Overhauser Dynamic Nuclear Polarization Instrument Development

Dubroca, T. (NHMFL); Akinfaderin, A. (NHMFL and FSU, Physics); Brey, W.; Frydman, L. (NHMFL and Weizmann Institute, Israel); Hill, S. (NHMFL and FSU, Physics); Long, J. (NHMFL and UF, College of Medicine); Trociewitz, B.; van Tol, J., Wi, S. (NHMFL)

Introduction

The EMR and NMR groups at the NHMFL are jointly developing a new spectroscopic tool, exploiting the so-called Overhauser effect to achieve Dynamic Nuclear Polarization (DNP) at high fields for studies of small molecules dissolved in non-polar organic solvents. DNP based on the Overhauser effect is a novel approach to NMR which can provide increases in sensitivity of up to an order of magnitude compared to traditional liquid state NMR, thereby greatly enhancing/expanding the utility of this powerful technique. Currently, the highest field at which Overhauser DNP has been demonstrated is 9.4 T by the Prisner group in Germany.[1] The NHMFL DNP Team are designing and building a new instrument with a goal of raising the bar to 14.1 T.

Instrument development

The key component of the instrument is a gyrotron source capable of producing up to 50 W of continuous microwave radiation at 395 GHz. A custom designed quasi-optical microwave transmission and control system has been built in collaboration with Thomas Keating Ltd in the UK. Upon exiting the quasi-optics, the microwaves propagate through a corrugated transmission line within the NMR probe all the way to the sample located at the 14.1 T field center of the NMR magnet. This instrument is in its final stages of construction (Fig. 1).

The high power microwaves are used to polarize electron spins (by EPR) associated with organic radicals dissolved together with the target molecule. Under the right conditions, the electron spins can transfer their non-equilibrium polarization to the nuclear spins in the target molecules via the Overhauser effect, thereby significantly enhancing the nuclear polarization and, hence, NMR sensitivity.

Acknowledgements

This work is supported by a grant from the National Science Foundation (CHE-1229170). A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

References

[1] Jakdetchai, O., *et al.*, J. Am. Chem. Soc., **136**, 15533–15536 (2014).

Fig.1. The Overhauser DNP instrument.