AETHER AND EINSTEIN

Aether: from everywhere to nowhere

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A *New Yorker* cartoon showed a television news reader reporting from the annual meeting of the American Physical Society where participants had just agreed that everything they knew about the nature of the universe was "wrongedy, wrongedy wrong". That a joke in the *New Yorker* is no laughing matter received further confirmation last July when Stephen Hawking renounced his belief that information could not escape from Black Holes.

The puzzles facing mathematical physicists today had their parallels100 years ago when the laws of mechanics did not fit with those of electrodynamics. In 1905, a 26-year old clerk in the Swiss Patents Office, Albert Einstein, published the first of his papers that would overturn our picture of the world. Atop Einstein's list of discards was the aether.

If nature abhorred a vacuum, seemingly empty space had to be filled with something or other, to which the ancients had given the name "aether", derived from the Greek for aethereal fire. Einstein's dismissal of aether as "obsolete" justifies the older spelling, rather than "ether", which invokes a different mind-numbing substance.

Belief in aether had been a useful construct but ended its days as a label for collective confusion. Its longevity offers insights into why scientists will cling to speculative ideas. Its prolonged death is the dark side of the story of Relativity, making it the unwelcome guest at this year's celebration of how brilliant physicists can be. Aether is also forgotten because its half-life is a reminder of how many such geniuses have been in thrall to mysticism.

The fondness for aether had valid underpinnings since the alternative had been to allow for "action-at-a-distance", which threatened a return to all manner of mumbo-jumbo. Scientists had marginalised any notion of aether as divine. But if aether were not angels in motion, what was it? A jelly metaphor introduced in 1838 gained support.

As any kind of solid, aether would act as a drag on the velocity of light passing through it. In the early 1880s, investigators in Ohio, Albert A. Michelson (1852-1931) and Edward Morley (18 -) wanted to measure that effect. Michelson explained his experiment to his children:

> Two beams of light race against each other, like two swimmers, one struggling upstream and back, while the other, covering the same distance, just crosses the river and returns. The second swimmer will

always win, if there is any current in the river.

Their 1887 measurements resulted in a dead heat – a “Null”. Could it be that there was no current - that is, no aether - for the light to swim against?

The battle was now on to preserve the aether. Well into the 1920s, experimenters tried to overturn the Michelson-Morley results. Others proposed that the earth dragged aether along with it. If so, aether need not alter the velocity of light crossing its path.

More profound challenges to the nature and functions attributable to aether were spreading from discoveries in electro-magnetism. From 1864, and working from the research of Michael Faraday (1791-1867), the mathematical physicist, James Clerk Maxwell (1831-1879), supplied mathematical proofs that light was a “mutual embrace” of magnetism and electricity.

Scientists think through metaphors as well as with data. For instance, Faraday’s version of Christianity had led him to believe that God’s creation moved in circles, rather than lines, as in Newtonian mechanics. Faraday’s theology encouraged Clerk Maxwell towards field theory.

The mathematical genius, Lord Kelvin (1824-1907), spent his declining decades chasing after an alternative to Maxwell’s field theory, determined to establish a mathematical model of the aether. Kelvin gave up on jelly only to promote what one friend called “froth”. In desperation, Kelvin proposed that aether occupied the same space as the objects moving through it without their affecting each other.

Giving up the aether would have been easier had some alternative been proposed. Oxygen and germs had taken over from phlogiston and miasmas. By contrast, the loss of aether suggested no tangible substitute. Several researchers hoped to retain aether as an electro-magnetic field. Beyond that, doubters were offered pure mathematics which Kelvin called “merely the aetherialisation of common sense”. Unfortunately, common sense was the problem.

Einstein escaped from this quagmire by leaping over aether as an article of faith. One version of how he revolutionized physics would have us believe that he had built on experiments, such as Michelson-Morley’s, to arrive at a more coherent picture of the whole. On the contrary, despair at resolving the contradictions that had built up from experiments drove him to postulate conclusions from principles. The concomitant was to eliminate concepts that added nothing to this understanding. Hence, he dismissed aether as “superfluous”.

Among the three tests that Einstein proposed for his picture of the world, the best known became the measurement of the effect of gravitation on light. The sun was so massive that its deflection of light passing from a star would be big enough to be calculated from an eclipse. The eclipse itself had no

effect on this difference but merely allowed any impact to be viewed.

The first opportunity to test this hypothesis came on 29 May 1919. The experimenters had to photograph the eclipsed sun in a patch of sky with lots of stars. They then imposed these plates on ones taken of the same patch when the sun was elsewhere. The shots from Brazil registered that the stars were further out of alignment when the sun was nearby than when it was far away.

Because the calculations from this sighting were perhaps no more than 50% accurate, not everyone was converted. In addition, critics wondered whether other solar effects had caused the shift.

Nontheless, accounts from London of the Royal Society's discussion of the results from the 1919 eclipse had "flashed through the daily papers like a nine-days' wonder". The Melbourne *Argus* accompanied its report with an explanatory essay stressing that the challenge to conventional views threatened more than the replacement of one arcane orthodoxy by another. Henceforth, the article continued, nothing could be accepted as absolute. The circularity of a circle might well be no more than the congruence of an ellipse with a similarly warped measuring device. Every measure was relative to its frame of reference.

Another aspect of Einstein's universe to amaze the public was challenge to Newton's law of gravity. Like the aether, gravity had offered a sense of security. The budding poet Kenneth Slessor was "morbidly anxious to know … *did* (ah, DID the Apple drop?"

Despite reporting that the world had been turned inside out, the *Argus* reprinted an explanation which could not shake off the past:

Suppose that in a layer of jelly you inscribed a perfect circle, and that you proved its perfection by measuring the radii with a two-foot rule made of the same jelly. Assume now that a state of strain in the jelly stretched it in one direction. The circle would be deformed into an ellipse, but when you measured it with your jelly rule, all the radii would still appear to be the same length, because the rule itself, being subject to the same strain, would vary in dimension from radius to radius.

The aether-based view became even more apparent in the summation: "Things placed in the aether stream have one length; placed across it they have another". Einstein had done away with an aether stream in which to lay rulers, whether made of jelly or fairy floss.

Popular interest remained high. In October 1920, the lecturer in Mathematics at Ormond College at the University of Melbourne, C. E. Weatherburn, compared the craze with "the appreciation of Omar Khayyam by the general public ten years ago … Some have been attracted by the psychological aspect of the blending of space and time … while others take it up because, like the Athenians contemporary with St Paul, they delight in

spending their time either in telling or hearing some new thing".

In the effort to confirm the 1919 eclipse results, Australia became the cynosure of the Einstein revolution because the next total eclipse would be visible from Ballina across towards Broome on 21 September 1922. The largest party came from the Lick Observatory outside San Francisco, bringing a 15-foot telescope with photographic attachments fashioned for the occasion. The Americans arrived in Melbourne in July to a Civic Reception before heading for Wallal, 300 km south of Broome, where the eclipse would last five minutes nineteen seconds.

Other researchers set up sites, one on Christmas Island and two more on the mainland. After the photographs from Cordello Downs in South Australia – close to where Burke and Wills had died - went to Britain for analysis, the Astronomer Royal thanked the team for its efforts, but concluded that their images' "close agreement with Einstein's value is a matter of luck." By contrast, in April 1923, the Lick Observatory announced that its Wallal images had proved so conclusive that its astronomers would not to bother to test Einstein's theory at the coming eclipse in Mexico. Having confirmed that the universe had no observation paid Wallal, it too disappeared from history.

Technical and popular journals went on publishing articles, mostly in favour of Einstein. Weatherburn was the exception, criticising Einstein's theories for being too abstruse, and wanting in confirmation. This reluctance to endorse Einstein's picture of the world was not a mark of antipodean backwardness. When Einstein finally got a Nobel Prize in 1921 it was not for work on Relativity, but on the photo-electric effect. Resident skeptics were abreast of European objections.

By 1932, the same could not be said in mitigation of the Victorian-educated polymath, Arthur Lynch (1861-1934), who, in *The Case Against Einstein*, argued that the Theory of Relativity had added nothing to science beyond replacing aether with a "mathematical expression" of doubtful accuracy.

In case the shocks from relativity had not sunk into Melbourne's respectable classes, the *Argus* confirmed their worst fears during a time of world war, revolution and the Influenza Pandemic: "Nothing is absolute, unalterable, all things are in accord with their environment and with all other things, changing if those other things and the environment change". Did relativism extend to loyalty to the King-Emperor, the sanctity of marriage and the arts? The gaps between appearances and actuality were widening as the wireless and electricity entered the domestic sphere. To appreciate the responses to Einstein requires recognition of how these disturbances reinforced each other. No wonder the public and many experts stuck to the insubstantial aether as a link to the certainties of religion.

For instance, the Perth Chamber of Commerce *Journal* in 1920 called aether "Nature's conductor" and feared that Einstein's disproof of aether disrupted the connectedness of the universe. Another Western Australian author would inform that State's grocers in 1925 that the aether was

necessary to demonstrate a “Divine Plan of Evolution”.

The social alarms persisted. In December 1924, a Sydney monthly, *The Triad*, reported the results of its “Great People Competition”. Thomas Edison and Benito Mussolini shared first place, followed by Giuglielmo Marconi and Henry Ford, with Einstein running last. Technological applications, it seemed, could be welcomed if kept under an iron fist.

Such attitudes were not the preserve of cranks. The Managing-Director of Amalgamated Wireless (Australasia) Ltd, E. T. Fisk, founded the monthly *Sea, Land and Air* to promote wireless, electricity and aviation. In June 1920, an anonymous contributor concocted an interview with “An Oriental” about Einstein. Parallels between social and physical disorders indicate why a journal promoting technological innovation could chase reassurance from the Wisdom of the East.

The interlocutor opened by noting that during “the present age a terrible bombardment is made on the brain-cells of men, and only those by nature extremely lethargic escape the constant stimulus which modern education, business and social life creates”. The inertia that gravitation imposed on our bodies softened this social maelstrom. Without this cushion we would be “resolved into the chaos whence we came”. On being told that space and motion were one and the same, the questioner pleaded: “What has become the Aether?” The sage replied: “How can you be deprived of what you have never had?”

While the world’s scientists had been preparing for the 1922 eclipse, Fisk’s co-founder of the Wireless Institute, Oswald F. Mingay, contributed an article on “The Electron Theory” to the *Australasian Electrical Times*. Electrons, he claimed, “produce vibrations or waves in the aether”:

All space – the entire universe – is, it is assumed, permeated by this medium, aether. It has been called “the all-pervading aether”. It exists in those portions of space which are apparently empty. It is probably at rest – stationary. Very little is definitely known about aether except that it – or something equivalent - exists.

> Aether is not matter, because matter is made up of electrons … in certain respects aether appears to be similar to a semi-rigid jelly-like substance.

Not only did technical experts go on talking as if aether was real, they clung to the jelly metaphor, rather than an electro-magnetic field.

Wireless transmission is now so old-hat that its mystical and mysterious dimensions have disappeared along with the aether through which many people assumed the sounds were moving. Static was a “demon” according to the *Wireless Weekly* in 1929, as if another life form inhabited the air waves. This metaphor overlapped with the hope that Spiritualists entertained of using the “Unseen Voice” of radio to contact young men killed

the Great War who were said to be present, but through a veil. Alternatively, they were suspended in Einstein's spacetime.

In 1916, the sometime President of the British Association for the Advancement of Science, Sir Oliver Lodge, had reported conversations with his dead son, Raymond. This loss carried Lodge beyond any of the scientific efforts to retain the aether. Indeed, he went further than those scientists who adapted the New Physics to let God back into their equations. Lodge's 1925 popular exposition, *Ether and Reality,* proclaimed aether to be the connecting link between the material and spiritual worlds, though "in ways which at present we can only surmise". The joke going around was that a bishopric rather than a knighthood had become the apt honour for a physicist.

Newspapers reported in June 1930 that the AWA's Fisk expected to use wireless to contact the departed. Whether or not Fisk held that opinion, he knew that such speculations gave his many critics a chance to ridicule his fitness to dominate the industry. Hence, he issued a correction. He claimed to have been answering a question about using radio waves to contact Mars; in reply, he had joked that such communication was about as likely as with the dead, who would at least understand what we were saying. Fisk's loss of a son in the Second World War revived his interest in wireless as a medium for Spiritualism.

The philosopher and mathematician Alfred North Whitehead is reported to have warned: "A science which hesitates to forget its founders is lost". That maxim is true in as much as reputation has no rights against evidence or better explanations. The brilliance of a Kelvin and a Lorentz was never an argument in favour of aether.

Researchers, however, forget one strand from their discipline's past at their peril. It is a truth, not universally acknowledged, that no picture of the world is in possession of the final word. *Tsunami* are now understood in terms of continental drift, a view considered ridiculous until the mid-1960s before acceptance of movement in tectonic plates.

Awareness of the refutation of past conjectures is essential in keeping the society of scientists open to discovery. Researchers who forget the reverence that their predecessors granted to phantoms such as aether risk repeating such dogmatics. Without the half-life of humility, investigators in every domain leave ourselves open to the joke against cosmologists who, while never in doubt, are frequently in error.

The genius who was not Einstein

The conviction that some form of aether existed as an expression of a godhead afflicted the Dutch physicist Hendrik Antoon Lorentz (1853-1928), who shared the second Nobel Prize for Physics in 1902. Instead of aether's being "God's conductor", as Newton had proposed, Lorentz hoped that it would be revealed as the "world-spirit that permeates a physical system, without being tied to a particular place. Such a spirit could feel all events in

its system and would pick a preferred coordinate system." In that case, relativity need not be absolute.

Until 1911, the Special Theory of Relativity was known as the Lorentz-Einstein theory because a 1904 paper by Lorentz was formally equivalent to Einstein's 1905 account. Yet, Lorentz never accepted Einstein's Special Theory. For him, an aether frame of reference held out the prospect of reaching absolute measures for time, length and the velocity of light.

Historians wonder whether Lorentz would have been Einstein had he been able to surrender his attachment to aether, which he kept as a silent partner in every area where he made breakthroughs. Indeed, no one had done more to renovate views about aether. Lorentz seemed ready to abandon any of the pillars of physics, bar that "world-spirit". By 1892, he had declared that the aether-ion was outside Newtonian mechanics. Three years later, he let go of Newton's law of action and reaction because aether had to be immobile.

In 1902, Lorentz suggested that aether was not just in between the atoms and electrons but inside them. Going further, he imagined matter as a local modification of aether. Shortly afterwards, he considered that aether could "be the seat of an electro-magnetic field with its energy and its vibrations". Nonetheless, he still regarded aether "as endowed with a certain degree of substantiality, however different it may be from all ordinary matter".

Lorentz appreciated that Einstein would never have reached either of his Theories of Relativity had he clung to aether, remarking, with typical grace, how we were lucky that Einstein had given it up.

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