HK 51: Fundamental Symmetries

Time: Wednesday 14:00–16:00 Location: H-ZO 70

Invited Group Report HK 51.1 We 14:00 H-ZO 70

Antihydrogen — •Jochen Walz for the ATRAP-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz

Future precision experiments with trapped cold antihydrogen promise to provide extremely stringent tests of the fundamental CPT symmetry in the hadron as well as in the lepton sector. Ultrahigh-resolution Doppler-free two-photon laser-spectroscopy of ordinary hydrogen and antihydrogen might be used to compare matter and antimatter at unprecedented levels of experimental accuracy. In addition, there is the fascinating prospect to directly observe the gravitational force on antimatter, because antihydrogen is a pure antimatter system which is both stable and electrically neutral.

Current antihydrogen experiments use the Antiproton Decelerator (AD) at CERN and this talk will review the status of the ATRAP experiment. An exciting new horizon is FLAIR, the Facility for Low-energy Antiproton and Ion Research. This is a next-generation low-energy antiproton source that will make use of the high flux of antiprotons at the upcoming international FAIR research center near GSI/Darmstadt.

HK 51.2 We 14:30 H-ZO 70

Anti-hydrogen Experiments at ATRAP — •Dieter Grzonka, Matthew George, Walter Oelert, Thomas Sefzick, and Marcin Zielinski for the ATRAP-Collaboration — Forschungszentrum Jülich, IKP, 52425 Jülich, Germany

The ATRAP experiment at the anti-proton decelerator of CERN aims for a precise test of CPT invariance by comparative spectroscopic studies of hydrogen and anti-hydrogen atoms. The trapping of neutral anti-hydrogen atoms is the prerequisite to achieve the required precision in these studies.

Anti-hydrogen is produced in a nested Penning-trap for positrons and anti-protons which is located within a magnetic gradient field for the trapping of anti-hydrogen. Since the trap depth is less than 1K, cold anti-hydrogen has to be produced in its ground state for a high trapping efficiency. With an improved apparatus - including a 1 K pot and an additional solenoid - anti-hydrogen production techniques are studied presently, which should result in low temperature anti-hydrogen.

The status of the experiment and further steps towards the precision spectroscopy will be outlined.

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HK 51.3 We 14:45 H-ZO 70

Test der Lorentzinvarinz mit Hilfe eines ^{3}He / ^{129}Xe Komagnetometers — •Kathlynne Tullney[1], Claudia Gemmel[1], Stefan Baessler[3], Martin Burghoff[2], Werner Heil[1], Wolfgang Kilian[2], Allard Schnabel[2], Frank Seifert[2], Yuri Sobolev[1], Lutz Thrams[2] und Christian Ludwig[1] — [1]Universität Mainz — [2]PTB-Berlin — [3]University of Virginia

Die Standard Modell Erweiterung (SME) beinhaltet Lorentz- und CPT verletzende Terme, die in Präzissionsexperimenten bei niedrigen Energien im Prinzip nachgewiesen werden können, z. B. durch Messung der periodischen Variation der Larmorfrequenz eines polarisierten Gases während eines siderischen Tages.

Wir verwenden zwei spinpolarisierte Gase (^{3}He / ^{129}Xe), die sich zur Eliminierung des Zeeman-Terms im gleichen Volumen befinden, so dass man nicht mehr auf Magnetfeldschwankungen empfindlich ist. Gemessen wird deren freie Spinpräzessionsfrequenz um ein homogenes Magnetfeld von ca. 400 nT, wozu LTc SQUID Detektoren verwendet werden mit einer Sensitivität von ca. 2 $\frac{fT}{\sqrt{Hz}}$. Die Apparatur befindet sich in einem magnetisch abgeschirmten Raum der PTB in Berlin. Um nach solch kleinen Effekten zu suchen bzw. eine neue Obergrenze angeben zu können, werden lange transversale Relaxationszeiten T_2 >10h und ein gutes Signal-zu-Rausch Verhältnis (SNR > $\frac{1000}{1}$) benötigt.

In diesem Vortrag werden die neuesten Ergebnisse präsentiert, Verbesserungen vorgestellt und die Empfindlichkeit unserer Messmethode mit anderen Messmethoden verglichen, etwa dem ^{3}He/^{129}Xe Maser-experiment der Gruppe von Ronald Walsworth.

HK 51.4 We 15:00 H-ZO 70

Electromagnetic corrections in $\eta \to 3\pi$ decays — •Christoph Ditsche[1], Bastian Kubis[1], and Ulf-G. Meissner[1,2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie) and Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany — [2]Institut für Kernphysik (Theorie) and Jülich Center for Hadron Physics, Forschungszentrum Jülich, D-52425 Jülich, Germany

We re-evaluate the electromagnetic corrections to $\eta \to 3\pi$ decays at next-to-leading order in the chiral expansion, arguing that effects of order $e^2(m_u - m_d)$ disregarded so far are not negligible compared to other contributions of order e^2 times a light quark mass. Despite the appearance of the Coulomb pole in $\eta \to \pi^+\pi^-\pi^0$ and cusps in $\eta \to 3\pi^0$, the overall corrections remain small.

HK 51.5 We 15:15 H-ZO 70

Results on the analysis of the $\eta \to 3\pi^\circ$ decay with WASA-at-COSY. — •Peter Vlasov for the WASA-at-COSY-Collaboration — Institut für Kernphysik and Jülich Center for Hadron Physics, Forschungszentrum Jülich, D-52425 Jülich, Germany

During the first production run of the WASA experiment at the COSY storage ring the $\eta \to 3\pi^\circ$ decay has been measured in proton-proton interactions at an excess energy of Q = 56 MeV. The goal of the experiment is the measurement of the $3\pi^\circ$ Dalitz plot density distribution which allows a precise test of chiral perturbation theory calculations.

The decay system was tagged by the WASA forward detector using the recoil protons. The η decay was reconstructed in the central detector by the subsequent $\pi^\circ \to \gamma\gamma$ decays. A kinematic fit with constraints was applied in order to optimally use the measured information. The constraints used in the fit are the masses of the subsequently decayed pions, as well as the mass of final state particles of in the eta-meson decay system.

We report on the final results of the analysis.

Supported by BMBF and Wallenberg Foundation.

HK 51.6 We 15:30 H-ZO 70

A Precision Measurement of the Hyperfine Structure of Antiprotonic Helium — •Thomas Pask[1], Daniel Barna[2], Andreas Dax[2], Sussane Friedreich[1], Ryugo Hayano[2], Masaki Hori[3], Dezso Horvath[4,5], Bertalan Juhasz[1], Johann Marton[1], Oswald Massiczek[1], Naoya Ono[2], Anna Soter[3,4], Eberhard Widmann[1], and Johann Zmeskal[1] — [1]Stefan-Meyer-Institut für subatomare Physik Boltzmanngasse 3, 1090 Vienna, Austria — [2]Department of Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan — [3]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Strasse 1, D-85748 Garching, Germany — [4]Institute of Nuclear Research of the Hungarian Academy of Sciences, H-4001 Debrecen,PO Box 51, Hungary. — [5]Institute of Nuclear Research of the Hungarian Academy of Sciences, H-4001 Debrecen,PO Box 51, Hungary.

A precise measurement of the Antiprotonic helium *hyperfine structure* has been completed.

Due to its long life time this unique particle provides an ideal subject to test three-body Quantum Electrodynamic (QED) calculations and CPT theory. The new results yield a factor of 10 improvement over our previous measurements and, through comparison with theory, can be used to determine a new value for the spin magnetic moment of the antiproton.

HK 51.7 We 15:45 H-ZO 70

Studies of the rare eta-meson decay $\eta \to \pi^0 + e^+ + e^-$ at WASA-at-COSY — •Alexander Winnemöller, Alfons Khoukaz, Florian Bergmann, Annika Passfeld, and Tobias Rausmann — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 9, D-48149 Münster, Germany

One main focus of the experimental program of the WASA-at-COSY facility is the investigation of symmetries and symmetry breakings to get a better understanding of the strong interaction physics. Since violations of conservation laws are directly connected to symmetry breaking effects, studies of rare meson decays are of high importance. In this connection the η-meson is of paticular interest. Precision measurements of rare η decays can be used to get new limits on the breaking of the fundamental C, P, and T symmetries, or combinations thereof.

In this contribution we will present and discuss studies of the C-violating η decay $\eta \to \pi^0 + e^+ + e^-$ using the WASA-at-COSY facility.

The dominant C conserving contribution to the decay is via $\pi^0+\gamma^*+\gamma^*$ intermediate state with an expected branching ratio of approximately 10^{-8}. An observation of a significantly higher branching ratio would, therefore, be an indication of a C violation. The status of the analysis will be presented and discussed.

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