Title
Internal representations and attractor dynamics in a small brain

Abstract
Decades of neurophysiological studies in mammals have uncovered intriguingly abstract and persistent neural representations in central brain regions that are thought to be involved in navigation. The complexity of the underlying circuits and their distance from the sensory and motor periphery has, however, made it difficult to obtain a mechanistic understanding of their function. I will discuss our efforts to understand how visual landmark and self-motion information is used to compute heading direction in an organism with a much smaller brain, *Drosophila melanogaster*. In a recent study, we used two-photon calcium imaging in head-fixed behaving flies to find compass-like attractor dynamics in the ellipsoid body—a substructure within the central complex. The central complex is a higher order brain region known to be conserved across insects and crustaceans. We are now employing modeling, genetic tools, connectomics, optogenetics, calcium imaging, and whole-cell patch clamp electrophysiology to dissect the structure and function of the recurrent circuits in this brain region. In particular, we are using a combination of theory and experiments to explore how visual inputs are processed to obtain the animal's orientation relative to landmarks in its surroundings and how the fly's turning movements update its heading representation. More broadly, we hope to exploit the fly's powerful experimental toolkit to extract fundamental principles of adaptive sensorimotor integration.