ASTRONOMICAL SOCIETY

Reflections

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President's Message

Happy New Year to you all and welcome to what I hope will be a very prosperous year for you and the Society.

2015 was not a year we will fondly remember weather-wise, as it seemed the clouds were quite keen to hang around every new-moon observing weekend.
In addition, both our proposed Linden Observing weekends with WSAAS had to be cancelled yet again due to poor weather.
So we say to 2015: adieu and, well...sorry, but good riddance. Here's hoping for clear skies in 2016.

The Society finished off the 2015 year with a fantastic Christmas BBQ at St Ignatius College.
There were over 60 members present to enjoy another excellent day.
Notwithstanding a forecast indicating a 90% cloud cover, Lawrie, forever the optimist, nevertheless brought along his solar scopes so that a lucky few could squeeze a quick 20 minutes of observing in after dessert.
Every bit counts when you've had that bad a year. Many sincere thanks to John, Bruce, Julie and Ross for all their hard work on the day.

It is an exciting time to be a part of the Society and there is a lot to look forward to this year.
New memberships have surged these past two years. Numbers at all our events are up which is encouraging.

Of even greater encouragement to me is seeing the number of people coming forward and getting involved in many different areas.
Can I take this opportunity to extend a special welcome to those new members who have joined the club over the past year, it's great to see so many new faces.
As a word of encouragement and advice: make sure to plan time for your hobby.
The more you get involved the more you will enjoy it and the more you will realise there is a lot the club and its members can do to assist you: our library contains all sorts of resources to assist both the beginners and the more experienced, guest speakers once a month, observing nights (and days), the new astronomers group and the likelihood of a new astrophotography group commencing in 2016.
Come along, meet people, make connections, find "veterans" who can guide you, educate you and share with you one of the most amazing hobbies there is.
Get involved, you won't regret it.

There has been a lot of interest expressed in the club organising a field trip this year.
Not only for some dark sky viewing nights, but also a trip to one of the countries professional observatories.
I am keen to ensure we do both. So stay tuned for details.

Many of you may not be aware that the Society was formed in 1986 primarily at the time to coincide with the passage of Halley's comet through our skies.

Of course this means that 2016 is the 30th year of the club's existence.
It is a testament to the Society's members and public officers that their ambition, enthusiasm and dedication see it as strong as it has ever been entering this significant milestone year.

A final word on our club's oracle, our very own "Reflections".
This periodical not only graces the inboxes or desks of our members but our city's public libraries as well.
Reflections has had a long history of many very fine astronomical and scientific literature and articles, stories and educational guides.
Can I encourage members to continue to add to this history with your contributions, and let's make 2016 a banner year.

Gordon Ogborne

In this issue

Page 1: President's message
Editorial
Page 2: Calendar/Communications
Travels across Persia
Page 3 How to get some (eye) relief
Page 4: Our Aerial Ocean (Part 2)
Page 6: Astrophotography 101 (Part 3)
Page 8: The Sun's weight-loss diet
Page 9: Notes on Iceland
Page 10: Xmas BBQ in pictures
What to expect in 2016

May I wish you all a happy new year and I do hope you have enjoyed these holidays.
In Sydney 2016 was ushered in by the "best-ever" fireworks and, similarly, Reflections will start this year with its own fireworks: for the first time ever, at least since I've taken over this editing position, I've been able to put together a 10-page edition. No that's not a misprint it is ten pages.
So, thank you to the contributors who made it possible.
I just hope that this not just a flash in the pan and that we'll be able to continue on this same path for the future editions.
As you have come to expect, you will find in this issue an eclectic mix of articles, from travel accounts to more technical pieces and, if you were not able to attend our Xmas BBQ, go to the last page to discover what you missed out on.
Cheerio,

Jean-Luc Gaubicher

Calendar

General Meetings:	February 16th	Speaker: Professor Charlie Lineweaver - Habitable planets and the Gaia theory
	March 15th	Speaker: TBA
NAG Meetings:	In Recess. To resume later in the year	
Observing Nights:	Consult NSAS' web site at http://nsas.org.au/observing/	
Solar Observing:	First Sundays of the months	
Deadline:	Please send your contributions to the next issue of Reflections in time to reach the editor **before March 15th** to nsas.editor@ozemail.com.au	

Travels across Persia

Astronomy is rarely far from my mind and while in Iran recently I came across two uses of astronomy that I thought interesting.

Our tour crossed the great Iranian Plateau, located down the centre of the country, roughly north to south, and we followed the old Persian trade routes that have connected eastern and western civilisations for millennia. Trade networks criss-crossed this vast area and merchants travelled for days taking their cargo of carpets, silver, gold and turquoise, silk, minerals, copper and tin and much more to the trading towns along the main trade routes.

These merchants often travelled through some of the harshest, driest areas on Earth, across deserts and salt-lakes, and also across some of the hottest areas in Iran where temperatures are regularly above 40° C in summer.

Our visit included the trade route from Kerman to Yazd that Marco Polo visited in 1272. In the book The Travels of Marco Polo, he commented:

The desert region near Kerman
Photo Credit: Christina Bunbury

"…you leave this city (Yazd) to travel further, you ride for seven days over great plains, finding harbour to receive you at three places only… At the end of those seven marches over the plain, you come to a fine kingdom which is called Kerman".

Kerman is one of a number of oasis trading centres that border the Lut Desert, a vast desert region of Iran. It is one of Iran's oldest cities and once the staging point for traders passing between Persia and the Indian Subcontinent. It was here that we saw the first of several "caravanserai", roadside inns where caravaners (travellers) could rest during the day or night and they were essential in supporting the flow of trade, information and people across these trade routes. Most of these caravanserai are now in ruins but some have been restored.

Near Kerman 2 minarets similar to those used as beacons
Photo Credit: Christina Bunbury

To avoid the scorching heat during summer, travel between these caravanserai (every 30-50km or so apart) would mostly be done at night.

To get lost in these conditions would be catastrophic and night time in the desert was, and still is, very, very black, except for the sky with its millions of stars.

From early times, therefore, astronomers accompanied the caravans, using their knowledge of the stars to guide the camel drivers to the next caravanserai, or towards a beacon indicating the existence of a mosque, which in turn meant a trading town, a caravanserai, an hammam (bath house) and a bazaar.

The beacon I've just mentioned was a flame burning on the tall minarets high above the surrounding landscape. Minarets in those days had practical use and weren't simply the place for the muezzin to call the faithful to prayer.

Astrolabe sculptures seen in the middle of large roundabouts in a number of Iranian cities and towns are more evidence of the use of astronomy in Iran.

Given the high profile of these placements, I assumed the astrolabe must have been very important to Persians, and indeed it was. In the Islamic world the astrolabe was once used to find the qibla (the direction of Mecca) and hence the direction that Muslims should face when praying, which was very important when building and positioning a new mosque or simply to know the direction for prayer.

Not only that, the astrolabe was used to find the times of sunrise and the rising of the fixed stars to help schedule morning prayers.

It's interesting to note that an astronomical text called the Book of Fixed Stars was written by al-Sufi, a Persian, around 964CE. It was based on Ptolemy's classical work, the Almagest, written around 137CE.

Mosque and minarets in Yazd
Photo Credit: Graham Nicholson

Wikipedia tells me al-Sufi's book was thoroughly illustrated along with observations and descriptions of the stars, their positions, their magnitudes and their colours. Al-Sufi's results were set out constellation by constellation.This work was highly influential and survives in numerous manuscripts and translations.

It contains the earliest known descriptions and illustrations of "a little cloud", which is actually the Andromeda Galaxy, and has the first recorded mention of the Large Magellanic Cloud.

18th century Persian Astrolabe
Source: Wikipedia

These were the first galaxies other than the Milky Way to be observed from Earth.

Perhaps the astronomers guiding the caravans used this book.
One can only guess.
Al-Sufi also described over 1,000 different uses of an astrolabe in areas as diverse as astronomy, astrology, horoscopes,

A restored 16th century caravanserai
Photo Credit: Graham Nicholson

navigation, surveying, timekeeping as well as calculating the qibla, and times for prayer.
The first geared mechanical astrolabe was later invented in 1235 in Isfahan, a major city on the trade route north of Yazd.
The lunar crater Azophi and the minor planet 12621 Alsufi commemorate al-Sufi's achievements in astronomy.
Persian astronomy seems to have had a long and active history.

Josephine Lindquist

Sources:
wikipedia.org/wiki/Book of Fixed Stars
wikipedia.org/wiki/Abd al-Rahman al-Sufi
www.atlascoelestis.com
eprints.jcu.edu.au
Two Wings of a Nightingale: Persian Soul, Islamic Heart by Jill Worrell

The inner courtyard of the caravanserai.
Goods were traded on the raised platform
Photo Credit: Christina Bunbury

How to get some (eye) relief

NSAS members have emphasised that, for comfort and good viewing, correct eye relief is important.

What is eye relief?
Simply the distance between the last surface of the eyepiece and the pupil at which the viewer can obtain the best viewing.

If the relief is not correct it may be uncomfortable on the eye and its socket and the image may be subject to vignetting. (Obscuring of the image on the fringes)

An excellent discussion on the topic can be found on Nikon's website.
→Nikon.com
→Products and support
→Sport optics guide binoculars
→Basic information about binoculars
From a well-respected optical equipment manufacturer and just remembering that a telescope can be considered as half a binocular.

If the eye relief on your equipment is not correct there may be an easy way out.
I have a pair of 7X50 Porro prism binoculars which need to be held out a little from my eyes to get a good view.

I found at Bunnings hardware store some clear plastic tube joiners of 32mm internal diametre (Pic 1)

Pic 1

They were easily cut to length over a broom handle as support and a razor sharp craft knife (Pic 2)

Pic 2

Just the right ID to slip over the eyepieces and hold firm (Pic 3)

Pic 3

Works on a 'scope eyepiece too (Pic 4)

Pic 4

Cost? $2.05

Graham Nicholson
All pictures by the Author

Our Aerial Ocean (Part 2)
Rambling reminders of the "sea" we live in.

A term with a long history in Astronomy is 'syzygy'.
It was not invented by Scrabble fanatics who are bent on scoring in straight lines! Three celestial bodies are said to be in syzygy if they are in a straight line. Since student days where I learned that 'street' was derived from 'straight', I have wondered how light travels down Sydney's CBD thoroughfare called Bent Street.

Eclipses require straight-line situations.
Surprisingly, Collins Dictionary of Astronomy allows a syzygy as 'approximately' in line so the Editor includes all oppositions and conjunctions with eclipses.
We all know that a lunar eclipse requires the Earth to be in between the Sun and the Moon so we would not expect both Sun and Moon to be visible during such an eclipse.
Enter atmospheric refraction!
Atmospheric refraction is zero at the zenith and a bit more than half a degree at the horizon.
The light path in the latter case is concave towards the centre of the Earth so the observed position of the source is above the actual geometric position. Coincidentally, the angular diameters of Moon and Sun are also close to half a degree so when these bodies are in syzygy, it is possible for them both to be above the observed horizon!
Unexpected and rare, we can have a 'horizontal eclipse'.
Word experts offered 'selenehelion' and 'selenelion' based on the Greek names 'Selene' for the Moon and 'Helios' for the Sun.
The shorter one is easier to say and is mostly used by those who think 'horizontal eclipse' is somewhat enigmatic.
There are two possible ways that selenelions can occur. In one case the Sun is about to set and the Moon to rise and vice versa for the other.
I expect that observers at antipodal points should be able to view the same horizontal eclipse at the same time but with the Sun rising for one observer and setting for the other.
The official length of daylight hours is affected by the definitions of sunrise and sunset.
Both are determined by the Sun's upper limb reaching the observed horizon, not the leading limb and not the centre. Both the lunar and solar discs look slightly flattened near a horizon, again an outcome of atmospheric refraction, so they have no geometric centre there.
The same daylight increments apply to the Earth's antipodal point so some of the increments to daylight hours are counted twice.

This puts "paid" to the oft-heard statement that at the equinox, all positions on Earth have day and night of twelve hours each.
We have to rethink the crazy word 'equinox' which really only means 'the night is equal' without saying what it is equal to. Back to the dictionary!
An equinox is not a day or anything else with duration. Rather, it is one of two positions of the Sun as its path crosses the Earth's orbital plane.
Our primary schooling said it involves the Sun being overhead at Noon on the equator when the Sun is crossing it, which can be North to South or the reverse
There are two annual but instantaneous crossings that alternate on a regular basis but the calendar dates can vary because of our superimposed pattern of leap years.
Alternatively, equinoxes can refer to the actual instants of those crossings and if this should cause any confusion, the crossing points are referred to as equinoctial points.

The atmosphere imposes its own terms and conditions on all electromagnetic rays that traverse it or attempt to so this applies to visible light too.
The components of visible light can be absorbed differently especially by smoky or dusty conditions and the higher rates of transmission for the red end of the spectrum give us our spectacular sunsets.
Light is scattered differently to a degree dependent on the wave length with the blue end being most affected and responsible for our blue skies.
Dispersion or spreading by differential refraction give us the elusive "green flash" during sunset.

Refraction can occur at any sudden change in a medium that changes the velocity of propagation.
Even the atmosphere can produce refractions where there are layers differing in temperature.
Mirages and shimmering effects are the results.

Mirage at Great Salt Lake
Photo Credit: Wikimedia Commons - Jay Galvin

However diffraction is not related to any of the effects noted above and occurs when light meets a sharp edge, a fine wire or hair, the edge of a hole or the lines of a grid.
For light entering a telescope, diffraction is an enemy that can give a stars a superimposed cross.
In contrast, a diffraction grating, a fine parallel grid, can spread the light coming out of a telescope into a spectrum, albeit with gaps caused by the atmosphere of a star. Where would we be without spectroscopy?
Similar effects can be seen on recording discs, special security printing: e.g., on NSW driving licenses.
Coloured oil films on water are the result of 'interference' which does not involve the atmosphere.

Rainbows are optical effects related to water droplets condensed on dust particles in the atmosphere.
For a rainbow to be seen, the Sun must be behind the observer and some falling rain must be in front.
Refraction of light entering and leaving the droplets is responsible for the colours but some reflection must occur within the droplets, one for the primary bow.
The colours are impure especially for the secondary bow and neither bow matches a true spectrum.

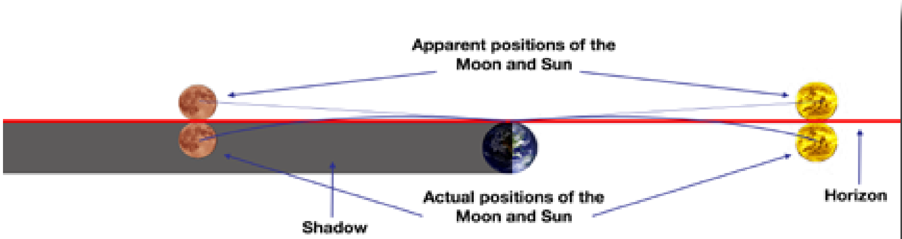
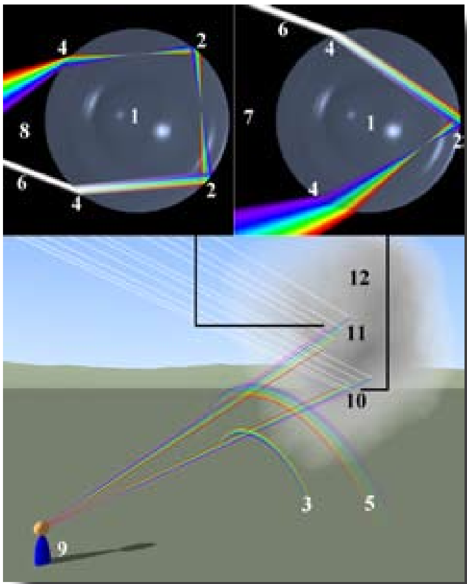


Diagram by Jean-Luc Gaubicher

With fine rain and good sunlight, the secondary bow can be seen outside the primary bow and 2 reflections are involved, as the order of the colours is the reverse of that in the primary.
The theory of the angles involved requires assumptions about the shape of water droplets. The finer the drops, the more nearly spherical they are as larger drops are flattened to a degree by atmospheric resistance.
The observer's head, if in sunlight, would have a shadow in front where the sunlight would otherwise have fallen: this direction is called the anthelion meaning opposite the Sun.
The rays of each wavelength received by the eye bear a fixed angle from the anthelion so the rays of that colour appear as if coming on part of the surface of a circular cone whose vertex is in the eye.



Legend:
1-Spherical droplet
2-Places where internal reflection of the light occurs
3-Primary rainbow
4-Places where refraction of the light occurs
5-Secondary rainbow
6-Incoming beams of white light
7-Path of light contributing to primary rainbow
8-Path of light contributing to secondary rainbow
9-Observer
10-Region forming the primary rainbow
11-Region forming the secondary rainbow
12-Zone in the atmosphere holding countless tiny spherical droplets
Source: Wikimedia Commons Søren Peo Pedersen

As this applies to each wavelength but with slightly different angles, but all about 42 degrees for the primary bow, the shape of each bow is that of a circular arc and each bow is a particularly personal phenomenon!
If viewed from a plane in flight or from the top of a waterfall, including the fine spray from your hand-held garden hose, there can be a complete circle.
When two rainbows are present, the area of sky between them can take on an unexpected colour different from elsewhere.
This area is named "Alexander's Band" after the first person known to have recorded it back in about 400 AD, which was well before Alexander's Ragtime Band of some musical repute.
Current explanations for the Alexander's Band involve the solar corona so the band may depend on an extra-terrestrial atmosphere.

Alexander's Band
Photo Credit: Wikimedia Commons Gnangarra

The most enigmatic colour effects from our atmosphere owe existence to ice crystals at very great heights.
Noctilucent clouds are night-shining clouds in the mesosphere, the third layer up. Why were they once attributed only to ice crystals formed on dust from volcanos and rockets?
Because they were first recorded shortly after the Krakatoa volcanic explosion and another one was observed soon after the launch of SpaceX Falcon 9.
It seemed that, over the following few years, they were on the increase and one regular observer suggested that they were like "miner's canaries" warning us against climate change.
It was eventually shown to be a simple matter of 'more looking, more seeing'. Current belief is that the tiny ice crystals at that height are shaped like either hexagonal plates or hexagonal blocks.

Both internal and external reflections are expected and, for every medium change, refraction with dispersion produces the colour effects.
Unfortunately for Australian locations, these and other special high-altitude effects are typically seen between 50 and 70 degrees latitude North or South.
We would waste our time expecting to see them from NSW.
Most of the web images come from Europe where 'sundogs' or 'parhelia' and a variety of arcs are often observed.

No article about our atmosphere should only have a token mention of the winds so … I offer an old saying," 'Tis an ill wind that blows no-one good" and Danny Kaye's arrangement in reference to a particular wind instrument, " 'Tis an ill wind that no-one blows good".

Enjoy your own personal rainbows and keep rain away from viewing nights.
Bob Roeth

Noctilucent clouds as photographed by the crew of the ISS
Photo Credit: NASA

Astrophotography 101 - 3rd Part

Reaching the limits of your current equipment.

Welcome back to the third edition of my "Astrophotography 101" column.

I hope you enjoyed the first 2 articles and, more importantly, learned something interesting from it.

Following on from where I left it, I'd like to now go into some more detail on advanced techniques and equipment.

Whilst we will still cover quite a broad range of topics in this edition, the following editions will then form the "deep dive" to further explore specific elements of this complex hobby.

Specialised capture software

One of the applications I've grown to love in 2015 is "Sequence Generator Pro", which is a fully automated capture software for Astro Imagers.

It can even be used for dome control for the real enthusiast, even by some professional observatories, I believe.

Sequence Generator has a number of modules that you can license and is indeed a very powerful tool.

Amongst other you can do the following:

- Create capture profiles of targets you want to image with simple or complex sequences
- Connect your camera (many types and models supported) and control/store/capture
- Connect your telescope via ASCOM drivers and manage full telescope control in PC Direct Mode (a Skywatcher term, it might be different with other mount brands)
- Integrate a Plate Solver and resolve any image you've captured or want to capture. This is a very handy function to identify where the telescope is pointing at (synchronise your mount via ASCOM) and to plate solve targets fully automatically. I run automated mosaic capture with this function.
- Use the Mosaic/Framing Wizard module to create and capture complex mosaics or simply frame your target in the best possible way.
- Control automated flat field boxes, automated focusers, automated camera rotators, automated filter-wheels, telescope dome, etc …

SGP is, yet again, another costly software, hundreds of $s, and you need to carefully consider whether this is required considering your level of expertise.

I had a massive learning curve and only after more than 6 months of using it can really say "I've got the hang of it".

DIY improvements to your equipment

There are many ways in which you can improve your astrophotography equipment.

Some are costly and others aren't.

Most of them will consume few or a lot of your time and some of them might be beyond your skill level, commitment to invest time and dedication to "pull it through".

I have done a few of such, which I'll list out below.

I might go into more detail on some of them in a later edition of this column.

Building a Light Box for Flat Field Frames

This is actually easier than most people would think.

It requires a bit of art and craft material ($20 - $30) and some moderate skill in assembling it all together (Pics 1 & 2).

I've previously written a detailed article on how to do this. It can be found under the following link: http://universeforeveryone.com/space-blog/entry/2-space-blog/13-how-to-build-a-lightbox-for-flat-frames-in-astrophotography

Pics 1 & 2

Flocking the telescope tube

This is a bit trickier as it requires disassembling the whole telescope tube. Note this only works for a Newtonian/Dobsonian telescope as all other telescope types are closed up and you can't open the interior. I've yet to type up a detailed description on how this works so will have to post this with one of the next editions. (Pics 3 & 4)

In short though, it requires the following steps.

- Order Protostar flocking material (for example from here: http://www.fpi-protostar.com/hitack.htm)
- Carefully disassemble your telescope tube by first taking the primary mirror off the back. Be extremely careful with your main mirror. Dirt, to an extent, but mainly scratches are a real deal breaker as your primary optics needs to be as perfect as they can be for good quality imaging.
- Unscrew the focuser, the finder scope mount, as well as the secondary mirror. Again, be extremely careful with the secondary mirror too. Don't let it drop. Only disassemble the tube in a horizontal position so nothing can accidentally drop onto the main mirror at either stage.

Pics 3 & 4

- Apply the flocking material to the inside of the tube.
- Reassemble everything in exactly the reverse order from when you've taken it apart.

Note: It's going to be tricky to re-align the secondary mirror to the main mirror again. I recommend you research this thoroughly before even attempting this modification.

Replacing the Allen key screws to collimate the secondary mirror with Bob's Knobs

This is probably the simplest but one of the most important modifications you can make! (Pics 5 & 6)

The Allen key screws that hold the secondary mirror in place are usually, unless you spend a lot of money on your telescope, of poor quality and give you grief when doing your collimation in the field.

Collimating the mirrors is such a vital thing to do that if you don't yet know how to do it right, practice this before you attempt anything.

Without proper collimation your images will show misshaped stars all over the field, which would be a real disappointment.

And Bob's Knobs will help you with that.

A simple change and something all telescope manufacturers should've long since included in their factory default, no idea why they don't!

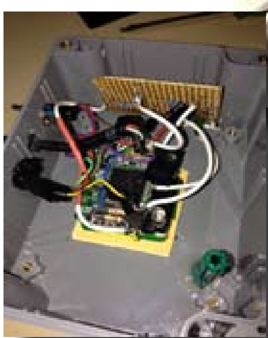
Check out Bob's Knobs here (http://www.bobsknobs.com/Newt/page66/SWdob.html) and you'll know what I mean (© picture insert is from Bob's homepage).
You replace the old Allen Key screws with the Bob's Knobs which you can simply turn by hand. No need for a tool anymore, so much easier to collimate in the field.

Pics 5 & 6

Cooling the main mirror with a PC fan
This is another super easy modification.
All you do is attach a PC fan to the back of your main mirror cell, I used rubber bands to strap it in between the collimation screws, this dampens most vibrations so to not impact imaging quality. (Pics 7 & 8)
A fan will help you cool your main mirror quicker to keep up with the dropping ambient temperature.
The main mirror is a hefty piece of glass that changes temperature much slower than other material, certainly compared to the ambient air, hence it's a good idea to put your telescope out before dark, turn the fan on for a little while so to help the main mirror cool down. This will improve your image quality a bit.
I normally don't run it throughout my imaging sessions for the fear of residual vibrations shaking up my pinpoint stars, though that fear might not be justified.

Pushing the main mirror further into the telescope so as to change the focal point
From here on in it gets harder. I wouldn't recommend this modification to anyone without proper preparation and skill.
In some cases it is hard to achieve focus with a Newtonian depending on your camera, filter wheel and potentially other equipment such as focal reducers.
Moving the main mirror further up the tube can help achieve focus again. There is a simple method that I used where you replace the main mirror-cell standard screws with extended (longer) ones so to push the mirror further in.
However, this only does a little and if you need more back focus then you'd need to cut the tube shorter and move the mirror up a proper distance.
Note: This is one of those "crazy" modifications that you'll only do when you have to ☺. I hadn't gotten to that point yet but I'll report out to you in case I ever get there.
Plenty of negative side effects can happen here so find someone who's done this mod before you attempt it.

Peltier cooling a Philips SPC900NC Webcam
Again, this mod is "a bit crazy" so not necessarily recommended ☺. (Pics 7 & 8)
If you happen to have such a webcam that is modified for long exposure and you can't/don't want to afford a dedicated CCD camera, this modification might be useful for you.
I've built a completely new housing for my webcam (Picture 3) and attached a "cold finger" onto the back of the sensor chip.
This cold finger is connected to a Peltier cooler which get's extremely cold on one side and very hot on the other.
With a massive fan on the hot side I dispersed the heat and hence cooled down the camera successfully. I managed to get it down to 15 degrees below ambient which was really



Pics 7 & 8

powerful for a home-made cooling function ☺
Of course there are other issues that come with this sort of modification hence I might write up a detailed "How To" and provide you the link in one of the next editions.

Dedicated Astronomy Cameras
This is a topic worthy further exploration. In fact, I doubt I can cover much ground here hence will make this a special deep dive topic for one of the next editions.
Dedicated Astro Cams, aka cooled CCD Cameras, are a huge step in regards to Astrophotography.
They provide two major benefits:
- Sensor cooling
- Increased sensitivity

Whilst cooling is important and very beneficial to reduce noise in your images, the increased sensitivity of the CCD chip is the real deal.
Where I had to take 4-5 minutes long exposures with the DSLR, I now have to only capture for about 30 seconds to achieve the same result. This means I can take a lot more images in the same period of time, which further reduces the noise through stacking techniques.
Also, whilst these CCD's have very low noise already, as well as being cooled down significantly, the heat generated in any sensor over 30 seconds is vastly lesser than in 4-5 minutes on a DSLR anyway.
Without a doubt a cooled CCD camera will provide huge benefits over a DSLR.
The choice of the right CCD camera though is as important, if not more so, as the choice of the right telescope.
These two go hand in hand and need to be paired strategically for specific outcomes.
In the world of imaging, a couple of concepts are of importance:
- Field of View
- Image Scale

The Field of View (FoV) determines the amount of sky you can see through your optics.
The image scale determines how much of the sky you can fit into one pixel of your camera sensor.
Both factors depend on your telescope as well as the specific camera you chose.
In general this means that a telescope that gives a greater image scale also gives a smaller field of view and vice versa.
This is rather complicated and warrants a fair bit of thinking and calculation should you consider going down this route.
It mainly depends on what you're trying to achieve with the resulting images.
If you have a small camera sensor but want to capture a fair amount of sky in one image, you should choose a telescope with a short focal length, e.g. around 400mm.
If you however want to capture a detailed image that is larger on a screen and yields better results when printing, you should focus on improving, decreasing in this case, your image scale, which means larger camera sensor with more pixels. That will increase your resolution on a given telescope.

Time for questions
After three editions of rather broad brushes across the landscape of Astro Imaging, I will from now on need to focus on and dive in some more specific topics.
I will dedicate each future column edition to one topic for a deep dive and maybe some Q&A.
You can help shape what will be talked about!
Please email me at universeforeveryone@gmail.com if you would like to suggest topics for one of the next editions or in case you have specific questions you like answered.
Thanks for your interest and participation.
Until then,
Hoping for some clear skies soon!

Mathias Sorg
All pictures by the author
Except Pic 2 by Murray Wilkinson

The Sun's Weight-Loss Diet

We know that the Sun is busily fusioning hydrogen into helium.
This resulting by-products of this process, mainly the helium nucleus, weigh less than the 4 hydrogen nuclei necessary to get that helium nucleus.
Mass has been lost and it is this lost mass that has been converted into energy.

So, how much mass does the Sun loose in this process?
The famous Einstein equation E=mc2 will give us the answer.
From this equation we deduce that the loss of mass Δm is equal to the energy radiated E divided by c^2, the square of the speed of light in a vacuum.
T
o get a meaningful result, we have to be consistent with the units we use: Einstein used the CGS (centimetre–gram–second) system with the energy measured in erg.
Nowadays, we use the International System (metre–kilogram–second) and we get the result in Joule.

C has been precisely measured and, since 1983 by way of the new definition of a metre, it is precisely 299,792,458 m/s but we'll use the approximate value of 300,000,000 m/s

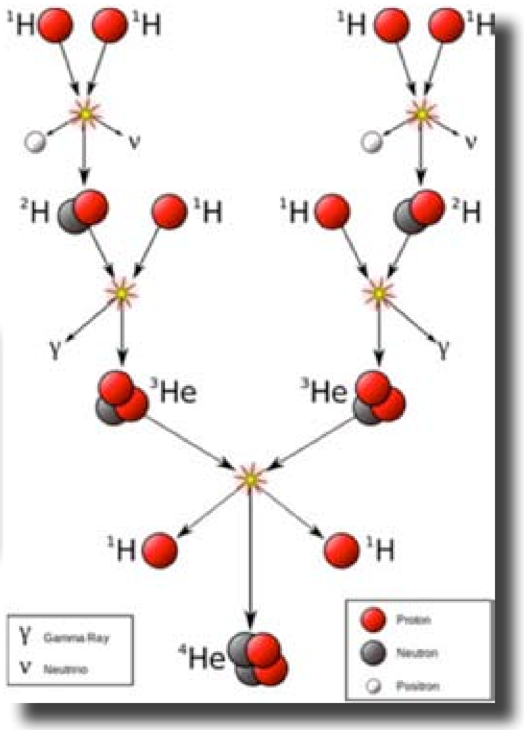
E cannot be directly measured but it is easily calculated.
Let's see how.
You first have to measure the energy that hits a unit of surface positionned at a particular distance from the Sun and multiply that amount by the surface of the sphere the radius of which is equal to the distance of your unit of surface to the Sun.
Two remarks here: firstly we need to know the total energy, which means that we have to include all photons, from the most energetic to the least energetic ones, from gamma rays to radio waves and, secondly, we have to assume that the Sun gives off its energy equally in all directions.
For us Earthlings, it is easy to measure the energy that reaches the surface of the Earth and it is approximately 1kw per m^2, which is the maximum energy you can ever hope to collect from your solar panels if they were 100% efficient
A lot of the solar energy is absorbed by the atmosphere and satellite measurements give us a value of 1367 w/m^2 and we will round this value to 1370 w/m^2.
So, now we can calculate the total energy output of the Sun.
We'll use 150,000,000,000m or 150x10^9m as the value of the radius of the Earth orbit.
The surface of the sphere that encloses the Earth orbit is therefore:
S = 4 π r 2 = 4 x 3 . 1 4 x 2 2 5 0 0 x 10^{18} = 282,600x10^{18} m2.
Multiply that by 1370 w/m^2 and you get 282,600.10^{18} x 1367 = 387.16x10^{24} Watts, a staggering 387.16x10^{24} Joules per second.
Now, using Einstein's equation we can calculate the mass lost:
Δm = 387.16x10^{24}/300,000,0002 = 4.302x10^8 kg, which is more than 4 million tonnes per second!
Can you believe it? The Sun "consumes" more than 4 million tonnes of mass per second or, one year being approximately 3.16x10^5s, 13x10^{11} tonnes per year to keep us warm and cosy.

Let's go a bit further.
We know that we need 4 hydrogen nuclei with an atomic mass of 1.00794u to get 1 helium nucleus with an atomic mass of 4.002602u, which means that in the process we loose 0.02914u of atomic mass that is to say 0.72276% of the hydrogen mass.
We can now calculate that the Sun has to fusion approximately 595x10^6 tonnes of hydrogen per second to produce 591x10^6 tonnes of helium.

So, how long before the Sun runs out of fuel?
The solar mass is estimated at 3x10^{30} kg or 3x10^{27} tonnes so, if the Sun were to carry on at this rate and assuming that no other processes took place, which as we all know is not the case, it could continue burning hydrogen for 3x10^{27} divided 13x10^{11} = 2.3x10^{15} years, (2300 terayears) which is two million three hundred thousand billion years in plain English (2).

Jean-Luc Gaubicher

(1) All the calculations in this article are based on simplifying assumptions and are highly approximative.
More scientific papers give different results but the reasoning would be the same.
(2) In reality, the "active" life of a sun-like star is around 10 billion years.



The Hydrogen to Helium Fusion Process
Source Wikipedia

Reminder on the powers of 10:

10^0 = 1 (unit)	10^1 = 10 (deca)
10^2 = 100 (hecto)	10^3 = 1 000 (kilo)
10^6 = 1 000 000 (mega)	10^9 = 1 000 000 000 (giga)
10^{12} = 1 000,000,000,000 (tera)	10^{15} = 1 000 000 000 000 (peta)
10^{18} = 1 000 000 000 000 000 (exa)	10^{21} = 1 000 000 000 000 000 000 (zetta)
10^{24} = 1 000 000 000 000 000 000 000 000 (yotta)	

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Notes on Iceland

A land of ice and fire.
"Spectacular" is the most descriptive word to convey just how stunning is this little island!
Also think adventure!

A land of water.
In a few days I saw more waterfalls than I have fingers and toes to count on: from little trickles gurgling beside paths, to long exquisite ribbons and to positively mammoth ones with water gushing over at an eye popping rate, waterfalls to walk behind, noisy, wet, misty and beautiful.

Thermal pools to swim in, geysers shooting up every few minutes, trickles of super heated water 70 – 100°C! Heated handrails in the town square: thermal activity keeps everyone warm.

Then there are those frozen rivers: glaciers.
Magnificent, awesome mighty ice flows. Walking on the 2nd largest with crampons and a trusty ice axe was invigorating but, for me, skirting crevasses was a tad scary! Glad I did it but glad to walk off.

Then the majesty of small icebergs in a glacial lake silently waiting to float out to sea only to be beached on long stretches of black sand; viewed as the sun sets... totally surreal. That night we had the thrill of watching the Northern Lights dance over the snow-covered volcanoes, glaciers and above our heads! Silent splendour.

Another adventure filled day had us in a specially converted 4wheel drive vehicle on 38" tyres driving in a near white-out on a glacier, a mere 100m of ice beneath us!

We walked between the tectonic plates of North America and Eurasia, epic!

Did I mention the volcanoes and their aftermath? Vast plains of old lava flows covered in moss so sensitive a footprint or tyre track lasts for 200 years!
I'm excited just recounting a few sights and adventures; I would return to Iceland in the blink of an eye. Put it on your "bucket list". You'll not be disappointed.

Chrissie Lloyd
Photo Credit: Johann xxx (Iceland)

What will be in the news in 2016

High cosmic hopes
Physicists think there is a good chance that they will see the first evidence of gravitational waves, ripples in space-time caused by dense, moving objects such as spiralling neutron stars, thanks to the Advanced Laser Interferometer Gravitational Wave Observatory (Advanced LIGO – see Reflections October 2015).
Japan will launch Astro-H, a next-generation X-ray satellite observatory that, among other things, could confirm or refute the claim that heavy neutrinos give off dark-matter signals known as bulbulons.
Hints of a potential new particle from the supercharged Large Hadron Collider (LHC), which has been running at record energies since last June, could become clearer as the machine rapidly accumulates data.
Even if the particle is not confirmed, the LHC could still unearth other exotic phenomena, such as glueballs, particles made entirely of the carriers of the strong nuclear force.

To Mars and beyond
The orbits of Earth and Mars will bring the planets close to each other this year, creating the perfect opportunity for a trip to the red planet.
A joint mission between the European Space Agency (ESA) and Roscosmos will capitalize on that chance.
Launching in March, ExoMars 2016 will analyse gases in Mars's atmosphere and test landing technology.
Farther afield, NASA's Juno mission will arrive at Jupiter in July.
In September, ESA's craft Rosetta will make a death dive into the comet it orbits; mourners can console themselves with the launch of NASA's OSIRIS-REx, a mission to bring back samples from the asteroid Bennu.

Space drive
Hot on the heels of the launch of the US Dark Matter Particle Explorer (DAMPE) last December, China's National Space Science Center will launch the second and third space-science probes in its planned series of five.
The world's first quantum communications test satellite will blast off in June.
The Hard X-ray Modulation Telescope will fly by the end of the year and will scour the sky for energetic sources of radiation such as black holes and neutron stars,
After a successful test flight in June 2015 LightSail will send a small spacecraft into Earth orbit carrying large, reflective sails measuring 32 square meters for a second, full-fledged solar sailing demonstration in 2016.

Aperture fever
September will see China complete the construction of the 500-meter Aperture Spherical Radio Telescope (FAST) that will supersede Puerto Rico's Arecibo Observatory as the world's largest radio telescope.
In Hawaii, the team behind the controversial Thirty Meter Telescope, which had its construction permit revoked in December, will try to work out whether and how it can move the project forward.

Sources: nature.com
sail.planetary.org

2015 Christmas Barbecue

Photo Credit: Jean-Luc Gaubicher