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Backscattering Reconfigurable Superscatterers Based on Plasma-Metasurface Structure

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The scattering of light is a fundamental problem in physics. As described by Rayleigh's law of scattering, the optical response of tiny objects is usually negligible. Typically, structures with large scattering cross sections, such as corner reflectors, usually have dimensions more than the wavelength. A superscatterer is a sub-wavelength scatterer capable of exceeding the single-channel scattering limit by specific design. Superscattering engineering, which optimizes the maximum scattering cross section by designing the particle structure while maintaining energy conservation and central symmetry, has been implemented experimentally in various systems such as microwave, acoustic and water waves since its introduction. In previous work, we have found that with careful design, superscatterers can achieve backward scattering capabilities that exceed the single-channel scattering limit. This makes it more promising for applications in radar, communications, and other fields.

Superscattering originated from resonance at sub-wavelength scales, which can be achieved by engineering the dispersion of plasma's surface waves. Previously, we combined the plasma and the metasurface to achieve superscattering. In this work, we demonstrate that by tuning the electron density of the plasma, the frequencies of resonant modes emerge can be changed. Complicated interfering superpositions between the different resonant modes arise, which in turn reconfigure the backscattering. The backscattering cross section of the structure can be manipulated over a very large range (about 4 orders of magnitude), from almost no backscattering to a sub-wavelength retroreflector, and has the potential to be reconfigured on fast time scales. These are valuable properties of optical switches, and such a mechanism can be expected to play a role in various reconfigurable photonics applications.

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References

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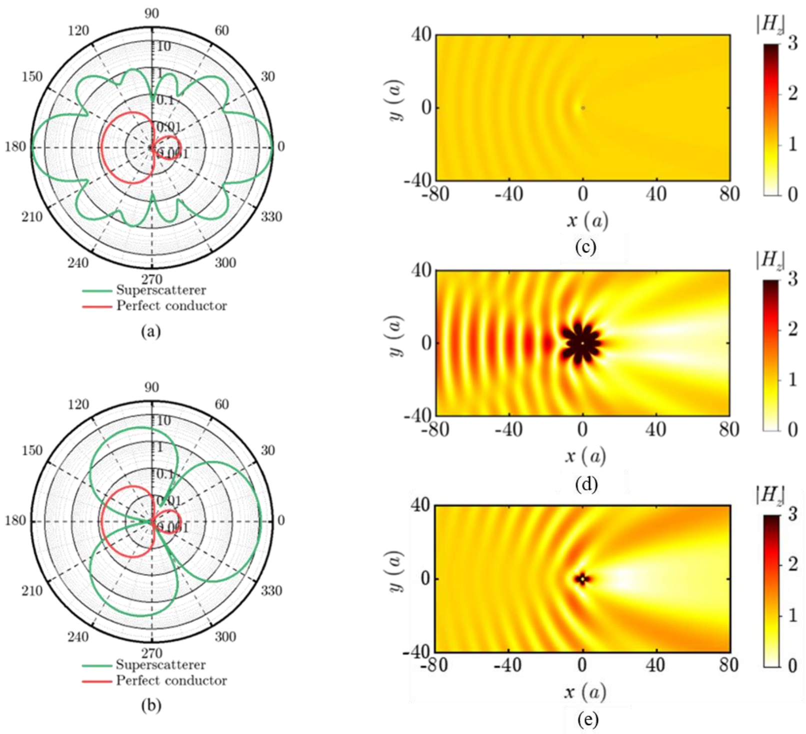

Figure 1. Scattering of two states reconfigured by regulate plasma density. Far scattering pattern of (a) strongly backscattering state and (b) scattering cancelling state; Near-field profile of plane waves incident from the left to three different scatterers: (c) The perfect electrical conductor, (d) reconfigurable scatterer in strongly backscattering state and (e) reconfigurable scatterer in scattering cancelling state.