J. At. Mol. Sci

Vol. 7, No. 1, pp. i-iii
February 2016

Preface

College of Physics and Information Engineering, Shanxi Normal University

This special issue preface of Journal of Atomic and Molecular Sciences describes the history and main research areas of Atomic and Molecular Physics Professional Master's Degree Program (AMPPMDP), Shanxi Normal University. Moreover, this preface presents the works published in this special issue of Journal of Atomic and Molecular Sciences.

1 THE HISTORY AND RESEARCH AREAS OF AMPPMDP

The master degree authorization of atomic and molecular Physics was gained in 2002, and the postgraduate students were enrolled in 2003. It has been strongly supported by Shanxi Normal University in terms of financial funding and talent introduction. Keli Han, Professor in the Dalian Institute of Chemical Physics of Chinese Academy of Science, is hired as the Specially-appointed Professor of AMPPMDP. Professor Xiangfu Jia acts as the AMPPMDP director. In recent years, more than 10 doctors from Institute of theoretical physics, Chinese Academy of Sciences, the Institute of Atomic and Molecular Physics at Jilin University, Dalian University of Technology are joined us. The 2rd Symposium on Frontier of Molecular Reaction Dynamics (2012) was hosted by us.

There are five main research fields in AMPPMDP: atom-molecular collision and interaction, interaction between laser and atoms or molecules, quantum classical correspondence of atoms and negative ions in external fields, cluster and nanostructure, new physics in low dimensional materials from the theoretical studies, and quantum information science. These fields strongly connect with each other. Based on them, a research system which is capable of understanding the relation between the structure and performance of the matter at atomic and molecular level is constructed. The laboratory has over 300 square meters working space and DELL-PowerEdge R720 server for theoretical calculation.

2 THE WORKS IN THIS SPECIAL ISSUE

Professor Xiangfu Jia and vice professor Shiyan Sun focuse on the theoretical study of ion-atom impact ionization. Based on the three-Coulomb (3C) wave and the four-body modified Coulomb-Born approximation including the internuclear interaction (MCB-NN), he

and his coworkers have calculated the fully differential cross sections (FDCS) for single ionization of helium by by 75 keV proton, 2 MeV/amu^{-1} and 100 MeV/amu^{-1} C^{6+}, 16MeV O^{7+} and 3.6 MeV/amu^{-1} Au^{Q+} (Q=24,53) ions impact for the different momentum transfers in the scattering plane. By comparing their calculations with experimental data and other theoretical predictions, they find that their results are able to reproduce most of the trend of experimental data and in good agreement with other theoretical results.

Professor Xiangyang Miao and vice professor Changlong Xia have investigated isolated attosecond pulse generation from the intense laser pulse interacting with atoms or molecules. Recently, attosecond pulses are mainly generated by superposing high-order harmonic spectra. The isolated attosecond pulse would be more useful in pump-probe ultrafast physical process. So control the quantum path that contributing to HHG process is also investigated. Different schemes have been proposed to control the quantum path and obtain isolated attosecond pulse. The present calculations are compared with splitting-operator method and strong field approximation model to show the scheme by combining a left circularly polarized pulse with a right circular polarized pulse.

Vice professor Haijun Zhao investigated the photodetachment cross section of H^- near two perpendicular elastic. This system provides a rare example that can be studied analytically by both quantum and semiclassical methods with some approximations. Both the traditional quantum approach and closed orbit theory are applied to explicitly derive the formulas of the cross section for different laser polarization direction. The quantum formulas is compared with closed orbit theory formulas. The quantum results show to be in good agreement with the semiclassical results. Furthermore, the cross section depends strongly on the direction of the laser polarization. When the polarization is parallel to the closed orbit, the corresponding oscillation in the cross section is very obvious. However, when the polarization is perpendicular to the closed orbit, the corresponding oscillation is too small for closed-orbit theory formula to describe.

Vice professor Junfeng Zhang has studied the low dimensional materials by using first-principles and multi-scale calculations. The structural mechanical and transport properties of polycrystalline graphene for both symmetric and non-symmetric grain boundaries. Moreover, Schottky barriers in two dimensional materials have also been explored and found different rule from that in three dimensional materials.

Vice professor Guohui Yang focus on the theoretical research in some regions of Quantum Information Science. Topics of interest include quantum entanglement, quantum correlations and some potential applications in quantum information processing. Recently, he and coworkers have propose one protocol to generate entanglement and steady entanglement via the atomic spontaneous emission. They found that two atoms get coupled by photon exchange due to spontaneous decay, which in turn generates the atomic entanglement. Through introducing the incoherent pumping, one not only can obtain the steady entanglement but also can overcome the decay of the atoms. Moreover, one can obtain the larger value of steady entanglement by proper tuning the incoherent pumping.

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4 ACKNOWLEDGMENTS

We thank the National Natural Science Foundation of China (Nos. 11047191, 11404204, 11447208, 11504221, 10804066, 2015021011), Discipline Construction Fund of Shanxi Normal University, the Natural Science Foundation for Young Scientists of Shanxi Province, China (Grant No. 2015021023, 2009011004), and Program for the Top Young Academic Leaders of Higher learning Institutions of Shanxi Province, China. Finally, we also thank Professor Keli Han from the Dalian Institute of Chemical Physics of Chinese Academy of Science.