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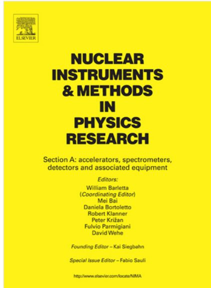

Robust high-resolution quantification of time signals encoded by in vivo magnetic resonance spectroscopy

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Robust High-Resolution Quantification of Time Signals Encoded by In Vivo Magnetic Resonance Spectroscopy

Revised manuscript

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Abstract

This paper on molecular imaging emphasizes improving specificity of magnetic resonance spectroscopy (MRS) for early cancer diagnostics by high-resolution data analysis. Sensitivity of magnetic resonance imaging (MRI) is excellent, but specificity is insufficient. Specificity is improved with MRS by going beyond morphology to assess the biochemical content of tissue. This is contingent upon accurate data quantification of diagnostically relevant biomolecules. Quantification is spectral analysis which reconstructs chemical shifts, amplitudes and relaxation times of metabolites. Chemical shifts inform on electronic shielding of resonating nuclei bound to different molecular compounds. Oscillation amplitudes in time signals retrieve the abundance of MR sensitive nuclei whose number is proportional to metabolite concentrations. Transverse relaxation times, the reciprocal of decay probabilities of resonances, arise from spin-spin coupling and reflect local field inhomogeneities. In MRS single voxels are used. For volumetric coverage, multi-voxels are employed within a hybrid of MRS and MRI called magnetic resonance spectroscopic imaging (MRSI). Common to MRS and MRSI is encoding of time signals and subsequent spectral analysis. Encoded data do not provide direct clinical information. Spectral analysis of time signals can yield the quantitative information, of which metabolite concentrations are the most clinically important. This information is equivocal with standard data analysis through the non-parametric, low-resolution fast Fourier transform and post-processing via fitting. By applying the fast Padé transform (FPT) with high-resolution, noise suppression and exact quantification via quantum mechanical signal processing, advances are made, presented herein, focusing on four areas of critical public health importance: brain, prostate, breast and ovarian cancers.

*Keywords***:** Magnetic resonance spectroscopy; quantum mechanical signal processing; early cancer diagnostics

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