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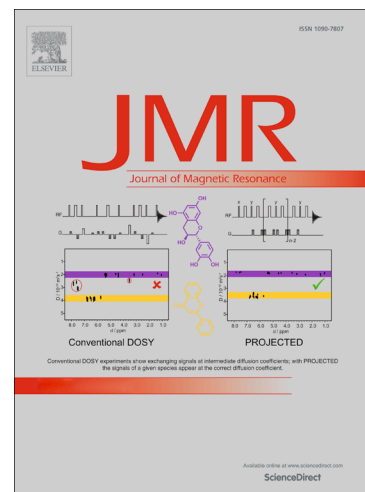
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Unilateral NMR with a barrel magnet

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Abstract

Unilateral NMR can examine samples without regard to sample size. It is also an easy path to mobile or portable NMR as well as inexpensive NMR. The objective of this work was to develop unilateral NMR with an improved performance in a sample region that was remote from the apparatus. This was accomplished with the creation of a saddle point where all second derivatives of the main component of the field were nulled. A ~10 cm diameter ~5 cm thick magnet combined with a gradiometer coil on the surface detected signals from a sensitive region that extended ~2 cm from the magnet. The relatively homogeneous field of these unilateral NMR devices allows the measurement of rapidly diffusing spins as well as the use of smaller RF amplifiers, which enhances system mobility.

Keywords: unilateral NMR, mobile NMR, low-cost NMR, saddle point, barrel magnet

Introduction

Unilateral, or single-sided, NMR to perform NMR measurements outside a magnet is gaining popularity [1]. It allows the studies of arbitrarily sized objects in situ. In addition, it offers a major path to portable NMR because, unlike conventional NMR, the magnet can be smaller than the objects to be measured. Such devices open new ways of using NMR technology, in which the apparatus is taken to the sample instead of the other way around.

An established technology that is related to unilateral NMR is NMR down-hole well logging. After initial Earth's field NMR work by Varian [2], Chevron led the way in down-hole well logging by Earth's field NMR starting in the 1950s [3]. Later, Jackson and coworkers proposed a pulsed NMR apparatus using permanent magnets [4, 5, 6, 7] which opened a way to investigate both the properties of fluids in the formation and the formation itself and spurred NUMAR (now Halliburton) [8, 9] and Schlumberger [10, 11] to develop NMR well loggers that are commercially

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