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PROGRESS IN APPLYING STABLE ATOMIC HYDROGEN METHODS TO POLARIZED PROTON SOURCES AND JETS

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Résumé - Nous résumons brièvement les progrès obtenus par l'utilisation de techniques de polarisation de l'hydrogène atomique pour produire des protons polarisés.

Abstract - Progress in using spin-polarized hydrogen techniques to produce polarized protons is briefly summarized.

The possibilities of applying the techniques of spin-polarized atomic hydrogen ($H\downarrow$) to provide polarized protons for application in particle and nuclear physics were recognized soon after the creation of spin-polarized hydrogen /1,2/. The basic science of $H\downarrow$ has been described in a recent review article /3/, and various experimental approaches have been described in previous conferences /4,5/. This brief account summarizes work in progress toward practical polarized proton jets and sources.

T. Niinikoski and his colleagues at CERN have produced $H\downarrow$ in an apparatus adapted from a dynamically polarized proton target, shown in Fig. 1. Atomic hydrogen enters via a Teflon tube (PTFE tube) and passes through a thermalizing region where it is cooled to approximately 0.3K. Atoms in the "down" electron spin state are magnetically attracted to the liquid helium-lined chamber in the stabilization solenoid; atoms in the "up" state are repelled. By using microwave radiation to drive an electron spin flip transition, atoms in a selected hyperfine state are ejected, forming an intense polarized atomic beam which can be used for a polarized proton source or target.

$H\downarrow$ has been created and studied in this apparatus with the exit window sealed, i.e., in a "closed" geometry. Tests are in progress on the "open" cell geometry. The principle challenge in an open cell is to control the superfluid He^4 film which is needed to prevent hydrogen recombination on the walls. The film naturally flows to high temperature areas, and can cause a thermal short circuit. This problem is avoided by film burners which evaporate the film and allow it to condense in a region of high refrigeration power. This system is currently under test.

Fig. 1. Spin-polarized hydrogen apparatus in use at CERN. Courtesy of T.O. Niinikoski.

A polarized proton jet is under design and construction by the university of Michigan Polarized Proton Group, in collaboration with the Spin-Polarized Hydrogen Group at M.I.T., and Brookhaven National Laboratory. The design goal is a column density at the jet's focus of 10^{14} particles cm^{-2} . Operation will be pulsed with a period of 2.5 s, and a duty cycle of 10%. The cryostat, refrigerator and storage cell are shown in Fig. 2.

The realization of polarized sources and jets involves such considerations as the design of beam optics /5/, transport, relaxation and recombination processes within the storage cell, and the design of an efficient microwave system. Work on these will be reported elsewhere.

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Fig. 2. Spin-polarized hydrogen polarized proton jet under construction by the Michigan-MIT-Brookhaven collaboration. Courtesy of the University of Michigan Polarized Proton Group.

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