

Polarized Solid State Target

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Abstract. The polarized solid state target is an indispensable experimental tool to study single and double polarization observables at low intensity particle beams like tagged photons. It was one of the major components of the Crystal-Barrel experiment at ELSA. Besides the operation of the 'CB frozen spin target' within the experimental program of the Crystal-Barrel collaboration both collaborative groups of the D1 project, the polarized target group of the Ruhr Universität Bochum and the Bonn polarized target group, have made significant developments in the field of polarized targets within the CRC16. The Bonn polarized target group has focused its work on the development of technically challenging polarized solid target systems towards the so called '4 π continuous mode polarized target' to operate them in combination with 4 π -particle detection systems. In parallel, the Bochum group has developed various highly polarized deuterated target materials and high precision NMR-systems, in the meantime used for polarization experiments at CERN, JLAB and MAMI, too.

1 Introduction

Within the recent decades polarized solid targets as well as polarized particle beams evolved into indispensable tools in order to explore the spin structure of the proton and the neutron. Single and double polarization measurements were performed with a variety of different particles beams, among them not only experiments with polarized electrons and real photons. Protons, antiprotons and even polarized muons have been used so far at various laboratories [1]. (Double) polarization experiments at ELSA [2, 3] with tagged photon beam fluxes in the order of some megahertz have to rely on polarized solid targets with high target densities in order to provide sufficient luminosities of the particle reactions of interest. The developments of the polarized targets for particle physics experiments at ELSA within the CRC16 were twofold. On the one side we focussed on the enhancement of the figure of merit (FOM), which is defined as the product of the number n_t of target particles per cm^3 , the squared target polarization P_t^2 and the squared ratio f^2 of the number of polarizable nucleons and the total number of nucleons in the target. Improvements in P_t and f are directly related to the search and preparation of suitable target materials and need a detailed understanding of the dynamic nuclear polarization (DNP), as given by the spin temperature theory (for an overview we refer to [1] and for deeper studies see [4]).

On the other hand we worked on a significant enhancement of the luminosity L and angular acceptance $\Delta\Omega$ of the polarized target beyond the standard 'frozen spin technique'

towards the so called 'large angular continuous mode target' or '4 π continuous mode polarized target'. The goal is to enhance the reaction counting rate N , which is defined as $N = L \cdot d\sigma/d\Omega \cdot \Delta\Omega$, and thus to improve considerably upcoming polarization experiments. The new scheme led to challenging and outstanding developments in cryogenics and superconducting magnet technology in the field of polarized solid state targets.

Besides the developments of new polarized target components and materials we operated the existing 'CB frozen spin target' (former 'GDH frozen spin target') as a major component of the Crystal Barrel experiment at ELSA for (double) polarization experiments.

Over the period of the CRC the goals and methods of the Bochum polarized target group focused on intense research on polarized target materials and their polarization behavior and the design and construction of more accurate as well as sensitive polarization measurement equipment. The broad spectrum of research covered the following topics:

- construction of a 'top-loading' ^4He refrigerator for target material research
- pulsed and CW NMR for polarization measurements [5, 6]
- polyethylene and other oxygen-free hydrocarbons (alkanes) as polarized target materials
- radiation resistance of target materials with spinless spectator nuclei for high intense particle beam experiments

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in rendering the algorithms which arise in relativistic studies tractable This has been exemplified in atomic structure theory where the dominant role of the central nuclear charge simplifies the problem enough to permit some prediction to be made with high precision especially for the highly ionized atoms of importance in plasma physics and in laser confinement studies Today s sophisticated physical models of the atom derived from quantum electrodynamics would be intractable without recourse to modern computational machinery Relativistic atomic structure calculations have a history dating from the early attempts of Swirls in the mid 1930 s but continue to provide one of the primary test beds of modern theoretical physics

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