

Two pion production in proton-proton collisions near threshold as a probe for the $N^*(1440)P_{11}$ resonance.

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Two pion production reactions in proton-proton collisions have been studied using the PROMICE/WASA detector and an internal cluster gas-jet target at the CELSIUS storage ring in Uppsala. Total cross sections for the $pp \rightarrow pp\pi^+\pi^-$, $pp \rightarrow pp\pi^0\pi^0$ and the $pp \rightarrow pn\pi^0\pi^+$ reactions are obtained at beam energies ranging from 650 to 775 MeV. The data are compared to an extensive model [1] including non-resonant as well as resonant production via $N^*(1440)P_{11}$ and $\Delta(1232)P_{33}$ excitation. This model singles out isoscalar excitation of the $N^*(1440)P_{11}$ resonance and its decay direct into two s-wave pions as the dominant transition when allowed.

Our data on the total cross sections supports these model calculations and thus give evidence for the excitation of the $N^*(1440)P_{11}$ resonance being the dominant reaction mechanism for the $pp \rightarrow pp\pi^+\pi^-$ and $pp \rightarrow pp\pi^0\pi^0$ reactions. Moreover, the direct decay of the $N^*(1440)$ into two s-wave pions is the dominating decay branch.

The experimental cross section for the $pp \rightarrow pn\pi^+\pi^0$ reaction, which does not allow the $N^*(1440)P_{11}$ excitation, is however as large as the $pp \rightarrow pp\pi^+\pi^-$ and $pp \rightarrow pp\pi^0\pi^0$ cross sections. This indicates, that other processes for the two pion production at threshold can have large amplitudes as well, although these are less important for the $pp \rightarrow pp\pi^+\pi^-$ and $pp \rightarrow pp\pi^0\pi^0$ reaction cross sections.

Our data show that the double pion production channels, $NN \rightarrow NN\pi\pi$, can give interesting information on different meson currents in the context of resonance excitations in the NN interaction. In particular the excitation of the $N^*(1440)P_{11}$ resonance and its decay properties can be studied.

Ref. [1] L. Alvarez-Ruso, E. Oset, E. Hernandez, Nucl. Phys. A 633, 519 (1998), E. Oset and M.J. Vicente-Vacas, Nucl. Phys. A 446, 584 (1994) and J.A. Gomez Tejedor and E. Oset, Nucl. Phys. A 571, 667 (1985).