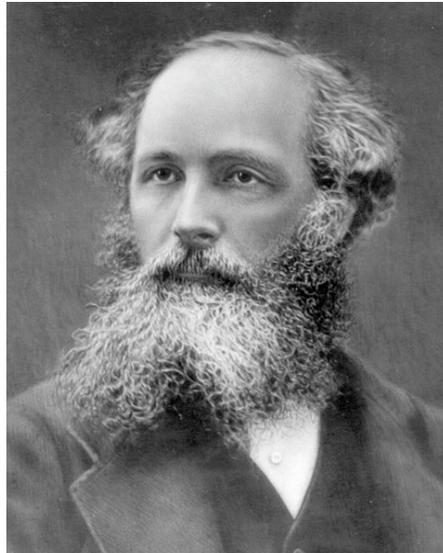


“My soul’s an amphicheiral knot”:  
**THE LAST POEM OF JAMES CLERK MAXWELL**

Daniel S. Silver

Last year marked the 175th birthday of Scottish physicist and mathematician James Clerk Maxwell, who died in midlife, at the age of 48. Many remember him for his elegant equations describing the electromagnetic field or for his profound ideas about the kinetic theory of gases and thermodynamics. Fewer know that Maxwell was also a compulsive poet. This is the story of Maxwell’s last poem, written during his final days. At first glance a hopelessly enigmatic piece, *A Paradoxical Ode* in fact reflects Maxwell’s private thoughts about the relationship of science and religion, choice and chance, death and eternity. As personal as they were, Maxwell’s ideas come to us clothed in a jester’s garments of humor and wit.



Portrait of Maxwell in his 40’s

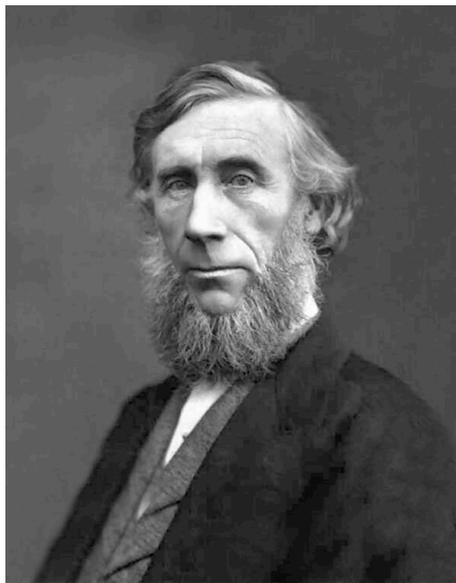
**John Tyndall’s Belfast Address**

Our story begins in Belfast five years earlier, in 1874, as the British Association for the Advancement of Science (BAAS) prepared to hold its annual meeting. Founded in 1841, the BAAS was less exclusive than its more illustrious relative, the Royal Society. The word “science” had been chosen carefully over an older term, “natural philosophy,” to reflect the Association’s more broad-minded membership. Indeed, Cambridge professor William Whewell had invented the word “scientist” in 1840 to describe the new cultivators of knowledge.

The annual meeting of the BAAS was a gala occasion. Newspapers and magazines heralded schedules and reported on events. Particularly anticipated was the President’s

Address. At the Belfast meeting, it would be given by the Irishman John Tyndall, Professor of Natural Philosophy at the Royal Institute, a noted author and untiring promoter of science and rationalism. On three previous occasions Tyndall had declined the presidency. But now, as controversy arose over the teaching of science at the Catholic University in Ireland, Tyndall felt the need to speak out from a big stage. Friends and foes had something new in common - apprehension about Tyndall's looming speech.

"All religious theories, schemes and systems, which embrace notions of cosmogony, or which otherwise reach into the domain of science," Tyndall contended, " must, in so far as they do this, submit to the control of science, and relinquish all thought of controlling it." Tyndall's call for reason over revelation was seen by some as an attack on religion. Many were offended that the President of the BAAS had used a scientific meeting for sectarian debate.



John Tyndall

### *The Unseen Universe*

Scottish physicists Balfour Stewart and Peter Guthrie Tait were among the offended. Tait, a lifelong friend of Maxwell and a collaborator of Sir William Thomson (later known also as Lord Kelvin), held strong religious beliefs and loved a good fray. He and Stewart responded to Tyndall's address by writing *The Unseen Universe or Physical Speculations on a Future State*. In it they argued that religious miracles and the immortality of the soul are compatible with modern science. God is hidden from us because all human thought is "conditioned," an idea that traces easily back to Kant, and one that was later expounded by the philosopher Sir William Hamilton, one of Maxwell's instructors at University of Edinburgh. Nevertheless, the "principle of Continuity," which *Unseen Universe* announced, comforts all with the gentle reassurance that nature will never do anything to confound us permanently.

[W]hat the principle of Continuity demands is an endless development of the conditioned. We claim it as the heritage of intelligence that there shall be an endless vista, reaching from eternity to eternity, in each link of which we shall be led only from one form of the the conditioned to another, never from the conditioned to the unconditioned or absolute, which would be to us no better than an impenetrable intellectual barrier. ... Finally our argument has led us to regard the production of the visible universe as brought about by an intelligent agency residing in the unseen.

Stewart and Tait were not timid about transporting a novel scientific theory to unfamiliar surroundings.

We therefore welcome an hypothesis like that of Sir W. Thomson, which regards the primordial atoms of the visible universe as vortices somehow produced in a pre-existing perfect fluid. ... In the production of the atom from a perfect fluid we are driven at once to the unconditioned - the Great First Cause.

Knotted vortices, according to Thomson's theory, constituted atoms. As a consequence of a celebrated theorem of Hermann von Helmholtz, once stamped in the perfect fluid or "ether" at the moment of creation they would be eternal. A trefoil knot adorns the spine and title page of *Unseen Universe*.

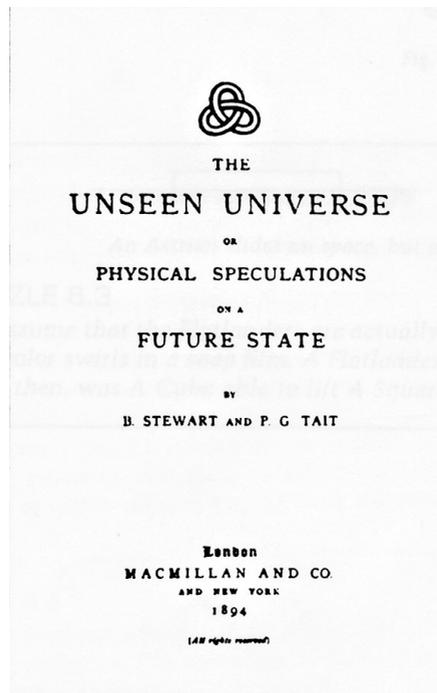
By this time, Tait had begun a sustained study of knots and links, and soon he would publish the first paper with the word "knots" in its title. He believed that he was constructing a table of the elements. Thanks to recent efforts of Cambridge University Press, we know today that Maxwell communicated to Tait new ideas about knots and more generally the nascent subject of topology. Indeed it was Maxwell who informed Tait of the knot-theoretic efforts of Johann Benedict Listing, a student of Gauss and the originator of the term "topology."

Readers of *Unseen Universe* learned that their every thought and action broadcasts eternal vibrations throughout the perfect ether. Inconveniently, nothing in our visible world, including fluids, is perfect. The authors were undeterred. Particles of good ether were next to particles of better ether, readers were told, while particles of better ether next to even better, ad infinitum. In effect, *Unseen Universe* postulated parallel avenues of of universes. More importantly, it described a world in which miracles and life after death were scientifically possible.

Hurriedly written and yet hugely successful, *Unseen Universe* spawned several editions and a sequel, *Paradoxical Philosophy*. The popularity of such books was a gauge of Victorian public interest in matters of science and religion.

Why did Stewart and Tait chose to publish the first three editions anonymously? As Tait's biographer C.G. Knott observed: "It seemed to be known from the beginning that the work was written by Balfour Stewart and P.G. Tait." Perhaps unlike Tyndall, Stewart and Tait wanted to maintain a separation between their profession and personal views. But there might have been another reason. Stewart and Tait were aware of the sensation and profits generated in 1844 by another anonymous scientific book, *Vestiges of Natural Creation*. Authored by Robert Chambers, *Vestiges* introduced evolution to the

British public. Although Chambers and his publisher rightly feared charges of “atheism” and “materialism,” Chambers soon discovered that he enjoyed his ability to move invisibly among his many readers. *Vestiges* was still anonymous when *Unseen Universe* was published in 1875, and it is reasonable to guess that Stewart and Tait hoped to generate the a similar sensation, this time in support of traditional religion.



Title page of *Unseen Universe*

### The Threat of Materialism

Tyndall was one of many Victorians who hoped that modern science would sweep away Christian dogma. Another was the mathematician William Kingdon Clifford, who, like his German colleague Felix Klein, enjoyed thinking about homoloids and other exotic 3-dimensional shapes. Clifford even speculated that gravity might be the effect of ‘a variation in the curvature of space.’ Clifford’s review of *Unseen Universe* in the *Fortnightly Review* was biting and highly amusing.

Victorian scientists with traditional Christian beliefs likely regarded Tyndall and Clifford as mere pests when compared to two other threats, one foreign, the other domestic. Ludwig Büchner, a medical lecturer in Tübingen, published his most influential work, *Kraft und Stoff (Force and Matter)*, in 1855. It was later translated into many languages including English. Büchner became the champion of what would be called “scientific materialism.” His vision of the universe seemed to many a godless one.

No force without matter—no matter without force! ...Those who talk of a creative power, which is said to have produced the world out of itself, or out of nothing,

are ignorant of the first and most simple principle, founded upon experience and the contemplation of nature.

Unlike Büchner, English biologist Charles Darwin was modest and shy, often becoming ill in the face of heated argument. His early religious beliefs, unquestioned and traditional, became casualties of his scientific investigation. As Darwin himself maintained, he discovered neither evolution nor its mechanism, natural selection. What he discovered was compelling evidence that all living things have developed from a few basic prototypes – possibly even a single form – by slow processes of modification. *The Origin of Species* (1859) and *The Descent of Man* (1871), his two most famous works, accelerated the erosion of Victorian belief in the literal truth of the Bible.

### Maxwell's Views

Maxwell's biographer, Lewis Campbell, writes that while his subject was devout, he distrusted the "practical applications or the popular dissemination of what appeared to him as crude and half-baked theories about the highest subjects." Maxwell declared more than once that science had nothing to say on matters of religion.

It is possible that Maxwell regarded religious ideas much like the analogies and mechanical devices that guided his scientific intuition. They were imperfect approximations to truths that could never be fully grasped. The attitude is suggested in the draft of a letter (never sent) to the Victoria Institute, a society that, like Stewart and Tait's *Unseen Universe*, attempted to reconcile Christianity with science.

Sir - I do not think it my duty to become a candidate for admission into the Victoria Institute. Among the objects of the Society are some of which I think very highly. I think men of science as well as other men need to learn from Christ, and I think Christians whose minds are scientific are bound to study science that their view of the glory of God may be as extensive as their being is capable. But I think that the results which each man arrives at in his attempts to harmonize his science with his Christianity ought not to be regarded as having any significance except to the man himself, and to him only for a time, and should not receive the stamp of a society... .

Maxwell's reticence on matters of religion would frustrate biographer Campbell in subsequent years as he later searched for reliable information about his subject's religious views. Maxwell's innermost thoughts, if he ever shared them, must have been a source of bafflement to his audience. According to a colleague, "[H]is love of speaking in parables, combined with a certain obscurity of intonation, rendered it often difficult to seize his meaning; but bright and penetrating little sayings, usually whimsical in form, and sometimes accompanied by strange gestures, recurred almost unfailingly at no distant intervals."

Maxwell attended the fateful Belfast meeting of the BAAS. There he read a paper, "On the application of Kirchoff's Rules for Electric Circuits to the Solution of a Geometrical Problem." His own response to Tyndall's Belfast Address was a whimsical poem entitled "British Association, 1874. Notes of the Presidential Address," containing the lines:

From nothing comes nothing, they told us, nought happens by chance, but by fate;

There is nothing but atoms and void, all else is mere whims out of date!

If Maxwell did not care for materialism, he cared less for *Unseen Universe*. In response to a rumor that Stewart and Tait were writing a sequel, Maxwell wrote to Tait, using characteristic humor to cloak annoyance with his friend's public religious pronouncements.

It is said in *Nature* that U.U. [*Unseen Universe*] is germinating into some higher form. If you think of extending the collection of hymns given in the original work, do not forget to insert 'How happy could I be with Ether.'

### **Paradoxical Ode**

*Paradoxical Philosophy*, the sequel to *Unseen Universe*, appeared in 1878. It is an imaginary dialogue between scientifically minded Christians, one of whom shares the given name of Tait's son, and a fictitious German materialist Dr. Hermann Stoffkraft (Stoff + Kraft), very possibly modeled on Büchner. The blunt polemic miraculously converts Stoffkraft to a belief in the doctrines of *Unseen Universe*.

Maxwell's discomfort became exasperation. His review of *Paradoxical Philosophy*, published in *Nature*, contains harsh words for his friend, Tait.

To exercise the mind in speculations on such media may be a most delightful employment for those who are intellectually fitted to indulge in it, though we cannot see why they should on that account appropriate the words of St. Paul.

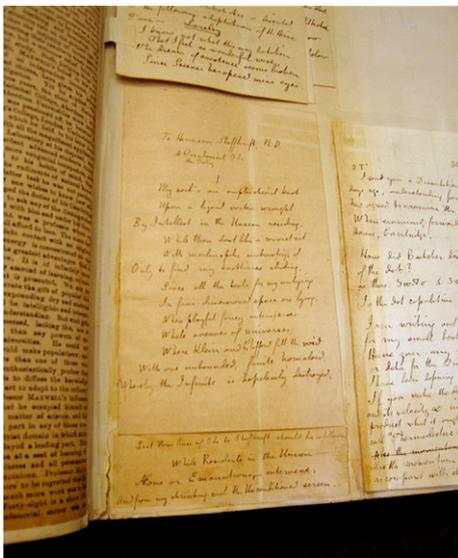
Questions about the soul's immortality were no longer merely academic for Maxwell. He was dying, and very likely knew it by now. For months he had been suffering from stomach pains, but he had consulted no doctors. We know from Campbell that when he wrote his review, he was having difficulty swallowing. He would learn soon that he had the same cancer that took his mother at the very same age that he was now. He would die within a year.

Now Maxwell would compose one last poem. A pastiche of Percy Bysshe Shelley's *Prometheus Unbound*, Maxwell's *Paradoxical Ode* pokes fun at *Unseen Universe*, evolution, Thomson's vortex atom theory and scientific materialism. But on a deeper level, it seems to express his deepest feelings about death.

Shelley, a widely-read Romantic poet, had been ejected from Oxford for publishing an atheistic tract. Prometheus, the hero of Shelley's four-act play, resembled Jesus in the sense that he was not afraid to speak the truth to Jupiter, his oppressor. *Paradoxical Ode* is addressed to Stoffkraft, who like Prometheus attempted to liberate man from the ancient gods.

The original version of *Paradoxical Ode* is contained in a large scrapbook donated not long ago to the James Maxwell Foundation in Edinburgh by a relative of Tait. The author had the chance to examine it during a visit in the summer of 2006.

A version of *Paradoxical Ode* was published in G.C. Knott's *Life and Scientific Work of Peter Guthrie Tait* (1912), and subsequently reproduced, each time, it seems, with small changes. Maxwell's original version, reproduced below, has a more personal tone than in any found elsewhere.



First page of Maxwell's poem, sent to Tait

To Hermann Stoffkraft, Ph.D.  
A Paradoxical Ode.  
[After Shelley]  
Original version

I

My soul's an amphicheiral knot<sup>1</sup>  
Upon a liquid vortex wrought  
By Intellect in the Unseen residing,  
While thou dost like a convict sit  
With marlinspike untwisting it<sup>2</sup>  
Only to find my knottiness abiding,  
Since all the tools for my untying  
In four-dimensioned space are lying<sup>3</sup>,  
Where playful fancy intersperces,  
Whole avenues of universes;  
Where Klein and Clifford fill the void  
With one unbounded, finite homaloid<sup>4</sup>,  
Whereby the Infinite<sup>5</sup> is hopelessly destroyed.

## II

But when thy Science lifts her pinions  
In Speculation's wild dominions,  
I treasure every dictum thou emittest;  
While down the stream of Evolution  
We drift<sup>6</sup>, and look for no solution  
But that of survival of the fittest<sup>7</sup>,  
Till in that twilight of the gods  
When earth and sun are frozen clods,  
When, all its matter degraded<sup>8</sup>,  
Matter in aether shall have faded,  
We, that is, all the work we've done<sup>9</sup>,  
As waves in aether, shall for ever run  
In swift expanding spheres, through heavens beyond the sun.

## III

Great Principle of all we see,  
Thou endless Continuity!  
By thee are all our angles gently rounded,  
Our misfits are by thee adjusted,  
And as I still<sup>10</sup> in thee have trusted,  
So let my methods never be confounded!  
O never may direct Creation  
Breach in upon my contemplation,  
Still may the causal chain ascending,  
Appear unbroken and unending,  
And where the chain is best to sight  
Let viewless fancies guide my darkling<sup>11</sup> flight  
Through aeon-haunted worlds, in order infinite<sup>12</sup>.

$$\frac{\partial p}{\partial t}^{13}$$

*Notes: 1. An amphicheiral knot is one that can be deformed into its mirror image. In Shelley's poem, Asia refers to herself as an "enchanted boat" drifting without course or star, driven only "by the instinct of sweet music." 2. Convicts might be given the task of recovering hemp from rope by using a marlinspike. 3. Maxwell was doubted that we live in a world of more than 3 spatial dimensions. In a letter to C.J. Monroe, dated 1871, he asked: "If you have 4 dimensions this becomes a puzzle, - for first, if three of them are in our space, then which three?" 4. Three-dimensional space in which the axioms and postulates of Euclid hold. 5. The Infinite was often identified with God. 6. In Shelley's poem, Asia also drifted down a stream. 7. "Survival of the fittest" was a term invented by philosopher Herbert Spencer. 8. Dr Stoffkraft asserts that all energy degrades. With*

*the end of humanity, collective consciousness will disappear. 9. Perhaps a very personal note. 10. always. 11. In the dark. 12. Likely intended as a bad rhyme. 13. Maxwell often signed his letters to Tait with  $\partial p/\partial t$ ,  $\partial p/\partial t = JCM$  being short-hand for one of the laws of thermodynamics.*

Taped to the bottom of the page of Tait's scrapbook is an addendum, sent by Maxwell some days afterwards.

Last three lines of Ode to Stoffkraft should be as follows.

While Residents in the Unseen–  
Aeons or Emanations – intervene,  
And from my shrinking soul the Unconditioned screen.

Was Maxwell teasing Tait by pointing out an unfortunate consequence of his philosophy – that the principle of Continuity should prevent Maxwell from ever encountering the Unconditioned, even after his death?

Maxwell's thoughts about dying remain uncertain to us. Whatever they were, they must have been certain and comforting to Maxwell. According to an attending physician, "No man ever met death more consciously or more calmly."

### **Acknowledgements**

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