One- and Two-pion production in pp and np reactions with HADES

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The High Acceptance Di-Electron Spectrometer (HADES) installed at GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt was designed to investigate di-electron production in heavy-ion collisions in the range of kinetic beam energies 1-2 A GeV. The main goal of the HADES experiment is to study properties of hadrons inside the hot and dense nuclear medium via their dielectron decays.

One specific issue of heavy-ion reactions in the 1-2 AGeV regime is the important role played by the baryonic resonances, which propagate and regenerate, due to the long life-time of the dense hadronic matter phase. The $\Delta(1232)$ is the most copiously produced resonance but with increasing incident energy, higher lying resonances also contribute to pion production. A detailed description of the resonance excitation and coupling to the pseudoscalar and vector mesons is important for the interpretation of the dielectron spectra measured by HADES. Baryonic resonances are important sources of dileptons through two mechanisms: (i) Dalitz decays (e.g. $\Delta/\ N \rightarrow Ne^+e^-$), and (ii) mesonic decays with subsequent dielectron production.

Pion production in NN collisions is one of the sources of information on the NN interaction and on nucleon resonance properties. Two-pion production, in particular, is an outstanding subject, since it connects $\pi\pi$ dynamics with baryon and baryon-baryon degrees of freedom. In our energy regime, $\Delta\Delta$ excitation becomes the leading process. The one- and two-pion production in pp and np reactions has been investigated with HADES in exclusive measurements for beam kinetic energies of 1.25 and 2.2 GeV. Total and differential cross sections have been obtained for the channels $pn\pi^+$, $pp\pi^0$, $pp\pi^+\pi^-$ and $pn\pi^+\pi^-$.

Due to the large cross-sections, the differential spectra can be measured with high statistics and provide strong constraints on the production mechanisms and on the various resonance contributions ($\Delta(1232)$, N*(1440)). In this talk, a comparison of our results on one- and two-pion production with several model predictions (Valencia, OPER, and Xu Cao et al.) will be presented.

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