Magnetic Resonance: From Molecules to Mice to Men to Minds

Paul C. Lauterbur, Ph.D.
Honorary Member, International Society of Magnetic Resonance in Medicine
Director, Biomedical Magnetic Resonance Laboratory
Professor, Department of Medical Information Sciences
University of Illinois, College of Medicine at Urbana-Champaign

Soon after it was discovered that nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) could be detected in ordinary solids and liquids, it was learned that they could be used to probe the detailed structures of molecules and solids. As the power and subtlety of magnetic resonance methods increased, they began to be applied to biological molecules and to living tissue and organisms. After about 25 years, it was realized that spatial locations could be encoded in the signals, giving rise to magnetic resonance imaging (MRI) and new forms of in vivo spectroscopy (MRS), as well as their EPR analogs. After tests on small animals, vegetables and fruits, and other objects, practical human imaging systems were developed and rapidly came into wide use in diagnostic medicine and biomedical research. Most recently, it has been discovered that the changes in blood flow and oxygenation that accompany local changes in brain activity can be detected by MRI and used to explore in great detail how the brain supports and manages mental functions. What else might magnetic resonance methods accomplish in their second 50 years?

Dynamic and Efficient Magnetic Resonance Imaging and Spectroscopy

Magnetic resonance imaging and in vivo spectroscopic imaging are usually carried out by acquiring data that define the Fourier transform of the image, and then calculating the inverse Fourier transform of that "k-space" image to obtain the usual picture in spatial (or frequency) coordinates. These "classical" methods can often by improved upon by using prior information and constraints to avoid inefficiencies redundancies, obtaining the desired information in much less time than otherwise required, while simultaneously optimizing the signal-to-noise ratio. Examples from several areas of application will be described.