AKjDPG 4: Metrology

Time: Sunday 16:00–17:30 Location: C 03

Tutorial AKjDPG 4.1 Sun 16:00 C 03

Optical atomic clocks and applications — •Tanja Elisabeth Mehlstäubler — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany — Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany

Time and frequency are the most precise measurable quantities in physics today. Optical atomic clocks have reached relative frequency uncertainties as low as 1e-18 inside laboratories and are used in fundamental and applied research. The dependence of the atomic frequencies on the gravitational potential makes atomic clocks ideal candidates for the search for deviations in the predictions of Einstein's general relativity, tests of modern unifying theories and the development of new sensors for gravity. I will introduce the concepts of atomic clocks and present the current status of international clock development and comparison. Further on, I will discuss the status of some fundamental tests of our standard model by means of high-precision spectroscopy and future applications of time and frequency metrology. Besides a continuous improvement in stability and accuracy of today's best clocks, a large effort is put into increasing the reliability and technological readiness for out of lab measurements with compact, portable devices. In the near future, optical clocks are foreseen to contribute together with satellite missions to the precise determination of the Earth's geoid with a height resolution on the cm-level.

Tutorial AKjDPG 4.2 Sun 16:45 C 03

Quantum enhanced measurements — •Karol Gietka — University of Innssbruck

This tutorial offers an elementary and self-contained introduction to quantum-enhanced measurements, aimed at participants with a basic background in quantum mechanics. We discuss how quantum noise sets fundamental limits to measurement precision and how these limits can be overcome using genuinely quantum resources. The tutorial focuses on two representative platforms: noise squeezing in harmonic oscillators and entanglement in collective spin systems. In the first part, we introduce quadrature squeezing and show how redistributing quantum noise enables enhanced sensitivity. In the second part, we explore the role of maximally entangled spin states in precision measurements and illustrate how they lead to improved scaling beyond classical limits. Emphasis is placed on physical intuition and simple models.