Harvey Mudd College
Mathematics

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Research Proposal: Investigation of Swarming Behavior

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1 Introduction

Collective motion by organisms is common. Fish, insects, birds, and bacteria all group themselves into swarms which then move in interesting patterns. This project will focus on how local behavior creates global structure in swarms.

2 Proposed Research

I will consider the rules that govern an individuals' motion in the group. An example of how these rules are seen experimentally, in the case of the fruit fly, is in [1]. Using the rules for social interaction I want to build a system of coupled ODE's to account for each individual's movement. From that point, I hope to build rules that govern the population density within a swarm and eventually create a continuum model for swarming behavior. This work will combine numerical and analytical methods.

3 Prior Research and Reading

My coursework from the past year, including math 180, 182, and 198 (Fluid Dynamics), will be essential toward the completion of my project. There is a body of literature out on the subject. The work I have done the most investigation into is that of Topaz and Bertozzi [2]. Who develop a general 2-D continuum model for swarming behaviors then numerically compare their model to observe phenomena. I want to familiarize myself with this paper and then continue reading into the literature, both from the mathematical perspective [2] and from the biological [1].

References

[1] L. Tammero and M.H. Dickinson. The influence of visual landscape on the free flight behavior of the fruit fly drosophila melanogaster. *J. Exp. Biol.*, 205:327–343, 2002.

[2] Chad M. Topaz and Andrea L. Bertozzi. Swarming patterns in a two-dimensional kinematic model for biological groups. *SIAM J. Appl. Math.*, 65(1):152–174 (electronic), 2004.