

# Living in the Past

*Historical perspective*



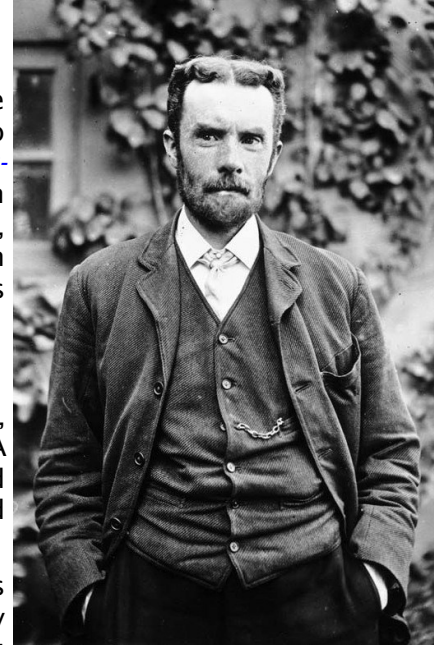
## Refining Maxwell's equations

As far as renowned physicists go, Albert Einstein was once asked whether he stood on the shoulders of Isaac Newton, to which Einstein replied, *No, I stand on the shoulders of Maxwell*. James Clerk Maxwell was considered the mathematician who had the greatest influence on physics up to that time, having revolutionized the entire field of electrodynamics in the scientific community with his twenty brilliant equations relating charge, the electric field, and the magnetic field.

### Uneducated genius

Who, then, would hold any respect for a non-PhD engineer, who dared to *refine* anything that Maxwell developed? A young man named [Oliver Heaviside](#), high school dropout and self-educated engineer and mathematician, was fascinated with Maxwell's work, but said (paraphrased), *I can do better*.

Oliver Heaviside was one of those heavily maligned geniuses who came up with ideas, formulas, and proofs that many mathematicians of his day had dismissed as foolish babbling by an uneducated engineer-wannabe, simply because they couldn't understand them. In 1884, Heaviside reduced Maxwell's twenty equations down to the four we know today, and so should probably more correctly be attributed as *Heaviside's Equations*. Like many of his day, some of Heaviside's work was not understood, let alone proven, until after he had passed away.



### Achievements

Although vector calculus predated Heaviside, he developed it into the forms we use today in modern physics. Heaviside introduced the idea of [gravitational waves](#). He invented the [Heaviside step function](#), which calculates the current when a circuit is switched on. He came up with a mathematical method that closely resembles a Laplace Transform, which allows mechanisms of differential equations to be treated like algebraic operations. Heaviside also developed the [Poynting vector](#) the same time as John Henry Poynting. Heaviside invented [coaxial cable](#).

In 1901, Guglielmo Marconi received the first trans-Atlantic wireless transmission, but it was not well understood how the signal survived the trip across the ocean. In 1902, Oliver Heaviside proposed the idea that the Earth is surrounded by an upper atmospheric layer of ionized gas. The term *ionosphere* wasn't coined until 1926, but it was Heaviside (and independently, Arthur Kennelly) who predicted the existence of the [ionospheric E-layer](#) (later called the *Heaviside Layer*), which plays an important role in amateur radio propagation. (Interestingly, the name emerged in public at least once through Andrew Lloyd Webber's musical *Cats* through the song [Journey to the Heaviside Layer](#).)

Heaviside was inducted as a [Fellow of the Royal Society](#) in 1891, for his insight into operational and vector calculus. As [J.Z. Buchwald](#) once said of Heaviside, *A mathematical thinker whose work long failed to secure the recognition its brilliance deserved*.