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Polarized Proton and Deuteron Source (State and Perspectives)

V.A.Aleshin, N.I.Zaika, V.S.Semenov and P.L.Shmarin

Institute for nuclear research of the Ukrainian Academy of sciences, Kiev, USSR

Polarized beams are widely used in nuclear physics. Polarization experiments give a possibility to get anumbiguous information on the role of the spin interaction in nuclear processes and to solve a number of problems of fundamental importance.

To solve some of them it is supposed to install the polarized particle source on the Kiev isochronous cyclotron U-240. The source was designed in the Institute for nuclear research of the Ukrainian Academy of sciences. It is based on the method of spatial separation of atoms with different electron magnetic moments (atomic beam method). The source arrangement is usual for conventional atomic beam sources. Hydrogen or deuterium atoms are generated by molecules dissociating in a RF discharge sustained in a dissociator pyrex tube. The atomic beam is formed and collimated by two skimmers. The discharge tube exit is a short ($d \simeq 1$) channel. With the adjustment system one can move the discharge tube 1 cm along the beam axis, 0.5 cm in the direction perpendicular to the axis and change the angle of the tube axis up to 5°. The formed atomic beam enters the sextupole separation magnet of 50 cm long. The magnetic gap is longitudinally tappered from 3 mm in diameter at the entrance to 6 mm at the middle and is constant till the end. The magnetic field is formed by coils fed by 360 A DC power supply and equals 1.3 T at the pole tips.

To enhance the polarization we use RF transitions in a weak and an intermediate magnetic fields. The oscillating magnetic field supperimposed on the static field changes the population of hyperfine substates. The two transitions, weak field ($H_o \simeq 0.8$ mT, f = = 7.5 MHz) and intermediate field with $2 \rightarrow 6$ transition ($H_o \simeq 6.2$ mT, f = 420 MHz) are used. Switching off the transitions means zero polarization. Using of this method decreases the accuracy of the experiment by the factor 1.4 as compared to the source with the same intensity and the possibility to reverse the sign of polarization but the reduction of the transition region increases the intensity and decreases the magnitude of statistical errors.

The atomic beam polarized on nuclear spin is ionized in Glavish type ionizer in the presence of the solenoid magnetic field of 0.15T. Great attention is paid to vacuum conditions in this unit. The ionizer vacuum housing is pumped by two magnetic electrodischarge pumps and liquid nitrogen trap. It is planned to mount a cryopump.

Tests of the polarized particle source showed that the vacuum system allowed to operate with gas flow rate up to 2-3 $cm^3 s^{-1}$ with no essential decrease of the atomic beam intensity as a result of scattering on the residual gas. The atomic flux density in the ionizer vicinity was about $3 \cdot 10^{15}$ $cm^{-2} s^{-1}$ when the gas flow rate was 0.76 torr Ls^{-1}.