

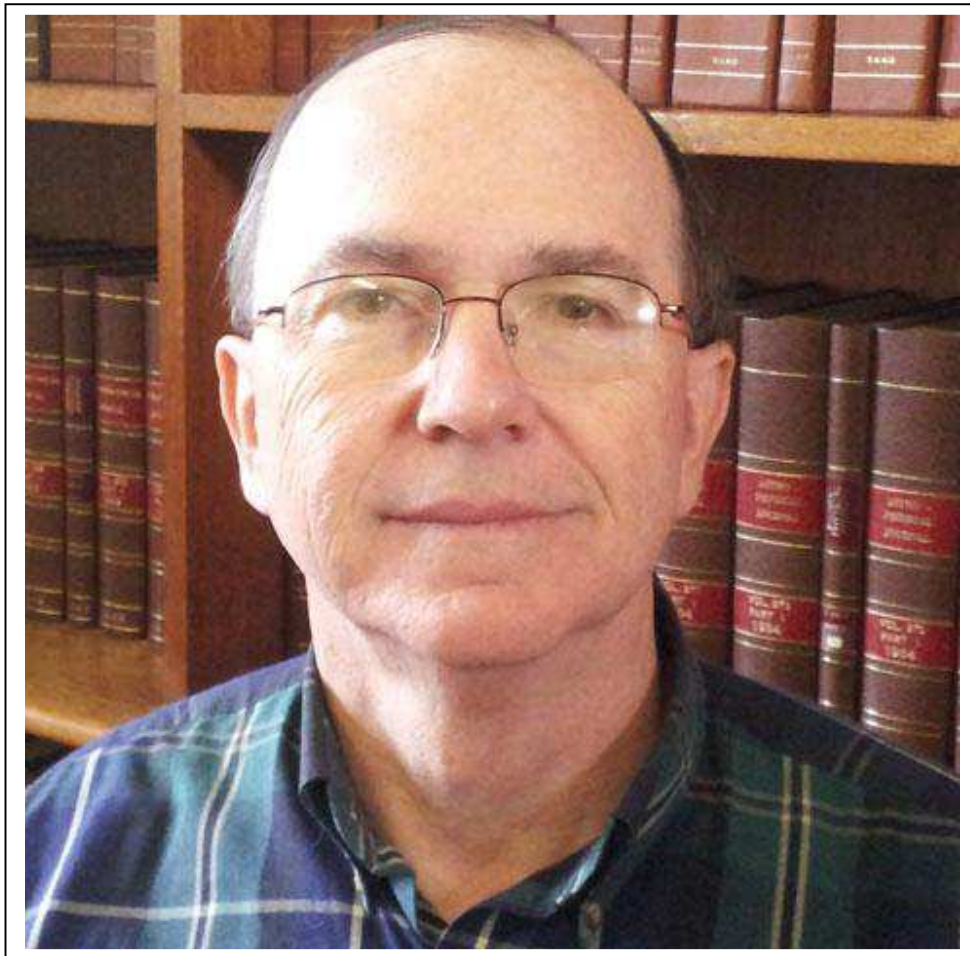
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Cover Photo:

Prof Theodore (Ted) Williams who leaves SAAO at the end of this year, having been Director since January 2013.



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News Note: Prof Ted Williams leaves SAAO

Prof Theodore (Ted) Williams (see cover picture) relinquishes his post at the end of December 2017. Some of the changes that occurred at SAAO during his tenure are as follows:

Acquisition of the MeerLICHT instrument and SAAO's first modern alt-az telescope, a 1-m instrument known as Lesedi (which means light or enlightenment in Sesotho).

Donation of some of the older telescopes to different university departments around the country.

Restructuring of the SALT Operations team leading to considerable improvements in all aspects of SALT as the facility continued to mature, particularly following the implementation of the edge-sensor system that actively maintains the alignment of the primary mirror array.

Encouragement for Fabry-Perot spectroscopy which continues to drive progress in this niche observing mode for SALT. He has promised to keep working on this from the comfort of his home in Maine USA.

Support of the mechanical workshop in taking on outside work which funded apprentices & enabled the purchase of a long-sought coordinate measuring machine. A new high-precision 5-axis milling machine has significantly enhanced the workshop's capabilities.

Ted's wife Janet has done incredible work at Vista Nova High School, teaching kids with learning (& physical) disabilities over five years.

He is being succeeded by Dr Petri S.M. Väisänen who completed his PhD in Helsinki in 2001 and has worked previously at the Harvard-Smithsonian Center for Astrophysics in Cambridge MA and the European Southern Observatory in Chile. He has been at SAAO since 2004.

News Note: ASSA and Historical Symposia in March 2018

Two conferences of particular interest to our readers will be held in March 2018 at the SAAO in Cape Town.

The first is the “SAAO History Symposium 2018” sponsored by the National Research Foundation and SAAO, to be held 7 & 8 March 2018 at SAAO. Please see <http://history2018.sao.ac.za>.

The second is the 11th ASSA Symposium “Amateur Astronomy in the Digital Age”, to be held 9-11 March at SAAO in Cape Town. Please see <http://symposium2018.assa.sao.ac.za>.

A Photo-Visual Instrumentation System

Chris Stewart

Abstract: A compact, versatile, integrated system for astronomical imaging & visual observation in the field or the observatory

If you are anything like me, you have dreams of things to do - and of having the means with which to do them. The vagaries of life have a habit of getting in the way of realizing one's dreams, and sometimes the world is simply not ready for them. I have recently completed an astronomical visual/imaging system, the likes of which I have contemplated for literally decades. What has finally made this possible is a combination of the progress in technology, recognition of what is (and is not) realistically

achievable within a (relatively) modest budget, and a lifetime's relentless application of judicious opportunism. Although it may seem simplistic and obvious – or else like too much hassle – this distillation of the process I followed and its outcomes should help. If you are contemplating such a system, you will of course still need to decide which aspects make sense in your own context, and deal with new or alternative technological choices available to you.

Part 1: Equipment selection process

Irrespective of whether you are wealthy enough to “just throw money at the problem” or are on an extremely tight budget, a little thought up front will pay dividends in terms of satisfaction and enjoyment. Here are some things to deliberate as you research your options.

General Considerations

The first step is to critically assess your actual needs & interests. Separate needs from wants. For instance, if you want to image solar prominences, you need a coronagraph and/or Hydrogen-alpha system. You may want a large telescope, but it is not necessary for this application – in fact it may actually cause difficulties. Assess the consequences of your decision: what will you have to sacrifice to afford it? (i.e. what is the opportunity cost?) Will you truly be happy with the result? (i.e. is it appropriate?) Recognise that technology, circumstances and interests change over time: any state-of-the-art equipment you get now will doubtless be eclipsed in the future. So should you wait for something better to come along - and lose out on using it in the meantime? Or will today's solution still be perfectly adequate for your purposes in a decade? Most likely it is not a black/white either/or proposition. I suggest you work to a plan: start small, plot out a course for the medium- to long-term, and leave room for growth.

Many people become deeply devoted to some particular aspect, and should clearly focus on supporting that specific interest. Others, like me, have a broad spectrum of interest.

Where are you going to use the system?

A permanent observatory is always a major convenience, but for deep-sky most of us must travel to dark skies. Lunar, Planetary, Solar and narrow-band imaging can however be done perfectly well from the city. This consideration can significantly influence your choices.

What equipment do you already possess?

Especially that which may at least partially fulfil the requirements? If you have been doing astronomy for a while, odds are that your current instruments are already in line with your interests. In that case, identify deficiencies that need to be improved or accommodated, and see whether you can build on what you have.

What is your budget for the project?

Ah, now that's the million dollar question, isn't it? This is where understanding your actual needs and constraints can pay off, by enabling you to focus on the truly important things first. Even with this restriction, you have options. How resourceful are you? Take judicious advantage of second-hand purchases, bartering, salvage, sales, and repurposing. Where feasible, avoid the "bleeding-edge": rather buy tried & true solutions a few years behind the latest and greatest. Let the early adopters pay the price and take the pain of teething troubles. I sum this up as "don't buy low serial numbers". Instead of buying new, take advantage of other people's folly to get second-hand bargains. Do it yourself, where possible. If you are good at DIY, you can both save money to deploy elsewhere in the project where it will really make a difference, whilst precisely tailoring things to your own requirements. Besides, it adds to the fun and satisfaction.

Simplify!

If it is not easy to use, you will end up not using it. Minimise the number of loose parts to deal with and keep track of: this will facilitate field setup, whilst reducing the likelihood of losing or forgetting something. Making up equipment cases with specific places to accommodate loose equipment

(e.g. eyepieces) not only protects the equipment, but makes life easy for you, so you should definitely keep this in mind. As your collection grows and changes over time, along with the emphasis of your interest, it will be necessary to revisit this periodically.

How are you going to use, store and transport the system?

Ask yourself: Will the parts fit in your vehicle? Can you lift/carry/set up by yourself? Or are you absolutely certain that you will always have willing hands to assist? When you first get that coveted 40-inch, people willing to help out will naturally flock to the novelty like moths to a flame. Then after suffering back strain a few times, they don't return and you are left stranded.

System Design Goals

These are the goals I consider particularly important to achieve in realizing the system.

Reliability is paramount.

It must work under field conditions so, again, keep it simple. Go for ruggedness over prettiness, and invest in high-quality components & construction.

Effectiveness.

It must actually do the required job properly, or you will be unhappy. Your choices will involve trade-offs, and you will inevitably have to live with compromise. So, once more, focus on your real needs to define what is important for your application.

Ease of Integration, and Interoperability.

These are closely allied. Subsystems must work well together, and you need to allow for expansion or change. But why suffer unnecessarily? We have thankfully reached a point in time where many of the problems that plagued us have been resolved. For instance, using off-the-shelf software

elements that adhere to the ASCOM standard (or INDI for Linux) allows you to utilise sophisticated tools with zero or minimal specialist assistance

Usability.

It is a common mantra, but it needs to be stressed: the scope which gets used is the one which is easy to use. Strive therefore for convenience. Does each component have an understandable user interface? Does it handle well... in the dark... even with gloves?

Cost/Performance Ratio & Affordability.

Spend budget wisely to maximise benefit. Frills can come later. Use free / low-cost / existing elements where feasible, and build on the existing equipment set. It is common for people who have become passionate, to fund upgrades to their instruments by selling off their existing kit. Also, some people sell virtually unused equipment simply because they got frustrated, decided to pursue other interests or were otherwise too busy to use it. As long as it has been looked after properly, astronomical equipment can last for centuries, which means there are bargains to be had for the vigilant vulture.

Portability.

Useful attributes include: manageable weight; few separate components to handle; reasonably compact; small enough to fit in the car; one-person setup; and Mains AC plus 12V DC power options so as to work anywhere.

Replicability.

One might not think this important, but it is allied to reliability and longevity. Even really specialist parts should have several alternatives in the marketplace. I tend to focus on readily-available mostly “Plug & Play” components that can be mixed & matched, plus some DIY with common hand tools, so that I can not only make it myself, but fix and upgrade things in future. Doing something similar should increase your likelihood of success.

Versatility & Adaptability.

Here, you should critically consider your needs, both current and potential, in a realistic fashion. Narrow focus will ease requirements (and costs) considerably, so let the actual needs temper your desires. Considerations may include: the possibility of remote control; the need to work both in the field and the observatory; the requirement to accommodate a variety of instrumentation. Again, sticking to standards (12V DC power, common dovetail rails, ASCOM...) will help. But in the end, be very careful what you wish for, because you just might just get it.

Mount Selection

The mount is the most important element for success in astrophotography

Tracking & pointing accuracy.

The better the mount, the less guiding and effort are required, the less frustrating your experience will be, and the better the results are likely to be.

Ruggedness, Reliability & Payload Capacity.

It is better to have more capacity than what you think you will need. This is extremely important for stability & long-term reliability in the field. Quality is a must: an equipment failure is devastating, especially in the field.

Standards compliance.

Why make life difficult? It is both easiest and best to follow the major standards, so look for a mount which is amenable to computer control, and for which appropriate ASCOM / INDI drivers are available. Does it have a widely recognized communications interface - both electrically and in terms of protocol? Mechanical compatibility is equally important, so it is preferable to choose (or make accommodations for) Losmandy / Vixen dovetail rails.

Portability.

Most of us must travel to dark skies, where one may need to lift, carry, assemble/disassemble & load equipment single-handedly. Remember too, that you will have to power the system.

Ease of alignment.

Without good polar alignment, pointing & tracking accuracy will be poor. Equatorial mounts perforce have the means for alignment, though the exact mechanisms can vary wildly in implementation. The trend is thankfully towards improved efficacy, but for an old mount you may need to make modifications to ease the process.

Versatility.

Future-proof as far as possible, as your needs may change over time. If the same mount is to be used for both field & observatory, make sure it is easy to swap between a fixed pier and a portable tripod. What if your equipment needs change? This is where additional load capacity and standard rail mounting systems help.

Primary Optical Component Selection

This is probably a more personal choice than the mount, as there are far more options available. But by now, you know the drill: understand your interests; choose carefully to suit your personal needs & budget; use what you have; consider the future; remember that your mount must be up to the task.

For photography, you will most probably require a guide scope as well as an imaging scope, or else an off-axis guider. A good finder telescope is generally pretty useful, but a small scope can often act as both super finder and guide scope. Settle on standard, or at least common, modes of optical accessory attachment (e.g. 2" focuser & T-thread adaptors).

Worth mentioning at this point is that a precise focuser – e.g. a dual-speed Crayford, preferably motor-driven to avoid vibrations - is vital. Additional accessories that may smooth one's path to success, but which are not

immediately needed, include filters (colour vs. OIII/ LPR/H α) in a slider/wheel, and (in the absence of a guide scope) an off-axis guider. In considering them for the future, you will need to take into account the characteristics of your camera/s, and how you will power and control them within the system.

Choice of eyepieces

Eyepieces represent another category of equipment about which people hold intensely personal opinions. It is clear that certain brands have gained deservedly good reputations for quality of construction and optical performance. TeleVu, Pentax, Baader, Explore Scientific and William Optics spring to mind. Other big names, usually at somewhat lower prices, include Meade, Celestron, GSO, Orion, Skywatcher - to name but a few. The full list, whilst not actually endless, covers a bewilderingly large set of makes, optical designs and focal lengths. Modern computer aided design, automated manufacturing processes and a global market with much competition, together with advances in glass and coating technologies, have put us in a golden age of eyepieces. A proper coverage of eyepiece selection could fill a book. Suffice to say that quality of optical design and of physical construction is important. Modern Plossl eyepieces provide excellent performance at a fair price, and all of the abovementioned marques produce equipment which is more than satisfactory for most people's needs.

But these sweeping statements hardly help in making a selection. The first thing to do is research: familiarize yourself with the basic categories of optical designs, and the metrics (focal length, apparent field of view, barrel diameter, eye relief...) Next, try out as many eyepieces as you can get your hands on, on a variety of telescopes and targets. Star parties present excellent opportunities to do this, with the added benefit of being able to discuss with people their real-world assessment, and the reasons for their choices and preferences. Then, consider what you want to do with the equipment. If you must wear glasses, you will need long eye relief. For eyepiece projection photography, you must either be able to fit your

camera directly to the eyepiece, or the eyepiece must fit inside an appropriate adaptor. Planetary viewing involves relatively narrow angular diameter targets, so you really do not need a very wide apparent field of view (and besides, the diameter of your best vision field is limited by your eye to about half a degree), but for low-power wide-field deep-sky work you will appreciate a wider apparent field of view. Planetary views are also more subject to ghosting, as the target is relatively bright, which drives choice of design and the need for very good optical coatings. The focal ratio of your telescope also plays a big part in the selection process; long f-ratios (say f/6 and above) do not impose such harsh requirements on the eyepieces as do “faster” short f-ratios (below f/6), and are much easier to focus adequately. Should you choose a set from the same range by a single manufacturer, you will probably have the benefit of them being parfocal - so when changing eyepieces it is not necessary to adjust the focus by much.

Whilst it is simply not possible to have “too many” eyepieces, it is best to promote quality over quantity. Each eyepiece has its good and bad points, and each target demands something special of the instrument to render the best achievable image. Most people begin by pursuing excessively high magnification, soon becoming disillusioned. Much has been written on the subject, usually involving the “maximum magnification per inch of aperture” concept. A more useful approach to building a set of eyepieces is to consider the exit pupil, i.e. the diameter of the beam coming out of the eyepiece and into your eye. Interestingly, once you have a set for an instrument with a given focal ratio, it will be appropriate for all telescopes having a similar focal ratio – irrespective of size. The preponderance of f/10 Schmidt-Cassegrains thus explains the prevalence of certain eyepiece focal lengths. Build your set moving from lowest to highest power, as outlined in the table below, then fill in any gaps later according to your needs.

Eyepiece Focal length = (F/D) * P, where F/D = the telescope focal ratio, P = desired exit pupil diameter

Category	Exit Pupil	Comment
Lowest power	<i>P = maximum pupil dilation.</i> Choose P = 6 or 7 mm if young, 5mm if older or suffer much light pollution.	Choose a wide-field eyepiece with good edge definition. To avoid vignetting, it should have a large barrel size. Higher-quality eyepieces have less distortion and internal reflections. With this, you can view extended objects as if from spaceship porthole.
Medium power	P ~ 3 mm	Choose a moderately wide field EP of excellent quality. Plossl or Orthoscopic are good. For general deep-space viewing.
Optimal resolution	P = 1 mm	Good compromise with respect to atmospheric turbulence. High resolution demands excellent quality, whereas a wide field is less important. For detailed deep-space, lunar, planets & moons.
High power	P = 0,75 mm	For very fine detail; mostly planetary & double stars. Quality is paramount. Good anti-reflection coatings are mandatory.
Maximum power	P = 0,5 mm	Extreme magnification, seldom used, demands utterly stable atmosphere. Requires an exceptionally high-quality eyepiece to glimpse the limits of the telescope's resolving power.

Table 1.

Camera Selection

Visual observation has relatively simple requirements. Doing astrophotography adds a whole new and more demanding aspect to the situation. Seasoned imagers can skip this section; you already know all this. For the rest and the curious, read on. But remember this is not a treatise on imaging per se.

Most likely you will need two cameras: the actual imaging camera and a guide camera. Basically, your options are: Webcam vs. DLR vs. Video vs. dedicated astro camera; and monochrome vs. colour. The number of available devices and options is bewildering – and the prices can be staggering, especially for those of us not earning in a major currency. So (yet again!), consider your real interests and budget very critically. Especially if you are new to this, keep it simple. Start with baby steps, learn the basics first, and then progress.

Even for fairly advanced work, you probably don't actually need a "pro" camera. Entry level DSLRs are very capable these days, readily available, not too expensive, and quite light weight. Obviously, a camera optimized for deep-sky astrophotography will be intrinsically better at the job, but don't fool your self – dedicated cameras come with a steep price, and have an even steeper learning curve. In order to justify the expense, one should first gain the experience, develop the expertise, and have a more focused interest.

A second-hand DSLR will be by far the most affordable entry-level imager - and you may already have one. On a DSLR, Live View (or equivalent) functionality enables you to see on a screen exactly what the camera sensor is getting. This should be considered mandatory as it is hugely beneficial for framing the shot and especially for achieving critical focus. Wide-Field, Deep Sky, Lunar, Planetary and Solar astrophotography can all be done with a DSLR. With Solar, there is generally plenty of light available and the size of the target is easy to deal with for shooting the entire Sun. The major brands are all decent and the relative merits leap-frog one another periodically. "Mirrorless" digital cameras are making inroads into

the DSLR space and appear eminently suitable for our application. Whichever you choose, consider these factors: over the long term the lenses are more important than the body; you are locking into a system; the camera has to work with your control software.

For Planetary (and to a lesser degree Lunar or high-power Solar) work, a webcam or video camera can be pressed into service to good effect, and guiding is not a major issue. Imaging of faint deep-sky objects however requires long exposures, which makes accurate polar alignment, tracking and guiding vital.

Having said all that, dedicated astro cameras are more prevalent and more capable than ever before, and the trend should continue. Some of these cameras contain both imaging and guiding sensors. Others can be used for either imaging or guiding and provide ST4-compatible auto guider outputs. Even cameras capable of providing almost real-time video outputs are available. You need to do your research carefully.

Choice of computer

We now come to the brains of the system. If you have chosen wisely on the mount, you may be able to dispense with this, as the mount should be able to locate and track objects with good precision all by itself. However, for astrophotography it is convenient to control the cameras, whilst long-exposure images inevitably require guiding.

But what exactly is guiding? In engineering terms, guiding is negative feedback. Due to imprecision in alignment and tracking (of the mount) together with atmospheric refraction, turbulence etc. the image will wander around slightly on the sensor. This results in blurring of the final image, especially when making long exposures. To combat this, we need to monitor the position of the image, and make fine adjustments to the position of the mount on a moment-to-moment basis in order to compensate, thereby keeping the image always in the exact same place on the sensor to avoid the blurring. In times gone by, hardy souls would spend hours at a high-power eyepiece, manually twiddling control knobs

to keep a reference star on the crosshairs. A moment's inattention or an inadvertent movement could ruin the shot – which they would typically find out about long after when their films were eventually processed. Today, we have it easy – we let a computer do the monitoring and automatically perform the corrections... tirelessly and consistently. Sometimes, guiding functionality is embedded in a dedicated guide camera that talks directly to the mount. If that's the kind of guide camera you have, it probably talks to the mount through an "ST4" interface, a de facto industry standard. If not, you need an external computer. And if you do have a computer, you might as well use it as your personal planetarium, to plan and log your observations, to control your imaging camera, to help you find objects that may be too faint to see, and even to process your images.

Most people would use a laptop PC in the field, and probably a desktop PC in the observatory. Although the laptop is much more portable and less power-hungry than a desktop, both need quite a lot of power to run. In the field, power is a real issue.

Application Software options

With the hardware covered, it is appropriate to say a bit about the software. Since I chose a Windows platform, which is the most common, for which a tool chain is well established, and with which I am most familiar, I shall restrict my comments accordingly. (For telescope control under Linux, search for INDI-compatible options. A free "astro distro" version of Linux complete with a full suite of properly integrated application software is also available free to download, which can eliminate a lot of pain.) What follows is a brief intro for those who are not already familiar with the technology.

Computer software at the most fundamental level comprises a set of simple instructions that the hardware can "understand" – and which in turn accommodate the hardware's peculiarities. Built on top of this are successive layers, each of which concerns itself with providing higher-level capabilities, and which views what is below in an abstract sense because

the particularities are dealt with at the lower level. Closest to the hardware are the *drivers*. Drivers “know” the details of the hardware and how to deal with it. Each hardware subsystem will have a set of drivers, handling concrete things like clocks, communications, GPS receivers, keyboards and displays, hard disk storage, and so forth that physically make up the PC, and which can be implemented differently from one PC to another. These drivers present specialist services to the *operating system*, which in turn provides a common platform for the *application* software. The operating system creates a standardized environment for the applications, providing simple standardized ways of getting the most common functions done, whilst hiding all of the messy details. Application software looks after the real work of interest to the user, examples being word processors, spreadsheets, music players and so forth. Usually there will be several applications for a given task, available from varying suppliers, that do essentially the same thing but with differing user interfaces and emphases, giving the user a choice. For example, if you want a “PC Planetarium”, you could have the option of Cartes du Ciel, Stellarium, Starry Night, The Sky, Redshift... to name but a few.

Now, let’s talk about ASCOM. PCs do not normally have any clue about the specific needs of astronomy. The operating system is unaware of the existence of mounts, astro cameras, filter wheels, focusers, or the need to instruct the telescope to move north/south/east/west. The ASCOM platform is like a set of “super drivers” which sit on top of the operating system, connecting compliant applications, and enabling them to communicate about the most needed actions in a standardized way. Today, most vendors of electronically-controllable astronomical equipment provide ASCOM drivers for their hardware. This vital glue function has made control of instrumentation very easy compared to the situation before. Read more about it at <http://ascom-standards.org/>

The whole arrangement is depicted schematically below. It is not necessary to understand everything in order to use the system, just as you do not need to know how an engine management system works in order to be able to drive a car. The important thing is to choose software that

runs on your system and does the things you want without hassles. ASCOM has removed a lot of the hassles. If you have ASCOM drivers for your equipment and use ASCOM-compliant applications, it should all go quite smoothly. There are many groups on the Internet where you can ask questions if you get stuck, and a lot of advice already out there. The equivalent for Linux is INDI.

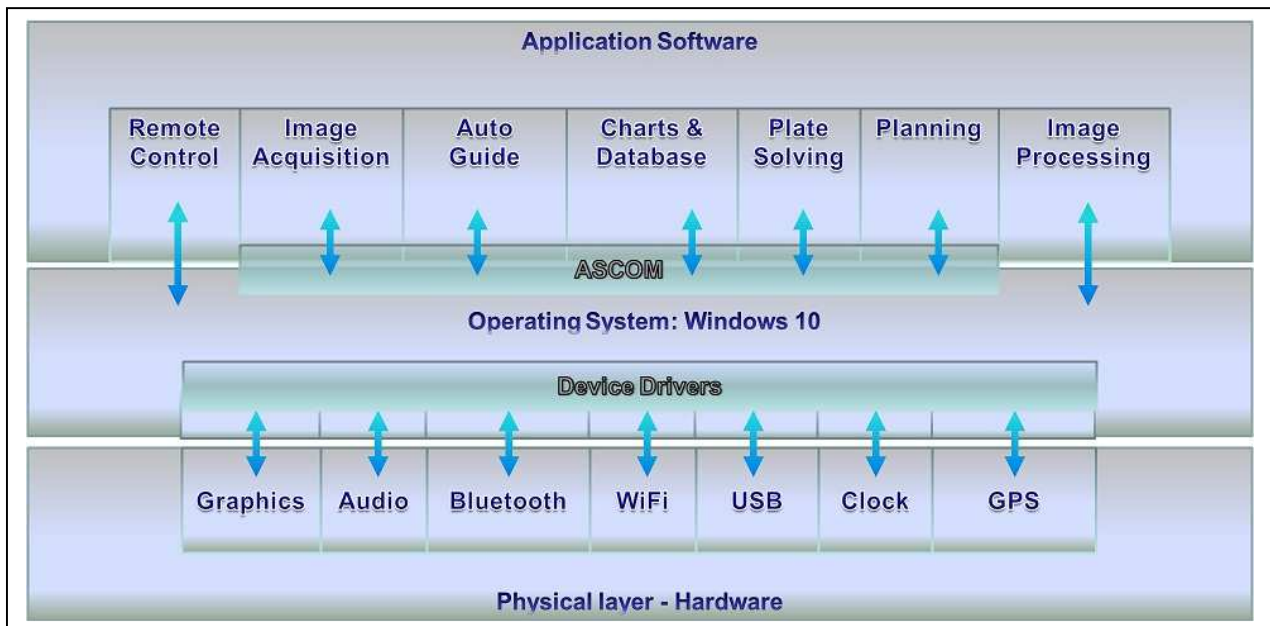


Fig. 1.

Part 2: My selection

Having been involved in astronomy for more than half a century, I know well where my interests lie: everywhere! I would like to do both visual and photographic observations of Wide-Field, Deep Sky, Lunar, Planetary and Solar objects. I may eventually wish to dabble in photometry and spectroscopy. In other words, I still want to do it all. Given the wide range of targets of interest, and the requirement for both visual and photographic work, versatility is clearly a priority. While that hardly narrows the focus, at least it is obvious that I shall need a variety of equipment, a place to use it, had better not go too big on anything, and should leave room for expansion. That my age dictates an aversion to backache, whilst my wallet remains slim, also imposes certain constraints.

My choice of mount, following much deliberation, was an iOptron CEM60-EC. It is compact, well-engineered and easy to set up, with an excellent payload-to-mass ratio and extremely accurate tracking. Not cheap in absolute terms, but also not in the stratospheric realms. All things considered, it is both exceptionally capable and good value for money. It has decent ASCOM drivers, is manageable in the field and can be loaded in the car by myself.

Versatility and “mix & match” ability both figured highly, given the requirement for both visual and photographic work across the spectrum. It happens that the standard Manfrotto (Bogen in the US) tripod head shoe - the part which screws onto the camera body or lens, and then clips into the tripod head – fits quite naturally into a Vixen-standard dovetail clamp. The CEM 60 mount has a combination saddle which accepts both Vixen- and Losmandy-spec rails. It is therefore possible to easily attach a single camera & lens directly to the mount for simple wide-field work, though it would usually be in combination with a guide/finder scope (in which case it would go on top of the guide scope).

My selection of primary optics was partially dictated by what I have collected over the years, which in turn was driven by my interests.

- Standard EF camera lenses covering $F=10\text{mm}$ to $F=400\text{mm}$ for low power, wide field DSLR work.
- William Optics Megrez - 72mm 2-element $F/6$ semi-APO refractor with Vixen-compatible dovetail rail. This gives $F=432\text{mm}$ (native) or $F\sim 345\text{mm}$ ($F/4.8$) with William Optics 0.8x focal reducer / field flattener for low power.
- Intane ED80 - 80mm triplet $F/7$ APO refractor on a Vixen-compatible dovetail rail, with a Vixen clamp attached above to piggy-back another instrument. This gives $F=560\text{mm}$ (native) or $F\sim 475\text{mm}$ ($F/6$) with Intane 0.85x focal reducer / field flattener for medium power

- Celestron C8 F/10 Schmidt-Cassegrain on a 3" Losmandy-compatible dovetail rail, with an Intane 2" Crayford focuser. This gives $F=2032\text{mm}$ (native) or $F\sim 1280\text{mm}$ ($F/6.3$) with focal reducer, for high power lunar, planetary and deep-sky work.
- Coronado PST 40mm solar telescope with Manfrotto shoe and Baader Barlow lens.

Any of these can be used individually on the mount without additional mechanical adaption. The Vixen clamp above the Intane APO can take the Megrez, the PST or a camera/lens as piggy-back instrument. This allows white-light plus Ha viewing of the Sun, or wide-field/deep-sky with the possibility of guiding. All of the telescopes except the Coronado PST have 2" focusers, each with a 1,25" adaptor, so a single set of eyepieces can be used across the range of telescopes. All of the telescopes can couple to a DSLR camera using a T-ring, or to the guide camera via a 1,25" nosepiece, so they are accommodated across the range. The C8 has a decent finder scope, but the Megrez also makes a fabulous finder or rich-field scope when coupled with a low-power eyepiece. Apart from the Coronado, which has an internal focusing system, all the scopes in my system have decent dual-speed Crayford focusers.

Initially, the C8 will work alone, but eventually the dovetail rail system will be expanded to enable all instruments mentioned to be on the mount simultaneously. None of this is too difficult to handle in the field, and one can choose to take only the items needed for a specific mission. In time, I may elect to substitute my 10" LX200 SCT optical tube assembly (or even a 12" should one happen to become available) for the C8 when used in the observatory setting, but the C8 will remain for field work. It would be nice if the focusers had motor drive, and I will most likely modify them myself at some point.

I took full advantage of the second-hand market to keep costs down, and none of these choices were made by accident; each fills a niche and they are quite complementary.

My eyepiece choice was determined by considerations of affordability, build quality and availability, together with the mechanical flexibility necessary for the envisaged applications. In my personal opinion, GSO and William Optics represent excellent balance in terms of price/performance ratio, while the Baader offerings shine in terms of mechanical build quality, versatility and coatings. Also, for the system described here, all of the instruments apart from the Coronado PST have 2" focusers. Focal ratios range from about f/5 up. I wear glasses, wish to do deep-sky as well as lunar/planetary observations, and expect to try eyepiece projection imaging.

My choice therefore was a complete set of Baader Planetarium Hyperion eyepieces, including the clickstop zoom with its dedicated 2.25x Barlow. Almost all of the Hyperion range can fit both 2" and 1.25" focusers. They have specific threads for securely attaching photographic equipment, plus other modular design aspects which add to their versatility.

For the Coronado, I have found that an early version 9mm TeleVu Nagler is an exceptionally good match, to view the entire solar disk with prominences. The Coronado is difficult to use photographically, as the focus cannot be brought far enough out. For this, the Baader 2.25x Barlow lens from the zoom comes to the rescue; it has provision to be used with a T-ring that couples to the camera body, enabling focus to be achieved without any modification to the focuser. The final image scale is also perfect for the APS-C sized sensors found in the majority of DSLRs.

Rounding out the collection is a GSO 50mm SuperView eyepiece, a GSO 2" ED 2x Barlow and a William Optics 2" SWAN 40mm eyepiece. The Hyperion aspherics and zoom plus the moderately-priced GSO items were purchased new; all the rest are excellent condition 2nd-hand items, providing an impressive range of high-quality versatile equipment at relatively modest cost. With care, all will last for a lifetime. A foam-fitted rugged Pelican hard case looks after safely storing and transporting this precious cargo. Again, I was fortunate to obtain one of these cases second hand, but cheaper versions from the orient are available (try

establishments catering for the 4x4 off-road fraternity; they are often less expensive than camera vendors).

My camera selection was mostly driven by affordability. Sure, I definitely want a dedicated astro camera, but for now shall perforce be content with what I have.

I long ago settled on a DSLR from Canon, because they were initially better for astrophotography than their competitors. The camera's software can be augmented with Magic Lantern for additional useful features (e.g. an intervalometer), it is the most-supported DSLR range by astro control programs, and there is good local support. I was fortunate to negotiate an excellent price on a Canon 60Da with the supplier; this camera is factory-modified for astronomy, enabling better sensitivity in the crucial deep red part of the spectrum. I already had two Canon 50D bodies for conventional photography, which can also be used. They are all capable of being run in a "tethered" mode, i.e. controlled from a PC via USB.

For guiding, and perhaps planetary work, I bought second-hand a first-generation Meade DSI (deep-sky imager). In its time, it was quite special, and its characteristics are probably far better than average for a guide camera. It is powered via the same USB cable that controls it and downloads the images. Most importantly, it is recognized by the guiding software. And, being out of production, it was very cheap! I did however battle to find drivers for the Windows 10 operating system, as it came out a decade ago in the XP era; fortunately Win 7 drivers work.

My choice of computer was, unconventionally, a tablet PC. Why use a tablet? Because: it is compact; it is very light in weight; it has extremely low power consumption; it is easy to run off 12V (i.e. from the same power source as the mount, with no need for large batteries, an expensive & power-hungry inverter, a generator or a special power adaptor); the touch-screen interface allows using a virtual keyboard in the dark; and it is usually cheaper than a laptop PC.

Why specifically the Lenovo Miix 2? Critically, it runs Windows 10. This enables common ASCOM-compliant applications to work in standard environment. Just as important, and unlike many tablets, it can charge through the USB port even whilst using the port for I/O. Build quality is good, it has a decent IPS HD display, up to 10 hours of runtime are possible on its internal battery and... it was low cost (only ZAR2000 ~US\$140 ~ 125€ for 64GB SSD version – including MS Office!) Why would one not choose that particular tablet? It has only one USB port. It is at end-of-range, which is probably why it was on sale. It would be nice to have a larger than 8” screen. There are of course others which would work just as well.

Remote Control		<i>Enables monitoring & control from warm room via Ethernet/WiFi</i>
TeamViewer	**	Free. Many satisfied users. Replicates user interface
Camera Control & Image Acquisition		<i>Check that your choice supports your camera!</i>
APT	**	Free indefinite trial version, large user base
Backyard EOS		Moderate cost, nice human interface
Autoguiding		<i>Must support existing camera</i>
PHD	**	Free. Well supported, many happy users
MetaGuide		Free. Powerful but more difficult to learn than PHD
Star charts / Object database		<i>Target selection. Feedback on scope pointing</i>
Cartes du Ciel	**	Free. Good ASCOM integration & scope control features
Stellarium		Free. Pretty user interface but difficult to drive on tablet, more suited to planning than operation
Plate solving		<i>For verifying target field when object is too faint to see</i>
AstroTortilla	**	Free. Only readily available option
Planning & logging		<i>To prepare for and document your observations</i>
Deepsky Astronomy Software, Deepsky Planner 7, SkyTools, Astroplanner		Under consideration. Nice-to-have
Image Processing & Organisation		<i>Crop, scale, adjust & enhance images, manage libraries (Post-Production tasks best performed on dedicated PC)</i>
LightRoom	**	Already have this for conventional photography
GIMP	**	Free. Powerful once familiar with the user interface
Image Stacking		<i>Specialist software to combine multiple lunar/planetary images into single high-resolution result</i>
AstroStack, Autostakkert!, DeepSkyStacker, RegiStax, StarStaX...		Under consideration. Nice-to-have. Can be done on PC in post-production

Table 2

Perhaps you already have or would prefer to use a laptop? No problem: just look after the power issues, and make provision for cabling. You could

still connect it to the control box which will be described later, via a single cable to the USB hub. You will probably need a larger battery pack and an inverter, or a travel charger that can run off 12V.

My Application Software choice.

From the vast list of options available, the applications noted below found their way into my shortlist. The ones marked ** appear most suitable for my purposes. Cost was certainly a factor, as were the user interface, wide adoption by the community, evidence of ongoing support and ease of installation.

Part 3: Integration

This is where we take the parts and put them together to make a system that can perform better than any of its parts individually. I'll walk you through it. As we start pulling the equipment together, let's consider the gaps - commencing with power.

Power strategy

My selected mount runs off a nominal 12V DC, which is typical because to get dark skies one must often run astronomical telescopes in the field, and automotive batteries are prevalent. For it, I built a 12V battery pack with intelligent charging facilities which, when not in use, simply stays connected to the mains. However, I would prefer to also be able to run the system from mains when available, so elected to include a switched-mode power supply in the mix. These power supplies are quiet, compact, efficient and readily available. A unit capable of delivering 12,5A provides much more than is required by the system and is a reasonable size. Since the power supply is under-stressed, it should run cool and be reliable in the long term.

The Canon cameras can run off their own internal batteries, but cold is an enemy of batteries and astrophotography frequently requires long exposures. Also, modern cameras use power to keep their shutters open,

so internal batteries can easily be depleted during long exposures. You do not want your camera battery giving out halfway through a 3-hour imaging session in the cold. External power is therefore strongly recommended for the camera, though it could be dispensed with if you are prepared to disturb the system during an observation run in order to change batteries. Most of the external supplies made for DSLRs use a “fake battery” with a cable to the external supply coming out the side of the battery compartment. Because the majority use of such adaptors is for tethered shooting in studio settings, these are typically mains powered. (Not to mention rather expensive.) I chose to make one that will accept 12V DC. It is not a difficult job; if you are not au fait with electronics you can purchase one ready made from a specialist supplier to the astronomical fraternity. Or, as an intermediate approach, buy an adjustable DC voltage converter from an electronics supplier and use a dead camera battery (available free from cameras shops & repair centers) to make the connection to the camera. The convertor lives with the camera, drawing 12V from the mount’s power reticulation. I built it into the housing of a dead laptop charger, making provision to simultaneously drive two cameras for the future.

The tablet and wireless keyboard each have internal lithium batteries from which they can run for a considerable period on a charge. Nonetheless, one would prefer them not to run out of juice at a critical moment. Both are designed to be charged through a USB port, requiring 5V DC. The DSI guide camera is also powered by the USB cable via which it communicates with the PC. Clearly, we need 5V DC but, like the camera supply, this is easily derived from the 12V. Special voltage convertors can be had, for a price, but here a little lateral thought made life easy. From an automotive spares establishment, I bought a motor car cigarette lighter socket designed to connect to 12V DC. From an electronics shop, I purchased a 4-port USB charger capable of delivering a total of 5A. Believe me, this is cheaper, more compact and less hassle than the alternatives. While I was at it, I got a spare which can quickly and easily be exchanged should the unit in use ever fail.

Murphy is ever-vigilant, waiting for the slightest opportunity to make things go wrong. When it comes to power, especially when you are carting stuff to remote viewing sites, the most likely problems are excessive power consumption depleting the battery, short circuits due to damage, and the possibility of a reversed connection frying your expensive equipment.

Cheap multimeters are perfectly adequate for monitoring power level & consumption, but a bit fiddly and tend to have LCDs that must be backlit. It is more elegant to build in a small panel-mounted Volt-Ammeter with LED display. Short circuits are effectively dealt with by means of a fuse; I chose to use the blade-style fuse common in modern motor vehicles. They are less fiddly and delicate than the tubular glass fuses, easier to inspect, and available even in some supermarkets. Get the fuse holder at a motor spares shop.

Reverse-voltage protection of the input is easily implemented by putting a reverse-biased diode across the power rails, immediately after the fuse. In this configuration the diode will not conduct in normal operation. However, should the power feed be reversed, it conducts, thereby instantly presenting a short circuit that blows the fuse and thus disconnects the feed.

Long ago I settled on XLR plugs as DC power connectors. Commonly used in the music industry, they are readily available, quite inexpensive, easy to use, rated for 5A, pretty much bullet-proof, and latch securely to the socket.

Communications Interconnects

Next up is the issue of communications between all the parts. The mount requires an RS232 serial connection to the computer for pointing instruction, position/status feedback, and guiding. This is normal for decent mounts, as the RS232 standard long established in industry. There is a trend towards USB or WiFi support in new mounts now reaching the market, and some equipment uses Ethernet, but RS232 is likely to be with

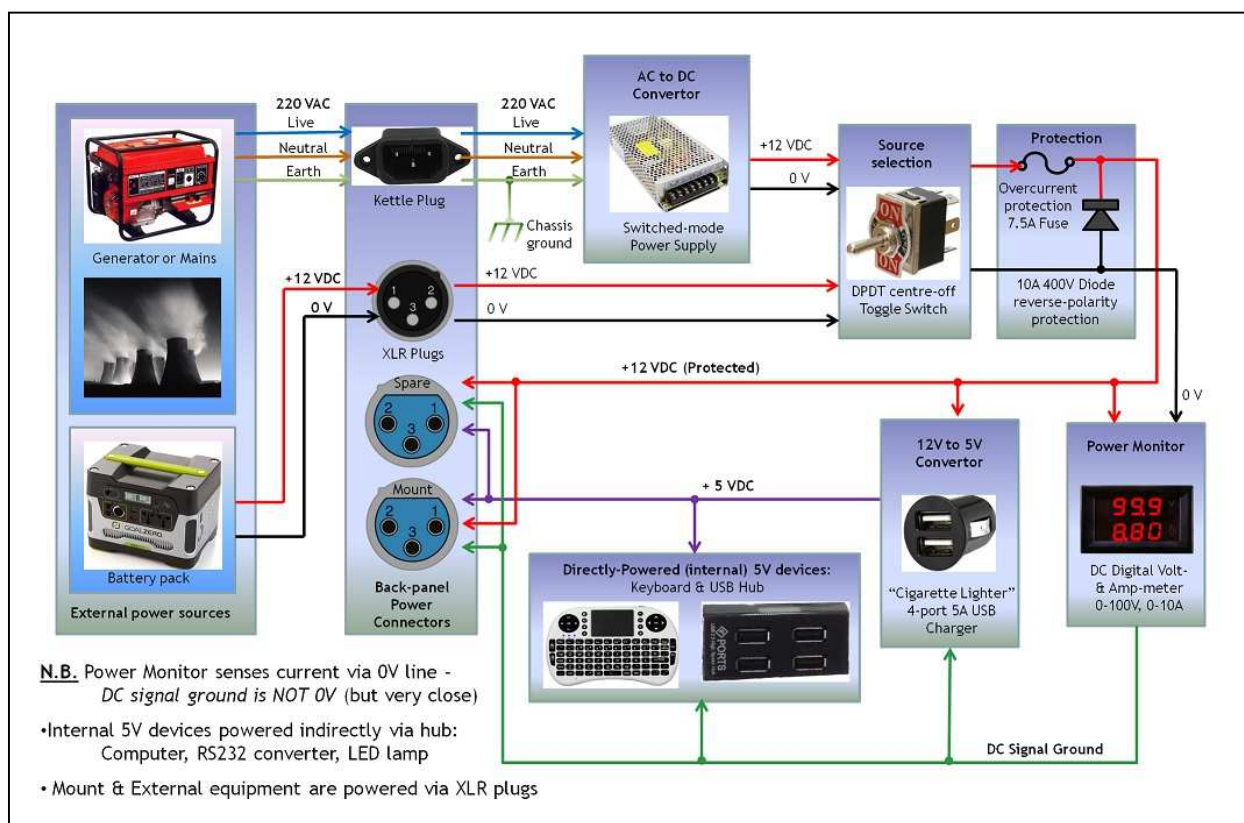


Fig 2 Power distribution schematic

us for some time still. The tablet does support WiFi, should your mount need it, and this can also be used for remote control of the system. But few PCs these days have an RS232 serial port, while tablets almost certainly don't. Fortunately, USB-RS232 converters are readily available, often with the convertor built into a cable. That is the route I took.

Important: when selecting a USB-RS232 convertor, it is strongly recommended that you pay the price for a high quality one which uses the FTDI chips. These are the most likely to work first time and stay working.

Now we have several devices using USB, i.e. at least two cameras, the mount, the keyboard and the PC. With only a single USB port on the tablet, we need a hub to distribute the USB communications. The crucial aspect here is that the hub must be able to feed power upstream to charge the tablet. Unfortunately, most powered hubs do not support this requirement. However, you can often get an unpowered hub to do the job, by simply feeding power into one of the ports - which is big a trick

because this is not normal usage. I was fortunate to find a 7-port hub which could do this. Even better, it is designed to either run unpowered or accept an external power input via a miniature barrel connector – and it can still feed power upstream to the tablet when connected to external power. This is a major bonus, because it is a much cleaner solution and you do not need to sacrifice a port for power supply. Once more, I bought two so that I would have a backup in the long term. You probably need to experiment before adopting a hub. The cable harness connecting the control box to the mount is described more fully later.

Ancillary Hardware

Just as the hub serves to tie various electronic subsystems together, so attention must be paid to mechanical interconnects.

Due to the requirement for a mix and match collection of optical & camera equipment, the mount potentially needs a range of counterweights to achieve balance in all configurations. It comes with a standard weight, and optional extras can be ordered. However, shipping dead mass around the planet is very costly. A better approach would be to adapt common locally-available weights to the mount. Accordingly, I had an adaptor sleeve machined that enables a variety of common barbell weights to be accommodated, up to three together at a time. Different manufacturers use different shaft sizes; you may be lucky to find one which fits your mount's counterweight shaft without adaptation, but you would still need a collar or other securing mechanism to clamp it to the counterweight shaft – preferably without marring the shaft. I selected a slightly upmarket make, which has rubber-coated weights, a relatively large bore, and cutouts that make carrying and handling the weights easier. The large bore enabled an adaptor sleeve to fit the counterweight shaft, with a threaded collar securing the weights to the sleeve. A hefty Allen screw clamps the assembly to the shaft, with a captive brass insert buffering the screw tip to prevent marring. The new weight assembly can be used alone, or in conjunction with the standard weight. Should the instrument payload change, different weights can be locally procured easily and cheaply.

Power	
220V AC to 12V DC switched-mode PSU	Commercial OEM type for Mains use
12V DC 7.5Ah sealed lead-acid battery pack	Home-made. Field use. External: can be upgraded later
12V DC to 5V DC @ 4.5A convertor	Commercial “cigarette lighter” 4-port USB charger
12V DC to 7.2V DC convertor for DSLR	Home-made “battery replacement” for DSLRs
Computer	
Lenovo Miix 2 8” Windows 10 tablet	With OTG USB Host adaptor
Wireless keyboard / mousepad combo	Would prefer backlit
External USB HDD for image storage	Need at least 1TB, must be easily moved to other PC
Mount	
iOptron CEM 60 EC	On pier for observatory, or on tripod for field
Additional mounting hardware	Adaptor for standard barbells as counterweights Custom dovetail adaptors for various equipment
Cameras	
Canon 60Da / Canon 50D DSLRs	Imaging cameras, can use both simultaneously
Meade DSI	Guide / planetary camera
Communications	
Powered 7-port USB hub USB-RS232 convertor WiFi	Ports can be switched on/off independently FTDI chipset specified to ensure reliability Built in to tablet, for external communications
Cable harness	
Single flexible, rugged, 4m-long cable bundle	Home made. 2x USB, 2x 12V DC, 1x RS232, 1x 5V DC Between computer & mount

Table 3 System Architecture summary

The C8 was “de-forked” (removed from its original fork mount) and treated to a Losmandy-style mounting rail for use on the CEM60. Similarly, the mounting rings for the Intane have been modified: adding a Vixen-standard dovetail clamp above enables the Megrez, a camera, the Coronado, etc. to be piggybacked. In time, Losmandy-style rails and clamps will enable more of the equipment to be accommodated simultaneously.

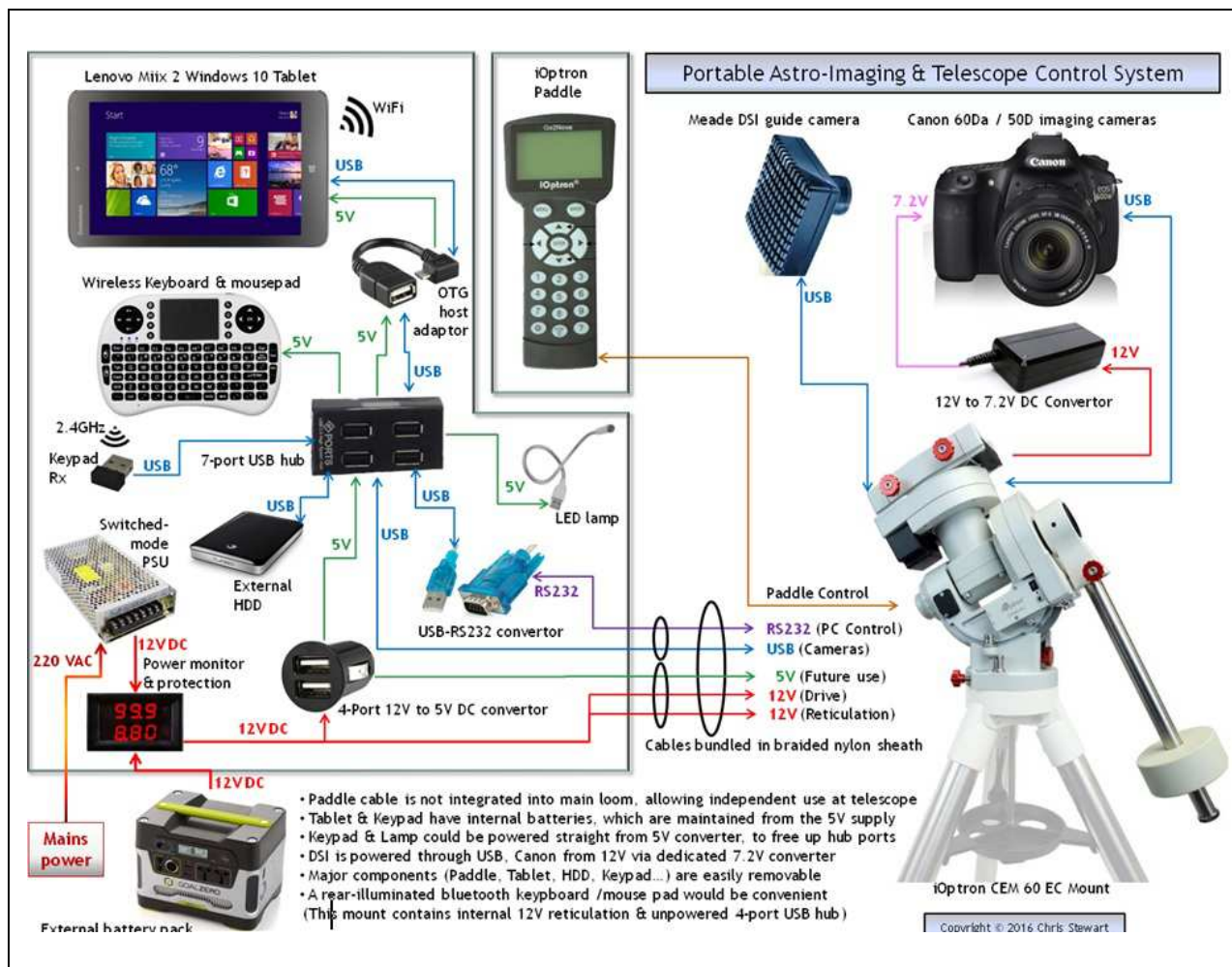


Fig. 3: The Control Box - bringing the loose parts together.

Control System Enclosure

We now have all the parts selected, but how are we to deal with this mess of objects in the field? You will doubtless have seen many photos of instruments literally dripping with cables, all of which are begging to be plugged into the wrong place, get snagged and tangled, be trampled on,

trip people up and absolutely ruin your night when a connection fails. Putting in some effort up front will pay dividends in reliability and your general enjoyment of the system. We need to package things so that there is the minimum number of individual items to deal with and the fewest things to connect when setting up.

My choice of a CEM60 mount means that the mount has a certain amount of cable management, 12V power distribution and a passive 4-port USB2 hub already built in, which already simplifies matters. If your mount does not provide this, you will have to make a plan to route cables so that they will not tangle or catch.

You need space around the instrument, and you need to make connections to it. Plus, you must manage the various components necessary for the control system. The best is to build as much as possible into a single box, which can simply be carted around as a unit and attached to the instrumentation via a single cable bundle. To this end, I built the parts into a box with just a few external connectors; these being power in, plus communications and power out to the mount.

What to do about housing your “control box”? You can probably use something already lying around, like a toolbox or an attaché case. I made an unusual choice: a Petty Cash box. Why? *Low cost* – much cheaper than electronics “project boxes”; *neatness* - rounded corners, powder coated, no seams to let in moisture; *robustness* - metal construction, stiff pressed form; *captive hinged lid*, with the possibility of locking; *it can be earthed* for safety when using the mains power, and used as heat sink for the electronics; *general availability* – there are many to choose from, from many vendors, anywhere in the world.

The superficial modifications were relatively simple: I added a carry handle, rubber feet, and toggle catches to secure the lid; a depression in the lid for the original handle was cut out to increase space for tablet (this is the only difficult part & not strictly necessary); provision was made to mount the box on a tripod.

Internally, the following features were implemented: the tablet clips into the lid so that it stands vertically, sort of like a laptop display; the coin tray was replaced by hinged shelf, to provide a work surface for keyboard & paddle whilst enclosing other electronics; there is one well for USB, RS232 & 5V pluggable parts, and another for external hard disk & keyboard storage; all brackets for partitioning or securing parts are screwed in, and can be removed if necessary for future modifications; all electronic modules are removable for alternative use, servicing and ease of replacement. I also made provision to lock the lid in the open position.

On the back, below the lid hinge, are the following panel-mount cable connectors: a 12-pin IP6 screw-on round industrial connector for data (2x USB, 1x RS232); three 3-pin XLR sockets for DC power (12V & 5V), being 1x male for external battery input and 2x female outlets (scope + spare); a male “kettle plug” socket for 220V AC input to the switched-mode power supply.

Whilst the mains-driven power supply is housed in the control box, I elected to keep the battery supply separate. The reasons include the following:

1. I already had a battery pack as a complete separate unit;
 2. Batteries are large and heavy - therefore better to keep on the ground);
 3. Should I wish to upgrade to a larger battery later, or tap into an alternative 12V supply in the field, there would be no need to modify the control box; and
 4. Should the battery leak it will not damage or destroy the control system.
- As a final touch, I added a gooseneck LED red lamp to illuminate the keyboard, examine eyepieces, see paper charts/documents, and make notes. This conveniently plugs into a spare USB port on the hub, but could equally be plugged directly into the 5V charger.

Being able to put the box on a tripod for field use without a table means a more compact arrangement to carry around. Also, most tripods are

extensible, so it can be positioned at a height suitable for sitting or standing. Nevertheless, the box has feet and will happily sit on a table. By simply unplugging the upstream USB cable of the hub from the OTG Host adaptor on the tablet, the cable can be fed through a grommited hole in the box and brought out to a laptop, should it ever become necessary to do so.

A spare USB cable and a spare 5V feed to the mount are included in the cable harness for future purposes. I contemplated putting in an Ethernet cable as well, but deemed it unnecessary.

Wiring Harness

Controller-to-instrumentation interconnect

We now have a whole slew of bits which need to be connected together, something that gets messy in the field. Therefore I made up a cable harness which collects the individual cables into a single large but flexible bundle encased for protection in braided nylon sheathing. It comprises three power distribution pairs (1x 5V and 2x 12V DC), plus 2x USB cables and 1x RS232 signal cables. At the control box end, the cable harness splits into two (for power and data connectors), whereas on the instrumentation end it splits to connect to the USB, power, control, etc. points to their individual locations. The cable bundle is cinched every half-metre with heatshrink in order for integrity. At those points, some Scotch reflective tape was added to aid visibility in the dark by glinting through the numerous small holes between the braiding fibres. The ends are finished off with heatshrink to prevent unraveling of the braiding. At each end of the harness is a clip, enabling the ends to be mechanically anchored to the mount and the box, thereby leaving the individual cables with additional length for strain relief.

An overall length of 4 metres was chosen as allowing the harness plus additional cable lengths at each end (within the control box and from the mount to the instrumentation USB hub) to respect the 5 metre limit set in the USB standard. Should a shorter one be desirable, that could be made

up. If a longer USB run is required (e.g. in the observatory) then “active” USB cables incorporating a powered booster midway along the cable are available, typically up to 20m. However - for reliability, cost and to allow much greater lengths - it would be preferable to use UTP cables with USB/Ethernet converters at each end instead.

Here are details of the connections between the control box and the mount:

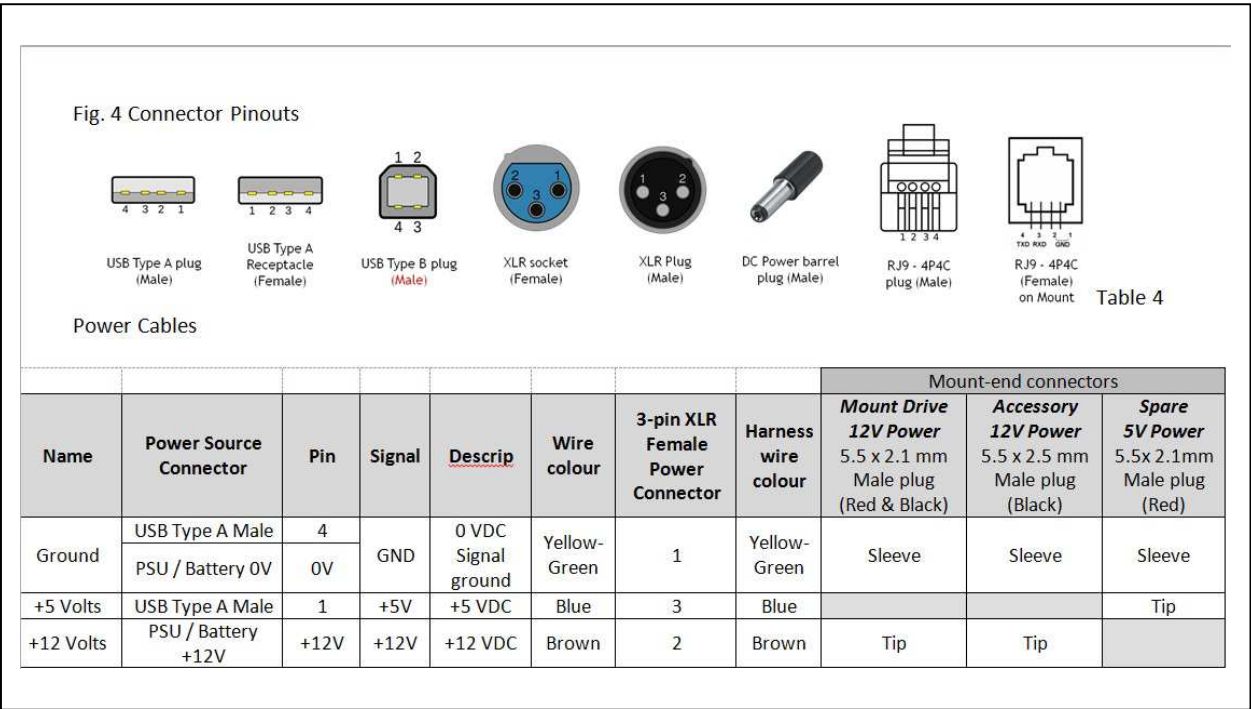


Fig. 4: Connector Pinouts and Power Cables

Many of us only sketch out a few thoughts when considering physical dimensions, keeping the majority of the information in our heads as we tinker with our projects. As we research we may find information that should be preserved in some ordered fashion to make life easier later. Considering the potential consequences of errors with respect to wiring, it is especially important to document that in some detail. This is not only to guide construction but also for later fault-finding, repair or expansion purposes. The above details have therefore also been permanently affixed to the box as a plaque, avoiding the need to hunt down documentation at a later stage.

Name	Signal Source Connector	Pin	Signal	Description	Wire colour	12-pin Female panel Connector	Harness wire colour	Mount-end connector	Pin
USB Accessory	USB Type A Male	1	VBUS	+5 VDC	Red	1	Red	USB Type B Male plug	1
		2	D-	Data -	White	2	White		2
		3	D+	Data +	Green	3	Green		3
		4	GND	Ground	Black	4	Black		4
		Shield	Shield	Shield	Braid	12	Braid		Shield
USB Spare	USB Type A Male	1	VBUS	+5 VDV	Red	5	Red	USB Type A Female socket	1
		2	D-	Data -	White	6	White		2
		3	D+	Data +	Green	7	Green		3
		4	GND	Ground	Black	8	Black		4
		Shield	Shield	Shield	Braid	12	Braid		Shield
RS232 Drive Control	DB 9 Female	5	GND	Ground	Blue	9	Blue	RJ9 4P4C Male plug	1
				Spare	Red		Red		2
		3	TXD	Tx Data (to mount)	Green	10	Green		3
		2	RXD	Rx Data (from mount)	Yellow	11	Yellow		4

Table 5: Signal Cables

Bells & Whistles

Although this project has followed a minimalist ethos up to this point, there is room for embellishment should you wish.

As a last minute indulgence, I added a physically miniscule 32GB flash drive that plugs into the one remaining “spare” port of the hub. The point of this is to take a collection of uplifting ambient music, which the tablet can play on demand at low volume in the field. Of course, the music files could equally have shared space on the external hard drive or the micro SD card, for either of which the USB flash drive can to an extent also act as a storage backup. By chance, a small Bluetooth – equipped amplifier/speaker with internal Li battery became available at low cost at the same time, nicely complementing the system. Unfortunately, it does not quite fit in the enclosure whilst leaving room for keyboard stowage,

but it is there should I need to augment the rather tiny speakers built into the tablet.

The “finished” article

There is always something else one can do on a project, and of course one has to trial it before pronouncing it OK, so nothing can really be said to be finished. This is what it looks like:



Fig. 5: The front of the case.

The hole for the lock was enlarged and rubber grommetting installed, leaving an aperture large enough for a USB connector to pass through. This enables the hub to be driven from an external PC instead of the tablet, or for cables to external devices to pass put unimpeded. In addition, it provides some ventilation under the shelf for components which may get warm in use.



Fig. 6 The rear of the case

On either side, U-Bolts were installed to protect the connectors, and to serve as anchors for the cable clips to assist in strain relief. On the left of the view are the main AC power input and the 12V DC input. To the far right is the data connector for communication with and powering of the mount and the instrumentation. Two female XLR connectors handle 12V and 5V DC output; one for the instrumentation, the other a spare.

Fig. 7 The lid of the case.

A plaque describes the wiring for future reference and covers the hole in the lid where the original handle was in a well that was cut out to provide space for the tablet inside the lid.

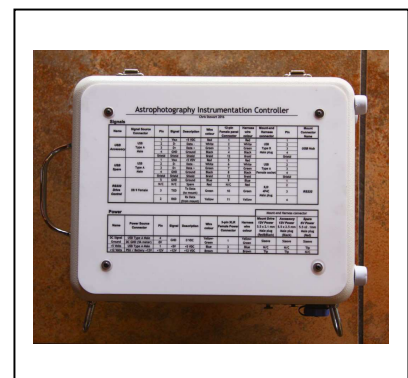


Fig. 8: Under the shelf.

The compartment at back left holds the 7-port hub, the 12V-5V DC converter and all the USB equipment. The USB-RS232 converter plugs in on top left, whilst the hub connects to the OTG host adaptor at the top rear centre. The bottom left has a well for loose equipment such as the keyboard and USB external HDD. On the right is the switched-mode power supply. Spare fuses and ancillary USB adaptors nestle securely in some gaps.



Fig. 9: In operation.



Inside the lid is a textured black ABS sheet (again to hide the hole) that provides a nice surface for the tablet to bed against. A section of floor tile edging serves as a channel for the tablet to rest on, padded with blue felt. Above is the clip that holds the tablet in place – a modified cupboard catch. A cut-out in the support edging allows the OTG host adaptor to connect to the tablet.

At the hinge is an aluminium angle bracket that flips backwards to lock the lid hinges in the open position during use. In front of this are hinges to hold the shelf. To the left of these is a charging outlet for the keyboard, and a fuse holder. To the right is the V-A meter and the power selector switch (Ext /Off/ Internal 12V).

The keyboard sits on the black Perspex shelf, affixed with Velcro to prevent it slipping off. There is space on the shelf to put the hand paddle for the scope next to the keyboard if so desired. Behind the red fuse holder is a gooseneck LED lamp to illuminate the keyboard, notes and reference material. It has its own on/off switch. The shelf has a finger hole in front of the keyboard on the centre line, to lift the lid and provide additional ventilation. When the box is closed, the keyboard is stowed under the shelf,

the LED lamp lies flat across the brass hinges, and the lip with the two rubber pads (on the top edge of the lid above the tablet catch) holds the shelf in place.

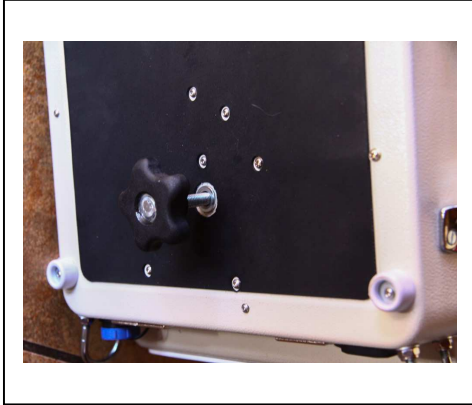


Fig 10.

An M8 rivnut positioned at the balance point in operation, enables the controller to be placed on top of a tripod. This allows seated or standing use in the field, without needing to take a bulky folding table.

The 12V DC battery pack

Prior to building the control system, I had made a battery pack with built in charger and capability to charge or draw from an external 12 lead acid battery. Inside is a 7Ah sealed lead acid gel cell battery and the charging circuitry. As an embellishment, a 5V USB charger was also built to recharge items such as cell phones in the field or during power failures. Additionally, faint dimmable red LED and (extremely bright!) white LED lamps were installed. Again, this project was built into a cash box, utilizing the handle well in the lid as the lamp housing. This power supply moves between a variety of mounts, having standardized on the XLR connector for 12V DC. So far, it has never failed during viewing sessions of up to about 6 hours, even in cold conditions. Nevertheless, it is probably insufficient for long astrophotography sessions.

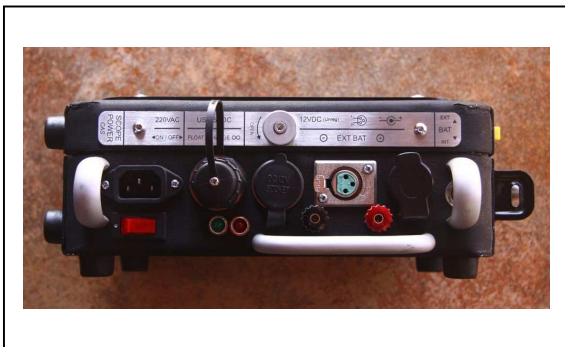


Fig. 11 Front panel: Left to right: 220VAC mains input (switch below); USB charging port (charging status lights below); Cigarette lighter, XLR & Hella connections for 12VDC out (Binder posts for external battery below); internal/external battery selector switch hidden behind protective handle.



Fig. 12: LED lamps. These are covered with a prismatic diffusing filter. The greenish zone has four high-intensity white LEDs. Below those can be seen the red of the night-vision friendly dimmable red LEDs. To the top right is the red switch to control the red LEDs, below which is a silver knob to control the brightness. At bottom right is a yellow rocker switch to control the white LEDs. This has three positions: latching On,

Off, and momentary On positions.



Fig. 13: Top view. This is conveniently arranged to control the white light whilst walking (either left- or right-handed). Also visible is the view side of the battery selector switch, nestled in the protective handle.

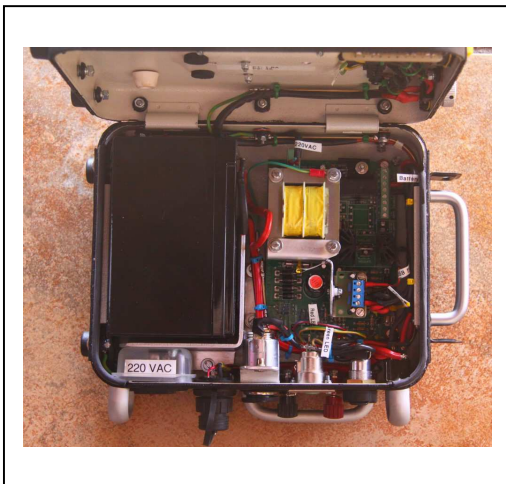


Fig. 14: Inside the box. To the left is the internal gel battery. To the right is the intelligent charging circuit, developed by my friend Rodney Hyman for emergency lighting in the lift industry. The advantage of this is that one can leave the battery permanently on charge, and the circuit will look after the battery's health, conditioning the battery during the "float" period. The disadvantage is that the battery is only

available when the input power fails (or is switched off or disconnected), in part to protect the equipment being powered from experiencing unusual voltage fluctuations necessary for conditioning the battery.

Part 4: Refinement

Does it work?

Having completed the project, the answer was a qualified Yes. There were a couple of teething troubles...

First, the switched mode power supply appeared to be generating noise which interfered with the USB and the wireless keyboard. Switching to the external battery immediately solved that, so some work was in order to see what could be done to suppress it - or to fit an alternative PSU. This has no effect on field use, where battery power is the norm, but was of course a source of great irritation. Worse, when I cranked up my trusty oscilloscope, it waited until I had just got the relevant signals to synchronize, and then started smoking! I concluded that there was some kind of interaction with the switched-mode mains supply and the “car charger” 5V converter, which is also switched a mode device. Some kind of intermediate smoothing/decoupling was evidently in order.

Second, the Meade DSI appeared to have a problem. PHD happily connects to it, and in the looping capture mode for focusing one can see changes in brightness levels if one blocks or opens the aperture of the guide scope, or the nosepiece of the camera. However, at the time of writing I have not been able to get it to produce an image. Having been bought second hand and left in a drawer for years unused and untried, it seemed possible that the camera itself was faulty. The auto-guiding and drift alignment facilities provided by PHD were prime motivations the project, and these are not possible without the camera – but it is no fault of the architecture. This was of course hugely disappointing. Again, some sleuthing was required.

Experimentation with a Celestron projection reticule enabled an illuminated crosshair to be focused on the chip, which the camera responded to perfectly. Most likely a lot more patience will be required in field trials, to get the image focused correctly on the camera.

Otherwise, it all worked perfectly. All the ASCOM compliant parts interoperate satisfactorily. The mount responds correctly to the RS232 inputs. APT controls the Canon cameras as expected. One can poke on an object in Cartes du Ciel and send goto commands to the mount. The cable harness is the perfect length. All in all, a very satisfactory initial outcome, despite the two issues above.

I then stumbled across an interesting device on sale at a local tool store. Designed as a highly portable jump starter for a car, it is an extremely compact Lithium Ion “battery” pack. In fact, it is a supercapacitor, with a huge charge density. In a module smaller and lighter than the mains power supply, it packs in 12Ah capacity and can handle short term discharge rates up to 600A, and provides a beautifully clean and stable 12V. As a bonus, it has facilities for charging USB devices, laptop power (3 selectable voltages) and an LED torch. A small “wall wart” mains charger is included, along with various cables and adaptors including a cigarette-lighter connector enabling it to be charged in a car.

The unit is now fitted neatly in place of the switched mode 12V supply, with self-adhesive Velcro holding it securely but able to be easily removed. It has almost double the capacity of the external battery pack, at a fraction of the weight.

For long-term observatory use, an alternative mains supply would nevertheless be preferable, if not strictly necessary. This can simply plug into the external 12V input of the box, no need to remove the power pack.

What changes are anticipated?

Apart from resolving the abovementioned issues, not much: so far the ensemble meets the requirements. These do however come to mind:

- Make up a longer straight cord for the mounting’s hand controller (paddle), so that the paddle can sit on the box. The supplied coiled cable can reach to a degree, but naturally wishes to spring back. I thought long and hard about including this in the wiring harness, but elected not to because everything can be done from the tablet. I am

not unhappy with that judgment call. Nevertheless, this is a simple thing to do and try, and would probably be convenient – at the expense of yet another loose component and something more to trip over in the dark.

- Build a larger capacity battery pack for the field, specifically using Lithium Iron Phosphate batteries, which can be treated exactly like lead acid batteries but which have a far greater charge density, do not suffer self-discharge in storage, and are much lighter in weight. Unfortunately, they are still rather expensive, but as they invade the automotive market the price should come down and availability will improve.
- When it becomes available locally, replace the keyboard with the newer version, which is back-lit.
- An alternative audio speaker/amplifier with a form factor allowing it to be accommodated internally.
- Provide a secure, dedicated place to store the tripod attachment knob.

What would I do differently 2nd time around?

- A larger tablet would be nice, though the display could be wirelessly exported to another device via TeamViewer (or similar remote access packages). In an observatory setting, one would have less need to integrate in a compact portable package, leaving many options for multiple displays etc., but this was built for the field so compromises had to be made. Tablets such as the MS Surface look interesting, but remain well outside the budget. This may well change in time, and other decent Windows tablets will become available. My personal assessment is that Android is not particularly viable for this application, but (for the brave) some tablets are amenable to porting various other flavours of Linux.

- Perhaps a lock that holds the lid open more obviously, without the possibility of stressing the hinges unduly should someone attempt to close the lid whilst in the locked open state.
- If cost were no object, the upcoming CEM120 mount (amongst others) would be very appealing. But alas, they are both out of budget and less portable by a single (not to mention ageing) individual.

Colloquia and Seminars

These form an important part of a research facility, often as a sort of pre-publication discussion or a discussion of an individual's current research, and as such it is virtually impossible to "publish" this material. However by recording the topics discussed in the form below does indicate to those, who are unable to attend, what current trends are and who has visited to do research: it keeps everyone 'in the loop' so to speak

Also included in this section are the colloquia/seminars at the SAAO, UWC, the Astrophysics, Cosmology and Gravity Centre at UCT, ACGC and the NASSP lectures, aimed the at the students and interested astronomers. In addition there are the SAAO Astro-coffees which are 15-20min informal discussions on just about any topic including but not limited to: recent astro-ph papers, seminal/classic publications, education/outreach ideas and initiatives, preliminary results, student progress reports, conference/workshop feedback and skills-transfer.

SAAO

Title: Observations and modeling of gas in and around galaxies

Speaker: Prof. Guinevere Kauffmann (Max Planck Institute for Astrophysics)

Date: 7 September

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: This talk will focus on gas around galaxies in the low redshift universe. I will review recent advances in quantifying scaling relations for atomic hydrogen in galaxies using radio telescopes, as well as the diffuse gas around galaxies using Hubble Space Telescope UV spectroscopy of quasars whose sight-lines pass through the halos of galaxies similar to our own Milky Way. I will show how such observations constrain galaxy formation models, in particular the physical processes that regulate the heating and cooling of gas as a function of cosmic epoch.

Title: Data and development: synergies between social science and astronomy

Speaker: Dr Dieter von Fintel (Department of Economics, Stellenbosch University)

Date: 14 September

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: Since the advent of the World Bank's Living Standards Measurement Surveys, the study of household socio-economic conditions has expanded dramatically into the developing world. Micro level data allow researchers to understand how households escape poverty, and which interventions can be put in place to improve the livelihoods of individuals. The work of Nobel laureate, Angus Deaton, attests to this massive emphasis towards understanding the micro-level effects of policies and household-specific drivers of development. These data have also assisted in setting clear Sustainable Development Goals, and monitoring their effectiveness. Understanding "development", however, is more multi-faceted than only focusing on incomes and Gross Domestic Product – Amartya Sen pioneered the capability approach, which emphasizes that people should not only have access to financial resources, but to education, health and food security. This list could easily be extended to other (sometimes intangible) characteristics such as mental

health, subjective happiness, crime-free environments and safe climatic conditions. Household surveys have become the work horse for measuring many of the micro-level facets of socioeconomic development. However, many low income countries still do not enumerate regular surveys, and even in better resourced economies, household surveys contain substantial biases. These include misreporting, operation outside of the experimental ideal, and missing important components of economic development. Morton Jerven laments this as Africa's "statistical tragedy". Not only are the data messy, but development economists operate outside laboratory settings. Economists and other social scientists are therefore more concerned about selection bias, omitted variables and endogeneity than researchers from many other disciplines. Longitudinal household data can – in some circumstances – assist in circumventing these problems. However, this type of data is rare in most African countries. To assist in modelling dynamics and solving statistical biases, economists are increasingly turning to data sources more commonly used in other disciplines – in particularly remote-sensed satellite data. Night lights data and vegetation coverage are known to correlate well with a host of development outcomes. Instead of following households, we follow the regions in which they reside at regular time intervals. Not only is data less noisily measured, but longitudinal estimates approach unbiased results. Economists are, however, open to learn about other approaches to measure economic development more effectively.

Title: LIGO Detection: An exploration of complex data

Speaker: Kai Staats

Date: 28 September

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Kai will provide an overview of his work at LIGO before showing his 20 minutes film "LIGO Detection".

Title: Asymptotic Giant Branch Stars in Local Group Galaxies and their importance for the Distance Scale

Speaker: Prof. Patricia Whitelock (SAAO)

Date: 5 October

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: I will review recent work on large amplitude variables in Local Group galaxies and discuss their potential as distance indicators. These cool stars, which are very luminous at near- and mid-infrared wavelengths, are important producers of dust, but have not yet been properly incorporated into the theoretical models of stellar evolution. The Local Group offers interesting opportunities to study them in different environments.

Title: From Astrophysics Research to Science Management – Latest results from ALMA & Spitzer

Speaker: Dr. Kartik Sheth

Date: 12 October

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: Since my last visit to South Africa, I made a career change switching from a full time research career to science management. I will discuss the incredibly challenging but fun work that needs to happen to make scientific research possible and also discuss our groups' latest scientific results with ALMA and Spitzer — specifically I will discuss an analysis of the increased star formation at high redshifts using ALMA data and show some of the latest results from molecular gas observations in the beautiful southern barred spiral NGC 1097 – an ideal target for SALT and MeerKAT.

Title: Letting the Data Speak for Themselves: What Observations Tell Us About Galaxy Formation

Speaker: Prof Neal Katz (Univ. of Massachusetts)

Date: 2 November

Time: 11h00 – 12h00

Venue: 1896 Building

Abstract: We infer the star formation rates in dark matter halos at different redshifts from halo merger histories expected in a Lambda CDM cosmology constrained to match the observed stellar mass/luminosity functions of galaxies at different redshifts and the local cluster galaxy luminosity function, which has a steeper faint end than that of field galaxies. The only other assumptions that we make are that the star formation rate of central galaxies depends on the halo mass and redshift and that when a galaxy becomes a satellite its star formation rate is quenched exponentially and it can eventually merge with the central galaxy on a dynamical friction timescale.

We find that 1) the star formation in the central galaxies of high mass halos ($>10^{12}$) has to be boosted at high redshift beyond what is expected from a simple scaling of the dynamical time; 2) below $z=2$ the star formation in halos below 10^{11} must be quenched, which is not directly expected in standard stellar feedback models and is most easily explained by some form of preheating and implies that there is a significant old stellar population in present-day dwarf galaxies with $M_{\text{star}} < 10^8$ and steep slopes for the high redshift stellar mass and star formation rate functions 3) the stellar mass of galaxies assembles in one of three ways depending on halo mass: $> 10^{12}$ the galaxies assemble through mergers and should hence have a spheroidal morphology and between 10^{11} and 10^{12} (e.g MW) it assembles slowly and at $z>2$ has less than 5% of its mass in place, which has extreme observational consequences.

Title: Domes and Telescopes in Cape Town

Speaker: Dr Ian Glass

Date: 9 November

Time: 11h00 – 12h00

Venue: McClean Dome

Abstract: Many local astronomers have never been inside the domes on the SAAO Cape Town site. This “colloquium” offers a quick (15 minute) overview talk about the Photoheliograph, 18-inch, Transit Circle and Astrographic domes with guided visits to each, led by Willie Koorts and Dr Ian Glass.

Title: Primary Mirror Control System for Segmented mirror telescope

Speaker: Prasanna Deshmukh (Indian Institute of Astrophysics, Bangalore)

Date: 10 November

Time: 11h00 – 12h00

Venue: 1896 Building

Abstract: New generation large telescopes are primarily made of segmented mirrors, and the design and implementation of such a telescope is a big challenge. As a first step towards realizing a bigger telescope in India, a project to develop a small Prototype Segmented Mirror Telescope (PSMT) has been initiated at Indian Institute of Astrophysics, Bangalore. The control of primary mirror made of a large number of small segments is one of the critical tasks, and telescope performance solely depends on it. We have developed local and global control systems for the PSMT primary mirror. In the first phase, we designed and developed a precision soft actuator which is needed to align and phase all the mirror segments precisely. The actuator is also expected to reject any disturbances induced by the wind or structural vibration. The tests carried out in laboratory shows that the actuator developed for the PSMT telescope meets most of the design requirement and can be used in the real telescope. In the next phase, we have developed a global controller which is expected to maintain the shape of the primary mirror

with the help of actuators and edge sensors. In addition to this, we have also developed a simulation tool named the codeSMT, which allow studying the overall performance of segmented mirror telescope based on the user inputs. Finally, we have developed an integrated system, comprising of local and global controllers for the PSMT and checked its functioning. In my presentation, I will discuss all these works linked with the primary mirror control of prototype segmented mirror telescope along with updates on different activities related TMT, NLOT and PSMT project.

Title: Time Domain Astrophysics with Liverpool Telescope and Liverpool Telescope 2

Speaker: Prof Iain Steele (Liverpool John Moores University, UK.)

Date: 17 November

Time: 11h00 – 12h00

Venue: 1896 Building

Abstract: Since first light in 2004, the 2.0m Liverpool Telescope has been the world's largest fully robotic telescope. It specialises in time domain astrophysics and has a dedicated instrument suite giving imaging, spectroscopic and polarimetric capabilities. In this seminar, I will describe how the robotic operation of the telescope works and give examples of the science accomplished in areas such as gamma-ray burst follow-up and supernova classification. I will also present our plans to develop a 4.0m robotic telescope which will deliver faster reaction and increased sensitivity. A modified version of the SPRAT instrument on the Liverpool telescope is being built for Lesedi in Sutherland.

Title: The James Webb Space Telescope: Mission overview and the road to science

Speaker: Sarah Kendrew, JWST-MIRI Instrument & Calibration Scientist, European Space Agency, Baltimore

Date: 21 November

Time: 11h00 – 13h00

Venue: SAAO Auditorium

Abstract: The James Webb Space Telescope is the NASA/ESA/CSA flagship infrared space mission for the next decade. Scheduled for launch in spring 2019, the telescope and spacecraft are in the final stages of integration and testing and the first science time allocation calls, open to the international astronomy community, are already in progress. I will give an overview of the mission and its instrumentation, with a focus on how to prepare for science proposals.

In the second part of the presentation, I will give demos of the proposal tools that are available for proposal preparation: the target visibility tool, the documentation system ("JDocs"), the exposure time calculator, and the Astronomers' Proposal Tool (APT). This part will be more interactive with time for questions and discussions

Title: Massive stars and intermediate-mass black holes in young stellar clusters

Speaker: Sergei Fabrika (Special Astrophysical Observatory of the Russian Academy of Science)

Date: 23 November

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: It is well known from N-body simulations that in young stellar clusters a very massive star (VMS) could be formed during first 1-2 million years because of direct encounters. Later this VMS will collapse to an intermediate mass black hole (IMBH). In a certain time of its evolution, the IMBH may produce the super-Eddington accretion. During several million years massive stars must be ejected from young clusters due to three or four not direct encounters. Depending on a stellar mass, and mainly on under-solar abundance, the VMSs may produce pair-instability supernovae (PISNe) or IMBHs. We selected a sample of young stellar clusters, which are located in nearby galaxies with the highest star formation rate and started a new program of direct spectroscopy of this sample using Russian 6m telescope at the Northern hemisphere and SALT telescope at the Southern hemisphere. The observational program is just

started, but we will report in our talk on the finding of one IMBH candidate and a few VMS candida

Title: The co-evolution of galaxies and their dark matter haloes from weak gravitational lensing

Speaker: Professor Mike Hudson, University of Waterloo

Date: 7 December

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: The evolution of galaxies is linked to the growth and accretion histories of their host dark matter haloes. Weak gravitational lensing allows us to measure the evolution of their dark matter haloes, as well as the larger cosmic web that these haloes inhabit. I will review recent results from weak lensing and other methods that allow us to probe the dark matter content of the Universe on the scale of galaxies and to provide new insight into the processes that shape the evolution of galaxies. I will also discuss the surprisingly tight link between globular cluster systems and the dark matter haloes their host galaxies inhabit.

Title: The Las Campanas Stellar Library: an essential tool to interpret NIR spectra of galaxies

Speaker: Dr Igor Chlingarian (CfA / Moscow State University)

Date: 8 December

Time: 11h00 – 12h00

Venue: SAAO Auditorium

Abstract: We present the most comprehensive up-to-date intermediate resolution ($R=6500$) stellar library, which covers the entire near-infrared wavelength range (0.83 to 2.5 μ m). It contains spectra of 1200+ stars across the HR diagram collected with the FIRE spectrograph at the 6.5m Magellan Baade telescope processed with a dedicated bright source data reduction pipeline. Among others, our library includes about 250 AGB stars, 50 LMC/SMC stars, and also a sample of chemically peculiar stars. We have about 150 stars in common with the X-Shooter Spectral Library

project which will allow us to perform cross-checks, assess the data quality and pin down potential systematic problems. By the start of the JWST mission, we plan to produce a new generation of stellar population models which will enable the extragalactic community to interpret nearby galaxy spectra in the NIR and analyze unresolved stellar populations in a manner similar to the one used in the optical domain. The spectral resolution will be sufficient to study the internal kinematics and stellar content of dwarf galaxies and nuclear star clusters in nearby galaxies. For about 650 stars, we built complete optical-to-NIR spectra at $R=6500$ using re-calibrated optical spectra from INDO-US and UVES-POP stellar libraries.

If I have time, apart from the stellar library, I will also talk about some aspects of the ground-based NIR spectroscopy in general, which are very important for the data analysis and interpretation but are usually known only to people working very closely to instruments/telescope operations.

UWC

Title: Astronomy for socio-economic development. Really?

Speaker: Vanessa McBride (Office of Astronomy for Development)

Date: 8 September

Time: 11h00 – 12h00

Venue: Rm 1.35 New Physics Building, UWC

Abstract: Join us for a discussion of astronomy for development. We'll introduce the Office of Astronomy for Development and some of the projects we fund. We'll look at the difference between outreach and development, and consider how astronomy-related skills can be applied in the development field.

Title: The emergence of galaxies in the epoch of reionization

Speaker: Pratika Dayal, University of Groningen

Date: 15 September

Time: 14h00 – 15h00

Venue: Rm 1.35 New Physics Building, UWC

Abstract: Galaxy formation in the first billion years mark a time of great upheaval in the history of the Universe: as the first sources of light, these galaxies ended the 'cosmic dark ages' and produced the first photons that could break apart the hydrogen atoms suffusing all of space starting the process of cosmic reionization. As the earliest building blocks, the shapeless elliptical galaxies that formed in the first billion years also determine the physical properties of all subsequent galaxy populations. At the forefront of astronomical research, the past few years have seen cutting-edge instruments provide tantalising glimpses of such galaxies chaotically assembling in an infant Universe. I will show how this data has provided an unprecedented opportunity to pin down the reionization state of the Universe (at least in its last stages), understand their physical properties, and study the key physics driving their formation and evolution. Finally, I will try to give a flavour of how the assembly of early galaxies, accessible with the forthcoming James Webb Space Telescope and the associated reionization history, can provide a powerful testbed for Warm Dark Matter models.

Title: AGN Feedback in groups of galaxies

Speaker: Somak Raychaudhury, Director of IUCAA, Pune, India

Date: 13 November

Time: 11h30 – 12h30

Venue: Rm 1.35 New Physics Building, UWC

Abstract: Most galaxies in the Universe live in small groups, and it is in this environment that much of their evolution takes place. Much of the research in the field, however, has concentrated on rich clusters. This talk will aim to show how the environment in galaxy groups is qualitatively different from that in clusters by looking at the effect of AGN feedback. In particular, I will discuss how low frequency (<1 GHz) GMRT radio observations of galaxy groups, in conjunction with Chandra and XMM-Newton X-ray observations, can provide a unique insight into the present and past interaction of active nuclei and the intergalactic medium in groups and poor clusters of galaxies.

Title: The art of Multi-wavelength cross-correlation

Speaker: Mara Salvato (MPE)

Date: 17 November

Time: 11h00 – 12h00

Venue: Rm 1.35 New Physics Building, UWC

Abstract: The number of surveys available at any wavelength is so vast that it is possible to construct detailed Spectral Energy Distributions (SEDs) for any kind of astrophysical object. However, a) different surveys/instruments, in particular at X-ray, UV, MIR and Radio wavelengths, have different positional accuracy and resolution and b) the surveys depth do not match each other and depending on its redshift and SED, a given source might or might not be detected at a certain wavelength. All this makes the pairing of sources among catalogues not trivial, especially in crowded fields. In this talk I will review the problems and the traditional methods of pairing sources. I will end presenting a new Bayesian pairing code that we have developed at MPE. Specifically, I will show its application to the finding of reliable counterparts to the ROSAT point-like sources.

The talk is thought as a practical guide to issues that we will be particular important as soon as the new Radio surveys will become available.

Title: Scientific validation of ASKAP continuum data

Speaker: Jordan Collier (CSIRO/U Western Sydney)

Date: 22 November

Time: 10h30 – 11h30

Venue: Rm 1.35 New Physics Building, UWC

Abstract: The Australian Square Kilometre Array Pathfinder (ASKAP) is currently undergoing commissioning, and is continuing to put out high-quality data products. One of its two top-ranked surveys, the Evolutionary Map of the Universe (EMU) survey, will use ASKAP to produce a deep (~ 10 μ Jy rms) radio continuum map of the whole Southern Sky, containing ~ 70 million radio sources, as compared to the 2.5 million radio sources

currently known. ASKAP Early-Science is well underway, and several key fields have been observed.

As part of commissioning ASKAP and its software, and assessing their performance, we need to validate the continuum data for surveys such as EMU, and surveys that make use of continuum data to produce their end products. We need to quantitatively assess the science-readiness of data for the purposes of quality control and science verification, which will also serve to develop the framework for the completely automated processes of the full ASKAP surveys. I will discuss the automated pipeline I have developed that takes an ASKAP continuum image and produces a science validation report in html, summarising several validation metrics, which are used for querying archival ASKAP data.

Title: Astrophysical dynamos and the origin of cosmic magnetic fields

Speaker: Jennifer Schober

Date: 11 December

Time: 11h30 – 12h30

Venue: Rm 1.35 New Physics Building, UWC

Abstract: Even though magnetic fields are strong and omnipresent in the local Universe, their origin remains one of the greatest mysteries of modern cosmology. A central role in overcoming the gap between extremely weak seed fields and strong present-day magnetic fields are magnetohydrodynamical (MHD) dynamos which I will introduce in my talk. Classical MHD dynamos operate by converting kinetic energy into magnetic energy. As an interesting example of a classical dynamo, I will discuss the turbulent small-scale dynamo. In our semi-analytical models of young galaxies, we show how this dynamo builds up equipartition magnetic fields by randomly stretching, twisting, and folding the field lines within only 4 to 270 Myrs.

In the second half of my talk, I will introduce a novel type of dynamo, the chiral MHD dynamo, which operates in high energy plasmas. Shortly after the Big Bang, these dynamos can convert the fermionic chemical potential

into magnetic energy. With our numerical simulations of early Universe plasmas we are able to follow the evolution of primordial magnetic fields and compare our results to observational constraints of magnetic fields in the intergalactic medium.

AIMS

Title: Machine learning for supernova classification

Speaker: Anais Moller from the Australian National University

Date: 20 November

Time: 14h00

Venue: Upstairs Hall

No abstract given.

Sky Delights: A Bee, Apes or perhaps a Vespa

Magda Streicher

In the 1690 Star Atlas, Johannes Hevelius contrived a northern fly-out of a small swarm of fainter stars hovering over the back of the constellation Aries, the Ram. Nearly 100 years earlier Dutchman Peters Plancius had devised a bee, which he called Apes, out of the same stars. The German Jacob Bartsch didn't have the same bee in his bonnet, but in 1624 he renamed the group Vespa, the Wasp, and by the time we get to Hevelius, the bug lost its sting and had been consigned to Aries. Aries is one of the smallest constellations of ancient times.

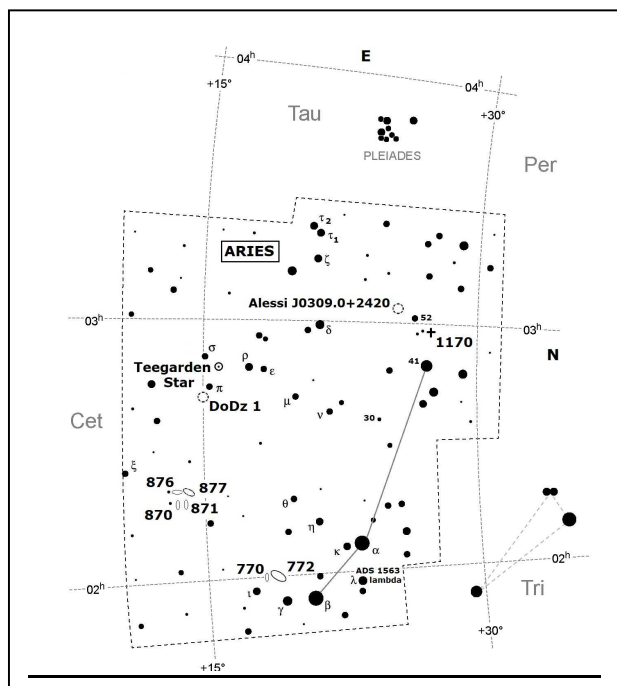


Fig. 1: Aries

Aries the Ram is a constellation that is somewhat mystifying, as it is near impossible to find such an animal in the pattern of the stars. Three visible stars – alpha, beta and gamma – are the only indication of the constellation and are relatively easy to find against the northern night sky.

Aries holds a few surprises among the stars representing its image. Ever wondered where there might be an NGC/IC object that has really been confused with a comet? Brian Skiff, a professional astronomer of Lowell Observatory, indicates that IC 2120 in the constellation Auriga is the only “missing” NGC/IC object that he knows of that is “confirmedly linked with a comet”, but says he would like to mention the case of **NGC 1170**, found by Charles Pierce with the Harvard 15-inch refractor on 31 December 1869 in the constellation Aries. It could be a part of the tail of comet Tempel-

Swift. If this object was on your list to do, there is no way that you will find it at the indicated position of 2° west of 52 Arietis.

A beautiful asterism, **Alessi J0309.0+2420**, can be found a degree south of 52 Arietis and was discovered by Bruno Alessi. This is one of Bruno's unique asterisms, displaying a handful of magnitude 11 stars somewhat in the form of a Robin Hood shoe, with the base towards the south. The stars to the east are slightly brighter than the rest.

This constellation has more surprises up its sleeve: in its south-eastern part is **Teegarden's Star**. This magnitude 15 red dwarf was discovered in 2002 in sky survey images by Bonnard J Teegarden from NASA/Goddard Space Flight Centre and his colleagues. Its movement of $5''$ per year suggested it is 7 to 10 light years away – one of the very nearest stars to the sun. Tom Stafford observed the star on 16 nights from September 2003 to January 2005 and obtained the following results. Proper motion RA $+0.2394s$ and DEC $+ -3.812''$ per year with a Parallax of $0.250''$. From results announced by Allegheny Observatory in Pittsburgh, Pennsylvania based on ccd observation made with the 0,76 metre Thaw refractor, it turned out that the star is more or less twelve and a half light years away.



It is now listed on the website of the Research Consortium on Nearby stars as the 23rd closest star. The star is situated between magnitude 5.5 sigma and magnitude 5.3 pi Arietis.

Fig. 2: The open cluster DoDz 1.

Barely half a degree south-west of sigma Arietis is the open cluster **DoDz 1**, named after the Georgian astronomer Madona Dolidze and IG Dzimselejsvili.

This is a lovely grouping, consisting of about eight stars, which is outstanding against the background star field. The sharp point of the group points towards the south with a double star consisting of a yellowish magnitude 8.5 primary and magnitude 12.7 companion with a separation of 29.4" a PA of 342 and listed as WDS 02474+1713.2. The double star at the southern tip at the position of RA: 02h47m.4 – DEC: +17°13'.4" was observed by Tim Cooper and me on the night of 30 October 2005. To our surprise, and after further investigation by Cooper on DSS plates, it showed a possible third companion which we estimated at around magnitude 15.5. When checking the proper motion of all stars, you are bound to get stars of similar proper motion through space. We contacted Brian Skiff who notes that it looks as though the faint third component of the pair could possibly be a physical companion. The data are not all that good for such a faint star, but the 2MASS colours at least do not totally exclude it. Hopefully observations of proper motion over time will include or exclude this star as a third companion to WDS 02474+1713.2.

In the far western corner of Aries is a group of four galaxies accompanied by a few bright stars. The western pair **NGC 870** and **NGC 871** has an 8.6 white-coloured star towards the south. Barely 10' towards the east are the two galaxies **NGC 877** and **NGC 876** with a magnitude 7.6 yellowish

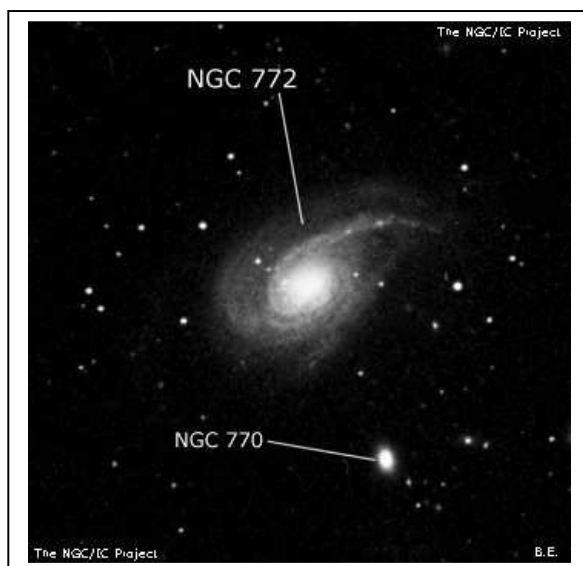


Fig. 3: Galaxies NGC 772 and 770.

star towards the south.

Compositions of deep space objects like these are indeed rare, but an observation through a relatively large telescope is exciting. NGC 877 is the easiest of these four galaxies to spot with a magnitude of 11.8 in a soft hazy roundish shape. NGC 871 and NGC 870 could perhaps be spotted with averted vision. All four galaxies are situated in a field of view of only 18'.

The brightest galaxy on offer in the constellation is **NGC 772**, which displays a roundish hazy shape at first glance. It brightens to a striking nucleus with a misty envelope. The satellite galaxy **NGC 770**, is situated 5' to the south. The pair can be found barely a degree east of gamma Arietis.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Lambda Arietis ADS 1563	Double Star	01h57m.9	+23°36'.0	4.9 7.7	Sep: 37.4" PA: 46
NGC 770	Galaxy	01h59m.2	+18°57'.3	12.9	1.0'x0.7'
NGC 772	Galaxy	01h59m.3	+19°00'.4	10.3	7.3'x4.6'
NGC 870	Galaxy	02h17m.2	+14°33'.0		0.2'x0.2'
NGC 871	Galaxy	02h17m.2	+14°33'.4	13.6	1.0'x0.3'
NGC 876	Galaxy	02h17m.9	+14°31'.3	13.7	1.6'x0.6'
NGC 877	Galaxy	02h18m.0	+14°33'.8	11.9	2.1'x1.7'
DoDz 1	Open Cluster	02h47m.5	+17°15'.3	7.1	7.5'
Teegarden's Star	Star	02h53m.2	+16°52'.5	15	*
Alessi J 0309.0+2420	Asterism	03h09m.0	+24°20'.0	9.5	8'
NGC 1170	Non-Object	03h02m.3	+27°02'.4	-	-

A double star which has a story to tell is **lambda Arietis** situated 2 degrees west of alpha Arietis. A lovely pair clearly separated by a magnitude 4.9 primary in a yellow-white colour while the companion, magnitude 7.7, appears blue-grey with a separation of 37.4" and PA of 46. The Sky Catalogue 2000.0 also listed AC and AD companions. Some amateurs claim they can spot a greenish colour to the companion star; this is hard to believe, but the double star perhaps provides a true glimpse of this statement. Due to the colour contrast between the two stars the eye of the beholder can easily be fooled.

Wasps and bees are nowhere to be seen at night when the stars shine in their full glory, but it is the time to be out exploring the fascinating objects in the constellation Aries.

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The **Astronomical Society of Southern Africa** (ASSA) was formed in 1922 by the amalgamation of the Cape Astronomical Association (founded 1912) and the Johannesburg Astronomical Association (founded 1918). It is a body consisting of both amateur and professional astronomers.

Publications: The Society publishes its electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa* (MNASSA) bi-monthly as well as the annual *Sky Guide Africa South*.

Membership: Membership of the Society is open to all. Potential members should consult the Society's web page assa.saa.org.za for details. Joining is possible via one of the local Centres or as a Country Member.

Local Centres: Local Centres of the Society exist at Bloemfontein, Cape Town, Durban, Harare, Hermanus, Johannesburg, Pretoria and Sedgfield district (Garden Route Centre). Membership of any of these Centres automatically confers membership of the Society.

Sky & Telescope: Members may subscribe to Sky & Telescope at a significant discount (proof of membership is required). Please contact the Membership Secretary for details.

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