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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

Ansprechpartner: Prof. Harald Giessen
E-Mail: giessen@physik.uni-stuttgart.de
Telefon: 0711 - 685-65111

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Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart-Vaihingen

Gastgeber: Prof. Dr. Peter Michler, Universität Stuttgart, Telefon: 0711 - 685-64660

How to change the color of a single photon (and why this is useful for quantum networks)

Christoph Becher
Universität des Saarlandes

Abstract

Photons are prime carriers of information and can bridge large distances in fiber-based networks provided their wavelength is within one of the low-loss telecommunication windows. This established technology is the basis of today's optical communication networks. On the other hand, physicists have the vision of a "quantum internet" where local quantum bits and memories are interconnected by flying quantum bits, e.g. single photons, to provide secure communication, distributed quantum computing or networks of quantum sensors. The majority of atomic or solid-state systems serving as qubits or quantum memories, however, do not offer optical transitions at telecom wavelengths but commonly emit in the visible to near-infrared range.

Surprisingly, simple nonlinear optics, i.e. frequency conversion in nonlinear crystals, provides an efficient and low-noise interface between qubit and telecom wavelengths, even at the single photon level. This technique has reached a level of maturity to be employed in demonstrations of remote entanglement in quantum network settings. I will report on application of quantum frequency conversion in such demonstrations with neutral atoms, trapped ions and semiconductor quantum dots.