

Neptune: towards understanding how Adams's upbringing enabled him to predict, then miss the discovery of the century

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The story of John Couch Adams the great Cornish astronomer of the nineteenth century is well known and this paper will not revisit old ground. However, many questions remain unanswered and in this paper I propose to indicate some of them as section headings, and seek to address them. In this way Adams's early life is examined, and its effect on his academic life during the time of the Neptune discovery. The row that followed discovery is high-lighted together with the equally contentious issue of the new planet's name. Although it is usually believed that Adams graciously accepted the failure of the Cambridge University Observatory to find his planet, examination of his later work which is often highly critical of French astronomers sheds a different light on that theory.



Fig. 1 Lidcott Farm the Adams family home

By courtesy of Richard Sleep

John Couch Adams was born in 1819 in an isolated farmhouse at Laneast, north Cornwall, as the eldest of a large family

To what extent did the nature of Adams's childhood influence his demeanour at Cambridge?

This part of Cornwall is very quiet even today, and people visit it for that very quality, the hustle and bustle of city life is a world away. Hence people deal with one another in a supportive and non-

confrontational way. If asked a question you give your response and that is the end of the matter. His father was a tenant farmer and his landlord lived at the imposing Palladian 'Tregeare House', just a mile from the Adams farm, and was one of the largest estates in the county

The landlord was John King Rennall Lethbridge who proved and he turned out to be very supportive. When Adams won one of Cambridge University's most prestigious awards as 1st Smith's Prizeman the



Fig. 2 Tregear House Adams Landlord's House

By courtesy of Pat and Anthony Winter
Winter C.W.R., *In Sundry Places...* (1999),

news reached Lethbridge at Launceston, he rode his horse home and on entering the yard took off his hat and shouted 'Adams for ever'. This was an apparent conversion from his earlier view that 'scarce resources should not be spent on college bills and that education was getting more prevalent and was not well paid'.¹

After Lethbridge's death it was said of him:

Besides these services to his neighbours and his County, he conferred an obligation on the Nation and on Science, by the judicious and kind protection which he offered to the illustrious Astronomer John Couch Adams, at that critical period of his early life, when the career of a greatly talented boy maybe determined by the direction and encouragement he receives. The father of Adams was a moorland tenant of Mr Lethbridge with a very large family, and when the extraordinary abilities of the son attracted attention in his remote and limited sphere, the judgement, encouragement and patronage of the landlord were most usefully exerted on his behalf.²

This final sentence relates to the Manganese Mine found on the Adams farm and which funded to a large extent John's university education. The right of a tenant to farm the surface of the land does not extend to the right to extract minerals from below ground. The mineral rights belong to the 'lord of the manor' and so of course do the profits from the sale of the minerals.

This was also the time when the children's hymn 'All things bright and beautiful' contained the lines 'the rich man in his castle the poor man at the gate God made then high and lowly and ordered their estate' and described the situation in Cornwall. So Adams went to Cambridge with great respect for his 'elders and betters'. This verse is in the original 1848 version; it has long since been removed from hymn books.

Where did Adams get his brains from?

It was evident from an early age that Adams had an intellect that was far beyond the normal. Of course all the modern ways of monitoring ability and universal education were still in the future. The truth is that he was not alone, his siblings were all to do great thing or at least the boys were. A lack of schooling meant that the girls in the family were not able to demonstrate their ability. However, they were able to pass the genes on to their children and it is a matter of record that many of the Adams extended family went on to be high achievers. The best clue comes from the fact that Adams's mother Tabitha Knill Grylls inherited from her Aunt Grace Couch a small estate of some 100 acres which was only a short distance from Adams's birthplace. The estate included a library which contained some books on astronomy originally owned by Grace's husband, John Couch. Eighteenth century books became Adams's early companions. It was certainly unusual to be able to read such volumes in those days, and it is evident that from this line the interest in astronomy stems, and indeed his ability to put it to good use.³

Did Adams high ability stem from the fact that he had a special brain condition?

Adams arrived at Cambridge University as a poor sizar and yet he was marked out as a student of exceptional ability, especially as a mathematician. There should be little surprise therefore to find that a student who could score twice the mark of the runner up should demonstrate quirks and differences from the normal person. These quirks, often single instances, have been assembled to suggest that he had a mild form of Asperger's syndrome. It is a suggestion that finds little support amongst the historians of astronomy at Cambridge today. However, one of the problems he would have encountered would be that of initially understanding and being understood by his fellow students, the Cornish dialect being very different from that spoken in England.

Although Adams was focused and single minded in the pursuit of the 'disturbing planet', he also found time for a wide range of pursuits. He was a good singer and Cornish wrestler, and each year he picked up the prize as the best in class for Greek Testament studies. He was also very fit; it being recorded that on one occasion he walked from Cambridge to London via Greenwich.⁴

There is no doubt that Adams did have self-confidence and the evidence is that he was looking for a problem that would test his skills. In George Biddell

Airy's 1832 report on, *The progress of astronomy*, he found what he was looking for in the final paragraph:

In the preceding suggestions I have endeavoured to fix on definite points for the attention of astronomers. I need not mention that there are other subjects (the theory of Uranus, for instance,) in which the existence of difficulties is known, but in which we have clue to their explanation.⁵

When Adams arrived in Cambridge Airy was already Director of the Royal Observatory at Greenwich. It impacted on the young Adams when he found Airy's report in a Cambridge second hand book shop in 1841. His noted comment was:

...formed a design at the beginning of this week, of investigating as soon as possible, after taking my degree, the irregularities in the motion of Uranus which are yet unaccounted for in order to find whether they may be attributed to the action of an undiscovered planet beyond it; and if possible then to determine approximately the elements of its orbit etc., which would probably lead to its discovery.⁶

The details of the search have been examined many times over the years. However one or two points remain unresolved.

Why did Adams not reply to Airy's Radius Vector Question?

After completing his first calculations, Adams left a brief note of them at the Royal Observatory, Greenwich. Airy, later accused of neglecting a young man, actually wrote to him asking for clarification of what to Airy was a key issue – how was Adams tackling the 'radius vector' element of the calculation. It was long alleged that Adams was neglectful, even discourteous in failing to reply, thus terminating any correspondence.

However, a part written letter was discovered in the Cornwall Records Office in 2004 by Dr Craig Waff. A clue to the reasons behind Adams failure to reply may be gleaned from this letter to Airy that was started, but never finished – something important seems to have prevented the letter from being finished. The draft reads:

Sir, I must apologise for having called at the observatory the other day at so unreasonable an hour, the reason was that I had only arrived in town that morning & it was necessary for me to be in Cambridge the same day, so that I had no other opportunity. The paper I then left contained merely a statement of the results of my calculation; I will now, if you will allow me, trouble you with a short sketch of the method used in obtaining them. My attention was first directed to the anomalies in

the motion of Uranus by reading, some time since, your valuable Report on Astronomy. If the action of known planets really proved insufficient to account for the perturbations of Uranus, it appeared to me that by far the most probable hypothesis which could be formed for that purpose, would be that of the existence of an undiscovered planet beyond. If this were the case, I conceived it might be possible to find from an examination of the observed perturbations, the approximate position of the new planet, so as to assist Astronomers in discovering it. The solution of this problem, however, would be deeply impracticable at present, without making some assumption as to the mean distance. Fortunately, Bode's law supplies us with a value which, at any rate has a claim to be first tried. Accordingly, using the differences between Observations, and the Tables given in Bouvard's Equations of condition as far as they extend, and subsequently those supplied by the Cambridge and Greenwich Observatories, together with those in the various numbers of the *Astron. Nachrichten*, I obtained values of the mass and position of the assumed planet, so as to satisfy all the observations very nearly. The series however, not being sufficiently continuous at one or two points, Professor Challis had the kindness to request you to communicate the results of a few of the Greenwich observations to supply the deficiency. For your kindness in sending the whole of the Greenwich observations of Uranus, I beg you will accept my warmest thanks. On receiving them, I determined to make them the base of a new investigation taking into account several quantities which I had previously neglected. The later observations used were the same as before...⁷

It is clear from a study of the available Adams records that a significant number of documents dating from the pre-discovery period have vanished – it is known that they were removed by the Adams family. We know that Adams had requested that no biography be written until after his death. The letter above is one that escaped the purge.

The standard explanation of Adams's failure to reply is that he considered the question trivial, which indeed it is if you accept the universality of the law of gravity extending right through the solar system and beyond. Adams certainly did, but Airy had clear reservations which he later communicated to Challis on Dec 21st 1846 by letter after the planet's discovery and succinctly expressed in the following terms:

There is no *a priori* reason for thinking that a hypothesis which will explain the error of longitude will *also* explain the error of radius vector. If

the numbers for theoretical radius vector had been discordant with the observed numbers of radius vector then *the theory would have been false*, not from any error of Adams but from a failure in the law of gravitation. On this question therefore turned the continuance or fall of the law of gravitation.⁸

Maybe the reason that Adams did not complete his letter was the thought that if senior astronomers like Eugene Bouvard and Thomas Hussey had tried to commend to Airy the theory of an exterior planet, and had been rebuffed by Airy, did he, Adams, really stand a chance?

Another possible explanation of Adams holding back his letter until he did further calculations was to satisfy himself regarding the resonance problem. It is clear that Adams's work, using successively revised calculations using modified elements, was placing the disturbing planet closer and closer to resonance with Uranus. This in turn would produce perturbations on a much grander scale than the evidence revealed. Airy would then have dismissed Adams work without further consideration. The fact is that the planets are in resonance, but the mid-eighteenth century happened to be a quiescent period in the cycle!⁹

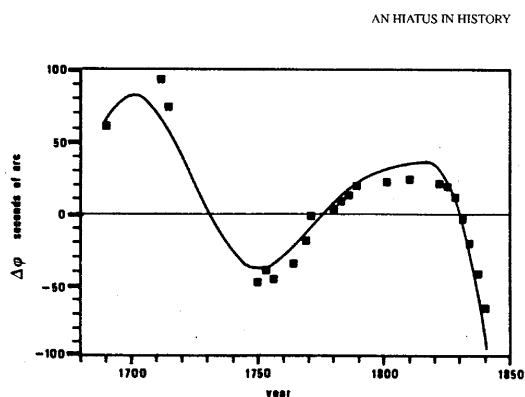


Fig. 3 From 'Perturbations of Uranus by Neptune: a Modern Perspective'

C.C Lai Lam & K. Young *American Journal of Physics*, **58**, No.10 (Oct. 1990) 946-953

By courtesy of Professor K Young

The evidence for this awareness by Adams is found in a letter which – a reprint of which can be found in Lionville's *Journal de mathématiques*, 1876 – where he dealt with Professor Pierce's, 16th March 1847, objection to his calculations, where Adams states 'the period of Neptune itself is almost exactly double that of Uranus, and this gives rise to some very considerable reciprocal perturbations of a character quite different to those which would be caused by our

hypothetical planets'.¹⁰ The fact that Adams's later orbits included considerable eccentricity indicates that he was already fully aware of the effects of two planets in resonance. We need to bear in mind that perturbation analysis before the availability of modern computers was very difficult, and involved long calculations of sines and cosines plus secular terms, for which Adams was trying in turn different values for different key elements. Trying to find the position of an unknown body of unknown mass and distance from the Sun only from its observed effect upon another was a challenge that most of those familiar with celestial mechanics shrank from tackling. This is a situation that pertains even to this day.¹¹

Was Adams's work used by Challis?

As soon as Airy read that Le Verrier in Paris was close to finding the position of the supposed perturbing planet, and realising Adams work was closely parallel, Airy who had no suitable refractor at Greenwich, urged James Challis the Director of the Cambridge Observatory to use the powerful Northumberland Refractor to urgently search for the new planet.

It is often stated that Challis diligently applied himself to his interpretation of Airy's instructions as being to repeatedly comb an area of the ecliptic 30 degrees by 10 – a huge area, strewn with stars – by noting the position of every star down to the 11th magnitude and to see which, if any, had moved since the previous scan. It has been alleged that Adams's contribution at this stage was nil. This is not so, since in fact a study of Challis's Reports shows that he made constant reference to Adams's calculations.¹² In reality the preliminary report by Le Verrier of his own work which resulted in very similar results to the figures that Adams had privately given only to Airy and Challis gave Challis confidence in his search.

The disturbing planet eventually named Neptune is now known to be of magnitude 8, so why was the much fainter level and therefore much larger number of 'stars' chosen? The brightness of a solar system object in the sky depends on its physical size, its distance from the Earth and its albedo i.e. the percentage of incident light reflected. As an ice giant Neptune is large, it also has a high albedo when compared with a rocky planet. As a body beyond Uranus it would be moving much more slowly than any other planet or main belt asteroid, it might even be stationary when observed for the first time. Hence there is no doubt that the method employed by Challis would have eventually turned up the planet. It is also true that the Cambridge Observatory was overworked so that Challis undertook the whole search himself

and that every short cut to secure early success should have been employed.

Why did Challis take so long to find the planet?

Fundamentally, although acknowledging the principle, he and Airy lacked the conviction that it would be possible to locate an unseen object from its effect on a nearby planet. This explains the large search area and the perceived need for re-examination of that area. Another problem is that the stars were very closely packed especially those between magnitudes eight and eleven in that part of the sky. Also Challis was older than many other full time observers and had laboured long and hard on difficult observing projects before. On this search he did not check each day the previous night's observations, but waited until he had the results for a much larger area. Had he done so much heartache would have been prevented?

What of the Cup of tea story?

One story appears to highlight these problems. Towards the end of September 1846 Challis was discussing the problem with the Rev William Towler Kingsley (1815–1916), Tutor of Sidney Sussex College over dinner in Cambridge. In those days dinner at college was taken at 4.00pm, Challis related that he had seen a 'star' that appeared to show a disk. Under pressure from Kingsley, not an astronomer, he agreed to examine it under a higher power. On their return to the Observatory the sky was clear; however they were prevented from going to the scope by James Challis's wife insisting that they should fortify themselves with a cup of tea. By the time they reached the Dome the sky had clouded over and the last opportunity for independent discovery was lost.¹³ News reached England a day or so later of the visual discovery in Berlin. Of course the perception is that the 'star' would have been easy to observe as soon as the pair started work.

However, it is more likely that it was only dusk while tea was being taken and that the cloud appeared as the temperature dropped, a common enough occurrence in England – it is all in the timing. Furthermore, it would have been as late as 8.30 pm before observing could start. Astronomical Twilight ended then, and the position of the 'star' would clear the horizon to an acceptable amount, which is some 15 degrees – there was no Summer Time in those days.

However the exact date is open to question, Challis's own report gives a first reference to a disk on September 29th, both from a comment from Le Verrier and also in his own log of observations. News of the discovery reached England from the continent

on the 1st October, so the only realistic date for the tea incident seems to be the 30th when according to the log no observations were made.

Conspiracy theory – did Airy give any help to the French?

The success of Le Verrier in Paris, who had started after Adams, and the swift discovery at his instigation by the Berlin astronomers, gave rise to thoughts that Airy had given Le Verrier some underhand assistance. Certainly members of Adams family thought so, however examination of the facts do not support these ideas.¹⁴ Airy was a Cambridge man through and through; he designed and built the Northumberland Telescope, the best in Europe for the purpose. Also he kept the pressure on Challis to find the disturbing planet, passing on positional information about Uranus throughout the summer of 1846. There is now no doubt that every effort was made to ensure a Cambridge success. Tragically, events conspired to thwart that ambition.

Why did Le Verrier and Arago not employ the telescopes of the Paris Observatory to ensure the glory was all theirs?

Although it is not easy to establish which instruments were available and in use at the time of the search, recent work indicates that none were larger than 15-cm, inadequate for the task. In addition, the Observatory was based in the city and the atmosphere was laden with soot reducing the effectiveness of those modest instruments. It was in fact the parlous state of French observational astronomy that caused the astronomers there to concentrate on mathematical analysis at that time.¹⁵

Why was Galle able to find Neptune so easily?

The pivotal fact is that Le Verrier's letter to Johann Gottfried Galle asking him to use the Berlin Observatory's 24.4cm (9¾-inch) Fraunhofer refractor to search for the planet at a specified position arrived on September 23rd, Director Johann F. Encke's, birthday. A long anticipated birthday party meant that the observatory would be available without Encke's supervision, and the opportunity was taken by the young and enthusiastic astronomers, Galle and Heinrich d'Arrest! In addition there was a clear moonless night. Crucially, the latest star maps produced by Berlin and covering the relevant area, but not yet distributed to other observatories, were available, the telescope was of excellent quality, and at 4.8cm (2-inch) smaller than the 11.5-inch (29.2cm) Northumberland telescope in Cambridge there were less faint stars to check!

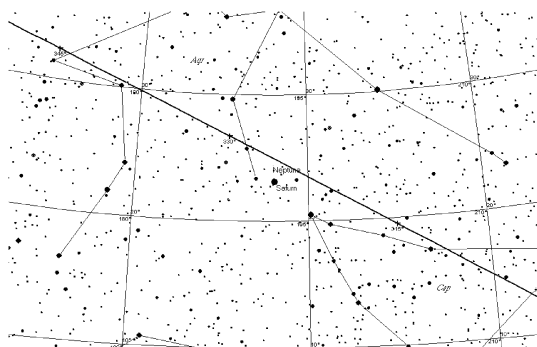


Fig. 4 Chart of the discovery area showing stars down to the 8th Magnitude prepared By the author using Sky Map Pro©

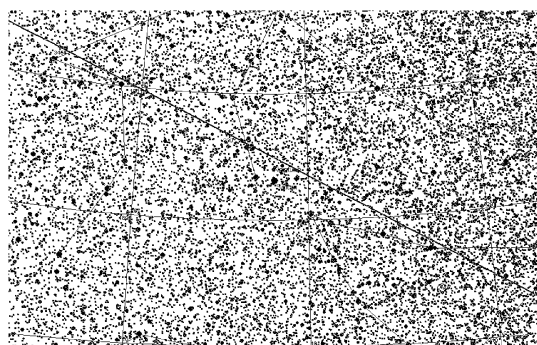


Fig. 5 Chart of the discovery area showing stars down to the 11th Magnitude prepared By the author using Sky Map Pro©

Hence the discovery took only an hour or so, although of course the 'new star' needed to be checked, how fast was it moving in its orbit, was it a main belt asteroid just one of a number of magnitude eight bodies still to be discovered in 1846. Or was it in fact a blue star. By the following night all these doubts had been removed, it was very close to the position indicated in Le Verrier's letter and showed a barely measurable disk.

The correspondence relevant to the discovery went as follows: John Russell Hind (Director at the Regent's Park Observatory) to Challis, Sept 16, 1846.

Sir, I have received a letter this morning from M. Herve Faye of the Paris Observatory on the subject of Le Verrier's planet, which I think may be of some service in the search. I mentioned to him a few days since that I had heard you were employed in observing stars with a view to its discovery and that I was similarly occupied. I will give the extract of M. Faye letter, So far I am not successful in this search, our instruments do not appear to me to be powerful enough for it.¹⁶

This letter indicates that following Le Verrier's preliminary notice of his work and indication of an

approximate area, published in Paris, a very few of those with potentially adequate refractors were actively searching and communicating as usual, although it seems that neither principal was aware of this.

Le Verrier seems only to have sought help from Berlin and wrote to Galle Sept 18th 1846.

Dr J. G. Galle, You see sir I have demonstrated that we cannot understand the observations of Uranus without introducing the effect of a hitherto unknown planet. What is remarkable there is only one position in the ecliptic that this perturbing planet can be located. Here are the elements of the orbit that I assigned to this star.

The current position of the star shows that we are now, and we will be still, for several more months favourably positioned for its discovery. Moreover from its high mass it can be concluded that its apparent diameter is more than 3 second of arc.¹⁷

The actual elements were those presented to the Academie des Sciences on Aug 31st 1846 It was entitled 'Sur la planete qui produit les anomalies observees dans le mouvement d'Uranus. – Determination de sa mass, de son orbite et da sa position actuelle.

Semi-major axis	36.154 AU
Sidereal period	217.387 years
Eccentricity	0.10761
Longitude of perihelion	284° 45'
Mean longitude, Jan. 1, 1847	318° 47'
Mass	1/9300
True heliocentric longitude, Jan. 1, 1847	326° 32'
Distance from the Sun	33.06 AU ¹⁸

Galle to Le Verrier, Berlin, Sept 25th 1846.

The planet you reported the position of really exists. The same day that I received your letter, I found a star of the 8th magnitude, which was not included in the excellent star map Hora XXI – designed by Dr. Bremmiker – as part of a collection of celestial maps published by The Royal Academy of Berlin.¹⁸

Professor Heinrich C. Schumacher (director of the Hamburg Observatory) wrote to Le Verrier, Altona Sept 28th 1846. 'I must send you my heartfelt and most sincere congratulations on your brilliant discovery. This is the noblest triumph of theory that I know of'.¹⁹

The Map problem

It has often been stated that the Cambridge University held a perfectly good map of the search area. This is

likely to be Karl Harding's map, known to be inaccurate and only recording stars down to the 8th magnitude, not the 11th as required by the Airy/Challis search plan, and therefore was not adopted by Challis as the basis for his search.

Sir John Herschel's contribution

Sir John, one of the finest astronomers of the day, summarised the relative positions of the Adams and Le Verrier predictions for the planet in the best of the contemporary reviews. He gives the following details for 23rd September 1846.

The geocentric longitude determined by Dr Galle from this observation was 325 deg. 53 mins. which converted into heliocentric, gives 326 deg. 52 mins., differing 0 deg. 52 min from M. Leverrier's place, 2 deg. 27 mins. from that of Mr Adams and only 47 mins. from the mean of the two calculations.²⁰

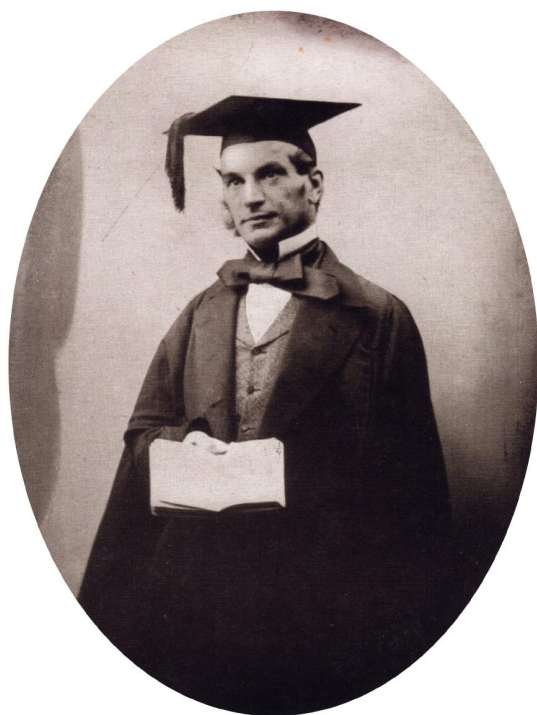


Fig. 6 Photograph of John Couch Adams

By courtesy of the Royal Astronomical Society
From 'John Couch Adams, the discovery of Neptune'
by W.M. Smart. No 11 *Occasional Notes of the Royal Astronomical Society* August 1947.

Why was the row between the French and the British so bitter and long lasting?

Shortly after the announcement of the discovery, Airy supported by several Cambridge men in key positions, asserted the priority of Adams's work and this was

swiftly interpreted by the press as a claim to co-discovery. A huge international row ensued. Both sides claimed that they had found the new planet first. Adams and Le Verrier were each unaware of the activity of the other. There was far more vitriol than the situation justified, most of it fuelled by the French press. There are explanations for this. First, it was only thirty years since the battle of Waterloo when the British and Prussians (Berliners) had combined forces to defeat the French. Second, there was a need to divert the French Public's attention from the sad and sorry state of the Paris Observatory. Attack is the best form of defence. D.F.J. Arago, director of the Paris Observatory, became involved but it seems that the vitriolic 'quotes' from his speeches that appeared in the *Le National* newspaper in fact came from its Editor. 'Airy has it on record that Arago moved the expulsion of the *Le National* editor from a special board meeting called to discuss this issue soon after the article was published, but that his motion was rejected'.²¹

The naming of the New Planet

This too was controversial. The account that follows is by Sir Henry Holland FRS, (1788–1873), royal physician and traveller, who describes a letter from Le Verrier that set the scene for another turbulent period in the discovery saga

That which most strongly clings to my memory is an evening I passed with Encke and Galle in the Observatory at Berlin, some 10 or 12 days after the discovery of the planet Neptune on this very spot; and when every night's observations of its motions had an especial value in denoting the elements of its orbit. I had casually heard of the discovery in Bremen, and lost no time in hurrying on to Berlin. The night in question was one of floating clouds gradually growing into cumuli; and hour after hour passed away without sight of the planet which had just come to our knowledge by so wonderful a method of predictive research. Frustrated in this main point, it was some compensation to stay and converse with Encke in his own observatory, one signalized by so many discoveries, the stillness and darkness of the place broken only by the solemn ticking of the astronomical clock, which, as the unfailing interpreter of the celestial times and motions, has a sort of living existence to the astronomer. Among other things discussed while thus sitting to together in a sort of tremulous impatience, was the name to be given to the new planet. Encke told me that he had thought of Vulcan, but deemed it right to remit the choice to Le Verrier, then supposed

the sole indicator of the planet and its place in the heavens; adding that he expected Le Verrier's answer by the first post. Not an hour had elapsed before a knock at the door of the observatory announced the letter expected. Encke read it aloud; and, coming to the passage where Le Verrier proposed the name of 'Neptune', exclaimed, 'so lass den Namen Neptune sein' it was a midnight scene not easily forgotten. A royal baptism with its long array of titles would ill compare with this simple name of the remote and solitary planet thus wonderfully discovered. There is no place, indeed, where the grandeur and wild ambitions of the world are so thoroughly rebuked and dwarfed into littleness, as in the astronomical observatory. As a practical illustration of this remark, I would add that my own knowledge of astronomers – those who have worked themselves with the telescope – has shown them to be generally men of tranquil temperament, and less disturbed than others by worldly affairs, or by the quarrels incident even to scientific research. I may mention as instances occurring to me at the moment, the two Herschels, Encke, Bessel, Piazzi and Bond. Other examples might readily be supplied.²²

However, only a few days after writing that letter, Le Verrier had a volte-face and suggested that the preferred name should be Le Verrier. Sir Harold Spencer-Jones later described the situation well:

On 1 October, Le Verrier wrote to Airy informing him of the discovery of the planet. He mentioned that the Bureau des Longitudes had adopted the name Neptune, the figure a trident, and that the name Janus, which had also been suggested, would have the inconvenience of making it appear that the planet was the last in the solar system, which there was no reason to believe.

Nevertheless Arago announced to the French Academy on 5 October that 'Le Verrier had delegated to him the right of naming the planet and that he had decided, in the exercise of this right to call it Le Verrier. 'I pledge myself', he said, never to call the new planet by any other name than Le Verrier's Planet".²³ Many astronomers were against naming the planet Le Verrier – Airy was their spokesman.

Airy to Le Verrier 12.01.47:

I intended my paper, (Airy's full report to the RAS meeting of the 13th November 1846) as a history of all that I know bearing upon this wonderful discovery, and I wish that you or some person well acquainted with what has been done in France would write your portion of the history.

I very much wish that you would pay a visit to England. It would gratify me very much to have

the pleasure of receiving you in my house. I am sure you would find that in England, not only among men of accurate science but also among the people generally, there is no national feeling adverse to the respect due to you; which is not incompatible with the assertion of some claims in favour of Mr Adams. Since your book arrived, I have conversed on it with only two competent judges of its merit, Sir John Herschel and Sir J.W. Lubbock; and they regard it with the most unbounded admiration.

Will you now permit me to mention a subject of utmost delicacy, which I mention now in the most private way only because I am confident that, if it is not now mentioned privately, it will soon be mentioned publicly, I mean the name of the planet. From my conversation with the lovers of astronomy in England and from my correspondence with astronomers in Germany, I find that the name assigned by M. Arago is not well received. They think in the next place that the character of the name is at variance with that of all the planets.

They think in the next place that M. Arago as your delegate could do only what you could do, and that you would not have given the name which M Arago has given. They are all desirous of receiving a mythological name selected by you. In these feelings I do myself share. It was believed, at first that you approved of the name Neptune and on that supposition we have used the name Neptune when it was necessary to give a name. Now if it was understood that you still approved of the Neptune (or Oceanus as some of my English mythologists suggested – or any other of the same class), I am sure that all England and Germany would adopt it at once, I am not sure that they will adopt the name that M. Arago has given.²⁴

Le Verrier to Airy, Jan 29 1847:

Sir and dear colleague,

I have carefully studied the previous note that you have presented to the Society of Astronomy. Thank you for the terms in which you talked about my work and that your last letter contains kind remarks, relating to this subject. You are, sir, among a small number of astronomers who are familiar with celestial mechanics. After I had given my memoirs I was convinced I would find the planet and I said to myself, rather naively, that I would call it Planet of Le Verrier, similar to Halley's comet, Encke's comet etc., that's all. When the planet was found it was proposed by the Bureau of Longitudes to call it Neptune. I was a big part of the Bureau at that time, but did not

have charge of it. By writing to various astronomers I told then the decision the Bureaux had made, but without adding blame or approval.²⁵ Harold Spencer Jones adds:

At a later date, when relations between Arago and Le Verrier had become strained, the true story was told by Arago. It appears that Arago had at first agreed to the name Neptune, but Le Verrier had implored him, in order to serve him as a friend and as a countryman to adopt the name Le Verrier. Arago had in the end agreed, but on condition that Uranus should always be called Planet Herschel, a name which Arago had frequently used.

The greatest of men are liable to human weaknesses and failings; Le Verrier was described by his friends as a *mauvais coucheur*, an uncomfortable bedfellow, by the general consensus of astronomers the name Neptune was adopted for the new planet; the name Le Verrier did not long survive.

This statement by Le Verrier was not correct. The minutes of the Bureau des Longitudes show that the Bureau had not considered assigning a name by 1 October, when Le Verrier had written not only to Airy but also to various other astronomers in Germany and Russia informing them that the Bureau des Longitudes, 'had adopted the name Neptune, the figure a trident'. The Bureau neither assigned the name Neptune nor subsequently withdrew it. The minutes of the Bureau des Longitudes show that Le Verrier's statements were repudiated by the Bureau at a subsequent meeting. It seems that the name Neptune was Le Verrier's own choice in the first instance but that he soon decided that he would like the planets to be named Le Verrier. There is no explanation of his reasons for stating that the name Neptune had been assigned by the Bureau des Longitudes; it was, in fact outside the competence of the Bureau to assign a name to a newly discovered planet²⁶

Was Adams disappointed about the failure to secure Neptune for Britain?

Although he never showed to friends in Cambridge his regrets that after so much work he should lose the race to discovery, his family were left in no doubt that it affected him greatly.²⁷ Adams great personal difficulty was in his readiness to publish his work. He had failed to meet with Airy in the early days, and had failed to get any paper read or published prior to discovery.

His full paper was presented at the RAS meeting 13th Nov 1846, following accounts by Airy and Challis. It was included as a supplement to the 1851

Nautical Almanac which was published in January 1847.

In addition to the Appendix in the Nautical Almanac it was also published as a standalone preprint. As a preface or 'Advertisement' to this preprint it is written:-

This paper was communicated by the Author to the Royal Astronomical Society, and was read to that body, at their ordinary meeting, on November 13, 1846. The press of the Society being engaged on an extensive paper, on the longitude of Valentia, by the Astronomer Royal, and it being deemed of national importance that Mr ADAMS's Paper should be submitted to the world without loss of time, application was made to Capt. W.H.SMYTH R.N., President, and to the Rev. R. Sheepshanks, Secretary, of the Society who with their usual promptitude and zeal, granted permission for the immediate printing and publishing of the Paper by the NAUTICAL ALMANAC OFFICE; and it is under these circumstances that the investigations of Mr. Adams first appear as an extract from the Appendix to the NAUTICAL ALMANAC for 1851.

Nautical Almanac Office, W.S.STRATFORD,
3, Verulam Buildings, Superintendent of the
Gray's Inn, London. Nautical Almanac
December 31, 1846'

Prior to this there were only Adam's private 1841 Memorandum that started his quest followed by the October 1845 memo to Airy and the Sept 1846 memo also to Airy. He failed to get his paper read on the 15th Sept at the British Association meeting.

His Nautical Almanac memoir was described by Spencer Jones in the following terms:

It was a masterpiece, it showed a thorough grasp of the problem: a mathematical maturity which was remarkable in one so young. Hansen, a top authority on lunar theory, stated that Adams's investigation showed more mathematical genius than Le Verrier's. Airy himself said On the whole I think Adams's mathematical investigation superior to M. Le Verrier's. However both are so admirable that it is difficult to say.²⁸

In truth Adam's work was not wasted. Using only the observations taken at Cambridge he was able to calculate the true orbit of Neptune. William Lassell who owned a large reflector was requested to search for any satellites. Triton was spotted almost immediately, and from the derived information the mass of Neptune was calculated.

Much of the evidence of Adams's disappointment is contained in his scientific papers. He spent a great deal of his time demolishing the work of the French

astronomers. Regarding Bouvard's tables of Saturn we read: 'I was immediately struck with the magnitude of the tabular errors in heliocentric latitude'.²⁹ Challis does not escape either: 'I am able to prove that the principal conclusions of Professor Challis are erroneous', these comments refer to a paper about the Moon's orbit.³⁰ Even Airy does not escape unscathed.³¹ Of Le Verrier on the other hand, he said: 'I have great pleasure in being allowed to express the great satisfaction in doing honour to the eminent astronomer whose labours have added so greatly to our knowledge of the solar system'. This was on the occasion of the presentation of the RAS Gold Medal to Le Verrier in 1876, 'For his work on the four great planets Jupiter, Saturn, Uranus and Neptune'.³²

Adams had to wait a long time however to deliver the *coup de grace* when at the 1884 Meridian Conference in Washington he was able to secure the Greenwich meridian as the Prime Meridian of the world in the face of a determined bid by the French in favour of the Paris meridian.³³

Today we recognised that both Adams (1st) and Le Verrier (2nd) predicted the position of Neptune with sufficient accuracy to allow a successful search to be undertaken. Galle working with d'Arrest discovered Neptune by knowing what they were looking at, after a short search. Hence the terms co-predictors and co-discoverers are used. Adams's brilliance as a young post-graduate was finally revealed to his peers by the publication of his work on Neptune in 1847. However his enduring reputation is based upon his later work on lunar and planetary theories. Director of the Cambridge University Observatory from 1861 to 1892, his work on the most difficult problem, the 'Three body problem or Lunar Theory' made him the foremost European mathematician of his generation, and for it he was awarded the RAS gold medal in 1866.

Conclusion

Such was the furore over Britain losing the discovery of Neptune, and so persistent the attempts to hold Airy responsible, that to his great credit Airy drew together every scrap of evidence available into a single file, now known as the Neptune File. The RGO library was hidden underground during the Second World War until 1955. Olin Eggen, chief assistant, took the Neptune File circa 1965, prior to departure for Australia and later to South America, Eggen died in Chile in 1999. This file together with many other texts were recovered by Adam Perkins soon after. On recovery it was catalogued in 1999 and given the RGO Archives title, 'Papers relating to Neptune and the minor planets and requests for information', and

the Cambridge University Library's class mark MS RGO 6/96A. Since that date Scholars have discovered relevant primary material in a number of sources. No pre - 1999 account could claim to be definitive. This paper has sought to review in a balanced way some of the new evidence that bears upon particular aspects of the Neptune controversy, and in particular upon Adams's enigmatic character. However, every time the end of the story seems to be in sight more facts are uncovered. The French side of the story has been written up finally in James Lequeux book, *Le Verrier: Savant magnifique et deteste* (Parc d'Activite de Courtaboeuf: EDP Sciences, 2009). The English translation is James Lequeux; *Le Verrier: magnificent and detested astronomer*, edited and with an introduction by William Sheehan, translated by Bernard Sheehan (New York: Springer 2013). This text, about to be published at the time of writing, lies outside the scope of the current work. There remains a great deal of information gleaned from many sources about Adams time in Cornwall which remains to be written up. The saga is pretty dramatic at times and this is deserving of a film which is Maarten Roos's ultimate objective. For a brief introduction see *Searching for Neptune* www.vimeo.com/26332551.

In addition, although a lot of good work is now in the public domain much of it lies in rare texts and journals which are difficult to find. Over the years there has been much talk of achieving a more complete biography of Adams, or a definitive review of the Neptune discovery timeline. However, such is the complexity of the history that it is unlikely that such a text by an individual author would be acceptable to other experts. Perhaps the way forward is to gather together all the well founded papers and articles into one volume, similar in fact to Adams's *Collected Scientific Papers*. The ultimate aim of this paper is to stimulate thinking about the relevance of Adams's Cornish upbringing, and to stimulate discussion that will result in a good video and book. For me this is not the end of the story, not even the beginning of the end, merely the end of the beginning.

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The author

Brian is the director of Roseland Observatory in Cornwall which exists in principle to encourage people from all walks of life to appreciate the environment about us in the way that suits them best. He serves on the RAS Education Committee and is the SHA's co-ordinator for Cornwall within the Society's county survey project.

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