

Diffusion-Weighted MRI as a Probe of Tissue Microstructure

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Magnetic resonance imaging (MRI) is an indispensable tool in the diagnosis of many diseases and in monitoring various treatments, functional activation, development, and aging. Sensitizing the MRI signal to diffusional motion of spin-labeled molecules enables the quantification of microstructural parameters that describe the geometry being examined. For example, when there is significant levels of anisotropy in the diffusion-weighted signal, the local orientation of white-matter fiber bundles can be estimated, which may be used in mapping the neural connections between different regions of the brain. In this talk, we will review several techniques developed to this end. Furthermore, we will discuss a novel application of characterizing anisotropy that enables the mapping of directions perpendicular to macroscopic interfaces. We will show how an anomalous diffusion model of gray-matter structures can be employed to quantify the scaling characteristics of diffusion in tissue. Finally, recent developments on the double pulsed field gradient acquisitions and the resolution of anisotropy at different length scales will be discussed.