Multidimensional MRFM experiments in real and spectral space using Hadamard and Fourier encoding

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The application of MRFM for sensitive non-invasive Magnetic Resonance Imaging (MRI) is discussed. As with MRI, the MRFM is not limited to the three spatial dimensions. Spectroscopic dimensions can be added, providing detailed chemical and structural information at the atomic level. Such experiments –at much larger length scales- are routinely performed in clinical imaging and are denoted as MR spectroscopic imaging (MRSI) or chemical-shift imaging (CSI)[1]. Spectral information, e.g. from dipolar and quadrupolar interactions, has indeed been used in MRFM experiments, in particular for generating new image contrast[2; 3; 4]. While chemical shift has used as a contrast before[5], we will describe in our contribution, how a proper chemical-shift dimension can be employed in MRFM.

Spatial dimension in one dimension is automatically built-in into the MRFM detection scheme by the presence of a strong field gradient. Additional dimensions can be added by scanning probe techniques and by using additional field gradients in either the static or the radiofrequency field. These additional gradients are used in one or two directions orthogonal to the readout gradient. In our experiments, we use the inhomogeneity of the excitation rf-coil as the source for as additional spatial dimension.

In these experiments the sampling of the spectral and spatial dimensions can employ either Fourier- or Hadamard schemes. Three-dimensional images with either one or two spatial dimensions using both schemes will be discussed and compared.

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