HK 27: Hadron Structure and Spectroscopy 5

Time: Tuesday 14:30–16:30 Location: T/SR19

Group Report HK 27.1 Tue 14:30 T/SR19

Open-charm Physics Opportunities at PANDA — •Elisabetta Prencipe[1], Lu Cao[1], Andreas Herten[1], James Ritman[1], Donghee Kang[2], and Andreas Pitka[3] for the PANDA-Collaboration — [1]IKP - Forschungszentrum Juelich — [2]Johannes Gutenberg Universität Mainz — [3]Justus-Liebig Universität Giessen

Open-charm physics is of high interest for the weak and the strong interactions. New observations in spectroscopy and the recent constraining limits on CP violation in the D sector strongly motivate the study of open-charm physics. The experiment $\overline{\text{P}}$ANDA at FAIR (Darmstadt) will investigate fundamental questions of hadron and nuclear physics in interactions of antiprotons with nucleons and nuclei. Among other topics, original contributions are planned from $\overline{\text{P}}$ANDA in the open-charm sector. With high average reaction rates up to $2{\cdot}10^7$ interactions/s, and a factor 20 higher mass resolution than attained at B-factories, $\overline{\text{P}}$ANDA is in a privileged position to perform measurements of widths of narrow states, such as the $D_s(2317)^+$ and the $D_s(2460)^+$, and form factors in semileptonic D_s decays. Very rare processes (e.g. $D^0 \to \gamma\gamma$) can be accessible with unprecedented accuracy. In addition, the search for new physics is a challenge that $\overline{\text{P}}$ANDA can take, for example with the study of the mixing in the D sector, analyzing the channel $\bar{p}p \to \psi(3770) \to \overline{D^0}D^0$. $\overline{\text{P}}$ANDA is expected to be decisive to answer on these and second-order open questions. A general overview of the benchmark channels in the D sector with $\overline{\text{P}}$ANDA is given in this report, showing the results of recent PandaRoot simulations.

HK 27.2 Tue 15:00 T/SR19

Lebensdauermessung neutraler D-Mesonen als Benchmark der Vertexrekonstruktion bei $\overline{\text{P}}$ANDA* — •Andreas Pitka und Kai-Thomas Brinkmann für die PANDA-Kollaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen

Eines der Hauptziele des zukünftigen $\overline{\text{P}}$ANDA Experimentes ist das Studium von D-Mesonen. Die Separation von hadronischen Untergrundkanälen und die Messung von CP-Verletzung in D^0–$\bar{D}^0$-Mischung über eine zeitabhängige Analyse der Zerfallsrate erfordert hierzu zwingend eine akkurate Bestimmung der nur wenige $100\,\mu$m langen Zerfallsstrecke der D-Mesonen innerhalb des Detektors. Im Rahmen einer Simulationsstudie innerhalb des PandaRoot-Frameworks wird exemplarisch anhand des Zerfalls $\bar{p}p \to D^0\bar{D}^0 \to \left(K_S\pi^+\pi^-\right)\left(K^+\pi^-\right)$ eine Abschätzung der zu erwartenden Orts- und Zerfallszeitauflösung vorgenommen und diese effektiv parametrisiert. Als Benchmark für die zu erwartende Leistungsfähigkeit des Mikro-Vertex-Detektors kann aus der rekonstruierten Verteilung der Lebensdauern durch einen Fit die mittlere D^0-Lebensdauer bestimmt werden, zudem wird die Auflösung der zur Messung von D^0–$\bar{D}^0$-Mischung ausschlaggebenden Zerfallszeitdifferenz zwischen D^0- und $\bar{D}^0$-Zerfall abgeschätzt.

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HK 27.3 Tue 15:15 T/SR19

simulation of D_s semileptonic decay with the PANDA detector — •Lu Cao[1] and James Ritman[1,2] for the PANDA-Collaboration — [1]Forschungszentrum Jülich GmbH — [2]Ruhr-Universität Bochum

The PANDA experiment will study a wide range of physics topics with beams of antiprotons incident on fixed proton or complex nuclei targets. One of the interesting issues is the D_s semileptonic decay, which is governed by both the weak and strong forces. Here the strong interaction effects can be parameterized by the transition form factor. Techniques such as lattice QCD offer increasingly precise calculations, but as the uncertainties shrink, experimental validation of the results becomes increasingly important. The achievable performance of the full PANDA detector for these types of reactions has not yet been studied in detail; however, this is expected to work very well based upon the design performance and experience with similar detector systems.

We evaluate the performance in the measurement of the semileptonic decay form factor of $D_s^+ \to \eta e^+ \nu_e$. The kinematics of the neutrino have been reconstructed with a complete simulation model of the detector and reconstruction tools. In the reconstruction procedure, we focus on developing the software and evaluating the expected precision. This talk summarizes the simulation and reconstruction status of the D_s decay chain. With theoretical predictions of the cross section, we obtain a preliminary estimate of the expected count rate for the future data taking.

HK 27.4 Tue 15:30 T/SR19

Feasibility study on the open charm rare decay at PANDA — •Donghee Kang[1] and Achim Denig[2] for the PANDA-Collaboration — [1]Helmholtz Institut Mainz, Universität Mainz, Germany — [2]Institut für Kernphysik, Universität Mainz, Germany

In the Standard Model (SM), Flavor Changing Neutral Currents (FCNC) are forbidden at the tree level and highly suppressed at the loop level by the GIM mechanism. Studies of such FCNC decay processes provide a sensitive probe of New Physics (NP) beyond the SM. Some of the SM extensions predict that the branching ratios of FCNC decays can be significantly enhanced by NP sources. We investigate the potential of rare charm decays to constrain the extension of the SM. A search for the FCNC decays of neutral D^0 into two photons and two leptons or including radiative photon could be an opportunity to pursue with PANDA since electroweak channels involving photons in the final state are competitive with ongoing experiments. The event selection in the the environment of hadronic reactions is challenging, since the ratio between signal and background of about 10 orders of magnitude requires an effective background rejection. Results on the rare decay modes $D^0 \to \gamma\gamma$ and $D^0 \to \mu^+\mu^-(\gamma)$ will be presented, which were obtained using Monte Carlo simulations of the PANDA experiment. In this presentation, we will perform an evaluation of upper limits of branching ratios incorporating previous experiments in sensitivity.

HK 27.5 Tue 15:45 T/SR19

Test of the $X(3872)$ molecular hypothesis in $\bar{p}A$ collisions — •Alexei Larionov[1,2], Mark Strikman[3], and Marcus Bleicher[1,4] — [1]Frankfurt Institute for Advanced Studies (FIAS), D-60438 Frankfurt am Main, Germany — [2]National Research Center "Kurchatov Institute", 123182 Moscow, Russia — [3]Pennsylvania State University, University Park, PA 16802, USA — [4]Institut für Theoretische Physik, J.W. Goethe-Universität, D-60438 Frankfurt am Main, Germany

The mass of the exotic $c\bar{c}$ state $X(3872)$ deviates by less than 1 MeV from the $D^0\bar{D}^{*0}$ threshold. It is thus possible that the $X(3872)$ state is the meson molecule with dominating $D^0\bar{D}^{*0} + \bar{D}^0D^{*0}$ content. Up to now, however, only indirect tests of this hypothesis have been proposed by measuring the $X(3872)$ radiative and isospin-violating decays. Unfortunately, the decay rates are very sensitive to the model details even within the fixed, e.g. charmonium or molecular model setups, (c.f. [1,2] and refs. therein). We show that the $X(3872)$-mediated $\bar{D}^*$ or D production in the antiproton-nucleus reactions results in the narrow light-cone momentum fraction distributions at small transverse momenta. This can serve as an unambiguous test of the molecular picture of the $X(3872)$-state, similar to the deuteron structure tests by neutron stripping reaction at high energies. Thus, we propose to test the molecular hypothesis of the $X(3872)$-structure at PANDA by searching for the D, $\bar{D}^*$ stripping production off nuclear targets

[1] E.S. Swanson, Phys. Lett. B **598**, 197 (2004).
[2] F. Aceti, R. Molina, and E. Oset, Phys. Rev. D **86**, 113007 (2012).
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HK 27.6 Tue 16:00 T/SR19

Light quark mass dependence and finite volume effects for the X(3872) in an effective field theory — •Maximilian Jansen[1], Hans-Werner Hammer[1,2], and Yu Jia[3,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [3]Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China — [4]Theoretical Physics Center for Science Facilities, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

The quark mass and volume dependence of hadrons are an important input for lattice calculations. We investigate the light quark mass dependence of the binding energy of the $X(3872)$ and the $\bar{D}^0D^{*0}$ scattering length in the $C = +1$ channel to next-to-leading order in an effective field theory for the X (XEFT) where pion interactions are perturbative. At this order, the quark mass dependence is determined by

a quark mass-dependent contact interaction in addition to the one-pion exchange. Using naturalness arguments to constrain unknown parameters, we find a moderate sensitivity of the binding energy for quark masses up to twice the physical value while the scattering length is more sensitive. Recent simulations for the X are performed on lattices with spatial box lengths being small compared to the typical length scale of the $\bar{D}^0 D^{*0}$ system. Finite volume corrections are hence essential in order to make reliable predictions for observables of the X. We present our preliminary results for the shift of the the binding energy of the X in a finite volume.

HK 27.7 Tue 16:15 T/SR19

Towards understanding the near-threshold antiproton-proton spectra from J/ψ and ψ' decays by the final-state interaction effects — •Xianwei Kang[1], Johann Haidenbauer[1], and Ulf-G. Meissner[1,2] — [1]Institute for Advanced Simulation and Jülich Center for Hadron Physics, Institute für Kernphysik, Foschungszentrum Jülich,Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics,Universität Bonn

Utilzing the Jost-function approach, we analyze all the existing data for $p\bar{p}$ spectrum up to excess energy of 100 MeV from J/ψ, ψ' decays to γ, π, η or $\omega p\bar{p}$. For the potential used in this analysis, both the chiral potential constructed by us previously and the Jülich model A(OBE) have been considered. We have shown that the near-threshold spectrum can be described by our treatment of the final state interaction effect.