POLARIZATION MEASUREMENTS ON IRRADIATED AMMONIA

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ABSTRACT

The polarization characteristics of ammonia irradiated at liquid helium temperatures and subsequently used in a scattering experiment are discussed.

INTRODUCTION

Over the past three years it has become evident that irradiated ammonia is a viable polarized target material.[1-3] Irradiations at 1K and 80K have shown that polarizations in the range 60-70% can be achieved. This paper reports the performance of ammonia irradiated at 0.5K by a 28.5 GeV/c proton beam.

EXPERIMENTAL DETAILS

The ammonia used in this experiment was prepared by slowly freezing it in a dry ice/alcohol bath then crushing and selecting fragments of 1-3 mm. The fragments filled the target cavity which was a cylinder 4.1 cm long and 2.9 cm diameter.

The irradiation was done with a 28 GeV/c proton beam from the AGS passing through the target cavity of a He^3 evaporation cryostat maintained at 0.5K in a 2.5T magnetic field. The polarization measurements were made with two NMR coils both surrounded by target material. The small coil was simply a thin wall tube along the axis of the cavity while the large coil consisted of a few turns of tubing of 2 cms. diameter.

The irradiation and subsequent measurments were done during setting up and data collection of a scattering experiment.[4] The history of the target is shown in Fig. 1.

During data taking the target was irradiated at $\sim 3.5 \times 10^{10}$/pulse; at other periods the rate was $\sim 10^{11}$ protons per pulse. The ammonia was annealed several times.

RESULTS

Figure 2 shows polarization vs time curves at two different points in the irradiation. Polarizations of 45-50% were achieved but only after many hours.

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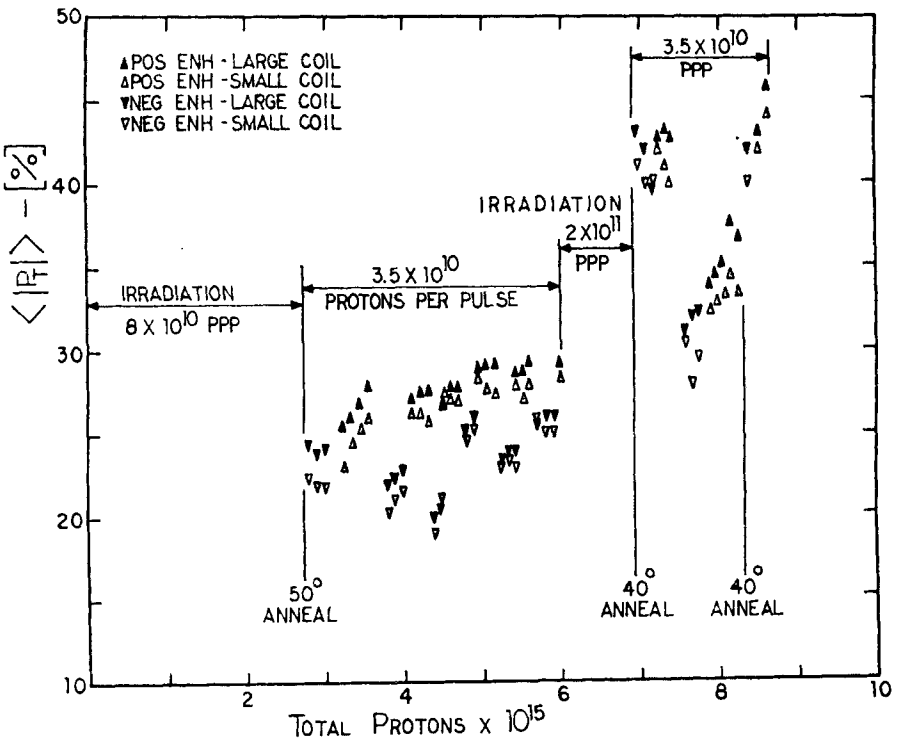

Fig. 1. Irradiation and polarization history of the ammonia target.

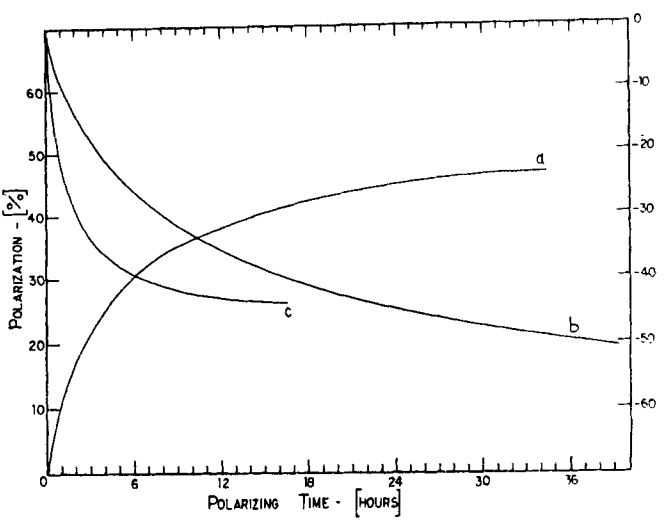

Fig. 2. Polarization vs time curves. (a) and (b) are the positive and negative polarizations respectively taken after a 50K anneal after 2.4 x 10^{15} protons through the target. (c) is the negative polarization obtained after a 40K anneal with 6.9 x 10^{15} protons through the target.

The small and large coils gave the same polarizations while the positive and negative enhancements are roughly symmetric. Curve (c) taken after further irradiation rises to ~40% much more rapidly than the earlier curves.

At intervals a microwave frequency scan was made and one is shown in Fig. 3 where the rate of change of polarization is plotted against microwave frequency.

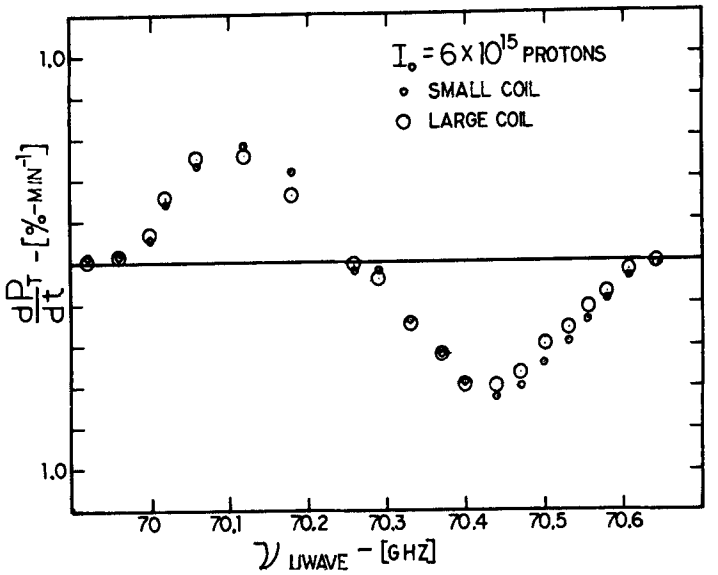

Fig. 3. Microwave frequency scan.

At the end of the run after 8.5 x 10^{15} protons had passed through the target some measurements of relaxation times were made. They are shown in Table I.

Table I Relaxation Times

Temperature °K	Large Coil Minutes	Small Coil Minutes
0.5	580	525
1.0	121	103
	After 60K anneal	
1.0	88	84

An estimate was made of the radiation damage characteristic value from the polarizations obtained during data taking and assuming an exponential decrease with total beam of the form $P = P_o \exp[-I/I_A]$. The values of I_A are shown in Table II.

Table II Radiation Damage Characteristics

Enhancement	I_A (Total Protons)	
	Large Coil	Small Coil
+	6.2×10^{15}	4.8×10^{15}
-	2.6×10^{15}	2.3×10^{15}

These values represent a resistance to radiation damage which is approximately three times better than butanol.

REFERENCES

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