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PRODUCTION OF STABILIZED ATOMIC
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THE UNIVERSITY OF IOWA APPARATUS FOR PRODUCTION OF STABILIZED ATOMIC HYDROGEN

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Abstract.- We have completed the detailed design and most of the construction of a low temperature apparatus for preparation of stabilized atomic hydrogen, based on a proposed production method described previously (J. Physique 39 (1978) C6-108). We will briefly describe the apparatus which includes a microwave source of atomic hydrogen, a dilution refrigerator capable of temperatures below 0.1 K, a 11 T superconducting magnet, and a dewar with access from the bottom for introduction of the atomic hydrogen.

1. INTRODUCTION.- The goal of preparing moderate density spin-polarized hydrogen (say \(10^{13} \text{H}/\text{cm}^3\)) in order to observe for the first time a near ideal Bose-Einstein Condensation is still some distance in the future. Nevertheless, encouraging magnetic resonance experiments at 4 K with atomic hydrogen densities approaching \(10^{14}/\text{cm}^3\) were recently carried out /1-2/. Very recently an exciting report /3/ of magnetic-field-induced stabilization of \(-2 \times 10^{14} \text{H}/\text{cm}^3\) for 532 seconds appeared; interestingly, relatively mild conditions (0.27 K, 7 T or 26 T/K) were employed compared to a previously suggested /4/ stability criterion of 100 T/K (at high densities of \(\geq 10^2\)/cm\(^3\), even more extreme conditions are presumably required /5-6/). We are in the final stages of construction of a system capable of >100 T/K, which, unlike the ingenious Amsterdam system /3/, should also be stable with respect to thermal leakage of \(\text{H}^+\) out of the high magnetic field region /7/; \(\tau\) is calculated to be \(\geq 10^{13}\) seconds.

2. DESIGN FEATURES.- The apparatus under construction is the physical embodiment of a schematic design given previously /8/. An S.H.E. dilution refrigerator used in previous tritium-solid hydrogen experiments /9-11/ is being refitted with a new custom-designed S.H.E. tail assembly. This tail assembly sits inside the 2" bore of an 11 T superconducting magnet, which in turn is inside a 10" O.D. dewar tail. The bottom of the dewar mates to a separate hydrogen atom source dewar which is located in a pit directly below the dilution refrigerator and below floor level. The beam from a room temperature microwave (27 MHz) hydrogen atom source is fed into the source dewar; the atoms undergo one or more collisions with liquid helium cooled walls and proceed upward through the bottom of the dewar tail and into the dilution refrigerator tail assembly inside the magnet bore.

The tail assembly is more or less cylindrically symmetric and configured as follows: at the top (but inside the magnet) is the brass mixing...
chamber supported from above; below that is a small Cu support rod from which is suspended a long cylindrical Cu shield. On the central axis within the cylinder is the cylindrical sample cell with 3 mm tubes above and below. The tube above provides support only, while the tube below provides access to the sample cell for the H atoms arriving from below; the sample cell is cooled through a variable thermal link to the mixing chamber. The sample cell is centered vertically with respect to the center of the superconducting magnet. The cell is equipped with a capillary inlet from above for introducing $^3$He or $^4$He for wall coating and with a resistance thermometer for detecting temperature rises expected (as in previous experiments 19-11). Further details including heaters, thermometers, shields, etc. are available from the authors. Final components of the tail assembly are scheduled for delivery in early June 1980, so preliminary experiments should be underway this Summer.

3. ACKNOWLEDGMENT.- Discussions with Ray Szarwinski, Duane Crum and Gene Hirshkoff of S.H.E. Corporation are gratefully acknowledged, as is the support of the National Aeronautics and Space Administration.

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