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Henri Poincaré: A Scientific Biography

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BOOK REVIEW

Henri Poincaré: A Scientific Biography, by Jeremy Gray, Princeton, NJ, Princeton University Press, 2013, xiii + 592 pp., $35.00/£24.95 (cloth)

One of the problems of the history of science is that historians usually do not know much about science, while most scientists are not sufficiently aware of the many links and connections in history. However, for a biography of Henri Poincaré (1854–1912), this is to some extent not a serious issue as he was one of the most inventive, versatile and productive scientists of all time. Any biography of him necessarily has to be restricted in scope, for one can describe him as a physicist, as a mathematician, as an influential figure in public discourse in France around 1900, or as a philosopher. In Jeremy Gray's biography, the emphasis is on Poincaré's scientific achievements, put in an appropriate historical context, with only a few pages about his life and personal relationships. The discussion of his work is organised in eleven chapters on specific topics like topology or the philosophy of science, followed by technical appendixes, references, name and subject indexes.

Before 2012, a year which marked the centenary of his death, there were only a few, rather sketchy biographies of Poincaré, the most interesting among which was by Paul Appell (1925), renowned scientist and a lifelong friend Poincaré's. The biography under review, points out that many important, even fundamental, discoveries by Poincaré were forgotten or ascribed to other scientists. While this is in itself an interesting topic for the sociology of science, how are we to explain it?

Shortly after Poincaré's death in 1912, the First World War broke out, disrupting life in general and daily university activities; after 1920, the style of doing mathematics changed abruptly under the influence of the Gottingen school (David Hilbert) and the Bourbaki movement in France. By then the theory of relativity and quantum theory had dramatically changed the study of mathematical physics, leading the Italian mathematician Vito Volterra to describe Poincaré as "an impressionist among the mathematicians," an adequate description but not one to make his writings popular among young and upcoming scientists.

But there is an important second explanation. Poincaré's papers were often so deep and far-reaching that it took many decennia for fellow scientists to understand their meaning. A few examples: Poincaré developed algebraic topology single-handedly, and his philosophy of science papers (conventionalism) are still of great value; he introduced the fundamental concept of qualitative changes in dynamical systems (bifurcations), linked differential equations with geometry and topology, and, most surprisingly, gave a detailed description of the dynamics of homoclinic and heteroclinic chaos. It took more that sixty years to absorb this information about chaos, and I know of no other work after Poincaré but before 1960, that offers such insight into the idea of chaos.

The eleven chapters of this biography can be read as more or less independent essays. All of them are of interest but most valuable are those that deal with complex function theory, group theory, mathematical physics and the foundations of science, while those on dynamical systems and celestial mechanics are perhaps less successful. For instance, in Chapter 4 Poincaré's work on plane differential equations is discussed as an introduction to the three-body problem. This topic, however, was developed by Poincaré in his doctoral thesis where it was related to solutions of first order partial differential equations, and had little to do with celestial mechanics. Some of Poincaré's new concepts in his thesis were the algebroid functions and the relation between the analysis of differential equations and geometry. The story of Poincaré's error in

his first submission for the Prize Essay granted by the Swedish King Oscar II has been told by a number of authors, but rarely correctly. As Gray notes, Poincaré corrected his initial error himself, yet he omits to add that the original submission contained so many novel ideas and results that this should have been sufficient for Poincaré to get the nomination. The famous three volumes of *Les Méthodes nouvelles de la Mécanique Céleste* are discussed here in a mere four pages, which is clearly not sufficient considering that in status and importance it may be compared with Descartes's *Discourse on the Method* and Newton's *Principia*. It should be noted that the title of the *Méthodes nouvelles* is unfortunate as it suggests that the main topic is celestial mechanics, today it is seen as the first visionary treatise on the general theory of dynamical systems, bifurcations and chaos.

Leaving this criticism aside, most of the chapters are exceptionally rewarding. Chapters 6 and 7 deal with mathematical physics in the work of Maxwell, Lorentz, Einstein and others in the context of the discussions in the early twentieth century. I have not seen such a useful description before; moreover, most scientists, in particular physicists, are not aware of Poincaré part in these discussions. Another fascinating chapter (chap. 11) concerns the philosophy of science. Most of Poincaré articles on this topic are included in his philosophical essay books where he develops his theory of conventionalism in mathematics and physics. Conventionalism takes a fundamentally different form in each of these fields. In mathematics it refers to the freedom to build a theoretical structure as long as it has no internal contradictions and is logically sound, each mathematical structure having its own conventions. In physics, in contrast, conventionalism is based on convenient hypotheses that are used to make predictions. According to Poincaré, questions about "reality as it really is behind the phenomena" make no sense. Several later authors, scientists and philosophers, usefully incorporated his ideas into structural realism. Poincaré's work, in short, is fully alive today and, since this biography is one of the first systematic introductions to his work, it should attract the attention of mathematicians, natural scientists, as well as philosophers.

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