Using the oscillator model to describe 2D materials.

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We model a 2D material as a monolayer of atoms represented by harmonic oscillators, with isotropic and anisotropic electronic vibration modes. We obtain the energy loss of relativistic charged particles interacting with it; consider a wide range of incident energies for different trajectories of the particle. In particular, we apply the model to describe the case of electrons interacting with graphene.

We obtain several useful analytical expressions for the energy loss considering isotropic and anisotropic in-plane oscillators, for parallel and perpendicular trajectories of the particle.

The results shown for stopping power and energy loss are analyzed for generic materials by the use of adequate normalization factors, absorbing the dependencies on the specific properties of the material, namely the oscillator's areal density η and their resonant frequency ω.

We notice that in an anisotropic 2D-oscillators system, the energy loss due to single oscillator presents a reduction with respect to the isotropic case, especially in the parallel trajectory. We ascribe this effect to the lower availability of oscillation modes, and hence to a reduction of the interaction channels.

Finally, we remark that the present model stands out for its generality, and provides a direct evaluation of the energy loss processes in a generic 2D material.