Review on the Project

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

N.A. Bazhanov et al.

The Project includes the programs of research directed to investigation of the spin structure of nucleon at three different laboratories, IHEP (Protvino, Russia), IKP (Mainz, Germany) and CTU (Prague, Czech Republic). The experiments require the use of polarized targets with frozen spin, which are being developed by JINR physicists from the Low Temperature Sector of the LNP.

The SPASCHARM part, which is realizing at IHEP (Protvino) with the use of unpolarized and polarized hadron beams of U-70 and a modernized polarized proton target developed at JINR, proposes a study of single and double-spin asymmetry in light particles and charmonium production. Investigation of different excusive and inclusive reactions with polarized target at good statistics will allow to estimate quark flavor effects and to solve 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. The development of antiproton beam opens new possibilities. Owing to the high statistics they will allow to see the contributions of different processes to the charmonium production mechanism. The new polarizing 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 has been developed for the dynamic build-up of polarization.

The GDH program includes double-polarization experiments at beams of tagged polarized photons of Mainz Microtron in the whole energy region from 0.2 GeV up to maximum energy of 1.5 GeV (MAMI C). The GDH part of the Project is planned to be fulfilled at the Institute of Nuclear Physics (IKP) in Mainz. In these experiments the new frozen spin polarized target is used. The ^{3}He/^{4}He dilution refrigerator, as the most important part of the target facility, has been designed and constructed by the JINR. 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. The good working parameters of the refrigerator (base temperature 30 mK, proton polarization over 90%, deuteron polarization up to 80%, polarization relaxation time more then 2000 hours) ensure very effective data acquisition. New 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.

The spin dependence of the total photoabsorption and meson photoproduction processes on proton and deuterons are the main goals of the GDH part of the Project. The important 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 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.**

Cand. of science

V. N. Pavlov

e-mail: pavlov1@jinr.ru

"8" April 2019