PHYSIKALISCHES KOLLOQUIUM

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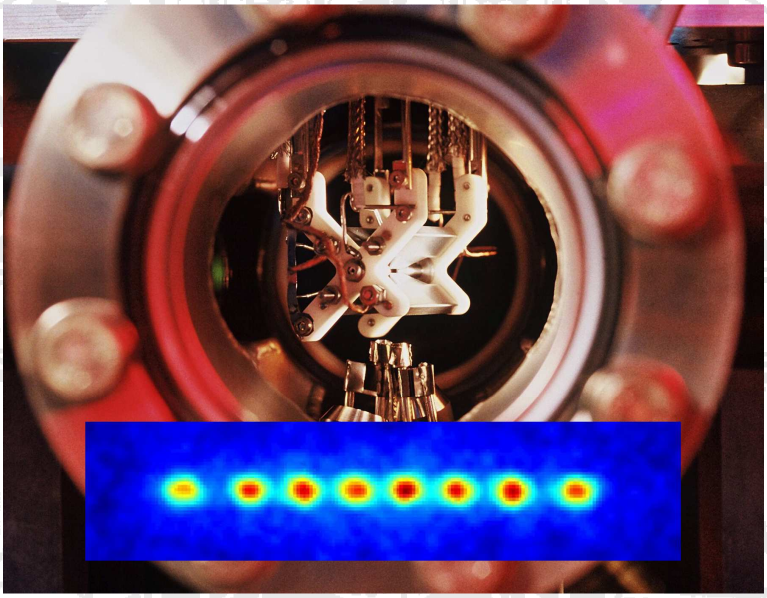

QUANTUM COMPUTER – DREAM AND REALIZATION

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Computational operations always rely on real physical processes, which are data input, data representation in a memory, data manipulation using algorithms and, finally, the data output. With conventional computers all the processes are classical processes and can be described accordingly. It is known for several years now that certain computations could be processed much more efficiently using quantum mechanical operations. Therefore, it would be desirable to build a quantum computer. This requires the implementation of quantum bits (qubits), quantum registers and quantum gates, and the development of quantum algorithms. In this talk, several techniques for the implementation of a quantum computer will be briefly reviewed. In particular, the trapped-ion approach will be highlighted in detail and experimental realizations of quantum registers and quantum gate operations using strings of trapped ions in a linear Paul trap will be discussed.

With a small ion-trap quantum computer based on up to eight trapped Ca+ ions as qubits we have generated in a pre-programmed way specific quantum states. In particular, entangled states such as Bell states, GHZ and W states, were generated deterministically using an algorithmic procedure. With a tomographic method, these states were subsequently analysed and the respective entanglement was characterized. With Bell states as a resource, entangled states were applied for teleportation and improved precision measurements.