Thomas Hinsley Astbury: from an English market town schoolroom to the internal constitution of the stars

Jeremy Shears

T. H. Astbury (1858–1922) was for many years the much-respected headmaster of a boys' junior school in the English market town of Wallingford. By night he was a dedicated amateur astronomer who enjoyed observing meteors, variable stars and many other objects. He began to search for new variable stars, his first discovery being the bright Cepheid variable RT Aurigae. This, along with his discovery of four other variable stars, brought him to the attention of some of the most famous professional astronomers of the age, including Herbert Hall Turner, Frank Dyson and Arthur Eddington.

Introduction

One afternoon in 2011 November, whilst researching another topic in the Royal Astronomical Society library, I was perusing the 1923 May edition of the BAA *Journal* when I came across the following notice:

'*PROPOSED MEMORIAL TO THE LATE T. H. ASTBURY*

The late Mr. T. H. Astbury was a hard-working schoolmaster, who, while paying full attention to his ordinary duties, and acting as organist on Sundays, devoted time and skill to the discovery of variable stars. He was formerly an active member of our Variable Star Section, and with only a binocular and a three-inch telescope has several such discoveries to his credit, among them one of considerable importance, as the subjoined note by Prof. Eddington makes clear. It has occurred to some of us that it would be in every way appropriate if a small brass could be erected to his memory on the walls of the school where he used to teach, *viz.*, the Council School at Wallingford, 'where he rendered good and faithful service from the time of its opening until his retirement'; these last words are quoted from a letter by the Secretary of the Berkshire Education Committee in signifying his entire approval of the project.

'The estimate from a local firm suggests that the amount required would be about £10, and it is hoped that the number of those who would sympathise with such a scheme may be sufficient to render it unnecessary for any one of them to give more than this.'[1]

The notice was placed by Prof A. S. Eddington, Prof H. H. Turner, Col. E. E. Markwick and Mr A. N. Brown. I was surprised by two aspects of the notice. Firstly, that I had never heard of Thomas Hinsley Astbury, in spite of being an active variable star observer who also has an interest in the history of the BAA Variable Star Section (VSS). The second surprise was that two of the most famous professional astronomers of the day had apparently lent their weight to an appeal to memorialise a schoolteacher and amateur astronomer.

Arthur Stanley Eddington (1882–1944) had been Plumian Professor of Astronomy and Experimental Philosophy at Cambridge University since 1913. In 1914 he was elected a Fellow of the Royal Society and won its Royal Medal in 1918.[2] Herbert Hall Turner, FRS (1861–1930) was Savilian Professor of Astronomy at Oxford. Ernest Elliot Markwick (1853–1925) had previously served as Director of the BAA VSS (1899–1909) and as BAA President (1912–1914).[3] A. N. Brown was at the time Secretary of the BAA VSS.

So who was T. H. Astbury? And what was his contribution to variable star astronomy that had brought him to the attention of these illustrious scientists? There and then, I resolved to find out more about Astbury, his life and his contribution to variable star observing, with the aim of bringing this long forgotten amateur astronomer to the attention of current members of the Association. The present paper is the result of this research.

The Wallingford schoolmaster

Thomas Hinsley Astbury (1858–1922; Figure 1) was born at Shifnal in east Shropshire. His father, Joseph Astbury, was an Iron Works Foreman,[4] this region being a centre of England's burgeoning iron industry. His mother, Hannah Hinsley, from whom Thomas obtained his middle name, was a dealer in drapery. Joseph and Hannah were married in Hannah's home town of Madeley, Shropshire.[5] The marriage resulted in seven children and the family at various times lived in Shifnal, Wellington, also in Shropshire,[6] and Handsworth, West Bromwich, in connection with Joseph's employment.[7]

Figure 1. Thomas Hinsley Astbury (1858–1922). *From ref. 15.*

Thomas became a schoolteacher by profession[8] and from 1883 taught in the Oxfordshire market town of Wallingford (until boundary changes in 1974, Wallingford was located in the county of Berkshire). Wallingford is situated about 20 km south-east of Oxford and a similar distance north-west of Reading. In 1886 he married Emily Wallis Naish in Wallingford.[9] They had two daughters[10]

Figure 2. Kinecroft School, Wallingford, today.

Figure 3. T. H. Astbury (back row, second from left) and other teachers at Brightwell Park, near Wallingford, *ca.* 1900. *From ref. 15.*

and lived at Croft Villas, Wallingford.[11] For most of his teaching career Thomas taught at Kinecroft School, a primary school in Wallingford (Figure 2) catering for both girls and boys and where he became headmaster. A photograph of Astbury with some of the other schoolteachers is shown in Figure 3.

However, in the first decade of the 1900s it was recognised that the school was outgrowing its premises and plans were soon drawn up for a new school for Junior boys. Thus the Wallingford Council Boys School[12] (Figures 4 and 5) was opened on 1910 April 4, with Astbury as headmaster.[13] The school was built by local company

Figure 4. Wallingford Council School for Boys, *ca.* 1910. *From ref. 15.*

Figure 5. Class 1 at Wallingford Council School in 1910. *From ref. 15.*

Messrs Boshers, Sons & Co[14] for the sum of £2256 15s 3d and comprised a hall surrounded by 6 classrooms.

As with many new buildings, it was not without its teething problems, which Astbury had to deal with, noting for example that 'the flushing apparatus at the boys' offices still does not act and the place is getting very offensive again'.[15] There was also a damp wall and several draughty window frames, not to mention one or two leaks. A further building was added in 1912 which comprised a Cooking and Manual Centre. This was used by the boys for woodwork classes for half the week (Figure 6) and by girls from another school in the town for cookery lessons during the other half.

Figure 6. A woodwork lesson in progress at Wallingford Council School for Boys, *ca.* 1912, shortly after the opening of the Cooking and Manual Centre. *From ref. 15.*

Astbury remained justifiably proud of the new Wallingford Council School for Boys that he had established. An inspection in 1911 March was complimentary about the quality of the education, with some improvements suggested:

'The boys are in excellent discipline, a pleasant tone prevails, the work is carried on with great care, and there are many meritorious points in the school... As a rule the fundamental subjects are effectively taught, but in the reading lessons greater stress should be laid on subject matter and the writing of the highest class should be better'.

The Punishment Book for 1910 makes an interesting read. Misdemeanours recorded included: 'laughing in class' (1 stripe of the ruler or cane), 'writing filthy words' (2 stripes), 'letting down bicycle tyres' (2 stripes), 'throwing milk on a

boy's book' (3 stripes) and 'running home from school on Wednesday afternoon and Thursday morning and rudeness and insubordination' (4 stripes).

A little over four years after the school opened, the First World War began and classes became increasingly disrupted by the absence of teachers on active service.[15] Desperate times called for desperate measures, thus by 1917, with several teachers away, Astbury found himself teaching classes of over 100 boys. The boys also played their part in the war effort. In 1917 September when they returned from five weeks of summer holidays, they started collecting horse chestnuts for the Ministry of Munitions of War. The conkers were used to produce acetone which was used in the manufacture of ordnance.[16]

Astbury was much admired and respected as headmaster of the school he had created. He eventually retired as headmaster in 1920 due to ill health.

Astbury and the BAA

Quite when Astbury's interest in astronomy began is not recorded, but by 1898 he was evidently sufficiently interested in the subject to be elected as a member of the BAA on February 23,[17] having been proposed by Miss Elizabeth Brown (1830–1899) and seconded by E. Bruce Mackay.[18] Brown was a well-known figure during the first decade of the fledgling BAA, having been involved in establishing the Association in 1890.[19] She was an active solar observer and was immediately appointed as Director of the Solar Section, having held a similar position in the Liverpool Astronomical Society. Apart from solar work, she was also active in the Variable Star, Lunar and Star Colour sections of the Association.

Shortly after Brown's death on 1899 March 5, Astbury wrote a letter to the *English Mechanic* putting on record that 'he wished to express his sincere regret for the loss sustained by her death. He would always consider it one of his greatest privileges to have been associated in some degree with her work'.[20] Drawings by Astbury of the Great Sunspot Group of 1898 September which he submitted to the BAA Solar Section are shown in Figure 7.

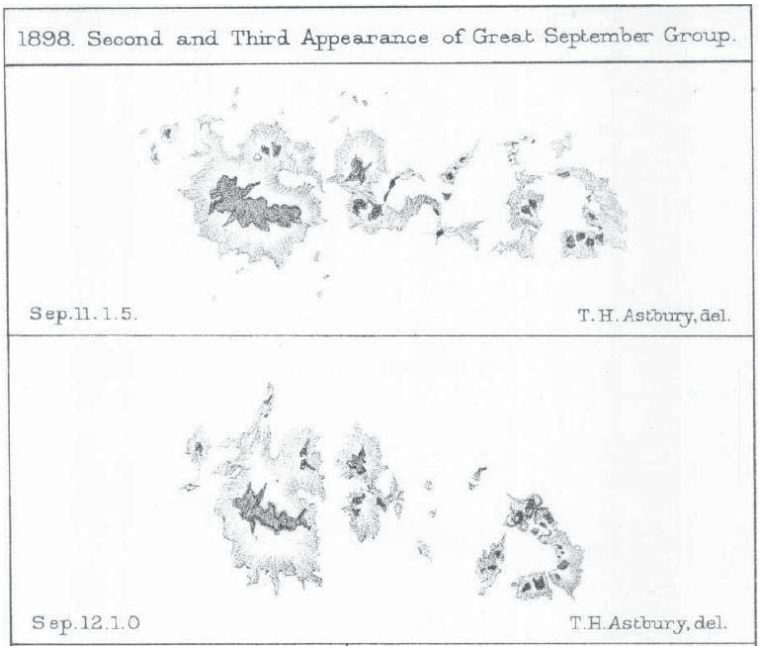

Figure 7. Drawings by Astbury of the Great Sunspot Group of 1898 September.

Astbury's first contribution to the BAA *Journal* was a letter concerning an unusual observation he made on the evening of 1899 March 27: 'At 8.10... I noticed, some distance to the left of the moon (full moon, 28d 18h 19m) and at an equal elevation, what appeared be another moon shining through a thick haze. Immediately afterwards another, precisely similar, was seen to the right of the moon'.[21] He described these as 'mock-moons', by analogy to 'mock-suns' which are sometimes observed. Later on in the evening he observed a lunar halo.

A mock-moon, sometimes called a 'moon dog' or *paraselene*, is a bright circular spot on a lunar halo and is an atmospheric phenomenon caused by the refraction of moonlight by hexagonal ice crystals in cirrus or cirrostratus clouds. They appear to the left and right of the Moon, 22° or more distant. By contrast to mock-suns, or sun dogs, they are infrequently seen because to be produced the Moon must be bright and therefore full or nearly full.

Throughout his astronomical career, Astbury used nothing larger than a 3¼-inch (8.3 cm) Wray refractor,[22] although many of his observations were made with the naked eye or binoculars.[23] He was also an early experimenter in the use of photography to record meteors, but was thwarted by the relatively slow emulsions of the age.[24] In 1904 he wrote a letter to *English Mechanic* confessing that in spite of many attempts during the main meteor showers, he had never succeeded in recording any, although there were plenty of star trails on his plates.[25] In spite of this, he provided advice for readers of the same publication in advance of the 1904 Perseids, including the suggested length of exposure, the type of photographic plates to use and the method of developing them.[26]

He was more successful with visual meteor observation and his results are included in the BAA Meteor Section reports from 1898 to 1904.[27] He was fortunate enough in 1899 August to see a fine Perseid equal to the brightness of Sirius which left a train that remained visible for 12 seconds.[28] He made this observation from Shifnal. According to W. F. Denning (1848–1931), then Director of the BAA Meteor Section, the same meteor was observed by Rev. S. J. Johnson at Bridport, Dorset,[29] and Rev. T. E. R. Phillips (1868–1942) at Yeovil, Somerset, who said it was equal to Venus in brightness.

Astbury was active in the Meteor Section until around 1905, when the Section essentially collapsed,[30] but even after that he continued to send observations to Denning who particularly valued their accuracy. In some cases, Denning was able to combine Astbury's data on a particular meteor with those of other observers and thus calculate its trajectory through the atmosphere by triangulation.[31] Other astronomical objects and phenomena that Astbury observed included the Sun, as mentioned previously, the zodiacal light,[32] aurorae[33] and comets, including Halley's Comet in 1910.[34]

He also observed the occultation of Saturn by the Moon on 1900 September 3 using his Wray refractor ×80. Just before the occultation he observed an unusual 'prominence' or protuberance near the rings, the origin of which he could not explain.[35] Four years later, and still perplexed by his observation, he wrote a further letter to the *Journal*,[36] wondering if a thin lunar atmosphere might have caused differential refraction as Saturn approached the limb. Of course we now know that the Moon's atmosphere is so tenuous that it could not cause such effects. What he saw, whether real or illusory, remains a mystery.[37]

Apart from his meteor and solar work, Astbury's other observations were generally more of a casual nature, rather

than being part of a sustained programme of study. However, it was of course the variable stars that eventually captured his imagination and after 1905 this branch of astronomy essentially dominated his observational work, resulting in his projection to fame as a discoverer of several new variables. Thus it is to his variable star observations that we shall now turn our attention.

Variable star observing and the discovery of RT Aurigae

Astbury might have begun making variable star observations in earnest with the appearance of Nova Persei in 1901 February, as his observations of this object are the earliest that can be traced in the published record.[38] He continued to report estimates of the nova's brightness to the BAA VSS until at least 1904 March, by which time the star had faded to about magnitude 10 (Figure 8).

OBSERVATIONS OF (CH. 1226) NOVA PERSEI.

Date.	Class.	Mag.	Observer.
1903.			
March 3	1	9 55	Markwick
,, 16	1	9·42	,,
April 12	1	10·1	Brook
Aug. 25	1	10·00	Brook
,, 25	1	9 95	Markwick
Sept. 23	2	9·9	Astbury
,, 25	2	10 0	,,
Oct. 23	1	10·0	Brook
Nov. 7	2	< 9·8	Markwick
,, 14	1	9 9	,,
,, 25	2	10·1	Brook
1904.			
Jan. 16	1	10 25	Markwick
,, 19	1	10·0	,,
Feb. 6	1	10·3	,,
,, 13	1	10·3	,,
,, 14	1	10 3	,,
,, 15	1	10 45	,,
,, 18	1	10·5+	,,
March 8	3	much < 9	Astbury
,, 10	2	10·2	,,
,, 10	1	9 87	Markwick
April 9	1	10·0	,,
,, 12	1	9·8	,,

E. E. Markwick, Col.
Salisbury, August, 1904.

Figure 8. Observations of Nova Persei 1901 made during 1903 and 1904, reported to E. E. Markwick and published in *English Mechanic*.[39]

After the initial excitement and the associated deluge of observations following the appearance of the nova, only three observers continued to report estimates to VSS Director Col. E. E. Markwick during 1903 and 1904:[39] Astbury, Markwick and Charles Lewis Brook (1855–1939; Figure 9).[40] Sadly, it is still the case today that most people tend to lose interest and stop observing novae after the initial fade.

According to Markwick,[41] Astbury joined the VSS in about 1903, although he had clearly been submitting observations of Nova Persei to him before that. He made observations of a range of variables and some are included in the VSS *Memoirs* covering the intervals 1900–1904 and 1905–1909.[42] By contrast the subsequent *Memoir* covering the years 1910 to 1914 contains no observations by him.[43] Rather than making routine estimates of known variables, as we shall soon see, Astbury turned to seeking out new such stars.

The VSS was formed in 1890 and is today the longest-established organisation for the observation of variable stars in the world. The first Director, Markwick's predecessor, was John Ellard Gore FRAS, MRIA (1845–1910), an Irish amateur astronomer and prolific author of popular astronomy books. In addition to collecting observations of known variable stars, Gore had increasingly focused the work of the Section on a nova search programme and observations of stars which were suspected of being variable. As John Toone points out,[44] this was probably a strategic mistake as by their nature such programmes generally yield negative results (and a few false alarms in the case of the nova programme). Many variable star observers, especially new ones, like actually to see the star and detect obvious variations to maintain their interest.

By the time Markwick became Director, membership was flagging and the Section was in the doldrums. Markwick brought the organisational and motivational capabilities that he had honed during years of military service to bear on the problem. Thus he set about reinvigorating the Section, and encouraged cooperation amongst observers on a limited list of variable stars. Through his regular Section circulars and personal letters providing feedback to observers, momentum was regained and membership of the Section began to grow.

Some three years after the appearance of Nova Persei, Markwick announced his own '*Plan for watching the Region of the Milky Way for Novae*' under the auspices of the BAA VSS.[45] The Milky Way was divided into six sections and observers were assigned to these areas with the aim of examining them regularly for novae. Charts were supplied to interested members, but it appears that this project, in contrast to Markwick's other ventures, never really took off. Nevertheless, one of the observers who did sign up was Astbury. He was allocated the constellations of Orion, Monoceros, Canis Minor, with part of Taurus and Auriga[41] and regularly monitored the region with the naked eye, sometimes supplemented with binoculars.

It was whilst engaged in the nova search programme that Astbury discovered his first variable star. In 1905 March he suspected the fifth magnitude star 48 Aurigae of variability. In his own words, from his BAA *Journal* paper 'A New Naked-eye Variable':

'As a member of the Variable Star Section I have been asked by Col. Markwick to watch a region of the Milky Way with the idea of detecting the possible appearance of a 'nova'. During these watches my interest was aroused by the star 48 Aurigae..., but until March 7th I was undecided whether the variation suspected was the result of a real change of brightness, or was due to imperfection of vision, or of the observing conditions.

'Hitherto observations had been made entirely with the naked eye, but the use of an opera glass on the succeeding evenings confirmed my impression so strongly that I felt quite assured as to the reality of the light changes'.[46]

Figure 9. Charles Lewis Brook, MA, FRAS, FRMetS (1855–1939) photographed in 1909. *Courtesy of Hugh Darlington.*

Astbury also 'photographed the region, allowing the stars to trail, and the results, although very amateurish, are quite sufficient of themselves to prove variability of the star'.[46]

Then, as now, variable star estimates required good comparison star sequences with which to compare the star's brightness. At the time, the most reliable sequences were those from the Harvard College Observatory prepared under the direction of Prof E. C. Pickering (1846–1919). Astbury wrote to Markwick on 1905 March 11, knowing that he had access to Harvard photometry, and received from him an appropriately annotated chart of the region by return.

In spite of being assured of the star's variability, and having initially estimated that the period was a little more than seven days, he did not want to make an announcement quite yet, confiding to Markwick on March 23:

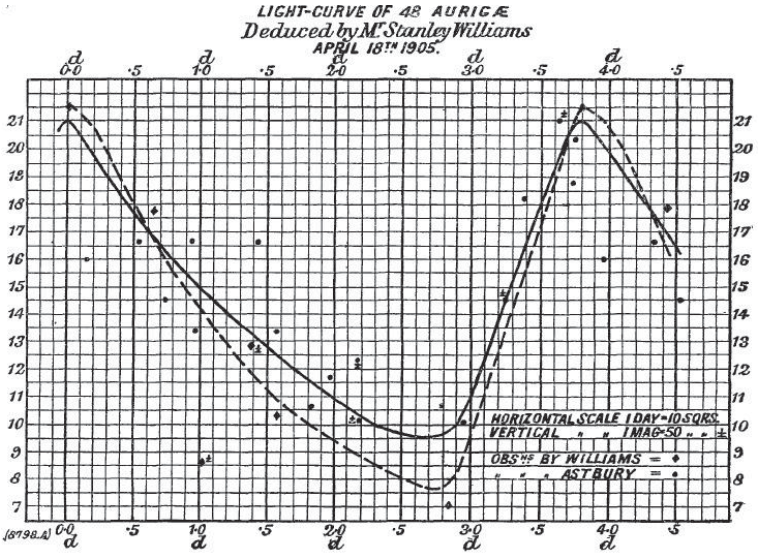

Figure 10. Lightcurve of RT Aur drawn by Arthur Stanley Williams, based on his own and Astbury's observations between 1905 March 18 and April 12. Stanley Williams plotted the data based on his assumed period of 3.8 days. Horizontal axis: 1 day = 10 squares. Vertical axis: 1 mag = 50 squares. *From ref. 52.*

'I do not intend to make any announcement at *present*. I do not feel any doubt of the general accuracy of my estimates, but it is very easy to go wrong in such matters when the light changes are confined within narrow limits'.[41]

We now know that those 'narrow limits' are actually not much more than half a magnitude, which stands testimony to Astbury's abilities as a variable star observer. He had hoped that further observations might be obtained by other VSS members, but Markwick was himself away on Army business at the time and was thus unable to alert others. Fortunately Astbury had also notified two other observers, J. E. Gore and Arthur Stanley Williams (1861–1938),[47] both of whom sent him their observations. He also informed Pickering at Harvard and Prof H. H. Turner at Oxford University of the potential discovery – Turner was a great friend and supporter of the VSS over many years.

Turner reviewed Astbury's and Williams' initial observations[48] and satisfied himself that the star was indeed variable.[49] On 1905 April 4 Turner penned a letter announcing the discovery on Astbury's behalf to the premier journal for such announcements, *Astronomische Nachrichten*.[50] It was given the temporary name 47.1905 Aurigae.[51]

Subsequently, Arthur S. Williams also analysed his and Astbury's estimates of the star between 1905 March 18 and April 12, finding a period of 3.8 days with an amplitude of 0.55 magnitudes.[52] From the shape of the lightcurve (Figure 10) he concluded that it was a Cepheid variable.[53] He was clearly impressed by Astbury's visual discovery and in a letter to Astbury on April 20 he wrote:

'It is no mean feat to discover the variability of a short-period star like this, in which the whole range of variation barely exceeds half a magnitude! There is very little merit attaching to the discovery of a variable by photography, but I always feel great admiration for a visual discovery of the kind'.[52]

Later, 48 Aurigae was given the official variable star name of RT Aurigae. Astbury received praise for his remarkable discovery and was lauded at the BAA meeting of 1905 April 26 where his discovery paper was read. The President, A. C. D. Crommelin (1865–1939) summed it up by stating that:

'[he] thought it was a matter of which the Association might be proud that one of its members had made this discovery. It seemed to be the brightest variable star that had been discovered for something like 36 years, not including novae but only regular variables. There were very few observers that could say that any of the ordinary naked-eye stars were varying to the extent of half a magnitude. It was a matter that warranted very precise observations, and very careful noting and collating of one's observations... he would ask those present to return their thanks to Mr. Astbury for his paper, and to congratulate him on his brilliant discovery.'[54]

Over the next two years, Astbury collected further observations of his new Cepheid and prepared a revised lightcurve based on a further improvement of the comparison star sequence,[55] and his result is shown in Figure 11.

The search for new variable stars continues

Spurred on by his discovery of RT Aur, Astbury continued his search for new variables by monitoring 30 stars which he had suspected of variability during his earlier observations,[56] but he was not successful in confirming any to be variable. Thus after two years, in 1907, he decided to change his tactics. His new approach was based on a procedure outlined in an 1899 article in the scientific periodical *Knowledge* by J. E. Gore to determine whether any stars in a particular field were variable. Astbury described the method thus:

'Decide upon an easily-recognised group of stars falling within the field of the binocular, and, with the aid of a lantern (preferably with a yellow shade), sketch the positions and magnitudes of the stars as accurately as possible. Now carefully number the stars in order of brightness, beginning with the brightest. In the case of two stars whose difference is considerable drop one or more numbers. For example, 1, 2, 4, 7, 8= 9 would signify that 2 was perceptibly less than 1, 4 obviously less than 2, 7 much less than 4...'[56]

Thus, after a time it would become evident if one of the stars had brightened or faded. Astbury commented that 'I do not keep any record of these observations until variability is discovered, but a written record would be of the greatest service afterwards when calculating the elements of the variation'. He said that it was important to become thoroughly familiar with a particular field and only then should new fields be added: 'Experience has proved the possibility of examining a dozen or more groups in the course of half an hour with sufficient care to detect any change'. Almost as if it were an afterthought he commented: 'Finally, I would strongly emphasise the necessity for persistent effort.'[56]

Fortunately Astbury's efforts were persistent and his next discovery, an Algol-type eclipsing binary in Vulpecula, came in 1908.

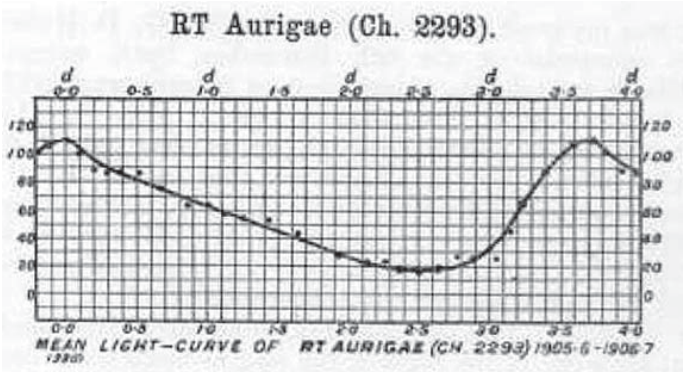

Figure 11. Astbury's revised lightcurve of RT Aur containing data from 1905 to 1907. *From ref. 93.*

During the spring and summer of that year he concentrated on a part of the Milky Way in Cygnus and Aquila and some neighbouring regions. His method was initially to inspect the area with the naked eye and then with binoculars, numbering the stars as described above, although 'After a while the sky became so familiar that the charts were but rarely consulted'.[57]

Until July 25 he saw nothing unusual, but on that particular night he found that one star seemed to be unusually faint. He observed it again on July 26, 29 & 30 and August 2, but on these occasions the star appeared its normal brightness. Then on August 3 'the star was again faint, being one magnitude lower than on the previous evening'. Convinced that he had found a new variable he contacted Prof. H. H. Turner who reviewed Astbury's data and then forwarded the discovery announcement to *Astronomische Nachrichten* on 8 August.[58]

The star, now known as RS Vul, was observed intensively by Astbury, Markwick and the Belgian variable star observer, Félix de Roy (1883–1942).[59] Astbury analysed their combined data and reported a period of 4.4764 days and a visual brightness range of magnitude 6.9 to 8.0.[60] The modern ephemeris lists the period as 4.47766 days.[61]

Astbury's RS Vul discovery paper was read on his behalf by Col. E. E. Markwick at the BAA meeting held in London on 1908 November 25. Markwick pointed out to the audience that 'the discovery was made by an amateur armed only with an opera glass, and reflected great credit on Mr Astbury for the care and discrimination shown in determining the fluctuations in light of this star'.[62] Markwick had a further surprise up his sleeve for his audience, for he went on to say that news had recently reached him that Astbury had discovered a further Algol-type eclipsing binary, bringing his tally of discoveries to three. He was thus taking the opportunity of announcing this very latest discovery at the meeting, saying:

'the third discovery reflected the greatest credit, and even lustre, on the Variable Star Section in particular, and the British Astronomical Association in general.'

The President, H. P. Hollis, BA, FRAS (1858–1939) went on to comment that '[he] used to think that the epithet 'patient' was most appropriately applied to the astronomer who searched for comets and found one in a year perhaps, but he was not sure now whether the variable star discoverer was not more patient still... He asked members to congratulate Mr Astbury, and said that he himself was pleased that the third discovery had happened in time to be announced at that Meeting.'[63]

Figure 12. Albert Stowell Flint (1853–1923) of the Washburn Observatory.

The newly discovered eclipsing binary announced at the meeting is now known as Z Vul. As with the previous two discoveries, Astbury asked Prof H. H. Turner to verify his observations, but it soon became apparent that the star in question had previously been reported as variable in 1901 by Albert S. Flint (1853–1923; Figure 12) of the Washburn Observatory, Wisconsin, USA.[64] Flint had made his discovery whilst carrying out parallax measurements with the 12.2 cm meridian circle at Washburn and had actually used the star as one of his photometric standards until he found it varying.[65] However, he had not determined a period. Astbury took Flint's times of eclipse minimum, made between 1898 and 1900, and combined them with his own from 1908 and determined a period of 2.525 days.[66] The following year, armed with further times of minimum determined from his own observations plus those of Flint and de Roy, he updated the period to 2.455 days and an amplitude between magnitudes 7.3 and 8.5.[67] The modern value for the period is 2.45493 days.[61] Thus Astbury had made an independent discovery of Z Vul and he and Flint should share the credit.

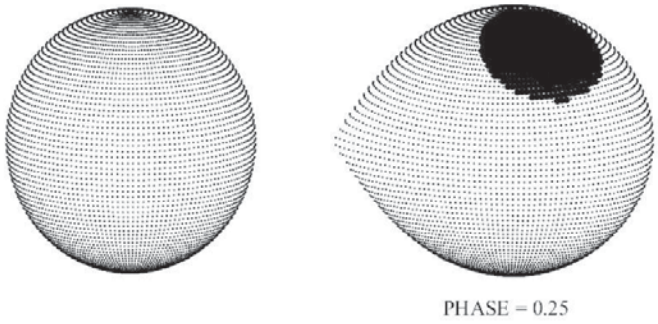

Figure 13. View of the TV Cas system at orbital phase 0.25, showing the proposed 'star spot' on the secondary. *From ref. 70.*

In 1911 Astbury discovered a third eclipsing binary, TV Cas. He had monitored stars in the neighbourhood of β Cas during the month of September in 1908, 1909 and 1910. Then on the evening of 1911 September 18 he found one of the stars appeared to be very faint. He therefore followed it during the rest of September and into early October, allowing him to confirm its variability.

Once again he shared his results with Prof H. H. Turner and on October 11 announced his discovery in *Astronomische Nachrichten.*[68] He also communicated news of his discovery to E. C. Pickering at Harvard College Observatory, who used the Observatory's extensive archive of plates to confirm the object was variable and thus was able to provide some additional times of minima to update the ephemeris.

Astbury sent his revised time of minimum ephemeris to Paul S. Yendell (1844–1918) of Dorchester, Massachusetts, USA. Yendell, a veteran of the American Civil War, who was one of the most active American variable observers of the period, accumulating more than 30,000 observations,[69] obliged by making further observations of TV Cas. Recent analysis of TV Cas's light curve suggests that it is a semi-detached binary system in which the Roche

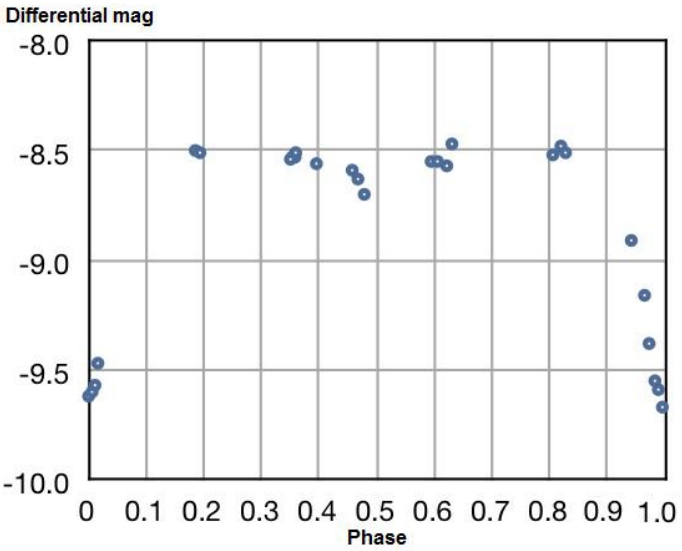

Figure 14. Phase diagram of W UMi, obtained by Des Loughney based on photometry with a DSLR camera.

Table 1. Astbury's variable star discoveries

Star	Prelim designation	Year	RA (J2000)	Dec	Type	Period (days)	Range (mag.)	Remarks
Unique discoveries								
RT Aur	47.1905	1905	06 28 34.09	+30 29 34.9	Cepheid	3.728115	5–5.82 V	
RS Vul	16.1908	1908	19 17 39.99	+22 26 28.4	EA/SD	4.4776635	6.79–7.83 V	
TV Cas	45.1911	1911	00 19 18.74	+59 08 20.6	EA/SD	1.8125956	7.22–8.22 V	
Independent discoveries								
Z Vul	26.1900	1908	19 21 39.10	+25 34 29.5	EA/SD	2.454934	7.25–8.9 V	Independently discovered by Flint in 1900[64]
W UMi	12.1913	1913	16 08 27.27	+86 11 59.6	EA/SD	1.7011576	8.51–9.59 V	Independent discovery at RGO[72]
Unconfirmed variables								
RT Vul	13.1909	1909	19 11 28.82	+22 22 59.3	CST	–	7.5 p	
VW Dra	1.1911	1911	17 16 29.40	+60 40 14.2	CST	–	6.32 V	
NSV 13759	39.1910	1910	21 29 19.3	+71 56 30.3	CST	–	–	Astbury identified it as BD +71°1070, ~9.5v. Possibly TYC 4469-1254-1 at RA 21 29 20.5, Dec +71 51 27.5 (see text)
NSV 7956	13.1913	1913	16 29 23.32	+86 26 00.9	CST	–	–	In the same field as W UMi and reported by Astbury at the same time

Preliminary designation is from *Astronomische Nachrichten*. An EA/SD star is an Algol-type eclipsing binary. CST= constant. Data from the AAVSO *Variable Star Index* (VSX) except for AN 39.1910 where the data are from the *General Catalogue of Variable Stars*

lobe-filling secondary is 'spotty',[70] as shown in Figure 13.

Astbury's fifth and final confirmed variable was discovered in 1913 April, with verification being provided by Prof Turner as had become the pattern.[71] The star is now known as W UMi and is another eclipsing binary. This also transpired to be an independent discovery, shared with observers at the Royal Observatory, Greenwich.[72] A recent lightcurve of W UMi obtained by VSS member Des Loughney using DSLR photometry[73] is shown in Figure 14. This clearly shows the deep primary and the shallow secondary eclipses in this semi-detached binary system. Astbury thought he had discovered another variable in the same field as W UMi,[74] but this star, now known as NSV 7956, was soon shown not to be a variable.

In spite of Astbury's success in identifying new variables, there were three other cases where he mistakenly identified a star as variable. He thought he had found small variations in the star later named RT Vul, during his studies on the nearby RS Vul, which were discussed above. On 1908 September 17 and again on October 27 he recorded the star about half a magnitude fainter than normal. He reported his observations in a letter to *Astronomische Nachrichten* on 1909 April 21, suggesting it might be an Algol-type variable.[75] Subsequent observations and modern data do not support this star being variable to any significant degree.

A similar story unfolded in the case of VW Dra (reported in 1911) and NSV 13759 in Cepheus in 1910.[76] Astbury found the latter star to be about magnitude 9.5.[77] However, there is a further mystery in that the General Catalogue of Variable Stars[78] lists NSV 13759 as a magnitude 12.1 star (spectral type K5). It is rather surprising that Astbury could have observed such a faint star considering that his largest instrument was a 3¼-inch (8.3 cm) refractor.[79] On the other hand there is a nearby 10th magnitude star (TYC 4469-1254-1 = GSC 04469-01254 = 2MASS J21292045+7151275) which I consider a more likely candidate for Astbury's discovery, although it too is essentially of constant brightness. Northern Sky Variability Survey data for this star have a mean magnitude of 10.075 ± 0.01.[80]

Astbury's variable star discoveries are listed in Table 1, along with a summary of their known properties. Thus between 1905 and 1913 he discovered five confirmed variables, two of which were independent discoveries shared with others. Of the five stars, one was a Cepheid (RT Aur) and the rest were Algol-type eclipsing binaries. Four further reported discoveries were subsequently found not to be variable, showing that whilst he was a very capable observer, he was not infallible.

Arthur Eddington and the Cepheid variables

As we have seen, Astbury's first variable star discovery, RT Aur, was soon shown to be a Cepheid and it was this discovery that brought him to the attention of Prof A. S. Eddington. Eddington was interested in understanding the internal constitution of stars and in 1916 began to investigate possible physical explanations for the light variations of Cepheid variables, proposing that they were pulsating stars.[81] His work on Cepheids later led him to generalise his ideas on the make-up of stars, concluding that virtually all stars behaved as ideal gases. In 1926 he published his seminal volume, *The Internal Constitution of the Stars*, which became one of the principal astrophysics textbooks of the age.

Although Eddington's work on Cepheids was not founded on the study of a specific star, after Astbury's death he did expound on his interest in RT Aur: 'a discovery of more than ordinary interest fell to Mr Astbury. His star RT Aur belongs to the class of Cepheids; and by reason of its brightness it is one of the half-dozen or so Cepheids which can be thoroughly investigated in all aspects. It is actually the third brightest of the ordinary Cepheids [now considered to be the eighth brightest].[82] Consequently it has figured conspicuously in all the studies of these stars which have furnished many surprising results; and astronomy owes a special debt to its discoverer... In my own efforts to find out the constitution of the interior of a star I have had much guidance from RT Aurigae and its colleagues'.[41]

Eddington's work on Cepheid variability dealt a death blow to one of the more popular alternative explanations of the time: that they were eclipsing binary systems. In fact in 1909 one researcher at the Lick Observatory had even gone so far as to publish the orbital elements of RT Aur and another bright Cepheid, Y Sgr.[83]

However, even today RT Aur is still studied by astrophysicists and it continues slowly to reveal its secrets. A 2007 paper by Prof David Turner of St Mary's University in Halifax, Canada, and his co-workers shows that its nominal 3.7 day pulsation period is actually increasing at a rate of 0.082 ± 0.012 seconds per year.[84] They looked at the difference between the observed (O) and calculated (C) times of maxima very closely and found superposed on the star's O–C variations a subtle sinusoidal trend.

They could not attribute this effect to random fluctuations in the pulsation period. Rather, they suggest it arises from the

effects of light travel time in a binary system. Their derived orbital period for the system is P= 26,429 ± 89 days (72.36 ± 0.24 years). So it appears that RT Aur may be a binary system after all, with one component a Cepheid variable. It is also interesting to note that the researchers used amateur observations of the star going back to 1973 in their analysis (Figure 15), once again highlighting the value of long-term amateur data contributing to the development of variable star science in particular and astrophysics in general.

It is also notable that the authors made use of recent CCD photometry obtained with typical amateur instrumentation. The importance of continued monitoring of Cepheid variables by amateur astronomers in an era when professional observations of such stars are declining[85] is illustrated clearly by the case of RT Aur.

The Wallingford school memorial

As we saw earlier, Astbury retired as Headmaster of Wallingford Council School for Boys in 1920 on the grounds of ill health, having served the school community of Wallingford for 36 years. He died on 1922 September 28 aged 64, 'his funeral being attended by representatives of education and science. Many of his old pupils can testify to the great interest Astbury took in his boys, and the kindness and help he showed them both at school and in after years'.[41]

The idea of erecting a tablet in his memory originated from H. H. Turner, who as we have seen was Astbury's mentor for many years.

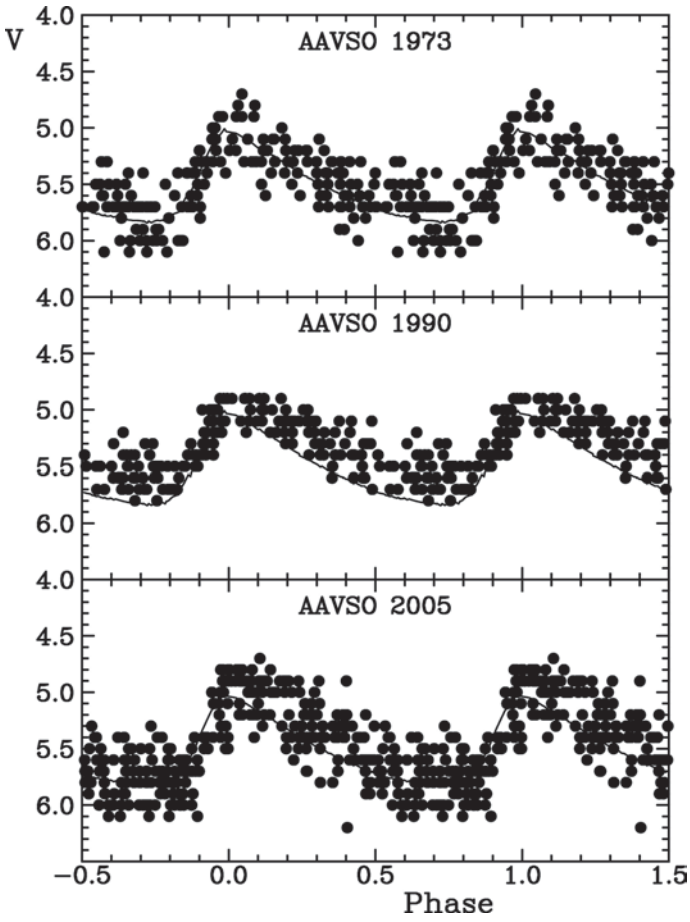

Figure 15. Sample of yearly phase diagrams for RT Aur using data from the AAVSO *International Database*. Figure from Turner D. G. *et al.*[84]

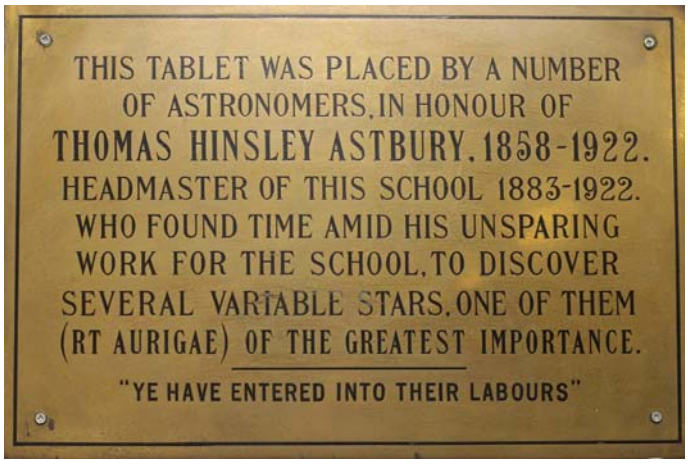

Figure 16. Memorial tablet to Astbury. There is an error in the dates during which he was headmaster; he in fact retired in 1920.

E. E. Markwick, who also had a long association with Astbury through the BAA VSS,[86] immediately threw his weight and enthusiasm behind the project. Knowing Eddington's interest in Cepheids, his support was also sought and readily given. A. N. Brown, VSS Secretary, collected the donations from supporters. The four then placed the notice in the BAA *Journal* which was cited in the Introduction, with similar appeals for support appearing in *The Observatory*[87] and *English Mechanic*.[88] Twenty-two subscribers supported the appeal fund.

The resulting brass memorial tablet, shown in Figure 16, was erected at Wallingford Council School for Boys and was unveiled by Sir Frank Dyson (1868–1939) on 1924 May 29. Dyson, the Astronomer Royal, had a long association with the BAA, including serving as President from 1916 to 1918. He would therefore have been familiar with Astbury's work. Dyson gave a talk during which he paid tribute to Astbury's variable star discoveries and explained in simple terms the pulsation theory of Cepheid variables.

Although Eddington was not able to be present in person, he sent a letter which was read on his behalf by A. N. Brown. Eddington praised Astbury's discovery of RT Aur and described how the study of Cepheid variables, such as RT Aur, had led him to develop his ideas on the internal constitution of the stars, noting: 'It is a real pleasure to associate myself with this tribute to one who laboured well for the advancement of astronomy. The study of variable stars, to which he devoted his leisure, is becoming more and more important, and is fundamental in much of the recent progress of our knowledge. The army of amateur observers who examine the stars night by night, as he did, to obtain the foundation-data on which so much is to be built, have little idea of achieving individual fame for themselves; they love their work, and they know that in due time progress will come from the united efforts of the whole band'.[41]

H. H. Turner went on to describe how Astbury had discovered RT Aur and conveyed a message of appreciation and sympathy from the Herschel family.[89] Col. Markwick also gave a speech highlighting the work of the BAA VSS and Astbury's contribution to the field of variable star research. He warmly described the many letters they had exchanged over the years, especially around the time of Astbury's discovery of RS Vul. A tribute was also read from Prof R. A. Sampson (1866–1939), Astronomer Royal for Scotland, who said: 'Men like Astbury appear to me some of the best on earth. Their single-hearted love of science may very easily impress others more, and reproduce itself better than does the work of a professional'.[41]

Other speakers at the ceremony honoured Astbury's contribution to education, including Alderman H. W. Wells, Chairman of the School Managers, and Mr Anderson, Secretary to the Berkshire Education Committee.

The afternoon ended with a tea laid out in Wallingford Town Hall, hosted by the Mayor, during which one of Astbury's daughters thanked Turner, on her mother's behalf, for organising the tribute. Turner had 'been a most kind and generous friend of the Astbury family'.[90]

Astbury's place amongst the stars

It is sometimes thought that links between professional and amateur astronomers are a modern phenomenon.[91] However, as Bob Marriott notes: 'A century and more ago it was natural for astronomers to work together, whatever their position or status, and many professional astronomers – including H. H. Turner – were members of the BAA'.[92] Thus the association between Astbury and Turner was not unique. Initially Turner was in a supporting role, verifying his observations and ensuring they were communicated properly and published in the literature, where they could be brought to the attention of other astronomers. Then as Astbury gained more experience he became confident enough to make his own announcements. Later, of course, Astbury's discoveries, RT Aur in particular, were taken up by professionals and noticed by the likes of Eddington. It is this background of mutual respect that led some of the country's most famous professional astronomers to erect the memorial to Astbury.


The International Variable Star Index

Search Submit Register Log In Account About

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Latest Details

Log in to retrieve additional aliases from SIMBAD.

Name	V RT Aur
AAVSO UID	000-BBL-373 (10692 observations)
Const.	Auriga
J2000.0	06 28 34.09 +30 29 34.9 (97.14204 +30.49303) » Search nearby
B1950.0	06 25 21.35 +30 31 39.5
Other names (Internal only)	48 Aur, AAVSO 0622+30, AN 47.1905, BD+30 1238, HD 45412, HIP 30827, HR 2332, SAO 59128
	(Not logged in) » Add name
Var. type	DCEP
Spec. type	F4Ib-G1Ib
Mag. range	5 - 5.82 V
Discoverer	T.H. Astbury
Epoch	09 Nov 1974 (HJD 2442361.155)
Outburst	--
Period	3.728115
Rise dur.	25%

Remarks

Some references may be clicked to view in new window. Roll over index number to view submission details.

1 GCVS Team B - V: +0.39, +0.80. [A/H] = 0.1. P var. Max = 2433040.867 + 3.728365d*E (JD2417970 - 33100). Since JD2433100 - see Table. Delta(V) var?

(Not logged in) » Add remark

References

Click reference title/citation to view in new window. Roll over index number to view submission details.

1 T.H. Astbury, 1905, JBAA 15, 270 1905JBAA...15..270A

Figure 17. Part of the AAVSO *International Variable Star Index* listing for RT Aur, showing Astbury listed as discoverer and, at the bottom, the reference to his *JBAA* discovery paper.

During the course of this research, I noticed that none of Astbury's five confirmed variable star discoveries were credited to him in the AAVSO Variable Star Index (VSX). I am delighted to report that with the help of one of the VSX managers, Patrick Wils, this is in the process of being corrected. The entry for RT Aur now proudly cites the name of T. H. Astbury as discoverer (Figure 17). A fitting tribute for a long-forgotten amateur astronomer.

Acknowledgments

I am most grateful for the assistance I have received from a great many people whilst preparing this paper. Special thanks are due to Tracey Clark & Emma Anderson for permission to reproduce several photographs from their book *St John's County Primary School Wallingford: Celebrating One Hundred Years of a Oxfordshire Market Town School*, some of which were first published in *Wallingford County Boys School 1910–1971* by Arthur Dean. Tracey was also kind enough to provide all sorts of background information about the School. Hazel McGee kindly researched Astbury's Census returns. Patrick Wils pointed me in the direction of NSVS data on TYC 4469-1254-1, the star that I propose as Astbury's 'constant' variable star in Cepheus, NSV 13759. He also updated the AAVSO Variable Star Index, crediting Astbury's variable star discoveries.

Arne Henden, AAVSO Director, gave permission to use the RT Aur listing from the AAVSO International Variable Star Index. Richard Baum, who has provided much encouragement in my forays into astronomical history, led me to appreciate the significance of Astbury's observation of the occultation of Saturn and suggested that this warranted further study, the results of which we have reported separately in a joint paper.[37] Des Loughney, BAA VSS Eclipsing Binary Secretary, undertook a programme of DSLR photometry to produce the phase diagram of W UMi, one of Astbury's discoveries. Prof David Turner, St Mary's University, Halifax, Canada, gave permission to use his figure from ref. 84 containing lightcurves of RT Aur. Mike Frost obtained copies of some of Astbury's published notes. Jill Barlow searched the Cheltenham College Archives for records related to Astbury and was able to rule out his having attended the college, in spite of the statement by Col. E. E. Markwick that he had done so. Hugh Darlington supplied the previously unpublished photograph of Charles Lewis Brook.

This research made use of the NASA/Smithsonian Astrophysics Data System, the AAVSO Variable Star Index, ROTSE data accessed via the Northern Sky Variability Survey operated through Los Alamos National Laboratory, and *SIMBAD* and *Vizier*, operated through the Centre de Données Astronomiques (Strasbourg, France). I also made extensive use of scanned back numbers of the BAA *Journal*, a truly wonderful resource, which is largely thanks to the efforts of Sheridan Williams, the existence of which saved me several trips to libraries to consult the printed word.

Finally I thank the referees, Mike Frost and Bob Marriott for their helpful suggestions that have improved the paper.

Address: 'Pemberton', School Lane, Bunbury, Tarporley, Cheshire CW6 9NR, UK [bunburyobservatory@hotmail.com]

References & notes

1 Brown A. N., Markwick E. E., Turner H. H. & Eddington A. S., *J. Brit. Astron. Assoc.*, **33**, 292–293 (1923)
2 Eddington was knighted in 1930.
3 Markwick's life and variable star activities are described in another paper by the present author, Shears J., *J. Brit. Astron. Assoc.*, **122**(6), 335 (2012)
4 Joseph was born in 1827. By 1886 he had become a 'Clerk', according to the occupation stated on his son's marriage licence.
5 Madeley is now part of the new town of Telford.
6 Wellington is now also part of the new town of Telford.
7 The 1861 Census shows the family, including the 3-year-old Thomas and one younger brother, living at 28 Hadley Village, Wellington, Shropshire. By the time of the 1871 Census there were 7 siblings, plus Joseph's mother Caroline, a widow of 71, living at Handsworth, West Bromwich. All 7 children bore the second forename of Hinsley.
8 E. E. Markwick's obituary of Astbury states that he attended Cheltenham College, but the College has no record of this. Therefore it is possible he attended another school in Cheltenham. However, given the modest background of Astbury's parents, and the number of children they had, it is unlikely that they could have afforded to send him away to boarding school.
9 Emily was born in Wallingford in1863. Her father was Henry Naish (born in Wallingford in 1831), a plumber by trade. Henry's father, A. Naish, was born in Wallingford in 1801. Emily's mother was Betsy Costar Naish; her middle name of Willis came from her maternal grandfather, James Willis. The witnesses to Astbury's marriage to Emily were Henry Naish, James Willis and Betsy Costar Naish. On the marriage certificate, Astbury is listed as Schoolmaster, from the Parish of St. Leonard's, Wallingford. Emily has no occupation listed, but the certificate states she was a Spinster from St Mary's Parish, Wallingford. The marriage took place in St Mary's Church on 1886 May 6.
10 The 1891 Census lists a 10 month old daughter and the 1901 Census lists her again (now aged 10 years) and a younger daughter of 10 months.
11 This address is listed in Astbury's entry in the 1891 and 1901 Census and appears on all his correspondence.
12 In the 1960s the school became St. John's School, a mixed primary, and continues to enjoy a very high reputation to this day.
13 The school building was designed in 1909 by architect Edmund Fisher, who also designed several other schools in the area, including Cholsey Council School.
14 Boshers Ltd., Master Builders of Cholsey, Oxfordshire, still trades and is now in its sixth generation of family ownership.
15 Anderson E. *et al.*, *St. Johns County Primary School Wallingford: Celebrating One Hundred Years of an Oxfordshire Market Town School*, Kumquat Publishing, Wallingford (2010)
16 Many British schools were involved in the conker collection scheme. Before WW1 most acetone was imported from the USA. Conkers contain starch which is the basic raw material for acetone production, but they were later found to be a rather poor source. Wallingford school received a letter from the Ministry in March 1918 apologising for the delay in collecting the sacks of conkers from Wallingford. Nevertheless, on 1918 March 5, 24 sacks were finally dispatched by rail.
17 *J. Brit. Astron. Assoc.*, **8**, 246 (1898)
18 Candidates for Election as Members of the Association, *J. Brit. Astron. Assoc.*, **8**, 198 (1898). The late Peter Hingley, Librarian of the RAS, checked the RAS records, but there is no evidence of Astbury being a Fellow.
19 A biography of Brown, with particular attention to her solar studies, can be found in a former *Journal*: Creese M., *J. Brit. Astron. Assoc.*, **108**, 193–197 (1998).
20 Astbury T. H., *English Mechanic*, 1776 (1899)
21 Astbury T. H., *J. Brit. Astron. Assoc.*, **9**, 270–271 (1899)
22 In 1904 November Astbury describes using a 3-inch Wray refractor to observe a comet (Astbury T. H., *English Mechanic*, 1904 November 25, item 424). The BAA VSS Memoir on variable star observations between 1905 and 1909 has him using a 2-inch and a 3¼-inch refractor. In another report on an occultation he refers to a 3¼-inch Wray, so we assume the 3-inch Wray referred to was in fact 3¼ inches. Curiously, a single publication refers to Astbury having, in addition to the Wray, a 16-inch equatorial by With (Stroobant P. *et al.*, *Les Observatoires Astronomiques*, l'Observatoire Royal de Belgique, 1907), but this appears to be incorrect.
23 In some writings Astbury refers to using binoculars and in others to opera glasses. It is not known whether these were different instruments. The sizes are not stated.
24 According to Keith Hindley, a past BAA Meteor Section Director, serious meteor photography only really took off in the 1920s with the use of small cameras that could only record bright meteors down to magnitude −1 or 0. See Hindley K., *New Scientist*, **72**, 695–698 (1976).
25 Astbury T. H., *English Mechanic*, 1904 June 15, item 641
26 Astbury T. H., *English Mechanic*, 1904 June 29, item 553
27 The first VSS report to include data from Astbury was Corder H., *Mem. Brit. Astron. Assoc.*, **8**, Part 1 (1898).
28 Denning W. F., *Observatory*, **22**, 337-338 (1899).
29 Rev S. J. Johnson FRAS, was Vicar of Melplash, near Bridport. He contributed many observations of meteors to the BAA.
30 The collapse of the Meteor Section in 1905 when the Director, W. E. Beasley, died suddenly is described in the BAA memoir *The First Fifty Years*. Between 1906 and 1911 there was an interregnum. Astbury is cited in the *Memoir* as an active member of the Section in the years leading up to the collapse.
31 An example was a meteor on 1906 April 16, which was observed by Astbury at Wallingford as being brighter than Venus and was also seen by Denning 'and four friends on Horfield Common in Bristol', see: Denning W. F., *English Mechanic*, 1906 May 4, item 319.
32 Astbury wrote a series of three letters on the zodiacal light observed from Wallingford in 1899 February and March: Astbury T. H., *J. Brit. Astron. Assoc.*, **9**, 328–330 (1899).
33 He observed an aurora on 1903 October 12 and commented that a magnetic needle showed distinct oscillations at the same time: Astbury T. H., *J. Brit. Astron. Assoc.*, **14**, 28 (1903). There was a magnificent auroral display on 1905 November 15 which he also observed: Astbury T. H., *J. Brit. Astron. Assoc.*, **14**, 28 (1903). The same edition of the BAA *Journal* carries reports by other observers across the country.
34 He wrote occasionally about his comet observations in the *English Mechanic*. He described how he saw the nucleus of Comet 1900 II almost occult a field star: Astbury T. H., *J. Brit. Astron. Assoc.*, **11**, 281 (1901), and also described his observations of Halley's Comet in 1910 February: Astbury T. H., *English Mechanic*, 2431 (1910 Feb 4).
35 Astbury T. H., *J. Brit. Astron. Assoc.*, **11**, 35–36 (1900). He describes his observation of the occultation with his 3¼-inch Wray under almost perfect conditions.
36 Astbury T. H., *J. Brit. Astron. Assoc.*, **15**, 40 (1904)
37 Astbury's observation of the Saturnian 'prominence' is discussed in more detail in a separate note by the author and Richard Baum: Shears J. & Baum R. M., *J. Brit. Astron. Assoc.*, **123**, 151 (2013).
38 Col. E. E. Markwick presented a report on the VSS observations of the nova to the BAA meeting of 1901 April 24 in which he drew attention to Astbury's observations during the period March 18–31 when the brightness was fluctuating. Astbury had noted that as it brightened, so it became redder.
39 Markwick E. E., *English Mechanic*, **2056**, 40, item 43 (1904)
40 Brook succeeded Markwick as VSS Director after Markwick resigned in 1909 December. Brook's life is described in Shears J., *J. Brit. Astron. Assoc.*, **112**, 1730 (2012).
41 'The late T. H. Astbury: An Appreciation' appears as: Markwick E. E., *J. Brit. Astron. Assoc.*, **34**, 327331 (1924).
42 The 1900–1904 and 1905–1909 memoirs are Markwick E. E., *Mem. Brit. Astron. Assoc.*, **15** (1906) and Markwick E. E., *Mem. Brit. Astron. Assoc.*, **18** (1912) respectively.
43 Brook C. L., *Mem. Brit. Astron. Assoc.*, **22** (1918)
44 Toone J., *J. Brit. Astron. Assoc.*, **120**, 135–151 (2010)
45 Markwick E. E., *J. Brit. Astron. Assoc.*, **14**, 122 (1904)
46 Astbury T. H., *J. Brit. Astron. Assoc.*, **15**, 244–245 (1905)
47 Williams was especially known for his observations of the planets, notably Jupiter and Saturn. He also excelled at photographic photometry of variable stars using a 4.4-inch (11cm) portrait lens on a hand-driven equatorial mount, and was the first British astronomer to use photography in the search for variable stars. With this equipment he discovered several variables, including RX And and VW Cyg. Stanley Williams' RAS obituary is at: Phillips T. E. R., *MNRAS*, **99**, 313 (1939).
48 Turner made no mention of Gore's observation; according to Astbury Gore had only made a single observation at that point, whereas Stanley Williams had made several.
49 Turner told Astbury that he had asked a Mr Bellamy of the Oxford University Observatory to photograph the region. Astbury also wrote to E. C. Pickering to see whether Harvard College Observatory could obtain images, and also to check their plate archives to confirm whether the star was varying.
50 Turner H. H., *Astron. Nachr.*, **168**, 29 (1905)
51 The *Astronomische Nachrichten* assigned preliminary names to new variables which contain a sequential number in order of the report of discovery followed by the year. Thus in the case of 47.1905 Aurigae it was the 47th new variable reported in 1905.
52 Astbury T. H., *J. Brit. Astron. Assoc.*, **15**, 270–273 (1905)
53 A. S. Williams found that the period was about one-half of Astbury's initial estimate. Astbury had originally considered it to be a β Lyrae eclipsing binary, but the shape of Williams' improved lightcurve showed

that it was a Cepheid.
54 Crommelin's quote is taken from the report of the BAA meeting of 1905 April 26: *J. Brit. Astron. Assoc.*, **15**, 258 (1905).
55 Astbury T. H., *ibid.*, **18**, 85–87 (1907)
56 Astbury T. H., *ibid.*, **21**, 267–268 (1911)
57 Astbury T. H., *ibid.*, **19**, 90–92 (1908)
58 Turner H. H., *Astron. Nachr.*, **178**, 367 (1908). The *AN* preliminary identification was 16.1908.
59 At the time, Félix de Roy was fairly new to variable star work, having begun in earnest in 1906. De Roy went on to serve as VSS Director 1922–1939. His biography is at: Shears J., *J. Brit. Astron. Assoc.*, **121**, 203–214 (2011). Astbury also attempted to gain observational support from Arthur Stanley Williams, but he noted that 'Mr Williams has, unfortunately, been unable for a long time to do any observational work'.
60 Astbury T. H., *Astron. Nachr.*, **183**, 223–224 (1910)
61 Kreiner J. M. *et al.*, in the online *Krakow Atlas of O–C Diagrams of Eclipsing Binary Stars* at **www.as.up.krakow.pl/o-c**
62 Markwick E. E., quoted at the BAA meeting of 1908 Nov 25 in *J. Brit. Astron. Assoc.*, **19**, 77 (1908).
63 Hollis H. P., quoted at the same meeting. Henry Park Hollis was BAA president 1908–1910. For most of his career he worked at the Royal Observatory, Greenwich. He was also one of the editors of *The Observatory* and was *The Times'* astronomical correspondent.
64 Flint A. S., *AJ*, **21**, 74–75 (1901)
65 Flint conducted two parallax surveys at Washburn. The first was between 1893 and 1896, being published in 1902 as Volume 11 of the *Publications of the Washburn Observatory*. The second survey, during which he discovered Z Vul, was between 1898 and 1905. In his obituary of Flint (Stebbins J., *Pop. Astron.*, **31**, 369–372 (1923)), Joel Stebbins notes: 'Students of astronomy should remember that the program of a parallax observer requires that he must literally burn the candle at both ends. For years Flint began his observing at dusk and continued to about 9 p.m.; there was then a pause until 3 a.m., when work was continued until dawn. This program, conscientiously followed for practically every clear night, meant the renunciation of a great deal that makes life attractive in a modern community, and would be undertaken only by a true devotee of science. The tremendous labor of reading the chronograph sheets and carrying out the necessary numerical work also stands as evidence of Flint's industry'.
66 Astbury T. H., *Astron. Nachr.*, **179**, 363 (1908)
67 Astbury T. H., *ibid.*, **182**, 389 (1909)
68 Astbury T. H., *ibid.*, **189**, 357 (1911). The preliminary *AN* designation was 45.1911.
69 Williams T. & Saladyga M., *Advancing Variable Star Astronomy: The Centennial History of the American Association of Variable Star Observers*, Cambridge Universityt Press, 2011
70 Djurasevic G. *et al.*, *A&A*, **402**, 667–682 (2003)
71 Astbury T. H., *Astron. Nachr.*, **194**, 413 (1913). The *AN* preliminary designation was 12.1913.
72 Markwick cites the independent discovers as 'Datu & Son' in *J. Brit. Astron. Assoc.*, **34**, 327–331 (1924).
73 Digital Single Lens Reflex Cameras (DSLRs) are increasingly being used for accurate photometry of brighter variable stars, especially in the V-band. Des Loughney, Secretary of the BAA VSS Eclipsing Binary (EB) programme, has pioneered the use of DSLRs in the study of EBs. Des has written an introductory manual on DSLR photometry which is available from the VSS Director.
74 Astbury T. H., *Astron. Nachr.*, **194**, 413 (1913). The *AN* preliminary designation was 13.1913.
75 Astbury T. H., *ibid.*, **181**, 13 (1909). The *AN* preliminary designation was 13.1909. In his letter Astbury noted 'As I shall not be able to do much observational work for some time, I desire to enlist the cooperation of others in the study of another new variable, which will soon become observable at convenient hours'. One wonders whether it was the construction of the new school in Wallingford that was taking up more of his time than usual and preventing him from observing.
76 Astbury T. H., *ibid.*, **184**, 301 (1910). The *AN* preliminary designation was 39.1910. Astbury first suspected the star of variability in 1909 May and suggested it might be a long period variable.
77 Astbury identified it as BD +71°1070.
78 Samus N. N. *et al.*, *General Catalog of Variable Stars* (GCVS online database, version 2011 January)
79 Assigning limiting magnitudes to telescopes is fraught with difficulties. Nevertheless, even under pristine skies – and they must have been pretty good at Wallingford since Astbury often saw the zodiacal light there – a magnitude 12.1 K5 star was almost certainly below the detection limit of his 3¼ inch Wray refractor. Moreover, his comments in the *AN* discovery paper show that this wasn't a rare sighting since he observed this star on many occasions.
80 NSVS data are available at: **http://skydot.lanl.gov/**.
81 Eddington A. S., *Observatory*, **40**, 290–293 (1917). Eddington's theory did not explain all the observed properties of Cepheids. It was not until 1953 that S. A. Zhevakin identified ionised helium as an important control factor in the process.
82 According to the *Database of Galactic Classical Cepheids* published by the David Dunlap Observatory (1997 version); Fernie J. D. *et al.*, *IBVS*, 4148 (1995).
83 Duncan J. C., *PASP*, **21**, 119–136 (1909)
84 Turner D. G. *et al.*, *ibid.*, **119**, 1247–1255 (2007)
85 In the case of bright stars like RT Aur, even the advent of professional all sky surveys does not help as the star is too bright for reliable photometry by most.
86 Markwick, like Astbury, was also an active member of the BAA Meteor Section at the turn of the 20th century.
87 Turner drew attention to the appeal in his regular 'From an Oxford Notebook' column in *The Observatory*: Turner H. H., *The Observatory*, **46**, 265 (1923).
88 H. P Hollis drew attention to the appeal and Astbury's life in an article in *English Mechanic* (issue 3049, 1923 Aug 31). Hollis had presided at the BAA meeting of 1908 November 25 where Astbury's discovery of RS Vul was announced.
89 Prof Alexander Stewart Herschel (1836–1907), son of Sir John Herschel, had contributed to the BAA Meteor Section, both as an observer and through his calculations of meteor trajectories. His work appears alongside Astbury's in the Section *Memoirs* and he used some of Astbury's data in his analyses.
90 This quote is from E. E. Markwick, *J. Brit. Astron. Assoc.*, **34**, 331 (1924).
91 The rather cumbersome expression 'pro-am' has become widely used to describe the links between professionals and amateurs in many fields, not least in the inconsequential world of golf.
92 Marriott R. A., Referee report (2012).
93 Astbury T. H., *J. Brit. Astron. Assoc.*, **18**, 132 (1907)

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