

### **Single Photon Source in High Demand**

The future of quantum mechanics is driven by the applicability of quantum mechanics. In recent years there has been a push of our quantum understanding as we probe the unknown worlds of the small. However God has laid the foundation of the quantum world, scientists continue to learn and explore the realm of possibilities of new technologies.

In particular we look at the future of single photon sources. There have been lots of proposes to the single photon source, such as single-molecules, mesoscopic quantum wells, colour centres, trapped ions, and of course our Quantum Dots. [1] It seems that the world needs a SPS to supply single photons for a variety of reasons. The need for a single photon source range from quantum cryptography to visualization of biological systems making the demand is high. In biology there is great deal of research going on to try to map out how proteins “walk.” Dr. Novotny’s group studies the conformational dynamics of single transmembrane proteins. However, the most popular need for single photons comes from quantum computing or quantum communications. Single photons sources need to not only be a single photon sources but also have strong quantum correlations among its photons, such as the anti-bunching effect of quantum dots.[3] Acquiring the control of a weak light source with a strong quantum correlation would essentially solidify the quantum cryptography desires.

Quantum Cryptography not only requires a single photon source, but also a high quality factor,  $Q$ , micro cavity structure. This would be the only way to provide the unconditional security over the internet when quantum computers start surfing. There is a need for as some

would say a stream of photons resembling a train. Curiously, no classical source can provide this demand, but is only satisfied by the anti-bunching effect of a quantum single photon source.

The reason for a high-Q cavity mode is to enhance the emission rate of the quantum dots. All in all the need for a SPS at a fast repetition rate is what scientists are trying to achieve.

The quantum dot seems to be an answer to quantum communications, however there is still much to study to control them as desired. One difficulty is just making them. There are lots of recipes to make the quantum dots, and lots of different types of quantum dots, there are lots of cavities that people have made to enhance the signal. Scientists have even noticed that quantum dots behave differently when they start interacting with the environment. [4] Not to say that the quantum dots change though that maybe be an answer but the fluorescence lifetime changes. There is difficulty also in determining how the radiative rates behave when quantum dots interact with the environment. [5] There is still a need to study of how quantum dots interact with each other, a suggested way to do that would be to physically bring in a nano-gold sphere close enough to a quantum dot and measure the anti-bunch histogram as a function of distance. This idea would require there to be flexibility of moving the nano-gold sphere with great accuracy.

All in all while there is tremendous progress in identifying the single photon source, there is still much work ahead to apply these to quantum computing or quantum information. However there is much promise in the scientific community in its optimism to overcome the barriers and control the spontaneous emission of these quantum dots.

References:

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