HK 8: Hadron Structure and Spectroscopy 1

Time: Monday 14:30–16:15 Location: T/SR19

Group Report HK 8.1 Mon 14:30 T/SR19

Compton Scattering Asymmetries at MAMI to Extract Proton Polarizabilities — •Philippe Martel — Institut für Kernphysik, Universität Mainz, Mainz, Germany — Department of Physics, Mount Allison University, Sackville, Canada

The internal structure of the proton is described by various fundamental quantities such as the mass, charge, and anomalous magnetic moment. The proton scalar and spin polarizabilities appear at second and third order, respectively, in the energy expansion of the Compton scattering amplitude. While the scalar polarizabilities have previously been determined, albeit with large uncertainties, the spin polarizabilities have only been extracted in various linear combinations.

A Compton scattering program in the A2 Collaboration at MAMI has sought to extract these fundamental quantities through measurements of the beam asymmetry, Σ_3, below either π^0 or $2\pi^0$ production threshold, and two beam-target asymmetries, Σ_{2x} and Σ_{2z}, also below $2\pi^0$ production threshold. All of the experiments made use of the Crystal Ball and TAPS detectors, while Σ_3 used a liquid hydrogen target and both Σ_{2x} and Σ_{2z} used a frozen-spin butanol target. The current results of these experiments as well as future plans will be discussed in this talk.

HK 8.2 Mon 15:00 T/SR19

Measurement of the Proton Scalar Polarizabilities at MAMI — •Vahe Sokhoyan for the A2-Collaboration — Institut für Kernphysik, Universität Mainz

The scalar polarizabilities α_{E1} and β_{M1} are fundamental properties related to the internal dynamics of the nucleon. They play a crucial role not only in our understanding of the nucleon, but also in other areas such as precision atomic physics and astrophysics. At the MAMI accelerator facility in Mainz, the proton polarizabilities were measured using a linearly polarized photon beam below pion photopoproduction threshold. The photons impinged on a liquid Hydrogen target and the reaction products were detected in the Crystal Ball and TAPS 4π spectrometer setup. The beam asymmetry Σ_3 was measured for the first time below pion threshold. In this talk the results on the beam asymmetry Σ_3, their significance and influence on the extraction of the scalar polarizabilities will be discussed.

HK 8.3 Mon 15:15 T/SR19

update on Kramers-Kronig relation for proton — •Oleksii Gryniuk[1,2], Franziska Hagelstein[1], and Vladimir Pascalutsa[1] — [1]JGU, Mainz, Germany — [2]KNU, Kyiv, Ukraine

New evaluation of the Baldin sum rule and forward Compton scattering amplitude, as well as higher order sum rules, was made with updated data for proton total photoabsorption cross-section. Stability of resulting values, comparison to previous evaluations and consequences of results for higher order sum rules are discussed.

HK 8.4 Mon 15:30 T/SR19

Feasibility studies of time-like proton electromagnetic form factors at PANDA-FAIR — •Alaa Dbeyssi[1], Luigi Capozza[1], Malte Deiseroth[1], Bertold Froehlich[1], Dmitry Khaneft[1], Frank Maas[1,2,3], Dominique Marchand[4], Maria Carmen Mora Espi[1], Oliver Noll[1], David Rodriguez Pineiro[1], Egle Tomasi-Gustafsson[4], Roserio Valente[1], Ying Wang[4], Manuel Zambrana[1], and Iris Zimmerman[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany — [4]Institut de Physique Nucléaire, Orsay, France

Electromagnetic form factors are fundamental quantities which describe the intrinsic electric and magnetic distributions of hadrons. Time-like proton form factors are experimentally accessible through the annihilation processes $\bar{p} + p \leftrightarrow e^+ + e^-$. Their measurement in the time-like region had been limited by the low statistics achieved by the experiments. This contribution reports on the results of Monte Carlo simulations for future measurements of electromagnetic proton form factors at PANDA (antiProton ANnihilation at DArmstadt). In frame of the PANDARoot software, the statistical precision at which the proton form factors will be determined is estimated. The signal ($\bar{p}+p \to e^+ + e^-$) identification and the suppression of the main background process ($\bar{p}+p \to \pi^+ + \pi^-$) are studied. Different methods have been used and/or developed to generate and analyse the processes of interest. The results show that time-like proton form factors will be measured at PANDA with unprecedented statistical accuracy.

HK 8.5 Mon 15:45 T/SR19

Feasibility studies for the measurement of the time-like electromagnetic form factors of the proton in reactions of $\bar{p}p \to \mu^+\mu^-$ at the PANDA-experiment at FAIR. — •Iris Zimmermann, Alaa Dbeyssi, Dmitry Khaneft, Frank Maas, Manuel Zambrana, Maria Carmen Mora Espi, Cristina Morales Morales, Dexu Lin, Bertold Fröhlich, Luigi Capozza, Oliver Noll, Malte Deiseroth, Samer Ahmed, Heybat Ahmadi, Roserio Valente, and David Rodriguez Pineiro for the PANDA-Collaboration — Helmholtz-Institut Mainz / GSI Darmstadt

The measurement of the time-like electromagnetic form factors (TL em FF), G_E and G_M, using reactions of $\bar{p}p \to l^+l^-$ (l=e,μ) gives access to the structure of the proton. It will be the first time measurement of TL em FF of the proton accessing the muons in the final state. One advantage of using this channel is that radiative corrections due to final state radiation are suppressed by the heavy mass of the muon. Measuring $\bar{p}p \to \mu^+\mu^-$ will also serve as a consistency check of the TL em FF data from $\bar{p}p \to e^+e^-$. Feasibility studies for the individual extraction of G_E and G_M out of the measured angular distribution are in progress for the muonic channel using the software package PANDARoot. Due to the strong hadronic background, mainly reactions of $\bar{p}p \to \pi^+\pi^-$, a very good signal-to-background separation is needed. For the analysis of both signal and background channel different multivariate classification methods are used. The current status of the studies will be presented.

HK 8.6 Mon 16:00 T/SR19

Two-photon exchange corrections in elastic lepton-proton scattering — •Oleksandr Tomalak and Marc Vanderhaeghen — Johannes Gutenberg Universität Mainz, Germany

The measured value of the proton charge radius from the Lamb shift of energy levels in muonic hydrogen is in strong contradiction, by 7-8 standard deviations, with the value obtained from electronic hydrogen spectroscopy and the value extracted from unpolarized electron-proton scattering data. The dominant unaccounted higher order contribution in scattering experiments corresponds to the two photon exchange (TPE) diagram. The elastic contribution to the TPE correction was studied with the fixed momentum transfer dispersion relations and compared to the hadronic model with off-shell photon-nucleon vertices. A dispersion relation formalism with one subtraction was proposed. Theoretical predictions of the TPE elastic contribution to the unpolarized elastic electron-proton scattering and polarization transfer observables in the low momentum transfer region were made. The TPE formalism was generalized to the case of massive leptons and the elastic contribution was evaluated for the kinematics of upcoming muon-proton scattering experiment (MUSE).