

Natural Philosopher, Engineer, Mechanist

Degrees Kelvin: A Tale of Genius, Invention, and Tragedy

David Lindley
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Reviewed by Curtis Wilson

David Lindley's *Degrees Kelvin: A Tale of Genius, Invention, and Tragedy* is a lively, well-written biography of William Thomson (1824–1907), the British natural philosopher—as he styled himself—and engineering genius who was raised to peerage in 1892 as Baron Kelvin of Largs. “Natural philosophy” is the term used by Isaac Newton and his contemporaries for what, since 1840, has come to be called physics. In the mid-19th century, the subject was transformed by the new understanding of energy as a fundamental conserved quantity; in that transformation, Thomson played a key role. In 1867, he and Peter Tait produced the first textbook written from the new standpoint. They called it *Treatise on Natural Philosophy*, Thomson preferring the older name.

Thomson's accomplishments were not minor. Lindley provides a lucid account of them and also gives us a feel for Thomson's mental habits and character. The man carried notebook and pen everywhere, ready to engage in calculation at the drop of a question. His clarity and quickness of mind made Hermann von Helmholtz feel dull-witted on first meeting Thomson. The subtitle of Lindley's text labels Kelvin's life a tragedy—a false note in a splendid book. (In a website conversation, he softens the claim to “a hint of tragedy.”) Kelvin was no Oedipus Rex or King Lear. He contributed mightily to scientific progress, but in the ongoing advance of physics, he would, in the end, be left behind.

Thomson was a mathematical prodigy. At age 16, he mastered Jean

Baptiste Joseph Fourier's *Analytical Theory of Heat* and wrote and published a defense of it. Fourier's theory allowed one to determine the distribution of heat in a body on the sole assumption that heat flow is proportional to temperature gradient. The approach was macroscopic, geometrical, and nonhypothetical, and Thomson took to it easily.

During his undergraduate years at Cambridge University, he traveled to Paris and met the mathematical savants—in particular, mathematician Joseph Liouville and experimental physicist Victor Regnault, who both considered Michael Faraday's curved lines of force outré. At Liouville's urging, Thomson produced for the *Journal de Mathématique* a demonstration that the lines of force, whether electric or magnetic, followed from inverse square laws. The relevant mathematics was a near cousin to that for heat flow, but the insight was new and would be seminal in the thinking that led James Clerk Maxwell to electromagnetic field theory.

While in Largs, Scotland, in 1845, Thomson came across a paper by Émile Clapeyron on the ideal cycle of a heat engine, which had originally been described by Sadi Carnot in 1824. By 1848, Thomson had devised what we now call the Kelvin scale of temperature, a scale based on the Carnot cycle and independent of the properties of any particular material.

By the time Thomson turned 28 in 1852, he had clarified, with help from James Joule and Rudolf Clausius, the foundations of a new science: thermodynamics. The science involved reconciling energy conservation with the Carnot cycle for a heat engine. At first, Thomson was wrong in supposing that heat was not consumed in the cycle, but by 1852 he had the correct reconciliation in focus and was expounding it magisterially. Thomson's presentation of the science was executed with finesse and avoided unnecessary assumptions about the nature of heat.

Such were Thomson's contributions to classical physics, all of them completed before he was 30. In 1854, after

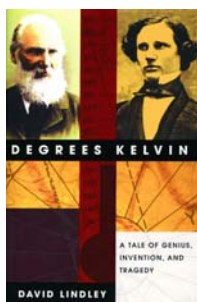
he was asked a question about telegraphy through undersea cables, he was pulled into solving engineering problems. He would go on to become an engineering whiz, an inventor, a patent holder, a wealthy man, and an authority in the field of electrical engineering. Not being shy, he made pronouncements—some of them were amiss, as hindsight would later reveal.

In 1862, Thomson launched a controversy over Earth's age. From the physics of Earth's cooling, he believed he could argue that its age was limited to some 100 million years. The geologists and evolutionists needed far more time for the processes they believed they had detected, but they knew not how to rebut Thomson's physics. The controversy spluttered on into the following century; Thomson conceded nothing, although his premises were beginning to unravel. Lindley gives the essentials of the story in which neither Thomson nor his partner in error, Tait, come off well.

At Johns Hopkins University in 1884, he gave the “Baltimore lectures,” promoting his program of mechanical analogy. Given his distaste for metaphysics, he was presumably not claiming that one could know the detailed mechanisms by which, say, the electromagnetic ether does what it does. Lindley faults Thomson for not adopting Maxwell's mathematical theory of electromagnetism but fails to mention that Maxwell, too, had constructed mechanical analogs for the ether and abandoned them only when he could show that his theory was consonant with the Lagrange equations of dynamics and, hence, not contrary to mechanism. Nevertheless, Lindley's biography is, so far, probably the best succinct account focusing on Thomson's life in science and engineering.

Late in life, Thomson saw on the horizon two clouds troubling the clear vistas that the program of mechanical analogy had opened up. Those clouds were the Michelson–Morley experiment and the anomalous specific heats of solids at low temperatures. We now know that the two heralded relativity and quantum theory, which sounded the death knell for mechanism in fundamental theory.

Even as an old man, Thomson knew threats when he saw them.



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