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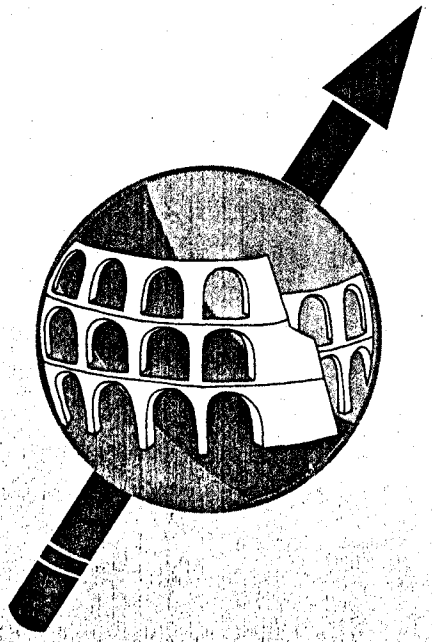

BOOK OF ABSTRACTS

Proton Density and T2 Calculation Using the Wigner Distribution

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Introduction

The time-frequency representations (TFRs) of signals have been applied to analyze non-stationary signals. Among the various quadratic TFRs the Wigner distribution (WD) is the most utilised because it exhibits some very important properties and ease of computation. Recently its use has been proposed for extracting amplitude, frequency and damping information from spectroscopic FIDs. We show here its merit in MRI.

Methods

The Wigner distribution $WD_x(t,f)$ of a continuous-time signal x(t) is defined by :

$$WD_x(t,f) = \int_{-\infty}^{\infty} x\left(t+\frac{\tau}{2}\right)x^*\left(t-\frac{\tau}{2}\right)e^{-j2\pi f\tau}d\tau$$

It is always real-valued and it preserves time shifts and frequency shifts of the signal. The WD of a discrete-time signal x[n] is defined by :

$$WD_x[n,f] = 2\sum_{k=-\infty}^{\infty} x[n+k]x^*[n-k]e^{-j2\pi fk}$$

It shares most of the properties of the WD for continuous-time signal, but it suffers from aliasing terms. To overcome this, the signal is oversampled by a factor of at least 2.

The WD of a finite duration sequence, at a fixed time n, could be determined from a finite set of samples by means of a DFT. So, for computing the discrete WD, FFT techniques are applied.

For the case of a signal consisting of a sum of sinusoids, as is the MR signals, the WD has peaks at the frequencies of these sinusoids (with the amplitude squared) and "cross-terms" midway for each pair of sinusoids. These cross-terms oscillate at a frequency given by the difference of the frequencies of the pair. We remove the cross-terms by smoothing in the frequency domain, using proper window-functions, yielding the so-called pseudo-Wigner distribution (PWD).

Results and Conclusion

We used projection reconstruction and spin-warp data of phantoms consisting of tubes , containing liquids of various relaxation times. The results showed that proton density and T2 information can be extracted simultaneously using only one data set, by means of the WD.