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**Friday, April 25, 2025**

15:00-16:00

2F E206 Seminar Room, DB Building D, Kobe / Broadcast online via Zoom  
※This seminar is only for BDR Members

## Neuronal Computations Underlying Cephalopod Polarization Vision

### Summary

Vertebrates and cephalopods independently evolved camera-type eyes ? a striking example of convergent evolution. While vertebrates detect color via wavelength-sensitive photoreceptors, cephalopods instead sense light polarization, likely conferring ecological benefits in underwater environments. Their retina consists solely of photoreceptor cells projecting to the optic lobe's superficial region, termed the "deep retina" by Cajal for its morphological resemblance to vertebrate retinal ganglion cells (RGCs). However, the extent to which the deep retina functionally parallels RGCs, as well as the mechanisms by which it integrates intensity and polarization signals, remain elusive.

Using juvenile squid (*S. lessoniana*) as our model, we developed a novel head-fixation method for two-photon in vivo calcium imaging in awake squid. Our results reveal distinct neuronal types in the deep retina, including neurons selective for specific polarization orientations and neurons computing the degree of linear polarization (DoLP). We also observed orientation- and direction-selective neurons, suggesting a feed-forward network for progressively complex feature extraction that parallels vertebrate retina.

Finally, I will present our recent in vivo electrophysiological recordings using Neuropixels probes targeting downstream regions. We found evidence for hierarchical processing in the optic lobe medulla, where receptive field size and non-visual activity increased with depth. Moreover, neural responses were nonlinearly modulated by light intensity and polarization.

This study provides the first in vivo physiological characterization of the cephalopod visual system, offering insight not only into their unique polarization vision but also into broader principles of convergent evolution in visual systems.