Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Long-range Acoustic Interactions in Insect Swarms - An Adaptive Gravity Model DAN GORBONOS, REUVEN IANCONESCU, Department of Chemical Physics, The Weizmann Institute of Science, P.O. Box 26, Rehovot, Israel 76100, JAMES G. PUCKETT, Department of Physics, Gettysburg College, Gettysburg, RUI NI, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802, USA, NICHOLAS T. OUELLETTE, Department of Civil and Environmental Engineering, Stanford University, Stanford, California 94305, USA, NIR S. GOV, Department of Chemical Physics, The Weizmann Institute of Science, P.O. Box 26, Rehovot, Israel 76100 —
The collective motion of groups of animals emerges from the net effect of the interactions between individual members of the group. In many cases, such as birds, fish, or ungulates, these interactions are mediated by sensory stimuli that predominantly arise from nearby neighbors. But not all stimuli in animal groups are short range. We consider mating swarms of midges, which are thought to interact primarily via long-range acoustic stimuli. We exploit the similarity in form between the decay of acoustic and gravitational sources to build a model for swarm behavior. By accounting for the adaptive nature of the midges' acoustic sensing, we show that our "adaptive gravity" model makes mean-field predictions that agree well with experimental observations of laboratory swarms. Our results highlight the role of sensory mechanisms and interaction range in collective animal behavior. Additionally, the adaptive interactions open a new class of equations of motion, which may appear in other biological contexts.

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Date submitted: 11 Nov 2016 Electronic form version 1.4