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Advanced Material Models for Nano-Plasmonic Systems via Discontinuous Galerkin Methods

KURT BUSCH, Karlsruhe Institute of Technolgy, Karlsruhe, Germany

Nano-Plasmonic systems offer a tremendous potential for the controlled delivery and extraction of electromagnetic energy to and from tiny objects such as molecules and quantum dots in their immediate vicinity. In view of the increasing sophistication of fabrication and spectroscopic characterization, quantitative computational approaches face challenges that go well beyond the usual description of metals as linear dispersive materials. These challenges include the development of material models that describe the (potentially) strongly nonlocal and nonlinear optical response of such metallic nano-structures themselves as well as the strongly modified light-matter interaction that is mediated by them. This talk reports on the progress of applying the Discontinuous-Galerkin Time-Domain (DGTD) method to the quantitative analysis of nano-plasmonic systems using advanced material models. This includes the efficient modeling of complex geometric features via curvilinear elements, the improvement of the time-stepping scheme via tailored low-storage Runge-Kutta schemes, and the incorporation of optically anisotropic media. In addition, this talk reports on recent results regarding the development and application of advanced material models that are based on a hydrodynamic description of the metal's conduction electrons. By coupling the Maxwell equations to this treatment of the free electrons as a plasma in a confined geometry one is able to capture nonlocal and nonlinear effects and to analyze their consequences.