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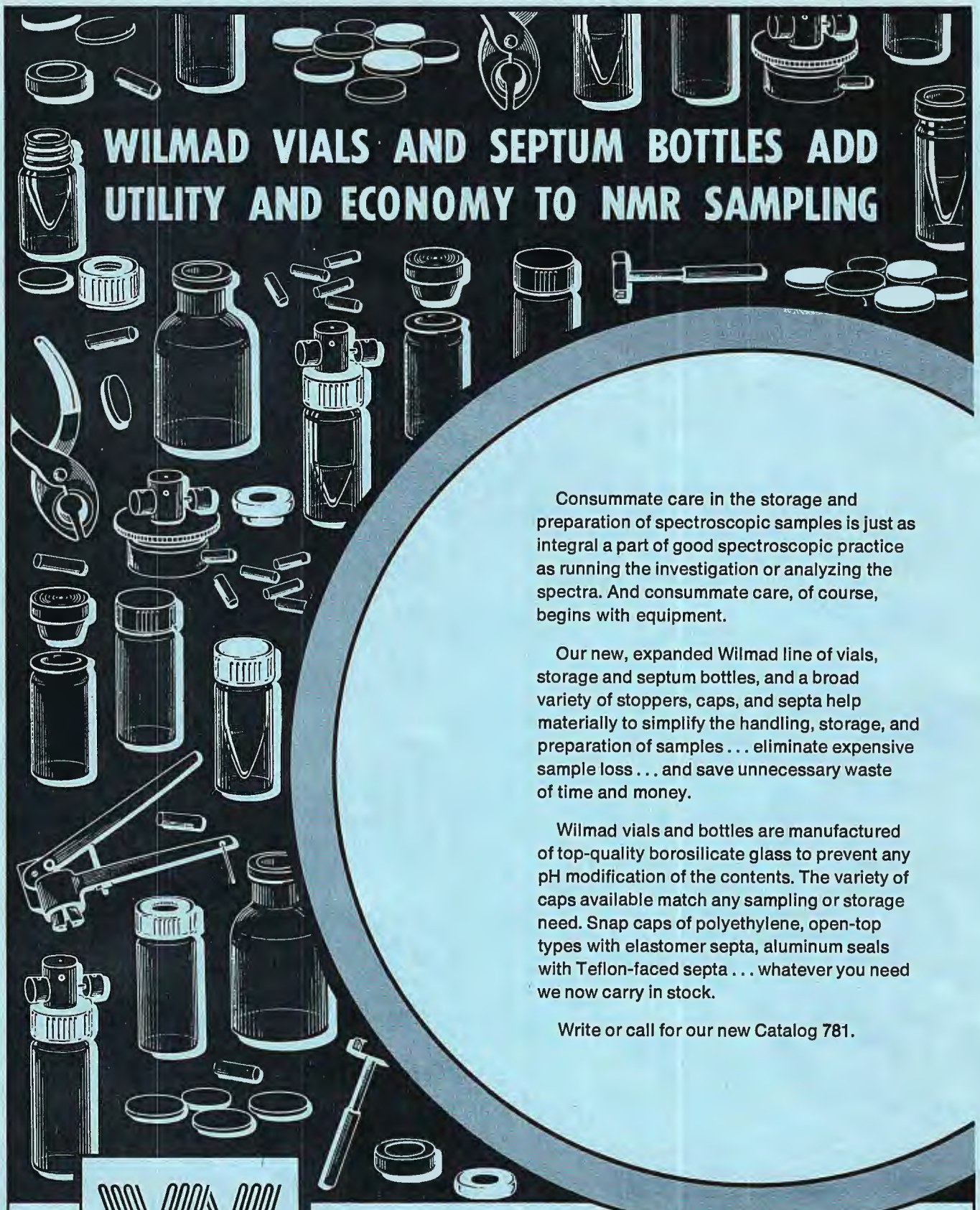
Texas A&M University N-M-R Newsletter

No. 270

March, 1981



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All Newsletter Correspondence, Etc., Should be Addressed To:

Dr. Bernard L. Shapiro
Department of Chemistry
Texas A&M University
College Station, TX 77843 U.S.A.

AUTHOR INDEX - TAMU NMR NEWSLETTER NO. 270

DEPARTMENT OF ORGANIC CHEMISTRY
THE ROBERT ROBINSON LABORATORIES P.O. BOX 147 LIVERPOOL L69 3BX TEL: 051 – 709 - 6022

The University of Liverpool

Professor Bernard L. Shapiro,
Department of Chemistry,
Texas A and M University,
College of Science,
College Station,
Texas 77843,
U.S.A.

27th January, 1981.

Dear Barry,

Ring Current Calculations in cytochrome c; water circulator wanted.

Your reminder prompts me to give the result of some of our recent work on ring current models for the porphyrin ring. We were concerned about the breakdown of the equivalent dipole approximation at positions near to the porphyrin ring, and have now formulated a simple amendment which allows the calculation of the ring current at all positions in space.[1] This amendment requires a knowledge of the actual ring current shifts at a point within the molecule, and the N-H protons are the obvious candidates. Initially we relied on some old data, comparing the pyrrole N-H chemical shift with that of the porphyrin N-H. However, in view of the need for a better parametrisation, particularly with regard to the application of the model to biological molecules such as cytochrome c[2], we re-measured some appropriate molecules and obtained a value for the ring current shift at the N-H protons of porphyrin of 10.5 p.p.m. This then standardises the model, which may be used for any porphyrin ring, and the table shows the observed ring current shifts in cytochrome c compared to those calculated using the model, for two sets of published atomic co-ordinates a) and b). The agreement is sufficiently good to open up the intriguing prospect that some of the atomic co-ordinates could be refined by using the N.M.R. shifts. The values obtained by such refinements are shown in the table (column c) and are essentually within the experimental errors involved.

This work is currently being written up for publication.

On a quite different task, we would like to purchase a water-circulating system (pump and heat interchanger) from any old N.M.R. electromagnet. We are currently using an old HA-100 water circulator to provide a stabilised water supply to two X-ray tubes,

which is working splendidly and would like to buy another. Any offers please contact me.

With best wishes,

Yours sincerely,

Dr. R.J. Abraham.

Table 1. Calculated and Observed Ring Current Shifts in cytochrome c.

Proton Signal	Ring Current Shifts (p.p.m.)			
Met 80	Calculated			Observed
	a)	b)	c)	
γ CH	-3.46	-2.93	-3.30	-4.50
γ CH'	-7.18	-5.44	-6.78	-6.36
β CH	-2.50	-2.65	-2.26	-2.34,-2.18
β CH'	-5.18	-8.09	-4.54	-4.57,-4.73
ϵ CH_3	-4.48	-4.08	-5.19	-5.41
His 18				
C-2 H	-7.93	-7.40	-7.46	-7.62
C-4 H	-7.77	-7.31	-6.81	-7.01

References.

1. R.J. Abraham, G.R. Bedford, D. McNeillie and B. Wright, Org. Mag. Res., 14, 418 (1980).

2. S.J. Perkins, J. Mag. Res., 38, 297 (1980).

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School of Science

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12th January, 1981

Dear Prof. Shapiro,

CRAP

The current vogue appears to be to invent a new pulse sequence and spend more time developing a suitable name for said sequence. We hope you find the attached not too inept and adequate to maintain our contribution. We have not thought of a good meaning for CRAP but we believe CRAP to be an adequate representation of such preparations.

The pulse train is as follows:

$$(90_xH) - (4J)^{-1} - (180_xH)(180_xC) - (4J)^{-1} - (90_xH)(180_x[1,0]C) - (4J)^{-1}$$
$$- (180_xH)(180_xC) - (4J)^{-1} - (\text{observe H, decouple } ^{13}C).$$

As usual, the $(180_xH)(180_xC)$ pulses act as refocussing pulses to remove the effects of chemical shifts. $180_y[1,0]C$ means this pulse is present during one pulse train and absent during the next. The signals from successive trains are subtracted.

The result of the sequence is that one observes in a ^1H spectrum only those ^1H coupled to ^{13}C. If we divide the ^1H spectrum into two classes, Class 1 arising from ^1H coupled to ^{13}C and Class 2 the remaining ^1H signals, then the pulses $(90_xH) - (2J)^{-1} - (90_xH)$ removes the Class 2 protons from the detection plane. The second (90_xH) pulse does not effect Class 1 signals which are phase alternated by the $180_x[1,0]C$ pulse.

Spectra resulting from the use of this sequence are attached. The sequence should find use in biosynthetic studies and studies of ^{13}C-^1H coupling constants.

Yours sincerely,

D.M. Doddrell. M.R. Bendall.

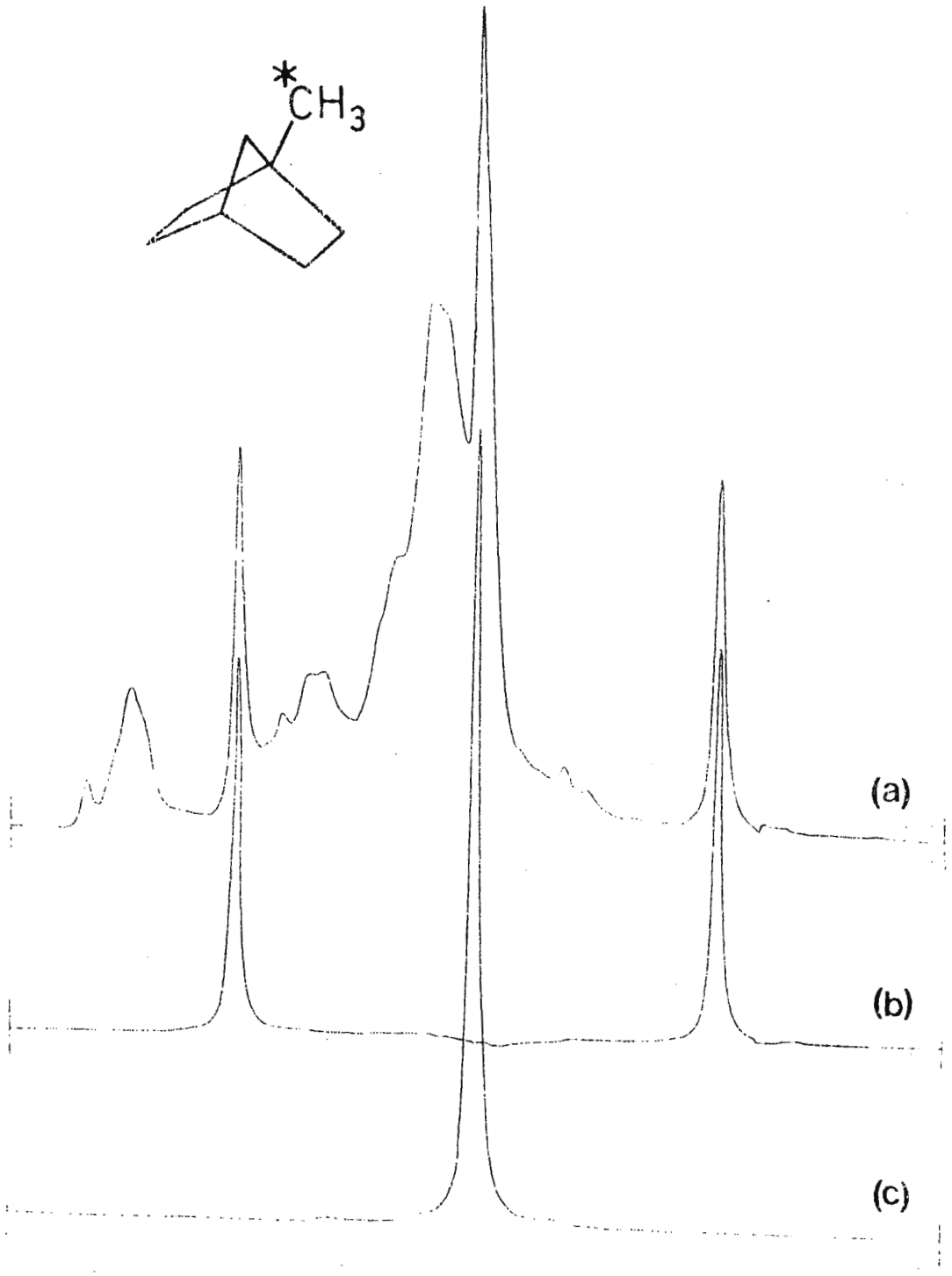

Fig. 2 ^{1}H spectra at 30°C of pure (external D lock) 1-methylnorbornane approximately 60% ^{13}C-enriched at the methyl group at 90 MHz. The sweep width is 250 Hz. 64 scans were collected.

(a) Normal spectrum.

(b) Using the pulse sequence without ^{13}C decoupling during acquisition.

(c) Using the pulse sequence with ^{13}C decoupling during acquisition.

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THE UNIVERSITY OF ALBERTA
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January 26, 1981

Dr. Barry Shapiro
Department of Chemistry
Texas A&M University
College Station, Texas
U.S.A. 77893

Dear Barry,

Re: FT "Wiggles"

In the course of some spin-echo work using the CPMG sequence on aqueous samples, we observed "wiggles" on the side of the water peak, as shown in Figure A. This only occurred if we collected the second or later echo - a simple Hahn echo experiment was normal.

Further investigation showed that the period of the wiggles (the peak to peak separation) was the reciprocal of the delay time between the pulses. Therefore, to get rid of the wiggles, you make them have a long period, i.e., shorter delays between pulses, as in Figure B.

As usual, pulse imperfections seem to be the problem. Magnetization is taken from the z-axis into the xy plane by the first pulse, and ideally the succeeding 180° pulses keep re-focussing it there. However, an imperfect second pulse will put magnetization back onto the z-axis and the third pulse brings it into the xy plane again. Because it has precessed between the first and second pulse, but not between the second and third, this magnetization has a phase error that depends on its Larmor precession frequency. On a broad shoulder (caused by maladjusted shimming) the signal "wiggles" in and out of phase. Normally, the shoulder is not noticed because it is smooth, but the wiggles show that it is there.

Please credit this contribution to Tom Nakashima's account.

Sincerely,

Alex D. Bain
Bruker Spectrospin (Canada) Ltd.

ADB/ss

DEPARTMENT OF CHEMISTRY

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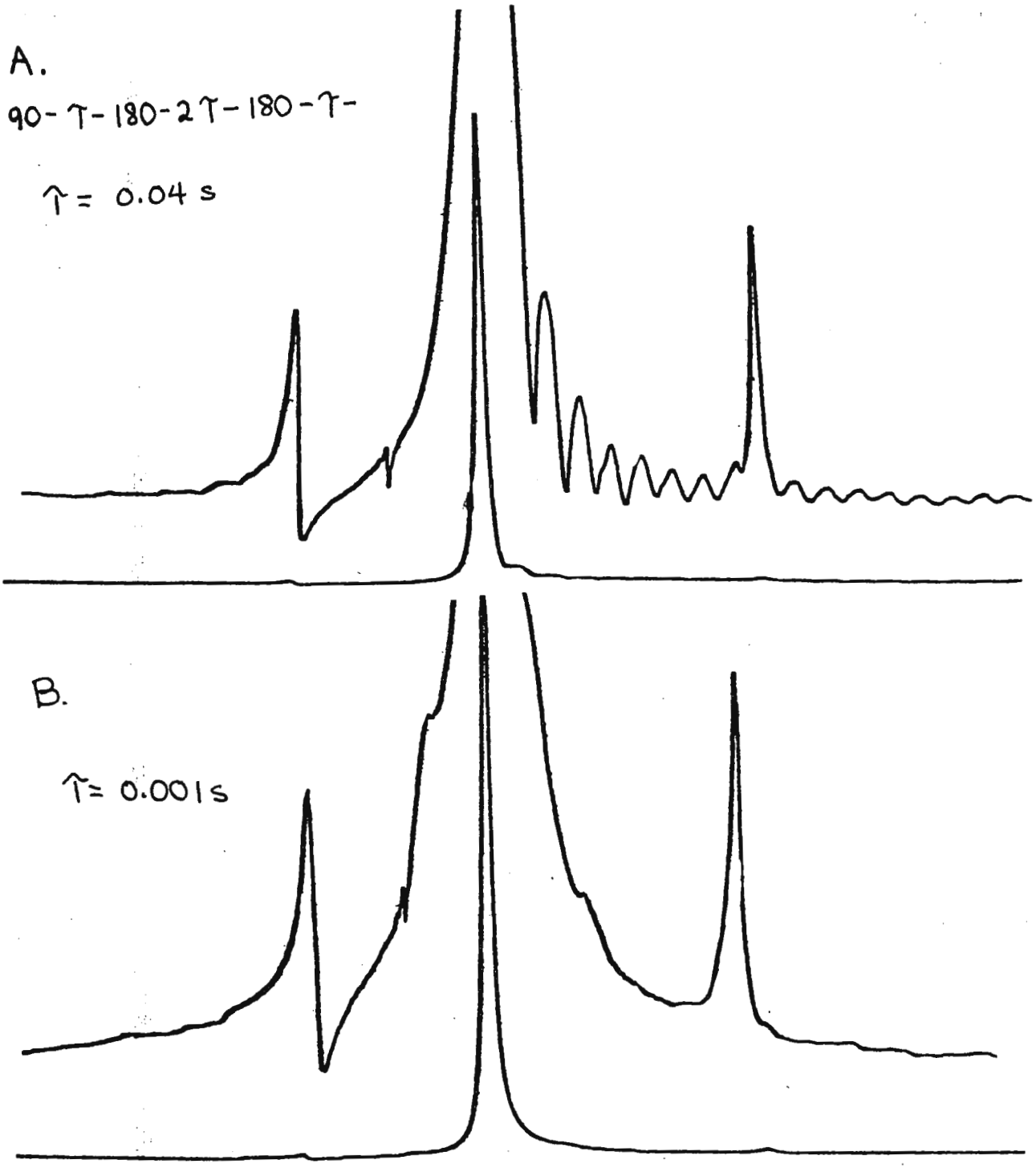

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DEPARTMENT OF CHEMISTRY, B-014
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February 17, 1981

Dr. Bernard L. Shapiro
Department of Chemistry
Texas A&M University
College Station, TX 77843

Dear Barry,

We suspect that by now you must be running out of colored paper and submit the following to avoid the appearance of a bilious green missive in our in-box and also as a response to a recent letter (TAMU 268-33) regarding probe ringing.

In that letter Tiffon and Ancian describes the familiar problem of acoustic ringing bothering the observation of weak, rapidly decaying signals from nuclei such as ^{33}S. In that case, the ringing occurred at 15 MHz in a WP200 spectrometer, which just goes to show that that some of the old problems associated with NMR in iron core magnets won't go away even if superconducting systems are used.

That's really too bad. But we suspect that the cure for acoustic ringing in supercon systems may be the same as that recommended for conventional magnet systems, as described for NMR spectroscopists by Fukushima and Roeder (1). It is probably no coincidence that our own most memorable experience with acoustic ringing was associated with the observation of ^{33}S during a relaxation study of CS_2 (2), in our case at 4.6 MHz at 14 kgauss. Observations of deuterium at 7 kgauss, also at 4.6 MHz, were bothered as well, although the effect is known to be field dependent. The cure, if not always 100% effective, is to wrap the probe insert with a grounded shield of an acoustically dampening material. Fukushima and Roeder (1) list the properties of a number of materials of interest to NMR spectroscopists. We have had particularly good luck with lead foil wrapped around our dewared insert.

As pointed out before (1), aluminum, which is the material most commonly used for probe construction, is also one of worst as far as acoustic ringing is concerned. In our low field probes no aluminum was used, and we assume that the ringing arose in the pole faces of the magnet. Whether the ringing observed by the Paris group arises in the aluminum shell of the probe or the stainless steel of the main dewar would be interesting to know. In either case, the insertion of a grounded lead shield between the coil and the probe casing might solve the ringing problem.

See you in Asilomar.

Best regards,

Bob & Gitte

Robert L. and Regitze R. Vold

1. E. Fukushima and S. B. W. Roeder, J. Magn. Reson. 33, 199 (1979).
2. R. R. Vold, S. W. Sparks and R. L. Vold, J. Magn. Reson. 30, 497 (1978).

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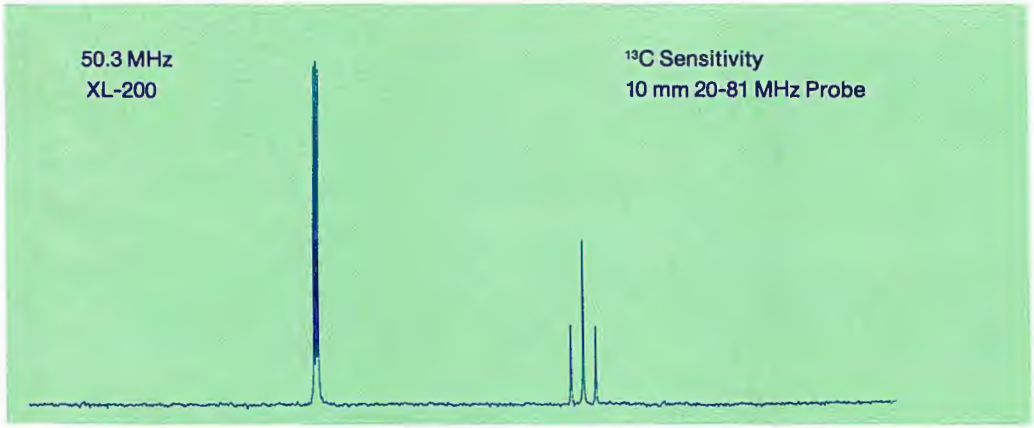
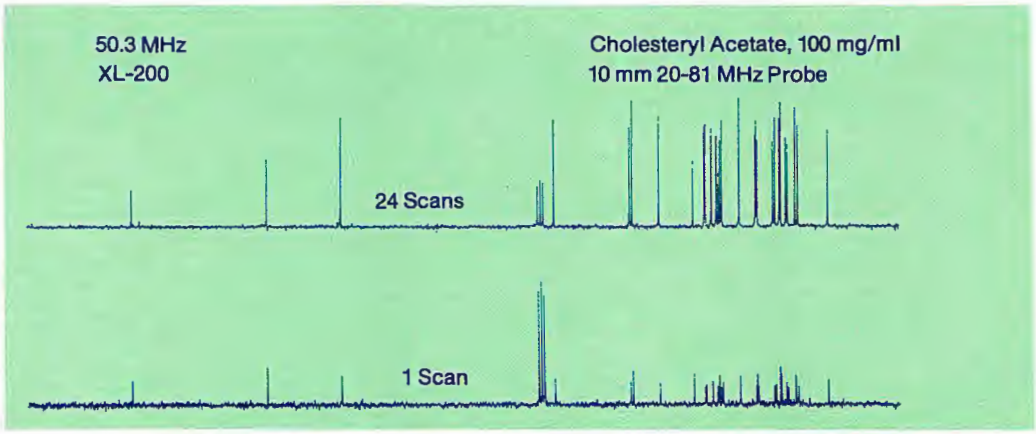
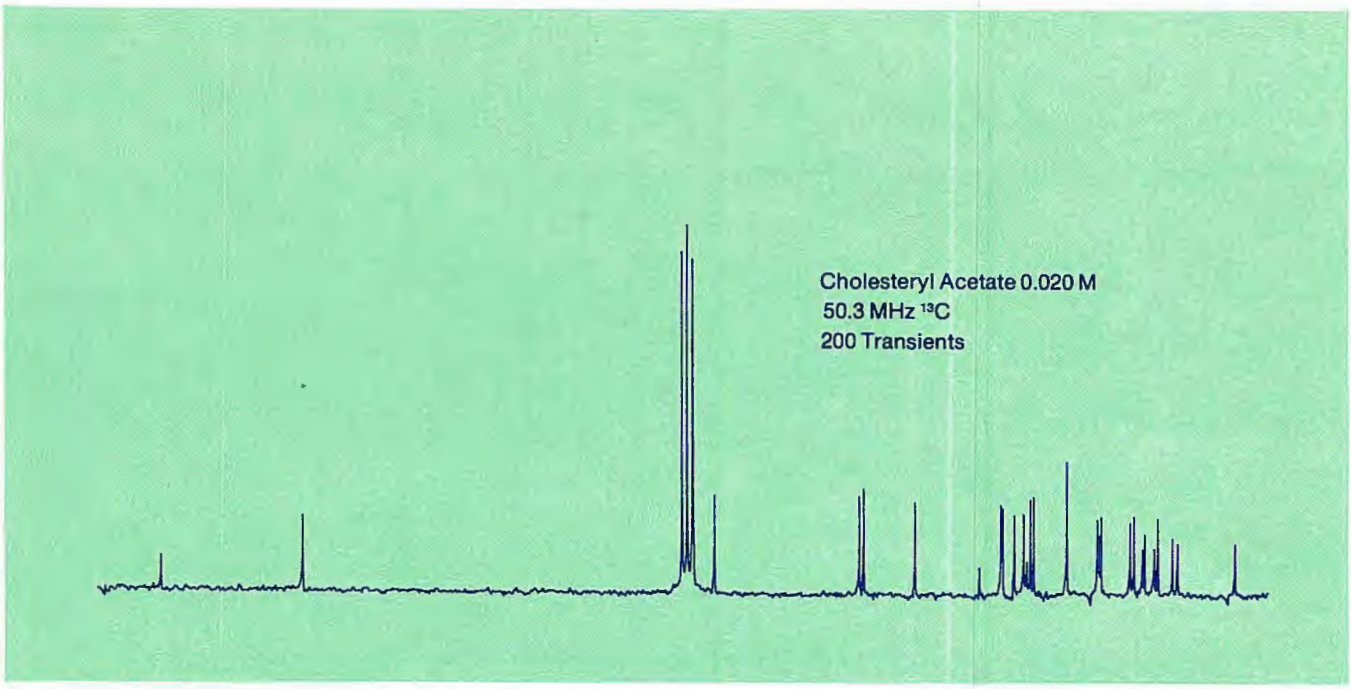


^{13}C Sensitivity Test: Single transient following 90° pulse on 60% C_6D_6/40% dioxane using the 10 mm 20-81 MHz broadband probe.

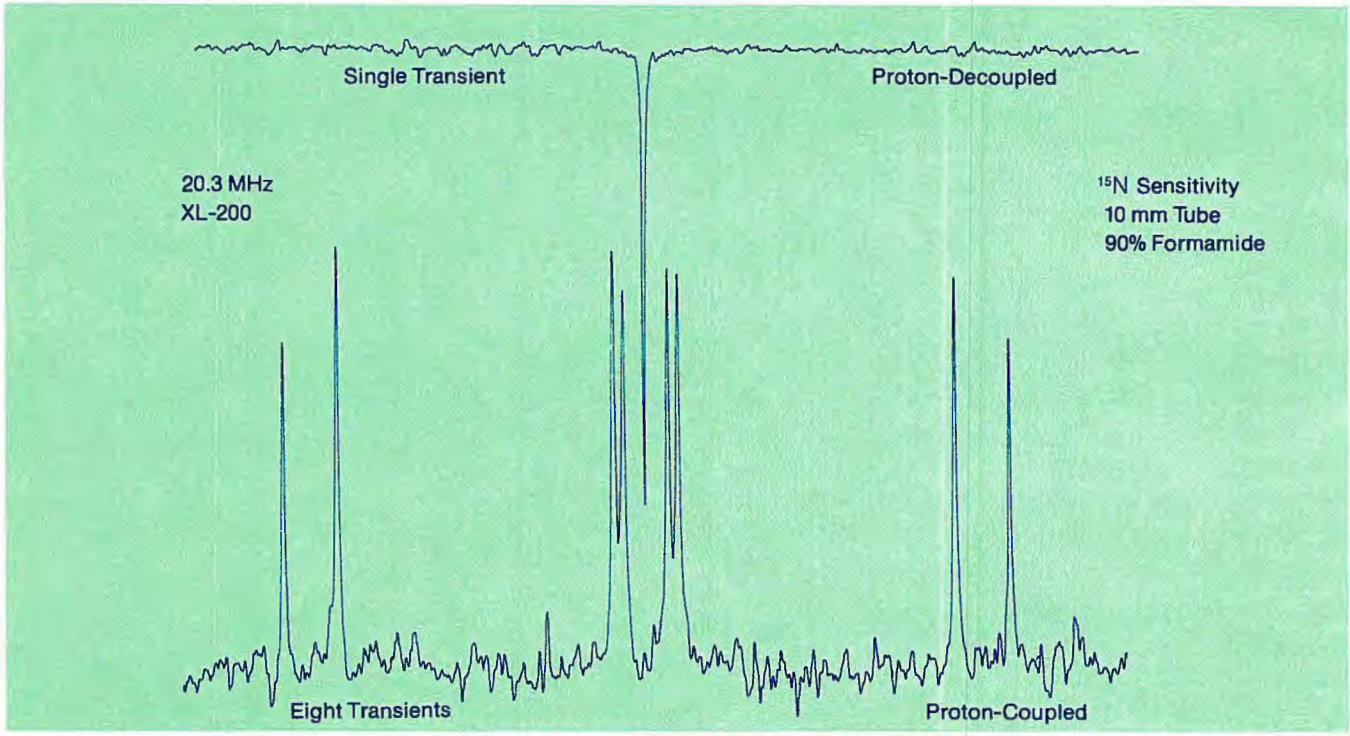


^{13}C Sensitivity Test: Cholesteryl acetate, 100 mg/ml, 10 mm broadband probe. Transients accumulated using 90° pulses every 2.28 seconds with 0.5 Hz line-broadening.

Additional spectra appear on the following page



^{13}C Sensitivity Test: 0.02 molar cholesteryl acetate in a 16 mm tube, 200 transients.



^{15}N Sensitivity Test: 90% Formamide in dmso-d_6, 10 mm 20-81 MHz broadband probe. Upper trace: single-transient (with NOE) proton-decoupled. Lower trace: eight transients, coupled (with NOE) 8-second acquisition time, 20-second delay time.

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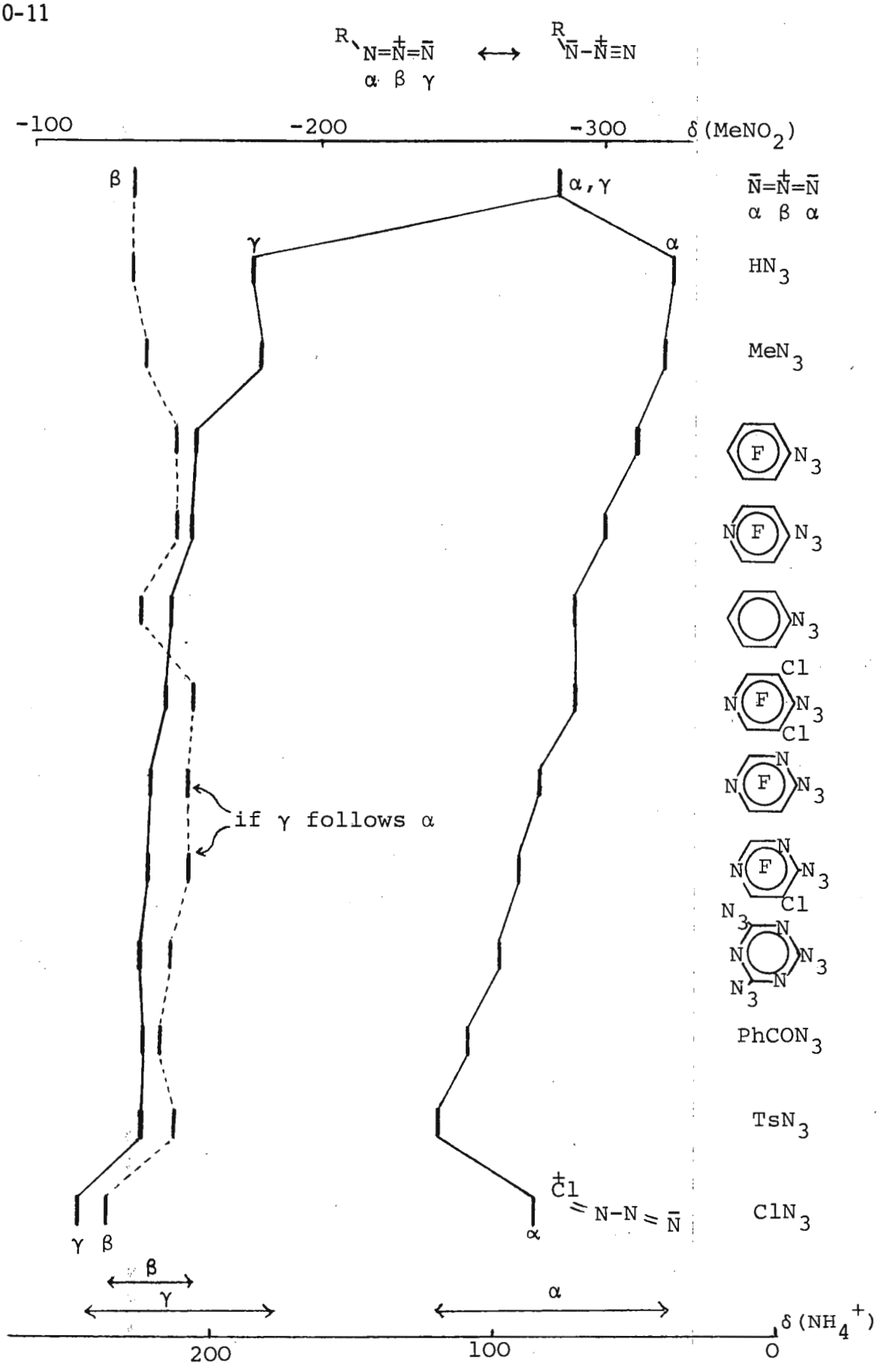
29.1.1981

Perfluoro effects in ^{15}N nmr spectroscopy: aryl and N-hetaryl azides

We have used fluoro and chloro effects in aryl and N-hetaryl compounds to probe electronic influences within the azido group, using azides made by Eric Banks and his group (at University of Manchester Institute of Technology) for nitrene work. Earlier ^{14}N studies suggested that azide nitrogen lines go downfield in the order α, γ, β, but no coupling was resolved. More recently Mueller (at Marburg) confirmed the assignments for HN_3, MeN_3, PhN_3, and related azides (using ^{15}N enrichment), but showed that there is a crossover of the β and γ lines when the R group in RN_3 is electronegative, as in ClN_3 or cyanuric azide; and this has now been found also for $PhCON_3$ (Vol'pin), and TsN_3 (C. Casewit and J.D. Roberts).

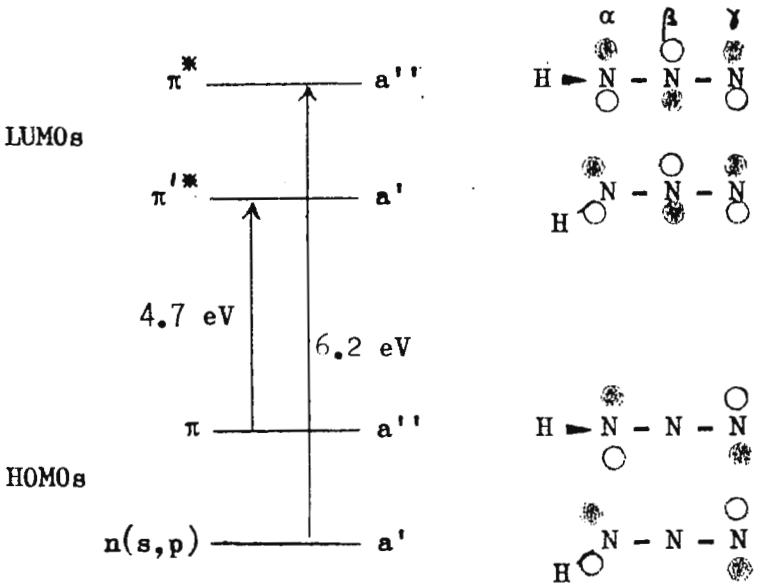
Their results and ours are shown in the correlation diagram, and the relationships are well interpreted by the diagram of HOMOs and LUMOs, as shown for HN_3. For HN_3 and other covalent azides there are two relatively weak bands in the uv spectrum which correspond to magnetic-dipole-allowed excitations, $n \rightarrow \pi^*$ and $\pi \rightarrow \pi'^*$, and we may expect the nitrogen shielding to be dominated by the corresponding electronic circulations in the magnetic field, since these have relatively low energy. The n_N and π HOMOs are located largely on N_α and N_γ, and this accords with the resonance formulation (shown above the correlation diagram) in which N_α and N_γ are negatively charged with respect to N_β.

These relationships show up in the ^{15}N shielding, for the N_α and N_γ lines tend to vary together (except for ClN_3). As we might expect, the N_α shift varies the most, but the N_β shift varies the least. (To be sure of the assignments we enriched the halogeno-phenyl and -pyridyl azides, but this was less easy for the pyrimidyl compounds, and their N_β, N_γ assignment assumes that the N_α and N_γ lines move in the same sense.)



Correlation diagram of ^{15}N shifts in covalent azides

ClN_3 is now seen to be an outsider to this pattern, and we can explain this by a difference in structure of the azide group. Microwave spectroscopy shows that it is (unusually) slightly bent at N_β in ClN_3, which has $\hat{NNN} = 172^\circ$. According to Mueller, ClN_3 also has the largest $^1J_{NN}$ yet recorded, 24 Hz for $N_\alpha N_\beta$ (cf. 13-16 Hz in other azides).



Low-energy a' ↔ a'' excitations in HN_3

With apologies for lateness,

Joan Mason

Joan Mason

BRUKER SPECTROSPIN NV

Dear Professor Shapiro, Wormer, January 28 1981

Strong magnetic stray fields, like from a superconducting magnet, as well as RF radiation around a magnetic resonance spectrometer are believed to be possibly harmful to persons wearing a pacemaker. This is normally indicated by appropriate warning shields in NMR laboratories.Detailed information about the nature of the influence the spectrometer may exert on pacemakers is scarce.

Most pacemakers only deliver stimulating pulses to the heart when the own heart activity is too slow. The heart activity is constantly monitored by the pacemaker and the latter switches itself off whenever strong and stable pulses from the heart are received. This switching mechanism may be overridden by means of a contact which is activated by bringing a magnet near to the pacemaker. Pulses then will be delivered irrespective of the own heart activity.

In cooperation with the Institute of Medical Physics TNO in Utrecht we performed some experiments around our Bruker WM 250 Spectrometer.- We moved a series of pacemakers in various orientations in the neighbourhood of the superconducting magnet. The magnetic switches could be enabled by a magnetic field as low as 10G corresponding to a distance of 1 m from the dewar. These figures are liable to be different for pacemakers we did not test or in the stray fields of other magnets. They may, however, serve as an indication for setting a limit outside which the magnet does not influence a pacemaker.We note that the effect of the magnetic field, i.e. switching the pacemaker on, is not considered as being harmful to the patient.

A more dangerous situation occurs when external signals are falsely interpreted by the pacemaker as coming from a soundly beating heart, causing it to switch off. The pacemaker was connected to a lead which was embedded in a saline solution in a configuration as it is after implantation in a human body. This setup, which is developed in the above mentioned institute, was placed near the magnet oriented such as to give maximum pickup of the signals fed to the RF circuitry in the NMR probehead. Continuous irradiation with RF signals of several frequencies and power levels did not cause any noticeable effects on the operation of the pacemaker.

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Even a series of RF pulses, where the pulse repetition was varied around the heart frequency, failed to switch off the pacemaker.

We conclude that the danger for a patient wearing a pacemaker coming near an NMR spectrometer is limited. Developments in pacemaker as well as spectrometer technology, however, could change this situation and sufficient care should be taken. When a certain combination of spectrometer, w.r.t. fieldstrenghts, frequencies and powerlevels, and pacemaker has been tested a person wearing such an instrument could be a regular visitor of NMR laboratories with comparable equipment.

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Bruker Spectrospin N.V.
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JEAN L. DELAYRE, Ph.D.
Research Associate in Biophysics

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Dr. B.L. Shapiro
Dept. of Chemistry
Texas A&M University
COLLEGE STATION, TX 77843

February 11, 1981

POSITION AVAILABLE

Dear Dr. Shapiro,

We have a position available immediately for an NMR specialist. Responsibilities include maintenance operation and training operators on our NT-360 Wide Bore Multinuclear instrument. Experience is required in the design, fabrication, operation and repair of NMR instrumentation as well as electronic theory and techniques, and computer operations.

Send resume and three letters of reference to the address above.

Yours sincerely,

Jean L. Delayre

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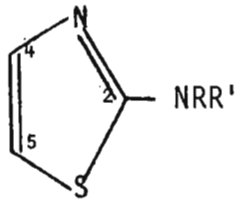
January 30, 1981

Professor B. L. Shapiro
Department of Chemistry
Texas A & M University
College Station, Texas 77843

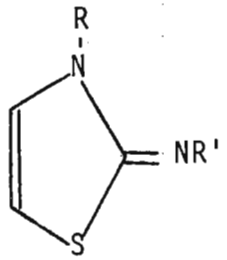
Subject: "H-C Coupling Constants in Aminothiazoles"

Dear Barry:

Aminothiazoles (I) can exist also in the imino form (II). In the course of our C-13 NMR studies of aminothiazoles, we found that the two-bond and three-bond H-C coupling constants varied significantly between I and II.



(I)



(II)

As shown in the table, the magnitude of $^{2}J_{H_4C_5}$ in the amino form is much larger than that in the imino form. (cf. 14.9 Hz for Ia and 9.7 Hz for IIb). The same trend is also observed for $^{3}J_{H_4C_2}$. (cf. 15.9 Hz for Ia and 9.4 Hz for IIb). The magnitude of $^{2}J_{H_5C_4}$ increases moderately from 5.9 Hz for Ia to 7.7 Hz for IIb. However, $^{3}J_{H_5C_2}$ decreases from 7.7 Hz for Ia to 6.0 Hz for IIb.

If these trends hold, measurement of $^{2}J_{H_4C_5}$ and $^{3}J_{H_4C_2}$ can help determine

the importance of the amino and imino form for aminothiazoles. For example, the product from the reaction of 2-aminothiazole and O,O-dimethyl-thiophosphoryl chloride can assume either the amino or imino form [R=H, R'= $(CH_3O)_2P(S)$] . The observed values of 9.1 and 10.8 Hz for $^2J_{H_4C_5}$ and $^3J_{H_4C_2}$ would suggest that the imino structure predominates.

Sincerely yours,

C. K. Tseng

D. J. Bowler

Table H-C Coupling Constants in Aminothiazoles*

	R	R'	$^2J_{H_4C_5}$	$^2J_{H_5C_4}$	$^3J_{H_4C_2}$	$^3J_{H_5C_2}$
Ia	H	H	14.9	5.9	15.9	7.7
Ib	H	CH_3NHCO	14.1	5.8	15.9	8.3
IIa	CH_3	$(CH_3O)_2P(S)$	7.9	6.4	--	-
IIb	CH_3	H-HI	9.7	7.7	9.4	6.0
IIc	H	$(CH_3O)_2P(S)$	9.1	6.2	10.8	5.8

*in deuterated DMSO

270-17

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TELEX NO. 13-8840 • (201) 272-8820

January 30, 1981

Professor B. L. Shapiro
Department of Chemistry
Texas A & M University
College Station, Texas 77843

Dear Barry:

The Highs and Lows of Rh-103 NMR

or

Confusion at Three Fields

Since we first observed ^{103}Rh spectra on the FX-90Q, we have been confused by the multiplet structure of 1M En_3RhCl_3 in 90% H_2O/10% D_2O. Since we tried several different decoupling modes (including no decoupling) proton spin spin coupling has been negated. The ^{1}H, ^{13}C, ^{15}N and ^{14}N spectra showed nothing unexpected. When we ran the same sample on the FX-200 we saw identical structure but with a separation that is field dependent (to the accuracy of the data point limitation). At this point we thought perhaps the chemistry was a problem and we ordered more sample from Alfa.

Our FX-270 Low Band probe beat the sample to Cranford and when we made up the new sample (1M En_3RhCl_3 in H_2O/D_2O) we ran the ^{103}Rh spectrum again. And again the same structure was observed with an increased field separation. However, this sample was run freshly prepared and after 4 scans a signal was observed (360s rep rate). It appeared that the signal was slightly changing during the acquisition which may indicate a complex equilibrium. The separation is approximately 2.4 ppm and we hope to clarify this phenomenon by dilution studies.

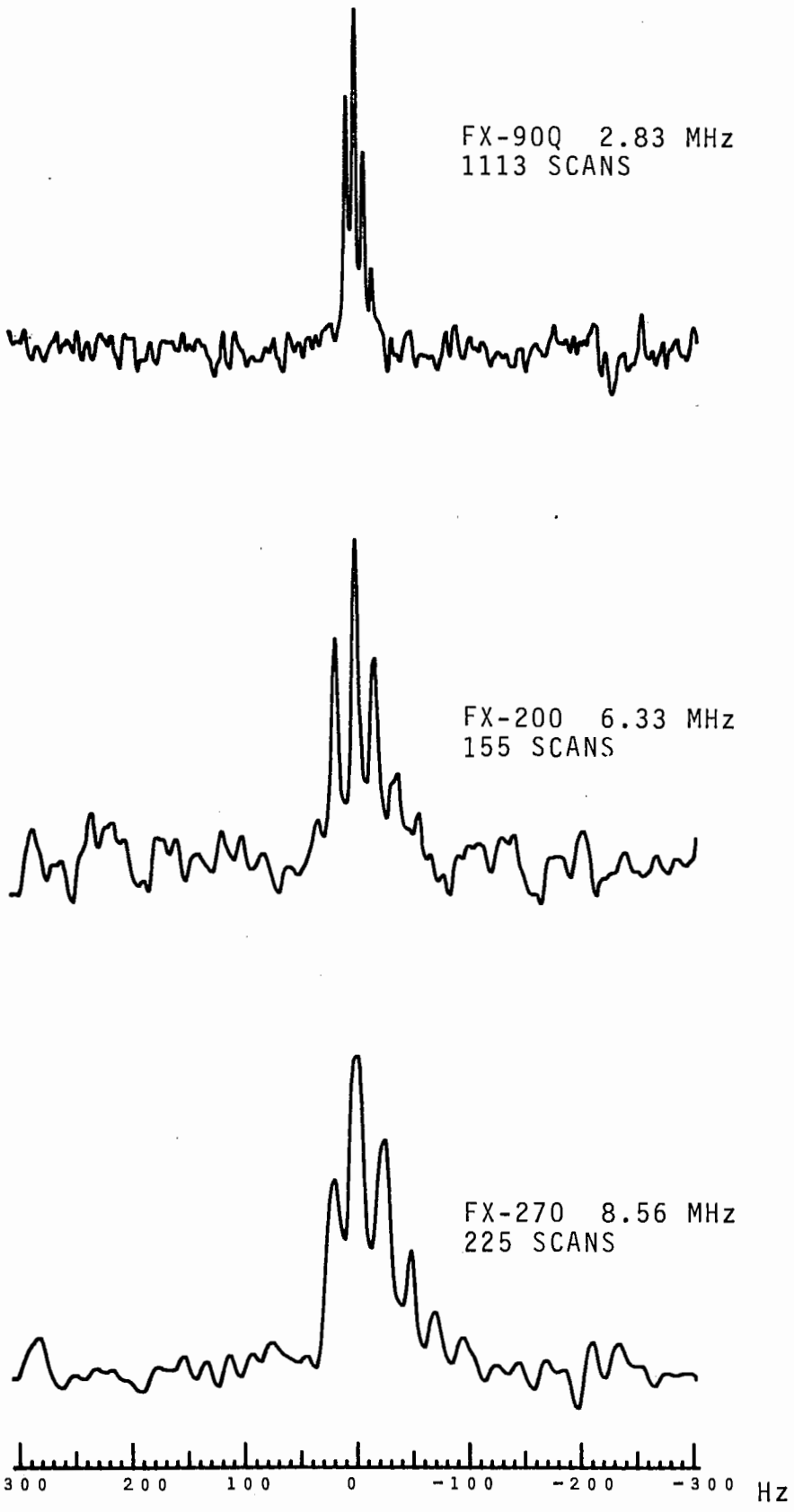
The initial sample was kindly provided by Ed Abbott at Montana State University.

Sincerely,

Michael J. Albright

MJA/mjd

1M En_3RhCl_3 ^{103}Rh Spectra



UNIVERSITY OF BRISTOL

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SCHOOL OF CHEMISTRY
CANTOCK'S CLOSE
BRISTOL
BS8 1TS.

Professor Bernard L. Shapiro,
Department of Chemistry,
Texas A & M University,
College Station,
Texas 77843, U.S.A.

5th. February 1981

Dear Professor Shapiro,

Complex Spin Systems and Resolution Enhancement

Our JEOL FX200 has performed well since it joined the FX90Q in April. Both spectrometers are multinuclear with foreground/background and discs, considerably increasing our F.t. n.m.r. capability over our old JEOL PFT100. We were able to try various probe/r.f. modules on the FX90Q. The ^{13}C performance of the tunable probe module did not seem significantly less than that of the C/H dual frequency system and as high sensitivity proton work would be best done on the FX200, the multinuclear system alone covers our needs. However, a 5 mm insert proved to be very useful in addition to a 10 mm one. Indeed, we use the 5 mm insert to provide the routine service for ^{13}C, ^{31}P, ^{195}Pt, etc., frequently using the same samples as are submitted for CW proton spectra.

Resolution enhancement is most commonly employed by those studying large organic molecules but it can be of use in the analysis of complex spin systems as we found in a problem presented to use by Professor Maitlis of the University of Sheffield. The X-ray structure of $[Rh_4H_4(\eta^5\text{-}C_5Me_5)_4][PF_6]_2$ shows a tetrahedron of rhodium atoms distorted in a D_{2d} manner so that two Rh-Rh edges are markedly shorter than the other four. This led Espinet et al. (Inorg.Chem., 1979, 18, 2706) to propose that the hydrides bridged the long edges. Somewhat surprisingly, the hydrides are not fluxional and thus give rise to the interesting pattern shown in Figure A. This suggested to us that each hydride was associated with three rhodium atoms which is possible if they lie above the four faces of the Rh_4 tetrahedron. We first investigated J(RhRh) via the ^{13}C spectrum of the carbons of the cyclopentadienyl rings. We could only get agreement with the observed spectrum from a simulation based on the symmetric, face-bridged structure. A pair of weak 'outer' features could be identified resulting in a value of 8.2 Hz for J(RhRh) which was then used in simulations of the hydride spectrum. Again, only the symmetric model gave anything resembling the observed spectrum.

As the conclusions based on n.m.r. seem at variance with those from X-ray, we were anxious that the n.m.r. case should be as strong as possible. The simulated spectrum, when plotted with a small line width (Figure C), shows fine structure not visible in the observed spectrum after normal processing. That this fine structure is in fact present can be shown by means of resolution enhancement. Using a (rather severe) positive exponential factor (Figure D), the detail of the strong lines is reproduced [this is sensitive to $^2J(RhH)$]. A milder enhancement (Figure B), using the sinebell approach, applied by subtraction of dispersion spectra (M. Guéron, J.Magn.Reson., 1978, 30, 515) helps to show up the weak features at the base of strong ones - the weak doublet between the strong lines is especially sensitive to J(HH).

Yours sincerely,

Dr. R.J. Goodfellow

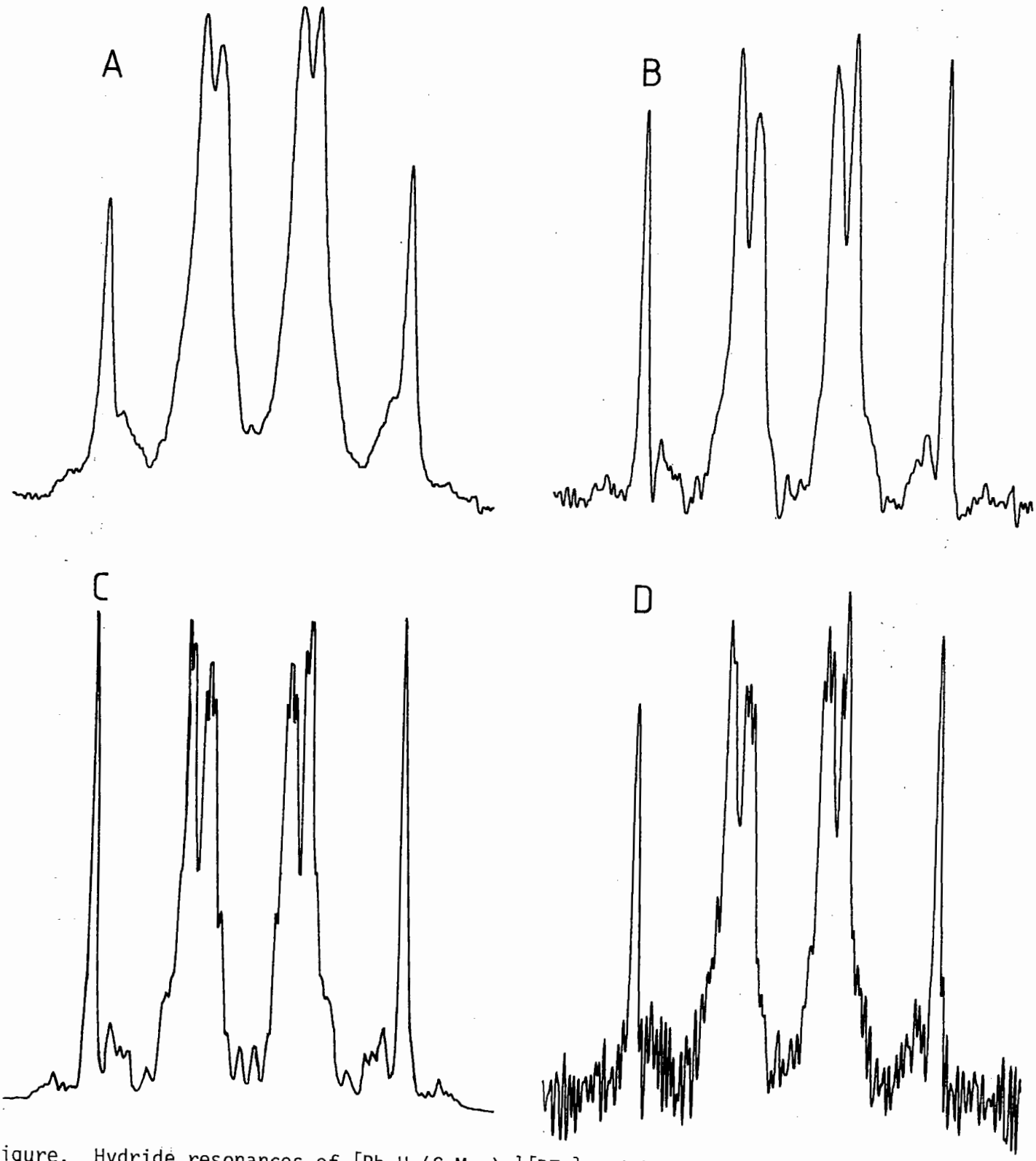

Figure. Hydride resonances of $[Rh_4H_4(C_5Me_5)_4][PF_6]_2$ with 0.5 line broadening (A), and resolution enhancement using an optimised sinebell (B) and a positive exponential (D) compared to the spectrum calculated for $^1J(RhRh)$, 8.2; $^2J(HH)$, 2.0 (opposite signs) and $^1J(RhH)$, 28.4; $^2J(RhH)$, 0.5 Hz (opposite signs).

270-21

The University of Alabama in Birmingham
Comprehensive Cancer Center
205/934-5696

February 5, 1981

Dr. Bernard L. Shapiro
Department of Chemistry
Texas A & M University
College Station, TX 77843

Title: NMR Study of Bleomycin Complexes

Dear Dr. Shapiro:

We have recently been conducting a proton NMR study of the interaction of the antineoplastic agent bleomycin with metal ions and DNA (more specifically, the DNA analog poly(dA-dT)). The pharmacological activity of this drug has been attributed to its degradation of DNA in the presence of molecular oxygen and a metal ion cofactor such as Fe(II) (1). We have demonstrated (2) the formation of CO-Fe(II)-Bleo-poly(dA-dT), which is a diamagnetic analog of the putative active complex of the drug, viz, O_2-Fe(II)-Bleo-DNA. This was accomplished by saturating one of the resonances of the drug and observing spin diffusion to the other resonances of the drug as well as those of the nucleic acid. This was a rather novel use of an otherwise undesirable phenomenon (spin diffusion). We are now involved in a more detailed study of Zn(II)-Bleo-poly(dA-dT), another diamagnetic analog of the active complex. The binding of Zn(II) to bleomycin is slow while the binding of nucleic acids is fast on the proton chemical shift time scale. By comparing the chemical shifts of the various resonances of this complex with suitable controls, we have determined the perturbations caused by metal ion and nucleic acid binding. Some of these perturbations are shown in the accompanying NMR spectrum recorded at 400 MHz. We find that the resonances perturbed by nucleic acid binding are not perturbed by metal ion binding and vice-versa. The residues which link the metal ion-binding end of the molecule with the nucleic acid binding fragments, however, are perturbed by both processes. This is in agreement with the bifunctional nature of the drug. We also find that the ternary complex retains the structural characteristics of the binary complexes. This may simplify further structural studies of these complexes.

Please credit this to the account of Dr. Jerry Glickson.

Sincerely,

Rajasekharan P. Pillai

1. Sausville, E.A., Stein, R.W., Peisach, J. and Horwitz, S.B. (1978) Biochemistry 17, 2746-2754.
2. Pillai, R.P., Krishna, N.R., Sakai, T.T. and Glickson, J.D. (1980) Biochem. Biophys. Res. Commun. 97, 270-278.

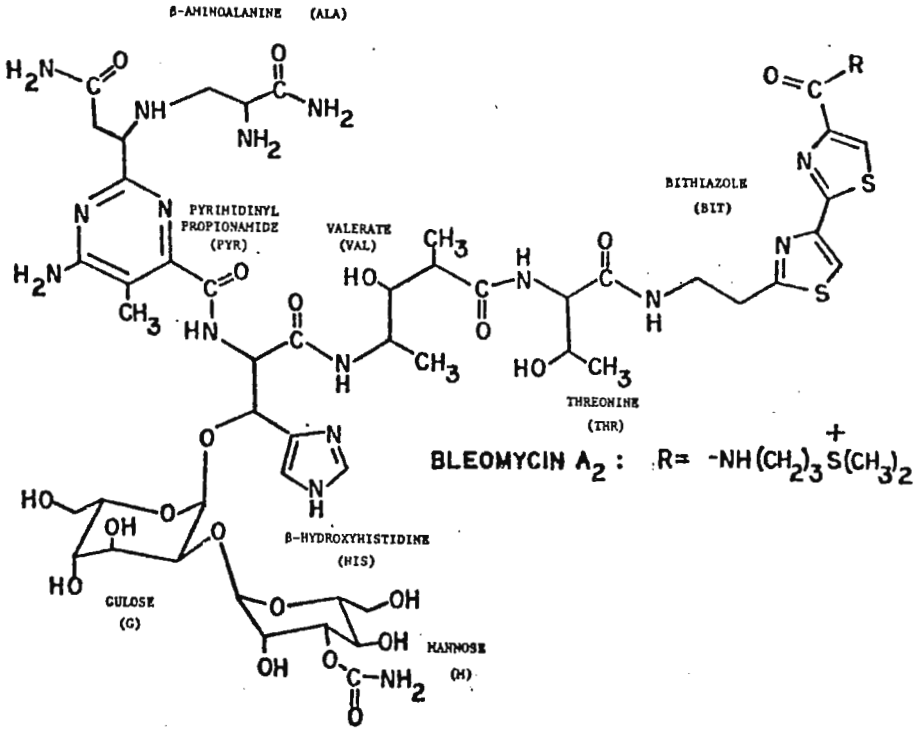

Figure 1: Primary Structure of Bleomycin

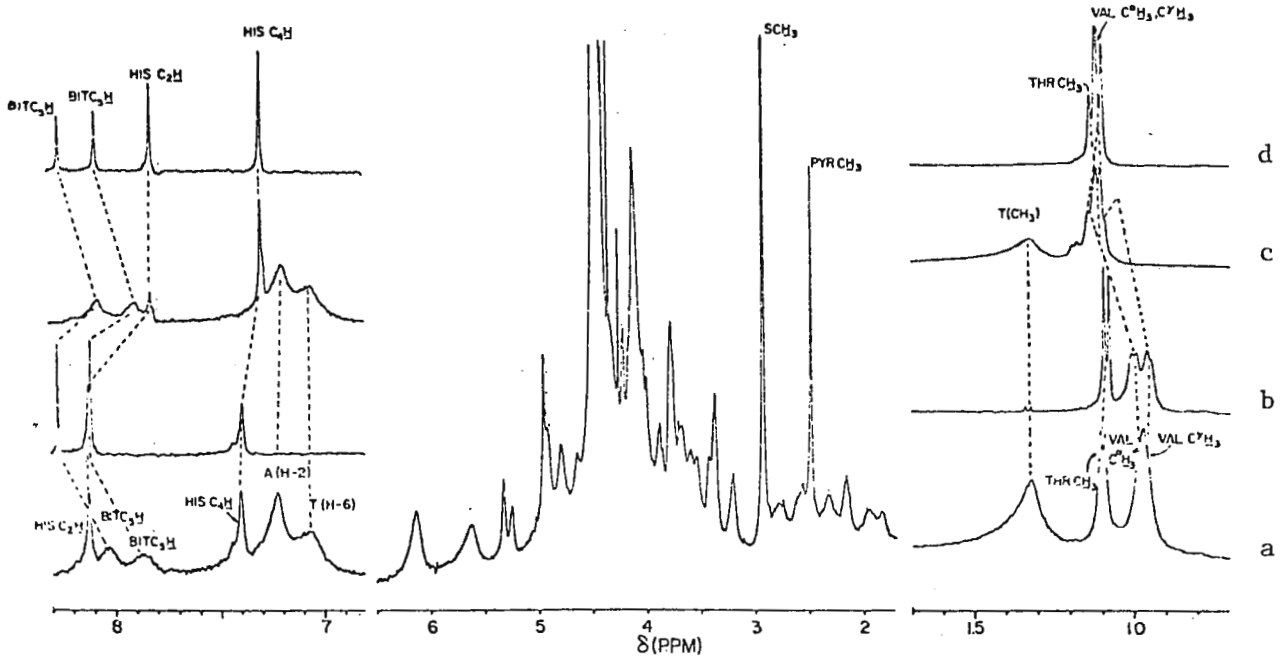

Figure 2; 400 MHz ^{1}H NMR Spectra of Bleomycin Complexes
(a) Zn(II)-Bleo-poly(dA-dT); (b) Zn(II)-Bleo;
(c) Bleo-poly(dA-dT) and (d) Bleo

270-23

STANFORD UNIVERSITY

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DEPARTMENT OF CHEMISTRY, B-014
LA JOLLA, CALIFORNIA 92093

February 13, 1981

Professor B. L. Shapiro
Department of Chemistry
Texas A&M University
College Station, Texas 77843

LINEAR HOMO-OLIGOPEPTIDE STRUCTURES

Dear Professor Shapiro:

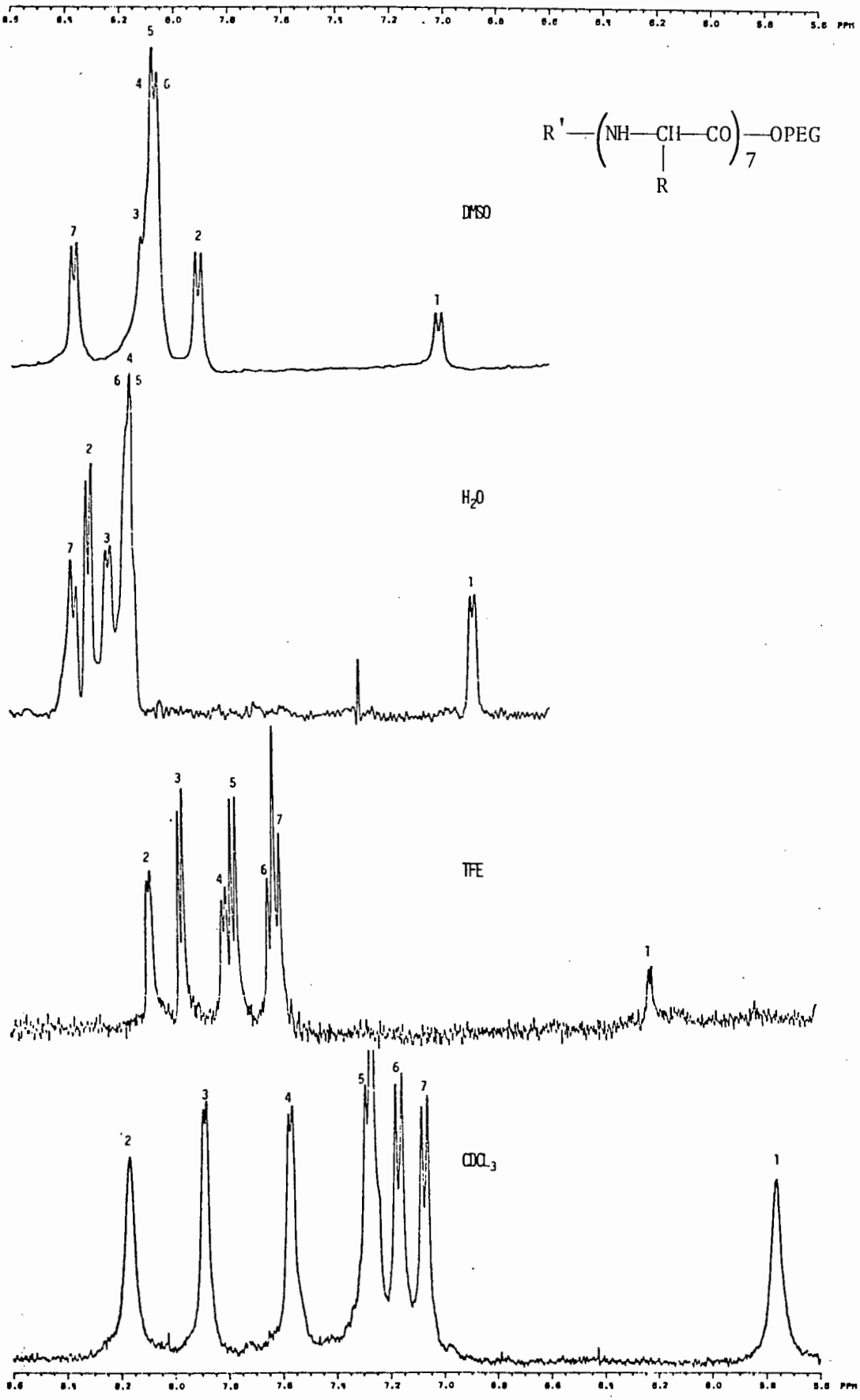
Thank you for your yellow reminder. We are continuing collaborative NMR studies on the structure of protected linear homo-oligopeptides in solution. We previously studied blocked methionine and glutamate methyl esters in $CDCl_3$ and in the helix-supporting environment, trifluoroethanol (1-3). A rapidly increasing insolubility with chain length proved to be a formidable obstacle with these series of peptides. However, recent attachment of strong solubilizing polyethylene glycol (PEG) groups to such peptides allows NMR studies in a wider variety of solvents (4). The accompanying figure shows the NH region for a blocked homo-heptapeptide-PEG in $CDCl_3$, TFE, DMSO and yes, even H_2O. The differing line shapes and the indicated assignment of individual NH resonances (made by using α-deuterated oligopeptides) give evidence for different structures in the four solvents. We hope this contribution will keep our beloved TAMU Newsletter coming to A.R.

Sincerely,

Anthony Ribeiro Robert Saltman Murray Goodman

A. Ribeiro R. Saltman M. Goodman

1. A. Ribeiro, M. Goodman and F. Naider, Int. J. Pept. Prot. Res. 14, 414-436 (1979).
2. A. Ribeiro, R.S. Saltman and M. Goodman, Biopolymers 19, 1771-1790 (1980).
3. F. Naider, A. Ribeiro and M. Goodman, Biopolymers 19, 1791-1799 (1980).
4. M. Mutter and E. Bayer, "The Peptides: Analysis, Synthesis, Biology" Vol. 2: Special Methods in Peptide Synthesis. Part A. E. Gross and J. Meienhofer, Eds., Academic Press, N.Y., pp. 285-332 (1980).


R'—(NH—CH—CO)7—OPEG
R
DMSO
H2O
TFE
CDCl3
PPM

Lund, February 16, 1981

CHEMICAL CENTER
PHYSICAL CHEMISTRY 2

Prof. B.L. Shapiro
Texas A & M University
College of Science
College Station, Texas 77843
U S A

Dear Barry,

^{43}Ca, an unusual quadrupolar nuclei

In our previous letter (259-1) we showed that ^{43}Ca is not such a "bad" nuclei after all, and that Ca^{2+} binding to biological macromolecules can be studied at millimolar Ca^{2+} concentrations. It has often been stressed by some of us that it would be very difficult, if not impossible, to directly observe the NMR signal from a quadrupolar nucleus bound to a protein. In the light of the past years of ^{43}Ca measurements we are now able to demonstrate that this was too pessimistic a view.

At the present time we have made direct observations of the ^{43}Ca signals of Ca^{2+} bound to three proteins, troponin C (1), calmodulin and parvalbumin (M_W = $18\cdot10^3$, $16.5\cdot10^3$ and $11.5\cdot10^3$ respectively). In these proteins, Ca^{2+} is co-ordinated by oxygen ligands (carbonyl oxygens from the peptide back-bone and carboxylate oxygens from the amino acid side chains). Due to chemical exchange effects we are, in the present type of studies, only able to directly observe the signals from Ca^{2+} sites having relatively slow exchange rates, i.e. $k_{off}<10^2 s^{-1}$ (which in practice restricts us to observe sites with association constants greater than 10^6 M^{-1}). The ^{43}Ca NMR signals have chemical shifts of ca 10 ppm downfield to the signal of free Ca^{2+}, and they vary in line-width from 700 Hz (parvalbumin) to 800 Hz (troponin C and calmodulin).

^{43}Ca is a spin 7/2 nucleus and under non-extreme narrowing conditions the decay of the magnetizations will be weighted sums of 4 exponentials. McLachlan has derived useful approximate expressions for the average relaxation rates (2,3):

$$R_1 = \frac{3}{40}\chi^2\frac{2I+3}{I^2(2I-1)}\left[\frac{0.2\tau_c}{1+(\omega\tau_c)^2} + \frac{0.8\tau_c}{1+(2\omega\tau_c)^2}\right]$$

$$R_2 = \frac{3}{40}\chi^2\frac{2I+3}{I^2(2I-1)}\left[0.3\tau_c + \frac{0.5\tau_c}{1+(\omega\tau_c)^2} + \frac{0.2\tau_c}{1+(2\omega\tau_c)^2}\right]$$

UNIVERSITY OF LUND — LUND INSTITUTE OF TECHNOLOGY

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By measuring both R_1 and R_2 it is possible to obtain both χ and τ_c. Halle and Wennerström have shown that for a spin 7/2 nucleus the obtained correlation time is ca 10% greater than the actual correlation time for a $\omega\tau_c$ value of 1.5 (R_2 estimated from the line-width).

In order to determine the correlation time and quadrupole coupling constant for Ca^{2+} ions bound to the high affinity sites of calmodulin and parvalbumin R_1 was measured by the inversion recovery method, and R_2 was estimated from the line-width. The measurements were performed on our home-made spectrometer. This spectrometer is equipped with an Oxford Instruments 6 T wide bore magnet, and in order to optimize the sensitivity the probe is designed with a horizontal sample position. Figures 1 and 2 shows the results of R_1 measurements for calmodulin and parvalbumin respectively. The obtained correlation time is 4 ns for parvalbumin and 9 ns for calmodulin. These values well agree with the reorientation times for the entire protein molecules. Figure 3 shows the spectra used in the R_1 measurement for parvalbumin in figure 2.

On the basis of the results we have got so far we now believe that significant information can be obtained from the "protein-bound" ^{43}Ca signals.

Sincerely

Thomas Andersson Torbjörn Drakenberg Sture Forsén Marianne Swärd

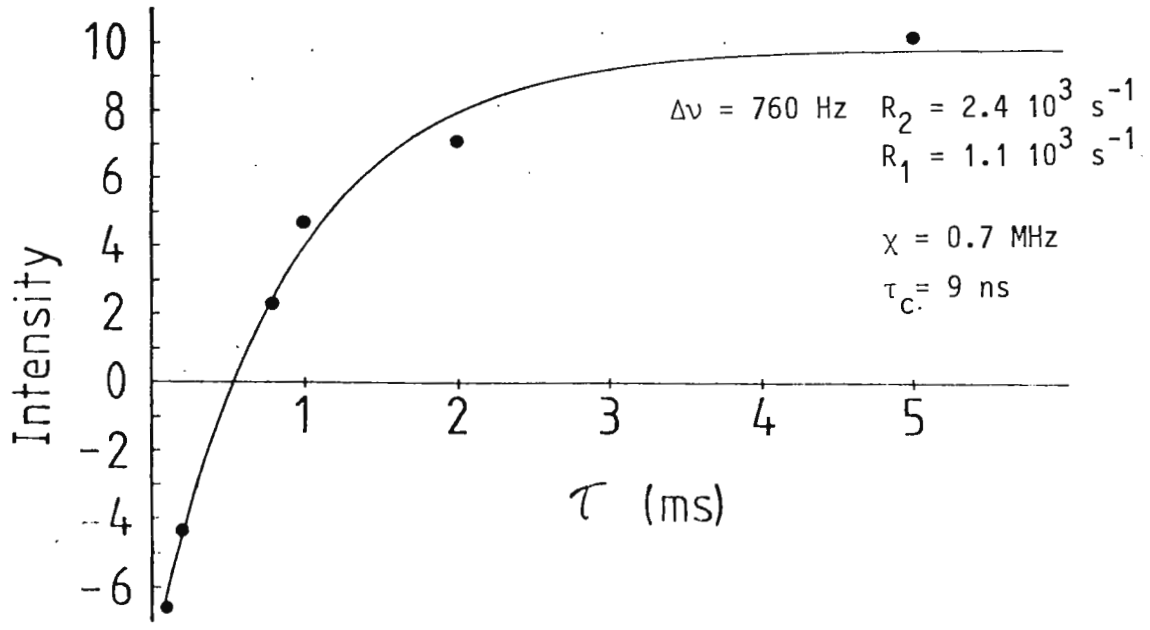

Figure 1. The integrated intensity as a function of the delay time, τ. The solid line represents the result of a non-linear fit of the data, yielding T_1 = 0.9 ms corresponding to R_1 = 1.1 10^3 s^{-1}. The measurements were made on a 2.5 mM calmodulin solution containing 4.5 mM Ca^{2+} (60% ^{43}Ca). Each data point required ca 15 hours of accumulation.

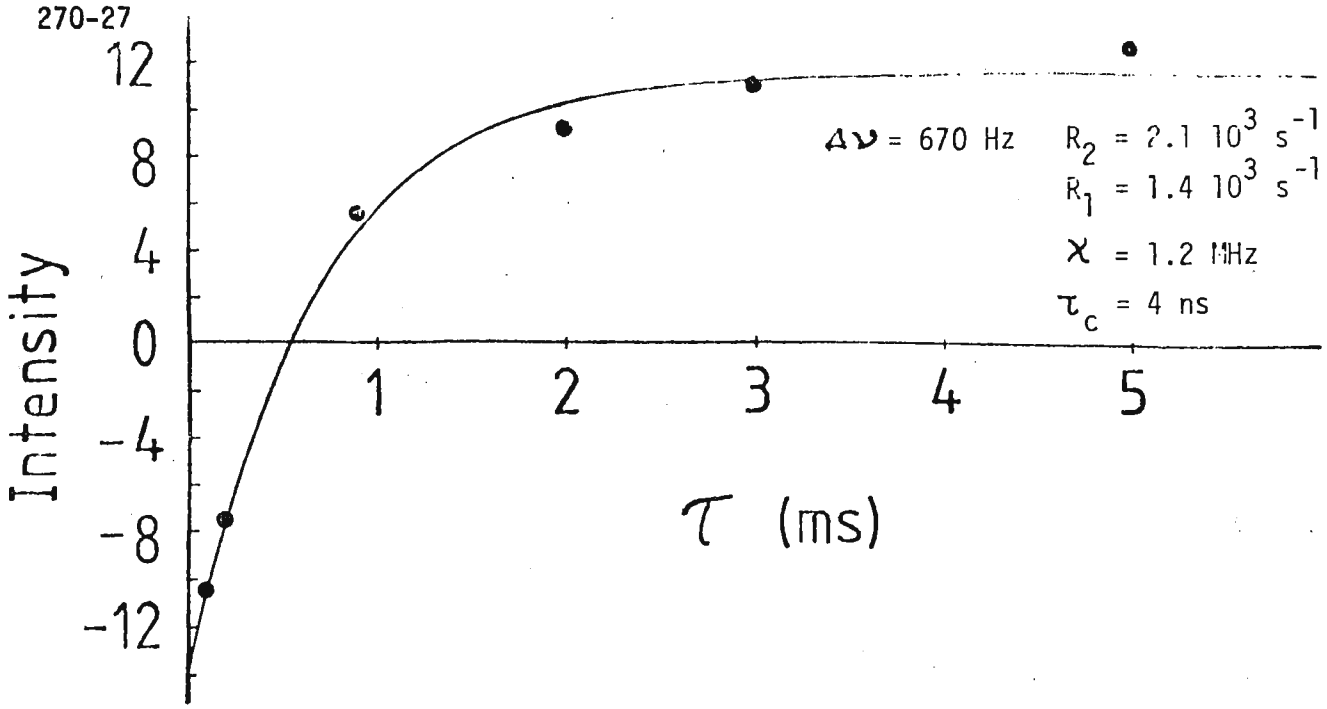

Figure 2. The integrated intensity as a function of the delay time, τ. The solid curve represents the result of fitting the data to an exponential decay. T_1 = 0.7 ms corresponding to R_1 = 1.4 10^3 s^{-1}. The measurements were performed on a 5 mM parvalbumin solution containing 8 mM Ca^{2+} (60% ^{43}Ca). Each spectrum required ca. 1.5 hours of accumulation.

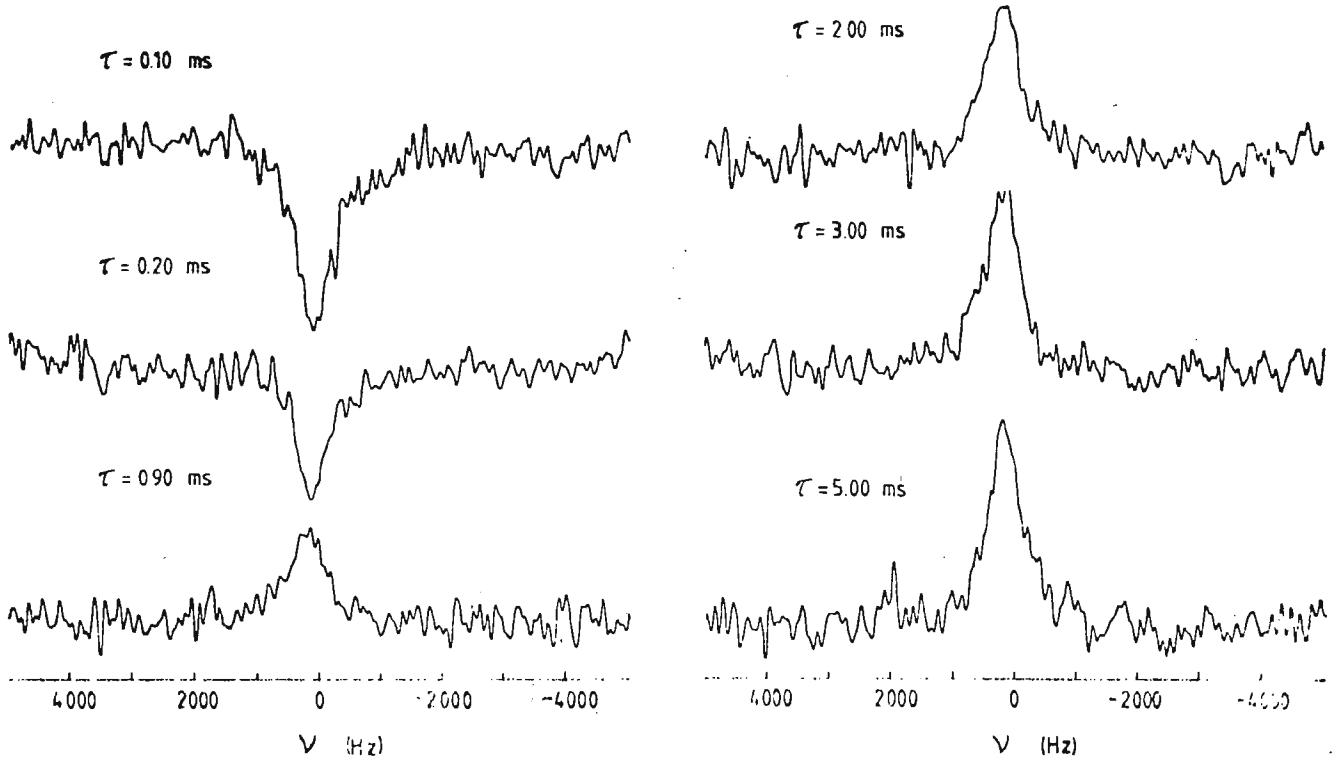

Figure 3. The spectra used to obtain figure 2.

References. (1) Andersson, T., Drakenberg, T., Forsén, S.and Thulin, E. (1981) FEBS Lett. in press.
(2) McLachlan, A.D. (1964) Proc. Roy. Soc. (London) 280 A, 271.
(3) Halle, B. and Wennerström, H. (1981) J. Mag. Res. in press.

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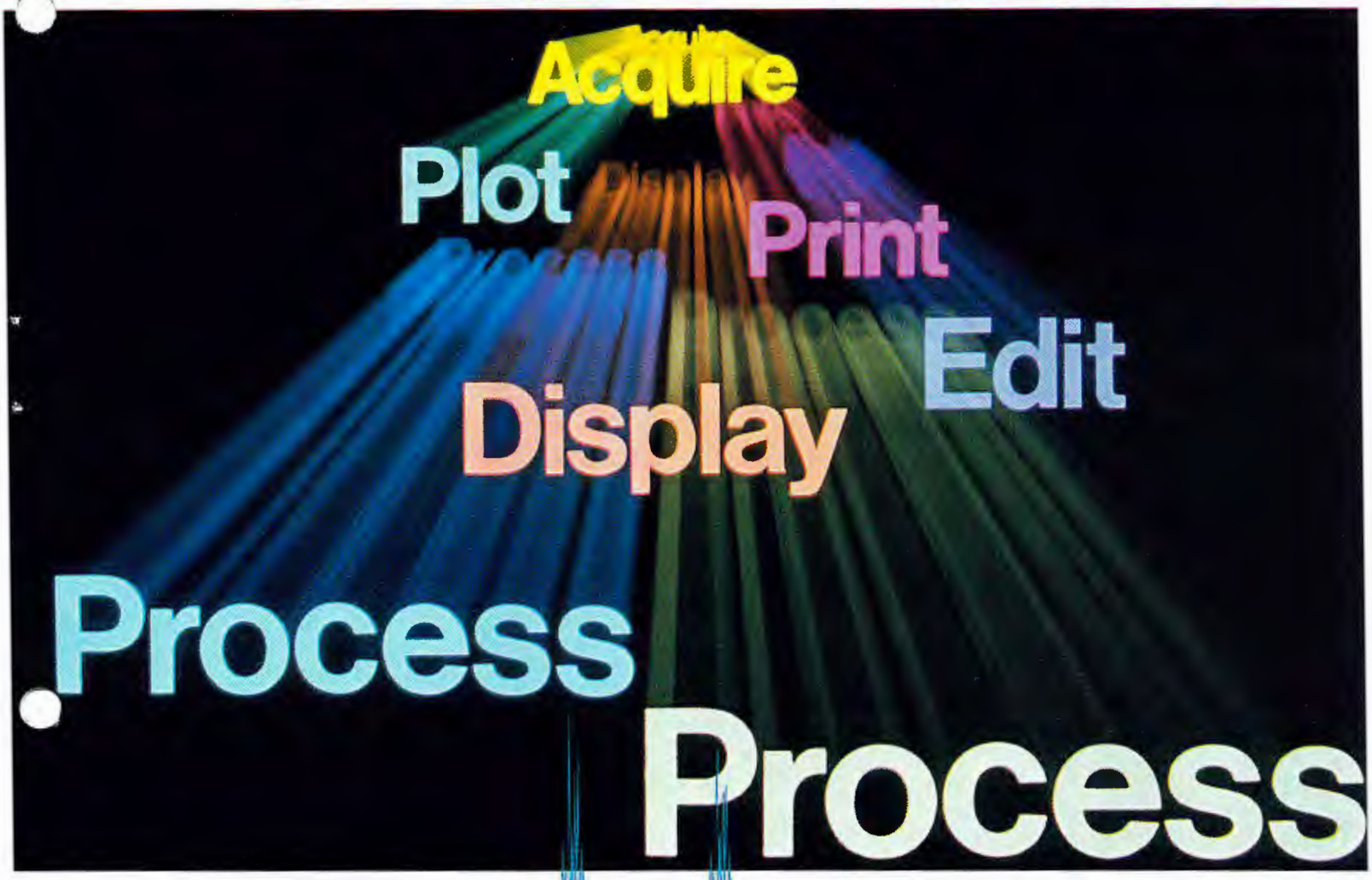

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University of Illinois at Urbana-Champaign

School of Chemical Sciences
505 South Mathews Avenue
Urbana, Illinois 61801

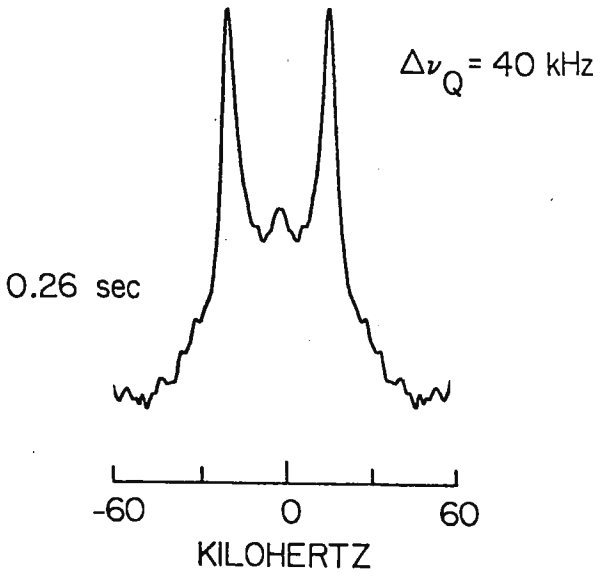
February 25, 1981

Professor Bernard L. Shapiro
Department of Chemistry
Texas A & M University
College of Science
College Station, TX 77843

Dear Barry:

^{2}H NMR of Valine in Membrane Proteins

Using our home-built 8.5 Tesla Oxford widebore magnet system we have recently been looking at the motions of amino-acids in membrane proteins in intact photosynthetic membranes. We have been able to obtain ^{2}H NMR spectra in rather brief time periods by use of large sample volumes, the following spectrum of [$^2H_6$]valine labelled "purple membranes" of the organism Halobacterium halobium having been obtained in only 260 msec (250 of these msec's were used in dumping data from our Nicolet Explorer Scope into our Nicolet 1180 computer). We are also, of course, now looking at all the other amino-acids in this system and a number of others.



Deuterium Fourier transform NMR spectrum of bacteriorhodopsin containing biosynthetically incorporated [γ-$^2H_6$]valine residues, in the purple membranes of H. halobium R1 in excess deuterium-depleted water at ∿ -100°, obtained using a quadrupole echo pulse sequence at 55.3 MHz, corresponding to a magnetic field strength of 8.5 Tesla. 10 scans, 26 msec recycle time (total time = 260 msec), $\tau_1=\tau_2$=50 μsec, 3.5 μs 90° pulse widths, 2 MHz digitization rate, 2048 data points, line-broadening = 2000 Hz.

Sincerely yours,

Eric Oldfield
Associate Professor
of Chemistry

EO:msh

Variable-temperature CP/MAS Relaxation Studies

Department of Chemistry

Colorado State University
Fort Collins, Colorado
80523

February 18, 1981

Prof. B.L. Shapiro
Department of Chemistry
Texas A&M University
College Station, TX 77843

Dear Barry:

Nick Szeverenyi and Mark Sullivan have recently been carrying out some very interesting experiments in our laboratory, experiments that bear on the question of why some simple organic solids are not readily observed by ^{13}C CP/MAS techniques under normal conditions. The key factor in many cases, we believe, is the influence of molecular motion on the cross polarization and proton decoupling processes (as discussed previously by Waugh, VanderHart, Garroway, and others).

A strong component of molecular motion at the rotating-frame Larmor frequency ($\omega_1^C = \omega_1^H$ for a carbon-hydrogen Hartmann-Hahn match) will lead to efficient $T_{1\rho}$ relaxation, resulting in rapid decay of ^1H and ^{13}C magnetization during the $^{1\rho}CP$ period. This effect is seen in Fig. 1c, where essentially no ^{13}C CP signal is observed for hexamethylbenzene (HMB) at -98°C, whereas CP signals are observed at other temperatures, and a ^{13}C spectrum can be obtained at -98°C by a simple pulse FT experiment (Bloch decay with MAS and high-power ^1H decoupling, Fig. 2).

The ^1H decoupling efficiency during data acquisition can also be reduced by molecular motion. In the presence of the proton H_1 field, the modulation of carbon-proton dipolar interactions by a component of molecular motion at ω_1^H can lead to dipolar terms that are very nearly static, leading to broadening of the ^{13}C resonance lines. An example is seen in Figure 3, which shows the effect of molecular motion (as influenced by temperature) and proton decoupling field strength on the ^{13}C CP/MAS spectrum of HMB. Figures 3c and 3d show the effect of two different ^1H decoupling field strengths on the room-temperature ^{13}C CP/MAS spectrum of HMB. Figures 3a and 3b show the corresponding spectra at -160°C. In 3b one sees that the ^{13}C lines are much broader than can be accounted for merely by the reduction in ^1H decoupler power, indicating a shift of motional spectral density to lower frequency with decreasing temperature.

This type of behavior has also been observed with cyclohexane, naphthalene and anthracene. Although we have been unable to obtain a ^{13}C CP/MAS spectrum of anthracene at room temperature, a spectrum is obtained at -113°C (Fig. 4). More quantitative experiments on these systems are underway.

Sincerely,

Gary E. Maciel
Professor

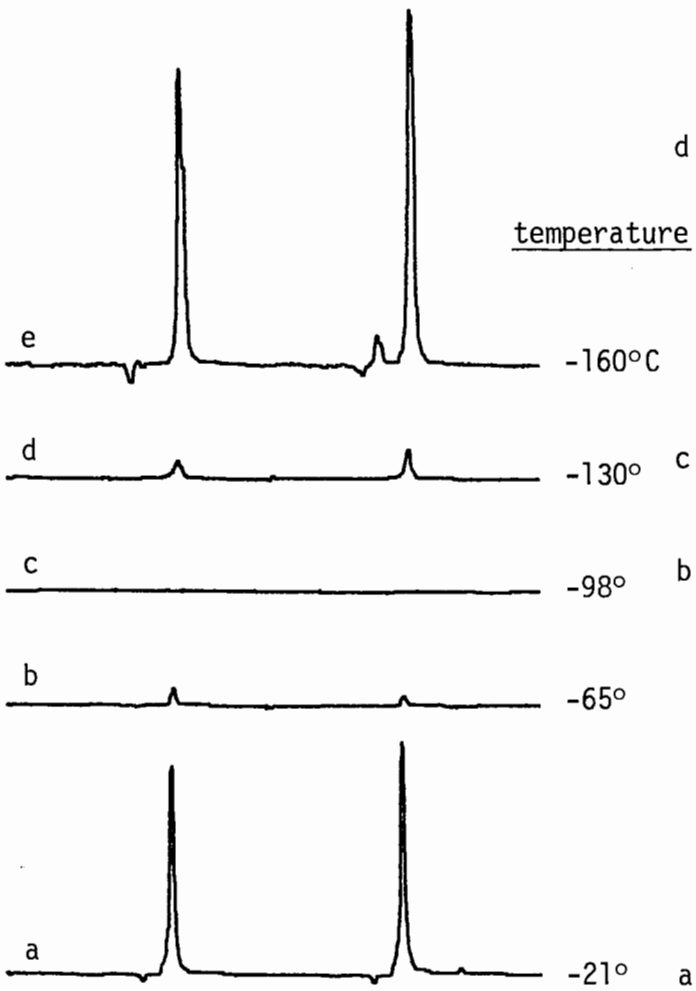


Fig. 1. ^{13}C CP/MAS spectra of HMB as a function of temperature, (all spectra obtained at 15.1 MHz).

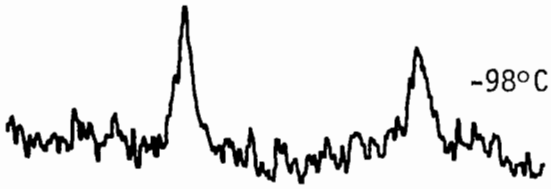


Fig. 2. Pulse FT (Bloch decay) ^{13}C spectrum of HMB at -98°C; with MAS and high power ^{1}H decoupling.

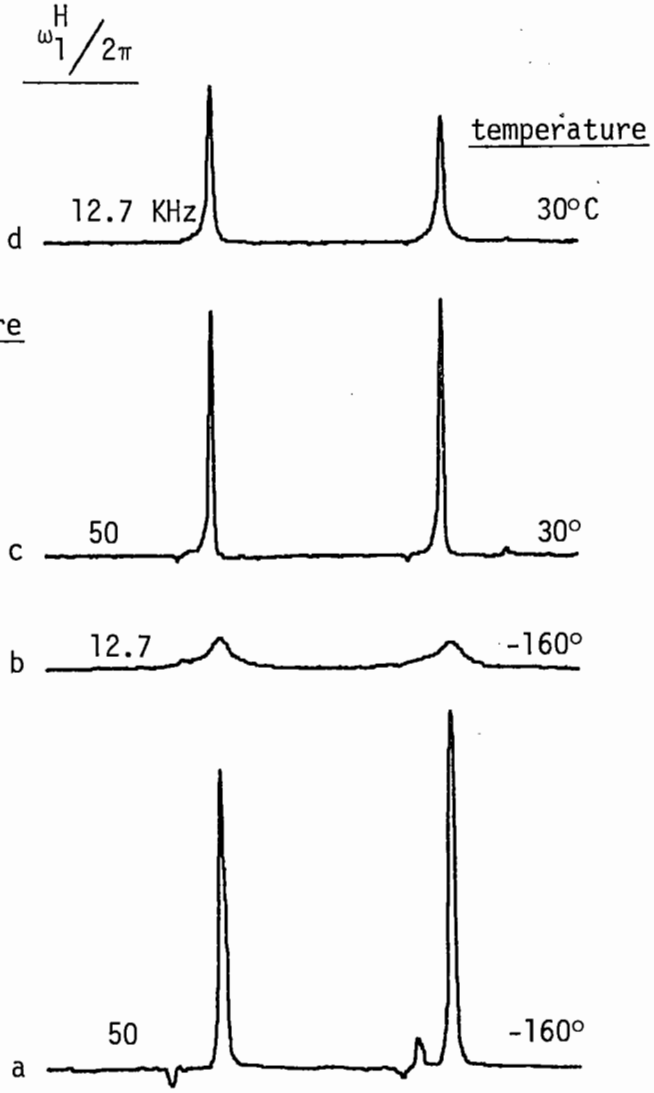


Fig. 3. ^{13}C CP/MAS spectra of HMB as a function of temperature and ^{1}H decoupling field strength.

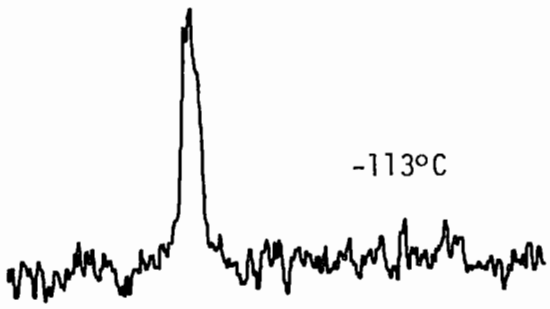


Fig. 4. ^{13}C CP/MAS spectrum of anthracene obtained at -113°C.

Professor B.L. Shapiro,
Department of Chemistry,
Texas A and M University,
College Station,
Texas 77843, U.S.A.

Physical Chemistry Laboratory,
Oxford University.

19 February 1981

Dear Barry,

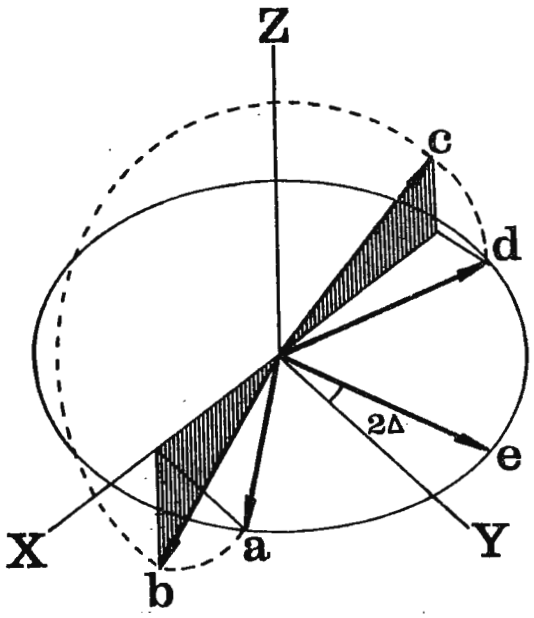
Meiboom and Gill Ride Again

It's very hard to improve on a classic, be it one of the old Ealing comedies like "Whisky Galore" or Paul Lauterbur's essay on the Cheetah. The Meiboom-Gill experiment (1) is undoubtedly an NMR classic - simple, elegant and a proven survivor, even in today's sophisticated spectrometers. Simply by replacing the refocussing pulse $R_X(\pi)$ of a spin echo experiment by $R_Y(\pi)$ they altered the symmetry of the problem in such a way that pulse length errors were compensated on even-numbered echoes.

Vold and Gutowsky (2) appear to have been the first to recognize that this compensation breaks down when the echoes are modulated by scalar spin-spin coupling; we now suggest an alternative method which does not have this drawback. It grew out of some work in which Malcolm Levitt (3) demonstrated that the sequence $R_X(\pi/2)\ R_Y(\pi)\ R_X(\pi/2)$ provided a much better inversion of Z magnetization than a simple $R_Y(\pi)$ pulse, compensating for pulse length misset or spatial inhomogeneity of the radiofrequency field. While the early analysis relied on computer simulation of magnetization trajectories, Malcolm has now produced a rotation operator treatment which indicates that this composite pulse also serves as a self-compensating refocussing pulse.

The effect of B_1 inhomogeneity may be evaluated by considering the sequence $R_X(\pi/2+\Delta)\ R_Y(\pi+2\Delta)\ R_X(\pi/2+\Delta)$ where Δ is a small angle. To first order in Δ, a transverse magnetization vector at a general position in the XY plane is rotated by this composite pulse back into the XY plane. It is just as if a perfect π pulse had been applied about an axis Y' in the XY plane but shifted through an angle Δ with respect to the Y axis. Whereas a conventional pulse $R(\pi+2\Delta)$ would have carried the vector beyond the XY plane, the composite pulse converts the error into a phase shift, independent of the initial conditions of the vector. Furthermore, although the subsequent spin echo has a phase shift 2Δ, this is cancelled for all even-numbered echoes.

The compensation can be visualized geometrically (see Figure). Suppose for the moment that the first and last pulses are perfect. A typical magnetization vector that has precessed during τ until it makes an angle ψ radians with respect to the X axis (a) is rotated by $R_X(\pi/2)$ to point b in the XZ plane. The imperfect second pulse $R_Y(\pi+2\Delta)$ carries it to point c where it makes an angle $(\psi-2\Delta)$ with respect to the -X axis. The third pulse takes it to d, so that a period τ of free precession generates an echo at e, subtending an angle 2Δ with respect to the Y axis. It is easy to show that the second echo is refocussed along the Y axis. When imperfections of the first and last pulses are included, the typical vector is carried a short distance behind the shaded vertical plane of the figure, but the error cancels to first order in Δ.



The most important property of this composite π pulse is that it compensates pulse length errors even when there is J-modulation of the echoes, in contrast to the Meiboom-Gill modification. Measurements on the spin-spin relaxation of protons in 1,1,2-trichlorethane show a vast improvement when the composite sequence is used compared with a conventional π pulse (both deliberately misset in pulse length). A slightly different composite sequence, $R_X(\pi/2)\ R_Y(4\pi/3)\ R_X(\pi/2)$ compensates for resonance offset effects.

Kindest regards,

Ray Malcolm

Ray Freeman, Malcolm Levitt

1. S. Meiboom and D. Gill, Rev. Sci. Instrum. 29, 688 (1958).
2. R.L. Vold and H.S. Gutowsky, J. Chem. Phys. 47, 2495 (1967).
3. M.H. Levitt and R. Freeman, J. Magn. Reson. 33, 473 (1979); R. Freeman, S.P. Kempsell and M.H. Levitt, J. Magn. Reson. 38, 453 (1980).

270-35

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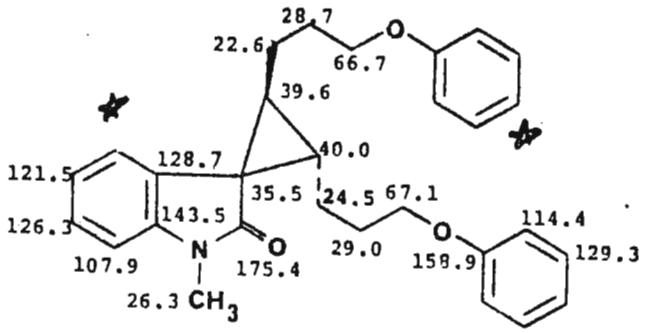
February 23, 1981

Professor Bernard L. Shapiro
Department of Chemistry
Texas A & M University
College Station, Texas 77843

LONG RANGE CHIRAL RECOGNITION

Dear Barry:

During the course of studies to determine the stereochemistry of some cyclopropylindolones we came across an interesting example of long range chiral recognition. Upon evaluation of the ^{13}C-NMR spectrum for the compound shown below,



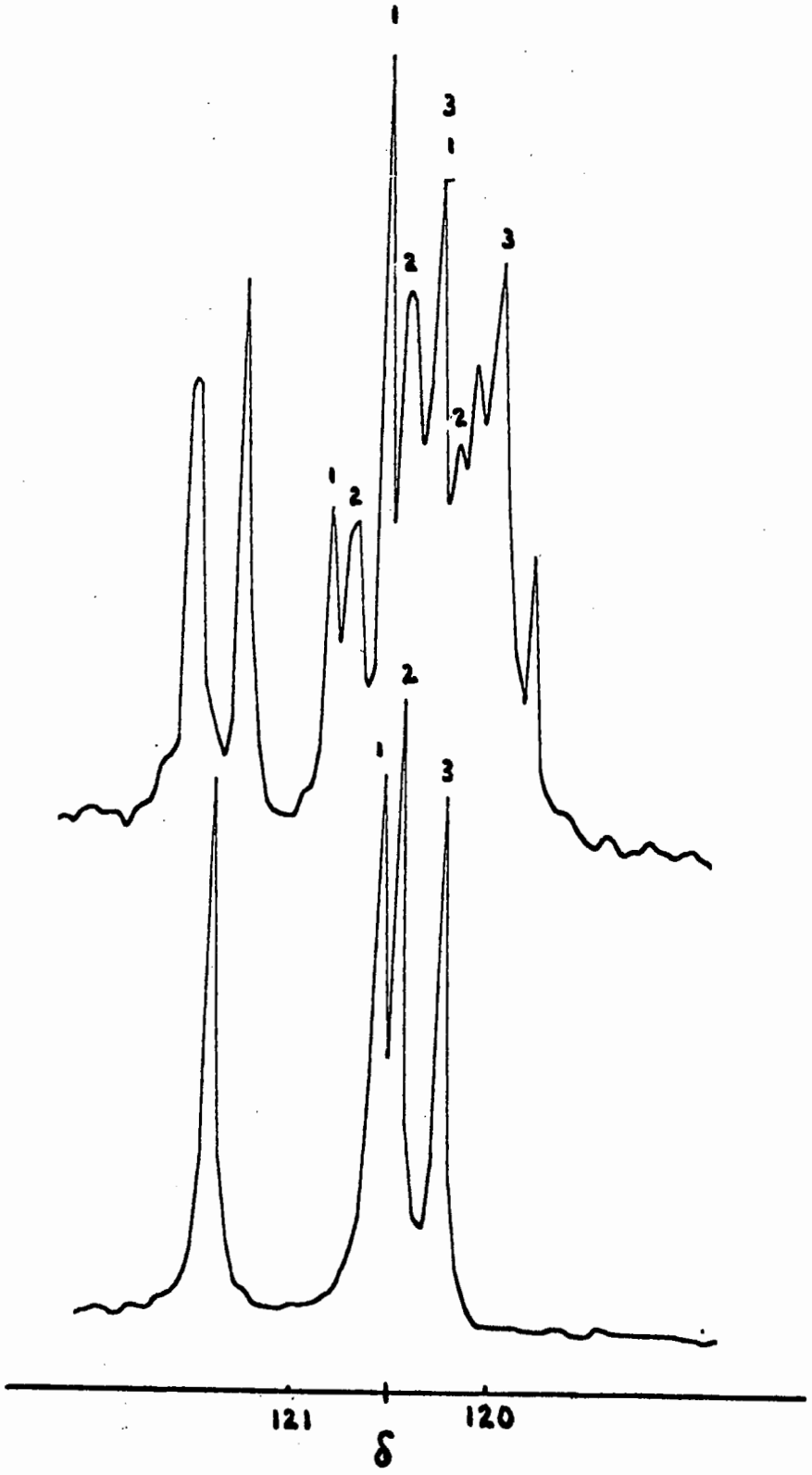
we noted that there was an extra resonance. All of the resonances could be assigned as shown above except for three resonances near 120 ppm. Note only two carbons seem to need assigning. Careful inspection of the proton-coupled spectrum revealed that one resonance was a doublet of doublets while the other two were doublets of triplets. (See figure) The latter signals would arise from the para carbons in the phenoxy ring and represents chiral recognition over 8 bonds! Is this some sort of record?

Yours sincerely,

Michael

M. Shapiro

MS:rck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3
121
120
δ

THE ROCKEFELLER UNIVERSITY
1230 YORK AVENUE · NEW YORK, NEW YORK 10021

25 February 1981

Professor Bernard L. Shapiro
Department of Chemistry
Texas A & M University
College Station, Texas 77843

Dear Dr. Shapiro:

(1) SPECTROSCOPIST POSITION AVAILABLE
(2) ANOTHER DISCOVERY OF NON-EQUIVALENT METHYLENE PROTONS (AS DEUTERONS) IN PHOSPHOLIPIDS

There is a vacany here for an NMR spectroscopist. The major duties will include maintenance and operation of the imminently-arriving (!?) new spectrometer, a wide-bore multinuclear 7T system. The projects using the spectrometer cover a wide range of physical, organic and biological chemistry. Previous spectroscopists have had training in engineering, or physics, or chemistry, with 0-8 years higher education, and as they have all been quite successful, I have no preconceptions about an applicant's training. Some familiarity with FT-NMR is very desirable. Applicants may write directly to the Personnel Office, The Rockefeller University, 1230 York Avenue, New York, N.Y. 10021, for forms, or may contact me for further details. Incidentally, this new spectrometer replaces the equipment previously advertised for sale, (TAMU 266-30) which is still available.

In my first contribution to the Newsletter, I should like to request you to waive your policy that "still another discovery of non-equivalent methylene protons... (will) not be considered adequate." In support of my request, I note that this report seems to settle a controversy of several years standing (1-4) concerning the observation of two quadrupole splittings in the deuterium NMR spectra arising from the sn-2 chain of 1,2 diacylglycerophosphocholines. This spectral feature might arise from non-equivalence of the proR and proS deuterons possibly in their orientation, or from a slow interconversion between two distinct conformers. A direct test of which hypothesis is correct involves measurements of the isotopic isomer in which only one of the C-2 protons of the sn-2 chain is replaced, stereospecifically, by deuterium.

In his Ph.D. thesis work, Dr. Alan K. Engel synthesised the necessary fatty acids and lipids, and, with the generous assistance of Dr. T.-H. Huang in Professor R. G. Griffin's lab at MIT, was able to obtain spectra of the dideutero- and mono-deutero isomers (Fig). This resolves the controversy, since only a single quadrupole coupling is observed in the spectrum of the

Professor Bernard L. Shapiro

25 February 1981

2R-^{2}H isomer, i.e. the two prochiral positions are significantly nonequivalent. Further synthetic and instrumental details will be presented in a manuscript.

Sincerely,

David Cowburn

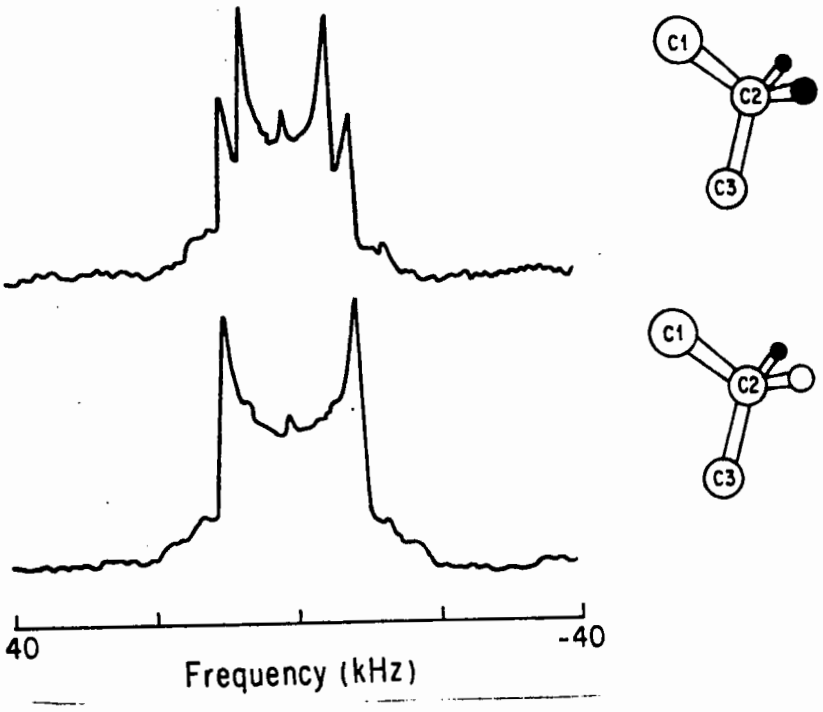
DC:mmh
enclosure (1 Fig)

1. Seelig, J. (1977) Q. Rev. Biophys. 10, 353-418

2. Mantsch, H. M., Saito, H., and Smith, I. C. P. (1977) Prog. NMR Spectrosc. 11, 211-271.

3. Rance, M., Jeffrey, K. R., Tulloch, A. P., Butler, K. W., and Smith, I. C. P. (1980) Biochim. Biophys. Acta 600, 245-262.

4. Haberkorn, R. A., Griffin, R. G., Meadows, M. D., and Oldfield, E. (1977) J. Am. Chem. Soc. 99, 7353-7355.



270-39

Varian / 611 Hansen Way / Palo Alto / California 94303 / U.S.A.
Tel. (415) 493-4000
Telex 34-8476

varian

February 26, 1981

Professor Barry L. Shapiro
Department of Chemistry
Texas A & M University
College Station, TX 77843

Dear Barry:

The last couple of months have been full of activity, particulary with exploring the capabilities of the new high sensitivity probes on the XL-200, as well as other interesting activities such as solids and 2D. Here I'd like to show just a couple of examples to demonstrate the potential of this increased sensitivity, which until now required a much higher field (and more expensive) spectrometer.

Figure 1 illustrates this nicely on a high purity polyethylene NBS standard. Jim Randall and I looked at this sample a year and a half ago and were able to detect branching down to three branches in 10,000 repeating units using a 20% solution in trichlorobenzene at 125°C. However, that spectrum took 229,432 transients (64 hours) using a 10 mm tube. The spectrum in Figure 1 is essentially identical to one requiring 64 hours, but was obtained in one tenth the time. The mainchain carbon peak has a S/N of 11,000:1 and the minor carbon signals an S/N of $\sim$5:1. Since this NBS standard 1483 has a number average MW of 28,900 (2064 methylene units), it is clear that we are seeing single carbon resonances corresponding to one branch per molecule. These data were obtained using the new design 20-81 MHz broadband 10 mm probe at 50.3 MHz. The time scale of this experment is, of course, much more practical for polymer analysis, and is a much less costly alternative that going to $\geq$360 MHz systems where, in addition, decoupling problems can often be a major impediment to improved sensitivity.

See you at the ENC,

George

George A. Gray, Manager
NMR Applications Laboratory

GAG/bry

XL-200 50.3 MHz ^{13}C

23,000 Transients

6.4 Hours

32-Bit Word Size

Floating-Point Fourier Transform

30 ppm Plot

New Design 20-81 MHz Probe

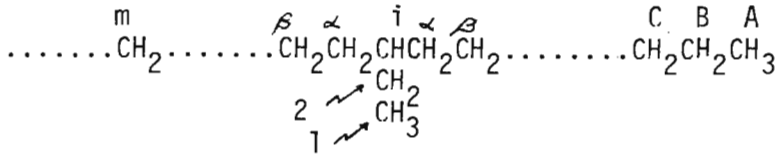
High Density Polyethylene

NBS Standard 1483

Mol. Wt. 28,900

20% in Trichlorobenzene

125°C 10 mm Tube



s = Stabilizer

270-41

BRUKER Instruments, Inc.
MANNING PARK
BILLERICA, MASSACHUSETTS 01821
(617) 667-9580

March 6, 1981

Dr. B. L. Shapiro
Department of Chemistry
Texas A and M University
College Station, TX 77843

Dear Barry:

Probe Technology: The Perennial Search for Higher Sensitivity

Few NMR spectroscopists would disagree that besides dispersion and resolution, signal-to-noise (S/N) is an important quality criterion of a spectrometer. Challenged by both their customers and competitors, manufacturers of NMR equipment have, over the past years, taken great strides to augment spectrometer sensitivity. Among the legitimate routes for boosting S/N are improvements in probe technology, magnet field homogeneity and preamplifier design. With preamplifier noise figures typically of the order of 3 db or less, the tappable resources for further sensitivity improvement are the magnet and the probe itself.

It is the line shape spectrum that indicates whether sensitivity is given away because of inadequate field inhomogeneity. The decoupled benzene line in Figure 1 shows a linewidth at .5% peak height of 2.24 Hz, which is only a factor of 2 above the theoretical value for a Lorentzian line of .08 Hz full width at half height. A further homogeneity criterion in this sample is the separation of the two weak peaks at .017 and .019 ppm, probably arising from naturally abundant doubly-labeled isotopomers, with the relative shifts reflecting the one-bond and two-bond ^{13}C-induced isotope effect, respectively.

From these data we conclude that any further increase in spectrometer sensitivity lies in the probe. The single-pulse spectrum of 10% ethyl benzene recorded at 62.8 MHz in a 10 mm tube showing S/N > 200:1 recently run in our laboratories may give an idea of these efforts. We still prefer this standard to the ASTM since the latter fails to provide a measure of S/N with ^{1}H decoupling, i.e., under the conditions 95% of the carbon spectra are recorded.

The ultimate test, however, is the long-term experiment on a dilute sample. We have, in an earlier Newsletter (No. 254, Nov. 1979), reported on the S/N achievable in a 20 mm tube on a 8.4 T wide bore system by indicating the practical detection limit for ^{13}C to be of the order of 1 mM or less. Although the data reported at that time are probably still unsurpassed, the spectrum in Figure 3 of 3 mM Vitamin B_{12} (4 mg/ml) recorded in 12.5 hours accumulation time on a WM-250 in a 10 mm tube illustrates that very low-concentration experiments have now become feasible on a medium-field supercon spectrometer.

Sincerely yours,

Peter Ziegler &
Felix W. Wehrli

PZ/FWW:lme

Fig. 1

62.8 MHz ^{13}C
80% C_6H_6/10 mm tube

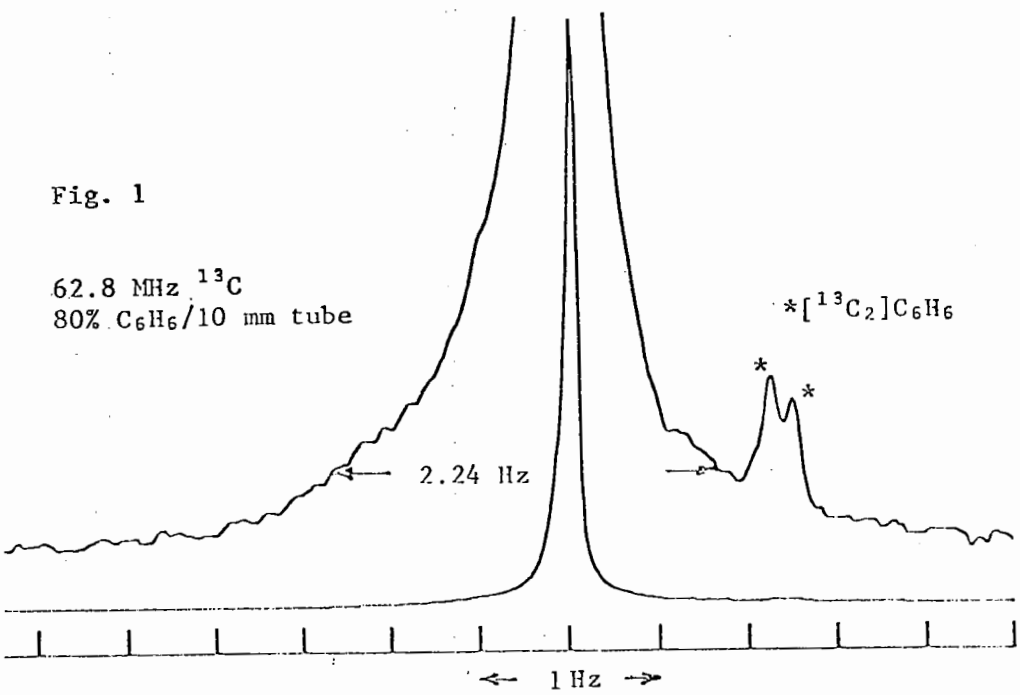


Fig. 2

62.8 MHz ^{13}C
10% ethyl benzene/
10 mm tube
S/N > 200:1

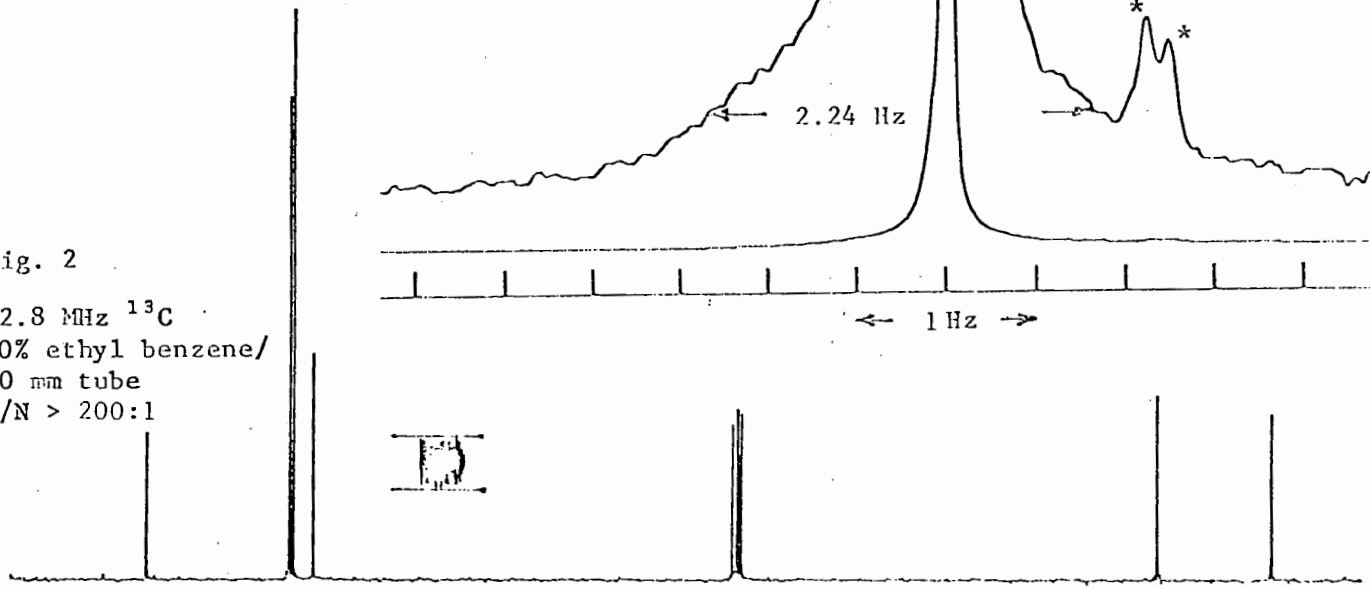
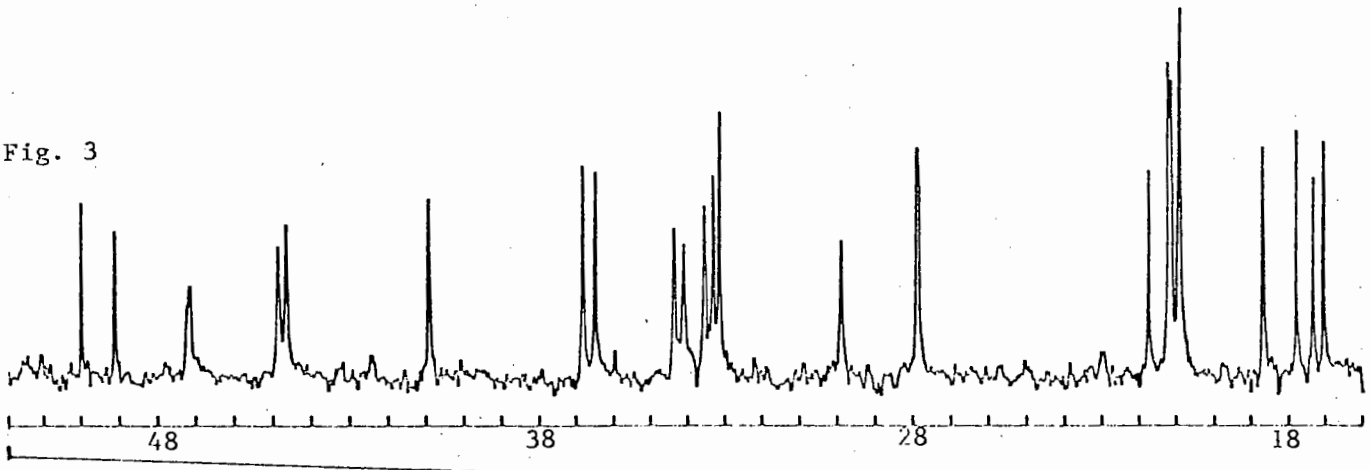
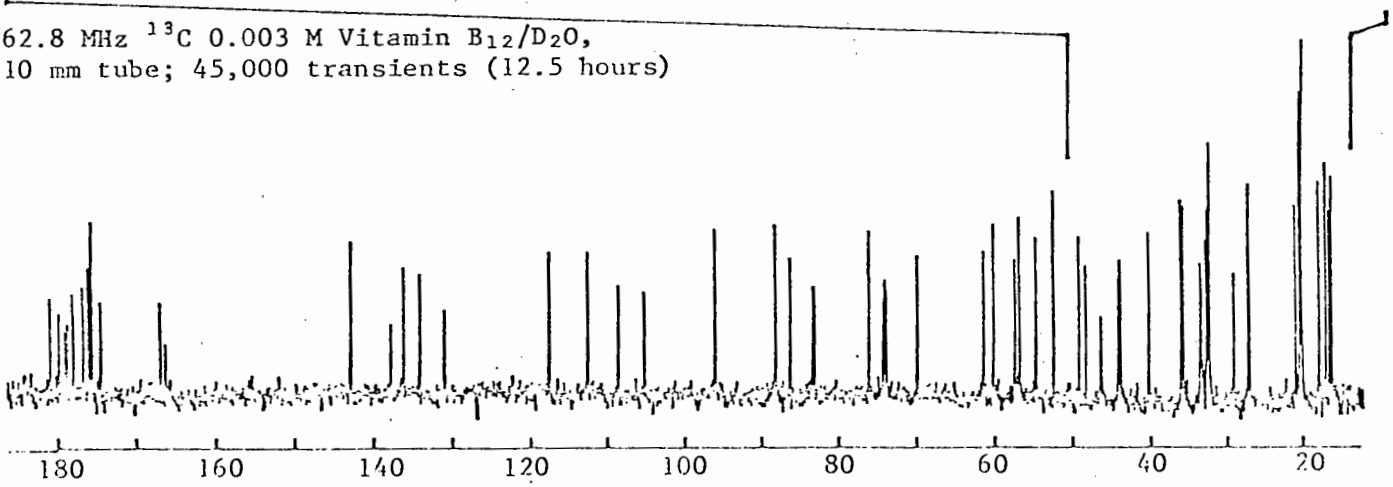


Fig. 3



62.8 MHz ^{13}C 0.003 M Vitamin B_{12}/D_2O,
10 mm tube; 45,000 transients (12.5 hours)



270-43

University of Cincinnati

Cincinnati, Ohio 45221
(513) 475-2263

DEPARTMENT OF CHEMISTRY

February 9, 1981

Professor Bernard L. Shapiro
Department of Chemistry
Texas A & M University
College Station, TX 77843

Dear Professor Shapiro:

The Chemistry Department of the University of Cincinnati anticipates an opening in March, 1981, for an Instrumentation Specialist to manage the Departmental NMR facilities. Responsibilities for this position include maintenance, operation and supervision of several spectrometers, training of student operators, and occasional running of samples for infrequent users.

A Ph.D. level person is preferred, but full consideration will be given to anyone with sufficient knowledge and experience. Knowledge of electronics and some experience in NMR is essential (we can provide more extensive NMR training). The annual salary range is on the order of $18-22,000; salary will be commensurate with qualifications and experience.

Our NMR equipment includes a 90 MHz FT instrument (homebuilt around a Bruker magnet; equipped for high resolution solids work as well as liquids), now being upgraded to 260 MHz, two Varian HA-100 spectrometers (only one is now in operation; the other is to be converted to FT), a Varian T60 spectrometer and a Varian A60 (used infrequently). A proposal has been submitted for a Jeol FX270 high field FT instrument. If this request is granted, this instrument as well would be supervised by the successful candidate.

The Department has 29 full time faculty members, two visiting professors, and about eight postdoctoral and 120 graduate students. Other professional support people include a Mass Spectrometer Specialist, an X-Ray Crystallographer, and an Electronics Specialist. One faculty member acts as a half-time computer specialist. The facilities of an electronics shop, as well as special high frequency test equipment specifically for the NMR's, is available to the NMR Specialist.

Direct and active participation of the NMR Specialist in research programs is encouraged. The University of Cincinnati is an Equal Opportunity/Affirmative Action employer, and especially encourages applications from minority and female candidates.

Applicants should submit vitae and arrange for three letters of reference to be sent to me at the above address.

Sincerely,

Jerry Ackerman

Jerome L. Ackerman
Assistant Professor
of Chemistry

js

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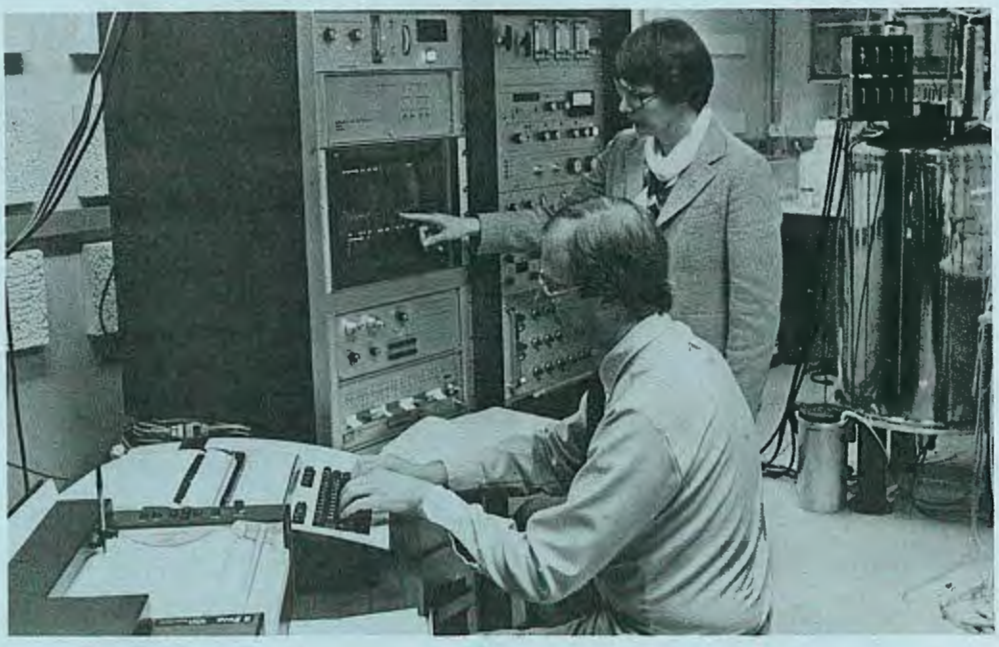

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- "Tilt" Micro Probe

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