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May 10th, 2024

Specialist of the Office for Organizational
Support of Dissertations Councils,
Saint Petersburg State University

Regarding: *Review of PhD thesis prepared by Krapivin Dmitry Andreevich*
Thesis title: *Electronic transitions in diatomic quasimolecules under interaction with pulses of a strong electromagnetic field*

This PhD thesis presents the theoretical exploration of the electronic transitions in diatomic quasimolecules interacting with intense laser fields, particularly in the study of non-dipole effects and relativistic effects, demonstrating significant originality. The author has developed novel algorithms for solving the time-dependent Schrödinger and Dirac equations, which exhibit good numerical stability and accuracy when dealing with the interaction of diatomic quasimolecules with strong laser fields.

Chapter 1 of this thesis focuses on the ionization process of the H_2^+ molecule in an intense laser field, in particular how the orientation of the molecular axis affects the ionization probability and the angular distribution of electrons. By solving the Schrödinger equation in a long ellipsoidal coordinate system, the authors take into account the barycentric symmetry of the molecule and can model more accurately the dynamics of the molecule in an external electromagnetic field. The study reveals that the ionization probability anomalously reaches a maximum at specific laser field parameters when the molecular axis is perpendicular to the laser polarization direction, contrary to intuitive expectations. In addition, the authors have developed a numerical method to calculate the energy and angular distributions of photoelectrons and to analyze the dependence of the ionization probability on the orientation of the molecular axis using these distributions.

Chapter 2 provides insight into the multi-photon ionization process of single-electron excimers in an intense laser field. The influence of relativistic effects on the ionization probability is investigated by numerically solving the Dirac equation and how these effects become more significant at different nuclear charges.

Chapter 3 provides an in-depth study of the charge transfer and ionization effects during low-energy collisions of protons with hydrogen atoms in a linearly polarized electromagnetic field. The authors find that the phase of the electromagnetic field has a significant effect on the charge transfer probability under a low-frequency laser field, while the effect of the phase becomes insignificant under a high-frequency laser field because the electromagnetic field oscillates much faster than the electron density oscillating between the colliding particles.

Although this PhD thesis focuses on theoretical analysis, the author has also proposed

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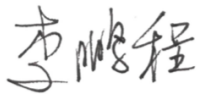
a research plan that integrates with experiments, providing a theoretical foundation for potential future experimental validation. The results presented in the thesis have undergone rigorous convergence testing and have been compared with other theoretical results from existing literature, showing good consistency. The algorithms developed by the author are innovative in theory and show potential value in practical applications, especially in the control of molecular quantum states and the study of molecular electronic structures. This thesis is structured clearly, with explicit arguments, and is written in a standardized and rigorous scientific manner, offering clear guidance and reference for scholars in the related field. It is recommended that the author further discusses the possibilities of experimental verification of the theoretical models in the final version and explores the potential integration with current experimental techniques. Overall, this research has offered important new insights into theoretical physics and has made significant contributions to the study of strong-field physics and quantum dynamics.

The dissertation by Krapivin Dmitry Andreevich is a meticulous examination of electronic transitions in diatomic quasimolecules under strong electromagnetic fields. It is clear, comprehensive, and presents significant original contributions to the field of theoretical physics. Andreevich has developed a novel algorithm for the nonstationary Dirac equation and provided a detailed analysis of ionization probability and electron angular distributions, particularly in the photoionization of H_2^+. The research offers theoretical insights into electron dynamics control and explores relativistic effects in diatomic quasimolecules, which are crucial for the development of intense coherent radiation sources. The work is scientifically rigorous and has been published in respected journals, contributing to the wider scholarly field. Minor revisions are recommended for further enhancement, but the thesis already meets the criteria for academic excellence. It is recommended that Andreevich be awarded the degree of Doctor of Physical and Mathematical Sciences.

Yours sincerely,



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