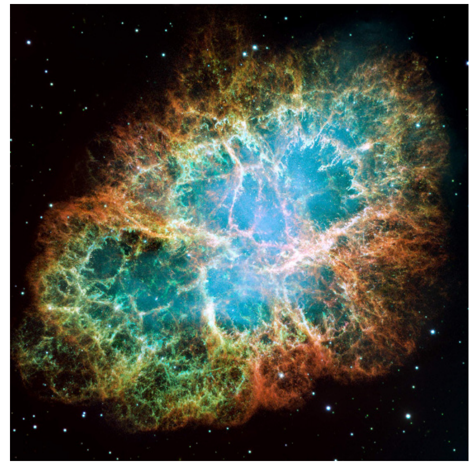

Figure 1 Hubble photo in the Hubble palette of the Crab Nebula

Figure 2 The Crab Nebula Supernova Remnant Bainbridge Island, January 10, 2012

(AT106 SBIG ST8300M with Ha- 60 minutes, SII 60 minutes, & OIII-60 minutes in Hubble palette; all binned 1x1)

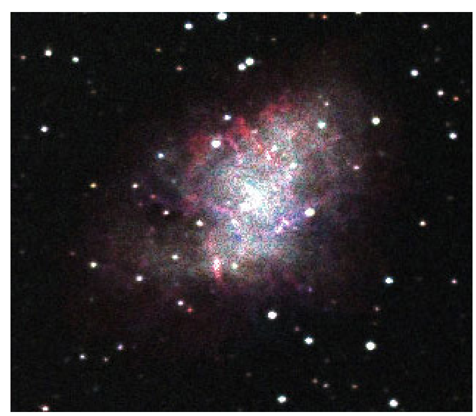

Figure 3 The Crab Nebula Supernova Remnant from Bainbridge Island, January 3, 2011

(AT106 SBIG ST8300M with Luminosity 25 minutes binned 1x1, Red, Green, Blue each 25 minutes; binned 2x2)

Figure 4 The Orion Nebula in Natural Light from Bainbridge Island, January 26, 2012
(AT 106 SBIG ST8300 w/ Red: Hα 60 minutes; Green 12 minutes; Blue 12 minutes; all binned 1x1)

Figure 5 The Orion Nebula in Hubble palette from Bainbridge Island, January 26, 2012
(AT 106 SBIG ST8300 w/ Red: SII 60min: Green; Hα 60 minutes; Blue: OIII 60 minutes; all binned 1x1)

For objects that emit continuous spectra, narrow-band may supplement an image but it should not be the sole source of data. These objects would include galaxies, open and globular clusters, and reflection nebulae.

—*Stephen Ruhl*

Figure 6 The Flame Nebula (NGC 2024) and the Horsehead Nebula (IC 434) Bainbridge Island, January 11, 2012
(AT 106 SBIG ST8300 w/ Red: Hα 120 minutes; Green 30 minutes; Blue 30 minutes; all binned 1x1)

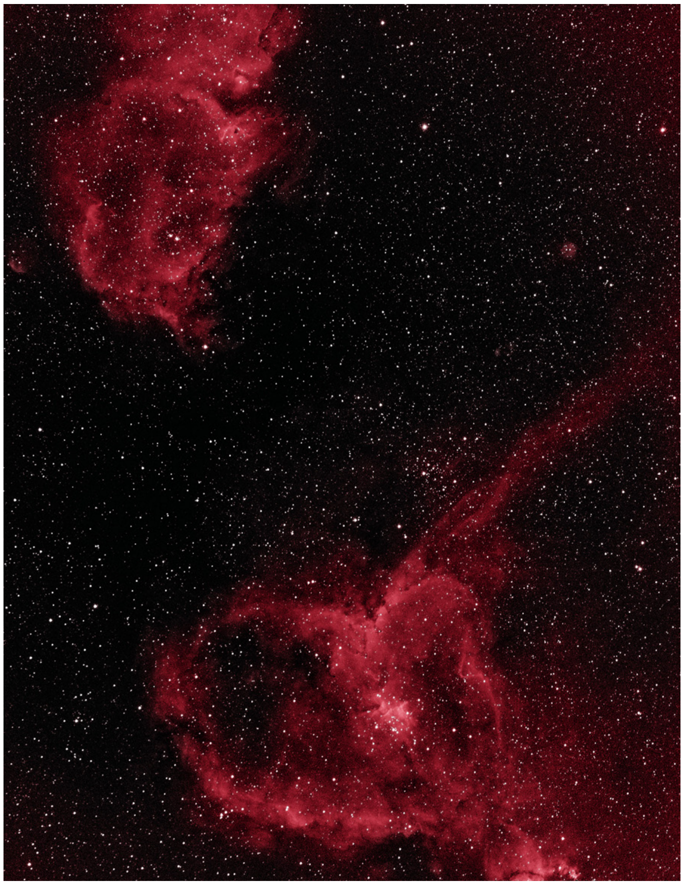

Figure 7 The Heart (IC 1805) and Soul (IC 1848) Nebula, Bainbridge Island, February 2, 2012
(Canon zoom at 200mm SBIG ST8300 with Hα 50 minutes; binned 1x1)

In this Issue

Articles

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