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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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