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# Band-Structure Based model for photoelectron emission from metal surfaces

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**Synopsis** Photoelectron emission spectra induced by grazing incidence of intense and ultrashort laser pulses on a metal surface are studied within a distorted-wave formalism. The proposed aproximation, named Band-Structure Based-Volkov (BSB-V) approach, includes a precise description of the surface potential, incorporating information of the band structure of the solid. Results are compared with the numerical solution of the time-dependent Schrödinger equation and with values derived from simpler theoretical models.

The research of the interaction of electromagnetic fields with surfaces in the attosecond regime has recently attracted a considerable interest because it opens the way to study the behavior of electrons in condensed matter in their natural time scale [1]. In this work we investigate electron emission from the valence band of a metal surface, induced by grazing incidence of an ultrashort laser pulse. Our aim is to derive a simple formalism that takes into account the main features of the process, including an accuarate representation of the electron-surface potential.

Within the framework of distorted-wave theory we develop the BSB-V aproximation, which makes use of the Band-Surface Based (BSB) model [2] to describe the surface interaction, while the action of the electric field is represented by means of the Volkov phase [3]. The BSB model provides a detailed description of the one-electron states at the metal surface, having been succesfully used in several branches.

The model is applied to derive electron emision distributions produced by a linearly polarized electric field oriented perpendicular to the surface plane. The temporal profile of the field is defined as

$$F(t) = F_0 sin(\omega t + \varphi) sin^2(\pi t/\tau) \text{ for } 0 < t < \tau$$

and zero elsewere, with $F_0$ the maximum field strength, $\tau$ the pulse duration, $\omega$ the carrier frequency, and $\varphi$ the carrier-envelope phase. In order to analyze the validity of the BSB-V approach, results are compared with values derived from the numerical solution of the time-dependent Schrodinger equation (TDSE), using the same model potential to describe the surface interaction.

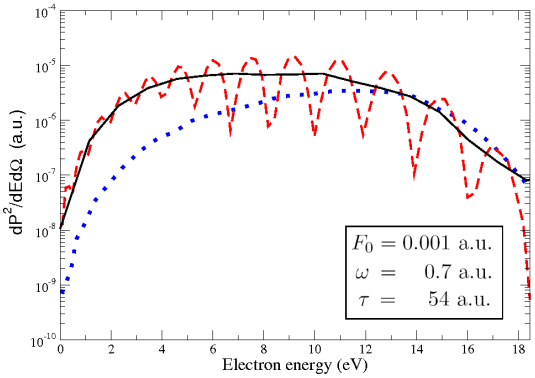


**Figure 1**. Electron distribution, as a function of the electron energy, for photoemission from an Al(111) surface. The ejection direction is perpendicular to the surface plane. Solid line: BSB-V approach, dashed line: TDSE results, dotted line: JV approach as reported in Ref 4.

In the figure, BSB-V and TDSE results for photoelectron emission normal to the surface are displayed along with values derived from a simpler description, given by the Jellium-Volkov (JV) approximation [4]. As expected, differences between both theories are observed in the low energy region.

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