# Single-Photon Generation and Detection: Chapter 11. Parametric Down-Conversion (Experimental Methods in the Physical Sciences)

*Andreas Christ, Alessandro Fedrizzi, Hannes Hübel, Thomas Jennewein, Christine Silberhorn*

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In this chapter we review the process of parametric down-conversion (PDC) and discuss the different methods to use PDC as a heralded single-photon source. PDC is a non-linear optical process, where an incoming pump photon decays, under energy and momentum conservation, into a photon-pair. The creation of photons in pairs allows for the implementation of a single-photon source by detecting one photon (trigger) to herald the presence of its partner (signal). The engineering possibilities of PDC enable the generation of single-photons with high rates in a wide range of frequencies. This chapter is structured as follows: Section 11.2 describes the principles of PDC in non-linear media. We derive the quantum state of the generated photon-pairs, investigate the spectral purity and photon-number purity of the heralded signal photon and discuss the achievable single-photon generation rates. In section 11.3 we turn towards experimental realizations and introduce bulk crystal PDC. Section 11.4 elaborates on the use of periodic poling to engineer the PDC process. Finally, section 11.5 gives an overview over PDC in waveguides. A comparison of experimental data from various heralded singe-photon sources based on PDC is presented in section 11.6 with an overview of nonlinear materials suited for PDC given in section 11.7.

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