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Towards ideal, "on-demand" single-photons: heralded sources vs single quantum emitters

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The crucial role played by Single-photon sources (SPS) in many applications, such as quantum metrology [1-5], quantum information [6, 7], and in the foundations of quantum mechanics [8-10], leads to much interest and effort in improving the performance of such sources [11, 12].
An ideal SPS (i.e. a SPS emitting indistinguishable single photons, with 100% probability of single-photon emission on demand and 0% probability of multiple-photon emission) is far to be realized, since deviations from these ideal characteristics are always present in real-world sources.
While, on the one hand, to achieve fully deterministic single-photon generation it appears natural to employ sources whose physics guarantees deterministic single-photon emission (single quantum emitters such as single atoms, ions, molecules [13, 14], quantum dots [15, 16], or color centers in diamond [18-21]) as opposed to probabilistic ones (most reliably heralded SPS based on parametric down-conversion) [22, 23], in practice, on the other hand, the distinction between deterministic and probabilistic sources often fades due to issues such as non unity extraction efficiency, which leads to probabilistic losses, so that this characteristic of the overall source is really a continuum [11, 12].
We present an overview of our latest results concerning "state of the art" single photon sources addressed both to the boosting of the performance of heralded SPS, reaching an extremely low level of residual background photons and unprecedented suppression of multiphoton components ($g^{(2)}(0)=0.005(7)$) without temporal post-selection [24], and to the (work-in-progress) optimization of the characteristics of sources based on single quantum emitters (color centers in diamond) exploiting recently reported centers which are interesting because of the narrow emission line, the shorter excited state lifetime with respect to NV centres (1~2 ns compared to 12 ns, allowing a ten-fold photon emission rate upon saturation) and the polarized emission.

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