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HHG in solids: dynamics of multilevel adiabatic states spanning the band structure[1]

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We investigate high harmonic generation in a solid, modeled as a multilevel system dressed by a strong infrared laser field [1]. We show that the cutoff energies and relative strengths of the multiple plateaus that emerge in the harmonic spectrum can be understood both qualitatively and quantitatively by considering the dynamics of the laser-dressed system. Such a model was recently used to interpret the multiple plateaus exhibited in harmonic spectra generated by solid argon and krypton [2]. We show that when the multilevel system originates from the Bloch states at the gamma−point of the band structure, the laser-dressed states (which are equivalent to the so-called Houston states [3]) map out the band structure away from the gamma−point as the laser field increases. This means that the cutoff energy of a given plateau can never exceed the maximum band gap between the valence band (VB) and the conduction band (CB) responsible for that plateau, thereby extending the cutoff limitation proposed in [4] to a multiband system. Finally, we discuss how this understanding leads to a semiclassical three-step picture in momentum space that describes the HHG process in a solid. In this picture, the delocalized electron first tunnels from the VB to the CB at the zero of the vector potential and then is accelerated on the CB as the vector potential increases and decreases through an optical half-cycle. The coherence between the VB and the CB populations leads to the emission of XUV radiation, with photon energies corresponding to the instantaneous energy difference between the VB and the CB. This means that each energy below the cutoff energy is emitted twice in each laser half-cycle. [1] M. Wu *et al.* PRA **94**, 063403 (2016). [2] G. Ndabashimiye *et al.*, Nature **534**, 520 (2016). [3] J. B. Krieger and G. J. Iafrate, PRB **33**, 5494 (1986). [4] G. Vampa *et al.*, PRL 113, 073901 (2014).

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