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Making Kew Observatory: the Royal Society, the British Association and the politics of early Victorian science

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Abstract. Built in 1769 as a private observatory for King George III, Kew Observatory was taken over in 1842 by the British Association for the Advancement of Science (BAAS). It was then quickly transformed into what some claimed to be a 'physical observatory' of the sort proposed by John Herschel – an observatory that gathered data in a wide range of physical sciences, including geomagnetism and meteorology, rather than just astronomy. Yet this article argues that the institution which emerged in the 1840s was different in many ways from that envisaged by Herschel. It uses a chronological framework to show how, at every stage, the geophysicist and Royal Artillery officer Edward Sabine manipulated the project towards his own agenda: an independent observatory through which he could control the geomagnetic and meteorological research, including the ongoing 'Magnetic Crusade'. The political machinations surrounding Kew Observatory, within the Royal Society and the BAAS, may help to illuminate the complex politics of science in early Victorian Britain, particularly the role of 'scientific servicemen' such as Sabine. Both the diversity of activities at Kew and the complexity of the observatory's origins make its study important in the context of the growing field of the 'observatory sciences'.

> The observations most appropriate for the ready and exact determination of physical data are … those which it is most necessary to have performed with exactness and perseverance. Hence it is, that their performance, in many cases, becomes a national concern, and observatories are erected and maintained, and expeditions despatched to distant regions, at an expense which, to a superficial view, would appear most disproportioned to their objects. But it may very reasonably be asked why the direct assistance afforded by governments to the execution of continued series of observations adapted to this especial end should continue to be, as it has hitherto almost exclusively been, confined to astronomy.[1]

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1 John Frederick William Herschel, *A Preliminary Discourse on the Study of Natural Philosophy*, London: Longman, Rees, Orme, Brown & Green, 1830, reprinted Chicago: The University of Chicago Press, 1987, pp. 213–214.

When Herschel wrote these remarks in his 1830 *Preliminary Discourse on the Study of Natural Philosophy*, he was very widely respected and arguably Britain's foremost practitioner of the physical sciences. Herschel's plea was novel in that it called for observatories that did other things than just astronomy. It is also important in the history of the physical sciences, in that just a few years later the British government set up several observatories across the British Empire that at least partially resembled the model envisaged by Herschel. Just as Herschel suggested, they principally studied the Earth's magnetic field and also took meteorological observations. This system of observatories, together with an associated Antarctic expedition, formed one of the largest scientific projects ever undertaken in Britain, which became known as the 'Magnetic Crusade'.[2] In 1841, while the Magnetic Crusade was still in progress, King George III's former private observatory in the Old Deer Park, Richmond, commonly known as the 'Kew Observatory' (Figure 1), was offered by the government to the Royal Society. When it was ultimately refused by the Royal Society, it was taken on enthusiastically by the British Association for the Advancement of Science (BAAS). The BAAS set about transforming it into what its Council hoped would be a 'physical observatory' – a phrase that was also used by Herschel to describe the kind of observatory he envisaged.[3] Kew was developed from a disused private observatory into a multi-functional scientific institution that did pioneering work in several physical sciences, of which astronomy was just one.[4] The story of how and why the future of the Kew Observatory building was debated by the Royal Society, and how it was then taken up by the BAAS, is of great interest to historians of science. Partly this is because it has never been analysed in detail before; more than this, it also tells us much about the early history of such physical observatories. More generally, it has the potential to shed much light on the politics of the physical sciences in early Victorian Britain. Through Kew Observatory we can learn much about the Royal Society in its period of 'reform' in the 1830s and 1840s, as well as the BAAS in its early years. The tale especially illuminates the role of the military in securing patronage for, and organizing, science in this period. It might build on David Philip Miller's important synoptic survey of the physical sciences in the early nineteenth century, which highlights the under-appreciated role of the 'scientific servicemen' in addition to that of the better-known 'mathematical practitioners' and 'Cambridge network'. These 'scientific servicemen' acquired great scientific reputations through

2 The origins of the phrase 'Magnetic Crusade' are unclear. Christopher Carter, 'Magnetic fever: global imperialism and empiricism in the nineteenth century', *Transactions of the American Philosophical Society* (2009) 99, Part 4, pp. xv–xvi, finds no evidence that the phrase was used in the lobby for the project in the 1830s and that it was first used in 1842 in an American textbook on electricity and magnetism. Elias Loomis's 1848 call for a 'grand meteorological crusade' along the lines of the British magnetic effort strengthens the idea that the term 'Magnetic Crusade' was American in origin – see James Rodger Fleming, *Meteorology in America, 1800–1870*, Baltimore: Johns Hopkins University Press, 1990, p. 77.

3 BAAS 1842 'prospectus' for Kew Observatory, reprinted in Robert Henry Scott, 'The history of the Kew Observatory', *Proceedings of the Royal Society of London* (1885) 39, pp. 37–86, 50.

4 Simon Schaffer has pointed to Kew as an important centre of a new experimental astronomy, but does not examine in detail the politics of its transformation. Simon Schaffer, 'Where experiments end: tabletop trials in Victorian astronomy', in Jed Z. Buchwald (ed.), *Scientific Practice: Theories and Stories of Doing Physics*, Chicago and London: The University of Chicago Press, 1995, pp. 257–299.

Figure 1. Kew Observatory, photographed by the author in December 2012. At the time of writing (early 2014), the building is unused and in the hands of a property developer.

military surveys and voyages of discovery and became increasingly influential in London scientific circles over the first four decades of the nineteenth century.[5]

Several scientific institutions, notably the Royal Observatory at Greenwich, have been written about extensively by historians. Their accounts note the use of the term 'physical observatories' at the end of the nineteenth century: not in the Herschelian sense, but to describe institutions dedicated to research in astrophysics, as opposed to traditional positional astronomy.[6] Kew Observatory, by contrast, is poorly covered in the literature.

5 David Philip Miller, 'The revival of the physical sciences in Britain, 1815–1840', *Osiris*, 2nd series (1986) 2, pp. 107–134, esp. 112–119. Jessica Ratcliff, *The Transit of Venus Enterprise in Victorian Britain*, London: Pickering & Chatto, 2005, p. 27, notes that the role of scientific military officers is poorly covered in modern scholarship of Victorian science. This is now starting to be rectified – see e.g. Michael S. Reidy, *Tides of History: Ocean Science and Her Majesty's Navy*, Chicago and London: The University of Chicago Press, 2008, who discusses how elite academic scientists collaborated with naval personnel in global tidal research in the early 1830s.

6 The best general history of Greenwich in the nineteenth century remains A.J. Meadows, *Recent History (1836–1975)*, vol. 2 of Eric Forbes, A.J. Meadows and Derek Howse, *Greenwich Observatory: The Royal Observatory at Greenwich and Herstmonceux 1675–1975*, 3 vols., London: Taylor and Francis, 1975. Robert W. Smith, 'A national observatory transformed: Greenwich in the nineteenth century', *Journal for the History of Astronomy* (1991) 22, pp. 5–20, offers a detailed study of how the Greenwich regime was changed during the nineteenth century under Astronomer Royal George Airy. Rebekah Higgitt, 'A British national observatory: the building of the New Physical Observatory at Greenwich, 1889–1898', *BJHS* (2014) 47, pp. 609–635, discusses a building at Greenwich that was purportedly for astrophysics. See also the contemporary account in E. Walter Maunder, *The Royal Observatory Greenwich: A Glance at Its History and Work*, London: Religious Tract Society, 1900, esp. Chapter 9 on magnetism and meteorology. Steven J. Dick, 'National observatories: an overview', *Journal for the History of Astronomy* (1991) 22, pp. 1–3, gives a brief but useful survey of national observatories generally. Dick has also written the standard

The three most commonly cited histories are all uncritical and celebratory in their character.[7] John Cawood's thorough, archive-based account of the origins of the Magnetic Crusade says little about Kew.[8] The more recent work by Christopher Carter is similar, although broader in its scope. It describes American research into geomagnetism in the 1830s and 1840s, in addition to addressing science and imperialism generally.[9] The diversity of activities at Kew from the mid-1840s makes a study of how and why this transformation happened especially urgent in the context of the developing historical field of the 'observatory sciences'. This field covers sciences of observation, such as geomagnetism and meteorology as well as astronomy, practised within the common space of the observatory and sharing the same set of techniques.[10] In particular, the transformation of Kew makes an interesting case study in the diversification of the work of the nineteenth-century observatory into non-astronomical fields, recently pointed to by David Aubin.[11]

This article will use a chronological framework to chart the history of Kew Observatory under the Royal Society and then the BAAS, before assessing the programme of work implemented at Kew up to the mid-1840s. We will see that the institution that emerged was different in many ways from Herschel's vision of a physical observatory and that it owes much to the politics of science in the 1840s and to other personalities than Herschel's. Indeed, I show that the story of Kew Observatory in the 1840s is an important case study in the importance of Miller's 'scientific servicemen', as it will become clear that the prime mover behind the Kew project was really the geophysicist and Royal Artillery officer Edward Sabine. Sabine, the chief mastermind behind the Magnetic Crusade, had by 1840 become at least as distinguished as a political manoeuvrer as he was as a man of science.

history of the United States' national observatory: Dick, *Sky and Ocean Joined: The U.S. Naval Observatory 1830–2000*, Cambridge: Cambridge University Press, 2003. A detailed survey of the development of observatories in universities in the nineteenth century is Roger Hutchins, *British University Observatories 1772–1939*, Aldershot: Ashgate, 2008.

7 For a general history to 1885 see Scott, op. cit. (3). L. Jacobs, 'The 200-years' story of Kew Observatory', *Meteorological Magazine* (1969) 98, pp. 162–171, tells the story up to the observatory's bicentenary. The chapter on Kew Observatory in O.J.R. Howarth, *The British Association for the Advancement of Science: A Retrospect. 1831–1921*, 2nd edn, London: BAAS, 1931, naturally plays up the role of the British Association.

8 John Cawood, 'The Magnetic Crusade: science and politics in early Victorian Britain', *Isis* (1979) 70, pp. 492–518.

9 Carter, op. cit. (2).

10 David Aubin, Charlotte Bigg and H. Otto Sibum, 'Introduction: observatory techniques in nineteenth-century science and society', in Aubin, Bigg and Sibum (eds.), *The Heavens on Earth: Observatories and Astronomy in Nineteenth-Century Science and Culture*, Durham, NC: Duke University Press, 2010, pp. 1–32, 4. Vanessa Heggie, 'Experimental physiology, Everest and oxygen: from the ghastly kitchens to the gasping lung', *BJHS* (2013), 46, pp. 123–147, suggests that the concept of observatory sciences can be extended further, in this case into physiological research on mountaineers at high altitudes.

11 David Aubin, 'A history of observatory sciences and techniques', in Jean-Pierre Lasota (ed.), *Astronomy at the Frontiers of Science*, Heidelberg: Springer, 2011, pp. 109–121.

Geomagnetism, meteorology and physical observatories

In Britain during the 1820s and 1830s, there were concerns among some of the younger generation of science devotees that British science was in danger of being left behind by its Continental neighbours. The best-known critique of British science in this period is Charles Babbage's stinging attack on the Royal Society and political attitudes to science,[12] but many other leading figures, including John Herschel, lamented Britain's scientific performance, particularly in comparison with that of France.[13] The fields of geomagnetism and meteorology were major exemplars of these concerns. At the beginning of the nineteenth century, geomagnetism and meteorology had hardly existed as sciences organized on a national scale. But when they took off, they did so together. In addition to being 'observatory sciences', as noted above, they were seen as being closely related for several reasons. Many thought that the weather and the Earth's magnetic field were subtly related to each other, or that both had astronomical origins, and in any case temperature and pressure were found to affect magnetic compass readings. Both sciences had immediate importance to navigation in an age when Britain was the world's chief maritime power. In particular, the reasons for the behaviour of the compass aboard ships were poorly understood, as were the weather and currents in many parts of the oceans. On a more international scale, a common set of techniques caused the two sciences to develop together during the 1830s and 1840s.[14]

Herschel, in the passage from his *Preliminary Discourse* quoted at the beginning of this article, seems to have been the first to suggest the general concept of a government-funded physical observatory. His aim for such an observatory was to provide long-term data for the use of theoreticians in the physical sciences generally, and he asked why government observatories continued to focus only on astronomy. As an example of the non-astronomical observations he had in mind, Herschel suggested the determination of global sea levels.[15] Yet nobody could agree on an exact plan for what a general observatory should be doing. The earliest known use of the exact phrase 'physical observatory' seems to have been made by the Scottish natural philosopher David Brewster, who wrote to William Vernon Harcourt – like Brewster, a leading light in the early years of the BAAS – that he had 'long thought that one of the greatest scientific desiderata in England is a *physical observatory*, erected and endowed by the government'. Specifically citing Herschel as his inspiration, Brewster suggested that in such an establishment his own experiments in optics could be carried out to a much higher standard than was possible in a private laboratory and that 'all the phenomena of magnetism, meteorology and electricity' could be observed

12 Charles Babbage, *Reflections on the Decline of Science in England, and on Some of its Causes*, London: B. Fellowes and J. Booth, 1830.

13 Carter, op. cit. (2), pp. 24–25; Miller, op. cit. (5), pp. 108–110.

14 Fabien Locher, 'The observatory, the land-based ship and the crusades: earth sciences in European context, 1830–50', *BJHS* (2007) 40, pp. 491–504.

15 Herschel, op. cit. (1), 213–216.

as they were in the magnetic observatories then being established across Europe.[16] Harcourt agreed,[17] though such a broadly based concept of a physical observatory made no further progress with the BAAS at this time.

Herschel further developed his ideas on physical observatories in October 1835, in a long letter to Francis Beaufort, Hydrographer to the Admiralty, written while living at the Cape of Good Hope. As Christopher Carter and Gregory Good have pointed out, Herschel was by this time calling for a more coordinated approach to meteorological work than hitherto. He had already published an instruction manual for making and recording meteorological observations, and receiving meteorological reports from numerous stations, across the British Empire and beyond.[18] The views expressed in his letter to Beaufort correspond very well with his remarks in the *Preliminary Discourse* and are important in that they help us to understand his attitudes to Kew Observatory in the 1840s. Herschel advocated to Beaufort a hierarchical system of observatories worldwide, in which the great national observatories such as Greenwich formed a 'first class', with which those institutions 'of an inferior class' could not and should not compete. However, there were many important tasks to be done by these lesser observatories. They should, said Herschel, carry out determinations of constants such as local gravity, mean atmospheric pressure and sea level ('the absolute height above the level of the Sea of some natural unobliterable mark above or below the station of observatory'). Herschel also proposed that an important part of these institutions' programmes should be to observe, with the most up-to-date instruments and methods available, 'magnetic intensity and direction', 'meteorology in all its extent', and tides. Thus Herschel's vision of a physical observatory involved routine monitoring of variables such as the Earth's magnetic field, as well as the establishment of constants. Herschel had no plans for how such a system of observatories should be put into effect and he concluded with the reflection, 'Perhaps all this is dreaming'.[19] We do not know the immediate context of this letter to Beaufort, though some remarks at its end on a ceasefire in the frontier war then taking place in South Africa give a clue. They suggest that this vision of a system of observatories was part of Herschel's view of enlightened imperial administration that he developed during his stay at the Cape of Good Hope in the 1830s.[20]

16 Brewster to Harcourt, 28 April 1832, in Jack Morrell and Arnold Thackray (eds.), *Gentlemen of Science: Early Correspondence of the British Association for the Advancement of Science*, London: Royal Historical Society, 1984, pp. 138–141, original emphasis.

17 Harcourt to Brewster, 4 May 1832, in Morrell and Thackray, op. cit. (16), p. 141.

18 Carter, op. cit. (2), pp. 38–40; Gregory A. Good, 'A shift of view: meteorology in John Herschel's terrestrial physics', in James Rodger Fleming, Vladimir Jankovic and Deborah R. Coen (eds.), *Intimate Universality: Local and Global Themes in the History of Weather and Climate*, Sagamore Beach: Science History Publications/USA, 2006, pp. 55–56.

19 Herschel to Beaufort, 11 October 1835, Royal Society Herschel Correspondence (subsequently RS:HS), 21.188. References to the correspondence of Herschel and Sabine here follow the conventions used in the standard index of John Herschel's correspondence: Michael J. Crowe (ed.), David R. Dyck and James R. Kevin (assoc. eds.), *A Calendar of the Correspondence of Sir John Herschel*, Cambridge: Cambridge University Press, 1998.

20 Steven Ruskin, *John Herschel's Cape Voyage: Private Science, Public Imagination and the Ambitions of Empire*, Aldershot: Ashgate, 2004, pp. 52–57; Elizabeth Green Musselman, 'Swords into ploughshares: John Herschel's progressive view of astronomical and imperial governance', *BJHS* (1998) 31, pp. 419–436.

In the 1830s elementary meteorological observations in the British Isles were being made at a small handful of stations, such as the King's Observatory at Kew, the Royal Society's headquarters at Somerset House and the Radcliffe Observatory at Oxford. A few private individuals were also engaged in such observations, but the science was not organized on a national scale until the 1850s.[21] Calls for better and more systematic meteorological observations, coordinated across the United Kingdom and beyond, began to increase from the 1820s onwards. However, practitioners of science realized that little progress could be made while meteorological instruments and observations remained in their existing state. The shambolic state of meteorology was described bluntly by the Edinburgh natural philosopher James David Forbes in a report read to the 1832 BAAS meeting, one of a series of reports prepared for the newly founded association on the current state of various sciences. Forbes lamented that meteorology was 'an infant science', in which 'meteorological instruments have been for the most part treated like toys, and much time and labour have been lost in making and recording observations utterly useless for any scientific purpose'.[22] Forbes went further at the 1840 BAAS meeting, calling for the establishment of well-equipped 'public observatories' which would 'furnish standards of comparison, to establish the laws of phaenomena and to fix *secular*, or normal data'.[23] That same year, at the Royal Society, Forbes called for one such meteorological observatory to be set up near London. This triggered a chain of events related directly, and intimately, to the relaunching of Kew Observatory in the 1840s, as we shall see below.

Geomagnetism began to gain prestige and public importance thanks to the well-publicized work of the Prussian explorer and scientific polymath Alexander von Humboldt. Observational work was stimulated by both Humboldt and the mathematical physicist Carl Friedrich Gauss, when they began to give the subject a firm theoretical basis and demanded large quantities of accurate data with which to test their theories. They asked that these data be produced by a system of geomagnetic observatories scattered across the globe. Within a few years, such a system of observatories became a reality across the German lands and beyond, including Russia.[24] In Britain, opinion was growing that the United Kingdom was in danger of being left behind in

21 Vladimir Jankovic, 'The end of classical meteorology, *c*.1800', in G.J.H. McCall, A.J. Bowden and R.J. Howarth (eds.), *The History of Meteoritics and Key Meteorite Collections: Fireballs, Falls and Finds*, London: Geological Society, Special Publications 256, 2006, pp. 91–99, has argued that there was widespread dissatisfaction with meteorology at the beginning of the nineteenth century, because it had only recently shrugged off its Aristotelian heritage and lacked a sound theoretical basis.

22 James D. Forbes, 'Report upon the recent progress and present state of meteorology', in *Report of the First and Second Meetings of the British Association for the Advancement of Science; at York in 1831, and at Oxford in 1832: Including its Proceedings, Recommendations, and Transactions*, London: John Murray, 1833. Part of this is quoted in Katharine Anderson, *Predicting the Weather: Victorians and the Science of Meteorology*, Chicago: The University of Chicago Press, 2005, pp. 87–88; and Malcolm Walker, *History of the Meteorological Office*, Cambridge: Cambridge University Press, 2012, p. 15.

23 James D. Forbes, 'Supplementary Report on Meteorology', in *Report of the Tenth Meeting of the British Association for the Advancement of Science; Held at Glasgow in August 1840*, London: John Murray, 1841, pp. 37–156, 144. See also Walker, op. cit. (22), pp. 15–16, original emphasis.

24 John Cawood, 'Terrestrial magnetism and the development of international collaboration in the early nineteenth century', *Annals of Science* (1977) 34, pp. 551–587, 583–584.

geomagnetism.[25] The historian John Cawood notes that several prominent figures in this field – among them Forbes and also Samuel Hunter Christie, professor at the Royal Military Academy in Woolwich – began calling for a major effort to build similar magnetic observatories across Britain's imperial possessions. Yet arguably the loudest of these voices to emerge during the 1830s was that of Edward Sabine (Figure 2), who had extensive experience of making magnetic observations during Arctic naval expeditions of the 1810s and 1820s. A Royal Artillery officer who was given generous leave from military service to undertake scientific research, Sabine was, like Christie, based at the Woolwich academy. Both were prominent 'scientific servicemen' – although Sabine was not a straightforward ally of Herschel and others who wanted to see change in British science. Indeed, Herschel's friend Babbage singled Sabine out as an example of what he saw as the corruption affecting the Royal Society, on account of the improbable accuracy of his measurements and his holding of multiple scientific offices.[26]

Cawood, and also Morrell and Thackray, have claimed that the politically astute Sabine lobbied for a British magnetic survey on a global scale by putting Humboldt up to writing to the Royal Society, urging Britain to join in the worldwide magnetic campaign. They have shown how at the same time Sabine appealed to British nationalist sentiment by claiming at BAAS meetings that Britain was being overtaken in science by its European neighbours.[27] Sabine moved deftly between the Royal Society and the BAAS in pursuit of his aims: when the Royal Society was not initially interested, he took his campaign to the BAAS. Finally, he went back to the Royal Society to seek its authority in applying to the government for funds. In the event it was John Herschel who, in 1838–1839, finally secured funding for the Antarctic expedition and magnetic observatories. Fresh from his successful four-year expedition of observation at the Cape of Good Hope, Herschel was lionized as a scientific and national hero. He also had class connections at the highest level; these enabled him to lobby for the magnetic project over dinner with Queen Victoria and the prime minister, Lord Melbourne, as well as to negotiate with the aristocratic presidents of both the Royal Society and the BAAS.[28] The project that the Melbourne government eventually agreed to fund had two components: an Antarctic expedition under James Clark Ross would survey the Earth's magnetic field in the southern hemisphere and find the as yet unknown location of the southern magnetic pole (or poles[29]); meanwhile, magnetic and meteorological observations were to be taken from fixed stations at Greenwich (under Astronomer Royal George Airy), Dublin, Toronto, St Helena, the Cape of Good Hope and Van Diemen's Land (now Tasmania).

25 Carter, op. cit. (2), pp. 46, 48–49.

26 Babbage, op. cit. (12), pp. 77–102; Miller, op. cit. (5), p. 118.

27 Cawood, op. cit. (8), pp. 502–507; Jack Morrell and Arnold Thackray, *Gentlemen of Science: Early Years of the British Association for the Advancement of Science*, Oxford: Clarendon Press, 1981, pp. 356–359. However, Carter, op. cit. (2), pp. 16–17, doubts whether Humboldt was really urged by Sabine to write to the Royal Society's president.

28 Cawood, op. cit. (8), p. 507; Gunther Buttmann, *The Shadow of the Telescope: A Biography of John Herschel*, Guildford: Lutterworth, 1974, p. 121. Ruskin, op. cit. (20), pp. 58–66, makes the case that Herschel's Cape voyage led to his being appropriated as a hero of British imperialism as well as science.

29 Some geophysicists at this time, including Sabine, believed that each hemisphere might have two magnetic poles.

Figure 2. Colonel Edward Sabine at the Southampton meeting of the British Association for the Advancement of Science in September 1846. Image courtesy Royal Astronomical Society/Science Photo Library.

The observations were coordinated at Dublin by Humphrey Lloyd, in close collaboration with the Irish-born Sabine. Christopher Carter has made a strong case that Herschel's concept of a global system of 'physical observatories' may have encouraged him to persuade the government to support the fixed observatories as well as the expedition.[30]

Britain's 'first-class' observatory in Herschel's hierarchy, the Royal Observatory at Greenwich, had been founded in 1675 for a strictly utilitarian purpose: to catalogue star positions in order to find longitude at sea. Magnetism and meteorology both technically came within this remit, because of their importance to navigation. Edmond Halley (Astronomer Royal 1719–1742) had laid many of the foundations for geomagnetic research and for some years John Pond, the sixth Astronomer Royal, had run a magnetic observatory at Greenwich.[31] But Greenwich had never done any magnetic work on a large scale and by the mid-1830s it had ceased altogether. In 1835 Pond was succeeded as Astronomer Royal by the Cambridge mathematician and astronomy professor George Airy (Figure 3). Airy supported magnetic work in principle, so long as it had a navigational purpose. In 1836 he agreed to support a limited programme

30 Carter, op. cit. (2), pp. 35–42.
31 Meadows, op. cit. (6), p. 96.

Figure 3. George Biddell Airy, Astronomer Royal 1835–1881. Courtesy Royal Astronomical Society/Science Photo Library.

of geomagnetic research suggested by the Royal Society in response to Humboldt's letter of that year.[32] It is clear, however, that from very early on in Airy's time at Greenwich, he and Sabine did not get on. This animosity may have arisen because Airy saw Sabine as a rival and a challenge to his authority. It may also stem from the fact that Sabine, unlike Airy (and Herschel), was no theoretician. Sabine was fundamentally a collector of data, who had learned his art through his career in the Royal Artillery and on voyages of exploration. He had not been trained in the regime of reformed Cambridge mathematics in which theory, not empirical data-gathering, was seen as the all-important driving force in the physical sciences. Miller has noted the 'superior attitude' taken by members of the Cambridge network towards those outside this group;[33] Airy, in particular, was notorious for his insistence on training in higher mathematics as a prerequisite for a leading role in the hierarchy of the observatory.[34] In 1837 Airy refused to support the plan for the Antarctic voyage, apparently out of jealousy towards Sabine's increasing political power.[35] He did agree to take part in the Magnetic Crusade by building a wooden 'pavilion' for magnetic observations at Greenwich, one of the six 'fixed' observatories

32 S. Hunter Christie and G.B. Airy, 'Report upon a Letter addressed by M. Le Baron de Humboldt to His Royal Highness the President of the Royal Society, and communicated by His Royal Highness to the Council', *Proceedings of the Royal Society of London* (1836) 3, pp. 418–428.

33 Miller, op. cit. (5), p. 110.

34 Aubin, op. cit. (11), p. 117. The importance of Airy's Cambridge education is described in Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics*, Chicago: The University of Chicago Press, 2005, pp. 72–75.

35 Morrell and Thackray, op. cit. (27), p. 364.

envisaged in the plan, for which Airy was allocated £2,000 per year for the duration of the project. But he was never an enthusiast for the Magnetic Crusade as a whole, as is emphasized by the sour tone of his letter to a colleague in early 1840:

> I have nothing to do with the new magnetic observatories, and know nothing about them. The supreme president over them is Professor Lloyd (Trinity College Dublin) who is certainly willing and I suppose able to tell what they are to be like.[36]

In the 1860s Airy would clash with Sabine in public over meteorology and in 1871 he even proposed that Greenwich instead of Kew should be used as a Meteorological Office observing station.[37] The events of the 1840s, described below, situate these later controversies in context.

'I think at Kew': the Royal Society's proposal for a physical observatory

In June 1840, during the same summer as Forbes's second call for an improved national system of meteorological observations, the Royal Society Council communicated to the government a proposal for something remarkably similar to what was eventually established at Kew: a magnetic and meteorological observatory in the vicinity of London, run by full-time staff and established on a permanent basis. These features contrasted with the system, described above, of temporary observatories set up at Greenwich and in various outposts of the British Empire. This episode – which involved a substantial funding application to the highest level of government – has been briefly noted by Marie Boas Hall, and also Morrell and Thackray, who have put the failure of the application down to the incompetence of the pre-1847 Royal Society.[38] Carter has discussed these events in more detail, but he overemphasizes the role of John Herschel, while attaching too little importance to that of Edward Sabine and overlooking evidence that the Royal Society withdrew its application to the government after the intervention of George Airy.[39] A further examination of the primary sources reveals some evidence, hitherto unnoticed by historians, that the Royal Society may possibly have had Kew in mind as a location for the proposed observatory. Certainly the similarity of the 1840 proposal to the programme of work eventually carried out there makes this episode crucial to understanding the history of how the former King's Observatory was transformed into the Kew Observatory of the 1840s and beyond.

The immediate beginning of the episode can be traced to 4 June 1840, when Forbes, while in London, used the opportunity to launch another of his attacks on the state of British meteorology, particularly the meteorological observations still being carried out at the Royal Society's premises in Somerset House. It was resolved to form a subcommittee of the Royal Society's Committee of Physics and Meteorology with a brief to

36 Airy to W.S. Stratford, 27 February 1840, Royal Greenwich Observatory Archives, Cambridge University Library (subsequently RGO), RGO/6/675/226.

37 Anderson, op. cit. (22), pp. 143–144.

38 Marie Boas Hall, *All Scientists Now: The Royal Society in the Nineteenth Century*, Cambridge: Cambridge University Press, 1984, pp. 155–156. Morrell and Thackray, op. cit. (27), p. 350, refer to the Royal Society's application as 'a gaffe of the first order'.

39 Carter, op. cit. (2), pp. 108–113.

consider and report on this subject.[40] This convened four days later and consisted of Forbes, Sabine, battery inventor John Daniell and the meteorologist William Snow Harris. The subcommittee resolved that the observations currently being made at Somerset House were 'unavoidably unworthy of the official character which they bear' and recommended that this system be replaced with something much more ambitious: the Royal Society Council should now apply to the government 'to establish a permanent Meteorological Register in connexion with some National Institution'.[41] By the next meeting of the Committee of Physics, on 17 June, this request had changed to 'a magnetic and meteorological observatory on the same plan as those already established in other parts of the globe … in the neighbourhood of London'. The Council was 'recommended to apply to the Government to carry this purpose into immediate effect'.[42] This was duly ratified at a Council meeting the following day, Thursday 18 June, which was attended by twelve people, among them Edward Sabine. They requested that the president, Lord Northampton, bring the subject up with the prime minister, Lord Melbourne.[43]

Quite how, between 8 and 17 June, the plan was transformed from an improved version of the meteorological record kept at the Royal Society into a full-blown observatory along the lines of those contributing to the Magnetic Crusade, doing magnetic work as well as meteorology, is not clear. However, some clues can be found in a brief exchange of letters between George Airy – who was not a member of the Council or the Committee of Physics – and his old friend, the noted astronomer Richard Sheepshanks, who was also a member of the Board of Visitors to the Royal Observatory. Sheepshanks reported that while walking home from the Athenaeum club on the evening of Monday 15 June, he had been informed by Ordnance Survey director Thomas Colby that 'there was some talk of the want of magnetic observatories at Greenwich & that there was & would be a considerable difficulty as to the regulation of the magnetic observatories recently established' (those of the Magnetic Crusade). In addition to making this slight against Airy's magnetic establishment at Greenwich, Sheepshanks's informer also intimated that there was the possibility of a move to appoint a 'magnetic chief' – he named Sabine as a possible candidate – to run the magnetic observatories independently of Greenwich.[44] Sheepshanks's letter has the tone of a friendly warning to Airy, who seems to have been kept in the dark about the whole move. From this it seems possible that it was Airy's rival, Sabine, who turned the idea for an improved meteorological register into a magnetic as well as meteorological observatory. He had attended all the various committee and Council meetings between 4 and 18 June. Moreover, as director of the Magnetic Crusade and with his long experience in magnetic survey work, he was an obvious choice for the post of 'magnetic chief'.

40 Royal Society, Minutes of Committee of Physics and Meteorology, 1839–1845 (subsequently RS:CMB/284), 4 June 1840.

41 RS:CMB/284, Report of Sub-committee of Meteorology, 8 June 1840.

42 RS:CMB/284, 17 June 1840.

43 Royal Society, Minutes of Council (printed) (subsequently RS:CM), 18 June 1840.

44 Airy to Sheepshanks, 17 June 1840, RGO 6/675/227; Sheepshanks to Airy, 17 June 1840, RGO 6/675/228–230.

The application took the form, to begin with, of a deputation consisting of Lord Northampton, John Lubbock, Samuel Hunter Christie and Sabine to Downing Street on 20 June. Lubbock was a wealthy banker who had gained experience in organizing large scientific projects through research into tides earlier in the 1830s.[45] The prime minister would have been used to such a deputation applying for funds for science: the government's agreement in 1839 to finance Ross's Antarctic expedition and the magnetic observatories contemporaneous with it was partly the result of consistent lobbying by small groups of leading scientific personalities, Sabine prominent among them. John Herschel did not attend this meeting or any of the Royal Society committee or Council meetings in June 1840. He was not a Council member by this time; also, just two months earlier he had moved into his secluded country residence in Kent and so may well have been preoccupied with settling in.

The day after the meeting Lubbock reported to Herschel that the prime minister had received the visitors well and that although no decision could be made there and then, Lubbock had 'no doubt that sooner or later it [funding] will be granted'. More importantly, Lubbock explained that the Royal Society was seeking funding for 'a permanent magnetic and meteor. observatory'.[46] According to a later letter from Lubbock, the observatory would need a director plus three assistants, giving a total annual salary cost of £2,000. The cost of printing the observations, together with various other expenses such as repairs, increased the cost estimate to a minimum of £3,000 per year. Lubbock emphatically stated that in addition to magnetic work, the observatory would also carry out 'meteorological observations similar to those now made at the Royal Society but on a more extended system'; in addition, 'it may be desirable to devise also observations of the electrical state of the air & others which the Royal Society did not furnish'.[47]

Sabine, in a letter to Herschel, claimed to have been 'perfectly ignorant of what had passed at the Council' on 18 June and that Lubbock and the others had put him on the spot, forcing him to say to Melbourne that the Royal Society wanted a permanent observatory.[48] Sabine's name clearly appears on the list of those who attended the Council meeting, so he could not have been as 'perfectly ignorant' of what had happened as he claimed. As Herschel was not a Council member, he would not have had access to the minutes of its meetings and so it would appear that Sabine was not telling the truth, either in this regard or in his claim to have been put on the spot by the others. This – in addition to Sheepshanks's letter to Airy and Sabine's track record of a poor working relationship with the Astronomer Royal – suggests that there is at least circumstantial evidence of Sabine colluding in the idea of a permanent observatory independent of Greenwich. Indeed, Sabine might well have been central to the project.

45 Reidy, op. cit. (5), esp. pp. 94–121.

46 Lubbock to Herschel, 21 June 1840, Royal Society, Miscellaneous Manuscripts (subsequently RS:MM), 16.141.

47 Lubbock to Herschel, 27 June 1840, RS:MM 16.142.

48 Sabine to Herschel, 6 July 1840, National Archives, Papers of Sir Edward Sabine (subsequently TNA: BJ 3), TNA: BJ 3/26. Many letters from Herschel to Sabine in the National Archives are not listed in Crowe, Dyck and Kevin, op. cit. (19).

Exactly how George Airy came to hear about the deputation to the government is not known. Certainly he was tipped off by Sheepshanks on 17 June about the Royal Society's plans, and one member of the deputation, Lubbock, was on the Greenwich Board of Visitors. Yet by the time he wrote to Lord Northampton on 28 June Airy had more up-to-date knowledge:

> I have just heard a very vague report that a recommendation has been addressed to the Government by the Council or by a Committee of the Royal Society, to the effect that a magnetic observatory should be erected or fitted up by the Government, I think at Kew.

Airy went on to describe his 'excellent Magnetic Observatory' at Greenwich, which had been built 'at considerable expense to the Government'. Asking Northampton for further information on the proposed new observatory, he emphasized the importance of saving the government expenses that were 'absolutely unnecessary'. He added that 'the machinery of a new establishment should be dispensed with when that of an old one can be made available'.[49]

In all the extensive correspondence on the 1840 magnetic observatory episode, Airy's 28 June letter is the only evidence we have that the proposed new establishment might be at Kew, and even this does not prove that the former King's Observatory was to be used as a site. None of the minutes and correspondence contain any suggestions for a site.[50] Yet it is interesting that Lubbock's estimate details only the annual running costs and makes no mention of a suitable building or instruments. A new, permanent building would certainly have required a substantial capital investment beyond the Royal Society's means. If the Royal Society had in mind a ready-made building that was available free of charge, it is difficult to think of any building at Kew other than the King's Observatory. Moreover, there is evidence that several leading men of science had been alerted to the situation of the disused observatory in the weeks following the death in 1839 of Stephen Rigaud, Savilian Professor of Astronomy at Oxford, who had assisted with the running of the observatory. Shortly after Rigaud died the amateur astronomer William Rutter Dawes had made enquiries about applying for Rigaud's vacant position at Kew.[51]

In a second letter to the Royal Society, dated 3 July, Airy outlined an alternative plan: an extended magnetic and meteorological observatory at Greenwich, under his own direction, which would obviate the need for a new, separate establishment. Airy offered to use his existing magnetic and meteorological building and to carry out the same programme of work with fewer extra staff than the Royal Society's proposal, sharing some personnel with the main astronomical observatory. His letter was read out at a meeting of the Committee of Physics on 9 July and at a meeting of the full Council held the same day. The minutes of the Council meeting quote a total extra staff cost of £550 per annum.[52] Even if we add the costs of extra instruments and printing, the

49 Airy to Lord Northampton, 28 June 1840, RS:MM 11.145.

50 Sabine, according to Herschel, suggested that a temporary observatory might operate at Woolwich until a permanent establishment was completed. Herschel to Airy, 6 July 1840, RGO 6/675/239.

51 Dawes to Herschel, 1 April 1839, RS:HS 6.58.

52 RS:CM, 9 July 1840.

total cost of Airy's proposal was still far less than the £3,000 per year quoted in Lubbock's plan. Again Airy made much of the need to save public money: he felt that to ignore the heavy investment that had already been made in the magnetic facility at Greenwich would not be fair on the government and would also compromise future applications for scientific funding. Airy concluded his letter by asking Lubbock to 'assure the Committee that, if they determine on not accepting my offer, I shall fully understand that the inconveniences attached to it do in their estimation exceed the conveniences'.[53] Airy may have sincerely thought that the committee might find his offer of an extended magnetic observatory inconvenient, perhaps for practical reasons, Greenwich being some distance from central London. But these words might have been a polite way of sending a different signal: if the committee were to reject Airy's offer, Airy would take it that they thought that he could not do as good a job as the Royal Society. The latter interpretation is especially plausible given that, as noted above, Sheepshanks had warned him of 'talk of the want of magnetic observatories at Greenwich', which would surely have perturbed Airy. Both of Airy's letters have a clear tone of anxiety about the very idea of a separate observatory. Clearly he wanted to keep the permanent magnetic and meteorological observations under his own control and saw any separate observatory as a rival.[54]

Faced with Airy's offer to do the job more cheaply and just as efficiently, the Royal Society had no option but to back down. At the Council's request, Northampton wrote to Melbourne on or before 20 July, retracting the application made one month before, claiming that the request for a separate observatory had been due to concerns about Airy's lack of resources to do the extra work himself, but he was now pleased 'to find that we were mistaken as there can be no doubt of his entire fitness for the most satisfactory performance of such additional duties'.[55] Melbourne was no doubt relieved at the opportunity to save some £2,000 a year of public money, particularly as by 1840 he was leading a minority government. Only a year earlier his government had reluctantly agreed to support the extremely expensive Antarctic expedition and the accompanying observatories, so it must have been difficult for him to justify more spending on costly scientific projects – in this case, moreover, a permanent observatory, not a series of temporary ones. Indeed, the political situation may well explain why Sabine and others at the Royal Society acted with such haste in applying for funding in June 1840: if they did not move quickly, the government that had funded the Magnetic Crusade could fall. It would be replaced by a Tory administration under Sir Robert Peel, who had a reputation for being keen to reduce public spending.

Herschel might have agreed with the prime minister about yet another substantial application for funding so soon after the Magnetic Crusade: 'it would not only seem but be importunate to press, just at present for further grants in this direction'. Herschel strongly supported, in principle, the idea of a permanent magnetic and meteorological

53 Airy to Lubbock, 3 July 1840, reprinted in RS:CM, 9 July 1840.

54 Morrell and Thackray, op. cit. (27), p. 350.

55 RS:CM, 9 July 1840; Northampton to Lord Melbourne, RS:MM 16.145, undated, but enclosed with letter from Roberton to Herschel, 20 July 1840, RS:MM 16.144.

observatory: he thought that such an institution would 'do honour to the country & confer great benefits on science'. According to Herschel, even more important than a physical observatory was what he termed an 'experimental Institute or College', which would do more general standardization work, such as determining atomic weights and electrical constants. Yet most tellingly for the future of Kew Observatory, Herschel thought that 'the proper locale of a physical observatory should be on the Sea Coast – 1st for observation of the tides – 2d as a centre of departure of a general coastland-line – to be ultimately referred to the mean-sea level at that spot as a probably invariable standard'[56] – goals that tied in perfectly with Herschel's friend Whewell's contemporary tidal research.[57] So it would appear that Herschel had good scientific reasons for not supporting Kew or anywhere else near London as a good location for a physical observatory: this was obviously the wrong place for a coastal observatory. Moreover, the vision expressed here of an observatory at a coastal location, measuring physical constants as well as making magnetic and meteorological observations, is entirely consistent with Herschel's earlier ideas for physical observatories in the *Preliminary Discourse* and his October 1835 letter to Beaufort.

Thus the Royal Society's failed application for a new government-funded observatory was likely not a 'gaffe', but rather a carefully planned manoeuvre by Sabine that was foiled only by Airy and his intelligence network. Before long, however, there would be a new possibility of an observatory at Kew and this time Airy would be powerless to do anything about it.

Sabine, science and politics: Kew Observatory and the Royal Society, 1841–1842

On 5 February 1841, Sabine wrote to Herschel with news from Francis Beaufort: a government official had told Beaufort that the Kew Observatory building was in such excellent condition that it would not be pulled down, as had been intended. The official had asked Beaufort if he could think of any use for it. According to Sabine, Beaufort had suggested a magnetic observatory, to which the official had replied in encouraging terms. Sabine went on to say, 'altho' the arrangement relative to Greenwich seems to have forestalled the use that could so well have been made of it as a Magnetc. & Meteor. Observatory, it seems a very suitable place for your ulterior project of a Physical Observatory'.[58] This suggests that the availability of the building may not truly have been news to Sabine. Beaufort had certainly been aware for some time that the building was disused: as early as 1839 he had reported to Herschel that it was to be pulled down.[59] This adds further weight to the idea that Sabine, at least, had had the Kew building in mind in 1840.

Nothing further then happened until 24 June. It may have been Sabine, who attended the meetings of the Committee of Physics and full Council that day, who informed the

56 Herschel to Airy, 6 July 1840, RGO 6/675/239, underlining in original.
57 Reidy, op. cit. (5), pp. 277–278.
58 Sabine to Herschel, 5 February 1841, RS:HS 15.123.
59 Beaufort to Herschel, 17 July [1839], RS:HS 3.40.

Royal Society that Kew Observatory was being made available by the government, apparently free of charge. In any event, the Committee of Physics passed a resolution in favour of acquiring it.[60] The Council duly adopted the resolution and once again the president was requested to make an application to the government,[61] not for funding this time, but only for possession of the building. But Northampton does not appear to have done this and instead there was another long delay. Nearly five months later the Council asked the Committee of Physics to report back as to 'what specific scientific purposes it would be desirable to appropriate the building formerly occupied by the Observatory at Kew' for and to suggest 'what would be the probable annual expense of applying it to such purposes'.[62] The Committee of Physics duly appointed a subcommittee, consisting of Herschel, Sabine and Charles Wheatstone (professor of experimental philosophy at King's College London since 1834), to draw up the report for the Council. These three met on 18 December, though their resulting report was not read to the Council until 10 February 1842. The report gave a mixed verdict on the observatory. To begin with, the subcommittee thought that Kew was not suitable for 'any regular and systematic course of physical observations' by the society, due to its 'peculiar restrictions as to access and inhabitancy and other circumstances'. The report did, however, recommend some other uses for the building, such as a depository for Royal Society instruments and a place for comparison of instruments such as pendulums. The estimated costs were a salary of about twenty-seven pounds per annum for a caretaker and a mere five pounds per annum for maintenance – a far cry from the £3,000 annual budget proposed for the 1840 observatory and even the £550 for Airy's extended 'Mag. and Met.' establishment at Greenwich.[63]

That the report dismissed Kew as unsuitable for regular, systematic observations may at first seem surprising, given that the building would be used for precisely that purpose later in the 1840s. We do know, however, that the report was drafted by Herschel,[64] who, as we have seen, would not have considered Kew a good site for a physical observatory. Probably no one at this time had greater authority in the physical sciences than Herschel and in a subcommittee of just three people Sabine and Wheatstone may have had no choice but to defer to his wishes. But the main reasons why the subcommittee decided not to use Kew as a magnetic and meteorological observatory – and, indeed, why the Council did not immediately go ahead with the proposal to acquire the building – may well have been financial and political. Given that the Council had specifically asked about the 'annual expense' and that the total cost of the watered-down proposal amounted to little more than thirty pounds, it is likely that a full-scale observatory, complete with staff and instruments, would have been too large an annual charge on the Royal Society's funds.

60 RS:CMB/284, 24 June 1841.
61 RS:CM, 24 June 1841.
62 RS:CM, 11 November 1841.
63 RS:CM, 10 February 1842. The report is reproduced verbatim in Scott, op. cit. (3), pp. 48–49. The original manuscript report is in RS:MM 16.189.
64 Sabine to Herschel, 13 January [1842], RS:HS 15.136.

Herschel himself may well have shared the general consensus about costs: just before the December 1841 subcommittee meeting, he confessed to Sabine that he thought Kew Observatory 'likely to cause some degree of embarrassment' to the Royal Society.[65] If Kew were to cost £3,000 a year to run, the Royal Society would once again have had to apply for a hefty government grant little more than eighteen months after its retreat in 1840. Also, Herschel believed that large-scale physical observatories of the sort envisaged in the *Preliminary Discourse* should be run by the government, not scientific societies: much later, he expressed the belief that to take responsibility for an observatory or any other permanent institution would 'deprecate' the Royal Society.[66] To make matters worse, by the end of 1841 the political climate had changed: Melbourne's Whig government had finally fallen and had been succeeded by the Tories under Peel. Herschel, for one, considered the outlook for science under the new government 'exceedingly ill-omened' and bemoaned 'the good old Tory feeling of hatred and contempt for Science and its followers'.[67]

It is also possible that Sabine, who had ruthlessly used both the Royal Society and the BAAS in his lobbying campaign for the Magnetic Crusade, agreed to watering down the proposal in order to steer the Royal Society towards rejecting the government's offer. He may have done this with the ulterior motive of making the observatory available to the BAAS, which he might well have thought would be more receptive towards it. We do not have any documentary evidence concerning Sabine's and Wheatstone's motives, however. All we know is that at the Council meeting exactly one month later, with no reasons recorded other than consideration of the subcommittee's report, it was decided that 'it does not appear to the Council to be expedient for the society to occupy the Observatory at Kew'. The Council requested the treasurer, Lubbock, to communicate this decision to the government.[68]

The British Association: founding the 'establishment' at Kew

On 28 March 1842, just eighteen days after the Kew building was finally rejected by the Royal Society, the possibility of acquiring it for the BAAS was formally raised at a BAAS Council meeting. The BAAS noted the Royal Society's rejection and commented 'that if an application should appear desirable on the part of the British Association, it was necessary that it should be made without delay'. Sabine and Wheatstone were both present at this meeting. At the 28 March meeting Wheatstone, who had been on the Royal Society subcommittee that had rejected Kew as a site for systematic observations, now read a statement 'of several important objects in the Physical Sciences' which the Kew building would offer to BAAS members 'in the prosecution of experimental inquiries'.[69]

65 Herschel to Sabine, 2 December 1841, TNA: BJ 3/26.

66 Herschel to Murchison, 15 February 1850, Harry Ransom Humanities Research Center, the University of Texas at Austin (subsequently TxU), H/L-26.11 (L0269).

67 Herschel to [Sabine], 5 September 1841, TNA: BJ 3/26.

68 RS:CM, 10 March 1842.

69 British Association, Minutes of Council, 1841–1857, Bodleian Library, Oxford, Ms. Dep. B.A.A.S. 18 (subsequently BAAS:CM), 28 March 1842.

Wheatstone appears to have drawn up this document,[70] and it is apparent from it that the proposed programme of 'experimental inquiries' was very different from the Royal Society's watered-down proposal for an instrument store and small-scale standardization centre. It stated unequivocally, 'It is proposed to establish, in connexion with the British Association, a Physical Observatory' in the Kew building. The proposed uses for this physical observatory fell under seven broad headings:

1 a repository 'and place for occasional observation and comparison' of newly invented meteorological instruments,
2 a place for the construction and trial of new self-recording meteorological instruments,
3 a repository of standard instruments with which people could compare their own instruments,
4 a place where magnetic instruments currently used 'in the various magnetic observatories' could be kept to enable people to learn how to use them,
5 the setting up of apparatus for research into atmospheric electricity,
6 a room for experimental work on optical astronomical instruments (an echo here of David Brewster's 1832 call for a large-scale optical laboratory) and
7 a collection of measuring instruments 'for the purpose of obtaining accurate quantitative results'.[71]

The 28 March Council meeting quickly approved the proposal.[72] On 16 May a formal application was sent to the prime minister and just ten days later the government sent an official letter to the BAAS, to the effect that the queen had given her permission for the association to take possession of the building.[73]

The contrast between the response of the Royal Society and that of the BAAS to the Kew offer is dramatic: whereas the Royal Society's discussions took nine months, the BAAS made the decision at the same meeting at which the availability of the building was announced and took possession of the observatory just over two months later. This further strengthens the possibility that Sabine had given up on the Royal Society as a probable lost cause long before the formal rejection on 10 March – and even that he had prepared the ground with colleagues on the BAAS Council well before the meeting on 28 March. But without a record of what was actually said at the meetings we cannot know for sure. Certainly there is no record in the BAAS Council Minutes of any discussion about Kew Observatory in the months prior to 28 March 1842.

The acquisition of the building was duly announced to the membership and wider public at the Annual Meeting in Manchester on 22 June and it was approved with no recorded dissent. The meeting also voted £200 to 'be placed at the disposal of the

70 Wheatstone to Sabine, 24 June 1842, Royal Society, Correspondence of Sir Edward Sabine (subsequently RS:Sa) 1779.
71 BAAS 1842 'prospectus' for Kew Observatory, reprinted in Scott, op. cit. (3), pp. 50–52.
72 BAAS:CM, 28 March 1842.
73 Earl of Lincoln to Lord Francis Egerton (BAAS), 26 May 1842, reproduced in BAAS:CM, 2 June 1842.

Council for upholding the establishment in the Kew Observatory'.[74] Not only was this a very different sum of money from the approximately thirty-two pounds a year suggested by the Royal Society; the phrase 'upholding the establishment' is suggestive of a permanent, or at least long-term, institution. And indeed, the BAAS voted similar sums of money for Kew over the next few years: £200 in 1843 and £150 in 1844 and 1845.[75] Most importantly, this annual vote was not a government grant but was from the BAAS's own limited resources, which further underlines the commitment given to the project by Sabine, Wheatstone and the others on the BAAS Council. In the early to mid-1840s the BAAS made no proposals to apply for government funding for Kew; nor is there evidence of any such proposals being considered at this stage. It was purely a privately funded project.

John Herschel seems to have played no part in the association's acquisition of Kew Observatory. In fact, the BAAS made more than one appeal to Herschel's authority during this time. This was certainly the tone of BAAS general secretary Roderick Murchison's letter to Herschel of June 1842, imploring him to attend the Manchester meeting: 'On this occasion your presence would be doubly useful in helping us to give birth to the child which you have so large a share in creating – the Kew Observatory of Physical Science'.[76] Herschel did attend this meeting, but he did not become personally involved in any BAAS committees on Kew. In reply to a letter from Wheatstone, he expressed no particular disagreements with the project and thought that the observatory would be useful for experimental work, but was rather cool towards the idea as a whole. It seemed to Herschel 'not very clear' that the British Association's plan for Kew as a physical observatory would work. He doubted whether the BAAS had adequate funds to support a physical observatory doing long-term, systematic observations.[77] We should remember, however, that he might well have had the same doubts about the Royal Society wanting such a heavy annual budget commitment. Herschel might have been 'prophetically right' in his doubts about the BAAS's ability to pay for such a long-term programme.[78] Yet as in 1840 he had qualms about the location of the observatory site for scientific reasons: he now questioned whether 'the locality is fitted' for such purposes.[79]

But perhaps the main reason why Herschel did not want to become too closely associated with Kew was that he was by now reluctant to become heavily involved in the management of large scientific projects generally. Always preferring to do research in a private capacity, without any obligation to larger organizations, or committing himself to regular, time-consuming work, Herschel was now fifty years old. He was eager to settle down to the mammoth task of writing up the results of his astronomical

74 *Report of the Twelfth Meeting of the British Association for the Advancement of Science, held at Manchester, 1842*, London: John Murray, 1843, p. xxii.

75 BAAS:CM, 25 September 1844; BAAS:CM, 17 June 1845; *Report of the Fifteenth Meeting of the British Association for the Advancement of Science, held at Cambridge, 1845*, London: John Murray, 1846, p. xviii.

76 Murchison to Herschel, 16 June 1842, RS:HS 12.385, original emphasis.

77 Herschel to Wheatstone, 17 June 1842, TNA: BJ 3/26.

78 Morrell and Thackray, op. cit. (27), p. 522.

79 Herschel to Wheatstone, 17 June 1842, TNA: BJ 3/26, Herschel's emphasis.

observations at the Cape of Good Hope while he still had time and physical energy remaining. In the same June 1842 letter to Wheatstone, he expressed the wish to confine himself to 'general advocacy' of scientific projects except for those that he felt particularly passionate about, 'now … that I can calculate on but very few years more of scientific efficiency'.[80]

Regardless of Herschel's views, the association lost little time in preparing the newly acquired building for work. In July 1842 a committee was appointed 'to superintend for the present the arrangements at the Kew Observatory'. This consisted of Wheatstone, the two general secretaries of the association (Murchison and Sabine) and the treasurer.[81] In charge of the day-to-day work at the observatory for its first ten years under the BAAS was Wheatstone's fellow telegraphy pioneer, Francis Ronalds. According to Ronalds himself (1860), he was offered the post by the BAAS.[82] It is possible that Wheatstone suggested Ronalds's appointment, for as early as November 1842 Ronalds had written him a long letter, setting out his objectives for the Kew 'project', including electrical apparatus and meteorology.[83] It is an indication of the association's limited budget that, unlike all the later superintendents at Kew, Ronalds's post had no salary attached.

In January 1843, the BAAS Council announced that it had employed a Mr John Galloway at an annual salary of £27 7s 6d to take care of the observatory, to assist researchers 'and to obey to the best of his ability whatever instructions he may receive from time to time'. Galloway was assigned living accommodation in the building. From the beginning he was much more than a caretaker. From 1 November 1842, he used instruments purchased by the BAAS to keep a 'meteorological register', a manual record of meteorological observations.[84] We have no formal record of Galloway's background or what, if any, scientific training he possessed, but in his 1844 report to the BAAS Ronalds describes a new anemometer, 'the invention of Sergeant Galloway, who made nearly the whole instrument'.[85] Given that Sabine employed soldiers to perform the day-to-day instrument readings in his colonial magnetic observatories, it is quite possible that Galloway was a soldier or ex-soldier recruited by Sabine from among his subordinates in the Royal Artillery at Woolwich. This possibility is greatly strengthened by Ronalds's earlier remark to Wheatstone that 'I suppose that the Artillery Sergeant could do some of the heavier work which might be wanted'.[86] This increases the likelihood that Sabine was central to the whole project. It is also an example of military personnel being used

80 Herschel to Wheatstone, 17 June 1842, TNA: BJ 3/26.

81 BAAS:CM, 14 July 1842.

82 Francis Ronalds to Carter, 21 February 1860, University College London Archives, GB 0103 MS ADD 206. I am grateful to Beverley Ronalds for this source.

83 Ronalds to Wheatstone, 16 November 1842, Institute of Engineering and Technology, Papers of Sir Francis Ronalds, notes, reports and copy correspondence relating to Ronalds's time at the Kew Observatory, journal of copy letters and diary entries (subsequently IET S.C.Mss.1/4/17b).

84 BAAS:CM, 12 January 1843.

85 Francis Ronalds, 'Report concerning the Observatory of the British Association at Kew, from August the 1st, 1843, to July the 31st, 1844', in *Report of the Fourteenth Meeting of the British Association for the Advancement of Science, held at York, 1844*, London: John Murray, 1845, pp. 120–131.

86 Ronalds to Wheatstone, 16 November 1842, IET S.C.Mss.1/4/17b.

as low-cost labour to gather scientific data and even build their own equipment, as happened earlier in the 1830s when Coastguard officers were used to take data for William Whewell's tidal research.[87]

According to Ronalds's 1844 report, the meteorological record begun by Galloway measured temperature, pressure, humidity, rainfall, wind speed and wind direction. Observations were made at least twice a day, 'almost exclusively by Mr. Galloway'.[88] It is notable that from the beginning, high-quality instruments were used. When they could not be afforded, they were borrowed, as with a 'mountain' (portable) barometer 'lent by Colonel Sabine until we can afford the expense of a standard instrument'. Even more important, from the beginning of his reports Ronalds showed a critical attitude to both his instruments and his observations. Where possible, instruments of different types were used at the same time and results compared. Those whose accuracy was found to be wanting were discarded. With regard to the observations, Ronalds praised Galloway's efforts, but reflected that 'had our habits and qualifications been always adequate to the attainment of extreme accuracy, our instruments and other means would have been far from being so'.[89] This comment suggests that, according to Ronalds, the instruments were only as good as the less-than-perfect observers who used them. It is clear that Ronalds was trying to do meteorology to the highest possible standard of accuracy, perhaps higher than had hitherto been achieved anywhere else. In its first years under the BAAS, Kew was also the site of some pioneering self-recording instruments, such as Wheatstone's 'Electro-magnetic Meteorological Register', which automatically recorded 1,008 observations per week. Wheatstone's six-foot-high device must have been a spectacular example of instrumental innovation and prestige at Kew,[90] but it did not replace traditional meteorological observations and instruments. Rather, it was experimental in nature. Although experimentation was clearly on the agenda, Kew was becoming at least as much a central meteorological observatory as it was an experimental station.

From the summer of 1843, Ronalds and Galloway also began to make observations of atmospheric electricity, which had been stated as a clear objective in both the 1840 proposal and the 1842 prospectus. These electrical observations were recorded along with the traditional meteorological readings and take up about half of the columns of the meteorological journal as reproduced in the 1844 annual report. The observations were made in the observatory dome; according to Ronalds's 1844 report, the instruments used to make the measurements were attached to the base of a conductor, a sixteen-foot-long tube of copper placed vertically so that it protruded twelve feet above the dome's outer surface (Figure 4). Observations of the intensity of electric charge were made four times a day, and it was further noted whether this was positive or negative. In addition, a maximum and minimum charge was noted, based on hourly observations between 12 noon and 10 p.m.; an attempt was also made to relate the

87 Reidy, op. cit. (5), pp. 169–172, 281–293.
88 Ronalds, op. cit. (85), p. 131.
89 Ronalds, op. cit. (85), p. 131.
90 Anderson, op. cit. (22), pp. 92–93.

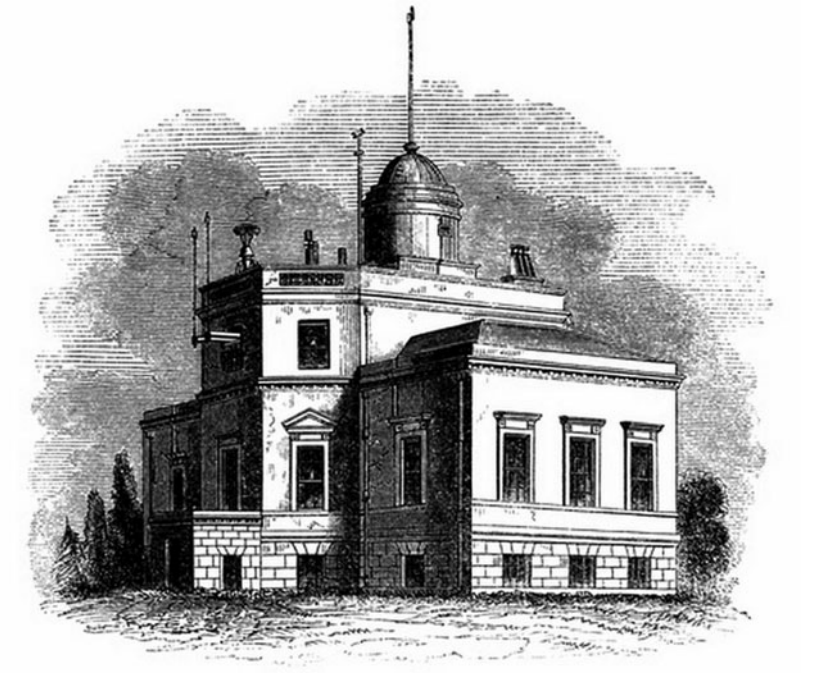

Figure 4. An engraving of Kew Observatory made in 1851. The vertical conductor used for observations of atmospheric electricity is clearly visible, protruding from the top of the dome. Courtesy Royal Astronomical Society/Science Photo Library.

electric charge to the type of weather.[91] These electrical observations must have made for a demanding routine, for in addition to the meteorological readings, Galloway had to read the electrical instruments 'every day from half an hour before sunrise until night'. In return for this his salary was increased to one guinea per week, or almost double his original remuneration,[92] which demonstrates how seriously the BAAS, with its limited budget, was taking this work.

On a first reading, Wheatstone's 1842 prospectus – unlike the 1840 proposal – makes no provision for magnetic observations at Kew. It merely mentions that the observatory could be used as a place for the storage of magnetic instruments and for training in their usage. But the prospectus clearly did not preclude systematic observational work, for even the electrical observations are described only as 'experiments on atmospheric electricity'.[93] In any case, the electrical observations had an important connection with geomagnetism, for the 1843 annual report noted that atmospheric electricity had been given priority 'on account of its importance in connexion with the system of simultaneous magnetic and meteorological observations now making on various points of the

91 Ronalds, op. cit. (85), pp. 121–126, 130–131.
92 BAAS:CM, 1 December 1843.
93 Scott, op. cit. (3), p. 51.

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earth's surface, in the recommendation of which the Association has taken so prominent a part'.[94] Thus from the very beginning, Kew Observatory was playing a direct part in the Magnetic Crusade. Moreover, as early as November 1842, in a list of meteorological instruments he said were needed at Kew, Ronalds had asked for 'Dipping & Variation needles',[95] and his 1844 report includes an as yet empty column in his meteorological register 'intended for the deviations of the electro-magnetic needle'.[96] This strongly suggests that at least basic magnetic observations were being planned for the near future, perhaps when funding for instruments was forthcoming. Sabine may even have applied for a grant from the BAAS for magnetic work at Kew in 1842 – something not mentioned in the prospectus – for a private letter from Wheatstone mentions a 'proposition for the grant for the magnetic instruments'.[97] Magnetic observations were introduced to Kew gradually in the mid-1840s; they were initially made with self-recording instruments devised by Ronalds, contemporaneously with similar instruments built for Greenwich by Charles Brooke.[98] It seems, therefore, that the 1842 prospectus, with its emphasis on experimentation, did not prevent Sabine from slipping his beloved magnetic observations into Kew by the back door.

Conclusion

By the mid-1840s, the BAAS Council could claim to have established at Kew a 'physical observatory' dedicated to meteorological observation, work in atmospheric electricity and experiments with new types of self-recording instrument; indeed, as we have seen, Wheatstone used precisely this phrase in his 1842 prospectus for the observatory. We can also see that only up to a point was it a physical observatory of the kind proposed by John Herschel. While aspects of it – meteorology, atmospheric electricity and experimental work – were certainly Herschelian, it was clearly not the kind of institution that Herschel had in mind. Herschel's idea of a physical observatory would also have incorporated fundamental work such as tides and sea levels and, just as importantly, would have been a government institution, not privately run by the BAAS (or the Royal Society). This goes a long way towards explaining why Herschel was equally lukewarm about Kew with both the Royal Society and the BAAS: the building at Kew was in entirely the wrong location for his idea of a physical observatory and both organizations, he felt, were incapable of supporting such an institution financially.

There is a strong case for saying that the prime mover behind the whole Kew project, at every stage from June 1840 onwards, was not Herschel but Sabine. As we have seen, Sabine had a motive: to wrest control of the magnetic and meteorological observations

94 *Report of the Thirteenth Meeting of the British Association for the Advancement of Science, held at Cork, 1843*, London: John Murray, 1844, p. xxxix.

95 Ronalds to Wheatstone, 16 November 1842, IET S.C.Mss.1/4/17b.

96 Ronalds, op. cit. (85), pp. 130–131.

97 Wheatstone to Sabine, 24 June 1842, RS:Sa/1779.

98 BAAS:CM, 9 August 1848. Self-recording magnetic instruments were up and running at Greenwich by mid-1848; see *Report of the Astronomer Royal to the Board of Visitors, Read at the Annual Visitation of the Royal Observatory, Greenwich, 1848, June 3*, London: Royal Observatory Greenwich, 1848, pp. 9–10.

from his arch-rival, Airy. The hand of Sabine is visible time and again throughout the story. That Sabine was behind the 1840 proposal is strongly suggested by the moves behind the scenes in the summer of that year. It was Sabine who, early in 1841, first let the Royal Society know of the availability of the Kew Observatory building and who then, seeing the society's lack of enthusiasm, was one of those who took the project to the BAAS, perhaps deliberately steering it towards the latter organization. At any rate, Kew in the mid-1840s was a permanent 'establishment' (the BAAS's own words) and was essentially a meteorological observatory, having as a central part of its programme observations of atmospheric electricity tied to the Magnetic Crusade. In other words, it fulfilled an agenda consistent with the 1840 proposal for a permanent magnetic, meteorological and electrical observatory independent of Greenwich, as far as was possible in the absence of government funding. Indeed, some years later Sabine confessed privately to the meteorologist and astronomer William Radcliff Birt that the government, by means of 'observations at Greenwich', had 'undertaken to do, and in the most efficient manner what we wished to have done at Kew but what we have never been able to accomplish except in a degree very inferior to our wishes'.[99] Sabine, 'the artful dodger of the British scientific establishment',[100] had succeeded in manipulating both the Royal Society and the BAAS towards his own agenda. While it is easy to see the establishment of an alleged 'physical observatory' at Kew as a straightforward realization of Herschel's dream, in reality the story is more complex.

99 Sabine to Birt, 25 May 1848, RS:Sa.1176.

100 Nathan Reingold, 'Sabine, Edward', in Charles Coulston Gillespie (ed.), *Dictionary of Scientific Biography*, vol. 12, New York: Charles Scribner's Sons, 1975, pp. 49–53.