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Reciprocal Asymmetric Transmission: A Way Passed From Plane Waves To Metaholograms

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Reciprocal Asymmetric Transmission (RAT) has attracted attention of the metamaterial, photonic crystal, and artificial chirality communities since 2000's. Initially, RAT has been understood as the difference in transmission when the structure with broken spatial inversion symmetry is illuminated by the same linearly or circularly polarized wave in forward and backward (i.e., opposite) directions. The diffraction gratings with one-side corrugations are probably the simplest structures enabling RAT. However, they are not well suitable for the achievement of a high-contrast RAT, because it is rather accidental therein. To ensure that zero (i.e., symmetric) order is suppressed, while the desired higher orders are excited only for one direction, photonic-crystal gratings, metamaterial gratings, and gratings involving epsilon-near-zero materials have been proposed. In these structures, dispersion and diffraction work jointly to block zero-order transmission and enable conversion of the incident-wave energy to the selected diffraction orders. Instead of diffractions, polarization states can be used, so that symmetric co-polarized transmission can be suppressed, while asymmetry occurs due to the forward-to-backward contrast in cross-polarized transmission. Metagratings with subwavelength slits, which support surface plasmons, have been the first structures, in which asymmetric field distribution has been demonstrated at beam-type illumination. The recently proposed Janus metasurfaces offer prospective RAT devices, which are used either for generation of asymmetric metaholograms at the identical forward and backward illuminations, or for asymmetric transformation of one hologram to another. To summarize, RAT has a floating focus, being presently shifted towards asymmetric functionality, and expectedly to the general asymmetric physics at the next step.

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