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Negative-Index Metamaterials in the Visible Range

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In conventional materials, out of the two field components of light, electric and magnetic, only the electric one ("electric hand") efficiently couples to and probes the atoms of a material while its "magnetic hand" remains almost unused because the interaction of atoms with the magnetic filed component of light is normally very week. Metamaterials, i.e. artificial materials with rationally designed properties, can enable the coupling of *both* field components of light to meta-atoms, enabling entirely new optical properties and exciting applications with such "two-handed" light. Metamaterials are expected to open a gateway to unprecedented electromagnetic properties and functionality unattainable from naturally occurring materials. Negative-refractive index metamaterials create entirely new prospects for guiding light on the nanoscale, some of which may have revolutionary impact on present-day optical technologies. The extraordinary nonlinear optical properties of negative-index metamaterials are also discussed. We review this new emerging field of metamaterials and recent progress in demonstrating a negative refractive index in the optical and visible range, where applications can be particularly important, including sub-wavelength imaging and cloaking objects, i.e. making them invisible.