



CHICAGO JOURNALS



History
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Science
Society

Chen-Pang Yeang. *Probing the Sky with Radio Waves: From Wireless Technology to the Development of Atmospheric Science*.

Probing the Sky with Radio Waves: From Wireless Technology to the Development of Atmospheric Science by Chen-Pang Yeang

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Isis, Vol. 105, No. 3 (September 2014), pp. 665-666

Published by: [The University of Chicago Press](#) on behalf of [The History of Science Society](#)

Stable URL: <http://www.jstor.org/stable/10.1086/679169>

Accessed: 26/09/2014 05:04

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luminous scholarly secondary literature, are ultimately anchored in Williams's own brilliantly perceptive readings and interpretations of the private letters, diaries, and creative works that the novelist Verne, the essayist Morris, and the story writer Stevenson each produced during their overlapping lifetimes.

I thought I already knew everything about Jules Verne. Little did I suspect the kinds of fruitful connections Williams extracts from Verne's upbringing in the French port city of Nantes, which was a headquarters for the merchants and sailors most deeply implicated in the French trade of African slaves. Williams ingeniously links the slave ship captains' practices and log books (objectively accounting for gains and losses among a tragically commodified human cargo) to Verne's stock characters who cope with the complexities of the natural and social worlds by enumerating facts and compiling quantitative details. "The captain is technically competent but emotionally remote. He is obviously attentive to recording information about the world in numbers and words but otherwise is alienated from direct experience" (p. 61). A presentiment of the emotional hollowness of scientific comprehension is exposed through this line of literary criticism. From Williams's examination of *Paris in the Twentieth Century* (a gloomy futuristic novel never published in his lifetime), we learn that Verne believed that the magic of technological wonders could not compensate for the broader historical tendencies of capitalism and political bureaucracy to squeeze all hope and humanity out of the lives of ordinary citizens.

William Morris was known to me only by his reputation as a Victorian British participant in the Arts and Crafts and Pre-Raphaelite movements. I had not appreciated the profound connection between Morris and the nascent scholarly tradition of investigation into Nordic and Icelandic mythology, which has flowered in the ensuing century. Nor did I have any previous awareness of Morris's extremely courageous and unpopular championship of a "sentimental" brand of Socialist ideology, one that was equally committed to egalitarian views of social justice and an aesthetic desire to preserve the beauty of ancient buildings and wild natural landscapes. Williams somehow manages to integrate this wildly diverse figure by carefully applying the details that she gathered from deep study of mythology and fantasy literature. For example, she introduces the term "polder" and connects this almost magical site of meaningful memory and spiritual renewal to help unify Morris's otherwise apparently disparate and sometimes par-

adoxically enigmatic behaviors and passions. Williams writes: "When a polder is submerged by the flood of ordinariness, it loses its grace as a pocket of rightness within the wrongful world. Its loss may be described in aesthetic terms, but its essence is moral. It is desecration" (p. 192).

Robert Louis Stevenson provides the book's clearest case for a literary indictment of the global reach of European men and machinery. Born into a family of devout Scottish civil engineers (lighthouse builders), Stevenson rebelled to become a writer of popular romances. He chased a married woman halfway around the earth and ultimately chose a life of exile among the native peoples of the South Seas, whose suffering at the hands of imperialism became a central theme of his writing and politics. Here Williams appends another powerful insight to her investigation of the impact of science and technology on the modern world. Through Stevenson's travels and travails, she illustrates the tremendous human and environmental costs of mass migration, a global phenomenon that Williams attributes (though without demonstration) to the Baconian project (p. 335).

Thoroughly researched and beautifully written, *The Triumph of Human Empire* deserves to be read by anyone curious about the relevance of imaginative literature to the history of science.

DAVID SPANAGEL

Chen-Pang Yeang. *Probing the Sky with Radio Waves: From Wireless Technology to the Development of Atmospheric Science.* xv + 361 pp., illus., bibl., index. Chicago/London: University of Chicago Press, 2013. \$60 (cloth).

The historiography of early twentieth-century physics has been dominated by the formation and developments of quantum mechanics, relativity, and atomic and nuclear physics. Many applied fields of physics closely related to industry, military, and government laboratories, where most physicists were employed, have largely been neglected. This discrepancy becomes apparent upon examination of the war effort during World War I, where physicists worked on wireless communication, sound ranging, and other fields not necessarily associated with modern physics. Chen-Pang Yeang's history of the physics of long-wave radio communication and its transformation into atmospheric science is an important and necessary extension of our perspective in this respect.

Yeang's actors are located between the scientific community and institutions of industry

and government, both military and nonmilitary. The relationships among the theory of wave propagation, field experiments, and the technological development of long-distance radio communication were by no means straightforward. Many of the advances in long-distance radio communication were achieved by inventors, engineers, and amateurs not because of, but despite, the calculations and predictions of physicists. Some scientists and engineers mainly wanted to solve practical problems, without having much interest in theoretical rigor, while others found theoretical problems arising out of practical applications, which they wanted to solve rigorously without being too interested in the practical value of their solutions. We can locate several of Yeang's protagonists at the core of the history of modern physics, like Arnold Sommerfeld and Henri Poincaré; many others are almost forgotten, like Jonathan Zenneck and William Henry Eccles.

Zenneck's and Sommerfeld's surface waves and the Austin-Cohen formula, derived at the United States Naval Research Laboratory around 1910, indicated that only long waveband could travel long distances around the curvature of the earth, leaving the short waveband to the radio amateurs. As a consequence, it was the international community of enthusiastic amateurs that played a key role in proving the possibility of long-distance radio communications in the short waveband. The scientists' agenda shifted from explaining the propagation of radio waves in the first two decades of the century to exploring the structure of the ionosphere by means of radio pulses and to developing the magneto-ionic theory in the 1920s and 1930s. Their magneto-ionic theory had to deliver a microphysical explanation of its function that challenged but did not overthrow conventional electromagnetic theory. The early Kennelly-Heaviside layer proposed by Eccles before World War I was thought of as a reflecting layer that enabled radio communication around the curved surface of the earth. Edward Vinton Appleton at the Cavendish and Merle Tuve and Gregory Breit at the Carnegie Institution of Washington, in comparison, developed radio sounding as an active probe and explored the fine structure of the ionosphere, work that earned Appleton his Nobel Prize in Physics in 1947.

Yeang's story is written from an Anglo-American perspective but also brings in German and French episodes. This is no easy undertaking. In British and German historiography World War I was crucial for the interwar con-

junction of science, industry, and the military. In American historiography, World War I still plays a minor role. I disagree with the characterization of Zenneck as an electrical engineer. He was, in contrast, the quintessential technical physicist. Technical physics emerged in Germany around the turn of the century and grew strong after World War I, indicating the fine structure of the relationship between physics, technology development, and industry, which was quite distinct in the German, British, and American communities.

Probing the Sky with Radio Waves presents an important episode in the origins of remote sensing and the study of the ionosphere. This is not the only story that can be told about these origins, as Northern Lights research and the connections between active sensing, underwater acoustics, and sound location of aircraft during and after World War I, for example, are left out. Yeang points out that experimenting with radio waves in the atmosphere undercuts certain distinctions between laboratory science and field science. Scientists experimenting in the field can be observed in various areas in the geosciences and in military research in the twentieth century.

Everyone interested in the history of electromagnetic theory, radio wave propagation, and the discovery of the ionosphere is strongly urged to read this well-researched book. It is clearly influenced by Jed Buchwald's *From Maxwell to Microphysics* (Chicago, 1985) and *The Creation of Scientific Effects* (Chicago, 1994) and other works heavy on mathematical formulas like Olivier Darrigol's *Electrodynamics from Ampère to Einstein* (Oxford, 2000). Several of the chapters present and discuss differential field equations that might satisfy the curiosity of physicists and mathematically trained historians but might be difficult for others to read. Finally, Yeang is promising a second book following ionospheric research through the 1930s and 1940s. We can look forward to finding out how the story continues.

ROLAND WITTJE

Paul Ziche; Petr Rezykh. *Sygkepleriazain: Schelling und die Kepler-Rezeption im 19. Jahrhundert.* (Schellingiana, 21.) vi + 299 pp., bibl., index. Stuttgart: Frommann-Holzboog, 2013. €74 (paper).

Writing in 1839 to his brother-in-law Christian Frisch, Professor of Philology at Erlangen, Joseph Kopp declared, in Greek, his wish that they should "live together, practise philology together, enthuse together, study the heavens to-