

**Title: Two-photon Spectroscopy**

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The two-photon absorption (TPA) process is one in which two photons are absorbed simultaneously by a molecule. This process is utilized in non-linear microscopy of biological molecules, absorption cross-section studies and two-photon fluorescence imaging. The main focus of the project is the detailed study of the absorption cross-section and its applications. A full analysis of the time-dependent perturbation theory applied to TPA was performed. Equations for the cross-section were derived for plane waves incident on molecules. For a plane wave, the cross-section was found to be dependent on the summation of the product of the cross-sections for individual transitions within the molecule and the lifetimes of the intermediate levels. The analysis was then extended to temporally and spatially localised laser pulses.

A review of experiments which determine cross-sections for haemoglobin and porphyrin molecules yielded results which support the large theoretical predictions of the order of  $10^2 GM$ , tested by Clay (2007). Based on the research papers presented, the potential applications of the TPA technique to the characterization of haemoglobin blood abnormalities will be discussed.