Astronomy and its Audiences: Robert Ball and Popular Astronomy in Victorian Britain*

Pedro Ruiz-Castell
St Cross College, University of Oxford.

Popular science writing has been viewed as a way to obtain economic and social support for science, to legitimise scientific research, as part of the scientific culture and as a scientific mediator. This paper explores the popularisation of astronomy undertaken by the one-time Royal Astronomer of Ireland Sir Robert Ball during the second half of the nineteenth century. The complex interactions between popular science and other elements of scientific culture are examined by looking at the different audiences for astronomy and the strategy adopted by Ball.

The figure of Robert Ball

Sir Robert Stawell Ball (1840–1913) was a prominent and well-respected figure in Victorian society. Born in Dublin on 1 July 1840, Ball entered Trinity College Dublin in 1857, where he distinguished himself, finishing his studies in 1865 – having worked on Brinkley's *Astronomy*, Newton's *Principia* and Laplace's *Mécanique Célèste*, among other texts. His first contact with practical astronomy was at Birr Castle, Parsonstown. There, from 1865 to 1867, Ball combined his job as tutor to the sons of the third Earl of Rosse with regular micrometric observations of nebulae. He then moved back to Dublin on being appointed Professor of Applied Mathematics and Mechanics at the Royal College of Science. During this period, Ball's prestige as a scientist able to bring abstruse subjects within the comprehension of his audiences led to his election, in 1873, as a Fellow of the Royal Society.

One year later Ball was appointed Astronomer Royal of Ireland and Andrews Professor of Astronomy at the University of Dublin, and director of the observatory at Dunsink. His role as populariser of science, which had started years before, now developed strongly, and the lectures he delivered opened to him the doors to an appealing career. It was as a popular lecturer that he would come in contact with the widest circles.[1]

Ball moved to Cambridge in 1892 to take up the Lowndean Professorship of Astronomy and Geometry, and the next year he was appointed director of the Observatory of Cambridge – posts he held until his death in 1913. At a time when the application of the spectroscope in astronomy was making great headway, Ball's geometrical knowledge had led him instead to focus on observational astronomy, in particular on measuring stellar parallax. But the rapid rise of astronomical photography led him to completely abandon visual observations in his field.[2] It is tempting to present Ball as a scientist displaced by the rise of astrophysics: although interested in it, Ball did not take an active part in the new astronomy.

Nevertheless, many astronomers continued to make visual observations during this period. The main problem for Ball could have been his serious limitations as an observer. From 1883 his right eye began to deteriorate, and it was finally removed in 1897. After the publication of his research at Dunsink in 1884, he seems to have done very little observing. It seems plausible that Ball made a voluntary shift in his career, focusing on popular astronomy topics, where his eye trouble was not an impediment. From 1877 to 1906 he published many works in this field. This was a consequence of his success as a lecturer, an activity that took him to several towns and cities of Britain and Ireland. He also visited America for lecturing tours in 1884, 1887 and 1901. His prestige as a scientist and populariser gained him positions in academies, associations and societies, as well as acting as adviser to official bodies such as the Irish Lights Boards.

The rise of popular science

During the second half of the nineteenth century, along with the creation of the modern concept of technology, a new role of science in education and the economy, and the gradual professionalisation of science from its amateur origins, there was a marked rise of popular science as a mass phenomenon. It had begun during the first half of the century by populariser who disseminated science because it was 'useful knowledge, an instrument of self-improvement, an aid to profitable, rational, and usually individualistic economic activity, and a pillar of natural religion'.[3]

The success of popular science was linked to social and economic factors such as the growth of an educated middle class and the invention of a cheaper steam-powered printing technology. Public science became more and more important in the

* Paper presented at the History of Astronomy Session at National Astronomy Meeting in Dublin, 10 April 2003
Paper submitted June 2003, accepted January 2004

social context. An example of this is the foundation in Britain of the University Extension Movement in the late 1860s.[4] Popular lectures became fashionable, not only in Britain but also on the continent, generally linked to the growth of liberalism. They were held in town halls, public libraries, Mechanics Institutes,[5] village schoolrooms, Co-operative Societies and even chapels.[6] This programme of bringing education to the masses helped to open up the universities to religious nonconformists, women and poorer men.[7] Changes in the popularisation of science also came about through the direct intervention of governments, such as scientific education through the foundation of science museums.[8]

Astronomy, like engineering, became a very popular subject during the nineteenth century. The studies of the stars made by William Herschel (1738–1822) and his son John Frederick William Herschel (1792–1871) with large reflecting telescopes had changed the character of astronomy. Popular lecturers translated to wondering audiences the Herschels' discoveries, which opened up 'new physical and intellectual horizons that captured the public imagination'.[9] The rise of science popularisation can also be linked to the need to create publics for science. Social diversity required different audiences. Popularisers addressed and adapted their rhetoric to these audiences, and at the same time redefined them.

Controversy: professional scientists *v.* popularisers of science

Ball was rated by his contemporaries as 'one of the two or three greatest British mathematicians of his generation'.[10] Famous is his theory of screws, based on his researches on screw motions[11] – a topic that could have, in some aspects, links with his first observations of many faint nebulae. He was also described as a master of practical astronomy and as one of the 'highest authorities in speculative astronomy'.[12] In his popular books he presented professional scientists as the right people to analyse and interpret scientific knowledge, 'as those competent to judge'.[13] Particularly interesting is the way he presented his own professional activity, the 'wondrous alliance between mathematics and astronomy',[14] and the role of mathematical reasoning in astronomy.[15]

Ball enjoyed a considerable vogue as a public lecturer and author. His lectures were delivered in a language appealing to the public, without any specific or exclusive terms. This way of addressing an audience has been identified in particular with the popularisers of science, non-professional scientists, of the late Victorian period. In fact, the second half of the nineteenth century has been traditionally seen as a time of increasing tension between amateurs (including journalists) and professional scientists (who tried to exclude amateurs from scientific activity). Robert Ball, however, was an individual astride both cultures. We can use his example to take a different approach to this traditional picture: to study the interactions between several expressions of public and popular science, and provide a way of studying the mediatory role of popular science. Ball is what one could call a bridge point between these two *cultures* that have been said to compete during the nineteenth century in the field of popular science.

One can sense this tension in some of Ball's pronouncements on controversial issues, such as the existence of Martian canals. He discussed the canals in his lectures, often at the request of a curious audience who wanted to know whether there was life on Mars. In 1892 and 1893 Ball wrote at least two articles supporting the existence of Martian canals and the possibility of finding (non-intelligent) life there.[16] He adopted a similar but even stronger attitude in the 1898/99 Royal Institution Christmas Lectures.[17] This position was in close agreement with those of Percival Lowell (1855–1916) and Camille Flammarion (1842–1925), two of the most respected popularisers of astronomy of the period. However, Ball supported the conclusions of the prestigious astronomer Edward Emerson Barnard (1857–1923), who questioned the existence of Martian canals, at two meetings of the Royal Astronomical Society in the mid-1890s.[18] This uncharacteristic vacillation seems to be related to how Ball performed for different audiences.

When they were addressed to the professional community, Ball's works were very descriptive, full of data. Professional scientists had a different way of communicating and presenting the results of their researches –a mode that Ball was as competent in as when he was speaking to the public. For his public lectures, though, he wove a coherent and convincing story that explained the truths of the real world, a tale full of anecdotes and other elements to catch the audience's attention and exercise their imagination. Ball, as a populariser, explained in an easily digestible way how the world worked, and justified the activities of professional scientists.[19] Popular science was also a scientific mediator, creating an interchange between the ideas discussed in the scientific community and the ones presented at popular lectures: each fed on the other.

Ball's programme to popularise astronomy

Ball consolidated his position in the world of science popularisation during the late 1870s and early 1880s. One is tempted to suggest that economic reasons were behind his decision to pursue a career in this field. In fact, he always charged a fee

for attending to his courses and seminars.[20] Whatever the reasons, my opinion is that Ball carefully planned the development of his career as a populariser of astronomy. The first stages of Ball as a popular lecturer saw him visit several Mechanics Institutes.[21] Later, in November 1880, he offered himself to the Royal Institution to deliver one of the Friday evening lectures. As Ball himself pointed out, in lecturing at the Royal Institution he was now in exalted company: 'all the most distinguished men of learning, past and present, who have being called into being since the days when these lectures were first started'; it was 'to receive the blue ribbon of the lecturer'.[22]

After his entrance into the pantheon of popularisers, with a lecture delivered at the Royal Institution on 11 February 1881, based on his work at Dunsink and entitled 'The distances of the stars', Ball received invitations to lecture at various institutions. He received one that same year from the Royal Institution to give the 1881/1882 Christmas Lectures.[23] By 1884 he had delivered around seven hundred public lectures, and he probably lectured to more than a million people during his entire life.[24] Ball's lectures became a mass phenomenon, regularly delivered to audiences of five hundred to a thousand. The Gilchrist Lectures, intended for the working classes, brought him to more than two hundred towns of England, Scotland, Wales, Ireland and the Channel Islands.[25] The lecture series for the Gilchrist Trust became of crucial importance for Ball's career, while they were an exceptional trampoline for developing his vocation as a populariser of science and gaining prestige both in the fields of popular and academic astronomy.

Characteristics and success of Ball's popular work

Ball worked hard to develop visual aids for his audiences to demonstrate the heavenly bodies, their sizes and their distances. A good example is the large india-rubber ball he used to suspend by a string and illuminate with a beam of electric light, in order to explain to his audience the phases of the Moon. He also used devices to illustrate the appearance of lunar craters, a Foucault's pendulum to demonstrate the rotation of the Earth, 'a model of Saturn with his rings, an arrangement to illustrate an eclipse, a comet which gradually extended a splendid tail and then disappeared, a nebulous-looking object which, when shown on the screen, was made to transform into a cluster of stars; and smoke rings which were shown in illustration of the annular nebulae'.[26] Models, slides and other kinds of apparatus helped him not only to illustrate and better explain the subject of his lectures, but were also used in delivering the same lecture as many times as he could. At the same time, his capacity for improvisation and his techniques and skills made Robert Ball an expert on the stage.[27]

He usually delivered public lectures only by invitation, and only if his terms and requirements were accepted. There is no doubt that, although he acted as someone interested in the dissemination of scientific knowledge, he was also guided by his own financial interests. Tickets for the lecture were usually distributed long before Ball arrived at the place. Once there, Ball was introduced by the chairman to the audience. Making use of his characteristic and loud voice, Ball presented during his lectures his theories of how climatic changes were caused by long-term variations in the Earth's orbit; his nebular hypothesis, which was based on his explanation of the solar system's origin; and other such theories. He always used an accessible language and made use of his 'delightful gift of humour … to enliven any dull parts of a lecture and retain the attention of his hearers'.[28]

Ball's success as a populariser of science came not only from his lectures, but also from several written works. This approach, frequently used during the nineteenth century, not only allowed a broader audience to be reached, but also involved little additional effort for the author, who gained the reputation of publication.[29] The most prolific years of Ball's career as an author were from 1880 to 1900. He published not only pure scientific papers dealing with astronomy, but also many popular books, as well as contributions to popular science journals such as *Nature*, *Science* or the French *L'Astronomie*. These works, many of them mere transcriptions of lectures, were described by his contemporaries as written in a pleasant, clear and concise style.[30] Good examples are Ball's most widely known lecture of his early period as a public speaker, 'A glimpse through the corridors of time',[31] and his popular book *Starland*, based on his 1887 Christmas Lectures at the Royal Institution.[32]

Astronomy and its audiences

As we have seen, Robert Ball, like other popularisers of science, adapted his rhetoric to match his audience. It seems to me clear that this was a very important part of their success. Ball, one of the most prestigious and best-known popularisers of science in the Victorian period, carefully cultivated this ability. His activity as a populariser opened to him the doors of fame, and provided him not only with the opportunity to make many different and important contacts, but also to gain personal prestige, both as socially and as a scientist.

I have mentioned the different ways of communicating knowledge that professional scientists used when addressing their colleagues and when talking to the public. Let me focus now on a more subtle and particular case: the transcription of the first of

Ball's Friday Lectures at the Royal Institution, 'The distances of the stars'. In this lecture, Ball addressed members of this scientific society and their friends – in other words, people acquainted with the rudiments of astronomy and scientific knowledge in general. The lectures were to enlighten them about recent discoveries and the results of astronomical research.[33] He explained the annual parallax of 61 Cygni with the aid of a diagram:[34]

> On a review of the whole question there seems no doubt that the annual parallax of 61 Cygni is nearer to the half second found by Struve, than to the third of a second found by Bessel. To exhibit the nature of the evidence which is available for the solution of such a problem, a diagram has been prepared. The abscissae are the dates of the second series of observations made at Dunsink. The ordinates indicate the observed effect of parallax on the difference of declinations between 61(B) Cygni [i.e. 61 Cygni B] and the comparison star. Each dot represents the result of the observations made on the corresponding night. The curve indicates where the observations should have been with a parallax of 0″.47, the effect of the parallax in declination being only 0″.40.

In his most popular work, *The Story of the Heavens*, the *Nature* article from which the above quote is taken became Chapter XXI. Of course, he did not use here the same words employed to address the audience of the Royal Institution and the readers of the journal:[35]

> It is desirable to give the reader the means of forming his own opinion as to the quality of the evidence which is available in such researches. The diagram has been constructed with this object. It is intended to illustrate the second series of observations of difference of declination which I made in Dunsink. Each of the dots represents one night's observations. The height of the dot is the observed difference of declination between 61(B) Cygni and the comparison star. The distance along the horizontal line – or the abscissa, as a mathematician would call it – represents the date. These observations are grouped more or less regularly in the vicinity of a certain curve. That curve expresses where the observation should have been, had they been absolutely perfect. The distances between the dots and the curve may be regarded as the errors which have been committed in making the observations.

Ball thus related the wonders and mysteries of the universe to the public using appropriate language, adapting his speech and his presentation for the particular audience. In the words of a letter he received at Dunsink, he almost made people believe that the *Story of the Heavens* was so simple that a child could understand it.[36] This was perhaps the reason for Ball's success: he learned to address different audiences in the appropriate way. However, he was also part of the creation of a scientifically aware public, and his programme to popularise astronomy became an element of what one might call a general scientific culture, a mediator between the scientific community to which he belonged and his contemporary society.

Notes and references

1. 'Ball, Sir Robert Stawell 1840–1913', *The Dictionary of National Biography*, Vol. 1912–1913 (Oxford University Press, 1927), pp. 19–20.
2. J.L.E. Dreyer, 'Sir Robert Ball, F.R.S.', *Nature*, **92**, 403–404 (1913).
3. Frank M. Turner, 'Public science in Britain, 1880–1919', *Isis*, **71**, 589–608 (1980), here p. 590.
4. This movement was strongly linked to the name of James Stuart (1843–1913). His first course, delivered in autumn 1867 in Liverpool, Manchester, Leeds and Sheffield, was on astronomy.
5. Adult education colleges established for the benefit of workers who wanted to improve themselves, often founded by wealthy industrialists.
6. Exactly the kind of places where Robert Ball delivered his lectures and courses when he visited towns such as Rochdale, Accrington, Huddersfield, Preston and Bury – towns that were part of his first tour as a lecturer for the Gilchrist Trust. For a complete study of the information we have about these lectures, including a brief history of the Gilchrist Trust, see W. Valentine Ball (ed.), *Reminiscences and Letters of Sir Robert Ball* (London: Cassell, 1915), pp. 214–219.
7. In Oxford, for instance, the Reverend Arthur Henry Johnson (1845–1927) delivered in Birmingham, in 1878, the first of the Oxford extension lectures, 'The history of England in the seventeenth century' – see Lawrence Goldman, *Dons and Workers: Oxford and Adult Education Since 1850* (Oxford, Clarendon Press, 1995).
8. Of many books dealing with the foundation of science museums, a good introductory one is T. Bennett, *The Birth of the Museum: History, Theory, Politics* (London and New York, Routledge, 1995).
9. H.C. King, *Geared to the Stars* (Bristol, Adam Hilger, 1978), p. xiv.
10. Cited in James Moseley, 'Sir Robert Stawell Ball F.R.S.', *Journal of the British Interplanetary Society,* **32**, 157 (1979).
11. A brief summary of his geometrical method can be found in Susan McKenna-Lawlor, 'Robert Stawell Ball: Mathematician and astronomer' in C. Mollan *et al.* (eds), *Some People and Places in Irish Science and Technology* (Dublin, Royal Irish Academy, 1985), pp. 56–57.
12. H. MacPherson, *Astronomers of Today* (London and Edinburgh, Gall & Inglis, 1905).
13. W.V. Ball, *Reminiscences and Letters*, p. 189.
14. Robert S. Ball, 'Comets', *Nature*, **30**, 454–457 (1884), here p. 454.
15. Robert S. Ball, 'A glimpse through the corridors of

time', *Nature*, **24**, 79–82 (1881), here p. 80.
16. See N. Whyte, *Sir Robert Stawell Ball (1840–1913)* (http://explorers.whyte.com/ball.htm, August 2002); and R. Jones, *Sir Robert Ball: Victorian Astronomer, 1840–1913* (http://www.geocities.com/ziksby2/Sir_Robert_Ball.html, January 2005). Whyte cites the *Fortnightly Review*, **52**, 288 (1892); Jones cites a Goldthwaite's *Geographical Magazine* published in 1893.
17. Whyte, *Sir Robert Stawell Ball*, mentions articles in *The Times* on 28 December 1898, 30 December 1898, 2 January 1899, 4 January 1899, 6 January 1899 and 9 January 1899.
18. Whyte, *Sir Robert Stawell Ball*. This conclusion is said to be based on reports in the *Monthly Notices of the Royal Astronomical Society*, **56**, 163 (1896) and *The Observatory*, **19**, 72 (1896); **20**, 152 (1897).
19. Scientists were used to discussing scientific controversies. However, Ball's interest in presenting science, and in particular astronomy, as a legitimate activity, as well as his ambition of becoming a well-recognised figure, led him to rarely mention in his lectures alternative arguments to the ones he put forward.
20. 'I cannot afford the time to give lectures unless I am well paid for them,' he wrote to a lady in 1880 – see W.V. Ball, *Reminiscences and Letters*, p. 224. Ball would deliver the same lecture as many times as he could so as to obtain more money for less intellectual effort. He did, however, give some free lectures, on behalf of the Missions to Seamen, in his later years.
21. This was on his first lecturing tour, when he visited Birmingham, Hanley and Gloucester.
22. W.V. Ball, *Reminiscences and Letters*, pp. 202–203.
23. He would also deliver the Christmas Lectures in 1887 and 1891.
24. F.W.D. and G.T.B., 'Sir Robert Stawell Ball, 1840–1913', *Proceedings of the Royal Society*, Series A, Vol. 91 (London, Harrison & Sons, 1915).
25. It was through the secretary of the Trust in 1879, his friend William Benjamin Carpenter (1813–1885), that Ball first undertook lectures for the Gilchrist Trust. This was because Richard Anthony Proctor (1837–1888), a well-known writer and lecturer on astronomy linked to the Trust, was about to embark on a world lecture tour.
26. W.V. Ball, *Reminiscences and Letters*, p. 208.
27. There are several curious and interesting anecdotes that show Robert Ball's capacity for solving unexpected problems when lecturing. One of the most famous relates to his lecture 'Krakatoa: The mighty volcano' that he had to deliver with the wrong slides (he used the ones for his lecture 'The Moon') and a crashed terrestrial globe. See W.V. Ball, *Reminiscences and Letters*, pp. 196–197; see also http://www.geocities.com/ziksby2/Lecturer.html.
28. F.W.D. and G.T.B., 'Sir Robert Stawell Ball'. There is also some valuable information about Ball's methods as a lecturer in W.V. Ball, *Reminiscences and Letters*, pp. 219–230.
29. D.A. Hinton, 'Popular science in Britain, 1830–1870', Ph.D. thesis, University of Bath (1979), pp. 170–197.
30. F.W.D. and G.T.B., 'Sir Robert Stawell Ball'; and Dreyer, 'Sir Robert Ball, F.R.S.', pp. 403–404.
31. This was the inaugural lecture at the new hall built by the Midland Institute, delivered on 24 October 1881. See W.V. Ball, *Reminiscences and Letters*, p.193. The lecture, unusually written before it was delivered, was subsequently printed in *Nature* (published in two parts: **24**, 79–82 (1881) and **25**, 103–107 (1882)) and in pamphlet form by Macmillan a year later.
32. It was the publisher who sought Ball's permission to transcribe his spoken lectures. They were recorded at the lectures by a reporter and later rewritten by Ball. The book, which appeared in 1889, was a great success.
33. In this case the lecture dealt with recent investigations by the Astronomer Royal of Ireland at Dunsink.
34. Robert S. Ball, 'The distances of the stars', *Nature*, **24**, 91–92 (1881).
35. Robert S.Ball, *The Story of the Heavens* (London, Cassell, 1985), pp. 449–450.
36. Letter signed in Aberdeen, 5 June 1889, probably by the Surgeon J. Farquhar. See the correspondence relating to Dunsink Observatory, Dublin, 1885–1900, at the Museum of the History of Science, Oxford (MS Museum 54).

Appendix: Robert Ball's popular scientific texts

Note that the distinction between scientific and popular works is not always clearly delimited.

Books

The place of publication is stated only if different from London.

Experimental Mechanics, a Course of Lectures (1871).
Elementary Lessons on Applied Mechanics (1872).
Astronomy (1877).
Mechanics (1879).
Elements of Astronomy (1880).
A Glimpse Through the Corridors of Time (1882).
The Story of the Heavens (1885).
Time and Tide: A Romance of the Moon (2 lectures) (1889).
The Cause of an Ice Age (1891).
An Atlas of Astronomy: A Series of Seventy-two Plates, with Introduction and Index (1892). [Later published as *A Popular Guide to the Heavens*.]
In the High Heavens (1893).
The Story of the Sun (1893).
Starland: Being Talks with Young People About the Wonders of the Heavens (1895).
Great Astronomers (1895).
A Primer of Astronomy (Cambridge, 1900).
The Earth's Beginning (1901).
The Latest Achievement in Astronomy (1904).
A Treatise on Spherical Astronomy (Cambridge, 1908).

Articles

'Speculations on the source of meteorites', *Nature*, **19**, 493–495 (1879). [27 March, read at the Royal

Irish Academy on 13 January.]
'The distances of the stars', *Nature*, **24**, 91–92 (1881). [26 May, lecture at the Royal Institution of Great Britain on 11 February.]
'A glimpse through the corridors of time, I', *Nature*, **24**, 79–82 (1881).
'A glimpse through the corridors of time, II', *Nature*, **25**, 103–107 (1882).
'On the occurrence of great tides since the commencement of the geological epoch', *Nature*, **27**, 201–203 (1882). [28 December, extract from a lecture delivered at the Midland Institute of Birmingham on 20 November.]
'Comets', *Nature*, **30**, 454–457 (1884). [4 September, lecture at the Montreal meeting of the British Association.]
'L'Origine des étoiles filantes', *L'Astronomie*, 331–337 (1886).
'A dynamical parable', Address to the Mathematical Section of the British Association, 1887.
'The absence of air from the Moon', *Science*, **21**, 99 (1893).