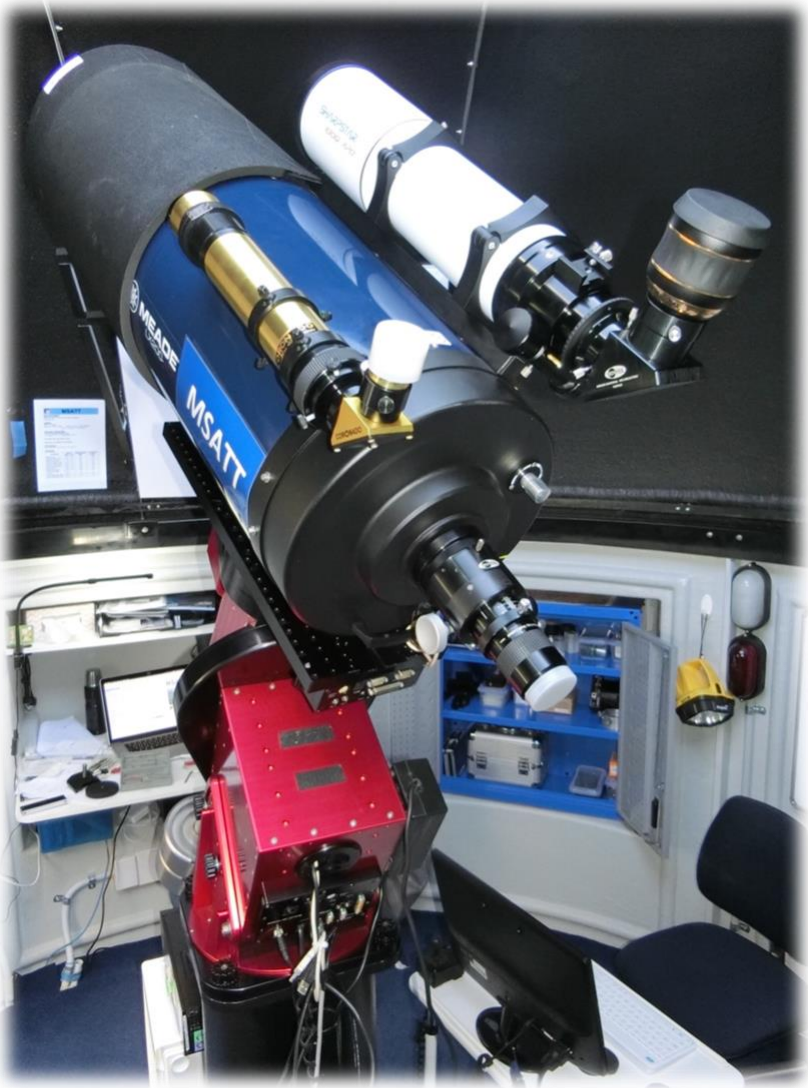
MSATT



My Sky Astronomy
STUDENT GUIDE 2018

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LAST UPDATED: 10/12/2017

MY SKY ASTRONOMY WITH MSATT

MSATT[1] is a new and exciting teaching facility for high school and college students in the ACT. It offers you the opportunity to engage in astronomical projects based on your own observations, emulating – and *learning* – the process of scientific exploration.

A list of potential projects that can be undertaken with MSATT is given on the following pages. The choice depends on your level of experience in astronomy and whether you've used a telescope before. However, ***no experience with astronomy or telescopes is needed to use MSATT.*** You will be given full instruction on how to operate MSATT so that ***you become the telescope operator and researcher, no matter what your prior experience***. Full support is provided on each subsequent session, but you are MSATT's operator for the duration of your project.

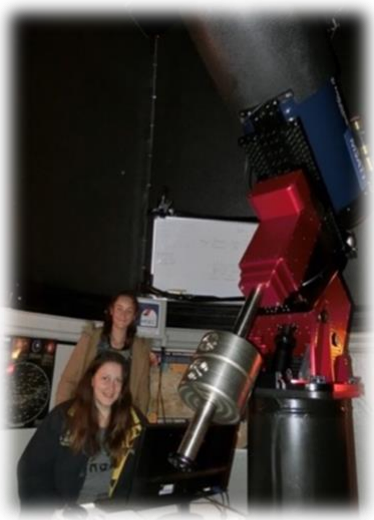
Even if you have not done any courses in Astronomy, that's not a problem: you will receive tuition in astronomy and astrophysics to help you get the most out of your project. Whether you're in high school or about to start university, you will receive all the tuition you need to make your project a success.

The amount of time you'll need to spend at MSATT varies with each project. Some require only one night at the telescope; other projects call for multiple sessions over several months. You may also be partnered with an astronomer from ANU's Research School of Astronomy and Astrophysics who will tutor you in the theoretical aspects and help with analysing your results.

All students are required to produce a referenced and refereed report on their project. Full tutorial support is provided for this part of the project. Ideally, the report will become a significant component of your Science assessment at school or college. We can negotiate this with your teacher.

WHAT YOU WILL GET OUT OF YOUR MSATT PROJECT

Since this is an opportunity to conduct an astronomical investigation using your own data, you will have complete ownership of the project. It will be driven by you; you will make all the observations and then analyse them. The skills you will develop along the way are generic to all the sciences, and include observational and analytical techniques, writing skills, and above all the thrill of discovery.



WHAT YOU DO NOW

Decide which of these exciting projects appeals to you the most. It is important to choose a project that you find interesting and fulfilling. I can help you decide on the project that's best for you.

Schedule a preliminary meeting and training session at MSATT. These are usually at night. A parent is required to attend all sessions.

Complete a series of observations required for your project. Remember that astronomy is a slave to the weather, so you may not be able to observe during every session.

Analyse your data with the assistance of a professional astronomer.

Write a refereed and referenced report on your project.

Clear skies!

Geoff McNamara

geoffrey.mcnamara@ed.act.edu.au

PHONE: 0 44 99 66 200

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[1] McNamara-Saunders Astronomical Teaching Telescope. **MSATT** is one of the nodes of the Mount Stromlo Space and STEM Education Centre, **MSEC** based at Melrose High School.

NIGHT SKY TOURS

Not everyone wants to undertake long-term projects in astronomy, at least not straight away. That's why MSATT offers ***Night Sky Tours***, a single night experience for those who want to find out what astronomy is all about.

Night Sky Tours are designed for small[2] groups of people wanting to know more about astronomy. Whether you're an Astronomy class at high school or college, a keen family group, or a group of friends wanting a deeper astronomical experience, MSATT can host a tailored ***Night Sky Tour*** for you. Smaller groups mean deeper tuition in astronomy and the use of telescopes – including MSATT – combined with observation and interpretation of astronomical objects.

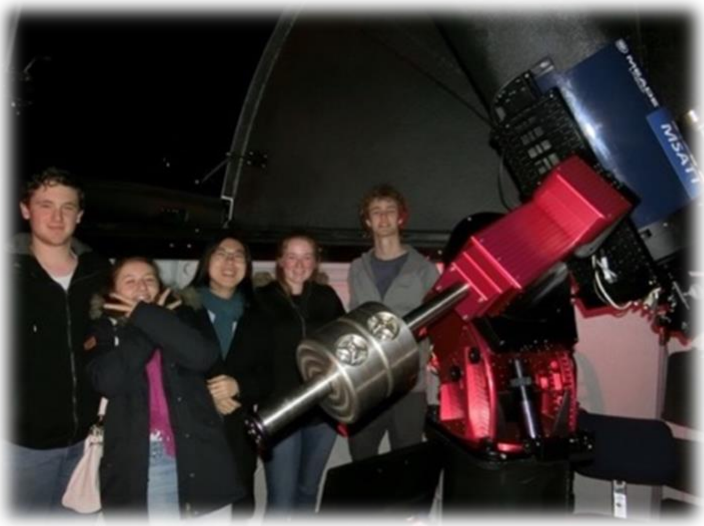
We start the night with a naked-eye tour of the night sky using star charts. I'll point out and explain the nature of stars, the Milky Way, Magellanic Clouds, and visible planets and the Moon. Then we turn to the small student telescopes, giving you the opportunity to search for astronomical objects on your own.

Then it's time for MSATT to you deeper into the night sky. We'll explore a range of astronomical objects and classify them according to the phenomena they represent. Students complete a worksheet during the evening so they have a permanent record of their achievements during the night, making Night Sky Tours a genuine educational experience.

Tuition can include:

- How to find your way around the night sky.
- How to use star charts, both all sky, deep sky and electronic.
- How telescopes work and what they do.
- How to use a Dobsonian telescope.
- How to choose eyepieces for the magnification you need.
- How to record astronomical observations.
- Understanding the nature of all astronomical objects at the eyepiece.
- Identifying and understanding astronomical and astrophysical phenomena.

Night Sky Tours are an ideal way to introduce students to astronomy with MSATT.



For bookings and enquiries, contact

Geoff McNamara

geoffrey.mcnamara@ed.act.edu.au

https://msatt.teamapp.com/

Please note: *MSATT Night Sky Tours are not intended for general school audiences without a specific focus on astronomy. Please contact the Research School of Astronomy and Astrophysics to book a Stargazing Night:* ***outreach@mso.anu.edu.au***

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[2] Maximum number of people is 8. School groups or children from Year 9 to 12 must be accompanied by a teacher or parent.

STUDENT PROJECTS WITH MSATT

The following is a list of potential projects with MSATT. Note that not all of the projects have been tried with students, and some depend on the level of experience you have with the telescope: these projects are a work in progress. The selection of project is negotiated with Mr Mac during your first visit to MSATT.

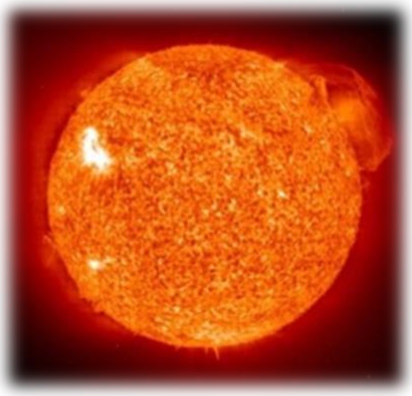
SOLAR SYSTEM

SOLAR ACTIVITY

The Sun is a dynamic and active star at the centre of our solar system. Its activity varies with an eleven-year cycle, and the student can therefore monitor solar activity over a six-month period in both visible light and hydrogen-α. The extent of active regions can be measured using the drift method, or by direct imaging. There is the longer-term possibility of monitoring the Sun at radio wavelengths.

Level: Entry – no experience required.

Sessions required: 10 (daytime, minimum) over three months.



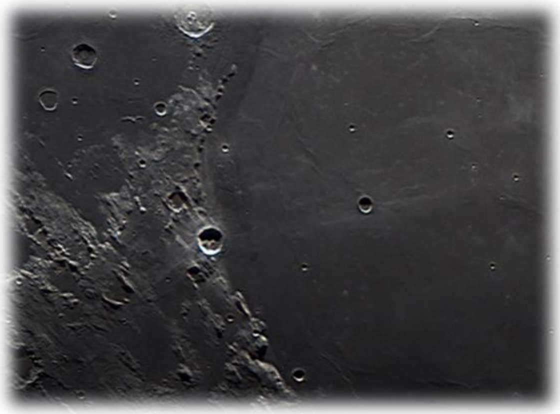
Solar and Heliospheric Observatory

LIFETIME OF THE SUN

By making a sequence of observations of the black body curve of the Sun, coupled with direct measurements of the solar constant, the rate of hydrogen consumption can be determined. Knowing the mass of the Sun and a few other parameters, the total lifetime of the Sun can be determined.

Level: Entry – no experience required.

Sessions required: 4 (non-telescopic, daytime)



LUNAR REGOLITH COMPOSITION

Spectroscopic measurements of large scale lunar surface features may yield data on composition of the lunar regolith. *Untried.*

Level: Entry – no experience required.

Sessions required: 4

LUNAR PHOTOMETRY

The Moon is an ancient world and yet is geologically complex. You will measure the relative albedo (reflectivity) of lunar surface types, and relate this data to composition, causes of reflectivity, sun-angle. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 4

LUNAR MORPHOMETRY

By measuring the lengths of shadows on the Moon, you will apply geometry and trigonometry to determine the shape and dimensions of a range of lunar features such as craters and mountains.

Level: Intermediate – experience using MSATT required.

Sessions required: 4

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LUNAR ECLIPSES

During a lunar eclipse, the Moon passes from one edge of Earth's shadow to the other. By measuring the various parameters of an eclipse, the student can determine the shape and size of Earth's shadow. Spectroscopic and photometric analysis may also yield interesting results.

Next total lunar eclipse: 31/1/18.

Level: Entry – no experience required.

Sessions required: 3

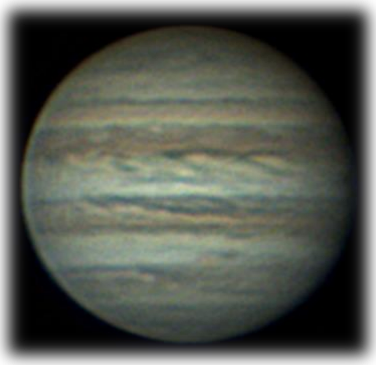
MEASURING THE MASS OF JUPITER

Jupiter's moon Io orbits the planet in a little under two days. Each orbit, it passes into and emerges from Jupiter's shadow, a satellite eclipse. By making visual or photometric observations of Io as it emerges from eclipse, the student can precisely determine the duration of Io's orbital period. Using Newtonian gravity, the mass of Jupiter can be determined. This project couples well with determination of the speed of light.

Level: Entry – no experience required.

Sessions required: 6

JUPITER ATMOSPHERIC ACTIVITY



Jupiter has the most dynamic and rapidly changing atmospheric patterns in the solar system. Imaging of Jupiter allows the student to monitor its current activity, as well as the behaviour of long- and medium-term phenomena such as the Great Red Spot, white ovals, etc. This project can be coupled well with current spacecraft monitoring. *Imaging untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

MEASURING THE DIAMETERS OF THE GALILEAN SATELLITES

By measuring the brightness of the four Galilean satellites of Jupiter as they emerge from eclipse, coupled with a measurement of the distance of the satellites from Jupiter and their orbital velocities, the student can determine the diameters of the satellites. *Untried*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

VENUS DICHOTOMY

When the angle between the Earth, Sun and Venus is approximately 90^{o}, Venus should logically appear half-illuminated like a first quarter Moon. This is called dichotomy. However, the observed date of dichotomy never coincides with the geometrically predicted date…and no one knows why. Using visual or imaging techniques, the student will determine the observed date of dichotomy.

Level: Entry – no experience required.

Sessions required: 15, weekly at least.

Next dichotomy: July-August 2018 Afternoon (daylight) observations.

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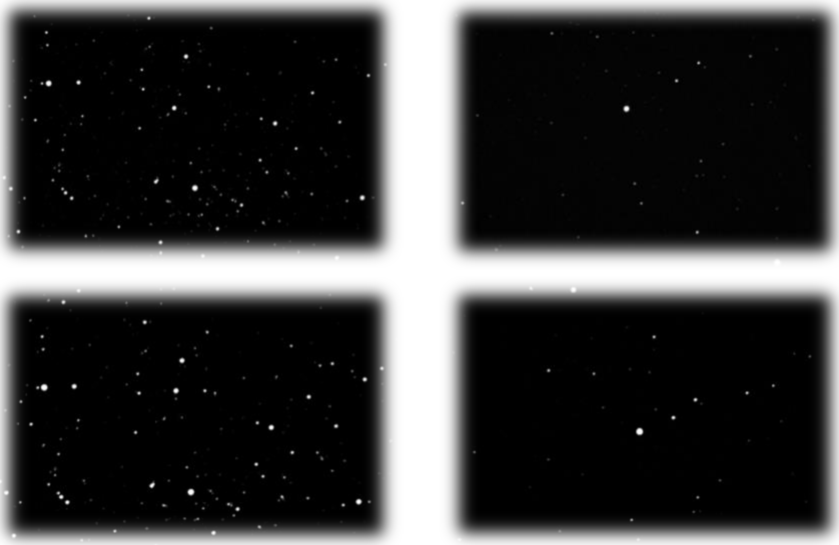
MINOR PLANET IMAGING



Minor planets are small bodies that occupy orbits mostly between Mars and Jupiter. Being relatively close, they appear to move quickly against the background stars. Using MSATT, you will be able to track and analyse the motion of minor planets currently visible from Earth. By taking images some time apart, from an hour to a day, you can follow the paths of these distant objects. Look at the images below. Quickly flick your gaze from the top to the bottom images to detect the motion of the asteroids.

Level: Intermediate – experience using MSATT required.

Sessions required: 4.

PLOTTING PLUTO

As with Minor Planets, Pluto can be observed as it ploughs its way through space in the distant reaches of the solar system. Using the same imaging technique used for minor planets, Pluto can be detected and monitored. The image below shows the motion of this distant body over four hours.

Level: Intermediate – experience using MSATT required.

Sessions required: 4.

MINOR PLANET PHOTOMETRY

Minor planets mostly orbit the Sun between Mars and Jupiter, but they also rotate just as planets do. Since they are typically asymmetrical, as they rotate they reflect different amounts of sunlight. Photometry can be used to determination of their rotation periods; astrometry may yield their orbital parameters. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

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DIMENSIONS OF THE SOLAR SYSTEM

The student will undertake a series of observations to determine the scale of the solar system determined from direct observation.

- Diameter of the Moon knowing the distance.
- Earth-Moon system as a double planet.
- Variation of distance from Earth during a lunar orbit from measurement of apparent diameter.
- Determination of ellipticity of Moon’s orbit.
- Diameter of Jupiter.
- Radius of orbits of Jupiter's and/or Saturn’s satellites.
- Diameter or distance of/to the Sun.
- Dimensions of lunar features knowing distance to the Moon.
    - Mare
    - Craters

PLANETARY SPECTROSCOPY

Spectroscopy can be used to identify specific elements and compounds in the atmospheres of the planets. *Untried.*

Level: Intermediate – experience using MSATT instruments required.

Sessions required: 6

COMET IMAGING

Dependent on current comets’ visibility. *Untried.*

Level: Intermediate – experience using MSATT instruments required.

Sessions required: 6

EARTH-MOON SYSTEM

You will analyse the Earth-Moon system as a binary planet, considering the gravitational and rotational characteristics, derived from original observations. *Untried.*

Level: Intermediate – experience using MSATTs instruments required. Good level of mathematics assumed.

Sessions required: 6

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STARS AND STELLAR EVOLUTION

STELLAR SPECTRAL CLASS

Spectroscopy can be used to determine the spectral class of stars as well as the identification of specific elements, temperatures, and therefore stage in stellar evolution. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

VARIABLE STARS

Virtually all stars vary in one way or another. Using visual or photometric techniques, students can monitor a range of short period variable stars – those stars with large variations in brightness – to ascertain their type and current behaviour.

Level: Advanced – experience using MSATT required.

Sessions required: 6

ECLIPSING BINARIES

Most stars exist in binary systems. If the alignment between Earth and the orbital plane is close enough, the two stars will appear to alternately eclipse one another. By observing the regular variation in brightness, the orbital period of these eclipsing binaries can be determined, as well as an estimate of the relative size of the stars. In some cases, an entire orbit can be observed in a single night. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

SPECTROSCOPIC BINARIES

Some binary stars are visually too close to be separated, but they can be detected using spectroscopy. By detecting the split and recombination of spectral lines, not only the existence of these "spectroscopic binaries" can be detected, but also their orbital periods. *Untried.*

Level: Advanced – experience using MSATT required.

Sessions required: 6

CONTENTS

IMAGING DEEP SKY OBJECTS

Imaging of a range of deep sky objects, looking at the variables affecting image quality, such as surface brightness, extent, concentration of the nucleus, etc. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

GALAXY EVOLUTION

By comparing the colours of galaxies with their morphology, you can determine the evolutionary stage of individual galaxies. *Untried.*

Level: Intermediate – experience using MSATT required.

Sessions required: 6

CATACLYSMIC VARIABLES

Cataclysmic variables are binary systems where one star is a white dwarf. Mass transfer from the larger star onto the white dwarf results in explosive release of energy. You can explore short term variations in the behaviour of these stars. *Untried.*

Level: Advanced – experience using MSATT required.

Sessions required: 6

SUPERNOVAE

Depending on current activity, you may be able to monitor the behaviour of recently discovered supernovae. This could yield valuable information on the behaviour of dying stars. *Untried.*

Level: Advanced – experience using MSATT required.

Sessions required: 6

PHYSICS

MEASURING THE SPEED OF LIGHT

You will observe eclipses of Jupiter's moon Io over a three-month period to measure the speed of light. This is a recreation of the original serious determination by Ole Roemer.

Level: Entry – no experience required. Good level of mathematics assumed.

Sessions required: 6+

Dilvar Barat

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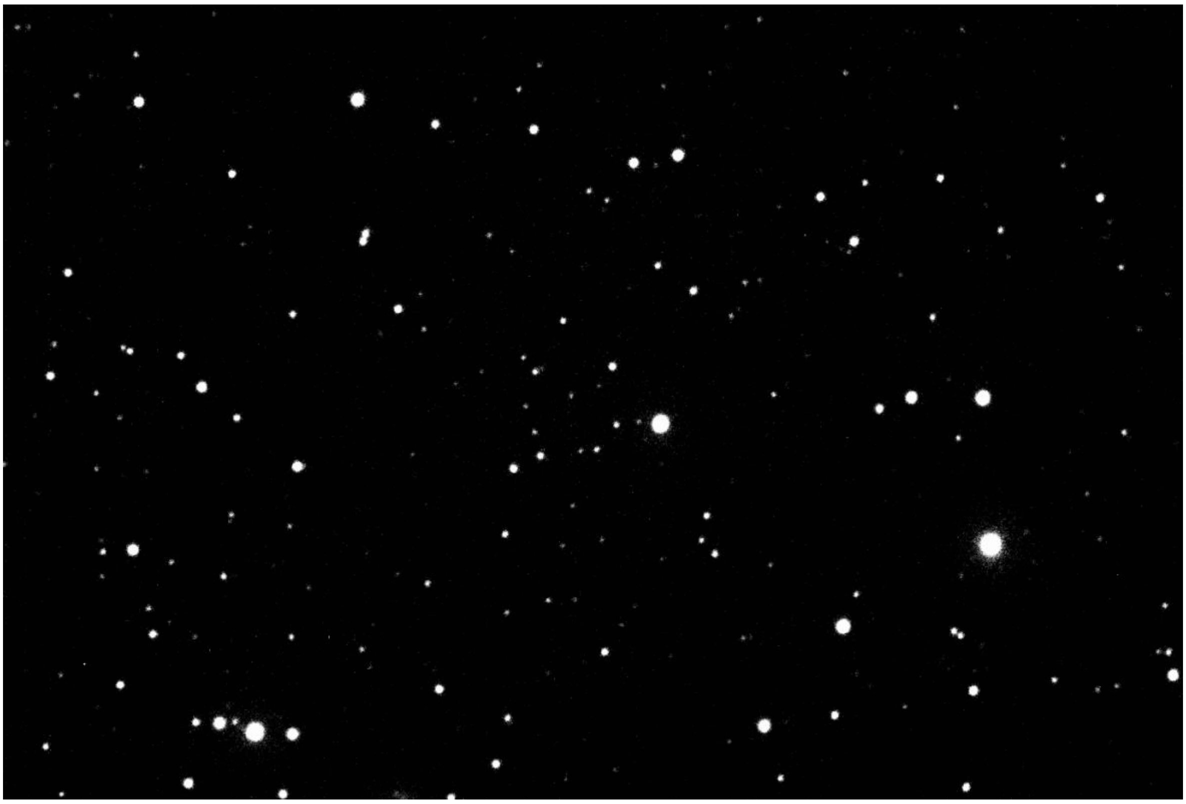
Where's Pluto?

Flick your gaze between the top and bottom images, taken three hours apart, to spot this distant world.



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Where’s 5 Astraea?

Flick your gaze between the top and bottom images, taken three hours apart, to spot this dwarf planet.

Hint: it’s near the centre of the images.

CONTENTS

Where's 6 Hebe?

Flick your gaze between the top and bottom images, taken three hours apart, to spot this dwarf planet.

Hint: it's near the centre of the images.

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Planetary imaging: Jupiter

Images of Jupiter before and after processing to reveal atmospheric behaviour

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Planetary imaging: Saturn

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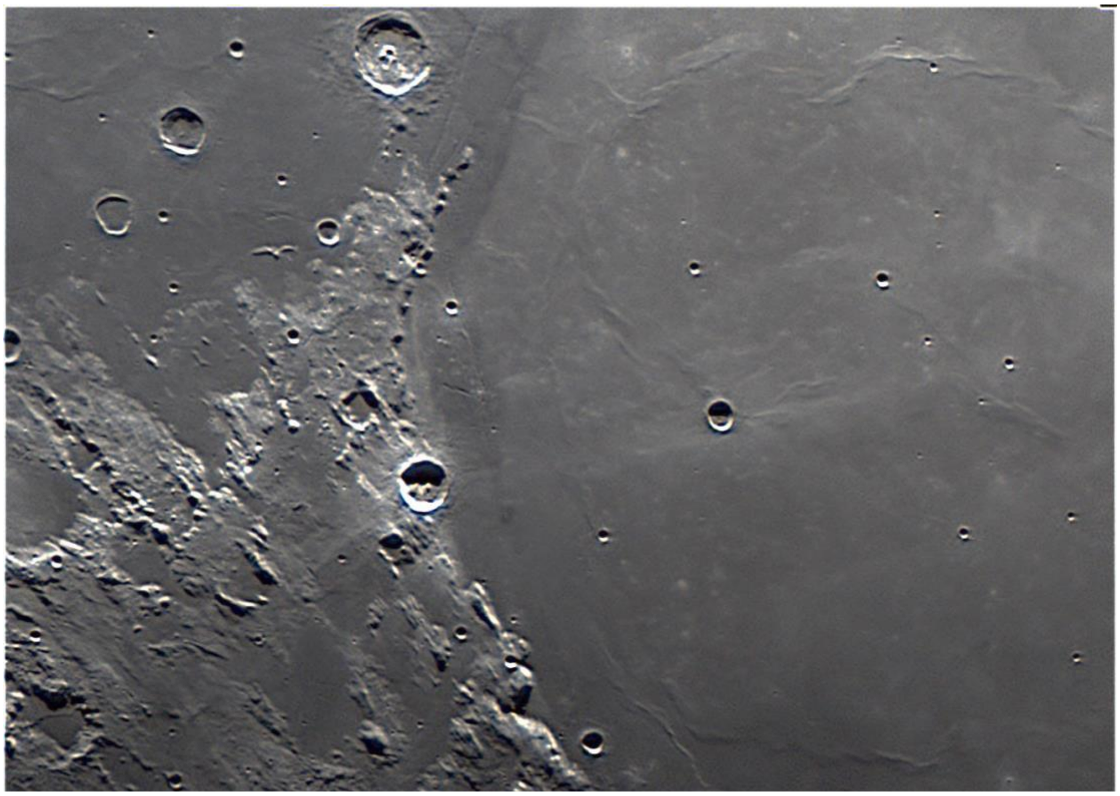
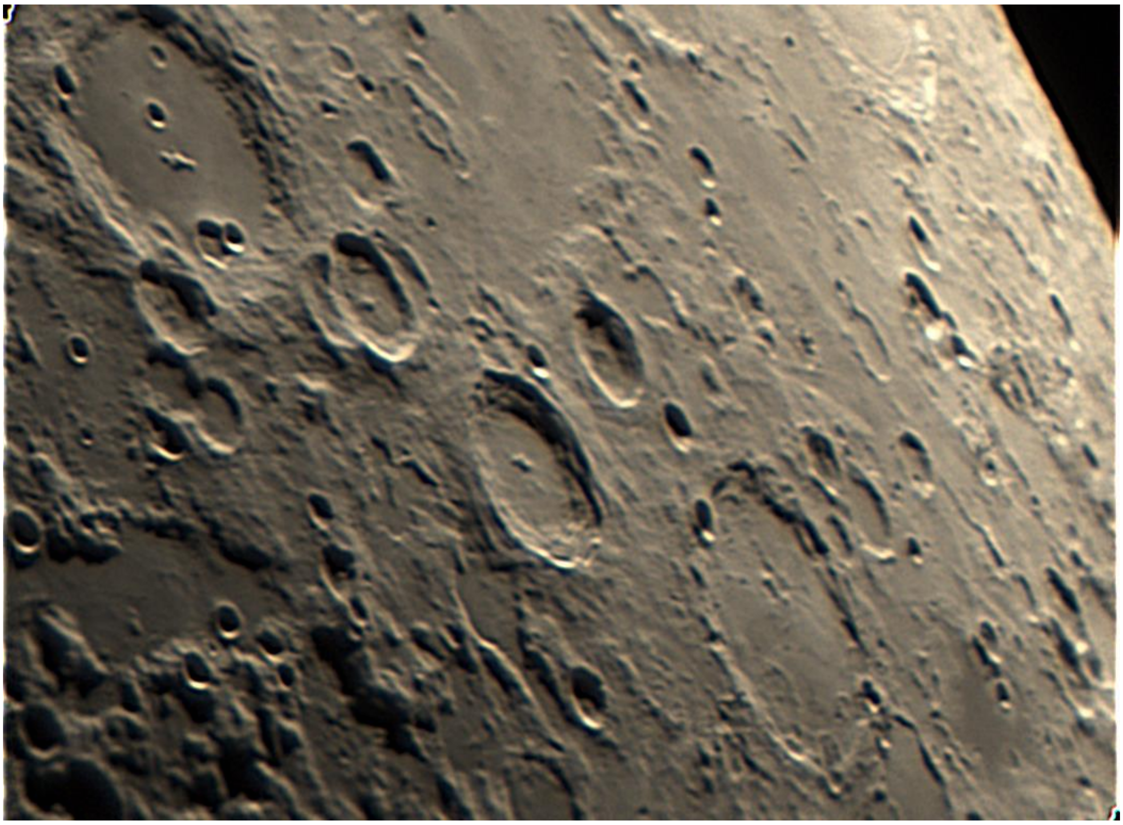
Planetary imaging: The Moon





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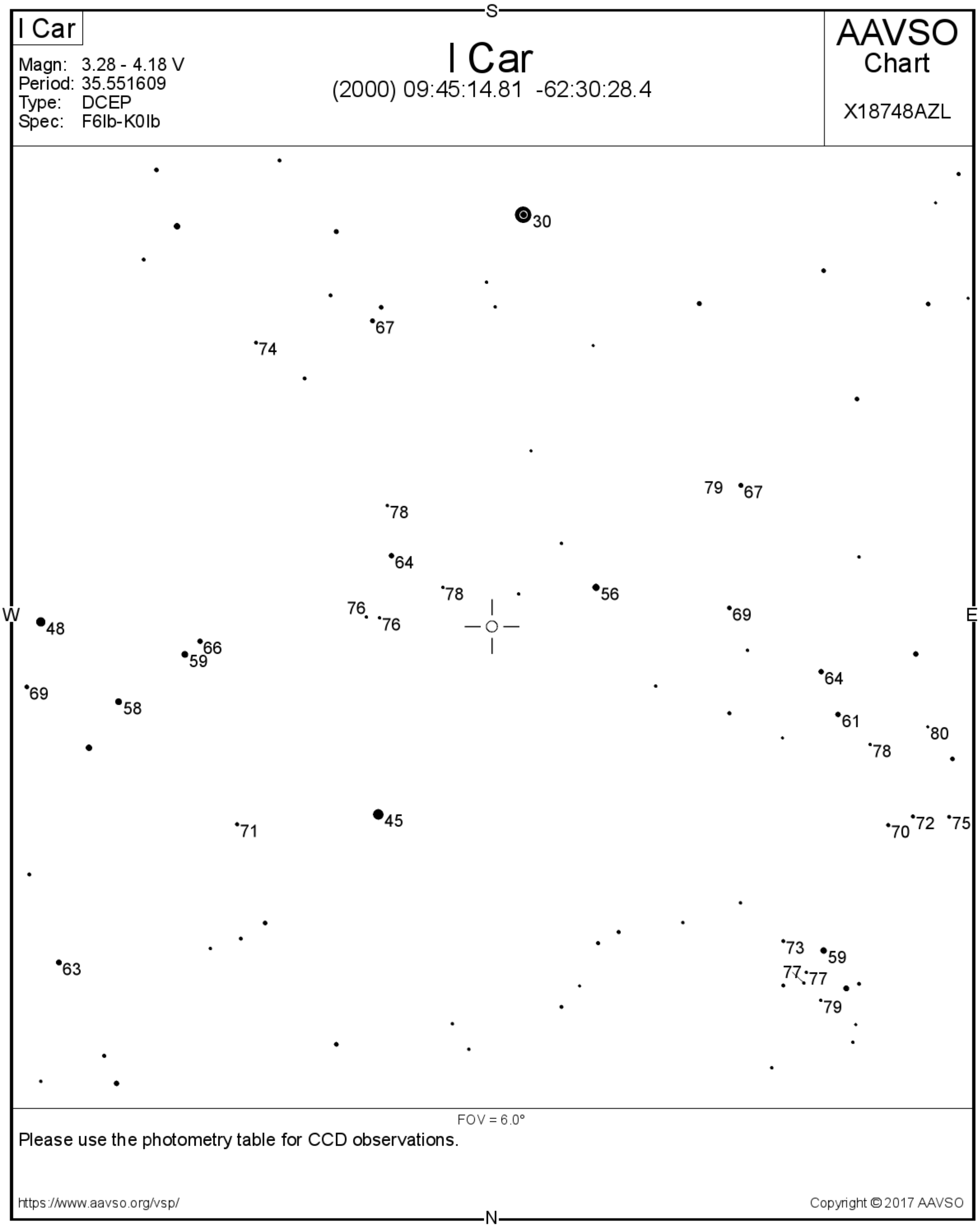
Variable stars: Monitoring the behaviour of dying stars.



Finder chart courtesy American Association of Variable Star Observers. Charts such as this are used by students to determine the brightness of variable stars.

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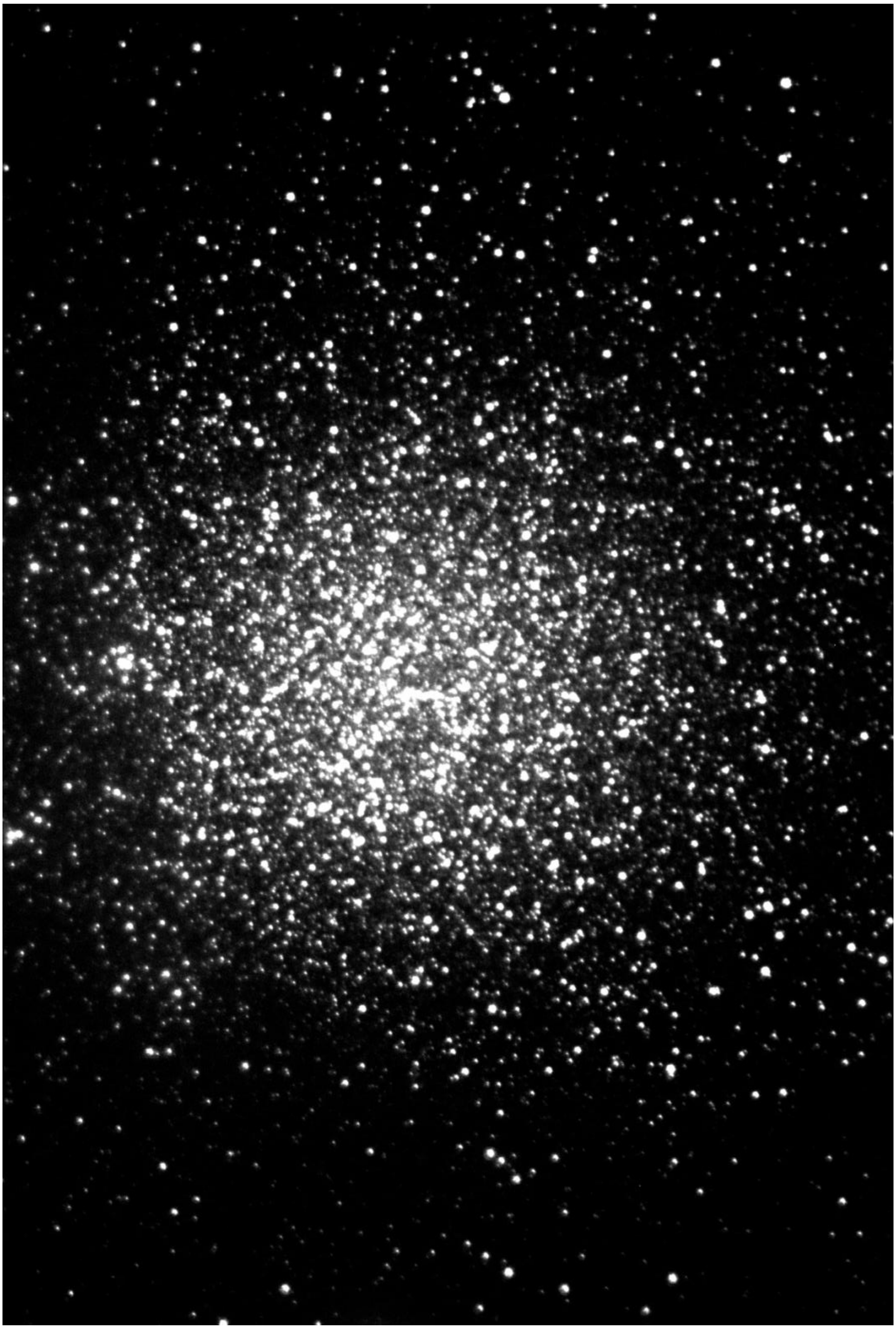
Deep Sky imaging



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APPENDIX 1: MSATT SPECIFICATIONS

SITE

Long: 149° 00’ 31.34” E	**Lat: 35° 19’ 10.87” S**	**Elevation: 772 m**

TELESCOPES

Meade LX200 ACF 300mm f10 Schmidt-Cassegrain
f = 3048
Paramount ME

SharpStar 100Q 100mm f5.8 Quadruplet Flat Field Apochromatic
f = 580 mm

Coronado Solar Max 40mm f10 Hα

AUXILIARY TELESCOPES

Dobsonians (x3) 200mm f6 Newtonians

Celestron 80mm F6 Spotting Scope
Low mag 20x, FOV 1.5°; High mag 60x, FOV 1°

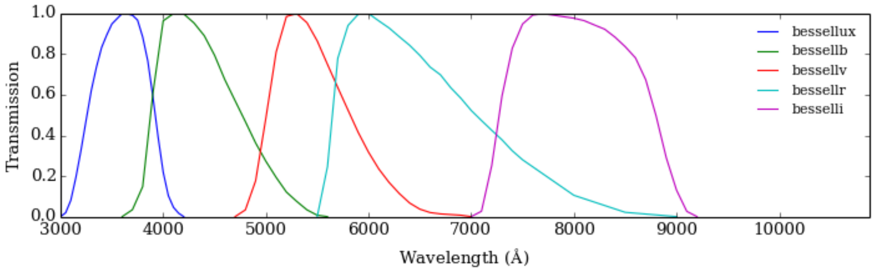
CAMERAS

SBIG ST-10XME	14.9mm x 10mm (17.9mm diagonal)
Imaging CCD KAF 3200E	2184 x 1472 pixels = 3.2 megapixels
	FOV 16’ x 11’ (Meade only)

ZWO Webcam ASI224MC	4.8 mm x 3.6 mm (6 mm diagonal)
	1304 x 976 pixels = 1.2 megapixels
	Pixel size 3.75 µm
	FOV 3’ x 2’ (no Barlow; with Meade)

FILTERS

Bessell U Band
Bessell B Band
Bessell V Band
Bessell R Band
Bessell I Band
Baader UV/IR cut-off



Visual filters

Astronomik UHC 2”

Bintel #12 Yellow	Bintel #21 Red	Bintel ND 96-09
Bintel #56 Green	Bintel #80A Blue	

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EYEPIECES

EYEPIECE	AFOV	MEADE		SHARP STAR		H α SOLAR	
		MAG	FOV	MAG	FOV	MAG	FOV
Sky Watcher 23mm	82 º	132x	37’	25x	3.3º	17x	4.7º
Sky Watcher 15mm	82 º	203x	24’	39x	2.1º	27x	3.1º
Sky Watcher 7mm	82 º	435x	11’	83x	1.0º	57	1.4º
Teleview Radian 18mm	50º	175x	18’	32x	1.6º	22x	2.3º
Teleview Radian 10mm	50 º	305x	10’	58x	0.9º	40x	1.3º
Teleview Radian 8mm	50 º	381x	8’	72x	0.7º	50x	1.0º
Bintel 42mm	48 º	73x	40’	13x	3.5º		
Bintel 30mm	48? º	101x	28’?	19x	2.5º?		
Criterion Plossl 32mm	41 º	95x	26’	18x	2.3º	13x	3.3º
Super Plossl 26mm	43 º	117x	22’	22x	1.9º	15x	2.8º
Orion Deep View 28mm	56 º	108	31’	28x	2.7º		
Orion 40mm	32 º	76x	25’	15x	2.2º		
Orion Erfle 20mm	54 º	152x	21’	30x	1.9º	20x	2.7º
Orion Orthoscopic 12.5mm		244x		46x		32x	
Orion Orthoscopic 9mm		339x		64x		44x	
Orion Orthoscopic 7mm		435x		82x		57x	

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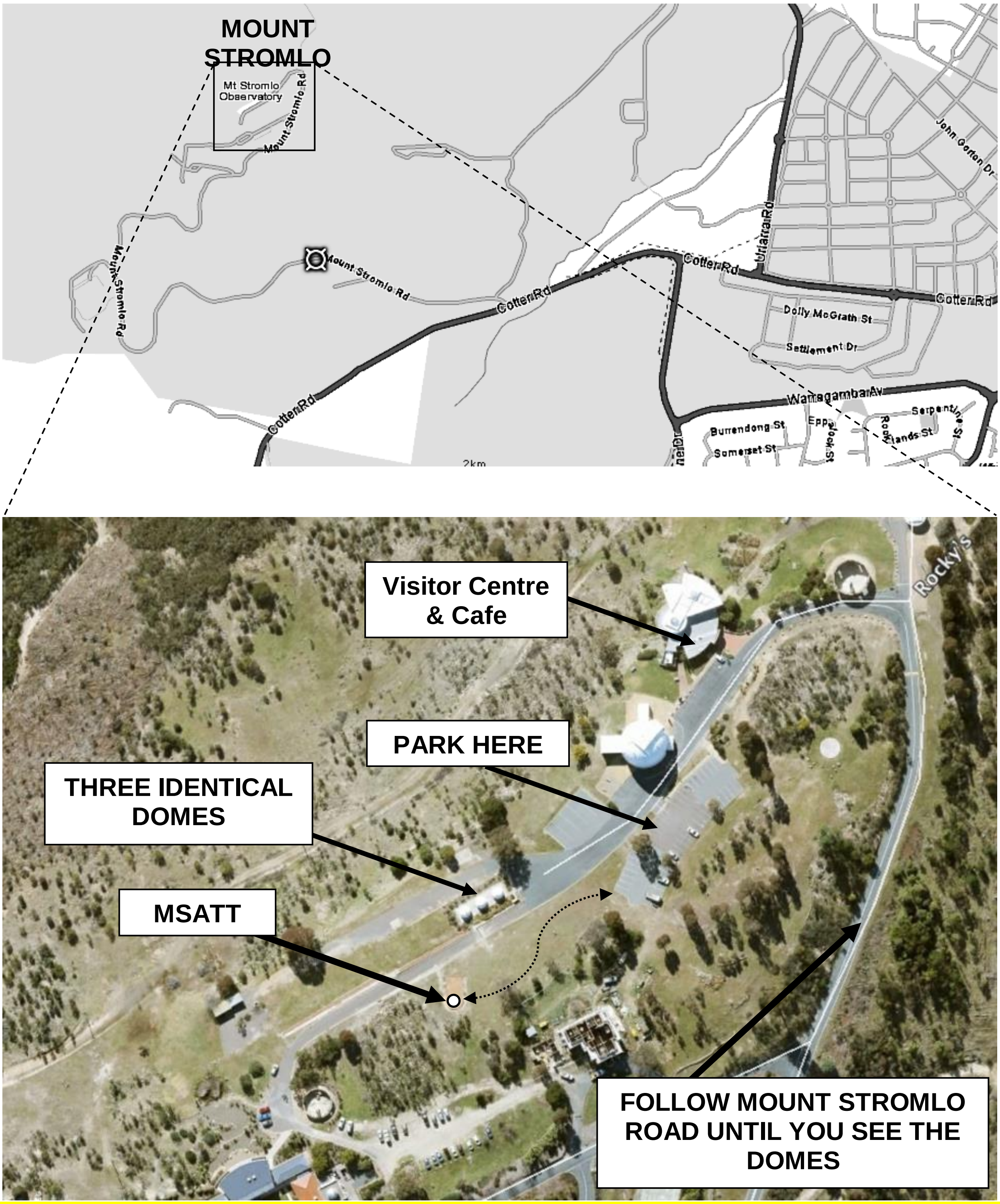
HOW TO GET TO MSATT

DARKNESS IS ESSENTIAL IN ASTRONOMY Please do not drive towards the site, nor shine your headlights on the dome or participants.
Please park in the area indicated.

PLEASE CALL FOR CONFIRMATION YOUR OBSERVING SESSION IS PROCEEDING.

PHONE: 0 44 99 66 200



Parental supervision is required at all MSATT sessions.

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MSATT is an ANU initiative
and is supported by the ACT Education Directorate.

Geoff McNamara is a Science teacher at Melrose High School, and Manager of MSATT.