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Terahertz saturable absorption in black phosphorus

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Black phosphorus is a unique two-dimensional (2D) material with a tunable infrared band gap and anisotropic conduction properties. We investigate the ambient pressure nonlinear terahertz (THz) electrodynamics of black phosphorus and found that its THz saturable-absorption properties can be understood within a thermodynamic model by assuming a fast thermalization of the electron bath. While black phosphorus does not display the presence of massless fermions at ambient pressure and temperature the material's anomalous THz nonlinear properties can be accounted for by a relativistic massive Dirac dispersion, provided that the Fermi temperature is low enough. This suggests that an optimal tuning of the Fermi level could be a strategy to engineer a strong THz nonlinear response in other massive Dirac materials, such as transition-metal dichalcogenides or high-temperature superconductors

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