Exploiting T1-dispersion using human-scale fast field-cycling MRI

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Much of the contrast in conventional MRI arises from disease-induced changes in T1. Extra information could be obtained from T1-dispersion measurements (T1 versus magnetic field), but this information is invisible to standard MRI scanners, since they operate only at fixed magnetic field (e.g. 1.5 T, 3.0 T). We have developed Fast Field-Cycling Magnetic Resonance Imaging (FFC-MRI) to exploit T1-dispersion as a potential biomarker of disease, with the aim of increasing diagnostic potential.

T1-dispersion is typically measured using FFC, by switching the magnetic field rapidly between levels during the pulse sequence; relaxation occurs at the (low) evolution field while detection is always at the same (higher) detection field. Thus, a single instrument can be used to measure T1 over a wide range of magnetic field strengths. FFC-MRI obtains spatially-resolved T1-dispersion data, by collecting images at a range of evolution fields.

We have built a variety of FFC-MRI equipment, including two whole-body human scanners, operating at detection fields of 0.06 T and 0.2 T. Recent work has focused on speeding up FFC-MRI using rapid pulse sequences, as well as the investigation of methods to measure T1-dispersion at ultra-low magnetic fields.

In vitro measurements in our laboratory have shown that FFC can detect changes in human cartilage induced by osteoarthritis; we have also demonstrated that T1-dispersion is sensitive to cancer-induced changes in breast tissues. We are exploring clinical applications and have imaged patients who have had an ischaemic stroke; the affected brain tissues are seen as hyper-intense regions in ultra-low-field (200 μT) FFC images.

This presentation will cover the main techniques used in FFC-MRI and will summarise current and potential bio-medical applications.

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