Study of baryonic resonances in the reaction $pp \to pp\pi^+\pi^-$ at 3.5 GeV with HADES

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Nuclear reactions at energies of 1-4 GeV/nucleon are characterized by the important role played by excited states of the nucleon (or baryon resonances, e.g. $\Delta(1232)$, N(1440), N(1520)...). Pion production in Nucleon-Nucleon (NN) collisions is a useful source of information on these processes, since baryon resonances mostly decay to $N\pi$ or $N\pi\pi$ channels. In particular, two-pion production is an appropriate tool to study both single and double baryon excitation, while providing information on mesons decaying into two pions (ρ, f_0,...).
The High Acceptance Di-Electron Spectrometer (HADES) [1] installed at GSI Helmholtz-Zentrum für Schwerionenforschung in Darmstadt, designed to investigate dielectron production in heavy-ion collisions in the range of kinetic beam energies 1-2 A GeV is also an excellent detector for charged hadron detection, due to its tracking capabilities.
Recently, differential and integrated cross sections for the reactions $pp \to pp\pi^0$, $pp \to pn\pi^+$ [2], [3], [4], $pp \to pp\pi^+\pi^-$, $pn \to pn\pi^+\pi^-$ [5], $pn \to d\pi^+\pi^-$ have been investigated with HADES at kinetic energies 1.25, 2.2 and 3.5 GeV. This talk will focus on the analysis of the $pp \to pp\pi^+\pi^-$ channel at 3.5 GeV, using results from $pp \to pp\pi^0$, $pp \to pn\pi^+$ [3] and $pp \to pK\Lambda$ [6] measured at the same energy by HADES. The contributions of the excitation of one or two baryonic resonances with masses up to 1.9 GeV and of the ρ production can be quantified. Differential invariant masses and angular distributions are also compared to two theoretical models [7], [8].
This study provides strong constraints on the role of baryon resonances and ρ meson in Nucleon-Nucleon reaction mechanisms. Since the baryon resonances Dalitz decay ($R \to Ne^+e^-$) and the ρ meson electromagnetic decay ($\rho \to e^+e^-$) are important sources of electron pairs (e^+e^-). Our results are also useful for the interpretation of di-electron spectra measured in parallel by the HADES collaboration.

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