Europhysics Study Conference on Multiphoton Processes

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L. ARMSTRONG (Johns Hopkins University, Baltimore, U.S.A.)
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P. KNIGHT (Royal Holloway College, University of London, England)
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N.V. Karlov, A.M. Prokhorov (P.N. Lebedev Physical Institute, Moscow, USSR)

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(Max-Planck Institute, Garching, Germany)

Multiphoton processes and laser-induced chemical changes.

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S. Geltman (JILA, Boulder, USA)

Multiphoton free-free transitions and ejected electron energy distributions.

G. Leuchs, E. Riedle, S.J. Smith, H. Walther

(Universität München, Garching, All.Fédérale)

Angular distribution of photoelectrons in three photon ionization of sodium.
ANGULAR DISTRIBUTION OF PHOTOELECTRONS IN THREE PHOTON IONIZATION OF SODIUM

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The angular distribution of photoelectrons produced by multi-photon ionization of atoms is a sensitive test for the ionization process since the distribution is determined by the intermediate states. In this paper we report measurements of the angular distribution which have been obtained for resonant three-photon ionization. The results also demonstrate that the angular distribution can be changed by mixing the intermediate states by microwave transitions. This can be used for optical microwave experiments to determine the energy splitting of Rydberg states.

In the experiment two nitrogen laser pumped dye lasers were used to excite the atoms of a sodium atomic beam. The sodium atoms were ionized in the resonant three-photon process \(3^2S_{1/2} \rightarrow 3^2P_{1/2}, 3^2P_{3/2} \rightarrow n^2D \rightarrow |l,k\rangle\). The electrons emitted in the plane perpendicular to the direction of the laser beams were detected with an angular resolution of 0.35 rad. The angular distribution was probed by rotating the direction of the linear polarization of the laser light.

In the case of single-photon ionization of atoms with an equal population of the m-sublevels the photoelectron angular distribution can be described by the general formula

\[ I(\theta) = 1 + 8P_2(\cos \theta) \]

\(\theta\) is the angle between the direction of emission of the photoelectron and the laser polarization. \(\beta\) is the anisotropy parameter and \(P_2\) the second Legendre polynomial. In the case where
m-sublevels are selectively populated in a n-photon ionization process, higher powers of $\cos^2 \theta$ have to be included:

$$I_n(\theta) = \sum_{v=0}^{n} a_v \cos^{2v} \theta.$$ 

Thus, for a resonant multi-photon ionization process sharp maxima appear in the angular distribution of photoelectrons which critically depend on the quantum numbers of the intermediate states $/1/$. Experiments on sodium demonstrating this behaviour are reported.

Fig.: The angular distribution of photoelectrons produced by resonant three-photon ionization $3^2 S_{1/2} \rightarrow 3^2 P_{3/2} + n^2 D \rightarrow |1,k\rangle$ is shown in a polar diagram. The solid line was obtained in a least squares fit of the theoretical function $I_6(\theta)$ to the experimental data, giving $I_6(\theta) = 0.03 + 0.32 \cos^2 \theta - \cos^4 \theta + 0.87 \cos^6 \theta$. The arrow indicates the direction of laser polarization.

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