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Towards time-resolved photoluminescence spectroscopy of Rydberg excitons in Cu2O

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Since their discovery [1], Rydberg excitons in cuprous oxide have garnered significant interest due to their giant dimensions resulting in exaggerated properties. One particular application of Rydberg excitons is their use in mediating indirect interactions between single photons in order to move towards achieving single-photon nonlinearities. If achieved, this would have wide-ranging applications from quantum information processing to quantum cryptography.
In developing these applications for Rydberg excitons, it is important to be able to properly characterise both the excitonic and material properties. One indispensable method for investigating this is time-resolved photoluminescence spectroscopy (TRPL), allowing us to probe the dynamics of the system. This not only provides information on the sample purity (since higher defect concentrations will result in diminished lifetimes) and the effects of lattice temperature and laser power on exciton stability but may also inform us about the interactions between excitons present, contributing to a deeper understanding of their properties.
In my poster, I present our progress in constructing a system capable of taking time-correlated single photon (TCSPC) measurements and the results it has provided in the characterisation of a naturally-formed Cu2O crystal. Specifically, we have begun investigating the lifetimes of the excitons under different exciting laser powers and temperatures.

[1] T. Kazimierczuk et al. “Giant Rydberg excitons in the copper oxide Cu2O”. In: Nature 514 (2014). url: https://www.nature.com/articles/nature13832.