Hyperpolarised $^3$He gas - Projects at low and high magnetic fields

Innovative methods for low field NMR and MRI

Low field work at LKB: MRI with $^3$He (laser-polarised gas) / $^1$H (thermally-polarised water)

Towards 3D TRASE MRI:

- MARGIN collaborative project
- Fast relaxation
- field dependence? Way around?

Low field work at LKB:
- Context and motivation

Breakdown of RWA in low field NMR

- 2-level quantum systems have similar time evolution
- MARGIN collaborative project (with Kazan Fed. Univ, 2020-2022)

Context, motivation
- High and low T (300 K-1.5 K), high and low densities
- Wide range of time and distance scales.
- Experimental and theoretical studies.

Current / planned work at LKB

- Probe gas diffusion by NMR (Experimental and theoretical studies).
- Optically detected NMR (new)

Optical pumping in $^3$He gas: MEOP

- Context, motivation
- Fast relaxation systematically observed at high OP power.
- Contribution of 1$^1S$-2$^3P$ excitation transfer collisions
- Field dependence? Way around?

Current / planned work at LKB

- Towards 3D TRASE MRI: Evaluation of image artefacts
- Breakdown of RWA in low field NMR

High field hyperpolarisation in helium plasmas

Optical detection of spin dynamics in $^3$He NMR

- Optical pumping in $^3$He gas: MEOP
- Discharge polarisation: PAMP

Pre-clinical lung MRI
with (inhaled) laser-polarised $^3$He gas

- Low field studies
- Gradient-free TRASE MRI

INTERNSHIP PROJECTS & PhD TOPICS

All involve hands-on NMR or MRI experiments
- Measurements on polarised gas or water samples.
- Advanced data analysis based on lattice simulations.

Optically detected NMR (new)
- sensitive detection of dynamics of all M components
- Gas diffusion studies in nanoporous materials (MARGIN)
- e.g., anisotropic aerogels, effect of wall interactions
- Impact of restricted diffusion on image quality

Computer lattice simulations - In vitro experiments
- Artefacts and limitations in gradient-free imaging
- Bloch Siegert effects - Concomitant RF gradients

INTERNSHIP PROJECTS & PhD TOPICS

- Measurements of AOC in rf He gas discharges
- Laser-induced polarisation losses in $^3$He-$^4$He mixtures
- Laser-induced polarisation losses at 0.1T

PhD TOPICS

- Laser-induced polarisation losses in high-B MEOP (7 T)
- High-B MEOP & PAMP in $^4$He-$^3$He gas mixtures
- High-B MEOP & PAMP at low temperature (down to 4 K)

Improved predictive models for MEOP, for PAMP
- In situ operation of $^3$He MR magnetometers

Please come and visit us!

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http://www.lkb.science/polarisedhelium/