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Quantum network technology - the second life of rare-earth crystals

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Abstract

Starting with the demonstration of lasing more than 50 years ago, the special properties of rare-earth crystals and glasses have enabled the development of numerous solid-state lasers and amplifiers, which are crucial for the functioning of today's Internet. As a fascinating generalization of their use in optical communication infrastructure, it became clear during the past decade that, when cooled to a few Kelvin, rare-earth crystals also promise the creation of technology for quantum communication networks.

I will discuss recent advances towards the development of key ingredients of such networks: the creation of single photons using individual rare-earth ions coupled to nano-photonic cavities, as well as the reversible storage of quantum states of light in large ensembles of rare-earth ions. This work is not only interesting from a fundamental point of view, but furthermore paves the path towards a quantum repeater, which will ultimately enable quantum communications over arbitrary distances.