Mathematics predicts discontinuities in dynamics of living cells

Friday March 22nd at 3pm in RT 1516

Bio: Mykhailo is an assistant research professor at the Pennsylvania State University. He defended his Ph.D. from Karazin’s Kharkov National University (Ukraine) in 2011, and then he joined the Pennsylvania State University in 2012. Mykhailo is an applied mathematician, and his current research interests involve the Analysis of PDEs, Math Biology, and Many Particle Systems.

Abstract: In this talk, I will focus on a phase field PDE model describing a moving deformable interface of a eukaryotic cell. In the previous computational studies, it was shown that this model successfully reproduces many intriguing phenomena with eukaryotic cells such as a spontaneous onset of a steady directed motion. The model consists of two coupled parabolic PDEs describing the cell shape and the actin filament network. I will discuss the asymptotic behavior of solutions in the limit as the interface width parameter goes to zero (a.k.a. the sharp interface limit). Derivation of the equation of the interface motion, which is curvature motion with an additional nonlinear term, will be presented. For a rigorous justification of the sharp interface limit I will introduce a 1D model problem. Using both analysis and numerical simulations, I will show that the interface velocity exhibits discontinuities and hysteresis in the case of large values of the coupling parameter. In the end of the talk, I will discuss how these results may elucidate key mechanisms of cell motility. These results are obtained jointly with L. Berlyand and V. Rybalko.

Refreshments at 2:30pm in RT 1517