The British Astronomical Association
Historical Section

Director: Mike Frost – FrostMA@aol.com
Deputy Director: Bill Barton – barton.bill@hotmail.com

Newsletter No. 21 Late Spring 2020

From the Director
Mike Frost

Since we launched the historical section newsletter in 2010, we have produced a newsletter twice a year, in spring and in autumn. However, these are not normal times… In these days of lockdowns and social distancing, Council have recommended that we increase our online output, so we looked to produce an extra edition of the newsletter.

Fortunately we already had a contribution that we were keen to bring to you as soon as possible. In the last edition of the newsletter, I wrote a short piece entitled *When the Dust Settles,* inspired by the 100th anniversary of the famous eclipse observations which confirmed Einstein's General Theory of Relativity. I was hoping that the article would be thought-provoking, and indeed there was a prompt, thorough and fascinating response from Christopher Taylor. It is good that we can publish this in full whilst my original article is still fresh in mind.

We are also keen to contribute to the BAA's campaign of Highlighting Women in Astronomy. In the last two editions of the newsletter we have featured Elizabeth Brown and Mary Evershed. We have written further about Mary Evershed, as one of the two female directors of the Historical Section, and will be presenting what we have found out about the other, less well-known HS director, Sheila Boulter. This short paper has been submitted to the Journal, as has a piece by Bill Barton commemorating the 100th anniversary of the death of Fiammetta Wilson, a co-director of the meteor section and another extraordinary character and dedicated observer. In this newsletter, Bill has also written about Irene Toye Warner and Ella Church, who were BAA members and also among the pioneering first women Fellows of the Royal Astronomical Society in 1916.

As we'll all be at home a lot more, why not take the opportunity to make a contribution to the newsletter. We welcome short articles, requests for information, letters to the editor, book reviews, and indeed anything relevant to the history of astronomy. Surprise us!

Finally – A conundrum for you (answer later on). **Only two people have won both a Nobel Prize and an Oscar.** Who were they **- and which one of them was a BAA member?**

(Those of you who attended the joint SHA/Historical Section meeting at Greenwich in 2015 will remember Tony Kinder pointing this fact out in his talk on "The Empire of the BAA")

Ella Katherine Church and Irene Elizabeth Toye Warner
Bill Barton

Of the five women elected to the Royal Astronomical Society in 1916 January, Mary Blagg is well known and I have previously described Grace Cook in the *JBAA* and Fiammetta Wilson in the SHA's *Antiquarian Astronomer*. But what of the remaining two, Ella Church and Irene Warner?

First let me say that this research has been partially conducted under lockdown conditions and thus I have been limited in the sources I can draw on. Hopefully when the lockdown eases (or ends) I will be able to consult materials currently unavailable to me.

Second I would like to highlight some common themes in these ladies' lives. It is almost as if, when the election of women to the fellowship of the RAS became a real possibility in late 1915, the foremost men of the amateur community got together and decided on suitable candidates to nominate. Thus H H Turner chose Mary Blagg; T E R Philips, Ella Church; W F Denning, Grace Cook and Irene Warner, and the less well known J R Leeson, Fiammetta Wilson. In the case of the subjects of this contribution there was also some sharing of fields of study with their nominator and when he upgraded his observational equipment the previous instrument was sometimes passed on.

Ella Church (1881-1948)

Ella's grandfather, Edmund Boyle Church (1818-1877) and father, William Edward Church (1849-1933), were Chief Clerk to the Master of the Rolls and Registrar in the High Court of Justice respectively. Ella's mother was Elizabeth Mary née Smith (1853-1941), and they married on 12 September 1877. The marriage produced two sons and three daughters. Both of Ella's brothers didn't live into old age, Edmund Henry (1882-1907) died in Dover, Kent at the age of 25, while Geoffrey William (1886-3 May 1917) was killed on the First World War Western front while serving with the East Kent Regiment. One of Ella's sisters, Hester Mary (1888-1971) received the War and Victory medals having served as a Great War Lady Doctor. Ella's younger sister, Naomi Darell (1893-1941), like Ella apparently had no occupation. The family grew up at Ashtead, Surrey, but around the time of the end of the First World War moved to Gregory's (sometimes Gregories) Cottage, Beaconsfield, Buckinghamshire where they were neighbours and friends of the novelist G K Chesterton (1874-1936). Ashtead was the parish of Rev T E R Philips (1868-1942) between 1906 and 1916 before his move to Headley Down, where he remained until his death. Ella was elected to the BAA on 25 November 1908 at the proposal of Philips and seconded by W H Maw. Ella sat on the BAA Council as an ordinary member from October 1918 until September 1924, except for the 1921-1922 session. She contributed to the Jupiter, Variable Star and Mars observing sections. She also briefly had BAA loan instrument No. 19, a 4⅛" aperture refractor previously belonging to Capt. William Noble. Gregory's Cottage is thought to have been demolished in the 1970's.

Irene Elizabeth Toye Warner (1882-1954)

Irene burst onto the astronomical scene in 1907 when she started writing a monthly astronomy column for the Bristol based newspaper *The Western Daily Press* and was elected to the BAA on at the proposal of W F Denning. A 1912 book of her poetry was, apparently, dedicated to Denning, although the subject of the verses is unknown. Her father, Wiclif Warner (1855-1925) was an architect and surveyor and thus possibly nouveau-riche. Her mother was Annie Amelia née Carroll (1861-1951), and they married in Midsomer Norton on 14 September 1880. Irene was their only child and has been described as a freelance journalist. She married somewhat late in life at the age of 38 to her 63 year old cousin Albert Warner Staples (1857-1927) who was visiting the U.K. from South Africa. After marriage they moved back to South Africa, taking Irene's mother with them where they all lived for the rest of their lives.

Irene practiced her astronomy, although where she gained her knowledge of the subject from is unknown, from the family home in Bristol. Before 1899 this was known as Poplar Cottage, due to the three large poplar trees that grew at its gates. Between 1900 and 1920 Poplar Cottage was occupied by the Warner family and was renamed Ardagh, from the Gaelic meaning 'High View'. After the Warner family left, Bristol Council recommended purchasing the estate, which comprised of the house and 5¾ acres of land at a cost of £4,850. Development plans for the estate didn't materialize straight away and by 1922 the house was starting to suffer from neglect. This delay resulted in the grounds being given over to allotments, however the house is currently used as a community centre. In addition to being a member of our association, she was also a 'compounded' member. This term was used in the BAA to confer life membership, although the BAA lost track of Irene after 1938. Observationally she followed Mercury without optical aid, and comets 1910a and Morehouse (1908) with a 6¼ inch refractor. Finally Jupiter was observed with a 12.6 inch aperture alt-az mounted Calver reflector which Irene obtained from Denning and in turn attempted to dispose of in 1924.

Additionally to being a BAA member and a Fellow of the RAS, Irene was a member of the Astronomical Society of Wales (joining in 1908) and the Société Astronomique de France (member no. 5022, joining in 1909). Politically she was a member of the suffragist WSPU.
Following the move to Africa Irene continued her journalistic career writing for The Cape Argus and The East London Daily Dispatch, however the subject of these contributions is unknown. Irene visited Cardiff in the spring of 1929 to broadcast a three part travelogue on BBC radio entitled *'Trekking by Caravan in South Africa'* which also appeared in book form as *'Through the Cape by Caravan and Car'*. Irene also took part in the post-war vogue for spiritualism which also involved national figures such as the physicist Sir Oliver Lodge (1851-1940) and novelist Sir Arthur Conan Doyle (1859-1930).

By way of conclusion - these ladies' lives started in the Victorian era, they took up astronomy in the Edwardian era, lived through two World Wars, and their lives ended in post war austerity. Unfortunately they seem to have been almost completely forgotten, until now.

An Appeal for Information – Betty Marion Davis
David Sellers

Does anyone know whether Elizabeth (Betty) Marion Davis is still alive and contactable? She wrote an excellent MSc thesis on *The Astronomical Work of Jeremiah Horrox* at London University in 1967. This 153-page detailed work has been relied on by many authors since, but she seems to have published nothing else. I would like to interview her (remotely of course!) for SHA e-News, of she is still around. QJRAS (1970) reports that she was made a Fellow of the Royal Astronomical Society on the proposal of WF Bushell (who also wrote articles about Horrocks). At the time, her address was given as Fernhill Manor School, New Milton, Hampshire. [Contact David at David.Sellers@ntlworld.com]

Einstein, Eddington and 1919
Christopher Taylor

While certainly making no claim to be a specialist in General Relativity, I have had a lifelong love-affair with the subject, from reading Eddington's classic *Mathematical Theory of Relativity* with a mixture of fascination and (mostly!) deep incomprehension while still at school, to giving an invited lecture *Einstein, celebrity and the eclipse of 1919* last August, nearly fifty years later, to about 100 students and faculty of the University of Georgia summer program at Trinity College Oxford. Naturally, therefore, Mike Frost's thoughtful piece *When the Dust Settles* in our section Newsletter No. 20 struck a chord and I thought it possibly worth making a few further points. The subject, certainly, is an important one in the history of science.

There are two pertinent remarks, in particular, concerning the verification of Einstein's light-bending prediction at the total eclipse of May 1919. Firstly, the role of *luck* – both Einstein's and Eddington's – in the whole story, which is not infrequently underplayed or glossed over in later accounts. And I don't just mean with the weather. Einstein was very lucky, as things fell out, that his predictions of the deflection of light by a gravitational field had *not* been successfully tested on at least one earlier occasion, despite attempts to do so and his own fervent hopes to that effect – for had that happened his prediction would have been proven wrong!

Invoking Einstein's own 1905 photon-hypothesis, it is a simple matter to calculate the deflection of light passing close to the Sun, as a standard exercise in purely Newtonian ballistics without any appeal to relativity theory: the answer is a deflection of limb-grazing rays by 0.87 arcseconds. This clearly has nothing to do with the curvature of spacetime, which is the essence of that final theory of General Relativity triumphantly vindicated at the 1919 eclipse. However, Einstein's earlier attempts at a relativistic theory of gravity based on the Equivalence Principle and that of unrestricted relativity did not fully include the role of intrinsically curved spacetime before November 1915, up to which point those relativistic theories were themselves also predicting exactly that same 0.87 arcsecond deflection. To predict the correct value of double the semi-newtonian answer, a relativistic theory must

model the gravitational field as a region in which spacetime has non-zero intrinsic curvature but Einstein didn't even learn the non-Euclidean differential geometry needed to think in such terms until the latter half of 1912, when working to develop the latest variant of the theory with the help of his friend the mathematician Marcel Grossmann. That first attempt at a 'geometrization' of gravity, the so-called *Entwurf* theory ('sketch' or 'outline'), was published jointly by the two of them in 1913 – still predicting 0.87 arcsec.

Meanwhile, ever since 1911 Einstein had been keenly urging astronomers to test the light-bending prediction, originally derived directly from his famous 'observer-in-a-lift' thought experiment. The challenge was enthusiastically taken up by Einstein's young Berlin colleague Erwin Freundlich (much later, as Finlay-Freundlich, first professor of astronomy at St. Andrews), with the result that a German expedition under Freundlich's lead was mounted to carry out the crucial test from the Crimea at the total eclipse of 21st August 1914. That, of course, aimed to verify the prediction of the *Entwurf* theory – the half-value – and it is not clear (to this student of the subject, at least) whether anyone at the time fully realised that exactly the same prediction arose naturally from the semi-newtonian argument cited above, so that the proposed observations were, on that basis, irrelevant as a test of the new theory. *Fortunately* (!) for Einstein and the acceptance of General Relativity by the scientific world, on 1st August 1914 Germany declared war on Russia. The members of Freundlich's party either turned back or were interned by the Russian army. It had been a close shave for Einstein's credibility: as Abraham Pais says on p. 303 of his standard scientific biography of Einstein "Several quirks of history saved him from the embarrassment of banking on the wrong result." History could so very easily have been entirely different from the triumphal 1919 outcome.

Incidentally, this raises interesting questions concerning the way that science, and Einsteinian gravitational theory in particular, is often presented in popular books and even some of the more elementary textbooks, whose authors sometimes appear to believe that any causal explanation of some of the observable *effects* of General Relativity is the same thing as an explanation of the theory *itself*. This can easily be seen to be patently untrue, for instance, by further applying the 'photons+newtonian dynamics' semi-newtonian approach previously cited, to derive a second consequence of relativity, the gravitational redshift. Taking Planck's equation $E = hv$ applied to photons rising against a gravitational field, treating those as particles of mass E/c^2 according to Einstein's most famous equation (from *Special* Relativity, of course, which is not a theory of gravity), and then doing a purely newtonian energy-conservation calculation, the result is *exactly the same* prediction of gravitational redshift as that given by Einstein's G.R. At no point has curved spacetime been invoked, so this one of the famous three 'Classical Tests' of G.R. is, in fact, not a test of the theory at all: we are back again to the 1914 situation, and for broadly the same reason. Given, also, the very considerable errors and uncertainties of the early eclipse-verifications of light bending, that for a long time really left only the third classical test, the perihelion advance of Mercury, as the sole quantitatively precise, totally compelling argument for the truth of Einstein's theory.

Similarly, it has been very fashionable in recent years among writers of popular expositions on black holes to trace the origins of that idea back to John Michell's purely newtonian proposal in 1784 of gravitating bodies so massive or so compressed that the escape velocity becomes as great as the velocity of light. Superficially this may look like the modern concept of a black hole as arising from Einstein's theory – but General Relativity just isn't that simple! This, again, is to conflate a consequence of a scientific theory with the theory itself, for the argument in G.R. leading to the prediction of black holes bears virtually no relation, logically, to Michell's idea, it is far subtler, deeper and more sophisticated conceptually, and there are actually very fundamental differences even between the two results: for instance, in newtonian celestial mechanics the escape velocity from any given spherical surface surrounding a gravitating mass, to an external point of observation, steadily decreases (of course) as that external point approaches the given surface so that, conversely, the surface from which that escape velocity always equals the velocity of light progressively shrinks as the point of observation approaches it; in G.R., on the contrary, the corresponding surface, the 'event horizon' of a black hole, is *fixed* in size irrespective of the location of the external observer. It is a curious irony that in Newton's 'absolutist' system the critical horizon is defined solely relative to the observer's location, whereas in relativity, so-called, it is an absolute feature of space!

The temptation to use such very elementary arguments as these two when attempting to explain General Relativity to a non-scientific public, or to students first encountering the subject, is obvious: the theory is conceptually challenging despite the deceptive simplicity of its postulates, and it requires some decidedly sophisticated mathematics, as Einstein himself found to his cost in 1912-1915. The trouble with doing this is twofold: firstly, what is presented is *not* G.R! And secondly, it trivialises the theory and risks leaving the critical-minded student first meeting it with the thought "Is that all? What's the big deal?" On both counts, such approaches to the subject let the intended audience down very badly by completely failing to convey any real flavour of Einstein's thinking and of the huge advance that that was on all previous ideas. As was famously said over 2000 years ago, "There is no royal road to geometry" and that remark is especially true of Einstein's great theory, which some of us value as the most beautiful piece of poetry, mathematically and conceptually, in all of physical science. I have no doubt whatever that Newton would emphatically share that last sentiment were he alive today.

To return to 1919 and the role of luck in the story, what of Eddington? Simply that he got there first, that no-one else had pulled off the light-bending verification at earlier eclipses, which might so easily have been the case had history been slightly different. Apart from the aborted Freundlich effort of 1914, the passage from Pais's book quoted earlier lists planned attempts to do this at the Brazilian eclipse of 1912 (rained off), that of 1916 from Venezuela (prevented by the war) and an American effort in June 1918 (results inconclusive), while other sources mention a second, American, expedition to the Crimea in 1914 being clouded out – some at least of this an all-too-familiar scenario to astronomers in general and eclipse-chasers in particular!

Mention of Eddington brings us neatly to the second 'pertinent remark' concerning the 1919 story. A trend has been increasingly noticeable in recent years, and particularly in the flurry of writing of the last twelvemonth prompted by the centenary, of assigning sole credit for the eclipse expedition of 1919 and its successful outcome to Eddington, as though this was a one-man show. It was, of course, absolutely nothing of the kind and the true story is well-enough known: many people contributed to the preparations for the eclipse expedition, during which the Cambridge team of Eddington and his colleague E T Cottingham went to Principe off the west coast of Africa, while the Greenwich (R.O.G.) team, A C D Crommelin and C R Davidson, set up at Sobral in Brazil; the whole thing was paid for by a government grant of £1000; and none of this would have happened without the original suggestion and huge continuing support of Eddington's good friend and former chief Frank Dyson, the Astronomer Royal. It was Dyson, in fact, who made the first presentation of the final light-deflection results at that famous joint meeting of the R.A.S. and the Royal Society on 6th November 1919, Eddington speaking second to fill in some of the technical details.

Dyson in particular seems almost to have been airbrushed from the story in recent years, a deep injustice to his memory given, especially, that during his time at Greenwich he had introduced greatly improved methods of measuring star-positions from photographic plates and that he was himself a veteran of three previous R.O.G. eclipse expeditions. His far greater experience in both of these vital respects must have been of immense value to all those who went on the 1919 expedition, Eddington included. Granted that Eddington, as the first person in Britain to understand Einstein's 1915 papers and, later, to become the great champion of General Relativity in the english-speaking world, was certainly the intellectual brains of the 1919 venture, and that he did most or all of the plate-measuring and numerical reductions of the results. Yet as Chandrasekhar recalls on pp.24-25 of his charming 1983 tribute *Eddington: The most distinguished astrophysicist of his time* "I once expressed to Eddington my admiration of his scientific sensibility in planning the expeditions under circumstances when the future must have appeared very bleak. To my surprise, Eddington disclaimed any credit on that account and told me that, had he been left to himself, he would not have planned the expeditions since he was fully convinced of the truth of the general theory of relativity!"

There, indeed, speaks the theorist.

And speaking of the truth of G.R. recalls the extremely important broader issue raised by our Section Director in his Newsletter piece, on which this writer emphatically agrees with him – that of the credibility of science in the public mind. General Relativity in particular has always been a favourite target for what might politely be called 'alternative thinkers' and other skeptics. A good friend of mine, a structural engineer of many years professional experience, so a man therefore of some training in mathematics and classical physics, still considers relativity to be "nature's joke", as he puts it. I've not attempted to persuade him out of that view. Another acquaintance, encountered at a local astronomical society about ten years ago, regaled me with his latest stroke of genius for 'explaining' gravity, to which it

was very obvious he was passionately committed. On the whole, I try to steer clear of being drawn into such conversations but that wasn't to be this time and it transpired that this man had independently thought of Lesage's 'corpuscular impacts' mechanism of 1758! Without, of course, ever having heard of Lesage.

Indeed, I too have done my share of 'alternative' thinking on the subject in the dim and distant past, before a deepening understanding of it brought home the folly of my ways. That took the form, in my first year at university, of a post-newtonian field-theory of gravity which applied $E = mc^2$ to the distributed energy-density of the gravitational field itself, in an attempt to take into account the second-order gravitational effects of that gravitational energy. I had never come across the idea anywhere in print (although Einstein and others had actually tinkered with something similar around 1910-11), it did at least explain rather neatly why any such post-newtonian formulation making any attempt at all to take relativity into account must necessarily be a nonlinear theory – which even then I knew G.R. itself to be – and for a while I was rather pleased with the result. Some years later it transpired that exactly the same gravity-theory had been published about the same time by an eminent professional physicist (Brillouin of solid-state fame). Then came the reality-check: the theory did *not* have Newton's $1/r^2$-law as its limiting form for weak fields but something entirely different and utterly incompatible, an embarrassing fact of which neither I, nor Brillouin apparently, were originally aware. It was only decades later that the further realisation dawned that Einstein's Equivalence Principle actually makes the whole idea impossible in principle from the very outset. So much for that idea – at least I'd never published it!

Gravity, for some reason, seems to attract such thinking like bees to honey, even a century after Einstein gave the world a theory which is irresistibly compelling to the overwhelming majority of those who have genuinely understood it. Meanwhile, G.R.'s concrete observational verification has steadily deepened and widened to a point which no-one could have dreamed of in 1919, and both light-deflection and gravitational redshift by celestial bodies have now long been almost irrelevant to the precise, quantitative evidential basis of the theory: the Shapiro time-delay for space-probe radio signals passing close to the sun, the various peculiarly relativistic effects exhibited by the Hulse-Taylor binary pulsar (for which piece of work the Nobel prize was given) and other such systems, the verification of the relativistic effects of geodesic deflection and frame-dragging by Gravity-Probe B, as well as other tests, have irresistibly vindicated Einstein's theory to levels of quantitative precision far beyond anything the sceptics would ever dare demand of their own pet theories. G.R. in 2020 is no more provisional than Newton's $1/r^2$-law: they are both fully mature mathematical models of one of the most important aspects of the real world, thoroughly grounded in concrete, quantitative evidence from that real world.

The whole issue of public credibility of scientific theories is, as Mike Frost highlights, thrown into particularly sharp focus by General Relativity and, as Mike says, this is fundamentally a matter of lack of public understanding, itself partly at least the result of a failure of communication between those in the know and the wider community. There are

two levels of scientific incomprehension here, in the writer's observation. First and most widespread, even among the highly educated, is a complete failure to grasp the very essence of the scientific method itself, in which external objective *evidence* is the final arbiter of truth, than which there is no higher court of appeal. To such scientific innocents the word 'theory' has exactly the same meaning as 'provisional working hypothesis' – how many times has one heard "Oh but it's only a theory"?! – while 'relativity' is taken to be little better than 'subjective'. So what chance does the poor old 'theory of relativity' have in these minds, who are quite likely to consider Einstein's work as nothing better than a wild guess, no more to be believed than any guess they could make for themselves and probably a great deal less plausible (to them)?

Sometimes, of course, we have to contend at this level of misconception with the downright science-deniers, aided and abetted by the soi-disant 'relativist' philosophers such as that darling of the dinner-party intelligentsia Michel Foucault. One of the main 'arguments' of such misrepresenters of the scientific endeavour is an absurd over-interpretation of the allegedly provisional nature of scientific understanding, frequently citing as a favourite example, indeed, Einstein "proving Newton wrong" on the subject of gravity. This of course shows a total misconception of the process of evolution of such models of the physical world, which is a far more cumulative process than one of 'throw-it-all-out-and-start-again', at least so far as concerns the specific quantitative predictions of the successive models. As anyone who knows the first thing about such scientific theorising is well aware, the process of one theory succeeding another is, in that sense, one of successive approximations – and since when should we reject the first approximation, *as* a first approximation, just because we've found the second approximation?! There are many occasions when the first approximation remains more than sufficient, irrespective of all possible later revisions.

In the case of gravity, what such science-deniers are blissfully unaware of is that their alleged example of the 'provisional' nature of science is, *au contraire*, peculiarly inappropriate. Einstein's work, far from disproving Newton, actually provided, for the very first time, an *a priori reason for* Newton's law of gravity, something completely lacking in Newtonian theory itself: the ingredients which go in to the construction of G.R. include no specific law of variation of the gravitational field but are purely postulates of a much more general nature yet, when the resulting field-equations are then solved, Newton's $1/r^2$-law pops out, almost magically, as the weak-field limit. This striking and highly impressive instance of the inner consistency of our models of the laws of nature ought to be far, far better known among those who preach the "all scientific understanding is provisional" gospel. None of this prevents such people when it suits them, nonetheless, from invoking the theory of relativity itself – as they misunderstand it – to justify their assertion "all knowledge is relative". Wonderful what you can prove by cherry-picking the truth!

Second-level incomprehension with respect to General Relativity specifically is closely connected with the points made earlier about the short-comings of the semi-newtonian arguments which sometimes masquerade as explanations of G.R. itself in popular

expositions. Here the unwitting victim of the deception is likely to be someone who is genuinely interested in science and does understand the broad principles of scientific method but who is coming to Einstein's theory for the first time with only very limited relevant mathematics. While it is certainly *not* necessary to master the technicalities of 4-dimensional differential geometry, tensors and all that to get a real flavour of the theory, the pitfall here is that that just can't be done without understanding the essential concepts, at least, of curved-space geometry. Many elementary and popular expositions simply fail to rise to that challenge at all.

Pseudo-explanations of non-Euclidean geometry, such as those 'triangles' (*sic*) consisting of three curved arcs printed on a flat page, insult the intelligence of the reader, who is likely only to be enraged at the blatant 'fudge' the author is attempting to foist on them. And yet it's not difficult to do an honest job of this without getting embroiled in a morass of calculus equations. How often does one see any mention at all in these elementary expositions, for instance, of that absolutely central point that there is such a thing as *intrinsic* geometry, that is, that it is simply not necessary, logically, to consider anything at all outside a curved surface to know that it *is* curved? This goes back to the work of Gauss on 2-dimensional surfaces about 1820, then generalised to 3-, and higher-, dimensional regions by Riemann in mid-century, whose work Einstein had to learn in 1912-13 to create G.R. When properly explained, not a difficult thing, this immediately answers the question I've been asked on a number of occasions in talks about curved space and all that, "But what is it curved *in*?" The answer, of course, is nothing. And how often is it pointed out that one can actually see a non-Euclidean triangle without fudging it by using obviously bent sides?, viz: on a clear night, imagine there is a bright star on the horizon due south, another due west and a third at the zenith; join them by *straight* lines, as seen by the observer's eye – bingo, a rectilinear triangle having three angles of 90º! These things are really not that difficult with a little thought and honesty.

Further reading on the 1912-1919 story:

Abraham Pais '*Subtle is the Lord…' The Science and the Life of Albert Einstein.* Oxford 1982. The definitive scientific biog. of Einstein, which includes the mathematics and technicalities of physics where relevant, by a theoretical physicist who knew him.
The sections bearing directly on what has been said here are pages 208-227 (Chap. 12) on the lead-up to the 1913 *Entwurf* theory and 303-306 on the 1919 eclipse.

Walter Isaacson *Einstein. His Life and Universe.* New York 2007. A splendid, if less technical, biography, extremely well-researched and thoroughly referenced to the literature on the history of relativity. Isaacson gives a good account of the events of 1919, and of the parts played by both Eddington and Dyson, on pages 255-262. The following chapter vividly tells the story of the fire-storm of publicity following immediately on the announcement of the results. It is worth noting that some historians consider Einstein to have been the very first 'celebrity' – of any sort – in the modern sense, from that moment on.

Arthur Eddington *Space, Time and Gravitation*. Cambridge 1920 (and many later reprints). On pages 113-122 we have the 1919 eclipse 'straight from the horse's mouth', the best account in print, in Eddington's classic style unsurpassable for clarity and elegance. Full justice is done here to the other participants in the 1919 enterprise (e.g. "…and here Mr. Davidson made the arrangements which were the main factor in the success of both parties." [p.114]) – this should certainly be required reading for anyone believing the '1919 eclipse = Eddington' myth! Incidentally, if you are interested in G.R. and haven't read 'S., T. & G.' then you have missed out on probably the best thing of its kind ever written on the subject.

Subrahmanyan Chandrasekhar *Eddington. The most distinguished astrophysicist of his time.* Cambridge 1983. This little 64-page memoir is the author's – he of 1.4 solar-mass fame – generous tribute to his former mentor and colleague of Cambridge days. I was privileged to be present at a seminar in Oxford sometime about 1983 when Chandra talked about this work. He and I had had an entertaining correspondence in the early '80s about the impossibility of climbing out of a black hole using a rope-ladder hung from an orbiting spaceship – another fundamental difference between newtonian 'black holes' and the real thing. Pp. 24-32 provide an interesting 'take' on the 1919 story.

Alice Vibert Douglas *The Life of Arthur Stanley Eddington* London 1956. Still the standard biography. Pages 38-44 give the 1919 story, complete with a brilliant pastiche of Fitzgerald's *Rubaiyat of Omar Khayyam* by Eddington on the subject of the eclipse.

Virginia Trimble *The Impact of World War I on Relativity – Part I* The Observatory **138**, 46-58, April 2018. The first of a recent series of papers giving some useful historical context and background for/to the early development of G.R. Pp. 51-57 deals with the evolution from *Entwurf* 1913 to full-blown G.R. Nov. 1915.

Erwin Freundlich *The Foundations of Einstein's Theory of Gravitation.* Cambridge 1920 (transln. H.L.Brose, first german edn. Berlin 1916). Freundlich was a young disciple and collaborator of Einstein, and practically first in the field of serious exposition of the new theory with the german original of this small 60-page book. The english translation was rushed out at Eddington's instigation within weeks of the Nov. 1919 announcement of the eclipse results. Both Einstein's *Preface* and H H Turner's longer *Introduction* are themselves interesting historical documents. No mention anywhere here of Freundlich's own 1914 eclipse expedition, despite the light-deflection test and the 1919 expedition being discussed on pp. 41-2.

The present writer

On the highly tenuous grounds of having faithfully attended the magisterial thermodynamics lectures in the mid-'70s of the great low-temperature physicist Nikolas Kurti, whose own doctoral viva in Berlin in 1931 was jointly presided over by Einstein, I claim an 'Einstein number' = 2. Much more amusing is that Prof. Kurti once told a colleague, who later told me, that Einstein, sitting in the front row of the faculty audience

next to senior examiner Walter Nernst, fell soundly asleep halfway through the proceedings!

LIVERPOOL'S VERY OWN PLANETARIUM 1970 - 2020,
50 Years of Star Gazing – With the Roof On!
Patrick Kiernan - National Museums Liverpool

May 2020 marks World Museum's planetarium's 50th anniversary, it is the longest surviving planetarium in a British museum and this is the story so far... In 1941 the Liverpool Museum, as it was known then, suffered a direct hit from a bomb during the Liverpool Blitz. It was reopened in 1956 and was to see huge redevelopment. A lot of that work happened in the late 1960s. The director at that time, Tom Hume, had the vision of creating a modern museum that would embrace science and technology. The 1960's was a decade of change and of belief in a new and better future, forged, as the Prime Minister Harold Wilson phrased it, 'in the white heat of technology'. Hume set up a new Astronomy Department early in 1969, establishing a new time and space gallery and installing the planetarium.

The image on the left shows the dome we still use being built, and by 1970 Phase two of the museum's development was complete. The driving force behind the planetarium and space gallery came from Dr Patrick V. Sudbury (shown here on the right), a scientist who had previously worked with NASA surveying possible landing sites for the Apollo missions to the Moon by using the telescope at the Pic Du Midi observatory in the Pyrenees and earned his PhD for his efforts. With his knowledge of telescopes and astronomy, he became the first head of the Astronomy Department and manager of the planetarium. He also served as President of Liverpool Astronomical Society between 1970 – 72.

Sudbury began the astronomy and science collections, particularly rocketry and telescopes, and created the new Space gallery next to the Planetarium. He was also

responsible for the oceanography, modern physics, photography, scientific instruments and medicine collections, some of which are nationally significant.

The restored museum was launched in January 1970 with a display of Moon rock brought back by the Apollo 11 crew. There were queues stretching hundreds of yards outside the museum and more than 32,000 people visited during the three-day showing.

The planetarium opened a few months later on Friday the 22nd May 1970. It was only the second planetarium to be built in a museum – the first, the London Planetarium, was built in Madame Tussauds in Baker Street in 1958, but was closed in 2006 and the new one at Greenwich wasn't established until a few years later.

The new Planetarium featured sixty-seven seats and initially there were two shows each afternoon, except on Monday's which were kept for maintenance of the equipment. As with all new equipment there were some initial difficulties with the £5,000 (about £85,500 in today's money) Zeiss projector.

There was a suite of 150 projectors using almost 50 different motors for images of planets, galaxies and other extras that were not build into the main projector. Each week four to five projector lamps had to be replaced along with bulbs around the dome. When new shows were introduced, new projectors had to be filled with slides, checked and installed; the planet projectors had to be moved to keep them correctly positioned in the sky.

On opening the entrance fee was 2 shillings (or £1.41 today), and after decimalization the price became 15p (or about £2.50 today).

A little after opening the Liverpool skyline was added to the base of the dome. Even though the shows were mainly pre-recorded, everything had to be done manually: bringing up images, moving the sky and pointing out items. The audio was recorded on a two track reel to reel tape recorder, the audio to the public from one track was fed through speakers whilst the operator wore headphones with this track playing in one ear and the prompts of what to do and when in the other! The operator's console took some learning and patience to work out which knob and which switch did what. Liverpool Astronomical Society became a recruiting agent for many of the operators, and in return the Planetarium was used to recruit new society members.

The Space and Time Gallery followed, opening on the 9th September 1993. Leading towards the Planetarium on Level 5, the cost for the renovation was £375,000 and was a new home for the collection of rockets and telescopes. The opening ceremony was overseen by Dr Stephen Hawking via video telephone link. At the time, Dr Hawking was the Lucasian Professor of Mathematics at Cambridge University, a position once held by Sir Isaac Newton. This renovation made the gallery an exciting and fascinating prelude to the planetarium. New comfortable padded seating was installed in the planetarium for visitors to sit back and enjoy the shows.

The first big improvement to the planetarium equipment since its opening was in 2012 when Zeiss (who made the original projector – the 'Star Ball') donated two digital projectors. The new projectors allowed us to present higher quality and more immersive shows without the need for filters, slides and weekly calibration. Unfortunately, because of the way the projectors work we had to remove the skyline from around the base of the dome. This feature is greatly missed by our visitors to this day, many of whom remember seeing it when visiting the Planetarium as children. Over the years our programme has changed; the first school shows began in 1979 nine years after opening and continue to this day. Since that date, we have welcomed around half a million school children! Over the years we increased the number of shows from two a day to our current full schedule of eight shows a day at weekends and holidays, with five public shows a day and three school shows a day during school term.

One of the highlights of the last few years took place in February 2016 when we had a live link-up with the International Space Station to talk with British astronaut Tim Peake. Schools from around the country attended the museum for the event and others watched it live online. Pupils were able to ask him questions which he then answered whilst whizzing over the Earth at 27,000 km an hour!

The planetarium remains a very popular and entertaining attraction with over 2 million visitors and counting! It is a unique venue and something of which the people of Liverpool and the region are rightly proud. The future for the planetarium is exciting: when we re-open why not pop in and say 'Hi'. Let's talk space and become part of the next 50 years of our journey through the cosmos.

All Images with thanks © World Museum Liverpool, The Liverpool Echo, ™Google Images. Text and several of the images with thanks to Patrick Kiernan, Education Demonstrator. Learning & Participation Department, National Museums Liverpool, plus SHA member and appreciation also to Phil Phillips, New Media Development Manager Systems Department. National Museums Liverpool.

Please note – Like many public facilities and buildings in the UK the Liverpool Museum and Planetarium are closed during the present COVID-19 containment situation.
But both plan to be open again when conditions allow.
Stay Home, Stay Safe, Save Lives.

Above - Members of The Society for the History of Astronomy visit the Liverpool Planetarium during their annual summer picnic event and visit to Liverpool, July 2017. © SHA James Dawson.

Answer to the Conundrum, and some further thoughts:
Mike Frost

Two people have won both a Nobel Prize and an Oscar:

George Bernard Shaw (1856-1950) won the 1925 Nobel Prize for Literature and the Best Adapted Screenplay Oscar in 1938 for *Pygmalion* (his own play, later the inspiration for *My Fair Lady*).

Bob Dylan (1941-) won the Best Original Song Oscar in 2000 for *Things Have Changed* from *The Wonder Boys* and the 2016 Nobel Prize for Literature. He has also won ten Grammys, a Golden Globe, a Pulitzer Citation and the Presidential Medal of Freedom.

George Bernard Shaw was a BAA member, elected on 1944 February 23. We're still working on Bob Dylan….

Thanks also to Tony Kinder for pointing out that we have another Nobel Laureate in our numbers, Sir Paul Nurse, FRS (Nobel Prize for Physiology and Medicine, 2001).

What other awards at the very pinnacle have our members (past-and-present) achieved?

I know of one. Captain John Aidan Liddell, V.C. (1888-1915), was elected to the BAA on 27 February 1907. I'll quote from his obituary, written by one of his schoolmasters from Stonyhurst [Initials A.L.C.] (Aloysius Laurence Cortie, S.J. (1859-1925), who also proposed his BAA election? *Ed*.)

"After leaving Oxford he, in 1911, joined the special reserve of officers of the 3rd Battalion Argyll and Sutherland Highlanders, and on the outbreak of the war proceeded to the front with the rank of captain, in charge of the machine-gun section of the battalion. He was for 43 days consecutively in the trenches, and displayed such cool courage and efficiency that he was mentioned in despatches and awarded the Military Cross. His brightness and affability and the general charm of his character made him a favourite with whomsoever he was associated. He was invalided home, and, after his recovery, joined the Royal Flying Corps in May. While at Oxford he had become an expert motorist, and later on received his certificate as pilot for flying at Brooklands in June 1914. He returned to the front on July 23, and, on July 31, it being only his second reconnaissance, he performed the truly wonderful act of devotion and bravery for which he received the V.C., and the wound which ultimately caused his death. The official grounds of his award were thus stated: '*For most conspicuous bravery and devotion to duty on July 31, 1915. When on a flying reconnaissance over Ostend-Bruges-Ghent he was severely wounded (his right thigh being broken), which caused momentary unconsciousness, but by a great effort he recovered partial control, after his machine had dropped nearly 3000 ft., and, notwithstanding his collapsed state, succeeded, though continually fired at, in completing his course, and brought the aeroplane within our lines – half an hour after he had been wounded, The difficulties experienced by this officer in saving his machine, and the life of his observer, cannot be readily expressed, but as the control wheel and throttle were smashed, and also one of the under-carriage struts, it would seem incredible that he could*

have accomplished his task.' … He lingered at the hospital at La Panne, in Belgium, after it was found necessary to amputate his leg, for a month, and died on August 31st."

His story puts our present troubles rather into perspective, doesn't it?

Do we have any other V.C.'s among our members? What other accomplishments can our members claim?

As always, we'd love to hear from you.

And Finally....

BAA Member Alan Thomas has sent in some scans from an old Ottway catalogue.
He has donated the originals to the BAA archives. Thanks Alan!

More on this company (which we're sure many will remember) can be found on line at

https://www.gracesguide.co.uk/W._Ottway_and_Co

A 6" NEWTONIAN REFLECTING TELESCOPE
ALTAZIMUTH MOUNTED ON GARDEN TRIPOD

Each Instrument fitted with first quality optical components of low expansion glass, aluminised and silica coated, guaranteed to be capable of resolving to the theoretical limit. Focus of mirror 48".

1" Star-finder on adjustable mount with double cross wires. Fine focusing to main Instrument, all adjustments for aligning provided.

Two slow motion drives which enables Instrument to be guided with accuracy when following objects. Trunnions of Stainless Steel. Stand will close up when not in use. Instruments are quite portable.

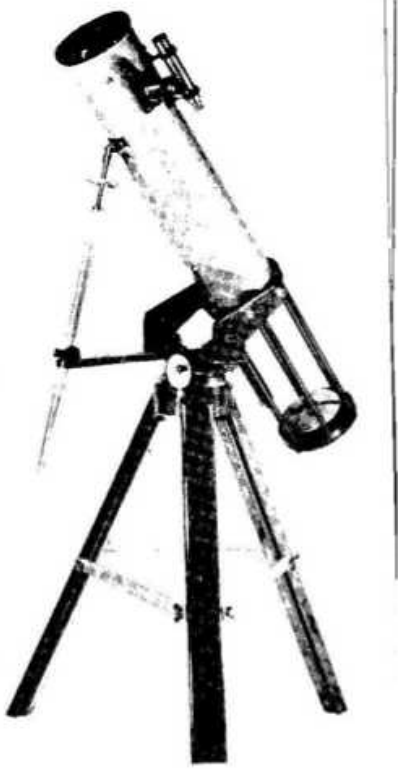
Finish: Stove enamel, brass work nickel plated.

Price complete £6 9 : 10 : .

Transport and packing charges Extra : : .

Delivery 10/12 weeks.

Barlow lenses, eye-pieces, and other accessories can be supplied to suit Customers' requirements.



H. N. IRVING & SON
Instrument Makers
258 KINGSTON ROAD, TEDDINGTON, MIDDLESEX
Telephone: TEDdington Lock 4553

3" STANDARD JOINTED ASTRONOMICAL TELESCOPE

J.244

SPECIFICATION

Telescope

The telescope is fitted with a 3" good quality object glass of 40" focal length without squaring on adjustment, and the eyepiece is of the usual pull-out variety with rack and pinion focusing. One astronomical eyepiece of 70x is supplied complete with dark glass head. The telescope body tube is made in two sections to facilitate stowage and make it more portable.

Mounting

The telescope is carried in trunnion bearings and supported by a forked member, which is provided with azimuth rotation. The tripod is of the split leg type and is made of good quality hardwood, fitted with stretcher chain and metal toe pieces. The mounting as described above is of the type illustrated on J.241 and not as shown on the above illustration.

Finish

The telescope is finished in white stove enamel, all fittings are nickel plated and the stand head finished black stove enamel.

J.242. 40x terrestrial eyepiece.

W. OTTWAY & CO. LTD., ORION WORKS, EALING, LONDON, W13

3″ STANDARD ALTAZIMUTH ASTRONOMICAL TELESCOPE

£20-11-0.

J.241

SPECIFICATION

Telescope

The telescope is fitted with a 3″ good quality object glass of 40″ focal length without squaring on adjustment, and the eyepiece is of the usual pull-out variety with rack and pinion focusing. One astronomical eyepiece of 70x is supplied complete with dark glass head.

Mounting

The telescope is carried in trunnion bearings and supported by a forked member, which is provided with azimuth rotation. The tripod is of the split leg type, and is made of good quality hardwood, fitted with stretcher chain and metal toe pieces.

Finish

The telescope is finished in white stove enamel with brass parts nickel plated and the stand head finished black stove enamel.

J.242. 40x terrestrial eyepiece.

J.243. Whitewood case for J.241 telescopes.

W. OTTWAY & CO. LTD., ORION WORKS, EALING, LONDON, W13