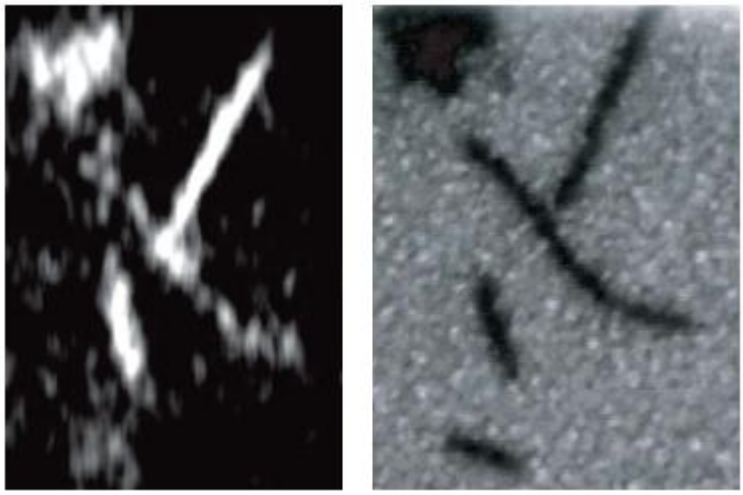
Magnetic Resonance Imaging with Nanometer Resolution (DoD, DARPA and ARL-ARO)

A significant breakthrough in magnetic resonance detection sensitivity has been achieved using magnetic resonance force microscopy (MRFM). The IBM group headed by Dr. Dan Rugar has achieved 3D MRI of 1H nuclear spins in a biological specimen (tobacco mosaic virus particles) with a spatial resolution down to 4 nanometers. This stands in contrast to conventional MRI where the spatial resolution is limited to a few micrometers by the magnetic induction approach. The enhanced capability obtained using MRFM is enabled by several key technical advances, including: the use of ultrasensitive cantilever detection techniques, the generation of magnetic field gradients as high as 4 million Tesla per meter, careful characterization of the MRFM point spread function, and finally, application of an image deconvolution technique capable of performing 3D image reconstruction on the nanometer scale. The demonstrated 3D resolution, plus the future possibility of incorporating more sophisticated chemical contrast mechanisms suggest that MRFM has the potential to become a significant tool for structural biologists in the near future.



MRFM (left) and SEM (right) images of tobacco mosaic virus particles.

C. L. Degen, M. Poggio, H. J. Mamin, C. T. Rettner, and D. Rugar, “Nanoscale magnetic resonance imaging,” PNAS Early Edition: 2009; doi: 10.1073/pnas.0812068106.