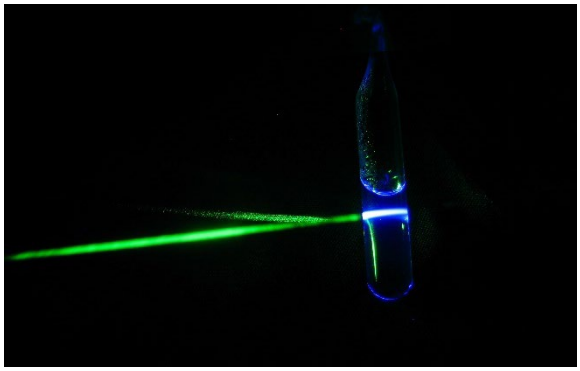
Master thesis proposal

Measuring Photon Upconversion using an Integrating Sphere

Aim: Design and develop a method for accurate measurement of efficiency of photon upconversion in solid state materials using an integrating sphere.

Background:
Photon upconversion (PUC) by triplet-triplet annihilation is a photophysical process where two low energy photons are combined to generate one higher energy photon. PUC can for instance be utilized in solar cells, where it is used to modify the energy of the photons from the sun to better match the photon energies that the solar cell can absorb. By that, PUC can make the solar energy harvesting more efficient. In our research group we are investigating the fundamental processes behind PUC with the overall aim of understanding the design criteria that gives an efficient PUC system.

One way to measure the efficiency of PUC is to measure the so-called quantum yield, i.e. the number of upconverted photons that are emitted per absorbed incoming photon. A quantum yield can be measured with high accuracy for liquid transparent PUC systems using spectroscopic techniques, but it is not so easy for solid non-transparent materials. As our research in the future will turn from investigating PUC in solution to developing solid PUC materials, there is a need to develop a method for measuring PUC quantum yield of solid-state materials. One way to measure quantum yield from non-transparent materials is to use a so-called integrating sphere, which is a sample container that has the ability to collect all light that is emitted in all directions from a sample.



Picture showing photon upconversion in a sample that emits blue light (high energy photons) when illuminated by a green laser (low energy photons).

Project description:
The project contains both practical hands-on work of implementing an integrating sphere into our existing spectrometers, as well as theoretical investigations about photon upconversion and how to quantify it. The project is focused on method development and the student will develop advanced skills in absorption and emission spectroscopy. Depending on time and interest, the project can also include LabVIEW programming with the aim of creating user friendly software connected to the instrument.

There are no specific requirements about previous experiences more than an interest in physical chemistry and optical spectroscopy. A background in chemistry or physics is preferred. The project will be performed at the division of Chemistry and Biochemistry, Chalmers.

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