Metamaterials and Plasmonic structures provide mechanisms for controlling and taming electromagnetic fields and waves in unprecedented ways. New directions, novel vistas and new applications are appearing in the horizon in the fields of metamaterials and its 2-D version, metasurfaces. In particular, when the extreme scenarios are considered, e.g., ultrathin structures (graphene), extreme near field (vortex in subwavelent near field), and extreme parameters (epsilon-near zero (ENZ), mu-near-zero (MNZ), epsilon-and-me-near-zero (EMNZ)), numerous exciting possibilities for the interaction of waves with matter may occur. These may include design of metamaterials for scattering management in numerous applications where low or high scattering is desired, “metafunctional platforms” that can be formed on the metamaterial paradigms, and new functionalities may result from proper combinations of meta-systems and metamaterials. We have been exploring various features and characteristics of these concepts, topics, and directions in metamaterials, and we have been investigating new classes of applications such paradigms may provide. Some of the features of interest include nonlinearity, anisotropy, chirality, non-reciprocity, and non-locality.
TOPICS

1. Metamaterials: Basic Principles
   • Background and History
   • Main Formulations
   • Waves in volumetric and surface-like metamaterials

2. Metasurfaces and Graphene
   • 2D metamaterials
   • Flat electromagnetics
   • Graphene THz structures
   • Graphene metamaterials
   • Graphene circuitry

3. Optical Metatronics
   • Lumped optical circuit elements
   • Optical circuitry
   • Unifying electronics with photonics
   • Optical analog computing and signal processing
   • Optical antennas and wireless links
   • Graphene Metatronics

4. Extreme-parameter metamaterials:
   • Epsilon-near-zero (ENZ) structures
   • Mu-near-zero (MNZ) structures
   • Field enhancement in ENZ media
   • Field distribution in MNZ media
   • Supercoupling phenomena
   • Radiation pattern engineering
   • Dipole emission enhancement
   • Unusual coupling among ports
   • Epsilon-and-mu-near-zero (EMNZ) phenomena

5. Metamaterial Guided and Radiating Structures
   • Metamaterial ultrathin waveguides
   • Deeply subwavelength cavities
   • Metamaterial antennas

6. Cloaking:
   • Wave interaction with metamaterials
   • 2D vs 3D structures
   • Cloaking of metallic vs dielectric structures
   • Reduction of scattering cross sections