

Reflections

Journal of the Northern Sydney Astronomical Society Inc.

Volume 26 Number 3

October 2015

Vice-President's Message

Hello all Members.

With this traditional greeting many of you will think that Bruce is the author of this month's President's report – it is not the case.

With Bruce away on a well-earned holiday I have had to step up to fill big shoes.

More about Bruce a bit later.

But first I would like to pay respects to our dear friend Arthur Boyd who recently passed away.

Arthur was a man who was very supportive of and well-respected by his local community. Many of you may not be aware that Arthur was a former Mayor of Hunters Hill, I wasn't.

Arthur was farewelled by his family and friends at his local church in which he was a very active and much loved member.

Arthur was a member of NSAS for a very long time and was very faithful in his attendance, it may be that we may have to refer to the centre chair in the front row as the "Arthur Boyd Memorial seat".

Farewell Arthur, you were our friend and you will be missed.

On a less sad note, but sad nonetheless, some of you may not be aware that Bruce has informed the committee that he will not have the time to continue to act as President, and so will stand down from the position at the October Annual General Meeting.

NSAS has been very fortunate over the past 28 years with the quality of the leadership of many of its Presidents, and Bruce is no exception.

At the time Bob Fuller stepped away from the Presidency it wasn't necessarily clear who might pick up the mantle.

Bob asked Bruce and I think it was an inspired choice.

Bruce has been humble enough to down-play the achievements that have occurred under his leadership.

Membership numbers have grown substantially, the financial under-pinning of NSAS is strong, and there is a real buzz within the Society.

So Bruce, on behalf of the committee and the members, can I please extend our sincere thanks for your leadership, your commitment, that relaxed dry sense of humour and for that steady hand on the tiller.

It is reassuring to know that many current members of the committee are continuing which is great.

We will also welcome 1 or 2 new committee members for the first time which is very good news indeed.

To have 1 or 2 additional new people join the committee I believe is important for the future of the club. Please consider coming on board.

It is an exciting time to be a member of NSAS and membership has been steadily growing.

We have now settled in to our new observing site at Terry Hills and it is a beauty.

St Ignatius College has continued to extend a very supportive hand via Bob Marsh – we have an excellent site for our Solar Observing, and the new screen in the classroom was a much needed addition.

Our new association with the Australian Sky & Telescope magazine is a nice new benefit members can take advantage of.

New books continue to be added to the library.

arrives at the Kuiper Belt!

Then, the presence of liquid water on Mars has been confirmed and, finally, gravitational waves may have been detected., not to mention numerous other news items.

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Looking to the new year, I am hopeful that 2016 will see the re-introduction of an astrophotography group to NSAS.

Fingers crossed.

It is interesting to look down the current membership list and see that at least 30-40 names are new in the past few years.

It's exciting.

Can I say to the new members – don't think that just because you are new to the club or new to astronomy that you aren't the right person or haven't been a member long enough to get involved or to assist the club. I would really encourage you find a way to get involved in the club. Looking back at my time in the club over the past 6 years there is no doubt that committing time to the club has actually been critical in ensuring my hobby didn't fall by the way-side and brought me into contact with people with valuable experience and knowledge. Get involved. There's lots to do and enjoy.

The final event of the year will be our Christmas BBQ (no cost) which we hope to have at St Ignatius College on Sunday 13th December. We will confirm details but please set aside the date. It's the perfect opportunity to come and meet other members.

Gordon Osborne

What an interesting period the last 3 months have been for astronomy! I'm sure all of you have gasped in awe, as I did, at the pictures of Pluto and Charon received from the New Horizons probe. Can't wait to see what it will send when it

Closer to us, the results for the 2015 GW Prize are in and the winners will be announced at the forthcoming AGM.

See you there and then

Cheerio,

Jean-Luc Gaubicher

Calendar

General Meetings:

October 20th Annual General Meeting
November 17th Speaker: Jan Hamaan - CERN
December 13th Christmas BBQ

NAG Meetings:

To resume 2016

Observing Nights:

Consult NSAS' web site at <http://nsas.org.au/observing/>

Deadline:

Please send your contributions to the next issue of Reflections in time to reach the editor **before December 15th** to nsas.editor@ozemail.com.au

How to do solar observing and photography on a low budget

WARNING

Looking at the Sun without an appropriate filter on the telescope will cause instant and permanent eye damage.

This article refers to my experience with a Meade ETX 125 Maksutov-Cassegrain telescope.

The filter is a "Thousand Oaks Optical" RG Solar film .0005 Polymer treated with "Solar 2+" It cost about \$100 (Figure 1).

Please note that you will not be able to see flares and prominences with this setup; for that you need a 'scope with a dedicated Hydrogen alpha filter.



Figure 1

My camera is an Olympus OM-D E5 micro 3/4 mirrorless digital SLR.

Adapters are a Meade T adapter for the rear of the scope (ex Bintel) and a T adapter-to-camera-body adapter sourced on the 'net. Cost about \$12 (Figure 2).



Figure 2

My camera shutter wired remote control was also sourced on the 'net. Cost is about \$15 (Figure 3).



Figure 3

I made the pointer from thin aluminium sheet (Figure 4).



Figure 4

Assembly and use are described as follow. I did not worry about elegance at this early stage, I was just after proof-of-concept. Tidying up and beautification would come later.

Straight out of the box the filter is not a tight fit on the end of the tube but the supplier included a roll of self-adhesive tape to put on the inside of the filter to make it a snug fit on the tube. (You can't risk the filter blowing off when observing!)

Viewing through the Eyepiece

Now I was ready for a preliminary alignment with the Sun. Obviously I couldn't use the normal optical finders since I had them securely blocked off.

I laid some masking tape from the top of the objective end of the tube right up to the eyepiece end giving me a track to follow

(Figure 5) and I tacked the pointer to the objective side of the filter (Figure 1).



Figure 5

To get a reasonable viewing angle I raised the altitude plate about 30 degrees, which gave more



Figure 6

clearance between the tube and the base of the 'scope (Figure 6).

A more precise setting would come later.

Then I had to get a temporary alignment of the 'scope and Sun. I pointed the 'scope as near to the Sun as I could to get a rough alignment.

By trial and error I found the best angle of elevation for the 'scope. Then, using the motor drive, I moved the pointer's shadow along the longitudinal masking tape and aligned the pointer's shadow to where I could see an image of the Sun in the 40mm eyepiece.

These points were marked on the tape.

A complete orb was visible with a 40mm eyepiece.

The magnification (scope focal length/ eyepiece focal length) was $1900/40 = 47.5$ times. Close-ups were possible with 26mm and 15mm eyepieces (73x and 127x). Higher magnification was not satisfactory at that time because of atmospheric and thermal disturbances.

Sunspots were clearly visible, cool regions in the centre and hotter on the outside.

Drifting of the image due the Earth's rotation was obvious but easily corrected with a tweak with the motor drive every 2 or 3 minutes.

I now have a 'scope that is dual-purpose, for solar and nighttime viewing. However one needs to be able to remove and put back the filter reproducibly. With masking tape already in place I marked the index spots as well as the position of the pointer so that when reassembly was needed I wouldn't have to start from scratch (see close-up Figure 7).

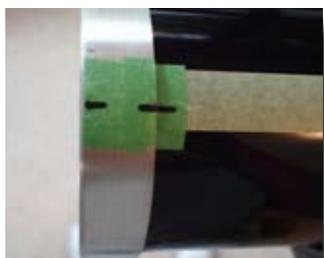


Figure 7

Solar Photography

I started by pointing the 'scope due south, then levelled the base and lifted the altitude plate, pointing south, to 34 degrees (Sydney's latitude).

I was now in an Equatorial/Polar mode. This would allow me to reduce the drift due to the Earth's rotation.

I set up the controls on the motor drive computer so that when the Sun was centred in the eyepiece the 'scope would track it. Making sure the viewfinders were blanked off I fitted the filter and its pointer.

I unscrewed the cap of the photo port (Figure 8, between the bright knobs) and fitted the adapters; the camera adapter to the camera and onto the T adapter.



Figure 8

I plugged the camera remote control, the 'scope battery and the handheld controller.

I opened the camera screen and checked it (Figure 9), set the camera to

ISO 200 and the shutter speed to auto.

The 'scope was lined up with the Sun using

Figure 9

the technique described in "Viewing through the Eyepiece" above, and focused with the 40mm eyepiece.

Next I checked that the camera was switched on and that the remote shutter control operated OK.



Then it's just a matter of diverting the Sun's image from the eyepiece to the camera through the dedicated photo port, which was done by flipping the lever shown in Figure 8.

An image of the Sun appeared on the camera screen and I was able to take some pictures after adjustment of the focus.

Viewing was difficult in bright sunlight so, next time out, I will take a dark cloth to cover the camera and the eyepiece end of the 'scope to make it easier to compose and focus.

An image of the Sun with some sunspots is shown in Figure 10. This image has been post-processed with Photoshop because the camera was flooded with light and was lacking in contrast.

The camera settings were ISO 200 and shutter speed 1 /400. with the f/15 aperture scope set the aperture of f15.

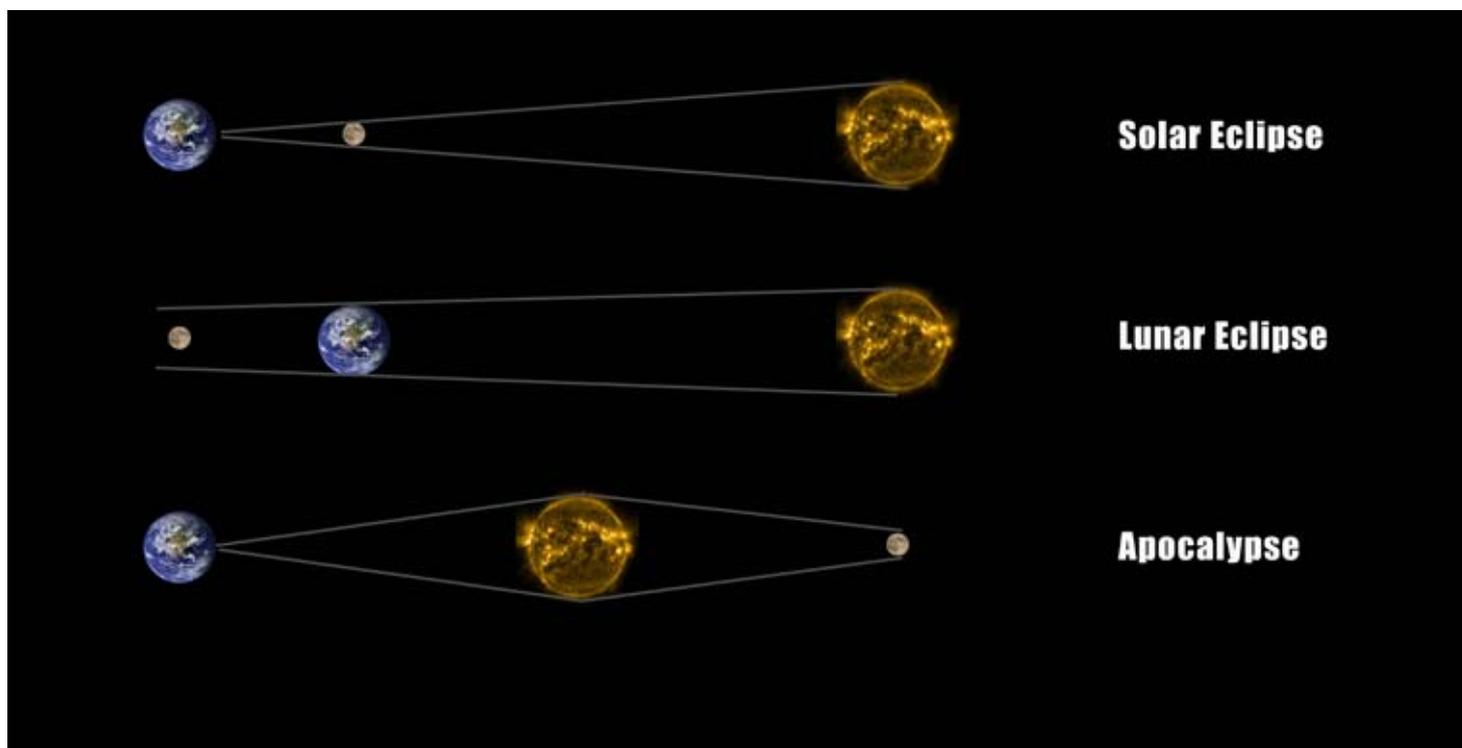
The process needs some refinement but my results are encouraging. I'll be back for more.

Graham Nicholson
All pictures by the Author



Figure 10

Smile...



Our Aerial Ocean

Rambling reminders of the “sea” we live in.

Earth’s atmosphere is a multi-layered, partially transparent envelope surrounding our planet and held in place by gravity.

Atmosphere is permissive, co-operative and protective but, unfortunately, not always respected.

Its layers (Diagram 1) are based on temperatures but there are transition zones. In addition, there are recognised and named zones that cut across the boundaries of the layers.

The heights of these layers and zones are not fixed absolutely and vary with diurnal illumination and solar activity.

The Sun produces a wide range of electromagnetic rays, some permit vision, some warm us as well as our solar hot-water systems or provide solar power.

Luckily for us the atmosphere is not 100% transparent and it filters out a sizeable fraction of the solar ultra violet rays, X-rays and gamma rays that would be harmful to life.

Such absorption is progressive and depends on the thickness of atmosphere traversed, which is why it is less efficient when the Sun is high in the sky.

In theory the close passing of a large

space object could suck off much of our protective atmosphere and put our survival in grave danger from numerous causes including loss of food production.

That atmospheric protection is aided by the Earth’s magnetic field that traps electrically charged high-energy particles in the solar wind.

The upper-atmospheric gases, mainly oxygen and nitrogen, convert

the energy of these particles into visible light creating the beautiful visual auroras known as Northern and Southern Lights.

The energy of cosmic rays is gradually dissipated by cascading collisions with the atmospheric atoms.

Nevertheless, such rays are believed to affect genes in plants and animals and to have so influenced the evolution of life on Earth.

Solid particles from space are called ‘meteoroids’ and some of these bounce off the atmosphere to head off into space but an unknown proportion enter the atmosphere where they are heated by the compression of air in front, and not by friction as commonly assumed, and so become ‘meteors’.

Any material burned off them contributes to the supply of a slowly falling ultra-fine dust at great heights.

The large meteors produce spectacular fireballs that, if they do not burst, survive to land in oceans or to hit the ground where, if observed, they spark searches for the resulting ‘meteorites’.

The atmosphere imposes its own terms and conditions on all electromagnetic rays that traverse it or attempt to do so. And this applies to visible light too.

The components of visible light are 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.

Reflection can occur at any sudden change in a medium that changes the velocity of propagation.

Even the atmosphere can produce reflections where there are layers differing in temperature, mirages and shimmering effects being the results.

Diffraction however 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 star 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 and special security printing: e.g., on NSW driving licenses.

Bob Roeth
To be continued

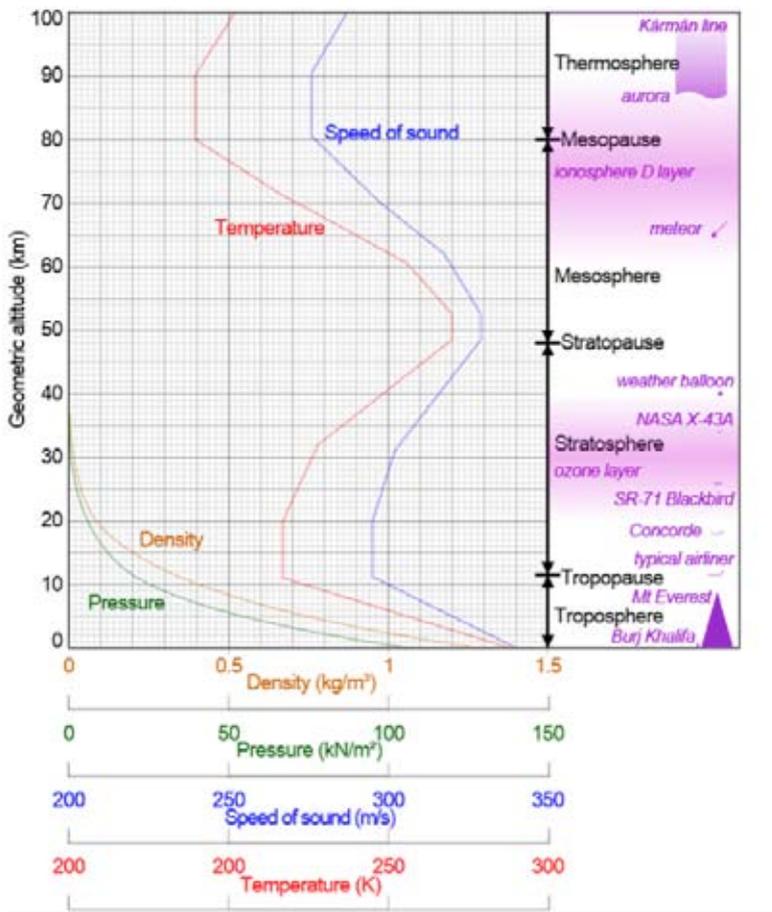


Diagram 1

The atmosphere transmits solar energy, part of which is used to recycle surface water as rain.

Rain cleans the atmosphere of dust and pollutants yet supplies us with water safe for drinking and distribution over agricultural areas that are not necessarily close to the original source.

The rain also dissolves some nitrogen oxides that are formed by lightning and that ultimately end up as nitrate fertilisers.

Hunt for gravitational waves to resume

Almost 100 years after Einstein presented the general theory of relativity in a Berlin lecture theatre, the quest to spot the gravitational waves he predicted may be entering its final stages.

This month, the world's largest gravitational-wave facility is expected to start collecting data again after a 5-year US\$200-million overhaul.

The Laser Interferometer Gravitational-Wave Observatory (LIGO) searched fruitlessly for these cosmic ripples for almost a decade in the 2000s.

But the odds that its improved version, known as Advanced LIGO, will detect any waves in the next three months may be as high as one in three, according to some of the physicists involved in the experiments.



*The LIGO Livingston Observatory in Louisiana sits in the middle of a pine forest
Picture Credit: LIGO/Caltech*

Initial tests have shown that the observatory's twin detectors, in Washington state and Louisiana, are performing as expected, says Gabriela González, spokesperson for the 900-strong LIGO Scientific Collaboration.

And that is no mean feat for an instrument that has cost \$620 million so far. "It's the first time that anything in this field is on budget and on schedule," says Karsten Danzmann, director of the Max Planck Institute for Gravitational Physics, in Hannover, Germany, who is not part of the LIGO management team.

*The worldwide gravitational-wave hunter network
Picture Credit: LIGO/Caltech*

According to general relativity, gravitation originates from the interplay between massive objects and the malleable fabric of space-time.

Einstein predicted that accelerating masses such as colliding neutron stars or black holes would disturb that fabric and produce gravitational ripples that propagate through the Universe.

Each of LIGO's detectors is designed to measure the deformation of space-time by comparing changes in the paths of laser beams that race down its two perpendicular 4-kilometre-long arms, bounce between mirrors and interfere with each other back at their source.

When a gravitational wave passes through, it slightly alters the lengths of the arms, and the observatory can spot such changes with a sensitivity of one part in 10^{22} . That is

comparable to a hair's-width change in the distance from the Sun to Alpha Centauri.

A crucial part of the improvement is better damping of the vibrations caused by less-than-heavenly sources.

The problem was especially acute at the site in Livingston, Louisiana, as it is in the middle of a timber plantation.

Any felling of trees would disturb the detector, so it could keep its laser beams 'in lock' only at night or on weekends.

A passing train would knock the site out for an hour.

But now, the detector should be able to take data over several days at a time without interruption.

Advanced LIGO is already three times more sensitive than its predecessor but, early 2016, it will shut down for more improvements that should make it ten times more sensitive.

When it reopens around 9 months later, it should be able to spot cosmic ripples from cataclysmic

events such as the collisions of black holes up to 326 million light years away on a regular basis and sample a volume of space 1,000 times greater than the original observatory.

Next year, LIGO will be joined by a slightly smaller Franco-Italian detector near Pisa, Italy, called Advanced Virgo, which is undergoing its own upgrade.

The LIGO and Virgo teams will pool their data to check each other's detections.

They expect to see waves from mergers of binary neutron stars, events that should generate strong, predictable signals, but do not know precisely how many to anticipate.

"It could be, depending on the models, ten binary neutron star detections a year or so," González says. "But it could be 10 times higher or 100 times lower."

"The first detections will be quite dramatic for us," says Rainer Weiss, a theoretical physicist at the Massachusetts Institute of Technology in Cambridge who was one of LIGO's founders. "The first thing we will need to sort out is whether we truly believe what we are seeing."

Having detectors on different continents is crucial for providing a rough estimate of the origin of the waves.

Once they know that, astronomers will be able to look for other signs of that event using electromagnetic radiations, such as X-rays or visible light.

Einstein published his first papers on gravitational waves in 1916. Detecting these ripples a century later, Weiss says, would be of "enormous symbolic importance".

Continued on page 8

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For more information go to:

<https://ligo.caltech.edu/>

or to:

<http://stuver.blogspot.com.au/>



Astrophotography 101 - 2nd Part

Starting to get it right

In my last article we learnt about the basics of Astrophotography, the difference between Planetary and Deep-Sky photography and some basic knowledge about equipment and setup/alignment techniques.

If the last edition was the appetiser, than this certainly will be a main course.

I'll dish up some more detail on image capturing, alignment and guiding as well as post-processing techniques, so you're well equipped to go out there with whatever equipment you have and apply some of your new knowledge to hopefully enhance your results but first and foremost the pleasure of the experience by doing it yourself.

Optimised Image Capture

Many factors can have a positive or a negative impact on your image capture. One of the basic rules is "poor input equals poor output".

There is no magic software trick that can make bad data look good.

No doubt there are quite advanced processing techniques these days that can make the most of your data and sometimes even polish away little error. However, you will always be disappointed with the resulting image if your data capture is flawed.

Hence there is all the reasons in the world to make sure you improve your data capture to whatever point possible within your budget, skill and patience levels!

Not everybody can go to the same length for a variety of reasons and that is perfectly ok; it's about finding out how far you want to immerse yourself in this fascinating yet time consuming hobby.

Polar Alignment

As discussed in my last article, an equatorial mount needs to be properly polar-aligned so that it can track across the sky, which means that the axis of the scope must be perfectly aligned with the rotational axis of our planet.

This can be done via an inbuilt polar scope. However, I've never managed to get this right as here in the southern hemisphere Polaris Australis is too dim to be seen in the polar scope.

But there are many alternative means of achieving sufficient polar alignment out of which I've got most comfortable with a method called "Drift Alignment".

It is vital to say that often a combination of methods yields the best and quickest result.

Here is how I do it:

I typically run the built-in Skywatcher Polar Alignment routine on my hand controller

after having done a 2-star alignment.

Then I go for manual drift alignment in order to further increase my accuracy.

In this method you target a star at two specific points in the sky and observe its "drift" in your viewfinder (Pic 1) or camera image on the computer.

As you wait, you will see the star move. Ideally the star won't move for about a minute.

This would mean your polar alignment is

accurate enough for long exposures of one minute without star drift.

Your autoguider will then take care of the rest and you could theoretically expose for much longer.

If the star however moves in a shorter time (for the first run it might move within a mere few seconds), you need to slowly correct the declination and right ascension axis of the telescope mount according to which part of the alignment you're at.

Not being able to list the detailed procedure here, there is a very good instruction on the following site: http://www.backyardastronomy.net/drift_alignment.html

Long Exposure and Guiding

In my previous article I mentioned that I guide via a small and handy Orion 50mm mini guide scope and an Orion Starshoot Guidecamera setup.

This is basically a small finder scope with a CCD camera attached.

Once sufficiently polar aligned, this neat little device takes care of the rest.

The camera shows you a field of view with available guide stars on the computer screen and after running a calibration routine, it will send guiding instructions directly to the telescope mount.

Guiding in itself will provide you with plenty of small challenges to overcome; I found that learning by trial and error is the best you can do.

There will be little guiding errors here and there and, sometimes, the software won't work properly. In this case a reboot usually helps.

The only two real let downs I've had where guiding wouldn't want to work were:

- Dew fogging up my guidescope and I didn't even realise that was the problem. All it took was to build a mini dew shield to solve this problem
- My mount had a tracking problem that

needed to be fixed by the telescope retailer. Can hardly blame guiding for it but it took me a while to realise that it wasn't a guiding related problem.

All in all guiding is a really robust thing and should make your life in the field much easier. There are also plenty of resourceful sites in the internet on this topic if you ever need more advice.

Dithering

Dithering is a basic technique that has been around for quite a while.

It is a small movement of the telescope between images, resulting in a slight offset of the target in each image.

When the images are realigned during stacking, the pixel defects move around relative to the image.

Statistical combine methods such as Sigma Clip are then used to eliminate the bad pixels, which results in a cleaner image.

This technique reduces the noise inherent in an image stack quite dramatically.

I've been dithering for about a year now and I believe that the results are much cleaner and less noisy, which in turn are much easier to process.

And the best thing is, dithering is easy.

If you're setup is computer controlled then dithering requires a mere tick in the right box of whatever control software you're using (Backyard EOS, Sequence Generator Pro, ASCOM, etc.)

Post Processing/Image Calibration

The theory of lights, darks, flats, offsets, and more.

Image Calibration is essential to maximise quality of the final output.

It is a complex mathematical procedure that is, these days buried, within computer programs.

It is a necessary step for a variety of reasons such as noise be it due thermal, pixel errors, cosmic rays or others.

By properly calibrating every exposure, we further enhance the actual signal we're interested in (aka deep-sky object) and suppress the noise we're not interested in.

This relation is called "Signal to Noise Ratio" or SNR and is probably the most important dimension we strive to improve.

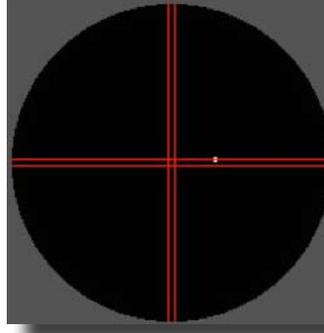
• Light Frames.

Light Frames (or "Lights") are the actual images we are taking of our target, e.g. that faint galaxy or reflection nebula somewhere out there.

For Deep Sky Photography, light frames can and should be long exposure.

They can be as short as a few seconds and as long as many hours.

The exposure length we choose depends on a variety of conditions.



Pic 1

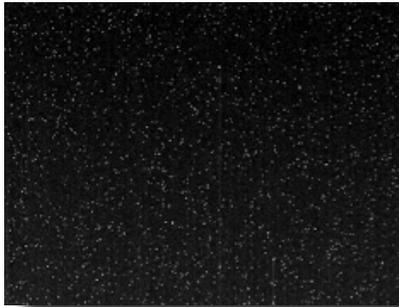
This is a whole story in itself but learning by doing will clarify most questions on this quickly.

As a matter of fact, we need to strike a reasonable balance between the length of each light frame and the overall number of light frames we take during the course of an imaging session.

Recently I've been taking Lights of 3-4 minutes exposure and about 10-20 of them. This is a good number for a variety of stacking algorithms to enhance the Signal to Noise Ratio.

• Dark Frames

"Darks" (Pic 2) are images taken under the same conditions as light frames except for that you attach the telescope cover in front of your imaging telescope so no light can get onto the camera sensor.



Pic 2

The exposure will be taken with the same settings used for the Lights, that is duration, ISO settings or binning factor; and around the same time of the evening so that the ambient temperature is close to when you took the Lights.

Dark frames record the thermal/electric noise generated by the camera that varies greatly between uncooled cameras (such as regular DSLRs) and cooled cameras (such as Astro CCDs or modified DSLRs).

Darks also contain any pixel damage of the sensor, aka hot and cold pixels.

All of this is noise we want to get rid of, hence we'll subtract the Darks from the Lights during calibration.

I used a regular DSLR for about 3 years and now have used a cooled CCD for about half a year.

This makes a huge difference. As the CCD camera is cooled down to 25 degrees below ambient there is almost no dark current left in the images.

Basically, this means that with uncooled cameras Darks are a must whilst with cooled cameras you may be able to get away without them.

• Flat Field Frames

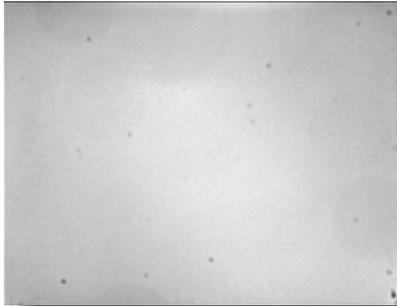
"Flats" are another absolute necessity for image calibration (Pic 3).

They are used to address unwanted problems in the optical path, including dirt/dust, vignetting and internal reflections. Any change in the optical path, such as focal reducers, filters, camera orientation or

focus will require a new flat field frame.

Flats need an evenly illuminated surface; they can be taken from the twilight sky.

The exposure time has to be chosen in such a way that the intensity level reached approximately 2/3 of the maximum of your camera's dynamic range, that is the histogram of your exposure that you can see in your image capture software.



Pic 3

Flat field frames should be taken for all filters used for the light frames.

I usually take about 20 Flats for each filter if the time allows (Flats are very short exposures).

I have since built my own "Light Box" (Pic 4) so that I can take Flats anytime in the field, usually right after I've taken the Lights so that the same conditions are given.

I'm more than happy to share instructions on how to build your own Lightbox. It isn't hard and a nice DIY Astro activity ☺ Just let me know.



Pic 4

• Offset (or Bias) Frames

Bias frames are used for advanced image calibration and can, in most beginners' cases, safely be ignored.

The Bias frame is the shortest exposure possible with your camera that captures "Read Out Noise", which might or might not be negligible depending on what camera you use.

The purpose of a bias frame is to apply it to a Dark and Light Frame to bring all the pixels on the CCD to an equal starting value.

To make a Bias Frame, cover the aperture or corrector plate in the same fashion as for a Dark and capture at the highest possible shutter speed your camera will allow.

I usually take about 50 Bias per setting (this can safely be done at home) and stack them together to get a Master Bias. This Master Bias can then be used forever given you don't change your camera as the Bias signal normally doesn't change.

• Stacking

As previously mentioned, images can be "stacked" together, using a variety of algorithms, in order to increase the overall Signal to Noise Ratio.

This is quite powerful and is used commonly across all areas of Astrophotography.

The so-called "shift-and-add method" or easier "image-stacking" is a basic principle of statistics that variation in a sample can be reduced by averaging together the individual values.

In fact, when using an average, the signal-to-noise ratio should be increased by a factor of the square root of the number of images.

Any commonly used astro image processing software is capable of stacking your Lights to improve the signal you're after.

The most widely used (and free for that matter) is called Deep Sky Stacker (or DSS, homepage: <http://deepskystacker.free.fr/english/index.html>) and should probably be your first choice to get started.

There are great tutorials on their webpage as well as all across various Astronomy Forums.

• Image Processing

Image Processing is a bit more delicate and, honestly, it can take years and years to master.

Depending on which software you use, there will be different results and different ways of getting there.

Basic image processing can be done in any photo editor with some more advanced stuff possible in GIMP (<http://www.gimp.org>), which is free of charge and again, probably a good starting point.

Complex processing was traditionally done by dedicated Astroimagers in Photoshop (dedication because of time investment as much as the hefty price tag).

In recent years, people have shifted over to more specialised softwares such as Pixinsight (<https://pixinsight.com>), which is what I've been using for a couple of years now. Pixinsight costs about €280 by now. Not cheap but it's still much more affordable than Photoshop and I believe better for the purpose anyway.

Again, I would need to run a whole dedicated training session on Pixinsight to cover even the basics. It is massively complex but very powerful and yields amazing results.

A great resource for tutorial videos can be found at Harry's Astro Shed under: <http://www.harrysastroshed.com/pixinsight/pixinsight%20video%20html/Pixinsighthome.html>

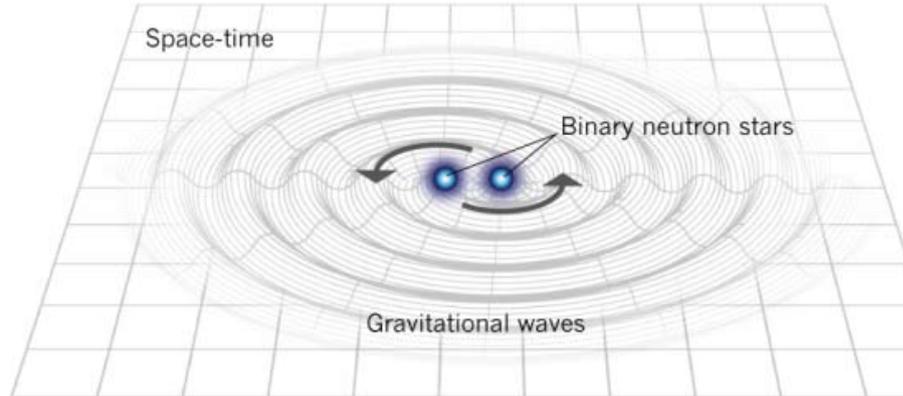
Clear Skies!

Mathias Sorg

All pictures by the author

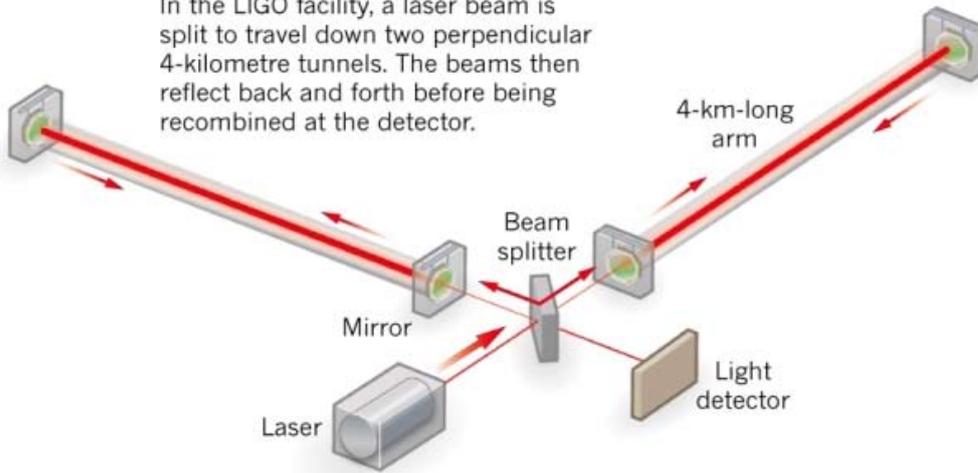
How to Catch a Wave

The Laser Interferometer Gravitational-Wave Observatory (LIGO) is trying to detect ripples in the fabric of space-time predicted by Einstein's general theory of relativity



These ripples are thought to be produced whenever moving masses distort the space-time around them. A particularly powerful source might be a pair of neutron stars or black holes whirling around one another in a close orbit.

In the LIGO facility, a laser beam is split to travel down two perpendicular 4-kilometre tunnels. The beams then reflect back and forth before being recombined at the detector.



Stop Press September 25, 2015

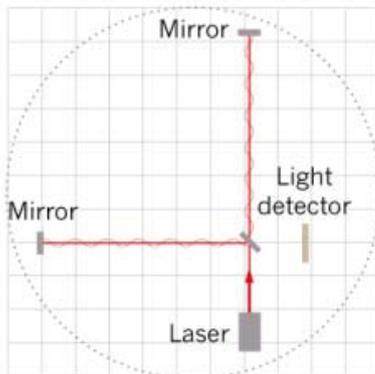
Rumour has it that LIGO might have already seen gravitational waves.

Lawrence Krauss reported on Twitter that LIGO had seen a signal just one week after its re-opening:

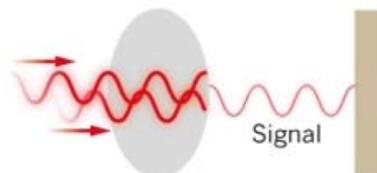
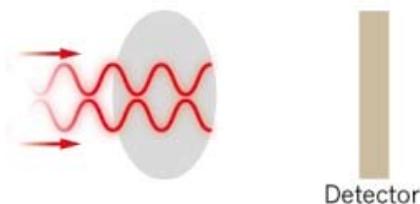
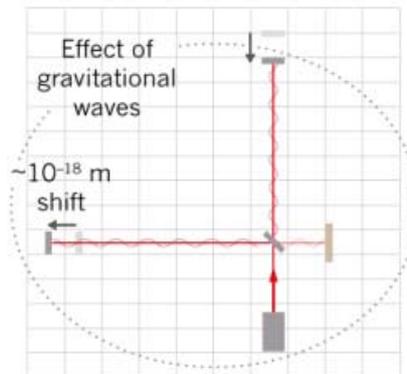
<https://twitter.com/LKrauss1/status/647510799678750720>.

This rumour however has not been confirmed or denied as it can just be one of the false signals that are deliberately sent to the system as a drill.

Normally, the two light beams travel paths of identical lengths, so that they cancel each other out when they recombine at the detector.



When a gravitational wave passes LIGO, the tunnels deform slightly and the distance travelled by each beam changes so that they no longer cancel out. This produces a measurable signal at the detector.



*Text and illustrations credit:
LIGO/Caltech*