FAS Newsletter

Federation of Astronomical Societies http://www.fedastro.org.uk

Clarifying the FAS Group PLI Scheme

Over 160 of the Federation's members subscribe to the group Public Liability Insurance (PLI) scheme and in these times of the claim culture and no-win no -fee litigation the topic is understandably one which arouses great interest and even greater uncertainty amongst the committees and councils of those societies.

Many of you will have seen via the ***FAS all societies email group*** that the recent policy renewal has not been a pain free process as we've tried to address your questions and concerns; so I thought it might be timely to do a quick review of what the scheme offers and, equally importantly, what it does not, and to let you know how we are progressing with resolving any outstanding issues.

Let's deal with the easy bit first: the FAS PLI scheme does ***not*** cover equipment such as telescopes and laptops or buildings owned or occupied by member societies including observatories.

Okay, so what is covered?

As part of the work we have been doing for the recent renewal we have agreed a modified "business description" on the policy which reads: "Astronomical Societies for the purpose of Members Meetings, Public Events for Educational Purposes, Seminars, and Exhibitions."

So the policy is to provide protection to member societies against claims for loss, damage, or injury suffered by members of the ***general public*** attending society meetings or observing sessions or events. This includes meetings at a hired room or village hall for example, or star parties at your observatory or observing site. A society visiting a school or scout group and giving a presentation or offering the use of telescopes is also covered. The addition of "events" extends cover to societies taking part in events organised by a third party – for example running a stall at a gala organised by the local Round Table or local council.

Please note however that fundraising events are not covered, so you may need to rethink the sponsored skydive you've been planning! We are still, at the time of writing, working with our broker to clarify if lower risk fundraising which is "incidental" to astronomical activities, for example running a raffle at a meeting or games of chance on your stall at a gala.

The existing policy does not cover members of your society either attending a meeting or "working" for the society.

To provide cover to of the society who are simply attending the meeting, the policy will need to be extended to include 'Member to Member' liability; we are awaiting more details and a quote from our broker.

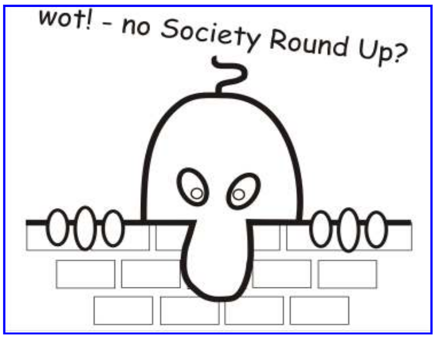
For those of us who undertake duties to keep our societies running the law is incredibly vague; the best advice seems to be that even though we are for the most part unpaid volunteers we should be regarded as employees! Again we are discussing with our broker extending to include Employers Liability cover.

We will of course keep you updated as negotiations progress.

Shaun O'Dell

Major Change to Newsletter Format

After much soul-searching we have reluctantly decided to discontinue with ***The Society Round Up*** in the Newsletter. Now, many of you will be disappointed with this decision, but, when explained, I hope you will understand the reasoning.



When I took over as Editor the Round-up took up around three pages out of the total of eight and the pressure has been to increase this. Initially this was acceptable because it was a major vehicle for member societies to publicise themselves and their activities to the amateur astronomy community.

However over the past year or so Sam George has been developing the FAS website to make it the 'vehicle of choice' for such publicity. The inclusion of the locating map and the facility for member societies to add their activities to the listing as they are decided means the information is as accurate and timely as possible.

We realise that there are still some societies that are not yet electronically active and for these few, this move may not be enthusiastically embraced. Perhaps these and the other societies will feel that the space this decision has freed up, will enable their activities to be more directly publicised by sending in reports and photographs.

Let me have your views on this subject.

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Issue 94 Summer 2010

Published by the Federation of Astronomical Societies ISSN 1361 - 4126

Presidents Spot

Since the last newsletter was issued the first annual membership subs renewal due by the end of April (instead of August) has been satisfactorily completed. As usual the renewal payment for optional PLI cover was due at the same time as the subs renewal. I would like to thank societies for their prompt payment of subs and PLI.

When we were arranging the PLI cover we put a number of cover clarification questions to the Insurers and were surprised by some of the responses! Elsewhere in this newsletter Shaun O'Dell, our PLI Officer gives further information on this clarification and what we are pursuing in the light of the responses. This exercise has been a useful review of what our Insurers PLI cover actually covers, and we have been sharing the information with member societies so that we are all clear on the cover provided.

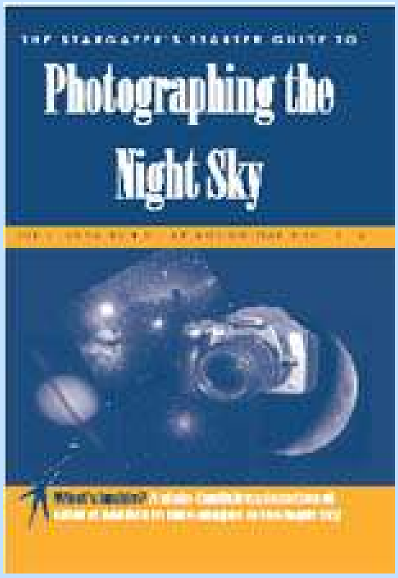
Now I would like to give notice of a proposed change to the FAS Constitution which will be sought at the AGM on 9th October. Currently the Executive officers of the FAS Council are the President, Vice President, Treasurer and Secretary. We will be seeking to change the Constitution by adding to the list of Executive Officers the PLI Officer and the Membership Secretary posts. We consider the duties carried out by these two posts to be as significant and important to the FAS as the current executive posts and therefore appropriate to seek to include them in the executive subject to AGM approval.

Whilst on the subject of Council posts, may I extend a general invitation to members of FAS societies who are interested in serving on the FAS Council to indicate any such interest to us via the usual e-mail links on the FAS website.

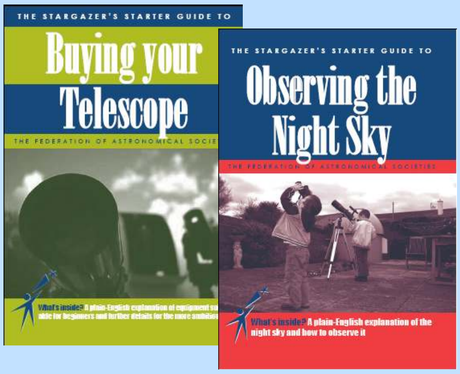
Finally, the FAS Council is always keen to hear from member societies as to what they would like the FAS to consider providing further by way of help and support.
Clear skies!

Richard Sargent

New Publication



The third title of the new range of booklets on various different astronomical topics is available This one covers the basic requirements for taking photographs of the night sky.



Notice of Meeting

2010 Annual General Meeting of
The Federation of Astronomical Societies
To be held at the Institute of Astronomy,
Cambridge on Saturday, 9th October 2010

AGENDA

1. Apologies
2. Minutes of 2009 AGM
3. Matters arising from minutes
4. Reports from Officers
    - *President*
    - *Vice President*
    - *Secretary*
    - *Treasurer*
5. Adoption of accounts
6. Appointment of Auditor
7. Subscriptions for 2011/12
8. Election of Council for 2010/11
9. Proposed Change to FAS Constitution
10. Any Other Business
11. Close

Introduction to Astronomical Spectroscopy

Ken Harrison

There have been many innovative and ground breaking advances in astronomy over the years (invention of the telescope, use of camera and film/ CCD, etc) but one stands head and shoulders above all others, and that is the application of the spectroscope to astronomy. It is said that more than 85% of everything we know about the Universe has been discovered using the spectroscope. Why is it then that amateurs do not use this tool frequently? Surely there is much more to be discovered and areas in which the diligent amateur could be rewarded with success?

Sir William Huggins was such an amateur astronomer in the mid 1800's. He had heard about Kirchhoff and Bunsen's experiments where they had positively identified the relationship between emission/ absorption lines in the spectrum with known elements, and thought to himself "Hmm what if I built a spectroscope and applied it to my telescope….what would I see?" It didn't take long before he discovered that the stars showed similar absorption lines, some close double stars (binary stars) showed varying double lines, the positions of the lines varied with the radial velocity of the star (Doppler shift) and last but certainly not least that some bright nebula were emitting emission line spectra (gaseous nebula)

He spent the next 40 years of his life observing spectra with his wife Margaret, from his backyard observatory in South London. He even managed to be the first to see solar prominences without having to travel all over the world to find a solar eclipse. How's that for dedication.

Nowadays, things are a bit easier for the average amateur; good telescopes, mountings and access to up to date data and knowledge via the Web is almost taken for granted.

So, why are there so few spectroscopic observers?

When I ask this question of amateur groups and societies, I frequently get the answers - "It's too complex"; "too mathematical"; "you need a degree in physics to understand it"; "I tried it and it didn't do anything for me". I think part of the problem is that you don't get the same "eye candy" and the instant gratification that you can get from CCD astro-imaging. Having said that, the amount of time required in getting mountings polar aligned, guiding systems to guide and then the amount of time spent in processing the images etc., is not insignificant; it does take time to produce a "Wow" image.

The answer I feel, is to make using a spectroscope in astronomy so easy that usable results can be obtained on the first night out; make the processing and calibrating of the spectra so straight forward that there's no discouragement to the amateur and gradually increase the challenges without information overload. Believe it or not, all this can be achieved with a £80 filter grating and a couple of freeware software packages called IRIS and Visual Spectrum (VSpec).

What you need

- Telescope and mounting
- Camera and 1.25" nosepiece adaptor
- Your usual imaging program.
- 1.25" filter grating (Star Analyser/ Rainbow Optics/ Baader)
- IRIS software
- VSpec Software

VSpec is a fully featured package which will accept a raw spectrum image as a 16 bit fits file and display a 1D graphic profile of the spectrum, allow calibration in Angstrom (Å) and contains a library of spectra covering all the bright star stellar classifications (A0 through M5) as well as many of the common elements (Hydrogen, Helium etc). Using these libraries allows correction of the spectrum for camera response and provides reference lines to assist in the identification of unknown lines.

How to start

Using the available telescope, mounting and camera body (either DSLR or CCD) fit the Star Analyser approx 50 or 60mm in front of the chip; and align the grating to the image frame.
Set the telescope to a bright star and insert the grating/ camera into the focuser.

Fig 1 grating fitted to CCD Camera

Fig 2 grating fitted to Webcam

Focus the star image (this is the Zero image) towards the edge of the frame and you will see a bright spectrum in the middle of the frame. An exposure of 0.5 to 3 sec will be enough to record the image of the spectrum.
To get the image formatted to import to VSpec; open your imaging processing software (AstroArt/ Maxim etc or IRIS), load the image and rotate it horizontal with the zero image towards the LHS and crop about 10 pixels above and below the spectrum, save as a .bmp

Fig 3 Spectrum of Vega showing zero order image

(Continued on page 4)

(Continued from page 3)

Fig 4 grating fitted to DSLR body

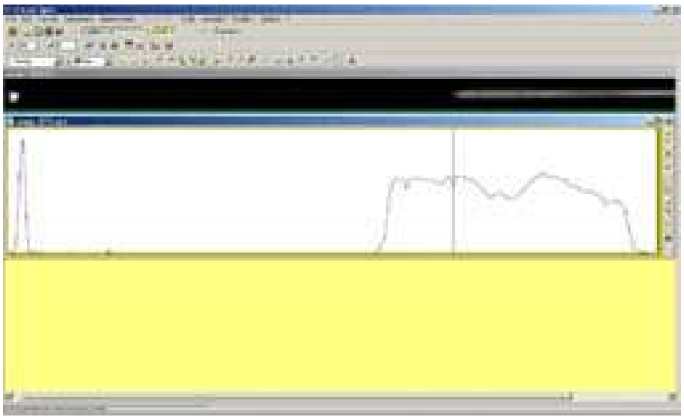


Fig 5 Vspec screen – uncalibrated spectrum profile

or .tiff file. Open IRIS, load the image then use the tab 'Digital Photo/48bit to 16bit' to convert it to a 16bit fits format and save.

Open VSpec and load the image. Display the profile by pressing 'Object binning' icon.

Now here is the fiddly but not difficult part; to be able to calibrate the spectrum by wavelength (Angstroms) we need to define at least two known points. One can be the Zero image which will be at 0000Å but initially the second has to be guessed.

Look at the profile of the spectrum and look for an obvious dip… this is usually a hydrogen absorption line (See Table 1 for reference wavelengths). Pick one, say Hβ at 4861Å as being represented by the dip.

Using the 2 line calibration Icon use the mouse to select the zero image peak and type "0000" press enter. Now select the dip and type "4861", again press enter.

The screen will change to show the plate scale Å/pixel – for a 50-60mm spacing and a CCD pixel size of 8 micron, this should be around 4 to 6Å/pixel.

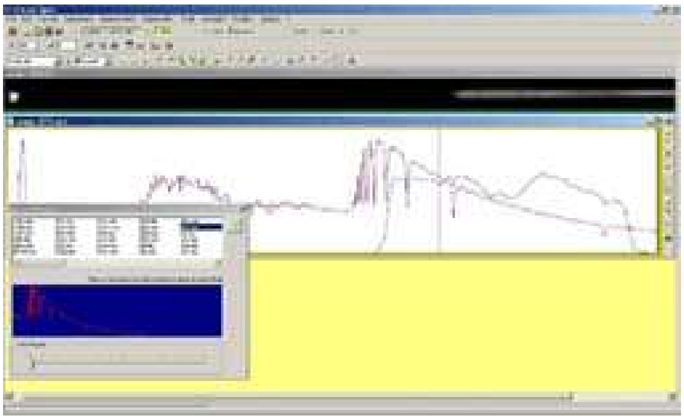


Fig 6 Vspec calibration showing A0v comparison spectrum

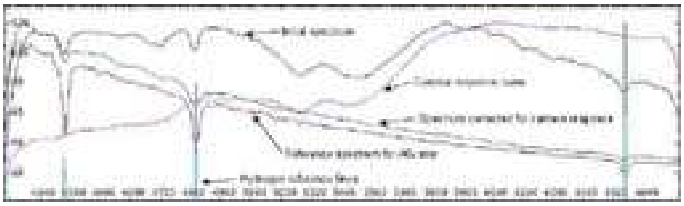


Fig 7 Vspec results showing original spectrum, camera response, corrected spectrum and the reference spectra from an A0v star

(I have prepared a spreadsheet SimTrans V2 which calculates the plate scale and resolution for various gratings and distances – See Webpages)

We can now save the calibrated profile for future reference and processing.

This very brief introduction shows how it is possible to obtain spectra and process the results with no mathematics and using astronomical equipment you probably already have to hand. Obviously this is just a "small step" along the road to spectroscopy, but with a little practise you will soon be able to analyse the spectra of variable stars, nova and determine the Redshift of distant galaxies!

Suggested reading

Martin, J.: Spectroscopic Atlas of Bright Stars. Springer (2009)
Cox, J., Monkhouse, R.: Philip's Colour Star Atlas E2000. Geo Philip Ltd (1991)
Kaler, J.B.: Stars and their Spectra. Cambridge University press (1989)
Robinson, K.: Spectroscopy: The Key to the Stars. Springer (2007)
Tonkin, S.F. (Ed): Practical Astronomical Spectroscopy. Springer (2002)

Olivier Thizy (Shelyak) has also prepared a "recommended" reading list:
http://www.shelyak.com/en/links.html

Websites and Y! groups

http://tech.groups.yahoo.com/group/astronomical_spectroscopy/?yguid=322612425
(The SimTrans spreadsheet is available in the files area)

http://www.threehillsobservatory.co.uk/astro/spectroscopy.htm
http://astrosurf.com/buil/us/book2.htm
http://www.patonhawksley.co.uk/staranalyser.html
http://www.starspectroscope.com/
http://www.astrosurf.com/buil/us/iris/iris.htm
http://www.astrosurf.com/vdesnoux/

Table 1

Sodium doublet	589.0nm and 589.6nm
Nebula emission lines	
NII	658.4nm
Hα	656.3nm
OIII	500.7nm
OIII	495.9nm
Hβ	486.1nm
HeII	468.6nm
Hγ	434.0nm
NeIII	386.9nm
O_2 and H_2O Atmospheric Telluric lines	
H_2O	594.45nm
H_2O	595.86nm
H_2O	596.83nm
O_2	627.8nm
O_2	686.9-694.4nm
O_2	760.6nm

Standard reference lines

See biopic of Ken Harrison on page x

Successful Outreach Event at Leighton Observatory

Hello Frank,
Following the Open day held by Liverpool AS at the Leighton Observatory on Saturday, (April 17th) the message below has I understand also been sent to the LAS website, as well as me......

Dear Mr Gilligan
Thanks to all in LAS who gave their time and help to us at the observatory open day. We came for half an hour and stayed for 3, then went home and came back after dark! It was a great and insightful introduction to the topic and I now understand a lot more about how to align and operate my mount on my scope thanks to some of your extremely patient members. I saw and understood more in the last couple of hours there than I had done in the last few months struggling on my own. It's really opened the subject up for us and given us the confidence boost we needed to get us out there more on clear nights.
Best Regards to everyone.
Guy & Susan

.......It makes it all worthwhile when you get messages like the one above.

Regards
Gerard
Gerard Gilligan, Hon Secretary
Liverpool AS

Images kindly provided by Chris Regan.

Darker skies over Lymm, Cheshire

It took two years of contact, persuasion and perseverance by Chris Reeves, local resident and Macclesfield Astronomical Society member, to obtain the result you see here.

These lights, at her local Lymm High School (also used after hours for Leisure Centre activities) had become worse over the years and could be seen more than 10 miles away. She finally had to call for the back up of Warrington Environmental Health to assist in bringing about the changes.

The lighting installers attended a presentation at Jodrell Bank Observatory in March to receive a well deserved BAA Good Lighting Award from CfDS Liaison Officer, Gerard Gilligan.

Just shows what can be achieved with great dedication and persistence.

Andy Poplett (Philips Lighting) ; Chris Reeves ; Roy Neale (Thorwill Floodlighting) ; Gerard Gilligan
Photographs: Macclesfield Astronomical Society

As reported in the Liverpool AS News by Gerard Gilligan

Book Reviews

The Universe in a Mirror   Robert Zimmerman

Princeton University Press US$29.95 / £20.95 ISBN13: 978-0-691-13297-6

Very few things in the areas of science and technology have the ability to inspire feelings of awe and wonder in large sections of the public across the world. Even fewer are able to continue doing so for more than sixteen years. The Hubble Space telescope, however, has not only managed to achieve this feat but also continues to provide scientists, cosmologists and astronomers with unprecedented data and insight into the workings of the Universe.

In this book, author Robert Zimmerman, a space historian whose previous books were about space stations (Leaving Earth) and Apollo 8 (Genesis), sets out to document the history of the HST. For those of us naive enough to believe that a project like Hubble, carried out by such an iconic organisation like NASA, is a matter of taking a good idea, designing and building it, this story is quite an eye opener. From Lyman Spitzer's first realistic proposal for a space teleascope in 1946, through decades of campaigning, fund-raising, design changes, engineering difficulties and opponents to the whole concept, the fact that the space telescope ever got built at all is largely a testament to perseverance and self-sacrifice. Even after it's belated launch in 1990, things did not run smoothly for the HST when a flaw in the construction of the main mirror was discovered and the success of the mission seemed to be in serious doubt. Subsequent and on-going budget constraints cast doubts over repair and servicing missions, jeopardising the future of the telescope.

Robert Zimmerman examines this fascinating history in considerable detail, providing not only a list of events but also a veritable Who's Who of the men and women who have contributed to the project over the course of over 60 years. In providing an insight into the life and work of many of the key players as well as the management of the organisations concerned, the author makes it clear that committing to a project of this type is not always a good career move. Many of those who took part, including Lyman Spitzer himself, ended up being sidetracked as the technology and political landscape changed over the years.

As a matter of necessity, the book provides a chronological list of events and developments from the first proposals in the post war years to the last service mission in 2009 and a look forward to what may replace the Hubble Space Telescope when it's mission is finally complete and it is brought back down to burn up in the Earth's atmosphere. However, the inclusion of so many key players

and an explanation of how they became part of the project gives the feeling of watching a film with a multitude of flash-backs – sometimes a little annoying. Overall, though, Robert Zimmerman gives an extremely detailed and interesting account of one of NASA's greatest achievements and the interest it has created around the world.

Phil Brotherwood

ANTIMATTER   by Frank Close

Published by Oxford University Press 2009   Paperback £7.99
ISBN-13: 978-0-19-957887-0

Frank Close writes with authority on all matters nuclear and relating to particle physics. In this book he explores the history of the looking glass world of antimatter from prediction to discovery, to applications in medicine, to antimatter storage and it's use in particle physics research. He also considers the place of antimatter in science fiction and as the stuff of hypothetical weaponry. The history has, of course, been told before. Dirac's prediction and the discovery of positrons as by-products of cosmic rays are surely as familiar to today's undergraduate cohort as they were to the students of forty years ago but with his knowledge of later developments in physics and of the consequent technology, Frank Close brings an insightful new look to this history.

Aspects of the antimatter story that are relevant to popular astronomy and astrophysics are dealt with thoroughly in this book. The author recounts the story of the Tungusta event and discusses the likelihood of an antimatter interpretation. This leads naturally to a discussion of the so-called missing antimatter problem, the apparent dominance in our part of the universe of matter over antimatter. The search for the requisite asymmetry in the fundamental particles and laws of nature is discussed in detail, as is the nuclear world of quarks and anti-quarks. In his recounting of the development of antimatter storage the author presents an aspect of the subject that was new to this reader and reviewer. Readers with an interest in the technology of particle physics research (The LHC for instance) will find this a valuable inclusion in the book. There is an interesting appendix that deals with the economics of antimatter production. Here we learn that if all of the man made antiprotons ever produced were allowed to annihilate with matter, then the resultant energy would be sufficient to power a feeble light bulb for just a few minutes. A second appendix in which the author returns to a discussion of the Dirac equation includes the only detailed mathematics in the book. The remainder of the book is easily accessible to the non-mathematician reader.

There is folklore that has grown up alongside the hard core of antimatter science. As the source of apparently free, clean and bountiful energy, antimatter is a beloved and frequently included 'solution' to some of the common issues that arise in science fiction. The author presents detailed arguments which 'put paid' to many of these imagined applications. We will not therefore boldly go anywhere in the foreseeable future. Nor will the world self annihilate in a furnace lit by antimatter weaponry. The world will, however, benefit greatly from the development of positron emission tomography. In considering the fictional applications Frank Close does not neglect the real technology which has emerged from decades of research into

the world of antimatter.

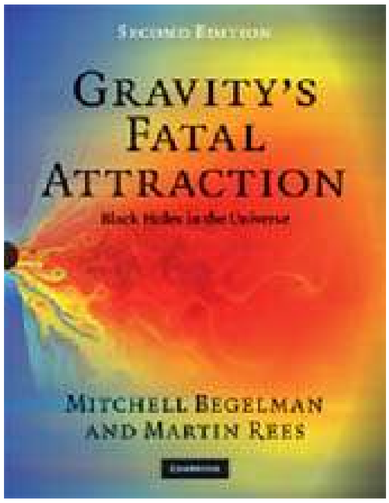
Frank Close's 'Antimatter' is a useful addition to the popular science library and amateur astronomers who delve into Big Bang astrophysics or into a range of related issues will find it an easy and interesting read.

Brian Parsons

Gravity's Fatal Attraction: Black Holes in the Universe

Mitchell Begelman and Martin Rees

Cambridge University Press ISBN-13: 9780521717939 £19.99



This colourful and easy to read 302 page softback book aims to explain what is perhaps the most mysterious and cataclysmically final of all entities in the Universe: Black Holes. Popular science fiction novels or films have portrayed black holes as the big black gravitational portal of no return where it is believed that what is pulled across the "event horizon" is utterly destroyed in the physics defying "singularity" . This second edition of the book deals with what we have actually dicovered about black holes and their place in the great scheme of things which seems to be as a crucial component of the mechanics of the universe as we observe it.

Since the first edition information has been added based on exciting new observations made in the last decade including definitive proof that there is a supermassive black hole at the centre of our Milky Way galaxy and that black holes are part of the engine of galaxy formation itself. It charts the observations made by increasingly powerful viewing platforms like the Hubble, Chandra, Spitzer and radio telescopes pooling their wide ranging wavelength viewing capacity, gaining real data on likely massive candidates to help explain the life of a black hole.

The book covers the complex ideas and the theoretical aspects of black holes that have accrued over the years in well explained detail using clear, easy-to-understand diagrams and backing it up with the most up-to-date observations. It charts how key historical players and current reseachers with their building of theories, mathematical modelling and actual observation of the phenomena associated with black holes like gamma and x-ray bursts, jets, star perturbations and accretion discs, have brought us to a greater understanding of what black holes are and what they do. The narrative shows the cumulative understanding provided by physicists, astronomers, mathematicians and theorists including Einstein, Swcharzchild, Hawking, Hubble, Hoyle, Penrose, Kerr… the list goes on… that has brought us to a level of understanding of the status of black holes, not as a fleeting oddity drifting in the Cosmos but as essential to the workings and formation of galaxies.

It looks at the conditions required and the evolutionary routes that can ultimately lead to a black hole. It is now clear that a stellar size black hole is formed from a supernova explosion of a supergiant star. If the initial mass is too small the result will be a white dwarf or a neutron star. But a supermassive hole that is the result of the gravitational aggregation of gas clouds and other star debris forming an entity that rotates at the centre of possibly each galaxy we can see. The largest so far identified is equivalent to 18 billion solar masses!

Rees and Begelman also explore the phenomenon of the binary star system where a large star's mass is being siphoned off by a companion black hole with the accompanying heating of an accretion disc and the double jets that emanate way out into space that seem to travel at almost the speed of light.

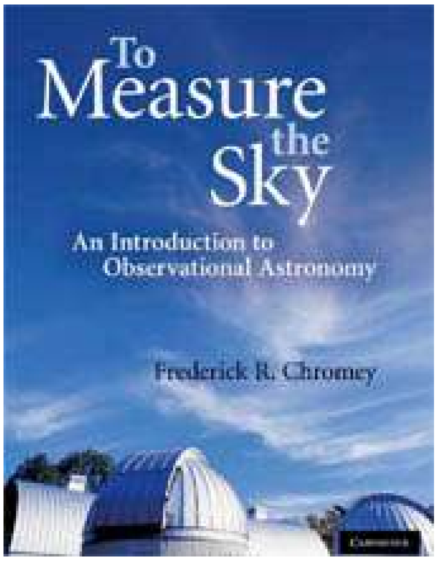
The witty style and clarity of de-jargonised text with all the essential concepts and definitions well explained and illustrated make for a book that is a state of the art authority on the subject suitable for a wide range of reader especially as it is written by such an eminent duo in this field of research and observation. Highly recommended.

Glynn Bennallick

To Measure the Sky: An Introduction to Observational Astronomy

Author: Frederick R. Chromey.

Publisher: Cambridge University Press. ISBN: 978-0521747684.
Price: £33.00 (paperback).



"To measure the sky" aims to introduce the fundamentals of observational astronomy to undergraduate students but it is also very much at home on bookshelves of amateurs with an interest in understanding how quantitative measurement of astronomical objects is performed. In particular this book will be useful to the many amateurs who are undertaking measurements of the sky via photometry or spectroscopy.

It is written in a lively and engaging style such that the author carries you along, explaining fairly complex topics in a clear and interesting manner. The narrative is supported by many clear and enlightening diagrams and illustrations. It begins with the fundamentals of light, optics and detectors (concentrating on the visible and IR), building up descriptions in a rigorous yet very readable style. There are certainly more complete volumes that explain individual subjects in great detail but Chromey selects the most relevant and useful parts of these complex topics and presents them in a way that is really relevant in their application to astronomical measurement. As an example, many amateurs can happily undertake imaging and measurements without an understanding of the workings of solid state detectors, yet Chromey's dealings with the subject help the reader to understand how to squeeze the best signal to noise performance from their chosen CCD camera.

A few sections of the book will be of little more than academic interest to the amateur audience, sections on space telescopes and adaptive optics will fall into this category. Overall though the majority of the content is highly suited to the capabilities of many amateur observers.

The last third of the book is the section that I certainly found most outstanding. Detailed sections on digital image manipulation, photometry and spectroscopy are pitched right at a level where an amateur can find most practical benefit. Chromey works methodically through image processing stages and helps to demystify some of the advanced processing techniques that more capable software packages provide.

The book also contains many useful appendices containing useful fundamental astrophysical data.

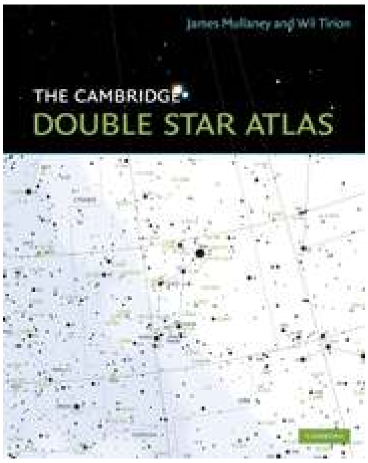
Overall I would highly recommend this book to anyone who is looking to develop their understanding of astronomical measurement. It is very well written, superbly produced and of high practical value.

Darryl Sergison

THE CAMBRIDGE DOUBLE STAR ATLAS

By James Mullaney FRAS and Wil Tirion

Cambridge University Press ISBN 978-0-521-49343-7 (pbk) RRP £27.50 (US$35.00)



At last it is refreshing to know that now, available in a single volume for the amateur astronomer there is a complete high quality modern atlas dedicated to the pursuit of double star observing. Here we not only have a publication that is a 'must have' reference for the astronomer's book shelf but one which should be used regularly at home and in the field in the planning of all double star observations suitable for beginners and more seasoned pros alike in this discipline.

Written by the well respected James Mullaney, author of *Double Stars and How to Observe Them*[1] ,and with charts by the incomparable Wil Tirion who's maps are a joy to use, one immediately feels a sense of inspiration and can readily take comfort knowing that the information contained within will be of great use and benefit to the observer.

Cambridge University Press publications are known for their high quality books and this atlas is no exception. High quality glossy front and rear covers allow accumulation of surface dew to be easily wiped free and the 303 X 240 spiral binding make this a practical design for the outdoors to be used at the telescope thus allowing easy access to each map respectively; for practicality, I personally prefer the atlas' of the smaller size of 220 X 150 such as *Sky & Telescope's Pocket Sky Atlas*[2] and *Binocular Highlights*[3].

The 148 page atlas is divided into several sections thus depicted on the contents page with four main areas covering map parameters and selection criteria; discoverer/catalog/observatory designations; observer, atmosphere and instrument; double and multiple star showpieces and there are also some useful recommended references, author acknowledgement sections not to mention an introduction.

Being an atlas publication, the main body of the book encompasses a star chart section divided into three appendices covering a constellation table; table of Greek letters and a *Cambridge Double Star Atlas* target list which, all in all provides an abundance of information for the double star observer to give many hours of enjoyment and make useful observations at the telescope.

It will now be necessary to review in more detail the star charts after all; it is here that most observers will be referring.

There are thirty two charts contained within the publication including a northern hemisphere and southern hemisphere chart index allowing the user quick access to a chart of interest or particular area of the sky.

What I liked and found to be particularly useful is for each chart; the constellations are labelled and outlined in light blue thus facilitating chart navigation and location of the double pairings sought after.

Whilst this atlas has been primarily designed with double star observation in mind, it also serves as a general-purpose guide for viewing all types of deep-sky objects, showing as it does many prominent asterisms, star clusters, nebulae, galaxies, variable stars and the majestic Milky Way itself[4] with object symbols following the design and layout similar to that of *Sky Atlas 2000*.

The horizontal and vertical axes are calibrated with declination and right ascention respectively with numbered green arrows taking the observer to the next most practical following chart. Locating double stars on the charts is made easy by way of labelling in green. Stars are shown from 0.0 magnitude down to 7.5 so this atlas publication will be of use to the small telescope and binocular user also. Each chart also has a key for the most popular objects using Tirion's popular and easy recognisable style. There is truly enough information plotted here to satisfy the hungriest of double star and deep sky observers alike.

Appendix C is a nice addition included within the atlas thus listing all the doubles found in the *Cambridge Double Star Atlas* by object/constellation; designation; right ascention; magnitude and separation/remarks. This is the original working list used in plotting all of the double and multiple stars shown in the atlas. Pairs having companions at or above the map visual magnitude limit of 7.5 and 180 arcseconds or more in separation were plotted as separate stars, the position angle (PA) in degrees being where available as an aid in positioning them in respect to their primaries[5].

In use I found the atlas a pleasure to use. With its high quality charted maps, and extensive objects embedded within along with a useful key on each page, planning an evening's observing session and using the atlas at the telescope eyepiece is not only fun, enjoyable and rewarding but, instils a sense of the true and traditional astronomer values. Like Norton's Star atlas, this double star atlas sets a benchmark standard for no doubt, many more similar publications which will no doubt follow in the future. It goes with saying, I would thoroughly recommend that all amateur astronomers own a copy of this atlas.

Simon Johnson

References

1. *Double Stars and How to Observe Them. James Mullaney, 2005.*
2. *Sky & Telescope Pocket Sky Atlas. Roger W Sinnott,*
3. *Binocular Highlights. Gary Seronik, 2006.*
4. *The Cambridge Double Star Atlas. James Mullaney and Wil Tirion; p.1. 2009.*
5. *The Cambridge Double Star Atlas. James Mullaney and Wil Tirion; p.93. 2009.*

The Secret Land

The origins of the Arthurian Legend and the Grail Quest.

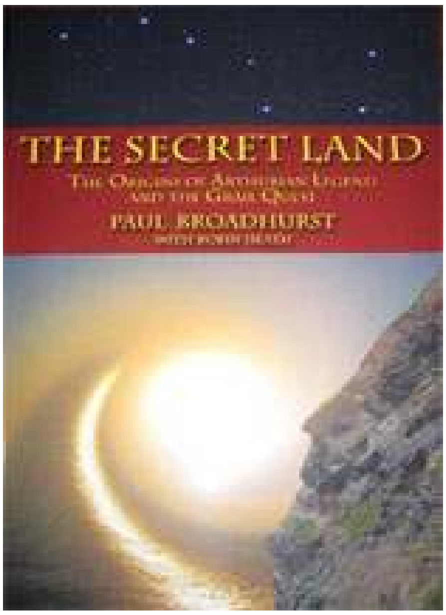
By Paul Broadhurst and Robin Heath.

ISBN No. 978-0-9513236-4-9
HB £25.00 PB £17.50
Publisher Mythos Press Cornwall.

Another fascinating book by Paul. He writes very well and it is possible to pick up this volume and read any chapter.

The main premise is that King Arthur is really King Bear and that he is represented in the sky by Ursa Major. As we know the constellationa wheels about the northern part of the sky. May be this is the origin of the "Round Table"? Arthur himself is almost certainly not a single Chief but the embodiment of a succession of Westcountry chiefs.

He believes that constellations can be traced out in the landscape by looking at the earlier maps e.g. OS 1" maps. Before the invention of the magnetic compass such



figures would have been impossible to make? However there is a way, with a proven ancestry, that makes such draughtsmanship doable.

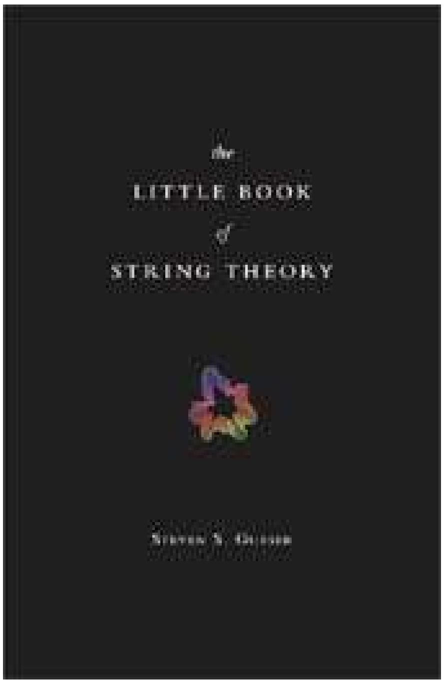
His colleague Robin Heath has written the more astronomical part of the book He was very interested in the fact that from the Church at Tintagel the flat topped Tintagel Island. He has discovered an observatory platform from where it is possible to see the Pole Star above the island and the circumpolar constellations circling around it. It seem to be no coincidence that the "constellations" of Orion's Belt & the Great Bear are known to almost everyone, an endorsement of a longing for things north of the British Isles?

Both Paul and Robin are keen that their discoveries are brought into the main stream of astronomy. This book is packed with facts some of which are about a place near you - they deserve to be checked out.

Brian Sheen
Roseland Observatory

The Little Book of String Theory by Steven S. Gubser

Princeton University Press ISBN-13: 978-0691142890 £13.95 ($19.95)



This book is part of the Science Essentials series published by Princeton University Press which aims to explain the latest thinking in complex science subjects to a general audience. It's a fairly short book, 174 pages including the index, divided into 8 chapters including an introduction and summary. Some might say this is long enough for a book of this nature and I'm inclined to agree. The author is Professor of Physics at Princeton University so you get the impression that this isn't going to be an easy read!

Actually, it's really not too bad and if elementary particles such as photons, gravitons, electrons, 6 kinds of quarks, gluons, neutrinos (and a few others) interest you, then this is definitely the book for you. Although the central theme of the book, as its title proclaims, is about string theory, the book sets the scene by introducing (or reminding more experienced readers) of some preliminaries, namely:

- Energy (length, mass, time and speed).
- Quantum mechanics (uncertainty, the atom and the photon).
- Gravity and black holes including the general theory of relativity.

These take up the first 3 chapters. We then get to string theory itself. We learn how string theory resolves a fundamental tension between gravity and quantum mechanics; how strings vibrate and move in spacetime; and get a glimpse of how spacetime itself emerges from the most widely used mathematical descriptions of strings. This is all fine except that we still don't know whether of not strings actually exist!

The final chapters discuss branes, string dualities, supersymmetry and the Large Hadron Collider (LHC), and heavy ions and the fifth dimension. It's actually all quite readable as very little maths is used but you really do have to be interested in the subject matter to stick with it. If this is a subject in which you only have a casual interest and want simpler explanations then there are other books that do a better job for example Marcus Chown's Quantum Theory Cannot Hurt You. Though this book is much broader in scope (it doesn't actually deal with strings or branes though does mention supersymmetry), it does explain many of the related concepts e.g. bosons and fermions in a very accessible and readable way. Chown's book also includes a very useful glossary which helps to look up a term when you've forgotten it - again.

The most obvious comparison to The Little Book of String Theory is Stephen Hawking's A Brief History of Time, and it did remind me of this as I read through it. Like Hawking's book it does have a tendency to get complicated quite quickly as the author digresses into related concepts but fails to explain them sufficiently. To be fair to the author though, it can't be easy when you have a very advanced in-depth understanding of a subject to explain it in a simple, but accurate, way to beginners.

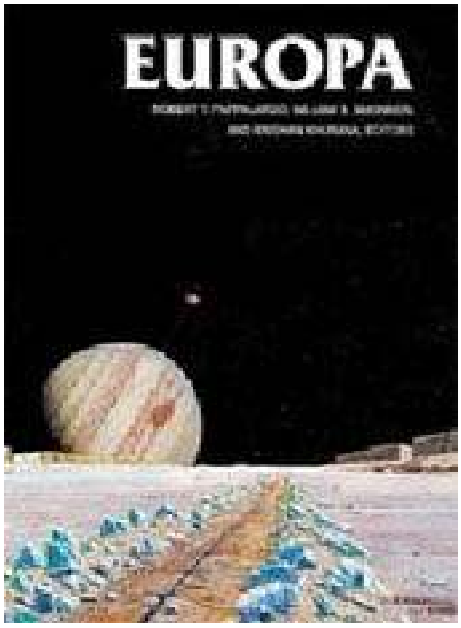
If you're a visual person who likes lots of diagrams or pictures to help you understand what's being presented, or if you're used to watching multimedia clips, you won't find this an easy read. There are a number of line drawings by the author (which I can imagine him drawing on the blackboard in the classroom) but I'm not sure they're all that helpful. String theory, is one of those subjects that would benefit a more visually interactive treatment such as DVD as concepts could be shown rather than simply described. However, as the author admits, it's very difficult to draw 11 dimensions and a 3-brane closing in on itself to form a surface without a boundary. You just have to use your imagination!

I did enjoy the book despite its occasional and sudden abstruse excursions and would recommend it to anyone seriously interested in finding out about the latest thinking in this branch of quantum physics but the absence of a glossary is unforgivable. A subject such as this definitely needs one.

Dale Moore

Europa edited by Robert Pappalardo, William McKinnon and Krishan Khurana

ISBN 978-0-8165-2844-8 HB £75.00. The University of Arizona Press,
in collaboration with the Lunar and Planetary Institute. Houston.



This massive tome tells you everything you ever wanted to know about Europa. (725 A4 pages)

It is a serious text reviewing current research related to Europa and relies largely on data gathered by the Galileo mission. No less than 85 authors were responsible for this collection of review papers.

The book itself is made up of five distinct sections of which two – the first and the last are of more general interest.

The first section (120 pages) covers the history of the discovery of Europa and goes on to discuss the formation of Jupiter and the Galilean satellites. One of the authors is reassuringly familiar to us all - Guy Consolmagno of "Turn left at Orion" fame. I would like to see this section published as a separate volume. It is accessible to the non-specialist and has a huge number of references to allow more in depth study.

The next three chapters cover the geology and atmosphere of the moon together with a study of what is known about its internal structure. Clearly areas for the planetary specialists.

The final section (130 pages) is the one everybody wants to read. The first chapter sums it up well "Astrobiology and the potential for life on Europa." Overall the section ranges far and wide discussing the opportunities, procedures, possibilities and potentials. It is well worth reading right through. Again extensive references support the text and allow for extended study. Would no doubt sell well as an independent text.

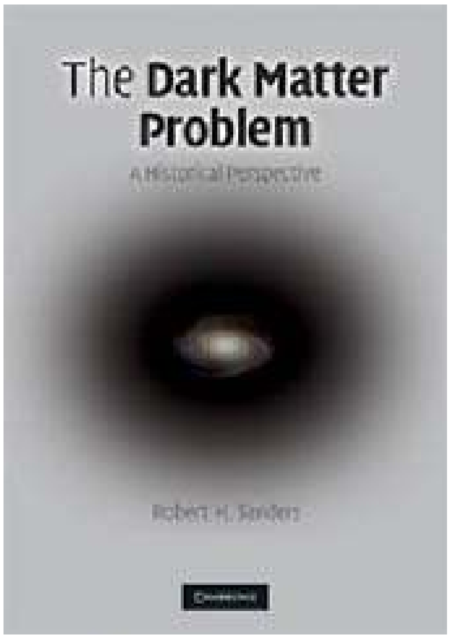
There is an extensive colour section, which illustrates for the first time many of the forces that act upon this tiny moon.

Overall this book makes full use of the English vocabulary but because it is written by people that know at first hand it is nevertheless eminently readable.

Brian Sheen
Roseland Observatory

THE DARK MATTER PROBLEM - A Historical Perspective

Robert H. Sanders
Published by Cambridge University Press 2009
ISBN-13: 978 0521 113 014 Hardback £35.00 ($60.00)



Some years ago (Was it really nearly twenty ?) when browsing my local bookshop for material to enhance the less exciting aspects of the A-level Physics syllabus I stumbled across 'The Fifth Essence' by Laurence Krauss - and was immediately hooked on the dark matter problem. Was it really true that I had spent my working life researching and teaching a tiny part of what is a tiny part of what exists? Krauss's book is still a good read and remarkably perhaps (or perhaps not) little of its content has become dated. This is not to say that little has emerged in the intervening years in advancing the dark matter paradigm.

From an 'annoying little difficulty' unearthed by Fritz Zwicky and Jan Oort in the 1930's, largely neglected for the best part of half a century, dark matter has emerged as the subject of major scientific effort. In The Dark Matter Problem – A Historical Perspective, Robert H. Sanders reviews the history, the emergence and current status of the dark matter paradigm. This is a splendid and timely book and the reader is rewarded with an insight into the tantalising conflict between the majority proponent view of dark matter and the competing viewpoint embodied in the Modified Newtonian Dynamics (MOND) hypothesis.. Sanders deals in detail with the astrophysical evidence which forms the basis of the dark matter viewpoint and contrasts its successes and shortcomings with the similarly limited success of MOND. The conflict is illustrated beautifully with a detailed account of the successful interpretation of flat galactic rotation curves by both proposals but Sanders also takes time to examine the key role played by the demands of spiral galaxy stability, by studies of Low Surface Brightness Galaxies and by the unique success of MOND in providing a possible basis for the Tully Fisher Law.

What was not available to Krauss in 'The Fifth Essence' is the mass of information gleaned over the past twenty years by satellite based x-ray and microwave instrumentation, by high spacial resolution radio astronomy and through gravitational lensing analyses. Sanders reviews the impact on dark matter thinking of this 'new' data at galactic, cluster and cosmological scales and considers the role of cold dark matter in the early universe as the initiator and dominant factor in structure formation. The argument against the neutrino and other hot dark matter contender particles is clearly presented. In parallel with the astrophysical search for a 'smoking gun' is this particle physics aspect of the dark matter paradigm. It is then the W in WIMP which drives a range of direct and indirect searches for a contender particle. As one would expect, there is a detailed review of the arguments for a lowest mass supersymmetric WIMP and the LHC gets its expected mention. Sanders reviews these diverse searches in detail.

And then there is Dark Energy. Terms such as 'Non diluting Cosmologicaal Constant' will keep this reader thinking for some time. I am drawn to subject reviews which state unashamedly that in some instances 'We just don't know and this is why we don't know'. In this book we are encouraged repeatedly to ask a key question: 'Are these proposals falsifiable?' Professor Sanders is an experienced theorist in the field of dark matter astrophysics and is eminently qualified to address this question and he does so with notable clarity. Sanders' historical perspective concludes with a short chapter presenting his personal reflections on the development of this subject over the past forty years. These reflections alone would make the book a must read volume. His book is written with the scientific community in mind and the language is uncompromisingly scientific but it is nonetheless fathomable by the non- specialist. Mathematical argument is kept to a minimum but is perhaps inevitable in discussing MOND - and there is a useful appendix which goes some way to provide a summarised background on which an inexpert reader can base a first reading.

The Dark Matter Problem will find an easily accessible place on this reviewer's bookshelf for some time.

Brian Parsons

Project Drax at The Spaceguard Centre

The aim of Project DRAX is to install and operate a 24 inch (61 cm) Schmidt Camera (it would be the largest telescope in Wales) at the Spaceguard Centre to conduct a wide field sky survey to detect Near Earth Objects and other transient phenomena.

The 24 / 17" Schmidt Camera

This instrument was built in 1950 by Grubb-Parsons of Newcastle-upon-Tyne. It is a 'Classical Schmidt' – the simplest and most efficient form of the ingenious wide-field camera invented in 1930 by Bernhard Schmidt of Hamburg Observatory. Light falls on a 61 cm (24-inch) mirror with a spherical reflecting surface. It is reflected to a focus in the centre of the tube and half-way up it, 163 cm (64 inches) from the primary mirror. At the focus a photographic plate 15 cm (6 inches) in diameter, which must be bent to fit a curved surface, records the star images from an area of sky 5 degrees in diameter. (The full Moon is half a degree in diameter.). It is an

ideal sky-surveying instrument.

The telescope tube is over 4 metres long, and the complete assembly stands more than 4 metres high (with the telescope horizontal). The machinery is immaculate – a testament to British engineering when corners were not cut and excellence was a way of life. Weighing in at 7 ½ tons this is a solid, reliable and totally outstanding instrument.

The total cost of Project DRAX is £84,600, and is of national and international importance. However, no government funding is available for this project, and as such will only be completed if sponsored by individuals and businesses. If you would like to donate to Project DRAX, you can do so in a number of ways. Check out the project website:
www.spaceguarduk.com/project-drax

Mid Summer Nights Snapshots By Dave Galvin

I thought that it would be interesting to see what I could image through my 14" Celestron (f7.7) on the brightest evening of the year i.e. June 21st / 22nd. The idea being that if I could get reasonable results with short exposures in a mid-summer astro-twilight sky then I should get better images in the darker autumn, winter and spring skies.

I used a Canon 350 DSLR camera set at ISO 800 and shot approximately 30 seconds exposures. These images, per object, were stacked with Deep Sky Stacker and saved as lossless images (TIFF) and transferred to Photo Shop CS3 for cropping and processing.

Whilst the images are not up to Hubble standard I am rather pleased to have 'caught' these summer delights in my light polluted skies.

Courtesy: LAS Newsletter

Albireo (β Cyg) *1 min 3 secs 5x frames*

Celestron C14
EQ6 Mount

M13 *2 min 53 secs 7x frames*

NGC6543 *Cats Eye Nebula 9secs 1 frame*

M27 2 mins 10 secs 6x frames

NGC 7662 Blue Snowball Nebula 2min 4sec 5x frames

Foucault Pendulum in a Guernsey Town Church

For six days in July, from Monday, 12th to Saturday, 17th, there was a Foucault Pendulum in the Town Church.

The pendulum provides evidence for the rotation of the Earth, as demonstrated by Leon Foucault in 1851.

The 9-metre pendulum swings freely in space, while the Earth turns beneath it. It thus appears that the angle of swing turns slowly, thereby demonstrating the daily rotation of the Earth on its axis. To illustrate this effect, pegs are positioned so that the pendulum knocks one over every few minutes.

Jean Foucault (1819—1868)
In addition to the pendulum, he collaborated with Arman Fizeau in the measurement of light using a Fizeau Wheel

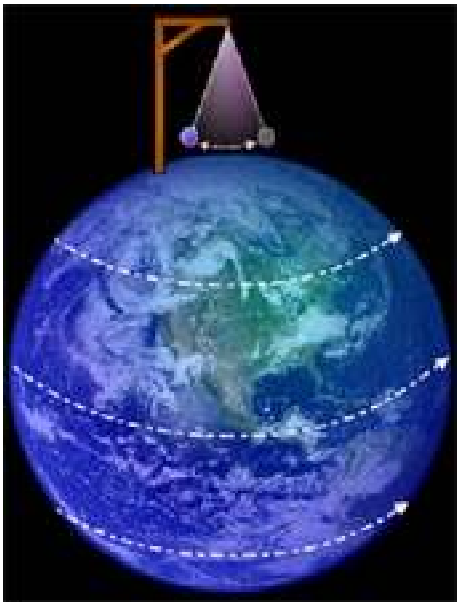
Jean Bernard Leon Foucault (1819-1868) was a French physicist. He first set up a pendulum at the Paris Observatory in 1851, and then at the Pantheon. His pendulum was 67 metres high and had a bob weighing 28 kg.

Our pendulum was just 9 metres long, with a bob weighing just 2 kg, but it demonstrated the same principles.

His experiment was reproduced by the Astronomy Section of La Société Guernesiaise, by kind permission of the Dean and Rector of the Town Church. Thanks go to Smith Signs for providing the baseboard for the pendulum.

The pendulum is set swinging each morning exactly north-south.

Although the Earth rotates on its axis once every 24 hours, the apparent rate of rotation of the pendulum depends upon the latitude. At the north and south poles it would take exactly 24 hours to make a complete rotation, but at the latitude of Guernsey (49.5°) the pendulum takes 31h 35m. Here, in the northern hemisphere the pendulum rotates clockwise, but in the southern hemisphere it would rotate anti-clockwise. At the equator it would not rotate at all.



A Foucault pendulum at the north pole. The pendulum swings in the same plane as the Earth rotates beneath it.

Some Interesting facts about pendulums

- The period of swing of a pendulum depends solely on its length; the longer the wire, the longer the period of swing, but not proportionately. (The period varies with the square root of the length.) Our 9-metre pendulum has a period of 6 seconds. If it was twice as long it would be 8 1/2 seconds.
- The weight of the bob does not affect the period of swing; neither does the size of the swing.
- The above facts were determined by Galileo in the early 17th century.
- However, the force of gravity does matter; a pendulum would swing slower if gravity is weaker. On the Moon, for example, where gravity is one-sixth that on the Earth, the period of our pendulum would be almost 15 seconds.
- A heavy bob is used simply to provide sufficient momentum to keep the pendulum going, minimising the effect of air resistance, air currents and friction at the point of suspension. Nevertheless, because of these effects the pendulum will eventually come to a stop.
- The rotation of the Earth shows itself in other ways: the deflection of winds, ocean currents, inter-continental flights, and space launches. It does not, however, affect the direction that bath water takes in going down the plug-hole!
- Longcase ('Grandfather') clocks typically have a pendulum one metre long, which gives a period of two seconds, ie one second in each direction.
- The Earth is not spherical; it is *oblate,* ie it is wider at the equator than at the poles. This is a consequence of its rotation. A pendulum would swing slightly slower at the equator than at the poles, as the gravity at the equator is less.
- The oblateness of the Earth and of the Moon is responsible for the fact that the Moon always keeps its same face turned towards the Earth. The Earth rotates 24 hours with respect to the Sun, but actually rotates once on its axis every 23h 56m 04s, with respect to the stars - the *sidereal day.* This is because the Earth is annually revolving in its orbit around the Sun; so in one year the Earth makes one extra rotation on its axis.

David Le Conte

Courtesy–Sagittarius–the Newsletter of the Astronomy Section of La Société Guernesiaise

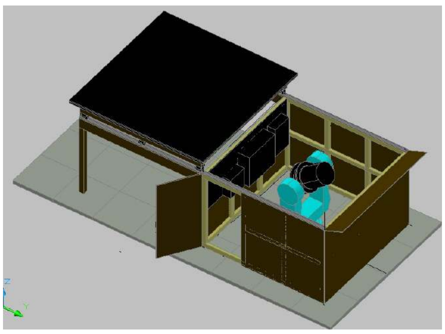
Foucault's Pendulum in the Panthéon, Paris

Supernova Searches - A New Telescope

By Brendan Martin and Dave Thomson

The primary observations to be undertaken with this telescope will be Supernovae searches to support the 20 inch Telescope and Observatory. Automated observing runs will normally be done late at night and through to the early hours of the morning. The telescope will do the 'larger' galaxies and areas of sky the dome does not/or cannot cover.

The telescope will also be used for 'public outreach' and 'education'. The telescope will be accessed remotely during Sidewalk events, or from the Pex Hill observatory. Control over the telescope and CCD camera will be displayed using a PC projector. Access to the telescope will be via REMOTE control Via VNC using wireless broadband (if a local connection is not available).



Overview

The Run-off roof observatory has been through a number of design changes over the last year (2009 to 2010). The original design was a small run-off shed, but this had drive issues and was not going to be large enough, or robust enough for remote and automated operation. We needed to have a design that was as reliable as or better than the dome. Advantages of a run-off roof over a small run-off shed/dome are:-

- Access to the telescope and control panels etc when the weather is bad (small run-off shed was too small!)
- Better wind protection for the telescope
- Faster slew rates for the Meade mount over a dome (it is not limited by the dome slew speed)
- Cheaper and cost effective
- Simpler and probably more reliable
- Relatively easy/quick to build (but there was a LOT equipment and software complexity required to make it remotely operable and semi-automated)

Disadvantages are:-

- Does not provide protection from glare as a dome does
- Does not provide protection from dew as a dome does
- Limited North horizon with the roof running off in that direction with limited space for the roof to run off (not that important)

Drive Mechanism

The drive mechanism is quite simple and uses a gearhead motor with interfacing direct gears to a 'roller' drive that has two fixed rubber wheels at either end. This means that 'both wheels' drive the roof off on the aluminium rails. The wheels are connected via a long drive 'tube' that is made from 100mm diameter thick wall ducting.

The image above shows the drive 'tube' with the wheels fixed at each end. The motor is not yet connected.

The image above shows the drive mechanism being installed at an early stage. The winch has been stripped of its casing and you can see the two gears. One of which is connected directly to the drive 'tube'. The other to the winch motor that is supplied by 12V from the main control panel. There is a manual release clutch on the winch. This drive motor has since been replaced with a gearhead motor controlled via a variable speed drive controller. Details of the reasons why this was replaced are outlined in the 'control system' section.

The wheels run on 3 x 3 inch 'T' section aluminium bought from Aalco in Liverpool.

The weight of the roof cladding has increased the load on the wheels and hence the friction to prevent slippage. To improve load on the drive wheels we have added 2 x concrete flags to the drive end of the roof. We

The image above shows the new motor in place (some painting is

(Continued on page 14)

(Continued from page 13)

Image above shows the mechanism that closes the door and the closed limit switch. One of the roof safety brackets can also be seen. Four of these are installed to prevent the roof from lifting during high winds if the roof happened to stay open during failure of the wind sensor.

have done tests with the aluminium rails wet and dry and there is very little chance of slippage.

The image below shows the other side of the mechanism with a piece of 'bungie' to help the door stay in contact with the guide wheel when the door is lowered.

The south side of the observatory has a mechanically operated door. This door opens when the roof opens and closes when the roof closes. Two roller wheels connected to the roof engage with aluminium angle slides that are connected to the south facing upper door. The door folds down to approximately 20 degrees above the horizon and is limited mechanically. The advantage with this system is reduced complexity, control, motors and limit switches. The door has operated reliably so far.

Control of the roof opening and closing, including roof and weather status, is done using the Observatory Auxiliary Control application.

Control System

The original roof motor (modified 12V winch motor) and associated control system installed in April/May 2010 worked fine until I began to integrate the rest of the observatory software systems.

The original design employed a modified 12V DC winch motor powered from an inverter using change over relays to control direction. Bypass capacitors and ferrite cores were used as part of the method to reduce RF noise.

This method of control is flawed and causes too much RF to be transmitted. USB ports and devices would drop out randomly during operation of the roof motor, in particular when the motor suddenly changed direction.

This system was stripped out and replaced with an old variable speed drive (VSD) and gearhead motor that I had forgotten about. See Run-off Roof Observatory documentation for the latest drawings. The VSD has additional controls over the motor that the DC system did not have. But it also had some disadvantages:-

VSD Advantages:-

- Control over start up and run speeds
- Acceleration and decelleration speed control
- Injection braking control
- Current limiting and overload protection
- Quite in operation compared to DC winch motor and associated gear noise

VSD Disadvantages:-

- More complex control with increased risk of failure
- More panels, cabling equipment
- Microprocessor/control failure could leave the roof open with no backup to close
- Increased cost

The control system was bench tested and installed early June 2010. Documentation has been updated to reflect the installation One part of the system I pondered over a LOT was the design of the roof limit switches. Industrial limit switches are located at either end of travel to control the open and close positions.

At the moment (dome included) there is only ONE limit switch to prevent over travel. We intend to install TWO limit switches at either end of travel to provide redundancy in the event of mechanical or electrical failure.

The primary hazards are:-

- The closed limit switch fails to operate and the motor keeps turning the drive wheels in a static position on the aluminium rails. The wheels do 'slip' on the aluminium rails at the end of travel.
- The opened limit switch fails to operate and the motor keeps turning the drive wheels in a static position on the aluminium rails. The wheels do 'slip' on the aluminium rails at the end of travel.

Consequences are:-

- Excessive wear of the drive wheels and/or tripping the supply on overload of the motor/VSD unit.

There were two options de-selected. These were:-

- Limit switches for position control and ultimate limit switches for safety by means of cutting the supply to the controller.
- Limit switches for position control and control of the supply to the controller from an 'enable' contactor. This 'enable' contactor could be on a timer to 'limit' the supply to the controller.

Solution implemented:-

- The new design has an 'enable' contactor turning the supply off to the VSD during quiescent periods.
- Mechanical stops have been installed to prevent the roof from ever 'falling off' the end of travel.

Primary failure modes and consequences identified are:-

- Loss off mains supply enabling the UPS to the variable speed drive. The likelihood of this happening was considered low. The limit switches would be detected by the VSD and stop the roof motor.
- Loss off mains supply enabling the UPS to the variable speed drive AND failure of the 'enable' contactor. The likelihood of this happening was considered VERY low. In this case the motor would remain running in a static position until the supply was isolated manually.As has been stated above, the drive wheels do slip on the aluminium rails at either end of travel.
- Variable speed drive failure leading to the limit switches not being acted upon. The likelihood of controller failure is low. In this case the motor would stop after the 'enable' contactor was de-energised.
- Variable speed drive failure leading to the limit switches not being acted upon AND failure of the 'enable' contactor. The likelihood of controller failure and failure of the 'enable' contactor to remove the supply is considered VERY low. In this case the motor would remain running until the supply was isolated manually.

There are other modes such as gears falling off, wires falling off and motor failure etc, but these cannot be accounted for in this design. Only good installation and regular inspections and maintenance can help reduce these sorts of failure mode. Gears are positively retained and should not fall off.

Hazards and consequences associated with the roof not closing are:-

- Exposure of the optics to sunlight causing damage to the CCD camera and possible fire.
- Damage to the telescope, equipment and observatory from water.
- Protective devices should isolate the supply before an electrical fire propagates

Option 2 was chosen for simplicity, practicality of installing additional limit switches (no room and roof closed does not give travel to allow for ultimate switches) and likelihood of failure of components.

The installation required extensive modifications to all panels and wiring. In addition, the motor required a new interface and gear coupler. Approximately 70% of the design had to be modified due to the change in a 12V DC motor system to a 230V VSD motor system.

Emergency stop:-

An emergency stop is provided to stop the

(Continued on page 15)

(Continued from page 14)
roof and telescope if required. The category of the emergency stop is 'Category 1'. This category was chosen for simplicity. The system originally had a category 2 emergency stop system, but this was removed as the roof would not close in the event of power failure.

The level of 'risk' was determined and deemed safe at category 1 for the purpose of this installation. The observatory is generally unmanned unless there is a fault or maintenance required

IMPORTANT SAFETY NOTES:-

- The door cannot be stopped part way open or closed unless the emergency stop is operated. This is located next to the control computer.
- The gear train mechanism for the drive is VERY dangerous and may cause amputation of fingers if not isolated for maintenance BEFORE the protective covers are removed.
- Isolate the mains at the main distribution panel and switch off the UPS supply at the main control panel.

The roof can be opened via:-

- A command is sent from the computer via the observatory auxiliary control screen to open.
- ACP, either manually or via an ACP plan after the mount is powered up
- Cartes du Ciel from a GOTO command after the mount is powered up
- Manually from the open/close switch on the main control panel so long as the enable contactor is energised.

The roof can be closed via:-

- BAD weather status from the observatory auxiliary system
- BAD weather direct from the weather station hard wired
- A command is sent from the computer via the observatory auxiliary control screen to close.
- Parking the telescope in ACP (either manually or via script fail initiating the park script)
- Parking the telescope in Cartes du Ciel
- Power failure to the observatory initiating UPS intervention
- Manually from the open/close switch on the main control panel so long as the enable contactor is energised.
- Axis limit activated

The roof will not open if:-

- Power to the observatory is lost and the door is closed
- The main isolator on the power control panel is off and the roof is closed
- BAD weather status from the observatory auxiliary system is reported
- BAD weather direct from the weather station hard wired interlocks the control system
- An Axis limit has been activated

Observatory control computer

The observatory control computer is an old Dell laptop that has all applications running including:-

- ACP
- MaximDL
- Cartes Du Ciel
- Observatory Auxiliary Control
- Filezilla
- VNC
- Web cam

A protective cover (foam sheet yet to be added for heat retention) has been added to prevent dew build up in the winter. This folds down over the laptop when closed. The laptop is configured so that 'nothing happens' when lid is closed except the screen is not illuminated.

Materials

- The main frame is made from 38 x 65mm planed wood 2.4M long and cut to suit.
- The sides and roof are covered in 5mm PVC white foam.
- Product code: 05PALITESSWH (1220 x 2440 sized sheets for reduced cost)
- The aluminium rails are 3 x 3 inch from Aalco in Liverpool.
- Most other materials are from B&Q and local hardware supplier TE Huges and Sons.

Images shown above are of the telescope on its

- Total cost to date (not including the telescope, mount or CCD) is approximately £800
- Stainless fixings and screws have been used were ever possible outside.
- Plastic DPCmaterial has been used for the skirts. This is cheap and durable.

Overview

The Wide Field Camera is installed in the Run-off Roof Observatory. Outline requirements are listed below.

- The wide field camera will be used for supernovae searches to support the 20 inch telescope in the dome and for public outreach remote access.
- The telescope and mounted in equatorial mode to allow for longer exposures without field rotation.
- The telescope is a composite instrument with a focal length of 407mm according to ACP (That makes it around F1.6 with the nominal 250mm objective)

(Continued on page 16)

(Continued from page 15)

- The observatory will be a simple Run-off Roof Observatory fully automatic with Observatory Auxiliary Control.
- The observatory will link into the existing weather station
- The telescope services from the main control room will be a 240V mains supply, Ethernet link and a cable for linking into the weather station
- ACP will be used to schedule observations

Telescope and mount

The telescope is a very short focal length instrument and is ideally suited to wide field imaging. The only issue being that the CCD camera must require very small pixels to get a usable image scale on sky.

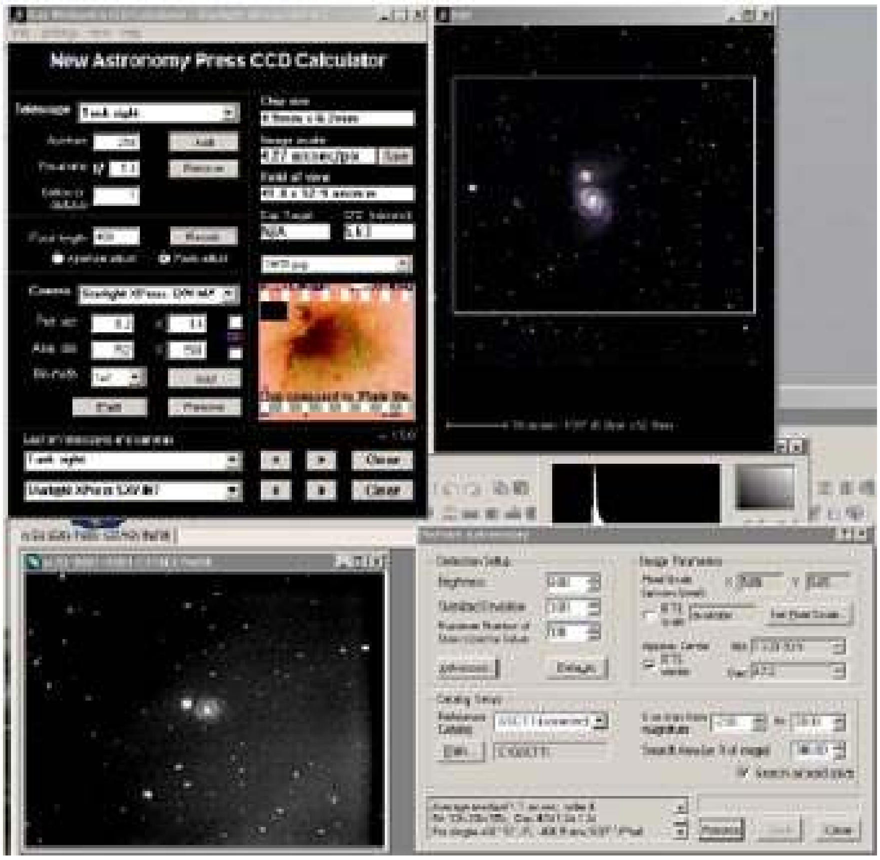
The telescope is mounted on a Meade LX200 GPS mount that originally housed a 16 inch RC. It has undergone modifications (April 2010) to mount it in equatorial mode, install axis limits and modify the central cable connector inside the fork to allow additional cables to run through. This will prevent 'wind up' and snagging of cables that originally where going to be 'dragged' around the mount.

The telescope is now nearly ready for observations after extensive modifications to the observatory run off roof control system. The only thing that will change over the next few months will be the focuser and CCD camera. The camera installed for testing and early observations is the Starlight Xpress MX716.

Magnetic reed switches (in white) can be seen on the Azimuth and Altitude axis. There are 2 axis limits for Altitude (upper

The image above shows the Azimuth central boss being 'opened up' to allow for additional cables to be routed through the central bearing.

The concrete wedge



and lower) and 1 x parked switch. The Azimuth axis has 1 parked switch and 1 axis limit switch. The telescope can slew +/- 180 degrees from its parked position of 180 degrees Azimuth (i.e. cannot track/slew through North). The roof will close if any axis limit is activated. The roof will close if 'both' parked switches are activated.

Status of the parked and axis limit switches can be seen using the Observatory Auxiliary Control application.

Mount modifications

The mount required some modifications due to the instrument mounted in it and also to allow for cables to pass through the azimuth bearing rather than be 'dragged' around the mount.

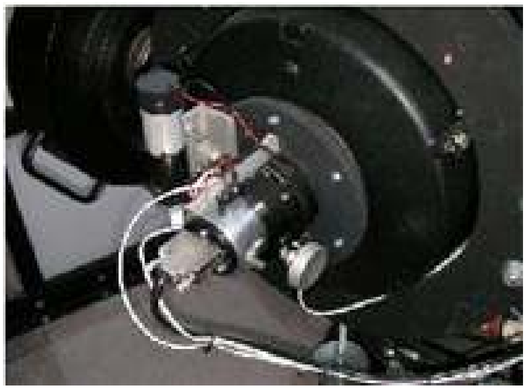
The original idea was to have the telescope AltAz mounted. The thinking behind this was that exposure lengths would be very short for the type of work it would be doing. But, if there was a requirement to do longer exposures or mosaics for education etc, then equatorial would be a better option. All we had to do was make a concrete wedge.

Other modifications include magnetic switches for 'Park' and 'Ultimate limit' position. These are wired back to the control panels and USB inputs.

The 'Park' switches on Altitude and Azimuth will close the roof when both are made, and open the roof when either is not made and the weather is ok.

CCD Camera

CCD may be a SXV-MX8C - Small (3 micron) pixels will be required to achieve the required resolution (2 arc/sec/pix). This will provide approx 1 degree field (based on test



results with the MX7

OR

The ATIK 320E

OR

The Opticstar Opticstar DS-335C ICE

A test image against the CCD calculator is below. M51 was the target and was only 20 seconds with the MX716.

The image below shows the rear of the telescope. The focuser and CCD camera (MX716) will be replaced with a larger chip later this year (2010) when funds allow. The focuser has one limit switch to prevent over-travel of the focuser in either direction. Minimal movement is required only due to the fast optical system. Focus is very fine and difficult to achieve by hand. The motor may be controlled via the Observatory Auxiliary Control application.

More can be seen at http://datscope.wikispaces.com/Run-off+Roof+Observatory

Courtesy: Liverpool AS Newsletter

Collimating the Newtonian with the South Cave Collimator

By Peter Clark

Introduction

Correcting or aligning Newtonian telescopes is said to have become more difficult as focal lengths and ratios have shortened and enhanced optics appeared. Accessories help, but four years on from first looking through one, many instructions have caused me to track back to the first one fitted with adjusters as the best point to start from.

I've come to regard it as an extension of gun sights and with the target having to change direction twice before hitting you in the eye and having an element of black art. The task should benefit from two or three more simple tools.

The word 'collimating' is not in *Norton's Star Atlas 11th edition* of c. 1950. 'Adjustment' was the word. But with more amateurs from the 1960's having it so good, enter new buzzwords that get more money from the more confused entry-level astronomers. Rather like sextants and string instruments, fairly regular adjustment, not giving up and changing just because you can't glean sufficient understanding from a first or second reading of anyone's instructions.

Gadget indication of what to adjust is small and the problems I was having with a well corrected laser collimator at over 150 x, seen by a patent attorney, are confirmed by patent application US2007/0263284 A1 of Nov.15 2007. I find mine is heavy on batteries and mainly a follower. The Cheshire Eyepiece with tapered Sight Tube is much better and actually recommended by the maker of my laser collimator for adjusting the secondary mirror.

That's £80 for both tools compared to the two cheaper and far handier ones to be described here. They work in the same way as the sight tube/ Cheshire Eyepiece, but the cross hairs don't hide the exact position of the centres and the gun sight line is focal length.

The genius was a black plastic front cover that cracked in 2006

Preparation for the SCC tool's part in collimating

Black front covers are replaced by moulding translucent ones in glass fibre matting over the front, protected by the makings of a useful Hartman Mask, then w.u. liquid or Clingfilm. Plan for 95% preparation, wear protective gloves, or have a plastics fabrications works cut you a disc for inserting from 2 to 4 mm translucent white plastic panel: £2 ex works to perform an Optrons 8" society commission. Expect a little sanding or shimming to fit a disc version then inscribe two sight lines on the in side, crossing at dead centre to complete the Collimating Front Cover.

If the secondary mirror's supporting spokes are in line with the focus tube axis you already have an equivalent, but my triple purpose cover keeps the dust out and light sources are filtered to an evenly whitish tone without reflections. Direct sunlight isn't helpful or wise.

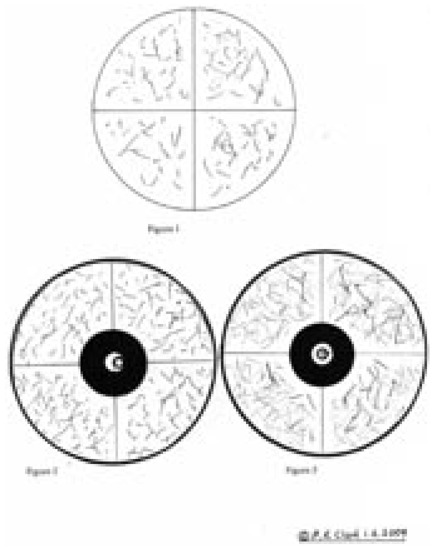
For 1200mm and *f* 6, a 7/64th / 2.5mm peephole needs drilling accurately with a new drill bit in the central depression of the bottom of a white 35mm-film canister. Paint the hole's surround red with glass paint from an art/ drawing shop, and then inscribe a black cursor line on the inside face; 5/64th/2mm for 500mm *f l* and *f* 4.4, highlighting optional. It's the same with Cheshire and laser collimators; one design for all sizes isn't the best possible. Finish by winding 12mm holograph fun tape around the canister to stop it dropping down the focus tube, arranged to gather light hemispherical: photo 1. Focus tube alignment is presumed.

For the greatest accuracy it is best to remove any blob type mirror centre mark with a plastic scraper, if necessary aided by water rinseable solvent on a baby bud. Stick a paper ring re-enforcer on centrally, then for long focal lengths I suggest painting over it with Tipex. For 1200mm and under inscribe a doughnut with a Tipex pen, and when nearly dry remove the ring. Any inner edge roughness will be too far away to be seen. Now with the two sighting aids fitted, align the cursor with a cross hair and the focus tube, if necessary adjusting the eyepiece clamps.

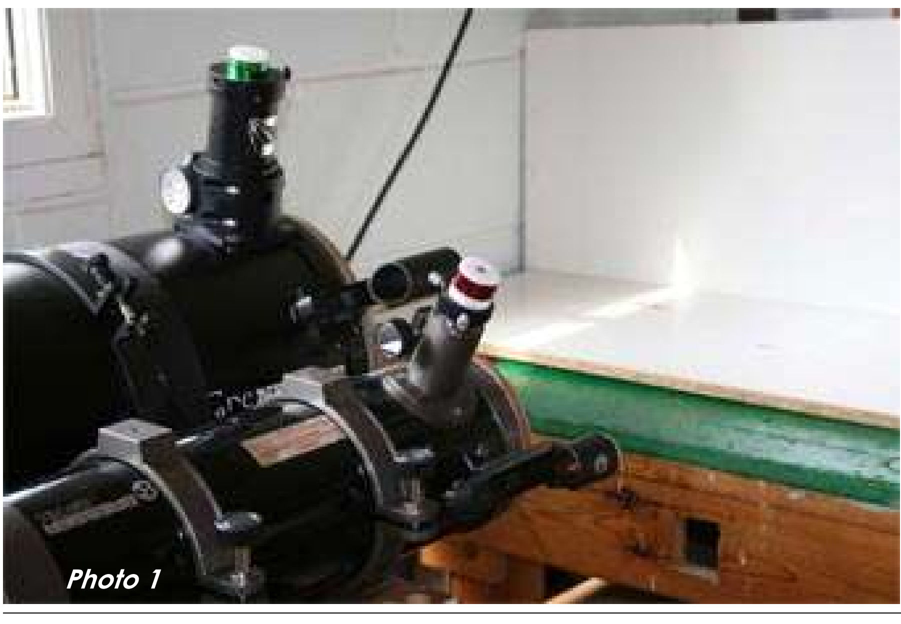
Method

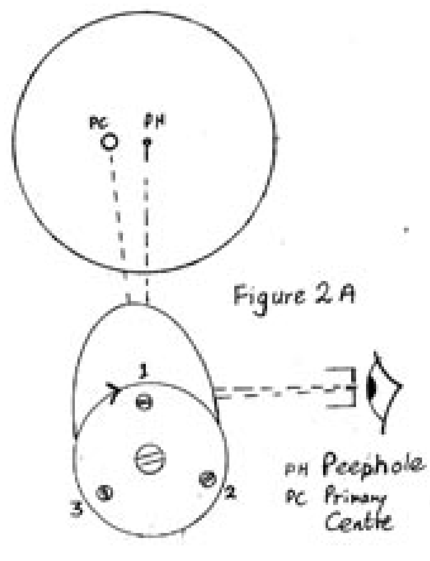
If the doughnut is off to one side, figs. 2 and 2A, there are three choices: Rotation of secondary mirror; check primary or secondary mirrors for slew and tilt errors. 90° sideways and results not good means secondary rotation is the first error to correct.

Correction:



[1] Displace the secondary mirror out to its mounting plate to reduce slew and tilt errors, then back to three turns off to start you from mechanically squared and with enough scope for optical adjustments. When the adjuster bolts are held only by the pressure





(Continued on page 18)

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Telescope	PH PC mm	O mm	Θ °	Comments whilst oblivious to rotation	Comments after error 1 and all errors corrected	Dawes and L. Mag
8" Wise-Newth + f6	2	2	0·7	Ovals, distinct false binary at 2½" arc.	β Delph 0·6" split 72 Aq. 0·55" split. Confirm [illegible]	0·58" 5·0 5·6
4½" Bresser + 'Pluto' f4·4		3	2½°	Flaring of ri Cephi 'A' 'B' OK 45 66 7·4"	Clear distinct [illegible] in fine field	1·0" 5
"	5·5	0·7	¼	de-focussed one sided rings	V. Concentric & sweet	5
12" Dobsonian f6	10			Large stars splashy. Splitting OK. Round Airys	Shunting was the solution.	0·38
20" Dobsonian f4·1	12			Some coma		0·23
10" Newtonian	O	O	O	No problems f5 +	Owner's claims agreed	0·45"
4½" Astrocan +	O	O	O	No problems f4	Surprisingly good	1·1"
8" gifted f6 Newtonian	O	O	O	Birdies, pulsars double images. Optrons.com	Return to dealer. Worse.	0·6"

+ = CFC on or improvised.
PH – PC is the Peephole to primary separation.

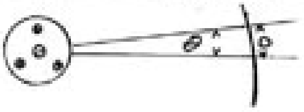

Figure 4
© P.R. Clark 2009

of a threaded centre bolt this stage is delicate, but it can be the best bolthole to run to. You may do the same for the primary mirror, re- setting inwards enough equally to reduce any triangular distortion of 3 bolts mounting, but not so far in that wider angle eyepieces won't focus.

[2] If the doughnut is still to one side, **rotate the secondary about the axis** of its centre bolt to align it with the cursor and focus tube. Some manufacturers make rotation easy by providing a spindle or oval bolt holes. With others you file your own, make keys from two drill bits and a strip of hardwood, or just loosen the unit, grab gingerly and turn.

[3] The centre doughnut now on the focus tube axis should be brought over the peephole reflection with the **tilt error** adjuster 1 to achieve Figure 3. The cursor may have needed turning off axis to locate the peephole reflection when the larger doughnut has covered it. Fig.2.

Generally you are now about to go beyond the abilities of most accessories. Exceptions may be the Easy Tester Eyepiece if you are very skilled at judging shades of black and what to do next, or the artificial star method, and luck. I found I could accommodate *f4.4* within my garden but 30 metres for *f6* would require scything into a farmer's field. Springtime is the best season to work up collimating skills owing to time for reflection and planning being forced by the shorter nights. Retired astronomers can utilise the even shorter but valuable early summer nights. Also, you can leave the dew shield off and avoid being heavy-handed with heater bands.

[4] Defocus a 2[nd] magnitude star at 200 to 450 x magnification and bring any unsymmetrical centre spot central with **primary mirror adjustment**. The side of focus you are on determines the adjustment direction towards or away from the centre mark side of the distortion.

On further focusing, if the star image does not remain circular all the way into focus, you will need to correct for the **3 remaining errors of the secondary mirror:**

[5] Remove any slight lop-sided oval appearance by **slewing sideways** with adjuster bolts 2 and 3. 1/16[th]-turn ease-tighten stages can be too much, flipping the oval past vertical. The precision of Allen keys can now be appreciated. These Secondary Mirror adjustments using a star are best performed by preplanned military drill, inspecting after retightening

[6] If a handsome vertical oval is then seen, **displace** the secondary mirror outwards in small stages until concentric. It is caused by the converging cone of light from the primary being wider were it strikes the lower part of the secondary when reflected at 90°.

[7] To see any **fine tilt error**, go to ε–Bootes with a neutral filter for 8" instruments, for **slew error** for 4.5" go to α–Hercules. Then with their B stars 10 x dimmer they will if screened suggest slight adjustment in order to see. A suitable rule for separation looks like 4.5 x your Dawes Limit in magnitude 5 + with elevation over 40°. In magnitude 4, ε–Bootes worked equally well for a 14".

Repeating primary mirror adjustment completes collimation. If the doughnut is again to one side, correcting with up to ¼ turn of slew and centre bolt is tricky and not necessary with success at [7], but will look concentric and keep a laser beam within 2.5 mm of the primary centre.

Blurred stars at best focus, aberration by spherical mirrors without correctors, suggests returning to the dealer. They should have Maksutov, Schmidt or Wise optics. Classic Newtonians are parabolic with the longer tube so primary mirror adjustments may need two people.

Laying the telescope lengthways for car for journeys and with the focus tube vertical, guards against secondary mirror rotation by gravity. Advantage dismantled Dobsonians.

Brief history. May18[th] 2008. 'Odd, but more reliable by aligning the reflection of a simple peephole with cross hairs pencilled on the fibreglass front cover!' noted in my log book. Which means the displacing [6] that removed a false discovery on 27-28.11.08 of a fainter companion 2 ½ arc" from double star STT155, still gave me 9 long adjusting sessions out of 20 until the fig.2 situation was first seen through the peephole a year later almost exactly.

Conclusion

Starting as described in [1] must be what was done when assembling the first Newtonian fitted with adjusters, but we've come to think it best to ship with secondary mirrors ready for use and pray they stay that way. Here now are two accessories that can be provided with new telescopes shipped in mechanical alignment and with complete collimating instructions. Many owners will want to take part from the start and be steered towards the best results for the least.

Mainly for beginners to Newtonian reflectors

Presuming telescopes on portable equatorial mounts still need to be speedily assembled and on a star within 15 minutes, paint 3 white blobs or bed in 3 tripod anti-vibration pads for placing tripod feet. True north alignment may be derived from the Sun's shadow of a vertical stick at its minimum length point. Or you can use the exact meridian passage time by applying the Equation of Time correction. Longitude at 4' of time per degree of hour angle, 15' of R.A., or click on the two number block at the bottom right hand corner of your computer screen. Then, with the counterweights pointing at Kochab and having crafted a 1° true FOV for your telescope with FOV= FSD x 57.3 , Focal length, Polaris should become easier to find at + 89° 34' in 2095.

Field Stop Diameter, the clear measurement across the back of an eyepiece, is easily obtained from stockists and gives conservative results with my 8" Wise-Newtonian, the shortest of the enhanced Newtonians.

The 4 ½" Bresser Pluto Newtonian '1[st] 'scope with the same eyepiece gives a very useful 2 ½°.

Figure 1. The Collimating Front Cover, mask, disk or plate.
Figure 2. Primary central doughnut displaced to the right at *f* 6 and 1200 mm.
Figure 2A. Shows reason for sideways displacement and arrow showing correction [1].
Figure 3. View of alignment after rotation. Possibly within just one adjustment to finish.
Figure 4. Logbook of several telescopes checked with the invention. Also, Figure 2A.

Photos. 1. Set up for checking rotation, showing the special peephole caps and Collimating Front Covers in position.

References. 'New Perspectives on Collimation' 4[th] Ed. p.1-16. Menard. *Instrument preparation.*
'Collimation and the Newtonian'. Pensack. www, *is straight into rotation emphasis.*
Norton's Star Atlas 2004, p.38, *is very clear on displacing the secondary at high f ratios.*

SKY CHARTS Trefor Harries

As amateur astronomers we all use a star chart of one type or another. It may be a poster-sized sky map pinned to a wall, a map of a section of the sky in a star atlas, a planisphere, or even a celestial globe. These charts not only differ in size and detail but also in shape and outlay. This article explores some basics of how sky charts are organised and why they take various forms. It is not only interesting to know this background but also helps in the use and interpretation of these aids to celestial navigation. Also, although we have no need to produce our own sky maps as there are plenty of good ready-made charts to choose from, it might be interesting and useful to be able to produce small-field-of-view charts of a particular part of sky so that we can recognise that area when we have acquired it in the field of view of our telescope, although, even here, there are many planetarium programs that can do this for you. Then again we might want to produce our own planisphere if the commercial offerings are too small for our ambitions.

Plotting a map of the sky presents similar problems to drawing a map of the world in that a spherical surface cannot be reproduced onto a flat surface without some form of distortion. If you were to carefully peel half an orange so that the whole peel is removed in one piece, you could not then lay it onto a flat surface without it splitting somewhere. A sky map is somewhat different to a world map in that in the former you are inside a sphere looking up to it, while in the latter you are outside the sphere looking down at it, but in each case the problem is how to minimise the inevitable distortions. Most of us will be familiar with the Mercator projection popularly used in world maps, but there are many other possible projections. Which one is best depends upon which type of distortion is most (or least) important in the application in which it is used, as they will all have their own pattern of distortion. So let us consider the requirements of a sky map.

For locating objects in the sky we require a fixed reference grid that will enable exclusive coordinates to be assigned for the position of any object. Since this is directly equivilent to the need for locating places on Earth it is not surprising that the system adopted is to simply project the lines of latitude and longitude assigned to the surface of the globe out onto the sky above. Hence lines of latitude on Earth have their direct equivilents as lines of declination on the sky. These are measured in degrees and go from 0° at the celestial equator to +90° at the north celestial pole, and from 0° to -90° going from the celestial equator to the south celestial pole. Lines of longitude become lines of right ascension on the sky. There are only two differences between longitude and right ascension :

(1) The zero point reference for longitude is the Greenwich meridian. This is no use for sky maps since we require a fixed direction in the sky. The chosen point is where the Sun's path in the sky crosses the celestial equator at the vernal equinox. It is also known as the first point of Aries.

(2) Whereas longitude is measured in degrees west or east of the zero point, each going from 0° to 180°, right ascension (R.A.) is usually quoted in time units of hours, minutes and seconds and goes eastward from 0 to 24 hours. Of course it can also be quoted in degrees. Since the 24 hours is equivilent to 360°, 1 hour = 360/24 = 15°, and since both systems have two subdivisions of 1/60th, we have 1 minute of R.A. = 15 minutes of arc and 1 second of R.A. = 15 seconds of arc. Incidently, don't confuse hours of R.A. with hour angles which are different. R.A. hours are measured eastwards from the vernal equinox whereas hour angle is measured westwards from the local meridian and represents the time since the object culminated there.

Since these coordinate systems pertain to spherical surfaces their properties are described by spherical trigonometry instead of the plane trigonometry that was probably the only type that we were introduced to at school. Lets compare some of the characteristics of these spherical systems to to the simpler and more familiar planar systems to see how they differ. This will provide a few insights into the things we need to consider if we wanted to produce a sky chart of our own.

If we were making a map of a perfectly flat surface we could ascribe a rectangular coordinate system to it for use in assigning positions. Our coordinate system would simply be a square reticule where the grids would delineate intervals of horizontal and vertical distance. All that is needed is to decide where to locate the origins :

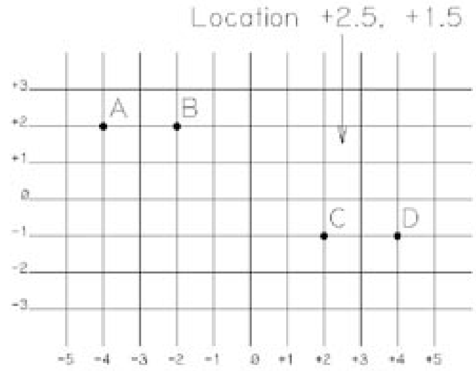

Fig. 1 : Planar Coordinates

On a spherical surface some things are different. For example, on our plane surface any two points having the same vertical (Y) ordinate and the same difference in horizontal (X) ordinates, e.g. A,B and C,D in figure 1, will have the same separation. This is not true on a sphere however, as demonstrated in figure 2 which depicts right ascension and declination grids :

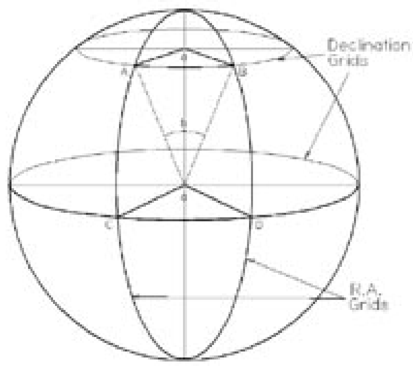

Fig. 2 : Spherical Coordinates

Here A,B and C,D are pairs of stars which each have the same declination and the same difference in right ascension, but A,B are at a northern declination while C,D are at declination 0°. The distance AB is obviously less than CD. What does this mean for our star chart ? Although their angular separation in R.A. is the same (= a°), their angular separation as seen by an Earth observer (= b°) will vary with their declination; the greater the declination the smaller the angular separation. To compensate for this when representing an R.A.- declination grid on a flat surface we could reduce the distance between the R.A. lines for increasing declination as in figure 3 :

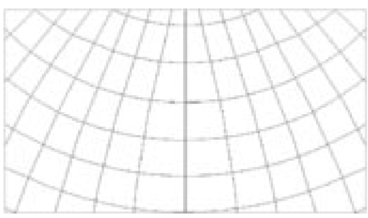

Fig. 3 : Compensated R.A. – Declination Grid

(Continued on page 20)

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Notice that the declination gridlines have also been curved. This is because unlike R.A. lines they are parallel and so their separation must be kept constant. Also they must intersect each R.A. gridline at a right angle. Of course, if we are plotting a field of view of only a few degrees then we could use a rectangular grid with reasonable approximation but the spacing per degree of R.A. will vary with declination. So what our sky chart ends up looking like depends on how big a field of view we want to include, and how we want to present it. If we are producing a full sky chart we could center it on the celestial pole, or the celestial equator. The former is more usual since the chart would normally be intended for use by an observer at at specific latitude. Either way we can't show much more than one hemisphere of the sky on our chart since any extension further that 180° sees the grid returning on itself. One way to include the whole sky would be to create two charts, one for each hemisphere, joined and folded at the middle. Figure 4 shows polar and equatorial single hemisphere plots :

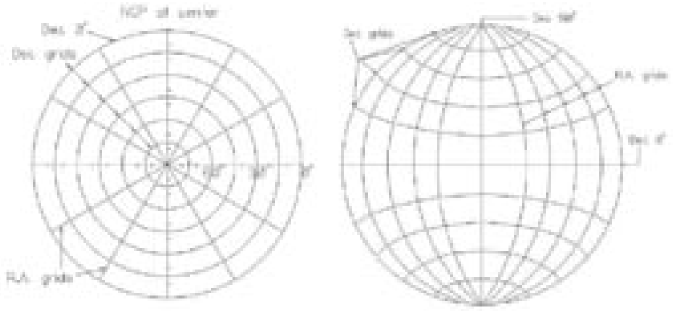


Fig. 4 : Polar And Equitorial Plots
(a) Polar (b) Equatorial

Figure 4 (a) shows one of the most popular plots for sky maps. This is a polar plot with straight radial R.A. grids, i.e. no compensation for distortion. This is very often perfectly adequate for a star map – it just means that RA separations at middle declinations will be constricted so that stars toward the edge of the chart will be stretched apart by comparison and will appear more widely separated than they should be. The R.A. scale could be reduced with radius to compensate for this as shown in figure 5(a), but this cannot be done all round the circle without leaving gaps somewhere so it leaves even wider stretched areas around the 45°, 135°, 225° and 315° areas. When this type of compensation is used the chart is sometimes left with gaps at these areas. Another way, often used in atlases, e.g. Norton, is to split the chart into equatorial strips. Figure 5 shows these shapes.

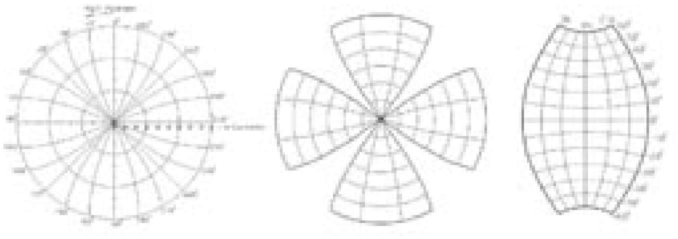


Fig. 5 : Chart Shapes :
(a) Compensated Polar (b) Polar With Gaps (c) EquatorialStrips

Properties Of The Polar Plot

Since this type of plot is quite common for single hemisphere star charts, we'll examine its properties, and it may sometimes be useful to know the degree of distortion in an uncompensated chart so we'll investigate that question too. The maths I have used is restricted to high-school geometry and the derivations are included only to justify the results for those who are interested; others can can skip over them; the only equations that are used for application are the ones that are numbered.

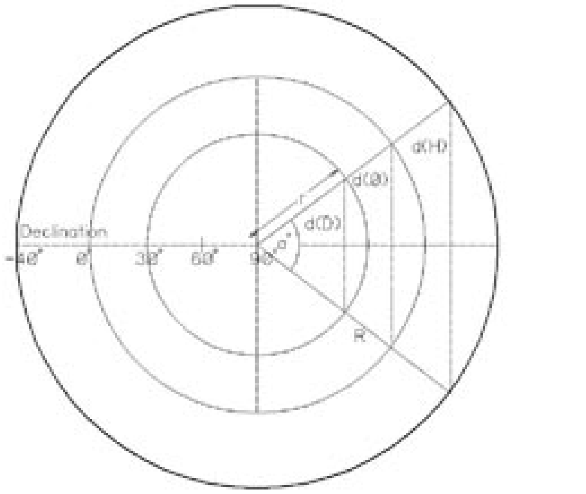


Fig. 7 : Properties Of The Polar Plot

d(D) = Linear distance between RA ordinates at declination D°
D = Declination
H = Southern horizon (i.e. lowest visible declination)
R = Radius of chart
R_D = Range of declination = 90 – H
S_D = Scale of declination
$S_R(D)$ = Scale of R.A. at declination D°

We will consider the declination and R.A. grids separately.

Declination Grids

For declinations we want a constant separation between each grid. As can be seen from figure 8, if we were to project the declination grid positions onto the flat surface then they would have nonlinear separations since the position of each declination circle is proportional to the cosine of its angle, but we want the positions to correspond with the angular positions in the sky so we want the declination circles evenly separated on our polar plot as in figure 4(a). If you imagine a star located at the end of each of the radiuses in figure 8, then if you looked up into the sky at these you would see a straight line of stars stretching from the horizon to the zenith, and they would all be equally separated by an angle of a°; hence the requirement for equally spaced declination grids.

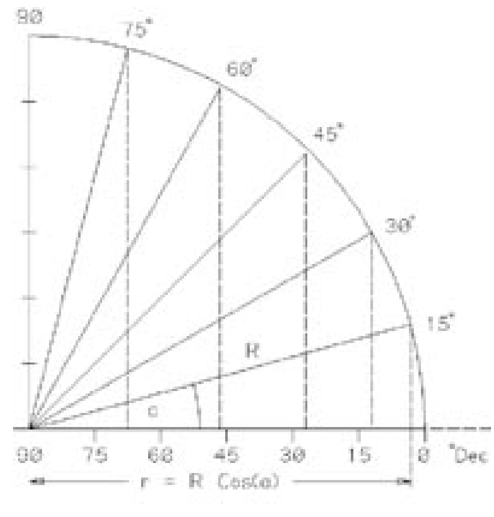


Fig. 8 Declination Grids

R.A. Grids

At the edge of the chart (Fig. 7) : $d(H) = 2 R \sin(a/2)$

and the local R.A. scale at the horizon is : $S_R(H) = d(H) / a$

(Continued on page 21)

(Continued from page 20)

To express this as mm per degree we put $a = 1°$:
$d(H) = 2 R \sin (0.5)$ mm / °

For a declination D : $\dfrac{r}{R} = \dfrac{R_D - (D - H)}{R_D}$

so the local R.A.scale (relative to the chart edge) at any specified declination is :

$$S_R(D) = \left[\frac{R_D - D + H}{R_D} \right] S_R(H) \text{ .... (1)}$$

putting $R_D = 90 - H$, and $S_R(H) = 2 R \sin (0.5)$ for $a = 1°$:

$$S_R(D) = 2 R \left[\frac{90 - D}{90 - H} \right] \sin (0.5)$$

So, for example, at $D = 0°$ $S_R(0) = \left[\dfrac{90 - 0}{90 - (-40)} \right] S_R(H) = 90 / 130 = 0.69\, S_R(H)$

We can see that the R.A. scale can only be equal to the declination scale at one value of declination. For our example this would occur at :

$$S_D = S_R(D)$$

$$\frac{R}{R_D} = 2 R \left[\frac{90 - D}{R_D} \right] \sin (0.5)$$

from which : $D = 90 - \left[\dfrac{1}{2 \sin (0.5)} \right] = 32.7°$

Note that this is independent of R_D so for any uncompensated polar chart the R.A. scale will equal the declination scale at declination 32.7°. All that this means is that at this declination on the chart, 1° of R.A. will have the same linear measure as 1° of declination. Be clear that 1° of declination corresponds to 1° of angular separation in the sky, but 1° of R.A. does not correspond directly to angular separation; it represents four minutes of sky rotation. Only on the celestial equator does it correspond to angular separation. The purpose of this section is to characterise the variation of R.A. scale with declination on our chart so that we can compare this with the true variation on a sphere which we will do in the next section. So, we have a fixed declination scale which we can consider as the true scale in that it represents angular separation, and an R.A. scale which varies with the declination.

We have quantified this variation of R.A. scale with declination for a flat, uncompensated polar chart. This will, of course, be a distortion of the true (spherical) case, so what is the character and magnitude of this error ? To investigate this we will refer the local R.A. scale to that at the celestial equator, i.e. the 0° declination. In figure 7 we see two R.A. grids of separation a°. d(D) represents the linear distance on the chart between these two R.A. ordinates as a function of the declination (D), d(0) being the distance for declination 0°. The R.A. scale will vary with declination in the same way that distance with longitude varies with latitude on Earth. We want to know how the variation, as measured on our chart, compares with reality. We are only interested in d(D) relative to d(0). We can find d(D) relative to d(0) by using equation (1) since :

$d(D) = a\, S_R(D)$ and $d(0) = a\, S_R(0)$. R_D is now 90° and H is 0°. so :

$$d(D) = \left[1 - \frac{D}{90} \right] d(0) \text{ .... (2)}$$

Figure 9 shows the true situation. We will refer to this as the spherical representation to distinguish it from the planar case. In the lower triangle this is related to the angular separation as seen by an observer on Earth.

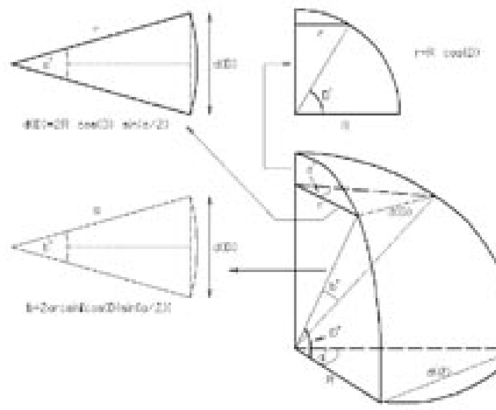


Fig. 9 : True Separation With Declination

Here $d(D) = 2r \sin (a/2)$ and as $r = R \cos (D)$:

$$d(D) = 2R \cos (D) \sin (a/2) \text{ .... (3)}$$

As before : $d(0) = 2R \sin (a/2)$

so $d(D) = \cos (D)\, d(0)$ .... (4)

In this figure we can find the true angular separation (b°) as a function of declination (lower triangle) :

$d(D) = 2R \sin (b/2)$

so $b = 2 \arcsin [\, d(D) / 2R\,]$

but $d(D) = 2r \sin (a/2)$

so $b = 2 \arcsin \left[\dfrac{r}{R} \sin (a/2) \right]$

Now $r / R = \cos(D)$

so $b = 2 \arcsin [\, \cos (D) \sin (a/2)\,]$ .... (5)

Equation (2) gives the linear R.A. scale of an uncompensated (planar) polar plot as a function of declination, d(D), relative to that at declination 0°, d(0). Equation (4) gives the same d(D) for the true (spherical) representation. Equation (5) gives the true angular separation (b°) with declination of two points of the same declination but differing by a° of R.A.

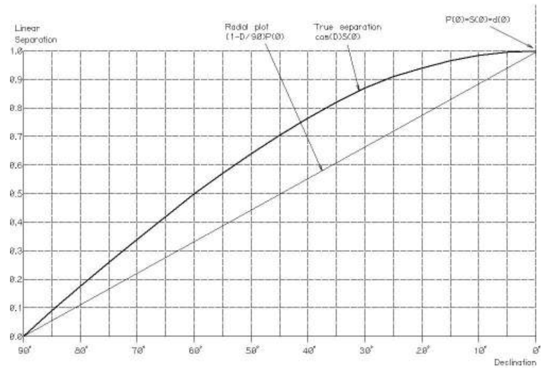
To distinguish between the two cases represented by equations (2) and (4) lets rename d(D) as P(D) for the planar case, and S(D) for the spherical case. Then we can express the error E :

$$E = P(D) - S(D)$$

$E = \left[1 - \dfrac{D}{90} \right] P(0) - \cos (D)\, S(0)$ And remembering that $P(0) = S(0) = d(0)$

$$\frac{E}{d(0)} = \left[1 - \frac{D}{90} - \cos (D) \right] \text{ .... (6)}$$

Equation (6) is the error in the flat polar chart of the linear separation of any two R.A. positions for a specified declination, relative to that at declination 0°.



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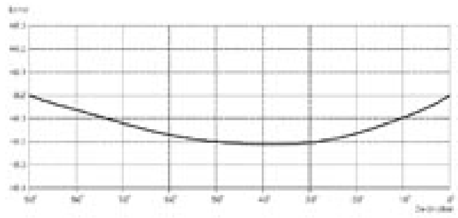
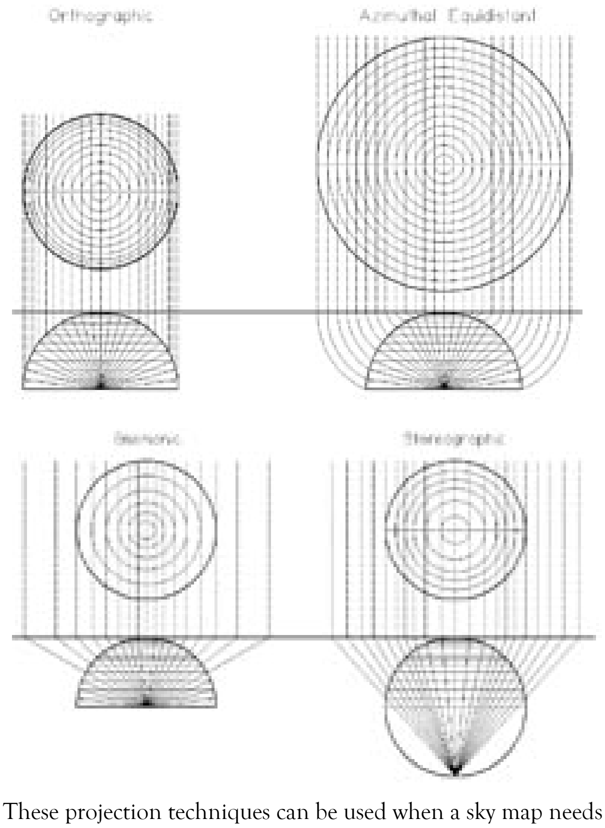


Fig. 10: Error Graph

Chart Construction

In this section we'll see how our polar chart might be produced, and how its construction affects its properties. We'll also take a brief look at planispheres. These charts are often produced using one of the class of azimuthal projection techniques adapted from terrestrial cartography. Four variations of these are worth mentioning and are called Gnomonic, Stereographic, Orthographic and Azimuthal Equidistant. Basically, they project the spherical surface of the globe (or the sky in our case) onto a plane surface. The differences between them come from the way the projection is done, mainly in the position of the projection point. In the Gnomonic this point is inside the sphere, in the stereographic it is at the antipode, in the orthographic it is at infinity, and in the azimuthal equidistant the projection lines are 'unfolded' to make them equally spaced. This is depicted in figure 11.

Fig. 11 : Azimuthal Projection Techniques



These projection techniques can be used when a sky map needs to be drawn to show the view available for a local observer. In this situation the chart needs to take account of the latitude and longitude of the observer, and the time and date all of which use the relevant projection equations. However, for a polar plot which simply encompasses all of the sky that can be seen at a particular latitude throughout the year we don't need to use a complicated projection technique since the RA grids will be radial and the declination grids will be concentric circles linearly spaced from the center of the chart (equivilent to azimuthal equidistant) so we can use much simpler plotting equations. For a polar chart covering a declination range of R_D the plotting radius, r, will be given by :

$$r = \frac{(90 - D)\, R_{chart}}{R_D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The only measure of the separation between two stars that we have on a flat sky map is the linear distance between the two points representing the stars. Ideally this relationship would be consistent across the whole map and so it would represent angular separation as would be seen in the sky by linear distance on the map, but of course, this will not be possible. Note that the declination range in a polar plot can be taken below 0°. This is, in fact, the normal case since a sky chart will need to display all areas of the sky that will be visible from the latitude that the chart is designed for. The lowest visible declination for an observer at a latitude L° is –(90 – L)°, so if we consider a chart designed for an observer at +50°, then it would need to extend from +90° to –(90 – 50) = –40°.

Plotting The Stars

To plot each star, two parameters of the projected point are needed; the angle, which comes directly from the R.A., and the distance from the north celestial pole which can be calculated from the identity above. The location of the point is then obtained in polar coordinates, i.e. r, A where r is the distance from the pole, and A is the R.A. angle. It is often easier to plot these as rectangular coordinates, i.e. x, y in which case they can be converted using the polar to rectangular coordinate transformations : x = r cos (A) and y = r sin (A). The resulting chart will have the 0 hour of right ascension along the positive x axis with the hours correctly increasing clockwise. If the zero hour of right ascension is required to be on the positive Y axis then this can be achieved by mapping the X ordinate as the –Y ordinate, and the Y ordinate as the X ordinate. The chart can be scaled to the required size by selecting a suitable value for R.

Doing all this finally gives us :

$$x = -\frac{(90 - D)\, R_{chart}}{R_D} \sin(A) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$y = \frac{(90 - D)\, R_{chart}}{R_D} \cos(A) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Figure 12 shows an example of a sky chart that I produced using the polar plot. It was produced with the aid of a Visual Basic program which I wrote to do all the data processing, calculations and plotting. It has a resolution of 0.1°. Note the stretching of the constellation shapes towards the edge of the chart.

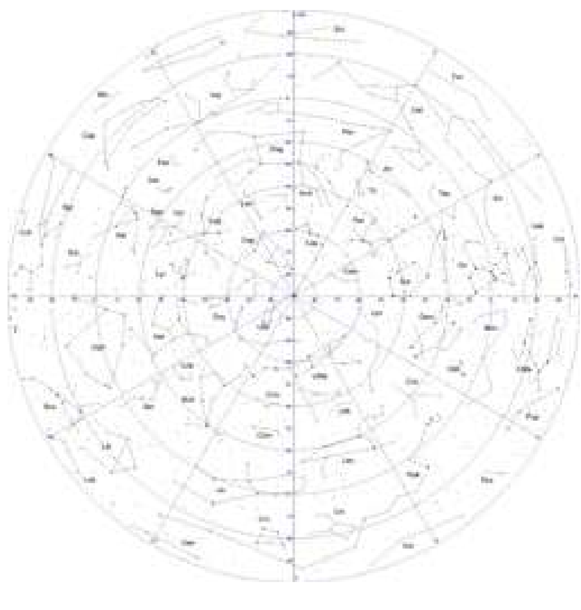


Fig. 12 : Example Of A Polar Plot Sky Chart (Altazimuthal Equidistant)

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Planisphere Construction

Since our polar plot shows all of the sky that can be visible through the year from the observer's latitude, it can be used as the base for a planisphere. All that is needed is a window to be overlaid it which can be rotated across the sky chart to reveal that part of the sky which is visible at a particular time and date. Since the southern horizon will be at –(90–L)° and will be in any direction depending upon the time of year, the total extent of the visible sky for this observer will be 360 – 2L°. The northern horizon will be at +(90–L)° The window will approximate to an ellipse which has a major axis of 2R and a minor axis of $R_N + R_S$. The values of R_N and R_S we can calculate from equation (7).

This then gives us the dimensions of our elliptical window. The edge of the R_S radius will lie on the edge of the chart. this is shown in figure 13.

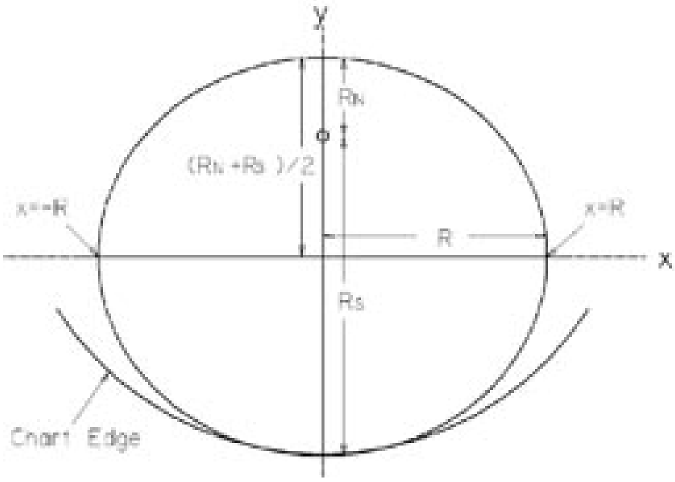


Fig. 13 : Planisphere Window

The equation for an ellipse is : $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

where from figure 16 : $a = R$ and $b = (R_N + R_S) / 2$

which gives : $y = \frac{R_N + R_S}{4R} Ö\, R^2 - x^2$ .... (10)

which can be used for plotting the ellipse.

Construction Of Small-Field-Of-View Chart

As an example of this let's construct a small chart of the area around Cassiopeia. For small areas we can approximate the curved grids with straight line segments.

(1) Define the area of the chart. For our example this will be :
R.A. : 23:00 hr – 02:00 hr (a° = 45°)
Dec : +50° – +70°

(2) Compile a list of stars and other objects to be included in the chart. There are many sources that can be consulted to get a list of these, especially on the internet. For one source see the downloads at the Saguaro Astronomy Club, www.saguaroastro.org. Another source is the star database which comes with the Nexstar telescopes which is made available for download at www.nexstarsite.com/Book/starlists.htm. A list can be restricted to naked eye stars by sorting or filtering.

(3) Decide on the scale factor for the plot, i.e. the number of millimetres per degree. For our example our chart has a field of 45° x 20° and if we want to print it on an A4 sheet in landscape orientation we have 30cm x 20 cm approximately of space, so we might select a scale of 5mm/° which would allow for 60° x 40° giving plenty of room for margin space. The scale sets the length for the R.A. segments, and for the 0° declination segment. Declination segment lengths will decrease with declination according to equation (4).

(4) Decide on the grid increments. Lets say 10° for declinations and 1 hr = 15° for R.A. grids.

(5) Calculate the length and separation of the declination grid segments (each of a° = 15°). From equation (5) we get the angular dimension for the segments, and multiplying by the scale factor gives us the length :

$b = 2 \arcsin [\cos(D) \sin(a/2)]$ (=a° at D=0)

where D is the declination, and a is the R.A. grid increment which we've set as 15°.

Dec (°)	Angular size (b°)	Length (mm)
50	9.6256	48.1
60	7.4839	37.4
70	5.1174	25.6

The vertical separation of the declination grids is simply the angular separation, which we've set as 10° multiplied by our scale factor, so this is 5 mm/° x 10° = 50 mm.

(6) Draw the middle set of declination grids (47, 38 and 25mm with vertical separation 50mm) and join the ends.

(7) Draw the next outside set of grids, each at 90° to it's corresponding first grid, and join ends.

(8) Finally, plot the stars from the R.A. and declination coordinates in your star list (figure 14).

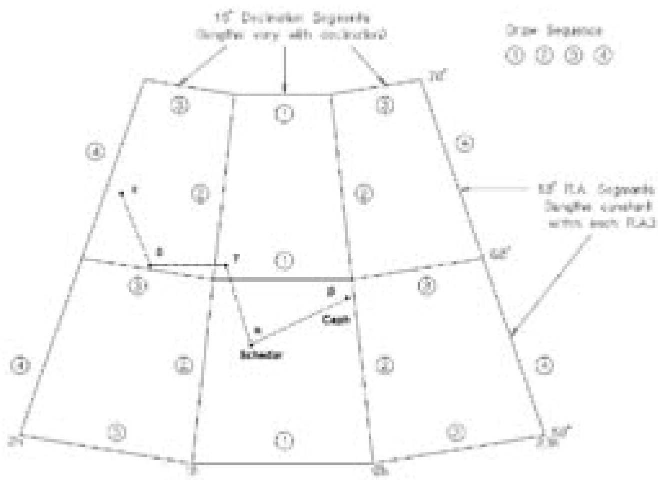


Fig. 14 : Final Plot

Unravelling the Mystery of Massive Star Birth: All Stars Are Born the Same Way

"Our observations show a disc surrounding an embryonic young, massive star, which is now fully formed," says Stefan Kraus, who led the study. "One can say that the baby is about to hatch!"

The team of astronomers looked at an object known by the cryptic name of IRAS 13481-6124. About twenty times the mass of our Sun and five times its radius, the young central star, which is still surrounded by its pre-natal cocoon, is located in the constellation of Centaurus, about 10 000 light-years away.

From archival images obtained by the NASA Spitzer Space Telescope as well as from observations done with the APEX 12-metre submillimetre telescope, astronomers discovered the presence of a jet.

"Such jets are commonly observed around young low-mass stars and generally indicate the presence of a disc," says Kraus.

Circumstellar discs are an essential ingredient in the formation process of low-mass stars such as our Sun. However, it is not known whether such discs are also present during the formation of stars more massive than about ten solar masses, where the strong light emitted might prevent mass falling onto the star. For instance, it has been proposed that massive stars might form when smaller stars merge.

In order to discover and understand the properties of this disc, astronomers employed ESO's Very Large Telescope Interferometer (VLTI). By combining light from three of the VLTI's 1.8-metre Auxiliary Telescopes with the AMBER instrument, this facility allows astronomers to see details equivalent to those a telescope with a mirror of 85 metres in diameter would see. The resulting resolution is about 2.4 milliarcseconds, which is equivalent to picking out the head of a screw on the International Space Station, or more than ten times the resolution possible with current visible-light telescopes in space.

With this unique capability, complemented by observations done with another of ESO's telescopes, the 3.58-metre New Technology Telescope at La Silla, Kraus and colleagues

Astronomers have been able to obtain the first image of a dusty disc closely encircling a massive baby star, providing direct evidence that massive stars do form in the same way as their smaller brethren -- and closing an enduring debate. The flared disc extends to about 130 times the Earth--Sun distance -- or astronomical units -- and has a mass similar to that of the star, roughly 20 times the Sun. In addition, the inner parts of the disc are shown to be devoid of dust. (Credit: ESO/ L. Calçada)

were able to detect a disc around IRAS 13481-6124.

"This is the first time we could image the inner regions of the disc around a massive young star," says Kraus. "Our observations show that formation works the same for all stars, regardless of mass."

The astronomers conclude that the system is about 60 000 years old, and that the star has reached its final mass. Because of the intense light of the star -- 30 000 times more luminous than our Sun -- the disc will soon start to evaporate. The flared disc extends to about 130 times the Earth-Sun distance -- or 130 astronomical units (AU) -- and has a mass similar to that of the star, roughly twenty times the Sun. In addition, the inner parts of the disc are shown to be devoid of dust.

"Further observations with the Atacama Large Millimeter/submillimeter Array (ALMA), currently being constructed in Chile, could provide much information on these inner parts, and allow us to better understand how baby massive stars became heavy," concludes Kraus.

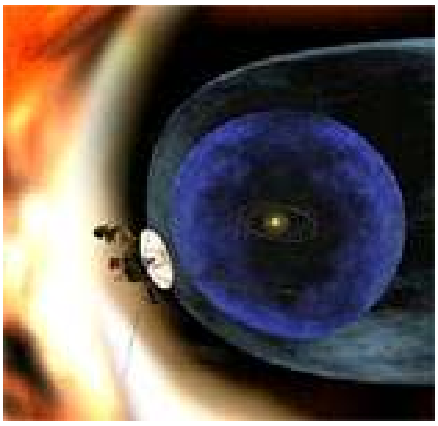
Voyager 2 at 12,000 Days: The Super-Marathon Continues

NASA's plucky Voyager 2 spacecraft has hit a long-haul operations milestone today (June 28) -- operating continuously for 12,000 days. For nearly 33 years, the venerable spacecraft has been returning data about the giant outer planets, and the characteristics and interaction of solar wind between and beyond the planets. Among its many findings, Voyager 2 discovered Neptune's Great Dark Spot and its 450-meter-per-second (1,000-mph) winds.

The two Voyager spacecraft have been the longest continuously operating spacecraft in deep space. Voyager 2 launched on August 20, 1977, when Jimmy Carter was president. Voyager 1 launched about two weeks later on Sept. 5. The two spacecraft are the most distant human-made objects, out at the edge of the heliosphere -- the bubble the sun creates around the solar system. Mission managers expect Voyager 1 to leave our solar system and enter interstellar space in the next five years or so, with Voyager 2 on track to enter interstellar space shortly after that.

Having traveled more than 21 billion kilometers (13 billion miles) on its winding path through the planets toward interstellar space, the spacecraft is now nearly 14 billion kilometers (9 billion miles) from the sun. A signal from

This artist's rendering depicts NASAs Voyager 2 spacecraft as it studies the outer limits of the heliosphere - a magnetic 'bubble' around the solar system that is created by the solar wind. Image credit: NASA/JPL-Caltech.

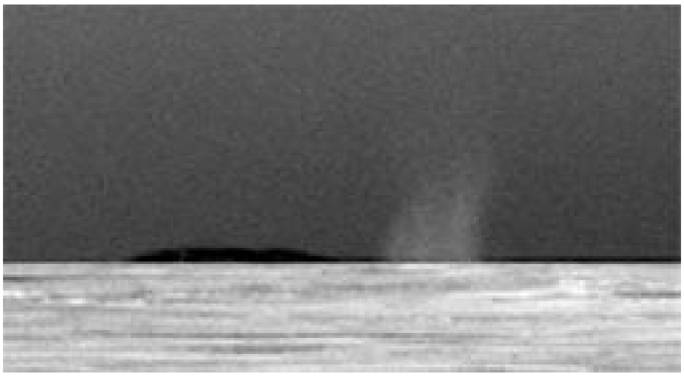


the ground, traveling at the speed of light, takes about 12.8 hours one-way to reach Voyager 2.

Voyager 1 will reach this 12,000-day milestone on July 13, 2010 after traveling more than 22 billion kilometers (14 billion miles). Voyager 1 is currently more than 17 billion kilometers (11 billion miles) from the sun.

The Voyagers were built by JPL, which continues to operate both spacecraft. Caltech manages JPL for NASA.

Martian Dust Devil Whirls Into Opportunity's View



This is the first dust devil that NASA's Mars Exploration Rover Opportunity has observed in the rover's six-and-a-half years on Mars. (Credit: NASA/JPL-Caltech/Cornell University/Texas A&M)

In its six-and-a-half years on Mars, NASA's Mars Exploration Rover Opportunity had never seen a dust devil before this month, despite some systematic searches in past years and the fact that its twin rover, Spirit, has seen dozens of dust devils at its location halfway around the planet.

A tall column of swirling dust appears in a routine image that Opportunity took with its panoramic camera on July 15. The rover took the image in the drive direction, east-southeastward, right after a drive of about 70 meters (230 feet). The image was taken for use in planning the next drive.

"This is the first dust devil seen by Opportunity," said Mark Lemmon of Texas A&M University, College Station, a member of the rover science team.

Spirit's area, inside Gusev Crater, is rougher in ground texture, and dustier, than the area where Opportunity is working in the Meridiani Planum region. Those factors at Gusev allow vortices of wind to form more readily and raise more dust, compared to conditions at Meridiani, Lemmon explained. Orbiters have photographed tracks left by dust devils near Opportunity, but the tracks are scarcer there than near Spirit. Swirling winds at Meridiani may be more common than visible signs of them, if the winds occur where there is no loose dust to disturb.

Just one day before Opportunity captured the dust devil image, wind cleaned some of the dust off the rover's solar array, increasing electricity output from the array by more than 10 percent.

"That might have just been a coincidence, but there could be a connection," Lemmon said. The team is resuming systematic checks for afternoon dust devils with Opportunity's navigation camera, for the first time in about three years.

Opportunity and Spirit arrived on Mars in January 2004 for missions designed to last for three months. NASA's Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the Mars Exploration Rover Project for the NASA Science Mission Directorate, Washington. For more information about the project and images from the rovers, visit http://www.nasa.gov/rovers.

ScienceDaily

IceCube spies unexplained pattern of cosmic rays

Though still under construction, the IceCube Neutrino Observatory at the South Pole is already delivering scientific results – including an early finding about a phenomenon the telescope was not even designed to study. IceCube captures signals of notoriously elusive but scientifically fascinating subatomic particles called neutrinos. The telescope focuses on high-energy neutrinos that travel through the Earth, providing information about faraway cosmic events such as supernovas and black holes in the part of space visible from the Northern Hemisphere.

However, one of the challenges of detecting these relatively rare particles is that the telescope is constantly bombarded by other particles, including many generated by cosmic rays interacting with the Earth's atmosphere over the southern half of the sky. For most IceCube neutrino physicists these particles are simply background noise, but University of Wisconsin-Madison researchers Rasha Abbasi and Paolo Desiati, with collaborator Juan Carlos Díaz-Vélez, recognized an opportunity in the cosmic ray data.

"IceCube was not built to look at cosmic rays. Cosmic rays are considered background," Abbasi says. "However, we have billions of events of background downward cosmic rays that ended up being very exciting."

Abbasi saw an unusual pattern when she looked at a "skymap" of the relative intensity of cosmic rays directed toward the Earth's Southern Hemisphere, with an excess of cosmic rays detected in one part of the sky and a deficit in another. A similar lopsidedness, called "anisotropy," has been seen from the Northern Hemisphere by previous experiments, she says, but its source is still a mystery.

"At the beginning, we didn't know what to expect. To see this anisotropy extending to the Southern Hemisphere sky is an additional piece of the puzzle around this enigmatic effect – whether it's due to the magnetic field surrounding us or to the effect of a nearby supernova remnant, we don't know," Abbasi says.

The new result publishes Aug. 1 in The *Astrophysical Journal Letters*, published by the American Astronomical Society.

One possible explanation for the irregular pattern is the remains of an exploded supernova, such as the relatively young nearby supernova remnant Vela, whose location corresponds to one of the cosmic ray hotspots in the anisotropy skymap. The pattern of cosmic rays also reveals more detail about the interstellar magnetic fields produced by moving gases of charged particles near Earth, which are difficult to study and poorly understood.

Right now "we can predict some models, but we don't have concrete knowledge of the magnetic field on small scales," Abbasi says. "It would be really nice if we did – we would have made a lot more progress in the field."

Since nearly all cosmic signals are influenced by the interstellar magnetic fields, a better overall picture of these fields would aid a large range of physics and astronomy studies, she says, adding that their newly reported findings rule out some proposed theories about the source of the Northern Hemisphere anisotropy.

The IceCube group is currently extending its analysis to improve its understanding of the anisotropy on a more detailed scale and delve further into its possible causes.

While the newly published study used data collected in 2007 and 2008 from just 22 strings of optical detectors in the IceCube telescope, they are now analyzing data from 59 of the 79 strings that are in place to date. When completed in 2011, the National Science Foundation-supported telescope will fill a cubic kilometer of Antarctic ice with 86 strings containing more than 5,000 digital optical sensors.

"This is exciting because this effect could be the 'smoking gun' for our long-sought understanding of the source of high-energy cosmic rays," says Abbasi.

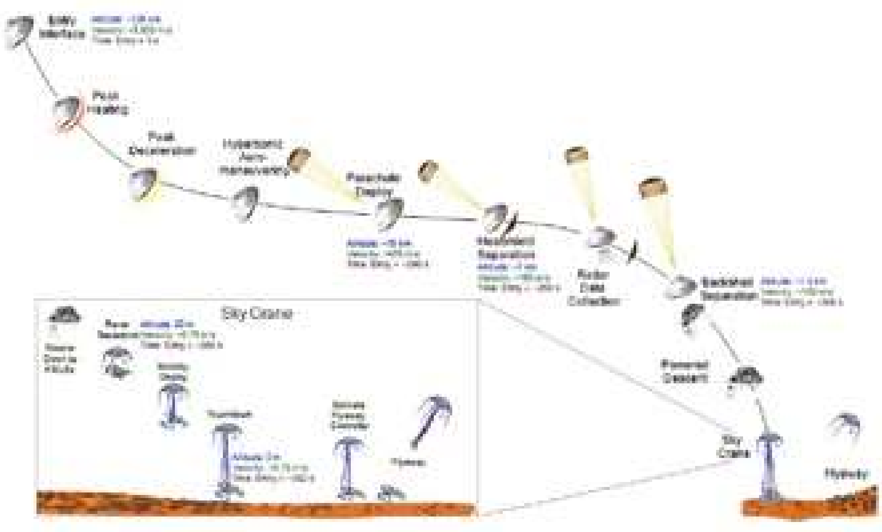
Astronomy & Space
Source: University of Wisconsin-Madison

Best Reality TV Ever: Camera Will Take Video of Next Mars Rover Landing

Written by Nancy Atkinson

Now **THIS** is what I call "must-see TV!" A camera on the next Mars Rover — MSL, also known as Curiosity – will start recording high-definition video about two minutes before the rover lands on Mars, currently scheduled for August 2012.

The Mars Descent Imager, or MARDI, will provide all of us Martian -wannabes with the first-ever ride along with the landing. And this will be a very unique landing, with the "Sky –Crane" lowering Curiosity to the planet's surface. The video won't be live, however – that's way too much data for the spacecraft to send back to Earth at such an important event, but we will get to see it later. JPL provided a description of what the video should look like:



This graphic portrays the sequence of key events in August 2012 from the time the NASA's Mars Science Laboratory spacecraft, with its rover Curiosity, enters the Martian atmosphere to a moment after it touches down on the surface.
Image credit: NASA/JPL-Caltech/Malin Space Science Systems

MARDI will start recording high-resolution video about two minutes before landing in August 2012. Initial frames will glimpse the heat shield falling away from beneath the rover, revealing a swath of Martian terrain below illuminated in afternoon sunlight. The first scenes will cover ground several kilometers (a few miles) across. Successive images will close in and cover a smaller area each second.

This Mars Descent Imager (MARDI) camera will fly on the Curiosity rover of NASA's Mars Science Laboratory mission. Image credit: NASA/JPL-Caltech/Malin

The full-color video will likely spin, then shake, as the Mars Science Laboratory mission's parachute, then its rocket-powered backpack, slow the rover's descent. The left-front wheel will pop into view when Curiosity extends its mobility and landing gear.

The spacecraft's own shadow, unnoticeable at first, will grow in size and slide westward across the ground. The shadow and rover will meet at a place that, in the final moments, becomes the only patch of ground visible, about the size of a bath towel and underneath the rover.

Dust kicked up by the rocket engines during landing may swirl as the video ends and Curiosity's surface mission can begin.

All of this, recorded at about four frames per second and close to 1,600 by 1,200 pixels per frame, will be stored safely into the Mars Descent Imager's own flash memory during the landing. But the camera's principal investigator, Michael Malin of Malin Space Science Systems, San Diego, and everyone else will need to be patient. Curiosity will be about 250 million kilometers (about 150 million miles) from Earth at that point. It will send images and other data to Earth via relay by one or two Mars orbiters, so the daily data volume will be limited by the amount of time the orbiters are overhead each day.

"We will get it down in stages," said Malin. "First we'll have thumbnails of the descent images, with only a few frames at full scale."

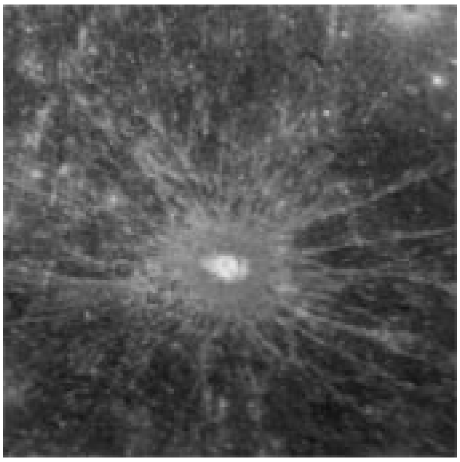
Subsequent downlinks will deliver additional frames, selected based on what the thumbnail versions show. The early images will begin to fulfill this instrument's scientific functions. "I am really looking forward to seeing this movie. We have been preparing for it a long time," Malin said. The lower-resolution version from thumbnail images will be comparable to a YouTube video in image quality. The high-definition version will not be available until the full set of images can be transmitted to Earth, which could take weeks, or even months, sharing priority with data from other instruments."

Courtesy of Universe Today

New Revelations About Mercury's Volcanism, Magnetic Substorms and Exosphere from MESSENGER

Analysis of data from MESSENGER's third and final flyby of Mercury in September 2009 has revealed evidence of younger volcanism on the innermost planet than previously recognized, new information about magnetic substorms, and the first observations of emission from an ionized species in Mercury's very thin atmosphere or exosphere.

The results are reported in three papers published online on July 15 in the *Science* Express section of the website of *Science* magazine.



"Every time we've encountered Mercury, we've discovered new phenomena," says MESSENGER principal investigator Sean Solomon, of Carnegie's Department of Terrestrial Magnetism. "We're learning that Mercury is an extremely dynamic planet, and it has been so throughout its history. Once MESSENGER has been safely inserted into orbit about Mercury next March, we'll be in for a terrific show."

During its first two flybys of Mercury, MESSENGER captured images confirming that pervasive volcanism occurred early in the planet's history. The spacecraft's third Mercury flyby revealed a 290-kilometer-diameter peak-ring impact basin, among the youngest basins yet seen and recently named Rachmaninoff, having an inner floor filled with spectrally distinct smooth plains.

The sparsely cratered Rachmaninoff plains postdate the formation of the basin and apparently formed from material that once flowed across the surface. "We interpret these plains to be the youngest volcanic deposits yet found on Mercury," says lead author Louise Prockter, of The Johns Hopkins University Applied Physics Laboratory, in Laurel, Md., and one of MESSENGER's deputy project scientists. "Moreover, an irregular depression surrounded by a diffuse halo of bright material northeast of the basin marks a candidate explosive volcanic vent larger than any previously identified on Mercury. These observations suggest that volcanism on the planet spanned a much greater duration than previously thought, perhaps extending well into the second half of solar system history."

Magnetic substorms are space-weather disturbances that occur intermittently on Earth, usually several times per day, and last from one to three hours. Terrestrial substorms are accompanied by a range of phenomena, such as the majestic auroral displays seen in the Arctic and Antarctic skies. Substorms are also associated with hazardous energetic particle events that can play havoc with communications and Earth-observing satellites, particularly at the altitudes of geosynchronous orbits. Terrestrial magnetic substorms are powered by magnetic energy stored in Earth's magnetic tail.

During MESSENGER's third Mercury flyby, the Magnetometer documented for the first time the substorm-like build-up, or "loading," of magnetic energy in Mercury's magnetic tail. The increases in energy that MESSENGER measured in Mercury's magnetic tail were very large, by factors of two to three, and they occurred very quickly, lasting only two to three minutes from beginning to end. These increases in tail magnetic energy at Mercury are about 10 times greater than at Earth, and the substorm-like events run their course about 50 times more rapidly.

"The extreme tail loading and unloading observed at Mercury implies that the relative intensity of substorms must be much larger than at Earth," says lead author James A. Slavin, a space physicist at NASA's Goddard Space Flight Center and a member of MESSENGER's Science Team. "However, what is even more exciting is the correspondence between the duration of tail field enhancements and the Dungey cycle time, which describes plasma circulation through a magnetosphere.

"With these new MESSENGER measurements we can show for the first time that the Dungey plasma circulation time determines substorm duration at another planet and not just at Earth, suggesting that this relation may be a universal feature of terrestrial-type magnetospheres, Slavin says. "A key aspect of tail unloading during terrestrial substorms is the acceleration of energetic charged particles, but no acceleration signatures were seen during the MESSENGER flyby. It appears that this new mystery will not be solved until more extensive measurements are made when MESSENGER is in orbit about Mercury."

Mercury's exosphere is a tenuous atmosphere of atoms and ions derived from the planet's surface and from the solar wind. Observations of the exosphere provide a window into the extensive interactions between Mercury's surface and its space environment. The insights such observations provide into surface composition, transport of material about the planet, and loss of material to interplanetary space improve our understanding not only of the current state of Mercury but also of its evolution.

The spacecraft's observations of Mercury's exosphere indicate remarkably different spatial distributions among the neutral and ionized elements in the exosphere. The third flyby produced the first detailed altitude profiles of exospheric species over the north and south poles of the planet. "These profiles showed considerable variability among the sodium, calcium, and magnesium distributions, indicating that several processes are at work and that a given process may affect each element quite differently," says MESSENGER participating scientist and lead author Ron Vervack, also at the Applied Physics Laboratory.

Differences in the distributions of sodium, calcium, and magnesium were also observed anti-sunward of the planet. "A striking feature in the near-planet tail ward region is the emission from neutral calcium atoms, which exhibits an equatorial peak in the dawn direction that has been consistent in both location and intensity through all three flybys," Vervack says. "The exosphere of Mercury is highly variable owing to Mercury's eccentric orbit and the effects of a constantly changing space environment. That this observed calcium distribution has remained relatively unchanged is a complete surprise."

Prominent among the discoveries during the third flyby were the first observations of emission from ionized calcium in Mercury's exosphere. "The emission was concentrated over a relatively small area one to two Mercury radii anti-sunward of the planet with most of the emission occurring close to the equatorial plane," says Vervack. "This concentrated distribution cannot be explained by in situ conversion of local calcium atoms to calcium ions and instead points to magnetospheric transport of the ions as a mechanism for concentrating them as observed. Although such transport is common in planetary magnetospheres, the degree to which it can affect the distribution of species in Mercury's exosphere was not fully appreciated."

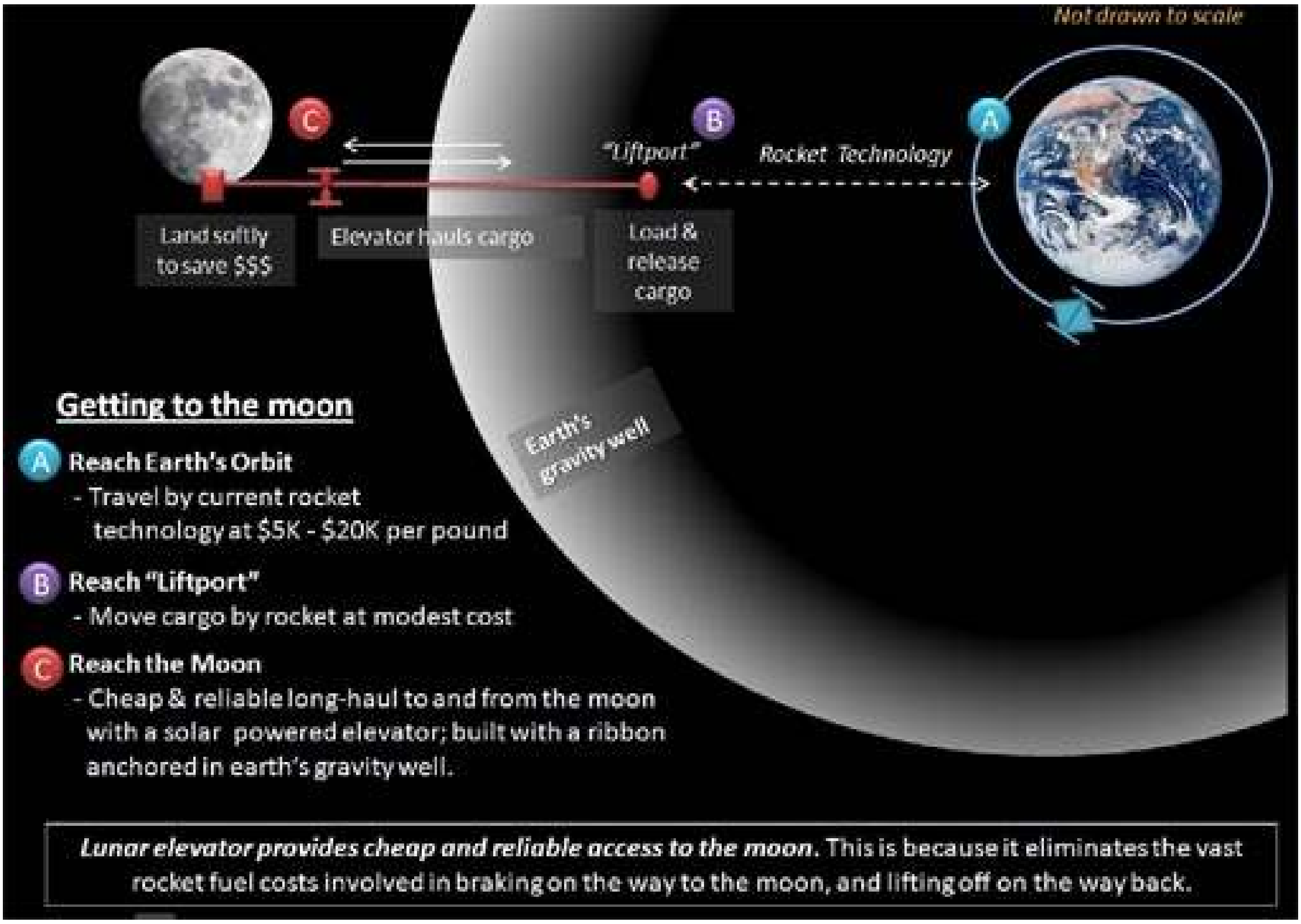
Additional information is available online at http://messenger.jhuapl.edu/mer_flyby3.html.

MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) is a NASA-sponsored scientific investigation of the planet Mercury and the first space mission designed to orbit the planet closest to the Sun. The MESSENGER spacecraft launched on August 3, 2004, and after flybys of Earth, Venus, and Mercury will start a yearlong study of its target planet in March 2011. Dr. Sean C. Solomon, of the Carnegie Institution of Washington, leads the mission as Principal Investigator. The Johns Hopkins University Applied Physics Laboratory built and operates the MESSENGER spacecraft and manages this Discovery-class mission for NASA.

ScienceDaily

Developers Say Lunar Elevator Could be Built Within a Decade

Written by Nancy Atkinson



Concept for a lunar elevator. Credit: Liftport, courtesy Michael Laine

The idea of a space elevator has been around since the late 1800's, but despite big dreams and years of research, the low-cost, easy access to orbit that a space elevator promises is likely still decades away. The biggest problem rests on the fact that no one has been able to successfully manufacture long ribbons made of ultra-light, ultra-strong carbon nanotubes, the only known material that is strong enough for a space elevator. But entrepreneur Michael Laine believes a lunar elevator – a space elevator from the surface of the Moon – could be created with materials that are available now. With more research and the right amount of capital, Laine says a lunar elevator could be built within a decade.

While Laine said he is still "emotionally very invested" in the concept of a space elevator based on Earth, for now he has shifted his focus to the lunar elevator. "There was a question of where was I going to put my time," he told Universe Today, "and being able to do this soon – perhaps within 5-7 years and not some mythic 15-25 years in the future is enticing."

Since the Moon's gravity is only one sixth that of Earth, it drastically reduces the requirements of the ribbon. A material that is available now, a synthetic polymer material called Zylon(poly(p-phenylene-2,6-benzobisoxazole) which has high strength and excellent thermal stability, could be used.

Additionally, the components to build the elevator that would be sent to the Moon would be relatively lightweight, so a smaller rocket would do the job. "The physical requirements of the system look like you could use a standard Atlas or Delta rocket to launch the components." Laine said. "That's a big deal that you don't need to build something like a Saturn V."

While Laine said he believes a lunar elevator in 5-7 years is feasible, he didn't want to go on record as saying it could be built in such a short time frame without adding some major caveats.

The biggest hurdle could be getting access to the 6 cubic meters of the Zylon material. "That actually could be the biggest challenge," Laine said.

Additionally, there are still an untold amount of unknowns about building such a system. "I used to say for the space elevator that we still didn't know all the questions, let alone the answers," Laine said, "and that is even more true for the lunar elevator."

The other hurdle is money. But a lunar elevator might actually be cheaper to build, initially, than a space elevator from Earth.

An Earth-based elevator is essentially a long cable – perhaps 100,000km (62,000 miles) long — that is anchored on Earth at one end with a counterweight at the other end (a large satellite, for example) in (beyond) geosynchronous orbit. Gravity and centripetal acceleration keeps the cable, or ribbon rigid and a small elevator, or "Lifter," can move up the elevator at a fraction of the energy and financial expenditure of launching an object into orbit. Once the elevator is built, using the elevator to put things in orbit could cost hundreds of dollars per pound, versus the $7,000 per pound it takes to launch satellites with the space shuttle.

A lunar elevator would use a ribbon at least 50,000 kilometers (31,000 miles) long extending through the Earth-Moon L1 LaGrange point from an anchor point near the center of the visible part of Earth's moon. A smaller Atlas or Delta rocket could send the components the L1 point, and the Zylong ribbon would be spooled from that point towards the Moon and the Earth.

"You would use the Atlas hardware as part of your counter weight," said Laine. "But that's a very small counterweight, which means that your cargo that you are taking up and down from the Moon is going to be small. This is not like the Earth elevator where you were going to be putting 100 tons

Artists concept of a space elevator. Credit: Caltech

a week into space. This is a very small system, capable of transporting 200-250 kilos."

But to put that in perspective, Laine said, the entire sample return system for the Japanese Hayabusa probe that recently returned from an asteroid was only about 20 kilos.

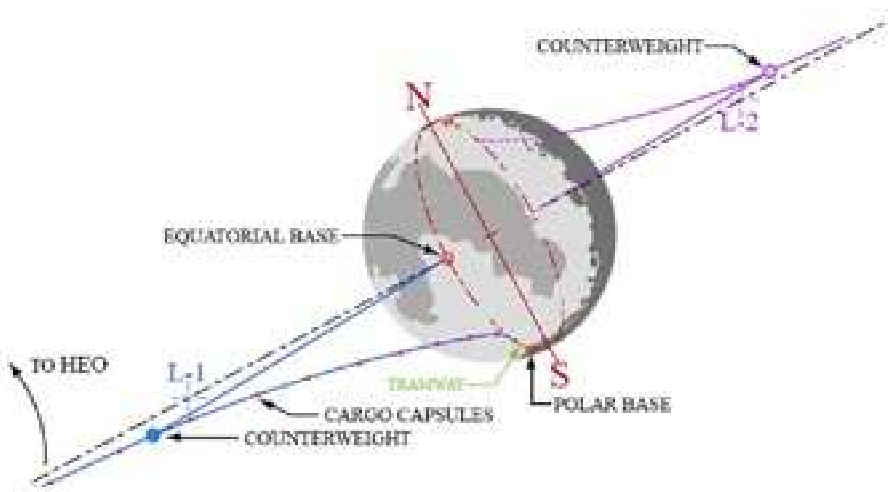
And that's what Laine has in mind for the first lunar elevator: a sample return mission. "It would be a lunar sample return mission within the next 5-7 years, for what we think is a pretty reasonable price," he said.

Once the initial ribbon is up and running, Laine said you could send up more ribbon to strengthen it, using same concepts for the Earth elevator, such as multiple stages of construction and ribbons that are added to it.

Of course, none of this – including the money – is trivial. Although the first string might be less expensive than an Earth elevator, additional construction of the lunar elevator would be fairly expensive, and take more time compared to the Earth elevator. "Once the first string on the Earth elevator is built, you work from the bottom and go up, whereas on the lunar elevator you'll have to send it from Earth. So that part starts adding up in a hurry," Laine said. "We don't have a complete estimate on price yet but an Atlas or Delta, that is a known and reasonable price tag. We're not talking about billions and billions of dollars here – maybe hundreds of millions – but not billions."

Still, he has a vision and a plan.

"It is not a flag and footprints vision of going to the Moon," Laine said, "but it goes to the heart of the new NASA budget and focus of developing technologies and infrastructure so that things can happen. And that's what we hope we can do by developing this ribbon. And then we jumpstart the process of creating an outpost or a research lab. We've played with the idea of using the counterweight at the end and using a habitat, something like a Bigelow (Laine stressed he hasn't talked with the Bigelow people yet about this) and if we could tie a couple of modules together they would make a great counterweight and that puts you in an interesting position. Some people don't think going to the Moon is worthwhile if you are going to Mars, but a lot of people think a fuel depot makes sense. We could be a great fuel depot for some of those long duration missions because we want that extra mass. In the Earth elevator, the counterweight is basically dead mass. For the lunar elevator, it becomes a working environment. So some people go to the modules, some people go to the Moon, some people go to Mars using this as a refueling and construction station. Once it is up and running you have safe reliable access to the moon, for the price of a Delta or an Atlas. That's huge."



One concept of a lunar space elevator.
Credit: Star Technology and Research, Inc./Jerome Pearson

But Laine said he doesn't want to give anyone the impression that he and others interested in this concept have everything figured out. "We've studied this enough to know that it is feasible and interesting and likely to happen sooner rather than later, which is why we're tackling it."

So, Laine and a core group of space elevator enthusiasts are starting a series of workshops to discuss this concept and tackle some of the significant questions with anyone who is interested and who might have the brainpower and spirit to understand and undertake such a project.

The first workshop was on July 29-August 1 in Seattle Washington.

"I'm a big believer in connecting with community, so if artists and musicians, want to come, that's great," Laine said. "Engineers, science guys, rocket guys would be helpful. But politicians and marketing people are equally important to answer the big questions of where we should focus our time and efforts."

There is also a space elevator conference August 13-15 at the Microsoft Conference Center in Redmond, Washington.

Laine started a space elevator company in 2003, LiftPort, which fell to financial problems in 2007. He sees the lunar elevator as a possible rebirth for the company, which once had 14 full-time employees. "This is a renaissance project, a rising again," he said. "I'm applying a lot of what I learned on the Earth elevator to this new vision. While tackling the Earth elevator, all my money came from real estate, and I had plenty of money for my needs. But this time is different. For us to build this thing we are going to have to earn our way."

"But I think it could be phenomenally lucrative, too," Laine continued. "We are going to make discoveries along the way that will lead to products and services that are not related to going to the Moon. We think there is a solid value proposition as part of this."

Courtesy: Universe Today

Lake levels are falling fast on Titan

Liquid levels in the lakes on Saturn's biggest moon Titan are falling fast, space scientists have discovered. It means that if there were any alien Titanites (which sadly is not terribly likely), they might be facing a hosepipe ban.

The lakes, discovered by NASA's orbiting Cassini spaceprobe, are dropping by around a meter a year in its southern hemisphere.

Titan is the most-Earthlike body in the solar system, with lakes, rivers, seasons and rainfall. But it is too cold for water with temperatures as low as -300F (149C) at the poles, and the liquid on Titan is a mix of methane, ethane and propane. Some scientists reckon the chemistry is right for alien life to develop in the future.

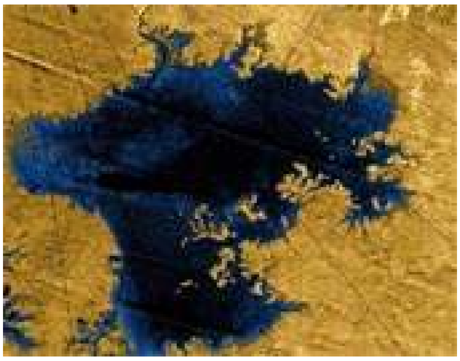
Scientists at the California Insitute of Technology studied data gathered by Cassini over four years. They blame the observed drop in lake levels on seasonal evaporation as Titan's lake district enjoys what amounts to midsummer 890 million miles out from the Sun.

Caltech student Alexander Hayes said: "It's really exciting because, on this distant object, we're able to see this meter-scale drop in lake depth. We didn't know Cassini would even be able to see these things."

One of the lakes, Ontario Lacus – named after North America's Lake Ontario – is the largest lake in Titan's southern hemisphere's. Hayes, Caltech associate professor of planetary science Oded Aharonson and colleagues report that its shoreline receded by about six miles from June 2005 to July 2009. A year on Titan lasts 29.5 Earth years so summer is a long time coming.

Cassini used a form of radar to produce images of Titan's lakes. The results suggest that the liquid in the lakes is transparent, like liquid gas sold on Earth, rather than dark like tar.

The radar was able to penetrate the liquid to a depth of several meters. Hayes said: "Then the radar hits the floor, and bounces back. Or, if the lake is deeper than a few meters, the radar is completely absorbed, producing a 'black' signature." Noting



One of Titan's Earth-like lakes (NASA)

changes in how far offshore they could "see" the lakebeds allowed their slopes to be measured and liquid loss to be gauged.

Space scientists from the UK and US have proposed that NASA send a new probe to land a "boat" in one of Titan's lakes to tell us more about their properties. In January 2005, as it arrived at Saturn, Cassini landed a European probe called Huygens on Titan. It landed on a slushy surface that UK scientists suggest could be a lake bed where the liquid has evaporated.

PAUL SUTHERLAND
Courtesy: Skymania.com

Planets found around dying star

DR EMILY BALDWIN ASTRONOMY NOW ONLINE

Two pairs of gas giants locked in unusually tight orbital dances have been discovered around old, dying stars.

The four gas giants were discovered via the Doppler shift method, that is, by detecting the wobble in the light emitted by their host stars as the planets track around them. The systems are part of the Keck Subgiants Planet Survey, which searches for planets around stars 40 to 100 percent times larger than our Sun.

In the case of HD 200964, located 223 light years from Earth, and 24 Sextanis, 244 light years away, the planets were found to be locked in a tight orbital embrace such that HD 200964's planets are separated by just 0.35 AU – comparable to the distance between Earth and Mars – while 24 Sextanis' brood are separated by 0.75 AU. "A planetary system with such closely spaced giant planets would be destroyed quickly if the planets weren't doing such a well synchronized dance," says Eric Ford of the University of Florida. "This makes it a real puzzle how the planets could have found their rhythm."

The planets' imposing masses – all much greater than Jupiter – exert considerable gravitational influence on their siblings. For example, the gravitational tug between HD 200964's two planets is 700 times greater than that between the Earth and Moon. Furthermore, the planets are also located relatively close to their parent stars; those orbiting HD 200964 do so once every 630 and 830 days; 24 Sextanis' planets have orbital periods of 455 and 910 days.

After planets form they often migrate around their orbits in a disorderly fashion before settling down and sometimes becoming locked in a resonance. One such scenario would see a planet orbit its star twice

When the subgiant stars like HD 200964 and 24 Sextanis eventually become red giants they will likely engulf their planets or even fling them out of the systems completely. Image: NASA, ESA & G Bacon (STScI).

for every one complete orbit that another planet makes – this is known as a 2:1 resonance, and is one of the most common and stable configurations.

"Planets tend to get stuck in the 2:1. It's like a really big pothole," says John Johnson at Caltech. "But if a planet is moving very fast it can pass over a 2:1. As it moves in closer [to its sun], the next step is a 5:3, then a 3:2, and then a 4:3."

The 24 Sextanis system is in this 2:1 arrangement, while the planetary pair in HD 200964 has arrived at the 4:3 configuration. "The closest analogy in our Solar System is Titan and Hyperion, two moons of Saturn which also follow orbits synchronized in a 4:3 pattern," says Ford. "But the planets orbiting HD 200964 interact much more strongly, since each is around 20,000 times more massive than Titan and Hyperion combined."

"This is the tightest system that's ever been discovered," Johnson adds, "and we're at a loss to explain why this happened. This is the latest in a long line of strange discoveries about extrasolar planets, and it shows that exoplanets continuously have this ability to surprise us. Each time we think we can explain them, something else comes along."

The so-called 'subgiants' that these host stars belong to is a class of star that has run out of hydrogen for nuclear fusion, causing its core to collapse and its outer envelope to swell.

"Right now, we're monitoring 450 of these massive stars, and we are finding swarms of planets," enthuses Johnson. "Around these stars, we are seeing three to four times more planets out to a distance of about three AU – the distance of our asteroid belt – than we see around main-sequence stars. Stellar mass has a huge influence on frequency of planet occurrence,

In our own Solar System, Jupiter's moon Europa is in a 2:1 resonance with Io, while Ganymede makes one orbit every time Io makes four. Image: NASA.

because the amount of raw material available to build planets scales with the mass of the star."

When HD 200964 and 24 Sextanis eventually become red giant stars some 10 to 100 million years down the line they will throw off their outer atmospheres, which will likely change the gravitational dynamics of the whole system, altering the planets' orbits and perhaps even flinging them out of the system completely.

Courtesy: Astronomy Now Online

New Planet-Hunting Method Could Find Earth-Like Alien Worlds

By Denise Chow - SPACE.com Staff Writer

A new planet-hunting technique that was used to detect an exotic alien world may be sensitive enough to help astronomers search for Earth-sized planets that orbit other stars, according to a new study.

The new approach, called Transit Timing Variation, was developed by a team of European astronomers led by Gracjan Maciejewski of Jena University in Germany.

The technique was used to pinpoint a planet that is 15 times the mass of Earth, located in the star system WASP-3, which is 700 light-years away from the sun in the constellation Lyra.

The method's high degree of sensitivity, however, could also make it a valuable tool for locating small planets with similar masses to Earth, the researchers said.

The results of the study have been accepted for publication in an upcoming issue of the journal Monthly Notices of the Royal Astronomical Society.

What is Transit Timing Variation?

The Transit Timing Variation (TTV) technique was suggested as a viable approach for discovering alien planets – or exoplanets – a few years ago. It built on the existing transiting method, which has been employed for years to detect a number of exoplanets, and is widely used by the Kepler and CoRoT space missions that scour the cosmos for Earth-like planets.

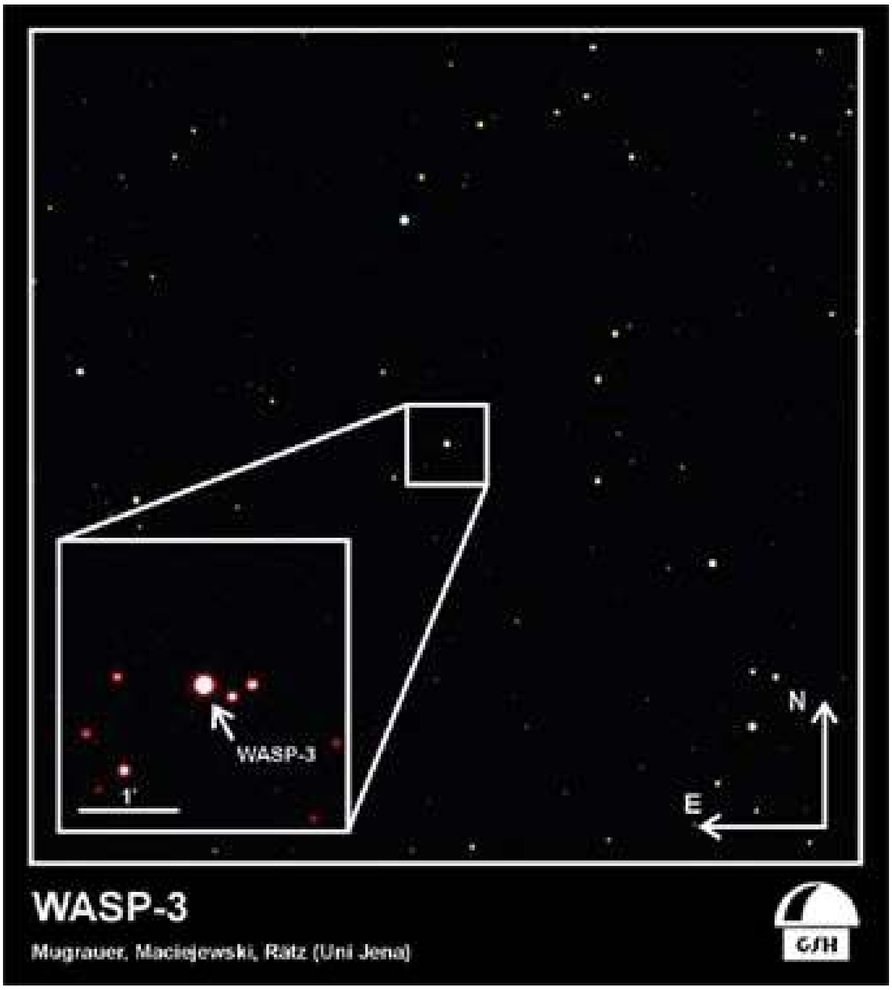
Transits occur when a planet passes in front of its parent star, temporarily blocking some of the star's light as seen from Earth. During these transits, astronomers can measure a drop in the host star's light, telling them that a planet has moved in front.

The new method allows astronomers to further identify smaller planets whose own transits might not be enough to significantly dent their star's light output. However, if smaller planets exist in addition to a large planet, the lesser siblings will exert a gravitational tug on the larger planet that changes its orbit, causing deviations in the regular cycle of transits.

The TTV technique compares these deviations with predictions that are made from extensive computer-based calculations. The estimates allow astronomers to infer the preliminary makeup of the planetary system being studied – including the presence of possible Earth-like planets.

Combing the WASP-3 system

For their study, Maciejewski and his team of researchers used the 35-inch (90-centimeter) diameter telescopes at the University Observatory Jena and the 24-inch (60-centimeter) diameter telescope at the Rohzen National Astronomical Observatory in Bulgaria to study the transits of WASP-3b, a large planet that has a mass 630 times that of Earth.



This image shows the faint star WASP-3 (magnitude 10.5 or about 60 times fainter than can be seen with the unaided eye) in the center of the image, made using the 90-cm telescope of the University Observatory Jena. The star is enlarged with better sensitivity and resolution in the inset in the lower left. WASP-3 is at a distance of 700 light years from Earth and is located in the constellation Lyra. North is up, east to the left. The large image is a composite of three images taken using different filters (blue, visual and red) and the small inset only uses a red filter. Credit: Gracan Maciejewski, Dinko Dimitrov, Ralph Neuhäuser, Andrzej Niedzielski et al

Their observations led to an unexpected finding.

"We detected periodic variations in the transit timing of WASP-3b," Maciejewski said in a statement. "These variations can be explained by an additional planet in the system, with a mass of 15 Earth-mass (i.e. one Uranus mass) and a period of 3.75 days."

This newly discovered planet was named WASP-3c, and is among the smallest exoplanets found to date. It is also one of the least massive planets known to orbit a star that is more massive than our sun.

Using TTV for future searches

This finding marks the first time that a new extrasolar planet has been discovered using the TTV method.

The detection of the smaller 15 Earth-mass planet makes the WASP-3 system very intriguing, the researchers said.

The new planet's orbit is twice as long as the orbit of the more massive planet. Such a configuration is likely a result of the early evolution of the planetary system.

The TTV method's ability to detect small perturbing planets could help astronomers locate more of these Earth-like exoplanets in the future, the researchers said.

For instance, an Earth-mass planet will pull on a typical gas giant planet orbiting close to its star, and cause deviations in the timing of the larger objects' transits of up to one minute. This effect is significant enough to be detected with relatively small 1-meter diameter telescopes. Any potential discoveries can then be followed up with larger ground-based instruments.

Courtesy: Space.com

Photos Inspire Dreams of Underground Moon Exploration

By Zoe Macintosh SPACE.com Staff Writer

Photographs of enormous pits on the moon, some hundreds of feet deep, from unmanned probes have given scientists a tantalizing glimpse into the lunar interior.

Some of the moon holes are wide enough to fit the White House and scientists think they are openings to underground tunnels that had been formed by rivers of lava.

"They could be entrances to a geologic wonderland," said lead researcher Mark Robinson at Arizona State University. "We believe the giant holes are skylights that formed when the ceilings of underground lava tubes collapsed."

First seen in close detail by Japan's Kaguya spacecraft last year, the lunar pits were also seen by NASA's Lunar Reconnaissance Orbiter using same high resolution camera that photographed the lander portion of the Apollo spacecraft and astronaut footprints in moon dust. [10 Coolest Moon Discoveries]

Lunar lava tubes and trails

The existence of tunnels in the moon was first proposed by scientists in the 1960s, when early photographs showed that hundreds of long, narrow channels trailed across the lunar plains.

Taken as evidence of past volcanic activity, the grooves – known as rilles – had pointed to the possibility of underground channels similar to lava tubes found on Earth.

Lava tubes form when the upper portion of a river of molten lava cools and solidifies while the rest of the lava continues to stream beneath it. The insulated molten rock can retain enough liquid warmth to flow for miles, carving out tubular channels and complex labyrinths.

Images from Japan's Kaguya spacecraft depict gaping holes on the same plain, or lunar maria, as the winding rilles. One particular pit appears in the middle of the channel, leading scientists to believe it represents the collapsed roof of an underground tube.

Tantalizing chambers

Researchers speculate that the tunnels, if unclogged, could serve as passages and livable lunar lairs for humans.

"The tunnels offer a perfect radiation shield and a very benign thermal environment," Robinson said in a statement. "Once you get down to 2 meters under the surface of the moon, the temperature remains fairly constant, probably around -30 to -40 degrees C."

Explorers would be sheltered from daily temperatures that swing from 212 degrees Fahrenheit (100 degrees Celsius) during midday to minus 238 degrees Fahrenheit (minus 150 degrees Celsius) at night, as well as from possible asteroids. But further exploration would be needed before the tubes could be used.

"Hold off on booking your next vacation at the Lunar Carlsbad Hilton," said Paul Spudis of the NASA-funded Lunar and Planetary Institute in Texas. "Many tunnels may have filled up with their own solidified lava."

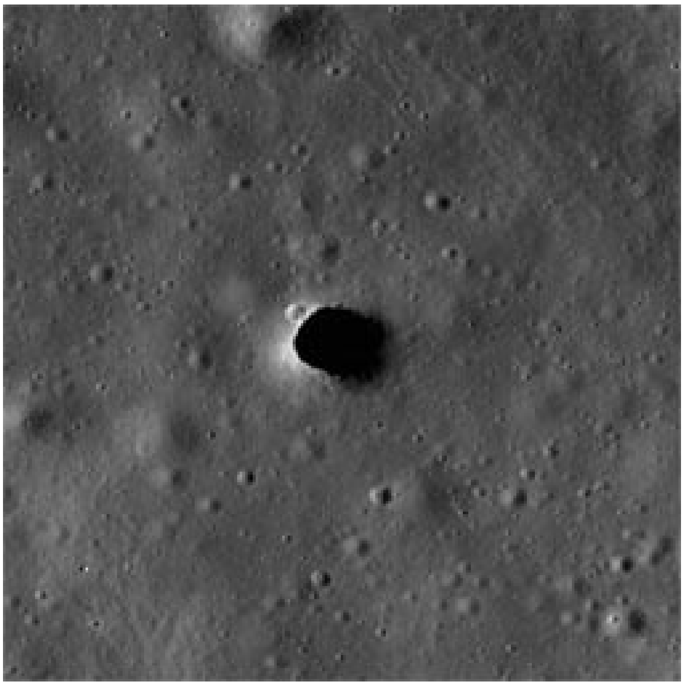
Viewed though entrances, the blackness of the enormous pits for now remains a tantalizing wall.

"We just can't tell, with our remote instruments, what the skylights lead to," said Spudis. "To find out for sure, we'd need to go to the moon and do some spelunking."

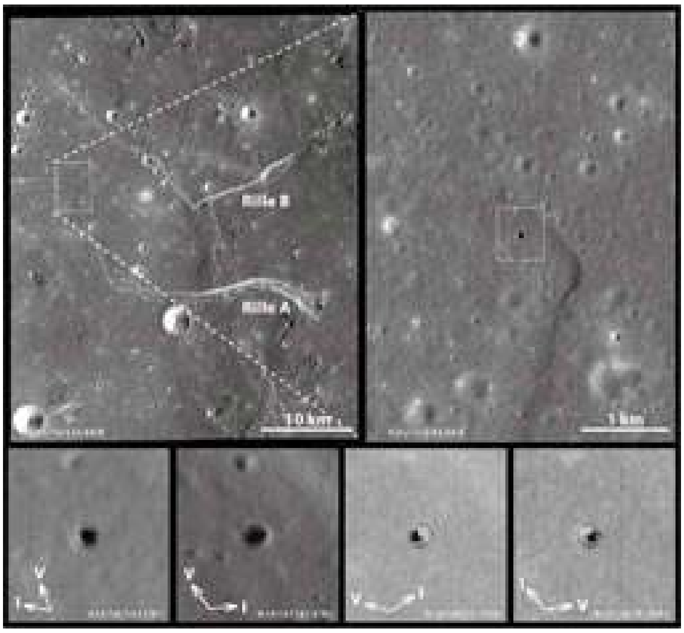
Relaying how a lava flow mapping expedition in Hawaii revealed a surprising system of vents similar to the skylights photographed, Spudis left open the possibility of a lunar labyrinth.

"It turned out that there was a whole new cave system that was not evident from aerial photos ... Who knows? The moon continually surprises me," he said.

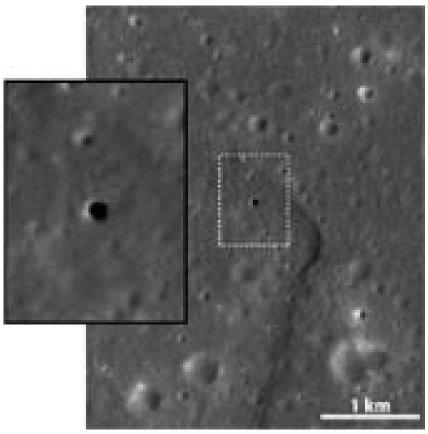
Courtesy: Space.com



This pit in the Moon's Marius Hills is big enough to fit the White House completely inside and was photographed by NASA's Lunar Reconnaissance Orbiter. Credit: NASA/ LROC/ ASU



These Kaguya photos show the Marius Hills hole on the moon in the context of a meandering system of ancient rilles formed by lava. Because the pit is in the middle of a rille, it likely represents



This apparent hole in the moon is like a skylight, a vertical cave 213 feet (65 meters) across and some 262 to 289 feet deep (80-88 meters). It is thought to be a collapsed lava tube. The inset shows close-up of the boxed area. Credit: ISAS/ JAXA/SELENE/Junichi Haruyama et al.

Potentially Hazardous Asteroid Might Collide With the Earth in 2182

ScienceDaily

The potentially hazardous asteroid '(101955) 1999 RQ36' has a one-in-a-thousand chance of impacting the Earth, and more than half of this probability indicates that this could happen in the year 2182, based on a global study in which Spanish researchers have been involved. Knowing this fact may help design in advance mechanisms aimed at deviating the asteroid's path.

"The total impact probability of asteroid '(101955) 1999 RQ36' can be estimated in 0.00092 – approximately one-in-a-thousand chance – but what is most surprising is that over half of this chance (0.00054) corresponds to 2182," explains María Eugenia Sansaturio, co-author of the study and researcher of Universidad de Valladolid (UVA). The research also involved scientists from the University of Pisa (Italy), the Jet Propulsion Laboratory (USA) and INAF-IASF-Rome (Italy).

Scientists have estimated and monitored the potential impacts for this asteroid through 2200 by means of two mathematical models (Monte Carlo Method and line of variations sampling). Thus, the so called Virtual Impactors (VIs) have been searched. VIs are sets of statistical uncertainty leading to collisions with the Earth on different dates of the XXII century. Two VIs appear in 2182 with more than half the chance of impact.

Asteroid '(101955) 1999 RQ36' is part of the Potentially Hazardous Asteroids (PHA), which have the possibility of hitting the Earth due to the closeness of their orbits, and they may cause damages. This PHA was discovered in 1999 and has around 560 meters in diameter.

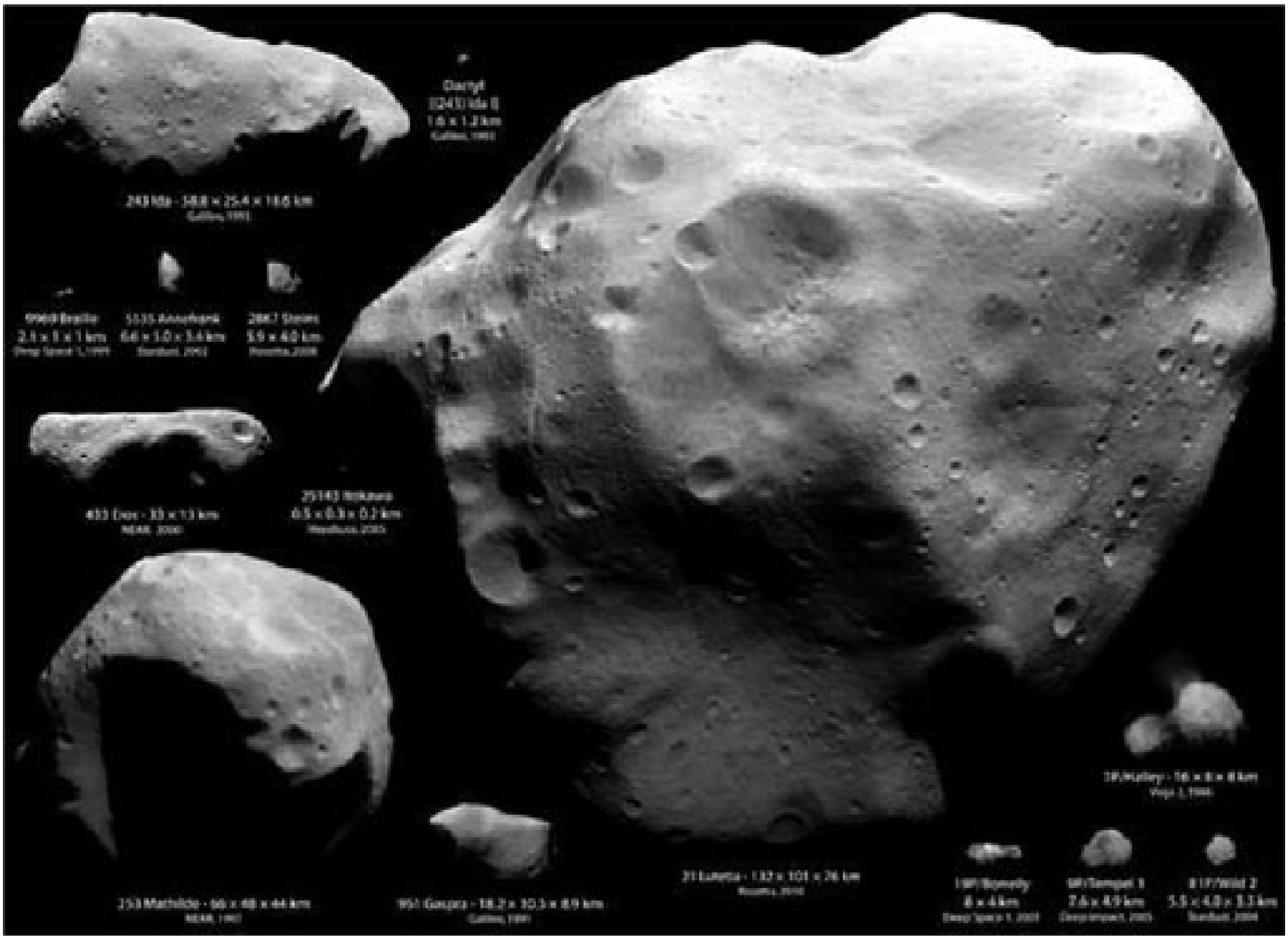
The Yarkovsky effect

In practice, its orbit is well determined thanks to 290 optical observations and 13 radar measurements, but there is a significant "orbital uncertainty" because, besides gravity, its path is influenced by the Yarkovsky effect. Such disturbance slightly modifies the orbits of the Solar System's small objects because, when rotating, they radiate from one side the radiation they take from the sun through the other side.

The research, which has been published in the journal *Icarus*, predicts what could happen in the upcoming years considering this effect. Up to 2060, divergence of the impacting orbits is moderate; between 2060 and 2080 it increases 4 orders of magnitude because the asteroid will approach the Earth in those years; then, it increases again on a slight basis until another approach in 2162, it then decreases, and 2182 is the most likely year for the collision.

"The consequence of this complex dynamic is not just the likelihood of a comparatively large impact, but also that a realistic deflection procedure (path deviation) could only be made before the impact in 2080, and more easily, before 2060," stands out Sansaturio.

The scientist concludes: "If this object had been discovered after 2080, the deflection would require a technology that is not currently available. Therefore, this example suggests that impact monitoring, which up to date does not cover more than 80 or 100 years, may need to encompass more than one century. Thus, the efforts to deviate this type of objects could be conducted with moderate resources, from a technological and financial point of view."



Asteroids and comets visited by spacecraft. (Credit: ESA, NASA, JAXA, RAS, JHUAPL, UMD, OSIRIS)

Smartphone apps that make sense of the stars

By Peter Price
BBC Click

A new host of smartphone applications which map the stars and chart changes in the universe are giving amateur astronomers the chance to be the first to spot new stars and supernovae.

Look up on a really clear night and you can see about 2,000 stars. That sounds a lot, until you realise that there are millions upon millions of stars in the universe.

Two weeks ago scientists spotted a new star and called it "R136a1". They were using the Hubble Space Telescope and the imaginatively-named Very Large Telescope in Chile.

But to explore the wonders of the universe you do not need anything more sophisticated than a decent pair of binoculars or perhaps something like the Meade LX200 telescope.

It costs about $7,000 dollars (£4,500) and is motorised and guided by GPS. After a few minutes of calibration, it can point anywhere in the sky at the touch of a button. The coordinates you need are easy to find on websites like Heavens Above.

It also works in reverse, so if you find something in the sky, enter the coordinates into Stellarium, a free open-source planetarium which can identify the star in your sights.

Astrotagging

But setting up these telescopes and websites is a time-consuming and costly business, so app developers have started taking advantage of the inbuilt GPS and digital compass of the smartphone to find nifty ways of navigating the night sky.

Tim O'Brien, astrophysics lecturer at the University of Manchester, believes technology is changing the way people view the sky.

"We get any number of phone calls about bright things in the sky. Quite often it is the planet Venus and we advise people to go and download one of these apps and go and have a look.

"In the future, people will just be able to check for themselves. It brings that science right down to Earth for people - it makes them part of it."

At the Royal Observatory in Greenwich, London's light pollution means the main scope is only useful as a research tool on the darkest winter nights.

However, what it is generating though the Flickr photosharing phenomenon is genuinely illuminating. Rookie stargazers are encouraged to join a group on the site and engage in astrotagging - geotagging for the heaven

Supernovae hunt

Dr Marek Kukula at the Royal Observatory,

Popular stargazing apps

Google Sky Map for Android. Just point it skywards to get a map of what you are looking at.
Star Walk for the iPhone - works just as well on older models without a digital compass.
GoSatWatch shows satellites travelling overhead which can be seen even in the daytime.

Greenwich is enthusiastic about the opportunities astrotagging presents.

"It means that anyone's picture of the night sky can actually be tagged with useful information and we can build up an amazing mosaic image of everybody's pictures of the sky, which anybody, amateurs, members of the public or professional scientists can access and use."

Using the astrotags, computers can automatically compare images of the same patch of sky and spot what changes over time. Sometimes, these changes can point to the most exciting thing of all - a newborn star.

Scientists are now relying on these automated comparisons because they do not have the time to manually inspect the huge number of photographs being taken around the world.

But classifying the shape and size of distant galaxies in grainy images is tricky for a computer. Luckily, it is easy for a human and that is where Galaxy Zoo comes in handy.

This iPhone app from the University of Oxford harnesses the power of the human

An example of astrotagging on Flickr. Photo:

brain to check the thousands of photos generated by the Hubble Space Telescope.

"We have very little time and there is a huge public out there who are really enthusiastic about astronomy and have loads of wasted time sitting on the bus or on the train," said Oxford researcher Joe Zuntz . "It is fantastic to be able to use that time up with doing astronomy, with doing science, no matter where you are."

The Oxford team is developing a way to use their apps to hunt supernovae - exploding stars which are visible for such a short time that they need to be identified by human eyes as quickly as possible.

The new app, coming later this year, will send an alert when a photo has been snapped which might contain a supernova.

Mr Zuntz says app users will then help to distinguish whether pictures show real supernovae or not, allowing the team to focus on getting pictures of the new stars in real time.

"We could have someone in Europe tell us whether something is really a supernovae and then by the time night comes to Hawaii we can get one of the massive 8m telescopes there to take a really good look at it and get some fantastic data," he says.

With technology in smartphones improving, stargazing is getting easier all the time - it is no longer the lofty preserve of scientists with big telescopes.

Apps like these could spark a renewed interest in astronomy, allowing us all to explore the extraterrestrial by night and join the hunt to spot supernovae by day.

Galaxy Zoo users will be able to help scientists spot real supernovae

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Material can only be returned if supplied with a SAE.