ABC Effect in Double-Pionic Fusion – a New Resonance?*

Annette Pricking[(a)] for the WASA-at-COSY Collaboration

[(a)] Physikalisches Institut, Univ. Tübingen, Germany

The ABC effect, an intriguing low-mass enhancement in the $\pi\pi$ invariant mass spectrum, is known from inclusive measurements of the production of an isoscalar pion pair in fusion reactions to light nuclei. Its explanation has been a puzzle since more than 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}He and ^{4}He with WASA at COSY. These measurements cover the full energy region, where the ABC effect has been observed previously in inclusive reactions. They also complement the systematic measurements of nucleon-nucleon induced two-pion production carried out at CELSIUS-WASA [1].

From the three basic double-pionic fusion reactions leading to the deuteron the purely *isovector* reaction $pp \to d\pi^+\pi^0$ is observed to behave as expected from the conventional t-channel $\Delta\Delta$ excitation, which is known to be the dominant process in all other pp induced, *i.e. isovector* two-pion production channels at beam energies above 1 GeV.

In contrast, the purely *isoscalar* fusion reaction $pn \to d\pi^0\pi^0$ does not behave as expected from conventional reaction dynamics. It rather exhibits a narrow resonance structure in the total cross section, which is correlated with the appearance of the ABC effect in the $\pi^0\pi^0$ invariant mass spectrum. Its peak energy is about 90 MeV below the nominal $\Delta\Delta$ threshold of 2 m_Δ and its width of only 70 MeV is much less than the 2 Γ_Δ expected from the conventional t-channel $\Delta\Delta$ process. From the angular distributions we assign the quantum numbers $I(J^P) = 0(3^+)$ to this structure [2]. At present no conventional process is known, which could at least qualitatively explain this phenomenon. We note, however, that quark-model calculations, notably those of Ref. [3] predict a state with exactly these quantum numbers at about the appropriate mass. However, the calculated width is far too large.

In the double-pionic fusion reaction to the helium isotopes $pd \to {}^3\mathrm{He}\pi^0\pi^0$ and $dd \to {}^4\mathrm{He}\pi^0\pi^0$ again the ABC effect is observed to be correlated with the appearance of a resonance-like structure in the total cross section at the same excess energy, however, with an increased width due to Fermi motion in initial and final nuclei. From this we conclude that this resonance structure obviously is strong enough to survive even in light nuclei.

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

1 T. Skorodko *et al.*, Phys. Lett. **B 679**, 30 (2009); **B 684**, 110 (2010); **B 695**, 115 (2011)

2 P. Adlarson *et al.*, Phys. Rev. Lett. **106**, 202302 (2011)

3 J. L. Ping *et al.*, Phys. Rev. **C 79**, 024001 (2009)

E-mail: clement@pit.physik.uni-tuebingen.de