The British Astronomical Association
Historical Section

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From the Director

Mike Frost

I hope you enjoyed this year's section webinar. On May 14th, Professor Wayne Orchiston told us about the research he and his wife, Darunee Lingling Orchiston, have carried out into "Asian Observations of the 18 August 1868 Total Solar Eclipse". It was a fascinating talk; I certainly hadn't appreciated what a pivotal event this eclipse was, being the one at which solar spectroscopy made its mark, including the discovery of helium. Eclipse photography took a big step forward at this eclipse too. And the presence of science teams from many of the European colonial nations allowed the king of Thailand to carry out some astute diplomacy.

The attendance on the day wasn't very high. It was a beautiful sunny day, and the time difference to Thailand (where the Orchistons live) meant the lecture was delivered early afternoon UK time. However… one advantage of Zoom presentations is that we can record the event for future viewing. The webinar can be seen on the BAA's YouTube channel at https://www.youtube.com/watch?v=XbD3gyQi7UY&t=413s

Last time I checked we'd had over 150 views, which is about three times as many people as attend our live meetings! So, Zoom meetings have their advantages.

The SHA were able to hold a meeting, very successfully, at the Birmingham Midlands Institute in Birmingham city centre, so, unless the pandemic takes another turn for the worse, we'll hold a real-world meeting there in spring next year. We'll do our best to record or livestream it – but I'm not going to promise anything, as I know how tricky this is technically.

We look forward to seeing you!

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I've said before in these pages how much I enjoy correspondence with section members.

One regular correspondent is Gary Dalrymple, of the Sydney Skywatchers in Australia. Gary is undertaking research on the early days of observing in the New South Wales colony. He has a "trove" of searchable newspaper reports which are full of fascinating material on the observers of a century or more ago. Many of these observers have been studied by Gary, Wayne Orchiston and others, but there is still lots of worthwhile research to be done.

Perhaps the most significant figure from the late nineteenth century was John Tebbutt, discoverer of the great comets of 1861 and 1881. He features on the Australian 100 dollar note. Gary has done research which puts his life story into the context of the growing New South Wales (NSW) colony. My predecessor, Mary Acworth Evershed, nee Orr, lived in NSW for several years in her twenties, and was a friend of John Tebbutt. She wrote "An Easy Guide to the Southern Stars", the first popular guide to the southern skies.

The current section director also has connections to New South Wales. I lived in Wollongong, fifty miles to the south of Sydney, in 1987-88, working on a project at the Port Kembla steel works. I was a member of the Illawarra Astronomical Society and observed from their bush observatory. I returned to NSW prior to the solar eclipse of 2012, which I saw from Queensland. All else permitting, I will be back in Australia for next year's solar eclipse, but it looks like I will be in Western Australia for the duration of my trip. But I suspect I will be back in NSW for the solar eclipse of July 2028, which is total over Sydney Harbour.

Of course, the BAA has many other connections to New South Wales. Sydney Skywatchers evolved out of the BAA's New South Wales branch, which was founded in 1895 and became the Skywatchers a century later. Sydney Skywatchers are still an affiliated society to the BAA and many of their members are also BAA members. Monty Leventhal, a Skywatchers stalwart, won the BAA's Steavenson award for his many years of distinguished solar observing.

We have talked about making Sydney Skywatchers webinar events available to BAA members. I attended their 125th anniversary meeting, representing the BAA, and then lectured to the Skywatchers on the Pioneering Women of the BAA, including of course Mary Evershed. Skywatchers meetings don't happen at the most convenient time of day for UK astronomers (early- to mid-morning, depending on daylight savings times) but they do have some great speakers.

I hope that we continue to be close to Sydney Skywatchers, for both historical and personal reasons. I also hope that we can play our part in resolving historical conundrums on the other side of the world. In this edition of the newsletter, we feature an enquiry from Wayne Orchiston to try to identify a telescope, an observatory and an observer, who may or may not be antipodean.

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This year marks the 200th anniversary of the death of William Herschel, the Anglo-German astronomer who is of course most famous for discovering the planet Uranus. That discovery didn't happen by accident – Herschel was a superb visual observer, arguably one of the greatest ever (who else? Tycho? Barnard? Galileo? Cassini?), using one of the finest telescopes of the age, so the discovery of a planet which had already been observed, but not recognised, by others, was likely once Herschel began a systematic program of observation. At its height, the observing program undertaken by William and Caroline yielded astonishing riches; sometimes discoveries of dozens of new nebulae in a single evening.

William was also an analytical natural scientist, best known for the discovery of infra-red radiation; and a proto-cosmologist, who tried to estimate the size and structure of the known universe. And all this after his 40th birthday! After all, his training was as a musician, one of the bandsmen who came over from Hanover with King George.

Elsewhere in this newsletter, you can read Alan Thomas's account of his visit to the Herschel Museum in Bath. The Bath Royal Literary and Scientific Society is organising a celebratory event for the week-end of Sep 31st – Oct 1st, which I will be attending (albeit virtually); and there have been similar events in York and in America.

It's good to remember William Herschel.

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George Abell and the End of Humanity

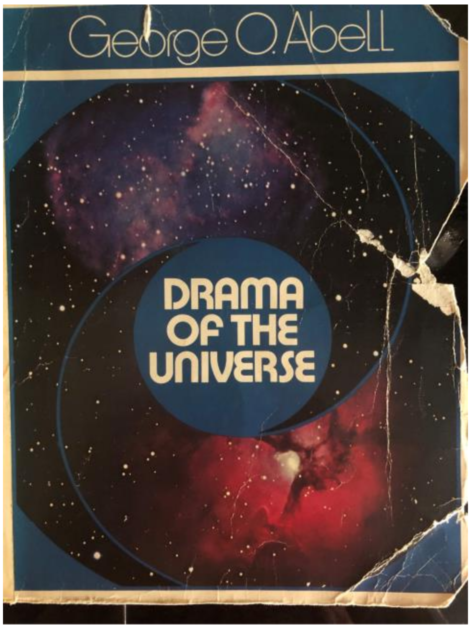
Mike Frost

A friend of mine, Karen Wilde (Leicestershire County Council's Heritage Development Officer), had an impressive tertiary education, studying at the University of California Los Angeles (UCLA) in the USA. One feature of the American educational system is that students are encouraged to study a variety of subjects in addition to their major. So it was that Karen, a humanities student, came to attend the astronomy course lectured by Professor George Abell of UCLA.

You may know the name Abell, particularly if you are an imager, because he published two catalogues which are full of interesting and beautiful targets. One is a catalogue of galactic clusters, the other a catalogue of planetary nebulae. George Ogden Abell (1927-83) studied as an undergraduate, after military service, at Caltech, and was the first Ph.D student of Donald Osterbrock. He was a lecturer at the famous Griffith Planetarium in Los Angeles (it features in “La La Land”, “The Terminator” and many other movies) and then a member of the Palomar Sky Survey team. The all-sky camera survey taken by the Palomar telescope, then the world’s largest, was his source for the two catalogues.

In later years Abell was a founder and supporter of CSICOP, the Committee for Scientific Investigation of Claims of the Paranormal, which was a leading debunker of much pseudo-science. He produced a TV lecture course on cosmology and relativity which was part-funded by the Open University, so the OU’s observatory (which I have visited) is named for him.

At UCLA, Abell delivered a lecture course in astronomy for 17 years and was regarded as an inspirational lecturer. Karen certainly thought so, and lent me her textbook from the course, “Drama of the Universe”. It’s a very readable and well-thought-out book, which seeks to place modern-day (for the 70’s and 80’s) astronomy in a historical and cultural context. There are several appealing idiosyncrasies; for example, as Abell regards the story of astronomy as a drama, he forsakes section and chapters in favour of acts and scenes.



I enjoyed reading the textbook, both straightforwardly as an astronomy textbook, also as a historical record of astronomical thinking in a golden age in American astronomy, when California was the observational capital of the world. But the thing which has stuck with me the most is a single, very precise prediction. In Act V Scene 5, on page 388, Abell calculates that humanity cannot exist after August 20th 2023.

Just in case you were speed-reading, I'll repeat that. George Abell, leading astronomer, proved mathematically that humanity will cease to exist by the middle of next year.

How did he come to this rather startling conclusion? Act V is titled "the search for life" and, after scenes discussing the possibility of life elsewhere in the solar system, and intelligent life elsewhere in the universe, scene 5 returns home to ask: "Is there intelligent life on Earth?". George Abell's thesis is that there isn't, because the one species which shows promise, Homo Sapiens, is busy destroying itself.

The particular thing that he worries about is population growth. Earth's population, he points out, is doubling every 37 years or so, and this means an ever-increasing usage of the Earth's resources. On page 388, in figure V.39, he plots the land area of the Earth available to each living human being, as a function of time. That plot contains seven data points, from around 1850 to around 1970, and they lie pretty much on a straight line. He then extrapolates that straight line to where it crosses the x-axis, the point at which there is zero land available. Humanity cannot survive beyond this point without doing something about population growth (which hasn't happened) or leaving the Earth (which is not yet fully up-and-running). The slope of the straight line must have some error bars on it – but, for dramatic effect I'm sure, he assumes an exact value and so comes up with August 20th 2023 as the date after which humanity cannot possibly continue to exist.

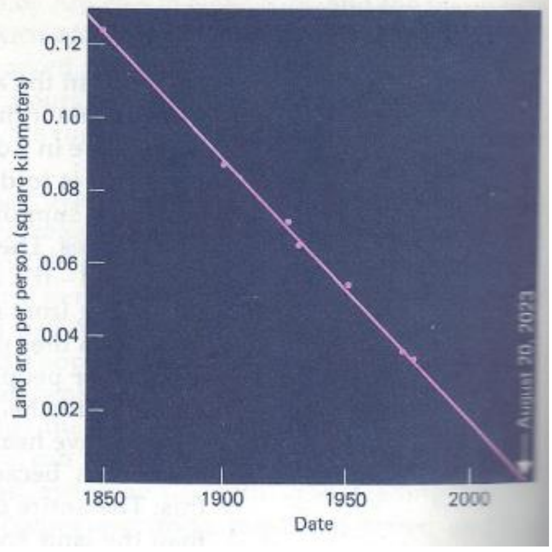


FIGURE V.39
The land area of the earth available to each living human being, as a function of time.

Now, some of this analysis is quite prescient. For example, he talks about how we are polluting the atmosphere and how increasing levels of carbon dioxide could create a greenhouse effect – global warming before it became fashionable. (He also talks about the possibility of other pollutants causing a drop in temperature and a new ice-age, so he wasn't certain that global warming was going to happen; but knew that climate change probably was). And I am certainly not complacent about the eventual effects of unbridled population growth.

However… in addition to being an astronomer, I'm a mathematician. And, mathematically, his analysis simply doesn't make sense. For there to be zero land-area per human being in 2023, Earth's population would have to be infinite. THAT CAN'T HAPPEN! Even if we had "gone at it like rabbits", we would not have gone from 3 billion or so people in 1970 to an infinite number by the mid-2020s.

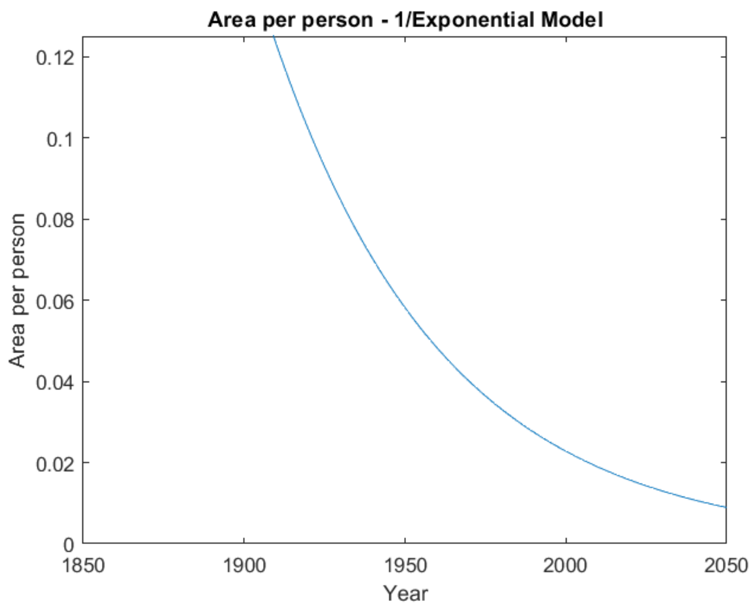
Sorry to introduce equations, but I think they are useful at this point. To a pretty good approximation, the human population of the world is increasing exponentially – doubling every 37 years, as Abell says. It was 4 billion in 1974, so we can model it as

Population in year x = 4 Billion x $2^{(x - 1974) / 37}$

The land area of Earth is 148 million square km, so divide Earth's population into this to get the land area per person.

Land area per person in year x = 148 Million / (4 Billion x $2^{(x - 1974) / 37}$)

It is straightforward to calculate this function, and so we can produce a plot of what "actually" will happen. You can see that the exponential model deviates away from the sloping straight line and approaches zero "asymptotically". That is to say: it never actually gets to zero!



Please, please note that I am not saying there isn't a problem. Earth's population cannot continue to grow exponentially without us hitting a problem at some time, through over-consumption of resources (food, minerals etc). It's just the prediction of August 20th 2023 that I object to. The simple model of exponential growth simply doesn't give a land area per person which decreases to zero as a straight line. It can't.

So, what on Earth was Abell thinking of? In his book, he hedges his bets a little, pointing out that the doubling time has not been constant, and has in fact been decreasing, so that growth is even faster than exponential. But even he, I think, doesn't claim that the doubling time for mankind's population will drop to zero, by next year, which is the implication of his plot.

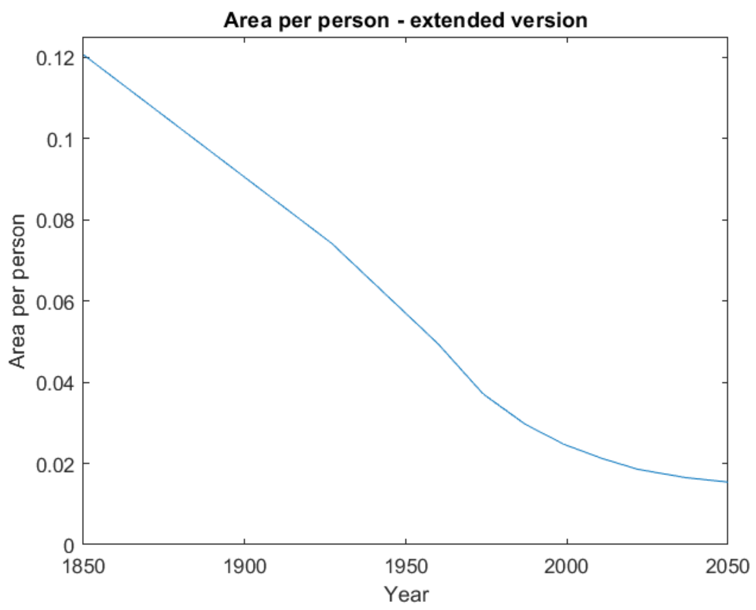
His choice of a calculation of land-area per person is a little curious. Why not just plot population? Well, that's difficult, because it isn't easy to show infinity graphically. Better to plot the reciprocal, one over population, which goes to zero. But, as we've seen, one over an exponential does not go to zero in a finite time.

Surely Abell knew this. He was a straight-A maths and science student, and the mathematics concerned is not particularly complex. Was he playing a rather arcane joke on his students? I'm sure that this isn't the case. There is a long online interview with Abell, in which he re-iterates his grave concerns about population growth, and his insistence that the crunch will come within decades.

On other hand… I rather suspect that Abell did know that his model wouldn't drop to zero by 2023, or indeed ever. But I think he did want to make it quite clear that there is a problem coming. I agree with him completely that there is an exponentially growing resource problem, pretty much across the board.

I think that since the 1970s there has been a rather more-nuanced understanding of over-population. It's a small proportion of the Earth's population, the developed world, that consumes most of the resources – but on the other hand the developed world has much smaller population growth rates (negative for some countries). So, there's a complex and perhaps intractable problem to bring un-developed countries up to developed standards and zero population growth. It's difficult, but it could be possible.

We are fifty years on from Abell's prediction – so how have the numbers panned out? We know (to a reasonable accuracy) the Earth's population for this period and can calculate the "actual" land per-person. We can see that the actual curve deviates from a straight line; first more steeply, because the doubling time decreased during the 1970s; and then more shallowly. The levelling out is for two reasons. First, the doubling time has been increasing in recent years; second, because the inverse exponential eventually levels out, as I explained earlier.



In conclusion - I think Abell was a little fast-and-loose with his mathematics. I think he wanted to scare people into doing something. I think he's wrong in the short-term – if we're all dead by August 20th next year, it will be Putin or a Pandemic to blame. But in the long-term, I think he's largely right.

We can't carry on doing what we're doing right now.

"Drama of the Universe", Abell, George Ogden (New York: Holt, Rinehart & Winston, 1978)

George Abell was interviewed in 1977 as part of the American Institute of Physics' oral history program:
https://www.aip.org/history-programs/niels-bohr-library/oral-histories/4475

In a section on exponential growth, he says:
Yes. It [*] *can be infinite in a finite time; it's certainly faster than exponential. The human population will become infinite about 2030 at the present rate.*

*The "It" isn't the world's population (actually he is talking at this point about the word-count in the Astrophysical Journal) but he quickly moves on to over-population. Note he has slipped back a few years from 2023 in this prediction.

Earth's population over time: https://en.wikipedia.org/wiki/World_population

Year	1804	1927	1960	1974	1987	1999	2011	2022	2037	2057
Population	1	2	3	4	5	6	7	8	9	10

Table of World population (in billions), the last two columns are predictions

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Before the BAA Handbook

Bill Barton

On page 123 of volume 36 part 1 (reprinted as volume 42 part 1) of our *Memoirs* it is stated that our annual *Handbook* and, indeed, the *Computing Section* tasked to produce it started in 1922 as the *'Companion to the Observatory'* had ceased publication in 1919. I had always assumed that this was an independent ephemeris of sufficient rarity that it cannot now be found in either physical or electronic format.

However, I have recently found that, in this case, the word 'observatory' refers not to a building used for witnessing celestial events, but to the magazine of the same name. In historical astronomy we have a powerful internet resource in the form of the Astrophysics Data Service (https://ui.adsabs.harvard.edu) and by correctly setting the search filters this publication appears back to 1886.

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Following Kepler

Robert Persse

I've always wondered how the early astronomers managed to make their discoveries with such limited equipment and mathematics.

Johannes Kepler worked for several years to understand the motion of the planets, and after many long and dispiriting detours he discovered three empirical rules which we now call Kepler's laws. I wanted to duplicate Kepler's results from first principles, but biographies gave little information on how exactly to do this. I finally worked out how to do it with assistance from several sources. I knew what I was aiming for of course, so I was able to avoid Kepler's detours.

Kepler finally won legal ownership of Tycho Brahe's data in 1603 and started work. Mars was the ideal choice – it was the most unruly planet, straying more than the others from the predicted path whichever theory was used; it is visible in the midnight sky at opposition so is usually easy to see; and Tycho's data included ten complete orbits. Kepler also used Tycho's solar data. He needed to know the position of Earth as seen from the Sun which is the exact opposite of the position of the Sun as seen from Earth. Of course, not all nights at Tycho's observatory near Copenhagen were clear, so often Kepler had to interpolate between existing observations.

I made the job easier by using data from an ephemeris generator. I recommend *Horizons System* from JPL for most purposes. This is a free web application used for mission planning and is simple to use. But I wanted to use data from the same period as Tycho's observations, and Horizons only goes back to 1600 for Mars. I found *Ephemeris Tool* by Ole Nielsen which is not as accurate, but does give positions of Mars in the 1500's. There are several versions on the internet – one is at http://www.m81.co.uk/emp.aspx The data table shows examples.

Data for 21:00hrs daily in 1595 November, location Copenhagen (55° 43’ N, 12° 34’ E, timezone UTC + 1)									
			6th	7th	8th	9th	10th	11th	12th
Sun	RA	hh:mm:ss	14:45:51	14:49:51	14:53:53	14:57:55	15:01:58	15:06:51	15:10:06
	Dec	+/-dd:mm	-16:03	-16:21	-16:39	-16:56	-17:13	-17:30	-17:46
	Altitude	dd:mm							
	Azimuth	ddd:mm							
	Longitude	ddd:mm	223:56	224:56	225:57	226:57	227:58	228:58	229:59
Mars	RA	hh:mm:ss	03:05:57	03:04:24	03:02:52	03:01:19	02:59:47	02:58:16	02:56:46
	Dec	+/-dd:mm	+17:25	+17:22	+17:19	+17:15	+17:12	+17:09	+17:06
	Altitude	dd:mm	37	39	40	40			
	Azimuth	ddd:mm	116	122	123	125			
	Longitude	ddd:mm	048:56	048:34	048:12	047:50	047:28	047:06	046:44
	Latitude	+/-dd:mm	-00:05	-00:02	+00:01	+00:05	+00:08	+00:11	+00:14
	Elongation	ddd:mm	175:	179:	178:	176:			

Right ascension and declination (RA and Dec) are ideal for making observations with equatorial instruments, but ecliptic longitude and latitude are much more convenient for calculating orbits. One system can be converted to the other by rotating the axes. Also the calculation of orbits needs heliocentric (Sun centred) positions which give a much simpler view than the one from Earth. I needed to find the heliocentric positions and distances using only Earth-centred observations.

The Sun, Earth and planet form the points of a triangle. If sufficient angles and sides are known the others can be calculated using simple geometry, but usually there is not enough information to do this. A planet appears to move around the ecliptic from west to east (prograde), but periodically goes backward for a while (retrograde) before resuming its prograde motion. At the same time its latitude varies so it makes a loop. These loops are caused by the Earth's motion around the Sun. In the middle of every retrograde part of a loop there is an opposition. This is the event when the Sun, Earth and planet line up. To be precise, the geocentric longitude of the planet is the same as the heliocentric longitude of both the Earth and planet (See Figure 1). However, the latitude is usually non-zero, as the planet is above or below the ecliptic (See Figure 2). We can measure angle MEP, the latitude observed from Earth. But we need to calculate angle MSP, the latitude observed from the Sun. To do this we need the ratio SE/SM (or SP).

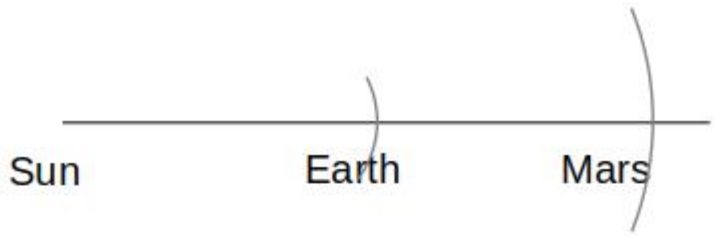

Figure 1: Opposition from Above

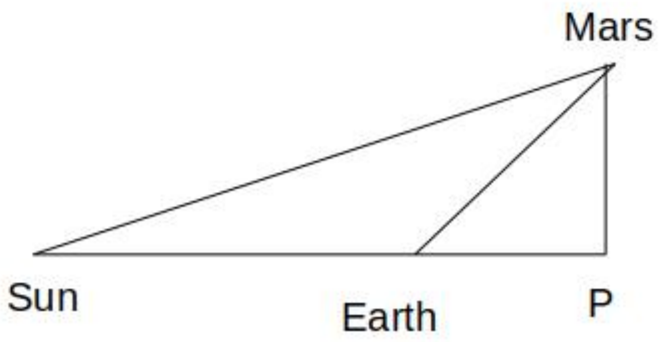

Figure 2: Opposition from the Side

Figure 3 shows how to find an opposition using data from Tables 1 and 2. The horizontal axis shows seven days in November 1595. The left axis shows the longitude of the Sun, and the right axis (180° different) shows the longitude of Mars. The Sun is moving prograde at nearly a degree per day, and Mars is moving retrograde at close to 2° in 5 days. The intersection of the two lines shows the time of opposition and the longitudes of both the Sun and Mars. Note that the graphs are close to linear around this time, so it is possible to interpolate accurately if some data points are missing.

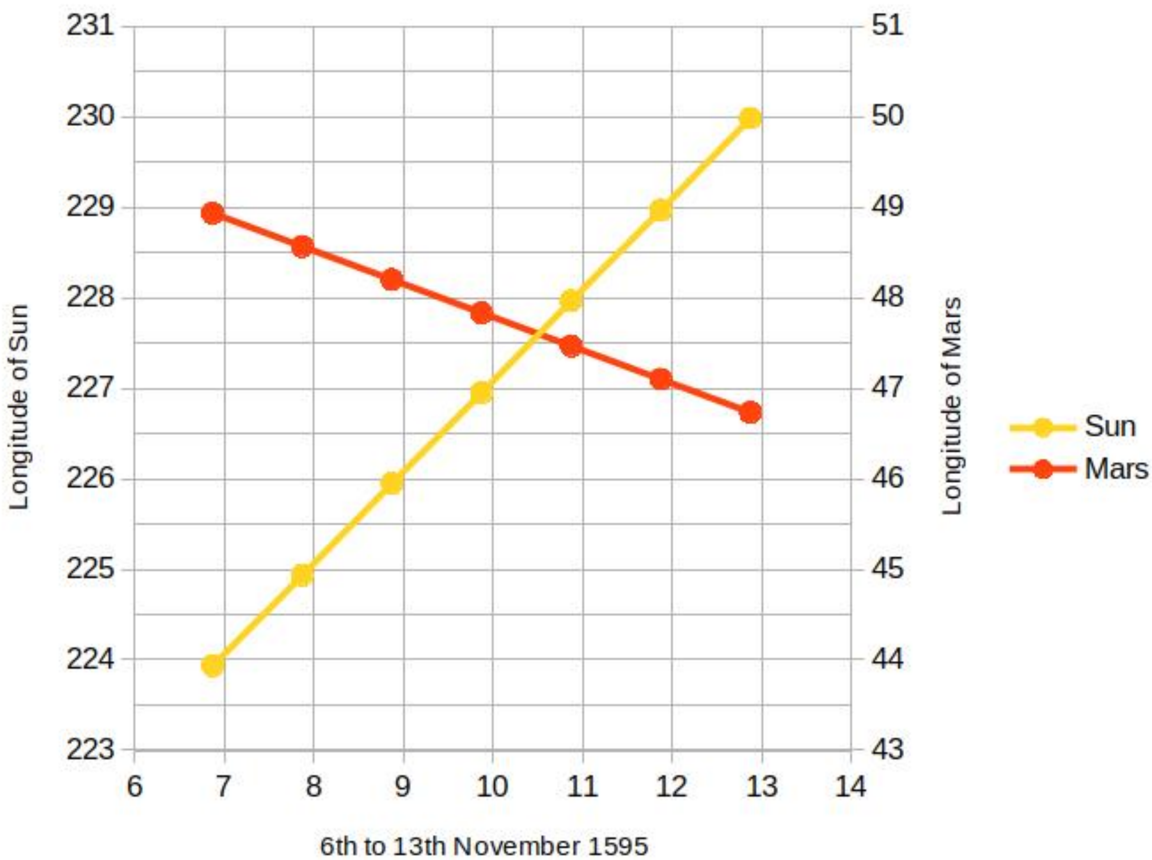

Figure 3: Finding the Opposition of 1595

Kepler used data from 12 Martian oppositions, ten from Tycho and two others. Data from oppositions were vital as they were times when the heliocentric longitude of Mars was known accurately. Figure 4 shows the observed positions of Mars at these 12 oppositions. But at opposition Mars is always closer to Earth than to the Sun, so the observed latitudes are always too great. Later I calculated the correct heliocentric latitudes and plotted the corrected points, but there was some work to do before I could do that.

Mars is sometimes north of the ecliptic, and sometimes south. The orbit cuts the ecliptic at two nodes. They are 180° apart so they are exactly opposite each other on the celestial sphere, and a line drawn between them must go through the centre of the Sun. Also, the sine curve shape of the corrected latitudes shows the orbit of Mars is in a plane through the centre of the Sun. Kepler was the first person to notice this fact.

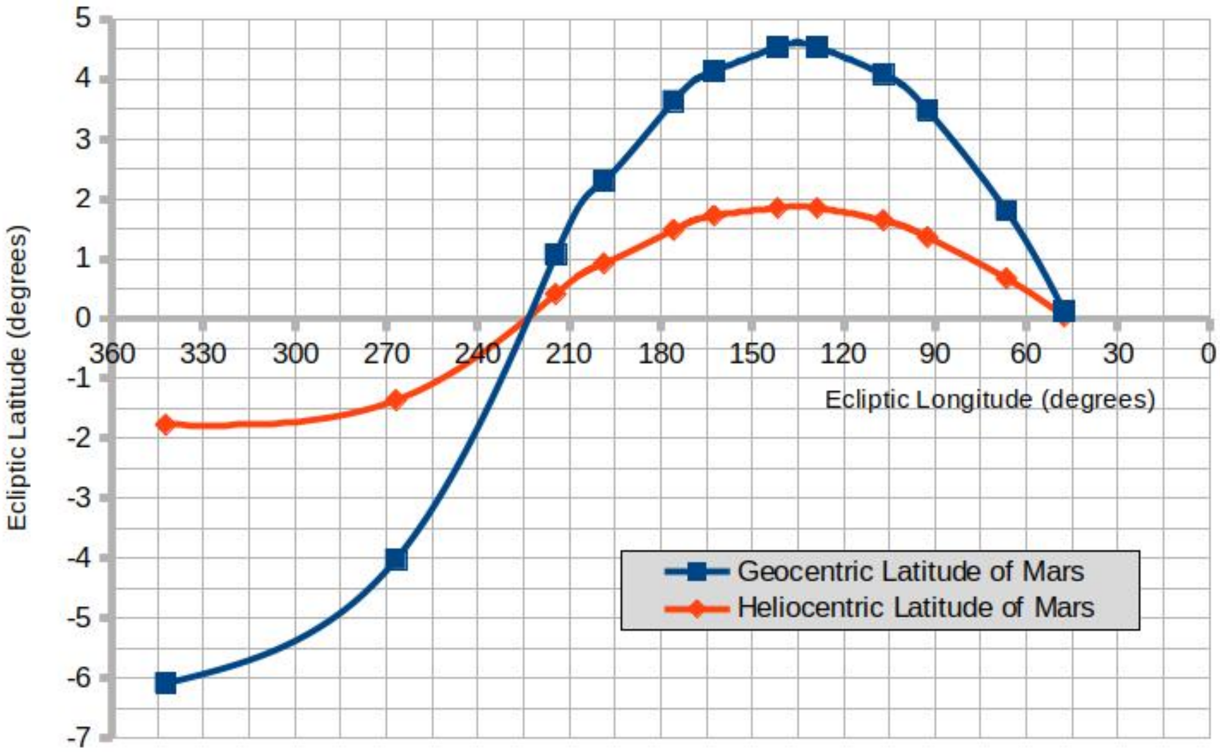

Figure 4: Positions of Mars at 12 Oppositions, 1580-1604

To get an idea of the distance of Mars I needed to find the Martian sidereal year. Once in each orbit Mars crosses the ecliptic traveling north at its ascending node. At this point its latitude is zero seen from both the Earth and Sun. The Martian sidereal year can be calculated from successive passes through this node. One of these crossings occurred two days before the opposition of 1595. (See the latitude figures in Table 1 and the rightmost data point in Figure 4). Mars crosses the ecliptic very slowly, at about one minute of arc per day, so the timing is not accurate. Kepler used four instances of Mars passing its ascending node and calculated its year to be 687 days. This is very close to the correct value of 686.98 days. Kepler was lucky that the figure is not 687.3, for example. He might not have got so accurate a result, and his later calculations might have been affected.

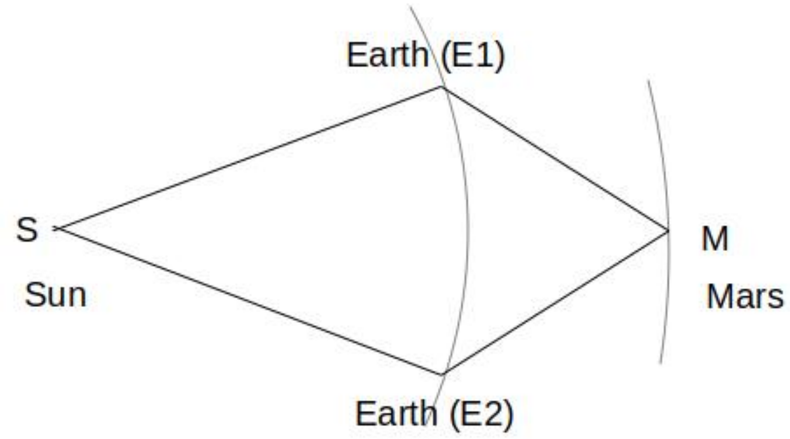

Figure 5: Triangulating the Position of Mars

Every 687 days Mars returns to the same point in its orbit. In this time Earth does nearly two orbits and ends up about 43° behind its initial position. So, given observations from two points on the Earth's orbit at E1 and E2 687 days apart, the position of Mars can be found on both these dates. All the angles can be calculated from observations, and the position of Mars can be calculated by triangulation if SE1 and SE2 are taken to be the same (see figure 5). I used this technique to sketch a rough diagram of the two orbits. The result is figure 6. From this diagram I calculated the correct latitudes of Mars at the 12 oppositions and plotted them in figure 4.

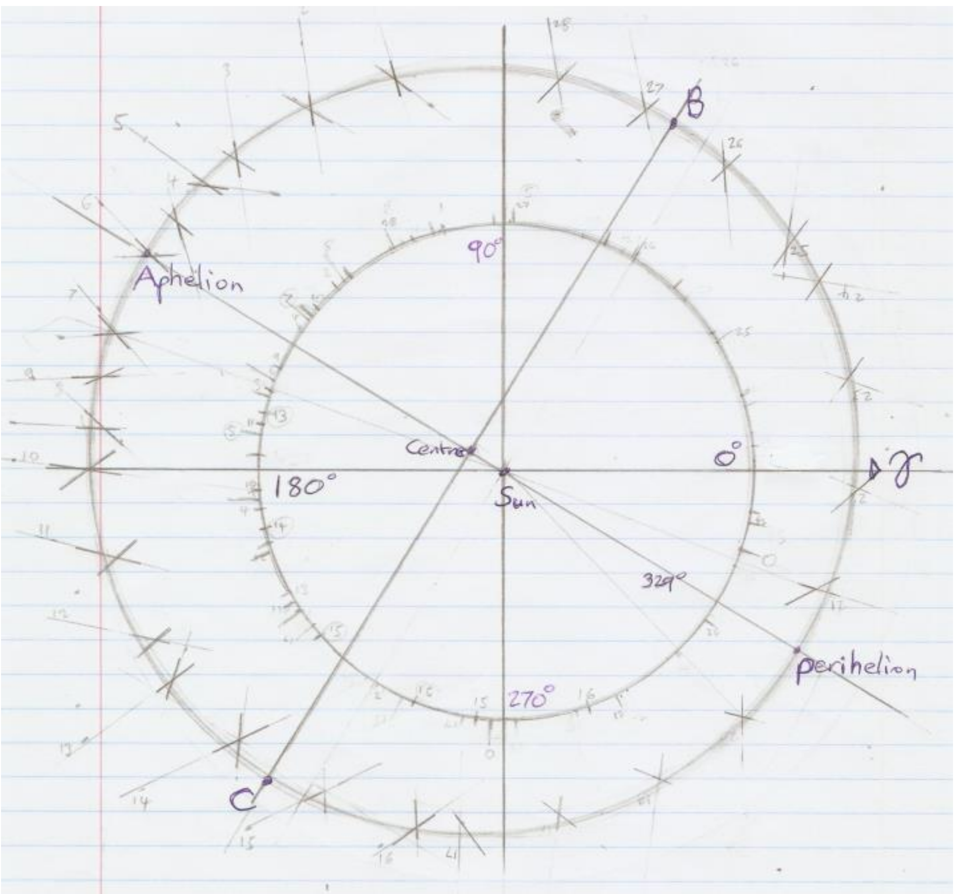

Figure 6: Sketch of the Orbits of Earth and Mars

But this diagram is not accurate, I drew it using only a ruler and school protractor on a piece of lined paper. Also, I took Earth's orbit as circular. Kepler needed accuracy at least 100 times greater, so he had to calculate the positions. The orbit looks very like an eccentric circle (the centre is not at the Sun) which explains why Kepler took so long to discover it's really an ellipse.

I was surprised how useful this diagram proved to be. I estimated the positions of perihelion and aphelion and drew a line between them through the Sun – this is the major axis. The longitude of perihelion is 329°: the eccentricity OS/OP, is 0.094; and the semi-major axis OP, is 1.56 astronomical units (Accepted values are 336°, 0.0934 and 1.524 au. respectively). It's also possible to find the date Mars passes perihelion. So, this rough diagram gives four of the six elements of the Martian orbit with reasonable accuracy! The other two, the inclination and the longitude of the ascending node, can be found from figure 4.

Also, by comparing points 28 days apart it is clear that the speed of Mars is greater at perihelion than at aphelion. I calculated the area (proportional to the angle and distance squared) and confirmed Kepler's second law, which he actually discovered before the first law.

Kepler needed a very accurate baseline to triangulate accurate positions of Mars. But he knew the Earth's orbit is not perfectly uniform so he couldn't just assume the Sun-Earth distance is constant. He needed at least two accurate positions of the Earth, and he found an ingenious method to do this. In Figure 7, SE0M shows the positions of Sun, Earth and Mars at an opposition. One Martian year later (687 days) Mars is again at M and Earth is at E1. All the angles in triangle SE1M can be calculated from observations of Mars and the Sun made at E0 and E1. And we can use the sine rule to calculate SE1 in terms of SM. We can also do this for two and three Martian years after the opposition, and also for dates before the opposition. This gives six accurate points (E1, E2, E3, E5, E6, and E7) on the Earth's orbit. Note that SE0 can't be calculated using this method, and Mars would be near conjunction and very hard to observe when Earth is at E4 and E8.

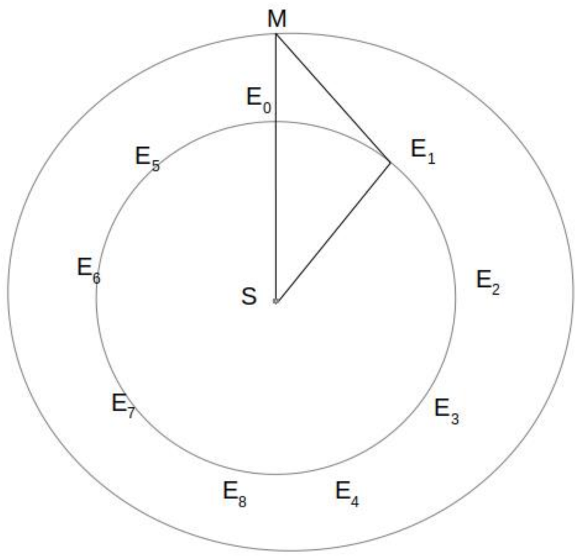

Figure7: Finding Accurate Relative Distances of Earth from the Sun

By using a pair of these points from fig 7 we can triangulate to get accurate positions of Mars. The diagram would look very like fig 6, but the data would be much more accurate. Suppose we use E1 and E2. The Earth passes E1 every 365.25 days and there would be a maximum of 20 such events in Tycho's data. But the last two cannot be paired with data from E2 which is 687 days later and Tycho's data does not include them. This gives 18 accurate positions of Mars 365.25 days apart and including the original opposition. If we use data from E5 and E6 we can again calculate a set of 18 accurate points spaced at 365.25 days and including the original opposition. So, these must be mostly the same set of points as before, although we might be able to increase the number to 20.

I took one opposition and calculated six accurate points on the Earth's orbit. I chose to use E1 and E2 as the baseline. To get the best accuracy I needed to calculate the positions of Mars. I used secondary school co-ordinate geometry and simultaneous equations. Coordinate geometry was invented by Descartes around 1637. Kepler must have used similar techniques. He seems to not have used graphs as accurate graph paper came later. I had the right data to use the point-gradient form of the equation of a line. The point is one of the positions of Earth and the gradient is the tangent of the longitude of Mars. There are two lines converging on Mars and the intersection is found by solving the simultaneous equations. I worked out a formula for this (we never did that at school) then used a spreadsheet to do the number crunching, and to draw a quick X-Y plot. This is adequate to check that no major mistakes were made, but I still did a manual plot on graph paper to help me to see the points better.

Even armed with accurate points on the Martian orbit Kepler took a long time to realise that the orbit is an ellipse. There are explanations of how he finally managed it, but I found them hard to understand. Figure 8 shows a diagram of an ellipse. F and S are the two focuses, and the Sun is at S.

Kepler noticed that the secant of angle CBS, that is BS/BC, is equal to CA/BC. So, BS equals CA, which is one of the basic properties of all ellipses.

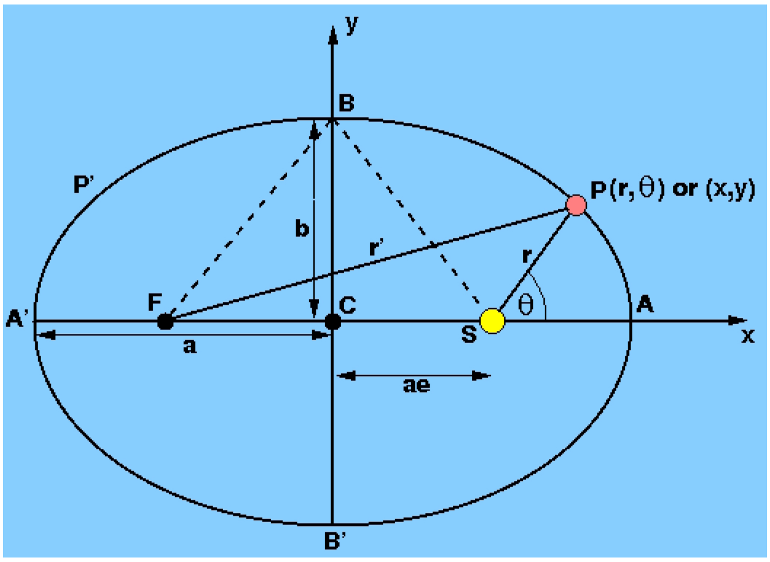

Figure 8: Ellipse Diagram

Kepler checked his calculated positions and found that an ellipse gave a reasonable fit (this is his ‘first law’). He did a great amount of repetitive manual calculation. Today we can use a spreadsheet:

- Rotate the axes so that the perihelion of the orbit is on the x axis.
- Move points right so the centre of the orbit and not the Sun is at the origin.
- For all x values calculate the expected y value and compare it with the original y value.
- Carefully adjust the angle of rotation, the distance moved, and the length of the axis to get the best fit.

Lastly, Kepler used his first and second laws to find a way to calculate accurate positions of a planet orbiting the Sun - this is known as Kepler’s Problem. The solution and proof can be found readily on the internet.

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The 1914 August 21 Total Solar Eclipse

Bill Barton

Like at previous total solar eclipses of 1896, 1898, 1900 and 1905, the BAA expected to undertake an expedition to observe this event which would be total through Eastern Europe. However just three and a half weeks earlier World War One broke out. This clearly made the planned observations impossible, however a few brave souls did venture forth.

Robert Charles Slater (sometimes Sclater) (1872-1933) planned to take a plate camera known as the ‘Niblett Camera’ (BAA instrument no. 2) to Riga, but only got as far as Strömsund, Sweden. He had already sent ahead the camera body and revolving plate changer (BAA no. 28, which appeared in the collection in 1913), but had the lens with him for safe keeping. He therefore re-manufactured a body from material obtained locally and using whatever tools he could lay his hands on. Successful images of the solar corona were obtained, however. The camera body and plate changer were sequestered at the Pulkovo Observatory for the duration of hostilities. Following its repatriation, S(c)later had the camera for the rest of his life.

The technical details of this instrument are as follows. It had a 4-inch aperture, 34-inch focal length photographic lens that had been presented to the Association by George Edward Niblett (1852-1894) and was later fitted with a revolving drum to carry six 5 by 4 plates (by E W Maunder?). To ensure correct exposure of the photographic plates the lens could be stopped down if light levels were excessive. To photograph the solar corona during an eclipse the camera was rigidly fixed pointing at the Sun during totality and as the longest exposure was not expected to exceed 2 seconds image blurring was not expected to be a problem.

Previously it had been used at the eclipses of 1896, 1901 and 1905. For the 1896 eclipse expedition Dr John Dill Russell (1874-1955) was to revolve the drum whilst Mrs Maunder effected the exposure. However, on this occasion cloud prevented any meaningful observations being taken. For the 1901 eclipse the Maunders took this instrument to Mauritius (“some good impressions of the polar rays and middle corona were secured with the Niblett lens” Maunder, Mrs E W, JBAA 12 p.226 also published by the Royal Society) In 1905 the camera was used at Burgos, Spain by Harry Krauss Nield

(1870-1926), an Original Member of our Association (1896 Eclipse Memoir page 20 & 1905 Eclipse Report page 12)

For the Royal Observatory Charles Rundle Davidson (1875-1970) and a young Harold Spencer Jones (1890-1960) to Minsk in Russia. They were joined by Patrick Henry Hepburn (1873-1929) as a volunteer assistant. He took the mounting of BAA loan instrument no. 19, Captain W Nobel's 4¼" (110mm) aperture Ross refractor. This was also sequestered for the duration of hostilities and after. The complete instrument came into the collection in 1904 following his death on 9 July 1904. This instrument passed through several hands over the years including Miss Ella Church (1881-1948) in 1911 & 1912, J P M Prentice (1903-1983) from 1937 until, possibly 1944. Postwar, Dr Cameron Walker (1896-1978) has it until 1953. Finally, it was at Kingston (Hull) School Observatory until at least 1976. See SHA bull 30 (2018), p.5-7.

Hugh Frank Newall (1857-1944) of the Solar Physics Observatory, Cambridge went to Thodosia (Crimea). Also in his party were Frederick John Marrian Stratton (1881-1960), Charles Pritchard Butler (1871-1952), Roberto Rossi (died 1919), & Newall's wife Margaret (née Arnold, 1850-1930).

South Kensington, Kiev, Prof Fowler, W E Curtis, father Cortie, with Major Hills, and Father O'Connor as volunteer observers. However, under Russian law, Jesuits were not allowed to enter the country, and it was found necessary to divide the expedition, and ultimately Father Edward Dominic O'Connor (1874-195?), Father Aloysius Laurence Cortie (1859-1925), George James Gibbs (died 1947), and Edward Turner Whitelow (1854-1932) proceeded to Hernösand, Sweden. Leaving Hull on July 28, and Stockholm on August 2, we arrived at our destination on August 3. (Nature, 94 (1914), p.202-4)

The partial phases of this eclipse were also observed from the safer confines of London by Henry Bridger Adames (1882-1922) in Ilford and William Alfred Parr (ca. 1865-1936) in Hampstead where the eclipse magnitude was 0.651. And from South Kensington, Oxford and Armagh.

References:

JBAA:-

Hepburn 25, p.12 & 28
Adames, 25, p.31 (51.5682N, 0.0611E = 51 Clarendon Gardens, Ilford/80 Cowley Road, Ilford)
Parr 25, 32 ("the above is not much to report, I fear, but I send these notes to show that I was duly in attendance at my post. 61 Antrim Mansions, Hampstead.")
25 (1915), p.417

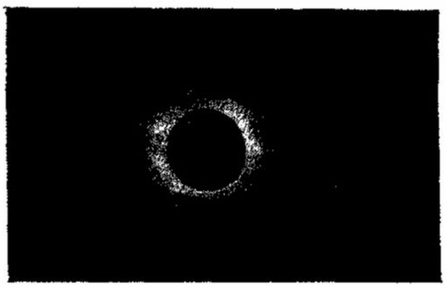
The Observatory:-

Eclipse News, vol. 37 (1914), p.355-358.
The Royal Observatory eclipse expedition to Minsk, Russia, vol. 37 (1914), p.379-384
The eclipse expedition to Theodosia (Crimea), vol. 37 (1914), p.384-387

Illustrations:

Mr. A. Webb, Mr. C. Arthur Pearson, and Mr. H. Krauss Nield with the Niblett Camera.

No. 5.



No. 7.

Corona images, no.5, ½ sec. exposure, no.7, 2½ sec. exposure (Journal of the Astronomical Society of India, vol. 5, no’s. 4, 5, & 6 (1915 Jan-Mar), p. 4-5)

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Visiting the Herschel Museum of Astronomy

Alan B Thomas

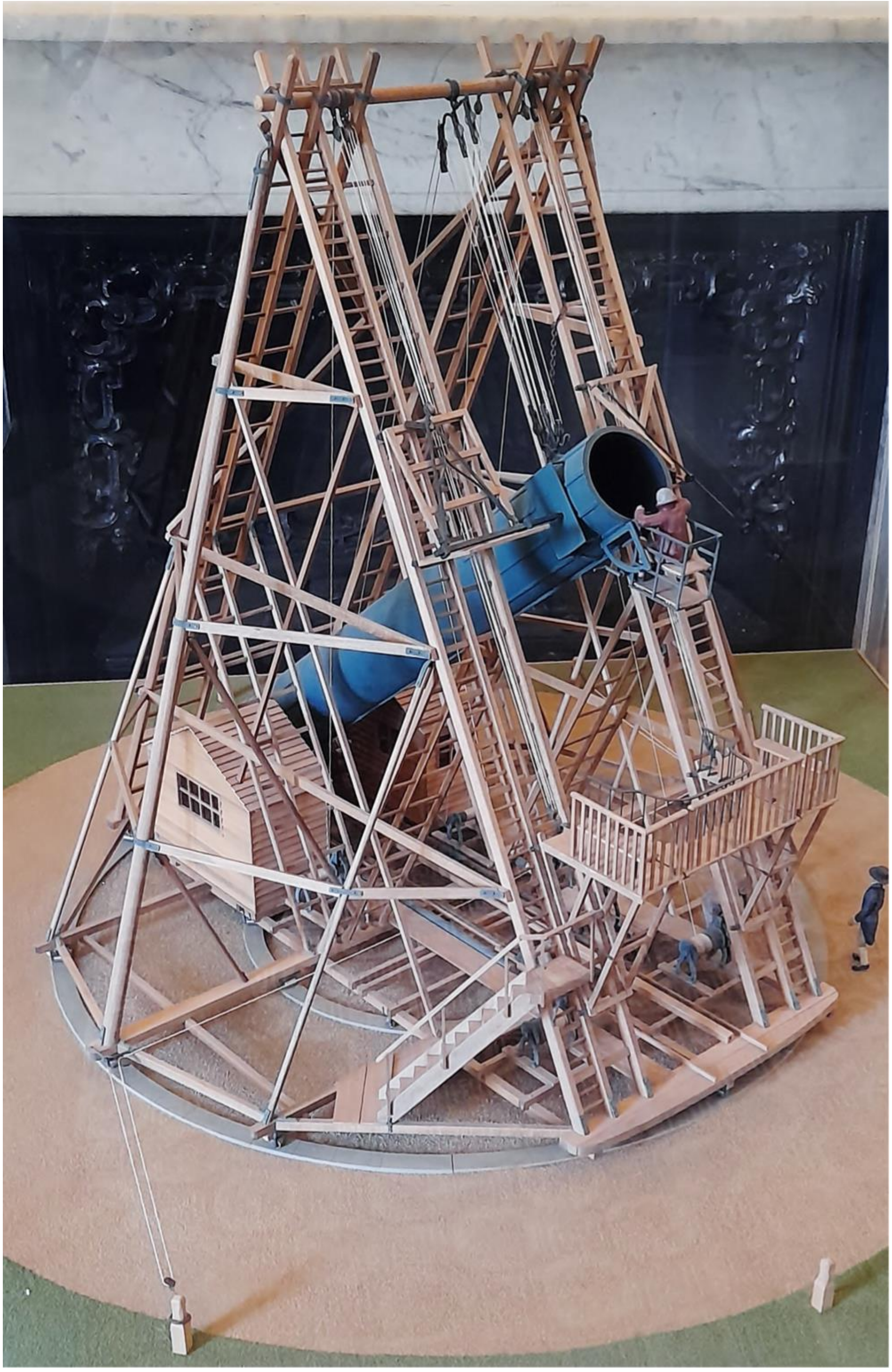
In March of this year, my wife and I happened to be in the lovely Georgian city of Bath visiting friends. Knowing that this was where the Herschel Museum was situated, and aware that 2022 was the bicentenary of William Herschel's death, I was determined to squeeze in a visit before returning home. So it was that on a bright, cold, spring Sunday morning, we walked the short distance from where we were staying to find 19, New King Street, Herschel's former residence in Bath.

New King Street is an attractive road located in the west of the city centre about half-a-mile's walk from Bath Spa station. Constructed between 1764 and 1770, each side is flanked by long terraces of Georgian houses built of pale yellow-ochre sandstone, which looked soft and warm in the morning sun. These dwellings are of modest size compared with the grander houses frequented by visitors during the fashionable Bath 'seasons' of Herschel's day and are typical of those that were occupied by artisans and tradespeople. Like much of the housing in the street, No.19 occupies five floors, three main storeys, a basement and an attic. The basement and two lower storeys constitute the museum.

Herschel first came to Bath in 1766 and moved into this house in March 1777, remaining for about five years before moving to Datchet, a village near Windsor. Although his stay here was relatively brief, it was during his time at 19 New King Street that he made the discovery that made him famous, the first sighting of a new planet in modern times. It was here too that he made many of his (literally) world-beating telescopes, and that his sister, Caroline, made the first of her own celestial discoveries. His brother, Alexander, also lived here for some years, and assisted William with his endeavours. The house therefore amply deserves its status as the Herschel Museum of Astronomy.

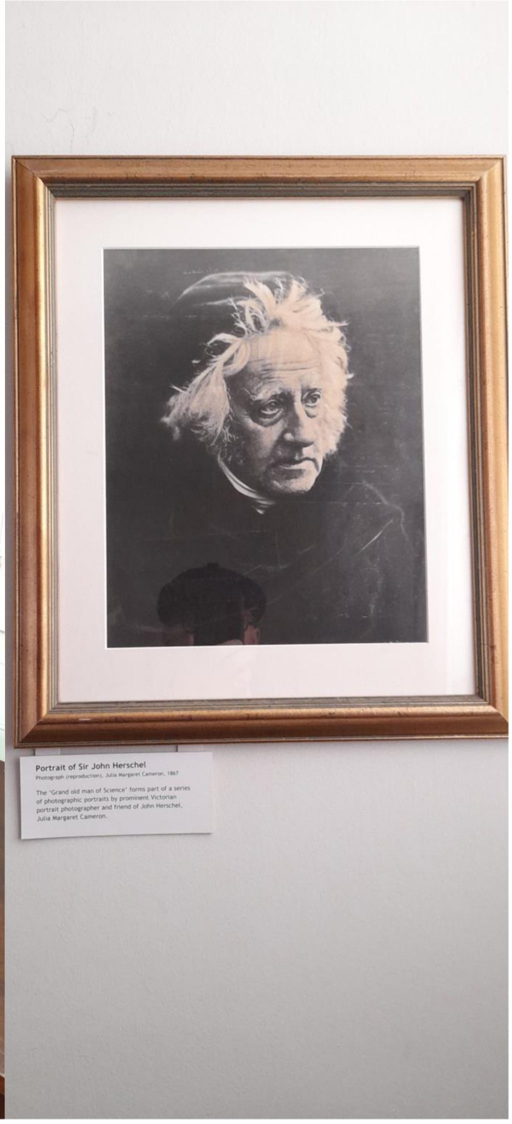
Passing through the front door and along the hallway into the rear room, we were greeted warmly by a masked gentleman[1] (Covid precautions) who gave us a very informative and interesting introduction to the museum. We were then left to wander at leisure. Fortunately, there were few other visitors, so we had the place more or less to ourselves, making access to the various exhibits easy and enhancing the feeling of being in a home rather than a museum. Although there are a few items in glass cases, mostly the house is refreshingly free of barriers. The place had a very homely feel to it and a relaxed, welcoming atmosphere.

The object that immediately caught my eye was the replica of William Herschel's 6.2-inch 7-foot (f14) reflector. He was using this telescope when he discovered the new planet, *Georgium Sidus*[2] (later renamed Uranus), in March 1781. Like so many scientific instruments of the day, this replica, like the original, is beautifully constructed. I was struck by the thought that it was smaller than my own 8-inch reflector!



In the same ground-floor room we found a second gem, a wonderful model of the famous 48-inch, 40-foot (f10) telescope, with a miniature Herschel perched perilously at the top of the tube. What a pity that the telescope did not live up to expectations, an experience that will be familiar to many who have succumbed to the temptations of 'aperture fever'.

Next to catch my eye was a framed set of photographs of the interior of Observatory House, Herschel's residence in Slough, where his son, John, was born and where William died. These photographs include pictures of the 48-inch mirror, looking in good condition.[3] How sad, even disgraceful, that Observatory House was demolished in the 1960s.



The ground floor front room of 19 New King Street is the Dining Room, where a dining table is set for dinner. Here, in the window, stands a bust of William. On a nearby wall hangs a photographic portrait of William's son, John, at the age of seventy-five.

Upstairs at the front of the house is the Music Room. Various musical instruments associated with the Herschels are displayed here, including the bizarre looking but well-named Serpent, together with various musical memorabilia - concert posters, tickets for concerts at which the Herschels performed and so on. The exhibits in this room are a reminder that Herschel was not only an outstanding astronomer but also a talented musician: multi-instrumentalist, composer, conductor, choirmaster and musical director.

To the rear is the Drawing Room which looks out over the back garden. This narrow garden was originally longer, probably about twice as long and reaching as far as James Street West, but it has been truncated by modern housing developments. Nonetheless, it was here that William made his great discovery. This first glimpse of it is an exciting moment.

Returning to the ground floor we descended to the kitchen. Just beyond is William's workshop, built by him as an addition to the kitchen, where he made his telescopes - speculum mirrors, eyepieces and mounts - from scratch. The room includes a furnace and a replica mirror-grinding machine among many other items. It is not often that one visits an historic house and pays close attention to a basement floor. But here we see the shattered stone flags, broken when a mirror mold cracked and spewed out molten metal. William and his brother Alexander had to make a rapid and undignified exit from the workshop as the stones beneath their feet began to explode!

A small modern exhibition and meeting area has been attached to the workshop, the Caroline Lucretia (Herschel) Gallery. The elevation to the rear is made of glass and a sliding glass door admits you to the garden. The design of the house is such that while the front door is at street level, the basement opens out onto the garden one floor below. Now I really did feel as if I was on hallowed ground. Rather like the house itself, this small, beautifully planted garden has a wonderful sense of calm about it. Being there was the highlight of our visit.

The garden faces to the southwest, and as I looked up at the clear blue sky, I imagined William there at dead of night with the 7-foot scope, scanning the pollution-free skies of 18th century Bath. And then that moment when "a new planet swims into his ken", even though he did not realise at first that what he saw was a planet. Even so, what a moment!

A memorial stone, originally located in Westminster Abbey, lies in the middle of the garden. It reads: 'William Herschel 1738-1822 *Coelorum Perrupit Claustra Alibi Sepultus* - He Broke Through the Barriers of Heaven - He Was Buried Elsewhere'.[4]

Before visiting 19 New King Street, I knew little about William Herschel other than that he was the discoverer of Uranus. But after visiting his home, I realised that he must surely be an icon to every amateur astronomer. Here was man with little or no formal education in astronomy who discovered a planet, as well as thousands of deep sky objects, when observing from the back garden of his home using a telescope of his own design and construction, a true astronomical enthusiast whose perseverance, skill, ambition and vision have seldom if ever been matched.

I left the Herschel Museum well-satisfied, better informed and keen to learn more, a testament to the excellence of the exhibits and their presentation and to the beautifully preserved house and garden. I cannot say that all my museum visits have been attended by such feelings. But this is not so much a museum as a shrine that every amateur astronomer has to visit at least once in their life.

[1] Joe Middleton, Front of House Manager.
[2] The Georgian Star, in honour of King George III, his future patron.

[3] A section of the telescope's tube can be seen at the Royal Observatory, Greenwich. The mirror is in the Science Museum, London.
[4] William was buried at St Laurence's Church, Slough. His son, John, however, was buried in Westminster Abbey.

For further information see https://herschelmuseum.org.uk/
and http://herschelsociety.org.uk/

A brief but informative virtual visit to the Museum can be found at
https://www.bbc.co.uk/programmes/p08gk6kq
courtesy of the BBC's *Bargain Hunt* programme.

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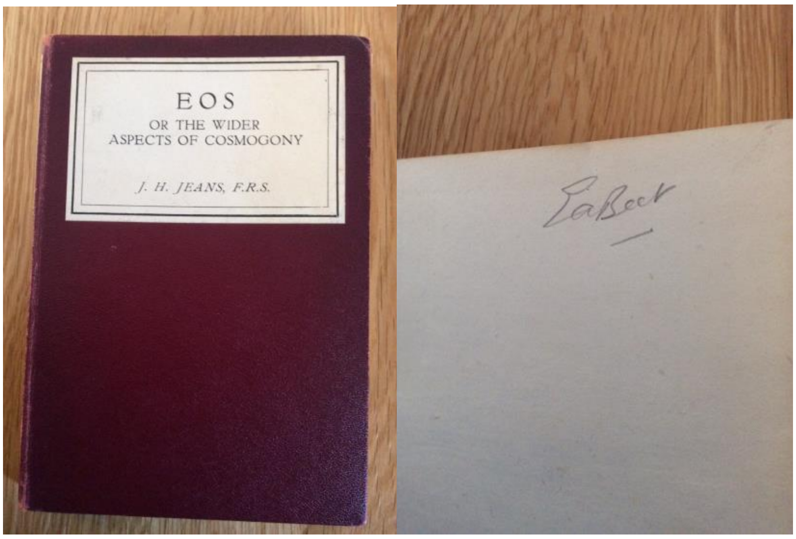
A Recently Acquired Book
Bill Barton

Earlier this year I attended the Society for the History of Astronomy Spring Conference in Birmingham. I found this small volume by Sir James Jeans on the second-hand book stall. The interesting thing about it is a previous owner's signature on the fly leaf, E A Beet. Mr. Beet was BAA Historical Section Director from 1968 to 1986.



An Enquiry
Wayne Orchiston

Wayne Orchiston has sent us a photograph of an observatory, with a figure, presumably the owner, sat outside and a telescope visible through the observatory aperture. He asks: Where is the observatory located? Who was the owner? Is it the owner sat in the photograph? What is the telescope? Internet research suggests that the observatory may have been in the Australian state of Victoria, but Wayne has his doubts.

As usual, we throw open the enquiry to our knowledgeable membership. Please let us know if you have any information which sheds light on this mysterious observatory.

Dates for your diary

A Celebration of the Astronomy of William Herschel, Saturday 1 October 2022, 09:30am to 5:45pm, live at 16 Queen Square, Bath, England or online. A joint conference of the Herschel Society and the Bath Royal Literary & Scientific Institution. Tickets: £15 for BRLSI members or £30 for non-members at the live event. £10 for BRSLI members or £20 non-members for participation online brlsi.org/whats-on

SHA Autumn Conference, Saturday 22 October 2022, 10am to 5pm, a physical meeting at the Birmingham & Midland Institute, 9 Margaret St., Birmingham. Booking essential, email meetings@shastro.org.uk to attend.