

Classifying the Classicality of Classical Physics

What does it mean for something to be classical? Author Robert Pirsig writes that “the classic style is straightforward, unadorned, unemotional, economical, and carefully proportioned. Its purpose is not to inspire, but to bring order out of chaos and make the unknown known.”¹ Music’s classical period is immediately recognizable by its clarity, balance, and moderation; classically-styled architecture is full of formal control of symmetry and shape. Overall, classical subjects are traditional, solid, enduring, and timeless.

How, then, does this concept fit with the classical physics of the nineteenth and early twentieth centuries? The values and aims of physicists were very classical, certainly, but their results were not: though vigorously sought after, proper symmetry, balance, and unification were ultimately not found. It would take the revolution of Einstein’s theory of relativity to raise physics to a level more in keeping with our classical notions of classicalism. (For a very brief period of time, anyway—he merely readied physics to be assailed by the distinctly non-classical confusions and paradoxes of quantum mechanics!)

The first important issue to consider is, what *was* classical physics? Science historian Russell McCormach’s composite character Victor Jakob, a self-described German classical physicist who “half took back the word [classical] every time he said it because it flattered rigidities of mind he wasn’t proud of,”² wonders about this very question:

¹ Robert Pirsig, *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (New York: William Morrow and Company, Inc., 1974), 60-62.

² Russell McCormach, *Night Thoughts of a Classical Physicist* (Cambridge: Harvard University Press, 1982), 10.

[H]e was troubled by the suggestion that people knew precisely what classical physics was. In the time of the classical physicists, the question of what it was had been one of the liveliest questions. Apart from universal principles and absolute constants—those rare and precious supports of physicists’ faith that they discover truth in nature—physicists hadn’t agreed about much...³

German physicists of the time recognized and embraced the classicalism of their culture’s approach to physics. They strove for an aesthetically-pleasing ideal of a perfect world, with laws deduced by pure thought from sound first principles based in a theory of fields. They certainly took the “traditional” descriptor to heart, with a strict, established, and sometimes militaristic linear hierarchy of power headed by the state, which determined academic positions and allocated resources (often inefficiently and unfairly). To physicists concerned with the proper place of everything in the world, this sometimes served as a bitter reminder of their *own* place in it, particularly if they had the misfortune of being a Jew in an anti-Semitic state.⁴

The British, meanwhile, were preoccupied with practicality and empiricism. Swept up in their country’s burgeoning industrialization, the Victorians concocted elaborate mechanical models of the world, always keeping in mind their zealous conviction in the ether, the invisible medium thought to permeate all space. They proposed everything from wheels-and-bands and strings-and-buttons to cogwheels, vortices and jellies.⁵ While these models were usually meant to be analogies, not equivalencies⁶—the mathematician Poynting saw them as “the most satisfying... not because of the nature of the universe but because of the nature of

³ McCormmach, *Night*, 10.

⁴ McCormmach, *Night*, 45.

⁵ Bruce Hunt, *The Maxwellians* (Ithaca: Cornell University Press, 1991), 73-107.

⁶ Hunt, *Maxwellians*, 76.

our minds”⁷—some occasionally got a little carried away. “Is it not highly beautiful?” wrote Oliver Lodge, a great popularizer of Maxwellian thought, on Thomson’s vortex atom model in 1882. “A theory about which one may almost dare to say that it deserves to be true.”⁸

Not all agreed with Lodge that beauty is sufficient for truth (despite classical poet Keats’ comparison). The new coin of the realm was fast becoming mathematical prowess, for physics was becoming professionalized and specialized for the first time, and a good university background was now a prerequisite to working in the field. This was provided particularly well by Cambridge University with its insanely rigorous mathematics program, the public oral debates in Latin now replaced by fiendishly grueling paper exams concentrating in mathematics, meant to train and discipline the mind. Backgrounds of natural philosophers such as Faraday, with no formal education, were no longer as acceptable, and the resulting “picture”-based theories (relying more on physical intuition and without rigorous mathematical backing) theories he and others produced were looked down upon by the mathematicians.

Maxwell tried, and succeeded, to bridge this gap, and didn’t let either side waste the contributions of the other. “I was aware,” Maxwell writes in his preface of his landmark

Treatise on Electrodynamics,

that there was supposed to be a difference between Faraday’s way of conceiving phenomena and that of the mathematicians, so that neither he nor they were satisfied with each other’s language. I had also the conviction that this discrepancy did not arise from either party being wrong.⁹

“The expression,” he stresses, is inherently a “literal translation into mathematical symbols of

⁷ Hunt, *Maxwellians*, 94.

⁸ Hunt, *Maxwellians*, 103.

⁹ James Clark Maxwell, *Treatise on Electricity and Magnetism*, 3rd ed (Oxford: Clarendon, 1892), vol. 1, viii.

the theory.”¹⁰

Maxwell’s electrodynamics were held in high esteem, but there were soon more disturbances in physics. Particularly troublesome was the null result of the Michelson-Morley experiment, which resolutely refused to detect the earth’s motion through the ether. As contemporary Harvard physicist David Morin puts it,

The experiment of Michelson-Morley
Allows us to say, very surely,
“If this ether is real,
Then it has no appeal,
And shows itself off rather poorly.”¹¹

But physicists were still loathe to give up their beloved ether and, “out of desperation,” made themselves to consider mathematical variations on the transformation of time in different reference frames,¹² such as Lorentz’s concoction of an elaborate rationale of “ether drag” for length contraction to explain away the Michelson-Morley data. (Ironically, he ended up with equations that hold beautifully in relativity—but for all the wrong reasons.) Classical physics was continuing to teeter.

Enter Einstein, whose 1905 paper, “On the Electrodynamics of Moving Bodies,” was to ring the death bells for classical physics (though utterly ignored for a number of years). In his paper, he introduces a new way of thinking about simultaneity, which “has come to symbolize the irresolvable break of twentieth-century physics from that of the nineteenth.”¹³ Intriguingly, he begins his argument by remarking, in the very first sentence, on his dissatisfaction with the asymmetries in the accepted interpretation of Maxwell’s

¹⁰ Maxwell, *Treatise*, 155.

¹¹ David Morin, “Physics Limericks,” *American Physical Society News Online* (Mar 1997), accessed Feb 24, 2004. Available from World Wide Web: (<http://www.aps.org/apsnews/morinet.cfm>)

¹² Peter Galison, “Einstein’s Clocks: The Place of Time,” *Critical Inquiry* (Winter 2000), 374.

¹³ Peter Galison, “Einstein’s Clocks: The Place of Time,” *Critical Inquiry* (Winter 2000), 356.

electrodynamics¹⁴ and continues in his proposed theory of relativity to show how the absence of an “absolute” reference frame leads to many symmetries between frames. In terms of its symmetry, at least, relativity theory is more “classical” than classical physics!

Newton’s view that “the order of the parts of time...absolute, true, and mathematical time... is immutable”¹⁵ had held the dominant sway for centuries, but its reign was coming to an end. Ernst Mach, highly influential on the young Einstein (who would, however, later come to reject much of his thinking), held that only experience was relevant, and called absolute time “an idle metaphysical concept.”¹⁶ Einstein shows an insistence in the beginning of his 1905 paper that “the fundamental problems of physics cannot be understood until an epistemological analysis is carried out, particularly so with respect to the meaning of the conception of time and space.”¹⁷

Physics was about to be turned on its head, and our conception of the world would never be the same. The balance and order that was so coveted by classical physicists in their ether and field theories was never found. Einstein’s new theory of relativity held great promise of beauty and symmetry, though it would only pave the way for the uncovering of yet more complications and snags. Physics today, however, embraces these oddities far more than in nineteenth century, and while an elegant Grand Theory of Everything would be nice, ultimately there’s more excitement to this ever-expanding field.*

¹⁴ Albert Einstein, “On the Electrodynamics of Moving Bodies,” translated and reprinted in Arthur I. Miller, *Albert Einstein’s Special Theory of Relativity: Emergence (1905) and Early Interpretation (1905-1911)* (Boston: Addison-Wesley, 1981), 392.

¹⁵ Isaac Newton, “Scholium,” in *Newton: Texts, Backgrounds, Commentaries*, ed. I. Bernard Cohen and Richard Westfall (New York: W. W. Norton, 1995), 231, 233.

¹⁶ Ernst Mach, *The Science of Mechanics* (LaSalle: Open Court, 1960), 273.

¹⁷ Gerald Holton, “Mach, Einstein, and the Search for Reality,” in Gerald Holton, *Thematic Origins of Scientific Thought: Kepler to Einstein*, 2nd ed. (Cambridge: Harvard University Press, 1988 [1973]), 242.

* I will *not* make any puns here about cosmological inflation models—oh no, too late...

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