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Multiscale numerical modeling in plasma metamaterial systems[1]

DYLAN PEDERSON, KONSTANTINOS KOURTZANIDIS, LAXMINARAYAN RAJA, The University of Texas at Austin — Plasmas have found application in metamaterials (MM)as a negative or near-zeropermittivity component. The permittivity of a plasma depends on its electron density, which can be influencedby an applied field. This means that plasmas can be used in MM to actively control the passageof incident waves, leading to applications in switching and power limiting. Numerical modeling of MMis inherently challenging due to disparate spatial and temporal scales. MMcomponents are typically much smaller than the wavelength they're designed to interact with. When a microplasma is generated by the MM, then the scale lengthsbecomeeven more disparate. Furthermore, capturing interesting physics in the plasma sheath region poses an even harder challenge. In all, plasma MMscale lengths and times can vary over or orders of magnitude. Flux-conservative methods on tree-based grids have shown to be effective in simulating multiscale plasma dynamics in static fields. In this work we address the corresponding techniques for multiscale modeling of plasma dynamics in dynamic fields, and the treatment of those dynamic fields via a multiscale Finite-Difference Time-Domain technique. Usingthese techniques, we can adaptively refine the simulation mesh as the plasma moves in the domain.

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