SOFTWARE IMPLEMENTATION OF A MULTI-CHANNEL, MULTI-FREQUENCY LOCK-IN AMPLIFIER

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Weak emission signals are usually measured and analyzed with one or more sensitive detectors, such as a photomultiplier tube, to obtain sufficient signal from fluorescent samples. Here we demonstrate the measurement of fluorescence from solutions of Rhodamine 6G in ethanol for optical excitation at 532 nm without a photomultiplier, but with a much less sensitive spectrometer (Ocean Optics OCEAN-FX-XR1-ES) and a Software Implementation of a Multi-Channel, Multi-Frequency Lock-in Amplifier (SILIA).

SILIA is a software implementation of a multi-channel, multi-frequency Lock-in Amplifier to extract modulated signals from noisy data with arbitrary dimensionality and number of channels. It emulates the functionality of a multi-channel, multi-frequency lock-in amplifier in a post-processing step following data acquisition. Unlike most traditional lock-in amplifiers, SILIA can work with any number of input channels and is especially useful to analyze data with high dimensionality. Since a photomultipler tube was not used, the observed spectrum contains spectral information from scatter photons of the pulsed 532 nm laser light and fluorescent signal of Rhodamine 6G onto the spectrometer. Without SILIA, this pollution renders the fluorescent signal indistinguishable from the background signal.

Present the methodology behind SILIA and demonstrate its application for extracting weak signals in spectroscopy. We also discuss more general applications and exhibit a method to automatically estimate error from a lock-in result.