Reconfigurable and Time-Varying Metamaterials

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Metamaterials and metasurfaces have been providing an exciting platform to manipulate electromagnetic wave propagation, scattering and radiation. The last fifteen years have witnessed an exciting progress in these fields, both from the theoretical perspective, in the understanding of complex wave interactions with artificial materials, and from the experimental point of view. These efforts span over a wide range of frequencies, from radio-waves to mid-infrared and optics, and have recently expanded also in the context of statics, mechanics, acoustics, and more. Yet, the impact of these efforts on practical technology has been quite limited, mostly due to the lack of reconfigurability, inherent limitations dictated by symmetries, and presence of losses in current metamaterials.

Here, we review our recent progress in the area of time-varying, reconfigurable metamaterials and metasurfaces. We show how time variations over a metasurface or a metamaterial can provide unique opportunities to break fundamental symmetries, such as time-reversal symmetry and reciprocity, open new frontiers for reconfigurable metamaterials exploiting topological signal transport in metasurfaces, and provide gain to compensate losses. We will also discuss how the effect of nonlinearities and multi-physics interactions over a surface may enable imprinting the desired modulation patterns and reconfigurability over large scales, opening opportunities to realize dynamically reconfigurable, broadband metasurfaces for isolation and source protection.

During our talk, we will overview our recent work in this area, put it in context with the recent technological interest in reconfigurable electronics and photonics, and envision the impact that these efforts may have in defining the future of metamaterial technology and beyond.