Announcing the Final Examination of Chi Hong Yuen for the degree of Doctor of Philosophy in Physics
Date: May 6, 2020
Time: 10:00 a.m. (U.S. Eastern Time)
Zoom Link: https://ucf.zoom.us/j/7579188749?pwd=K3krMGRNdnJrNUZUSmdPMmtzOFNhZz09
Dissertation title: Theoretical Studies of Collisions Involving Three Bodies and Electron-Molecule Collisions Relevant to Astrophysical and Atmospheric Conditions

Abstract:

Atomic and molecular processes are of significant importance in astronomy. Accurate rate coefficients of these processes allow us to probe conditions in space and understand the history of the Universe. Even though experimental data are usually more reliable than theoretical, such processes as three-body recombination or collisions involving radical species at temperatures relevant for astronomical environments are very difficult to study experimentally. One of the objective of this dissertation is to develop and apply a number of theoretical approaches to study such processes for which experimental methods are not available or very expensive. Additionally, this dissertation aims to provide theoretical data, which are not available and to set directions for future studies.

In the dissertation defense, theoretical tools for three-body collisions will be presented and applied to the three-body recombination of $H+H+H \rightarrow H_2+H$, the process by which molecular hydrogen was formed in the primordial Universe. Using a fully quantum-mechanical approach, state-to-state rate coefficients are computed. The contribution of the Jahn-Teller effect to the total rate coefficient of the process was also considered. Among other results, a nascent rovibrational population of the H_2 molecules formed in the recombination process, is found to be dominated by highly excited rovibrational levels, which could have a substantial impact in some astrophysical models.

In addition, a novel simplified approach for dissociative electron attachment to polyatomic molecules will be presented. The approach is applied to the reaction $H_2CN+e^- \rightarrow CN^- +H_2$. Although this reaction is exothermic, it is found that the estimated rate coefficient is too small to contribute to formation of CN^- in the interstellar medium. Therefore, the recent astronomical observation of CN^- in the interstellar medium remains enigmatic.

Outline of Studies:
Major: Physics

Educational Career:
B.S., Hong Kong Baptist University

Committee in Charge:
Dr. Viatcheslav Kokoouline (Chair)
Dr. Zenghu Chang
Dr. Luca Argenti
Dr. Mehdi Ayouz, University of Paris-Saclay (External Committee Member)

Approved for distribution by Viatcheslav Kokoouline, Committee Chair, on April 22, 2020.

The public is welcome to attend remotely.