Photon Generation in Ultraviolet Integrated Photonic Circuits

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Quantum information processing relies on the fundamental property of quantum interference, where the quality of the interference directly correlates to the indistinguishability of the interacting particles. The creation of these indistinguishable particles, photons in this case, has conventionally been accomplished with nonlinear crystals and optical filters to remove spectral distinguishability, albeit sacrificing the number of photons. This research describes the use of an integrated aluminum nitride microring resonator circuit to selectively generate photon pairs at the narrow cavity transmissions, thereby producing spectrally indistinguishable photons in the ultraviolet regime to interact with trapped ion quantum memories. The spectral characteristics of these photons must be carefully controlled for two reasons: (i) interference quality depends on the spectral indistinguishability, and (ii) the wavelength must be strictly controlled to interact with atomic transitions. The specific ion of interest for these trapped ion quantum memories is Ytterbium which has a transition at 369.5 nm with 12.5 GHz offset levels. Ytterbium ions serve as very long lived and stable quantum memories with storage times on the order of 10's of minutes, compared with photonic quantum memories which are limited to 10^{-6} to 10^{-3} seconds. The combination of the long-lived atomic memory, integrated photonic circuitry, and the photonic quantum bits are necessary to produce the first quantum information processors. In this seminar, I will present results on ultraviolet wavelength operation, dispersion analysis, propagation loss in aluminum nitride waveguides, and the path forward to towards multiwavelength integration.