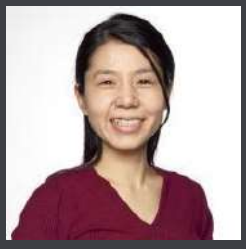
The University of Edinburgh - Friedrich Schiller University

Population Dynamics Virtual Seminar



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Co-existence and extinction due to surfing viral infections in a spatially expanding bacterial colony

Despite their relevance in natural environments, the spatio-temporal consequences of the interactions between phages and bacteria remain largely unexplored. In the most well-studied setting, i.e. plaque formation, phages infect a uniform background of bacteria, within which the phages spread diffusively, causing the plaque front to grow linearly as a function of time. Here, we investigate the dynamics of the spread of the infection due to a phage-lambda during the range expansion of an *E coli* colony; the phages "surf" the front of the growing bacterial colony by hitchhiking on *E coli* that are advected due to growth of the bacteria in the colony, resulting in an anisotropic spread of the phages -- ballistically in the direction of colony growth and diffusively in the lateral direction (occurring over timescales of many hours and millimetric length scales). We identify microscopic processes -- of the phage release during lysis (occurring on short millisecond timescales at length scales close to that of a single bacterium) and local nematic alignment of the rod-like *E coli* bacteria (occurring on timescales comparable to the bacterial growth rate and on the length scales of a few bacteria) -- that enhance the advective effects driving the hitchhiking behavior. Altogether, the interplay between the phage infection, cell replication and transport processes -- all involving multiple length and time scales, ranging from diffusion of individual phages to single-cell lysis events to colony-level patterns -- result in a panoply of dynamical patterning phenomena. Combining our experiments with simulations, we explain the multiple spatio-temporal dynamical regimes -- from coexistence of the uninfected bacteria, resistant (lysogenic) cells and phages to fixed points where the entire population turns resistant or remains uninfected.

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