

Abstract for an Invited Paper
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Symmetries and Hadron Spectroscopy with WASA-at-COSY

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Experiments with the WASA detector at COSY Juelich focus both on studies of symmetries and symmetry breaking mechanisms in hadronic systems as well as hadron spectroscopy, to investigate the properties of QCD in the non-perturbative regime, where confinement and chiral symmetry breaking are the characteristic phenomena. Isospin violation and tests of conservation of the fundamental C, P, and T invariances and combinations thereof are the key physics issues in studies of η decays. From the very first production run, results on the Dalitz plot slope parameter in the isospin violating $\eta \rightarrow 3\pi^0$ decay have been obtained. End of 2008, a high statistics data sample of more than 10^7 neutral and charged η decays has been recorded in the reaction $pd \rightarrow {}^3\text{He}\eta$, in which η tagging can be solely based on ${}^3\text{He}$ detection and is thus unbiased with respect to the η decay system. Low-mass enhancements in isoscalar $\pi\pi$ invariant mass distributions in nuclear fusion reactions to few-body systems d , ${}^3\text{He}$, and ${}^4\text{He}$, known as the ABC effect, have been reproduced in exclusive data taken with the WASA detector at CELSIUS. The data indicate the formation of an isoscalar pn resonance coupling to a $\Delta\Delta$ intermediate state. Follow-up high-statistics experiments have recently been performed on the reactions $pn \rightarrow d\pi\pi$ and $dd \rightarrow {}^4\text{He}\pi\pi$ covering the complete energy range relevant for the ABC effect with WASA-at-COSY. Physics results obtained so far and the physics program with WASA-at-COSY will be presented. The scientific potential for hadron spectroscopy at COSY will be related to activities at Jefferson Lab, and will be discussed in view of future opportunities, e.g. at the FAIR facility at Darmstadt (Germany).

¹for the WASA-at-COSY Collaboration