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► **To cite this version:**

Alexander Makarchenko, Vyacheslav Kuzmin, Kajum Safiullin, Murat Tagirov, Zeyuan Zhang, et al. Progress in polarization of ^3He atoms in a magnetized plasma (PAMP). 19th European Magnetic Resonance Meeting (EUROMAR 2023), Jul 2023, Glasgow, United Kingdom. , <https://euromar2023.org/wp-content/uploads/2023/07/PA-Book-v3.pdf>. hal-04334228

HAL Id: hal-04334228

<https://hal.science/hal-04334228>

Submitted on 10 Dec 2023

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Progress in polarization of ^3He atoms in a magnetized plasma (PAMP)

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Introduction

Hyperpolarization techniques allow a strong increase in NMR sensitivity, most often by many orders of magnitude. The recently discovered PAMP technique yields significant ^3He polarization at high magnetic field strength, simply obtained by firing a strong rf discharge in the gas [1]. It is a promising alternative to laser-based hyperpolarization in pure helium gas by metastability exchange optical pumping [2]. The physical mechanism of PAMP remains to be firmly established.

Aim

The reported new investigations aim at further exploration of PAMP dynamics and conditions for improved efficiency, as well as at a deeper insight on the polarization build-up process.

Methods

^3He gas contained in sealed glass cells [3] of different shapes was polarized in a magnetized plasma from room to 200°C temperature at 3.66 T [4]. Filling pressures lied in the few millibars range and rf powers of up to 60 W were applied to a wired coil to sustain the discharge. Nuclear polarization was monitored by NMR. Simultaneously, the optical fluorescence spectrum of the plasma and the cell temperature were recorded.

Results:

A set of ^3He polarization build-up curves were obtained for a wide range of applied rf power. Correlations between the ^3He steady-state polarization values and the atomic oxygen impurity number density and cell temperature measurements were observed. A ^3He polarization as high as 8% was reached.

Discussion

The collected data indicate that higher polarization values should be achievable with higher rf discharge power and gas temperature. Further investigations of PAMP and in-depth studies with complementary diagnostic tools are planned [5]. They will assess the potential of this

technique for a variety of NMR-based applications. They will also help for the development of suitable models of PAMP.

[1] A. Maul et al., doi.org/10.1103/PhysRevA.98.063405

[2] T.R. Gentile et al, doi.org/10.1103/RevModPhys.89.045004

[3] A. Makarchenko et al., doi.org/10.1134/S0020441221050213

[4] A. Makarchenko et al., doi.org/10.1103/PhysRevA.106.023101

[5] HELPING project, anr.fr/Project-ANR-20-CE30-0021

