Review on the Project

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

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The current Project is directed to an experimental investigation of the QCD spin-flavor structure of nucleon at three different facilities, IHEP (Protvino, Russia), IKP (Mainz, Germany) and CTU (Prague, Czech Republic). Both experiments require the use of polarized targets, which determines the key role of JINR physicists, who are developing two frozen spin polarized targets.

The SPASCHARM part of the project , which is realized at IHEP (Protvino) with the use of unpolarized and polarized hadron beams of U70 and a modified transversely polarized proton target developed at JINR, envisages a study of various single and double-spin asymmetry in light resonances and charmonium production. Investigation of miscellaneous excusive and inclusive reactions with polarized target at very good statistics will allow to estimate quark flavor effects and to attack the problem of gluon contribution to the nucleon spin at rather high **x**-values (0.3-0.6). Measurements of spin effects in charmonium production in hadron interactions will be the first ones. Owing to the high statistics they will allow to disentangle contributions of different processes to the charmonium production mechanism. The significant progress in the preparation of the polarized target for SPASCHARM experiment has been achieved. In particularly, new magnet with high homogeneity has been developed and tested. A transistor with quartz oscillator with output power 400 mW at a frequency of 67 GHz is developed for the dynamic build-up of polarization.

The GDH part of the Project is fulfilled at the Institute of Nuclear Physics (IKP) in Mainz. The program includes double-polarization experiments at beams of tagged polarized photons of Mainz Microtron within the framework of the A2 collaboration in the whole energy region from 0.2 GeV up to maximum energy of 1.5 GeV (MAMI C). In these experiments the new frozen spin polarized target is used. The $^3He/^4He$ dilution refrigerator, as the most important part of the target facility, has been designed and constructed by the JINR group (leader Yu.A. Usov). Horizontal geometry of the cryostat and the use of thin internal superconducting coils for supporting the frozen polarization (longitudinal and transverse) allows to place the target inside the 4π Crystal Ball detector. Excellent working parameters of the refrigerator (base temperature 30 mK, proton polarization over 90%, deuteron polarization up to 80%, polarization relaxation time 1000 hours) ensure very effective data acquisition. New two-element insert based on a new principle which was developed by the JINR group makes the operation of the target easy and convenient. In addition, on the proposal of A2 collaboration JINR scientists have developed an "active" polarized target using solid-state scintillated films as a working substance of the target and firstly in the world have measured the spin polarizabilities of the proton.

Helicity dependence of the total photoabsorption and meson photoproduction processes on proton and neutron are the main goals of the GDH part of the Project. The key role in the theoretical support is provided by JINR physicists S.B. Gerasimov and S.S. Kamalov who are the members of the A2 collaboration. The well known Gerasimov-Drell-Hearn (GDH) sum rule predicts a dependence of the spin asymmetry of the total photoabsorption cross section on the fundamental characteristics of the nucleon. S.S. Kamalov together with Mainz theorists developed a package of programs for the multipole analysis of meson photoproduction processes (MAID). S.B. Gerasimov used the MAID fit to receive experimentally checkable relationships including multipion photoproduction cross section on neutrons which measurements are an important part of A2 collaboration.

The experiments carried out at the accelerator Van de Graaff of the Czech Technical University with a 14-MeV polarized neutron beam and a polarized deuteron target permit to see the effect of three-nucleon forces (3NF) in the two-spin asymmetry in the total cross section of scattering neutrons on deuterons $\Delta\sigma_T$ and $\Delta\sigma_L$ (transversal and longitudinal asymmetries). Improvement of the experiment condition will be reached with the increase of the deuteron polarization up to approximately 80 % with the use of Trityl radical and the increase of the deuteron polarization up to 60 % and the beam intensity. This may be reached with the neutron generation on the Tritium target in the resonance region of dt reaction at the energy of polarized deuterons about 105 keV. The deuteron polarization is made by Kaminsky's method at the capture of the polarized electrons from magnetized Nickel single-crystal foil by deuterons with the use of channeling effect.

The previous success of the Dubna group of physicists and cryogenic experts and its wealth of experience gained in the development of polarized targets raises no doubt in the implementation of the stated objectives of the upcoming Project experiments.

. The requested resources and time schedule are reasonable. Taking into account considerable scientific importance of the both parts of the Project under consideration; high probability to obtain pioneering results; decisive and key role of JINR physicists both in the theoretical and experimental parts of the Project, I recommend to the Scientific-Technical Board of the participating JINR Laboratories and to the JINR PAC to **approve the Project for the years 2020-2022 as the first priority.**

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