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Phase Transitions in Bacterial Cultures HANNA SALMAN, ANTON ZILMAN, ALBERT LIBCHABER, Center for Studies in Physics and Biology, The Rockefeller University, New York, NY, LIBCHABER TEAM — We study how the concentration of bacteria affects their response to temperature changes. The bacteria are grown in a batch mode culture, which affects their physiological state due to nutrient depletion. For bacteria at a constant physiological state, we observe a critical transition in behavior in a one-dimensional temperature gradient as their initial concentration in the sample increases. Above a concentration of 10^8cells/cm^3, an early accumulation near their favored temperature, caused by thermotaxis, develops into a sharp pulse moving at a fast velocity ($\sim$3.5 μm/sec). This mode is the result of a positive feedback mechanism provided by inter-bacterial communication. A theoretical model describing this interaction shows good agreement with the experimental results. For different physiological states, we observe a critical transition in the bacterial response to localized heating by infrared laser. When the bacteria are grown to concentrations below 2x10^{8}cells/cm^3 they swim towards the heated region; when they are grown beyond this concentration they escape from the heated region. This effect is reversible. Also, mixing populations from different physiological states does not affect the response of either population. A genetic switch controlled by the nutrients' availability seems to be responsible for this behavior.

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