Two-Photon Absorption, Upconversion, Photon Avalanche, Cross Relaxation: Exploring Commonalities and Mechanisms with Practical Examples

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The captivating phenomenon of invisible laser radiation inducing vibrant green emission has intrigued many observers. While most spectroscopists are acquainted with the fundamental mechanisms underlying this phenomenon, this lecture aims to delve deeper into both well-known and lesser-explored pathways.

We will study familiar mechanisms such as absorption from excited states (ESA) and energy transfer through upconversion (ETU, formerly known also as APTE) [1], alongside less conventional processes involving dopant ions that result in photon emission with energies surpassing those of excitation. Specific questions will be addressed, such as whether upconversion intensity is always proportional to the square of the pumping power [2], or if pulse excitation leads to the same mechanisms as continuous excitation [3].

The lecture will also delve into the details of two-photon absorption and the generation of an avalanche of photons [4], outlining the conditions conducive to its formation, as well as elucidating methods to differentiate between processes like ESA and APTE.

Furthermore, strategies to enhance the efficiency of upconversion processes will be discussed. Practical applications of these mechanisms will be highlighted, shedding light on their utilization thus far, while also addressing the limitations encountered and strategies for overcoming them.

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