PHY 598: Abstract

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Quantum measurements usually require that the system be disturbed. For example, when detecting light, photodectors are used, where light intensity is used to create a current in the photodetector. In this process, the photons are the system of interest. Obtaining measurements requires that photons annihilate, and convert into electrons. When measuring atomic properties such as the excitation frequencies, experimentalists must use light to probe the atomic transitions. In both of these measurements, the systems of interest are being probed, and altered. Atomic physicists Serge Heroche and David J. Wineland developed experiments where the quantum states of the systems being measured are not altered by the measurements made.[1]

By trapping microwave photons in a cavity composed of highly reflective mirrors, and sending atoms, in a state sensitive enough to detect a single photon, through the apparatus, Serge Heroche has managed to count the number of trapped photons. This is done by measuring the difference in atomic energy levels before and after the atoms leave the trap. In this process, none of the photons are lost to absorption. Using this experimental set up, Heroche has managed to perform unique experiments measuring photon loss in the cavity, when the photons are prepared in different quantum states.[1]

Using his technology developed to capture, and make measurements on a single ion, David Wineland made the most precise spectroscopic measurements ever obtained. Making these measurements involved coupling the ground state normal modes of two ions (one designated for spectroscopy, and the other to carry information called the logic ion) using coulomb forces. Therefore, the two ions shared common normal modes of motion that were used to map excitations of the spectroscopy ion. The net process left the spectroscopy ion unchanged from it's initial state, and the spectroscopy information was transferred to the logic ion.[2]

Bibliography

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[2] C. Langer W. M. Itano J. C. Bergquist D. J. Wineland P. O. Schmidt, T. Rosenband. Spectroscopy using quantum logic. *Science AAAS*, 309:749–752, 2005.