Quantum engineering optical clocks based on multiple trapped ions

Initiative: zukunft.niedersachsen (nur ausgewählte Ausschreibungen)

Ausschreibung: Forschungskooperation Niedersachsen - Israel

Bewilligung: 26.07.2020

Laufzeit:

Optical atomic clocks are the most accurate devices currently available for timekeeping, with many applications ranging from fundamental physics to navigation. Comparisons of different types of optical clocks support the search for the elusive dark matter, which is five times more abundant than normal matter. Einstein's theory of relativity tells us that clocks near a gravitating body tick slower compared to clocks at zero gravity. This so-called red shift effect can be employed on Earth to measure height differences across very long distances, an important application in Earth monitoring and relativistic geodesy. Finally, atomic clocks are also at the heart of all satellite navigation systems, which modern society heavily relies upon. Optical clocks based on ions (i.e. charged atoms) were in the past operated with single atoms only, requiring a long time to obtain accurate timing information. In this project, it will employ techniques developed in the context of quantum information processing and quantum engineering in order to develop multi-ion clocks which will boost the performance of ion clocks. By applying oscillating electro-magnetic fields, the scientists can engineer clock reference transitions that are free of most environment-induced frequency shifts. Furthermore, they will entangle clock ions to further improve the accuracy of the clock and enhance the signal-to-noise ratio beyond the classical limit. This will pave the way for quantum-enhanced optical clocks with a performance beyond the current state-of-the art.

Projektbeteiligte

Prof. Dr. Piet Schmidt
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin (PTB)
QUEST Institute for Experimental Quantum Metrology
Braunschweig

Prof. Roee Ozeri
The Weizmann Institute of Science
Faculty of Physics
Physics of complex systems
Rehovot
Israel

Dr. Nitzan Akerman
The Weizmann Institute of Science
Physics faculty
Physics of complex systems
Rehovot
Israel