Novel high-frequency performance of nanodevices with coherent electron-photon interactions

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Typically, the performance of quantum electron device is engineered through the modulation of the transmission coefficient T(E) with the longitudinal electric field [1] solution of Gauss's equation. In this work, the transverse electromagnetic fields is considered quantized and its effects on the device dynamics is analysed with a coherent electron-photon model. The computational burden involved in the multi-time measurements of THz currents in nanodevices is minimized by invoking a Bohmian description of the light-matter interaction [2],[3] as shown in Fig. 1. For a double barrier structure, the second peak of the original transmission coefficient, without interaction with photons, splits into two new peaks due to the electron-photon interaction in the resonant case, as seen in Fig. 2. Such phenomenon, which mimics known effects predicted by a Jaynes-Cummings model in closed systems [4], exemplifies how the full quantum treatment of electrons and electromagnetic fields opens unexplored paths for engineering new THz electron devices.

References

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Figures

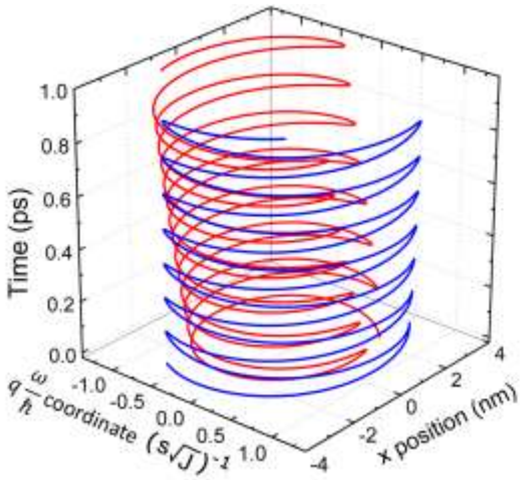

Figure 1: Typical Bohmian trajectories in the 2D electron-photon plane with x the position of the electron and q the amplitude of the mono-mode electromagnetic field.

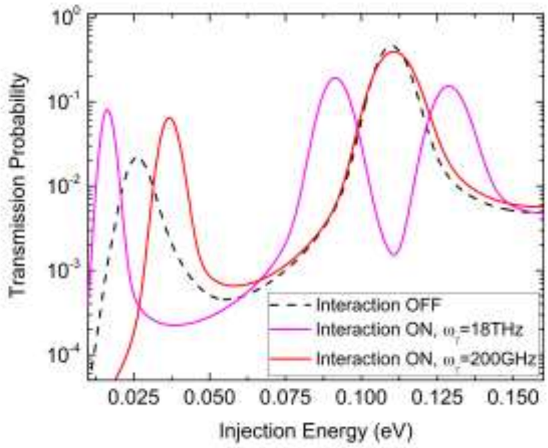

Figure 2: Transmission probability T(E) as a function of the energy of the electron entering into a double barrier potential and interacting with a mono-mode electromagnetic field with frequency ω_γ. The cases of no-interaction (dashed black), interaction with a resonant photon (magenta) and a non-resonant photon (red) are plotted.