Supplementary Material: Glass-like dynamics in confined and congested ant traffic†

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1 Fundamental diagram of ant-traffic

To determine if traffic flow was related to ant density we measured the speed-density relationship within the four tunnels from experiment. We observed that within all tunnel sizes, the upper bound of speed vs. density decreased with increasing density (Fig. SI1). Comparison of the upper bound curves of speed vs. density between large and small diameter tunnels illustrated that speed decreased with increasing density more rapidly in larger tunnels than in smaller (Fig. SI1 left, solid line 2 mm, and dashed line 6 mm).

A fundamental measure of traffic throughput is the traffic flow, F, which is the product of speed and density (Fig. SI1). F is the product of speed and density and is the number of ants that pass a point in space over time within the tunnel. At zero density, no ants are in the tunnel and $F = 0$. At large density ants become jammed together and speed approaches zero, in which case again $F = 0$. Thus the flow is maximized with a value F_{max} at an intermediate density called the carrying capacity. Flow curves constructed from the upper bound curves of speed vs. density increased in size with increasing tunnel diameter (Fig. 6a). The maximum flow achievable in tunnels of varied diameter increased with tunnel diameter (Fig. 6c).

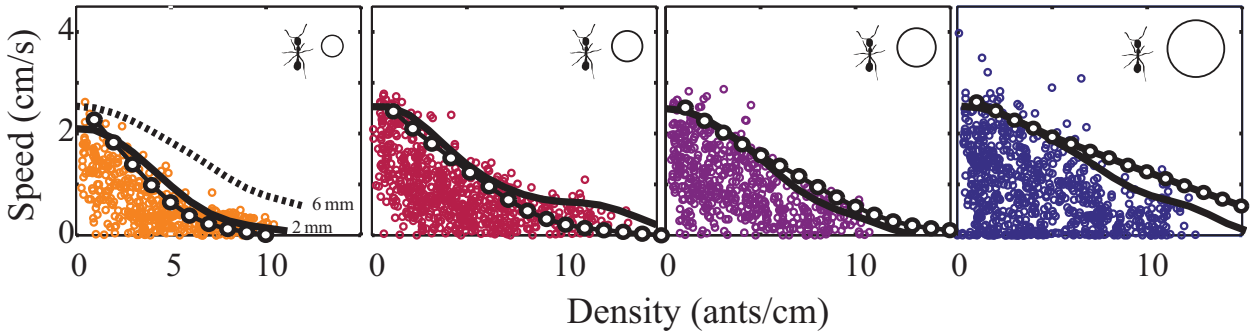

Fig. 1 Fundamental diagram of bi-directional traffic flow in tunnels. Tunnel diameter increases from left to right. Solid lines are estimates of the bounding curves for the speed-density relationship. Dashed line in left panel is for comparison between 2 mm and 6 mm tunnels. Black and white circles are results from simulation for simulated tunnel diameters of $D_{eff} = 2, 3, 4, 6$ from left to right.

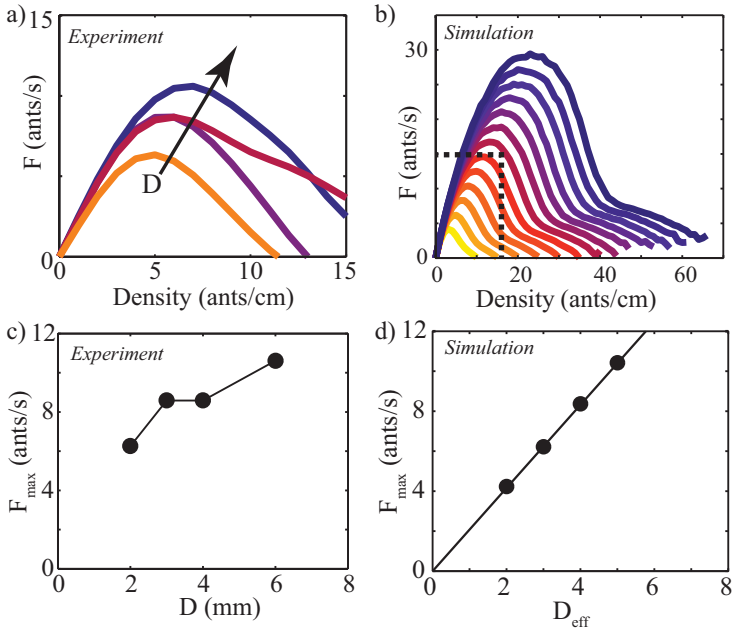

Fig. 2 Flow vs. density in tunnels of varying D. a-b) Flow curves in experiment (a) and simulation (b). Experiment flow are of increasing diameter as shown by arrow. Dashed box in (b) shows the axis range of (a). c-d) Maximum flow vs. tunnel diameter in experiment (c) and simulation (d).

2 SI Videos

2.1 SI Video 1

This video shows an example of tunnel locomotion and the interactions that occur between ants in traffic. The video is played back in real-time.

2.2 SI Video 2

This video shows tunnel traffic within the four tunnel diameters. The video is sped up 4x.