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C. Larat, P. Nacher, M. Leduc

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OPTICAL PUMPING OF ^3He and $^3\text{He} - ^4\text{He}$ MIXTURES WITH A HIGH POWER INFRARED LMA LASER

C. LARAT, P.J. NACHER and M. LEDUC

Laboratoire de Spectroscopie Hertzienne⁽¹⁾, 24 rue Lhomond, F-75231 Paris cedex 05, France

Optical pumping is an efficient method to create electronic orientation in the excited metastable state 2^3S_1 of helium through the 2^3S-2^3P line at $1.08\mu\text{m}$. In the case of ^3He , nuclear polarization builds up in the ground state as a result of hyperfine coupling and metastability exchange collisions. In view of the numerous applications of spin polarized ^3He (magnetometers, targets for nuclear physics, neutron, spin filters and quantum fluids at low temperature), we tried to improve the results of this optical pumping method. The lamp pumped Nd doped LMA lasers were developed. They now deliver up to 5 Watts of continuous power tunable around $1\mu\text{m}$. The laser cavity contains a 10cm long LMA rod doped with 15% Nd and shaped with concave curved ends to compensate for the thermal lensing resulting from lamp heating. A linewidth of 2GHz, matching the Doppler absorption profile of the atoms, is obtained with two uncoated etalons in the laser cavity, tuned by temperature control of the glass. With this laser, nuclear polarizations over 80% were recorded in a gas of pure ^3He at pressures in the torr range. These studies were extended to $^3\text{He}-^4\text{He}$ mixtures. Pumping on one of the ^4He lines results in nuclear polarization of ^3He through metastability exchange collisions between different isotopes. In some cases, higher ^3He polarizations can thus be obtained in $^3\text{He}-^4\text{He}$ mixtures than in pure ^3He . A systematic experimental and theoretical study was carried on with isotopic mixtures of various proportions. One interesting result is the large nuclear polarization obtained at low laser power (over 25% of ^3He polarization per milliwatt of laser power was observed in some situations).

⁽¹⁾Unité de recherche de l'École Normale Supérieure et de l'Université Paris VI, associée au CNRS (URA 18)