

# “Astonishing Successes” and “Bitter Disappointment”: The Specific Heat of Hydrogen in Quantum Theory

Clayton A. Gearhart

Received: 7 July 2009  
© Springer-Verlag 2009

**Abstract** The specific heat of hydrogen gas at low temperatures was first measured in 1912 by Arnold Eucken in Walther Nernst’s laboratory in Berlin, and provided one of the earliest experimental supports for the new quantum theory. Even earlier, Nernst had developed a quantum theory of rotating diatomic gas molecules that figured in the discussions at the first Solvay conference in late 1911. Between 1913 and 1925, Albert Einstein, Paul Ehrenfest, Max Planck, Fritz Reiche, and Erwin Schrödinger, among many others, attempted theoretical descriptions of the rotational specific heat of hydrogen, with only limited success. Quantum theory also was central to the study of molecular spectra, where initially it was more successful. Moreover, the two problems interacted in sometimes surprising ways. Not until 1927, following Werner Heisenberg’s discovery of the behavior of indistinguishable particles in modern quantum mechanics, did American theorist David Dennison find a successful theory of the specific heat of hydrogen.

## 1 Introduction

In 1919, the German theoretical physicist Fritz Reiche, a student of Max Planck and soon to be Professor of Physics in Breslau, published a paper on the quantum theory

---

Dedicated to the memory of Martin J. Klein.

---

Communicated by R.H. Stuewer.

---

This paper was written in cooperation with the joint project in the history of quantum physics sponsored by the *Max-Planck-Institut für Wissenschaftsgeschichte* and the *Fritz-Haber-Institut* in Berlin.

---

C. A. Gearhart (✉)  
Department of Physics, St. John’s University, Collegeville, MN 56321, USA  
e-mail: cgearhart@csbsju.edu