NOVA

NEWSLETTER**OF**THE**VANCOUVER**CENTRE**RASC**

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Babylonian Astronomy:

What do we know and how do we know it?

by Michael Levy

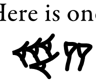
When I am at the telescope, I realize the impossible dream of time travel. I am looking at the distant past history of the galaxy and the universe. But when I set my telescope to go to Right Ascension 00h 42m 44.3s and Declination +41° 16' 9", I am engaged in a form of time travel, too—back to Sumeria and Babylon at least 2,500 years ago.

The Sexagesimal System

Although the exact origins of the sexagesimal system are not known, we do know that it was the numeric system used by Babylonian astronomers. The influence of this system, which is more than 2,500 years old, still persists in our periodic measurement systems, namely time, astronomical coordinates and geo coordinates.

Although it is called a "Base 60" system, it is actually a combination of unary, binary, base 10 and base 60. In Babylonian cuneiform, there are only two digits (hence my possible misuse of the word binary):

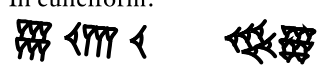
The numbers from two to nine are represented in unary—in a row up to three, and then stacked in two rows for 4, 5 and 6 and three rows for 7, 8 and 9. Using the symbol for 10, remaining numbers (up to 59) are represented as combinations of these symbols and stacking rules. Here is one to test you:



(Answer can be found in The Hitchhiker's Guide to the Galaxy). To get to fractions, and, to some extent, larger numbers, such as the ones needed for astronomy, the Babylonians used a place-value (positional) Base 60 system. Modern translations use semicolons and commas to separate the parts of a cuneiform number. Hence (in modern notation),

6,13;10,0,58 represents $6 \times 60 + 13 + 10 \times 60^{-1} + 58 \times 60^{-3} = 373.166935185185$

In cuneiform:



It was left up to the reader of the table to work out (from context) where the fractional part and the zero was.

• • •

Now that you are an expert in the number system used by the Babylonians, let's talk about their astronomy. More specifically, about how we know what we know about their astronomy.

Much of the ancient world's

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JULY 8 **Zoom**
JPL Ambassador, Matthew Borghese, returns, this time to present Moon 2024. See Meetup for Zoom details.

NO MEETING IN AUGUST

SEPTEMBER 9 **Zoom**
Speaker TBA. Please see Meetup for updates.

An Interesting Pair

by J. Karl Miller

Lately, there have been several missions to Mars; a number more to the Moon and the "rocky" planets in our solar system are planned. Among these, NASA and JPL are working on two missions to Venus, the planet physically very similar to Earth, but, environmentally speaking, very different.

Venus and Earth (Credit: NASA/JPL)

Venus' orbit is closer to the Sun. It is also the closest planet to us—its distance from the Sun is 72% of Earth's distance. This implies that Venus may have had a climate similar to Earth's in the earlier years of its existence. It makes sense that a closer distance to the Sun would result in a higher, but still tolerable, average surface temperature there. Venus orbits within the "Goldilocks" zone, nearer the inner limit. Mars orbits inside the outer limit. Water can exist in a liquid state in that zone. However, at the present time, Venus' surface temperature is about 460[!] degrees Celsius. In addition, the atmospheric pressure is about 90 times that of our home planet; the composition of its atmosphere is also very different from ours. The reason for this extreme climate change is unknown, a greenhouse gas effect, perhaps? The rotational axis of Venus is only 2.3 degrees off its orbital plane and Venus rotates "retrograde" once in 243 days; could this have contributed to the current situation? Finding a possible cause is also a purpose of the two missions.

As usual, NASA's planned Venus missions are named to have some clever, and purpose-implying acronyms. VERITAS (Venus Emissivity, Radio science, InSAR [Interferometric Synthetic Aperture Radar], Topography, Spectroscopy) will orbit Venus with the purpose of obtaining surface and interior gravitational details. Perhaps there are formations (i.e. possible traces of lake beds or river valleys) that indicate the presence of water at an earlier time. There will also be an effort to determine whether there is evidence of tectonic plates and activity in the past, or even now.

The other orbiter, DAVINCI+ (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, Imaging Plus) consists of an orbiter and a lander. The lander is designed to settle on the surface of Venus, to measure atmospheric details on the way down, and surface characteristics as well. Both orbiters will probably act as communications relays. Lately, there have been some reports of detecting phosphine gas in the atmosphere, maybe indicating some form of airborne life. Others disagree. After a number of years of lax interest, Venus has come to the forefront of scientific investigation again.

To withstand the current temperatures on Venus, a lander will have to have especially well-designed heat protection. Russia sent the world's first-ever lander to Venus (Venera 9) in 1975; it sent signals for a little more than 50 minutes, after which contact was lost. There have been a number of landers by both Russia and NASA since then. I think that the super-hot environment likely gets the better of most of them.

Venus' atmosphere now is mostly carbon dioxide, with sulfur dioxide clouds and sulfuric-acid rain drops. Life on Earth (you and I are included) also generates carbon dioxide all the time, much of which, via a series of chemical actions, is converted back to oxygen by plankton in the oceans, and our plants and trees. But our industrial and agricultural activities are releasing large amounts of methane (20x more efficient at trapping heat than CO_2) and other pollutants, some of which also trap heat. Recent climate changes hint that global warming is happening now.

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President's Message

by Gordon Farrell

Being the President means that, in addition to many other duties, one sometimes has sad news to report. This is one of those times.

On June 21, we lost our webmaster, Ken Jackson, to complications from a bone marrow transplant he received years earlier to treat leukemia. Ken never told us about his condition, but some of us had suspected he wasn't well. We had no idea it was as serious as it was so his passing came as a shock to all of us.

Ken, a member of Vancouver Centre since 2012, first joined council back in April of 2016. As a software developer, his skills were essential to getting our web presence into proper shape and making our council emails function more effectively, improving both reliability and security as our one-man IT department. When we were forced to go virtual last year due to COVID, Ken's skills proved invaluable, not only getting our lectures online, but enabling us to quickly pivot the

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About RASC

The RASC Vancouver Centre meets at 7:30 PM on the second Thursday of every month at SFU's Burnaby campus (see map on page 4). Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $89.00 per year ($52.00 for persons under 21 years of age; family memberships also available) and can be obtained online, at a meeting, or by writing to the Treasurer at the address below. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd-numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address below.

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in the Trottier Studio in the Chemistry wing of the Shrum Science Centre at SFU. Please contact a council member for directions.

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Honourary President J. Karl Miller

Library

The centre has a large library of books, magazines and old NOVAs for your enjoyment. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

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GA that Vancouver Centre was hosting from an in-person to an online event. His torch has now been passed to the capable hands of his two assistants, Karimbir Singh and Renuka Pampana, who will keep things running smoothly into the future.

Ken also loved public outreach and was a constant presence at our many events, engaging with the public and sharing his love of astronomy, often with his partner Sumo at his side. He also volunteered at SFU's Starry Nights public astronomy events on Friday nights, where Howard Trottier described him as a "kind and gentle presence."

Ken was a loving father to three daughters. In lieu of flowers, the family has asked for donations to Plan Canada's "Because I am a Girl" programme (https://plan-canada.ca/because-i-am-a-girl). The Vancouver Centre has made such a donation in Ken's honour.

Clear Skies, Ken. ✸

Ken volunteering at public events. At Canada Day, alongside many other volunteers in 2017 (top, second from left) and setting up his solar observing gear with Sumo in their tent (middle). And handing out NOVA newsletters to visitors as they arrive at Astronomy Day/Science Rendezvous at SFU that same year (right).

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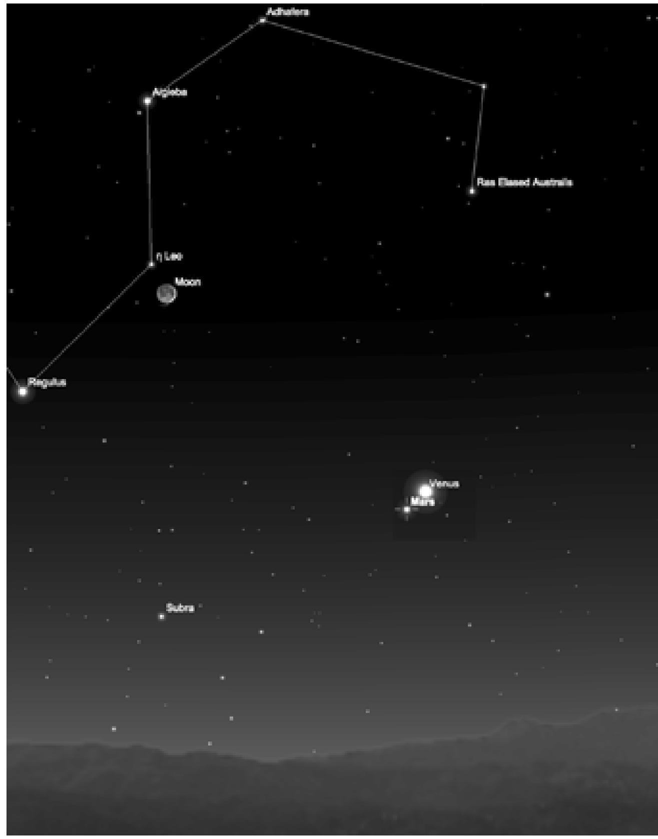
Venus and Earth are an interesting—at first glance very similar—pair of planets next to each other, yet they have such amazingly different surface environments.

Are we looking at a future on Earth similar to the present conditions on Venus? Are we smart and nimble enough to head off such a future?

If you're interested in seeing both of the other two planets sharing the Goldilocks zone, in the western sky on July 12, 2021, around 9:30 pm and later, you can see both Mars and Venus close together (and the Moon a bit farther away). Be careful if you look for Venus before sunset. It is fairly close to the Sun—the standard warning is: don't damage your eyesight, never look at the Sun with the naked eye, binoculars, or telescopes. Proper solar filters are necessary for that. After sunset, Venus, Mars, and the Moon are all close to the West-North-Western horizon; at that point binoculars are helpful. An unobstructed western horizon is best. ✸



Simulated west-north-west view from SkySafari 4 Plus

Membership has its Privileges!

Are you tired of looking at the same objects again and again (planets, moon, etc.)? Is your telescope collecting dust because it's hard to locate deep sky objects? Would you like to bring your observing to a stellar level? Robert Conrad, our new observing director, revived the Vancouver RASC observing group and invites you to join by sending him an email at observing@rasc-vancouver.com. Some of the benefits of belonging to this group include:

- Hands on training on how to operate the SFU Trottier observatory
- Weekly observing sessions at the observatory or at dark sky locations
- One-one-one coaching on how to locate thousands of objects in the night sky
- Attend small interactive seminars delivered by Robert on a range of topics including failsafe star-hopping, charting challenging objects and understanding the motions of the cosmos
- Learn to make your telescope dance by locating objects such as asteroids, nova, and supernovae
- Spectroscopy and imaging training from Howard Trottier and an opportunity to collaborate on observatory research projects
- Updates on observable sky events happening during the week like asteroid/comet/deep sky conjunctions
- Access to observing guides and lists that Robert created that took hundreds of hours to create and will help with planning observing sessions
- Knowledge and expertise from other observing group members
- Learn how to quickly and efficiently find and star-hop to deep sky objects using a range of binoculars and telescopes

Upcoming Events

August
7 - 15 – Mt. Kobau Star Party

September
4 - 12 – Merritt Star Quest

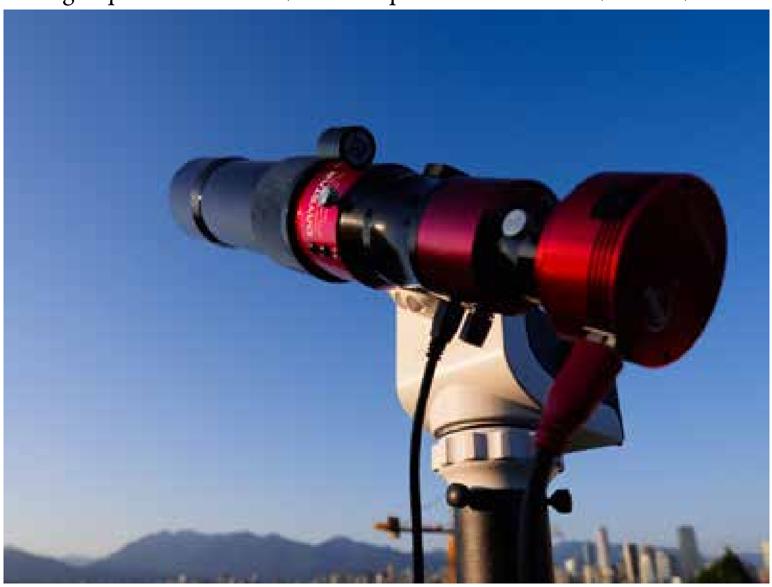
December
12 – AGM

A Beginner's Guide to Solar Viewing & Imaging

by Robert G. Lyons

It is summer solstice, the longest day of the year and the shortest night. As an astrophotographer, this is a challenging time of year. We have just emerged from galaxy season and are getting our first glimpse of the Milky Way's stunning nebulae, but we have no astronomical darkness and only 3-4 hours of twilight. It's not a great time for night astrophotography… What is an avid astrophotographer to do?

Embrace the daylight by imaging the Sun!



Daystar Solar Scout

Now is an excellent time to learn solar imaging, as we are entering a nine-year cycle of increased solar activity. Below, I will outline basic options and equipment necessary to start you on your solar journey.

It's very important to NEVER attempt to view or image the Sun without the proper equipment. You can cause permanent damage to your scope, your camera, and most importantly to your vision if you attempt to do so.

There are several different ways to view and image the Sun.

The easiest and least expensive option is to use a white light solar filter, which you can purchase for around $30 and up. Solar filters fit over the end of your telescope or camera lens and are made of the same material as solar glasses. They effectively block 99.99% of the extremely powerful energy of the Sun from entering your scope or lens. A white light filter will allow you to observe the Sun's photosphere. The Sun will look like a big flat disc, and you will be able to see Sunspots and objects transiting in front of the Sun, like Mercury, but you won't see much detail.

If you're wanting to image more of the Sun's details, calcium k (CaK) filters, are a mid-range option. A CaK filter can run anywhere from $500 to $1500. They work by blocking all light except for a slim transmission line of blue light at 393.4nm… and have absolutely nothing to do with milk! CaK filters allow us to see a lot of detail on the Sun, but because the wavelength is so close to ultraviolet range, our eyes have difficulty viewing this type of light and CaK filters should be reserved for imaging only.

Finally, we have hydrogen alpha (Ha) filters and telescopes which block out all light except a small slice of red light at 656.3nm. These are the most popular choices for solar imaging. Ha filters made for deep-sky narrowband imaging should not be used for solar imaging. They work on the same principle of narrowband imaging but

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knowledge was lost when the Library of Alexandria was destroyed. How and why this great collection of books was lost is still a subject of scholarly controversy.

Six hundred years before the destruction of the Library of Alexandria, in 612 BC, a similar library was burned by invaders. This was the Royal Library of Nineveh, the creation of the king and scholar, Ashurbanipa. Ironically, in this case, the burning of this library served not to destroy the books, but to preserve them. Why? Because they were clay tablets, written in cuneiform. Cuneiform is not a language, but a writing system. It was created at least 5,000 years ago, changing with time, but still being in use around 500 BC. This date is significant for astronomers, because it was around this time that Greek civilization was flourishing, and cuneiform tablets provided early Greek astronomers with observational data that were used in the development—by Hipparchus of Nicea (c 180 BC) and later by Ptolemy (c 120 AD)—of mathematical models of the universe.


Artists's impression of Assyrian palaces from the monuments of Nineveh by Sir Austen Henry Layard, 1853

Agriculture began independently in different parts of the globe. In Eurasia, the Sumerians started to live in villages about 10,000 years ago, relying on waters from the Tigres and Euphrates rivers and a canal system for irrigation. What is especially significant for the purpose of this article is that this part of the world has very low annual rainfall, which in turn means that most nights are clear. Knowing when to plant a crop is a crucial step for agriculture, and the Sun, Moon and stars became the ultimate "Farmer's Almanac" in those ancient days.

Whoever designed the universe did not make it easy for us humans, leaving us with great puzzles that still preoccupy scientists. How convenient it would have been, for example, if the Earth took precisely 100 days to orbit the Sun, and the Moon took 10 days! Or even, and closer to reality, a year consisted of exactly 12 months, and each month had exactly 30 days. Amazingly, ancient Babylonian astronomers invented such an ideal system, and used it to very good effect. The ideal days are called "tithis" by science historians. Modern astronomers still talk about "mean" months and "mean" orbits. For example, a mean sidereal[1] month is 30.438030250333 days if we use the J.2000 sidereal year value of 365.256 363 004 days.

Reality is complicated, and humans still struggle to deal with the motion of the Earth in relation to the Sun[2].

It is most likely that humans across the planet relied on the so-called synodic events (like the first time Sirius rose just before sunrise) to help them plan their lives. But it was in the Mesopotamian plains that conditions were almost perfect for star gazers.

It is only since around the late 19th century that we have come to appreciate the work done by Babylonian astronomers. Before

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[1] A Sidereal year is the time it takes for the sun to travel to the same position with respect to the fixed stars. A solar year is the time for the sun to travel exactly 360 degrees through the sky. The sidereal is just over 20 minutes longer than the solar year.

[2] For example, in July 2020, the International Earth Rotation and Reference Systems Service announced that there would be no leap second on the last day of 2020. The Earth's rotation is not uniform, and these adjustments to official clocks need to be made based on observation: there is no exact closed model for the rotation of our Planet.

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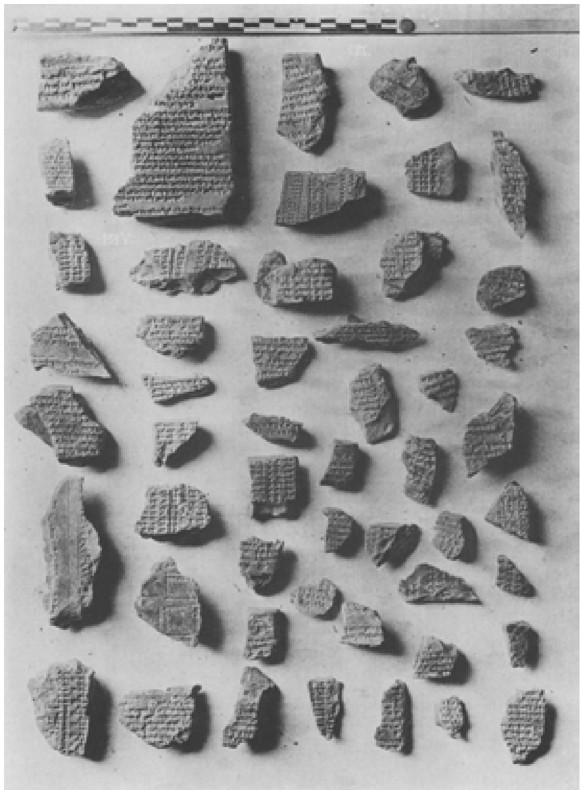
that time, we only knew about Babylonian astronomy indirectly, through references by Greek astronomers. For example, Ptolemy, in his magisterial work now known as *The Almagest*, refers to "three ancient eclipses which are selected from those observed in Babylon" (Book IV section 6). He gives specific dates for these eclipses, from which we can only infer that he had direct or indirect access to observational material from that time (approximately 760 BC, more than 800 years before he wrote *The Almagest*). Greeks astronomers also adopted the sexagesimal system and the idea of using a band of the sky called the Zodiac as a reference for all "synodic[3]" events.

Direct evidence of the methods of Babylonian astronomy can be said to have started around August, 1849 when the Great Library of Nineveh was excavated, and more than 30,000 fragments of cuneiform tablets were brought to the British Library. This was not the only repository of cuneiform tablets, but the scope of material available proved crucial to the difficult task of trying to understand cuneiform. The decipherment was aided by the use of the Behistun Inscription, found on a rock relief on a cliff at Mount Behistun near the city of Kermanshah in Western Iran, a city established by Darius the Great.



Cuneiform tablet fragments in the British Museum

This inscription is to cuneiform what the Rosetta Stone is to hieroglyphics. The inscription had been known to scholars for many years, but it was the Nineveh tablets that provided the depth of material crucial to the remarkable achievements of these scholars.

According to the renowned historian of ancient astronomy and mathematics, Otto Neugebauer, scholars were able to read most cuneiform tablets starting in around 1875. The translations were almost immediately mired in both excitement and controversy because of the appearance of stories related to the Bible, such as the flood story in The Epic of Gilgamesh. A Jesuit priest named Father J. N. Strassmaier decided that the best way to treat this avalanche of newly discovered ancient history was to make as much material as possible available for others. By this time there were tens of thousands of clay tablets in the British Museum collection. He suspected that much of the material he worked with might be related to astronomy, but that was not an area he was familiar with. He therefore recruited, to help him, Father J. Epping, a Jesuit friend who was teaching mathematics and astronomy in Holland. After much effort, they published the first book on Babylonian astronomy in 1889. This was the beginning of a fruitful period of study of this subject. Following their work, other researchers included material from many other sources, now housed in collections in many major cities around the world. This culminated in a monumental book undertaking by Neugebauer, which he called *Astronomical Cu-*

[3] A Synodic event is used most broadly as some kind of astronomical event that is repeating. Usually conjunctions, but also, for example, "stations" - the date and time when a planet enters or exits its retrograde motion.

neiform Texts. This remarkable book, completed in 1955, is still available from Springer-Verlag. It includes detailed technical analysis of all the cuneiform tablets that were known at that time to be mathematical astronomy.

Since then, work on these sources has continued. For example, he most recent book in my collection, *Babylonian Mathematical Astronomy: Procedure Texts* by Mathieu Ossendrijver, was published in 2012.

What is in these ancient clay fragments that is so fascinating to modern scholars?

A portion of the Behistun inscription

There are three types of astronomical cuneiform tablets. The bulk of these are "diaries," basically recordings of specific observations. The most interesting tablets, though, are the tablets illustrating mathematical techniques. These are either synodic tables or so-called procedural tablets—in modern terminology, algorithms for computing astronomical events. These particular tablets come from archeological sites in Uruk and Babylon—both in Iraq. They date from around 450 - 50 BC. These dates are very significant because they coincide with the rise of Greek astronomy and, of course, with the conquest of Babylon by Alexander the Great in 331 BC. It is likely that it was at this time that Greek astronomers were exposed to the methods of the Babylonians, including the sexagesimal number system mentioned in the introduction.

The mathematical tablets comprise an estimated 5% of all astronomical cuneiform tablets, but have provided scholars with insight into the remarkable achievements of the Babylonians.

I hope to explain some of this in a future article. But I would like to highlight one piece of information which I found fascinating, because of its relevance to computer programming (which is my specialty). The Babylonian procedural texts of course used arithmetic operators (like addition, subtraction, multiplication). But they used multiple terms for these operators to distinguish between operators that were used to compute a value, and those used in the modern algorithmic sense of assignment. Thus if the Sun was at position A at time t, but moved D degrees in a certain period of time, then its position would be A <> D where I am using the symbol <> in the sense of assigning a new value to the variable A. This blew me away when I realized what it meant.

Strangely, modern scholars are not certain what the purpose of Babylonian astronomy was. There is some evidence that it was used as a kind of Astrology, but the level of detail and sophistication is much broader than this. Furthermore, a fascinating part of their work is their use of series and interpolations based on ideal mean periods rather than observations, and yet with remarkably good predictive results. Furthermore, there is a notable absence of any use of geometry, even though geometric techniques such as the so-called Pythagorean Theorem have in fact been found on cuneiform tablets.

Like our ancient Babylonian colleagues, we astronomers are travellers in space and time, exalting in the wonders of the universe and using our imaginations to make sense of the wonders of the sky. ✸

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are not safely interchangeable. An H-Alpha scope or filter will let us see the Sun's chromosphere in all its turbulent, scorching glory. We can see roiling, granular spicules; filaments which appear like great dragons flying over the solar surface; sunspots which are dark, colder areas of the Sun where convection has stopped; and the star of the show, the prominences, which are massive plasma filaments reaching out into space like Leviathan's tentacles from the sea. H-alpha filtration will give us the most dramatic and exciting views of the gigantic nuclear fusion reactor in the sky, named Sol.

H-alpha filtration comes in two formats, filters and dedicated telescopes.

The filters, such as Daystar Filter's Quark are a bit pricey at $1500 CAD, but can be used with the telescope you already own—ideally, a refractor that is between *f*/4 and *f*/8. The Quark eyepiece contains a 4x Barlow filter. To create a full disc image of the Sun, the telescope's focal length should be below 450mm.

For non-refractor style scopes or refractors with apertures over 80mm, it is recommended to add an external energy rejection filter (ERF) to stop your scope from turning into a giant magnifying glass and frying your camera sensor or eyeball like an ant.

The combined price of the ERF and Quark puts you in the same price range as a dedicated 90mm H-alpha telescope, so the choice becomes more difficult. There are a variety of scopes available from Lunt, Coronado, and Daystar Filters that all offer a straight-out-of-the-box H-alpha solution that can handle both visual observation and photography with ease.

In my case, I went with Daystar Filter's Solar Scout DS 60mm telescope ($1000 CAD). This is the most affordable way to get into viewing/imaging the Sun in H-alpha as it is a 60mm telescope with a Quark filter built-in. It comes with the additional benefit of mimicking a "double stack", which is when solar telescopes stack two H-alpha filters to make them extremely narrowband in order to resolve the Sun's most elusive details. That is a lot of bang for the buck, as a single stack Ha filter will cost about $1500 without the telescope! Like all telescopes, aperture is king, so as you move up to larger aperture scopes, the prices will also soar… astronomically. Sorry!

So you've pulled the trigger and your new scope is on the way… remember to hide the credit card bill from your significant other! (She found out eventually. They always do. Usually when the telescope arrives.)

Next up, you will need to track the Sun in order to view or image it. If you already have a tracking mount, check its specifications, as most mounts have a solar speed built in. Precise polar alignment is not as important in solar imaging.

I did my first sessions with the entry-level SkyWatcher Star Adventurer tracker and it worked well. I then purchased a SkyWatcher Solar Quest mount because it is able to find and track the Sun by itself… and also because I tend to spend every last dollar on astrophotography equipment. It is a problem! Help!

Once you have your tracking set up, if you're a visual observer, you can place your favourite eyepiece into your scope and you will be able see to the solar surface like you never have before. You will likely curse under your breath in disbelief and amazement!

For imaging and electronically-assisted viewing, I recommend a dedicated astronomy camera, preferably monochrome. Your images will be black and white, but you can add the scorching warm tones back in when you edit. DSLR and mirrorless cameras do not work well for solar imaging as they are not sensitive to Ha light. Cameras like the ASI 1600MM or 183MM work well for capturing full disc images.

If you already own a guide scope and camera for auto guiding, it may also be great for shooting close-up images of the Sun. In my case, I use an ASI 183MM Pro for full disc images and an ASI 290MM for close-up images. The 290mm scope is a very common guide scope, and mine performs triple-duty as a guide cam, solar cam, and lunar cam.

Another very popular choice for solar imaging is the ASI 174MM. It has a global shutter and shoots at an extremely fast frame rate which will be helpful during our next step in the imaging process: acquisition.

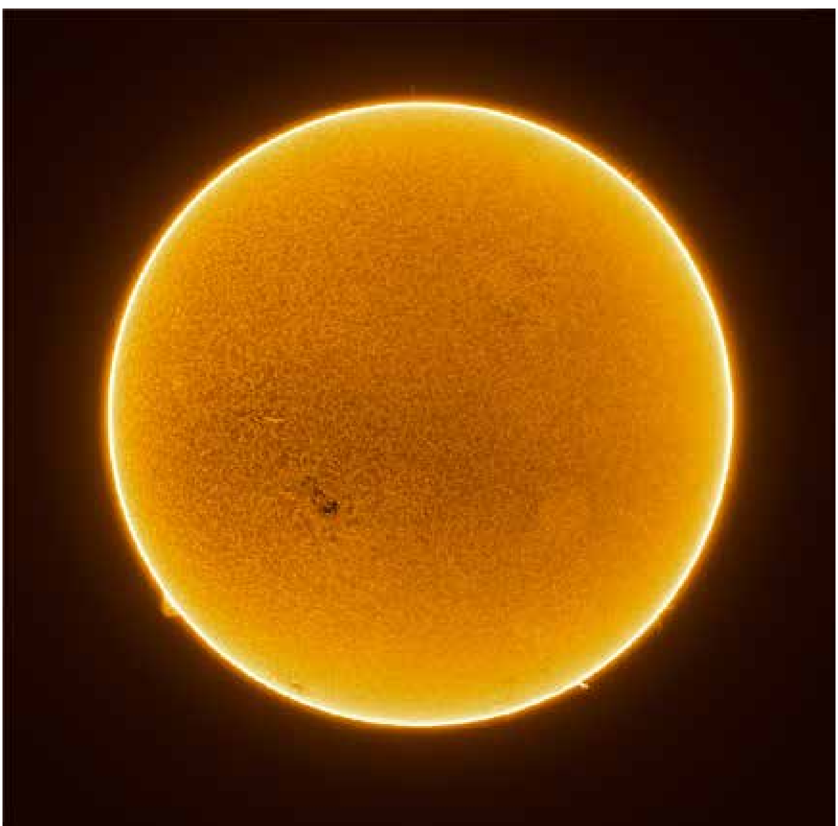
To complete your solar images, you will need various software programs. I will outline the basic steps and suggest some software apps, most of which are free. You can use those as a starting point for your research.

It seems counter-intuitive, but to shoot a photo of the Sun, we actually have to shoot a video! If you have done planetary or lunar imaging then you will be familiar with the concept of "lucky imaging." Due to atmospheric turbulence, the Sun waves around on the screen, distorting the image. However, for a few frames every second, we get "lucky" moments where the Sun appears razor sharp. These are the frames we want to use and this is why a high frame rate camera is ideal for solar imaging.

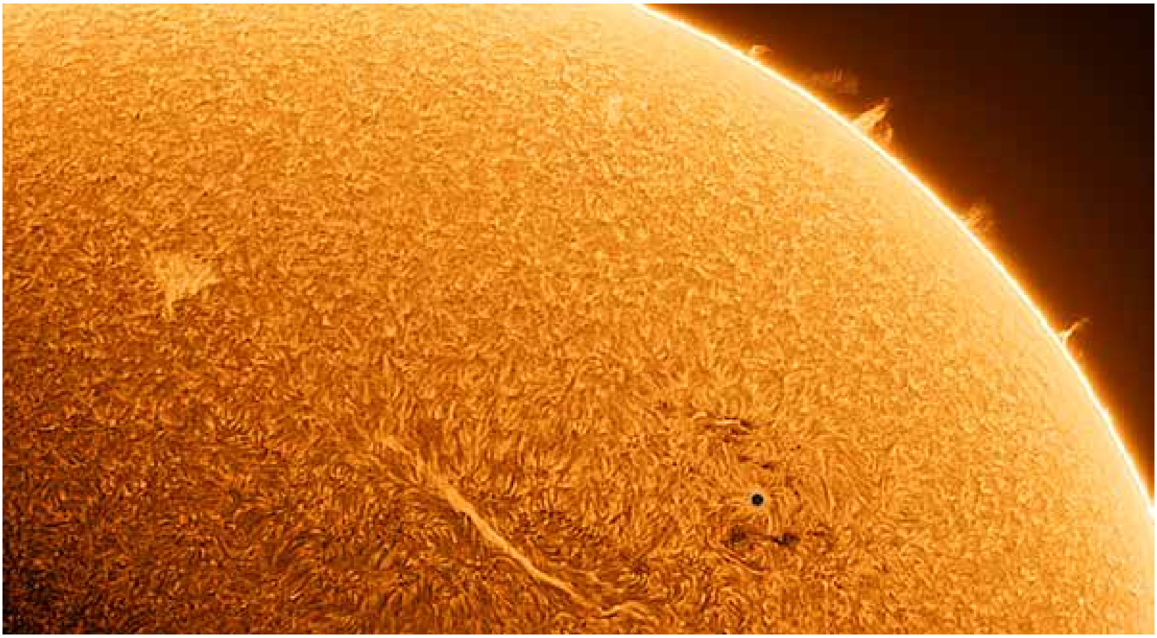
Start with software like Fire Capture, Sharp Cap, or ASI Cap on your laptop or computer to shoot a short, ten-second video of the Sun. Next, use an application called Autostackkert! to analyze the video, pick out the sharpest frames, and stack them together into one super image. To sharpen the image, try applications like Registax or ImPPG. Finally, import into Adobe Photoshop to play with curves and noise reduction, and to add those reds, oranges, and yellows to our amazing new photo. Did I say this was going to be easy? I guess I lied! Sorry, again. Look up "Woodland Hills Solar" on YouTube and Simon will take you through all of this step-by-step in a calm, British accent. It can be easy! If you can do night imaging, you can definitely do solar imaging!

I hope you found this an insightful introduction and will consider doing solar viewing or imaging on your own. You may be overwhelmed by gear and technical specs, but please take my word for it that once you give it a go, you will soon find that solar imaging is actually easier than most astrophotography. The beauty of solar imaging is that you can practice every day and no two of your images will ever be the same. If you have questions, please feel to reach out from one beginner to another and I will be happy to chat! Clear skies!

rob@supercreative.ca ✸



A full-disk H-alpha image of the Sun taken with the Daystar Solar Scout described in the article. Prominences are visible around the edges of the disk along with the detailed chromosphere on the Sun's surface, including a pair of sunspot complexes in the lower left quadrant (one near the centre and the other near the edge).



The Sun by Robert G. Lyons

Images of the Sun taken through a Hydrogen-alpha telescope. Taken on June 2 (below) and June 21 (above), the images show the turbulent chromosphere and some prominences along the edge of the visible disk. The above image also shows some filaments above the surface. Daystar Solar Scout DS 60mm scope with ASI 290MM camera.