Title: Structure and content of internally generated sensory cortical activity across sleep states

During sleep the cortex exhibits large-scale internally generated activity patterns which vary in structure depending upon sleep sub-state. Specifically, rapid-eye-movement (REM) sleep is characterized by awake-like high frequency desynchronised activity, while during non-REM (NREM) sleep the cortex exhibits synchronised slow wave activity. Here we aim to describe how the structure of internally generated activity during different sleep states relates to that produced during awake cortical processing, using the mouse primary visual cortex (V1) as a model system to address this question.

Following a period of visual stimulation mice were placed in darkness for 2-3 hours. We found that after dark onset cortical activity rapidly ramped up in V1 and then exhibited phasic bursts of activation across all states. Both ramping and phasic activation patterns could not be explained by changes in animal movement. The similarity of internally generated patterns to sensory evoked activity was next quantified as a function of state by comparing pairwise correlation matrices, fraction of variance explained using awake-fitted PCA principal components and a non-linear autoencoder based approach. Finally, we used a pixel-wise sensory representation decoding approach (based on a convolutional neural network) to reconstruct video-rate internal visual representations during sleep, and compared their spatial and temporal characteristics to reconstructions during awake processing of visual stimuli. Together the results provide new insights into what is encoded in internally produced sensory cortex activity across sleep states.