Research Opportunities in the Castner group for Rutgers undergraduate students

The Castner research group will be seeking highly motivated, self-starting Rutgers undergraduate students to join our research team for a longer-term research commitment. The framework for this research is that students will take undergraduate research courses during the academic year, and some will be hired as NSF-funded research assistants during the summer of 2021 and beyond. Interested students should contact Prof. Castner by e-mail at ecastner@chem.rutgers.edu. I will be deciding about whether to have research projects begin with off-campus, computer-based training in either the Fall 2020 or Spring 2021 semesters. This would involve having students register for one of our 1, 3, or 6 credits in Chemistry research courses, such as Chem. 391/392, 491/492, 495/496, or 497/498.

Because of the global pandemic lockdown, undergraduate researchers are not yet permitted back into the Rutgers research laboratories. Thus, research in the 2020-21 academic year will necessarily begin with assigned readings from the scientific literature, online weekly group meetings, and experimental design, and data analysis of experiments that have been completed recently. Thus, access to a computer with high-bandwidth internet, microphone and camera is a crucial pre-requisite for team members.

The research will involve experiments using chemical physics and physical chemistry methods to study the physical and chemical properties of ionic liquids, or molten salts comprising molecular ions that are liquid at and below room temperature. Among the many applications of ionic liquids (or ILs) are for energy storage devices and environmental remediation through advanced chemical separations. Experiments are often done at national laboratory user facilities for high photon-energy X-ray scattering and neutron scattering. NMR experiments will be done at Rutgers Much of the work involves the design of the experiments, meticulous preparation of samples, and analysis of the data. We work closely with the team of Prof. Claudio Margulis (Univ. of Iowa) to compare their theoretical and computational work with our experimental results.

Each student will receive training in the appropriate scientific methods and laboratory safety. After such training, each student will design their own research project that they will work on independently. No prior research experience is require, although it is highly valued. The research topics presume that students have a high aptitude for learning physics-based methods for modern research techniques, so some experience with physics, mathematics, physical chemistry, programming, and laboratory engineering will be very helpful. Biochemical, medical and pharmacy training is much less relevant for the nature of our research projects.

Experimental projects will focus on some of the following topics:

- neutron and X-ray scattering of ionic liquids and mixtures (NIST/Gaithersburg and Rutherford Appleton Laboratory/UK, and the Advanced Photon Source, Sector 11, Argonne National Laboratory)
- neutron dynamics experiments: quasi-elastic neutron scattering and neutron spin-echo (at NIST/Gaithersburg, Rutherford Appleton Laboratory/UK, and Oak Ridge National Laboratory/SNS).
- NMR experiments: pulse-gradient spin-echo measurements of molecular diffusivities
- Preparation and characterization of novel ion gels for environmental applications
- Vibrational spectroscopy investigations of ionic liquids, mixtures, and ion gels.

Rutgers students from a wide variety of backgrounds have participated in our research programs. Roughly half of the undergraduate alumni have been co-authors on high-impact and strongly cited scientific publications based on their research projects; they also regularly attend regional and national

conferences to present talks and posters on their work. More than half have gone on to Ph.D. programs in Chemistry and related fields. Castner group alumni have completed Ph.D. degrees at Rutgers, Harvard, MIT, CalTech, Stanford, UC Berkeley, Univ. of Chicago, Columbia Univ., and the Univ. of Pennsylvania, among many others. Others have pursued very successful careers in the chemical, pharmaceutical or personal care products industries, or in government science policy. Thus, a research project in our group is best matched for the student who wishes to determine if a science research career (at the doctoral level) is in their future. The projects are not well matched for students who already know that they wish to pursue medical, dental or pharmacy careers.

We have many national and international collaborations, so we will hope to arrange exchange visits between the labs of our collaborators. In the USA, we have existing collaborations with teams at Brookhaven National Lab., NIST, Univ. of Iowa, Notre Dame, Univ. of Kansas, Texas A&M. International collaborations include scientists in Japan (Chiba Univ. and Kanazawa Univ.), Italy (Univ. di Roma, 'La Sapienza' and CNR-Roma), Ireland (Queens University Belfast) and Australia (Univ. of Western Australia, Perth).

For more information about research in the Castner group, please consult the following web resources:

https://chem.rutgers.edu/people/faculty-bio/132-castner-jr-edward-w
https://chem.rutgers.edu/research/faculty-research/133-castner-jr-edward-w
https://scholar.google.com/citations?hl=en&user=n5QCPPQAAAAJ
https://oirap.rutgers.edu/Facsurv/html/Edward_W._Castner%20Jr..html