

# MARE BALTICUM LECTURES

The International Research Training Group  
“Imaging of Quantum Systems”  
and the University of Rostock

cordially invites you to a guest lecture by

**Prof. Dr. Barry Sanders**  
**(University of Calgary)**

on

**"Introduction to Quantum Computation"**

The lecture takes place  
on October 22<sup>nd</sup> 2024 (Tuesday) at 3pm  
in Lecture Hall II (Albert-Einstein-Straße 24).

*Abstract: Quantum information theory transforms the very foundations of information theory and computing by replacing pre-quantum, or ‘classical’, informational foundation of binary strings into superpositions thereof, utilising quantum theory’s wave-particle duality. In a sense, bits capture the particle-like behaviour with the bit being zero or one like a particle being there or not there (half a particle is forbidden). Superposing bits, such as allowing a 0 and a 1 to co-exist as a superposition of waves representing each, relies on the wave-like property. From this wave-and-particle representation of information is introduced, even the logical rules such as for Boolean operations, manifested as concatenations of one-bit operations such as NOT and two-bit operations such as NAND, gives way to quantum logic, which respects and preserves wave-and-particle-like properties. From this new paradigm of information processing, disruptive changes occur to the notion of whether problems such as number factorisation are even hard in the sense of whether the sub-exponential cost for solving with respect to the size of computational input, and a provable advantage exists for a kind of unstructured search problem. I present the essentials of quantum computation, including motivation, quantum computational resources, and how quantum computation is performed. Furthermore, I discuss the advantages and limitations of quantum computation, both fundamental and practical. arXiv:2408.05448*

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**Prof. Barry Sanders is a guest at the University of Rostock as part of the  
Mare Balticum Fellowship Program at the University of Rostock.**