Control of Reflection and Absorption using Subwavelength Arrays

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Antenna arrays can be used to control absorption of incident waves (loading the array elements by lossy loads) as well as reflections (in the reflectarray regime, using purely reactive loads). Usually, half-wave spacing between the array elements is used, ensuring all-angle scanning in the transmitting regime. For reflectarrays the desired response can be in principle synthesized by solving for the load values that correspond to the desired distribution of the induced currents over the array plane. However, the required loads in general appear to be complex-valued, which does not allow realizations of reflectarrays as passive structures. Recently, we have shown that the use of subwavelength arrays allows to overcome this limitation and realize theoretically perfect anomalous reflection into any angle [1].

In this presentation, we will discuss a broad generalization of the approach proposed in [1], showing possibilities to control both reflections and absorptions in a very general way. On an example of a finite-size array of loaded wires over a ground plane, that can be studied with fully analytical means, we show examples of reflectarrays acting as beam splitters, flat focusing reflectors, and absorbers. Especial attention is given to extreme-performance examples, such as tunable focal distance, absorption at nearly grazing angles, or super-directive effects.

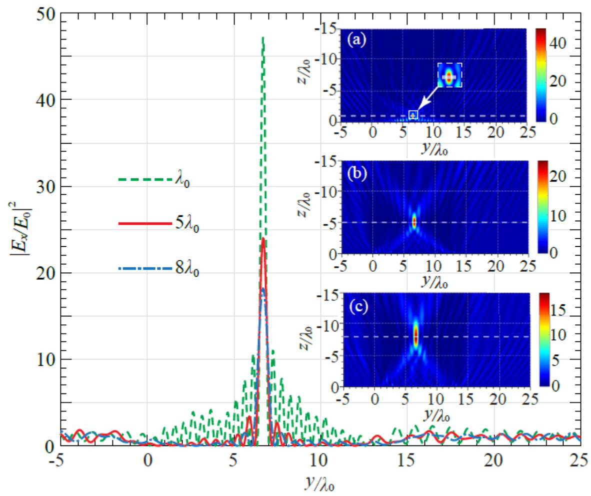

Figure 1. Normalized intensity of the scattered electric field distribution along the focal plane, for subwavelength arrays tuned to focus at distances equal to λ_0, $5\lambda_0$, and $8\lambda_0$, where λ_0 is the wavelegths in free space.

Figure 1 presents an example of a tunable focusing reflector. In this example, the geometric period of the array is $\lambda_0/8$, and the total reflector aperture is $13.5\lambda_0$. It is seen that by varying reactive loads of the array elements, the focal distance can be effectively reconfigured. Note the extremely small focal distances, much smaller than the array aperture and comparable with the wavelength. Such performance is not achievable using conventional reflectarrays that suffer from strong parasitic scattering.

1. Y. Li, X. Ma, X. Wang, G. Ptitcyn, M. Movahediqomi and S. A. Tretyakov, All-angle scanning perfect anomalous reflection by using passive aperiodic gratings, *IEEE Transactions on Antennas and Propagation,* doi: 10.1109/TAP.2023.3329665, 2023.