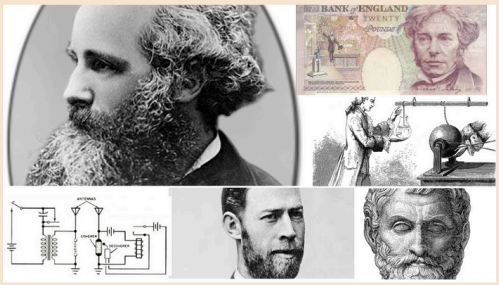
From the beginnings of electricity into antennas and radio wave propagation: A road over 3000 years.



Abstract

To achieve a broad-minded view and understanding of their field, engineers, scientists, and students of antennas, propagation, electromagnetics need a wide perspective into the history of the electricity, magnetism, and radio waves. This tutorial travels through the 3000-year road from Ancient Greek and China through Middle Ages and into modern times and describes the salient discoveries and innovations of electricity, magnetism, electromagnetics, and radio wave propagation.

Workshop outline

The workshop consists of interactive lectures that follow the chronological order of the historical developments in understanding electromagnetics.

Starting from the discovery of electricity (the attractive force in rubbed amber) and magnetism (fabrication of iron tools) in ancient Greece and China, the story continues through the Middle Ages (Petrus Peregrinus), into the scietific revolution in the 17th century (Gilbert) and understanding of the static electricity (Franklin). After the discovery of the Voltaic battery (1800), very soon the magnetic effect of the electric current was found (Ørsted, 1820), followed by the electrodynamic theory by Ampère. The converse effect was found by Faraday soon after: the power of time-changing magnetism to create electromotive forces (1831). And the discovery of full electromagnetic equations by James Clerk Maxwell (1860's) finalized the developments in the unification of these two separate phenomena, electriciy and magnetism.

Parallel to the historical developments in understanding the electromagnetic concepts, their technological exploitation will be covered during this workshop. Innovations like electrostatic generator, compass, Leyden bottle, telegraph, electrical generator and motor are connected to the historical storyline. Particular emphasis will be directed to the developments of the wireless telegraphy and use of radio waves in telecommunications. Works by Heinrich Hertz, Alaksander Popov, Guglielmo Marconi, and Nikola Tesla are essential in this part of the course, and have connections to new fields in radio science in the early 20th century, like ionospheric research and radio astronomy.

The workshop contains demonstrations on the basic electromagnetic effects with coils, batteries, and magnets. Interaction with the audience will be strengthened by conceptual tests.

Ari Sihvola received the degree of Doctor of Technology in 1987 from the Helsinki University of Technology (TKK), Finland (presently Aalto University). Besides working for TKK, Aalto, and the Academy of Finland, he has had visiting positions in Massachusetts Institute of Technology, Cambridge (1985–1986), Pennsylvania State University, State College (1990–1991), Lund University, Sweden (1996), Swiss Federal Institute of Technology EPFL (2000–01), University of Paris 11 (2008), and the University of Rome La Sapienza (2015). His research interests include waves and fields in electromagnetics, modeling of complex media and metamaterials, remote sensing, education in physics and engineering, and history of electrical engineering. He is presently professor in the School of Electrical Engineering at the Aalto University. Ari Sihvola is Life Fellow of the IEEE and the President of the International Union of Radio Science (URSI).

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