SYWS 2: Fundamental Interactions and their Symmetries II

Zeit: Mittwoch 16:00–18:00 Raum: 1A/B/C

Hauptvortrag SYWS 2.1 Mi 16:00 1A/B/C

Cold and ultracold molecules - a path for fundamental studies — •Gerhard Rempe — Max-Planck Institute for Quantum Optics, Hans-Kopfermann-Str. 1, D-85748 Garching, Germany

Remarkable progress has been made in the ability to produce samples of cold and ultracold neutral molecules, homonuclear and heteronuclear, with and without permanent dipole moment, thus opening up new possibilities for precision experiments and fundamental studies. In our laboratory, we have been able to extract the slowest molecules of dipolar gases such as formaldehyde or water with near-unity efficiency from a thermal reservoir, guide the molecules over long distances and trap them, all with electric fields. We have associated ultracold rubidium molecules from ultracold atoms by means of ultranarrow Feshbach resonances, and have produced highly correlated arrays of such molecules in optical lattices. The talk reviews some of these experiments, including the realization of a universal cold molecules source operated at liquid Helium temperature, the measurement of the rotational distribution of the guided molecules, and the investigation of fundamental quantum phenomena which occur when ultracold molecules are restricted to move in zero or one spatial dimension.

Hauptvortrag SYWS 2.2 Mi 16:30 1A/B/C

The time Dependence of Fundamental Constants — •Thomas Udem — Max-Planck Institut für Quantenoptik Garching

Since Webb *et al.* [1] have detected a slightly smaller fine structure constant by quasar absorption spectra about 10 billion years ago an old idea of P.A.M. Dirac [2] from 1937 was revived. Using arguments philosophical in nature he speculated that fundamental constants should vary along with the expanding universe. For a long time the only possibility to search for these minute changes was to exploit the large look-back time of astronomical or geological observations. With the advent of frequency combs the possibility to check for these time variations in the laboratory with optical transitions in atoms, ions and molecules became readily available. Even though the time period covered by these laboratory measurements is typically 10 orders of magnitude shorter than for astronomical observations, they can be 10 orders of magnitude more accurate to provide comparable sensitivity. The question of the time dependence of fundamental constants is of high relevance in the context of modern cosmological models.

[1] J. K. Webb et al. Phys. Rev. Lett. **87**, 091301 (2001).
[2] P.A.M. Dirac Nature, **139**, 323 (1937).

Hauptvortrag SYWS 2.3 Mi 17:00 1A/B/C

Highly-charged ions for high-precision Penning trap mass spectrometry — •Szilard Nagy — Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany

This contribution will give a detailed insight into the field of high-precision mass spectrometry employing a Penning Trap Mass Spectrometer (PTMS), where the main observable is the cyclotron frequency $\nu_c = qeB/(2\pi m)$ of an ion with charge-to-mass ratio q/m trapped in a homogeneous magnetic field B. The application of ions with multiple charges in high-precision mass spectrometry yields a distinct benefit due to an increased resolution $\nu_c/\Delta\nu_c$.

Recent results will be presented mostly from the Penning trap mass spectrometer SMILETRAP with emphasis on results relevant for fundamental physics questions. Among the highlights are the most precise tritium beta decay Q-value [1], which is of importance in the search for a finite rest mass of the electron anti-neutrino; a newly evaluated ^{76}Ge double beta-decay Q-value [2] relevant in the search for neutrinoless double beta-decay ($0\nu\beta\beta$); the masses of the lithium-like and hydrogen-like ^{40}Ca ions [3], which are indispensable input values when evaluating g-factor measurements of the bound electron in these ions.

Other Penning trap facilities dedicated to highly-charged ions will be discussed such as HITRAP at GSI Darmstadt.

References

[1] Sz. Nagy *et al.*, Europhys. Lett. **74**, 404 (2006)
[2] M. Suhonen *et al.*, JINST **2**, P06003 (2007)
[3] Sz. Nagy *et al.*, Eur. Phys. J. D **39**, 1 (2006)

Hauptvortrag SYWS 2.4 Mi 17:30 1A/B/C

Determination of the neutrino mass — •Christian Weinheimer — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

The recent evidences for neutrino oscillation from atmospheric, solar, reactor and accelerator neutrinos prove, that neutrinos of different flavour are non-trivial mixtures of non-zero neutrino mass eigenstates. Oscillation experiments determine differences between squared neutrino masses, but not the masses, which are very important for particle physics as well as for cosmology and astrophysics.

Information on the absolute neutrino mass scale is obtained from astrophysical observations, from the search for the neutrinoless double beta decay and directly from the investigation of the endpoint region of the tritium or rhenium single beta decay.

The cosmological method and the status of the double beta decay experiments will be discussed. The KATRIN experiment, which is currently being set up by an international collaboration at Forschungszentrum Karlsruhe will be presented. By investigating the tritium beta decay spectrum KATRIN will improve the direct neutrino mass sensitivity by one order of magnitude to 0.2 eV allowing to distinguish between hierarchical and quasi-degenerate neutrino mass scenarios and to check the cosmological relevant neutrino mass range.