Measurement of the single-photon and two-photon fluorescence chirality of chiral dye molecules and nanoparticles

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Chirality is the geometric property of a molecule that is non-superposable on its mirror image. The molecule and its mirror image form two enantiomers. Although enantiomers have the same chemical and physical properties, their interactions with other chiral elements (biological receptors, left- and right-handed light…) are quite different. When irradiating some chiral material with two light beams with opposite circular polarizations, the difference in absorption due to the material chirality is known as circular dichroism. The measurement of circular dichroism is used as an optical method for evaluating the chiral properties of molecules. Yet, this method usually requires a large amount of chiral molecules to interact with the incident light in order to obtain a measurable absorption difference. Monitoring the fluorescence intensity of chiral dye molecules provides an indirect measurement method to evaluate the difference of absorption down to the single molecule level [1].

In this work, we investigate the chirality of the fluorescence response of chiral dye molecules under single-photon and two-photon excitation conditions. A green CW laser emitting at 532 nm is used to probe the single photon fluorescence, whereas the two-photon fluorescence is excited by using a fs-pulsed fiber laser with a center wavelength at 1035 nm. While single-photon excitation results in a relative difference of fluorescence intensity up to 10% (g-factor ~ 0.1), a relative difference of fluorescence intensity above 20% (g-factor ~ 0.25) can be obtained under two-photon excitation condition. The chiral response of nanoparticles made of aggregated chiral dye molecules is also investigated [2,3]. This work could lead to significant progress in the measurement of circular dichroism of chiral fluorescent molecules and nanoparticles.

References:

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