Mathematical models for bacterial communities: Swarming processes and mechanical behavior of biofilms

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Abstract

Bacterial biofilms are structured cellular communities that represent the dominant bacterial growth state for both environmental and clinical scenarios. There is great interest to understand biofilm assembly, as infections resulting from biofilms are notoriously resistant to antibiotic treatments. Treatment of a broad spectrum of human health issues, ranging from lethal infections from opportunistic pathogens such as those in cystic fibrosis patients, to catastrophic failure of prosthetic implants, could improve with a greater understanding of biofilm formation. Among the biofilm development steps for which we lack understanding is the ability of bacteria to first colonize host surfaces. Bacterial swarming motility has been shown to be important to biofilm formation, where cells act not as individuals, but as coordinated groups to move across surfaces, often within a thin-liquid film. In this talk two models are presented. The first one focuses on simulating the swarming process for Pseudomonas aeruginosa bacterial communities, whose spread is aided by the production of a surfactant that lowers surface tension of the liquid film to improve bacterial motility. The second model simulates the mechanical behavior of biofilms. In particular, deformation and detachment produced by interaction with liquid flow is studied by using a multi-component complex fluid formulation.