Annotated Bibliography

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Senior Thesis

December 9, 2005

References

[1] R. N. Bearon and T. J. Pedley. Modelling run-and-tumble chemotaxis in a shear flow. *Bulletin Of Mathematical Biology*, 62:775–791, 2000.

> This paper is a modern approach to the modeling of chemotaxis by bacteria. It features a large bibliography that will be helpful if I require more resources for the modeling of chemotaxis.

[2] Howard C. Berg. *Random walks in biology.* Princeton University Press, Princeton, NJ, 1983.

> Berg's text offers a basic overview of how the methods of statistical mechanics can be applied to problems or models in Biology. His description of the movement of *Escherichia coli* is clear and concise, addressing both the mechanics of run-and-tumble and the probabilistic ways of thinking about it.

[3] B. J. Cole. Fractal time in animal behavior - the movement activity of drosophila. *Animal Behaviour*, 50:1317–1324, 1995.

> This paper presents experimental results which show that fruit fly activity demonstrates scalability, or according to Cole is, "time-fractal." Though he uses the term loosely, his observations provide justification for the use of biased Lévy flights to model fruit fly movement.

[4] William Feller. *An introduction to probability theory and its applications. Vol. I.* Third edition. John Wiley & Sons Inc., New York, 1968.

A classical text in probability theory. I read parts of this work to gain insight into the Central Limit Theorem and sums of independent random variables.

[5] William Feller. *An introduction to probability theory and its applications. Vol. II.* Second edition. John Wiley & Sons Inc., New York, 1971.

The second part of the two volume set, this edition covered limiting sums of independent random variables in greater depth.

[6] M. A. Frye and M. H. Dickinson. Closing the loop between neurobiology and flight behavior in drosophila. *Current Opinion In Neurobiology*, 14:729–736, 2004.

This paper presents flight path data on fruit flies in three dimensions. The authors give distributions for saccade angle, inter-saccade length, and other statistics relating to free flight. The data is quoted in Chapter 2 of my thesis.

[7] M. A. Frye, M. Tarsitano, and M. H. Dickinson. Odor localization requires visual feedback during free flight in drosophila melanogaster. *Journal Of Experimental Biology*, 206:843–855, 2003.

This paper provide flight data on fruit flies that are foraging for a hidden food source. It exposes the chemokinetic properties of fruit fly foraging and is heavily used in Chapter 2.

[8] D. Grunbaum. Translating stochastic density-dependent individual behavior with sensory constraints to an eulerian model of animal swarming. *Journal Of Mathematical Biology*, 33:139–161, 1994.

This paper provides an example of a swarming model that starts with individual behavior and goes on to look at global structure. The techniques are outlined in Chapter 4 and will be extended in my work.

[9] D. Grunbaum. Advection-diffusion equations for internal state-mediated random walks. *Siam Journal On Applied Mathematics*, 61:43–73, 2000.

The analysis from this work focuses on random walks which are governed by some internal state variable. The techniques that Grunbaum uses might be useful in modeling fruit flies and properly reflecting their saccading behavior.

[10] J. Klafter, A. Blumen, G. Zumofen, and M. F. Shlesinger. Levy walk approach to anomalous diffusion. *Physica A*, 168:637–645, 1990.

This work focuses on taking a Lévy walk and developing the probability density function for the walker in space and time. It provides insight into Lévy processes and its techniques may be echoed in my formulation of a IPDE.

[11] D. Marthaler, A.L. Bertozzi, and I.B. Schwartz. Lévy searches based on a priori information: The biased lévy walk. *UCLA CAM Report*, 04-50, 2004.

This work analyzes the effectiveness and efficiency of biased Lévy searches. They find that the most effective way to bias a search is to alter direction based on *a priori* information with biasing of step size to be less effective, but more efficient than the unbiased search. This work is covered in Chapter 3.

[12] A. Mogilner, L. Edelstein-Keshet, L. Bent, and A. Spiros. Mutual interactions, potentials, and individual distance in a social aggregation. *J. Math. Biol.*, 47(4):353–389, 2003.

The authors of this paper develop a Langrangian model for a general aggregation to investigate spacing within a swarm. They express the interaction between individuals as a potential with stable minima meant to correspond to a comfortable distance. They find that long range attraction and short range repulsion do not always create a well-spaced group, where the average distance between members is the comfortable one, instead many swarms grow more dense with increasing population.

[13] H. G. Othmer, S. R. Dunbar, and W. Alt. Models of dispersal in biological-systems. *Journal Of Mathematical Biology*, 26:263–298, 1988.

This work provides a two simple cases for swarm models that begin at the individual level and are extended into Eulerian formulations. The development of Telegrapher's Equation that is covered in Chapter 4 of my thesis comes from this work.

[14] H. G. Othmer and A. Stevens. Aggregation, blowup, and collapse: The abc's of taxis in reinforced random walks. *Siam Journal On Applied Mathematics*, 57:1044–1081, 1997.

This paper develops a Lagrangian model for bacteria which socially forage by leaving trails of slime where they travel. A successful searcher will signal others in the group using the slime. The techniques used here, in the development of PDE which describe the global structure of the group, may be of use in my work.

[15] S. Tinette, L. Zhang, and A. Robichon. Cooperation between drosophila flies in searching behavior. *Genes Brain And Behavior*, 3:39–50, 2004.

This paper presents an experiment meant to judge how fruit flies cooperate while foraging. The authors develop the two-phase foraging idea that I have chosen to study in this thesis. The article is heavily cited in Chapter 2

[16] C. M. Topaz and A. L. Bertozzi. Swarming patterns in a two-dimensional kinematic model for biological groups. *Siam Journal On Applied Mathematics*, 65:152–174, 2004.

The authors construct a continuum model for swarming agents and examine its pattern formation properties. They find that the patterns that show up in their numerical simulations closely mirror patterns seen in fluid mechanics, including the development of vorticies.

[17] G. M. Viswanathan, S. V. Buldyrev, S. Havlin, M. G. E. da Luz, E. P. Raposo, and H. E. Stanley. Optimizing the success of random searches. *Nature*, 401:911–914, 1999.

This paper discusses Lévy searches and presents the proof that they are optimal when food sources are scarce. This work is described in detail in Chapter 3.

[18] E. R. Weeks, J. S. Urbach, and H. L. Swinney. Anomalous diffusion in asymmetric random walks with a quasi-geostrophic flow example. *Physica D*, 97:291–310, 1996.

This paper is a analytical and numerical investigation of Anomalous diffusion in the context of particles in a flow that are either in jets or vorticies and can be modeled as moving in one dimension. It provides much of the background seen in Chapter 3.