

BOOK REVIEW

## Kenneth L. Caneva, *Helmholtz and the Conservation of Energy: Contexts of Creation and Reception*

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The principle of the conservation of energy was a pivotal advance in nineteenth-century physics, ushering in a new understanding of the discipline and reshaping its status. Diverse subjects began to merge into a unified domain centred on the concept of energy – the precise definition of which was elusive. Helmholtz, a master of physics and mathematics and the chief architect of modern physiological optics, formulated, in his seminal 1847 essay *On the Conservation of Force*, what became known as the principle of the conservation of energy. Notably, he did this without a clear general concept of energy in mind, as the term ‘force’ in his title suggests. Kenneth L. Caneva retraces the intricate path leading to the development of the conservation of energy, focusing on Helmholtz’s significant contributions to the subject. Caneva does not dwell on the debates over precedence or Helmholtz’s broader achievements as a scientist. Instead, he explores the sources Helmholtz drew upon, what he thought he had achieved, and how his perspective evolved. This evolution was influenced by responses, critiques, the parallel contributions of contemporary scientists and the gradual introduction of the principle into textbooks, thereby becoming part of established science.

Caneva relied on an enormous corpus of primary and secondary documents, published and unpublished, to address these topics and organize them into a coherent set of chapters. The first five chapters provide a detailed examination of Helmholtz’s seminal 1847 essay and the intellectual milieu in which it originated. Caneva begins by delineating the central inquiries that motivated Helmholtz to compose his memoir. Subsequently, the author explores recurring topics and debates that resonate in Helmholtz’s contemporary reception, such as the impossibility of constructing a *perpetuum mobile*, physiological questions related to the origin of animal heat, molecular and material theories of matter and motion, philosophical considerations of causality and the nature of force.

After outlining the broader and immediate context leading to Helmholtz’s essay, Caneva proceeds with a detailed examination of the essay itself. He delves into how Immanuel Kant’s ideas influenced Helmholtz’s formulation of the conservation of force – a topic that has received considerable scholarly attention. Well aware of the complexity of the topic, Caneva builds a narrative that highlights interrelations among various themes, such as the concept of heat as a form of motion and its relation to the principles of mechanics. He then illustrates the multiple intentions behind Helmholtz’s essay and examines how Helmholtz’s understanding of his work evolved. Initially motivated by the need to determine the relationship between the forces of nature that make a

*perpetuum mobile* impossible, Helmholtz's ideas developed alongside the affirmation of thermodynamics and the recognition of the conservation of force as a universal law of physics.

Contrary to later interpretations, Caneva emphasizes that Helmholtz did not intend to establish a definitive concept of 'energy' or 'energy conservation'. The understanding of Helmholtz's work as a fundamental step towards the law of energy conservation progressed over several decades through various stages of reception and reinterpretation, including reassessment by Helmholtz himself. In challenging, yet intriguing, paragraphs, Caneva describes how interpretations of the essay developed in the decades following its publication. These shifts were intimately connected to the relationships between physics and mechanics, particularly the development of the concept of force as energy. After conducting a thorough examination of its reception in two prominent German physics journals – *Die Fortschritte der Physik* and *Annalen der Physik und Chemie* – through the mid-1860s, Caneva analyses in Chapter 9 how Helmholtz's essay influenced the acceptance of energy conservation through the late nineteenth century. This chapter is pivotal in the book, exploring the evolving consensus on Helmholtz's contributions, particularly after the 1870s, and addressing central concerns among physicists towards the century's end. In the final paragraphs of the chapter, Caneva examines how energy conservation gradually became incorporated into German, English, and French physics and mechanics textbooks and monographs.

Chapter 10 explores Helmholtz's evolving relationship with Robert Mayer, one of the co-discoverers of the principle of the conservation of energy, a topic that Caneva previously addressed in his still unsurpassed volume *Robert Mayer and the Conservation of Energy* (1993). In this chapter, Caneva investigates both the relationship between Helmholtz and Mayer and the reception of their work, along with the implications of their contributions to the nature of scientific knowledge in general.

A concluding historiographical discussion evaluates past analyses of Helmholtz's contribution. This section provides a comprehensive review of central arguments from prominent historical analyses and lesser-known or less accessible works. This critical survey significantly enriches discussions of Helmholtz's role in the development of the principle of the conservation of energy. The topic has been extensively covered in academic literature. Recently, David Cahan's monumental biography *Helmholtz* (2018) has also contributed to this discourse within a broader exploration of Helmholtz's multifaceted role as a scientist and a man. Caneva's volume does not focus on Helmholtz himself or on priority debates. Instead, it explores the contexts surrounding Helmholtz's 1847 essay. This groundbreaking study provides a masterful example of the transformative evolution of a scientific concept across disciplines. It illuminates the reception of the principle of the conservation of energy, its integration into context, and its eventual interpretive stabilization, all enhanced by Caneva's profound expertise and extensive research.

This volume primarily addresses historians of science familiar with the topics treated and debated within its pages. Prior awareness of these subjects is essential to fully appreciate Caneva's purpose. Indeed, it is challenging for a general audience to follow and fully comprehend the intricate development and interrelation of the topics discussed in this volume. However, to facilitate reading and to maintain coherence, the text includes helpful connecting points and references. The extensive list of secondary sources serves as a valuable starting point for readers interested in delving deeper into the subject.