Announcing the Final Examination of Josh FORER for the degree of Doctor of Philosophy in Physics.

Date: September 25, 2023
Time: 08:00 am
Room: PSB 160
Zoom link:
https://nam02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fucf.zoom.us%2Fj%2F99736169978%3Fpwd%3Delo2a2QzVGkwQ1A0bloxR1lhckIrdz09&data=05%7C01%7Csoto%40ucf.edu%7Cc3ffda5480eb416cc39408dbb3a6f0b9%7Cbb932f15ef3842ba91fcf3c59d5dd1f1%7C0%7C0%7C638301301798932114%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=Ovk3bp%2F1mExUfr4YG7xImpS3DFIJPaRuwOgm7c%2B0kV0%3D&reserved=0
Dissertation title: A theoretical study of elementary processes in interstellar plasma

Interstellar plasma — interstellar clouds in particular — play an important role in determining the structure and evolution of galaxies. Understanding the time evolution of such plasmas requires knowledge of the chemical processes that drive their dynamics. Two processes are studied in this dissertation: radiative electron attachment (REA) via dipole-bound states (DBSs) and dissociative recombination (DR). Of the several hundred molecules detected in the interstellar medium, only eight anions have been detected: CN-, C3N-, C5N-, C7N-, C4H-, C6H-, C8H-, and C10H-.
Their production mechanism is not well known; REA was suggested as a possible formation pathway, but previous theoretical studies have found that REA rate coefficients were too low to explain the formation of CN-, C3N-, and C5N-. It was later suggested that including DBSs — an electron weakly bound at a large distance to the large dipole moment of a neutral molecule — could appreciably enhance the REA rate coefficients.
The first portion of this study is dedicated to investigating the role of the large dipole moment of rotating C3N using an accurate ab initio approach with electronic and rotational resolution. DBS wavefunctions of C3N- are calculated and used to obtain REA cross sections that produce even smaller rate coefficients, suggesting that C3N- is efficiently formed by a different process. The second part of this study investigates DR in the difficult case of molecules with low-lying electronic resonances, although these are not necessary for the approach. An approach to treat both direct and indirect mechanisms of DR in a diatomic ion with electronic, vibrational, and rotational resolution using R-matrix scattering calculations, frame transformation theory, and multichannel quantum defect theory is presented and applied to the CH+ and CF+ molecular ions at low collision energies. The calculated CH+ cross sections agree well with recent rotationally state-resolved experimental results and overall better than previous theoretical results. The calculated CF+ cross sections agree well with experimental results, although these do not have rotational resolution, and overall better than previous theoretical results at low energies. Additionally, the method can study rovibronic (de–)excitation — a process in competition with DR. These are calculated and compared to previous theoretical calculations for CH+, with which our results agree well.

Outline of Studies:
Major: Physics

Educational Career:
B.S. in Pure Physics and Mathematics
University of Miami, FL, 2017

Committee in Charge:
Viatcheslav KOKOOULINE (Supervisor)
Luca ARGENTI
Li FANG
Thierry STOECKLIN (Supervisor, External Committee Member, University of Bordeaux) Roland WESTER (Chair, University of Innsbruck) Alexandre FAURE (Referee, University of Grenoble) Ann E. OREL (Referee, University of California in Davis) Mehdi AYOUZ (University of Paris Saclay)

Approved for distribution by Viatcheslav Kokoouline, UCF Committee Chair, on September 7, 2023.

The public is welcome to attend in person or remotely.