FAS Newsletter

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

FAS Annual Convention 2016

The 2017 FAS Annual Convention and AGM will again be held in Birmingham.

The venue will be the University of Birmingham's Poynting Building. The Poynting Building remembers Sir John Henry Poynting the first professor of physics at the University of Birmingham. He seems to have been an interesting character, and worked out how to describe the direction and magnitude of electromagnetic waves with the "Poynting Vector", and was the first to work out an accurate determination of the mass of the Earth.

Directions & Map:

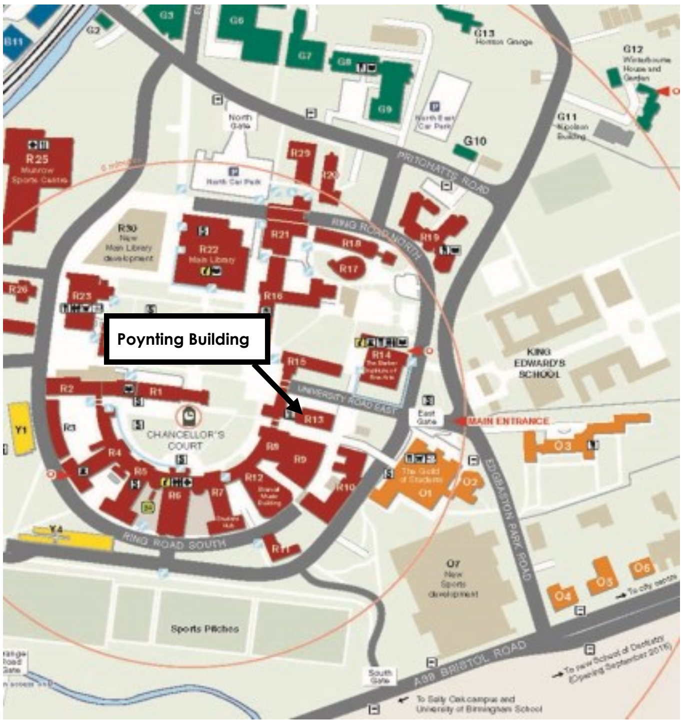
Venue address: Poynting Physics Building, University of Birmingham, Birmingham, B15 2TT.

The Poynting Physics Building is situated in the heart of the University of Birmingham's Edgbaston campus, R13 on the Campus map. Detailed directions, via public transport, bicycle, car and air can be found here:

http://www.birmingham.ac.uk/visit/maps-and-directions.aspx

Car parks in the University are free at weekends.

Please note that there are a few venues on site which sell food, such as a 'Spar' and 'Subway'. You are also welcome to bring your own packed lunch, and slightly further away (~10 minute walk, on the Bristol Road) there are a number of pubs which serve food.



The 2016 FAS Convention will take place on October 22nd 2016 at the University of Birmingham, Birmingham. The convention will start at 9.30am.

Speaker lineup (at time of printing). Check the FAS website for further details.

- Prof. Andreas Freise – *Gravitational Waves: From Einstein's Equations to a New Era in Astronomy*
- Dr. Rhodri Evans – *50 years since the accidental discovery of the oldest light in the Universe – what have we learnt from it?*
- Chris Longthorn - *A Brief History of the Cymbeline Observatory*
- Dr. Nigel Bannister - topic t.b.a.

There will be a number of traders, exhibitor and other organisations set up in the area of the talks, for your interest. Those established at the time of printing are:

- Society for the History of Astronomy
- British Astronomical Association
- Birmingham AS
- nPAE Precision Astro Engineering
- W&W Astro (softica.co.uk)

It is expected that other will be secured by the time of the convention.

Tickets: £ 5 for FAS members, £ 7 for non-members

A little about the speakers

Professor Andreas Freise. School of Physics and Astronomy, University of Birmingham

Professor Freise leads a small research team in the Gravitational Wave Group, working on new technologies and instrumentation for high-precision experiments.

Professor Freise also has a leading role in the optical design of new gravitational wave detectors. For several years, he chaired the optical design working groups of the international projects Advanced Virgo and the Einstein Telescope. Furthermore, Freise has developed and maintains the software package Finesse, which is used world-wide for the design of interferometer systems.

Dr Rhodri Evans School of Physics and Astronomy. Honorary Research Fellow

His main area of research is extra-galactic astronomy. For the past 16 years he has been involved in airborne astronomy, and is part of the team building the facility far-infrared camera for SOFIA. He also does

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Acting-President
Callum Potter

Treasurer
Peter Cooke
Haven Cottage, Frithville, Boston, Lincs, PE22 7DS
01205 750868
treasurer@fedastro.org.uk

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Secretary
Shaun O'Dell
147 Queen St, Swinton, Mexborough, S Yorkshire. S64 6NG
07714 093723
secretary@fedastro.org.uk

Newsletter Editor
Frank Johns
38 Chester Road, Newquay, Cornwall. TR7 2RH
01637 878020
newsletter@fedastro.org.uk

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FAS Handbook
- Amendments

The 2016 edition of the FAS Handbook has recently been distributed to the nominated contacts of each member society.

This publication has always proved to be a bit of a problem for the compiler. With well over 200 member societies and the details of many of these changing in some way, getting up to date for publication is a bit like trying to nail jelly to the wall.

This year was my first attempt and it was a bit of a trial trying to keep up with the changes. I did manage to get most of them but inevitably some did not get picked up.

One of these was for **Lowestoft and Yarmouth Regional Astronomers**.

Their revised details are:

Treasurer's contact: treasurer@ lyra-astro.co.uk

Their meeting venue is now:

Parkhill Hotel, Coach House Room, Oulton, Suffolk. NR32 5DQ

Another was for **Aberdeen AS**. Their venues have changed.

They meet at Robert Gordon's College, School Hill, Aberdeen on second Tuesdays—September to May. They also meet on fourth Tuesdays, every month, at Bettridge Centre, Newtonhill.

Check their website - www.aberdeenastro.org.uk, for details.

Another amendment is in the Speakers list.

In order to ensure this list is complete as possible every person listed in the previous edition was emailed to check if they wished to remain in the Handbook. It was assumed that non-responders were either not able or didn't wish to be listed.

I have since heard from a previous speaker, who missed the email enquiry, and his details are as follows:

Steve Tonkin FRAS

5, Albion Road, Fordingbridge, Hampshire, SP6 1EL.

01425 650713 / 07518 862656

astronomy@astunit.com

List of talks at http://astunit.com/talks.php

Normal range: 100 miles; further by special arrangement.

No fee, but have never knowingly refused a bottle of decent Rioja or donation on my behalf to the CfDS.

Travel expenses at AA "running costs" rate.

Please amend your Handbooks to reflect the above.

For the 2017 edition, Roger Steer will be putting it together. His contact details will be found on the FAS website and will be included in a later edition of the FAS Newsletter.

Frank Johns

Fresh Blood Needed

I know it's a common theme from visiting local societies - finding people to take on the various roles that are essential for the running of your society. It's never very fair to load up those that do stand with extra roles, just to keep things going. And the FAS is not immune from this either - when I heard at the AGM last year that more help was needed on the FAS council, having served a few years previously, I offered to help out in some small way. So it was a bit of a surprise when asked to be Acting President.

It was my intention to do this for the year, so the FAS could get back to a firm footing and move forward, but council have asked if I could continue for the following year, and it would seem a little churlish to refuse. We have had some other volunteers to join Council after the AGM, but there are still vacancies, and there will be roles that need to be filled following the standing down of one of our long serving council members, and to reduce the number having multiple roles.

Having a role on the FAS council need not be onerous. Most discussions are by email or Skype, with two face-to-face meetings a year.

Specifically at the AGM this year, the following roles will be vacant and need filling; Vice-President, Deputy Treasurer, Newsletter Editor, Publications Distribution Officer, and Meeting Speakers Organiser. In addition there may be a need for ordinary members of council (without portfolio).

If any of these roles appeal, please get in touch with me or the current incumbent to find out what's involved.

It goes without saying, but I'll say it anyway, that it is **very difficult for the FAS to continue without people coming forward to fill these roles**.

Without a Newsletter Editor there will be no newsletter, and we do need someone to distribute the publications otherwise there is little point in producing them.

Much thanks goes to Frank Johns who is stepping down from the roles of Newsletter Editor and Handbook editor - luckily Frank has agreed to continue to help with the publications - and to Adrian Roach, who has stepped down from Publications Distribution.

Callum Potter

Acting President

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research in star-formation and cosmology. He is a regular contributor to TV, radio and public lectures and also does a blog - https://thecuriousastronomer.wordpress.com/, which is sometimes about astronomy. You can find out more about him on his Facebook page: https://www.facebook.com/rhodri.evans1

Dr Nigel Bannister Department of Physics and Astronomy, University of Leicester

His research interests include activities in space instrumentation development, mission analysis, observational astronomy and a number of technology developments for terrestrial applications. He is Co-Investigator on J-MAG (Principal Investigator Prof. Michele Dougherty, Imperial College London) the Magnetometer instrument selected for flight on ESA's JUICE mission to Jupiter. His role in this project is the radiation design of the instrument, working with the teams at Imperial College London, Technical University Braunschweig, and the Space Research Institute of the Austrian Academy of Sciences, to ensure that the instrument is capable of surviving in the extreme radiation environment around Jupiter and its moons.

Chris Longthorn is the secretary for Coventry and Warwickshire A.S.

LETTERS

Dear Mr Johns,

I understand that you are the Newsletter Editor for the Federation of Astronomical Societies and hope that you may fell the following request worthy of your consideration and subsequent publication.

"I am involved in the refurbishment of an Observatory here on the Isle of Mull. The octagonal shaped observatory once had an opening roof (The operating mechanism is still in place though the opening was sealed in the 1990s.)

The building is rotated on a track by turning a hand crank (It no longer rotates as some years ago it was blown off the track during a gale). I believe that it was a bought to the island in kit form sometime in the 1940s or even earlier. I would like to learn more about its history, especially who made the kit and when it was made.

The present owners and I plan is to return it to the original and refit a telescope so that it can be used by local astronomers and visitors in this wonderful dark sky area."

Perhaps someone among your readers may have seen or used a similar observatory.

Thank you in anticipation of you assistance.

Peter Williams

The Anchorage, Craignure, Isle of Mull, PA65 6AY UK

Peter Williams <pw812249@live.co.uk>

Dear Sir

18' 6" ASH dome for sale

The University of London Observatory has an 18' 6" ash dome looking for a new home. We were wondering if any of your members would be interested in re-homing it.
Please contact me for further details.

Mick Pearson

Email: mpearson@ulo.ucl.ac.uk

The RAS Bicentenary - an opportunity for FAS Member Societies

The Royal Astronomical Society was founded nearly 200 years ago, in 1820. To celebrate the bicentennial the Society has established an Outreach and Engagement Fund of £1M to support astronomy and geophysics projects. In the RAS's words the projects they are interested in are ones "that create a real buzz about science – understanding, discussion and dialogue – in diverse sections of the community."

Please see https://www.ras.org.uk/200 for further details.

Approximately one half of that funding has been awarded to the winners of the first tranche of projects bid in 2015 by various organisations, most of whom were charities. Now it's time for the 2nd tranche of bids to be submitted, and I attended the initial Stakeholders Meeting held at the RAS offices at Burlington House, Piccadilly. I was attending initially to represent Astronomy Groups in local U3A areas. (U3A - the University of the Third Age, a self help educational body for retired people - like me) but I also volunteered to represent the FAS Council as I served for a few years recently as FAS Membership Secretary.

The point I made at this meeting is that there are thousands of individuals in FAS member societies who are already very experienced at outreach work - not just stargazing but giving short talks and just generally talking to the public about astronomy. It's part of what most amateur astronomy societies do. Charitable organisations can train up their own staff in some basic observing skills, but they are unlikely to achieve the experience level that we have already, and a charity is unlikely to be able to buy the sort of telescopes that many amateurs use on a regular basis. Following on from this, if a charity is thinking about putting in a proposal they could do well to find out the nearest FAS member Societies to sound them out about some kind of cooperation.

We could look at two of the five 2015 winners as illustrations of what I mean, the Prince's Trust and the Workers Education Authority (WEA). The Price's Trust has a project called "Stars and Space" and is a constituent of their "Fairbridge Residential Programme and Get Started Programme". It is targeted at "Young people not in education, employment or training". It is intended to run this at 20 locations across the country. The WEA project is entitled "Open your eyes - look up to the sky" (where have I heard that before?) and its description is "Using astronomy courses to better the lives of unemployed, disabled and people with low literacy. WEA in partnership with John Moores University. Star in NW England, national roll-out". Clearly any proposed project of a similar nature could benefit from practitioner involvement from experienced and well equipped amateur astronomers, both in terms of stargazing and lecture giving.

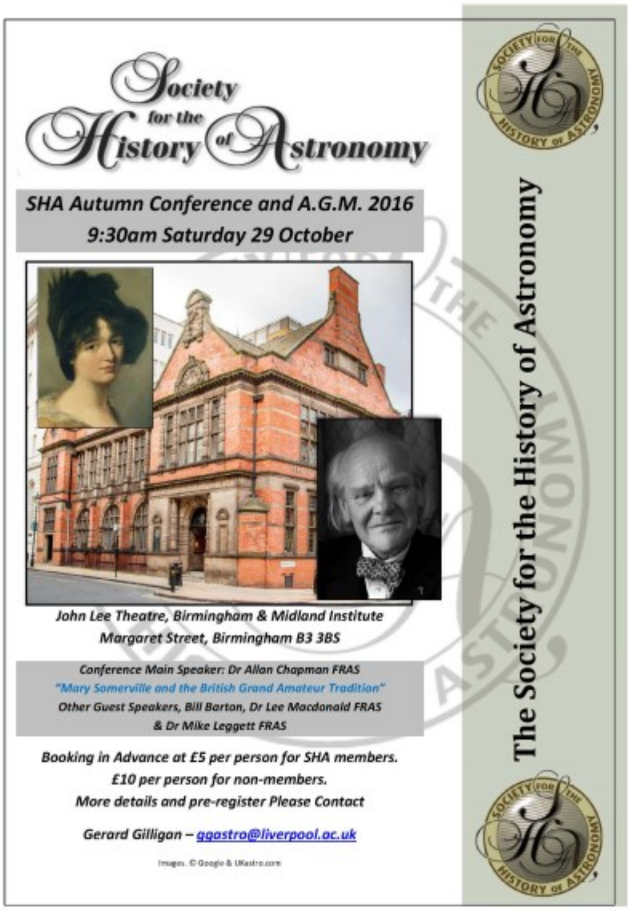
The time table for 2nd tranche is as follows:

- Local stakeholder (what RAS calls "Townhall" meetings) Sept-Dec 2016
- Outline proposals - open 10th October close 9th December 2016
- 1st Grants Panel 8th Feb 2017
- Full proposal deadline 7th April 2017
- 2nd Grants Panel 19th April

I have volunteered to act in a facilitation role, i.e. as an initial contact point for any organisations that wish to construct a project proposal that might need the boots-on-the-ground support that the amateur astronomy community can provide. I would then identify suitable nearby FAS member societies and make the introductions and then bow out. Apart from the satisfaction gained by any involved Society from helping the community, there could well be a negotiated input to society funds - but that would be down to your own negotiation.

I hope that FAS Societies will welcome this potential opportunity. Please note that this RAS scheme is not a route to get your own observatory built!

John Axtell



Time	Speaker	Subject
09.30 to 10.00	REGISTRATION - Refreshments will be available in the lecture theatre	
10.00	Bob Bower, Chairman SHA	Welcome to the BMI
10.15 to 11.15	Bill Barton FRAS	*"The Chaldean Astronomical Society"*
11.15 to 12.15	Dr Lee Macdonald FRAS	*"George Airy and the Origins of the Magnetic and Meteorological Department at Greenwich"*
12.15 to 13.30	LUNCH BREAK	
13.30	Bob Bower,	Welcome back
13.30 to c14.30	SHA COUNCIL	*2016 Annual General Meeting* All Members and Guests welcome
c14.30 to 15.30	Dr Mike Leggett FRAS	*"The Hartwell Synod: Doctor John Lee, Admiral Smyth, and their associates"*
15.30 to 16.00		AFTERNOON REFRESHMENTS
16.00 to 17.00	Dr Allan Chapman FRAS President SHA	*" Mary Somerville and the British Grand Amateur Tradition"*
17.00	Bob Bower	CONCLUSIONS & DISPERSAL
Delegates are asked to make their own arrangements for lunch. There is an excellent cafeteria upstairs and a pub nearby.		

Summer Fayre at St. John's Church, Knotty Ash

David Galvin

Following a recent invitation, the Liverpool Astronomical Society was invited to St. John the Evangelist Church, Knotty Ash for their annual Summer Fayre, which was based on a Victorian theme.

As the LAS was started in 1881 which was during the Victorian period, stall holders, including some of the LAS members dressed in period costume.

The day started rather cloudy but by mid-afternoon the Sun decided to join us and display its prominences, flares and sunspots.

Questions were asked regarding the scale of the Solar System and answered by comparison of a beach ball, table tennis ball and a garden pea to represent the Sun, Jupiter and Earth. Maybe not the most accurate scale model, but the general idea of how small the Earth actually is was put across in the most basic of ways that suited our visitors.

The event was located in three areas: the church, the church hall and the vicarage garden where the Liverpool AS was situated. There were numerous activities in the garden including 'Afternoon Tea' and children's activities, which gave a diverse age group and good interest in what we were displaying.

We were able to safely show prominences and filaments on the solar disc through the society's Coronado H-alpha telescope and a magnificent sunspot through a white-light filter on Chris Banks' refractor. Thanks go to members Ali Southern , Chris Banks, Geoff Simm & Tricia Banks . Camelia Usher-Galvin and Sue Farley , who both organised the event, greatly appreciated the LAS attending .

A great day of fun was had by all.

courtesy LAS Newsletter

Shropshire AS Astro-Imager of the Year

The seed of an *astro-imaging* competition emerged from the confirmation of **Pete Lawrence** (of *Sky at Night* fame) as the presenter at the sixth Shropshire AS annual lecture. As with all committee decisions, the concept was mulled over at length before a consensus of a way forward was reached. Following initial reservations, there is now the desire for it to become an annual event.

Deciding who was to carry off the Astro-Imager winner's trophy in the first Shropshire Astronomical Society's (SAS) competition proved difficult for the panel of judges. Standards proved to be high and produced some exceptional images across all categories. Winners **Christine Morton** (under 16), **Jane Newell** (Society member) and **Alan Jones** (Shropshire resident) won subscriptions to *SPA Young Stargazer*, *Astronomy Now* and *Sky at Night* respectively, with Jane scooping the trophy for Astro-Imager of the year.

Not able to be present to receive her trophy on the night, SAS member and winner Jane Newell received her awards from chairman Peter Gunn at a later date: a year's subscription to Astronomy Now and a copy of Shooting Stars by Nik Szymanek.

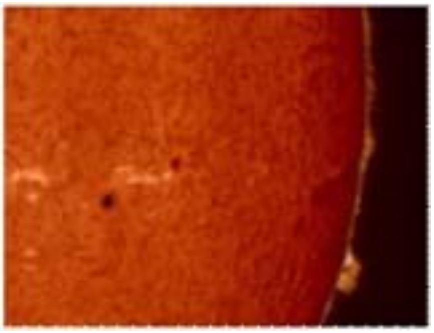
These winners, together with other highly recommended images by **Pete Williamson** and **Tania Jones**, were awarded their prizes by *Sky at Night* presenter **Pete Lawrence** at the annual lecture of the SAS, who shared his expertise and experience of the Aurora Borealis to a large audience at *Meole Brace School Science College.*

This new venture by the Society encouraging stargazers of all abilities and ages to share the wonders of the night sky proved to be very popular and will be repeated again this year. So, with the dark nights with us, get your cameras out and get snapping.

A judge's comment by planetary imager **David Woodward**: "For years I have wanted the society to hold a photo-competition but I have had to wait until the technology caught up; it is so much easier now for individuals to make and submit images. What I hadn't anticipated was that the first competition would be open to such a wide range of people, including non-members and teenagers! It was a pleasure to be one of the judges and get to use my accumulated if strictly limited knowledge to help come up with what I hope are the most deserving winners. It's a pity that the message didn't get through to youngsters and to some of the Society's more experienced imagers but we have made a start. Next time it will be even better."

A judge's comment by deep sky imager **Andrew Johnson**: "I was very excited when the photo competition was announced and delighted to be asked to provide technical input as a judge, much as I would have liked

Shropshire resident and SAS member Alan Jones wins his subscription to Sky at Night for his image of Jupiter. He also received a copy of Nik Szymanek's book.



Highly recommended were Pete Williamson (FRAS), image of sun activity AR241, and Tania Jones, image @Fades of Grey' -each received a copy of Nik Szymanek's book.

(Continued from page 6)
to have entered it myself! Even with just under 40 entries, short-

listing winners in each category was no easy task and picking overall winners was even harder. There were a lot of high quality images from people with equipment ranging from phone cams through to some top of the range astro-imaging gear making it very difficult to choose between entrants. There were a lot of photos I would love to have awarded prizes to, both from both a compositional as well as

technical perspective, sadly we had to pick three winners and runners-up and separating the top two in each category was a tough choice. I'd like to thank everyone who spent the time taking, processing and sending in an entry and giving us all such a hard time in picking this year's winners and congratulate all of you for making this such a success."A winner's reflection **by Jane Newell**: "I was so surprised when I found out I had won both the member's category and over all. It's an honour to be the first winner of the Trophy! Over the past 12 months I've learnt so much about astroimaging through society members, in particular from **Kev Wildgoose** and his excellent astro-imaging course and also **Andrew Johnson**, through his talk on Astrophotography and the helpful advice he has given me along the way. When taking my winning image, I was actually trying to capture a Perseus Meteor. When it came to editing I realized not only had I not captured any but the images I had were very clear, so I decided to combine all the images and Star Trails was the end result. That sums up astro-imaging for me. Frustrating and rewarding in equal measure."

The awards

Not able to be present to receive her trophy on the night, SAS member and winner **Jane Newell** received her awards from chairman **Peter Gunn** at a later date: a year's subscription to *Astronomy Now* and a copy of *Shooting Stars* by **Nik Szymanek**.

Jane's star trail image (previous page) was awarded best in show,

earning her the title of Astronomy Photographer of the Year Selection 3, and so she received the SAS Astro-Imager 2015 trophy.

Receiving a copy of and a year's subscription to SPA *'Young Stargazer'* from **Pete Lawrence** is under 16 winner **Christine Morton** for her close-up image of the moon.

Shropshire resident and SAS member **Alan Jones** wins his subscription to *Sky at Night* for his image of Jupiter.

All winners also received a copy of *Shooting Stars* by **Nik Szymanek**. Highly recommended were **Pete Williamson** (FRAS) for his image of sun activity AR241 and **Tania Jones** for 'Fades to Grey', receiving their copies of Nik Szymanek's book.

Shropshire Astronomical Society

Taken from Hermes—newsletter of Shropshire AS

Apollo astronaut Buzz Aldrin touches down in the North West

Phil Williams (with photos by John Williams) *- courtesy LAS Newsletter*

Legendary former NASA astronaut Buzz Aldrin made a rare visit to the North West of England on 2nd June, giving a talk which included details of his extraordinary life at NASA and in particular his experience of the Apollo 11 Moon landing. The event took place at the Croston Theatre at Westholme Senior School and Sixth Form in Lancashire. The talk was attended by a number of LAS members as well as members of other amateur astronomical societies and the general public.

It was followed by an opportunity to purchase copies of Buzz's books and to have the books signed by the man himself. Buzz and his fellow astronaut, the late Neil Armstrong, became the first men to land and walk on the Moon. They touched down on the surface of the Moon at 20:18 UTC on 20th July 1969 and Neil Armstrong took his first steps 6 hours later at 02:56 UTC on 21st July 1969, with Buzz joining him on the surface 20 minutes later. Buzz gave a fascinating, entertaining and humorous talk about his early life, his military career and his career as a NASA astronaut. The talk was supported by impressive scale models of the Saturn V rocket, the combined Command/Service module and Lunar Module used in the Apollo 11 Mission and an excellent audio-visual presentation (Photo 1). Buzz was joined on stage by Christina Korp who has supported Buzz in outreach work for the last eight years in her capacity as "Manager and Mission Control Director".

Photo 1: Standing by for lift off (Saturn V Rocket; combined Service, Command and Lunar modules)

Buzz told a captivated audience that he was selected as a NASA astronaut in October 1963. His initial earlier application had been rejected on the basis of him never having been a test pilot, but this restriction was subsequently lifted making him eligible to apply. He was appointed pilot on the last of the Gemini missions. During the mission he set a record for Extra Vehicular Activity demonstrating that astronauts could work for extended periods in space outside spacecraft. He proudly pointed out that during the Gemini 12 mission he became the first person to take a space "selfie" (Photo 2).

Buzz talked about the Apollo 11 Moon Landing Mission in some detail. Launched by a Saturn V rocket from Kennedy Space Centre in Florida on 16th July 1969, Apollo 11 was the fifth manned mission of NASA's Apollo programme. The Apollo spacecraft consisted of three parts: the Command Module containing a cabin for the astronauts; the Service Module which supported the Command Module with electrical power, water, oxygen & propulsion and thirdly the Lunar Module for landing on the Moon. The astronauts were sent toward the Moon by the upper stage of the Saturn V rocket and travelled for three days until they entered lunar orbit. Buzz and Neil Armstrong moved into the Lunar Module in preparation for the landing leaving the third member of the mission, Michael Collins, to pilot the Command spacecraft alone in lunar orbit. The Lunar Module landed on the surface of the Moon in the Sea of Tranquillity. They stayed for approximately 211/2 hours on the lunar surface before lifting off in the upper section of the Lunar Module and rejoining Collins in the Command Module. They returned to Earth and landed in the Pacific Ocean on 26th July.

Photo 2: Buzz displays his space "selfie" taken during the Gemini 12 Mission

The lecture and book-signing were a great success and follow Buzz's 2015 visit when he featured on BBC Stargazing Live, a programme in which members of Liverpool Astronomical Society have participated for a number of years. Following the book-signing, an opportunity was taken to show Buzz a group photo taken in the Stargazing Live studio just after the broadcast. This included himself, other members of the scientific panel and a number of LAS members

Photo 3: Buzz leaves the Lunar Module and descends the ladder to the lunar surface

who were present in the studio audience at Jodrell Bank. Buzz commented how he had enjoyed the event and remembered the photo being taken. Let's hope it's not too long before he returns to this part of the planet.

Photo 4: Buzz having a look at the group photo taken at "BBC Stargazing Live 2015", which included Buzz and some LAS members

TRANSIT OF MERCURY FROM IPSWICH ORWELL AS

The arrangements for coordinating the arrangements for observing the transit from Orwell Park Observatory were undertaken by James Appleton and Martin Cook.

After some debate, they decided to utilise the Tomline Refractor to project an image of the solar disk, which could be studied visually and photographed, leaving observers on the balconies of the Observatory to use more sophisticated electronic imaging in white light and Ha wavelengths.

The Dome—Preparations

Experience with the transit of Mercury on 07 May 2003 and the transit of Venus of 08 June 2004 demonstrated the benefit of an effective sunshade in minimising ambient sunlight entering the dome, thereby improving the contrast of the projected image. The sunshade used in 2004 comprised essentially a lengthy home-made blind attached to the dome via nylon cords passing through eyes screwed into the wooden framework around the aperture. The end of the telescope holding the object glass (OG) protruded through the sunshade. By adjusting the length of various cords in a coordinated manner, the sunshade could be raised and lowered to match the altitude to which the telescope was directed.

The sunshade used in 2004 worked to a reasonable extent but did not fit well the curvature of the inside of the dome and thus allowed considerable ambient light to enter. James and Martin therefore planned a new, improved sunshade. Planning started several weeks in advance and initial thoughts were simply to fabricate a sunshade similar to that used in 2004 but with more cords enabling it to be held tighter to the curvature of the dome. Eventually, however, a more elaborate scheme evolved, based on a pair of runners fitted to the interior side of the aperture of the dome, with the sunshade held in position between the interior of the dome and the runners. Matthew Leeks constructed the runners from 15 mm copper pipe and brought

them to the Observatory on Wednesday 27 April where, together with Alan Smith, he shaped them to the correct curvature. The following Wednesday, James, Martin, Matthew and Alan erected scaffolding in the dome and secured the runners in position, using brackets fabricated by Martin (figures 1 and 2).

Fig. 1. Erecting scaffolding in the dome. (JMA)

Fig. 2. Fitting the runners for the sunshade. (ML)

Two days later, James constructed a sunshade from 10 m of material secured to wooden battens; despite leaving work early to begin the task, practical difficulties meant that work continued late into the night! The following day, James, Martin, Matthew and Alan attended the Observatory and fitted the sunshade; as the Sun was shining in a clear sky, they were able to test its effectiveness. Unfortunately, it was immediately apparent that the material was just too thin and the degree of obscuration was far short of what was necessary. With the aperture of the dome turned in the opposite direction to the Sun, the blue of the sky was clearly visible (figure 3); conversely, with the aperture turned towards the Sun, the material allowed enough sunlight to enter the dome to cast a distinct shadow of the telescope on the projection screen, and the solar image had poor contrast (figure 4). The personnel withdrew to consider the best course of action.

The following day, James and Martin returned to the dome determined to improve matters. Enhancements included doubling the thickness of material used for most of the length of the sunshade (figure 5), obscuring the arched windows at the base of the dome, and

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Fig 3. Material of the sunshade provides limited obscuration. (JMA)

Fig. 4 Solar image with very poor contrast. (JMA)!

Fig. 5. Enhancing the sunshade. (JMA)

fitting a 1 m square shadow screen at the OG-end of the telescope. After many hours of work, the task was complete and the dome was ready! The new sunshade worked well: figure 6, taken on the day of the transit, looking along the length of the telescope, shows the considerable attenuation of direct sunlight provided by the sunshade, and shows too the shadow screen. Collectively, the light-exclusion measures considerably reduced the ambient illumination in the dome. The Tomline Refractor produced an image of the Sun 50 cm in diameter, with good contrast, and no hint of a shadow of the telescope on the projection screen.

Arrival At Orwell Park On 09 May

On the day of the transit, James, Martin and David Murton were first to arrive at the Observatory, at approximately 09.30am. After helping to transport David's imaging equipment to the south-west balcony,

Fig. 6. The sunshade and shadow screen. (JMA)

where he began setting up, James and Martin went to the dome to prepare the Tomline Refractor. They selected a large, ex-military surplus eyepiece (the same as that employed for observation of the transit of Venus in 2004). The aperture of the dome was so well obscured that it was difficult at first to align the Tomline Refractor on the Sun. Eventually the pair succeeded, whereupon two sunspot groups (Active Regions 2542 and 2543) together with a few isolated sunspots were immediately visible. There was no evidence of granulation or plages. Martin fitted his Canon D1100 and Samsung WB750 cameras to the mounting bracket at the eyepiece end of the Tomline Refractor (figure 7) and centred them on the region where 1st contact would occur. He secured a large radio-synchronised "Rugby" clock (more properly an MSF clock) to the corner of the projection screen for timing events. Once the prep-

Fig. 7. Cameras fitted to the Tomline Refractor. (JMA)

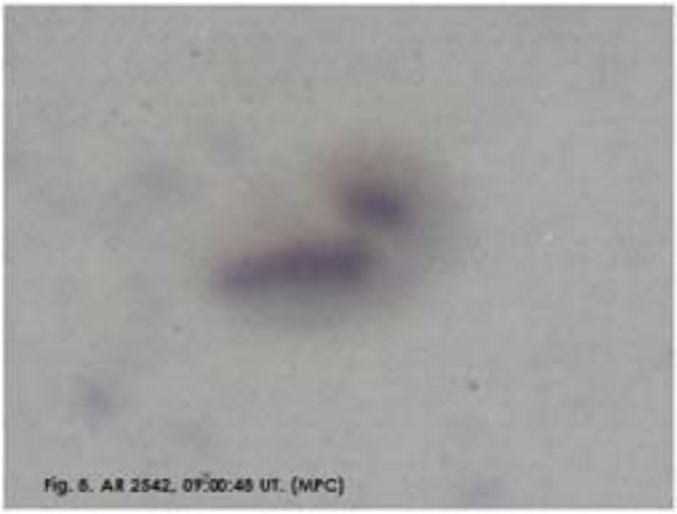

Fig. 8. AR 2542, 07:00:48 UT. (MPC)

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arations were complete, he took some photos of AR2542 (figure 8) to test the cameras.

Estimate	1st contact	2nd contact
Observers in dome	11:12:45 (Paul Whiting)	Possibly 11:14:36 - 11:14:39, certainly by 11:15:16
James Appleton (video)	11:12:38	11:15:35
Martin Cook (video)	11:12:38	11:15:33
Predicted	11:12:23	11:15:35

Estimates of event times (UT).

Bill Barton and Paul Whiting arrived at the observatory at 10.00am, and John Wainwright shortly thereafter. Preparations complete, the observers settled down to wait for ingress to begin. The weather was promising: the sky was clear! To provide some light entertainment, Martin employed an industrial thermocouple to measure the temperature of the Sun's rays concentrated by the eyepiece of the Tomline Refractor. After a few seconds at the focus, the thermocouple glowed bright red and the temperature reading went off the scale at 750°C! (Figure 9.) Shortly after 11.00am, more observers arrived: Adrian Cubitt, Tina Hammond, Richard Stansfield and Mike Whybray. Figure 10 shows some of the observers studying the projection,

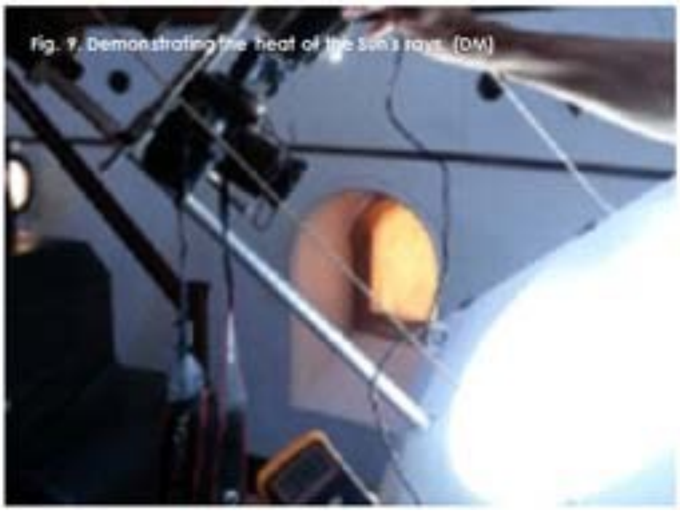


Fig. 9. Demonstrating the heat of the Sun's rays. (DM)


Fig. 10. Studying the sunspots. (DM)

waiting for the transit to begin.

Approximately 15 minutes before the transit started, some thin cloud passed in front of the Sun, causing a loss of definition of the projected image. Fortunately, the cloud passed after approximately five minutes, and definition returned. The observers gathered around the projection screen and Martin set the cameras so that the D1100 took a still image every approximately 4 s and the WB750 recorded a video (which terminated shortly after 2nd contact). A handheld "Rugby" clock was placed briefly in the field of view of the WB750 to provide a timing reference for later, off-line analysis of the video. The observers then concentrated on the image, waiting for 1st contact.

Ingress Phase

The observers recorded the following event times (UT). Paul was first to detect the barely-perceptible indentation of the silhouette of Mercury on the Sun's east limb, at 11:12:45. Once he indicated the phenomenon, other observers were immediately able to see it too, thus all observers were reasonably confident that they had observed the silhouette of Mercury within a few seconds of the instant of 1st contact. However, there was no such certainty in the estimation of 2nd contact due to a prolonged teardrop effect. At 11:13:32, Paul detected the teardrop, but this was not confirmed by other observers. At 11:14:20, Paul called out an observation of 2nd contact, but this was not confirmed by other observers, and was later thought to be an error. Paul called out the instant of 2ndcontact again at 11:14:36 and at 11:14:39 and several observers in the dome agreed that 2nd contact occurred somewhere around these times. However, other observers were of the opinion that there was still a pronounced teardrop effect at this time, and the silhouette of Mercury had not detached from the solar limb. Nonetheless, all present agreed that 2nd contact had certainly occurred before 11:15:16.

Later, James and Martin independently analysed the video recording and produced off-line estimates of event times. The following table compares the various empirical estimates together with predicted contact times calculated using the NASA JPL ephemeris DE-431.

Figure 11 is a montage of the images from the D1100 during the period 11:12:37 - 11:16:15 UT, from approximately the instant of 1st contact until after 2nd contact. It shows the very pronounced teardrop effect extending from approximately 11:14:09 - 11:15:27 UT. (Note that the timer triggering the camera was not completely accurate, and a few images deviate from the intended 4 second periodicity.) Observers with handheld cameras also recorded the teardrop effect: see figure 12, compiled from images by James Appleton taken with a Canon PowerShot SX220, 11:13:24 - 11:15:48 UT (note that the images are not evenly spaced in time).

After 2nd contact, the diameter of the silhouette of Mercury was measured as approximately 3 mm, illustrating the huge difference in scale between the planet and the Sun, the image of which had a diameter of approximately 50 cm.

Mid-transit

After the ingress phase, observers in the dome continued to observe the transit. Of course, observations were not conducted as diligently as during the ingress phase, as little of interest was expected to happen. Figure 13 (by John Wainwright) shows the scene in the dome roughly an hour after ingress: a sense of *ennui* is evident! Fortunately, a diversion soon presented itself. The sky became noticeably hazy. Martin siezed the opportunity to demonstrate the attenuation of solar radiation by haze, by once more holding the industrial thermocouple at the focus of the Tomeline Refractor: this time, the temperature topped out at a mere 505°C!

Throughout the transit, observers in the dome plotted on a large sheet of paper, attached to the projection screen, the progress of the silhouette of Mercury across the solar disk. Figure 14 shows their efforts. (Note, the projection is E-W reversed relative to the naked eye view.)

Chromatic Aberration

The OG of the Tomline Refractor is an unsophisticated doublet, manufactured by Merz in the early 1870s, comprising a crown glass and a flint glass. It provides colour correction at just two wavelengths (unlike modern multi-element OGs which provide colour correction

(Continued on page 12)

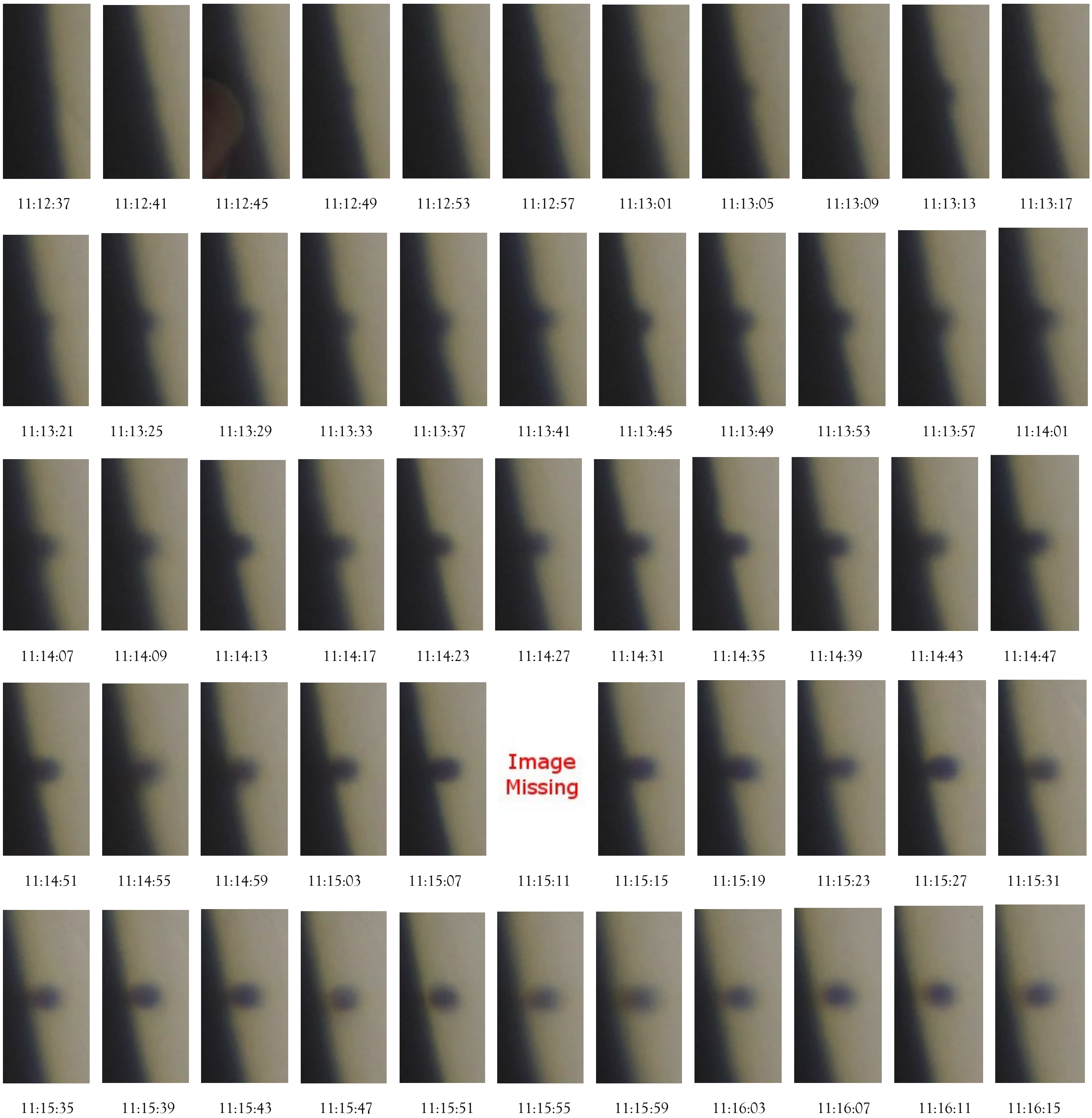


Fig. 11. Images taken approximately every 4 s during ingress. (MPC)

(Continued from page 11)

at three or even four wavelengths) and is not of high quality by today's standards and, unsurprisingly, suffers from chromatic aberration.

Chromatic aberration was apparent in the projected image during the transit. It was visible to the eye, but was sometimes difficult to photograph, and sometimes easy, perhaps determined by the spectral response of the camera. The effect was radial, the black disk of Mercury exhibiting a green/yellow fringe on the circumferential arc closest to the centre of the image and a red/purple fringe on the diametrically opposite arc. In addition, the limb of the Sun was bordered by a yellow fringe and, beyond, a green/blue fringe. Off-line analysis of images afterwards, decomposing colour photographs into RGB components, revealed that green and red wavelengths were in focus, but blue was not.

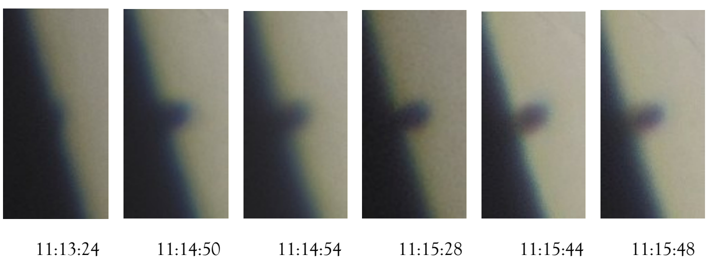


Fig. 12. Images taken during ingress. (JMA)

Some photographs of the aberration are shown in Figure 15, by Tina Hammond, using a Samsung mobile phone, at 11:14:22 UT (between 1st and 2nd contact), shows the green and yellow fringe around both the solar limb and the limb of Mercury facing the centre of the image. Figure 16, also by Tina, at 11:16:59 UT, shortly after 2nd contact, shows clearly chromatic aberration around the entire limb of Mercury. Lindsay Hammond-Smith (last of the observers to arrive, *circa* 4.00pm) captured figure 17 at 16:03:00 UT, also showing chromatic aberration around the entire limb of the planet. At this time, Mercury appeared much closer to the centre of the disk so the aberration is less pronounced, and the sunshade was less effective, allowing more ambient light to enter the dome, so the image suffers from reduced contrast compared to those captured during the ingress phase.

End Of Observations

(Continued on page 13)

(Continued from page 12)

As the afternoon progressed, the sky became increasingly hazy and cloudy, although with some clear patches. At 5.00pm, thick cloud began rolling in and, by 5.15pm, the sky was overcast. Reluctantly, with no hope of further observations, the observers in the dome

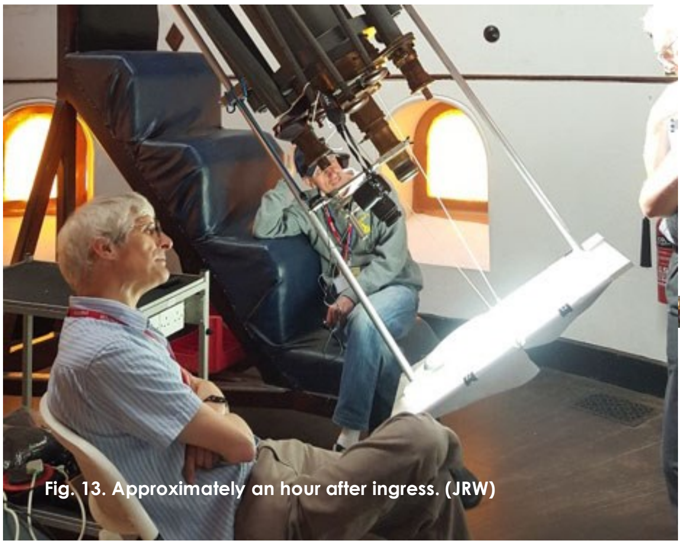


Fig. 13. Approximately an hour after ingress. (JRW)

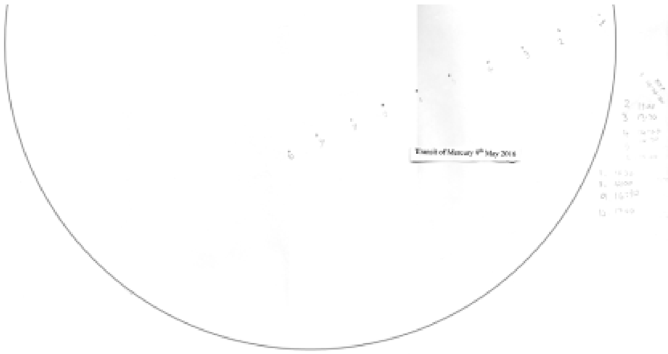


Fig. 14. Progress of the silhouette of Mercury across the solar disk.

packed away the equipment. By 6.00pm, it was raining.

Note: Image credits above are as follows: JMA = James Appleton, MPC = Martin Cook, TH = Tina Hammond, LHS = Lindsay Hammond-Smith, ML = Matthew Leeks, DM = David Murton, JRW = John Wainwright.

David Murton, On the South-West Balcony

David observed from the south-west balcony of the Observatory using two instruments as follows:

- in Hα light using a Coronado PST (Personal Solar Telescope) with Altair GPcamV2 IMX224 camera on a Skywatcher *Star Adventurer* mount. Figures 18-21 are images from the PST. Note the small prominence on the limb at the position of first contact.
- in white light using a William Optics 71ED with Orion white light filter and Altair colour GPcam on a Skywatcher alt-az mount. See Figures 22-23

Paul Whiting, FRAS, On the South Balcony

At 10.30am, Paul used a handheld scanner to tune in to a schools radio link with Major Tim Peake, orbiting some 400 km above in the International Space Station. The communication lasted a few minutes, during which Tim responded to a question posed by a pupil about time dilation.

After observing the ingress phase of the transit in the dome, Paul observed during mid-transit from the south balcony of the Observatory using a William Optics GT-81 with Nikon D3200 camera on Skywatcher mount. Figure 24 shows an image captured in white light at 11:44 UT, 1/1600 s exposure at ISO 400.

Fig. 18. 11:14:31 UT

Fig. 19. 11:29:26 UT

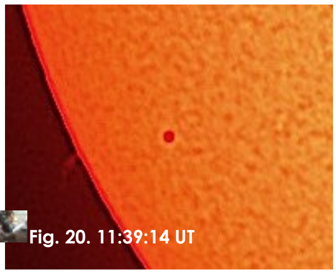


Fig. 20. 11:39:14 UT

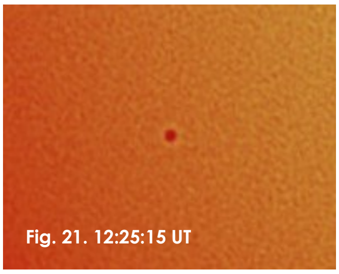


Fig. 21. 12:25:15 UT

Taken from OASI News.

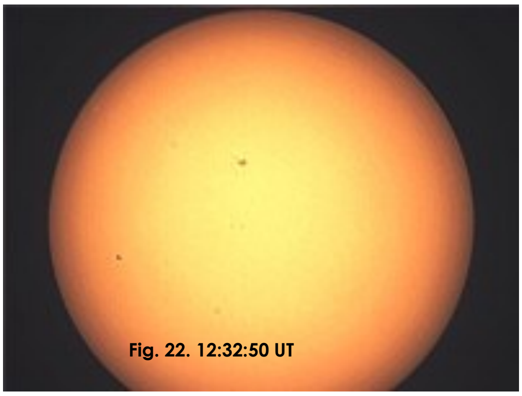


Fig. 22. 12:32:50 UT

Figures 22-23 are images from the 71ED.

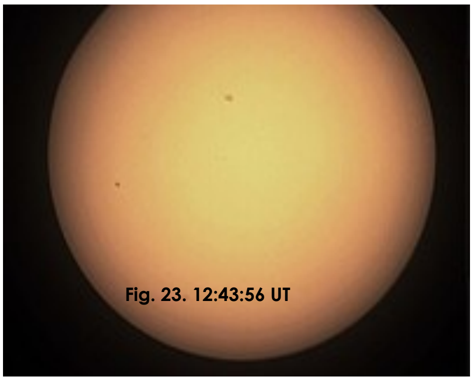


Fig. 23. 12:43:56 UT

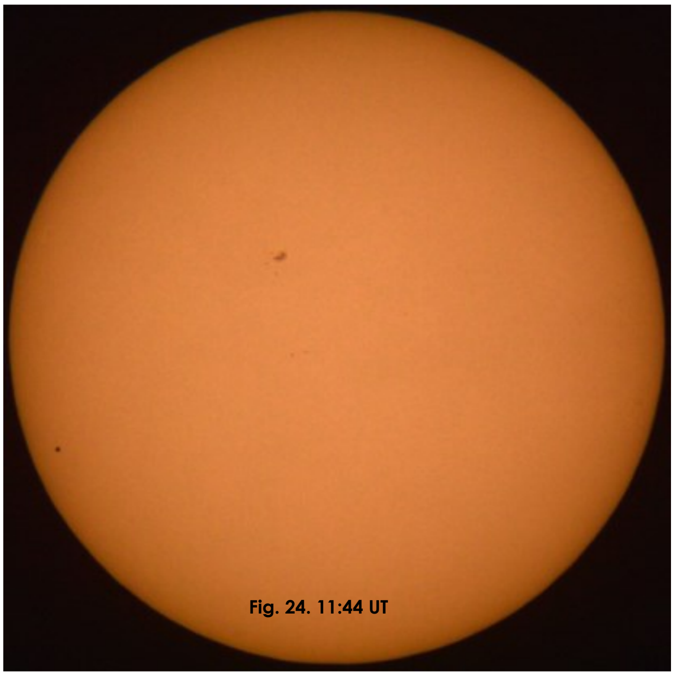


Fig. 24. 11:44 UT

Partially-sighted

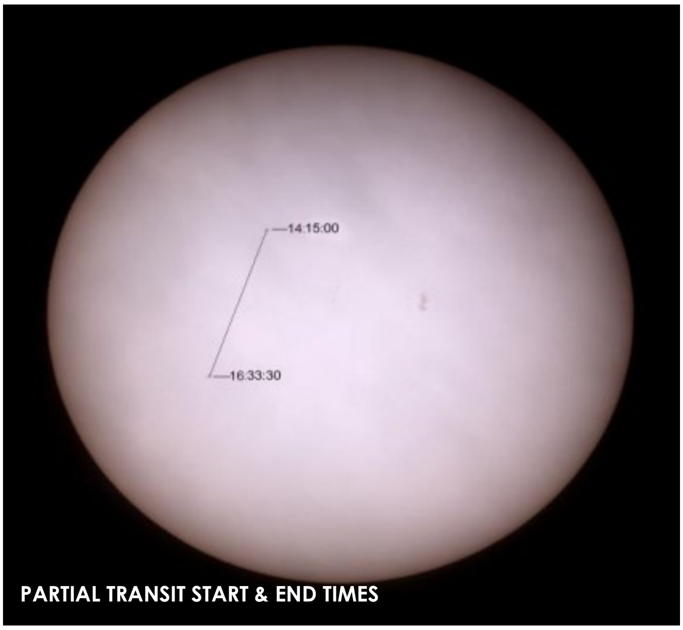
David Woodward, Shropshire AS, makes good use of the Transit of Mercury:

No, I'm fine. In spite of being myopic since the age of twelve I have good vision but, like the rest of us, only saw Mercury transiting the face of the Sun for a couple of hours or so on the afternoon of 9th May, less than half of the duration of the transit. I took lots of photos and it has occurred to me that I could make use of three useful tools of digital technology to try and estimate the transit times and the diameter of Mercury given that the most excellent *Canopus Encyclopedia of Astronomy* tells me that the actual diameter of the Sun is 1,391,940 km.

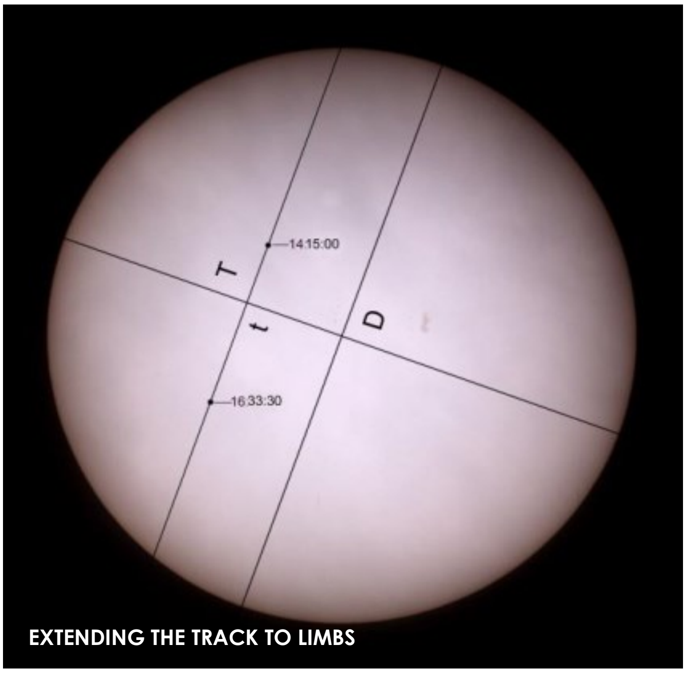
DETAIL OF TRANSIT AT 14:39

Of course, the established way of working out these figures was to make accurate measurements through large telescopes and use classical celestial mechanics and orbital elements to work out accurate figures. My simple, very crude method, is to scale up the images on screen or screenprint and physically measures the relative dimensions of Sun, transit path and planet.

This is where the first tool mentioned above comes in. If you



PARTIAL TRANSIT START & END TIMES



EXTENDING THE TRACK TO LIMBS

switch on the grid function on an image in PhotoShop then it stays in the same ratio to the image when you zoom in using the magnifying glass. So, to begin, here is my attempt to extrapolate the path of Mercury and back-predict the start and end times of the transit.

The first job was to superimpose the first and last images and draw a line between them and then extend it to the Sun's limbs.

By adding a third, parallel line to define a solar diameter I had all the required lines which could then be measured.

The next task was to compare the time shown on my camera clock with that given by my weather station which is continually updated by a radio signal from a transmitter in Germany. This is the second tool. The corrected times are shown next to the two planetary positions above.

Corrected Time of 1st Image	14:15:00 BST
Corrected Time of 2nd Image	16:33:30 BST
Duration of Partial Transit	02:18:30 = 8280 secs

From the photos, measured in arbitrary units:

Distance Traversed	(t) = 66 arbitrary units
Distance of Full Transit	(T) = 213.3 arbitrary units
Diameter of Sun	(D) = 225.5 = 1,391,940 km
Nominal Duration of Total Transit	(δ) = T / t x 8280
	= 26,760 secs
	= **07h:26m:00s**

Transit Distance from Start to 14:15:00 = 82 units
Transit Distance from 16:33:3O to end = 65 units
Duration of Transit from Start to 14:15:00 = 82 / 213.3 x 26,760
= 10,287 secs
= **02h:51m:27s**

Duration of Transit from 16:33:30 to end = 65/213.3 x 26,759
= 8,154 secs
= **02h:15m:54s**

(Continued on page 15)

(Continued from page 14)
Note that, at this stage, the times represent the crossing of Mercury's centre over the limb of the Sun, so, ignoring this refinement:

Nominal Start Time of Transit (α) = 14:15:00 – 02:51:27
= **11h:23m:33s**
Nominal End Time of Transit (β) = 16:33:30 + 02:15:54
= **18h:49m:24s**

Of course, to work out the times of first and fourth contacts, I need to estimate the diameter of Mercury and this has to be done in two stages.

Measured Diameter of the Sun = 39.25 squares of the grid

Measured Diameter of Mercury = 0.280 squares

Estimated Diameter of mercury = (0.245 / 39.25) x 1,391,940
= 8,681 km

This is an apparent diameter and will need to be corrected (see below):

Measured Length of Sun's Diameter (D) = 347 arbitrary units

Measured Length of Partial Transit (t) = 100.7 arbitrary units

Duration of Imaginary Transit of Mercury Sun's Diameter (Φ)
= 347 / 100.7 x 8280 secs
= 28,532 secs
Time Taken by Mercury to Transit its Own Diameter (θ)
= apparent dia. of Mercury x Φ dia. of Sun
= 11,936 / 1,391,940 x 28,532
= 245 secs = 4m:5s
Duration of Transit from 1st to 4th Contact (Δ)
= $\delta + \theta$ = 07:26:00 + 00:04:05
= **07h:30:05s**

Allowing for the addition and subtraction of $\theta/2$ at the start and end of the transit:
Time of 1st Contact (**A**) = $\alpha - \theta/2$
= 11:23:33 – 00:02:02
= **11h:21m:31s**
Time of 4th Contact (**B**) = $\beta + \theta/2$
= 18:49:24 – 00:02:02
= **18h:47m:22s**

Now all that remains to do is to work out the true diameter of Mercury (m) because the measurement of its diameter on a photograph is a measure of its apparent diameter (M).

We think of Mercury as being very close to the Sun but, in fact, its orbit can take it to nearly half the distance from the Earth to the Sun so, its true size is less than is apparent at a transit.

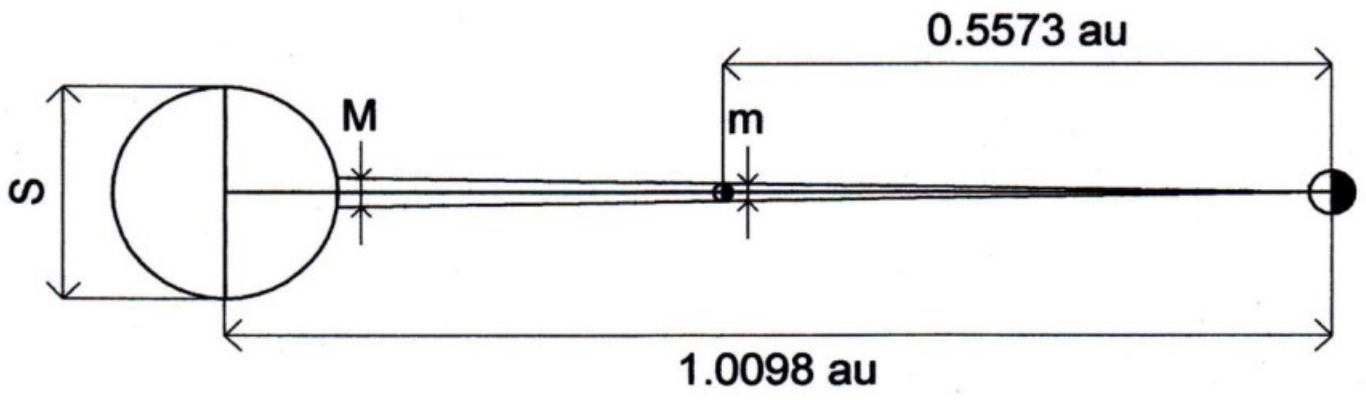
For the time in question the third tool available to us is invoked, namely a planetarium programme. My *Cartes du Ciel* tells me that Mercury was at a distance of 0.5573 au from the Earth and that the Sun was at 1.0097 au.

So, by proportion:
Actual Diameter of Mercury = 0.5573 / 1.0097 x 8,681
= **4,792 km**

So where does that get me? Here is a comparison of my estimates with the true values:

* Times by Fred Espenak and NASA Eclipse Website	Estimated Values (UT)	Actual Values (UT)
Duration of Transit from 1st to 4th Contact (Δ)	07h:30:05s	07h:30:07s *
Time of 1st Contact (**A**)	11h:21m:31s	11h:12m:19s *
Time of 4th Contact (**B**)	18h:47m:22s	18h:42m:26s *
Diameter of Mercury	4,792 km	4,879 km

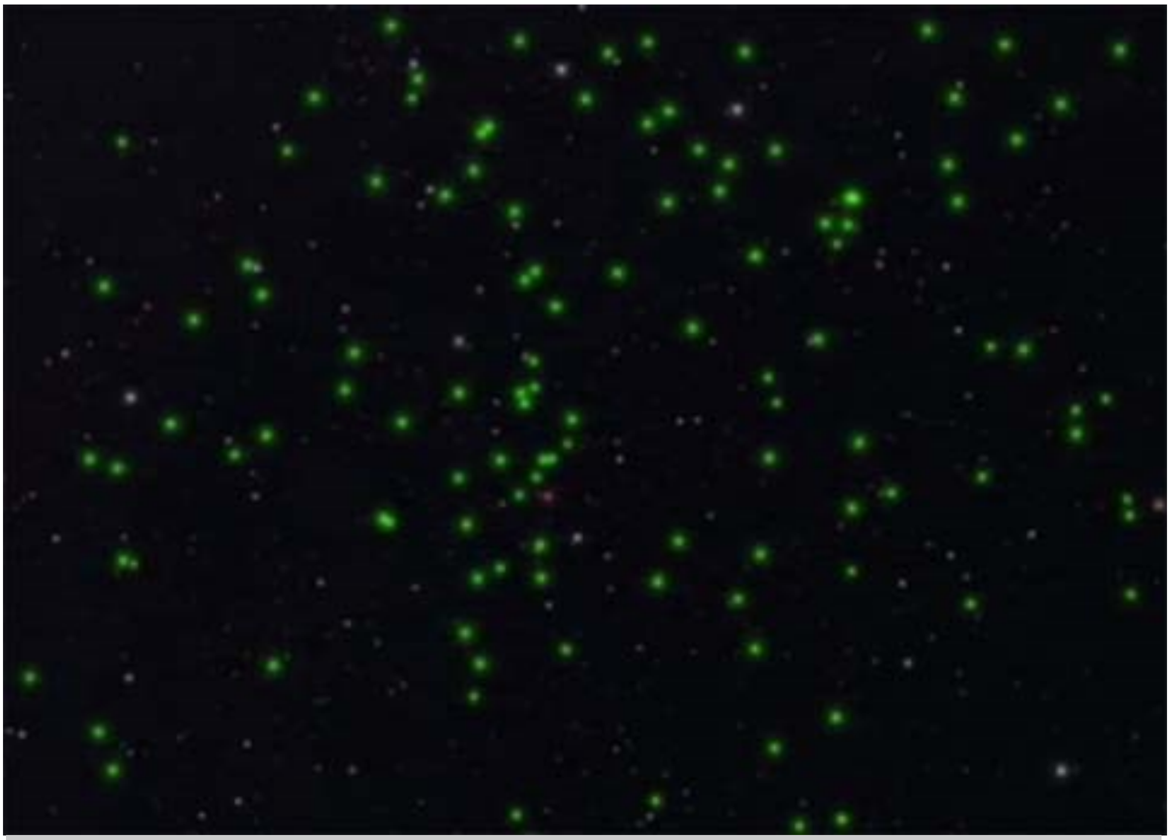
It turns out that the errors inherent in the process appear to have cancelled themselves out where the duration of the eclipse is concerned. Nevertheless, a good result for the duration of the transit is not matched by the times of first and fourth contacts which appear to be five to nine minutes late. I wonder whether the official figures are calculated for observers somewhere in the USA and whether the separation of that location and the UK would make any difference.



FINDING THE TRUE DIAMETER OF MERCURY

Brown dwarfs reveal exoplanets' secrets

Source: Carnegie Institution for Science



Brown dwarfs are smaller than stars, but more massive than giant planets. As such, they provide a natural link between astronomy and planetary science. However, they also show incredible variation when it comes to size, temperature, chemistry, and more, which makes them difficult to understand, too. New work surveyed various properties of 152 suspected young brown dwarfs in order to categorize their diversity and found that atmospheric properties may be behind much of their differences.

Credit: Jacqueline Faherty and David Rodriguez

New work led by Carnegie's Jacqueline Faherty surveyed various properties of 152 suspected young brown dwarfs in order to categorize their diversity and found that atmospheric properties may be behind much of their differences, a discovery that may apply to planets outside the solar system as well. The work is published by *The Astrophysical Journal Supplement Series*.

Scientists are very interested in brown dwarfs, which hold promise for explaining not just planetary evolution, but also stellar formation. These objects are tougher to spot than more-massive and brighter stars, but they vastly outnumber stars like our Sun. They represent the smallest and lightest objects that can form like stars do in the Galaxy so they are an important "book end" in Astronomy.

For the moment, data on brown dwarfs can be used as a stand-in for contemplating extrasolar worlds we hope to study with future instruments like the James Webb Space Telescope.

"Brown dwarfs are far easier to study than planets, because they aren't overwhelmed by the brightness of a host star," Faherty explained.

But the tremendous diversity we see in the properties of the brown dwarf population means that there is still so much about them that remains unknown or poorly understood.

Brown dwarfs are too small to sustain the hydrogen fusion process that fuels stars, so after formation they slowly cool and contract over time and their surface gravity increases. This means that their temperatures can range from nearly as hot as a star to as cool as a planet, which is thought to influence their atmospheric conditions, too. What's more, their masses also range between star-like and giant planet-like and they demonstrate great diversity in age and chemical composition.

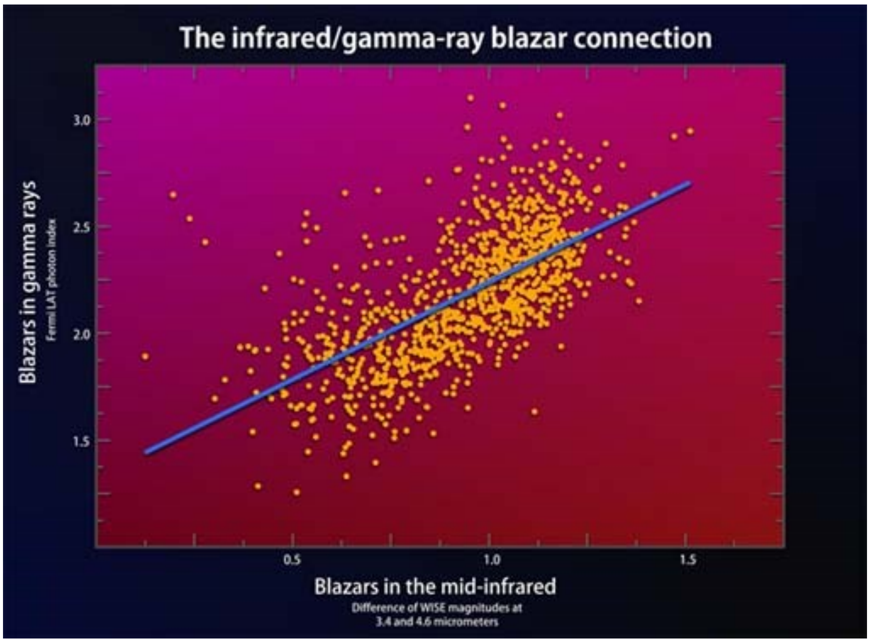
By quantifying the observable properties of so many young brown dwarf candidates, Faherty and her team -- including Carnegie's Jonathan Gagné and Alycia Weinberger -- were able to show that these objects have vast diversity of color, spectral features, and more. Identifying the cause of this range was at the heart of Faherty's work. By locating the birth homes of many of the brown dwarfs, Faherty was able to eliminate age and chemical composition differences as the underlying reason for this great variation. This left atmospheric conditions -- meaning weather phenomena or differences in cloud composition and structure -- as the primary suspect for what drives the extreme differences between objects of similar origin.

All of the brown dwarf birthplaces identified in this work are regions also host exoplanets, so these same findings hold for giant planets orbiting nearby stars.

"I consider these young brown dwarfs to be siblings of giant exoplanets. As close family members, we can use them to investigate how the planetary aging process works," Faherty said.

Science Daily

WISE, Fermi missions reveal a surprising blazar connection



An analysis of blazar properties observed by the Wide-field Infrared Survey Explorer (WISE) and Fermi's Large Area Telescope (LAT) reveal a correlation in emissions from the mid-infrared to gamma rays, an energy range spanning a factor of 10 billion. When plotted by gamma-ray and mid-infrared colors, confirmed Fermi blazars (gold dots) form a unique band not shared by other sources beyond our galaxy. A blue line marks the best fit of these values. The relationship allows astronomers to identify potential new gamma-ray blazars by studying WISE infra-red data. Credit: NASA's Goddard Space Flight Center/ Francesco Massaro, University of Turin.

Astronomers studying distant galaxies powered by monster black holes have uncovered an unexpected link between two very different wavelengths of the light they emit, the mid-infrared and gamma rays. The discovery, which was accomplished by comparing data from NASA's Wide-field Infrared Survey Explorer (WISE) and Fermi Gamma-ray Space Telescope, has enabled the research-ers to uncover dozens of new blazar candidates.

Francesco Massaro at the University of Turin in Italy and Raffaele D'Abrusco at the Harvard-Smithsonian Cen-ter for Astrophysics in Cambridge, Massachusetts, show for the first time that the mid-infrared colors of blazars in WISE data corre-late to an equivalent measurement of their gamma-ray output.

"This connection links two vastly different forms of light over an energy range spanning a factor of 10 billion," said Massaro. "Ultimately, it will help us decipher how supermassive black holes in these galaxies manage to convert the matter around them into vast amounts of energy."

Blazars constitute more than half of the discrete gamma-ray sources seen by Fermi's Large Area Telescope (LAT). At the heart of a blazar lies a supersized black hole with millions of times the sun's mass surrounded by a disk of hot gas and dust. As material in the disk falls toward the black hole, some of it forms dual jets that blast subatomic particles straight out of the disk in opposite directions at nearly the speed of light. A blazar appears bright to Fermi for two reasons. Its jets produce many gamma rays, the highest-energy form of light, and we happen to be viewing the galaxy face on, which means one of its jets is pointing in our direction.

From January to August 2010, NASA's WISE mapped the entire sky in four infrared wavelengths, cataloging more than half a billion sources. In 2011, Massaro, D'Abrusco and their colleagues began using WISE data to investigate Fermi blazars.

"WISE made it possible to explore the mid-infrared colors of known gamma-ray blazars," said D'Abrusco. "We found that when we plotted Fermi blazars by their WISE colors in a particular way, they occupied a distinctly different part of the plot than other extragalactic gamma-ray sources."

The scientists detail new aspects of the infrared/gamma-ray connection in a paper published in The Astrophysical Journal on Aug. 9. They say the electrons, protons and other particles accelerated in blazar jets leave a specific "fingerprint" in the infrared light they emit. This same pattern is also clearly evident in their gamma rays. The relationship effectively connects the dots for blazars across an enormous swath of the electromagnetic spectrum.

About a thousand Fermi sources remain unassociated with known ob-jects at any other wavelength. Astronomers suspect many of these are blazars, but there isn't enough information to classify them. The infrared/ gamma-ray connection led the authors to search for new blazar candidates among WISE infrared sources located within the positional uncertainties of Fermi's unidentified gamma-ray objects. When the researchers applied this relationship to Fermi's unknown sources, they quickly found 130 potential blazars. Efforts are now under way to confirm the nature of these objects through follow-up studies and to search for additional candidates using the WISE connection.

"About a third of the gamma-ray objects seen by Fermi remained un-known in the most recent catalog, and this result represents an important advance in understanding their natures," said David Thompson, a Fermi deputy project scientist at NASA's Goddard Space Flight Center in Green-belt, Maryland.

Black-hole-powered galaxies called blazars are the most common sources detected by NASA's Fermi Gamma-ray Space Telescope. As matter falls toward the supermassive black hole at the galaxy's center, some of it is accelerated outward at nearly the speed of light along jets pointed in op-posite directions. When one of the jets happens to be aimed in the direction of Earth, as illustrated here, the galaxy ap-pears especially bright and is classified as a blazar. Credit: M. Weiss/CfA

Journal reference: Astrophysical Journal
Provided by: NASA's Goddard Space Flight Center
Courtesy: phys.org/

ON THE ORIGIN OF PHOBOS' GROOVY MYSTERY

Mars moon Phobos sports linear grooves and crater chains whose origin has never explained. Credit: NASA/JPL

Mars' natural satellites – Phobos and Deimos – have been a mystery since they were first discovered. While it is widely believed that they are former asteroids that were captured by Mars' gravity, this remains unproven. And while some of Phobos' surface features are known to be the result of Mars' gravity, the origin of its linear grooves and crater chains (catenae) have remained unknown.

But thanks to a new study by Erik Asphaug of Arizona State University and Michael Nayak from the University of California, we may be closer to understanding how Phobos' got its "groovy" surface. In short, they believe that reaccretion is the answer, where all the material that was ejected when meteors impacted the moon eventually returned to strike the surface again.

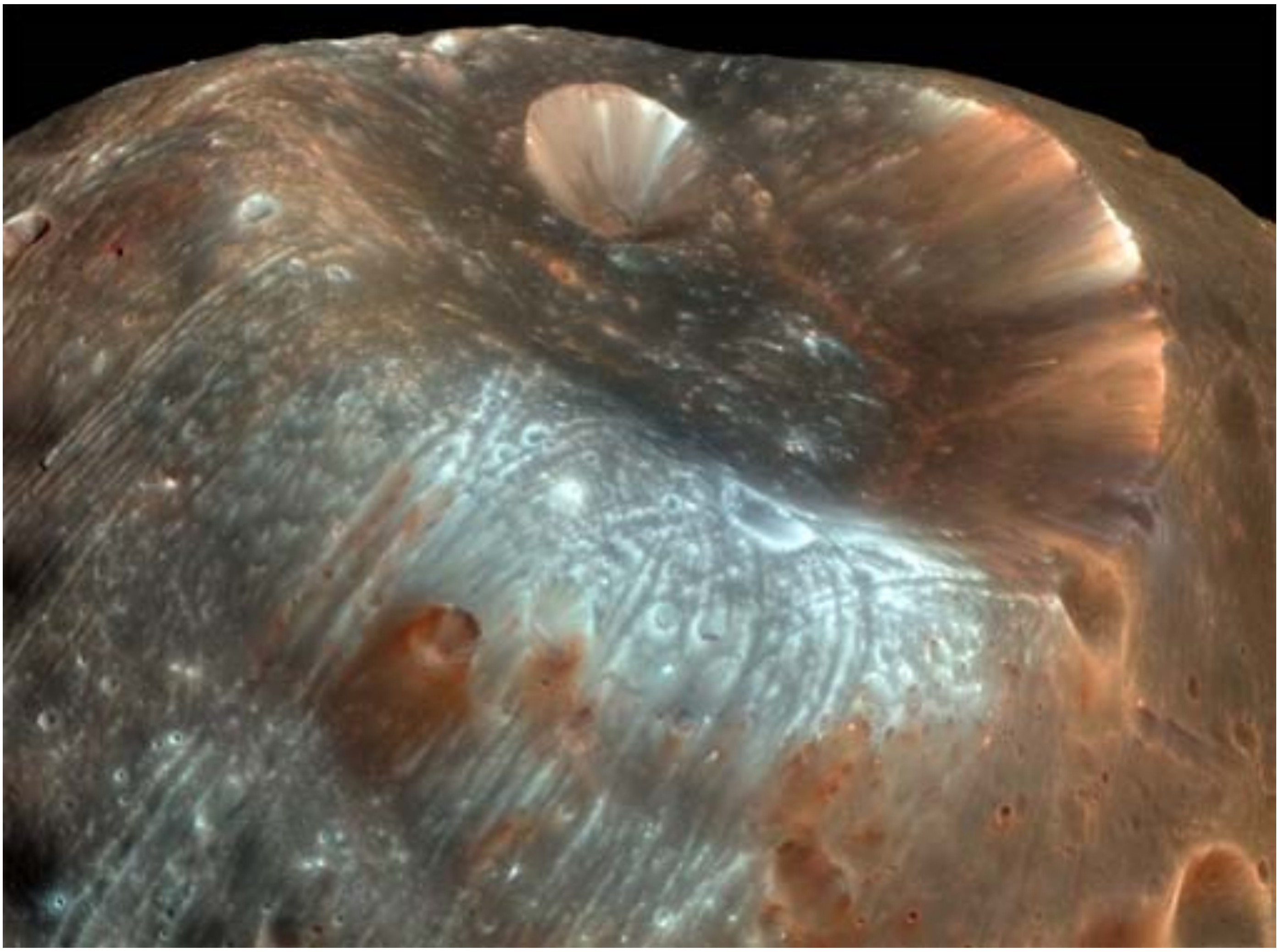
Naturally, Phobos' mysteries extend beyond its origin and surface features. For instance, despite being much more massive than its counterpart Deimos, it orbits Mars at a much closer distance (9,300 km compared to over 23,000 km). It's density measurements have also indicated that the moon is not composed of solid rock, and it is known to be significantly porous.

Because of this proximity, it is subject to a great deal of tidal forces exerted by Mars. This causes its interior, a large portion of which is believed to consist of ice, to flex and stretch. This action, it has been theorized, is what is responsible for the stress fields that have been observed on the moon's surface.

However, this action cannot account for another common feature on Phobos, which are the striation patterns (aka. grooves) that run perpendicular to the stress fields. These patterns are essentially chains of craters that typically measure 2o km (12 mi) in length, 100 – 200 meters (330 – 660 ft) in width, and usually 30 m (98 ft) in depth.

In the past, it was assumed that these craters were the result of the same impact that created Stickney, the largest impact crater on

(Continued on page 19)



The streaked and stained surface of Phobos, with the Stickney crater shown in the center. Credit: NASA/JPL/Mars Express

(Continued from page 18)
Phobos. However, analysis from the *Mars Express* mission revealed that the grooves are not related to Stickney. Instead, they are centered on Phobos' leading edge and fade away the closer one gets to its trailing edge.

For the sake of their study, which was recently published in *Nature Communications,*Asphaug and Nayak used computer modelling to simulate how other meteoric impacts could have created these crater patterns, which they theorized were formed when the resulting ejecta circled back and impacted the surface in other locations.

As Dr. Asphaug told Universe Today via email, their work was the result of a meeting of minds that spawned an interesting theory:

"Dr. Nayak had been studying with Prof. Francis Nimmo (of UCSC), the idea that ejecta could swap between the Martian moons. So Mikey and I met up to talk about that, and the possibility that Phobos could sweep up its own ejecta. Originally I had been thinking that seismic events (triggered by impacts) might cause Phobos to shed material tidally, since it's inside the Roche limit, and that this material would thin out into rings that would be reaccreted by Phobos. That still might happen, but for the prominent catenae the answer turned out to be much simpler (after a lot of painstaking computations) – that crater ejecta is faster than Phobos' escape velocity, but much slower than Mars orbital velocity, and much of it gets swept up after several co-orbits about Mars, forming these patterns."

Basically, they theorized that if a meteorite stuck Phobos in just the right place, the resulting debris could have been thrown off into space and swept up later as Phobos swung back around mars. Thought Phobos does not have sufficient gravity to reaccrete ejecta on its own, Mars' gravitational pull ensures that anything thrown off by the moon will be pulled into orbit around it.

Once this debris is pulled into orbit around Mars, it will circle the planet a few times until it eventually falls into Phobos' orbital path. When that happens, Phobos will collide with it, triggering another impact that throws off more ejecta, thus causing the whole process to repeat itself.

In the end, Asphaug and Nayak concluded that if an impact hit Phobos at a certain point, the subsequent collisions with the resulting debris would form a chain of craters in discernible patterns – possibly within days. Testing this theory required some computer modelling on an actual crater.

Using Grildrig (a 2.6 km crater near Phobos' north pole) as an reference point, their model showed that the resulting string of craters was consistent with the chains that have been observed on Phobos' surface. And while this remains a theory, this initial confirmation does provide a basis for further testing.

"The initial main test of the theory is that the patterns match up, ejecta from Grildrig for example." said Asphaug. "But it's still a theory. It has some testable implications that we're now working on."

In addition to offering a plausible explanation of Phobos' surface features, their study is also significant in that it is the first time that sesquinary craters (i.e. craters caused by ejecta that went into orbit around the central planet) were traced back to their primary impacts.

In the future, this kind of process could prove to be a novel way to assess the surface characteristics of planets and other bodies – such as the heavily cratered moons ofJupiter and Saturn. These findings will also help us to learn more about Phobos history, which in

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turn will help shed light on the history of Mars.

"[It] expands our ability to make cross-cutting relationships on Phobos that will reveal the sequence of geologic history," Asphaug added. "Since Phobos' geologic history is slaved to the tidal dissipation of Mars, in learning the timescale of Phobos geology we learn about the interior structure of Mars"

And all of this information is likely to come in handy when it comes time for NASA to mount crewed missions to the Red Planet. One of the key steps in the proposed "Journey to Mars" is a mission to Phobos, where the crew, a Mars habitat, and the mission's vehicles will all be deployed in advance of a mission to the Martian surface.

Learning more about the interior structure of Mars is a goal shared by many of NASA's future missions to the planet, which includes NASA's InSight Lander (schedules for launch in 2018). Shedding light on Mars geology is expected to go a long way towards explaining how the planet lost its magnetosphere, and hence its atmosphere and surface water, billions of years ago.

Courtesy: Universe today

Mosaic of space images showing the many "faces" of Mars inner moon, Phobos. Credit: NASA

'Wow!' Again? SETI Mystery Signal Could Long Puzzle Astronomers

By Samantha Mathewson, Staff Writer | Space.com

A recently detected SETI signal could end up being this generation's version of the famous "Wow!" signal of 1977: an intriguing mystery that keeps astronomers guessing for decades.

In May 2015, a team of researchers using a Russian radio telescope spotted a strong radio signal coming from the vicinity of the sunlike star HD 164595, which lies 94 light-years away from Earth.

The signal is consistent with something an alien civilization might send out, astronomers have said. But that's just one scenario, and not the most likely one, researchers cautioned; the signal may also have resulted from a natural celestial event or terrestrial interference of some sort. [Stephen Colbert's WOW! Alien Signal Response (Video)]

Without a follow-up detection or confirmation, humanity may never know the signal's true origin, said Seth Shostak, a senior astronomer at the SETI (Search for Extraterrestrial Intelligence) Institute in Mountain View, California. (Shostak was not part of the detection team.)

"If they can't find it again, and if we [at SETI] can't find it, all we can say is, 'Gosh, I wonder what it was,'" Shostak told Space.com.

That's pretty much all that astronomers can say about the Wow! signal, a 72-second-long event picked up by the Big Ear radio observatory at The Ohio State University in August 1977.

The 1977 signal received its name after a volunteer astronomer named Jerry Ehman wrote "Wow!" on a computer printout of the signal's transmission record. Ehman made the comment after finding the radio signal was 30 times stronger than background emissions.

Astronomers never discovered any evidence linking the Wow! signal to an alien civilization, and, despite recent efforts from the SETI Institute, a repeat detection of that signal has not been made. Researchers did conclude the signal was coming from the direction of the constellation Sagittarius.

"There are going to be signals that you see once and don't see again," Shostak added. "It's like people who see ghosts. If you see it once, but when you go back, with a camera and all that, it's not there, what do you conclude from that?"

The May 2015 and Wow! signals are analogous in another way, Shostak said: Both seemed to appear and then disappear quite quickly. This doesn't seem consistent with a signal from an orbiting satellite, which would be in range of the radio telescope for longer stretches, he said.

"The thought is: Well, that wouldn't be a satellite. A satellite would be on, and maybe it'd be on for a minute or something like that. It wouldn't just go up and down right away," Shostak said.

Astronomers know that HD 164595 houses a roughly Neptune-mass world, but this close-orbiting planet is likely far too hot to host life as it exists on Earth. But it's possible that other planets lie undiscovered in the

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The Allen Telescope Array at the Search for Extraterrestrial Intelligence (SETI) Institute has been listening for signals that may indicate that sophisticated alien civilizations are trying to communicate.

Credit: SETI Institute

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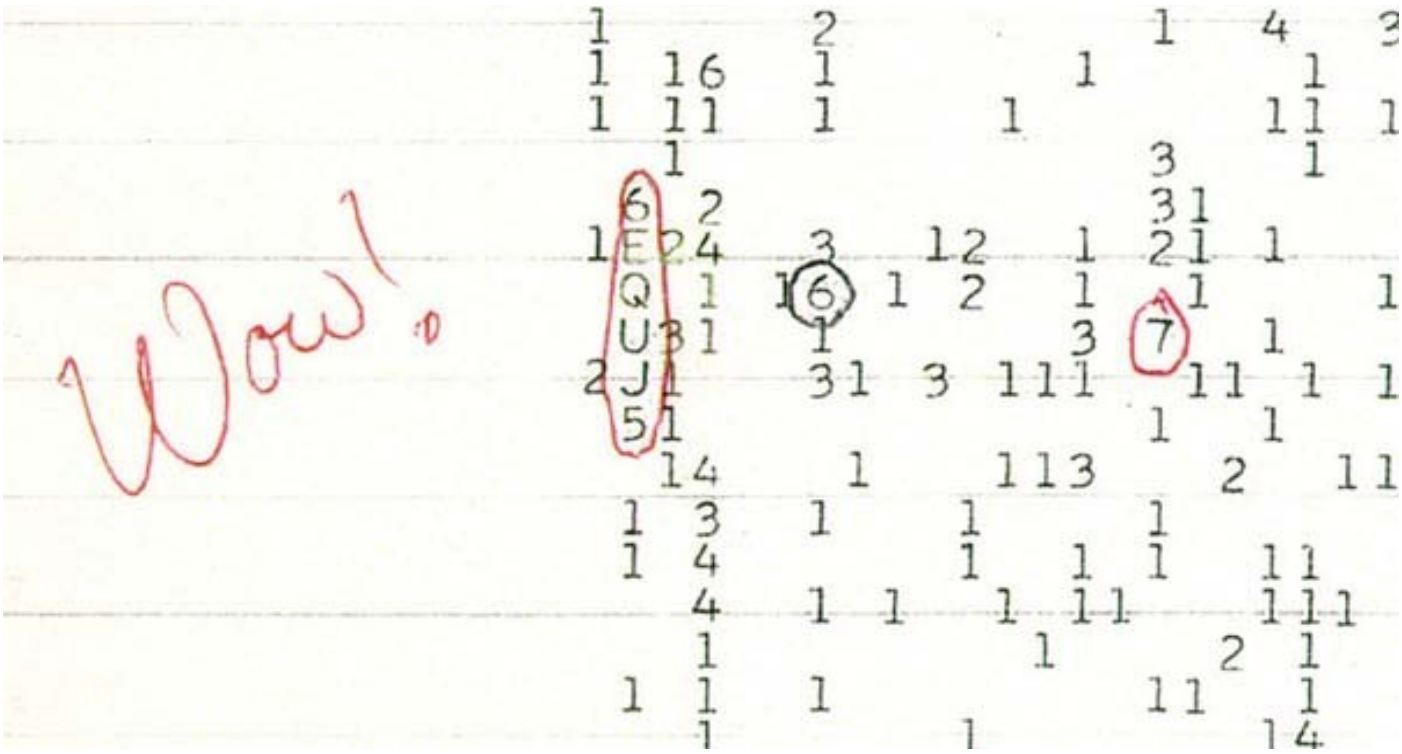
system, Shostak said.

The team of astronomers who spotted the May 2015 signal apparently studied the HD 164595 system 39 different times but made just the one detection, Shostak said. The detection team has not yet published a study of its findings. Instead, the researchers plan to discuss the signal next month at the 67th International Astronautical Congress (IAC) in Guadalajara, Mexico.

The detection of the May 2015 signal was made public on Aug. 27 by Centauri Dreams' Paul Gilster, who wrote that one of the astronomers on the detection team forwarded him the IAC presentation.

In hopes of learning more about this possible extraterrestrial signal, astronomers from the SETI Institute focused the Allen Telescope Array in California at HD 164595 Sunday night (Aug. 28) and Monday night (Aug. 29), Shostak said.

Courtesy: space.com



When volunteer astronomer Jerry Ehman found that a signal detected in 1977 was 30 times more powerful than the average radiation from deep space, he wrote "Wow!" on the computer printout, as photographed here.

Credit: The Ohio State University Radio Observatory and the North American AstroPhysical Observatory (NAAPO)