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An "optical diode" based on surface plasmon cavity modes[1]
MICHAEL J. BURNS, FAN YE, MICHAEL J. NAUGHTON, Boston College, Department of Physics, Chestnut Hill, MA, 02467 — We present the discovery and systematic study of a novel optical phenomenon that works like an "optical diode," where the center of an optically thick circular Ag disk surrounded by step gap looks dark when observing in the far field from the top side, and appears bright when seeing from the bottom side. In both cases, the circular step gap circumference appears bright. We call the effect when observing from the top side the "plasmonic halo," and the effect from the bottom side the "reverse halo." In our previous work, we have demonstrated the physical nature of the "plasmonic halo" effect: modulation of transmission by the surface plasmon polariton (SPP) drumhead modes.[2] Here we will explain the "reverse halo" effect by a three-step process: coupling from photons to SPPs, interference of SPPs forming cavity modes, and out coupling from SPPs to photons. Full-wave electromagnetic simulations based on finite element method support our theory. We have thus arrived at a thorough understanding of this "optical diode" effect, which could have potential applications in biomedical plasmonics, dielectric constant sensing, discrete optical filtering, and photonic logic, among others.

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[2]F. Ye, M. J. Burns, M. J. Naughton, *Nano Lett.* **13**, 519-523 (2013).

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