Quantum Electromagnetics: An Introduction and Two Game-Changing Computational Electromagnetics Algorithms

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Monday, October 16th, 2023, 9:55am CT
Zoom: https://zoom.us/j/9762699678?pwd=RUp5ZmN3cHUyQ1FvUExVQjVsc1hVUT09
(Meeting ID: 976 269 9678; Passcode: K91Bwy)

LECTURE ABSTRACT

Quantum technology is becoming increasing important in the modern world. They are transformative in computing, sensing, communication, encryption etc. Many quantum technologies are mediated by photons, which is related to quantum Maxwell's equations or quantum electromagnetics. However, understanding quantum electromagnetics requires a paradigm shift in thinking. We will introduce quantum nature of electromagnetic fields in the simplest way possible so that classical electromagneticists can capture the main ideas behind it. We will then use quantum communication as an illustrative example of this new technology.

Next, we will introduce two CEM algorithms. First, we will introduce a differential equation solver with the use of differential geometry or discrete exterior calculus to develop a computational electromagnetics algorithm. This algorithm is broadband valid from DC to optics, auguring wide applications in electromagnetics simulations.

Second, we will introduce an integral equation solver, which are in general harder to implement. Approximately, a scatterer is broken into many small pieces. The solver simultaneously accounts for the interactions among these smaller scatterers using Green's function. Green's function accounts for long-range interactions, implying N^2 interactions for N scatterers. By using fast multipole algorithm, such interactions can be reduced to N or N log N. But an algorithm valid from DC to optics has eluded researchers for two decades. Recently, we have developed a hybrid algorithm with uniformly small error valid from DC to optics. By iterations, a convergent solution can then be rapidly obtained.

SPEAKER BIOSKETCH

W.C. Chew received all his degrees from MIT. His research interests are in wave physics, specializing in fast algorithms for multiple scattering imaging and computational electromagnetics in the last 30 years. His recent research interest is in combining quantum theory with electromagnetics, and differential geometry with computational electromagnetics. After MIT, he joined Schlumberger-Doll Research in 1981. In 1985, he joined U Illinois Urbana-Champaign, was then the director of the Electromagnetics Lab from 1995-2007. During 2000-2005, he was the Founder Professor, 2005-2009 the YT Lo Chair Professor, and 2013-2017 the Fisher Distinguished Professor. During 2007-2011, he was the Dean of Engineering at The University of Hong Kong. He joined Purdue U in August 2017 as a Distinguished Professor. He has co-authored three books, many lecture notes, over 450 journal papers, and over 600 conference papers. He is a fellow of various societies, and an ISI highly cited author. In 2000, he received the IEEE Graduate Teaching Award, in 2008, he received the IEEE AP-S CT Tai Distinguished Educator Award, in 2013, elected to the National Academy of Engineering, and in 2015 received the ACES Computational Electromagnetics Award. He received the 2017 IEEE Electromagnetics Award. In 2018, he served as the IEEE AP-S President. He was a distinguished visiting professor at Tsinghua U, China, Hong Kong U, and National Taiwan U.