Advanced material models for nano-plasmonic systems

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Plasmonic systems offer a tremendous potential for the controlled delivery and extraction of electromagnetic energy to and from metallic nano-particles as well as molecules and quantum dots that are located in their immediate vicinity. In view of the increasing sophistication of fabrication and spectroscopic characterization, quantitative computational approaches thus face the corresponding challenge of incorporating into their frameworks the strong nonlinear optical response of the metallic nano-strucutres themselves as well as the strongly modified light-matter interaction that is mediated by them.

In this talk, we report on our progress in applying the Discontinuous-Galerkin Time-Domain DGTD (DGTD) method to the quantitative analysis of nano-plasmonic systems. This includes the efficient modeling of complex geometric features via curvilinear finite elements, the improvement of the time-stepping scheme via a judicious choice of the numerical flux, and the incorporation of optically anisotropic media. In addition, we describe advanced material models that are based on a coupled-system dynamics approach. For instance, modified light-matter interactions in plasmonic systems can be treated via the Maxwell-Bloch equations and the nonlinear optical response of metallic nano-particles can be dealt with by treating the corresponding free electrons hydrodynamically, i.e., as a plasma in confined geometry.