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Between teaching and research: Adolphe Ganot and the definition of electrostatics (1851–1881)

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ABSTRACT

Adolphe Ganot's *Traité* was a canonical physics textbook in 19th-century Europe. In this period, static electricity was largely based on research conducted during the eighteenth century. However, the discussion on the theories of electricity had an important role in the configuration of physics as a discipline through the replacement of imponderable fluids by other frameworks such as the conservation of energy. In spite of this process of unification, the practices defining nineteenth-century electrostatics were not uniform. In this paper we intend to provide a big picture of nineteenth-century electrostatics and to launch a fruitful dialogue between historians and scientists.

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1. Introduction

In 1851, Adolphe Ganot (1804–1887) published in Paris his *Traité élémentaire de physique expérimentale et appliqué* [1] The book was the result of twenty years' experience as a science teacher. The *Traité* met with rapid success, running through eight editions in eight years. Ganot produced successive editions of his book until 1881, when he retired and handed them over through contract to Hachette, the leading French publisher of secondary school textbooks. According to Ganot, the last edition of the *Traité* (18th, 1880) that he prepared himself, had a print-run of 20,000 – a considerable number in this period [2] –and he claimed to have produced 204,000 copies of the book since 1851 as stated in the 18th edition [3].

Furthermore, during the second half of the century, the *Traité* was read in French in many countries, and it was translated into twelve languages. Namely, Italian (1852), Spanish (1856), Dutch (1856), German (1858), Swedish (1857–60), Spanish (Paris, 1860), English (1861–63), Polish (1865), Bulgarian (1869), Turkish (1876), Serbian (1876–77), Russian (1898) and Chinese (1898) (dates between brackets indicate the year of first editions, in most cases there was more than one; the Spanish and English editions were almost as numerous as the French). Although the translation of French physics textbooks was common in this period [4], Ganot's textbooks were certainly amongst the most widely translated and read, and as such made a major contribution at an international level to the making of physics as a discipline. By the 1880s, they were considered standard works of physics by a wide range of readers across the educational, cultural and social spectrum in France and other countries. This conferred them with a canonical cultural status in science, in international perspective [5–7].

Accordingly, Ganot's textbook is an excellent source for historians of physics, offering a major opportunity to characterize the discipline. With his *Traité*, Adolphe Ganot managed to combine fundamental characteristics of previous major textbooks by Claude Pouillet (1790–1868), Eugène Péclet (1793–1857) and Marcel Despretz (1789–1863) with new ingredients. These authors had dominated the French physics textbook market since the late 1820s. Through translation they also contributed to shape physics in many other countries as well. Ganot took the lead from the 1850s and although he had strong competitors, his *Traité* was during the second half of the century the major standard work used to introduce students to physics in secondary education and in the early stages of university degrees in science.

In spite of this, so far, Ganot's work has not received much attention. Historians and philosophers of science have in general ruled out the use of textbooks as sources. Conventional views about textbooks have been prejudiced by an inaccurate separation and hierarchization of teaching and research. Ganot was not involved in research like for instance Pouillet, Péclet and Despretz. He was mainly a teacher who kept very well informed, especially on scientific instrument design. As far as we know, he only used scientific instruments for pedagogical illustrations, although he was also involved in the design of some industrial applications in

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relation to lighting and steam machines. During his career, Ganot registered at least four patents in France [8].

Teaching and textbooks – as major educational products and tools – have been considered as uncreative, dogmatic and mere simplifications of research and research papers. However, these views have been increasingly criticized. Recent scholarship is showing that often research and teaching come together, and that teaching and textbook writing are highly creative practices having a major role in shaping science [9–14]. This is the approach taken in this paper.

Accordingly, we argue that scientific disciplines such as physics and subjects such as electrostatics are not only shaped by research and researchers but also by other actors such as teachers and textbook authors. Thus we intend to use the case of Adolphe Ganot's *Traité* in order to build a richer picture of the shaping of physics as a discipline in the nineteenth century and to provide in this context a historical definition of electrostatics which hopefully will be intellectually-engaging for the modern reader.

In the following narrative, we begin by presenting a brief panorama of physics and its constitution as a discipline in the nineteenth century by analysing its structure, the relevance of its unification projects and the diversity of actors intervening in the process. Subsequently, we devote two sections to the study of electrostatics through Ganot's textbook account. Finally, we suggest several aspects which can contribute to make Ganot's book interesting for contemporary readers involved in the practice of electrostatics.

2. Physics and its discipline(s)

In 1825, the mathematician and science writer Louis-Benjamin Francoeur (1773–1849), expressed the heterogeneity of the field of research designated then as 'physics' or 'natural philosophy':

> "Of all elementary treatises which aim to be used in the teaching of the sciences, the most difficult to do is certainly a work of physics: the reason is that in this branch of knowledge are classed several different sciences which are distinct sciences having often nothing in common between them."[15] *(all translations are by the authors)*

Indeed, during the first half of the nineteenth century, 'physics' was composed by several areas of research studying different phenomena in nature. Accordingly, physics textbooks were composed by separate parts – often designated as "books" – devoted to the study of the properties of matter (solids, liquids, and gases), light, sound, heat, magnetism and electricity, respectively. The study of electricity was often divided in two separate books devoted to static or frictional, and dynamical electricity. These overall divisions were based on the eighteenth-century use of the concept of imponderable fluids. Each of the aforementioned phenomena was accounted for by the interaction of a particular imponderable fluid with matter.

The historiography of physics has placed the unification of these fields as the central phenomenon leading to the constitution of physics as a discipline in the late nineteenth century [16,17]. Different programs were put forward in this period with this intention. In the early nineteenth-century, the French Laplacian programme intended to unify physics by proposing that molecular forces with a common origin governed the action of the different imponderable fluids. This program was subsequently rejected and substituted in succession, first by theories giving central explanatory power to the correlation, conversion and conservation of forces in Britain, and later by the conservation of energy proposed in Britain and Germany, and in electricity and magnetism by Maxwell's field theories. As expressed by Rudolf Stichweh, this element of discontinuity in the historicization of physics is an attractive solution, as it allows presenting "physics" as an "invention", thus making the contingency of its origin a central object of discussion [18]. In fact, available general histories of physics have especially focused on the conservation of energy and conventionally linked the different unification programmes to the culmination of a process of disciplinary formation around that concept.

However, in the light of case studies such as that of Ganot's *Traité* and other physics textbooks, this strategy is problematic, as it has resulted in a periodization of the development of physics as a discipline implying a simplistic national division. The development of physics is supposed to have been carried forward by French, German and British scientists, in successive periods and mostly through separate initiatives. Furthermore, it is generally suggested that the different theoretical frameworks put forward in different moments of this process were immediately accepted everywhere. The reality is much more complex, and the analysis of textbooks reveals this rich complexity.

During the long editorial life of the *Traité*, Ganot only declared in the fourteenth edition of 1870, that "the hypothesis of imponderable fluids, abandoned everywhere, has been replaced by that of a unique fluid", in his textbook [19]. The reader might be surprised by the lateness of this declaration and by the fact that Ganot still used the term "fluid", instead of talking about forces and their correlation, or even about the conservation of energy – taking into account that this doctrine had from 1867 been vigorously promoted in Britain by William Thomson and Peter Guthrie Tait. In fact, Ganot never rewrote his textbook in terms of this principle, which was at the core of the making of physics at the end of the century. In spite of this, he did provide accounts of the different researches that where leading towards a unification of the interpretation of natural phenomena by physicists, such as Fresnel's wave theory and Joule's dynamical theory of heat. Moreover, from the mid-1860s, in the introductory chapter of his *Traité*, Ganot accepted that all physical phenomena could be subdued to a mechanical cause and to the vibrations of 'ether', a unique substance filling the universe [20]. It is significant to pinpoint that although the English edition of Ganot's *Traité* did introduce a section on the new principle of energy conservation as soon as 1868, as for the French case, it did not imply a significant change of the structure of the book and its conceptual and narrative arrangement [7].

Ganot's conception of physics was led by other priorities. For him, the theoretical frameworks successively proposed to unify the study of natural phenomena, were mere hypothesis, which in many senses were unnecessary to explain the latter. On the contrary, the accurate description of scientific apparatus, experimental sets, and experimental procedures, and their exposition in a clear and precise way had a fundamental role in Ganot's physics. Indeed, pedagogical concerns were essential in Ganot's writing and his theoretical choices were often led by pedagogical instrumentalism. As has been pointed out by scholars like Frederick L. Holmes and James Secord the communication of science is an integral part of its making [21–23]. The following sections are devoted to expose Ganot's approach to physics, through the analysis of his book on static electricity.

3. A tale of two electricities

The book on static electricity started like the other books composing Ganot's *Traité* with a historical record of research in this field, followed by a short empirical definition of the behaviour of static electricity and an exposition of the theoretical framework in use.

At this point, Ganot expressed again his characteristic approach to theory. Two theories of electricity were in use since the late eighteenth century. Benjamin Franklin's theory supposed there was a unique imponderable fluid, whose relative absence or presence

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