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Diffusion and Relaxation Probed by Mobile NMR

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The measurement of translational diffusion by NMR requires magnetic fields with high field gradients. Such gradient fields can be pulsed or time-invariant. The latter are readily available with the stray fields of magnets. Stray-field NMR has been pioneered with super-conducting magnets and is routinely applied with permanent magnets in well-logging NMR to characterize fluids in rock formations by diffusion and relaxation. The first small stray-field NMR device for materials testing at the site of the object is the NMR-MOUSE. Since its first use in 1995, we have extended its capabilities to include high-resolution depth-profiling of layered objects like master paintings, plastic gasoline tank walls, and human skin to characterize their state and function by profiles of relaxation and diffusion parameters.

The NMR-MOUSE technology of building NMR magnets from permanent-magnet blocks has been refined to build small permanent magnets for NMR relaxometry, imaging, and spectroscopy. The very simple relaxometry magnets are being employed in Laplace exchange experiments to study moisture migration by diffusion and advection in partially saturated model porous media and soil with the aim to give an arrive at a description of the pore space in terms of an average pore geometry as opposed to a pore radius distribution. Similar experiments are envisioned to be performed with a moisture logging tool which has been tested for outdoor use in the field.

This work is supported in part be the transregional DFG collaborative project TR 32.

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