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Spin observables in pd-pd and in dd⟶n+p+d processes at NICA SPD energies

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Spin amplitudes of pN elastic scattering contain fundamental information on the dynamics of the NN-interaction and so far can not be derived from theory. Experimental data from systematic study of spin amplitudes of pp- and pn-scattering are collected in the SAID partial-wave analysis at kinetic energies below 3 GeV and 1.2 GeV, respectively [1]. At higher energies experimental data on spin amplitudes are rather incomplete for pp- and very scarce for pn-scattering, therefore, phenomenological models and corresponding parametrization of pN amplitudes [2-4] are used in analysis. Complete polarization experiment can provide spin amplitudes of pN- scattering, but is very complicated because requires measurement of ten and more observables at each collision energy. On the other hand, an effective test of existing spin pN-amplitudes can be provided by measurement of spin observables of pd-elastic scattering, that is the simplest process which charakteristics can be calculated on the basis of the spin-dependent Glauber theory of multistep scattering [5,6] involving both the pp- and pn-amplitudes.

Asymmetric mode of pd-collision will be not realized at the NICA SPD collider, but the symmetric dd-mode will be done. While the elastic dd-scattering also can be used as a test of pN- helicity amplitudes, this process is more complicated as compared to the pd-pd, and the spin dependent Glauber theory for dd⟶dd is not yet developed. In this situation we have found that spin observables A_y^p, A_y^d, A_{yy}, $_{y,y}$ of the dd⟶ npd reaction for the pole mechanism of the quasi-free pd-elastic scattering are directly related to the corresponding spin observables of the free pd- elastic scattering, for those the spin-dependent Glauber theory [5,6] with existing models of the pN spin amplitudes at suitable energies [3-5] can be applied. Most of these observables a very sensitive to contribution of spin pN amplitudes and therefore a comparison of results of such calculations with expected NICA SPD data on quasi-free pd-scattering will provide an effective test of the phenomenological pN amplitudes [7]. Furthermore, the tensor analyzing power A_{yy} in pd-pd is rather large at non-zero relative momentum of nucleons in the deuteron and much less sensitive to spin pN-amplitudes and, therefore, can be used for tenzor polarimetry at SPD NICA energies. Preliminary Monte-Carlo simulations indicate the feasibility of such measurements at the first stage of the SPD detector and more detailed studies are still being performed.

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Primary authors: DATTA, Amaresh (JINR, DLNP); DENISENKO, Igor (JINR); UZIKOV, Yuriy (JINR)

Presenter: UZIKOV, Yuriy (JINR)

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