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Centuries of stars: The history of astronomical visualisation in and out of museum collections

The centenary of the first opto-mechanical planetarium projector, the Zeiss Mk 1, fell not quite two years ago.[1] In October 1923, on a rooftop in Jena, Germany, a public audience felt the *'illusion of infinite space'*[2] as the stars and planets were represented with points of light on a domed surface that appeared to have *'been rolled away, revealing the sky'*.[3] This device, able to dial up the appearance of the night sky for any date in the past or the future, was a mechanical wonder of the modern world. Perhaps *'the most important single device for popularising astronomy since the early twentieth century'*, it was yet just the latest in a line of astronomical visualisation technologies that had stretched back centuries.[4] In the hundred years that have followed the first outing of the Zeiss Mk 1, planetariums have continued to evolve, including a diminishing number of opto-mechanical projectors but the addition of high-definition video, lasers and, recently, solid-state screens. All of these are building on the visualisation traditions of the past.

Remaining within collections around the world — including those of Museums Victoria — are many older technologies of display, including mechanical orreries and astronomical lantern slides. Other technologies of popular astronomy, such as the transparent orrery, or Eidouranion, have been lost almost entirely, recorded only in printed memories and artefactual reflections. New devices have always built on older ones — the first opto-mechanical planetarium projector, the Zeiss Mk 1, was itself

1 For more on this centenary, see Bush, M., & Hill, T. (2025). For 100 years, we have marvelled at planetariums. Here's a brief history of how humans brought the stars indoors. https://theconversation.com/for-100-years-we-have-marvelled-at-planetariums-heres-a-brief-history-of-how-humans-brought-the-stars-indoors-255228; McMahon, M., Raposo, P., Smail, M. & Boyce-Jacino, K. (2024). 100 years of planetaria: 100 stories of people, places and devices. Springer Praxis Books.

2 Marche, J. (2005). *Theaters of time and space: American planetaria, 1930–1970*. Rutgers University Press.

3 Love, G. (1939, October 23), Theatre of the Stars. *Pittsburgh Press*, p.18.

4 Bigg, C. (2017). The view from here, there and nowhere? Situating the observer in the planetarium and in the solar system. *Early Popular Visual Culture, 15*(2), pp. 204–26. https://doi.org/10.1080/17460654.2017.1323409

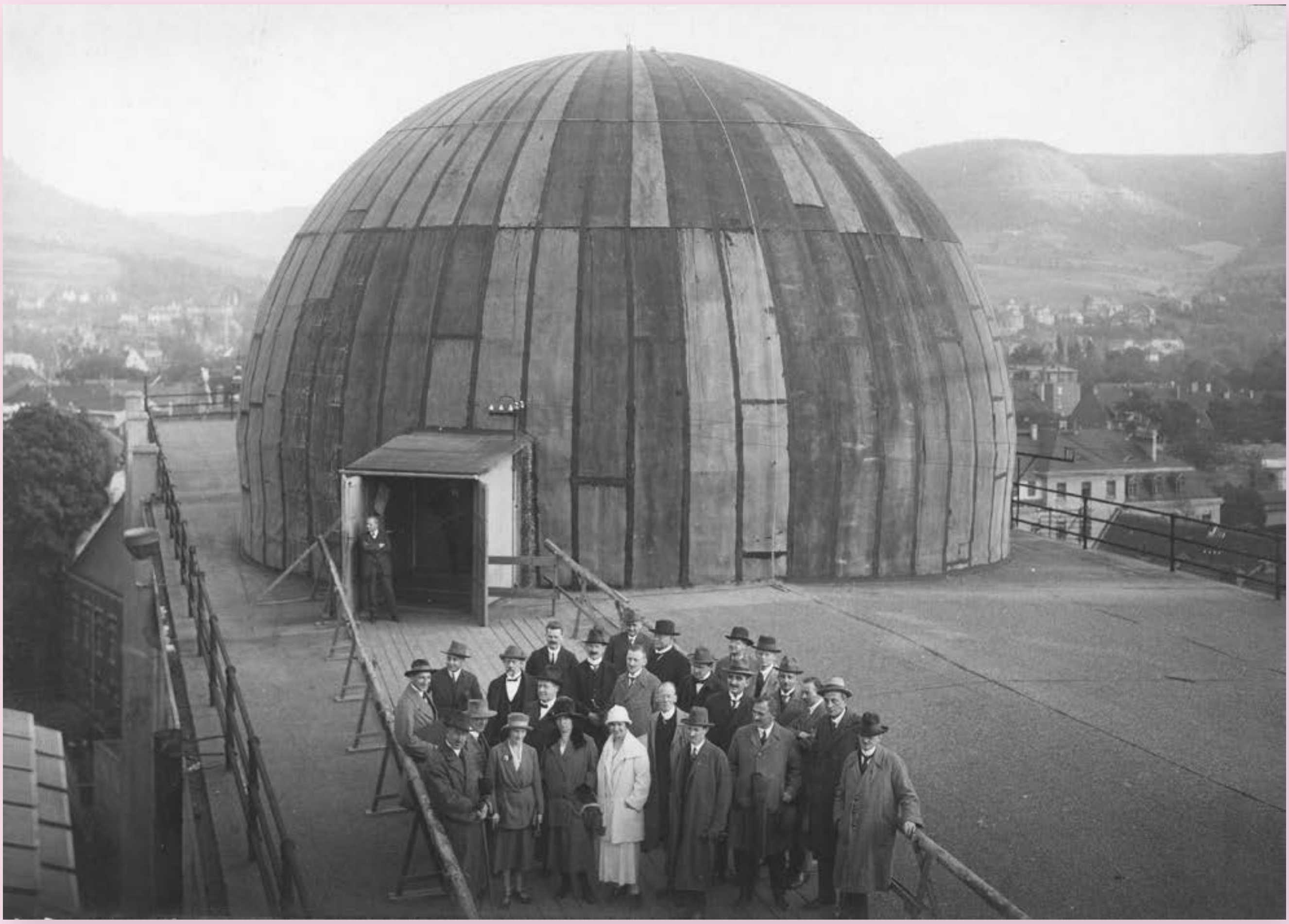

Figure 1: The world's first opto-mechanical projection planetarium on the roof of the Zeiss company building in Jena, 1923. ZEISS Archives; photographer: unknown; © ZEISS Archives.

built around lantern slides. All have their stories to tell. All have contributed to cultural stories about the role of astronomy in society.

Personal histories

Melbourne — and Museums Victoria — holds an excellent heritage of astronomical popularisation. However, the honour for the first planetarium in Australia — and indeed in the Southern Hemisphere — goes to Sydney. From 1950, the Museum of Applied Arts and Sciences (MAAS) operated a Spitz planetarium projector, although the first public showing of this planetarium projector was in the Queen Victoria Building under the auspices of QANTAS.[5] However, the installation in MAAS was never entirely suitable and the planetarium was removed around 1980 in preparation for the Powerhouse Museum redevelopment. The H. V. McKay Planetarium, at the Science Museum of Victoria in Swanston Street, Melbourne, opened in 1965 and operated until its closure in 1997,

5 Minister opens Sydney planetarium (1950, 16 December). *Sydney Morning Herald*, p. 5; Exhibition on QANTAS (1950, 14 November). *Sydney Morning Herald*, p. 12.

to be replaced with only a short delay by the current Melbourne Planetarium at the Scienceworks campus of Museums Victoria in Spotswood, Melbourne.

The museum may have changed names and locations, but it has maintained a continuous connection with planetariums for 60 years.[6] One consequence of this is that the museum holds a range of planetarium projectors — possibly the most extensive in the world — including a rare near-complete opto-mechanical projector, the GOTO from the H. V. McKay Planetarium, and the Digistar II, one of the only examples of the first generation of purpose-built digital projectors.[7] At the same time, the museum is also custodian of one of the best international collections of astronomical lantern slides in the world.

If I am sounding invested in this tradition, it is because I am. Growing up in Brisbane, one of my childhood delights was a trip to the Sir Thomas Brisbane Planetarium at Mt Coot-tha; I moved to Melbourne in 1997, just in time to see one of the last public sessions at the H. V. McKay Planetarium; and shortly after getting a job at Museum Victoria I was entrusted with programming the Digistar II. Fascinated by the astronomical lantern slides within the museum's collection, I went on to research the history of astronomical visualisation and have now visited many of the most significant public collections of astronomical lantern slides in the world.

What most struck me on moving from producing early twenty-first century planetarium shows to scholarship on late nineteenth century popular astronomy is how continuous they were in tradition. With just a few edits, talks that the then world-famous popular astronomer Richard Proctor gave in Melbourne in 1880 would be little out of place in the Melbourne Planetarium today.[8] In both presentations, we can hear about the vastness of space and the tininess of the planet Earth in comparison, the remarkable regularities of the motions of the heavens, the sublime beauty of a total solar eclipse and the startling appearances of great comets.

Images of astronomy in lantern slides

Many differences do, of course, exist between the presentations of the nineteenth century and those of today. These are revealed by the images of lantern slides in collections. Some of these reflect changes in style of presentation while others portray changes in historical memory. Amongst my favourite examples are the uses of the 'ship proof' to demonstrate that the shape of the Earth is spheroidal. There are several versions of this slide image, including both animated and non-animated versions, but across many instances of the astronomical slide set they appear at the start of the sequence, intended to be used at the start of a lecture. A very common example of this is the animated slide MM 112717 in Museums Victoria's astronomy collection. The slide is drawn from a set of rackwork slides, first appearing around 1840 but common throughout the nineteenth century. This particular image is

6 The current longest-running planetarium in the Southern Hemisphere is in Montevideo, Uruguay, having opened its doors ten years before the H. V. McKay Planetarium.

7 The Digistar II projector was based around a single beam of light from a Cathode Ray Tube that could be projected to any point of the dome through a fish-eye lens. Successive generations of digital projectors relied upon edge-blending from multiple high-end projectors, with the control coming through standard (but also high-end) computing devices.

8 For more on Proctor's tour of Australia, see Bush, M. (2017). The Proctor-Parkes incident: Politics, protestants and popular astronomy in Australia in 1880. *Historical Records of Australian Science*, 28, pp. 26–36. https://doi.org/10.1071/HR17001

Figure 2: Item MM 62766, Negative showing an audience at the H. V. McKay Planetarium at the Museum of Victoria with the Goto M-1 projector in the centre, around 1970. Museums Victoria; photographer unknown; © Museums Victoria.

Figure 3: Item MM 112717, Lantern slide, 'the Earth's rotundity', showing an animated version of the 'ship proof', around 1850. Museums Victoria; photographer: John Broomfield; © Museums Victoria.

intended to demonstrate what we see when a steamship sails over the horizon towards a port. The first part of the ship to appear in view is the top of the funnel, while the last part to appear is the waterline. Meanwhile, an observer standing at a higher location, like a tall tower, can see further over the horizon than an observer standing at sea level and thus sees the ship earlier. These are all observational facts compatible with a round Earth.

The slide 'Rotundity of the Earth', part of item 64091 in the Bill Douglas Museum at the University of Exeter, has a slightly simpler animated version of this 'ship proof'. This slide comes from a set produced by the brothers William and Samuel Jones, who are among the earliest producers of astronomical lantern slides. The Joneses' slide also contains a static image with a counterfactual version of this argument: if it *were* the case that the Earth were flat then we would see ships shrink strictly in geometric proportion as they approached the horizon, but with all parts visible at all times. Since this is *not* what we see, we can be confident that the Earth is not flat. I can only imagine what my science communication mentors would have said had I tried to introduce a counterfactual argument in the first five minutes of a presentation.

Another use of this technique is shown by the slide MM 112613 in Museums Victoria's collection, which demonstrates that the Earth is smaller in size than the Sun. This slide comes from yet another early astronomical lantern slide set, the 'Popular Lecture on Astronomy'. Here, we are presented with a diagram that illustrates what the consequences would be if the Earth were larger than the Sun. In that case, the shadow cast by the Earth would continue indefinitely in space, always growing, and even the most distant of the planets would be eclipsed when it travelled into this shadow. Again, since this is what we do *not* see, we can be confident that it is *not* the case. As well as the use of a style that is unusual today, this slide is evidence of the

Figure 4: Slide 'Rotundity of the Earth', part of item 64091 in the Bill Douglas Museum showing animated and non-animated versions of the 'ship proof', around 1925. The Bill Douglas Cinema Museum, University of Exeter; photographer: unknown; © University of Exeter.

Figure 5: Item MM 112613, Lantern slide, 'Newtonian system' and 'Earth's shadow' including a proof that the Earth is smaller than the Sun, around 1847. Museums Victoria; photographer: Jon Augier; © Museums Victoria.

Figure 6: Item MM 112612, Lantern slide, 'Pythagorean, or Copernican System' and 'Tychonic System' including an illustration of the Tychonic theory of the solar system, around 1847. Museums Victoria; photographer: Jon Augier; © Museums Victoria.

kinds of questions that were pertinent in the mid-nineteenth century. It is unlikely that this question would even be posed in a contemporary planetarium show.

An even more striking example of this changing historical memory, appearing in the same lantern slide set, is the slide MM 112612, which shows the Tychonic theory of the solar system. Almost forgotten today outside the academic field of the history of astronomy, this 'system of the world' was an intermediate position between the old Ptolemaic system — in which the Earth was stationary at the centre of the Universe, with the solar system revolving around it — and the radical heliocentric theory of Copernicus, which placed the Sun at the centre and the Earth as just one of many planets orbiting it. In so doing, the Tychonic system incorporated all the empirical evidence in support of the Copernican system while avoiding the very real theoretical — and theological — issues associated with a moving Earth. For most of the mid-seventeenth century, between the 1620s and the 1680s, before astronomy was reorganised around Newtonian mechanics, the Tychonic system was taken extremely seriously by scholars. Two centuries after this, the Tychonic system was still being recognised, in part because it was able to be portrayed by British popularisers as another stepping stone on the path to the truth revealed by the great Isaac Newton. The rational sciences, like astronomy, have always been bound up with nationalistic traditions. In any case, the memory of the Tychonic system was kept alive with the magic lantern slide. Subsequently, with the demise of that format, it has fallen into obscurity.

One more aspect of the practice of popular astronomy that is revealed by the images of magic lantern slides is the interplay of emotion and reason in communication strategies. It is clear that these elements have long been intertwined. In particular, historians of science have recently shown the importance of performance to science communication, the role of awe in those performances and the role of epistemic emotions in general.[9] Nonetheless, it is striking that astronomy has long been recognised as one of the most visual of the sciences — and one in which even everyday observations of the unaided eye can participate, and yet the character of many of the images above is mathematical and diagrammatic. For many popularisers of science in the nineteenth century, the wonder of astronomy was expressed precisely through its geometrical aspects and their implications of a perfect celestial science — one with particularly philosophical and spiritual dimensions. However, this is not the case for all lantern slide images. The item 1699998 in the National Film and Sound Archive's collection shows a far more naturalistic image of a comet over a landscape. This is a depiction of the great Comet Donati of 1858, and the image bears resemblances to many of the works of art that were produced in the wake of this comet. In contrast to the abstract, universalising laws of other astronomical slides, this image evokes a place-centred, affective response to celestial science. This tension was present in the astronomical performances of the past and remains so today.

9 For example, Morus, I. (2010). Worlds of wonder: Sensation and the Victorian scientific performance. *Isis, 101*(4), pp. 806–16. https://doi.org/10.1086/657479; for awe as epistemic emotion, see Silva Luna, D., & Bering, J. M. (2020). The construction of awe in science communication. *Public Understanding of Science, 30*(1), pp. 2-15. https://doi.org/10.1177/0963662520963256

Figure 7: Item 1699998, Lantern slide depicting Donati's comet of 1858, around 1870. Courtesy of The National Film and Sound Archive.

Past technologies of display

The Joneses' slides, the 'Popular Lecture on Astronomy' and the animated rackwork slides all come from the heyday of magic lantern technology in the nineteenth century. This era of a new media technology was driven by a longstanding cultural interest in astronomy as well as a burgeoning industry of slide manufacturing. However, the presence of lantern-slide projection as a public format depending crucially on the intensity of illumination with which these images could be projected. At the turn of the nineteenth century, slides were best lit by oil lamps, powered by whale oil. This allowed projections that could be clearly seen by audiences in a small room during daytime or in a much larger space if completely darkened. Lantern illumination was revolutionised by the application of the limelight, a lighting originally developed for lighthouses. This combination of new illuminants and more easily produced slides allowed the magic lantern to be used consistently for large audiences in public spaces. This combination created a screen culture inherited by cinema at the end of the nineteenth century.

Yet the techniques of the astronomical lantern show were shaped by an even earlier tradition — that of stage astronomy. Before the limelight, there were astronomical lecturers who were able to present large, illuminated displays in front of theatre crowds. From at least the 1780s — a decade before there is evidence of commercially produced astronomical lantern slides — the Walker family's Eidouranion was impressing crowds in London and elsewhere. As part of the British Enlightenment's use of 'polite astronomy', the Walkers' performances were *'widely hailed for their morally uplifting effect on their audiences'*.[10] The Eidouranion itself would go on to have a remarkably long life, but even more notably its technology would be copied, adapted and shamelessly plagiarised around the world.

This stage astronomy tradition in Britain expanded remarkably in the early nineteenth century, with multiple performers presenting lectures with devices that were similar to the Walkers' Eidouranion but had different names, like the Dioastrodoxon and the Ouranologia. The style and content of these popularisers varied widely, ranging from the devoutly religious to the philosophically secular.[11] These presentations were not confined to the United Kingdom. At around the same time, such devices were seen in North America and in the Australian colonies. The images that this tradition displayed — the tides, the zodiac, building up to the Copernican 'system of the world'[12] — would influence later lantern slides.

Unlike the magic lantern, there are no surviving artefactual traces of the Eidouranion or its imitators. A particular complication is that names like 'Eidouranion' or 'Dioastrodoxon' were brands of performance rather than specific devices; and each such performance included a range of technologies, including static transparency paintings as well as several animated machines.

This confusion has led to differences of opinion about the different constructions of the devices of stage astronomy. Scholars of orreries have suggested that the major apparatus might have been a clockwork orrery mounted vertically, while scholars of the magic lantern have suggested that it would have been a lantern projection. Neither makes sense for the theatrical size of these performances — 6 to 10 metres, or even more, in diameter. A metal gearwork ring of that size would be expensive to forge and too cumbersome to operate, let alone set up and pack down. Lanterns were not capable of projecting at that scale until decades after the Eidouranion was selling out crowds.

In my opinion, the most plausible account of the construction of the Eidouranion and its imitators comes from George William Francis (later curator of the Adelaide Botanic Gardens) in a near-contemporary article from his *Magazine of Science*. He describes a skeleton frame, made from timber, with pulley-operated rotating arms which carry internally illuminated, painted glass globes, each of which could be swapped in and out between scenes. This not only matches the descriptions of the performances of these devices that we have from William Walker himself, but also further descriptions of these 'machines', by the stage astronomer William Goodacre, and by the novelist Maria Edgeworth, who described a lecturer with an Eidouranion who '*should have pleasure in showing Frank the orrery again, and in letting him see the concealed machinery, by which it was moved.*'

10 Golinski, J. (2017). Sublime astronomy: The Eidouranion of Adam Walker and his sons. Huntington Library Quarterly, 80(1), pp. 135–57. https://doi.org/10.1353/hlq.2017.0005

11 Huang, H. (2018). A shared arena: The private astronomy lecturing trade and its institutional counterpart in Britain, 1817–1865. *Notes and Records of the Royal Society, 72*, pp. 319–341. https://doi.org/10.1098/rsnr.2017.0018

12 Walker, W. (1793). *An account of the eidouranion; or, transparent orrery; invented by A. Walker, … as lectured upon by his son W. Walker. With the new Discoveries..*

Figure 8: Deane Walker exhibiting the Eidouranion at the English Opera House in 1817. S.176–1997. Copyright Victoria and Albert Museum, London.

Stage astronomy in Australia

The Eidouranion had an impact in Australia. As in Britain, there are as yet no known surviving devices, but there are several descriptions of this kind of astronomical visualisation in the nineteenth century. None were as grand as the performances on the London stages, but several smaller-scale devices were built. Cabinet maker John Cox built a small transparent orrery for the Sydney Mechanics' School of Arts in 1834, and local clerk Phineas Moss built one for the Bothwell Literary Society in Tasmania in 1836.

In Australia — as happened elsewhere — the reputation associated with the names of the famous devices of the stage astronomy tradition was invoked by completely unrelated performers. Noted actor John Meredith used in his advertising the names of both the Eidouranion (in Hobart in 1837) and the Dioastrodoxon (in Sydney in the 1840s). The technology involved in the former of these is uncertain but the latter was almost certainly a magic lantern show, itself novel in the colonies in the time.

Perhaps the most entertaining instance of the stage astronomy tradition in Australia was when a self-styled Professor Muggeridge appeared in South Australia to embark on a series of astronomical lectures '*by means of transparencies*'.[13] The professor, whose legal name was Henry James Masterton but was also known as Professor Norries, would turn out to be a swindler who would use the social cachet of polite astronomy to make his way around the rural districts of the colonies without paying his bills. When he fled his final hotel before capture, he had left behind '*two or three yards of botched calico, coarsely painted over with illustrations of the heavenly bodies*'.[14]

A visual turn

The sophistication of astronomical communication has come a long way since the mid-nineteenth century. Much of the material of earlier practices is lost to us. We will never have Muggeridge's 'botched calico', or the small transparent orreries of Cox or Moss to study. Yet an astonishingly rich legacy of popular astronomy is held within collections around the world. We have astronomical lantern slides from across the nineteenth century and planetarium projectors for most of the twentieth. Multiple sources — texts, images and objects — speak to the lives of these artefacts.

This cultural heritage indicates a more extended tradition. The importance of astronomy within our human story is enduring and the role of visualisation in its telling is almost as long-standing. Although the science of the twenty-first century is new — as it was in the twentieth and nineteenth — it is often interpreted in ways that are reminiscent of the past. Previous practices speak to us; we cannot fully appreciate contemporary science communication in the Melbourne Planetarium without understanding the through-line from the opto-mechanical projectors of the 1960s back to the magic lantern slides of the 1880s and the stage astronomy of the 1820s.

Each of these technologies has built new forms — and played to new audiences. Each has deployed cultural meanings of the skies that have been layered across centuries.

13 For a review of previous discussion on the technology of the Eidouranion see Golinski, J. (2017), footnote 10; for the evidence presented here, including reference to Goodacre and Edgeworth, see Bush, M. (2019). The astronomical lantern slide set and the Eidouranion in Australia. *Early Popular Visual Culture, 17*(1), pp. 9–33. https://doi.org/10.1080/17460654.2019.1620437

14 Lecture on astronomy at Gawler. (1868, July 16). *South Australian Register*, p. 2.