Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Asymmetric gears in a bacterial bath: Crossover between equilibrium and active motion[1] AYHAN DUZGUN, JONATHAN SELINGER, Kent State University — A fundamental distinction between active matter and equilibrium systems is that active matter is not governed by the conventional laws of thermodynamics. As a specific example, recent experiments have put asymmetric gears into a "bacterial bath," in which bacteria consume food, propel themselves forward, collide into the gears, and induce asymmetric rotation, thus converting chemical energy into mechanical work (Sokolov et al, 2010). By comparison, the same gears would not rotate in a thermal bath, because the second law of thermodynamics prohibits converting equilibrium thermal energy into mechanical work. This experiment leads to the basic question of what makes the difference between self-propelled motion and equilibrium thermal motion. To address this question, we perform simulations of a gear in a bacterial bath, following the approach of Angelani et al (2009); these simulations confirm that bacterial motion leads asymmetric rotation. We then modify the equations of motion, interpolating between bacteria and equilibrium Brownian particles, and determine the motion of the gear. These results help to identify what features of active bacterial motion are necessary to violate the laws of thermodynamics and generate rotation, and how these features can be controlled.

[1]This work was supported by NSF DMR-1106014.

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Date submitted: 09 Nov 2012 Electronic form version 1.4