

Astronomer



Journal of the Tamworth Regional Astronomy Club Inc

Vol 5
2020

Feature

Wonders of the Night Sky Through Our Eyes!

Research

TRAC assists UK satellite tracking project

Member articles

Auroras and lightning – is there a link?

Murchison Meteorite 50th Anniversary

Very Large Telescope – Australia's role

Is there anybody out there? The Drake Equation

Pitcairn Islands' International Dark Sky Sanctuary

Book review

Dark Sky Dreamings

Cover photo: M8 The Lagoon Nebula
Photo: Chi Chan



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A major highlight for TRAC in 2019 was the *Wonders of the Night Sky Through Our Eyes* astrophotography competition and Exhibition at the Tamworth Regional Gallery organised in conjunction with Tamworth Regional Council. Pictured at the Exhibition's launch on 13 December were TRAC members (back row, left to right) Grant Quinn, Bernard McNamara, Elise Copper, Sharon Goff, Karlie Noon, Garry Copper, Leigh Tschirpig, Phil Betts, Michael McHugh, Stephen Carter, Barry Gilbert, Ian Hynes (front row) Margie Schofield, Warwick Schofield, Craige Watson and Neta Horniman. Photo: Craige Watson.

Contents

- 3 **At the Eyepiece**
An exciting new decade for TRAC!
By TRAC President Leigh Tschirpig
- 4 
Photo: David Magro.
- Feature: Wonders of the Night Sky Through Our Eyes**
By TRAC President Leigh Tschirpig

- 15 **AASEC progress report**
By TRAC Vice President Garry Copper



AASEC Centre – concept image by Garry Copper.

- 17 **Argus 2 UK Satellite Tracking Project**
Introduction by TRAC President Leigh Tschirpig and Dstl media release
- 18 **Is there a relationship between auroras and lightning?**
By TRAC member Dr Garry Bott
- 20 **TRAC Member profile**
Neta Horniman
- 21 **Very Large Telescope – Australia's role**
By TRAC member Dr Ray Hare
- 23 **Is there anybody out there? The Drake Equation**
By TRAC member Grant Quinn
- 25 **Pitcairn Islands' International Dark Sky Sanctuary**
By TRAC member Steve Rogers
- 27 **Murchison Meteorite 50th anniversary**
By TRAC member Chris Wyatt



Photo: Tony Forsyth.

- 29 **A very special donation**
By TRAC President Leigh Tschirpig
- 31 **Solar Astronomy**
By TRAC member Grant Quinn
- 32 **Book Review: Dark Sky Dreamings – An Inland Skywriters Anthology**
Review by TRAC Vice President Warwick Schofield
- 33 **2020 Evening sky maps**
- 37 **2019 President's Report**
- 46 **TRAC info and diary**



An exciting new decade for TRAC!

Welcome to 2020, a new decade and, at long last, a new edition of *Astronomer*!

When the last edition of our Club's journal was produced 12 months ago, TRAC Vice President, Warwick Schofield, and I gave some thought as to whether *Astronomer* should become an annual publication, encapsulating our activities over each 12 month period in a yearly volume. Regular updates about our activities and astronomical information could then continue to be provided via the monthly *Observer* e-newsletter and this seems to have worked quite well during 2019. We would continue to reprint the TRAC columns produced for The Northern Daily Leader in *Astronomer*, creating a permanent record of the many fascinating subjects researched and written by our members. This would help to reduce the level of work in producing *Astronomer* and create a publication written by a larger number of our members, rather than just a few. So, for the time being, we'll continue this format and trust the combination of an annual Journal and monthly e-newsletter, together with our Facebook page, website and TidyHQ club management system will fulfil our Club's information and communication needs.

This edition of *Astronomer* is therefore something of a 'bumper' edition with a fantastic collection of member articles, an in depth look at our activities over the past year as detailed in my 2019 President's report (see page 37) as well as plenty of other Club and astronomy related information.

A major focus during the year has of course been the continued planning for the Astronomy and Science Education Centre and Planetarium Theatre complex at Victoria Park. While the project has been delayed, our Vice-President,

Garry Copper, has overseen an enormous amount of work in conjunction with Tamworth Regional Council to ensure the project can be constructed within the limits of the NSW Government grant approved to Council in 2018 and fulfill the scope of the project to provide a high quality facility from which TRAC can operate and promote the science of astronomy in our region. An update by Garry commences on page 11.

Another major highlight in recent months has been TRAC's participation in the Argus 2 satellite tracking space situational awareness project being undertaken by the Defence Science and Technology Laboratory (Dstl), UK Ministry of Defence, in conjunction with the Basingstoke Astronomical Society. A copy of a media release issued by Dstl on 30 January 2020 about Argus 2 is provided on page 13 and further details regarding TRAC's involvement in this excellent pro/am collaboration are provided in my President's Report.

We were also delighted with the outstanding success of the *Wonders of the Night Sky Through Our Eyes* astrophotography competition which TRAC conducted with Tamworth Regional Council during 2019 and the subsequent Exhibition of the many amazing images at the Tamworth Regional Gallery which ran from December 2019 through to February of this year. Details of the winners and their fantastic astrophotos, together with some additional amazing entries displayed at the Exhibition, are the feature article of this edition of *Astronomer*.

Enjoy!

Best wishes and clear skies. ☆

Leigh Tschirpigg
President

Astronomer

Journal of the Tamworth Regional Astronomy Club Inc

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Karlie Noon

Wonders of the Night Sky Through Our Eyes!

BY TRAC PRESIDENT LEIGH TSCHIRPIG

Overall winner of the *Wonders of the Night Sky Through Our Eyes* Astrophotography Competition was this stunning image titled 'Field of Stars' by David Magro. Congratulations David and to all of the Competition's category winners and entrants!

Astrophotography Exhibition Winners!

The inaugural *Wonders of The Night Sky Through Our Eyes* astrophotography competition conducted in 2019 by TRAC, in conjunction with Tamworth Regional Council (TRC), saw around 170 truly amazing entries submitted by astrophotographers from across Australia. The winners were announced at a gala event held at the Tamworth Regional Gallery on Friday, 13 December 2019 which also saw the launch of the *Wonders of the Night Sky Through Our Eyes* Exhibition of the entries opened by Astronomer and TRAC Honorary Life Member, Karlie Noon. The Exhibition ran until 2 February 2020 and attracted hundreds of visitors with the event running throughout the very busy Tamworth Country Music Festival. A sincere thank you to TRAC member Craige Watson for coordinating the competition and Exhibition, the many members who assisted, TRAC Publicity



Kamilaroi Elder, Len Waters, providing the Welcome to Country at the opening of the *Wonders of the Night Sky Through Our Eyes* astrophotography Exhibition. Photo: Garry Copper.

Officer and Tamworth Regional Council Deputy Mayor, Cr Phil Betts, for proposing the competition and to Tamworth Regional Gallery Director, Bridget Guthrie, and her team for setting up what was truly an amazing and immersive display of these stunning astronomical images. A sincere thank you as well to the competition and event sponsors Michael McHugh and Stacks The Law Firm, Tamworth Regional Council and Maxxum Pty Ltd for their wonderful support.

Over this and the following pages, we showcase the winning entries across the various categories, plus a few additional amazing entries, and we think you'll agree these images are certainly on par with some of the finest astronomical photographs captured by amateur and professional astronomers. We hope to conduct similar competitions in the future and thank you once again to all involved for making this such as a successful competition and event!



Featured on the cover of this edition of *Astronomer* is the winning image of the Deep Sky Category, M8 The Lagoon Nebula by Chi Chan. Well done and congratulations Chi!

Category details:

Deep space, also known as 'Deep Sky', refers to astronomical objects found in very distant outer space such as nebulae, galaxies and star clusters. It involves exploring the regions of space distant from the earth. Deep space photographs focus on one main subject in detail whereas some other astrophotography categories show an expanse of space such as the Milky Way. Some favourite objects for deep space imaging include M83 Southern Pin Wheel Galaxy, the Orion Nebula and the Andromeda Galaxy among others.

This field of astrophotography allows us to see views and objects that with other techniques and equipment would remain hidden. Some of the objects are faint and dim through the telescope,

but when photographed show great colour and detail which cannot otherwise be seen.

Camera sensors can record much more light than our eyes can, so when looking at deep space objects through a telescope it becomes obvious that the vibrant colours and contrast we see in the photographs do not show up through an eyepiece. This can be assisted by a technique of 'stacking' or layering multiple images of the same object in an image processing program which clarifies, sharpens and enhances the vividness of dim objects.

Some of the techniques used in deep space astrophotography involve using camera settings to capture long exposure images, enhance the brightness, gain sharp focus, and post camera image processing. Usually the goal is to let in as much light to the camera sensor as possible.



Winner of the Wide Field category is this amazing image of The Pleiades by Ross Giakoumatos. Congratulations Ross on this incredible new 'take' of a wide field favourite!

Category details:

Wide field astrophotographs show an expanse of space such as the Milky Way instead of focussing on one main subject in detail. These photographs include a broad range of objects in a single image to capture the large-scale view or 'skyscape'.

Popular subjects for wide field astrophotography include wide star fields, comets, constellations, planetary alignments, auroras, star trails and meteor showers.

With the increase in accessibility to improved camera technology, it is now easy for anyone to photograph the universe with digital cameras and even smart-phones.

A DSLR camera mounted on a tripod and short exposures are the main requirements to start taking wide field images making this a great option

for beginners. Most photographers also use wide-aperture lenses. To reduce vibrations and camera shake a cable remote or timer release can be used to open and close the shutter for a picture with minimised blurring.

Location is also a key factor when viewing faint objects like the Milky Way, nebulas and galaxies, so dark skies are a must whereas brighter objects can be viewed in moderate light pollution.

Photographing when the Moon is at its dimmest will greatly reduce light pollution resulting in more contrast and detail within the images and bring out the fainter objects. Many amateur astronomers track the phases of the Moon with a Lunar chart to find the nights when it is at its faintest.



Ross Giakoumatos was also the winner of the Comets Category with this fantastic image of Comet Lovejoy. Well done and congratulations once again Ross!

Category Details:

A comet is a small 'dusty snowball' which comes from the cold outer parts of the Solar System and orbits the Sun.

The main part of a comet is called the nucleus and can contain water, methane, nitrogen and other ices and is surrounded by a large cloud of gas and dust known as the coma. The tail of a comet always points away from the Sun. Sunlight and particles streaming away from the Sun, called the Solar Wind, sweep the tails back, away from the Sun. Comet tails can be longer than the distance from the Earth to the Sun.

Some notable comets include:

Comet Halley (1P/Halley) is a famous example of a short-period comet (orbits the sun in less than 200

years) with an orbital period of just 75 to 76 years and was last visible in 1986.

Comet Hale-Bopp (C/1995 O1) in 1997 outshone all but the brightest stars and was visible for 18 months.

Comet McNaught (C/2006 P1) was discovered by Astronomer Robert McNaught at Siding Spring Observatory near Coonabarabran and displayed multiple tails.

Comet Lovejoy (C/2014 Q2) is a long-period comet, discovered on 17 August 2014 by Australian amateur astronomer, Terry Lovejoy.

Comet 46P/Wirtanen is a short period comet that orbits the sun every 5.4 years at an average distance of 3.1 AU.

The speed of a comet can vary a lot, depending on the orbit and where it is in relation to the Sun. The closer they are to the Sun, the faster they're going.



Titled 'Peek a boo' is this stunning image of the Moon occulting Saturn taken by Roger Gifkins which was named as the winner of the Solar System Category. Well done and congratulations Ross!

Category details:

Ancient astronomers believed the Earth was at the centre of the Universe. Today, we know the Sun is at the centre of our Solar System around which the Earth and seven other planets orbit, located in the Orion Arm of the Milky Way Galaxy. Along with the main planets, at least five dwarf planets, more than 170 moons and billions of asteroids and comets exist.

The Sun contains 99.9% of our Solar System's entire mass providing a strong gravitational pull. This gravitational pull causes other objects in our Solar System to be pulled into orbit around the Sun. The path the Sun takes across our sky is known as the Plane of the Ecliptic.

The planets orbit the Sun at different distances, from about 58 million km to about 4.5 billion km.

The planets don't move in perfect circles but in elliptical (oval) orbits.

Known planets: Mercury, Venus, Earth, Mars, (these are called the inner terrestrial or rocky planets) Jupiter, Saturn, Uranus and Neptune (these are called the outer gas giants).



The winning image of the Nightsapes Category was this amazing image titled “The Dish” by David Magro. What an amazing and creative image – congratulations and well done David!

Category details:

Nightscape photography is an area of astrophotography where images of the night sky, Moon, planets, Milky Way, and constellations include an interesting terrestrial object or landscape in the foreground.

This genre is an exciting new field of astrophotography where digital cameras excel and can include celestial bodies and lighting phenomenon like auroras and lightning from nearby storms. Nightscape photographers can use a variety of light sources including Moon light and artificial light sources.

Long exposure camera noise is one of the major challenges, among others, that astrophotographers face.

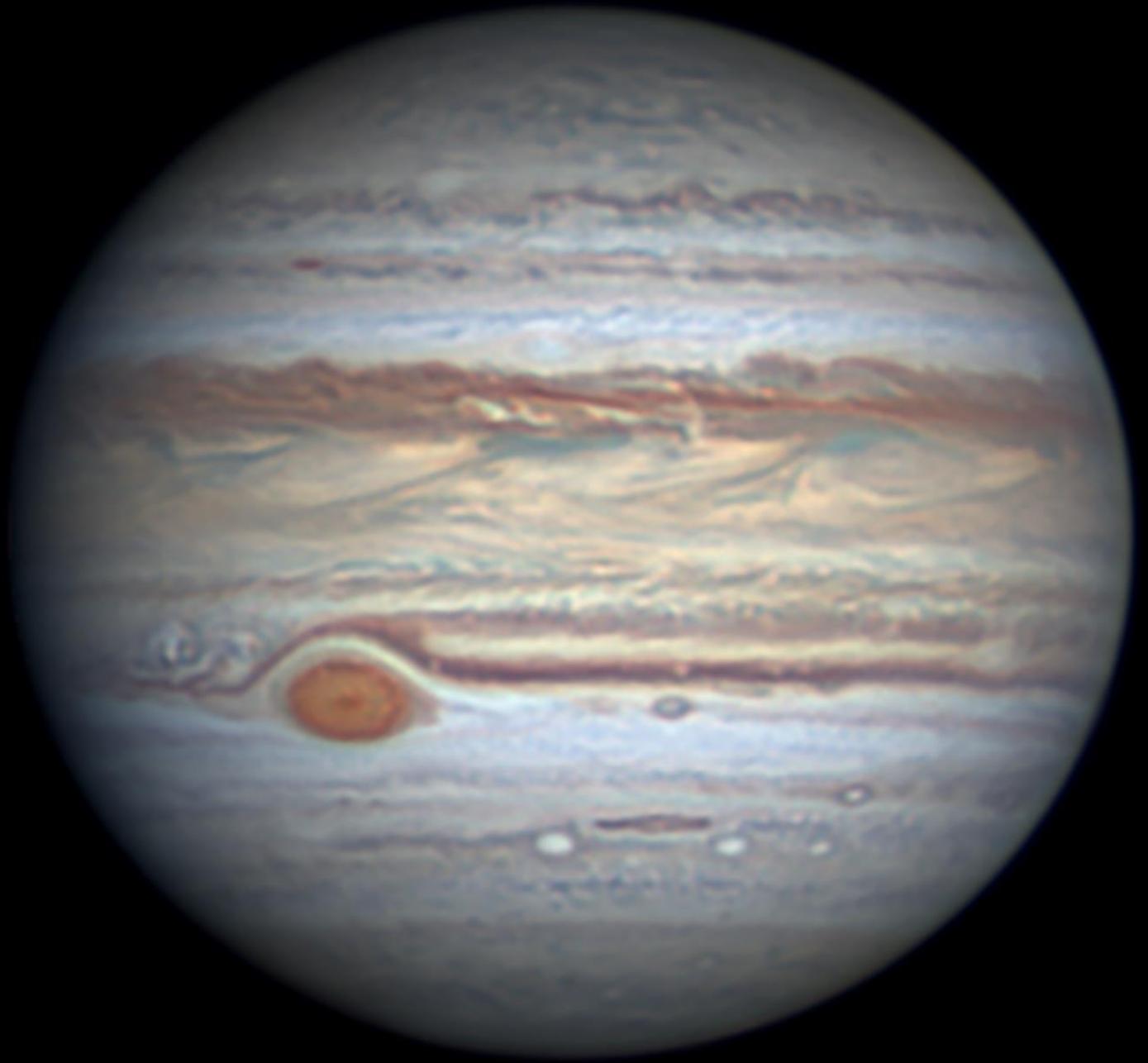
To combat these issues, astrophotographers usually rely on multiple stacked images and post-production using computer software to process images to provide a ‘Wow’ factor. Shooting nightsapes is a very cool way to teach yourself low light photography.



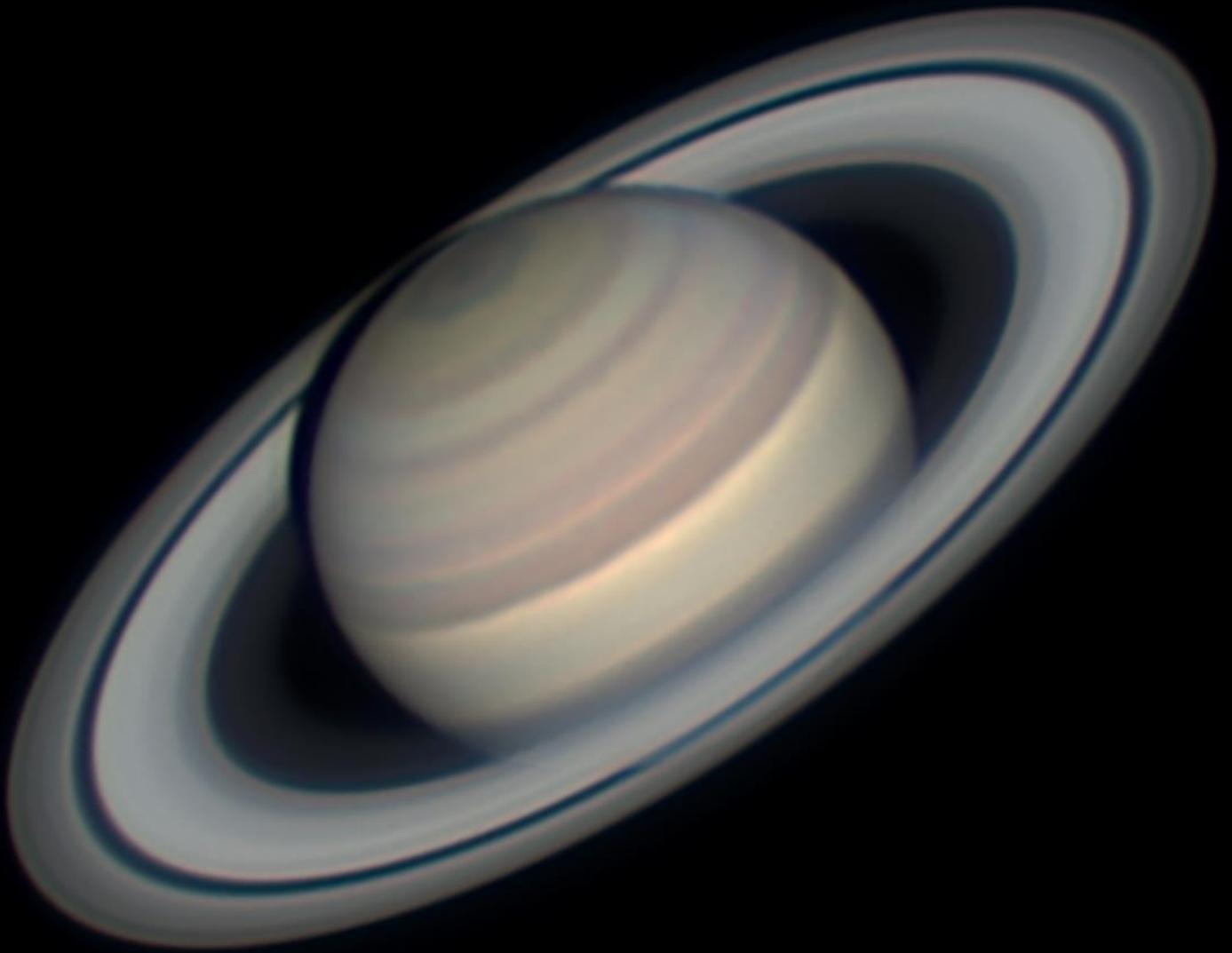
The winner of the Junior Category was Logan Nicholson who produced this remarkable image of the 'Statue of Liberty Nebula'. Congratulations and well done Logan. I think we can safely say the future of astrophotography is in very good hands!



Tamworth Regional Gallery Director, Bridget Guthrie, speaking at the astrophotography Exhibition opening with Astronomer and TRAC Honorary Life Member, Karlie Noon (far left). Photo: Garry Copper.



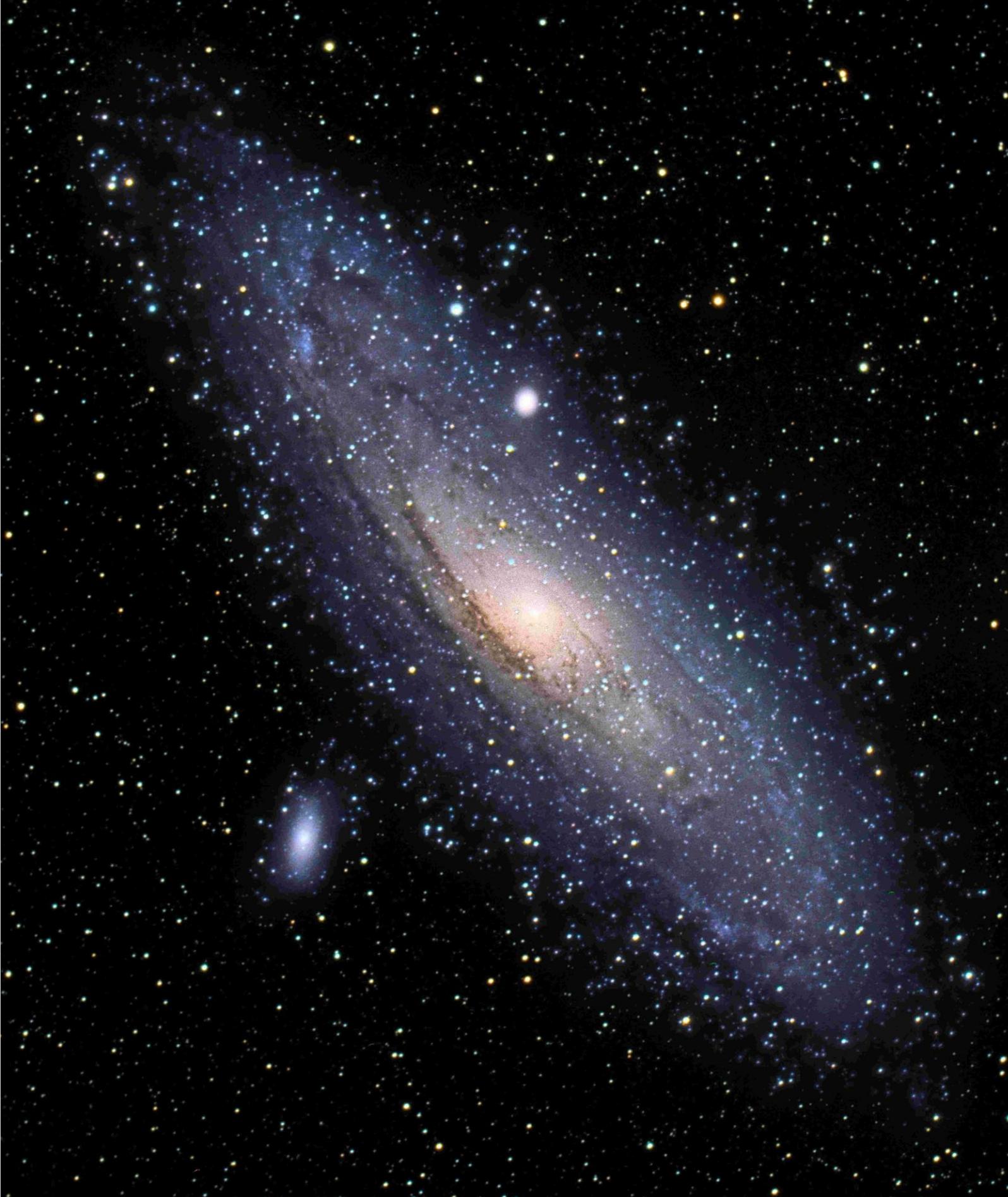
Some amazing additional entries displayed at the *Wonders of the Night Skies Through Our Eyes* Exhibition are provided on this and the following pages. Above: An incredibly detailed image of Jupiter by Niall MacNeill.



Another remarkable entry by Niall MacNeill – a truly stunning image of Saturn!

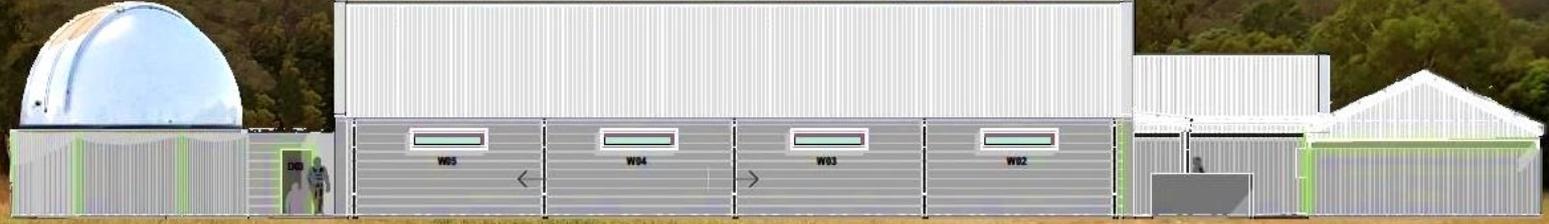


TRAC member Craige Watson's amazing entry titled 'Seeding under the Milky Way'.



TRAC member Ian Hynes submitted this brilliant image of M31, the Andromeda Galaxy. Once again, congratulations and well done to all entrants! ☆

AASEC on track!



Concept image by Garry Copper.

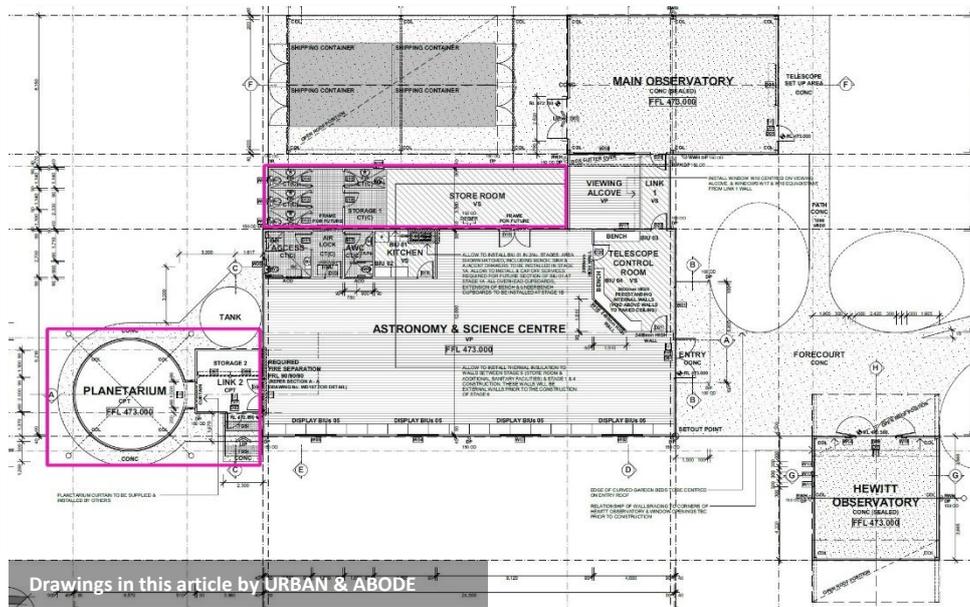
BY TRAC MEMBER GARRY COPPER

Astronomy and Science Centre progress report

A GREAT deal has been happening with the Astronomy and Science Education Centre and Planetarium Theatre, the Roll-off Roof Observatory and Hewitt Camera Observatory development at Victoria Park since the last edition of *Astronomer*. At the time of writing tenders have just been called for by Tamworth Regional Council. TRAC's AASEC Project Manager, Garry Copper, provides an overview of what has happened to date with this exciting project.

Tamworth Regional Council (TRC) was successful in gaining NSW Government Regional Growth Grant Funding for the AASEC project at Victoria Park in East Tamworth initiated by TRAC in 2017.

TRC formed a Project Team in July 2018 for the AASEC, the amenities block near the Tamworth and District Model Engineers facilities and the carpark upgrade. TRAC had a nominated representative on the Council Project Team and moved forward to further develop TRAC's original concept plans with the aid of Councils appointed Architect.



Drawings in this article by URBAN & ABODE

The design was modified to have gable roof designs and included;

1. The AASEC (Astronomy & Science Education Centre) – a large open space building to develop astronomy related tourism displays, provide STEM activities for school education, hold TRAC public events and training sessions, Club meetings etc.
2. The main observatory - a large Roll-off-Roof Observatory facility to house the Club's many telescopes, including the 36 inch Jos Roberts Telescope.
3. The Hewitt Camera Observatory – a split Roll-off-Roof Observatory to house the historic 34inch, 8.5 tonne Hewitt Camera.
4. The Planetarium Theatre – a multipurpose domed theatre for educational/tourism video presentations, since modified to additionally become a fully functional observatory dome.

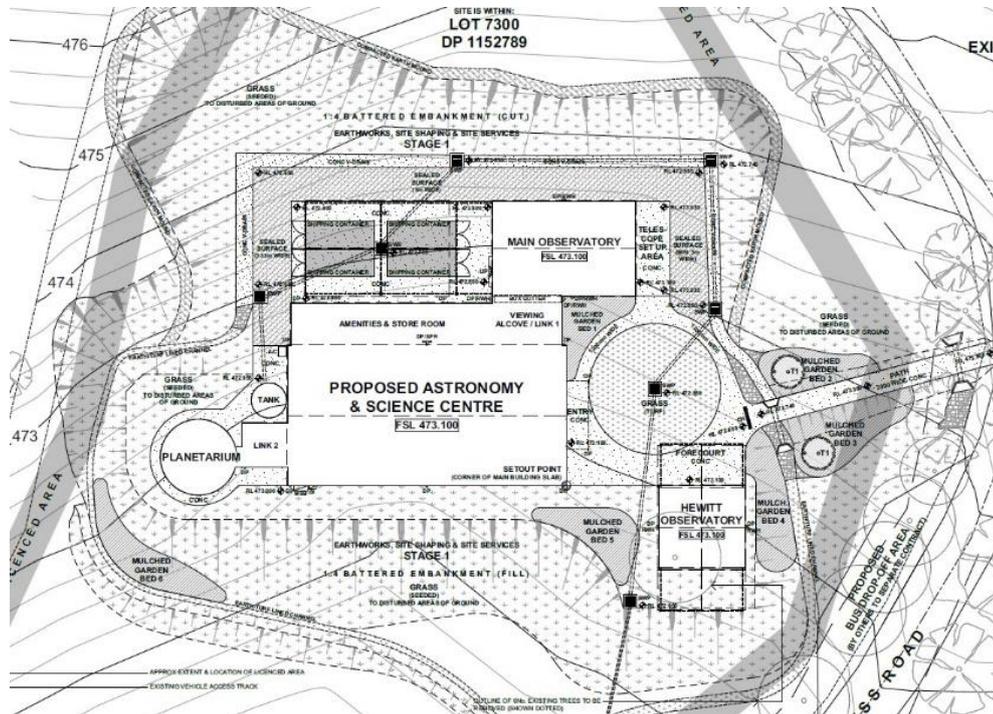
In early 2019, Council called tenders for the final Design and Construction of the Astronomy Complex. Unfortunately, prices came in at approximately double the budget (grant allocation) and Council made the decision to proceed with the final design and construction in-house (using consultants and contractors) and project manage the construction.

Ongoing Project Team meetings ensued through the latter half of 2019 to finalise the design and specification. There were a couple of modifications made to the design. After holding discussions with observatory dome manufacturers, it was decided to reconfigure the Planetarium from a fixed domed roof to a full “University Size” rotating observatory dome. This would allow for astronomy teaching sessions to be held with a reasonably large telescope able to be rolled out and registered in position in the Observatory. Additionally, the dark grey colour scheme for the complex was modified to be a lighter “shale grey”.

It should be noted the floor areas and general layout of the complex has been unchanged from TRAC’s original concept design of 2017, just the roof configurations have been modified.

By February 2020, the revised plans, specification and general site layout were completed and Council is aiming to call tenders on Friday, 28th of February. The aim is to have the tender prices submitted prior to Easter for review and letting of the contracts shortly thereafter. It is anticipated that a build period would be approximately six months.

While this may seem a very drawn out process, as the project is being undertaken by Council, they have to provide very complete documentation, specifications and plans to put the project out to a public tender. In addition, a whole raft of probity requirements have to be met by all government organisations. The fact that the AASEC is a ‘public space’ means it has to comply with a range of DA requirements, fire ratings, disability



and other requirements, plus there are a few intricacies with rolling roofs and observatory fittings that aren’t exactly standard builds.

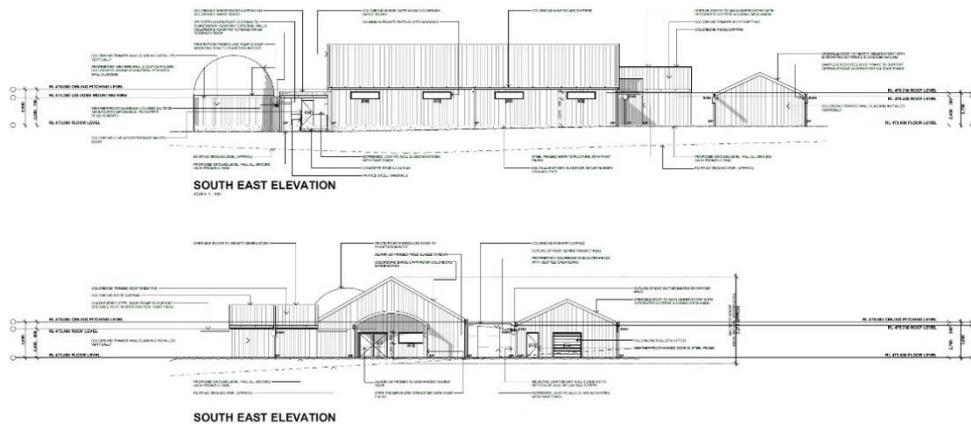
It should also be noted that the Astronomy Complex has been set-up as a possible staged construction and the stages achieved will depend on the tendered prices received. We are reasonably confident of gaining the first three stages but hopefully all four. The grant funding was also specifically for ‘building infrastructure’ only, so final fit-out will still have to be completed by TRAC. There will be plenty of Club work to undertake to finalise the complex – there was

both a funding and in-kind component to the grant application and TRAC undertook to contribute these.

We look forward to the completion of the AASEC

Complex and being able to fully undertake the many activities that members are planning to promote the science of astronomy in the Tamworth region and beyond. ☆

Garry Copper
Vice-President and
TRAC AASEC
Project Manager



TRAC assists UK Defence Science and Technology Laboratory with satellite tracking project Argus 2

AS DETAILED in my 2019 President's Report (page 37), TRAC has been excited to be involved in recent months with the capturing of images of Low Earth Orbit (LEO) and Geostationary Orbit (GEO) satellites as part of project Argus 2 being undertaken by the Defence Science and Technology Laboratory (Dstl), UK Ministry of Defence, in conjunction with the

Basingstoke Astronomical Society. Reprinted below is a media release issued by Dstl on 30 January 2020 regarding Argus 2. At the time of writing, imaging of LEO satellites had just concluded with further images being obtained of GEO satellites, including those being gathered by TRAC's refurbished Hewitt Camera. Further updates will be provided in our monthly newsletter *Observer* and the next edition of *Astronomer*.
Leigh Tschirpig

MEDIA RELEASE

Dstl, UK and Australian Astronomers Collaborate in Deep Space Situational Awareness

Orbiting satellites will be tracked in international experiment by scientists from the UK's Dstl and amateur astronomers from Australia and the UK.

Published 30 January 2020

From: [Defence Science and Technology Laboratory](#)

Operational and retired satellites orbiting more than 36,000 km above the Earth will be tracked in a collaborative international experiment by scientists from the UK's Defence Science and Technology Laboratory (Dstl) and amateur astronomers from Australia and the UK.

Argus 2 is the latest phase of a "citizen science" exercise which assesses the viability of tracking of objects in Space using commercially available cameras and lenses. The experiment is designed to explore affordable options for Space Situational Awareness, the process of tracking objects in orbit and predicting their future paths to help mitigate the risks to UK satellites posed by collisions with debris.

During Argus 1 in 2019 Dstl collaborated with the Basingstoke Astronomical Society (BAS) in the UK to track objects orbiting in the Low Earth orbit (LEO) belt 400km above the Earth. Dstl scientists developed automated image processing tools and in-house orbit estimation software to analyse the large amount of data captured and learned valuable lessons on the surveillance of Space. As part of Argus 2, members of the Tamworth Regional Astronomy Club (TRAC) in Australia will be observing the satellites from the Southern Hemisphere; this is to ensure that results are consistent with those captured by BAS



The Hewitt Camera/telescope will observe satellites in the GEO belt. Photo: Leigh Tschirpig.

from the Northern Hemisphere and to examine the benefits and challenges of processing observations from two sites.

To track objects in the geostationary (GEO) belt, 36,000 km above the Earth, the Australians will be utilising one of the only two historic 34 inch Hewitt camera/telescopes designed by the Radar Research Establishment in Malvern, Worcestershire, and built by Grubb Parsons. The powerful, 8.5 tonne telescope with 24 inch aperture and f1 focal ratio was developed in the late

1950s to monitor the early generation of satellites.

As part of the project the astronomers will also be observing redundant satellites which have reached the end of their operational life. In accordance with international guidelines such satellites are moved 300 km beyond GEO to the Super-GEO satellite belt, a Space "graveyard". Once there they cannot directly collide with operational satellites in GEO, however the long term motion of these satellites is unknown. Argus 2 aims to better understand the evolution of the debris population to assess the risk posed to satellites critical to the UK that help underpin so much of modern life.

Mike O'Callaghan, Dstl's Space Programme Manager, said: "Space Situational Awareness is fundamental to protecting the operation and security of Space satellites. As Space becomes more crowded the likelihood of collisions increases. By observing current satellites we can help predict how they may behave in future and design measures to avoid collision. The data gathered with BAS was extremely useful and we look forward to adding a new dimension with the Australians."

Trevor Gainey from BAS added: "We enjoyed participating in the original Argus 1 project and testing our observational skills. We have more members interested in this follow-on project so are hoping for clear skies."

TRAC Publicity Officer and Tamworth Regional Council Deputy Mayor, Cr Phil Betts, said the Club was delighted to have the opportunity to assist with this international collaborative project and contribute to the important work being undertaken by Dstl and BAS to help address the risk of possible collisions between satellites.

Cr Betts said TRAC's involvement in Argus 2, which has the support of the Australian Department of Defence, will see Club members making a valuable contribution to this important field of Space research, utilising equipment ranging from DSLR cameras and amateur telescopes to the Club's recently restored and upgraded Hewitt Camera.

"The Argus 2 project provides TRAC members with a great opportunity to use their observational skills and equipment for this important research program and may pave the way for similar pro/am and citizen science collaborations in the future, particularly with the Astronomy and Science and Education Centre, Planetarium Theatre and Roll-off Roof Observatory project at Victoria Park in Tamworth set to commence construction this year which will become the Club's home base," Cr Betts said. ☆

Is there a relationship between auroras and lightning?

By TRAC member Dr Garry Bott



Photo: Garry Bott.

Shot by Bott

THE ANSWER is maybe.

We know that auroras are the result of the interaction of the Earth's magnetic field and the solar wind and its associated magnetic field, often called the interplanetary magnetic field.

There is also a possibility that lightning discharges, like the one photographed on the next page, are a result of cosmic rays ionizing the air between the cloud and the ground. Cosmic rays are high energy particles which have their origin from outside of the Solar System. Violent events like supernovae spew very high energy particles into the universe.

The solar wind, with the Sun as its source, provides a protective canopy over the Earth. It is known that the Voyager 1 and Voyager 2 space

probes as they have left the Sun's influence are now being bombarded with cosmic rays!

However, the Sun is currently in a solar minimum. Measurements are made of sunspot numbers and we know that currently these numbers are very small. We have measurements dating back 400 years. The number of spotless days in 2018 were 221 (61%). This also means that the incidence of auroras has decreased significantly and the solar wind has diminished.

So, what is the relationship between cosmic rays and the solar wind?

Well, the solar wind helps protect the earth from cosmic rays. Instruments onboard NASA's Lunar Reconnaissance Orbiter have found that cosmic rays are reaching levels in the Earth-Moon system which have never been seen before in the Space Age.



Photo: Garry Bott.

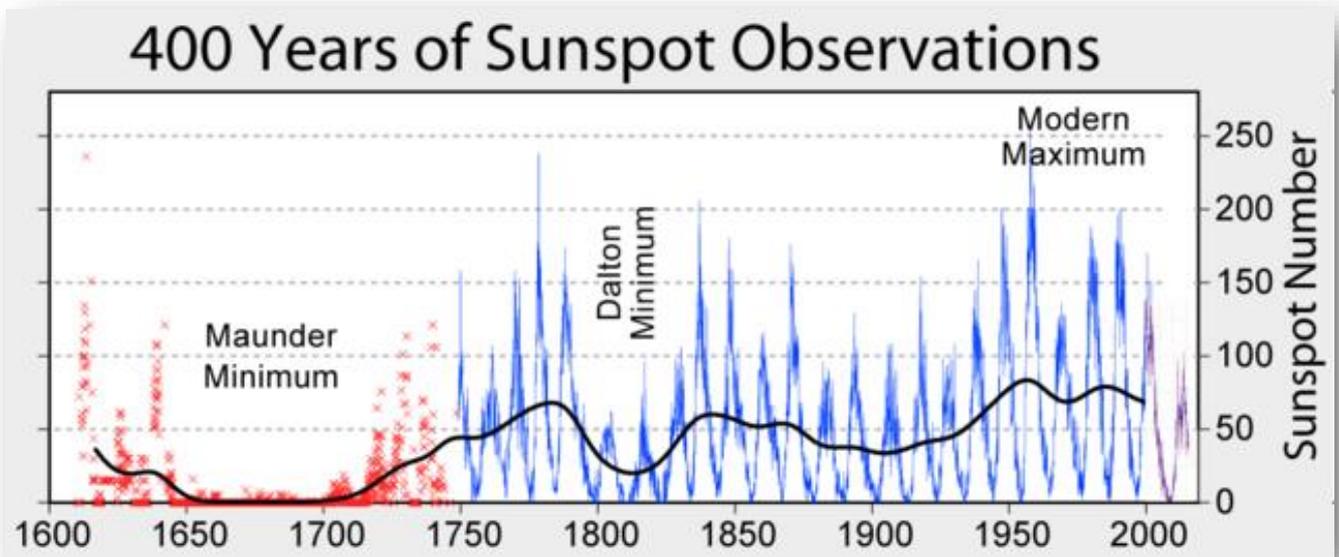


Image credit: Robert A. Rohde. Source: https://commons.wikimedia.org/wiki/File:Sunspot_Numbers.png

In the 1990's an astronaut could spend 1,000 days in space with normal shielding around him. In 2014 it was only 700 and the situation is worsening.

While we are all not astronauts, there is an impact for us! Flight crews are now being exposed to much higher levels of radiation. It is known that cloud formation on Earth has some of its origin from cosmic rays, so the Earth may have more cloud. Are we also going to see larger electrical storms?

We are currently experiencing fewer auroras. There are many more cosmic rays hitting Earth. Are we seeing other effects in our world? ☆

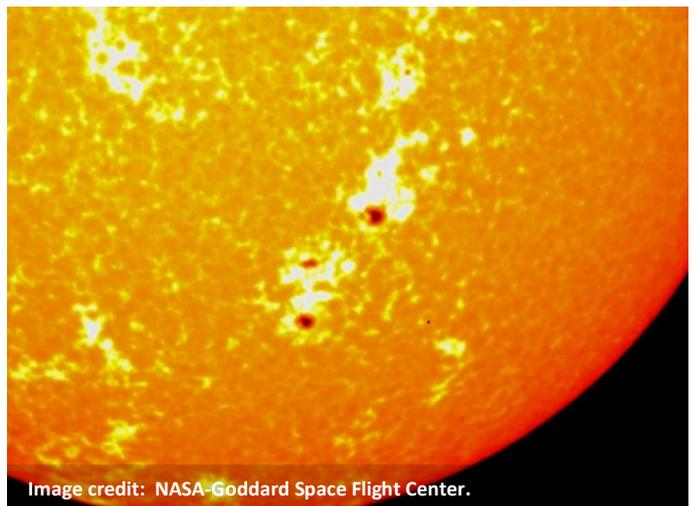
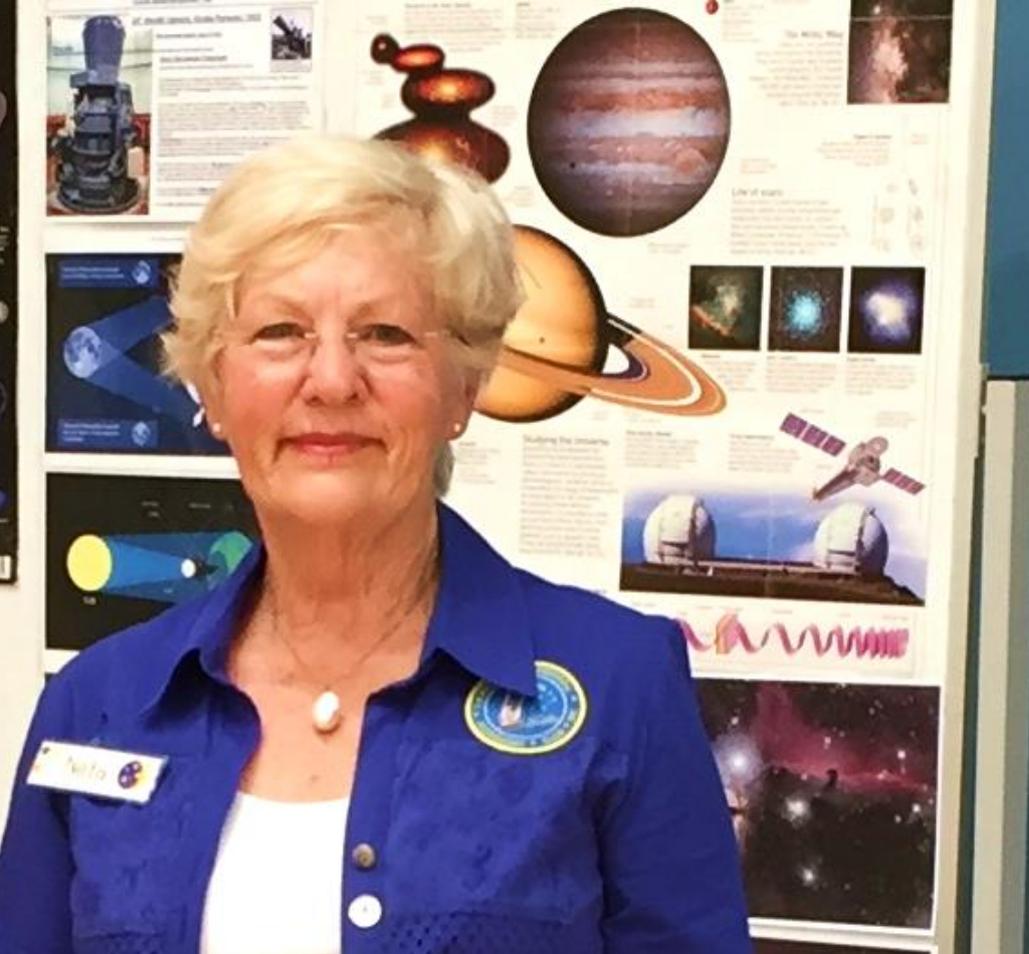


Image credit: NASA-Goddard Space Flight Center.

Neta Horniman

Member Profile

BY WARWICK SCHOFIELD



Photos on this page by Garry Copper.

Neta Horniman was born in Sydney and attended Liverpool Girl's High and Gosford High Schools.

In her early years and after Tech, Neta worked as a personal secretary, office manager, machine operator and accounts manager. She was always interested in accounting machines and mechanical devices, their components and how they worked. Later, Neta enjoyed outback touring for a year with her young family and was captivated by the night skies and often wondered how she could learn more!

Living for some time in Broken Hill and enjoying the dark night skies, Neta vividly recalls seeing Halley's Comet in 1986. The move to Tamworth saw Neta working in schools, working as a volunteer in various community groups, including the 2000 Olympics and Paralympics, and as a personal assistant and travel guide on outback tours.

Neta is a Life Member of TRAC and has assisted in the development of the Hewitt Schmidt Camera project, the Astrophotography Committee, the Starr Touring Planetarium project and most other TRAC activities. Thanks Neta, you are a true contributor! ☆



Neta Horniman with fellow TRAC members Geoff Tall (top left), Phil Betts and TRAC supporter Rachel Peake.

Very Large Telescope - Australia's role

By TRAC member Dr Ray Hare

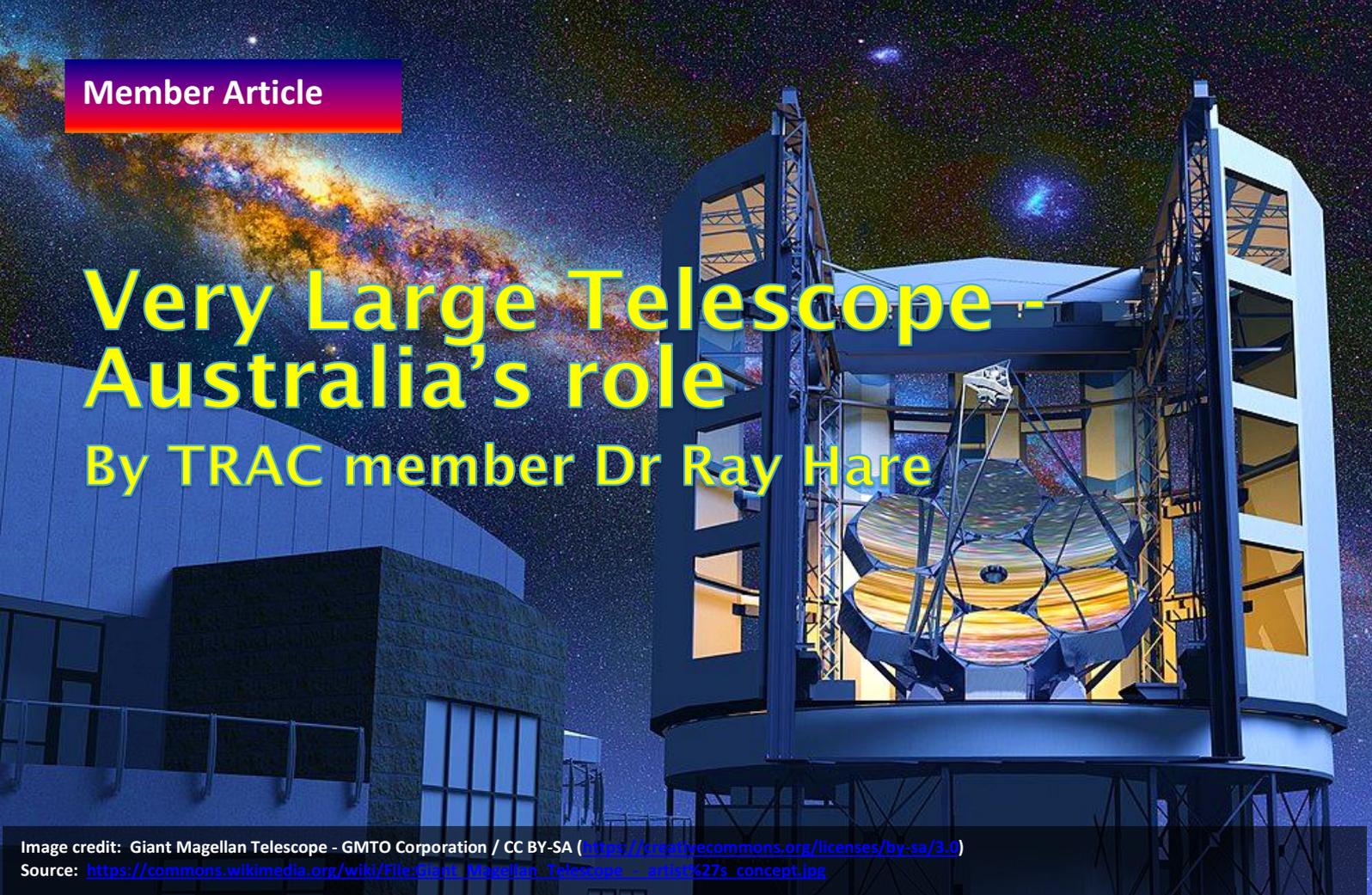


Image credit: Giant Magellan Telescope - GMTO Corporation / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>)
 Source: https://commons.wikimedia.org/wiki/File:Giant_Magellan_Telescope_-_artist%27s_concept.jpg

Astronomers around the world are designing and building very large optical telescopes to meet the needs of their future research projects. These telescopes are very expensive to design, build and operate and consequently each instrument involves funding from international partners. An individual country cannot justify the full expenditure alone, in the order of \$1 billion to \$1.5 billion. Three telescopes are expected to

commence operation (called 'first light' by astronomers) by 2029.

The Australian Government's science budget is contributing funds for a share of access to one of these telescopes. This access will allow Australian astronomers observing time on this instrument, known as the Giant Magellan Telescope (GMT). The international partners involved with this telescope include the US, Brazil, South Korea and Australia, contributing an estimated final construction cost of US\$1.05 billion with an expected completion date of 2029.

The reason astronomers require very large telescopes is that distant astronomical objects are so far away from Earth (millions to billions of light years distant) that their light is exceedingly faint. To form an image of these extremely distant objects, a large telescope is needed to focus the tiny amount of light onto a highly sensitive detector. The more light collected at the telescope's detector, the more detailed information can be gained about the object.

Astronomers like to observe really distant objects as they are looking back in time, even close to the beginning of the known Universe. The light from these objects left the stars within these distant galaxies billions of years ago. It has taken the light all this time to reach Earth.

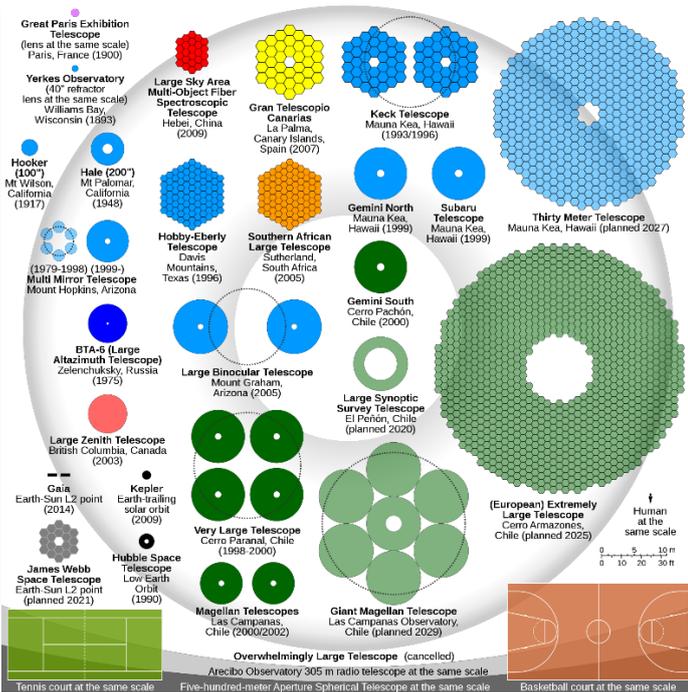


Image credit: Cmglee / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>)
 Source: https://commons.wikimedia.org/wiki/File:Comparison_optical_telescope_primary_mirrors.svg



Site of the Giant Magellan Telescope, Las Campanas Observatory.

Image credit: Krzysztof Ulaczyk (more work on Wikimedia Commons: Kszulogaleria) / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0/>)
Source: <https://commons.wikimedia.org/wiki/File:cc.jpg>

The GMT will have seven 8.4 metre primary mirrors, forming the equivalent of a single mirror 24.5 metres in diameter. Compare this to Australia's largest telescope, the Anglo-Australian Telescope (AAT) at Siding Spring Observatory which has a single primary mirror 3.9 metres in diameter. The GMT will have a light collecting area forty times that of the AAT. Forty times more light energy will fall on the detector of the GMT compared to that of the AAT. Far fainter objects can be resolved by the GMT.

The construction of these massive telescopes, which in the case of the GMT has a moving weight of some 1,500 tonnes, requires advanced mechanical, electronic and optical engineering and science. The GMT's seven 8.4 metre mirror sections must be aligned to a very high degree of accuracy to enable all of the mirrors to operate as a 24.5 metre mirror. To obtain a clear image and overcome the 'twinkle effect' of the atmosphere, engineers use laser technology and highly sensitive servo motors to continuously and quickly adjust the alignment of the primary mirror sections to compensate for the 'twinkle effect'. This rapid mirror adjustment is called adaptive optics, and provides images close to those given by telescopes in space, such as the Hubble Space Telescope. Land based telescopes can now overcome most of the limitations of observing through the Earth's atmosphere. Further, land based telescopes, which are much bigger than those in space, can be modified and serviced with comparative ease and are likely to remain in active service for a greater period.

The location of these large telescopes is very important. The GMT is being built at high altitude in the very dry Atacama Desert of northern Chile, at Cerro Las Campanas, 2,520 metres above sea level. This location provides very clear, dry skies free of haze and cloud producing water vapour, no light pollution as nobody lives in such an inhospitable place and an atmosphere that has very little 'twinkle' as the prevailing air flow is laminar coming from the west off the Pacific Ocean. The ocean is relatively flat compared to the land surface and does not impose significant hot air turbulence in the air at higher altitudes, resulting in a reduced 'twinkle effect'.

Astronomers push the boundaries of technology in the pursuit of a better knowledge of the Universe, the place where we live. Such a pursuit requires ever continuing improvements in optics, electronic detectors and computers, to name a few. In the recent past, such astronomical demanded improvements have given the world community high quality digital cameras and WI-FI communication, both used in our smart phones as well as numerous other devices. Australian CSIRO astrophysicist Dr John O'Sullivan and others invented WI-FI. Investment in astronomy does yield very real and valuable practical returns apart from a greater understanding of the marvellous Universe that we live in. It has been said, "the sky above is a significant part of our environment to admire and understand". Further information about the GMT project is available online at: <https://www.gmto.org/overview/> ☆

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

Is There Anybody Out There? The Drake Equation

By TRAC member Grant Quinn

Image source: <https://www.flickr.com/photos/kevinmgill/14486519161>
 © 2014 KEVIN M. GILL WWW.APOAPSYS.COM EUROPA IMAGE: NASA/JPL/TED STRYK

FRANK DRAKE is an American Astronomer who was one of the first to take seriously the question, “Is there intelligent life elsewhere in the galaxy?”

Drake was born in 1930 and began wondering about the possibility of extra-terrestrial civilisations as a child after learning that our Sun is one of billions of stars in the Milky Way Galaxy.

While organising a conference to push for the scientific search for ET in 1961, Drake realised that each of the important issues to be discussed could be expressed as a number. This became the famous Drake Equation, which can be used to estimate the number of detectable civilisations in our galaxy:

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

R_* - The Average Rate of Star Formation

For there to be a civilisation, there needs to be a star for the planets to orbit. Drake estimated that on average one new star formed in the Milky Way every year. Latest estimates are that between 0.7 and 1.45 solar masses of material form new stars each year and the average star is 0.5 of a solar mass. This gives us between 1.5 - 3 new stars being formed each year.

f_p - The Fraction of Those Stars that Have Planets

This was long before scientists such as Tamworth’s own Dr Stephen Kane confirmed that exoplanets do exist. Drake’s original estimate was that perhaps 20% to 50% of stars have a planetary system. We now know

that the fraction of stars that have orbiting planets is very close to 100%.

n_e - The Average Number of Planets that Can Support Life

This is difficult to estimate. Some stars are too volatile, giving off frequent bursts of radiation. The planets have to be in the “Goldilocks” zone, not too hot, not too cold, but just the right distance from the star to allow liquid water. The planets also need to contain the right heavy elements to allow life to form. Drake’s estimate was between 3-5 planets per planetary system. Modern estimates are lower, assuming only 10% - 40% of systems contain a single planet capable of supporting life.

f_l - Fraction of Planets that Can Support Life that Do Develop Life

Life began on Earth quite early, leading us to perhaps think that if a planet can support life, then the development of life may be inevitable. However, a sample size of one is not very large. A counterargument is that life appears to have started on Earth only once (all living things share at least some DNA. If we were to detect even microscopic life elsewhere in our Solar System (Mars, Europa, Titan and Enceladus being the best candidates) then this would lend weight to the theory that life is ubiquitous. Drake’s estimate for this number was 100% and this remains the most common assumption.



Globular star cluster 47 Tucanae

Image credit: NASA/ESA/Hubble Heritage Source: <https://exoplanets.nasa.gov/news/744/fantastic-alien-civilizations-and-where-to-find-them/>

f_i - The Proportion of Planets that Have Life Where Intelligent Life Develops

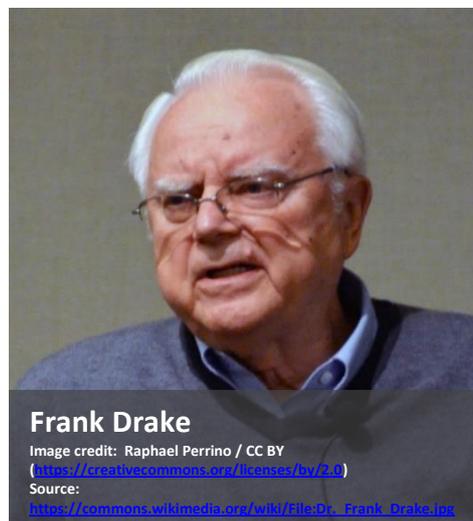
Using Earth as an example, one would be tempted to say that once life develops, intelligent life is inevitable. The counterargument is that of all the billions of species on Earth, only one branch (humanity) developed intelligence, and that only one intelligent species (homo sapiens) has survived. Drake's estimate was 100%. Modern estimates vary between virtually 0 and 100%.

f_c - The Fraction of Civilisations that Develop Technology that Can Be Detected

Earth has sent very few deliberate signals into space, and none of those we have sent have reached their destination. We have also attached plaques and records to the Pioneer and Voyager probes, but the chances of them ever being discovered are vanishingly small. We have sent plenty of accidental signals into space via TV and Radio broadcasts since the 1920's however these are very weak and would only be able to be discovered within a radius of one light year. The nearest star is 4 light years away. Also, humanity is quickly moving away from technology that broadcasts electromagnetic waves into space. Drake estimated that between 10-20% of planets would develop technology that could be detected.

L - Lifetime of a Civilisation

How long does a civilisation last? Do they use their technology to save or destroy? Can any civilisation



Frank Drake

Image credit: Raphael Perrino / CC BY
(<https://creativecommons.org/licenses/by/3.0/>)
Source: https://commons.wikimedia.org/wiki/File:Frank_Drake.jpg

become so advanced that it becomes indestructible? Drake's estimate was between 1,000 and 100,000,000 years. Modern estimates range from 300 years to 10 billion years.

How Many?

Drake and his colleagues estimated there would be between 20 and 50 million civilisations in the galaxy at any one time. Modern estimates tend to be lower, between 0 and 15 million. So where are they? Despite all the efforts so far and advances in detection of exoplanets, no evidence has been uncovered that points to life, intelligent or otherwise, anywhere else in the galaxy. I will leave the final word to Monty Python, "pray that there's intelligent life somewhere out in space, 'cause there's bugger all down here on Earth." ☆

Pitcairn Islands' International Dark Sky Sanctuary

By TRAC member Steve Rogers

The amazing view from the Pitcairn Island School.
Photo: Di Rogers.

THE PITCAIRN ISLANDS have exceptionally stunning dark skies, free from all light pollution. In late 2018 the Government of Pitcairn Islands made application to the International Dark-Sky Association (IDA) for the four islands in the Pitcairn Islands group to be granted the status of an International Dark Sky Sanctuary (IDSS). On March 18th 2019 the IDA formally approved Mata ki te Rangi being designated an official International Dark Sky Sanctuary.

It is currently the only island group in the world to be listed as an IDSS.

Mata ke ti Rangi – Eyes to the Sky International Dark Sky Sanctuary encompasses all four islands in the Pitcairn Islands

Group, a total land area of 43.25 sq km.

Pitcairn is one of the four islands in the Pitcairn Islands Group. The other three islands, Oeno, Henderson and Ducie, are uninhabited. Henderson is a UNESCO World Heritage site, home to many endemic species of flowering plants, birds and insects. All four islands are surrounded by a Marine Protected Area. At 834,000 sq km, it is the world's third largest such area.

Pitcairn Island itself is one of the world's most remote inhabited islands. It lies in the South

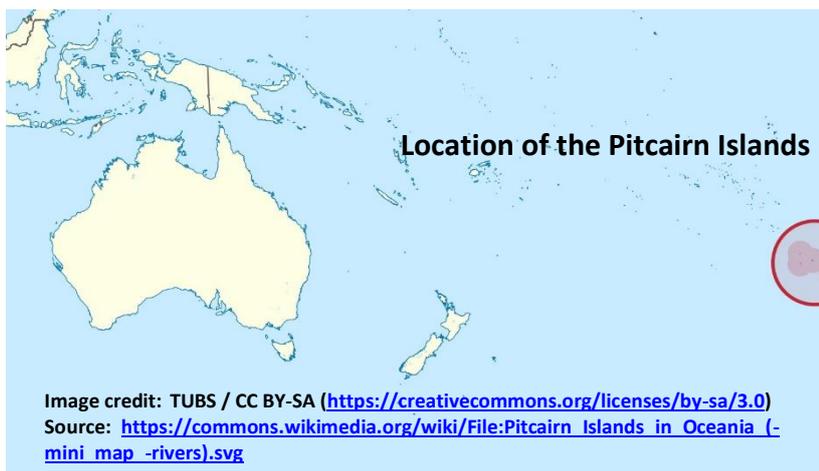
Pacific approximately 2,300 km east of Tahiti and 6,500 km west of northern Chile. At latitude 25.1 degrees, it is just south of the Tropic of Capricorn, the climate and vegetation are sub-tropical.

The Pitcairn Islands group has a rich history but Pitcairn itself is best known for the place where the mutineers of HMAV Bounty chose to settle in January 1790, together with 12 Polynesian women and six Polynesian men, mainly from Tahiti.

Today the population of Pitcairn is less than 50, although the population reached a maximum of over 230 in the 1930s. It has been declining steadily since and the government has initiated a repopulation strategy.

Pitcairn Island has been working toward this application since

August 2017. Small Astro-tourism ventures are currently being established as a new activity to help boost the island's visitor economy. A start has been made to train a small group of islanders in the essentials of star-gazing and using telescopes and binoculars.





The three students of the Pitcairn Island School.

Photos on this page: Di Rogers.

The March 2019 designation by the IDA makes the Pitcairn Islands only the eighth International Dark Sky Sanctuary on earth. Additionally, the Pitcairn Islands Group is the first British Overseas Territory to have been granted IDA Dark Sky Sanctuary status

The Tamworth Regional Astronomy Club (TRAC), has recently donated a small telescope to the children of Pitcairn Island. TRAC member Di Rogers' Grandmother was born on Pitcairn, and earlier this year Di was able to visit the Island. Currently, there are only three children at the school. The Club hopes that this telescope will help to encourage a love of astronomy in the children. ☆



Backpacks belonging to the three Pitcairn Island school children.

Murchison Meteorite

50th Anniversary

By TRAC member Chris Wyatt

A fragment of the Murchison Meteorite displaying a 'Roll over lip' caused by ablation during entry.
Photo courtesy of owner Tony Forsyth.

ON THE 28th September 1969, in Murchison, Victoria, at around 10:58am a bright orange fireball was seen streaking across the South-Eastern sky splitting into pieces and leaving a lingering trail of blue smoke behind it. Not long after a sonic boom was heard, the tell-tale sign that a meteorite survived atmospheric entry. Fragments of the falling meteor were strewn over 13 square kilometres across the township and surrounding countryside. Soon afterwards fragments were being recovered, eventually over 100 kilograms in total were found with the largest specimen being 7 kilograms. The meteorite was unique in that it had a strong aroma, similar to methylated spirits.

The meteorite is a "Carbonaceous Chondrite" (CM₂), a rare type of stony meteorite rich in carbon compounds, small round pre-solar grains called 'Chondrules' and a very high water content of 12%. The complex organic (carbon-based) molecules give rise to its dark colour. Over 100 Amino acids, the building blocks of life, were discovered and surprisingly only 20 are known to exist on Earth. Could this be a key to the origin of life in the early Solar System?

It also has small white round specks embedded known as Calcium-Aluminium Inclusions (CAI's), which formed in the pre-solar nebula, indicative that it has not been subjected to high temperatures and pressures and remained chemically pristine.

So where did it come from?

Visual reports at the time indicated the meteor came in from a low angle, the entry velocity was a slow 13 km/sec relative to Earth. An orbit was approximated and traced back to a few possible candidates, interestingly including comet 15P/Finlay. Comets are rich in carbon and water and they follow elliptical orbits. Material shed from comets are usually small, light and fragile and don't usually survive atmospheric entry, although the chemistry was a good match. Asteroids are known producers of meteorites but their orbits are relatively more circular than cometary ones. Attention turned to an Earth-crossing (Apollo type) Asteroid discovered in late December 1979 and designated '1979 VA'. Reflectance spectroscopy identified this asteroid as a carbonaceous type (C-class asteroid), that typically orbit on the outer rim of the asteroid belt.



Photo: Tony Forsyth.



Meteorite Park at Murchison, Victoria.

Image credit: Mattinbgn / CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>)

Source: <https://commons.wikimedia.org/wiki/File:MurchisonMeteoritePark.JPG>

In the early 1990's researchers found that 1979 VA's orbit matched up to a comet discovered by astronomers Wilson and Harrington on photographic plates, displaying a coma and tail, from Palomar Observatory in 1949. Only a few observations of this newly discovered short-period

comet were recorded and its orbit couldn't be refined and subsequently wasn't recovered on its next predicted return and became 'lost'.

It was unknowingly re-discovered in 1979 not as an active comet but an asteroid. After subsequent returns, every 4.3 years, it was given a permanent asteroidal designation (4015) 1979 VA, before it was finally linked to the orbit of lost comet Wilson-Harrington, now doubly known as Comet 107P/ Wilson-Harrington and Asteroid (4015) Wilson-Harrington.

Could the asteroid in fact be a dormant comet nucleus? Could the Murchison meteorite have originated as a fragment ejected from the nucleus during a period of relatively recent cometary activity?

Interestingly, the Murchison is one of the most studied meteorites in the world and continues to be studied today. The abundance of Amino acids from this meteorite helped trigger the science mission 'Rosetta' to the comet 67P in search for the origins of life (2014-2016). ☆

References:

<http://adsabs.harvard.edu/full/1990Metic..25..341S>

https://en.m.wikipedia.org/wiki/4015_Wilson-Harrington

<http://adsabs.harvard.edu/full/1988JIMO...16..111S>



Fragment of the Murchison Meteorite.

Image credit: Jon Taylor / CC BY-SA

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Source:

https://upload.wikimedia.org/wikipedia/commons/a/ad/Murchison_meteorite_0.459g.jpg

A very special donation

By TRAC President Leigh Tschirpig

Photo By Stuart Goff

IN FEBRUARY 2019, the members of the Tamworth Regional Astronomy Club were deeply saddened by the sudden passing of one of our Club's founding members, Stuart Goff. Stuart was a great friend over many years and a highly regarded local builder, amateur astronomer, telescope maker and astrophotographer whose photos of the night sky were truly stunning. At the time of his passing, Stuart was in the process of completing the construction of a high quality, short focus telescope which he was planning to

install on an equally high quality computer controlled telescope mount with the intention of taking high resolution digital images of deep sky celestial objects such as galaxies, nebulae, star clusters and other astronomical wonders.

In the weeks that followed, Stuart's family indicated to TRAC they would like to see his collection of astronomical instruments being used as they were intended, rather than gathering dust, and TRAC subsequently offered to purchase Stuart's telescope, together with another telescope he had also recently re-built for visual observing. These were acquired with a view to installing them at the Astronomy and Science Education Centre and Planetarium Theatre complex (AASEC) to be constructed at Victoria Park, Tamworth next year. The Club then began to look at raising some additional funds to make an offer to purchase Stuart's computer controlled mount.



Left to right: Sharon and Amber Goff, Tamworth Lions Club Immediate Past President Mick Evans and TRAC President Leigh Tschirpig.



The late Stuart Goff was passionate about astronomy, a keen astrophotographer and was actively involved in all aspects of TRAC's operations.

Photo: Garry Copper

It was around this time our Club received the fantastic news that the Lions Club of Tamworth had taken a decision to donate \$2,000 to TRAC to assist with our aim to promote the science of astronomy in the Tamworth Region. This generous donation allowed the Club to acquire Stuart's computerised mount and will now see his imaging telescope and mount assembled and put to very good use by TRAC.

On Thursday, 11 October, Stuart's wife Sharon and daughter Amber, along with the Immediate Past President of the Lions Club of Tamworth, Mick Evans, attended a special evening with members of TRAC at which our Club extended its sincere thanks to the Tamworth Lions Club members and the Goff family for the opportunity to acquire these high quality astronomical instruments which will be used for research, public outreach and educational purposes at the AASEC complex. The Club also expressed its thanks to TRAC member Steve Rogers, who is also a member of the Tamworth Lions Club, for arranging an astronomy evening and dinner with local Lions Club members last year and who has fostered the wonderful links between our organisations.

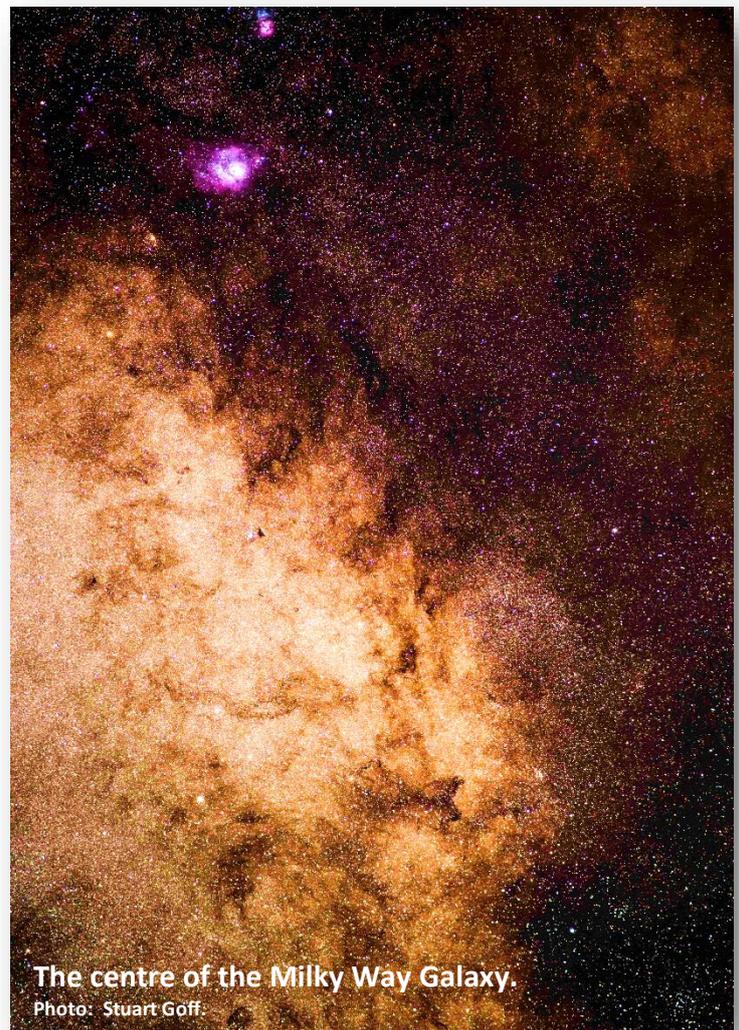
Our members will be forever grateful for Stuart's many contributions to the establishment of TRAC, having served as our inaugural Treasurer, coordinated and conducted the Club's first two astrophotography courses and provided an enormous amount of technical, construction,

observational work and advice on just about every facet of the Club's operations. Stuart always enthusiastically and freely shared his many years of experience in the field of astronomy and astrophotography for the benefit of anyone interested in learning more about our amazing universe.

The Club will always be grateful too for the generosity of the Lions Club of Tamworth and the Goff family for their wonderful assistance in enabling TRAC to acquire Stuart's telescopes and mount, which will carry his name in the AASEC facility, and will be a very important part of the array of telescopes to be installed at the

complex. Once again, a sincere thank you to all involved.

Finally, vale and thank you Stuart - mate, we miss you.



The centre of the Milky Way Galaxy.

Photo: Stuart Goff

Solar astronomy

By TRAC member Grant Quinn



Image credit: NASA Goddard Space Flight Center
 Source: https://en.wikipedia.org/wiki/File:Magnificent_CME_Ejects_on_the_Sun_-_August_31.jpg

YOU MIGHT think astronomers are a bit like vampires, only appearing at night, but if done safely, solar astronomy can be an interesting and more time friendly part of the science.

Firstly, **ONLY USE SPECIALLY DESIGNED SOLAR OBSERVATION EQUIPMENT.** Never look at the Sun directly, even through sunglasses or welding goggles. Especially never look at the Sun through a normal telescope or binoculars, **YOU WILL PERMANENTLY DAMAGE YOUR EYES.**

The Sun is huge compared to the Earth and the rest of the Solar System, making up 99.86% of the matter in the Solar System. You could fit 1,300,000 Earths inside the Sun. If the Sun were the size of a basketball, the Earth would be as big as a sesame seed and orbit at a distance of 25m.

At the core of the Sun, gravity is so immense that hydrogen is being turned into helium via nuclear fusion (the stuff in your party balloons was created in another star billions of years ago). The heat and light created as part of this process takes hundreds of thousands of years to reach the surface of the Sun, but only eight minutes to travel from the Sun to the Earth. The heat creates rising bubbles of gas, giving the surface a bumpy appearance similar to the skin of an orange.

You might remember from your school days sprinkling some iron filings around a magnet and

seeing them line up with the magnetic field in big loops from North to South. The Earth has a magnetic field as well, caused by iron and nickel in the molten core, this is what allows us to find our direction using a compass. The Sun's magnetic field is much more complex and active. This magnetic field drives many of the features we can observe with our solar telescopes.

Sunspots are "cooler" areas of the Sun's surface (but still 4,500° Celsius), they appear where the lines of magnetic force enter the surface of the Sun. The number of sunspots rise and fall in an 11 year cycle. Though they appear as small dots on the surface, many are as big as the entire Earth.

Prominences are loops of gas that leap out from and return to the Sun's surface, following the lines of magnetic force. When a prominence is facing the Earth it appears like a dark line and is called a filament.

These prominences can appear then disappear within a brief 30 minute observation.

Solar flares are when the gas escapes from the surface of the Sun and flows out into space. When these charged particles hit the Earth's atmosphere they cause the impressive light displays known as the Aurora Australis (Southern Lights) and Aurora Borealis (Northern Lights).

TRAC members have access to several solar telescopes and any schools in the Tamworth area that would like their students to observe the Sun in a safe, guided manner are welcome to contact us at TRACschools@gmail.com ☆



Image credit: NASA/SDO (AIA)
 Source: http://sdo.gsfc.nasa.gov/assets/img/browse/2010/08/19/20100819_003221_4096_0304.jpg

Dark Sky Dreamings an Inland Skywriters Anthology

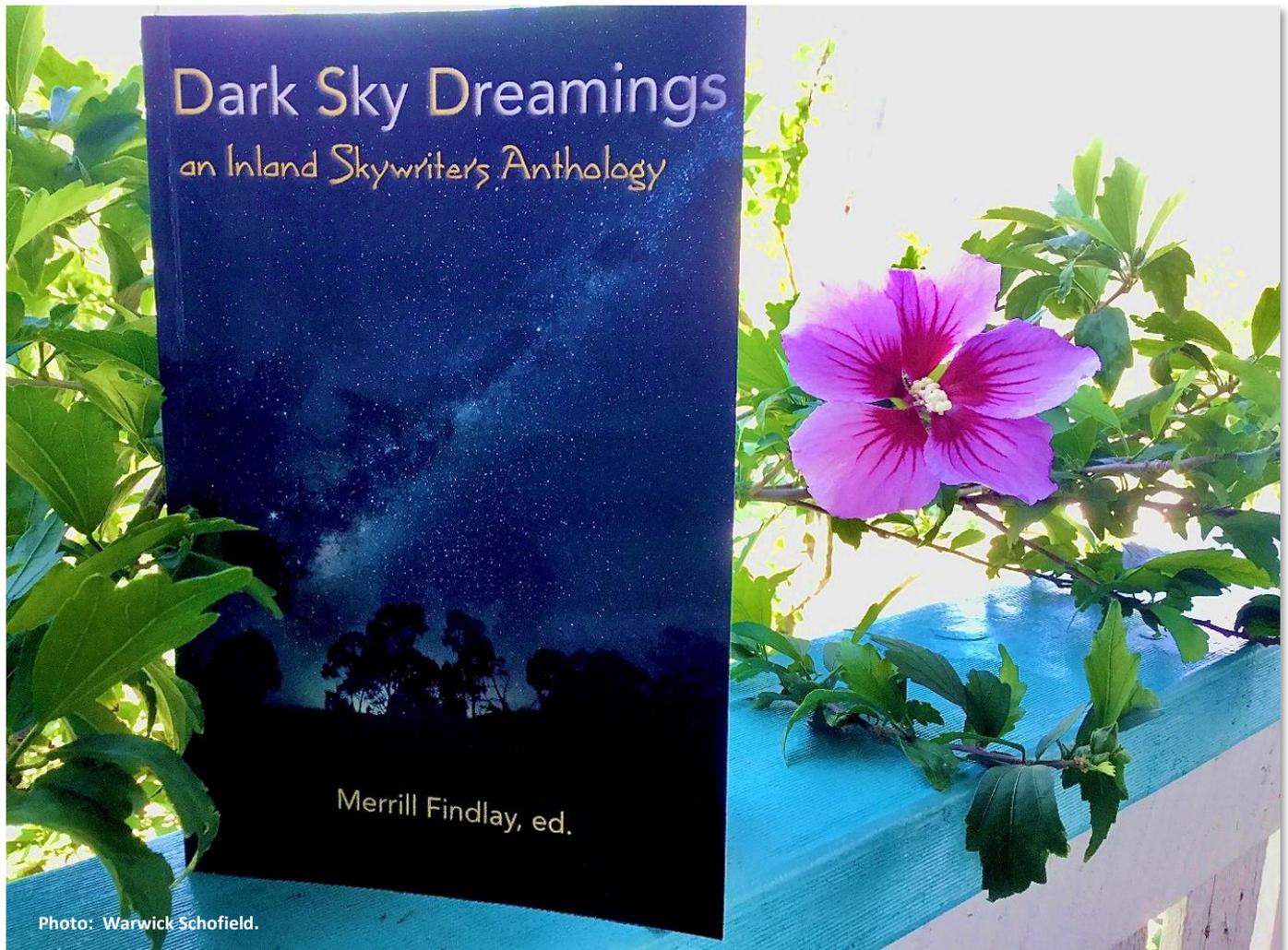
REVIEW BY WARWICK SCHOFIELD

Edited by Dr Merrill Findlay

Cover photos by Niall MacNeill.

Interactive Press, Brisbane, 2019. Card cover, 250 pp.

\$33.00 Discounted price, (postage free, through [interactive publications store](#), online).



SOME TIME ago, TRAC representatives met with Dr Merrill Findlay and discussed the production of a publication of prose and poetry works based on the wonders and mysteries of astronomy and the night skies. Merrill explained that how "...forty nine writers who have gazed at our big inland sky and imagined new narrative paths to Connect Heaven and Earth, our Planet with its Universe, and our inner worlds with the great beyond..." were to contribute to the works.

So, the resulting anthology is a published series written by writers from throughout western NSW

and the ACT. The project was supported by Regional Arts NSW and arts outwest.

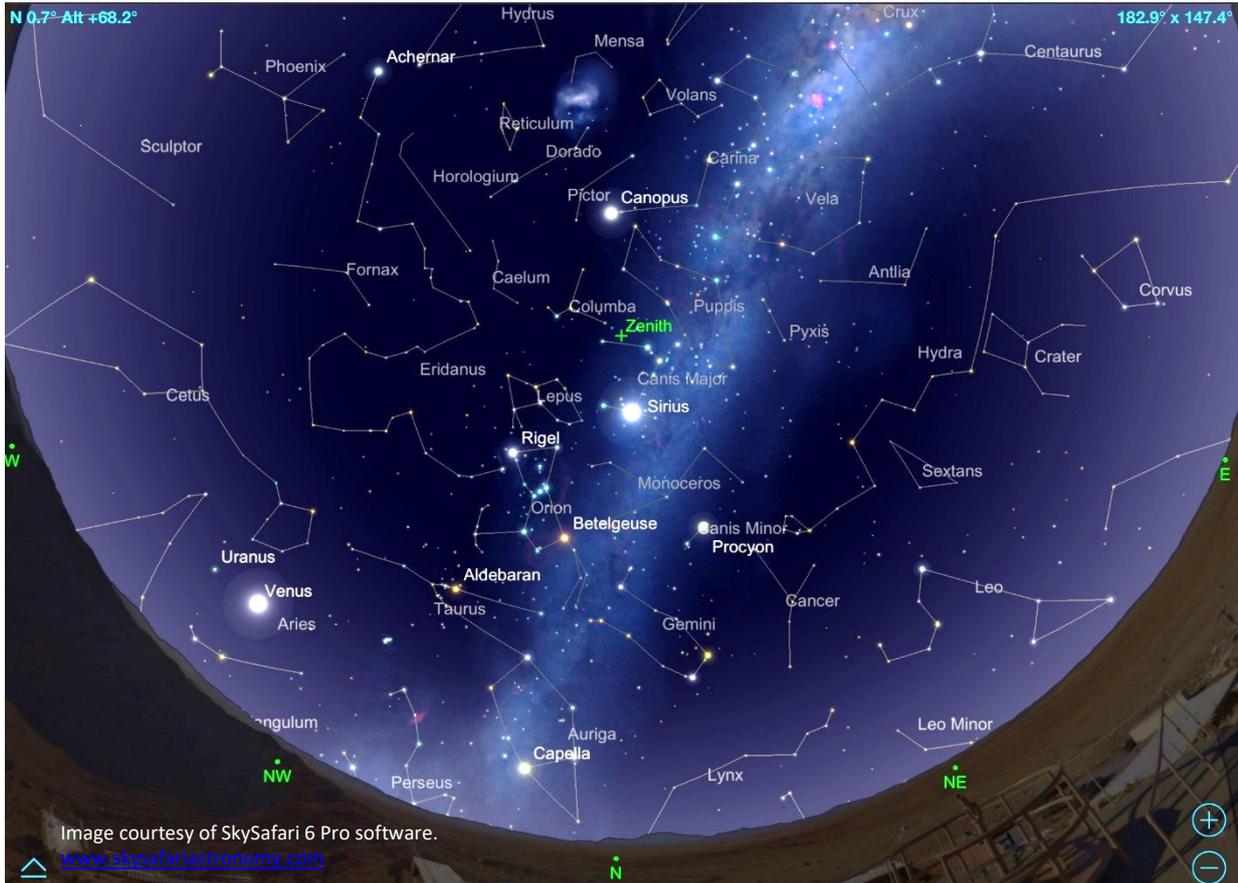
The opening contribution is a captivating bedtime child's story by a long time contact of mine, Michael Anderson (seen on the ABC TV show Stargazing Live, with Professor Brian Cox). The story tells of Mars, Antares, Scorpio and Jupiter and includes reference to the Mars Rover.

TRAC members were present for a recent launch of the book in Bicentennial Park, Tamworth and a multi-signed copy sits proudly in the TRAC library!

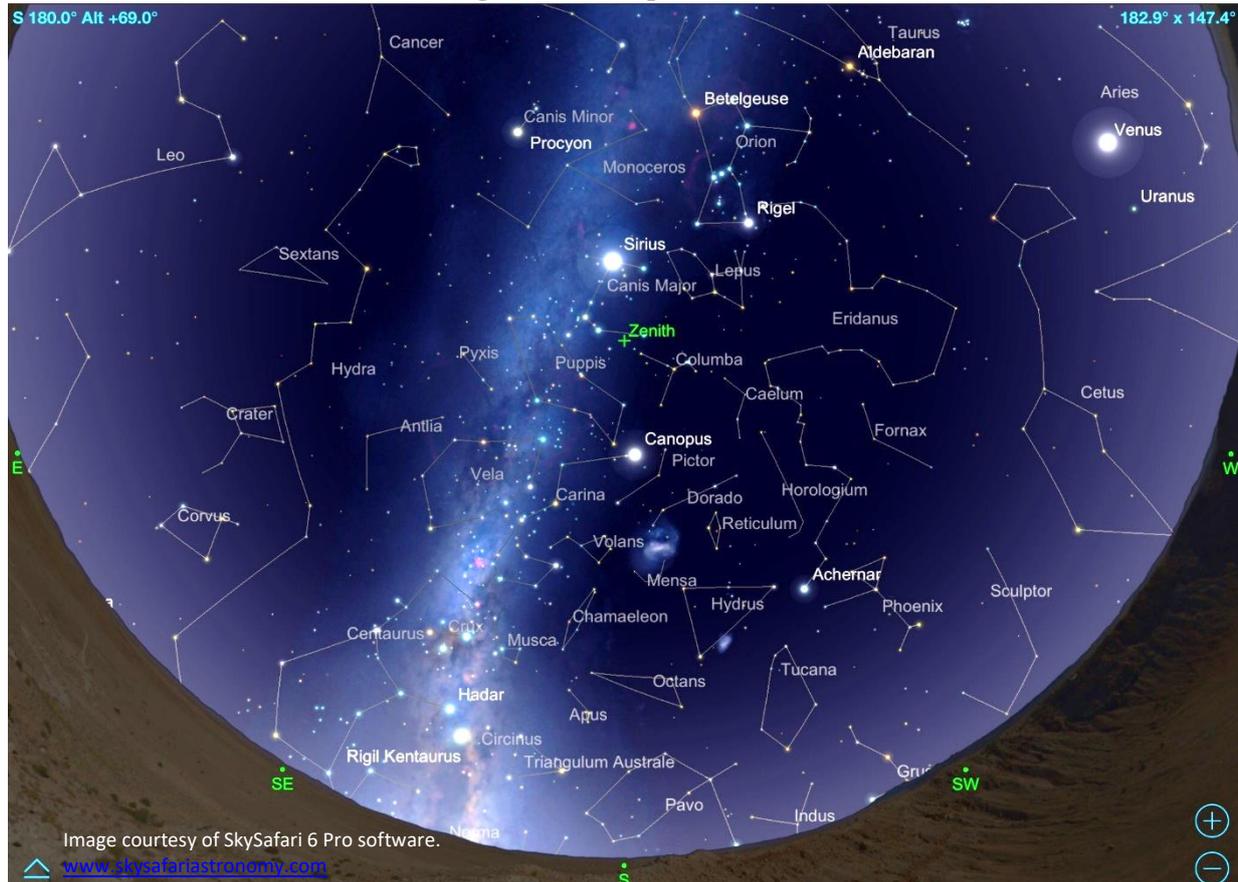
☆

The following maps show the evening sky views to the north and south at 8.00 pm mid-month for March, June, September and December 2020 from the Tamworth region. The images have been produced using SkySafari 6 Pro software - www.skysafariastronomy.com An all-sky map, with a list of forthcoming astronomical events (free for personal printing), is available at www.skymaps.com/downloads.html - scroll down to the latest Southern Edition and download the pdf file.

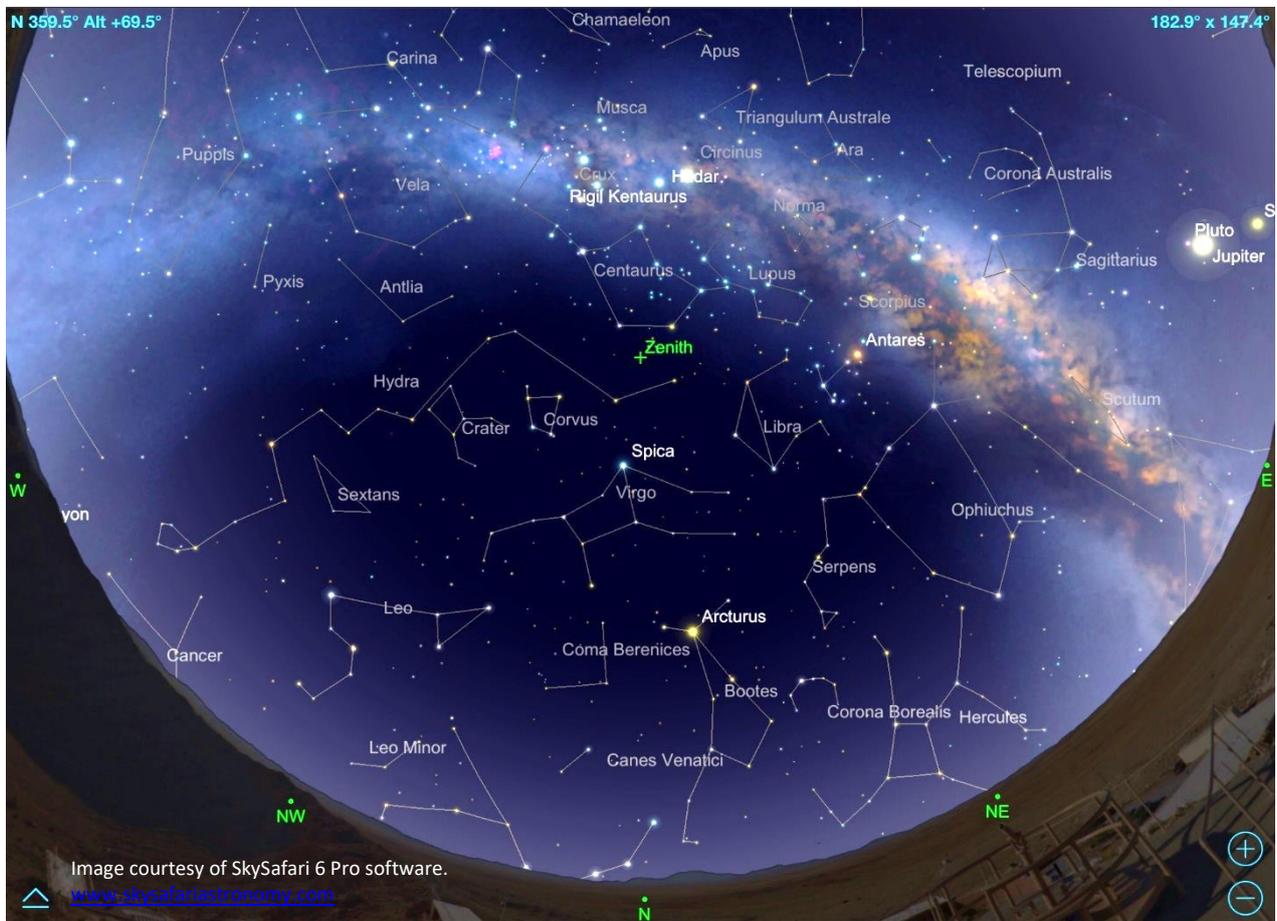
Looking north – 8.00 pm, 15 March 2020



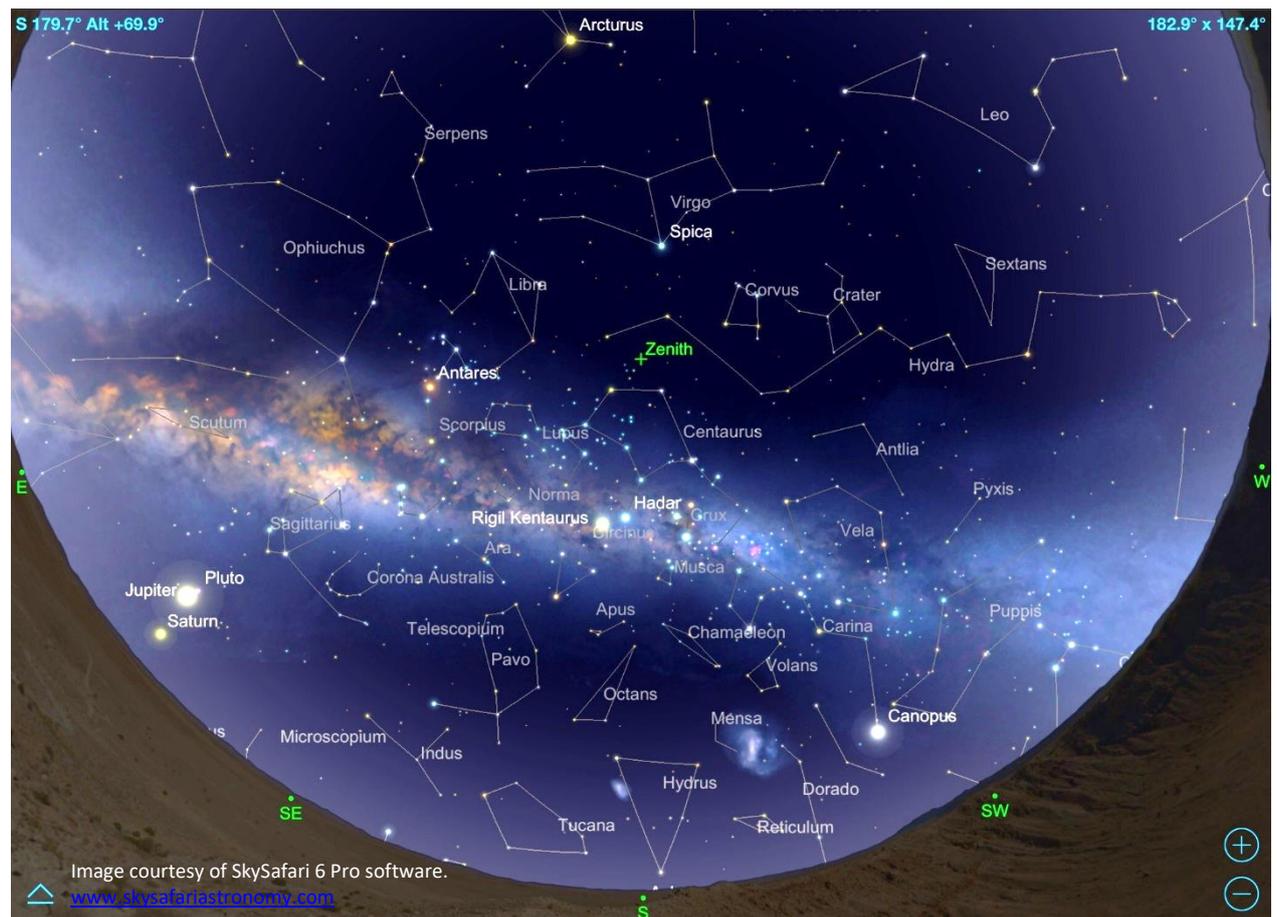
Looking south – 8.00 pm, 15 March 2020



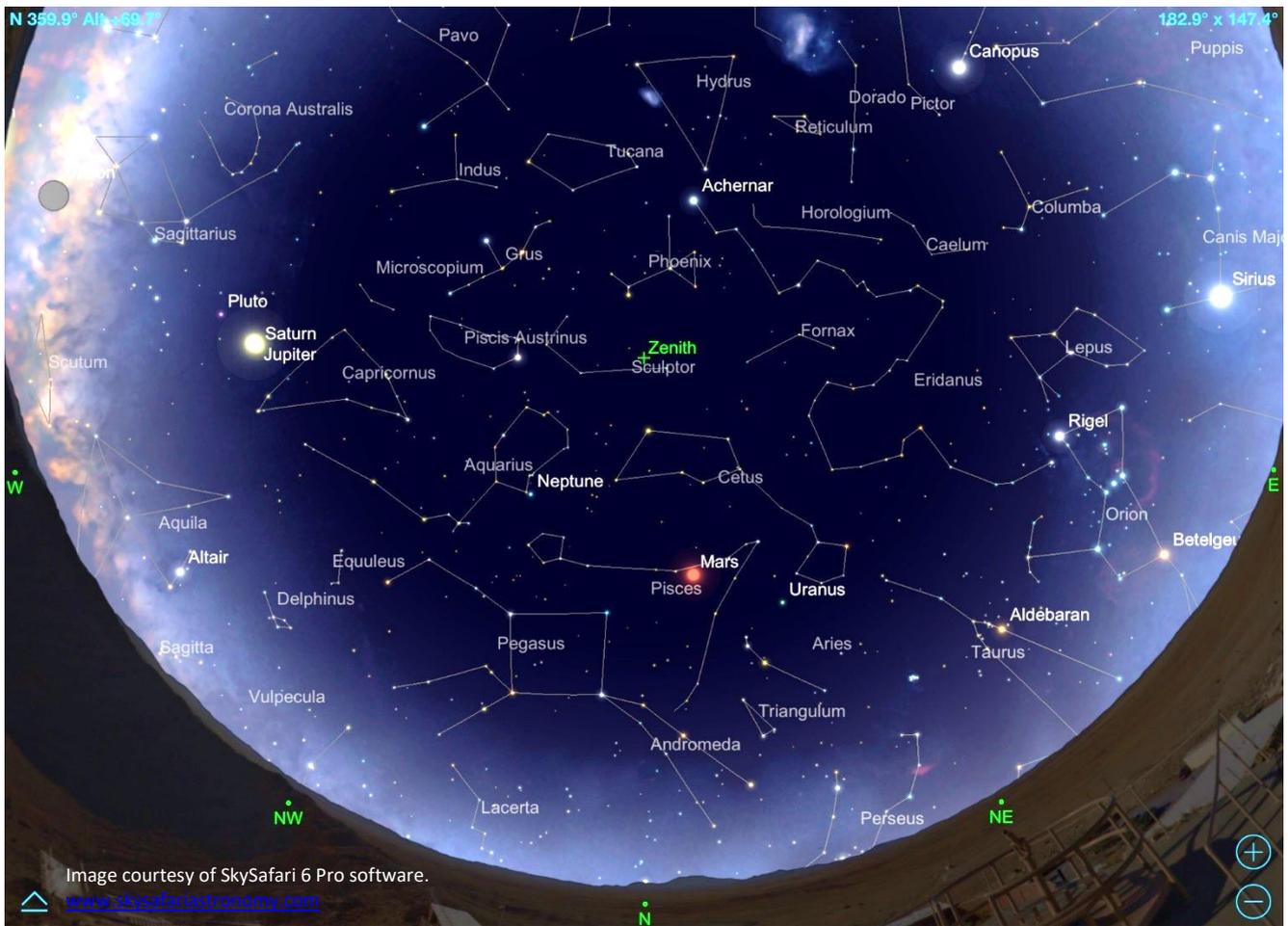
Looking north - 8.00 pm, 15 June 2020



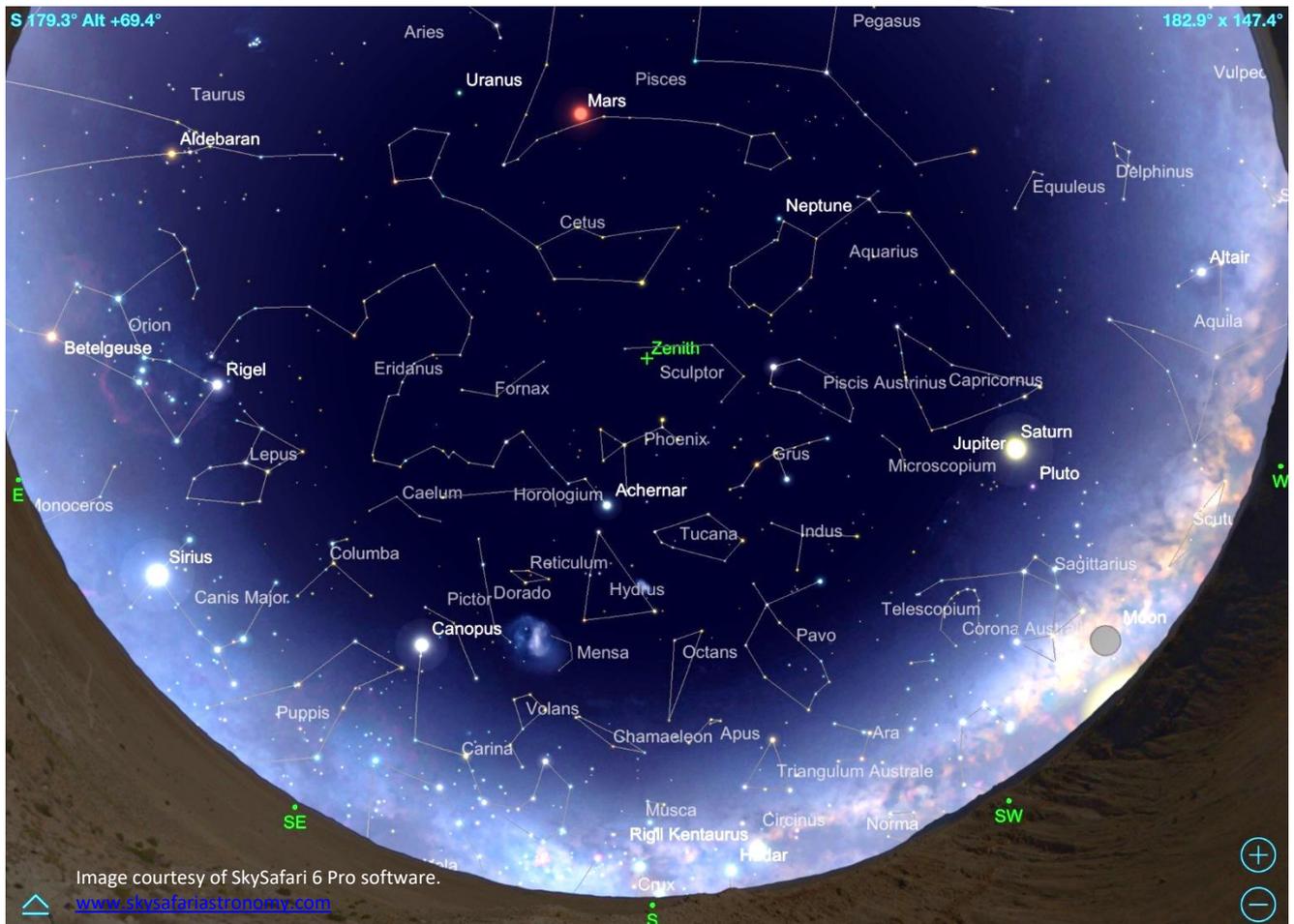
Looking south - 8.00 pm, 15 June 2020



Looking north - 8.00 pm, 15 December 2020



Looking south - 8.00 pm, 15 December 2020



Tamworth Regional Astronomy Club Inc President's Report

Presented to the Annual General Meeting held on Monday, 18th of November 2019.



TRAC was deeply saddened by the sudden passing in early 2019 of founding member Stuart Goff, seen here providing a talk at the December 2018 TRAC Technical Evening. Photo: Leigh Tschirpig.

IT IS with great pleasure that I present the President's Report to the 2019 Annual General Meeting of the Tamworth Regional Astronomy Club Inc (TRAC).

The past 12 months have certainly been another very busy time for our Club with numerous events and activities being held throughout the year and it's been a great honour and privilege to have had the opportunity to once again serve as President. It's hard to believe four years have passed since we formed TRAC and held our first meeting at the Longyard Hotel – a lot has certainly occurred since that time!

Our major focus during the year has of course been the Club's ongoing work with Tamworth Regional Council, led by our Vice-President Garry Copper, and assisted by a number of our members, towards the development of the Astronomy and Science Education Centre and Planetarium Theatre complex (AASEC) at Victoria Park. This time last year, I wrote in my 2018 President's Report there was a good chance this evening's AGM would be held in the AASEC and, while this hasn't occurred, we've certainly crossed a number of hurdles since then with the lodgement and approval

of the DA, revisions of the complex layout, costings and management of the development and we are now much further advanced than we were a year ago with the project now scheduled for completion by mid-2020. While the process has taken longer than originally anticipated, it appears the project is set to reach a better outcome with the focus very much on achieving the best possible value under the allocated budget and a good chance all of the AASEC buildings can now be constructed. 2020 is certainly set to be an exciting year with this major project due to get underway after the Christmas/New Year break which will no doubt further ramp up interest in TRAC and our activities in the local community and beyond. Our message next year for the AASEC development at Victoria Park is very much "watch this space!" Many thanks again to Garry for the excellent work he has been undertaking as TRAC's Project Manager on the AASEC development and to all involved.

The year had barely started when in mid-February we were all shocked and deeply saddened to receive the news that Stuart Goff, one of our Club's founding members, had passed away suddenly after suffering a heart attack. I would like to once again extend our Club's deepest condolences to Stuart's wife Sharon, their children Amber and Geordi and their family on Stuart's passing as well as our Club's deep gratitude for everything he contributed to TRAC and the promotion of astronomy in our region. Stuart served as our inaugural Treasurer, coordinated and conducted the Club's first two astrophotography courses and provided an enormous amount of technical, construction, observational work and advice on just about every facet of the Club's operations. Stuart always enthusiastically and freely shared his



Left to right: NSW Member for Tamworth, the Hon Kevin Anderson MP, Mayor of Tamworth Regional Council, Cr Col Murray, Deputy Mayor and TRAC Publicity Officer, Cr Phil Betts with TRAC Committee member, Dr Ray Hare, displaying the initial plans for the AASEC complex at Victoria Park. Photo: The Northern Daily Leader.

many years of experience in the field of astronomy and astrophotography for the benefit of anyone interested in learning more about our amazing universe. His loss has been sorely felt by all and, once again, I would like to say on behalf of the Club a sad farewell and thank you Stuart.

The ongoing support of the local community to TRAC during 2019, with several donations of equipment and funds, has been absolutely fantastic, particularly during the continuing drought conditions which have presented numerous challenges across our region and beyond. The Club was very grateful for the donation of a three inch equatorial refractor in late 2018 by Dal Greentree of Tamworth who sadly passed away, at the age of 92 I believe, only a couple of months after donating this instrument. We extend our deepest condolences to Dal's family as well as our gratitude for his donation.

The Club was also very fortunate to receive the donation earlier this year of an Anssen Technologies heavy duty Alhena German Equatorial Mount from Brian Coote of Barraba following his donation of an as new ten inch reflecting telescope in 2018. Thank you once again to Brian for these wonderful donations and to Warwick Schofield for giving me a hand to collect the mount from Barraba. The 'Brian Coote Telescope and Mount' will certainly be important and very useful additions to the Club's array of instruments in the Roll-off Roof Observatory at the AASEC complex.



TRAC Vice President Warwick Schofield with the Anssen Technologies Alhena German equatorial mount generously donated to TRAC by Brian Coote of Barraba. Photo: Leigh Tschirpig.

I would also like to extend the Club's sincere thanks to Michael McHugh and Stacks Law Firm for the donation of \$1,000 towards the First Prize of the *Wonders of the Night Sky Through Our Eyes* astrophotography competition which ran during 2019

with the Exhibition and announcement of the competition winners set to occur at a gala event next month. Many thanks as well to Craige Watson for coordinating this competition and we look forward to seeing some of the amazing astrophotos which have been entered at the Tamworth Regional Gallery with the Exhibition set to run from December through to next February. Thank you also to our Publicity Officer and Deputy Mayor of Tamworth Regional Council, Cr Phil Betts, for his work in organising this event through Council.



The 12.5 inch telescope constructed by the late Stuart Goff, purchased by TRAC, and his equatorial mount acquired by the Club following a generous donation by the Lions Club of Tamworth. Photo: Leigh Tschirpig.

In February, due to the keen eye of Warwick Schofield, the Club received a donation of six surplus steel locker cabinets from Farrer Memorial Agricultural High School for which the Club is extremely grateful. The Club was able to subsequently purchase a further 12 lockers from Nemingha Auctions, collected and transported by Warwick to Andromeda Industries (thank you Warwick). These will provide much needed lockable storage facilities in the Roll-off Roof Observatory at the AASEC complex following their interim current use at Andromeda Industries to store our various items of equipment.

In mid 2019, we were delighted to receive a donation of \$2,000 from the Tamworth Lions Club following an astronomy night organised last year for local Lions Club members coordinated by TRAC member Steve Rogers who is also a member of the Lions Club. The donation of these funds enabled TRAC to purchase Stuart Goff's Sky-Watcher AZ-EQ 6 GT telescope mount and I would like to once again

extend the Club's sincere thanks to the Tamworth Lions for this wonderful support, particularly the immediate Past President, Mick Evans who I understand recommended this donation, which will see the mount put to very good use at the AASEC facility for educational, photographic, observational and research purposes. It will be fantastic to see the mount, together with

Stuart's photographic 12 inch telescope that he was in the process of building at the time of his passing, together and his 12 inch Dobsonian telescope which have also been purchased by TRAC, being used as they were originally intended and, appropriately, they will carry Stuart's name at the AASEC facility.

TRAC also received a donation of a number of astronomy books from the Rotary Club of Tamworth for which the Club again extends its thanks as well as two surplus telescopes from Karen Keys and son Cameron for which we are also very grateful.

There have been other donations by members throughout the year such as the digital encoders which Ian Hynes has provided along with other items of equipment for the Jos Roberts Telescope plus a cash donation of \$100 by Barry Schofield. Thank you Ian and Barry. Many thanks also to Steve Rogers for organising the donation of a small Dobsonian telescope to the school and children of Pitcairn Island for which the students will no doubt be extremely appreciative. As members often contribute items without any fanfare,



The 34 inch Hewitt Camera Grubb Parsons primary mirror following its realuminising at Siding Spring Observatory. Photo: Rob Brookfield.

I would like to recognise all of these contribution by extending a sincere thank you.

Of course, it would be remiss of me not to mention the wonderful ongoing support of Raymond McLaren, owner and operator of Andromeda Industries, who has provided TRAC with the ongoing use of his excellent workshop facilities at Moonbi for another year as a place to meet for our monthly Technical Nights, our weekly Thursday night working bees, dark sky observing sessions and as a secure location to store our many items as we await the development of the AASEC complex. Raymond has also donated an enormous amount of time, work and energy towards the upgrading of the Hewitt Camera, having designed and machined a new CCD camera mount capable of holding much larger cameras in the future, not to mention the disassembly and reassembly of the Hewitt, with each process taking a full day to complete with the assistance of several members. Thanks to all involved with this important work, particularly Barry Gilbert, Ian Hynes, Ashley Anderson, Garry Copper and many others who have assisted. Raymond has also provided ongoing materials and assistance with the construction of the Lowe 16 inch telescope and personally delivered to Siding Spring Observatory, and later collected, TRAC's two largest mirrors, the 36 inch Jos Roberts Telescope mirror and the Hewitt Camera's 34 inch primary mirror for realuminising. Thank you once again Raymond.



TRAC is extremely grateful for the ongoing use of the excellent facilities provided by TRAC Life Member, Raymond McLaren, at his Andromeda Industries business at Moonbi for our Technical Meetings, workshop activities and other events. Photo: Garry Copper.

The realuminising of TRAC's 36 and 34 inch mirrors together with the Jos Roberts Telescope's secondary mirrors and a 14 inch mirror donated to the Club last year by Peter Lebach was certainly a major undertaking during the year requiring a great deal of planning and coordination. On behalf of TRAC I would like to thank Doug Gray at Siding Spring Observatory (SSO)/ANU for his wonderful help over an almost 12



software and a few minutes of time when you have some to spare to capture a few images and GEO observations requiring a telescope anywhere from 6 inches of aperture or larger. This is a great opportunity for TRAC to contribute to an international space research project of major importance and may pave the way for our Club to participate in similar observational programs in the future.

TRAC has continued to be actively involved in a range of community events during the year, commencing in January with a visit by ABC Radio's

Australia All Over host Ian "Macca" McNamara to Andromeda Industries on 25 January during the Country Music Festival to interview Raymond McLaren. Many thanks again to Raymond for inviting TRAC members to meet with Macca during his visit which provided some excellent national coverage of our Club, our activities and our future plans with the AASEC complex. Macca was very impressed with TRAC and our equipment and we thank Macca, the ABC and Raymond for the wonderful publicity the Club received.

Another great community event was the visit of Gary Starr's portable Planetarium to Tamworth in February courtesy of Neta Horniman. Neta had won a free group viewing and visit by the Planetarium worth \$650 at a raffle conducted at the 2018 StarFest event at Coonabarabran and generously donated her prize for the benefit of local schools in the Tamworth region. A sincere thank you once again to Neta for planning and coordinating the visit which took place over several days and saw many students from across our region

month period in arranging for the scheduling of this exacting work as a commercial arrangement for our Club together with the free aluminising of the smaller mirrors. Following Doug's relocation from Siding Spring to Canberra, the Club was very grateful for the ongoing assistance provided by Rob Brookfield and the team at SSO for finalising arrangements and undertaking the aluminising of our mirrors. The results are truly excellent with the freshly coated mirrors set to provide the best possible observational results from our two largest telescopes for many years to come. Thanks once again to the team at SSO/ANU for their assistance with this major job.

In late July, we were very interested to receive an e-mail from Grant Privett, Principal Scientist, Defence Science and Technology Laboratory (Dstl) UK Ministry of Defence, Porton Down, enquiring about the conversion of TRAC's Hewitt Camera to a digital imaging system and the possible involvement of TRAC in a number of Geostationary(GEO) and Low Earth Orbit (LEO) satellite observation programs. Subsequent discussions and proposal have led to TRAC's involvement with a program known as Argus 2 in conjunction with Dstl and the Basingstoke Astronomical Society in the UK to undertake photographic observations of GEO and LEO satellites over the coming months. TRAC is delighted to be involved with this scientific observational program, which has the support and endorsement of the Australian Department of Defence, aimed at increasing knowledge of the hazards of orbital debris to communications satellites. Argus 2 follows the successful completion of the first Argus project between Dstl and Basingstoke members last year. The results of Argus 2 will be published and presented at the 2020 AMOSTECH space situational awareness conference held each year in Maui. I would certainly encourage our members to participate in this program which for LEO observations requires little more than a DSLR camera, a laptop, a simple interface, some



A Canon DSLR camera controlled by a laptop running the DSLR Trigger program developed by Basingstoke Astronomical Society member John Murphy during an imaging run by TRAC President Leigh Tschirpig to capture precisely timed images of a Low Earth Orbit satellite for the Argus 2 project.
Photo: Leigh Tschirpig.

attending the planetarium sessions. The feedback from the students was excellent with those attending expressing their amazement and delight with the presentation and experience of the planetarium which invigorated their interest in astronomy, space and science and provided an excellent preview of what TRAC is planning to establish at the AASEC Planetarium Theatre. A sincere thank you as well to Gary Starr for bringing his inflatable planetarium to Tamworth from Sydney and to our members who were able to assist Neta with this event.

Also in February, Phil Betts and Barry Gilbert travelled to Parkes for the Inland Astro Trail (IAT) Symposium. A big thank you to Phil and Barry for attending this important meeting and networking with the many attendees from various astronomical organisations along the Inland Astro Trail. Thank you also to Dr Merrill Findlay and all involved with the IAT. TRAC looks forward to exploring the many tourism and other opportunities arising from this important inland initiative in the future.

On 30 March, TRAC members joined with members of the UNE and Northern Tablelands Astronomical Society (UNENTAS) and the Astronomical Society of Coonabarabran (ASC) for a visit to the Lockheed Martin Uralla TT&C Station. The Station is not usually open to the public, so this was a rare opportunity to visit the facility and learn more about its operations such as the repositioning, parking and testing of newly orbited geostationary satellites. A sincere thanks to TRAC and UNENTAS member Chris Wyatt for organising the tour and to the management of the Station for providing the opportunity for our members to visit this important space facility in our region. A participant on the tour was recently retired astronomer and famous comet discoverer, Rob McNaught, who also took the opportunity to inspect



TRAC and UNENTAS members at the Lockheed Martin Uralla TT&C Station. Photo: Chris Wyatt.

the Hewitt Camera. Rob undertook many observations using the Hewitt whilst it was stationed at Siding Spring Observatory and was delighted to see it back in operation as a digital imaging instrument.

Another great inter-club event was held on Saturday, 25 May when a number of members from the Port Macquarie Astronomical Association visited TRAC for our monthly Technical Night. It was wonderful to have the opportunity meet with the visiting members for what was a great social evening and to share some of our organisations' histories and future plans for major astronomical facilities in our respective regions. Thank you once again to Craige Watson for coordinating the visit and to the members from Port Macquarie who travelled across to Tamworth.

Our major public event in 2019 was the 50th Anniversary of Apollo 11 evening held on 12 July at Victoria Park which was attended by around 160 people. It was fantastic to see another large roll-up at our public night and the high levels of interest in space

and astronomy. From the overhead pass of the International Space Station right on cue at the starting time of 6.30 pm (for which several members took credit for organising with NASA!) to the various talks and video presentations, Grant Quinn's wonderful interview with Barry Gilbert about his work as a technician with the PMG and being amongst the first to see the images of Neil Armstrong's first steps on the Moon by tapping into the live video feed from Honeysuckle Creek, to the live projections of the Moon on



Port Macquarie Astronomical Association and TRAC members during the inter-club visit held on 25 May 2019. Photo: Leigh Tschirpigi.



A section of the large crowd at the 50th Anniversary of Apollo 11 Public Night conducted by TRAC at Victoria Park, Tamworth on 12 July 2019. Photo: Leigh Tschirpig.

our big screen, Lorraine Staniland's Kids Corner to the great BBQ run by Ren Tschirpig and Di Case, the evening was certainly another outstanding success. The night even drew a short review of our Club on Google described as "an amazing night for the 50th anniversary of man walking on the Moon". A sincere thank you to Garry Copper for coordinating the evening and to the many TRAC members who made presentations and contributed in many ways to ensure the night went off so well. Well done everyone!

On Saturday, 17 August another great social "Dark Sky Night" was held at Raymond McLaren's property on the New England Gully Road attended by a number of members and guests with several people camping over for the night. Whilst there wasn't too much 'dark sky' astronomy on the evening with an almost full Moon in the sky, by all reports it was a very enjoyable evening with chats and socialising around the campfire and TRAC again extends its sincere thanks to

Raymond for making his property available for this event.

TRAC once again operated a stand at the Siding Spring Observatory Open Day on Saturday, 5 October as part of the annual StarFest event at Coonabarabran. A steady stream of visitors stopped by at the stand throughout the day to hear about TRAC's activities in the Tamworth region, the planned AASEC development and to glimpse the Sun between breaks in the clouds through the Club's solar telescope. It was also great to catch up with a number of staff members at the Observatory including Rob Brookfield who undertook the aluminising of TRAC's telescope mirrors. Thanks once again to those who were able to assist and to Siding Spring Observatory for the opportunity to participate at the Open Day.

On the evening of 31 October, TRAC was pleased to assist with the book launch of Dark Sky Reflections: an Inland Skywriters Anthology edited by Inland Astro-

Trail Coordinator, Dr Merrill Findlay at Tamworth's Bicentennial Park following the opening of the Regional Arts NSW ArtState Conference.

Collaborator, writer, publisher and amateur astronomer, Dr David Reiter, who met with a number of our members last year, was also present for the launch with several readings from the book presented on the evening.

Congratulations to Merrill, David and all involved and thanks



TRAC members and friends enjoying the warmth and conversations around the campfire at the TRAC Dark Sky Night held at Raymond McLaren's Moonbi property on 17 August 2019. Photo: Garry Copper.



TRAC member Dr Ray Hare presenting one of his excellent astronomy talks during a Club meeting at Victoria Park. Photo: Leigh Tschirpig.

to those TRAC members who were able to assist on the evening coordinated by Garry Copper.

In addition to these many events, since the last AGM TRAC has conducted 10 First Saturday of the Month Astronomy Meetings and Telescope Viewing Nights at Victoria Park, 11 Technical Evenings at Andromeda Industries (one being combined with the Port Macquarie visit), and 7 Committee Meetings.

The talks and presentations at the Victoria Park and Tech Nights have been excellent and a sincere thank you to our many presenters including Grant Quinn (Signals from Space and a talk about the Sun which he presents at school visits), a visit by Jos Roberts to our February meeting who spoke about the importance of

Survey (ThrUMMS)' research work she undertook on finding possible tracers of magnetic fields near the equator of our Galaxy through the detection of the cyano radical (CN) molecule using the Mopra Radio Telescope near Coonabarabran for her research as part of her recent Masters degree at the UNE and also an excellent talk about Indigenous Astronomy), Dr Brian Timms, Adjunct Professor, Centre for Ecosystems, University of New South Wales (a close friend of Warwick and Margie Schofield), accompanied by his colleague, Dr Luciana Barbosa, Science Lecturer at Federal University of Paraíba, Brazil (not an astronomy presentation, but a very interesting scientific talk about Brian's research in the field of the taxonomy of large branchiopods (fairyrshrimps, clam shrimps and shield shrimps) and his discoveries over the last few years of 26 new species, including discoveries made near Moonbi), Garry Copper (various technical presentations on CCD imaging, satellite observations, regular updates on the AASEC development and many astronomy video presentations), and I was also pleased to make a presentation on the History and Future of Amateur Astronomy at our recent November meeting at Victoria Park. My sincere apologies if I've overlooked anyone – thank you to everyone who has been able to prepare and present these talks throughout the year and particularly to Ray Hare for coordinating our presenters.



UNENTAS and TRAC member, Dr Margaret Sharpe, presented a fantastic talk about her research and observations using the Mopra Radio Telescope near Coonabarabran as part of her recent Masters degree. Photo: Leigh Tschirpig.

eyepiece selections for the Jos Roberts Telescope, Dr Ray Hare (presentations on Pluto and Mars, large telescopes currently under development around the world including Australia's involvement in the 8.4 metre Magellan Telescope in Chile, plus a great video presentation on black holes), Di Case (Equinoxes and Solstice and the Hubble Space Telescope), Dr Margaret Sharpe (the 'Three-mm Ultimate Mopra Milky Way

The Club was pleased to be invited to make astronomy presentations at two schools in 2019 with a daytime solar presentation at St Nicholas Primary School in Tamworth and an astronomy evening at Tintinhull Public School. Thank you once again to Grant Quinn for organising and making presentations at these school events, to Lorraine Staniland for the



TRAC member Craig Watson making a presentation during one of two astrophotography workshops which he and TRAC Vice President Garry Copper provided to the Tamworth Camera Club during 2019. Photo: Garry Copper.

invitation to visit Tintinhull Public School and to those members who were able to assist at these events.

We were also pleased to receive invitations from the Tamworth Camera Club to make presentations on DSLR astrophotography and on behalf of the Club I would like to thank Craig Watson and Garry Copper for undertaking these instructional sessions. TRAC has since been invited by the Camera Club to provide an astrophotography workshop on Friday, 15 May, 2020

at the Northern NSW Zone of Photographic Societies' Convention being held in Tamworth which is expected to attract around 100 to 120 attendees and this will be another great opportunity for interaction between our organisations and to foster an interest in astronomy and astrophotography.

Ray Hare also made a presentation on behalf of TRAC at the Tamworth Lionesses Club during the year which was very well received and we thank Ray for undertaking this talk and outreach activity.

During the year we've held three Bunnings BBQs with a fourth scheduled for Sunday 22 December. A sincere thank you once again to Lorraine Staniland and Bunnings for the opportunity to operate these important fundraisers which have raised several thousand dollars for the Club and also to the many helpers who have donated their time to assist with the cooking and serving at these events.

My one regret during the year is that I have only completed a single edition of our Club's Journal 'Astronomer' in February due to time constraints and other commitments, however I have been pleased to continue the production and distribution of our e-newsletter 'Observer' each month apart from January when TRAC is in recess. I am hoping to have another edition of 'Astronomer' in the works soon and distributed by the end of this year or early 2020 at the latest. Many thanks once again to Warwick and Margie Schofield and also to Garry Copper for helping with the proofreading of these publications and particularly to Warwick and Margie and other contributor for the great articles they have written for our journal.

Our columns in the Northern Daily Leader, which are syndicated to many other regional newspapers, have



Thanks again to Tamworth Bunnings for the opportunity to run several Sausage Sizzle fundraisers during the year. Photo: Leigh Tschirpig.



Left to right: TRAC Life Members Raymond McLaren and Barry Gilbert with TRAC Secretary Geoff Tall during the final stages of the Hewitt Camera's reassembly following the realuminising of the primary mirror. Photo: Garry Copper.

continued generally on a monthly basis and I would like to once again thank our members who have written articles on a broad range of astronomical topics for these columns. I intend to reprint many of these in our forthcoming journals which over time will form a collection of important resources and information for our Club and the broader community.

I've also been pleased to continue with the operation of the TRAC website and TidyHQ online club management system during the year and many thanks to Garry Copper for maintaining our Facebook page following Stuart's passing. Our online presence is an important aspect of our operations and a vital link in getting our messages out to the community. Many thanks as well to Grant Quinn for establishing a MYOB account during the year in his role as Treasurer which has been of great benefit in streamlining the maintenance of our Club's finances and reporting requirements.

As we head into 2020, I am delighted to report that our Club is in very good shape with 76 active members currently listed on our records and a number of people

who have indicated they intend joining in the near future. I would particularly like to extend a very warm welcome to our new members who have joined during the year and thank the great majority of our existing members who renewed their memberships. There are so many opportunities for members of all levels of experience from beginners to more advanced observers to be involved in our activities and events and to share their interest and passion for the science of astronomy.

Finally, I would like to conclude my report by thanking the members of the 2019 Committee, Vice-Presidents Garry Copper and Warwick Schofield, Secretary Geoff Tall, Treasurer Grant Quinn, Committee members Raymond McLaren, Steve Rogers, Lorraine Staniland, Ray Hare and Scott Jackson, our Publicity Officer, Phil Betts and Public Officer Michael McHugh for their outstanding work and input into our Club's operations during the year. There is so much that goes on during the year behind the scenes with numerous group e-mails, phone calls, meetings and interactions to ensure our Club operates smoothly and everything comes together in an organised way. Thank you so much for your wonderful efforts. A very sincere

thank you as well to our members and supporters – our Club would not exist without you and I would like to recognise everyone for their many contributions whether they have been large or small during the year which make TRAC the wonderful organisation it is.

Once again, well done everyone and I wish TRAC all the very best for continued success in the future as we move into an exciting year, particularly with the AASEC facility set to commence in 2020, and as we continue with our aim to promote the science of astronomy in the Tamworth region and beyond.

Leigh Tschirpig
 President
 Tamworth Regional Astronomy Club Inc
 18 November 2019 ☆



TRAC member Ashley Anderson adjusting the focus of the Hewitt's CCD camera. Photo: Leigh Tschirpig.

Club shirts, jackets and logos available

TRAC MEMBERS can order polo shirts, jackets and hoodies with our Club logo from [Monogram It/Hip Pocket](#) at 192 Bridge Street, Tamworth. If you would like to place an order, contact our Executive (see page 3 for contacts) to obtain an authorisation slip, then call into the store with the signed slip to check your size, place your order and confirm pricing. It usually takes around two weeks for items to be printed. The polo shirts are slightly different to the sample pictured (the collar is blue), and all clothing items are available in male and female styles.

Members can also purchase embroidered TRAC logos which can be ironed on to any suitable item of clothing. Patches are available for purchase at \$10.00 each and can be obtained by sending an e-mail to: tracthestars@gmail.com



Thank you once again to Sandy McIntosh at Monogram/Hip Pocket for assisting with the supply of these items. ☆

Diary



Photo: Warwick Schofield.

TRAC meetings

First Saturday of the month Astronomy Presentation and Telescope Viewing Nights

TRAC conducts its Astronomy Presentation and Telescope Viewing Night on the first Saturday of each month at the Botanical Gardens Training Room, Victoria Park, located at the top end of Piper Street in East Tamworth, at 6.30 for 7.00 pm. The evenings commence with either a talk or video presentation on astronomy followed by telescope viewing, weather permitting.

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Please check our website www.tamworthastronomy.com.au for the latest details. Meetings are not held during January.

Technical Meetings

TRAC's Technical Meetings are held on the third Saturday of each month commencing at 6.00 pm during daylight saving and at 5.00 pm during non-daylight saving periods. Location details and confirmation of these meetings are e-mailed to TRAC members. For enquiries, please contact our Vice-President, Garry Copper, via e-mail (see page 3 for contact details).

TRAC also conducts weekly Thursday evening working bees on our telescopes and equipment with telescope viewing if the sky is clear. If you are interested in attending, please contact our Vice-President, Garry Copper, as noted above. ☆

Tamworth Regional Astronomy Club (Inc.)

C/- PO Box 1023, Tamworth NSW 2340, Australia

Web site: www.tamworthastronomy.com.au

Facebook: www.facebook.com/groups/427835424074950/ (public page)

Return to: **The Secretary**

Email: tracthestars@gmail.com

Tel: 0458 772 747

Membership Application & Renewal Form



Full name of applicant _____ Tick if renewal or amending details

Home address _____

Postal address _____

E-mail address _____ (please print CLEARLY)

Telephone (home) _____ (Mobile) _____

Age (if under 18) _____ Occupation _____

(Optional) Areas of expertise: _____

Areas of astronomical interest: _____

Type of Membership: (See Category definitions at bottom)

NB. Fees below are for 2018/19 year only.

- Life Membership - with voting rights (once only payment) \$1,000
 - Full Membership - with voting rights (option to pay in advance): 3 Yrs \$150, 2 Yrs \$100, 1 Yr \$50 pa
 - Family Membership - with one voting right, includes parent(s) and unlimited children under the age of 18 \$70 pa
- Spouse/Partner's Name: _____ Children's Names: _____
- Concession Membership - with voting rights, includes pensioners, seniors & students over the age of 18 \$25 pa
 - Associate Membership - with no voting rights, (educational institutions, non-active members) \$25 pa
 - Junior Membership with no voting rights. \$10 pa

(Members under the age of 18 must be accompanied by a parent or designated guardian, compliant with NSW W.W.C. Legislation, to all TRAC meetings and activities) **Please check current membership fees.**

I agree to abide by the constitution, rules, and by-laws of the Tamworth Regional Astronomy Club Inc.

Members or Sponsors may make donations to the AASEC/Observatory Fund Here. Amount \$.....

Signature of Applicant _____ Date _____

Proposed by: _____

Signature of Proposer: _____ Date _____

Seconded by: _____

Signature of Seconder: _____ Date _____

N.B. Payment can now be made by Direct Deposit as below:

If paying by Direct Deposit, please add your **Name** for identification; Nthn Inland Credit Union, BSB - 802298 A/c No - 100100515

Your application will be considered for approval at our next Committee meeting.

Thank you for your interest in joining our club.

Membership Categories

- **LIFE** membership entitles the member to all the rights of full membership, including full voting rights. Life members will not be required to pay the annual subscription.
 - **FULL** membership is available to any Australian resident and entitles the member to voting rights and access to all functions and facilities (subject to accreditation procedures).
 - **FAMILY** membership is available to parents and their children (the number of children in a family is not limited). Family membership entitles one parent to full voting rights.
 - **CONCESSION** membership is only available to pensioners, seniors and persons who are over 18 years of age and a full-time student at a school, university, college or other tertiary institution. It entitles the member to all the rights of a Full member. Upon ceasing full-time study, student members shall automatically change to Full membership.
 - **ASSOCIATE** membership is available to any person who is the spouse, partner or dependent child (person under 18) living at the same residential address as a Full member. Associates are entitled to all the rights of a Full member with the exception of voting rights. Includes Educational Institutions and non-active Members.
 - **JUNIOR** membership is only available to persons who are under 18 years of age and entitles the member to all the rights of full membership except voting rights.
- (NB. Members under the age of 18 **MUST** be accompanied by a parent or designated adult to all TRAC meetings and activities).

OFFICE USE ONLY. Approved by the Committee on ____/____/____(Date) Signed: _____(Club President)

Receipt No: _____ \$ _____(Paid) ____/____/____(Date) Signed: _____(Club Treasurer)

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