**Terahertz saturable absorption from relativistic high-temperature**

**thermodynamics in black phosphorus**

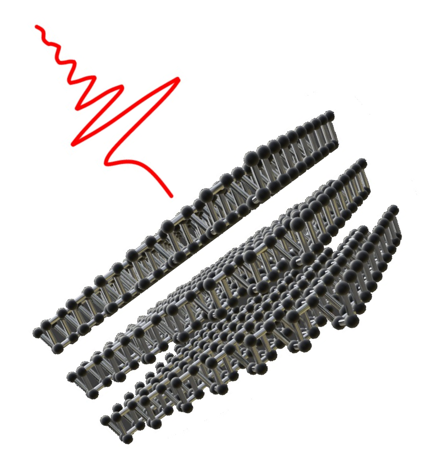
Nidhi Adhlakha1, Zeinab Ebrahimpour1,2, Paola Di Pietro1, Johannes Schmidt1, Federica Piccirilli1,Daniele Fausti3,4, Angela Montanaro3,4, Emmanuele Cappelluti5, Stefano Lupi6, and Andrea Perucchi1,\*

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1. Elettra-Sincrotrone Trieste S.C.p.A., Trieste 34012, Italy
2. Abdus Salam International Centre for Theoretical Physics, Trieste 34151, Italy
3. Department of Physics, Università degli Studi di Trieste, Trieste 34127, Italy
4. Department of Physics, University of Erlangen-Nürnberg, Erlangen 91058, Germany
5. Istituto di Struttura della Materia, CNR (ISM-CNR), Trieste 34149, Italy
6. CNR-IOM and Dipartimento di Fisica, Università di Roma Sapienza, Roma I-00185, Italy

\* andrea.perucchi@elettra.eu

Black phosphorus is a unique two-dimensional (2D) material (Figure 1) with a tunable infrared band gap and anisotropic conduction properties [1]. Black phosphorus also displays the occurrence of a pressure-induced topological Lifshitz transition turning the material from a narrow gap semiconductor to a massless Dirac metal due to a nonavoided band crossing [2]. We investigate the ambient pressure nonlinear terahertz (THz) electrodynamics of black phosphorus along the more conducting armchair direction and found that its THz saturable-absorption properties can be understood within a thermodynamic model by assuming a fast thermalization of the electron bath [3]. 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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**Figure 1.** Sketch of black phosphorus’ crystal structure

References

1. X. Ling *et al.*, The renaissance of black phosphorus, Proc. Natl. Acad. Sci. **2015**, *112*, 4523.
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