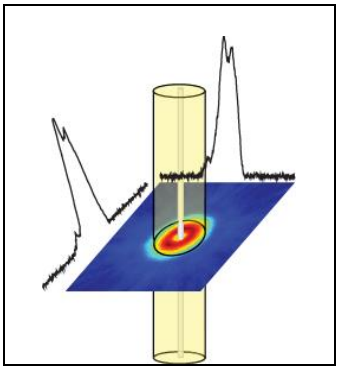
Cutoff-free Traveling Wave NMR

Joel Tang[a], Alexej Jerschow[a]

[a]*Chemistry Department, New York University, 100 Washington Square E,, New York, NY 10012*
(Alexej.jerschow@nyu.edu)

In recent articles Travelling-Wave MRI/NMR Brunner et al. (1) fascinated the community with the demonstration of MRI images acquired through travelling rf waves in the magnet bore of an MRI scanner. This approach has a significant limitation in that each bore has a specific cutoff frequency, which is very high (in the case of Brunner et al. the cutoff frequency was very close to the operating frequency with a bore diameter of 58 cm). The smaller the bore, the higher the cutoff frequency. With a 51 mm (standard bore) magnet bore one would obtain 3.45 GHz, too large to be useful.



We overcome this limitation by turning the magnet bore into a transmission line (TL). TLs allow the propagation of TEM modes without a cutoff frequency (2), and thus allow broadband propagation of waves through the sample.

NMR spectra and images acquired with such an arrangement will be shown (example in the Figure), and genuine travelling wave behavior will be demonstrated.

In addition to facilitating NMR spectroscopy and imaging in smaller bores, this approach will also allow one to easily perform heteronuclear travelling wave experiments, and the study of samples in unusual geometries (e.g. microfluidics) and with relatively inaccessible samples. Furthermore, this arrangement allows testing general traveling wave concepts.

References
1. Brunner DO, De Zanche N, Frohlich J, Paska J, Pruessmann KP. Travelling-wave nuclear magnetic resonance. Nature 2009;457(7232):994-U992.
2. Jackson JD. Classical Electrodynamics. New York: Academic Press; 1998.