

Single pion production in proton-proton collisions at 1.25 GeV measured with HADES and the Bonn-Gatchina PWA description

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Collaboration

HADES

Abstract content

HADES is a versatile magnetic spectrometer installed at GSI Darmstadt at SIS18 [1]. Thanks to its high acceptance, powerful particle ($p/K/\pi/e$) identification and very good mass resolution (2 – 3% for dielectrons in the light vector meson mass range) it allows to study both hadron and rare dilepton production in $N + N$, $p + A$, $A + A$ collisions at a few AGeV beam energy range. In collisions $p + p$ @ 1.25 GeV, the intermediate $\Delta(1232)$ resonance is expected to play a dominant role in the pion production, but it is known to be not sufficient to describe fully the data. The resonance cross section was determined from exclusive $pp\pi^0$ and $pn\pi^+$ channels [2] in the framework of a OPE model with accuracy of 20 – 30%. Investigation of these reaction channels by means of the PWA (Partial Wave Analysis) was also done [3] by the Bonn-Gatchina group at a smaller beam energy [4]. It revealed a dominant contribution of $\Delta(1232)p$ intermediate state but also sizeable non-resonant terms and interference effects. In this work we report on the PWA of the single-pion production in proton-proton collisions (as in [2]) measured with HADES. The pp is a pure isospin $I = 1$ state and, at this beam energy the following initial pp -states contribute: (J=0) 1S_0 , 3P_0 , (J=1) 3P_1 , (J=2) 1D_2 , 3P_2 , 3F_2 , (J=3) 3F_3 and (J=4) 1G_4 , 3H_4 . Unlike in proton-proton collisions at lower energies, higher partial waves are necessary for a proper data description. The final states are limited to $S-$, $P-$, $D-$, $F-$, $G-$ and $H-$ wave states with the two possible intermediate resonance states $P_{33}(1232)$ and $P_{11}(1440)$. The data samples (for both channels, $pp\pi^0$ and $pn\pi^+$) were analysed with the event-by-event background estimation (Q factors). The analysis was performed together with other available data (see [5], 11 measurements for $pp\pi^0$ and only two for $pn\pi^+$ channel) covering mostly lower beam energies. The stability of solutions was investigated based on a few parametrisations of the transition amplitude A_{tr} (with total energy dependence) and various descriptions of resonance states (Δ and N^*). The obtained solutions generally describe the HADES data very well in various projection observables (CM angular distributions, invariant masses, angular distributions in the helicity and the Gottfried-Jackson frames). The analysis shows the dominant $P_{33}(1232)$ contribution in $pn\pi^+$ at the level of 95% and in $pp\pi^0$ (80%) which is an important message for the dilepton analysis, where the branching of Δ Dalitz decays can be identified (in the pe^+e^- channel).

[1] G. Agakishiev et al., Eur. Phys. J. A41 (2009) 243 [2] G. Agakishiev et al., Eur. Phys. J. A48 (2012) 74 [3] A. V. Anisovich et al., Eur Phys. J. A34 (2007) 129 [4] K. N. Ermakov et al., Eur. Phys. J. A47 (2011) 159 [5] Data Base on page <http://pwa.hiskp.uni-bonn.de/>

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