

## HK 55: Hadronenstruktur und -spektroskopie

Zeit: Freitag 11:00–13:00

Raum: RW 2

## Gruppenbericht

HK 55.1 Fr 11:00 RW 2

**On the Observation of a Narrow Resonance Structure in  $pn$ -scattering and Two-Pion Production\*** — ●MIKHAIL BASHKANOV for the WASA-at-COSY-Collaboration — Physikalisches Institut, Univ. Tübingen

Whereas for the **isovector** two-pion production in NN-collisions a smooth energy dependence is observed, which is well described by  $t$ -channel meson exchange, the purely **isoscalar** reaction  $pn \rightarrow d\pi^0\pi^0$  exhibits a pronounced narrow resonance structure at  $m = 2.37 \text{ GeV} = 2m_\Delta - 90 \text{ MeV}$ , which is strictly correlated with the appearance of a large low-mass enhancement (ABC-Effect) in the  $\pi^0\pi^0$ -invariant mass spectrum. From the angular distributions we deduce  $I(J^P) = 0(3^+)$  for the resonance structure [1].

If this structure originates from a genuine  $pn$  resonance, then it has to be sensed also in other two-pion production channels with isoscalar contributions as well as in  $pn$  scattering. Indeed, the  $pn$  total cross section exhibits a structure at the energy of interest, which is well described by inclusion of the hypothetical resonance.

Experimental results are shown for the two-pion channels  $d\pi^0\pi^0$ ,  $d\pi^+\pi^-$  and  $pp\pi^0\pi^-$ . Scheduled measurements on quasifree  $\bar{p}n$ -scattering and the  $\bar{p}n \rightarrow pn\pi^0\pi^0$  reaction are discussed.

The fact that the ABC effect is observed also for double-pionic fusion processes to heavier nuclei, suggests that this resonance structure is robust enough to survive even in nuclei.

\* supported by BMBF and COSY-FFE

[1] P. Adlarson et al., Phys. Rev. Lett. **106**, 242302 (2011)

HK 55.2 Fr 11:30 RW 2

**Double-Pionic Fusion to  ${}^3\text{He}$  – ABC-Effect and Resonance Structure\*** — ●ELENA PEREZ DEL RIO for the WASA-at-COSY-Collaboration — Physikalisches Institut, Univ. Tübingen

The double-pionic fusion to  ${}^3\text{He}$  was historically the reaction, where the ABC effect (low-mass enhancement of the  $\pi\pi$ -invariant mass spectrum) was observed in inclusive measurements more than 50 years ago for the first time. Meanwhile we know from exclusive and kinematically complete high-statistics measurements with WASA at COSY that there is a strict correlation between the ABC effect and a narrow resonance structure with  $I(J^P) = 0(3^+)$  in the total cross section of the most basic double-pionic fusion, the  $pn \rightarrow d\pi^0\pi^0$  reaction [1].

In order to investigate the situation in the double-pionic fusion to  ${}^3\text{He}$  we have measured the energy dependence of the ABC effect in the fusion to  ${}^3\text{He}$  by fixed energy measurements of the type  $pd \rightarrow {}^3\text{He}\pi\pi$  and by quasifree and coherent measurements of the type  $dd \rightarrow {}^3\text{He}\pi\pi n$ .

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

[1] P. Adlarson et al., Phys. Rev. Lett. **106**, 242302 (2011)

\* supported by BMBF and COSY-FFE (FZ Jülich)

HK 55.3 Fr 11:45 RW 2

**In Search of the ABC Resonance Structure in the Reactions  $pn \rightarrow pp\pi^0\pi^-$  and  $pn \rightarrow pn\pi^0\pi^0$ \*** — ●TATIANA SKORODKO for the WASA-at-COSY-Collaboration — Physikalisches Institut der Universität Tübingen

As we have shown recently [1] the basic double-pionic fusion reaction  $pn \rightarrow d\pi^0\pi^0$  exhibits a pronounced narrow resonance structure with  $m = 2.37 \text{ GeV}$ ,  $\Gamma = 70 \text{ MeV}$  and  $I(J^P) = 0(3^+)$ , which is correlated with a low-mass enhancement in the  $\pi^0\pi^0$ -invariant mass distribution, the so-called ABC effect. If the scenario of a  $s$ -channel resonance with a reaction process  $pn \rightarrow d^* \rightarrow \Delta^+\Delta^0 \rightarrow d\pi^0\pi^0$  is correct, then the resonance should be observed also in  $pn$  scattering as well as in other two-pion production channels like  $pn\pi^0\pi^0$  and also  $pp\pi^0\pi^-$ . These channels can be accessed in quasifree proton reactions on the deuteron. The latter channel is particularly well suited for a reliable data analysis, since the four-momenta of all ejectiles can be detected in WASA.

A corresponding WASA run at  $T_p = 1.2 \text{ GeV}$  has been analyzed providing first results for the  $pn \rightarrow pp\pi^0\pi^-$  reaction, which cover also the region of the putative ABC resonance.

The experimental results exhibit surprisingly large cross sections at low energies pointing to so far unknown processes. In the ABC region neither an ABC effect nor a resonance behavior is observed, which is understood by the fact that the  $\pi^0\pi^-$  pair must be in relative  $p$ -wave, whereas the  $pp$  pair prefers to be in the  ${}^1S_0$  state.

[1] P. Adlarson et al., Phys. Rev. Lett. **106** 242302 (2011)

\*supported by BMBF and COSY-FFE (FZ Jülich)

HK 55.4 Fr 12:00 RW 2

**Double pion photoproduction off nuclei** — ●YASSER MAGHRBI for the A2-Collaboration — Departement Physik, Basel, Switzerland

The study of the invariant mass distributions of pion pairs produced in atomic nuclei has been intensively discussed in view of a possible in-medium modification of the  $\sigma$  meson, related to partial chiral restoration effects. The interpretation of the results from both hadron- and photon-induced reactions is complicated by final-state interaction (FSI) effects of the pions. New, precise results have been obtained with the Crystal Ball/TAPS experiment at the Mainz MAMI accelerator. Invariant mass distributions of the  $\pi^0\pi^0$  and  $\pi^0\pi^\pm$  pairs have been studied for  ${}^2\text{H}$ ,  ${}^7\text{Li}$ ,  ${}^{12}\text{C}$ ,  ${}^{40}\text{Ca}$ ,  ${}^{nat}\text{Pb}$  targets with much improved statistical quality compared to previous experiments. The results allow for the first time to study these distributions also close to threshold for very low energetic pions, which are not much affected by FSI and thus has to separate FSI effects from  $\sigma$ -in-medium effects. As a preliminary result the dominating effect seems to be due to FSI.

HK 55.5 Fr 12:15 RW 2

**Efimov Effect for P-wave Interactions** — ERIC BRAATEN<sup>1</sup>, ●PHILIPP HAGEN<sup>2</sup>, HANS-WERNER HAMMER<sup>2</sup>, and LUCAS PLATTER<sup>3</sup> — <sup>1</sup>Department of Physics, The Ohio State University, Columbus, OH 43210, USA — <sup>2</sup>Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics, Universität Bonn, 53115 Bonn, Germany — <sup>3</sup>Chalmers University of Technology, Department of Fundamental Physics, SE-412 96 Gothenburg, Sweden

Nonrelativistic particles with short-range interactions that produce a P-wave threshold resonance can exhibit the Efimov effect: if the inverse scattering volume  $1/a$  and the P-wave effective range  $r$  are simultaneously tuned to zero, there is an infinite sequence of three-body bound states called Efimov states that have an accumulation point at the threshold. The discrete scaling factor that characterizes the Efimov effect depends on the mass ratios and the symmetries of the three particles. There is no Efimov effect if all three particles are identical, but it can occur if two identical particles have a resonant P-wave interaction with a third particle. The spectrum of Efimov trimers is compatible with discrete scale invariance. The Efimov trimers disappear through the three-particle threshold at values of  $a$  and  $r$  that differ by appropriate powers of the discrete scaling factor.

HK 55.6 Fr 12:30 RW 2

**Perturbative pions in chiral effective field theory for NN scattering** — EVGENY EPELBAUM<sup>1</sup> and ●JAMBUL GEGELIA<sup>1,2</sup> — <sup>1</sup>Institut fuer Theoretische Physik II, Fakultät fuer Physik und Astronomie, Ruhr-Universität Bochum, 44780 Bochum, Germany — <sup>2</sup>High Energy Physics Institute, TSU, 0186 Tbilisi, Georgia

New approach to NN scattering problem in EFT suggested by Beane, Kaplan and Vourinen [1] exploits the fact that the convergence of perturbative series in quantum field theories depends on the choice of the renormalization condition. In particular, it is expected that by choosing a more adequate renormalization scheme one can make the perturbative expansion of the NN scattering amplitude convergent within the (modified) KSW power counting scheme, i.e. where the pions are treated perturbatively. We present our results for NN scattering amplitude obtained within this approach.

[1] S.R.Beane, D.B.Kaplan and A.Vuorinen, Phys.Rev. C 80, 011001(2009)

HK 55.7 Fr 12:45 RW 2

**Giessen coupled-channel model pion and photon induced reactions** — ●VITALY SHKLYAR, HORST LENSKE, and ULRICH MOSEL — Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen

An unitary coupled-channel Lagrangian model is developed for simultaneous analysis of pion- and photon-induced reactions in the resonance energy region. The  $\pi N$ ,  $\rho N$ ,  $\pi\Delta$ ,  $\sigma N$ ,  $\eta N$ ,  $\omega N$ ,  $K\Lambda$ ,  $K\Sigma$  final states are treated on the same basis. The coupling constants are constrained by comparison with the available experimental data. Recent results on  $\eta$ -production and the extended treatment of the two-pion channel are presented and discussed.