A Coupled Spin System Simulator for Pulse Sequence Development and in-vivo Spectrum Quantitation in jMRUI

Zenon Starcuk, Jana Starcukova

Institute of Scientific Instruments, Academy of Sciences of the Czech Republic, Brno, CZ

Introduction: Animal as well as human MR scanners operating at 3 T and above give the access to in vivo MR spectra of metabolites characterized by coupled spin systems. Their spectral multiplets are affected by the volume selective excitation carried out with limited RF power and field gradients, coherence transfer pathway selection, and also by relaxation. The new simulator (NMRScope-B), implemented as a part of jMRUI, has been designed as an easy-to-use tool for both the generation of basis spectra for spectroscopic quantitation and for the study of excitation and quantitation possibilities.

Methods: The simulation of coupled homo- as well as heteronuclear spin systems undergoing relaxation, cross-relaxation and/or magnetization transfer, exposed to spatially and/or frequency-selective excitation, potentially involving phase cycles and/or RF and gradient modulation, is based on density matrix calculations with the Redfield model of relaxation. This core computation takes place in a compiled Matlab kernel, serviced by a java-based GUI that provides access to spin system parameters, simple as well as sophisticated pulse sequence programming, and arraying possibilities suitable for the study of various dependences (spatial selectivity, B1 sensitivity, offset dependences etc.) on spin system as well as excitation parameters. Arbitrary observable can be examined in an arbitrary set of observation points.

Results: The simulator runs on a range of PCs – netbooks to workstations. The calculation time depends heavily on the computer, the pulse sequence, spin system, and cycling requirements; 7-11 coupled spins seem to be the current practical limit. Simple tasks (individual spectra, excitation profiles, B1 dependences etc., 7 spins) can be determined mostly in 0.5-5 min, but 20 h may be needed for a glycerophosphorylcholine spectrum.

Conclusions: NMRScopeB provides the ability to simulate coupled and relaxing spin systems undergoing evolutions typical for current MR spectroscopic and spectroscopic imaging sequences. It is suitable for spectroscopic pulse sequence design and the preparation of basis sets for spectroscopic quantitation. The merger of imaging and spectroscopic approaches may be found useful for NMR education. This simulator is available with the latest versions of jMRUI, currently for Windows only.

Acknowledgements: The work was supported by the ASCR grant AV0 Z20650511, GACR grant GA102/09/1861, EC and MEYS CR project No. CZ.1.05/2.1.00/01.0017 and EU Marie Curie Research Network ‘FAST’, MRTNCT-2006-035801.

In vivo MRI of myocardial infarction induced by hypoxic hypoxia in a murine model (ApoE LDLR-/-)

M. Suchanek1,2, U. Tyrankiewicz1, T. Skórka1, S. Chłopicki3

1Institute of Nuclear Physics, Polish Academy of Sciences, ul. Radzikowskiego 152, 31-342 Kraków, Poland
2Department of Chemistry and Physics, Agricultural University, Al. Mickiewicza 21, 31-120 Kraków, Poland
3Department of Pharmacological Analysis, Chair of Pharmacology, Jagiellonian University Collegium Medicum, Grzegorzecka 16, 31-531 Krakow, Poland

Myocardial infarction remains the most common cause of death in the world and is strongly related to coronary atherosclerosis. To increase our knowledge and to evaluate new therapeutic strategies preventing these pathologies a suitable animal model of cardiovascular disease should be developed. The Magnetic Resonance Imaging (MRI) is the method which gives detailed insights into the structure and function of the heart with high temporal resolution allowing for in vivo assessment of the cardiovascular system. The aim of this study was to investigate the MRI model of myocardial infarction induced by hypoxia stress.

Ten ApoE LDLR-/- male mice at the age of 7 months were investigated using 4.7 TMR system. The anesthetized mice (isofluorane, 2%) were first exposed to a pharmacological