Summary

In this thesis I investigated how odor information is represented and processed in the antennal lobe (AL) of the fruit fly *Drosophila melanogaster*.

In *Drosophila*, as in other animals, odor information is encoded in the ensembles of activated olfactory sensory neurons (OSN). This information is integrated and processed in the AL glomeruli, where OSNs make synapses with projection neurons (PN) and local neurons (LN). While most PNs arborize in single glomeruli and thus receive input from a single OSN class, LNs innervate many glomeruli. It is still not fully understood how the interglomerular LN network affects the activity transfer from OSNs to PNs.

To investigate this question I used the genetically engineered calcium sensor G-CaMP and performed *in vivo* recordings of odor-evoked spatio-temporal activity patterns in different neuron populations of the fly AL.

In **Chapter I**, I analyzed the concentration dependency of odor responses of OSNs, two types of LNs and PNs. I found stereotyped and concentration dependent spatio-temporal response patterns in all neuron populations. While OSN and PN responses were clearly glomerular, LN responses were spatially structured but distributed over broad areas of the AL. Responses in the two LN subpopulations differed, suggesting that these neurons might have different functional roles. The gain of each glomerulus (relationship between OSN and PN responses) was concentration dependent, and the concentration-gain relationship was different for different odors in some glomeruli. These results suggest that interglomerular interactions shape glomerulus gain in an odor dependent manner.

In **Chapter II**, I analyzed the representation of odor mixtures and its components in OSNs and PNs and the role of GABAergic neurons in shaping the AL output. I found that PN responses to odor mixtures could not be predicted from the OSN response alone. Furthermore, I found that glomerular responses to odors are constitutively suppressed by fast GABAergic inhibitory input.

Taken together, these results show that the transmission of olfactory information from OSNs to PNs is not a simple feed-forward process. Instead, odor processing in the AL is complex and involves the interplay of several LN networks. AL network activity might decorrelate odor representations at the input and output and thus increase the capacity to discriminate between odors.