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The Hong Kong University of Science and Technology

Department of Mathematics

Seminar on Applied Mathematics

Modeling and Simulation of Bacterial Colony Growth with Cell-Cell Mechanical Interactions

by

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Abstract

The growth of bacterial colony exhibits striking complex patterns and robust scaling laws. Understanding the principles that underlie such growth has far-reaching consequences in biological and health sciences. In this work, we develop a mechanical theory of cell-cell and cell-environmental interactions and construct a hybrid three-dimensional computational model for the growth of E. coli colony on a hard agar surface. Our unique treatment of the force arising from the liquid-air surface tension is applicable to both the monolayer (discrete) and multilayer (continuum) growth regimes. Our model consists of microscopic descriptions of the growth, division, and movement of individual cells, and macroscopic diffusion equations for the nutrients. The cell movement is driven by the cellular mechanical interactions. Our large-scale simulations and analysis predict the linear growth of the colony in both the radial and vertical directions, conforming the experimental observations. Our analysis reveal the mechanisms for such linear growth: the constant vertical growth results from an active growth zone in the colony above which nutrients decay exponentially; and the constant radial expansion results from an active growth ring near the periphery of the colony determined by the buckling transition. This work is the first step toward detailed computational modeling of bacterial growth with mechanical and biochemical interactions. This is joint work with Mya Warren, Hui Sun, Yue Yan, Jonas Cremer, and Terence Hwa.

Date: **Monday, 10 December 2018**
Time: **3:00p.m. – 4:00p.m.**
Venue: **Room 3598, Academic Building, (Lifts 27/28), HKUST**

All are welcome!