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Optical Properties of Transiently-Excited Semiconductor Hyperbolic Metamaterials

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Hyperbolic metamaterials (HMs) behave as uniaxial materials with hyperbolic isofrequency wavevector surfaces. These materials are characterized by extremely large densities of states which can greatly enhance spontaneous emission and near-field thermal energy transfer, and lead to enhanced absorption processes. The degree to which these properties appear depends upon the range of photon momenta over which the isofrequency surface remains hyperbolic. We compare properties of both semiconductor and metallic hyperbolic metamaterials (SHMs and MHMs) and find that SHMs allow for the attainment of very high photon momentum states. In addition, ultrafast optical excitation of photocarriers has the potential to transform undoped semiconductor superlattices into SHMs, giving rise to reflectionless features, perfect absorption and negative refraction on ultrafast timescales.

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