Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Statistical Mechanics of Collective Transport by Ants ITAI PINKOVIEZKY, Department of Chemical Physics, Weizmann Institute of Science, AVIRAM GELBLUM, EHUD FONIO, Department of Physics of Complex Systems, Weizmann Institute of Science, ABHIJIT GHOSH, NIR GOV, Department of Chemical Physics, Weizmann Institute of Science, OFER FEINERMAN, Department of Physics of Complex Systems, Weizmann Institute of Science —

Collective decisions and cooperation within groups are essential for the survival of many species. Conflicts within the group must be suppressed but conformism may render the system unresponsive to new information. Collective transport by ants is therefore an ideal model system to study how animal groups optimize these opposing requirements.

We combine experiments and theory to characterize the collective transport. The ants are modeled as binary Ising spins, representing the two roles ants can perform during transport. It turns out that the ants poise themselves collectively near a critical point where the response to a newly attached ant is maximized. We identify the size as being proportional to an inverse effective temperature and thus the system can exhibit a mesoscopic transition between order and disorder by manipulating the size. Constraining the cargo with a string makes the system behave as a strongly non-linear pendulum. Theoretically we predict that a Hopf bifurcation occurs at a critical size followed by a global bifurcation where full swings emerge. Remarkably, these theoretical predictions were verified experimentally.

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Date submitted: 02 Nov 2015 Electronic form version 1.4