Contribution ID: **165** Type: **Plenary**

Studies of Time-like Electromagnetic Structure of Baryons with HADES

Saturday, 24 June 2023 11:30 (30 minutes)

The High Acceptance Di-Electron Spectrometer (HADES) [1], installed at GSI Helmholtzzentrum in Darmstadt, was designed for spectroscopy of positron-electron pairs in heavy-ion reactions in the SIS-18 energy range (1-2 GeV/nucleon). HADES results on e+e- production in proton-nucleus and nucleus-nucleus systems at various energies reveal a strong enhancement of the e+e- yield with respect to a nucleon-nucleon reference. Such observations point to a significant contribution from baryon resonance decays (R⟶ Ne+e-) and a strong modification of the in-medium rho spectral function driven by the coupling of the rho to baryon-resonance hole states. To study this effect a precise measurement of the electromagnetic baryon-resonance transition form factors (eTFF) in the time-like region is needed.
The elementary collisions, especially those with pion beams, offer a great opportunity to study eTFF in a direct way. The HADES collaboration has started these investigations with measurement of the Delta(1232) Dalitz decay in pp collisions [2]. In the next step, combined measurements of hadronic and dielectron final states have been performed in p-N reactions using polyethylene and carbon targets [3].
Two-pion channels have been included into the multichannel Partial Wave Analysis (PWA) developed by the Bonn-Gatchina group [3]. As a result cross sections for \Delta\pi. N\rho, N\sigma isobar contributions have been extracted. In particular the off-shell rho meson contribution has been obtained providing \rho-N couplings for N*(1520) and N*(1535) and extraction of the mass dependence of the effective time-like eTFF [4]. Studies of angular distributions of emitted electrons have delivered information on hadronic spin density matrix elements (the helicity structure of baryon eTFF) [5].

The results of the HADES collaboration obtained with proton and pion beams will be presented, with emphasis on the connection with the HADES results on the emissivity of baryonic matter measured in heavy ion collisions [6]. The eTFF will be compared to various versions of the Vector Dominance Model, to quark-constituent model [7] and Lagrangian microscopic calculations [5]. Prospects for HADES measurements at SIS-18 in the near future within the FAIR-Phase0 program will also be discussed.

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Collaboration

HADES

Primary author: CIEPAŁ, Izabela (Institute of Nuclear Physics PAS)

Presenter: CIEPAŁ, Izabela (Institute of Nuclear Physics PAS)

Session Classification: Plenary session