Special University Oral Examination

**SPIN-MANIPULATION METHODS FOR EFFICIENT MAGNETIC RESONANCE IMAGING**

Brian A. Hargreaves

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(Lunch served at 11:30 AM in Room 101)

**ABSTRACT**

Magnetic resonance imaging (MRI) is a powerful, non-invasive medical imaging modality that provides excellent soft-tissue contrast compared with other methods. Although MRI is extensively used in clinical practice, reductions in imaging times and improvements in image contrast are still possible. In MRI, the "spins" of atomic nuclei align with a strong magnetic field in equilibrium. They can be excited magnetically to a state where they give off a signal that can be used to form an image. Two excitation methods that allow for different types of diagnostically useful contrast will be presented.

Driven equilibrium is a technique where spins are excited, but after imaging, are driven back towards their equilibrium state. In imaging the knee, a bright cartilage signal results, allowing good visualization of cartilage structure. Additionally, the much brighter fluid signal provides contrast that is helpful in identifying regions of abnormality in the joints. Driven equilibrium is compared with other knee imaging methods theoretically, and clinical results are shown.

In "steady state" imaging methods, spins are excited periodically at a rate that is sufficiently rapid that they never return to equilibrium, but rather reach a certain steady state. The transient time, during which the steady state evolves can be long, and is typically not useful for imaging. A new analysis of the transient dynamics of steady state methods suggests methods of spin-manipulation to speed up the evolution of the steady state. Results using these methods are shown from simulations and actual experiments.