WED-ID 3: Quantum Communication & Internet

Time: Wednesday 14:45–16:20 Location: ZHG101

Invited Talk WED-ID 3.1 Wed 14:45 ZHG101
Quantum Internet: Technologies & Applications — •Imran Khan — KEEQuant GmbH, Gebhardtstr. 28, 90762 Fürth

We live in an era where the precise control and engineering of quantum states enables new technologies, like quantum computing, quantum communication or quantum sensing. Emerging from the combination of all of these, is the concept of a quantum internet, allowing for unprecedented use cases of such technology. In this talk we will discuss the state of the art and explore what this interplay could look like in the future.

5 min. break

Invited Talk WED-ID 3.2 Wed 15:10 ZHG101
From Promise to Practice: The Challenges in Finding Quantum Computing Applications — •Nicole Holzmann — PsiQuantum, Palo Alto

Quantum computing has long been heralded as a revolutionary force poised to transform numerous industries. Early predictions by consulting firms such as McKinsey and BCG suggested significant impacts across pharma, chemistry, materials science, and related sectors. In pharmaceuticals specifically, quantum computing was expected to revolutionise drug discovery and enhance molecular simulations, substantially reducing R&D timelines and associated costs. Yet, despite considerable investment, these optimistic forecasts have not yet materialised into tangible industrial benefits. Quantum algorithms such as Quantum Phase Estimation (QPE) theoretically offer groundbreaking capabilities, enabling calculations beyond classical limits. However, practical industrial applications remain elusive. Accurate quantum calculations alone do not automatically accelerate drug discovery or improve material designs. Industries require clear, substantial, and cost-effective quantum computing advantages to justify significant investments and organisational changes*a challenge further heightened by continuous improvements in classical computing methods and artificial intelligence. Bridging this gap demands sustained collaboration, realistic expectation setting, and integrated end-to-end methodologies delivering genuinely beneficial outcomes.

5 min. break

Invited Talk WED-ID 3.3 Wed 15:35 ZHG101
Deterministic Photon-Emitter Interfaces for Quantum Technology — •Peter Lodahl — Sparrow Quantum and Niels Bohr Institute, University of Copenhagen, Denmark

Quantum physics is transitioning from an area of fundamental research to the realm of technology. 100 years after Niels Bohr and colleagues unraveled the mind-boggling nature of quantum systems, it is today realized that transformative new technology is possible when exploiting intrinsic quantum phenomena, such as quantum superposition and quantum entanglement. A fundamental challenge has been how to deterministically interface light and matter to create on-demand photon sources. I will discuss how the merger of nanophotonics and atomic physics has bridged that gap, and that we today can construct deterministic photon-emitter interfaces based on solid state quantum emitters (quantum dots). We will discuss the fundamental operational principle, the relevant figures-of-merit, and the routes for implementing these novel foundational building blocks in scalable fault-tolerant quantum computing or a quantum network [1,2].

[1] Uppu et al., Nature Nano. 16, 1308 (2021). [2] Lodahl, Ludwig and Warburton, Phys. Today 75, 3-44 (2022).

5 min. break

Invited Talk WED-ID 3.4 Wed 16:00 ZHG101
Entanglement-based Quantum Key Distribution — •Sebastian Neumann — zerothird/Quantum Industries GmbH, Clemens-Holzmeister-Str. 6/6, 1100 Wien

Online security faces a fundamental threat: With the advent of quantum computing, the main encryption techniques used today will become vulnerable to attacks using Shor's algorithm. Quantum Key Distribution (QKD) is the only technology that can protect internet traffic in a future-proof way. Based on the no-cloning theorem, QKD allows for the creation of physically secure keys for unhackable secret communication. The gold standard of QKD are implementations based on entanglement (eQKD), since monogamy of entanglement intrinsically prevents any information leakage of the quantum state to other degrees of freedom. In my talk, I will introduce the concept of entanglement in a QKD context and present scientific publications whose findings are now being commercialized by zerothird. Special emphasis will be put on the challenges to be overcome for long-distance connections, for creating high key rates over short distances, and for connecting many users in a quantum network. I will also give an outlook regarding future technologies which rely heavily on entanglement, such as quantum repeaters and connections between quantum computers.