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Alkali-atom photoionization and negative-ion photodetachement processes in the presence of external fields

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Synopsis Processes of alkali-atom photoionization and negative ion photodetachement in the presence of external fields are investigated. The corresponding photoabsorption spectra are interpreted by employing the theoretical framework of Schwinger variational principle and the local frame transformation theory.

Two-photon ionization of an alkali-metal atom in the presence of a uniform electric field is investigated using a standardized form of local frame transformation (LFT) and generalized quantum defect theory [1]. The relevant long-range quantum defect parameters in the combined Coulombic plus Stark potential is calculated with eigenchannel R-matrix theory applied in the downstream parabolic coordinate η. The present formulation permits us to express the corresponding microscopy observables in terms of the local frame transformation, and it gives a critical test of the accuracy of the Harmin-Fano theory[2, 3] .

The negative-ion photodetachement in a uniform magnetic field is also investigated where polarization of the photon is chosen to be perpendicular to the field. The LFT theory and a new non-perturbative method in terms of the Schwinger variational principle are employed interpreting the corresponding photoabsorption spectra. In particular, the physics of *all* the closed channels due to the magnetic field is included and compared with previous studies [4]. Indeed, the inclusion of the closed channel manifold induces non-trivial effects, particularly in the regime of large atom-electron scattering lengths. Fig.1 illustrates the differences between the photoabsorption probabilities with (solid line) and without (dashed line) the physics of the closed channels. These differences emerge due to a bound state which is collectively supported by all the closed channels.

Furthermore, the concept of collective bound states is generalized and studied in negative-ion photodetachement in the presence of parallel and crossed electric and magnetic fields. We observe that such bound states yield intriguing features in the collisional aspects of atom-electron scattering which can be manipulated by adjusting the strength of the electric and magnetic fields.

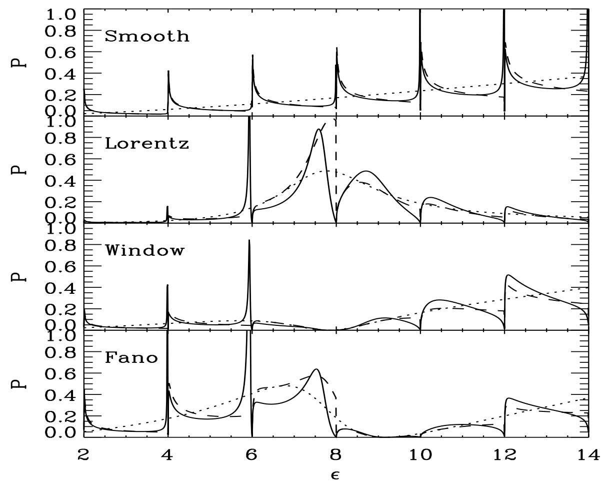

Figure 1. The p-wave photoabsorption probability for different cases of free-field resonances. In all panels, the dotted line is for photoabsorption spectrum without the external field, the dashed line is the approximation that includes the external field but does not include the effect of closed channels, and the solid line is the full calculation including the magnetic field. The “Smooth” case does not have a resonance. The “Lorentz”, “Window”, and “Fano” cases only differ in the energy dependence of the dipole matrix element when no field is applied.

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References

[1] P. Giannakeas, F. Robicheaux, and C. H. Greene, arXiv:1410.5360.

[2] U. Fano, Phys. Rev. A **24**, 619 (1981).

[3] D. A. Harmin, Phys. Rev. A **26**, 2656 (1982)

[4] C. H. Greene, Phys Rev. A **36**, 4236 (1987).

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