Event Horizon

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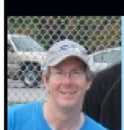
May 2018



From The Editor

Warmer weather is finally here, and everybody is getting ready for astronomy activities.
And on that note, H.A.A. member and astrophotographer Peter Wolsley has a couple of Digital SLR articles this month.

Bob Christmas,
Editor
editor 'AT' amateurastronomy.org

Chair's Report by Bernie Venasse

April showers bring May flowers….

The April 7 Scope clinic and Workshop event was a major success. With five astronomy presentations and 10 equipment demonstrations plus a meteorite collection to view there was something for each of the 50 to 75 visitors who attended. We will definitely do this again!

The Astronomers without Borders SUNday event on the 15th was rained /snowed/iced out. Our next SUNday is scheduled for June 24th.

The outreach event at Bayfront Park on the 21st was a very busy event. It was held on a great evening under clear skies, mild temperatures and very little breeze; many members set up scopes and allowed our visitors and newbies to view through them. We all enjoyed views of the moon, Venus, the Orion nebula, Beehive cluster, M81 & M82, The Hercules cluster, Jupiter and at least one Lyrid meteor. Many oohs

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IN THIS ISSUE:

Chair's Report (continued)

and ahhs resounded as newbies and visitors glimpsed their views of the heavens through any of the dozen or so scopes available.

Be sure to join us for our next outreach event being held on May 26, 2018 at McQuesten Park at 1199 Upper Wentworth St. – just south of the Linc. There should be great views of Venus, Jupiter, the moon, M44 and a flyover of the International Space Station (at 9:19).

Matthew Mannering will be presenting to our group at the May membership meeting – May 11, 2018. He will be speaking about his imaging experiences. You won't want to miss this talk if you are interested in beginning astrophotograhy.

And just a quick reminder to return your library books.

H.A.A.'s Loaner Scope Program

We at the HAA are proud of our Loaner Scope Program.

If you don't have a telescope of your own and want to make use of one for a month or so, you can borrow one of our fine loaner scopes.

Please contact *Jim Wamsley*, at: 905-627-4323

…and we'll gladly get one signed out for you.

HAA Helps Hamilton

To support our community, we collect non-perishable food items and cash for local food banks at our general meetings. Please bring a non-perishable food item to the meeting or a donation of cash and help us help others.

Our donations go to Hamilton Food Share, which delivers them to various food banks around the Hamilton area. If you would like to help or have any questions about this initiative, please contact the H.A.A.

Masthead Photo: *The Milky Way, Saturn and Mars, by Susan MacLachlan.*

Taken July 4, 2016 at 11:41pm from Manitoulin Island, Ontario, with her Nikon D7100 through her 16mm lens for a 15 second exposure. The streak near upper right is likely an Iridium flare.


Hamilton Amateur Astronomers
Hamilton Amateur Astronomers
25th Anniversary Celebration
Stars & Q
Join us for a BBQ and Star Party to celebrate the
Hamilton Amateur Astronomers 25th Anniversary.
After dinner there will be a brief Night Sky Tour
followed by an evening of star gazing.
So come prepared.
Date: Saturday September 8, 2018 (no rain date)
Location: Binbrook Conservation Area Large Pavilion
Please bring your own lawn chairs and beverages.
Dinner at 5 pm
Tickets: $35.00
Available through the HAA Website or
at the May and June General Meetings.
https://www.amateurastronomy.org/
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The April 2018 General Meeting of the HAA by Matthew Mannering

Bernie's introduction included an April Fools slide showing a solar transit of Jupiter. Only Mercury and Venus which are closer to the Sun transit the Sun (as well as our Moon on occasion). Also, Bernie is looking for volunteers for the outreach events this summer.

Jim mentioned that there were two 8" dobs available to borrow. The donations to the food share program in Hamilton are much appreciated.

Our speaker this month was *John Percy*. The following text is taken directly from our website. His email is john.percy 'at' utoronto.ca .

For millennia, people (including our First Nations) have used the sky as a clock, calendar, and compass. Astronomy thus became deeply rooted in their spirituality, mythology, and culture. This profusely-illustrated, non-technical presentation will describe the astronomy of civilizations ranging from the Polynesians who navigated the vast Pacific Ocean, the builders of Stonehenge and the Great Pyramids of Egypt, and the Chinese, Indian, and Islamic astronomers who preserved and developed astronomy through Europe's "Dark Ages", leading to the Copernican Revolution and our present conception of the universe.

John Percy (PhD Astronomy 1968 University of Toronto) is a very active Professor Emeritus at the University of Toronto, in Astronomy & Astrophysics, and in Science Education. He was a founding faculty member of the University of Toronto's Mississauga campus in 1967.

His research deals with the nature and evolution of the stars, and he has published over 250 research papers and three books in these fields, most recently "Understanding Variable Stars" (Cambridge 2007).

He has also been active in science education, especially astronomy education, at all levels, throughout the world. He has edited five major conference proceedings in this field. He has served as president of six national or international scientific and educational organizations, and as Vice-Chair of the Board of Trustees of the Ontario Science Centre, and as Honorary President of the Science Teachers Association of Ontario. He has received many awards, most recently the inaugural University of Toronto President's Teaching Award in 2007, the inaugural Qilak Award of the Canadian Astronomical Society for outstanding contributions to public appreciation and understanding of astronomy in 2012, and the 2013 Education Prize of the American Astronomical Society. He is a Fellow of the American Association for the Advancement of Science, and of the Royal Astronomical Society of Canada.

Rather than recreate John Percy's talk, here is a link to the actual power point presentation. We would like to thank John for making his talk available to us. http://www.astro.utoronto.ca/~percy/archaeo.pdf

Steve presented "The Sky This Month" after the break.

- The Lyrids meteor shower peaks with about 20 meteors per hour on April 22/23. The Lyrids are the result of comet Thatcher which last approached the Sun in June 1861. Thatcher will return in 2276.
- The April Friday the 13th, 2029, flyby of asteroid Apophis will be on a HAA meeting night. Apophis will become the closest flyby of an asteroid of its size when it comes no closer than 19,400 miles (31,300 kilometers) above the Earth's surface.
- Asteroid Vesta will be an easy binocular object for the next four months. Check out the website "Heavens Above" to get a location chart.
- Barnard's Star is the fourth closest star to our solar system. At magnitude 9.5 you may be able to see it in a large pair of binoculars. A small scope will definitely show it. Barnard's Star moves about 10 arc seconds per year. Plot its position in the star field and see how it moves relative to the stars around it over time.
- The May 6th Eta Aquarids meteor shower is the result of comet Halley passing the Earth in the past. The best time to see the meteor shower is after midnight.

Meeting closed at around 9:30pm.

Hamilton Amateur Astronomers Astrophysics Group by Mike Jefferson

April 20, 2018

The people present at this meeting were Doug Black, Doug Currie, Steve Germann, Mike Jefferson, Aidan King, Ian Rabenda and Gary Sutton.

The topic under scrutiny was *The Hubble Constant*. Mike brought in a flash-drive with a Wikipedia article on this topic, for sharing and discussion. We went through this material, section by section, and conversed about the meaning of each, the ramifications it entailed and questions it posed. This occupied the vast majority of the time available.

Doug Black handed out a paper he found on the Hubble Constant. It stated as follows:

v = HoD

Where:
Ho is The Hubble Constant, 67.8 (km/s)/Mpc (data derived from the Planck Mission)
D is the "proper distance" to the galaxy (Mpc)
v is the "recessional velocity" of the galaxy, NOT very simply related to the redshift "velocity" (km/s)

HUBBLE'S LAW – works beyond ~30Mly

Ho above is time dependent and o refers to the time of the observation. **D** is the proper distance corresponding approximately to where a distant object would be at a specific moment of cosmological time. This can change over time due to the universe's expansion. Unlike the (1) comoving distance, (2) proper distance can change over time as the universe expands.

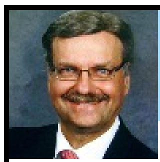
(1) & (2) are defined to be equal at the present time. The universe's expansion results in (2) changing while (1) is unchanged by this expansion because (1) is (2) divided by the scale factor.

(1) & (2) are not the same concept of distance as in special relativity.

v above is the rate of change of (2) with respect to the cosmological time coordinate, the standard time coordinate for specifying the Friedmann-Lemaitre-Robertson-Walker solution of Einstein's field equations. That solution describes a homogeneous, isotropic expanding or contracting universe.

The point of this is that Einstein's General Theory of Relativity had foretold a moving universe, too. At the time, it did not matter whether this could be defined as expanding, contracting, slowing down or accelerating. He did not believe in his own work and introduced a factor to describe a static universe, despite the earlier findings of Lemaitre and V. M. Slipher to the contrary. It was only after Hubble's observations also pointed to an expanding universe that Einstein declared his factor to be the greatest mistake he had ever made and he promptly removed it to describe an expanding universe.

We again thank the Blacks for their hospitality and refreshments. The next Astrophysics meeting is likely to be Friday, May 18 @ 7:30. Please ask at the next HAA general meeting on May 11, email HAA from the website or call me for confirmation. - Mike Jefferson (905-648-8919)



The Sky This Month for May 2018 by Steve Germann

Halley's Comet

What does it mean to see a comet? Well, it's up to you to decide that.

Basically, it means to see light that has hit some part of the comet, or some part of the cloud of dust and gas around the comet. You never really see the core of the comet. It's far too small and dark coloured to be seen by eye, so really you are looking at some part that WAS part of Halley's comet in this case.

Well...

Halley's comet has been orbiting the Sun on its current orbit for thousands of years that we know about, and in the process it has shed a lot of gas and dust, generally into the same elliptical orbit as the comet follows, but trailing or leading the comet along that orbit.

After enough orbits, the dust is a continuous doughnut in space, along the comet's orbit. The earth passes through this dust-doughnut twice a year, with the spring pass going through the doughnut with the dust approaching from the sunward side of the earth.

You can 'see' Halley's comet if you see any meteorites in the *Eta Aquarid meteor shower*.

This is best viewed in the early morning, Saturday May 6, and looking east. It's ideally placed this year. No Moon... early on a Saturday morning, peaking at 2 am but continuing until dawn.

The 3rd quarter Moon rises at midnight, but is low in the west near dawn. We are not looking for faint meteors here… The meteroids of this shower are particularly fast and bright, rivaling the Persieid meteor shower of August both in speed and zenithal hourly rate. They are spectacular!

Here's a website with more details: https://www.space.com/36502-eta-aquarid-meteor-shower-guide.html

So, if you look, you will see. And if it's cloudy, don't worry. Try again Sunday morning. The rate of this shower is at least half-the peak for 2.5 days on each side of 7 UT May 6.

Then you can cross it off your bucket list...

The means the dust doughnut is so large that the earth takes 5 days to pass through it on its orbit. About 12 million kilometers. Of course there are still particles outside that range.

The common trait is that they will all appear to come from Eta Aquarii.

I suggest that you take a sketch pad or planisphere with you when watching for meteors, and mark on the map where they started and ended in the sky.

It's not that difficult to do.

Will you see 3 or more meteors that appear to have come from the same part of the sky? Those will be part of a meteor shower.

Don't wait for 2061 to be able to say you have seen Halley's comet. Here's something you can do this week.

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The Sky This Month for May 2018 (continued)

Vesta

While you are thinking about solar system objects, remember that *Vesta* is VERY bright right now, and in really dark skies, you could see it without binoculars. It will be easy, at magnitude 6.5 to see Vesta with binoculars, anytime this month. It's close to Saturn and Mars.

As usual, Heavens Above will be your best resource for locating Vesta.

First, find Sagittarius and Saturn, then star hop your way to Vesta using the maps that Heavens-Above will generate for you. You don't even have to log in to get the maps.

A word of warning... you will not appreciate the view of Saturn without a telescope. I recommend at least 50 times power to get a good look at Saturn, and an 8 inch scope to see details in the rings.

In Sagittarius, Mars, Saturn and Vesta are rising not long after Sunset these days, and will rise earlier and earlier as they near opposition.

Vesta is close and bright enough, that you should be able to see its motion over a few hours, or a day.

But you won't see any such apparent motion on the evening of May 7, when Vesta is stationary, (relative to the distant star-field) before it begins retrograde motion.

You can sketch the star field including Vesta, and try again the next night. It's so bright you won't have any trouble spotting it again with binoculars.

Moonrise

The Moon has gone back to it's old routine of rising full only once per month. This month the Moon rises on Tuesday May 29, being full in the early part of the daytime when we cannot see it. So you will get an equally good moonrise the night of or the night before May 29th.

The azimuth of the Moon for our area is 115 degrees on May 29 and 112 degrees on May 28th. Both offer good views over the lake as viewed from Burlington Waterfront Park near Burloak Drive.

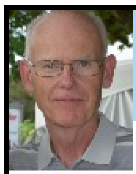
The moon rises at 19:53 local time on the 28th and 20:53 local time on the 29th. The azimuth means the rising Moon will pass near the cloud of mist coming from Niagara Falls. This would be a good time to use a telescope to see better detail of the Moon low on the horizon.

Other highlights...

Jupiter is at opposition on May 9th, reaching its closest distance to Earth and apparent magnitude -2.5.

The moons of Jupiter will also be at their brightest at this time.

I wish you clear skies, and observing success. Please send me reports and photographs I can share at our monthly meeting on May 11.



Noise analysis of my Nikon D5300 DSLR by Peter Wolsley

I have been using the winter months to try and learn more about how my DSLR works and maybe improve my technique for taking astrophotos. A big issue for astrophotography is reducing image noise. I decided to try and characterize the electronic noise in my camera. Many websites talk about Read Noise and Thermal Noise. While they quote noise values in electrons, I want to initially focus on using the values contained in the image files my camera creates. These values are the integer count values for each pixel. They are typically stored as unsigned 16 bit numbers which means they can have values as small as 0 and as big as 65,535. For a 14 bit camera, such as my D5300 the numbers can be no bigger than 16,383. For a 12 bit camera they can be no bigger than 4095.

I discovered a simple formula on the Photometrics website used in their Read Noise Calculator:
https://www.photometrics.com/resources/imaging-tools/read-noise-calculator.php

The formula is based upon a really simple method of taking the difference between two images and then calculating the standard deviation of the difference. They use what are called BIAS images which is a type of image that we generate as part of the astrophotography hobby.

A BIAS image is created by simply putting the lens cap on the camera and then setting the shutter speed to the fastest possible. Then you take 10 or 20 or more photos this way. The photos are essentially pitch black but they contain a tiny amount of variation that is generated by your camera as it reads all of the information from the imaging chip and stores it as an image file. Every imaging chip has unique variations that exist in these BIAS images. There could be specific pixels that always give higher values or lower values. Sometimes an entire row or column of pixels can be slightly different which may arise from a design flaw. In addition to these consistent "signals" or "flaws" there is some random noise that is different for every image. In astrophotography we use BIAS images to cancel out these "signals" or "flaws". The random noise remains as a problem we try to minimize by combining several BIAS images together to create a Master BIAS image.

The method described on the Photometrics website has the ability to cancel out these "signals" and "flaws" by subtracting one individual BIAS image from another individual BIAS image. The resulting difference image contains only the random noise. The math theory that kicks in here is that when you take the difference between two datasets that contain random noise that the resulting difference dataset contains more noise. If you express the noise by its standard deviation(SD) you can calculate the increase in noise using the following equation:

$(SDdifference)^2 = (SDdataset1)^2 + (SDdataset2)^2$

If we make the assumption that both BIAS images have the same amount of random noise then we can say that:

SDdataset1 = SDdataset2 = SDbias ; substituting we get the following equation:

SDbias = SDdifference/sqrt(2) ; where sqrt(2) = 1.414 and SDbias is the Read Noise scaled in counts for a BIAS image.

The Photometrics website goes one step further and tries to calculate this Read Noise in electrons which requires you to calculate the camera gain. I don't want to bother doing this right now. I decided to also use this method with my DARK images. DARK images are another type of image we need to generate for astrophotography. These images are generate by once again putting the lens cap on the camera. This time we set the exposure time to be very long so that it matches the exposure times we use in taking astrophotos. The main goal here is to try and generate photos that contain the "thermal" or "dark current" noise generated by our camera. Just like BIAS images, these DARK images contain a "signal" which indicates how the pixels in the camera respond during a long exposure. Typically these pixels accumulate thermal

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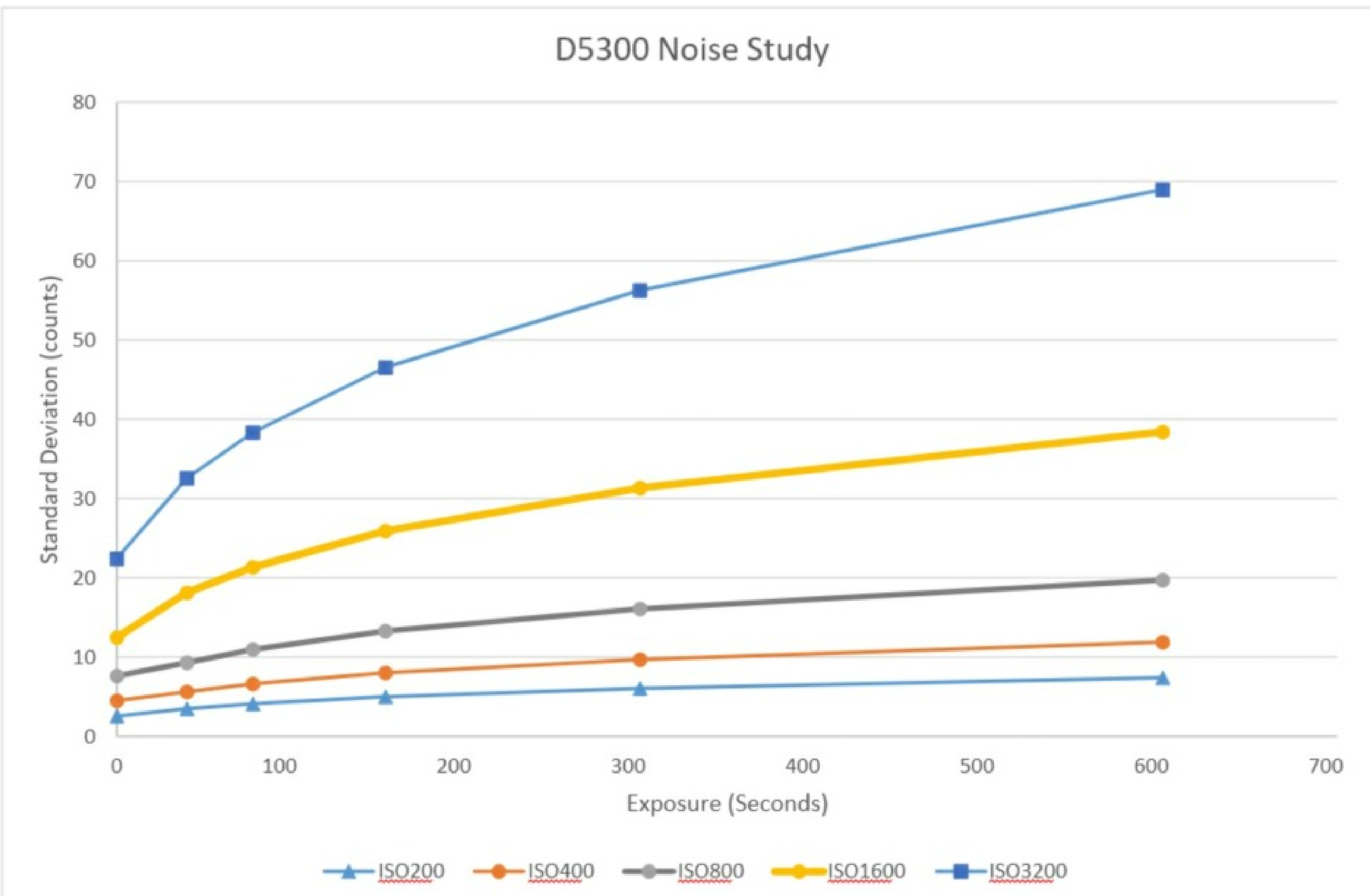
or dark current electrons which causes the values in the image files to increase with the exposure time. Just like BIAS images, these DARK images also contain random noise which we try to minimize by combining multiple DARK images.

The image difference method we used with the BIAS images should also be valid for the DARK images. Any "signal" should be cancelled out leaving only the random noise which we can use to calculate the noise in the DARK image. I wrote a program to calculate the difference between two images and then calculate the standard deviation. I divided these values by 1.414 to yield the standard deviation for the individual images. I had lots of BIAS and DARK images at various ISO settings so I decided to graph the result. I typically had 10 or more images for each datapoint. To arrive at one value for each datapoint I divided these images into several pairs and calculate standard deviations for each pair. I then averaged the standard deviations for the pairs to yield a single value. I would estimate that over 100 photos were used to generate this graph.



Exposure (Sec)	ISO200	ISO400	ISO800	ISO1600	ISO3200
0	2.56	4.49	7.61	12.48	22.42
40	3.48	5.60	9.29	18.12	32.55
78	4.10	6.60	10.95	21.35	38.35
154	4.98	8.01	13.29	25.91	46.55
300	6.02	9.69	16.07	31.33	56.28
600	7.38	11.88	19.70	38.40	68.98

The 0 exposure values are the values derived from BIAS images. The 300 second values are from an ISO study I did using DARK images. The full column for ISO 1600 are from an exposure study I did last year using DARK images. The values shown in grey are interpolated values.

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Noise Analysis of my Nikon D5300 DSLR (continued)

Clearly, the random noise in the DARK images increases with exposure time. In other words…the "Dark Current" or "Thermal signature" is not just a "signal" that can be compensated for. There is also a random noise component that has to be dealt with.

I decided that now I should try to convert these values to electrons. There is a website called www.sensorgen.info that contains a huge list of data for a wide variety of cameras. My Nikon D5300 is listed. The data includes Saturation values which Sensorgen says is the Saturation Capacity. Their definition is that Saturation Capacity represents the maximum number of electrons a camera pixel can hold before the image for that pixel is pure white. Any additional electrons are simply not counted. Pure white for my 14 bit image files corresponds to a value equal to 16,383. If I combine this Saturation Capacity and this 16,383 figure I can calculate a gain factor that will tell me how many electrons it takes to yield one count in my 14 bit image file. The Saturation value for ISO 100 is 33925. This corresponds to the 16,383 value so, for ISO 100 it takes 33925/16383 = 2.07 electrons per count. This crude method for calculating the camera gain allows me to translate all of my existing noise data from counts to electrons. I decided to focus on the BIAS data and the 300 second DARK data.

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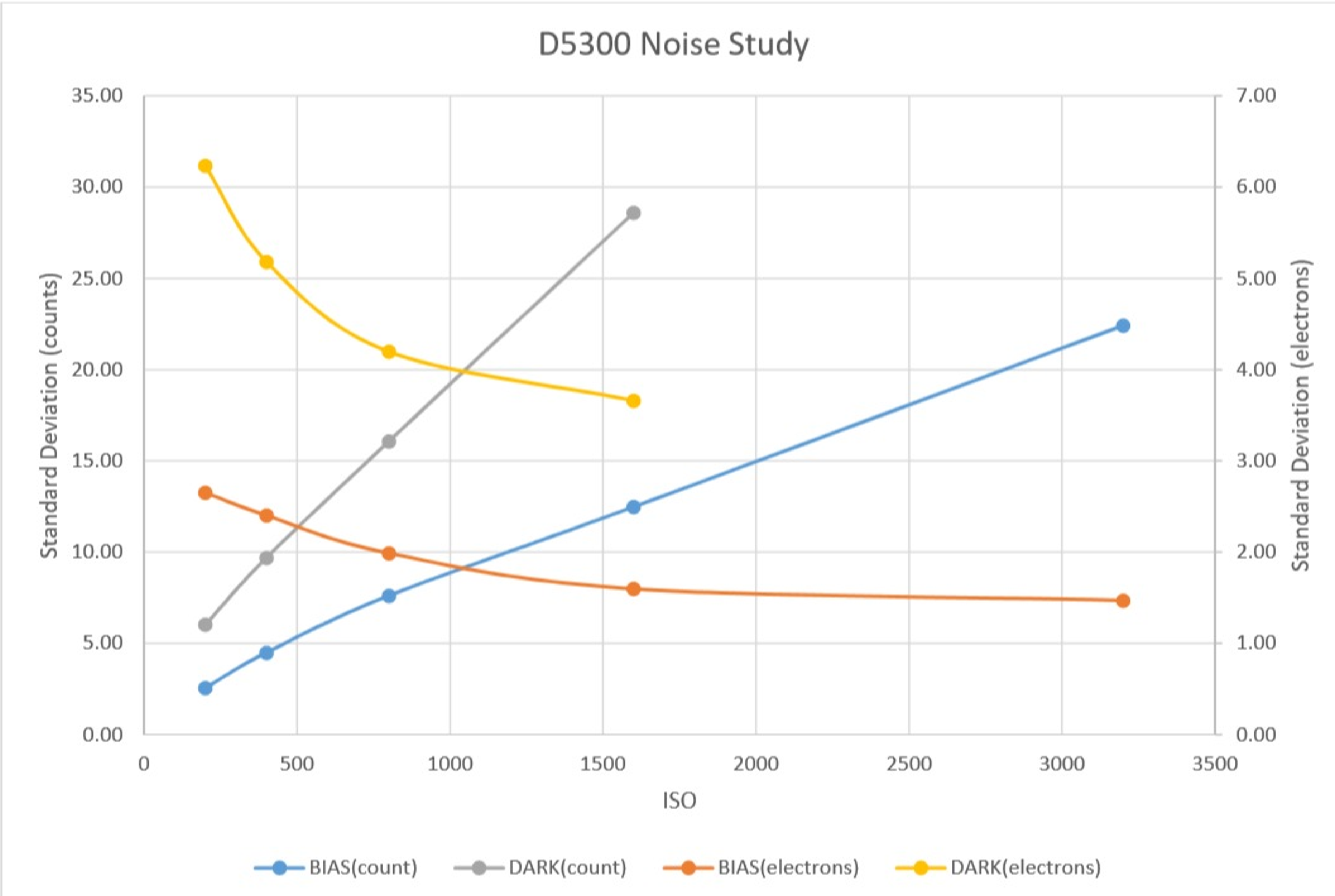
Sensorgen.info

Sensor data for Nikon D5300

Make	Nikon	ISO	Measured ISO	Read Noise (e-)	Saturation (e-)	DR (stops)
Model	D5300	100	78	3.4	33925	13.3
Sensor	Sony	200	157	2.7	16968	12.6
Tech	CMOS	400	311	2.9	8764	11.6
Date	17/10/2013	800	622	2.7	4279	10.6
Pixels	4016x6016	1600	1244	2.0	2097	10.0
Size	15.6x23.5mm	3200	2483	2.3	1074	8.9
Pixel size	3.9 micron	6400	5079	2.3	543	7.9
Bits	14	12800	9891	2.3	271	6.9
Q.E.	55%	25600	19842	2.8	137	5.6

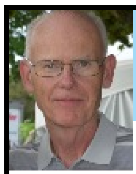
Noise Analysis of my Nikon D5300 DSLR (continued)



			BIAS Noise		DARK Noise	
ISO	Saturation	Gain 14b	Count	Electrons	Count	Electrons
200	16968	1.04	2.56	2.65	6.02	6.23
400	8764	0.53	4.49	2.40	9.69	5.18
800	4279	0.26	7.61	1.99	16.07	4.20
1600	2097	0.13	12.48	1.60	28.6	4.01
3200	1074	0.07	22.42	1.47		

The two electron noise graphs are interesting. The graph for the BIAS(electrons) shows that the electron noise does increase slightly for lower ISO values. The values are close to the Sensorgen values for Read Noise (e-) which is encouraging. The graph for the DARK(electrons) is very interesting. It drops off quite quickly from ISO 200 up to ISO 800 and then seems to level off for the higher ISO 1600 value.

This gives me the impression that I will get the best faint detail astrophotos if I shoot at ISO 800 or higher. Since the improvement in noise seems to level out above ISO 800 I don't think I will benefit from shooting at higher ISO than ISO 800 because at higher ISO is becomes too easy to have bright stars saturate.



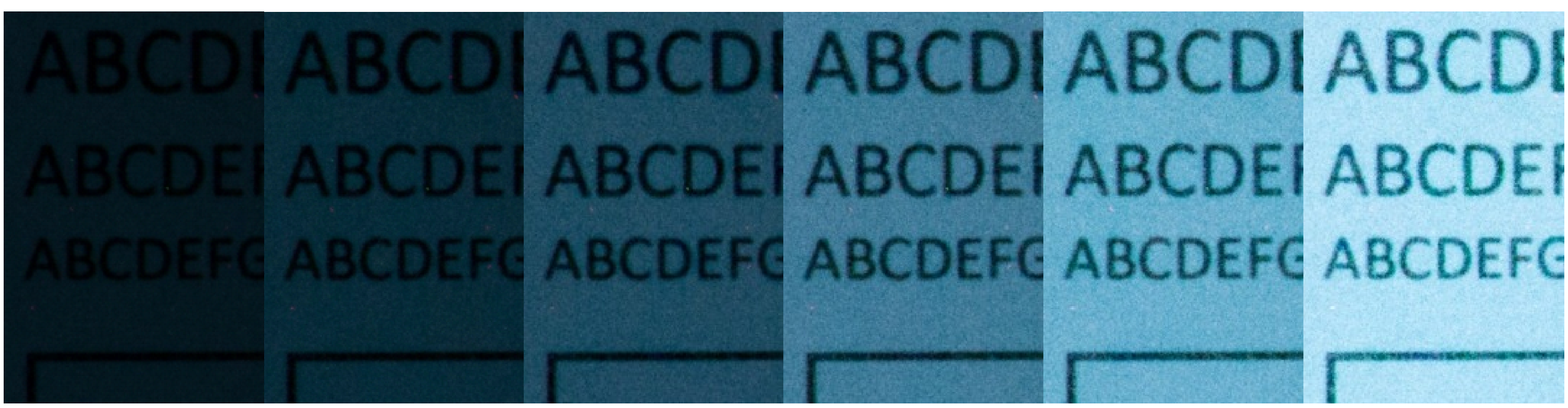
Nikon D5300 ISO Invariance Testing by Peter Wolsley

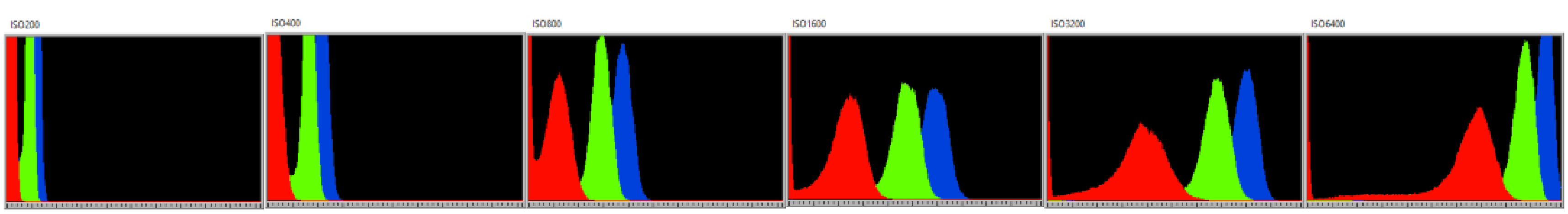
I read on a web site that my D5300 camera is ISO invariant. ISO invariance means that the ISO setting on the camera tends to not be important. You can dramatically underexposure a photo and when you brighten the photo using a photo editing program there is little to no loss in quality. They also said that I should conduct my own test to prove this. They used evening sky photography with exposures that were only a few seconds in length. I decided that I would like to know if the long exposure thermal noise in my camera was ISO invariant. Thermal noise is inherent in all imaging chips and its main characteristic is that it grows steadily with exposure. This means that long exposures needed for astrophotography will have much more thermal noise than images where the exposure is only a few seconds. In other words…

“If I want to take a 300 second exposure of a DSO(Deep Sky Object)…is there a best ISO to use?” Or

“You always want as much dynamic range as you can get your hands on because stars over-expose so easily…BUT…if you try to use a low ISO will you capture less of the faint details?”

I decided to conduct the test in my darkened basement wood shop. There are no windows so I had full control of exactly how much light was available. I used a single white LED as my light source and, after some fiddling, I was able to take 300 second (5 minute) exposures at various ISOs ranging from 6400 down to 200. I created a target which was a piece of white paper with some lettering and some squares printed on my laser printer. The paper target was placed roughly eight feet away from my camera. I took all the photos at full resolution (6000x4000) and using 14 bit RAW format. Here are the RAW cropped images I created and there histograms. The histograms all use the same X and Y-axis scale. I did not white balance the images…they all came out with a blue tint. The smallest font is 8pt.





ISO 200 ISO 400 ISO 800 ISO 1600 ISO 3200 ISO 6400

These are all 300 second exposures. I used my telephoto lens and set the aperture at f29 and the focal length to 300mm. I focused manually and set the camera to MANUAL so that the aperture, ISO and exposure were held fixed. The main difference in each photo is that the pixel values in the RAW files were progressively reduced from the ISO 6400 image down to the ISO 200 image. The histograms clearly showed this to be true.

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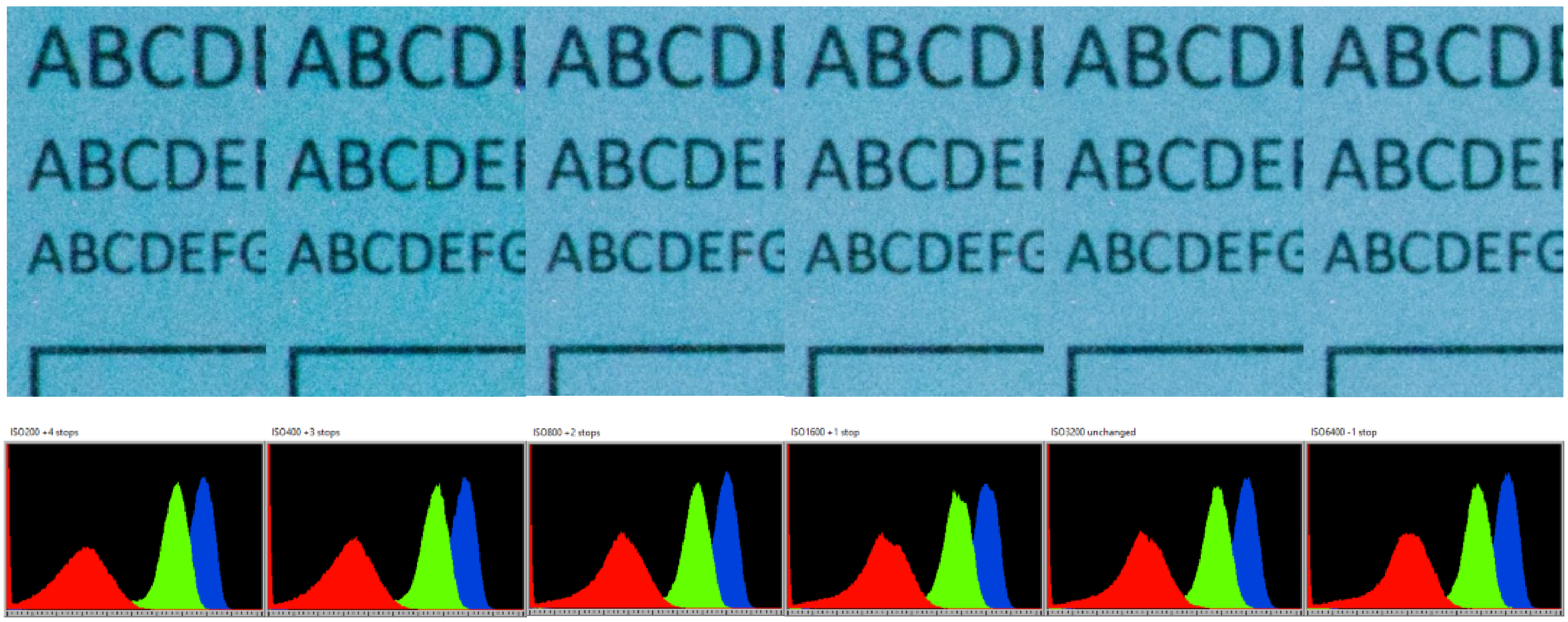
Nikon D5300 ISO Invariance Testing (continued)

The test for ISO invariance says that I should now use a photo program to adjust the exposure by whatever stops are required to compensate for the differences in ISO. What I chose to do was to lower the ISO 6400 image by one stop, leave the ISO 3200 as is and then brighten the remaining images by 1 stop, 2 stops, 3 stops and 4 stops respectively. I used Lightroom to alter the images. Here is what I got.



ISO 200 + 4 stops ISO 400 +3 stops ISO 800 +2 stops ISO 1600 +1 stop ISO 3200 unchanged ISO 6400 +1stop

Interesting result…They are now all very close in brightness. The ISO 400 and ISO 200 images are just slightly darker. The other thing to note is that the noise in each image is pretty much the same. The ISO 400 and ISO 200 images are slightly noisier. A key point here are that the number of photons, or signal, in each of these images is virtually identical. Same aperture…same focal length…same exposure time. The only difference is the ISO, which for a digital camera is effectively a gain or scaling factor for the RAW data.

My interpretation of this result tells me that my NIKON D5300 DSLR appears to be ISO invariant…including long exposure thermal noise. Does this mean it doesn't matter at what ISO I take an astrophoto? In this specific case the visible noise in the images didn't change much no matter what ISO I used. What did change was the available dynamic range. Given this fact, I conclude that shooting astrophotos with my Nikon D5300 at ISO 200 or ISO 400 should give me good results in spite of the fact that the dim DSO may well be pitch black in the RAW photo. After stacking and digitally developing, the resulting noise may not be any worse or better using a lower ISO but the available dynamic range will be superior. An important find…but still not conclusive.

My D5300 camera can shoot at ISO 100 but the web page I read gives me the impression that this would not be a good choice. This conclusion comes from visiting the Sensorgen website https://www.sensorgen.info/ (see previous article). On this website you will find testing data for virtually all cameras of all makes. For each camera you can find test data for a large range of ISO settings. The most significant parameter for me is the Saturation (e-) values. The Sensorgen site states that the Saturation (-e) values are actually "Saturation Capacity" values. The value is meant to represent how many electrons can be stored in a pixel before the resulting image is pure white. Adding any more electrons will not alter the value obtained from the pixel. The interesting point here is that this saturation value changes with ISO. As ISO is increased it takes less and less electrons in a pixel to end up with a pure white image. This hints at the fact that there are some electronics in the camera that, based upon the ISO, amplifies the analogue signal coming from each pixel and when the amplified signal reaches a limit the

(Continued on page 14)

Nikon D5300 ISO Invariance Testing (continued)

resulting value stored in the RAW image file is clamped at its maximum. What is not indicated here is that the number of bits used by the analog to digital conversion in the camera also plays a role.

For a 12 bit camera the values in the RAW image file can range from 0 - 4095. For a 14 bit camera this range increases to 0 - 16383. When you combine these ranges with the Sensorgen "Saturation Capacity" values you discover something important about your camera. Here is a subset of the data for my D5300 camera taken from the Sensorgen site.

ISO	Saturation (e-) "Saturation Capacity"
100	33925
200	16968
400	8764
800	4279
1600	2097
3200	1074

At ISO 100 my camera's pixels can hold 33925 electrons before the electronics reaches its maximum…BUT…at 14 bit resolution my camera can only discern 16383 distinct values. This means that my camera might be able to collect lots of electrons but the resulting RAW file will have rounded off the results. It's as if I wasted my time collecting all those electrons…I don't get to see any increase in detail possible by collecting 33925 electrons. The one advantage here is that the dynamic range of the resulting image is maximized. This might be something to consider if my goal is to take an astrophoto of a bright star cluster where there isn't faint details such as nebulosity.

At ISO 200 the story is better. At ISO 200, my camera's pixels can hold 16968 electrons before the electronics reaches its maximum. My camera can discern 16383 distinct values so this is pretty close to 1:1 ratio. Virtually every electron I collect will add to the detail in my image. This situation is described as being the unity gain point for a camera. I give up a little in dynamic range but I still preserve my ability to record faint details. On the website http://dslr-astrophotography.com/iso-dslr-astrophotography/ they have tried to summaries the best ISO for various cameras. For my Nikon D5300 they suggest ISO 200 or 400 which is what I am concluding right now. I am going to do a little more research…stay tuned.

Treasurer's Report by Ann Tekatch

Treasurer's Report for April 2018 (Unaudited)

Opening balance:	$9,200.18	
<u>Revenue:</u>		
50/50 Draw:	$61.00	
Memberships:	$55.00	
PayPal Memberships:	$140.00	
* February PayPal Memberships:	$55.00	* missed on last month's report
<u>Expenses:</u>		
PayPal fees:	$7.77	
Speaker Honorarium:	$50.00	
Telescope Clinic Handouts:	$24.86	
Closing Balance:	$9,428.55	

NASA's Space Place

This article is provided by NASA Space Place.

With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology.

Visit spaceplace.nasa.gov to explore space and Earth science!

What's It Like Inside Mars?

By Jessica Stoller-Conrad

Mars is Earth's neighbor in the solar system. NASA's robotic explorers have visited our neighbor quite a few times. By orbiting, landing and roving on the Red Planet, we've learned so much about Martian canyons, volcanoes, rocks and soil. However, we still don't know exactly what Mars is like on the *inside*. This information could give scientists some really important clues about how Mars and the rest of our solar system formed.

This spring, NASA is launching a new mission to study the inside of Mars. It's called Mars InSight. InSight—short for Interior Exploration using Seismic Investigations, Geodesy and Heat Transport—is a lander. When InSight lands on Mars later this year, it won't drive around on the surface of Mars like a rover does. Instead, InSight will land, place instruments on the ground nearby and begin collecting information.

Just like a doctor uses instruments to understand what's going on inside your body, InSight will use three science instruments to figure out what's going on inside Mars.

One of these instruments is called a seismometer. On Earth, scientists use seismometers to study the vibrations that happen during earthquakes. InSight's seismometer will measure the vibrations of earthquakes on Mars—known as marsquakes. We know that on Earth, different materials vibrate in different ways. By studying the vibrations from marsquakes, scientists hope to figure out what materials are found inside Mars.

InSight will also carry a heat probe that will take the temperature on Mars. The heat probe will dig almost 16 feet below Mars' surface. After it burrows into the ground, the heat probe will measure the heat coming from the interior of Mars. These measurements can also help

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NASA's Space Place (continued)

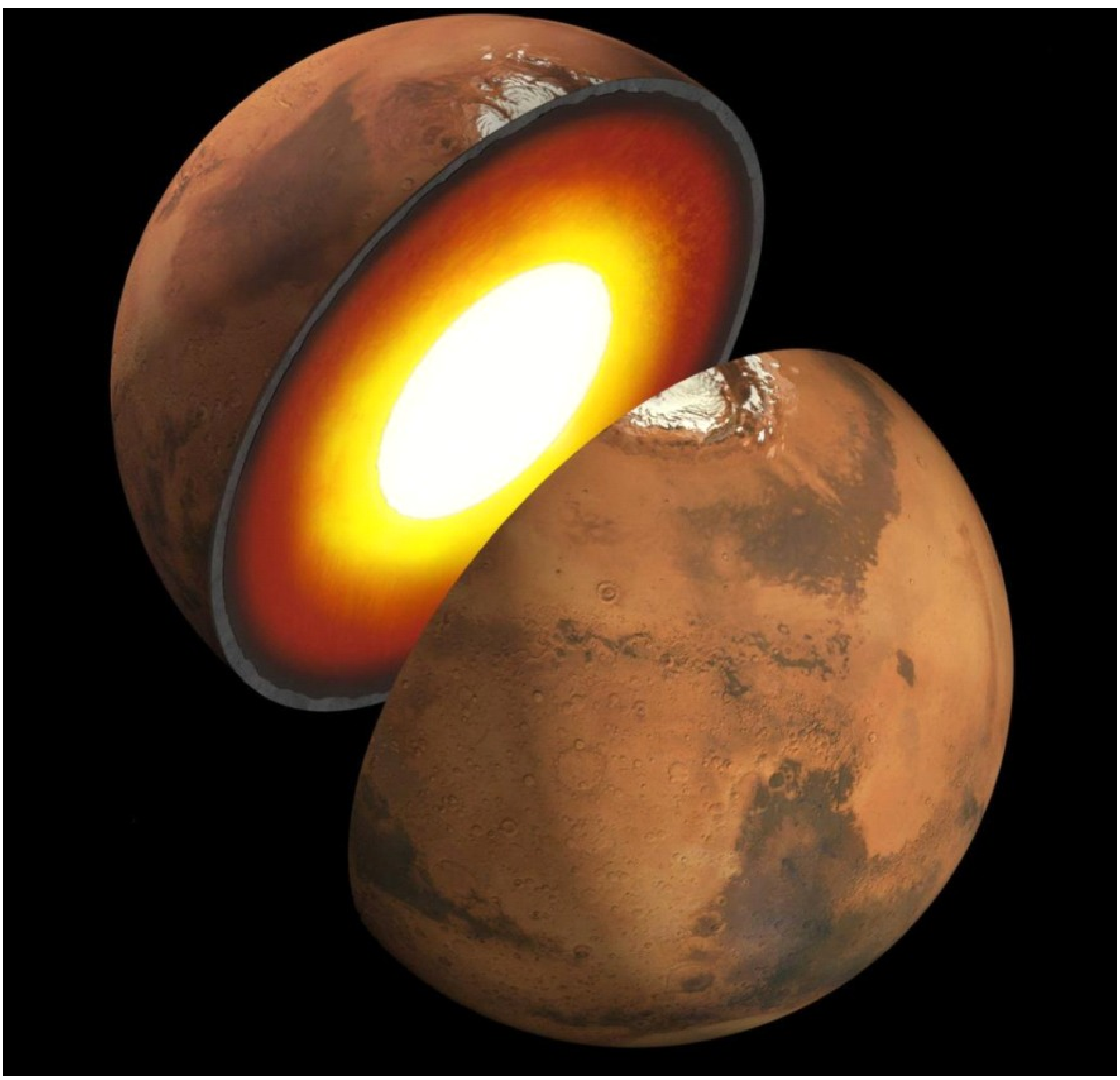
us understand where Mars' heat comes from in the first place. This information will help scientists figure out how Mars formed and if it's made from the same stuff as Earth and the Moon.

Scientists know that the very center of Mars, called the core, is made of iron. But what else is in there? InSight has an instrument called the Rotation and Interior Structure Experiment, or RISE, that will hopefully help us to find out.

Although the InSight lander stays in one spot on Mars, Mars wobbles around as it orbits the Sun. RISE will keep track of InSight's location so that scientists will have a way to measure these wobbles. This information will help determine what materials are in Mars' core and whether the core is liquid or solid.

InSight will collect tons of information about what Mars is like under the surface. One day, these new details from InSight will help us understand more about how planets like Mars—and our home, Earth—came to be.

For more information about earthquakes and marsquakes, visit:
https://spaceplace.nasa.gov/earthquakes

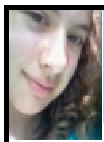


An artist's illustration showing a possible inner structure of Mars. *Image credit: NASA/JPL-Caltech*

Eye Candy the Members' Image Gallery

(above) **The First-Quarter Moon on April 21, 2018** from Hamilton, ON, by **Geoffrey Whitman**

(left) **Jupiter and its Moons on April 21, 2018** from Hamilton, ON, by **Brian Whitman.**
Taken through Barry Sherman's telescope.



Cartoon Corner by Alexandra Tekatch

William J. McCallion

Planetarium

McMASTER UNIVERSITY, HAMILTON, ONTARIO

- **Public shows every Wednesday (7:00pm)**
- **Public transit available directly to McMaster campus**
- **Tickets $7 per person; private group bookings $150**
- **Different shows every week**
- **Upcoming shows include:**
  - **May 2: Introductory Astronomy for Kids — Solar System**
  - **May 4: Star Wars Day Special! — Star Wars: The Science Awakens**
  - **May 9: Serendipity**
  - **May 16: A Timeline of our Universe: From the Big Bang to the Big Freeze**
  - **May 23: Stories of the Sky**
- **For more details, visit www.physics.mcmaster.ca/planetarium**

UPCOMING EVENTS

May 11, 2018 - 7:30 pm — *HAA Meeting* at the Hamilton Spectator Auditorium. Our main speaker will be H.A.A. member ***Matthew Mannering***, who will talk about his experiences with astrophotography.

May 26, 2018 - 8:00 pm - 11:00 pm — *Public Stargazing Night* at McQuesten Park, 1199 Upper Wentworth St, Hamilton, ON.

June 8, 2018 - 7:30 pm — *HAA Meeting* at the Hamilton Spectator Auditorium.

2017-2018 Council

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Observing site for the HAA provided with the generous support of the
Binbrook Conservation Area
Come observing with the HAA and see what a great location this is for stargazing, a family day or an outdoor function.
Please consider purchasing a season's pass for $79 to help support the park.
http://www.npca.ca/conservation-areas/binbrook/
905-692-3228

Check out the H.A.A. **Website**
www.amateurastronomy.org

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