**Information Metamaterials and Metasurfaces**

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Metamaterials are artificial structures engineered to achieve unique electromagnetic (EM) properties that are unavailable in nature. In the past decade, metamaterials described by the effective medium theory have been widely used to manipulate EM waves, producing a lot of exciting physical phenomena like the negative refraction, perfect lens, and invisibility cloaking, etc. However, metamaterials based on effective medium model can hardly control EM waves in real time.

Here, we introduced the concepts of coding, digital, and programmable metamaterials and metasurfaces. Instead of using the effective medium parameters, digital coding particles with specific phase responses were used to characterize metamaterials and metasurfaces. For example, 1-bit coding metamaterials are constructed by a sequence of binary coding particles “0” and “1”, which correspond to 0 and π phase responses, respectively; while 2-bit coding metamaterials are constructed by a sequence of four coding particles “00”, “01”, “10”, and “11”, which have 0, π/2, π, and 3π/2 phase responses, respectively; and so on. The coding representation not only simplifies the design and optimization procedures of metamaterials owning to the digitalization of the meta-atom geometry, but also provides a link between the physical world and digital world, leading to digital metamaterials, field programmable metamaterials, and information metamaterials.

In this talk, we firstly introduce the concept of coding metasurfaces in the microwave frequency and show their powerful manipulations to EM waves with several examples. Then we present several types of coding metasurfaces in the terahertz frequency, including broadband diffusion metasurface, frequency-dependent dual-functional coding metasurface, highly efficient transmission-type coding metasurface, and polarization-controlled anisotropic coding metasurface. By switching the spatial coding particles in a digital way, we further introduce the digital and programmable metamaterials and their new applications, including programmable antenna, single-sensor and single-frequency imaging, and programmable holographic imaging. Taking the advantage of digital coding representation, two information features of the coding metasurfaces, Shannon entropy and digital convolution, are presented. Finally, we make an outlook on the future trend of information metamaterials and metasurfaces.