Broadband Inverse-Detected 2D Localized High-Field 13-C MRS

A. Leftin, B. Baiysha (Weizmann Institute); J. Rosenberg, F. Calixto-Bejarano, V. Schepkin, S. Grant (NHMFL); Lucio Frydman (Weizmann Institute, NHMFL)

Introduction

The 21.1 T MRI/NMR system at the National High Magnetic Field Lab (NHMFL) provides the highest sensitivity available for localized *in vivo* biomolecular spectroscopy. When combined with unique double-resonant animal imaging RF probe technology being developed on-site, challenging spectroscopic measurements of in vivo metabolic flux in localized regions are made possible. In order enable the two-dimensional (2D) detection of ^{13}C stable isotopes we designed and implemented localized, broadband heteronuclear 2D pulse-sequences and tested the sensitivity gains afforded by the new probe technology at the NHMFL.

Experimental

Two-dimensional heteronuclear localized magnetic resonance spectroscopy (MRS) experiments were implemented on Paravision 5.1 and Topspin on the NHMFL Bruker Avance III spectrometer operating at 21.1T. Heternuclear multiple quantum coherence (HMQC) experiments (Figure 1a), and hybrid HMQC and heteronuclear single-quantum coherence (HSQC) experiments (Figure 1b) were designed using either PRESS or STEAM based three dimensional gradient localization strategies in combination with gradient assisted coherence pathway selection. Fully adiabatic heteronuclear ^{13}C excitation and storage was carried out using a uniform-phase broadband (UPB) scheme which makes use of frequency swept pulses optimized for challenging ultra-high field applications using MRI probe technology. The sequences were tested using a variety of phantoms including [U-^{13}C] glucose (Figure 1c).

Results and Discussion

Initial results obtained on the 21.1T NHMFL imaging platform demonstrate the sensitivity advantage afforded by the ultra-high filed and NHMFL probe technology as compared with low-field experiments. Moreover, the requisite for UPB heteronuclear pulses was demonstrated for broadband inverse-detection of ^{13}C-^{1}H coherences in metabolites of interest.

Conclusions

Increased resolution and sensitivity afforded by the 2D ^{13}C MRS experiments in combination with ultra-high field and new probe technology at the NHMFL can further improve signal detection of isotope markers, and enhance spectral resolution both with respect to natural abundance ^{13}C resonances arising from lipids and amino acids, as well as isotopically enriched metabolite products. *In vivo* demonstration of these gains using natural abundance and isotope tracers is currently being evaluated.

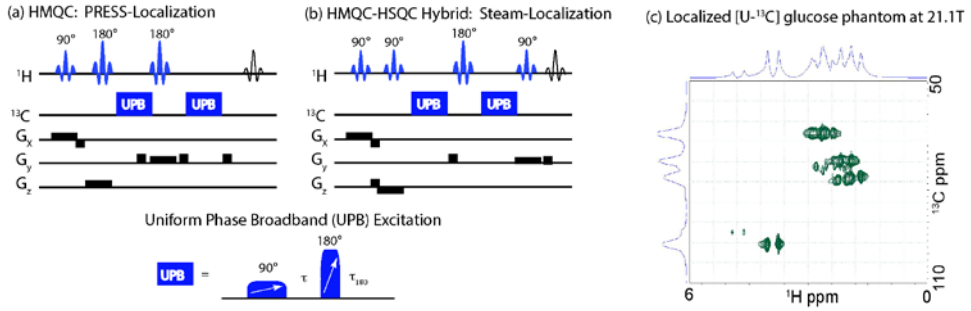

Figure 1. 2D Localized Inverse-Detected Heteronuclear Sequences for *In Vivo* Biomolecular MRS and Validation on a [U-^{13}C] Glucose Phantom at 21.1T.

Acknowledgements

Funding is acknowledged from Fulbright Award (A.L.), NSF IRFP CHE 1064075 (A.L), Minerva Foundation (L.F.), Metaflux (L.F.)