Quantum optics approaches for quantum networks and other applications

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Quantum networks promise many exciting applications from secure communication over distributed sensing to distributed quantum computation. I will describe several efforts related to designing the hardware architecture for such quantum networks. One approach towards a global quantum network combines quantum communication satellites with quantum repeaters. An important capability in this context is the ability to detect photonic qubits non-destructively, which may be possible in solids using single rare-earth ions or ensembles of rare-earth ions. Single rare-earth ions are also promising for the implementation of quantum repeaters. An attractive approach towards distributed quantum computing is to connect superconducting quantum processors via optical channels. This requires the transduction of photons from the microwave to the optical domain, which may also be possible using rare-earth ion ensembles in solids. In the long term it would be highly desirable to realize quantum networks whose components can operate at ambient temperature. This may be possible using plasmonics or spin-optomechanics approaches. Finally it is interesting to ask whether there could be quantum networks in the brain. Besides quantum networks, I will also briefly describe efforts towards bringing quantum effects to the macroscopic level, as well as an approach towards super-resolution imaging using heterodyne detection.

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