



Recovering the Neptune files

What exactly went on when Neptune was discovered? Nicholas Kollerstrom can shed new light on this story of scientific logic and heated claims of precedence – not to mention long-lost letters spirited away across continents.

The discovery of Neptune was “the most magical predictive-math moment in the history of the oldest science”, according to historian Dennis Rawlins (1999). In 1846 Urbain LeVerrier correctly predicted where the new planet would be found in the heavens, and ever since then scholars have wondered how he could have been quite so confident. The saga of its discovery has seen – perhaps surprisingly – some major developments in the past couple of decades. This summary of the story so far was presented at the National Astronomy Meeting in Dublin in April 2003.

In 1980 a scholar reconstructed the complex perturbation calculations whereby LeVerrier had predicted the new planet’s position to within 52 arcmin of celestial longitude. One can nowadays solve these equations to a higher order of accuracy than was earlier feasible, and it was shown that the prediction thereby became even more exact, to within 16 arcmin of longitude (Baghdady 1980). This enhanced accuracy suggests that this computation really was the achievement of deductive logic that LeVerrier believed it to be – and not some kind of fluke as is, now and then, suggested.

In 1990 some Chinese physicists answered the question of how the modern equations for the

Abstract

The existence of Neptune was famously predicted, then observed by LeVerrier in Berlin 1846. The discovery was also claimed – after the event – by British astronomers. Many letters between the protagonists and colleagues were collected in the “Neptune file”, long lost from the Royal Greenwich Observatory. The missing letters reappeared in Chile, among the papers of Olin Eggen after his death. They, together with re-evaluation of the historical calculations and the observations on which they were based, show that the discovery was indeed more than just a “happy accident”.

perturbation of Neptune on Uranus compared with those used by the historical characters (Lai *et al.* 1990). The problem was that the actual orbit of Neptune turned out to be bewilderingly different from that used in the (fairly comparable) models of its orbit constructed, independently, by John Couch Adams in Cambridge and LeVerrier in Paris (Standage 2000, Baum and Sheehan 1997). The dominant term in the

1: The elusive Neptune file, “borrowed” from the RGO archives by Olin Eggen and recovered in Chile.

perturbation arose from the 2:1 ratio in the orbit periods of Neptune and Uranus – unsuspected before the discovery. This ratio is out by 2%, and it is this inexactitude which generates “beats” in the resonant interference-pattern having a period of somewhat over 2000 years. This periodicity was discovered by the American astronomer Benjamin Pierce a few months after the new planet’s appearance – and he used it to argue in the *Washington Daily National Intelligencer* (Pierce 1847) that the prediction had been a mere “happy accident”.

The perturbations observed in Uranus’s longitude, used by both LeVerrier in Paris and Adams in England as the basis of their prediction, were between one and two arcminutes, while the modern terms of perturbation of Uranus due to Neptune’s pull are an order of magnitude larger. This discrepancy was resolved by the Chinese team, who showed that the nineteenth century astronomers had investigated the perturbations over a period when they were *minimal*, not maximal as they had assumed. Also, the historical characters wondered whether they could really believe Flamsteed’s early observations because the perturbation seemed unlikely. It was not until the Chinese team’s result that this perturbation value was understood, and shown to be valid. I believe that no science historian has as yet used or alluded to these important Chinese results, published in the *American Journal of Physics*.

In 1993 Dennis Rawlins published a re-evaluation of the Neptune saga. His grasp of positional astronomy combined with an anti-establishment disposition seems to have been just what was required (Rawlins 1993). The British claim to co-prediction of Neptune had been, he explained, more or less entirely constructed in retrospect – an “entirely post-discovery-published claim of prior prediction (Rawlins 1999 p3)”. Adams had indeed worked through the calculations, but he did not have enough confidence to go public or make a definite prediction as to where anyone should look – although, after the discovery, his work was made to appear as if he had (Kollerstrom 2003). The predictions that he gave to James Challis at Cambridge and Airy the Astronomer Royal in July and September of 1846 (after LeVerrier had gone into print with his predictions and before the planet was found) did range over 20° of the zodiac. After the discovery it became public knowledge that Challis at Cambridge had spent six weeks trying to find a planet, whereas the Berlin Observatory had found it in half an hour (following LeVerrier’s directions). Amid nationalistic fervour, pressure grew for a degree of exaggeration of Britain’s prior-prediction claim.

In 1999 the Royal Observatory’s long-lost Neptune file, collated and bound by Airy, resur-

faced in Chile. It was found at the Cerro Tololo Observatory in the bungalow of Olin Eggen, who had died the year before. Eggen had been Chief Assistant to the Astronomer Royal Woolley between 1956 and 1961. He had had the task of sorting out the RGO's library at Herstmonceux where, it would appear, he succumbed to temptation.

The Neptune file was found with piles of other historic manuscripts and about 60 rare books. Archive material from his flat in Chile recovered by Cambridge University Library archivist Adam Perkins filled three tea chests (Perkins 2003): the Neptune file was by no means the only thing that Eggen had "borrowed". Initially he had borrowed material to compose the *Dictionary of Scientific Biography* sections on Airy and Challis. Eggen later moved to Mt Stromlo Observatory outside Canberra and he could not have had permission to take the files to Australia. In 1967, Dennis Rawlins was the first to be told that Britain's Neptune file had gone missing, in response to enquiries at the RGO. Later, his journal *Dio* correctly predicted where the missing file would be found. It is now at the University Library, Cambridge.

Surprises in the archives

Once the file had reappeared, I obtained an RAS grant to archive and transcribe the collection of Britain's Neptune papers. This enterprise was more successful than I had anticipated, because others before me had had the same idea, of rescuing the ancient letters by transcribing them. The two main handwritten collections of copies of these letters are by Sir Donald McAllister, now kept at St John's College, Cambridge, and by a John Herschel, grandson of Sir John Herschel the astronomer, now kept at the Royal Society. They collated large collections of letters relevant to John Couch Adams and Sir John Herschel respectively. It has been valuable to have these collections for comparing with the very faded originals. Airy is the most prolific correspondent in the discovery saga – exerting a profound and somewhat godfatherly authority upon the astronomers of Europe – but the Neptune file only has faint blotting-paper copies of his letters; only a proportion of his originals turn up on other archive collections, such as in Paris.

At the same time in 1999, the St John's College library finally finished computer indexing their collection and sorting out their J C Adams archives into 45 boxes. I requested any of J C Adams' diaries and was shown a fragment from 1846. The diary mainly showed his close friendship with Challis, who he was see-

Table 1: Neptune correspondence archives

The RGO file – University Library, Cambridge	G B Airy	106 letters
John's College Library, Cambridge	J C Adams	45
Institute of Astronomy, Cambridge	J Challis	22
Trinity College, Cambridge	W Whewell	10
Royal Society Library	J Herschel	41
Royal Astronomical Society	R Sheepshanks	17
Academie des Sciences Biblioteque	U LeVerrier	22

Table 2: Discovery milestones

1845	
5 Nov	Airy letter to Adams, on receipt of his note
10 Nov	1st Memoire by LeVerrier at Paris Academy
1846	
1 June	LeVerrier's first paper on the new planet
9 July	Airy urges Challis to attempt sky-search
29 July	Challis starts his sky-search at Cambridge
31 Aug	Leverrier's second paper, in <i>Comptes Rendus</i>
2 Sept	Adams' first letter about new planet, to Airy
10 Sept	BAAS meeting starts at Southampton
23 Sept	New planet found, in Berlin
13 Nov	RAS meeting: Adams' "prediction" first announced

ing on an almost daily basis in March and April. No previous scholar had apparently seen this diary fragment, although it had always been there: it somehow became accessible only through the computer index! His biographer made no suggestion of any close liaison between Challis and Adams over this period (Harrison 1994). A similar surprise came from the McAllister copy of Airy's important letter of 8 December 1846 to Adam Sedgwick which earlier researchers seem to have found inaccessible: it is part of a candid exchange between these two old friends over who was to "blame" for the perceived British failure. The original letter turned up in the Neptune file in 1999, along with its copy in the archives at St John's.

Table 1 shows the archives that house Neptune material and the main character responsible for the collection being kept in each place, for example James Challis at the Institute of Astronomy in Cambridge, with the number of letters to or from that person that I have copied out from each. Thus the RAS library holds, primarily, correspondence to and from the Rev. Richard Sheepshanks, who was the RAS's Secretary over this period. LeVerrier's preserved correspondence on the subject is mainly with his English friends – I found no letters to any compatriots, friends or relatives on the subject (or indeed, any subject). Revolution broke out in February 1848 and barricades went up outside the Paris Observatory. As to LeVerrier's discussions with his peers, we hear about a row he had with Arago over the name of the new planet, but only via the English correspondence. Both the name "Neptune" and its symbol, a trident, were published in letters sent

out by LeVerrier within days of receiving notice that his planet had been found. He claimed that these suggestions came to him from the Bureau de Longitude – but they denied it. I transcribed 35 letters to and from LeVerrier and six to and from Arago, and hope that they will facilitate fuller appreciation of this topic than has hitherto been feasible.

Table 2 gives some major dates for the Neptune discovery. One finds eight dated sections in Adams' manuscripts over the period, of which no less than four concern the "radius vector", i.e. Uranus's distance from the Sun. Adams sent off his first letter about the new planet on 2 September 1846, after finding his solution to this problem the day before. This was the issue on which Airy questioned him about in his letter of 5 November 1845 and to which Adams, notoriously, made no reply. Accounts normally quote Adams' comment made years later that the question was "trivial", but his notebooks are far from confirming this. They rather show him still working on a problem which (one gathers) it was first necessary to solve in order to achieve a full solution.

In conclusion

I hope that the publication of this correspondence will elucidate aspects of the case not yet discussed by scholars. My US colleagues on this project are astronomy historians Craig Waff and Bill Sheehan. A comprehensive archive of the John Herschel correspondence exists (Crowe and Kelvin 1998), and perhaps this can be made compatible with or linked to a Neptune discovery archive. I have summarized the story here in order to stimulate renewed interest in this fascinating tale.●

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