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Fast atom diffraction for multi-electronic atoms scattered from a LiF surface

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Synopsis In this work we investigate experimentally and theoretically angular distributions of swift multi-electronic atoms after colliding with a LiF(001) surface under axial surface channeling conditions. We use the surface eikonal approximation to describe the quantum interference of scattered projectiles. The atom-surface interaction is represented by means of a pairwise additive potential that includes the contribution of the projectile polarization. The aim is to use the experimental spectra to test the range of validity of the proposed potential model.

Recent diffraction experiments [1] for fast atoms colliding grazingly with crystal surfaces are attracting considerable attention. In part this interest is motivated by the high sensitivity of the diffraction patterns to the projectile-surface interaction, which opens the way for a method to probe surface potentials with high accuracy.

Although until now most of the research on this diffraction phenomenon was carried out using H or He atoms as projectiles, the effect has been also observed for neon atoms [2], which have several electrons interacting with the crystal ions. In this work we study experimentally and theoretically axial surface channeling scattering of multi-electronic atoms, focusing on the role played by the projectile polarization.

To describe the diffraction process we employ the surface eikonal approximation [3], which is a distorted-wave method that makes use of the eikonal wave function to represent the elastic collision with the surface. In the model, the motion of the fast projectile is described classically by considering axially channeled trajectories for different initial conditions.

The interaction of the incident atom with the crystal surface is represented by a sum of individual interatomic potentials, which takes into account the contribution of the different ionic centers of the insulator material (pairwise hypothesis). The asymptotic contribution of the projectile polarization is included in the surface potential and its effect on angular distributions is analyzed.

In Figs. 1 and 2 we show results for Ne [4], N and S projectiles impinging on a LiF(001) surface along the <110> and <100> channels, respectively.

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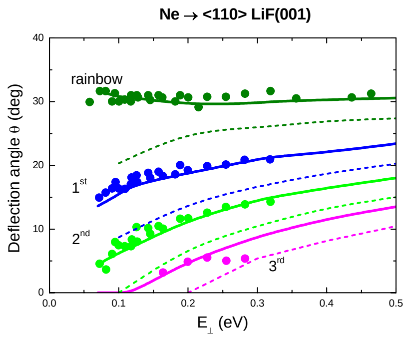

Figure1. Deflection angles corresponding to maxima of angular distributions, as a function of the perpendicular energy, for Ne atoms scattered from LiF(001) along the ⟨110⟩ channel. Symbols: experimental data, solid (dashed) line: eikonal calculations including (without including) polarization.

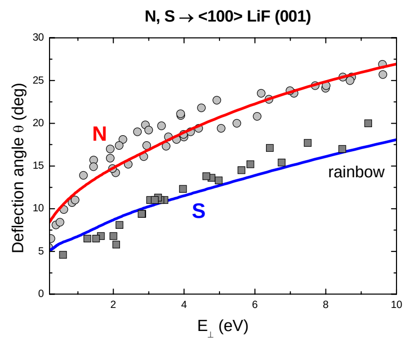

Figure2. Deflection angle of rainbow peak for N (circles) and S atoms (squares) scattered from LiF(001) along the ⟨100⟩ channel.

References

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