$\pi\pi$ Production in Proton-Proton Collisions

T.Skorodko, M. Bashkanov, H. Clement, O. Khakimova, F. Kren, G. J. Wagner
for the CELSIUS-WASA collaboration

Physikalisches Institut der Universität Tübingen

One of the major programs carried out at CELSIUS with the WASA detector has been the systematic study of two-pion production in proton-proton collisions at incident energies from 0.65 - 1.45 GeV, i.e. from threshold up to the region, where the $\Delta\Delta$ excitation in both of the participating nucleons is expected to dominate [1].

The data taken at WASA constitute the first exclusively measured samples of solid statistics in the considered energy range. Most of the data have been accumulated for the $\pi^+\pi^-$ and $\pi^0\pi^0$ channels, which are most easily accessible experimentally. The $\pi^+\pi^-$ and $\pi^+\pi^0$ channels are much harder to access, since they are associated with the production of neutrons. Hence the accumulated statistics is substantially lower and the data analysis much more involved with respect to a clean separation from competing reactions.

At low incident energies, i.e., in the threshold region, the data on the $\pi^+\pi^-$ channel have been successfully explained by excitation and decay of the Roper resonance [1,2] and alternatively also by calculations within the concept of chiral dynamics [3]. The data for the $\pi^0\pi^0$ channel, which is free of any isospin $I_{\pi\pi} = 1$ contribution, agree very well with these calculations near threshold. However, towards higher incident energies the description of data gets significantly worse. Also, at the lowest energies the purely isovector $\pi^+\pi^0$ channel exhibits cross sections, which are substantially larger than predicted.

At incident energies above 1 GeV, where the $\Delta\Delta$ mechanism should take over, the data for $\pi^+\pi^-$ and $\pi^0\pi^0$ channels change drastically. Indeed this mechanism is seen to take over by observing the simultaneous excitation of Δ^{++} and Δ^0 in the appropriate $M_{p\pi}$ spectra. However, in contrast to the predictions [1] of a double-hump structure we observe a phasespace like behavior in the measured $M_{\pi^+\pi^-}$ spectra. In the measured $M_{\pi^0\pi^0}$ spectrum on the other hand we find a systematic low-mass enhancement, which is in line with the situation observed in the exclusive measurements of double-pionic fusion processes [4] and which has been termed as so-called ABC effect. First results for the $\pi^+\pi^+$ channel indicate no special low-mass enhancement there - favoring thus no Bose-Einstein correlation scenario. First results on $pp \rightarrow !d\pi^+\pi^0$ will be discussed.

[1] L. Alvarez-Ruso, E. Oset, E. Hernandez, Nucl. Phys. A633, 519 (1998); L Alvarez-Ruso, PhD thesis, Univ. Valencia 1999 and Phys. Lett. B452, 207 (1999)

[2] W. Brodowski et al., Phys. Rev. Lett. 88, 192301 (2002) and Phys. Rev. C67, 052202(R) (2003)

[3] H. A. Clement, M. M. Kaskulov, E. A. Doroshkevich, Int. J. Mod. Phys. A20, 674 (2005) [4] M. Bashkanov et al., contribution to this conference

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