TECHNIQUES AND BIO-MEDICAL APPLICATIONS OF FIELD-CYCLING MAGNETIC RESONANCE

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NMR relaxometry refers to the measurement of relaxation times (usually T_1) as a function of magnetic field strength. It is usually accomplished using fast field-cycling (FFC), in which the magnetic field is switched rapidly between levels during the pulse sequence. By switching the magnetic field, the nuclear spins can "evolve" at a chosen magnetic field strength, after which the magnetic field is switched to the "detection" magnetic field, which is the same for every repetition of the pulse sequence. In this way, a single instrument can be used to measure T_1 over a wide range of magnetic field strengths. FFC-NMR relaxometry of small samples has been in development for several decades, and is now used routinely in many laboratories, using commercially-available relaxometers. In recent years the use of FFC with magnetic resonance imaging (MRI) has been increasing, often using home-built equipment.

Relaxometric MRI is the imaging equivalent of field-cycling relaxometry. The aim is to obtain spatially-resolved T_1-dispersion data, by collecting images at a range of evolution field strengths [1,2,3]. We have recently demonstrated methods for implementing relaxometry on localised regions defined on a pilot image [4]. We have also shown that FFC relaxometry can detect the formation of cross-linked fibrin protein from fibrinogen *in vitro*, in a model of the blood clotting process, via the measurement of ^{14}N-^{1}H cross-relaxation phenomena [5], and we have demonstrated that FFC-MRI can detect changes in human cartilage induced by osteoarthritis [6]. Recent work has focussed on speeding up the collection of FFC-MRI images by incorporating rapid MRI scanning methods and improved pulse sequences and algorithms [7,8].

In our lab we have built a range of FFC-MRI equipment, including two whole-body human sized scanners, operating at detection fields of 0.06 T [9] and 0.2 T. The 0.06 T scanner uses a double magnet, with field-cycling being accomplished by switching on and off a resistive magnet inside the bore of a permanent magnet; this has the benefit of inherently high field stability during the detection period. Our newest scanner (0.2 T) uses a single resistive magnet, giving increased flexibility at the expense of greater complexity and susceptibility to magnetic field fluctuations.

This presentation will cover some of the techniques used in FFC-NMR and FFC-MRI and will summarise current and potential bio-medical applications of the methods.

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