

## HK 24: Hadronenstruktur und -spektroskopie VI

Time: Tuesday 16:30–19:00

Location: C-2

**Group Report**

HK 24.1 Tue 16:30 C-2

**The ABC Effect in the Double-Pionic Fusion to Light Nuclei - Do We Observe a Resonance Phenomenon?\*** — ●ANNETTE PRICKING for the WASA-at-COSY-Collaboration — Physikalisches Institut, Univ. Tübingen

The ABC effect – an intriguing low-mass enhancement in the  $\pi\pi$  invariant mass spectrum – is known from inclusive measurements of two-pion production in nuclear fusion reactions to the few-body systems d,  $^3\text{He}$  and  $^4\text{He}$ . Its explanation has been a puzzle now for 50 years.

In an effort to solve this long-standing problem by exclusive and kinematically complete high-statistics experiments, we have measured the fusion reactions to d,  $^3\text{He}$  and  $^4\text{He}$  with WASA at COSY. These measurements cover the full energy region, where the ABC effect has been observed previously in inclusive reactions.

As a result we find in all cases a huge low-mass enhancement in the  $\pi\pi$ -invariant mass in agreement with previous measurements. However, we do not observe a pronounced high-mass enhancement, which is seen in the inclusive data and predicted in conventional  $\Delta\Delta$  calculations.

Most intriguing is our experimental finding of a resonance-like energy dependence of the total cross section in the ABC region. From the angular distributions for the basic fusion reaction to the deuteron we infer  $I(J^P) = 0(3^+)$  for this structure with a width of only 70 MeV. From the fusion reactions to the He-isotopes we infer that this structure is apparently robust enough to survive even in nuclei. Model calculations for this scenario are in agreement with the data.

\* supported by BMBF, COSY-FFE, DFG (Eur. Graduate School)

HK 24.2 Tue 17:00 C-2

**Precision measurement of the  $\eta$ -meson mass at ANKE-COSY** — ●PAUL GOSLAWSKI, INGO BURMEISTER, MALTE MIELKE, MICHAEL PAPENBROCK, ALEXANDER TÄSCHNER, and ALFONS KHOUKAZ — Institut für Kernphysik, Universität Münster, D-48149 Münster, Germany

Measurements of the mass of the  $\eta$ -meson performed at different experimental facilities (i.e. COSY-GEM, MAMI, CLEO, KLOE, NA48) over the last decade have resulted in very precise data which differ by up to 0.5 MeV/ $c^2$ , i.e., more than eight standard deviations. In order to clarify this situation a new measurement of the  $dp \rightarrow ^3\text{He}\eta$  reaction near threshold was proposed at the Cooler Synchrotron - COSY - of the Forschungszentrum Jülich with the aim to achieve a mass resolution of  $\Delta m < 50 \text{ keV}/c^2$ .

In order to measure the  $\eta$  meson mass with high accuracy through the  $dp \rightarrow ^3\text{He}\eta$  reaction, the momentum of the circulating deuteron beam in COSY has to be determined with unprecedented precision. This has been achieved by studying the spin dynamics of the polarised deuteron beam. By depolarising the beam through the use of an artificially induced spin resonance, it was possible to determine the beam momentum  $p$  with an accuracy of  $\Delta p/p < 10^{-4}$  for  $p \approx 3 \text{ GeV}/c$ . In parallel the CMS momenta of the produced  $^3\text{He}$  nuclei have to be determined with high precision with the ANKE spectrometer. The method for determination of the  $\eta$  mass, as well as current results will be discussed in this presentation.

Supported by the COSY-FFE program.

HK 24.3 Tue 17:15 C-2

**Rückstreuereffekte in  $\eta \rightarrow 3\pi$  - Zerfällen** — ●SEBASTIAN PHILIPP SCHNEIDER, BASTIAN KUBIS and CHRISTOPH DITSCHKE — Helmholtz-Institut für Strahlen- und Kernphysik (Theorie), Universität Bonn, Nußallee 14–16, D-53115 Bonn

Der isospinverletzende Zerfall  $\eta \rightarrow 3\pi$  eignet sich in idealer Weise zur experimentellen Extraktion von Massenverhältnissen der leichten Quarks. Für eine Präzisionsbestimmung dieser Massenverhältnisse ist eine detaillierte Beschreibung des Dalitz-Plots unumgänglich. In dieser Hinsicht wirft insbesondere der quadratische Dalitz-Plot-Parameter  $\alpha$  des neutralen Kanals Fragen auf: Chirale Ein- und Zweischleifen-Vorhersagen zeigen substantielle Abweichungen vom experimentellen Ergebnis.

Wir analysieren Dalitz-Plot-Parameter der geladenen und neutralen Zerfallskanäle mithilfe einer modifizierten nicht-relativistischen effektiven Feldtheorie, einer Methode, die sich hervorragend zur Analyse von Rückstreuereffekten jenseits einer Schleife eignet, und überdies die Ein-

beziehung isospinbrechender Korrekturen erlaubt. Durch Anpassung der Niederenergiekonstanten an chirale Störungstheorie zu nächstführender Ordnung finden wir  $\alpha = -0.024 \pm 0.005$ , in guter Übereinstimmung mit experimentellen Bestimmungen. Wir leiten zusätzlich eine Beziehung zwischen geladenen und neutralen Zerfallsparametern her, die eine signifikante Spannung zwischen jüngsten KLOE-Messungen dieser Observablen offenbart.

HK 24.4 Tue 17:30 C-2

**Meson production in coherent pd interaction** — ●TATIANA AZARYAN and VLADIMIR KOMAROV for the ANKE-Collaboration — Joint Institute for Nuclear Research, 141980, Dubna, Russia

The reaction  $p + d \rightarrow p + d + X$  was studied in the proton beam energy range of 0.8-2.0 GeV at small forward angles of the pd pair production. A peculiarity of the experiment is the large momentum transfer from the projectile to the target nuclei resulting in high lab momenta of the final deuterons: at 1.4 GeV beam energy the deuteron momenta are in the range of 0.6 to 2.0 GeV/ $c$ . The intense multimeson continuum includes, in particular, single pion, low-mass pion pair or eta-meson production which are well identified in the missing mass distribution. The deuteron-meson invariant mass distributions reveal broad quasi-resonance peaks consistent with the excitation of  $\Delta(1232)$ ,  $N(1440)$ ,  $\Delta\Delta$  or  $N(1535)$  resonances in the intermediate state of the target two-nucleon system.

HK 24.5 Tue 17:45 C-2

**Double-Pionic Fusion to  $^3\text{He}$  in  $dd$  Collisions - Quasifree versus Coherent Process\*** — ●ELENA PEREZ DEL RIO for the WASA-at-COSY-Collaboration — Physikalisches Institut, Univ. Tübingen

The double-pionic fusion to  $^3\text{He}$  is generally studied via the reaction  $pd \rightarrow ^3\text{He}\pi\pi$ . Exclusive and kinematically complete measurements of this reaction have been performed previously with the WASA detector in and above the energy region of the ABC effect, which denotes a puzzling low-mass enhancement in the  $\pi\pi$ -invariant mass distribution.

In case of  $dd$  collisions this fusion occurs with an associatedly produced neutron in the reaction  $dd \rightarrow ^3\text{He}\pi\pi n$ . The associatedly produced neutron has a momentum distribution with kinematic boundaries, which are given by the spectator emerging either from the target or from the beam in the course of a quasifree process. The kinematic region in-between is covered by non-quasifree, possibly coherent processes, where the associatedly produced neutron is no longer spectator, but active reaction partner.

We have investigated the diverse processes by measuring the  $dd$  collisions with the WASA detector setup at COSY both at energies below the ABC region for the quasifree process as well as at energies in the ABC region.

The experimental results for the different reaction scenarios will be discussed.

\* supported by BMBF, COSY-FFE (FZ Jülich), DFG (European Graduate School)

HK 24.6 Tue 18:00 C-2

**Investigations of Double Pion Production in Proton-Proton Collisions at  $T_p = 1400 \text{ MeV}$**  — ●TAMER TOLBA and JAMES RITMAN for the WASA-at-COSY-Collaboration — Institut für Kernphysik and Jülich Center for Hadron Physics, Forschungszentrum Jülich, Germany

Pion production, especially double pion production, in proton-proton collisions is an important source of information on the nucleon-nucleon ( $NN$ ) interactions and on nucleon resonance properties.

The mechanisms for double pion production in proton-proton collisions are strongly momentum dependent and are expected to be dominated by baryon resonance intermediate states. This channel was studied at energies close to threshold up to  $T_p = 1300 \text{ MeV}$  at the CELSIUS/WASA experiment.

The reaction  $pp \rightarrow pp\pi^0\pi^0$  was investigated with the WASA-at-COSY facility and values for both the total and differential cross sections have been obtained for a beam energy of 1400 MeV. The results are compared to theoretical expectations. Clear evidence for the  $\Delta\Delta$  excitation is observed, without a significant signature for a contribution of the Roper  $N^*(1440)$ .

Supported in part by BMBF, FZ-Jülich and the Wallenberg Foundation.

HK 24.7 Tue 18:15 C-2

**Recent Results from the Deuteron Charge-Exchange on Hydrogen Programme at ANKE/COSY** — ●DAVID MCHEDLISHVILI for the ANKE-Collaboration — Institut für Kernphysik, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — High Energy Physics Institute, Tbilisi State University, 0186 Tbilisi, Georgia

A good understanding of the Nucleon-Nucleon interaction ( $NN$ ) remains one of the most important goals of nuclear and hadronic physics. Apart from their intrinsic importance for the study of nuclear forces,  $NN$  data are necessary ingredients in the modelling of meson production and other nuclear reactions at intermediate energies.

Experiments at COSY, using a polarised deuteron beam and/or target, can lead to significant improvements in the  $np$  database by studying the quasi-free reaction on the neutron in the deuteron -  $dp \rightarrow \{pp\}n$ . At low excitation energies of the final  $pp$  system, typically  $E_{pp} < 3$  MeV, the spin observables are directly related to the spin-dependent parts of the neutron-proton charge-exchange amplitudes. Measurement of the deuteron-proton spin-correlations allows one also to fix the relative phases of these amplitudes in addition to their overall magnitudes. Recent results of this study at ANKE/COSY are presented, including preliminary data on  $dp \rightarrow \{pp\}\Delta^0$ .

Supported by the COSY-FFE program.

HK 24.8 Tue 18:30 C-2

**Measurement of the vector analyzing power of the  $\bar{p}p \rightarrow \{pp\}_s\pi^0$  reaction at intermediate energies at ANKE/COSY** — ●DMITRY TSIRKOV for the ANKE-Collaboration — Laboratory of Nuclear Problems, Joint Institute for Nuclear Research, 141980 Dubna, Russia

The reaction  $\bar{p}p \rightarrow \{pp\}_s\pi^0$ , where  $\{pp\}_s$  is a proton pair with an excitation energy  $E_{pp} < 3$  MeV, has been observed with the ANKE spectrometer at COSY-Jülich using a polarized beam with energies 353, 500, 550 and 700 MeV. The data have been processed to obtain the vector analyzing power  $A_y$  of the reaction. The setup acceptance covers most of the angular range at 353 MeV and forward angles at the higher beam energies, allowing one to obtain the  $A_y$  angular dependence. From the results of the analysis at 353 MeV, one can extract information on the pion  $d$ -wave contribution, which is important for Chiral Perturbation Theory tests at this energy. At higher energies the results are compared with a phenomenological model and this gives additional information about  $\Delta$ -nucleon dynamics.

Supported by the COSY-FFE program.

HK 24.9 Tue 18:45 C-2

**Cross section and analysing power of  $\bar{p}d \rightarrow {}^3\text{H}\pi^+$  and  $\bar{p}d \rightarrow {}^3\text{He}\pi^0$  at 353 MeV** — ●VERA SHMAKOVA for the ANKE-Collaboration — Joint Institute for Nuclear Research, 141980 Dubna, Russia — Institut für Kernphysik, Forschungszentrum Jülich, 52425 Jülich, Germany

The angular distributions of the differential cross section and analyzing power  $A_y$  for the  $\bar{p}d \rightarrow {}^3\text{H}\pi^+$  and  $\bar{p}d \rightarrow {}^3\text{He}\pi^0$  reactions have been measured at an incident energy of 353 MeV. The polarized proton beam interacted with a deuterium cluster-jet target and the charged recoil particles were detected in the COSY-ANKE spectrometer. Isospin conservation ensures that the  $A_y$  for the  ${}^3\text{H}\pi^+$  and  ${}^3\text{He}\pi^0$  final states are the same, though there is a factor of two difference in the cross sections.

The data covered small angles in both hemispheres and are thus complementary to the  $\bar{p}d \rightarrow {}^3\text{He}\pi^0$  results obtained at TRIUMF. The two data sets are compared and discussed in terms of a  $NN \rightarrow d\pi$  reaction model.

Supported by the COSY-FFE program.