HK 25: Hadron Structure and Spectroscopy IV

Zeit: Dienstag 16:30–18:30 Raum: HS 13

Gruppenbericht HK 25.1 Di 16:30 HS 13

A New QCD Facility at the M2 beamline of CERN SPS — •Jan Friedrich for the COMPASS-Collaboration — Physik-Department, Technische Universität München

In view of completing the current physics programme of the COMPASS collaboration in 2021, ideas are shaped up for future measurements in the context of QCD with a refurbished and upgraded detector in the same experimental hall at the M2 beamline of the CERN SPS with 100–200˜GeV beam energies. They range from high-energy elastic muon scattering for a proton radius measurement, with rather modest changes to the COMPASS setup, to upgrading the beamline with a radiofrequency separation of the hadron beam components, allowing e.g. for a strongly enriched kaon beam. This will allow measurements of the kaon parton distributions via the Drell-Yan process, and the kaonic excitation spectrum through diffractive dissociation. Further ideas, amongst others, concern measurements of antiproton production cross-sections, as of interest for Dark Matter Search, hadron spectroscopy with annihilation processes initiated by the antiproton beam component, and hard exclusive reactions using a muon beam on a transversely polarised target. Status and timelines of the project will be discussed.

HK 25.2 Di 17:00 HS 13

News from the "proton radius puzzle" — •Randolf Pohl for the CREMA-Collaboration — JGU Mainz, Germany

For more than eight years now, the "proton radius puzzle" has let us dream about new physics: Our measurements of muonic hydrogen and muonic deuterium, performed in the CREMA Collaboration at PSI, yielded a proton radius which is more than five standard deviations smaller than the CODATA world average from measurements using electrons, namely precision spectroscopy of atomic hydrogen and deuterium, and elastic electron scattering.

A wealth of new experiments has been fueled by this exciting discrepancy, and the first results are now coming in. I will report on several new measurements in atomic hydrogen we have performed at MPQ Garching. These, together with new hydrogen measurements from LKB Paris and York U. Toronto and new elastic electron scattering data from the PRad experiment at Jefferson Lab start to paint a clearer picture on the "proton radius puzzle", albeit not without raising new questions.

HK 25.3 Di 17:15 HS 13

High-precision Measurement of the Proton Radius with TPC — •Vahe Sokhoyan for the A2-Collaboration — Universität Mainz, Institut für Kernphysik

The so-called "proton radius puzzle" originated due to a striking discrepancy between the electric charge radius of the proton, extracted from the muonic hydrogen Lamb shift, compared to the CODATA value, based on electron-proton scattering experiments as well as most of the atomic transition measurements in electronic hydrogen. To address this puzzle, a high-precision measurement of the differential *ep* scattering cross section in the region of low momentum transfer ($0.002\ \mathrm{GeV}^2 \leq Q^2 \leq 0.04\ \mathrm{GeV}^2$) will be performed at the Mainz Microtron (MAMI). The experimental setup consisting of a Hydrogen Time Projection Chamber and Forward Tracking System will allow us to measure the energy as well as the angle of the recoil proton in combination with the angle of the forward scattered electron. This is a completely new approach for the extraction of the proton radius, compared to previous low-Q^2 scattering experiments. Moreover, the construction of the Time Projection Chamber and Forward Tracking System will open avenue for various experiments using deuterium and helium targets with a detection of recoil particles in the final state. In this talk, the current status of this project and the future plans will be presented.

HK 25.4 Di 17:30 HS 13

Proton Radius in High-Energy Muon Scattering — •Christian Dreisbach[1], Jan Friedrich[1], Martin Hoffmann[2], Alexander Inglessi[3], Eva Kabuss[4], Bernhard Ketzer[2], Oleg Kiselev[6], Evgeny Maev[3], Stephan Paul[1], Sebastian Uhl[1], Benjamin Veit[5,6], and the COMPASS Collaboration[5] — [1]Technische Universität München, Physik-Department, Garching, Germany — [2]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [3]Petersburg Nuclear Physics Institute (PNPI), Gatchina, Russia — [4]Universität Mainz, Institut für Kernphysik, Mainz, Germany — [5]CERN, 1211 Geneva 23, Switzerland — [6]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic-scattering and laser-spectroscopy measurements of the proton radius have been performed with contradicting results, the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN*s Super Proton Synchrotron in the year 2022. A high-precision measurement at low Q^2 realized with a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. In the year 2018, a test measurement with silicon tracking detectors upstream and downstream of a prototype TPC was performed to study the feasibility employing both detector systems. We present results of the on-going analysis and discuss ideas for a possible setup in 2022.

HK 25.5 Di 17:45 HS 13

Investigations of muon-proton elastic scattering to measure the proton charge radius — •Martin Hoffmann[1], Christian Dreisbach[2], Jan Friedrich[2], Alexander Inglessi[3], Eva Kabuss[4], Bernhard Ketzer[1], Oleg Kiselev[5], Evgeny Maev[3], Stephan Paul[2], Sebastian Uhl[2], and Benjamin Veit[5] for the COMPASS-Collaboration — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]Technische Universität München, Physik-Department, Garching, Germany — [3]Petersburg Nuclear Physics Institute (PNPI), Gatchina, Russia — [4]Universität Mainz, Institut für Kernphysik, Mainz, Germany — [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The proton radius puzzle is an exciting problem in particle physics. To help solving it, the COMPASS collaboration plans to conduct a measurement of the proton electric form factor at very small values of the squared momentum transfer using high-energy muons scattered in a high-pressure hydrogen TPC (Time Projection Chamber). In the year 2018 a first proof-of-principle experiment was performed at the COMPASS beam line using a prototype TPC and eight double-sided silicon detectors. The talk will focus on the analysis of the TPC data and of the combined data of both detector systems. Correlations between parameters measured in the TPC and in the tracking system will be discussed. The resolutions achieved with the present setup will be presented. They will be used together with ongoing Monte-Carlo studies to define the final setup for the measurement.

Supported by BMBF.

HK 25.6 Di 18:00 HS 13

Status of the analysis for the search of polarization in the antiproton production process — •Dominika Alfs, Dieter Grzonka, and James Ritman — Institut für Kernphysik, Forschungszentrum Jülich, Germany

The goal of the P-349 experiment is to measure the polarization of antiprotons produced in pA collisions. Experimentally this is done by the measurement of the left-right asymmetry of elastic antiproton scattering on a liquid hydrogen target in the Coulomb-nuclear interference region.

According to preliminary calculations, the maximum of the analyzing power A_y, equal to about -4.5%, is reached for a four-momentum transfer $|t| \simeq 0.003$ GeV/c which corresponds to a scattering angle in the laboratory frame in the range of 10 - 20 mrad. Therefore, the required track reconstruction precision expected to be sufficient for the asymmetry determination is equal to about 1 mrad.

The experiment was performed in the PS test beam East Area at CERN in 2014, 2015 and in 2018 with an improved detector setup. The data analysis is ongoing. Currently, the main goals are reaching the desired track reconstruction precision and elimination of the dominant pionic background.

In this contribution the current status of the analysis will be presented with a focus on track identification and reconstruction and Monte Carlo supported particle identification with DIRC.

HK 25.7 Di 18:15 HS 13

Studies on deuteron-proton collisions at the magnetic spectrometer ANKE — •Christopher Fritzsch and Alfons Khoukaz for the ANKE Collaboration — Westfälische Wilhelms-Universität, Münster, Germany

Total and differential cross sections of the reaction $d+p \to {}^3\mathrm{He}+\eta$ are of special interest since they differ strongly from a pure phase space behavior near threshold. The asymmetry factor α of the differential cross sections show a distinct effect of an s- and p-wave interference, caused by a rapid variation of the relative phase. These observations are an indication for an unexpected strong final state interaction between the ${}^3\mathrm{He}$ nuclei and the η mesons which could lead to a quasi bound state of the ${}^3\mathrm{He}\eta$ system. Current investigations using high precision data of the internal fixed target experiment ANKE of the storage ring COSY allow the extraction of total and differential cross sections for the η production up to an excess energy of $Q = 15\,\mathrm{MeV}$. Additionally, new differential cross sections of the reaction $d + p \to {}^3\mathrm{He} + \pi^0$ were determined for the forward hemisphere, covering a range where no differential cross sections are available so far. Both the η meson and π^0 production were normalized absolutely by using the dp elastic scattering. Here, also new differential cross sections of high precision were determined to enrich the existing data base. Recent results will be presented and discussed.

*This work has been supported by the COSY-FFE program of the FZJ and the DFG through the Research Training Group "GRK 2149: Strong and Weak Interactions - from Hadrons to Dark Matter".