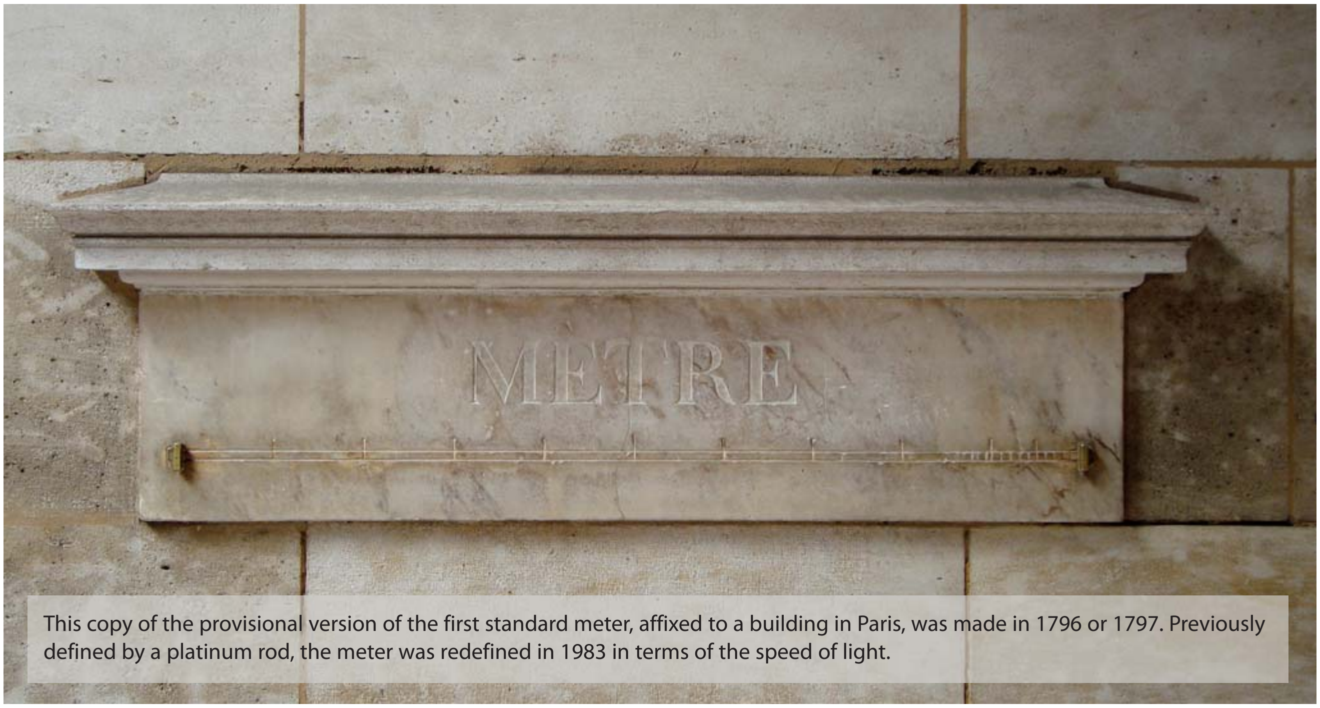
The history of a universal constant FREE

Lightspeed: The Ghostly Aether and the Race to Measure the Speed of Light. , John C. H. Spence, Oxford U. Press, 2020, $32.95

Theresa Levitt

Physics Today **74** (8), 51–52 (2021);
https://doi.org/10.1063/PT.3.4816



This copy of the provisional version of the first standard meter, affixed to a building in Paris, was made in 1796 or 1797. Previously defined by a platinum rod, the meter was redefined in 1983 in terms of the speed of light.

The history of a universal constant

The speed of light is one of the few universal constants in the universe, and the effort to measure it was one of the most enduring scientific problems in physics. In *Lightspeed: The Ghostly Aether and the Race to Measure the Speed of Light*, physicist John C. H. Spence travels through more than 2500 years of human history to reveal the lengths to which people have gone for an answer, from building a system of mirrors on the rooftops of Paris to spending eight years in India waiting to measure the transit of Venus. (Spoiler: It was cloudy that day.)

The subtitle bills the book as "the race to measure the speed of light," and although the term "race" may oversell the urgency of the enterprise, Spence does his best to keep things lively. Obtaining the measurement itself was fairly straightforward: 17th-century attempts using Jupiter's moons were surprisingly good, and 19th-century efforts with rotating mirrors got even closer to the value accepted today.

But that is just the starting point for

Lightspeed
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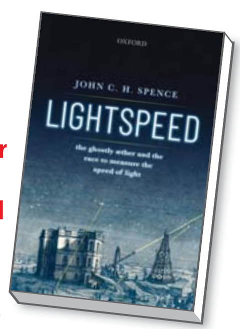


what Spence calls an "adventure" that seeks to place the effort in the context of a bigger set of questions about the nature of light and its ability to move through space. Spence gleefully follows digressions—almost all of which are interesting—through topics as varied as stellar aberration, Foucault's pendulum, and Saturn's rings. He draws effectively on the work of prominent historians such as Olivier Darrigol and Bruce Hunt, albeit with an occasional misstep like referring to the French physicist Alfred Cornu by his first given name, Marie, which Cornu never went by.

About halfway through the book, Spence shifts his focus from the experimental measurement of light speed to a different, more theoretical set of questions about the nature of how light moves. That portion centers on Albert Michelson, who began his career with efforts to measure the speed of light. But Spence admits that those early experiments by Michelson are not terribly interesting and mostly refined the techniques used by Hippolyte Fizeau and Léon Foucault, so he moves instead to Michelson's next project: measuring the "ether wind" caused by Earth's motion.

It's a well-worn myth that the Michelson–Morley experiment, which was unable to detect any motion of Earth relative to the ether, inspired Albert Einstein to reject the existence of the ether entirely and propose instead the special theory of relativity. Spence does not quite fall into that trap, as he acknowledges that Einstein saw his own work as addressing the theoretical problem of reconciling Maxwell's equations of electrodynamics with the physics of motion.

But he does place the Michelson–Morley experiment at the center of the action and frames his narrative around it. Spence quotes a 1931 speech by Einstein, in which he credited Michelson for having "paved the way for the theory of relativity," although one may imagine

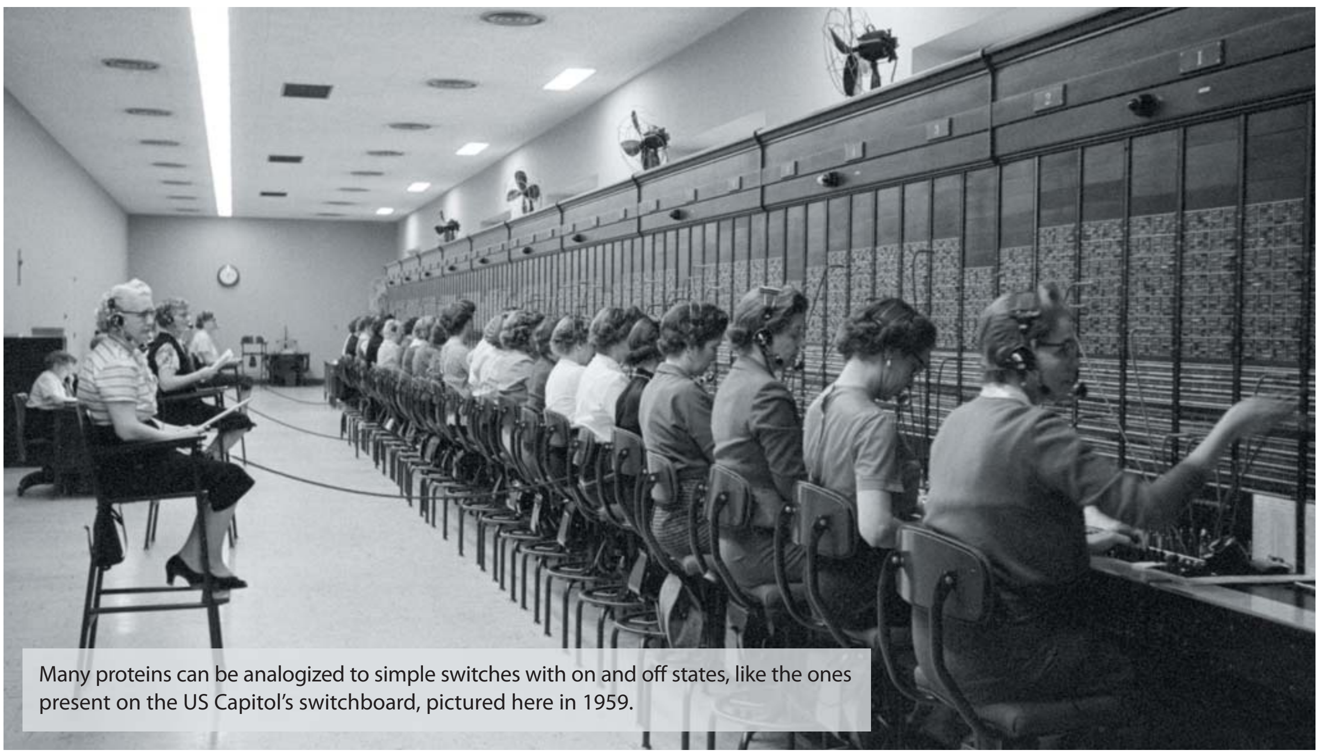
Einstein was being polite to Michelson, as Michelson had invited him to give that speech. Spence also claims that Einstein referred to Michelson's experiment in his 1905 paper "On the electrodynamics of moving bodies," but that is not the case. Although Einstein did allude to "unsuccessful attempts to discover any motion of the earth relatively to the 'light medium,'" historians like Gerald Holton have shown that he was not specifically referring to Michelson.

Spence points out that we now live in a moment where the concept of measuring the speed of light has been turned on its head. Einstein's work elevated c to a fundamental constant of nature, and in 1983 the General Conference on Weights and Measures gave it an exact value. Previously, the speed of anything had been measured by the distance—traditionally defined by the length of a platinum bar preserved in a vault in Paris—that it traveled over time, traditionally defined as a fraction of the day. But the conference has scrapped the platinum bar and effectively defined the speed of light as exactly 299 792 458 meters per second, meaning that the speed of light now determines the length of a meter.

Spence ends the book by asking whether there is any possibility of information moving faster than the speed of light. He then presents a lengthy discussion of Bell's theorem and spooky action at a distance, but notes that the question remains unresolved. He also mentions that the process of writing the book changed his own position on the matter.

Lightspeed has the tone of an exuberant physics lecture, complete with a lab exercise at the end that involves measuring the speed of light with pizza dough. The book's strength is its clear and thorough explanation of the underlying physics, which does not necessarily assume any prior knowledge of the subject but quickly accelerates to a high level. For that reason, it is hard to imagine someone sticking with Spence if they haven't already decided that they like physics. But for those of us who do, *Lightspeed* is an animated account that vividly evokes the numerous and often outsized personalities who contributed to figuring out just how fast light travels.

Theresa Levitt
University of Mississippi
Oxford



Many proteins can be analogized to simple switches with on and off states, like the ones present on the US Capitol's switchboard, pictured here in 1959.

Biology unified by physics

The Molecular Switch
Signaling and Allostery
Rob Phillips
Princeton U. Press, 2020. $85.00

Biology is often taught with diagrams. But you can also teach it with equations, the language of physics. In his new book, *The Molecular Switch: Signaling and Allostery*, biophysicist Rob Phillips does just that, explaining allostery—a biological enigma—using the formalism of statistical physics.

Phillips is a professor of biophysics, biology, and physics at Caltech. He has authored or coauthored several books that creatively combine concepts from biology, physics, and materials science, including *Crystals, Defects and Microstructures: Modeling Across Scales* (2001); *Physical Biology of the Cell* (2nd edition,