Can three-photon absorption lead to better bio-imaging?

One of the more interesting concepts being looked at in terms of quantum chemistry is that of three-photon absorption (3PA). 3PA works when three photons are simultaneously absorbed in one event. Because three photon absorption most commonly occurs in longer wavelengths (near infrared), some scientists see hope for it in terms of biomedical and photonic applications.

Gregory Scholes, a scientist at the University of Toronto, tells *PhysOrg.com* that three-photon absorption can be done using a process similar to one photon absorption. “What we’ve done with this paper is show that 3PA for semiconductor quantum dots can be predicted based on the spectral dependence of normal one photon absorption.”

Scholes is joined in this work by Jun He, also at the University of Toronto, who carried out the experimental measurements with Yu Long Ang, Wei Ji, Cyrus W. Beh and Wee Shong Chin at the National University of Singapore. Their work can be found in *Applied Physics Letters*: “Direct observation of three-photon resonance in water-soluble ZnS quantum dots.”

“As far as I know,” Scholes says, “this hasn’t been tried yet with quantum dots as an imaging technique.” He does, however, concede that he would be “surprised if it hasn’t been tried at all.”

Scholes points out that the goal is to use three-photon absorption as a high resolution microscopy technique. He explains that when one uses such techniques when probing bio systems, it is possible to functionalize quantum dots so that they “go to different parts of a cell. When you have them there, you excite them and you can make a really nice color map.”

This microscopy is usually done in the near infrared part of the spectrum because of the unique properties of that light: “Red light penetrates better in tissue,” Scholes explains.

He also expounds on the problems faced by photon absorption in terms of microscopy. “When you do this with two photon absorption,” he says, “you can’t easily predict where to excite these quantum dots. The excitation pattern doesn’t always correspond the same way.” Scholes says that with one-photon absorption, it is much easier to predict where to excite the quantum dots to see the color image. But with one-photon absorption, the spatial resolution isn’t as good.

Scholes says that the current paper is important because it sheds some light on three-photon absorption in terms of processes. “We found that the three photon absorption process follows the same pattern as the one photon process. It also has very high spatial resolution. So we know exactly where to excite the quantum dots, and we have better resolution.”

Scholes points out that his colleagues haven’t tested the process. “We do other types of experiments, usually,” he says. But he is hopeful that the current paper will inspire others to give it a try. “I imagine this would inspire researchers to try this with quantum dots as an imaging technique.”

In any case, Scholes believes that he and his peers have found something fundamentally important. “It’s not going to revolutionize quantum computing,” he chuckles, “but it does provide some mapping out of the wavelength dependence process. This is something that is important to establish.”