Abstract. To those not engaged in the practice of scientific research, or telling the story of this enterprise, the image of empirical observation may conjure up images of boredom more than anything else. Yet surprisingly, the profoundly uninteresting nature of research to many science workers and readers in history has received little attention. This paper seeks to examine one moment of encroaching boredom: nineteenth-century positional astronomy as practised at leading observatories. Though possibly a coincidence, this new form of astronomical observation arose only a few decades before the English term ‘boredom’, for which the Oxford English Dictionary has no record prior to 1850. Through examining forms of observatory labour and publications, I offer in this paper an example of how boring work and reading helped shape a scientific discipline.

The grammarian of the laboratory is often the victim of his trade. He staggers forth from his workshop, where prolonged concentration, on a mechanical task, directed to a provisional and doubtful goal, has dimmed him of his faculties; the glaring motley of the world, bathed in sunlight, dazzles him …

Sir Walter Alexander Raleigh

Ah, there’s nothing more exciting than science. You get all the fun of sitting still, being quiet, writing down numbers, paying attention … Science has it all!

Principal Seymour Skinner

To those not engaged in the practice of scientific observation or telling the story of this enterprise, the thought of empirical research may conjure up images of boredom more than anything else. Long hours spent observing the habits of genetically identical mice, the artefacts of invisible particles, or the slow and patient movement of the stars can hardly bring forth immediate sensations of excitement or pleasure. Neither does the patient accumulation and calculation of data gathered from experiment often stir the imagination. Studies of American high-school science classes show trouble in attracting
student interest, and despite the high praise many in the public have for scientists, they are rarely seen as engaging figures.\textsuperscript{3} Specialized journals for science educators are filled with remedies for uninteresting class lessons and, outside the classroom, few people follow, let alone understand, recent developments in science or even theories fully accepted by the scientific community.\textsuperscript{4} Scientists themselves readily admit that their daily tasks are far from the excitement of discovery and debate.\textsuperscript{5} The quote from \textit{The Simpsons}, drawn from when the show was both a popular and a critical success, is but one piece of evidence that core activities that comprise empirical research – ‘sitting still, writing down numbers, and paying attention’ – are received by the public with yawns at best and active unease at worst.\textsuperscript{6}

Why \textit{does} the practice of science often entail boring jobs while simultaneously boring great segments of its intended public? In this paper I seek to sketch a possible answer to a question which historians of science have not often posed but which may merit asking.\textsuperscript{7} Certainly, debates have taken place over what has defined ‘public’ science,\textsuperscript{8} but few of these have focused on how the seemingly dull aspects of science have been responsible for public disengagement.\textsuperscript{9} Other features of scientific practice have been studied in depth, from the physical pains endured by scientists to the sometimes odd and absurd devotion of practitioners, but rarely boredom.\textsuperscript{10} While this lacuna is regrettable, it may not be surprising. The two dominant groups who have written the history of science, scientists and historians of science, have been composed of individuals who take the

\textsuperscript{3} On the difficulty of engaging students see Margaret L. Hilton, Susan R. Singer and Heidi A. Schweingruber (eds.), \textit{America’s Lab Report: Investigations in High School Science}, Washington, DC: The National Academies Press, 2005, p. xii. On general boredom in the classroom see John Tranter, ‘Biology: dull, lifeless, and boring?’, \textit{Journal of Biological Education} (2004) 38, pp. 104–105.

\textsuperscript{4} Press release, ‘Public praises science; scientists fault public, media’, Pew Research Center, 9 July 2009, available at www.people-press.org/2009/07/09/public-praises-science-scientists-fault-public-media, accessed 9 July 2012.

\textsuperscript{5} Stephen Battersby, ‘Now that’s what I call boring’, \textit{New Scientist} (2009) 204, pp. 58–61.

\textsuperscript{6} In the same episode, Bart’s participation in the scientific enterprise is even seen as punishment. The task was imposed because Bart had foiled Skinner’s earlier attempt to float a weather balloon. In Skinner’s words, ‘Because you have impeded science, you must now aid science.’

\textsuperscript{7} This is not to confuse boredom with the merely mundane. Latour and Galison have argued persuasively for the role of quotidian practice in resolving scientific problems in Peter Galison, \textit{How Experiments End}, Chicago: The University of Chicago Press, 1987; Bruno Latour, \textit{Laboratory Life: The Social Construction of Scientific Facts}, Beverly Hills: Sage Publications, 1979. Such works builds on Kuhn’s understanding of ‘normal science’ in Thomas Kuhn, \textit{The Structure of Scientific Revolutions}, Chicago: The University of Chicago Press, 1962.

\textsuperscript{8} Most recently in the ‘Focus’ section of \textit{Isis} (2009) 100(2). In particular see Andreas W. Daum, ‘Varieties of popular science and the transformations of public knowledge: some historical reflections’, pp. 319–332; Ralph O’Connor, ‘Reflections on popular science in Britain: genres, categories, and historians’, pp. 333–345; Katherine Pandora, ‘Popular science in national and transnational perspective: suggestions from the American context’, pp. 346–358; and Jonathan R. Topham, ‘Introduction’, pp. 310–318.

\textsuperscript{9} The phenomenon has recently been examined in Theodore M. Porter, ‘How science became technical’, \textit{Isis} (2009) 100, pp. 292–309.

\textsuperscript{10} Rebecca Herzig, \textit{Suffering for Science: Reason and Sacrifice in Modern America}, New Brunswick, NJ: Rutgers University Press, 2005. Jennifer Michael Hecht, \textit{The End of the Soul: Scientific Materialism, Atheism, and Anthropology in France}, New York: Columbia University Press, 2003.
interestedness of science for granted. Consequently, one of the primary features of this history goes unnoticed.\textsuperscript{11}

Though it is beyond the limits of this paper to explore how boredom manifested itself in multiple forms of scientific research – and the consequences both for the producers and for products of boring science – some understanding may be gained by examining the development of one particular kind of scientific practice: positional astronomy of the nineteenth century.\textsuperscript{12} Positional astronomy was a model of boredom in action, and perhaps an ironic one, because the practice of observing the skies had once been considered the most exciting endeavour of the human mind. Astronomy had historically been treated by natural philosophers and intellectuals as the model of science, a part of the medieval quadrivium and the pinnacle of Comte’s positivist hierarchy. But in the nineteenth century, in the time between William Herschel’s landmark discoveries and the rise of spectrography and astrophysics, astronomy was characterized by two core activities which had little relation to the discipline of old: long and consecutive hours of recording fixed-star positions, and the tedious and time-consuming practice of reducing these observations. Astronomy did not cease to be productive – or in the case of the discovery of Neptune or of new moons, even rousing – during this period, yet based on descriptions of observatory work and complaints of public apathy, the labour and products of the discipline were rarely exciting. As these accounts attest, astronomy as practised in the nineteenth-century professional observatories was at the vanguard of boredom.

To explore this phenomenon, I begin by describing the simultaneous development of modern boredom and positional astronomy in Europe and America during the early nineteenth century. The increased routinization of observatory practice was the result not only of new forms of mechanical technology, particularly the chronograph, but also of organizational technologies: it required new techniques as well as new observers.\textsuperscript{13} At the forefront of both of these developments were observatory directors like George Biddell Airy, Adolphe Quetelet and Friedrich Bessel, who simultaneously revolutionized the practice of astronomy and created entirely new kinds of scientific labour that demanded patience, discipline and attentiveness in place of open-ended observation,

\textsuperscript{11} Notably, the most extensive examination of boredom in science has come from the field of anthropology. The most sustained examination of the topic I have found is located in a PhD thesis by María Alejandra Sánchez-Vázquez, ‘Scientific indifference: understanding science in a Mexican planetarium’, University of Manchester, 2004, Th25022, pp. 91–114. The dissertation can be found at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.121.559&rep=rep1&type=pdf, accessed 9 July 2012. In reference to another aspect of nineteenth-century astronomy, it has been suggested that ‘[p]ainstaking (and often boring) experimentation, observation, and data gathering are … important components of science’. John G. Burke, Cosmic Debris: Meteorites in History, Berkeley: University of California Press, 1991, p. 3.

\textsuperscript{12} Nineteenth-century commentators had many names for these activities, including positional, computational, observational or pure astronomy, but all referred to the practice of creating accurate ephemerides.

\textsuperscript{13} It should not be assumed that the new observing technologies forced changes in observing techniques. Rather the activities, organization and material means of observing all underwent significant changes together. On this development in the broader field of observation see Jonathan Crary, Techniques of the Observer: On Vision and Modernity in the Nineteenth Century, Cambridge, MA: MIT Press, 1990, pp. 5–9.
reflection and creativity.\textsuperscript{14} In the first two sections I investigate the new forms of observing and computing in the observatory for evidence of boredom.

In the second half of the paper I look outside the profession for more evidence of boredom. Nineteenth-century European science was characterized by what has variously been called ‘professionalization’, ‘standardization’ or ‘specialization’, when the former eclectic groups of gentleman scientists ceded authority to powerful state-run organizations and the sciences began to differentiate themselves from other forms of intellectual activity.\textsuperscript{15} Such a process, whatever its name, often eliminated astronomy as a meaningful practice for those outside the observatory walls. Therefore, after investigating the labour of positional astronomy, popular presentations of astronomy will be investigated to explain what it was that the public was missing. Most, if not all, successful popularizers—including formally trained astronomers like Richard Proctor and Camille Flammarion—professed a hostile vision of the astronomy practised in the observatory. Their efforts were in turn treated with laughter and derision by what one might anachronistically call the ‘scientific community’. Central to the process of drawing the line between these groups was whether the material could be made interesting to the general population. When science became boring, it turns out, it also became science.

It might initially be suspected that a boring workplace and a bored public would obstruct the development of positional astronomy, and, indeed, many early nineteenth-century astronomers worried that the field would not progress with an apathetic public and disgruntled workers. Yet, as examined in the concluding section of the paper, such reservations may have been unfounded. As the legacy of boredom in positional astronomy demonstrates, the virtues of soporific scientific research have long been underappreciated.

The boredom of observing: a new feeling meets an old calling

The intellect of the individual was stunted for the benefit of the work. The astronomer became a mere operative.\textsuperscript{16}

\textsuperscript{14} A nice summary of this development can be found in Robert W. Smith, ‘Remaking astronomy: instruments and practice in the nineteenth and twentieth centuries’, in Mary Jo Nye (ed.), \textit{Cambridge History of Science, vol. 5: The Modern Physical and Mathematical Science}, Cambridge: Cambridge University Press, 2002, pp. 154–173, 154–156. See also Mari Williams, ‘Beyond the planets: early nineteenth-century studies of double stars’, \textit{BJHS} (1984) 17, pp. 295–300; O.B. Sheynin, ‘On the history of the statistical method in astronomy’, \textit{Archive for the History of the Exact Sciences} (1984) 29, pp. 151–199.

\textsuperscript{15} While the literature of professionalization is large, a representative sample would include for England Jack Morrell and Arnold Thackery, \textit{Gentleman of Science: Early Years of the British Association for the Advancement of the Sciences}, Oxford and New York: Oxford University Press, 1981. For France the model continues to be Charles Coulton Gillispie, \textit{Science and Polity in France: The End of the Old Regime}, Princeton, NJ: Princeton University Press, 1980; Gillispie, \textit{Science and Polity in France: The Revolutionary Years}, vol. 2, Princeton: Princeton University Press, 2004. For Germany an excellent summary of the literature can be found in Ulfred Geuter, \textit{The Professionalization of Psychology in Nazi Germany} (tr. Richard J. Holmes), Cambridge: Cambridge University Press, 1992, pp. 20–32.

\textsuperscript{16} Simon Newcomb, \textit{Reminiscences of an Astronomer}, Boston: Houghton Mifflin, 1903, p. 139.
Before examining the work and publications of positional astronomy, the features of another nineteenth-century phenomenon need to be examined in brief outline. An auspicious coincidence, it was near the time when positional astronomy was becoming the most important scientific practice in Europe and America that the Oxford English Dictionary documented the first usage of a word virtually unknown prior to 1850, but one in full and active circulation today: boredom.

The ‘boredom’ that entered into both the English language and astronomy around the middle of the nineteenth century had precedents. Though variations on the verb ‘to bore’ had existed for over a hundred years, most English writers and speakers were forced to rely on the inadequate ennui to describe a state of being which to many connoted a form of restlessness more than uninterest. And while ‘boredom’ itself was absent, the concept was certainly appreciated; Byron, for one, lamented the absence of an English equivalent to ennui at the beginning of the century.¹⁷ Nor were concerns about what we might call boredom or tedium new to cultural observers. The Greeks complained of accidie and the Romans taedium, while Pascal authored one of the better treatments of ennui long before the creation of the equivalent English noun.¹⁸ Yet as cultural historians have investigated the term they have been in agreement that boredom experienced since the nineteenth century differed from its linguistic ancestors and that the affliction, whatever its name, had not begun to affect large numbers before the last 150 years.¹⁹ When Beckett, for example, wrote that in modern life ‘the pendulum oscillates between ... Suffering ... and Boredom’, he was not simply updating a concern of the ancients.²⁰ These authors have understood that boredom, like professional science, was integral to modern life.

The simultaneous introduction of positional astronomy and ‘boredom’ into nineteenth-century culture could indicate a shared history. If so, the following description of modern boredom might serve as a provisional reference for investigating its appearance in observatory life:

It is not difficult to establish that there was one characteristic common to all instances of boredom, present and past, namely the loss of a sense of personal meaning, whether in relation to a particular experience or encounter, or to an entire life-situation. This loss might be occasioned by the withdrawal or absence of the meaningful, or by the imposition of the unmeaningful.²¹

¹⁷ Seán Desmond Healy, Boredom, Self, and Culture, Rutherford: Farleigh Dickinson Press, 1984, p. 27.
¹⁸ Blaise Pascal, Pensées (tr. Roger Ariew), Indianapolis: Hackett Publishing, 2005, pp. 24, 163.
¹⁹ This is the central ideal of both Elizabeth S. Goodstein, Experience without Qualities: Boredom and Modernity, Palo Alto, CA: Stanford University Press, 2005; and Healy, op. cit. (17). For the particular influence on women see Patricia Meyer Spacks, Boredom: The Literary History of a State of Mind, Chicago: The University of Chicago Press, 1995.
²⁰ Samuel Beckett, Proust, New York: Grove Press, 1970, p. 16. Originally published as Samuel Beckett, Proust, New York: Chatto and Windus, 1931. He may have been referencing Schopenhauer, who wrote that ‘life swings back and forth like a pendulum to and fro between pain and boredom’. Arthur Schopenhauer, The World as Will and Representation (tr. E.F.J. Payne), vol. 1, New York: Dover Publications, 1969, p. 312.
²¹ Healy, op. cit. (17), p. 110.
Healy’s definition of boredom may not be definitive – there are as many ways to describe ‘boredom’ as there are to describe ‘modernity’ – but it resonates particularly with the experience of many workers and readers in positional astronomy. This is not the listlessness of ennui or the simple drudgery of tedium, but the more profound feeling of absence twinned with the inability to remember what exactly has been lost. To investigate appearances of boredom in observatory life and astronomical publications means looking for more than the routine or the tedious. While certainly necessary to establishing boring acts, the very nature of astronomy itself lends it to routine. What will be most relevant, then, is whether descriptions of observatory practices and publications reveal evidence of a ‘loss of personal meaning’ or the lack of individual initiative and not simply repetitive behaviour.

As will be seen in the portraits of the observatory worker and the reading public, ‘personal meaning’ was indeed lost in the process of observation and calculation, and purposefully so at the behest of observatory directors who intentionally imposed ‘unmeaningful’ labour on their employees. Individual skill often impeded production and countered the stated goal of standardizing observatory computers and observers. The result was often boredom for workers and the public, with occasional great moments of professional triumph, if not excitement, for observatory directors.22 Outside the observatory, with the exception of a few navigators and a handful of others who derived a functional meaning from the new research, most individuals experienced the loss of a sky relevant to everyday experience. As Adolphe Quetelet, director of the Royal Observatory in Brussels, wrote, ‘people have ceased to make calendars for themselves … they have ceased to be able to even appreciate the service that is given them’.23 The ‘service’ of accurate star charts and time-keeping benefited certain aspects of public life but the public had become bored with the work coming out of the major observatories.

In the nineteenth century, few would have predicted that a subject as rich in history as astronomy could become boring. As the Edinburgh Review put it, ‘Astronomy is a subject so capable in its results … that there is scarcely any age or period of the world in which men have not … been drawn to it with a strong feeling of interest and awe.’24 Astronomy was the kind of science that could appeal to large numbers of people with little training. In dedicating the Dudley Observatory in 1856, Edward Everett noted that ‘astronomy exhibits phenomena … which are well adapted to arrest the attention of minds barely tinctured with scientific culture’. Unlike other sciences, which ‘are lost

22 The most notable moment being the placement of Neptune among the planets of the solar system in 1845. Interestingly, the ‘failure’ of Airy to properly attain credit for England was in part due to the fact that the observer who first identified the possible source of Uranus’s perturbations, John Coach Adams, fell outside Airy’s typical hierarchy of labour. For a work that summarizes and challenges the traditional account of the Neptune controversy see Robert W. Smith, ‘The Cambridge network in action: the discovery of Neptune’, Isis (1989) 80, pp. 395–422. For an interesting account that privileges Adams’s personality over the ‘ineptitude’ of Airy and James Challis see William Sheehan and Steven Thurber, ‘John Couch Adams’s Asperger Syndrome and the British non-discovery of Neptune’, Notes and Records of the Royal Society (2007) 61, pp. 285–299.
23 Adolphe Quetelet, Astronomie populaire, 2nd edn, Brussels: Remy, 1832, p. vi.
24 James David Forbes, ‘National observatories – Greenwich’, Edinburgh Review (1850) 91, pp. 299–356, 301. My thanks to Stephen Case for identifying Forbes as the author of this piece.
on the common understanding’, astronomy recorded events ‘which charm and astonish alike the philosopher and the peasant … the mathematician … and the untutored’.25

The reason for the past fascination with the skies is clear: societies marked time and place though the movement of objects in the skies, and human imagination, ritual and theology were inscribed into the celestial world. Outer space had historically been the physical expression of an inner space.

In the early nineteenth century, the popularity of astronomy was reflected by a tremendous interest in creating national, public and private observatories. In this period, there was no institution in the scientific hierarchy more revered than the observatory.26 Between 1810 and 1910, the number of European and American observatories increased sevenfold, from thirty-one to 234.27 Observatories were built at a frantic pace in Germany, England, Belgium and Scandinavia often more for reasons of prestige than for scientific advancement.28 John Quincy Adams was only following a pattern first established in Europe when he lamented that there was not a single observatory in the Western hemisphere while there were ‘one hundred and thirty of these light-houses of the skies’ in Europe.29 In England, astronomy became the second discipline to form a formal society, while in Belgium Quetelet pleaded for eight years before an observatory was built, claiming everything from scientific necessity to national defence.30 Observatories not only stood for precision, accuracy and the progress of science; they also were sources of national pride, paid for by state governments and given dedications by leaders and kings alike. While funding and staffing differed across nations, the observatory was held in similar regard from St Petersburg to Dublin to Washington, DC.31 They drove scientific practice, legitimized universities and nations, and became the physical embodiment of a new idea of order, accuracy and precision in science.32

Precision and legitimacy did not necessarily mean excitement. The order and stability of the observatory in fact owed much to a central preoccupation of nineteenth-century astronomy: determining a fixed and rigid stellar map against which to measure

25 Edward Everett, The Uses of Astronomy, Boston: Little, Brown, and Company, 1856, p. 16.
26 For an excellent collection that establishes the importance of observatories for science, politics and foreign policy see Charlotte Bigg, David Aubin and H. Otto Sibum (eds.), The Heavens on Earth: Observatories and Astronomy in Nineteenth-Century Science and Culture, Durham, NC: Duke University Press, 2010.
27 Dieter B. Herrmann, ‘An exponential law for the establishment of observatories in the nineteenth century’, Journal for the History of Astronomy (1973) 4, pp. 57–58.
28 Roger Hutchins, British University Observatories, Burlington: Ashgate, 2008, pp. 13–51.
29 John Quincy Adams, ‘First annual address’, in Addresses and Messages of the Presidents of the United States of America, New York: McLean and Taylor, 1838, pp. 287–302, 299, delivered 6 December 1825.
30 Adolphe Quetelet, ‘Extrait d’un rapport sur la formation d’un observatoire dans le Royaume des Pays-Bas’, Correspondance mathématique et physique (1825) 1, pp. 67–70.
31 A possible exception was France, where the flagship Paris Observatory suffered from a lack of sustained leadership. David Aubin, ‘The fading star of the Paris Observatory in the nineteenth century: astronomers’ urban culture of circulation and observation’, Osiris (2003) 18, pp. 79–100.
32 Timothy William Kneeland, Managing Science and Technology: A Study of Change, 1868–1919, Norman: Oklahoma University Press, 1993; Simon Schaffer, ‘Astronomers mark time: discipline and the personal equation’, Science in Context (1988) 2, pp. 115–145; Robert W. Smith, ‘A national observatory transformed: Greenwich in the nineteenth century’, Journal for the History of Astronomy (1991) 22, pp. 5–29.
the movement of other heavenly bodies. As J.A. Bennett has shown, the process of determining the accurate declension and right ascension of stars dominated the era but left little room for personal initiative. This project of mapping the sky, he writes, ‘came to be pursued in all the active observatories of Europe, with the research goals of the individual enterprises subsumed in the broader consensus’.  

33 The Brussels director Quetelet recognized this new feature of scientific research early on, writing that his ideal employee ‘ceased to act as an individual and became a fraction of the body that attained the most important results’.  

34 Quetelet’s plan was to create actual ‘average men’ to complement his abstract l’homme moyen, and the plan to create the new man of science meshed perfectly with the empirical project of positional astronomy.  

35 Because the consensus of nineteenth-century positional astronomy dictated uniformity in research and production, the individual observers and assistants were expected to be similarly interchangeable. The period saw a massive increase in the number of new training manuals for positional astronomy at the same time as national observatories were demanding unanimity.  

36 Yet standardization went beyond simple training. Almost as important in standardizing practice was calculating an individual observer’s ‘personal equation’.  

37 No matter how well trained, directors found that individuals had particular tendencies that caused observations to differ consistently even after hundreds of trials. Try as they might, directors were unable to overcome the stubborn differences that existed in their employees. Though the first man to discover the personal equation promptly fired his assistant, it was soon realized that the personal equation could be accounted for and later factored into reducing the figure. If they could not normalize the observers prior to the observations, the mathematics would enforce standardization afterwards. Such determinations required hundreds of ‘mock’ observations, where the practice of observing the skies was simulated and observers practised ‘seeing’ and reporting. Before they were given the opportunity to spend hours marking the positions

33 J.A. Bennett, ‘The English quadrant in Europe: instruments and the growth of consensus in practical astronomy’, Journal for the History of Astronomy (1992) 23, pp. 1–14, 1.

34 Adolphe Quetelet, Sciences mathématiques et physiques chez les Belges au commencement du XIX siècle, Brussels: Buggenhoudt, 1866, p. 5.

35 On Quetelet’s ‘average man’ and his relationship with astronomy, the best source remains Joseph Lottin, Quetelet, statisticien et sociologue, Louvain: Institut supérieur de philosophie, 1912.

36 The growth of practical manuals can be seen in Jean-Charles Houzeau’s Bibliographie général. In a bibliography of the most important works published in Europe, Houzeau offered four categories of literature, each with a different audience and function: rudiments, popular introductions for beginners; éléments, explanations of material techniques for advanced students and potential future observatory employees or amateurs; traités, for the mathematical and theoretical foundations of observational practice, and grandes ouvrages didactiques, which attempted to summarize all the theory and practice of astronomy combined with a history of the discipline. In all, Houzeau found 203 works since the late eighteenth century, nearly half of which (ninety-six) were éléments devoted to the practice of professional work. J.C. Houzeau and A. Lancaster (eds.), Bibliographie général de l’astronomie, Brussels: Hayez, 1889.

37 For ways in which the ‘personal equation’ has been a means both to discipline observers and to control physical bodies see Jimena Canales, ‘Exit the frog, enter the human: physiology and experimental psychology in nineteenth-century astronomy’, BJHS (2001) 34, pp. 173–197; and Schaffer, op. cit. (32). Rarely discussed in either paper, however, has been what the experience of determining the equation was like for the observers themselves.
of actual stars, observers were required to spend days and sometimes months recording fake ones.\(^{38}\)

Observations at the beginning of the century were conducted using the ‘eye-and-ear’ method, where an observer would look for a star to cross his vision while listening for a clock to sound the time. In the Brussels Observatory, Quetelet noted that his assistant Jacques Crahay conducted the ‘painful obligation of observing by oneself, hour upon hour’.\(^{39}\) Yet the move to a chronograph in the 1830s hardly lessened the demands or increased the amount of individual participation. Observers still had to patiently watch the skies, only now the time was recorded automatically. The new form of annotation had ‘brought about a sentiment at the same time agreeable and painful to those who had dedicated a part of their life to the old form of observation’.\(^{40}\)

Neither form of observation required much intellectual work or personal skill. As Simon Newcomb, director of the Nautical Almanac in America, said of Airy’s observatory, ‘the large part of the work necessary … was of a kind that almost any bright schoolboy could learn to do in a few weeks’. ‘More important than scientific training’, Newcomb discovered, ‘most of the remaining part [was] plodding industry, properly directed’.\(^{41}\) Though the material methods of observation changed, the requirements of positional astronomy meant long and tedious work for observatory assistants.

The creation of boring observatory work was experienced by the well-travelled astronomer Newcomb, who began his career in the fledgling Nautical Almanac office but travelled to a range of European observatories, including Airy’s Greenwich, Le Verrier’s Paris, and Quetelet’s Brussels. When he began at the Nautical Almanac he claimed the work ‘embod[ied] the highest intellectual power to which man had ever attained’, but after moving to the US Naval Observatory in Washington, he observed that ‘the drudgery of night work at the observatory … interfere(d) with carrying on any regular investigation’. Just a few decades after the observatory had evolved from its humble origins as the Depot of Charts and Instruments, Newcomb found that the ‘personnel was as insufficient as the instruments’ and the ‘astronomical clock … kept worse time than a high-class pocket watch does today’. While such obstructions hindered the work of the observatory, they may have also made the job more enjoyable. Indeed, Newcomb claimed that in earlier days, his schedule was so independent that when his group got tired, ‘we could “vote it cloudy” and go out for a plate of oysters at a neighbouring restaurant’. Yet by the time he had left Washington, four assistants were called on to monitor the mural and transit in steady cycles, requiring shifts from nine in the morning until ‘midnight or even the dawn of the next morning’. Such a routine, Newcomb noted with understatement, ‘was certainly a departure from the free and easy way in which we had been proceeding’.\(^{42}\) From Newcomb’s perspective the early work of professional observatories had the surprising benefits of being intellectually engaging at the same time as it was profoundly unproductive.

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38 Raynor L. Duncombe, ‘Personal equation in astronomy’, *Popular Astronomy* (1945) 53, pp. 2–13, 3.
39 Quetelet, op. cit. (34), p. 253.
40 Quetelet, op. cit. (34), p. 253.
41 Newcomb, op. cit. (16), p. 129.
42 Newcomb, op. cit. (16), pp. 129, 63, 97, 104–105, 102, 110.
The loss of the ‘free and easy way’ of observatory work was the result of methods implemented by observatory directors who differed from previous leading astronomers. Bessel and Airy, perhaps the two most respected observatory directors of the time, hardly ever recorded an observation of their own, instead reserving the work for their employees.43 While Bessel is most noted today for his mathematical calculations used to reduce astronomical observations, he was praised at his death for his ‘earnest attention and zealous occupation’ at having ‘mastered the routine’ of his own ‘subordinate position’ as a young observatory assistant, a routine he re-created at his own observatory.44 As Newcomb noted of the reigning observatory hierarchy, ‘All the observatory really needs is an administrative head who shall preserve order, look after his business generously, and see that everything goes smoothly.’45 Newcomb could have added that an observatory director also needed a few workers. As Simon Schaffer described the practice of positional astronomy at the time, ‘the managers of the great observatories’ required a ‘regime of vigilant surveillance of subordinate observers’ to make the ceaseless observations.46 At times directors would take over, but at the largest observatories the observer’s status was the equivalent of an entry-level position. ‘The lowest of all employments in the Observatory is mere observation’, Airy claimed. ‘No intellect and very little skill are required for it. An idiot with a few days’ practice may observe very well.’47 Newcomb confirmed this position, noting that at Greenwich ‘labor is so organized that unskilled men bring about results that formerly demanded a high grade of technical ability’.48 The only ‘technical ability’ present at the observatory would seem to be assembling and directing the ‘unskilled’ workers.

As historians have noted, the practice of astronomy in the nineteenth-century observatory had inverted since the days when Galileo used observational records to argue against speculative theory: in the nineteenth century, the people actually watching and tracing the movement of the stars had very little to contribute to the science. Praise was instead reserved for those who theorized about the heavens and organized their exploration. Even the production and creation of instruments themselves had been moved outside the observatory, so that few observers or directors had any relationship

43 Though influential in England, Bessel’s Königsberg Observatory was something of an anomaly during the first half of the nineteenth century in Germany, where most observatories had few, if any, assistants. For a revisionist account of how Bessel’s work ‘destroyed the older conceptions of the astronomical observer as the skillful master of an art’ and both anticipated and broke from English practices of creating observers see Cristoph Hoffman, ‘Constant differences: Friedrich Wilhelm Bessel, the concept of the observer in early nineteenth-century practical astronomy and the history of personal equation’, BJHS (2007) 40, pp. 333–365, 348. For a guided tour of nineteenth-century German observatories see Adolphe Quetelet, Notes extraits d’un voyage scientifique fait en Allemagne pendant l’été de 1829, Brussels: Hayes, 1830.
44 John Frederick Herschel, A Brief Notice on the Life, Researches, and Discoveries of Friedrich Wilhelm Bessel, London: Barclay, 1847, p. 4.
45 Newcomb, op. cit. (16), p. 112.
46 Schaffer, op. cit. (32), p. 115.
47 From a letter from Charles Biddell Airy to Charles Wood, 22 March 1847. Quoted in Allan Chapman, The Victorian Amateur Astronomer: Independent Astronomical Research in Britain, 1820–1920, Chichester: John Wiley & Sons, 1998, p. 34.
48 Newcomb, op. cit. (16), p. 139.
with their equipment prior to its delivery. So powerful had the organizing principle become that by the end of the nineteenth century some astronomers were even cautioning against the model set by Airy. The editors of The Observatory worried the strict division of labour was problematic for creating new ideas: ‘there is . . . no greater danger than that of drifting into routine in the case of an advancing science’. However, as any director at the time well knew, Airy had proved that having his workers drift into impersonal and meaningless routine was the most direct path to success in positional astronomy.

**The boredom of computing**

While the day-to-day routine of the average observer was the engine powering the observatory’s production of data, the resulting product—accurate and reliable star catalogues—required another class of labourers: computers. As one catalogue put the matter, ‘astronomy is the science where one encounters the most frequent occasions to make long and complicated calculations’. In the language of astronomers, ‘figures were cheap’, and observatories distinguished themselves not with the raw data of observation, but with the finely tuned numbers they published. This had not always been the case. In previous centuries the worth of an observer was determined by how well he calibrated his instruments in preparation for observing, not how well he manipulated the data afterwards; the great bulk of labour was done prior to looking through the lens. Yet as the mathematics behind reducing large numbers to averages was being completed by Gauss and Laplace, observatory directors realized that all of the work could be back-loaded. Not only could all of the messy details of individual personality and equipment error be corrected for, but great piles of information previously considered useless could be given meaning. In the hands of able computers, error could be made fact. As one director explained his effort to reduce thousands of observations once thought worthless, ‘these valuable observations have so long remained in the crude state of ore, without any known attempts to extract the precious metal which they contain’.

Like any mining expedition, of data or otherwise, the actual work of ‘extraction’ required a great deal of labour, and here again Airy provided a new model. After taking over at Greenwich, he had radically overhauled the hierarchy by hiring relatively untrained workers and providing them with ‘skeleton forms’ which would essentially do the work of computing for them. At Greenwich, it was an ‘exception that an astronomer or his assistant is to be found using the instruments’. Instead, the Edinburgh Review noted, most workers stayed in the cramped ‘Computing Room . . . with their silent and

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49 Dieter B. Herrmann, *The History of Astronomy from Herschel to Hertzsprung* (tr. Kevin Krisciunas), Cambridge: Cambridge University Press, 1973, p. 158.
50 *The Observatory* (1895) 17, p. 175.
51 L.B. Francoeur, *Astronomie pratique: Usage et composition de la connaissance des temps*, Paris: Bachelier, 1840, p. vii.
52 *The Observatory* (1895) 17, p. 377.
53 Benjamin Apthorp Gould, *Reduction of the Observations of Fixed Stars Made by Joseph Lepaute d’Agelet, at Paris, 1783–1785*, Washington, DC: National Academy of Sciences, 1866, p. 70.
laborious tasks’. The calculators need only enter the raw observation data, perform a few simple arithmetic calculations, and the corrected number would appear. This is not to say that Airy had little work to do, only that he rarely spent time with the computers in what the Astronomer Royal called the ‘most pitiful little room’. In fact Aubin has claimed that calculation itself had very little to do with scientific recognition at the time, noting that directors ‘won prizes and medals … not because of their computations but for the ingenious ways they devised avoiding them’. Aubin’s position is not simply one of hindsight. In 1897 the editors of The Observatory claimed, ‘The Director of a Government Observatory is in fact not solely an astronomer … We might even say he is not an astronomer in the first instance.’ The success of computing meant that both the workers and directors of an observatory required little of the training or skills of previous astronomers.

While the work of observatory computers and directors seemed to have little to do with the former practice of astronomy, it is of course still possible that workers enjoyed their work. Many assistants spent lifetimes in observatories, and it may be that they were not bored by the tasks, but the historical literature reveals few exciting or rewarding elements to the job. In the most extensive survey of observatory computers, Mary Croaken sums up a computer’s work as ‘repetitive, sedentary, and often wearisome’, and ‘done largely for financial gain rather than intellectual stimulation’. In her work she quotes two descriptions of observatory life worth reproducing in full. Edwin Dunkin, the son of a computer at Greenwich, related his father’s experience:

I have often heard him express a real regret at the loss of his semi-independent position … in exchange for the daily sedentary confinement to an office-desk for a stated number of hours, in the company of colleagues all junior to himself in age and habits.

Thomas Evans, described as a ‘gentleman of talents and respectability’, who worked at Greenwich as an assistant, offered an even more sombre vision:

Nothing can exceed the tediousness and ennui of the life the assistant leads in this place, excluded from society … Here forlorn, he spends days, weeks, and months, in the same long wearisome computations, without a friend to shorten the tedious hours, or a soul with whom he can converse.

54 Forbes, op. cit. (24), p. 329, original emphasis.
55 Wilfred Airy (ed.), Autobiography of Sir George Biddell Airy, Cambridge: Cambridge University Press, 1896, p. 123.
56 David Aubin, ‘Observatory mathematics in the nineteenth century’, in Eleanor Robson and Jackie Stedall (eds.), The Oxford Handbook of the History of Mathematics, Oxford: Oxford University Press, 2009, p. 238.
57 The Observatory (1895) 18, p. 175.
58 Mary Croaken, ‘Human computers in eighteenth- and nineteenth-century Britain’, in Eleanor Robson and Jackie Stedall (eds.), The Oxford Handbook of the History of Mathematics, Oxford: Oxford University Press, 2009, p. 336.
59 Peter Hingley, Edwin Dunkin and Tamsin Dabiel (eds.), A Far off Vision: A Cornishman at the Greenwich Observatory: Autobiographical Notes by Edwin Dunkin, Cornwall: Royal Institution of Cornwall, 1999, p. 45. Quoted in Croaken, op. cit. (58), p. 384.
60 John Evans, The Juvenile Tourist, 4th edn, London: Baldwin, Cradock and Joy, 1818, p. 341.
61 Evans, op. cit. (60), pp. 342–343. Quoted in Croaken, op. cit. (58), p. 387.
The accounts of Evans and Dunkin in England mirrored the experience of workers at the US Naval Observatory. In Washington, Newcomb commented on the ‘lonely life’ of an astronomer: ‘One drawback from which the astronomers suffer is the isolation of the place’.\(^{62}\) Even in an overwhelmingly positive document drawn up for Congress, J. Melville Gillis admitted that in Washington ‘An occasional night ... might be attractive from its novelty ... but the charm is soon broken, and the observation becomes a matter of duty (and) is performed listlessly at best.’\(^{63}\)

Though the work may have been ‘tedious’, ‘listless’ and ‘wearisome’, boredom was not a concern from the perspective of advancing positional astronomy; in fact, boredom was essential. Writing fifty years after Evans’s complaint, the *Edinburgh Review* praised the Greenwich Observatory precisely because it was not an interesting place to work. Comparing Greenwich to the imposing and ornate Pulkovo Astronomical Observatory, the authors admitted the St Petersburg facility was the ‘noblest edifice ever yet erected to the purposes of science’, but claimed that the ‘splendour’ and ‘mere luxury in buildings [and] instruments’ hindered scientific work. The problem with all the excitement was that it had the possibility to ‘seduce men from the full performance of a most toilsome duty’.\(^{64}\)

Not all contemporaries agreed with the *Edinburgh Review* and many lamented the absence of skilled and interested amateurs in positional astronomy. It was not necessarily the case that observatories were excluding amateurs through requiring more new training or certification. In fact they were expecting less. By 1888, most astronomers had recognized that the day of the single observer making major contributions to the field had ended. In a guide for amateur astronomers in England, John Oliver admitted that the large networks of observers ‘helped towards the elimination of the personal factor’. Yet an irony was emerging that threatened to hurt amateur astronomy: the most successful work was also the least interesting. As Oliver wrote, ‘What is absolutely necessary to successful organization, and what, as it happens, is sadly lacking in the meantime, is enthusiasm.’\(^{65}\) The enthusiasm gap was caused in his opinion because organization

implies, to a considerable extent at least, the effacement of the individual, the sacrifice of the observer’s liberty of action, the compression of his energies into a narrow and cramping channel, the reduction, in short, of his work ... to the driest and most machine-like drudgery.\(^{66}\)

In other words, in the opinion of a supporter of highly organized research, the demands of successful scientific research in nineteenth-century positional astronomy required

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62 Newcomb, op. cit. (16), p. 312.
63 J. Melvile Gillis, ‘Report on the erection of a building in Washington, as a depot for charts and instruments’, in I. Bernard Cohen (ed.), *Aspects of Astronomy in America in the Nineteenth Century*, New York: Arno Press, 1980, pp. 51–80, 67.
64 Forbes, op. cit. (24), p. 316. Forbes may have been happy to know that a recent history of Pulkovo found that the director, Otto Struve, was fond of equating ‘more lowly personnel with machines’. Simon Werrett, ‘The astronomical capital of the world: Pulkovo Observatory in the Russia of Tsar Nicholas I’, in Bigg, Aubin and Sibum, op. cit. (26) pp. 33–57, 48.
65 John A. Westwood Oliver, *Astronomy for Amateurs: A Practical Manual of Telescopic Research in All Latitudes*, London: Longmans, Green and Co., 1888, p. 14.
66 Oliver, op. cit. (65), p. 15.
precisely the characteristics—‘effacement of the individual’, ‘sacrifice ... of liberty of action’, ‘machine-like drudgery’—identified with modern boredom. Oliver recognized that only ‘enthusiasm can carry [the amateur] through such a disgusting ordeal’ and that most had ‘halt[ed] on the threshold of all ... organization proffered for their personal adhesion’. Amateurs had not stopped participating in positional astronomy because of something they lacked; in Oliver’s view it was their very excitement for astronomy that kept them outside the observatory walls. Only those less enthusiastic could be entrusted to carry out the work of the professional observatory.

This sketch of observatory labour is hardly exhaustive, and the system of specialized and depersonalized work practised at places like Greenwich and Washington was not the only method. Other directors took different approaches, denying a strict division of labour and repetitive tasks in favour of promoting the spirits of their workers. Even the journal The Observatory, never short of praise for the accuracy produced at Greenwich, quoted approvingly the remarks of the astronomer Seth Carlo Chandler that ‘the harmonious development (of observations) is due to individual effort, and not to any concerted scheme of operation’. In contradiction to the labour model dominant at the major observatories, Chandler claimed that the accuracy of his numbers was not a result of ‘a formal organization of work, directed from headquarters, prescribing and circumscribing the operation of each participant’. Such a model, Chandler argued, ‘destroy[s], by its benumbing influence, the enthusiasm which springs from the individual initiative of the observers themselves’. Here, it seems, was a direct challenge to the ‘tedious’, ‘lonely’ and ‘wearisome’ science of positional astronomy.

But was Chandler right that ‘enthusiasm’ was necessary for positional astronomy? The evidence of successful astronomers of the period would seem to find few observatories of the nineteenth century that benefited from encouraging ‘individual initiative’. As seen in this section, the most successful observatories also happened to be the ones that required depersonalization, a lack of connection to fellow workers, and a loss of meaning in their work. Were the computers, assistants and observers of every observatory experiencing boredom in the modern sense? To generalize about individuals, especially those who had little incentive to leave behind a record of their boredom, would be difficult, but from the description given by contemporaries and historians, the work of the observatory seems to have become far less interesting and meaningful throughout the development of positional astronomy. Whether observatory workers were bored, or the work of observation and computation attracted that narrow portion of mankind who happened to be interested in long hours and repetitive tasks, the consequences of boredom in scientific experience demands attention. After all, while Chandler’s decentralized approach may have removed the ‘benumbing influence’ of practising positional astronomy, it was not suited to success in the discipline. In the nineteenth century, Airy’s Greenwich was the model scientific institution in the world while Chandler was the compiler of one more meaningless star catalogue.

67 The Observatory (1897) 20, p. 115.
68 Seth Carlo Chandler, ‘Third catalog of variable stars’, Astronomical Journal (1896) 16, pp. 145–172, 145.
The boredom of reading: ephemerides and the ‘paradox’ of public astronomy

In 1797, the astronomer Alexander Ewing stated what he called a ‘paradox’ of the progress of astronomy: ‘the discoveries and improvements made in Astronomy during the last 40 years ... instead of primping study, have had a contrary effect’. For Ewing the larger public was turning away from astronomy at great detriment to the science as a whole. ‘Although great discoveries and improvements have been made in astronomy’, he wrote, ‘the science is still possessed by a small number of persons’. In the late eighteenth century this was still considered a problem, and Ewing’s goal in writing a book intended for the public was not education for its own sake, or even for the development of the reader’s mind, but simply to advance knowledge of the discipline. As he envisioned astronomy: ‘To make the most of any art or science for the benefit of mankind, it is necessary that many people understand it’. Historians of science may quibble with Ewing’s belief that progress in science requires active understanding, but like many of his contemporaries he was steadfast in believing that further progress required the integration of public interest and astronomy.

Positional astronomy as practised in the decades after Ewing did not live up to the ideal of integrating an active public. The primary culprit that drove away public interest was the ephemeris, the catalogue of star positions and observations that each observatory was expected to produce. So rare was an interesting star chart that John Herschel was once praised for ‘clothing the description of so boring a thing as a Catalogue of stars with the amities of human interest’. The star catalogues of positional astronomical data stood in stark contrast to previous astronomical publications. Earlier catalogues – usually called almanacs – had reflected the inclusion of belle-lettres, moral philosophy and essays in public life in the eighteenth century. From 1675 to 1775 American almanacs doubled in size, from an average of sixteen pages to 30.86 pages, with most of the increase resulting from a surge in tabular information. Numerical tables shot from an average of one page per almanac to nearly twelve, growing from 6.7 per cent of almanac pages to more than a third. In 1783, an eclectic almanac could still include ‘A Receipt for Making very good INK’, ‘Thoughts on Happiness’ and a moral lesson on the ‘True Greatness in Henry IV of France’, but the tables of data were beginning to take over at the beginning of the nineteenth century. These older eclectic almanacs were valuable – America had no observatory and farmers did not require detailed star positions, only general guides to astronomical and meteorological activity – but the revolution in observational practice in the nineteenth century would make such almanacs, and their asides on politics, history and humour, obsolete.

69 Alexander Ewing, Practical Astronomy: Containing a Description of the Solar System; the Doctrine of the Sphere; the Principal Problem in Astronomy, Edinburgh: Peter Hill, 1797, p. vi.
70 The Observatory (1897) 20, p. 115.
71 John T. Kelly, Practical Astronomy during the Seventeenth Century: Almanac-Makers in America and England, New York: Garland, 1991, p. 13.
72 An Astronomical Ephemeris, Calendar, or Almanack for the Year of Our Lord 1783, Hartford: Hudson and Goodwin, 1783.
While the new genre of star catalogues could claim accuracy and precision over the old almanacs, they may have been more important as a source of pride and status than as publications meant for practical use. Greenwich and the US Naval Observatory in Washington provided essential information for navigation, but the consolidation and standardization of star catalogues had an ironic effect for scientific research in observatories. Since Gauss and Bernoulli, observatory directors had known that they needed large numbers of observers to accurately determine the stellar map, but a large number of observers also meant that much of the work was superfluous. The more observatories signed up for the plan, the less the results of each observatory mattered. Simon Newcomb recognized as much when he wrote that all

the leading nations publish ephemerides of this sort. The introductions and explanations are, of course, in the languages of the respective countries; but the contents of the volume are now so much alike that the duplication of the work involved in preparing them seems quite unnecessary. Yet, national pride and emulation will probably continue it for some time to come.73

As publisher of one of the most respected astronomical publications of the time, Newcomb had good reason to disparage other efforts, but his point was sound. There was no need for each country, let alone every single operating observatory, to publish their own catalogues when Greenwich and Washington offered the most accurate figures.74 Especially given the tremendous effort of observers and calculators alike, it would have been more than a simple waste of numbers; it was a waste of workers’ time. Yet Newcomb offered no alternative. After all, if observatories were to eliminate their own publications, they might have faced a question more profound than national pride: what else, exactly, were they there to do?

At the beginning of the nineteenth century, astronomers could have answered the question of relevance by appealing to their public function. In some cases, cultivating public interest was pragmatic, as in the case of O.M. Mitchel’s lectures to the citizens of Cincinnati on the need for an observatory. As Mitchel told his audiences of both well-connected fundraisers and a voting populace, ‘the future scientific character of the country rested with the people’.75 Historian Agnes Clerke also believed that ‘the new physical astronomy depends for its prosperity upon the favour of the multitude’.76 The ‘favour’ of the public was not limited to material support, however; several authors believed that research itself was based upon a knowledgeable public. In 1797 Ewing hoped that public instruction in astronomy might model the success of accounting, noting, ‘About 400 years ago there were fewer good accountants in Britain than there are

73 Newcomb, op. cit. (16), p. 62.
74 Bennett, op. cit. (33), p. 1, has also argued that during this period observations became the ‘sine qua non of an astronomical observatory’ even when the data was ‘unpublished’ and ‘unreduced’.
75 O.M. Mitchel, The Planetary and Stellar Worlds: A Popular Exposition of the Great Discoveries and Theories of Modern Astronomy, New York: Baker & Scribner, 1848, p. v.
76 Agnes Mary Clerke, A Popular History of Astronomy during the Nineteenth Century, Edinburgh: Adam and Charles Black, 1885, p. 5. Reprinted in Agnes Mary Clerke, ‘Astronomy still young’, in Dennis Richard Danielson (ed.), The Book of the Cosmos: Imagining the Universe from Heraclitus to Hawking, Cambridge, MA: Perseus, 2000, pp. 326–333, 327.
astronomers at this day.’

77 Even Airy thought that the public could appreciate the work of his observers and computers at Greenwich, including a brief article in the popular *Penny Cyclopaedia*. In a longer work on the same subject, he was explicit that the great theories could be grasped by everyone. Astronomical ideas, he argued, should ‘not be restricted to the instruction of readers who are unable to pursue them with the powers of modern analysis’.  

78 This was not the ‘diffusionist’ model of science that saw popularization as a means to spreading useful knowledge, but a call by serious astronomers for active participation of the public in scientific life.

Yet the ‘modern analysis’—mathematics—mentioned by Airy proved to be a significant obstacle to keeping the public interested in astronomy. How could a science that was becoming quantitative—and owed its great success to mathematics and probability—still be understood by a general reader? Many claimed it could not. *The Observatory* editors, for example, warned that it was impossible to teach much astronomy because ‘the average man draws the line at what mathematical knowledge should be expected of him at some relatively early stage’.  

80 The author of a popular work entitled *Heroes of Science* conceded that while he would avoid any equations, mathematics was ‘the one key that would unlock its mysteries’.  

81 Earlier almanacs had presented the workings of astronomy in the language of history, evocative description and even poetry, but the language of mathematics had less purchase on the public interest. By the middle of the century it was clear that quantitative reasoning had failed to interest the public in the way older almanacs had. The popularizer George Chambers recognized that astronomical publications now only came in two kinds: dense mathematical works and overly simplistic surveys. In 1861, he offered his own work as a solution to the divide between dry professional manuals and condescending pamphlets, commenting that there were no works in the English language which were ‘attractive to the general reader, serviceable to the student, and handy for purposes of reference’. Not only could authors seemingly no longer write for a wide range of readers, but it was hard to find ‘works which are popular without being vapid, and scientific without being unduly technical’.  

82 Chambers, however, did his best to make the material interesting, including informing his readers that the sun’s light was ‘equal to that of 5,563 wax candles of moderate size placed at a distance of one foot’. On comets, Chambers began with the poet Brayley describing ‘The blazing star, Threat’ning the world with famine, plague, and War.’ Chambers’s *A Handbook of Descriptive Astronomy* went through

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77 Ewing, op. cit. (69), p. v. The comparison to accounting was apt, as the new form of astronomy had many similarities to the world of business. See William J. Ashworth, ‘The calculating eye: Baily, Herschel, Babbage and the business of astronomy’, *BJHS* (1994) 27, pp. 409–441.

78 George Biddell Airy, *Gravitation: An Elementary Explanation of the Principal Perturbations in the Solar System*, 2nd edn, London: Macmillan, 1884, p. iv.

79 On the rise and fall of this model in France see Bernadette Bensaude-Vincent, ‘A public for science: the rapid growth of popularization in nineteenth-century France’, *Réseaux* (1995) 3, pp. 75–92.

80 *The Observatory* (1895) 18, p. 376.

81 E.J.C. Morton, *Heroes of Science: Astronomers*, London: Society for Promoting Christian Knowledge, 1882, p. v.

82 George F. Chambers, *A Handbook of Descriptive Astronomy*, 3rd edn, Oxford: Clarendon Press, 1877, p. vii.
several editions, but was mostly limited to those who were already attracted to the subject and had little connection to the work of observatories. The key for Chambers was ‘preferring fact to fancies’ and avoiding all theoretical discussions, what he called ‘those mischievous speculations on matters belonging to the domain of Recondite Wisdom’. It also helped that he focused on history, comets and description rather than on the stellar map, devoting only six of his six hundred pages to variable stars, a fixation of the professional observatory astronomers.

The problem of teaching a subject so tied to mathematics baffled even one of the most able, and certainly one of the least boring, astronomers of the time: François Arago. In *Astronomie populaire*, based on lectures given at the Bureau des longitudes, Arago took a different approach from Chambers, insisting that the theory of astronomy – the ‘mischievous speculation’ – should ‘precede’ any discussion of true astronomy. The theoretical basis would replace mathematics, which few in his audience would have understood and which was anyway unsuited to a public lecture. Replacing mathematics with descriptive accounts of the physical theories of motion may have made the work easier but did little to make it more exciting, a problem Arago recognized when he asked his students to ‘pardon me for the dryness of this debut’.

*L’aridité* continued throughout the lectures, however, and Arago warned his students that there would be a lot of ‘repititions’, but that ‘this inconvenience cannot be avoided’. Though the class upon which *Astronomie populaire* was based had lasted for thirteen years, and proved a success among highly educated Parisians like Auguste Comte and Victor Hugo, Arago had doubts about its effectiveness. He had enjoyed teaching the class, but was concerned that it might have to be discontinued. Of the fifteen members of the Bureau des longitudes, Arago had been the only person willing to teach astronomy to the public. The objection from his colleagues was simple: ‘these eminent men maintain that this science cannot be taught to those who do not already understand mathematics’. By the mid-nineteenth century, professional astronomers were following the lead of Arago’s colleagues, producing textbooks for practising observers and abandoning a public they believed to be innumerate. While Arago and others were able to maintain classes for several years, the efforts of nineteenth-century professional astronomers to popularize astronomy could only be seen as failures if the aim was to correct Ewing’s complaint on the ‘small number of persons’ who contributed to astronomy.

83 Chambers, op. cit. (82), p. vii.
84 On the categorization of Chambers’s work see Peter Johnson, ‘George F. Chambers, 1841–1915’, *Journal of the British Astronomical Association* (1990) 100, pp. 13–16, 14.
85 François Arago, *Astronomie populaire*, 4 vols, Paris: Claye, 1854, vol. 1, p. iii.
86 Arago, op. cit. (85), p. iv.
87 It has been suggested that the varying success of Arago’s lectures was deeply embedded in French society and politics, though the objections of his colleagues suggest that public inexperience with numbers contributed to their end as well. Theresa Levitt, ‘“I thought this might be of interest ...”: the observatory of public enterprise’, in Bigg, Aubin and Sibum, op. cit. (26), pp. 285–304, 302.
88 Arago, op. cit. (85), p. xii.
89 This is not to say that popularizing astronomy could not be done by the professionals. The Berlin Urania was a massive success in attracting attention to the astronomical wonders, but this was a different kind of
A century after Ewing’s supposed paradox of an elite yet progressive discipline, popular astronomy was closer to a punchline than a possibility. By the late 1800s the pages of professional journals were filled with accounts of an uninformed public. One anecdote related the well-worn tale of a farmer who wrote to the Astronomer Royal at Greenwich to ask ‘how many piglings his sow would farrow next time’.90 Another story told of a teacher who had abandoned astronomy as a subject because one girl in her class had held ‘the zodiac’ responsible for the bursting of a steam pipe.91 Worst of all, even educated men did not seem immune. One account which elicited both humour and horror from the teller concerned two Austrian military officials who were discussing the possibility that a hot-air balloon could reach Mars. Such foolishness was bad enough, but made worse when a lieutenant field marshal interrupted to argue that it was ‘only that our technical means would not yet suffice to give the necessary size to the balloon’.92 Even in a piece for the Edinburgh Review meant to explain the workings of Greenwich to the public, the author could not help poking fun at the public misperception of astronomy. In what he called ‘an epistolary specimen of the march of intellect’, the author told of a correspondent who asked that the Observatory tell him his future wife based on his date of birth.93 The time for a public interest in positional astronomy, it seemed, had passed.

A near abandonment of the project of professional astronomers to provoke public participation – the necessity that had guided Ewing’s work – was at hand by the close of the century. In 1895, in an interview given to the San Francisco Examiner, the director of the Lick Observatory, E.E. Barnard, expressed the waning hopes that the newspaper-reading public would follow astronomy the way they followed ‘prize-fighting and horse-racing’. His belief was ‘that people who ordinarily are supposed to only appreciate such reading matter in the daily papers … will be found to be deeply interested in the astronomical subject’. Unfortunately, Barnard’s solution was to present the findings of astronomers in ‘an easily intelligible form’, a plan that had been unpersuasive in the past. Reviewed in the The Observatory, Barnard’s comments provided only mild amusement to the editors, who claimed that astronomy was just not that sort of thing. Unlike other activities which offered ‘new developments’ every day, astronomy only advanced over long periods of time and was therefore inadequate for newspapers.94 To support their claim the editors could have pointed to Airy’s work in reducing eighty years of observations at Greenwich – which they called ‘the greatest work of the kind that was ever attempted, and the most useful to astronomy’ – but which ‘could however have but few readers’.95 A century after Ewing’s paradox, the editors seemed resigned that the most ‘useful’ work in positional astronomy would be of no interest to the public.

90 The Observatory (1898) 21, p. 468.
91 The Observatory (1896) 19, p. 69.
92 The Observatory (1895) 18, p. 377, original emphasis.
93 Forbes, op. cit. (24), p. 348.
94 The Observatory (1895) 18, p. 177.
95 Forbes, op. cit. (24), pp. 345–346.
'Methods merely curious and of no practical utility': the astronomy of Robert Proctor and Camille Flammarion

When I heard the learn’d astronomer,
When the proofs, the figures, were ranged in columns before me,
When I was shown the charts and the diagrams, to add, divide, and measure them,
When I, sitting, heard the astronomer, where he lectured with much applause in the lecture-room,
How soon unaccountable I became tired and sick,
Till rising and gliding out I wander’d off by myself,
In the mystical moist night-air, and from time to time,
Look’d up in perfect silence at the stars.96

When professional astronomers gave up trying to interest a public bored with charts and numbers, authors not attached to observatories were happy to provide a substitute. Popularizations of astronomy that had once been the province of observatory astronomers like Arago and Quetelet were taken over by amateurs, historians and former observatory workers. These works, while distinct enough to avoid broad generalization, shared three common characteristics. Primarily they excluded references to any mathematics or mechanical theory. Second, in their place popularizers employed a variety of rhetorical strategies—poetry, astrology, ancient myths and divine explanation—that were once part of the astronomical discourse of almanacs but had been expunged in the creation of ephemerides. Third, popular works on astronomy also explicitly condemned the observatory model of positional astronomy as unscientific. National observatories in this account became merely chroniclers of useful data, often dismissed as relevant for ‘commerce’ but little else. While these works sold well and provided exciting stories to an eager audience, they had little success in penetrating the boundaries of professional astronomy.

One of the most successful and controversial of popular expositors was Richard Proctor, a former member of the Royal Astronomical Society who turned to popular writing after a bank failure caused him to look for more lucrative employment in astronomy.97 Proctor’s approach, which served him well over the course of dozens of books, hundreds of articles and thousands of lectures, was that ‘a general public could not be attracted by writing which required a prolonged effort of reasoning or study to understand’.98 ‘Prolonged effort’ at observation and calculation, the goal of Arago, Airy and others, was replaced by what Proctor called ‘contemplation of a scene so magnificent’. It was an anti-quantitative theory which explicitly rejected the techniques that had been employed in positional astronomy:

A man may have at his fingers’ ends the distances, volumes, and densities of all the planets, the rates at which they move … and a hundred other facts equally important in astronomy;

96 Walt Whitman, ‘When I heard the learn’d astronomer’, in Justin Kaplan (ed.), Walt Whitman, Poetry and Prose, Washington, DC: Library of America, 1996, p. 409.
97 For an excellent recent treatment of Proctor see Chapter 6 of Bernard V. Lightman, Victorian Popularizers of Science: Designing Nature for New Audiences, Chicago: The University of Chicago Press, 2007, pp. 295–351.
98 Richard A. Proctor, Old and New Astronomy, London: Longmans, Green and Co., 1888, p. iii.
but, unless he has in his mind's eye a picture of the solar system, with all its wonderful variety, and all its yet more amazing vitality, he has not yet passed even the threshold of the science.99

Nowhere in an ephemeris, Proctor argued, could one find a description of ‘wonderful variety’, only ‘distances, volumes and densities’. His alternative to professional astronomy not only lacked much in the way of quantification, it even claimed murals and transits were not necessary: the naked eye could appreciate astronomy ‘without optical instruments of any sort’. Quantification and technological advances could certainly make astronomy more ‘useful’, but instrumentality was beside the point. The great astronomers like Galileo and Copernicus, Proctor argued, had only made ‘accidental’ advances in ‘practical astronomy’; their true genius lay in what he called ‘understanding’. Astronomy, rather than a useful tool for generating practical information, was ‘a subject for study and contemplation ... for ennobling and purifying the mind’. The professional astronomer, whom he derisively labelled the ‘astronomical surveyor’, was necessary to generate important information, but he should not be confused into thinking that he was practising true science. Contrasting the great astronomers of the past with the observatory directors of the present, he argued that ‘the stupendous celestial mechanism, the beauty and harmony of the celestial architecture, is not for the Flamsteeds, the Maskelynes, and the Airys’. To this group ‘commerce owes much’, but ‘scarcely any ... value’ in astronomy was the result of their labours.100

In his complaint against the ‘surveyor’, Proctor invoked the career of John Herschel, the most prominent astronomer of the nineteenth century. In an article published in the year of Herschel’s death, 1871, Proctor praised the ‘greatest and most amiable philosopher of our times’ for his diligence and work ethic – necessary for any observer – but added that the compilation and reduction of star positions was but a small part of the reasons for his success.101 Though Herschel had spent long hours making observations at Good Hope, his genius resided in ‘seeing beneath the surface’ of the numbers and employing ‘analogy’, ‘imagination’ and ‘theory’ in understanding the data. Challenging the dominant model of positional astronomy, Proctor claimed that Herschel was successful because he recognized that ‘observed facts often, on the face of them, show little which tends to enlighten the enquirer’.102 Proctor believed that Herschel was far from the model scientist of Greenwich or Washington precisely because he was interested in more than the accumulation of numbers.103

Proctor was joined in his complaints by Camille Flammarion, perhaps the most complex figure of late nineteenth-century astronomy. Flammarion, who began his career at the Paris Observatory, would have seemed to be the natural heir to Arago’s attempts to attract public attention. His best-selling *Astronomie populaire* shared its title with

99 Proctor, op. cit. (98), p. 4.
100 Proctor, op. cit. (98), p. 9.
101 Robert Proctor, ‘Sir John Herschel as a theorist in astronomy’, *Saint Pauls Magazine* (1871) 8, pp. 326–339, 327.
102 Proctor, op. cit. (101), pp. 335–338.
103 For Herschel’s complicated relationship with positional astronomy see Bennett, op. cit. (33), pp. 1–2.
Arago’s, and he had a similar belief that the public could overcome the challenges of the dense material. Flammarion even expressed shock that anyone would believe that the public was not interested in the science. ‘It cannot be that we are indifferent’, he wrote, ‘because (astronomy) alone tells us what and where we are’. He dismissed complaints by ‘severe scholars’ that the public would not follow astronomy because they were ‘bristled by numbers’. Rather, the ‘algebraic formulas’ needed to understand astronomy were ‘analogous to scaffolds which are needed to construct’ an observatory. ‘When the numbers fall’, he wrote, the ‘grandeur’ of the building remained.104 To make the science real he called on his readers to send him their scientific work. It was necessary, he added, because the world of science ‘was not made for the privilege of one thousand or ten thousand; it is made for everyone’.105 As Bernadette Bensaude-Vincent has argued, Flammarion in Astronomie populaire ‘inverted’ the Greenwich model of specialization to argue for a discipline that advanced in step with popular appreciation.106 If Flammarion was correct, it was possible that Ewing’s paradox could be resolved.

Flammarion had worked at a major observatory and published best-selling works on astronomy but, much like Proctor, he could not do both at the same time. Lasting only four years at the Paris Observatory, Flammarion had bristled under the unsociable Le Verrier, and set about establishing a unique dual career.107 While he maintained contact with leading astronomers and contributed important work, French scientists saw him more as the public face of astronomy than as a major contributor. According to one notice published at his death, ‘his scientific reputation suffered’ because of the ‘activity which he displayed in popularising the science’. The review concluded that ‘fame as a public lecturer and as the author of popular books … somewhat detracted from his standing as a professional astronomer’.108 It is worth quoting this review because of how striking it appears in contrast to the earlier reception of Arago, Quetelet and even Airy, who all wrote popular astronomy without suffering similar damage to their professional reputations. Flammarion’s career in particular indicates that astronomy could not be both exciting to the public and acceptable in the professional discipline. Ewing’s seeming paradox, that the sciences progressed at the same time as the public removed themselves from the proceedings, was by the twentieth century no paradox at all. Not only did advances in practical astronomy take hold in spite of rapt public attention; they seemed to take place because the public had lost interest.

As the mathematician Robert Woodhouse recognized in his introduction to astronomy, any work worth the name of science needed to ignore the elements most interesting to the public. Such speculations of the kind favoured by Flammarion and Proctor could only ‘divert the attention of the student’ towards ‘foreign, fanciful, and antiquated’ theories. He argued that progress could only be made ‘by detailing and

104 Camille Flammarion, Astronomie populaire: Description générale du ciel, Paris: Gauthier-Villars, 1880, p. 2.
105 Flammarion, op. cit. (104), p. 829.
106 Bensaude-Vincent, op. cit. (79), p. 87.
107 Flammarion’s dismissal took place against the backdrop of a significant change in the role of astronomer at the Paris Observatory. See Aubin, op. cit. (31).
108 Hector MacPherson, ‘Camille Flammarion’, Popular Astronomy (1925) 33, pp. 654–658, 656.
explaining the best methods’, even if these methods were ‘very tedious’. For his practical manual, Woodhouse proposed only to describe practice—the day-to-day techniques of observers—and eliminate all references to history or theory, what he called ‘methods merely curious and of no practical utility’. There was no point in referencing even Tycho Brahe or Ptolemy, because ‘the spirit of defending’ those practices was ‘extinct’. Even Proctor agreed that work in the observatory was incommensurate with an appreciation of the history of astronomy or its cultural influence: ‘the astronomical surveyor must work unmoored by (historical contemplation), or he will scarcely work in an effective manner’.

The move away from history and other ‘methods merely curious’ of appreciating astronomy may have been the single largest reason why positional astronomy lost the public imagination. Even Arago may have hurt his own cause, and the cause of those who wished astronomy to be a ‘universal subject’, by severely limiting the variety of approaches that could be entertained. Arago deemed the history of astronomy and its place in literature and culture to be unnecessary to the project, calling them ‘foreign ornaments’. Instead, a ‘true’ appreciation of the science could be found in understanding ‘rigour, the clarity of the methods of investigation, and the magnificence and utility of the results’. Prior to Arago, the astronomer and physicist J.B. Biot proposed a similar plan for public instruction, arguing in his highly influential *Traité élémentaire* for a form of instruction for ‘the student with absolutely no knowledge of astronomy’. The first step, like that of Woodhouse and Arago, was to ‘disengage the student from his prejudices’. Then ‘little by little’ the freed student would ‘through reason ... find for himself ... the true mechanism of the system of the world’. Wonder and awe, the kind of immersed contemplation prescribed by Proctor and championed by poets and astronomers alike, was to be replaced by calculation. The ‘system of the world’, Biot argued, ‘envisioned in this world becomes a great problem of physics’ instead of a mystery. It should have been no surprise the public lost interest: how many readers would opt to solve a physics problem over reading a great mystery?

Biot, like Ewing, had observed that there was a ‘bizarre contradiction’ in astronomy between its success as practice and its failed reception in the general public. The field was, after all, making progress at an extraordinary rate, and the scope of ‘the oldest and most perfect’ of the sciences had been extended. Somehow, however, Biot felt that it ‘had not yet been introduced in the first instances in public instruction’. Biot’s multiple-volume solution to this ‘gap’ may indeed have been a cause of the contradiction. By limiting astronomy to a physics problem, he emptied the discipline of other approaches.

109 Robert Woodhouse, *An Elementary Treatise on Astronomy*, Cambridge: Smith, 1812, p. viii.
110 Woodhouse, op. cit. (109), p. xiv.
111 Proctor, op. cit. (98).
112 Arago, op. cit. (85), p. 1.
113 J.B. Biot, *Traité élémentaire d’astronomie physique*, 2nd edn, Paris: Klostermann, 1810, p. ix. For an interesting discussion of the ironies of the positions taken on public astronomy by Biot and Arago see Theresa Levitt, *The Shadow of Enlightenment: Optical and Political Transparency in France, 1789–1848*, Oxford: Oxford University Press, 2009, pp. 71–103.
114 Biot, op. cit. (113), p. x.
For a century after Biot wrote, in fact, the popularizers who had the most success in
relieving public boredom, like Proctor and Flammarion, knew well not to turn planetary
and stellar movement into a solvable puzzle.

Astronomical literature fragmented at the end of the nineteenth century, and no vade
mecum of astronomy covering the works produced at the turn of the century could have
justified including the writings of Proctor alongside the practical instruction books of
Chambers. *Astronomie populaire* was a title fit for canonical inclusion when used by
writers like Arago and Quetelet, but not when adopted by Proctor or Flammarion. While
astronomers at the beginning of the century like Ewing and Biot had held out hope for a
science that could attract both public and professional attention, professional astron-
omers by the end of the century had give up such hopes. Not only did the precise and
time-consuming work of positional astronomy create boring work in the observatory,
the resulting products of this work—star catalogues and ephemerides—were self-
consciously arid documents. Instead of following the daily progress of positional
astronomy in newspapers, audiences found a diverse array of popularizations whose
work was ignored or mocked by the professionals.115 Instead of being drawn into the
lectures of the ‘learn’d astronomer’, the public followed Proctor, Flammarion and
Whitman’s bored student outside.

**Conclusion**

Normative philosophies of science once claimed that scientific practice was epistemo-
logically sound because of a lack of bias on the part of its practitioners, a view rarely held
today even among scientists.116 Yet such philosophies may have been grammatically
close: scientific progress in positional astronomy required not disinterest but *uninterest*,
at least on the part of observatory workers and the newspaper-reading public. After this
sketch of the state of observatory work and astronomical publications of the nineteenth
century, one may wonder whether the success of positional astronomy in the face of
public ignorance was as ‘paradoxical’ and ‘bizarre’ as Ewing and Biot believed. Though
these astronomers did not know the word ‘boredom’ when they lodged their complaints,
their concern that a public which found astronomy lacking in meaning, interest or

115 Bigg has suggested that popular participation in astronomy may have been diverted to astrophysics by
the end of the nineteenth century because this field had ‘a preference … for representation rather than
calculation, for speculation rather than standardization’. Charlotte Bigg, ‘Staging the heavens: astrophysics
and popular astronomy in the late nineteenth century’, in Bigg, Aubin and Sibum, op. cit. (26), pp. 305–324, 322. It
has also been argued recently that astrophysics itself could only have originated in those ‘operating outside
the boundaries of professional physics’ and not in the ‘workers dedicated to the arduous tasks of mapping the
stars’. Barbara Becker, *Unraveling Starlight: William and Margaret Huggins and the Rise of the New
Astronomy*, Cambridge: Cambridge University Press, 2011, p. 13. Such an emergence may have been short-
lived, however; for the re-emergence of professionalism in astrophysics see John Lankford, ‘Amateurs and
astrophysics: a neglected aspect in the development of a scientific specialty’, *Social Studies of Science* (1981) 11,
pp. 275–303. A further study of how popular practices fared in astrophysics in the twentieth century is vital to
understanding whether this development was temporary.

116 Committee on Science Engineering and Public Policy, *On Being a Scientist: Responsible Conduct in
Research*, 2nd edn, Washington, DC: National Academy Press, 1995, pp. 3–4.
enthusiasm would hamper the development of the science seems to have been misplaced. During the very period when the observatory became a less interesting place to work and the publications far less interesting to read, the observatory also became the model scientific research institution. Boring science was a success! The less interesting method of astronomy practised in Greenwich and Washington, the observatories that Chandler proclaimed could not succeed because of their ‘benumbing influence’, was far more influential in establishing scientific methodology than Pulkovo, the Urania or Chandler’s small outpost in Buenos Aires. Furthermore, the publications of the discipline seemed almost intended to bore non-specialized readers. As the introduction to a recent collection of essays has suggested, astronomy may have needed to ‘seclude’ itself in order to ‘protect an aura of certainty’. As the editors note and contributions to the volume confirm, ‘the very idea of pure science depended on preserving this untainted site of knowledge production’.117 So much is true; what better way to keep knowledge pure than to make acquiring it uninteresting.

To return to the contemporary persistence of boredom in the sciences, it appears that the public ignorance and uninterest mocked by The Simpsons, invoked by Whitman and lamented by modern scientists may not be a coincidence. If astronomy, the oldest and most respected of the sciences, needed to expunge history, rich description and artistic contemplation from its publications while at the same time depersonalizing and deintellectualizing the actual labour, what hope did other sciences have? While boredom may have manifested itself in different forms in different scientific disciplines, its appearance in a science as influential as astronomy might indicate that boredom was present in many moments of scientific research in the past two centuries. The scope of boredom in the sciences has recently been suggested in New Scientist, where the author, a former scientist, reports that boredom was rampant among his colleagues in the lab. The ‘mind-numbing tasks’ and ‘ennui’ of his co-workers seem an open secret among the editorial offices of the magazine and are likely found in laboratories across the world today as well.118 An element of scientific research this pervasive cannot go unexamined.

If further investigations confirm incidents of boredom in the history of science, modern scientists frustrated by an indifferent public may face a difficult choice: continue to be successful using the models of investigation and dissemination developed in the nineteenth-century observatory or, conversely, allow other forms of investigation, including those ‘methods merely curious’ of art, history and philosophy, to contribute to scientific discourse. For our part, historians of science can hopefully overcome bias for the excitement of science and come to appreciate an overlooked yet essential feature of scientific production for the past 150 years.

117 Bigg, Aubin and Sibum, op. cit. (26), pp. 1–32, 26.
118 Battersby, op. cit. (5), p. 58.