Integrated photonics for quantum technologies

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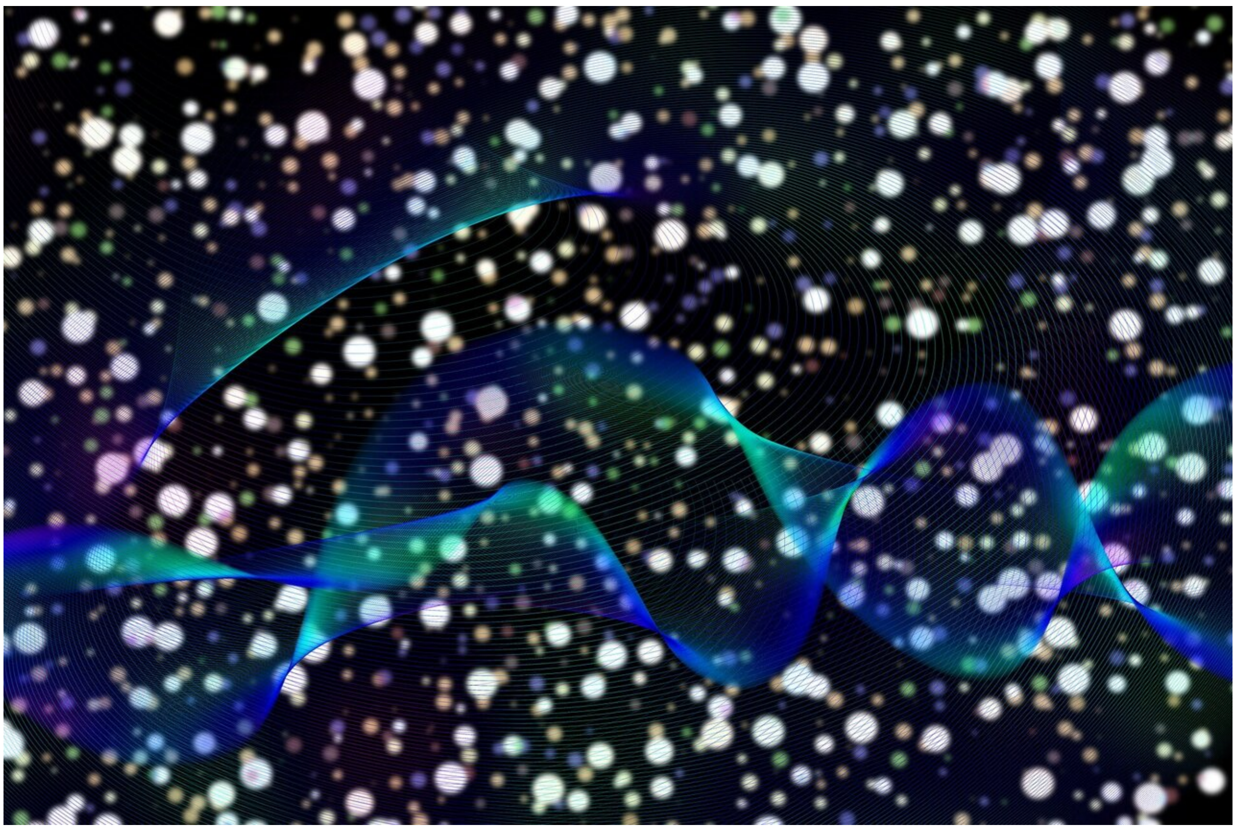

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An international team of scientists, headed up by Paderborn physicist Professor Klaus Jöns, has compiled a comprehensive overview of the potential, global outlook, background and frontiers of integrated photonics. The paper—a roadmap for integrated photonic circuits for quantum technologies—has now been published in *Nature Reviews Physics*. The review outlines underlying technologies, presents the current state of play of research and describes possible future applications.

"Photonic quantum technologies have reached a number of important milestones over the last 20 years. However, scalability remains a major challenge when it comes to translating results from the lab to everyday applications. Applications often require more than 1,000 optical components, all of which have to be individually optimized. Photonic quantum technologies can, though, benefit from the parallel developments in classical photonic integration," explains Jöns. According to the scientists, more research is required. "The integrated photonic platforms, which require a variety of multiple materials, component designs and integration strategies, bring multiple challenges, in particular signal losses, which are not easily compensated for in the quantum world," continues Jöns. In their paper, the authors state that the complex innovation cycle for integrated photonic quantum technologies (IPQT) requires investments, the resolution of specific technological challenges, the development of the necessary infrastructure and further structuring towards a mature ecosystem. They conclude that there is an increasing demand for scientists and engineers with substantial knowledge of quantum mechanics and its technological applications.

Integrated quantum photonics uses classical integrated photonic technologies and devices for quantum applications, whereby chip-level integration is critical for scaling up and translating laboratory demonstrators to real-life technologies. Jöns explains that "efforts in the field of integrated quantum photonics are broad-ranging and include the development of quantum photonic circuits, which can be monolithically, hybrid or heterogeneously integrated. In our paper, we discuss what applications may become possible in the future by overcoming the current roadblocks." The scientists also provide an overview of the research landscape and discuss the innovation and market potential. The aim is to stimulate further research and research funding by outlining not only the scientific issues, but also the challenges related to the development of the necessary manufacturing infrastructure and supply chains for bringing the technologies to market.

According to the scientists, there is an urgent need to invest heavily in education in order to train the next generation of IPQT engineers. Jöns says that "regardless of the type of technology that will be used in commercial quantum devices, the underlying principles of quantum mechanics are the same. We predict an increasing demand for scientists and engineers with substantial knowledge of both quantum mechanics and its technological applications. Investing in educating the next generation will contribute to pushing the scientific and technological frontiers."

More information: Emanuele Pelucchi et al, The potential and global outlook of integrated photonics for quantum technologies, *Nature Reviews Physics* (2021). DOI: 10.1038/s42254-021-00398-z

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