Towards 3D TRASE MRI: Breakdown of RWA in low field NMR

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

Current / planned work at LKB
- Towards 3D TRASE MRI: Evaluation of image artefacts
- Breakdown of RWA in low field NMR
  - 2-level quantum systems have similar time evolution
- MARGIN collaborative project
  - with Kazan Fed. Univ. (2020-2022)
  - Magnetic Resonance studies of gas diffusion in nanoporous materials

Probe gas diffusion by NMR of \(^3\)He and \(^{129}\)Xe
- \(^3\)He: high and low T (300 K - 1.5 K), high and low densities
- wide range of time and distance scales.
  - Experimental and theoretical studies.

Gas diffusion studies in nanoporous materials
- Impact of restricted diffusion on image quality
- Advanced data analysis, based on lattice simulations.
- Measurements on polarised gas or water samples
  - e.g., anisotropic aerogels, effect of wall interactions

B - High field hyperpolarisation in helium plasmas

Optical pumping in \(^3\)He gas: MEOP
- Fast relaxation systematically observed at high OP power
- Physical mechanism? Field dependence? Way around?

Discharge polarisation: PAMP
- Alignment-to-orientation conversion + metastability exchange
- Preliminary expectations: numerical toy model

Current / planned work at LKB
- On going PhD work: low field MEOP study
  - Contribution of \(^1\)S-\(^2\)P excitation transfer collisions
- Next steps: 3 mT – 0.1 T studies
  - Plasma – OP beam matching for MEOP
  - First optical investigations of PAMP
  - Preparation of 7 T studies
    - Design of optical and NMR experiments
    - Design of low T optical systems
    - MEOP of \(^3\)He-\(^4\)He mixtures

Two applications of high-field \(^3\)He polarisation:
- Zeeman magnetometers accuracy dB/B = \(\leq 10^{-12}\)
  - Demonstrated with high-B OP (2013), with PAMP (2018)
- Polarised \(^3\)He targets and ion beams

INTERNSHIP PROJECTS
- Laser beam shaping for improved MEOP efficiency
- Measurements of AOC in \(^3\)He gas discharges

PhD TOPICS
- Laser-induced polarisation losses in high-B MEOP (7 T)
- High-B MEOP & PAMP in \(^3\)He-\(^4\)He gas mixtures
- High-B MEOP & PAMP at low temperature (down to 4 K)
  - Improved predictive models for MEOP, for PAMP

Privileged access to a 7-T spectrometer installed Aug. 2018 at CEA Saclay (WideMR project)

http://www.lkb.science/polarisedhelium/  Please come and visit us!