Spatially Resolved Nuclear Magnetic Resonance Experiments.

The distribution of magnetic nuclei, such as protons, and their relaxation times and diffusion coefficients, may be obtained by imposing magnetic field gradients (ideally, a complete set of orthogonal spherical harmonics) on a sample, such as an organism or a manufactured object, and measuring the intensities and relaxation behavior of the resonances as functions of the applied magnetic field. Additional spatial discrimination may be achieved by the application of time-dependent gradient patterns so as to distinguish,

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for example, points that lie at the intersection of the zero-field (relative to the main static field) lines of three linear gradients.

The experiments proposed above can be done most conveniently and accurately by measurements of the Fourier transforms of the pulse response of the system. They should be capable of providing a detailed three-dimensional map of the distributions of particular classes of nuclei (classified by nuclear species and relaxation times) within a living organism. For example, the distribution of mobile protons in

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tissues, and the differences in relaxation times that appear to be characteristic of malignant tumors [R. Damadian, Science, 171, 1151 (1971)], should be measurable in an intact organism.

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