A directional and stable solid-state source of single photons for quantum cryptography

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Examples of present single photon sources include trapped atoms [1], quantum dots, organic dye molecules and diamond NV colour centers [2] and atoms inside tunable photonic band-gap structures [3]. The ability to create single photons is a basic ingredient for secure quantum cryptographic protocols as well as for linear optics quantum computation [4]. Atom-cavity schemes [5] and spontaneous parametric downconversion can be used to obtain directional singe photon sources. Presently, secure quantum cryptographic schemes rely on the creation of entangled photon pairs with the help of spontaneous parametric downconversion (SPPC) [6].

Here we present an alternative single photon source with potential applications in quantum cryptography and quantum information processing which can easily be implemented with present technology and has many advantages compared to previous schemes. With the help of two atomic sources provided, for example, by two NV colour centers in a diamond, and laser excitation, photon pairs are created that are highly correlated in space, time and polarisation. Dipole-dipole interaction between the atoms is not required. The strong correlations result from the *symmetry* of the given setup.

The two-atom case has interesting features that are absent in the one-atom case. Thus one can demonstrate that perfect singly excited atomic state preparation is possible even without precise control of the laser parameters and knowledge of the atom decay rate. For applications in quantum cryptography we employ the fact that the detection of a photon in a specific direction away from the atoms triggers the emission of a second photon into another direction with a high probability. If Alice performs a measurement on one of them, she obtains enough information about the other photon. When sent to Bob, it can be used to create one bit of a shared secret key.

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