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Theoretical Modelling of Interactions of Moving Charged Particles with Two-Dimensional Materials

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Extended Abstract

I shall review some of our recent work on theoretical modelling of the interaction of a charged particle with mono-layer black phosphorus, called phosphorene, which is well known for its strong in-plane optical and electronic anisotropy [1]. First, using a relativistic formulation of the problem, I shall show that the angular patterns in the transition radiation emitted from doped phosphorene, triggered by a traversal of a fast electron in a Transmission Electron Microscope (TEM), can be related to the in-plane conductivity tensor of this material in the frequency range from the terahertz to the mid-infrared (THz-MIR) [2]. This can be used to probe the dispersion of the so-called hyperbolic plasmon polariton modes in doped phosphorene at such low frequencies, which are still not accessible via energy loss measurements in TEM [3]. Second, using a non-relativistic formulation, I shall show some results on an anisotropic stopping force that acts on a charge moving parallel to a supported layer of doped phosphorene on a SiO_2 substrate [4]. For this configuration, I shall also show results on an anisotropic wake effect in the electric potential induced in phosphorene by a fast-moving charge, as well as illustrate an application of the concept of stopping force to the calculation of an anisotropic dc mobility tensor in doped phosphorene. In our calculations for both configurations [2,4], we have used an empirical model for the conductivity tensor of doped phosphorene in the THz-MIR frequency range that was developed by a careful calibration against the *ab initio* data, which include both the intraband and interband electronic transitions in this material [5].

References

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