Abstract:

The spectacular growth of metamaterials (MTMs) research has been fueled by fantastic ideas like invisibility using MTM “cloaks” and imaging with unlimited resolution using MTM “superlenses”. These ideas, however, are just manifestations of a much more tangible concept: that MTMs afford unprecedented control over electromagnetic (EM) waves. This talk will focus on new ideas being developed at the University of Alberta involving cylindrical MTM geometries. Many microwave devices exhibit cylindrical symmetry (e.g. circular waveguides/apertures, dielectric-resonator antennas, radomes, etc.) and can benefit from the incorporation of MTMs. For example, we recently discovered that hollow circular waveguides lined with thin, cylindrical MTMs could potentially be operated well below their natural cut-off frequencies. This is tantamount to extreme miniaturization, which is unprecedented in the case of hollow-waveguide technology. I will present theory, simulations, and experiments verifying below-cut-off propagation and discuss three distinct and intriguing applications: (1) miniaturized waveguide probe antennas, capable of higher-spatial-resolution near-field characterization of antennas and surfaces, (2) enabling a new type of MRI based on traveling waves, and (3) the miniaturization of aperture arrays leading to new mechanisms for extraordinary transmission.