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(G*) Towards an on-demand, all electrical single-photon source

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Single-photon sources (SPSs) are an elementary building block for quantum technologies. An ideal SPS is deterministic, on-demand and produces exactly one photon per pulse. Despite the large interest in single photons for both fundamental and applied applications, an ideal SPS remains elusive. The most common SPSs today are heralded single photons based on parametric down-conversion, which are neither on-demand nor deterministic.

Many proposals for an ideal SPS have been made. One such proposal is the integration of a single-electron pump (SEP) in proximity to a p-n junction in a direct bandgap semiconductor[1]. By using the SEP to deterministically inject individual electrons from the n-side into the p-side, single electrons can combine with a hole to produce a single photon. The operation of SEPs with sub-parts-per-million accuracy indicates that multi-electron injection, and therefore multi-photon pulses, will occur at a negligible rate.

We report on progress towards such a single-photon source, describing both our progress in electrical measurements of SEPs and optical measurements of p-n junctions in undoped AlGaAs/GaAs heterostructures. Undoped AlGaAs/GaAs allows the integration of both electrons and holes in the same device[2]. Provided that the injection rate is slower than the exciton lifetime, single-photon pulses will not overlap. The sub-nanosecond exciton recombination lifetime in GaAs should therefore allow photon emission rates above 1 GHz.

References:
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