"Optical Clocks and Quantum Logic Spectroscopy"

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During the past years, tremendous progress has been made in optical precision spectroscopy, culminating in a recent frequency ratio measurement of two optical clocks with an accuracy of 18 digits. Such measurements provide a means to test fundamental theories beyond the standard model, e.g. by probing potential temporal changes in fundamental constants.
In the first part of my talk, I will review the current status of optical clock development and discuss limitations and possible future applications of these devices. In particular, I will discuss the single aluminium ion optical clock which has been developed at NIST in Boulder, USA. Aluminium has no accessible transition for laser cooling and state detection. Therefore, a logic ion is trapped together with the clock ion to provide sympathetic cooling, state preparation and detection using quantum logic techniques. I will present pathways to improve the stability and accuracy in a new incarnation of this clock currently under development at the PTB in Braunschweig, Germany.
In the second part of my talk, I will discuss how quantum logic together with direct frequency spectroscopy can be used in a versatile spectroscopy apparatus to open the door for precision spectroscopy of a variety of previously inaccessible atomic and molecular species with interesting physical properties. We plan to perform spectroscopy on metal ions with a complicated level structure that are of interest in astrophysical searches for a possible time variation of fundamental constants.