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(U*) Photons in the Brain: Imaging Biophotons with Quantum Detectors

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Ultra-weak light, known as biophotons, are emitted spontaneously by living organisms, but the origin, wavelength and the underlying mechanisms have not yet been clearly identified; although energy metabolic processes seem to be involved. Moreover, neurons can emit photons and there is strong experimental and theoretical evidence that myelinated axons can serve as photonic waveguides. Thus, it has been conjectured that biophotons are involved in neural communication. The main challenge of imaging biophotons is their low intensity, which requires detectors displaying high sensitivity and very low noise level.

To accommodate for the detection of ultra-weak biophoton signals, we use superconducting nanowire single-photon detectors (SNSPDs) where spectral filtering of blackbody radiation –achieved by spooling the input fibres –yields extreme low dark counts (on the order of 0.5 counts per minute). For our study, we have chosen tadpole and frog Xenopus brains as our models, since these conserve most of the essential cellular and molecular mechanisms from mammalian brains and are easy to manipulate.

In my talk, I will present our setup and results from our recent measurements of biophoton emission. I will also introduce a range of planned measurements e.g. spectral and temporal characterization, application of neural activity stimulators/inhibitors, and discuss some improvements to the experimental apparatus such as implementing fiber-coupling to an array of SNSPDs, EMCCD cameras, and using different biological samples. These measurements are all aimed at our long term goals of understanding how biophotons are generated in neurological cells and determining if biophotons play a role in communication in the nervous system (beyond the current paradigm of electro-chemical signalling processes). This could open the door to the fascinating fundamental question of whether quantum phenomena, such as entanglement, play a role in higher level functions of the brain, e.g., consciousness.

Primary authors: ZIBAKHSH, Rana (University of Calgary); SHALEV, Amit (University of Calgary); BERTOLESI, Gabriel (University of Calgary); MCFARLANE, Sarah (University of Calgary); SIMON, Christoph (University of Calgary); OBLAK, Daniel (University of Calgary)

Presenter: ZIBAKHSH, Rana (University of Calgary)

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