Experimental image transfer and frequency conversion based on an atom ensemble

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In this talk, we will show the experimental research about the image transfer between different lights with the aid of the atomic ensemble. We report on two different image transfer experiments: one is based on electromagnetically induced transparency effect. Another is based on four wave-mixing in an atomic ensemble. In the first experiment, we realize not only an image transfer from a control light to a probe light, but also an image transfer from a control light to two different probes, which can be definitely extended to more probes. This process can be regarded as image cloning. Besides, we consider a case in which a single photon detector instead of CCD camera is used to detect the probes, and find that the transferred images still exist. In the second experiment, we demonstrate an image transfer with large frequency conversion using four-wave mixing process in ladder-type configuration in an atomic ensemble. We realize experimentally that an image with telecom-band frequency that is suitable for fiber transmission over long distance is transferred to a short wavelength signal that matches the D_2 line of the atom Rb^{85}, which can couple to the Rb atomic ensemble and realize the quantum memory based on atomic ensemble. All experiments are never reported before to our best knowledge. We believe this effect definitely has important applications in image metrology, high dimensional information transfer in quantum information field, and makes a preliminary step toward to realize the high dimensional information transfer in quantum network.

Besides, we will show another important progress: we report on at the first time to out best knowledge the experimental frequency conversion of a light at 780 nm, which matches the D2 line of Rb atom transition, to a light at 1530 nm in the window of the fiber through four wave-mixing in an atom ensemble. After that, the light at 1530 nm obtained previously is converted back to the light at 780 nm again through another FWM in another atom ensemble. Besides we experimentally prove that the coherence of the input light can be kept through this cascade FWM process by observing the interference between the light obtained finally and a reference light. Our research makes a preliminary step toward to realize the quantum repeater.