Review on the Project

"A study of the nucleon spin structure in strong and electromagnetic interactions" (GDH & SPASCHARM & NN)

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The current project is directed to an experimental investigation of the spin structure of nucleon at three different facilities, IKP (Mainz, Germany), IHEP (Protvino, Russia) and CTU (Prague, Czech Republic). All the experiments require the use of polarized targets, that determines the key role of JINR physicists, who are the world level experts in the development and manufacture of frozen spin polarized targets.

The first part of the project is realized in SPASCHARM experiment (IHEP, Protvino) with the use of unpolarized and polarized hadron extracted beams of U70 and a modernized polarized proton target developed at JINR. The project involves the study of various one- and two-spin asymmetries in the production of mesons, baryon resonances and charmonium. The study of various exclusive and inclusive reactions with a polarized target with good statistics will make it possible to evaluate the effects of quark flavors and address the problem of the contribution of gluons to the nucleon spin at sufficiently large values of the Bjorken variable x (0.3-0.6). Measurements of spin effects in the production of charmonium in hadron-hadron interactions will be made for the first time. Thanks to large statistics, they will make it possible to separate the contributions of various processes to the charmonium production mechanism.

The second part of the project (GDH) is being carried out at the Institute for Nuclear Physics (IKP) in Mainz. This program includes experiments on measuring of two-spin observables on beams of tagged polarized photons obtained at the Mainz microtron within the framework of the A2 collaboration in the entire energy range from 0.2 GeV to a maximum energy of 1.5 GeV (MAMI C). The most important part of the experimental setup is the ^{3}He/^{4}He dilution refrigerator developed by a group from JINR (leaded by Yu.A. Usov). The horizontal geometry of the cryostat and the use of thin internal superconducting coils to maintain frozen polarization (longitudinal and transverse) allows the target to be placed inside the Crystal Ball detector with 4π geometry. The excellent parameters of the cryostat (basic temperature 30 mK, proton polarization above 90%, deuteron polarization up to 80%, polarization relaxation time about 2000 hours) provide efficient data acquisition.The two-element target insert, based on a new principle developed by the JINR group, makes target handling easy and convenient. In addition, and at the suggestion of the A2 collaboration, JINR scientists have developed an "active" polarized target using solid-state scintillating films as the working substance of the target, and measured the proton spin polarizabilities for the first time in the world.

The main objectives of the part of the project on photon beams is the study of the spin dependence of the total photoabsorption cross section and the processes of meson photoproduction on protons and neutrons. The key role of theoretical support is provided by S.B. Gerasimov, who is a member of the A2 collaboration. The well-known Gerasimov-Drell-Hearn (GDH) sum rule predicts the dependence of the spin asymmetry of the total photoabsorption cross section on the fundamental characteristics of the nucleons. S.S. Kamalov, together with theorists from Mainz, developed a package of programs for the multipole analysis of meson

photoproduction processes (MAID). S.B. Gerasimov used the MAID fit to derive experimentally verifiable relationships involving multipion neutron photoproduction cross sections, the measurement of which is an important part of the A2 collaboration program.

The project also includes the development of a cryostat for an electron polarimeter with an accuracy of 0.5% for the experiments at the MESA superconducting accelerator under construction. The experiment consists in recording the parity-nonconserving elastic scattering of electrons with an energy of 150 MeV on protons. The ultimate goal is to accurately determine the electroweak mixing angle.

The third part of the project includes experiments carried out at the Van de Graaff accelerator of the Czech Technical University with 14-MeV polarized neutrons and a polarized deuterium target, which will make it possible to study the contribution of the effect of three-particle forces (3NF) to the two-spin asymmetry of the total neutron-deuteron scattering cross section $\Delta\sigma_T$ and $\Delta\sigma_L$ (transverse and longitudinal asymmetry). Improvement of the experimental conditions will be achieved by increasing the polarization of deuterons up to 80% using the Trityl radical, as well as the intensity and polarization of neutrons up to 60%. The latter can be achieved by generating neutrons on a tritium target in the resonance region dt at an energy of polarized deuterons of about 105 keV. Deuteron polarization is carried out according to the Kaminsky method when polarized electrons are picked up from a magnetized nickel single-crystal film using the channeling effect.

The experience of the active participation of the Dubna group of physicists and cryogenic scientists in the leading spin experiments, as well as its highest level in the development of polarized targets, does not cause doubts in the fulfillment of the stated goals of the upcoming experiments of the Project.

It should be noted that the project is well balanced in terms of participation in experiments carried out on the territory of the Russian Federation and abroad. The required resources and time schedule are quite reasonable. Taking into account the significant scientific importance of the project, the high probability of obtaining new results, the decisive and key role of JINR physicists, both in the theoretical and experimental parts of the project, I recommend to the STC of the JINR Laboratories and to the JINR PAC to **approve the Project for 2024-2028 yy with the first priority.**

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