# Isospin Decomposition of the Basic Double-Pionic Fusion in the Region of the ABC Effect*

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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 three basic fusion reactions to deuterium

- $pn \to d\pi^0\pi^0$
- $pn \to d\pi^+\pi^-$
- $pp \to d\pi^+\pi^0$

with WASA at COSY. These measurements have been carried out with a proton beam hitting the deuterium pellet target at $T_p = 1.2$ GeV in quasifree kinematics. That way the energy range 2.35 GeV $\leq \sqrt{s} \leq$ 2.45 GeV has been covered, which coincides with the energy region, where the ABC effect has been observed previously.

The purely *isovector* reaction $pp \to d\pi^+\pi^0$ exhibits a smooth energy dependence in the total cross section as well as no ABC effect – as expected from the conventional $t$-channel $\Delta\Delta$ excitation, which is known to be the leading process in all $pp$ 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. The cross section maximum is about 90 MeV below 2 $m_\Delta$, the mass of a $\Delta\Delta$ system, and its width of only 70 MeV is three times smaller than 2 $\Gamma_\Delta$ 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 [1]. At present no conventional process is known, which could at least qualitatively explain this phenomenon.

The $pn \to d\pi^+\pi^-$ reaction contains both isoscalar and isovector parts. Its data are well understood by combining appropriately the results from the $pn \to d\pi^0\pi^0$ and $pp \to d\pi^+\pi^0$ reactions. The data also demonstrate, why previous low-statistics bubble-chamber measurements of this reaction with neutron beams of low momentum resolution had actually no chance to discover the narrow resonance structure.

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

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