Space-Time Modulated Metagratings

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In recent years a significant progress has been made in the development of magnet-less nonreciprocity using space-time modulation, both in electromagnetics and acoustics. This approach has so far resulted in a plethora of non-reciprocal devices, such as isolators and circulators, over different parts of the spectrum, for guided waves. On the other hand, very little work has been performed on non-reciprocal devices for waves propagating in free space, which can also have many practical applications. For example, it was shown theoretically that non-reciprocal scattering by a metasurface can be obtained if the surface-impedance operator is continuously modulated in space and time [1]. However, the main challenge in the realization of such a metasurface is due to the high complexity required to modulate in space and time many sub-wavelength unit-cells of which the metasurface consists. As opposed to that, in another work [2], a space-time modulated non-reciprocal leaky wave antenna has been designed and easily built based on a coplanar transmission line that was corrugated to establish radiation through the -1 Fouquet harmonics. The simplicity of the leaky wave antenna originated from the fact that the distance between the modulating capacitors has been roughly half a wavelength.

In the talk we will show that spatiotemporally modulated metagratings can lead to strong nonreciprocal responses, despite the fact that they are based on electrically-large unit cells [3]. We specifically focus on wire metagratings loaded with time-modulated capacitances. We use the discrete-dipole-approximation and an ad-hoc generalization of the theory of polarizability for time-modulated particles, and demonstrate an effective nonreciprocal anomalous reflection (diffraction) with an efficient frequency conversion. Thus, our work opens a venue towards a practical design and implementation of highly non-reciprocal magnet-less metasurfaces in electromagnetics and acoustics.

References

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