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Report on funding application 48
Dr. Jian Wie PAN visiting Physikalisches Institut, Universität Heidelberg

Dr. Jian Wie PAN came to the Physikalisches Institut at the Universität Heidelberg to discuss with us possible experimental implementations of a Quantum Repeater in photonic and atomic quantum information networks.

Current experiments for Quantum Communication (QC) can only be implemented for moderate distances (up to a few tens of kilometres in the case of quantum cryptography). *For a long-distance QC, one must realize quantum network that is scalable and may incorporate many communication nodes*. We extensively discussed the feasible realization and the potential applications of quantum network with linear optics and atomic ensembles. The main emphasis was put on learning how to combine the concepts of various implementations of a quantum repeater and their advantages and disadvantages. New features discussed were the following: (1) We stress *the robust realization with less stringent requirement* with emphasis towards the experimental realization, (2) We are discussing *using the polarization degree of freedom of photon as quantum information carriers,* and (3) we started to investigate *detailed atomic physics / quantum optics assessment of the real life situations when implementing the theoretical proposals*. The breakthrough on such the proposed quantum network may offer a fascinating testing ground for applications aiming to fundamental research and practical quantum information processing.

A second theme discussed extensively was to transfer schemes for quantum information processing with photons, to beams of guided neutral atoms on atom chips. An important aspect thereby is that atom optics is intrinsically non linear, and significant one atom non linearities can be achieved in tightly confining traps, as can be implemented on atom chips. Linear optics QIPC schemas will have to be revisited in detail, but the well controllable non linearities in atom optics can allow direct implementations of controlled not gates. Implications for QIPC with guided atoms have to be discussed further in the future

The visit of Dr. Jian Wie PAN at the Physikalisches Institut at the Universität Heidelberg gave us many new ideas and stimulated many new discussions. It resulted in plans for joint experiments and some of the mechanisms discussed are now active part of our ongoing research effort on slow light, atomic ensambles and QIPC with neutral atom qubits on atom chips.

Prof. Dr. Jörg Schmiedmayer