Jonathan Dworkin & Ruben Gonzalez, *Regulation of Ribosome Recycling*

Much of every cell’s energy is devoted to making proteins. Yet, little is known about the cellular mechanisms underlying a cell’s ability to turn protein production on and off during times of nutrient limitation. In 2013, Dr. Jonathan Dworkin, Associate Professor of Microbiology & Immunology, and Dr. Ruben Gonzalez, Professor of Chemistry, collaborated to study this elusive problem, and were awarded $160,000 in seed funding through the Office of the Executive Vice President for Research’s Research Initiatives in Science & Engineering (RISE) competition. Their RISE-funded research identified two regulatory factors in protein synthesis that they are now investigating as part of an R01 [GM114213-01, “Regulation of Protein Synthesis by Ser/Thr Phosphorylation”]. One of these regulatory factors allows the cell to chemically modify and inactivate the protein synthesis machinery when cellular energy intake is low, essentially putting the machinery into a sleep-like, or dormant, state. Once the cell has adequate energy intake, the other regulatory factor then reverses the chemical modification, allowing the cell to rapidly activate the dormant protein synthesis machinery and initiate the process of building new proteins. A detailed molecular understanding of the process through which the protein synthesis machinery can be switched from “active” to “dormant”, and vice versa, has the potential to unlock new avenues of basic scientific and biomedical research.

Venkat Venkatasubramanian, *Center for the Management of Systemic Risk*

The recent financial crisis and ensuing sovereign debt crisis once again highlighted the great societal value of understanding the potential instabilities in the financial system. Financial instability typically results from positive feedback loops intrinsic to the operation of the financial system. The challenging task of identifying, modeling and analyzing the causes and effects of such feedback loops requires a proper systems engineering perspective that is lacking in the remedies proposed in recent literature. In this project, we developed a signed directed graphs (SDG)-based framework, a modeling methodology extensively used in process systems engineering, as an appropriate framework to address this challenge. The SDG framework is able to represent and reveal information missed by more traditional network models of financial system. This framework adds crucial information to the edges in a network in terms of the direction of flows and relationship between the variables associated with the nodes at the two ends of a directed edge, thereby providing a framework for systematically analyzing the potential hazards and instabilities in the system. This work also discusses how the SDG framework can facilitate the automation of the identification and monitoring of potential vulnerabilities.

Tanya Zelevinsky & Daniel Wolf Savin, *Laser Cooling of an Organic Molecule*

The cooling of atoms with lasers has been a workhorse of atomic physics for three decades now, providing scientists with tools to create the world's best clocks, sensors, and probes of fundamental physics. Molecules have been off-limits for this technique because their rotational and vibrational motions make it difficult to scatter enough laser photons for effective cooling. Recently, it has become clear from theory and experiments that some molecules can in fact be laser cooled. In this project, we are building a cryogenic beam of hydrogen-containing molecules that are promising candidates for laser cooling and that will allow us to try new cooling and trapping approaches. These barium monohydride molecules should result in a very interesting dipolar ultra-cold gas, and could lead to improved precision measurements with ultra-cold atomic hydrogen, which has long been of interest for testing fundamental principles.