

Relativistic calculations of excitation and ionization probabilities in highly charged H-like ions exposed to intense laser fields

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Synopsis A method for the investigation of highly charged ions exposed to an intense laser field is developed and tested on various examples. The time-dependent Dirac equation for a hydrogenlike ion in presence of a strong laser field is solved numerically. The method is used for calculations of excitation and ionization probabilities in hydrogenlike ions. The interaction with the electromagnetic field is described within the dipole approximation in the length and velocity gauges.

Nowadays, laser technologies are rapidly developed and highly charged ions are ones of the most interesting objects that can be studied with intense laser fields [1, 2]. The time-dependent problems including an interaction with intense laser fields attract much attention during the past few years [3, 4].

In this work, a new method and code were designed for the investigation of highly charged ions exposed to an intense laser field. The theoretical consideration requires to solve the time-dependent Dirac equation. The method for solving the Dirac equation is proposed within the dipole approximation of a laser potential.

At the first stage the stationary problem in the Coulomb potential of the nucleus was solved within the dual kinetic balance (DKB) approach [5]. The DKB approach provides a solution of the stationary radial Dirac equation. A significant advantage of this approach is the absence of spurious states that makes our method more suitable for calculations of transition probabilities in comparison with others. At the second stage the time-dependent problem for a hydrogenlike ion in presence of a strong electromagnetic field was solved. The time-dependent Dirac wave function was expanded in terms of the stationary Dirac equation solutions. The expansion coefficients were found employing the Crank-Nicolson propagation scheme [6].

Based on the method developed, excitation and ionization probabilities were calculated for various ions. For instance, the multiphoton ionization process for the hydrogenlike tin ion ($Z = 50$) was investigated. The laser potential was chosen in the form of linearly polarized 20-cycle \cos^2 -shaped pulse with a peak intensity of 5×10^{22} W/cm². The ionization probability was calculated in both length and velocity gauges (see Figure 1). The results obtained in two gauges coin-

cide with each other. Moreover, our results are in a good agreement with the corresponding data from Refs. [3, 4]. This investigation is expected to be required for the future High-Intensity Laser Ion-Trap Experiment (HILITE).

This work was supported by SPbSU (Grant No. 11.38.269.2014), by RFBR (Grant No. 13-02-00630), by the Dynasty foundation, and by FAIR-Russia Research Centre.

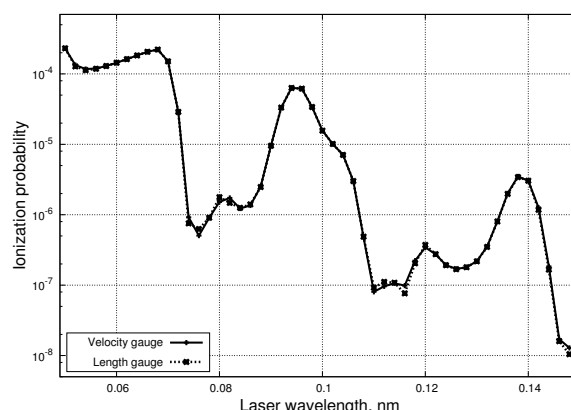


Figure 1. Ionization probability for the H-like tin ion as a function of the laser pulse wavelength.

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