Controlling light-with-light without nonlinearity

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According to the fundamental Huygens superposition principle, light beams traveling in a linear medium will pass though one another without mutual disturbance. Indeed, the field of photonics is based on the premise that controlling light signals with light requires intense laser fields to facilitate beam interactions in nonlinear media, where the superposition principle can be broken.

Here we challenge this wisdom and demonstrate that two coherent beams of light of arbitrarily low intensity can interact on a metamaterial layer of nanoscale thickness in such a way that one beam modulates the intensity of the other. We show that the interference of beams can eliminate the plasmonic Joule losses of light energy in the metamaterial or, in contrast, can lead to almost total absorption of light. Applications of this phenomenon may lie in ultrafast all-optical pulse-recovery devices, coherence filters and THz-bandwidth light-by-light modulators.

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