

Supplementary Material

1. Calibration of z-coordinate

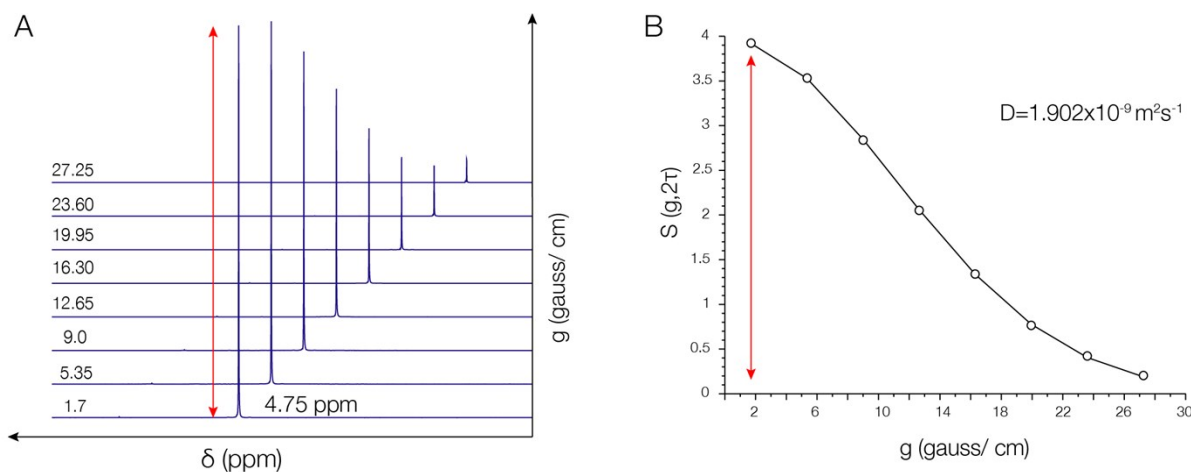
The self-diffusion coefficient of water is related with the molar fraction of D_2O (x_{D_2O}) at 298 K according to the follow relationship¹

$$D_{HDO} = 2.30 - 0.46x_{D_2O} + 0.0672x_{D_2O}^2 \cdot 10^{-9} m^2/s \quad (1)$$

The Stejskal-Tanner² equation (Eq. 2) allows to relate the self-diffusion coefficient of a species with attenuation S of resonance signals caused by gradual increments in the strength the pulsed field gradient g for the spin-echo experiment

$$S(g, 2\tau) = M_0 \exp\left(-\frac{2\tau}{T_2}\right) \exp\left(-\gamma^2 g^2 \delta^2 D \left(\frac{\Delta - \delta}{3}\right)\right), \quad (2)$$

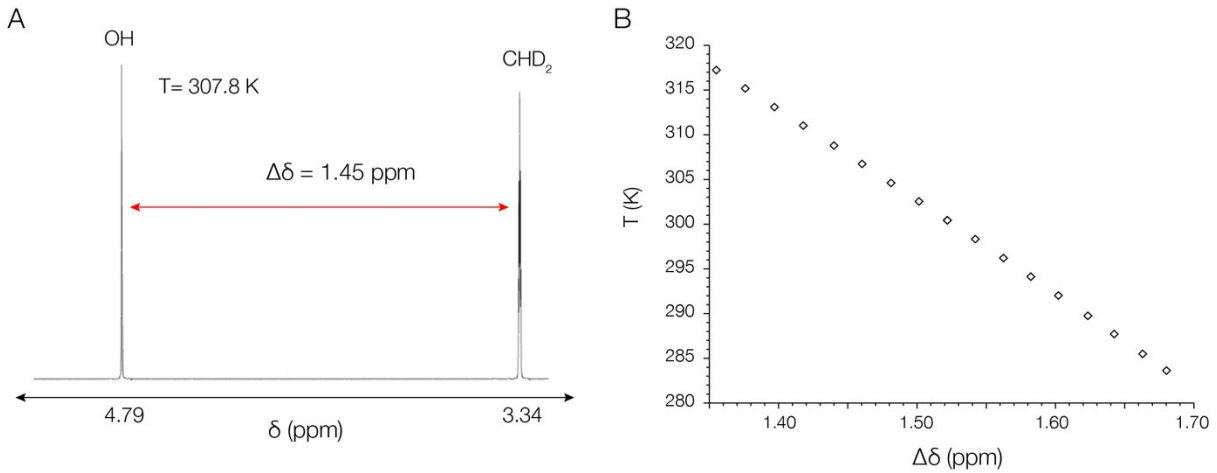
where Δ , δ and τ are adjustable parameters in the pulse sequence spin-echo, while M_0 and T_2 represent the magnetization at equilibrium and the spin-spin relaxation time, respectively. If the self-diffusion coefficient is known precisely, it is straightforward to recalculate the real values of g for each increment.



2. Bulk temperature

The strong dependence of hydrogen bond formation of the non-deuterated species (CHD_2 and OH) on temperature allows to relate the chemical shifts of the protons involved to the temperature of the bulk fluid using the following the relationship³ (Eq. 3)

$$T = [-16.7467(\Delta\delta)^2 - 52.5130(\Delta\delta) + 419.1381] K \quad (3)$$



3. intensity to mole fraction

NMR is known to be a quantitative technique provided certain conditions are met. An advantage of NMR over other techniques is that its response is linear over a broad range of concentrations and therefore any molecule of known concentration may act as internal standard.

This relation holds provided the bandwidth of the pulses is homogeneous for all observed resonance frequencies and provided that the spin system is fully relaxed between two acquisitions, i.e., that the relaxation time is chosen to be at least five times the longitudinal relaxation time T_1 .

The integral of the signal is preferred over the signal height, since it is less dependent on the individual spin relaxation rates. This relation holds provided the bandwidth of the pulses is homogeneous for all observed resonance frequencies and provided that the spin system is fully relaxed between two acquisitions, i.e., that the relaxation time is chosen to be at least five times the longitudinal relaxation time T_1 . Finally, in the case of spatially selective experiment, the diffusivity of the species should be small compared to the overall duration of each NMR acquisition.

It is thus possible to demonstrate that the molar fraction x_j is readily obtained from the intensities Eq. 4:

$$x_j = \frac{A_j^{-1} I_j}{\sum_{k=1}^n A_k^{-1} I_k} \quad (4)$$

In our experiments, the relaxation rates depend on time and spatial location. Therefore, a longer relaxation time of 4.0 s was chosen to ensure that all spins were relaxed. Moreover, the accumulation of only two acquisition was necessary to obtain a high signal-to-noise ratio.

3. Tables

Table 1S

Redlich-Kister coefficients Eq. (5) and fitting parameters for the initial conditions Eq. (6) at both experimental temperatures.

T / K	A	B	C	D
278.2	-10.36	-2.33	-5.15	0.29
283.2	-10.77	-0.68	-2.76	3.78
	U	V	Y	W
278.2	2.64	2.49	2.07	-14.08
283.2	2.56	2.42	1.63	-13.57

Table 2S

Coefficients v_2 and v_4 of Eq. (7) for the TEA/H₂O system together with correlation coefficient R^2 .

T / K	v_{210}^9 m ² s ⁻¹	v_{410}^9 m ² s ⁻¹	R^2
283.2	2.68	0.65	0.9936
283.2	2.28	0.68	0.9946
278.2	2.21	0.62	0.9905
278.2	1.82	0.59	0.9924

3. Relaxation study

Although pure species have long relaxation times (T_1) and thus slow repetition rates ($\geq 5 \times T_1$), even a small contamination will affect those long relaxation times. Since in the proposed method the recording of the gradients starts after the convection process vanishes, no spectra of pure phase are ever recorded. While the system returns to equilibrium, diffusion increases mixing and shortens T_1 . Furthermore, lowering the temperature is also known to shorten T_1 . In the reported experiments, both the mixing process and the mixing temperature work to shorten the relaxation times of the involved species.

To illustrate this, the longitudinal relaxation times were measured for two different slices at the extremities of the gradient ($z = -4.3$ mm and $z = +4.3$ mm) both at mixing and room temperatures (283.2 K and 300 K). The figure below shows indeed that at a lower temperature the relaxation time is shorter by a factor of 3.

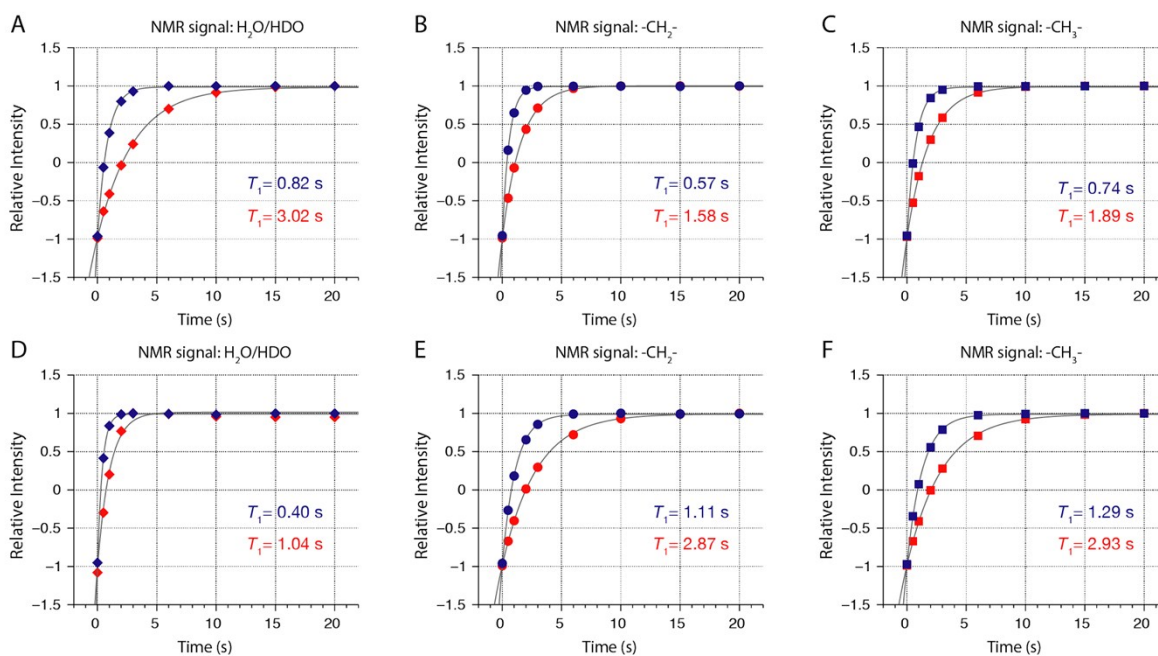


Figure 1. Relaxation time measured at 300 K (red dots) and 283.2 K (blue dots) and, in the mainly aqueous ($z = -4.3$ mm A, B and C) and organic phases ($z = +4.3$ mm D, E, and F). In both cases, the principal component shows the longest T_1 . A spatially encoded Inversion Recovery (IR) experiment was performed using the same values for the pulses as in the reported experiments.

Thus, by choosing a recycle delay of 4 s, we are on the safe side for most signals except for TEA. Indeed, the methyl group has a recycle delay shorter than the common $5 \times T_1$ ($3.1 \times T_1$). Since a longer recycling delay implies a longer duration of the mapping and thus a lower spatial resolution (fewer slices can be measured in the same amount of time), we proceeded to the estimation of the error induced by choosing a shorter-than-ideal delay. This was performed by repeating the experiment, a complete gradient mapping, increasing the recycle delay. The signal integrals were normalized to the ones observed with a recycling delay of 25s. The second figure shows the experimental errors observed for slices at 4.3 and -4.3 mm. At the mixing temperature, the larger deviation from perfect behavior never exceeded 3%.

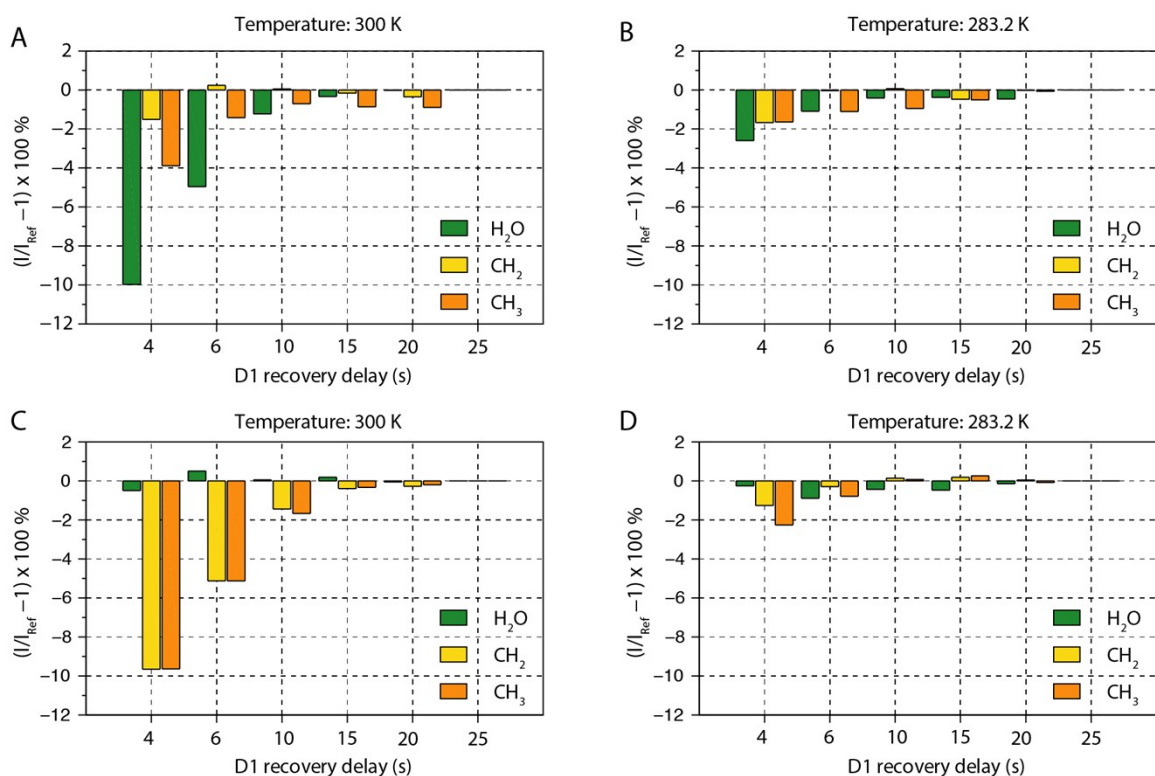


Figure 2. Estimation of the error produced by a recycling delay shorter than $5 \times T_1$ at both 300K and 283.2K for two slices, at $z = -4.3$ (A, B) and $z = 4.3$ (C, D).

In contrast, at room temperature, the observed deviations are close to 10% for the same signals. The choice of 4 s as recycling delay is a compromise between relaxation and spatial and temporal resolution. Thus, although the referee is correct in signaling that pure compounds have very long longitudinal relaxation time, the experimental conditions in which the reported experiments were performed allowed us to reduce the recycling delay without compromising the end results. For future experiments, it is possible to think of more complex strategies that avoid the excitation of the whole sample. If the experiment is completely selective, we are not forced to wait until the system goes back to equilibrium before recording the next slice.

Reference

1. M. Holz and H. Weingärtner, *J. Magn. Reson.*, 1991, **92**, 115-125
2. E. O. Stejskal and J. E. Tanner, *J. Chem. Phys.* 1965, **42**, 288-292
3. M. Findeisen, T. Brand, S. Berger, *Magn. Reson. Chem.* 2006, **45**, 175-178.