Photoelectron Angular Distributions and Nonperturbative QED

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The shape of photoelectron angular distributions (PADs) is determined by three dimensionless numbers: 1) the binding number, 2) the ponderomotive number, and 3) the absorbed-photon number. Thus, PADs satisfy a scaling law: For corresponding abovethreshold-ionization (ATI) peaks, the PADs from an atom of binding energy E_b irradiated by a laser beam of intensity I and frequency ω are the same as for an atom of binding energy KE_b irradiated by a laser beam with intensity K^3I and frequency $K\omega$. The number of jets in PADs are determined by the number of maxima of the generalized phased Bessel function.

The nonperturbative quantum electrodynamics (NPQED) can explain all phenomena in strong field laser physics. NPQED has achieved many important results. Following are some examples:

1. What is the final state in multiphoton ionization (MPI)? NPQED disproved the Keldysh ansatz (Volkov state is the final state). NPQED concludes that photon and electron noninteracting plane wave is the final state, while Volkov states are intermediate states. Bucksbaum's Kapitza-Dirac (KD) effect experiment strongly supports the NPQED conclusion.

2. Prediction of ponderomotive momentum. According to NPQED, the ponderomotive energy is not a potential energy. It is the counter part of the ponderomotive momentum. The ponderomotive four momentum is light-like, thus, cannot be absorbed by photoelectrons in single-mode MPI.

3. Prediction of the spin-other-orbit effect between photon modes.

4. Explanation of PADs and the scaling law of PADs.

5. Prediction of quantum field effects in strong laser fields.