Foreword by the Guest Editors

Pulsed gradient magnetic resonance (MR) measurement of diffusion, which is the subject of the present issue, exhibited dramatic developments in the past two decades. These developments encompass technological, methodological, and theoretical issues, as well as novel applications. This special issue of the Israel Journal of Chemistry, “Diffusion NMR and MRI: Basic Concepts and Applications”, attempts to demonstrate the interdisciplinary nature of the subject and the range of applications to which diffusion MR contributes.

Since pulsed gradient MR techniques provide means for studying diffusion in complex systems without affecting the system and totally noninvasively, diffusion MR became the method of choice for measuring diffusion and flow in chemical and biological systems in the last twenty years or so. The technique is used in solution and polymer chemistry, material science, biology, medical research, and medical diagnosis. Pulsed gradient NMR and MRI are currently used to study supramolecular systems in solution, porous materials, surfactants, zeolites, and catalysts to characterize flow in complex fluids, to study microstructure, microdynamics, and compartmentalization in cells and organs, and to provide a means of noninvasively studying tumors, including brain tumors and severe neurological disorders such as stroke, brain trauma, multiple sclerosis (MS), and other white matter associated disorders, as well as aging, dementia, and other neuropsychiatric disorders. Recently, diffusion tensor imaging (DTI) was found to be extremely important in mapping white matter fiber tracts in the central nervous system and in studying microstructure of white matter.

The concept of molecular diffusion was proposed more than a century ago and the fact that molecular diffusion can be measured by NMR methods was realized by Hahn and others in the early days of NMR spectroscopy. The most practical pulse sequence to measure diffusion with NMR was introduced by Stejskal and Tanner in the mid-sixties, long before the advent of two-dimensional NMR (2D-NMR). However, the widespread utilization of diffusion measurements by NMR had to await improvement in gradient technology, which occurred during the seventies and the eighties with the development of MRI and the realization that coherence selection can be achieved efficiently by gradient pulses. Today, gradient coils are standard in conventional high-resolution NMR spectrometers, and very strong and efficient gradient coils are commercially available, making these techniques accessible to a large number of researchers. Indeed, the last decade brought about a dramatic increase in the utilization of diffusion NMR in so many fields and disciplines, making it nearly impossible to cover all aspects of diffusion NMR and MRI in a single volume. This issue presents an attempt to span a wide range of methodological aspects covering basic issues of diffusion NMR, applications in cells and organs, and extending up to diffusion MRI in humans. We believe that these papers, some of which were written by leading scientists in the field of diffusion MR, provide a glimpse of the interdisciplinary nature of the subject and the vast promise that application of these techniques holds. We hope that this volume will encourage new scientists to join this exciting scientific endeavor. Last but not least, we wish to thank the editorial board of the Journal for inviting us to edit this issue and all the contributors to this issue for their contributions and remarkable collaboration.

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