

# Spécialité de Master « Optique, Matière, Plasmas »

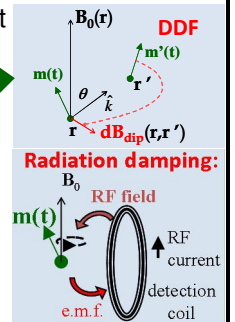
Stage de recherche (4 mois minimum, à partir de début mars)

Date de la proposition : 30 Octobre 2013

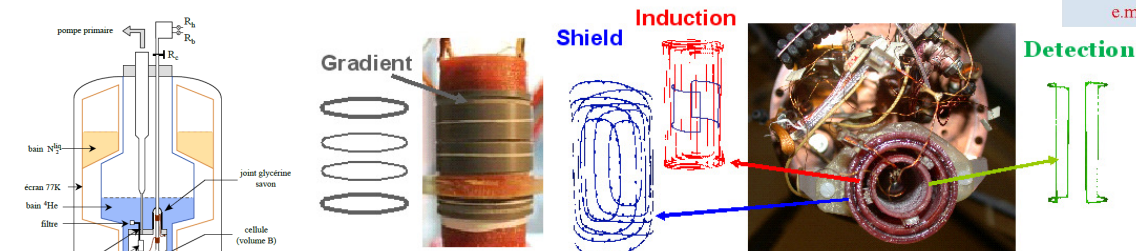
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<b>Nom du Laboratoire / laboratory name: Laboratoire Kastler Brossel</b>	
Code d'identification : UMR 8552	Organisme : ENS / CNRS / Paris 6
Site Internet / web site: <a href="http://www.lkb.ens.fr/-Helium-polarise-et-fluides-">http://www.lkb.ens.fr/-Helium-polarise-et-fluides-</a>	
Lieu du stage / internship place: ENS 24 rue Lhomond 75005 Paris, pièce L164 / P5	

## Non-linear spin dynamics in liquid NMR

**Context :** Hyperpolarisation or high magnetic fields provide high S/N ratios in liquid-state NMR but also lead to non-linear and ill-controlled dynamics (precession instabilities, multiple spin echoes...) due to distant dipolar fields (**DDF**, from the distant parts of samples since the field of neighbors is averaged out in liquids) and/or radiation damping (**RD**, from coupling to the detection coil).  
See, e.g., H. Desvaux, *Prog.NMR Spectr.* 70 (2013) 50.

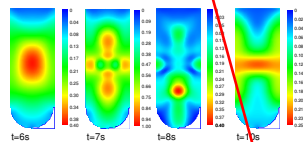
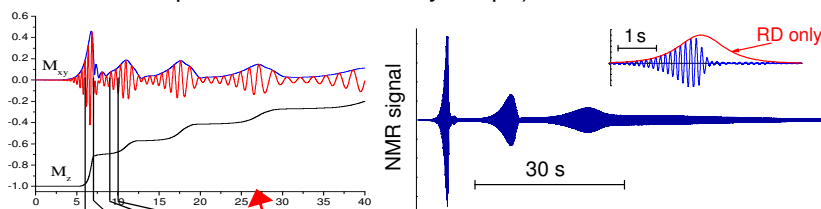


Our group at LKB performs **low field studies** with laser polarised liquid  $^3\text{He}$ - $^4\text{He}$  mixtures (at 1K) with full control of **RD** (with a non-magnetic  $^4\text{He}$  cryostat, optical pumping of  $^3\text{He}$  gas at room T, dissolution in superfluid  $^4\text{He}$ , and NMR in 2.2 mT field).

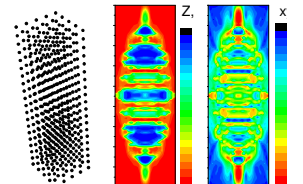


Elements of our experimental setup, with sets of NMR coils used in various experiments on hyperpolarised liquid helium.

We also perform **numerical simulations** (exact calculation of time evolution of coupled magnetic moments on a cubic lattice, integrating the non-linear Bloch equations in 3D unit cells; up to  $10^7$  sites, arbitrary shape).



Experimental and numerical multiple maser emissions with fast atomic diffusion ( $^3\text{He}$ )



Simulated maser emission with slow atomic diffusion ( $^{129}\text{Xe}$ )

Comparison of **numerical** and **experimental** data provides a deep insight on collective behaviours resulting from the balance of competing processes.

More details: [www.lkb.ens.fr/Instabilites-de-precession-et](http://www.lkb.ens.fr/Instabilites-de-precession-et)

**Internship project:** In-depth experimental and/or numerical studies of combined non-linear phenomena in liquid NMR, in particular on the recently observed multiple MASER emissions.  
This will be combined with time reversal control in a **PhD** work  
[www.lkb.ens.fr/-Offres-de-theses-et-stages-](http://www.lkb.ens.fr/-Offres-de-theses-et-stages-)

<b>Ce stage pourra-t-il se prolonger en thèse ? Possibility of a PhD? : OUI</b>	
<b>Si oui, financement de thèse envisagé/ financial support for the PhD: Contrat doctoral ou BDI</b>	
Lasers, Optique, Matière	<b>X</b>