TRANSIT

The April 2014 Newsletter of

Cleveland & Darlington Astronomical Society

<u>NEXT TWO MEETINGS, each at Wynyard Planetarium</u>

Friday 14 April 2014, at 7.15 pm

Astro-imaging: An introduction, including historical and practical aspects

Dr Jürgen Schmoll, *CaDAS chair*

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Friday 9 May 2014, at 7.15 pm

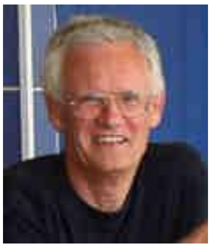
Presidential address (title TBD)

Jack Youdale FRAS, *CaDAS honorary president*

Content

Editorial

Rod Cuff



Firstly, welcome to **new members** Michael Tiplady and Douglas Wilson – we hope you enjoy and get a lot out of your membership!

Next, just to confirm the result of the recent **Extraordinary General Meeting**, convened to hear a presentation and vote on the question: 'An agreement has been reached with Stockton Borough Council for a new, not-for-profit organisation to sign a lease in order to run the Planetarium and Observatory. Do you want CaDAS to be represented on the board of that body?'. The vote from the 35 members attending was unanimously 'Yes'.

As a result, members of the CaDAS committee are in the process of forming a Charitable Incorporated Organisation (CIO) to take over the running of Wynyard Planetarium and Observatory. This CIO will be known as **Teesside Astronomical Science Centre** or **TASC**. TASC and CaDAS are/will be formally and legally separate entities, so further and continuing information about the former will mostly come from the TASC board when it has been constituted. Approval from the Charities Commission may take some time, but until then Stockton Borough Council will allow CaDAS to continue to hold its monthly meetings in the Planetarium.

Both CaDAS and TASC are very grateful to the solicitors' firm of **Tilly Bailey and Irvine**, who are offering us their legal services over this matter free of charge – a very generous offer.

And so to the current issue of *Transit*. **Ray Worthy** has a telescopic mystery to unfold, even if he doesn't have the resolution … **Ray Brown** explores the technology of how we currently detect exoplanets (as of 4 April, we know of 1780 planets in 1103 planetary systems). **John Crowther** reflects on what both Rays have been writing about recently, while **Keith Johnson** has been practising capturing images of Mars as the planet's opposition approaches this week. And there's a particularly interesting press release from the **European Southern Observatory** to absorb.

By the way, there were no takers for the astronomy-related books I offered free last month, so they've gone to Oxfam.

And a **personal statement** from me. I'm retiring from the grandly named post of Communications & Information Secretary at June's AGM, and CaDAS is looking for someone else to take on the role. There are three parts to it: participating in CaDAS committee meetings (which, now that the Planetarium situation has been resolved, will revert to three or four a year); passing on by email any announcements, requests or news relating to the Society (perhaps a dozen or so per year); and editing *Transit* (at the moment, usually 10 issues a year). If you are or might be interested in taking this role on, please contact either me or any committee member ASAP. Note that the nature, content, size and frequency of *Transit* is entirely up to its editor – I've chosen to make it monthly, to fill it almost entirely with contributions from within CaDAS itself and to edit/display material in a certain way, but the new editor will make his or her own decisions on that! Note, though, that if no new C&IS comes forward at or before the AGM, there will be no *Transit* issues after June's until someone volunteers.

Many thanks to all contributors for this issue. Please let me have material for the next issue by 25 April; I'll need to get that one out before the end of April.

Best wishes –

Rod Cuff, info@cadas-astro.org.uk *1 Farndale Drive, Guisborough TS14 8JD*
(01287 638154, mobile 07775 527530)

Letters

Dear CaDAS folk...

from Ed Restall

I should just like to express my sincere thanks to you all, without succumbing to the over-emotional tendencies I displayed at the meeting in March!

I was immensely touched by your good wishes and the incredible generosity of both my leaving present as well as the completely unexpected award of honorary life membership of the society.

Many people have contributed to the success of the Planetarium and Observatory over the years, too many to mention, and I am hugely grateful to all of you who have supported the facilities with your energy, enthusiasm, expertise and time, especially over the period when I was director. Having said that, there are two individuals I wish to thank especially, as they have shown unstinting support for outreach events at the Planetarium throughout my tenure, as well as making an immense contribution through their own activities to astronomy in the region as a whole; they are John and George Gargett – I can't thank you enough, guys.

For those of you who were at the last meeting but didn't quite get the gist of what Jürgen said I'd spent the leaving present money on, or if you couldn't make it to that meeting: I splashed out on a new smart TV. Some people found this surprising, but my old TV was on its last legs. It probably isn't something I would have done without your generosity; I will think of you all every time I get a chance to sit down in front of it.

Finally, I should just like to wish the newly formed, CaDAS-led management body of the Teesside Astronomical Science Centre every success in establishing themselves as a charitable body and in operating the Planetarium and Observatory for the benefit of everyone in the area in the future. Hopefully independence from local authority control will free the facilities to reach their full potential.

Wishing you all clear skies – Ed

It's a load of Taurus...

from Neil Haggath

I've recently added to my website a major section rubbishing astrology. You can find it at www.spaceandsanity.com by clicking on 'Why Astrology is Gibberish'.

Best wishes – Neil

OBSERVATION REPORTS AND PLANNING

Websites – April 2014

Here are some suggestions for websites that will highlight some of what to look out for in the night sky in April. Mars is a main attraction this month, as it reaches opposition on 8 April at an altitude of about 34°.

- **BAA Sky Notes** for April:
  http://britastro.org/skynotes_render/5402

- **HubbleSite**: a **video** of things to see each month (a transcript can be downloaded from the site as well):
  http://hubblesite.org/explore_astronomy/tonights_sky
- **Night Sky Info's** comprehensive coverage of the current night sky:
  www.nightskyinfo.com
- **Jodrell Bank Centre for Astrophysics** – The night sky:
  www.jodrellbank.manchester.ac.uk/astronomy/nightsky
- **Telescope House** monthly sky guide:
  http://tinyurl.com/pzzpmsx
- **Orion's** What's in the Sky this Month:
  www.telescope.com/content.jsp?pageName=In-the-Sky-this-Month
- **Society for Popular Astronomy's** What's Up for April 2014:
  www.popastro.com/youngstargazers/skyguide

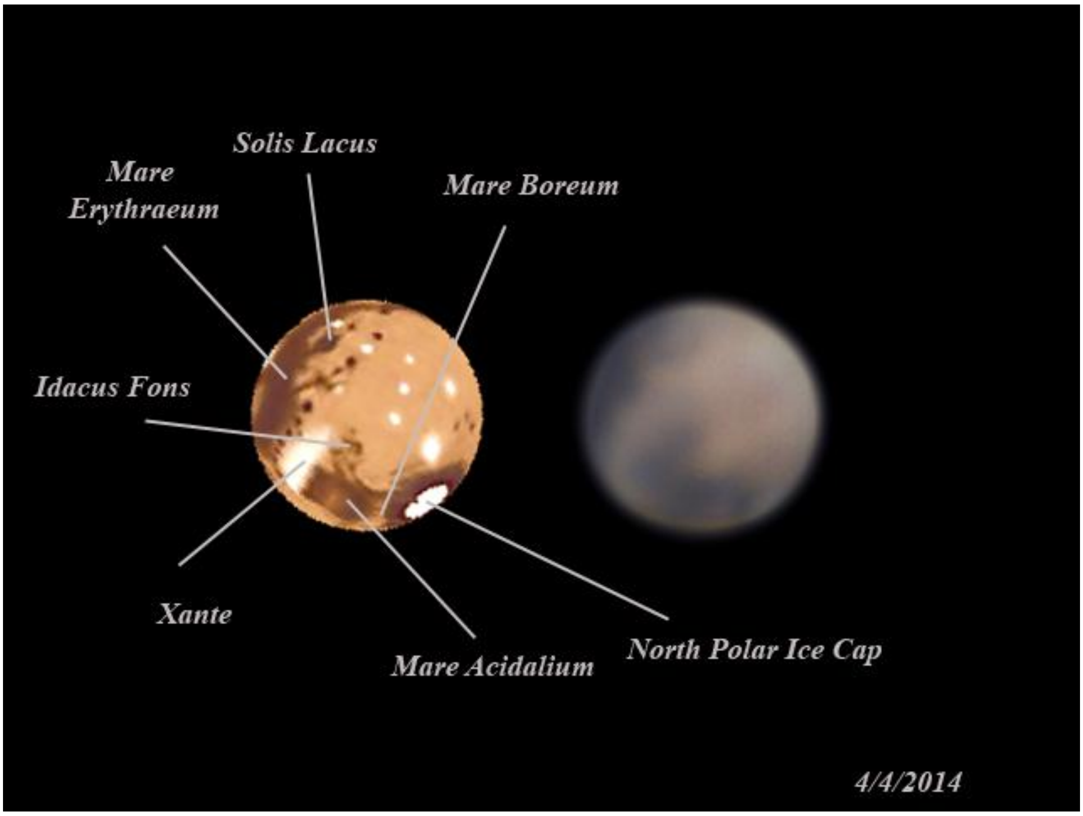
Mars near opposition

Keith Johnson

Mars reaches opposition on 8 April, and is visible all night for the next few weeks at least. I'll probably produce better images than the one here, but it's a start!

Seeing wasn't as good as I expected on the evening of 4 April, which became apparent after my equipment had been cooling down for an hour – Mars was still a boiling mass of yuck.

I captured one solitary AVI (video sequence) and quickly processed it in Registax v6. A little surface detail *can* be made out, but after having looked at the jet stream forecast I'd expecting it to be much better.



Equipment: Celestron C9.25" …. 4× ImageMate …. EQ6 Pro mount …. ASI120MC camera.

Processing and display:

A single 4-minute AVI aligned and stacked in Registax v6.
Graphic simulation – Mars Previewer II. Text and lines – Adobe Photoshop CS II

GENERAL ARTICLES

Let's finish this game of bowls

Ray Worthy

Long, long ago, during a time when computers were something mysterious and were the size of your front room, I was preparing notes to teach O-level Astronomy. The syllabus published by the East Anglian Examination Board had a section on the history of astronomy and, true to type, it skated across the highlights of the subject, naming the outstanding astronomers through the ages. Now in those days, this sort of preparation meant research by studying the contents of books (things with print on paper – have you heard of them?). Often, indeed, it meant a visit to a library. The point I'm making here is that this work took time and I hadn't a lot of it. I was studying the life of Tycho Brahe and remarking how my pupils would be interested in his amazing lifestyle, what with his metal nose, his keeping of a dwarf as a kind of jester, and a drunken reindeer which wandered around the house.

Tycho Brahe

Tycho Brahe was the greatest of the pre-telescope astronomers and did most of his work using a quadrant as large as the side of his house. The prevailing ideas of the time had the stars fixed in the 'Firmament' where nothing changed. This ethos was shattered in 1572 when a bright new star appeared in the constellation of Cassiopeia. We would now call it a supernova. This event shook the prevailing complacency of the day and made astronomers all over the world sit up and take note. Astronomers of different nations began to correspond with each other in a way they had not done previously. What caught my attention was that one of Tycho's correspondents was an Englishman who stated that he had attempted to work out the parallax of the new star, to get an idea of its distance from the Earth. I can recall the astonishment when I came across this item, but I put it to one side because I was so busy. I resolved that one day I would investigate further.

That day arrived only recently, when I came across an article in which an illustration of the Moon was shown, purporting to have been made by an Englishman and dated at least nine months before the famous drawing by Galileo – a drawing which, together with those of the moons of Jupiter, upset the leaders of the Church of the day and led to Galileo's incarceration and almost to the loss of his life.

As best as I could with my damaged eyesight, I examined this lunar picture and determined that, whoever the artist was and regardless of its provenance, that person had needed a telescope to see the detail contained in the work. Who was he? When did he live and where did he come from? Above all, was there any connection with the mysterious correspondent from the Tycho Brahe archives? So, I resolved to have a go and do some ferreting of my own.

What a difference the passage of time had wrought! Naturally, I had been aware of this change going on in the background. Last summer, my wife and I had been on holiday in a hotel in Majorca. Each afternoon, there had been a general knowledge quiz and a particular group of people had won it several times in a row. One afternoon, I was swimming lazily past their table beside the pool when I became aware that someone was cheating, with a tablet of some description beneath their table. I was amazed at the speed at which this cheating could be done.

This new world of ours with computers, the World Wide Web, Google and Wikipedia enables us to follow up research in seconds, where earlier it took weeks of careful work.

So, what were the results of this marvellous new facility? Unlike that quiz cheat, I cannot operate a tablet or an iPad, but I *can* operate a desktop computer in which the software enables me to invert the spectrum so that I can read white on black. My son Christopher and I worked this miracle by arranging the colour scheme to my advantage. Amazing!

I was looking for an Englishman who in 1572 was probably in the prime of his life and was inquisitive enough and had sufficient mathematical background to be interested in the parallax of the new star. Furthermore, I assumed that this man must have possessed some sort of instrument with which he thought he could work out a parallax.

Thomas Harriot

The lunar illustration, now in the archives of the estate of the Earl of Northumberland, was by a man called Thomas Harriot. Harriot could not have been the man who corresponded with Tycho. Undoubtedly, at some point in his lifetime he possessed some sort of telescopic instrument, but he was born in 1560 and would have been only twelve years old at the time of the supernova.

Who was alive and functioning well in 1572? Going back to the Brahe papers, the name Digges came to light. There were two Digges in the records: father and son. When I looked at Leonard the father, I was greatly encouraged. The records show that he had been a noted surveyor and had been credited with the invention of the theodolite. Leonard Digges could well have been the correspondent. Unfortunately for the purposes of my search, he died in 1559. My quarry must be the son Thomas, born in 1546. Thomas was therefore thirteen years old when his father died and twenty-six years old at the time of the supernova. Thomas must be the man I sought.

At this point in my narrative, to achieve a more enlightened approach, I should remind you of just where we are in the turbulent history of England. This is the time of the reign of Queen Mary, the Catholic monarch who desired to marry the King of Spain against the wishes of many of her subjects. Mary died in 1558, after which the Protestant Queen Elizabeth came to the throne and reigned until just after the turn of the century (1603).

Strangely enough in the history of a 'scientist', this historical placement is relevant. Leonard Digges, if not one of the high aristocracy, came from a family who owned land in Kent. He was a Member of Parliament (such as it was) and eventually took part in the Thomas Wyatt revolt (1554) and ended up in prison awaiting execution. His life was saved only because Mary died. He lived for only one year after his release. He had a lot of things to think about besides surveying and inventing instruments.

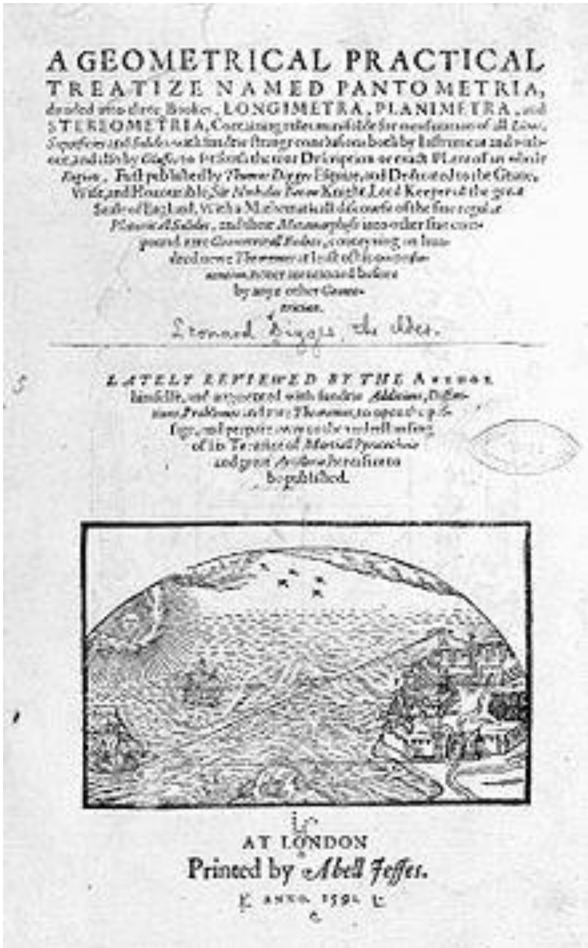
I put the word 'scientist' in quotation marks because that word simply did not exist at this time. A man who was a natural philosopher, knowledgeable about the stars or an able mathematician was simply thought of as a magician and was expected to cast horoscopes or make similar predictions.

Further to this point, a man such as this, in order to survive, had to attach himself to a nobleman and his entourage. Leonard Digges was a follower of the Earl of Northumberland, head of the famous Percy clan from Alnwick. Very much to the point of this unfolding story is that the London base of the Earl was at Syon House, immediately across the Thames from Kew. Leonard was only one of a group of similarly able men who were invited to take up residence on the Syon House estate. When I tell you that Harriot, the lunar artist, took up residence there later, you may see where I am getting to.

So, at this point, we have a gifted Leonard Digges, who was reputed to have invented a map-making instrument, the theodolite, and who died leaving a thirteen-year-old son called Thomas. Because of his unfortunate predicament, facing imminent execution, Leonard Digges arranged for a close friend to take over the upbringing of his son Thomas.

In this Syon House entourage was one of the leading mathematicians of the age, John Dee. At the age of twenty-four, Dee had been invited to become the Professor of Mathematics at a university in Paris. He must have been top-notch. Dee took it upon himself to educate the young Thomas. It is important to note that Dee was close to the Queen (Elizabeth) and was often called in to act as a consultant.

Thomas was immensely proud of his brilliant father. He assembled his father's papers and published a book called *Pantometria*, which dealt with his father's work on surveying. Thomas made no secret of the fact that he had held his father in great esteem. It was when I read this encomium that my senses suddenly became alive and my heart began beating strongly. I shall set out Thomas's words as he himself wrote them all those years ago. Once again I caution you to bear in mind that Thomas was trying to write down technical explanations for which the words had not yet entered the English language.


A GEOMETRICAL PRACTICAL
TREATIZE NAMED PANTOMETRIA,
LONGIMETRA, PLANIMETRA,
STEREOMETRIA,
LATELY REVIEWED BY THE
AT LONDON
Printed by Abell Jeffes.
ANNO. 1591

Title page of *Pantometria* (1591)

His divine mind aided with this science of Geometrical mensurations, found out the quantities, distances, courses, and strange intricate miraculous motions of these resplendent heavenly Globes of Sun, Moon, Planets and Stares fixed, leaving the rules and precepts thereof to his posterity. Archimedes also (as some suppose) with a glass framed by revolution of a section Parabolicall, fired the Roman navy in the sea coming to the siege of Syracuse. But to leave these celestial causes and things done of antiquity long ago, my father by his continual painful [painstaking] practices, assisted with demonstrations Mathematical, was able, and sundry times hath by proportional Glasses duly situate in convenient angles, not only discovered things far off, read letters, numbered pieces of money with the very coin and superscription thereof, cast by some of his friends of purpose upon downs in open fields, but also seven miles off declared what hath been done at that instant in private places.

When I read these lines (written before 1580), fireworks went off in my head. No matter in what language they were expressed, I had no doubt whatsoever that Leonard had used some sort of apparatus that we today would call a telescope. For me, there was a kind of proprietary interest. Let me explain.

In the year 1962, I was a mature student at a teacher training college in Weymouth, just a hundred yards from the shore. Whilst there I built a very successful reflecting telescope with an eight-inch mirror. It was an alt-azimuth model from a design by Texerau.

When it was finished, my friends were not satisfied with just pointing it at some star. They wanted some terrestrial corroboration of its ability and its powers of resolution. We decided to carry out an experiment. I set the instrument up at the top of the college fire escape and pointed it at a place in a village called Preston along the coast. At a certain spot along the coast road was a white-painted ice-cream kiosk, beside which was a public telephone. At the college end we arranged for a telephone extension to be brought out to the fire escape.

At the Preston end someone had to display a number of pennies between their fingers and hold out their hands against the white background of the ice-cream kiosk. At the telescope end I or someone else had to declare how many coins were being displayed. One of the college lecturers came along as guarantor of fair play. The kiosk was at least two miles away.

So you see why that boy's recollections rang my bells. What he was describing was, in its very essence, exactly the same experiment that we conducted in 1962. The instrument made by his father was some sort of telescope, at least thirty years before such an instrument was supposed to have been 'invented' in Holland.

When the word 'telescope' is used, I must caution the twenty-first-century reader. The word connotes a long, narrow tube. It can even be used as a verb. My grandfather bequeathed me the brass-tubed military telescope that he used in South Africa during the Boer War. It always gave a satisfactory crack as the tubes 'telescoped' together.

As his was the very first instrument constructed to see far off, Leonard Digges had no opportunity to talk it over. There cannot have been many people with whom to discuss this esoteric project, and being incarcerated in the Tower of London expecting to be hanged could not have helped.

When Leonard died and his equipment was inherited by Thomas, all the members of this learned group must have seen the Digges' instruments. There is a certain amount of collateral information to hand. In the group were two gentlemen with contacts high in the country's administration. One was the aforementioned John Dee, consultant to Queen Elizabeth, and the other was William Bourne, in modern terms a brilliant 'boffin' who assembled in a book a list of ideas that might help the Royal Navy. There was evidence in their writings that they were aware of the existence of an instrument that could be used to see distant objects close up.

It did not come as a surprise to me to learn that Harriot was a member of that magic circle at Syon House. In his papers, he mentioned that he bought a box which he called a 'Dutch Trunke'.

I know I am not being clinically clean in my linkages, but I would bet my bottom dollar that the instrument that Harriot used to make his lunar drawing was the very same as was made by Leonard Digges. There is some suggestion that the operator of this 'Dutch Trunke' had his or her back to the direction of operation, and this, together with the young Robert's mention of a 'parabolic glasse', suggests that the thing was essentially a reflecting telescope in a box.

So, the question that presents itself is: how did it come about that such a world scoop of an invention remained so obscure and was hidden for thirty years?

Galileo had little money of his own. It is recorded that, after he had put his telescope together, he took a businessman up to the top of the tower of St Mark's Cathedral in Venice and showed him ships coming over the horizon. That business man immediately saw the advantage of having advance knowledge of just what cargoes would be coming onto the market in the near future, which would enable him to make a profit trading on the Rialto nearby. He bought a telescope straight away.

In England, thirty years before that Venetian transaction, other intelligent men saw the advantage of being able to get a closer look at what ships were in the offing. The men in the Syon House group were not short of a bob or two, so their thoughts may not have run to petty commerce, but with their military and government connections they would certainly have seen the advantages of having that precious instrument on a clifftop overlooking the English Channel. The Earl of Northumberland's followers were staunch Elizabethans, and over most of the years in question there was a naval threat from the Spanish Armada (1588).

What is more natural than that some of the most intelligent men in England would have the idea that the Digges' instrument would give an 'edge' in intelligence, given the slow speed at which the battle fleets of the day travelled?

Who knows? It may well have been that Drake, playing his game of bowls on Plymouth Hoe, already had several hours' advance knowledge of the Armada's disposition that the history books do not reveal.

How do they do it?

Ray Brown

How fortunate we are to live at a time when amazing technological advances enable access to astronomical information hitherto the territory only of science fiction – none more exciting than the exponential increase in the rate of discovery of **exoplanets**. Before 1992 the existence of planets orbiting stars beyond the Solar System was a matter for conjecture; even in the Middle Ages, thinkers bold enough to defy the Church had suggested that the Sun was highly unlikely to be a unique stellar host for planets, but only in 1992 were planets orbiting the star PSR B1257 confirmed, so initiating a new, important, and now burgeoning topic of study.

To date, some 19 exoplanets have been observed *directly*, although this figure does include a few brown dwarfs within binary pairs. Direct observation is expected always to be extremely difficult because the intensity of reflected light from a planet is swamped by glare of the much more brilliant radiation from its nearby parent star – note that our Sun (apparent magnitude –27) is around a billion times brighter than Venus (apparent magnitude –5). So the vast majority of known exoplanets have been discovered and characterised by various **inferential (indirect) methods**. Despite a few claims to have detected extragalactic planets in the Andromeda or other nearby galaxies, our current knowledge of exoplanets is essentially confined to those within the Milky Way.

All inferential methods examine various characteristics of the electromagnetic radiation (e.g. light) received from the star, or more generally from the stellar system, that hosts the exoplanet. Variations with time (especially periodic patterns) in the overall intensity, in the intensity of individual wavelengths and in the frequencies of the overall spectrum all provide information which can, in suitable cases, be interpreted in detail.

Radial velocity method

The star and its exoplanet each orbit around a **barycentre** so, relative to the barycentre, each body moves periodically towards and away from the Earth except when the vector (or 'radial') from Earth to the star is orthogonal to the plane of the planetary orbit. Readers will be familiar with the Doppler effect whereby the frequency of a transmitted or emitted periodic signal is increased at a receiver that is moving relatively towards the source, and is decreased at a receiver receding from the source.

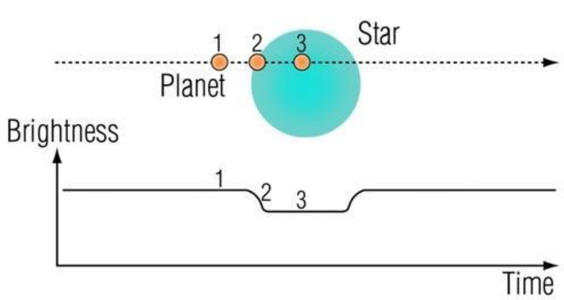
In the case of a spectrum, each frequency changes by the same multiplying factor. The much larger mass of the star causes it to have a much smaller orbital radius around the barycentre (and so move much smaller distances) than the planet does. Nevertheless, the frequency of all of the peaks in the solar spectrum will increase and then decrease periodically as the star moves respectively towards and away from Earth (relative to the barycentre). In principle, periodic Doppler shifts in starlight from the parent star should allow detection of every exoplanet, but in practice the method is sufficiently sensitive only (a) when the planetary mass is sufficient large relative to the parent star and, as already stated, (b) provided that the vector (or 'radial') from Earth to the star is not orthogonal to the plane of the planetary orbit.

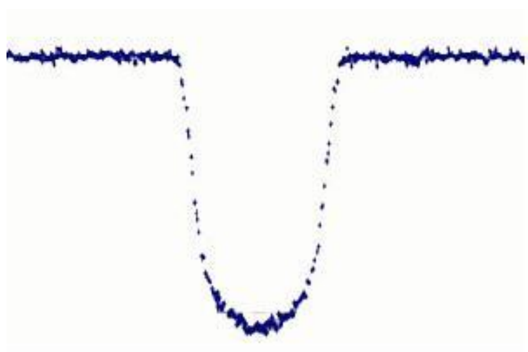
The radial velocity method is less suitable for more remote star systems because a good signal-to-noise ratio is essential, so Earth-size planets more than 160 light-years distant would not be found. Incredibly, the sensitive HIRES and HARPS spectrographs have precisions of around 1 m s^{-1}. The method provides both the orbital period and the peak-to-peak amplitude of the frequency variation with time. Hence, provided that an approximate value for the mass of the star has been calculated from a knowledge of its type, luminosity and distance from the Solar System, Kepler's Laws can be used to estimate a *lower limit* for the mass of the exoplanet. The method determines only the radial component of the star's velocity. Consequently only the lower limit can be obtained, because in general the radial from Earth will not lie in the orbital plane. However, an advantage is that the method does allow the eccentricity of the orbit to be found.

Transit photometry

The transit photometry technique can detect only the small proportion of exoplanets whose orbital planes lie sufficiently close to the radials from Earth, such that transits of the planet across the face of its parent star occur. The probability of this situation is the ratio of the diameter of the star to half the circumference of the planetary orbit, so it is most suited to exoplanets in close orbits. The method measures the observed brightness of the star with time; the larger the exoplanet in comparison with the size of the star, the greater will be the percentage decrease in brightness during the transit.

The decrease is of course only a tiny fraction of the star's brightness, so the method needs to measure brightness with high precision. An imaginary 'alien' astronomer examining the Solar System would require equipment able to detect a 1% drop in brightness in order to discover Jupiter by transit photometry. To find planet Earth the equipment would need to be a further 100 times more sensitive. So it is no surprise that most of the early discoveries of exoplanets were made with the radial velocity method. However, in the past couple of years transit photometry has drawn ahead in the number of new exoplanets being reported, mainly as a consequence of the Kepler space mission, which provides much better signal-to-noise ratios than ground-based equipment such as TrES, OGLE, HAT and WASP. The exoplanet Kepler-37b is estimated to be smaller than Mercury and only slightly larger than our Moon.





Photometric result for Kepler-6b

Obviously, transit photometry yields both the orbital period and the diameter of the planet relative to its parent star. Moreover, for any system suitable for study by transit photometry, the true planetary mass essentially *is* the lower limit delivered by the radial velocity method. Furthermore, if the extent of the decrease in starlight intensity is found to depend on the wavelength then the observations provide an absorption spectrum produced by any gases in the planetary atmosphere, allowing conclusions to be drawn about the atmospheric composition.

Even more remarkable is astronomers' ability to gain spectral data from **secondary transits** occurring midway between successive transits, when the exoplanet passes *behind* its star. Subtraction of the observed spectrum at this time from the normal stellar spectrum provides an estimate of the planetary temperature as well as its atmospheric composition.

Major disadvantages of transit photometry for the detection of exoplanets are the brief durations of all transits and the need to observe several successive repeat transits in order to establish their regular periodicity and so to exclude 'false positives' due to other causes for brightness fluctuations. Automated observations are almost essential for what would otherwise be a poorer bet than searching a dozen haystacks for one missing needle. Nevertheless, once an exoplanet has been discovered, some amateur astronomers have been able to witness transits, as in the case of Gleise 876. Not surprisingly, transit photometry has been most conveniently suited to exoplanets in close orbits around large stars, giving a high 'duty ratio' of transit time to orbital period – remarkably, as high as 0.075 in the case of the Kepler-13b merry-go-round.

Postscript

Regardless of whether you are interested in their much-discussed habitability, exoplanets have to be one of the most fascinating topics on the current scientific scene. The Internet abounds with excellent accounts and detailed information for those who wish to learn more – e.g.

- http://kepler.arc.nasa.gov/science
- http://en.wikipedia.org/wiki/Methods_of_detecting_exoplanets

In addition to the two main techniques outlined above, there are others less often used, such as the modification by exoplanets of **microlensing** phenomena. Also important are effects of exoplanets on the timing of various stellar events; indeed, the very first detection of any exoplanet resulted in 1992 from the influence of the planet causing an anomaly in the period of the pulsar PSR 1257+12. This method is potentially more capable of detecting low-mass exoplanets than any other current alternative, but pulsars are uncommon and those with planets are rarer still.

Re-reading *Transit* from February & March

John Crowther

Several of us without the internet still receive the magazine by Royal/snail mail, so we have the joy of taking it out of the letter-box a few days before our monthly meeting. The advantage is that it can easily be re-read, written or drawn upon. For instance, I could add Jupiter and the tracks of the other moons to Ray Brown's March drawing.

Ray also showed me that the orbits of binary stars are more complex than I had imagined. I knew that the Earth–Moon system had a barycentre beneath our feet, though how far down I don't know.[1] Four and a quarter light-years away we have the Alpha Centauri system. Is it possible to have a diagram of it on a flat sheet of paper?

And those binaries with long orbital periods of hundreds of years – could the Sun be one of those, unbeknown to us?

Ray also mentioned deterministic chaos, which started me thinking about 'breaking a camel's back' but with a butterfly's flapping wings instead of a straw. Might a person starting up their new gas-guzzler in the USA tip our global warming scenario into chaos?

Ray Worthy's space-sail article from March

Can we compare the long-lasting age of sail with the possibility of a future age of sail in space? The age of sail on the seas and oceans lasted about 3000 years. Ancient ships usually had just one sail, although Roman craft powered by both sail and and oars had up to four. But after 2000 years the tea-clippers and nitrate- and wool-carrying ships could set more than thirty, some with names such as skysail or moonraker.

So the eight-masted space sailing ship as now imagined may be about right, although its size will truly be astronomical. Indeed. To ask an unanswerable question: have such craft already been made to move between the planets of other stars?

Ray told us of his well-loved sailing dinghy, which was highly manoeuvrable, as indeed were the many sailing ships of past centuries. Their large crews could adjust the wooden yards to 'back' their canvas and slow and almost stop the ship.

But such adjustments to the radial sails of a 'space sailer' would, as Ray says, be difficult and slow to take effect. Could gravity help? A seabird flying against the wind gains speed by swooping down before soaring again. Perhaps fresh thoughts on the subject may come from glider pilots or from our gifted CaDAS youngsters.

So here the musings of an oldie end with a final recollection. Isn't there a sailing ship on the British Interplanetary Society's T-shirt?

The first ring system found round an asteroid

ESO

[An email from Ray Worthy reminded me that a recent announcement from the European Southern Observatory (ESO) is worth flagging up here, in case you missed it when it hit the news after Nature published a paper on it on 26 March. Here's an edited version of the press release. – Ed.]

Observations at many sites in South America, including ESO's La Silla Observatory, have made the surprise discovery that the remote asteroid Chariklo is surrounded by two dense and narrow rings. This is the smallest object by far found to have rings and only the fifth body in the Solar System — after the much larger planets Jupiter, Saturn, Uranus and Neptune — to have this feature. The origin of these rings remains a mystery, but they may be the result of a collision that created a disc of debris.

The rings of Saturn are one of the most spectacular sights in the sky, and less prominent rings have also been found around the other giant planets. Despite many careful searches, no rings had been

[1] *[Apparently about 1707 km. – Ed.]*

found around smaller objects orbiting the Sun in the Solar System. Now observations of the distant minor planet (10199) Chariklo as it passed in front of a star have shown that this object too is surrounded by two fine rings.

'*We weren't looking for a ring and didn't think small bodies like Chariklo had them at all, so the discovery — and the amazing amount of detail we saw in the system — came as a complete surprise!*' says Felipe Braga-Ribas (Observatório Nacional/MCTI, Rio de Janeiro, Brazil) who planned the observation campaign and is lead author on the new paper.

Chariklo is the largest member of a class known as the Centaurs and it orbits between Saturn and Uranus in the outer Solar System. Predictions had shown that it would pass in front of the star UCAC4 248-108672 on 3 June 2013, as seen from South America. Astronomers using telescopes at seven different locations, including the 1.54-metre Danish and TRAPPIST telescopes at ESO's La Silla Observatory in Chile, were able to watch the star apparently vanish for a few seconds as its light was blocked by Chariklo — an occultation.

But they found much more than they were expecting. A few seconds before, and again a few seconds after the main occultation, there were two further very short dips in the star's apparent brightness. Something around Chariklo was blocking the light! By comparing what was seen from different sites, the team could reconstruct not only the shape and size of the object itself but also the shape, width, orientation and other properties of the newly discovered rings.

The team found that the ring system consists of two sharply confined rings only seven and three kilometres wide, separated by a clear gap of nine kilometres — around a small 250-kilometre diameter object orbiting beyond Saturn.

'*For me, it was quite amazing to realise that we were able not only to detect a ring system, but also pinpoint that it consists of two clearly distinct rings,*' adds Uffe Gråe Jørgensen (Niels Bohr Institute, University of Copenhagen, Denmark), one of the team. '*I try to imagine how it would be to stand on the surface of this icy object — small enough that a fast sports car could reach escape velocity and drive off into space — and stare up at a 20-kilometre-wide ring system 1000 times closer than the Moon.*'

Although many questions remain unanswered, astronomers think that this sort of ring is likely to be formed from debris left over after a collision. It must be confined into the two narrow rings by the presence of small putative satellites.

'*So, as well as the rings, it's likely that Chariklo has at least one small moon still waiting to be discovered,*' adds Felipe Braga Ribas.

The rings may prove to be a phenomenon that might in turn later lead to the formation of a small moon. Such a sequence of events, on a much larger scale, may explain the birth of our own Moon in the early days of the Solar System, as well as the origin of many other satellites around planets and asteroids.

The leaders of this project are provisionally calling the rings by the nicknames Oiapoque and Chuí, two rivers near the northern and southern extremes of Brazil.

THE TRANSIT QUIZ ***set by Neil Haggath***

Answers to March's quiz

Every answer starts with the letter N.

1. He compiled a star atlas in 1910 that is still in print today. **Arthur P. Norton (1876–1955).**
2. The common name of Sigma Sagittarii. **Nunki.**

3. The second satellite of Neptune to be discovered. **Nereid.**
4. A list of deep-sky objects published by J.L.E. Dreyer in 1888. **The *New General Catalogue of Nebulae and Clusters of Stars* – usually referred to as the NGC.**
5. The 7000th object in Question 4. **NGC7000 is of course the North America Nebula.**
6. A constellation, which isn't named after Marilyn Monroe! **Norma, the Rule (Marilyn's real name was Norma Jean Baker).**
7. The Large Magellanic Cloud. **Nubecula Major.**
8. An extensive canyon system on Mars. **Noctis Labyrinthus.**
9. The former husband of the first woman in space. **The late Andrian Nikolayev, also a cosmonaut, who married Valentina Tereshkova.**
10. The formal name of the facilities at Jodrell Bank. **Nuffield Radio Astronomy Laboratory.**

An elaboration on No. 9:

As is well known, Valentina Tereshkova was the first woman to go into space, when she flew on Vostok 6 in 1963. Andrian Nikolayev, who had flown on Vostok 3 a few months earlier, was the only bachelor among the first group of male cosmonauts; they later married. Their marriage wasn't happy, and they were divorced in 1982 – but they had a daughter, Yelena, who was born normal and healthy, thereby disproving the fears of some doctors that exposure to radiation during spaceflight would cause genetic damage.

It was later alleged, by people in high places, that the couple were 'persuaded' to marry by the Soviet Government, to see what effects, if any, spaceflight would have on their children!

April's quiz

Every answer starts with the letter O. The questions are in very rough order of increasing difficulty.

1. The common name of M97.
2. A mechanical model representing the orbital motion of the planets.
3. The biggest plain, or 'sea', on the Moon. Either the Latin or the English name will do!
4. The phenomenon where one astronomical body passes in front of another in our line of sight, and obscures it from view.
5. The highest mountain in the Solar System.
6. The Solar System's distant realm of comets.
7. The constellation that 'holds' the one that is split into two parts.
8. A meteor shower associated with Halley's Comet.
9. His paradox asks, 'Why is it dark at night?'.
10. An observatory in the Czech Republic.