12th NUCLEAR MAGNETIC RESONANCE USERS MEETING

3rd IBEROAMERICAN NMR MEETING

MAY 4th - 08th, 2009 - HOTEL DO FRADE, ANGRA DOS REIS,
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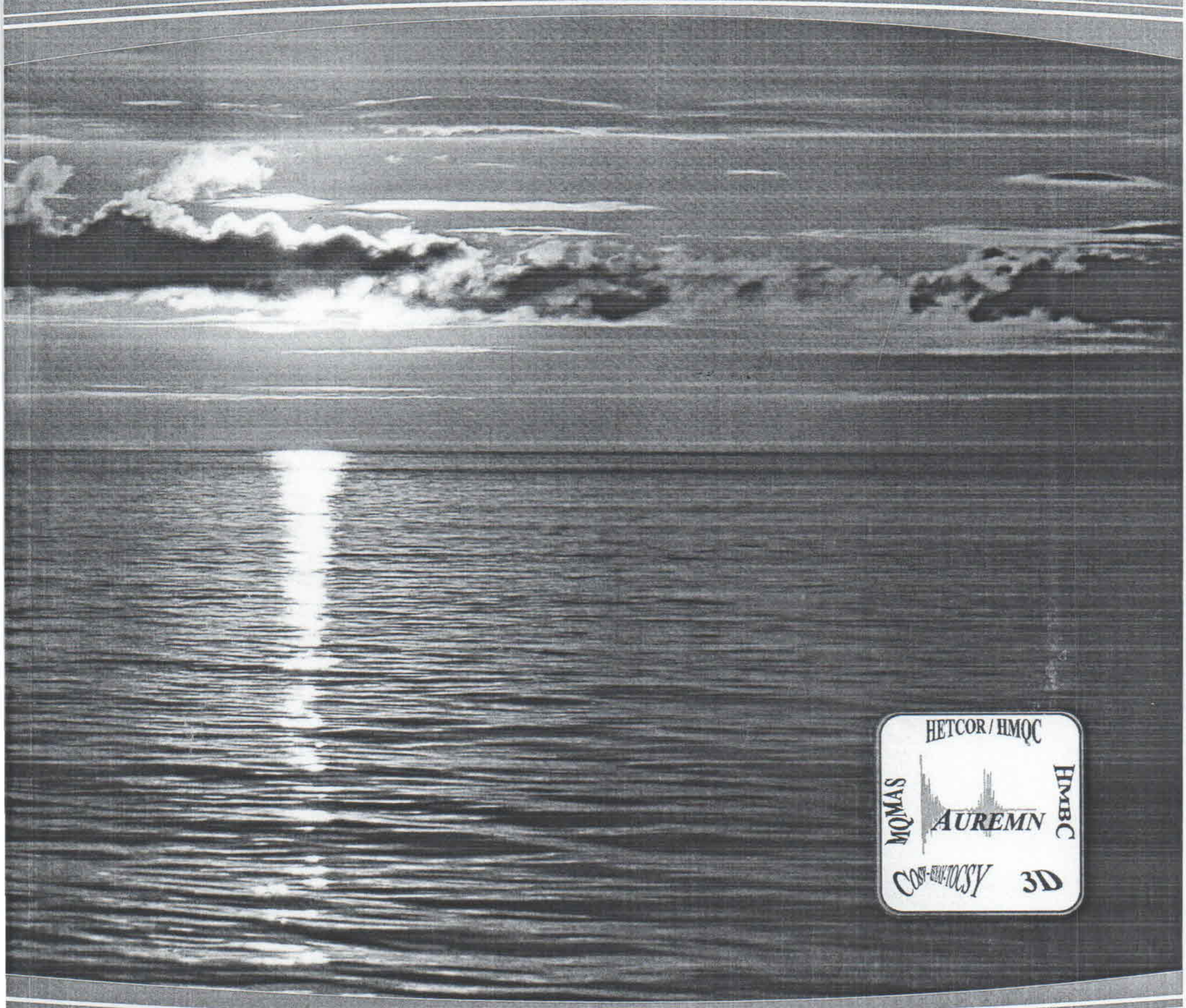

EXTENDED ABSTRACTS BOOK

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THEORETICAL ANALYSIS OF CPMG DECAY MEASUREMENT WITH LOW REFOCUSING FLIP ANGLES

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The Carr-Purcell-Meiboom-Gill (CPMG) sequence has used in many scientific and technological applications. Recently it has been used in *on-line* measurements[1]. In this application, the CPMG pulse train has been applied for very long periods. In this case, 180° refocusing pulse can cause undesirable sample heating and equipment overload, mainly on probe and power amplifier, which can reduce their durability.

Some measurements showed that 90° refocusing pulse can produce echoes and provide relaxation time T_2 with accuracy. By using low refocusing flip angle (90°) it is possible to reduce the RMS power up to 75%. Thus, the purpose of this work was the theoretical study of refocusing pulse with angles lower than 180° and the inhomogeneous field effects of B_0 and B_1 to measure T_2.

The theoretical signals were calculated by the Bloch equations[2] and were compared to experimental measurements. The experimental CPMG data was obtained for deionizated water at 22 ± 1°C on SLK-100 Spin Lock spectrometer, model SL.IM.01 with 0.23T permanent magnet. The sequence used $\pi/2$ and π pulses of 5.8 μs and 10.28 μs, respectively; echo time of 928μs and 6000 echoes, acquisition time of 10.6μs and four scan with repetition time of 15s. The parameters used in the simulations were: echo time of 928 μs, relaxation time T_1 of 2.74s and relaxation time T_2 of 2.52s.

The B_0 inhomogeneous was simulated by assuming a Lorentzian distribution with full width at half maximum (FWHM) of 250 and 10 Hz to offset frequency discrete values. To the B_1 inhomogeneous was assuming a Gaussian distribution centered at the refocusing flip angle (45°, 90°, 135° or 180°) ±10° with a full width of 5°.

Figure 1 compares the simulated signals of CPMG with 90° refocusing pulse ($CPMG_{90}$) at FWHM of 250 Hz (A) and at FWHM of 10 Hz (B). It shows that inhomogeneity at FWHM of 250 Hz leads to a large oscillation in contrast with the signal at 10 Hz. T_2 value is also affected in less homogeneous field (2.57s) than in more homogeneous field (2.53s), which is closer to the experimental value (2.52s).

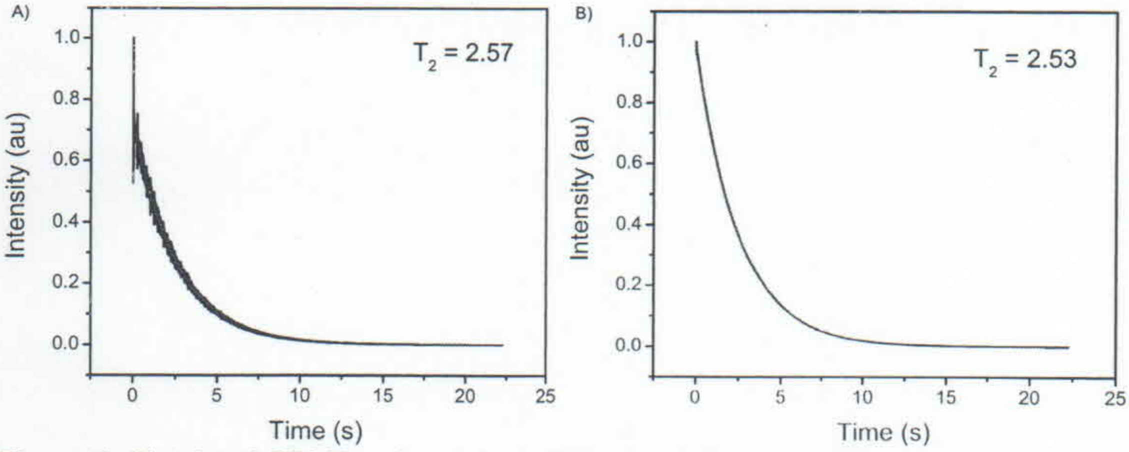

Figure 1. Simulated $CPMG_{90}$ signal, A) at FWHM of 250 Hz and B) at FWHM of 10 Hz.

Figure 2A shows simulated $CPMG_{90}$ signal for the same condition of figure 1A, considering B_1 inhomogeneity and assuming a Gaussian distribution centered at 90 ±10°. In this Figure is demonstrated that B_1 inhomogeneity does not affect T_2 comparing with the signal simulated without B_1 inhomogeneity (Figure 1A) despite the reduction in signal oscillation.

Figure 2B shows the experimental signal acquired from $CPMG_{90}$ sequence, indicating also a higher T_2 value than the measured by conventional $CPMG_{180}$, in the same magnet (FWHM of 250 Hz).

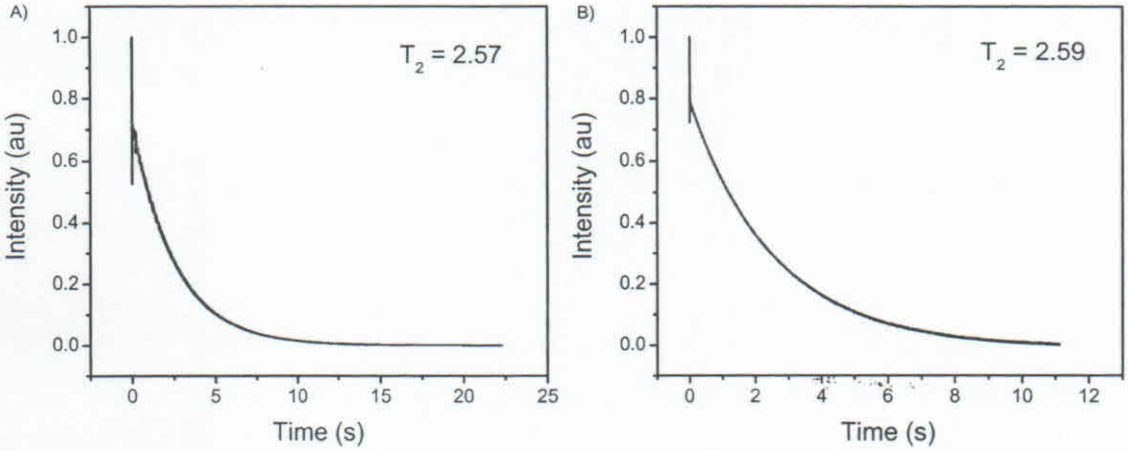

Figure 2. A) Simulated $CPMG_{90}$ signal under effect of B_1 inhomogeneity, B) Experimental $CPMG_{90}$ signal.

These results show that T_2 value, with refocusing flip angles lower than 180°, is affected by B_0 inhomogeneity, but not by B_1 inhomogeneity. Through this information it is possible determine a limit to use different flip angles depending on conditions of B_0 inhomogeneous field used, which it can reduce power by more than 75%.

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