Dates	Speaker	Title	Abstract
Jan. 17	No		
Jan. 24	Anca Radulescu	Graph theory, dynamics, and how to classify brains	Modeling complex networks and understanding how their hardwired circuitry relates to their dynamic evolution in time can be of great importance to applications in the life sciences. When the system is the brain, this becomes one of the most daunting research questions of our century: can brain connectivity (the ``connectome'') be used to predict brain function and ultimately behavior? We will start by describing an original study of neuroimaging data in humans, comparing a group of patients with schiophrenia with a group of healthy controls. We found that connectivity patterns between prefrontal and limbic regions can be help accountable for differences in emotion regulation eficiency between the two groups. This result can be explained within the theoretical framework of oriented nonlinear dynamic net-works. To illustrate this framework, we will consider two examples: one in continuous, and one in discrete time. In continuous time, we use configuration dependent phase spaces and probabilistic bifurcation diagrams. In discrete time, we use complex quadratic nodes and define extensions of the traditional Julia and Mandelbrot sets. Finally, we return to interpreting our results in the context of brain networks, synaptic restructuring and neural dynamics in learning networks. As our newest application to human brain function, we show how the topology of the Mandelbrot set can be used to classify human connectomes obtained with tractography measures, and how this can be further used to predict the subject's \emotional profile."
Jan. 31	Saulo Orizaga	Introduction to phase field models and their efficient numerical implementation	In this talk we will provide an introduction to phase field models. We will focus in models related to the Cahn-Hilliard (CH) type of partial differential equation (PDE). We will discuss the challenges associated in solving such higher order parabolic problems. We will present several new numerical methods that are fast and efficient for solving CH or CH-extended type of problems. The new methods and their energy-stability properties will be discussed and tested with several computational examples commonly found in material science problems. If time allows, we will talk about more applications in which phase field models are useful and applicable.
Feb. 7	Andrew Jensen	A dynamical systems approach to cloud-rain interactions	Clouds are complex physical systems with many degrees of freedom and interactions across a vast range of spatio-temporal scales. Despite this complexity, there exist non-trivial aspects of their macrobehavior that are predictable without considering the full complexity of the physical system. I survey some previous models and results, including systems of ODEs and DDEs. An application of a generalization of the Benedixon criterion for DDEs is given in this context. Next, I will show that the interaction between cloud droplets and rain can be described by a system of ODEs which have properties in common with predator-prey and foodweb models from population dynamics and discuss the physical significance of some mathematical properties of the model.
