Engineering Physics Department

Presents

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Internal Variables in the Equation of Motion for
Collective Cell Migration

Abstract: Coordinated motions of multicellular systems typically generate cooperative packs, swirls, and clusters. These cooperative motions are driven by active cellular forces, but how the forces generate collective cellular motion remains poorly understood. Here we study forces and motions in a confined epithelial monolayer and make two experimental observations: (i) the direction of local cellular motion deviates systematically from the direction of the local traction exerted by each cell upon the substrate, and (ii) oscillating waves of cellular motion arise spontaneously. Based upon these observations, we propose a theory that connects forces and motions using two internal state variables, one of which generates an effective cellular polarization, and the other, through contractile forces, an effective cellular inertia. In agreement with theoretical predictions, drugs that inhibit contractility reduce both the cellular effective elastic modulus and the frequency of oscillations. Together, theory and experiment provide evidence suggesting that collective cellular motion is driven by at least two internal variables that serve to sustain waves and to polarize local cellular traction in a direction that deviates systematically from local cellular velocity.

Biography: Professor Jacob Notbohm’s research applies principles of mechanics and applied mathematics to reveal how physical interactions between cells and their surroundings control cell migration in development, wound healing, and cancer progression. To conduct this multidisciplinary research, members of the Notbohm group use a range of experimental and theoretical tools such as high resolution microscopy, digital image correlation, atomic force microscopy, analytical solutions, and finite element models. Dr. Notbohm was recently a postdoctoral research fellow at the Harvard Chan School of Public Health. Before that he received his Ph.D. from the California Institute of Technology in Mechanical Engineering and his B.S. from the University of Wisconsin-Madison in Engineering Mechanics.

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Room 106 Engineering Research Building
1500 Engineering Drive