HK 73: Fundamental Symmetries II

Time: Thursday 16:00–17:45 Location: HK-H9

Group Report HK 73.1 Thu 16:00 HK-H9

Electric dipole moments of charged particles at storage rings — •Vera Shmakova for the JEDI-Collaboration — University of Ferrara, Ferrara 44100, Italy

The Standard Model (SM) of Particle Physics cannot explain the matter-antimatter asymmetry in the Universe. Therefore, the search of physics beyond the SM is required and one way to achieve it is to strive for the highest precision in the search for electric dipole moments (EDMs). Permanent EDMs of particles violate both time reversal and parity invariance and, via the CPT theorem, also the combined CP symmetry. Finding an EDM would be a strong indicator for physics beyond the SM.

Storage rings offer possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion in the ring. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, making it an ideal testing ground and starting point for the JEDI collaboration (Jülich Electric Dipole moment Investigations) for such an experimental program. The talk will present the JEDI program for the measurement of proton and deuteron EDMs and discuss recent results of the first direct (precursor) measurements of the deuteron EDM in COSY.

Group Report HK 73.2 Thu 16:30 HK-H9

Muonic X-ray measurements at the Paul Scherrer Institute — •Frederik Wauters — Johannes Gutenberg University Mainz, Germany

When negative muons are stopped in a target material, they are quickly captured and form an exotic atom. During this formation process, muonic X-rays, which can have energies up to several MeV, are emitted until the 1s orbital is reached. The muon wave function in the lower orbits has a large overlap with the nucleus, making this system an excellent laboratory to study short range interactions between the muon and the atomic nucleus such as finite size effects, nuclear capture, and possble parity odd interactions.

The muX project at the Paul Scherrer Institute is performing muonic X-ray measurements on medium and high-Z nuclei, deploying a large high-purity germanium array in combination with muon, electron and neutron detectors. A new technique was developed utilizing transfer reaction in a H2/D2 gas cell to stop a standard muon beam in a few ug of target material.

A wide physics program is focusing on atomic parity violation (APV) by measuring the the charge radius of 226Ra, which will serve as an important input for an upcoming APV experiment with Ra in a Paul trap. We are also pursuing measuring APV directly in muonic atoms in the 2s-1s transition. Furthermore, absolute nuclear charge radii measurements serve as a benchmark for laser spectroscopy, and nuclear muon capture gives access to highly excited nuclear states of interest to determine double beta-decay matrix elements.

HK 73.3 Thu 17:00 HK-H9

Status report of the Fermilab Muon g–2 experiment — •René Reimann for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

In spring 2021 the Muon g–2 collaboration published the most precise measurement of the anomalous magnetic moment of the muon, a_μ, with a 460 ppb uncertainty. The measurement principle is based on a clock comparison between the anomalous spin precession frequency of spin-polarized muons, which is the deviation of the Larmor- from the cyclotron-frequency, and a high-precision measurement of the magnetic field environment using nuclear magnetic resonance (NMR) techniques, expressed in terms of the (free) proton spin-precession frequency. The published results are based on the run 1 data. In the meantime a data set of about 12.5 the size of run 1 has been acquired through runs 2-4 and more high-quality data is currently recorded through run 5. In this talk I summarize the current status and focus on improvements and systematic studies that the Muon g–2 collaboration implemented. In particular, I discuss the magnetic field stability and characterization.

HK 73.4 Thu 17:15 HK-H9

Magnetic field measurement in the Fermilab Muon g − 2 experiment — •Hassan Qureshi for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon $g-2$ experiment aims to measure the anomalous magnetic moment of the muon, a_μ, to a precision of 140 ppb. Run 1 results were published in April 2021 with an unprecedented precision of 460 ppb. This increased the new world average deviation between the Standard Model theory prediction and the average experimental measurements to $4.2\,\sigma$. The experiment measures the muon anomalous spin precession frequency w_a and the proton spin precession frequency w_p, the ratio of which is used to calculate a_μ. The w_p value expresses the magnetic field as experienced by the circulating muons in the experiment's storage ring. The magnetic field inside the ring is measured using two nuclear magnetic resonance (NMR) probe arrays. First is an array of 378 fixed NMR probes, spread evenly around the top and bottom walls of the vacuum chambers, which continuously measures the field drift within the muon storage ring. The second array consists of a set of 17 NMR probes, mounted on a trolley, which is periodically driven around the muon storage cavity to measure its spatial distribution of the field. In this talk I will discuss the method for tying together data from the two NMR probe arrays in time, in order to interpolate the magnetic field as experienced by muons during their storage time. Furthermore, I will discuss plans to streamline the tying procedure for Run 2 and 3 while improving the w_p uncertainty compared to Run 1.

HK 73.5 Thu 17:30 HK-H9

Electromagnetic interactions as the source of all known forces. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

Older physical theoretical models represent the space as filled with a substance (ether) where subatomic particles (SPs) are submerged. Newer models represent the space as empty and forces between SPs are explained with the exchange of fictitious carrier particles. In both type of models, the space is composed of SPs and of a fictitious substance or of fictitious carriers. An approach is presented where the space is filled with Fundamental Particles (FPs) with longitudinal and transversal angular momenta, FPs that move with light or infinite speed. The different types of SPs are formed by different configurations of FPs; fermions are focal-points of rays of FPs with aligned angular momenta, photons are rays of FPs with alternating opposed angular momenta, and neutrinos are pairs of FPs with opposed angular momenta. FPs are the constituents of all subatomic particles. Forces between subatomic particles are the product of the interactions (scalar and vector product) of the angular momenta of their FPs. Neither fictitious substances nor fictitious carriers are required. All forces are due to electromagnetic interactions and are described by QED. An important finding of the approach is that the interaction between two charged SPs tends to zero for the distance between them tending to zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. More at: www.odomann.com