Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

A stochastic model for bacterial dynamics toward point food sources with emergent run-and-tumble[1] HOSSEIN JASHNSAZ, TYLER NGUYEN, HORIA PETRACHE, STEVE PRESSE, Indiana University- Purdue University- Indianapolis, STATPHYSBIO TEAM — Despite stark differences in chemotactic signaling networks and flagellar physiology across bacterial species, all bacteria sense their environment through a series of stochastic detection events ("hits") at their chemoreceptors and bias their random walk on the basis of this information. We present a general statistical model describing how bacteria locate point sources of food on the basis of stochastic event detection, rather than gradient information. We show how model parameters can be directly inferred using maximum likelihood methods from microscopy tracking data. We find that "run-and-tumble" dynamics naturally emerge from our statistical model and recapitulate known results from experiments when we consider bacterial dynamics in well-controlled chemoattractant gradients. However, our model goes beyond reproducing known run-and-tumble statistics. It also makes a number of predictions unique to bacteria tracking point sources. In our model, all parameters are directly inferred from tracking data thus there are no adjustable parameters; detection events by bacteria are assumed stochastic as they occur in nature; and our "top-down" modeling approach is broadly applicable across bacterial species.

[1]SP acknowledges the NSF (MCB-1412259), the Purdue Research Foundation and his IUPUI Start-up.

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Date submitted: 14 Nov 2014 Electronic form version 1.4