Magnetic Resonance Microscopy of Mammalian Cells

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DMR-Award 0654118

AMRIS User Program, University of Florida

- Magnetic Resonance Microscopy has evolved over the last quarter century as a major subset of MRI. Still, limitations in signal-to-noise ratio have restricted cellular level MR to the study of relatively large cells (frog ova, *Aplysia* neurons, and some plant cells).

- Using high magnetic fields and new radio frequency microcoils, we have for the first time visualized real mammalian cells (rat neurons – see left cover image) and obtained nerve fiber track maps at the cellular level (see right cover image), both with direct histological correlation.

- Additionally we have data visualizing, for the first time, human brain cells on freshly excised human brain tissue.

- On frog ova we have visualized the nucleoli, the first time cellular substructure in single cells has been visualized using Magnetic Resonance Microscopy.

Left: Flint *et al.*, *NeuroImage* 2009 15;46(4):1037-40
Right: Flint *et al.*, *NeuroImage* 2010 15;52(2):556-61

These data, in collaboration with colleagues in Denmark and Canada, recently supported an NIH proposal on the development of an MR microscope to further advance the state-of-the-art in MR microscopy.

This research is supported by DMR-0654118 (Stephen J. Blackband *et al.*); DSR(UF)-00072725; Aarhus (Denmark)-00077476.

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-Using the cellular level data, S.J. Blackband and his colleagues intend to construct working mathematical models of Magnetic Resonance signals in tissues that in turn will improve the sensitivity and specificity of Magnetic Resonance Imaging.

- So far the studies are on fixed tissue, since data acquisition requires several hours. Through new NIH funding, the long term goal is to improve sensitivity so that perturbation studies may be performed at the cellular level on live human tissues.

- These MR microscopy methods have broader application to materials, and the group has begun exploratory studies in plants and polymers to address diffusion and sample degradation.

- New rf microcoils and small planar gradients are being tested and offer further improvements, as does the move to even higher field strengths (>600MHz). This work proceeds in collaboration with Bruker Instruments and colleagues in Denmark and Canada. We plan to compete to become an NIH Center for MR Microscopy.

- Danish support includes training students and postdocs through international workshops. The first was held at UF (fall 2009), the second will be in Denmark (2011). These results are being presented at several international meetings, the Gordon Conference on *In Vivo* MRI and an upcoming workshop on cutting edge neuroscience (UCL, England, September 2010).