SUPPORTING INFORMATION

Sequential Diels-Alder Reaction/Rearrangement Sequence: Synthesis of Functionalized Bicyclo[2.2.1]heptane Derivatives and Correction of Their Relative Configuration

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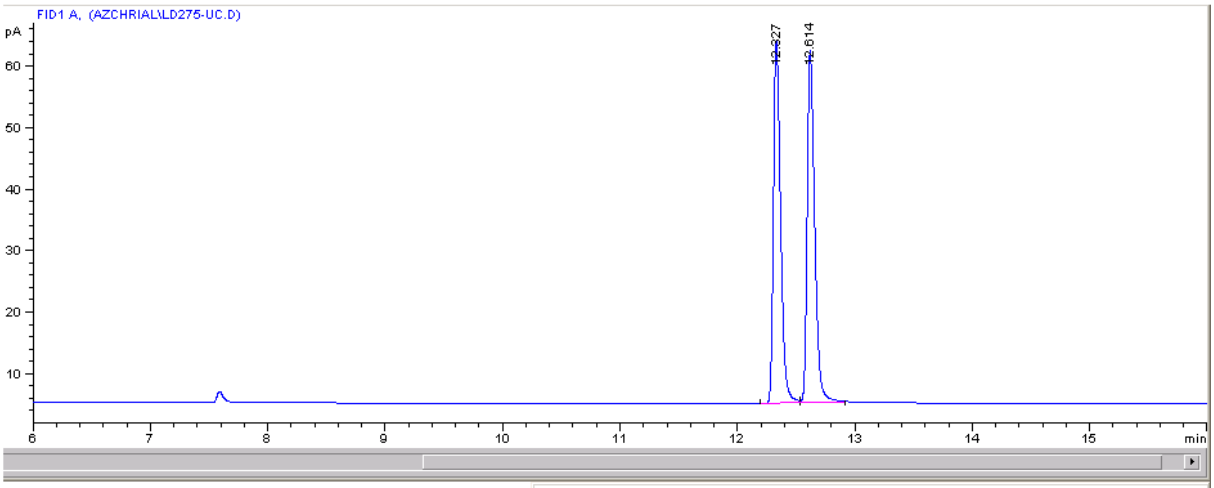
I. Chiral GC chromatograms:

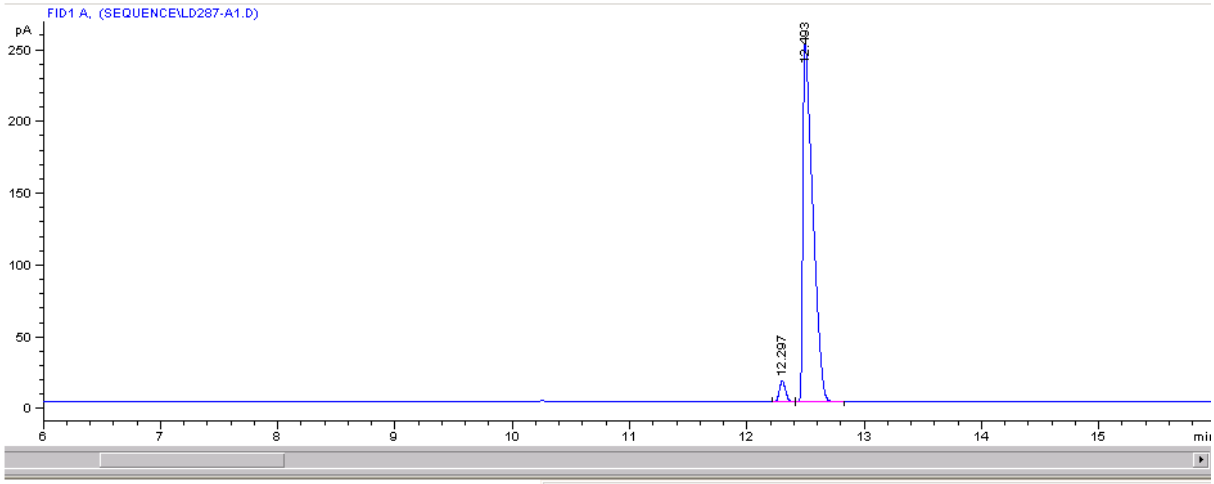
GC chromatogram of (*rac*)-*endo*-**15b**



File Information	
Date	2/27/2014 3:25:55 PM
Sample	LDM-275-UN
Sample Info	
Barcode	
Operator	bz
Method	NM-M1.M

#	Time	Area	Height	Width	Area%	Symmetry
1	12.327	250.9	58.9	0.0602	49.722	0.654
2	12.614	253.7	57.1	0.0633	50.278	0.595

GC chromatogram of (1*S*,3*R*,4*R*)-**15b** with e.r. = 96.5:3.5



File Information	
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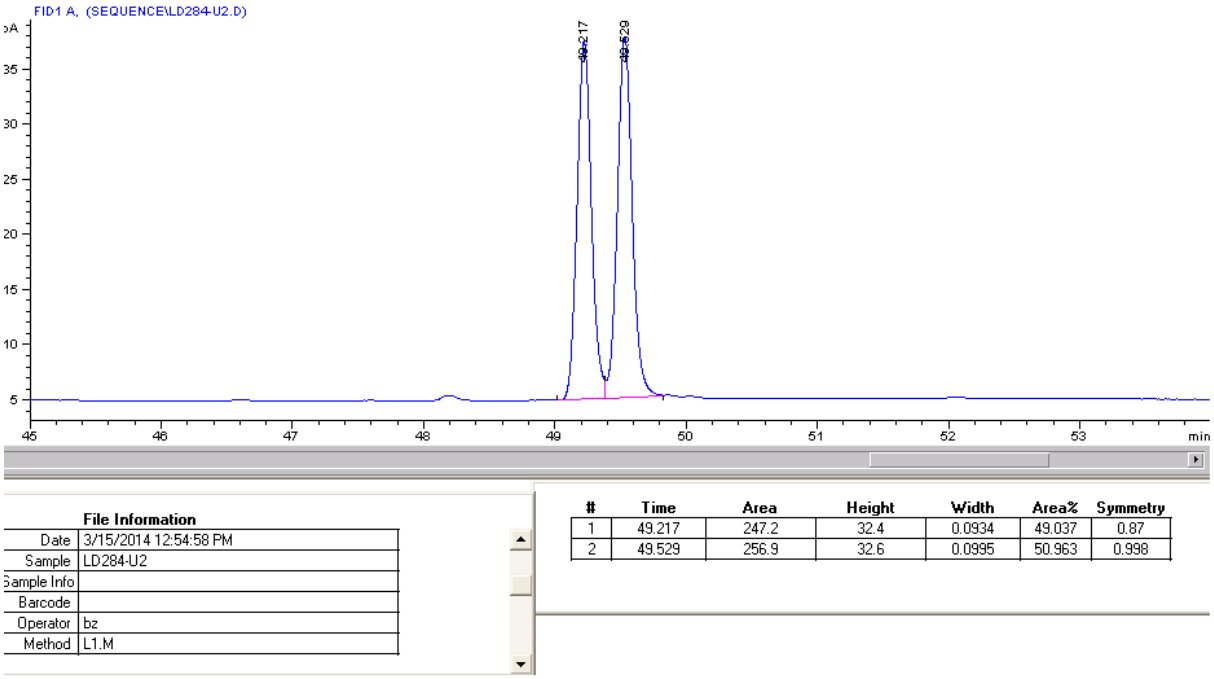
Sample Info	
Barcode	
Operator	bz
Method	NM-M1.M

#	Time	Area	Height	Width	Area%	Symmetry
1	12.297	53.3	14.6	0.0576	3.511	0.912
2	12.493	1465.8	252.5	0.0817	96.489	0.296

GC chromatogram of (*rac*)-**31**



File Information	
Date	3/15/2014 12:54:58 PM
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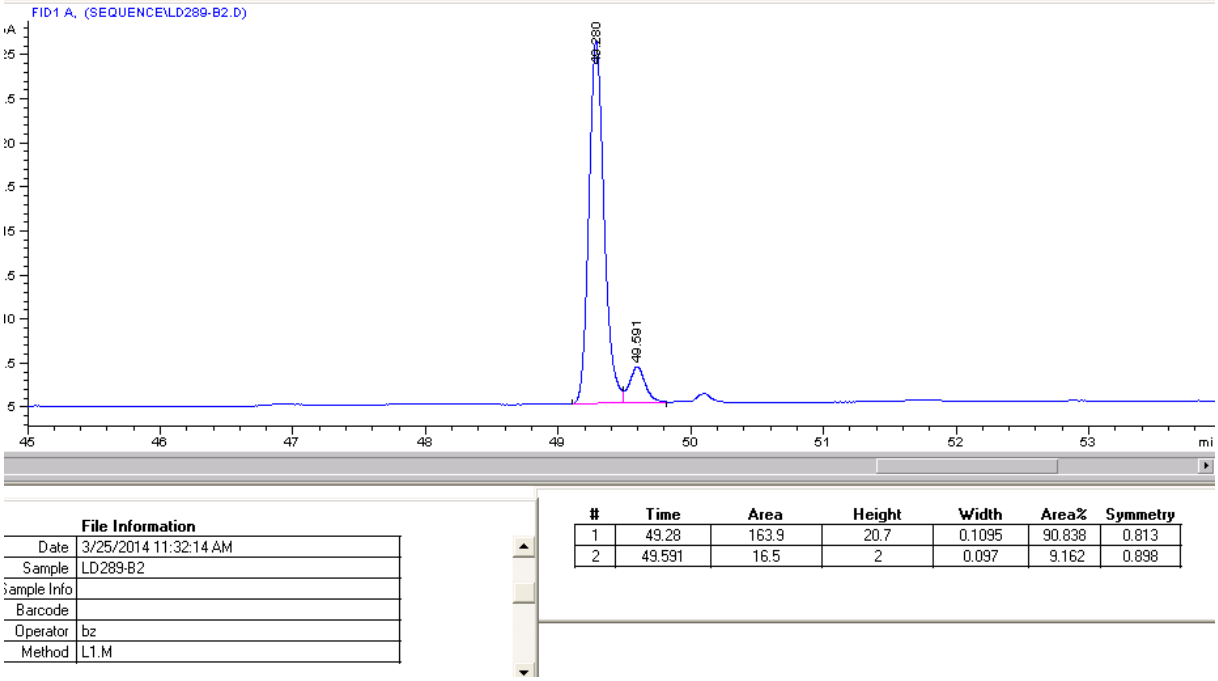
Sample Info	
Barcode	
Operator	bz
Method	L1.M

#	Time	Area	Height	Width	Area%	Symmetry
1	49.217	247.2	32.4	0.0934	49.037	0.87
2	49.529	256.9	32.6	0.0995	50.963	0.998

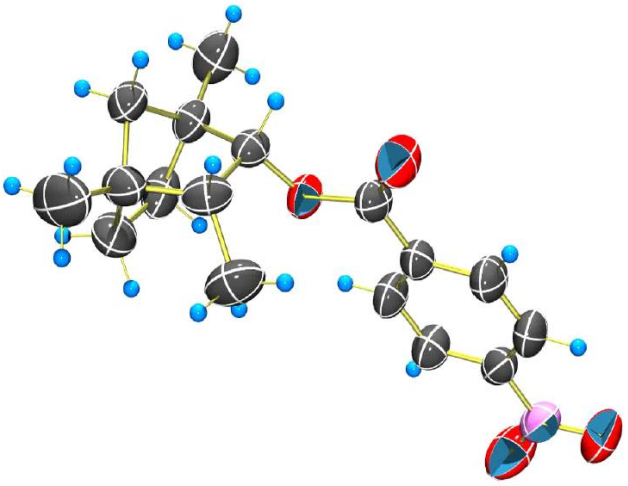
GC chromatogram of (2*S*,4a*S*,8a*R*)-**31** with e.r. = 91:9



File Information	
Date	3/25/2014 11:32:14 AM
Sample	LD289-B2
Sample Info	
Barcode	
Operator	bz
Method	L1.M

#	Time	Area	Height	Width	Area%	Symmetry
1	49.28	163.9	20.7	0.1095	90.838	0.813
2	49.591	16.5	2	0.097	9.162	0.898

II. X-ray Crystal Structure Analysis of compound 15b”



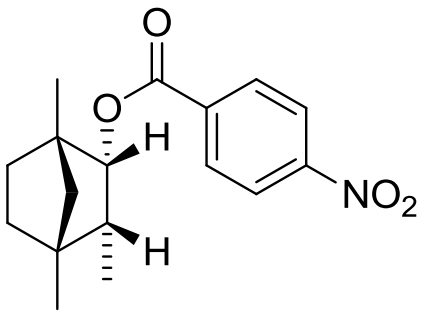


Table 1. Crystal data and structure refinement for **15b”**.

Identification code	a40415b	
Empirical formula	C17 H21 N O4	
Formula weight	303.35	
Temperature	293(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P -1	
Unit cell dimensions	a = 6.082(3) Å	α= 66.576(4) °.
	b = 11.612(5) Å	β= 79.752(4) °.
	c = 12.591(5) Å	γ = 88.139(4) °.
Volume	802.2(6) $Å^3$	
Z	2	
Density (calculated)	1.256 Mg/m^3	
Absorption coefficient	0.089 mm^{-1}	
F(000)	324	
Crystal size	0.620 x 0.420 x 0.200 mm^3	
Theta range for data collection	1.792 to 25.096 °.	
Index ranges	-7<=h<=7, -10<=k<=13, -15<=l<=15	
Reflections collected	3982	
Independent reflections	2783 [R(int) = 0.0225]	
Completeness to theta = 25.242 °	95.9 %	
Absorption correction	Semi-empirical from equivalents	

Max. and min. transmission	0.746 and 0.652
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2783 / 0 / 203
Goodness-of-fit on F^2	1.059
Final R indices [I>2sigma(I)]	R1 = 0.0478, wR2 = 0.1386
R indices (all data)	R1 = 0.0586, wR2 = 0.1487
Extinction coefficient	0.081(10)
Largest diff. peak and hole	0.194 and -0.175 e.$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for **15b"**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
N(1)	6977(3)	8662(2)	-325(1)	69(1)
O(1)	-570(2)	7242(2)	4323(1)	81(1)
O(2)	2406(2)	7757(1)	4899(1)	54(1)
O(3)	6199(3)	8464(2)	-1062(1)	102(1)
O(4)	8900(3)	9025(2)	-467(2)	103(1)
C(1)	1239(2)	7312(2)	6112(1)	47(1)
C(2)	1604(3)	5915(2)	6838(2)	58(1)
C(3)	2611(3)	5974(2)	7859(2)	64(1)
C(4)	4998(3)	6556(2)	7380(2)	82(1)
C(5)	4681(3)	7924(2)	6601(2)	69(1)
C(6)	2134(3)	8030(2)	6744(1)	51(1)
C(7)	1393(3)	7083(2)	8014(1)	56(1)
C(8)	2935(4)	5216(2)	6149(2)	88(1)
C(9)	2385(5)	4737(2)	8935(2)	112(1)
C(10)	1315(4)	9353(2)	6430(2)	77(1)
C(11)	1350(3)	7603(2)	4121(2)	54(1)
C(12)	2855(3)	7918(2)	2960(1)	50(1)
C(13)	4991(3)	8434(2)	2718(2)	58(1)
C(14)	6337(3)	8701(2)	1639(2)	61(1)
C(15)	5514(3)	8423(2)	815(1)	56(1)
C(16)	3394(3)	7900(2)	1034(2)	69(1)
C(17)	2070(3)	7655(2)	2109(2)	65(1)

Table 3. Bond lengths [Å] and angles [º] for **15b”**.

N(1)-O(3)	1.213(2)
N(1)-O(4)	1.215(2)
N(1)-C(15)	1.474(2)
O(1)-C(11)	1.202(2)
O(2)-C(11)	1.3321(19)
O(2)-C(1)	1.4533(19)
C(1)-C(6)	1.528(2)
C(1)-C(2)	1.545(2)
C(2)-C(8)	1.528(3)
C(2)-C(3)	1.544(3)
C(3)-C(9)	1.521(3)
C(3)-C(7)	1.527(2)
C(3)-C(4)	1.535(3)
C(4)-C(5)	1.527(3)
C(5)-C(6)	1.534(3)
C(6)-C(10)	1.517(3)
C(6)-C(7)	1.533(2)
C(11)-C(12)	1.493(2)
C(12)-C(13)	1.380(2)
C(12)-C(17)	1.386(2)
C(13)-C(14)	1.378(3)
C(14)-C(15)	1.376(2)
C(15)-C(16)	1.378(3)
C(16)-C(17)	1.373(3)
O(3)-N(1)-O(4)	123.68(18)
O(3)-N(1)-C(15)	118.01(19)
O(4)-N(1)-C(15)	118.30(17)
C(11)-O(2)-C(1)	117.38(12)
O(2)-C(1)-C(6)	110.01(12)
O(2)-C(1)-C(2)	113.12(13)
C(6)-C(1)-C(2)	105.12(13)
C(8)-C(2)-C(3)	116.07(17)
C(8)-C(2)-C(1)	115.55(16)
C(3)-C(2)-C(1)	102.49(13)
C(9)-C(3)-C(7)	117.02(17)

C(9)-C(3)-C(4)	114.91(18)
C(7)-C(3)-C(4)	99.94(16)
C(9)-C(3)-C(2)	113.87(19)
C(7)-C(3)-C(2)	100.38(13)
C(4)-C(3)-C(2)	108.98(15)
C(5)-C(4)-C(3)	104.30(15)
C(4)-C(5)-C(6)	104.00(14)
C(10)-C(6)-C(1)	114.30(15)
C(10)-C(6)-C(7)	117.14(14)
C(1)-C(6)-C(7)	98.70(13)
C(10)-C(6)-C(5)	115.28(16)
C(1)-C(6)-C(5)	108.44(14)
C(7)-C(6)-C(5)	101.01(14)
C(3)-C(7)-C(6)	96.23(13)
O(1)-C(11)-O(2)	124.66(16)
O(1)-C(11)-C(12)	123.65(15)
O(2)-C(11)-C(12)	111.69(14)
C(13)-C(12)-C(17)	119.41(16)
C(13)-C(12)-C(11)	122.47(15)
C(17)-C(12)-C(11)	118.11(15)
C(14)-C(13)-C(12)	120.75(16)
C(15)-C(14)-C(13)	118.44(17)
C(14)-C(15)-C(16)	122.10(17)
C(14)-C(15)-N(1)	118.70(17)
C(16)-C(15)-N(1)	119.18(16)
C(17)-C(16)-C(15)	118.55(16)
C(16)-C(17)-C(12)	120.74(18)

Symmetry transformations used to generate equivalent atoms:

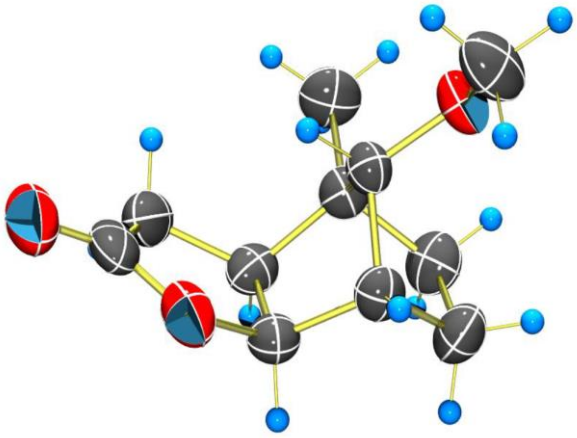
Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for **15b"**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ...\ + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
N(1)	89(1)	68(1)	53(1)	-28(1)	-9(1)	18(1)
O(1)	52(1)	127(1)	81(1)	-60(1)	-8(1)	-16(1)
O(2)	47(1)	73(1)	46(1)	-28(1)	-5(1)	-9(1)
O(3)	115(1)	148(2)	61(1)	-60(1)	-17(1)	18(1)
O(4)	97(1)	136(2)	82(1)	-59(1)	17(1)	-21(1)
C(1)	37(1)	58(1)	48(1)	-24(1)	1(1)	-5(1)
C(2)	50(1)	52(1)	68(1)	-25(1)	8(1)	-5(1)
C(3)	59(1)	67(1)	53(1)	-15(1)	-1(1)	15(1)
C(4)	48(1)	125(2)	79(1)	-46(1)	-15(1)	16(1)
C(5)	54(1)	102(2)	53(1)	-32(1)	-3(1)	-22(1)
C(6)	53(1)	56(1)	44(1)	-21(1)	-2(1)	-7(1)
C(7)	56(1)	65(1)	46(1)	-22(1)	-1(1)	1(1)
C(8)	105(2)	70(1)	97(2)	-48(1)	1(1)	11(1)
C(9)	136(2)	82(2)	78(2)	-2(1)	-2(2)	41(2)
C(10)	108(2)	55(1)	66(1)	-25(1)	-9(1)	-7(1)
C(11)	50(1)	63(1)	57(1)	-31(1)	-13(1)	-1(1)
C(12)	53(1)	53(1)	51(1)	-24(1)	-15(1)	5(1)
C(13)	63(1)	70(1)	50(1)	-31(1)	-11(1)	-8(1)
C(14)	64(1)	66(1)	57(1)	-28(1)	-8(1)	-6(1)
C(15)	70(1)	52(1)	46(1)	-22(1)	-12(1)	15(1)
C(16)	73(1)	92(1)	61(1)	-45(1)	-25(1)	11(1)
C(17)	56(1)	91(1)	64(1)	-42(1)	-17(1)	0(1)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for **15b"**.

	x	y	z	U(eq)
H(1)	-365	7441	6126	57
H(2)	126	5488	7174	70
H(4A)	5747	6500	8017	99
H(4B)	5868	6136	6926	99
H(5A)	5346	8114	5787	83
H(5B)	5345	8490	6862	83
H(7A)	1935	7325	8579	68
H(7B)	-217	6932	8225	68
H(8A)	4279	5698	5687	133
H(8B)	2048	5096	5639	133
H(8C)	3315	4413	6689	133
H(9A)	2848	4868	9570	168
H(9B)	3311	4134	8749	168
H(9C)	854	4431	9164	168
H(10A)	1901	9858	5619	115
H(10B)	1815	9710	6919	115
H(10C)	-290	9327	6553	115
H(13)	5528	8603	3290	70
H(14)	7768	9062	1471	74
H(16)	2872	7717	465	83
H(17)	630	7309	2269	78

III. X-ray Crystal Structure Analysis of compound 28a



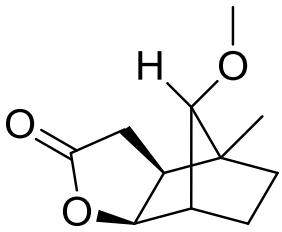


Table 1. Crystal data and structure refinement for **28a**.

Identification code	f71018b
Empirical formula	C11 H16 O3
Formula weight	196.24
Temperature	293(2) K
Wavelength	0.71073 A
Crystal system, space group	Monoclinic, P2(1)/c
Unit cell dimensions	a = 6.282(15) A alpha = 90 deg.
	b = 25.09(6) A beta = 94.09(3) deg.
	c = 6.268(15) A gamma = 90 deg.
Volume	985(4) A^3
Z, Calculated density	4, 1.323 Mg/m^3
Absorption coefficient	0.095 mm^-1
F(000)	424
Crystal size	0.35 x 0.15 x 0.08 mm
Theta range for data collection	3.25 to 25.00 deg.
Limiting indices	-7<=h<=7, -23<=k<=29, -7<=l<=6
Reflections collected / unique	3813 / 1689 [R(int) = 0.0299]
Completeness to theta = 25.00	97.1 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.9924 and 0.9675

Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	1689 / 0 / 127
Goodness-of-fit on F^2	1.102
Final R indices [I>2sigma(I)]	R1 = 0.0529, wR2 = 0.1495
R indices (all data)	R1 = 0.0689, wR2 = 0.1654
Largest diff. peak and hole	0.179 and -0.206 e.A^-3

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (A^2 x 10^3) for **28a**.
U(eq) is defined as one third of the trace of the orthogonalized Uij tensor.

	x	y	z	U(eq)
O(1)	2387(3)	5005(1)	11372(4)	86(1)
O(2)	1123(3)	5783(1)	10415(2)	55(1)
O(3)	5700(2)	6835(1)	8096(2)	49(1)
C(1)	2038(4)	5324(1)	10007(4)	58(1)
C(2)	2490(4)	5287(1)	7740(4)	61(1)
C(3)	1807(3)	5807(1)	6733(3)	45(1)
C(4)	3549(3)	6190(1)	6140(3)	41(1)
C(5)	2424(4)	6659(1)	5044(3)	56(1)
C(6)	1324(4)	6940(1)	6816(4)	55(1)
C(7)	1977(3)	6610(1)	8759(3)	42(1)
C(8)	764(3)	6099(1)	8542(3)	43(1)
C(9)	4205(3)	6428(1)	8292(3)	38(1)
C(10)	6454(4)	7049(1)	10045(4)	62(1)
C(11)	5319(4)	5955(1)	4929(3)	59(1)

Table 3. Bond lengths [A] and angles [deg] for **28a**.

O(1)-C(1)	1.180(3)
O(2)-C(1)	1.320(4)
O(2)-C(8)	1.422(3)
O(3)-C(10)	1.386(4)
O(3)-C(9)	1.398(3)
C(1)-C(2)	1.472(5)
C(2)-C(3)	1.499(4)
C(2)-H(2A)	0.9700
C(2)-H(2B)	0.9700
C(3)-C(4)	1.522(4)
C(3)-C(8)	1.536(4)
C(3)-H(3A)	0.9800
C(4)-C(9)	1.506(4)
C(4)-C(11)	1.509(4)
C(4)-C(5)	1.512(4)
C(5)-C(6)	1.522(4)
C(5)-H(5A)	0.9700
C(5)-H(5B)	0.9700
C(6)-C(7)	1.505(4)
C(6)-H(6A)	0.9700
C(6)-H(6B)	0.9700
C(7)-C(8)	1.491(4)
C(7)-C(9)	1.520(4)
C(7)-H(7A)	0.9800
C(8)-H(8A)	0.9800
C(9)-H(9A)	0.9800
C(10)-H(10A)	0.9600
C(10)-H(10B)	0.9600
C(10)-H(10C)	0.9600
C(11)-H(11A)	0.9600
C(11)-H(11B)	0.9600

C(11)-H(11C)	0.9600
C(1)-O(2)-C(8)	111.9(2)
C(10)-O(3)-C(9)	113.25(18)
O(1)-C(1)-O(2)	120.7(3)
O(1)-C(1)-C(2)	128.3(3)
O(2)-C(1)-C(2)	111.0(2)
C(1)-C(2)-C(3)	106.4(2)
C(1)-C(2)-H(2A)	110.4
C(3)-C(2)-H(2A)	110.4
C(1)-C(2)-H(2B)	110.4
C(3)-C(2)-H(2B)	110.4
H(2A)-C(2)-H(2B)	108.6
C(2)-C(3)-C(4)	117.6(2)
C(2)-C(3)-C(8)	103.2(2)
C(4)-C(3)-C(8)	103.4(2)
C(2)-C(3)-H(3A)	110.7
C(4)-C(3)-H(3A)	110.7
C(8)-C(3)-H(3A)	110.7
C(9)-C(4)-C(11)	116.2(2)
C(9)-C(4)-C(5)	100.8(2)
C(11)-C(4)-C(5)	114.3(2)
C(9)-C(4)-C(3)	100.79(19)
C(11)-C(4)-C(3)	116.5(2)
C(5)-C(4)-C(3)	106.3(2)
C(4)-C(5)-C(6)	104.5(2)
C(4)-C(5)-H(5A)	110.8
C(6)-C(5)-H(5A)	110.8
C(4)-C(5)-H(5B)	110.8
C(6)-C(5)-H(5B)	110.8
H(5A)-C(5)-H(5B)	108.9
C(7)-C(6)-C(5)	103.0(2)
C(7)-C(6)-H(6A)	111.2

C(5)-C(6)-H(6A)	111.2
C(7)-C(6)-H(6B)	111.2
C(5)-C(6)-H(6B)	111.2
H(6A)-C(6)-H(6B)	109.1
C(8)-C(7)-C(6)	106.9(2)
C(8)-C(7)-C(9)	101.4(2)
C(6)-C(7)-C(9)	102.14(18)
C(8)-C(7)-H(7A)	114.9
C(6)-C(7)-H(7A)	114.9
C(9)-C(7)-H(7A)	114.9
O(2)-C(8)-C(7)	110.8(2)
O(2)-C(8)-C(3)	107.0(2)
C(7)-C(8)-C(3)	103.6(2)
O(2)-C(8)-H(8A)	111.7
C(7)-C(8)-H(8A)	111.7
C(3)-C(8)-H(8A)	111.7
O(3)-C(9)-C(4)	110.74(17)
O(3)-C(9)-C(7)	115.6(2)
C(4)-C(9)-C(7)	95.43(18)
O(3)-C(9)-H(9A)	111.4
C(4)-C(9)-H(9A)	111.4
C(7)-C(9)-H(9A)	111.4
O(3)-C(10)-H(10A)	109.5
O(3)-C(10)-H(10B)	109.5
H(10A)-C(10)-H(10B)	109.5
O(3)-C(10)-H(10C)	109.5
H(10A)-C(10)-H(10C)	109.5
H(10B)-C(10)-H(10C)	109.5
C(4)-C(11)-H(11A)	109.5
C(4)-C(11)-H(11B)	109.5
H(11A)-C(11)-H(11B)	109.5
C(4)-C(11)-H(11C)	109.5
H(11A)-C(11)-H(11C)	109.5

H(11B)-C(11)-H(11C) 109.5

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters (A^2 x 10^3) for **28a**.

The anisotropic displacement factor exponent takes the form:

-2 pi^2 [h^2 a*^2 U11 + ... + 2 h k a* b* U12]

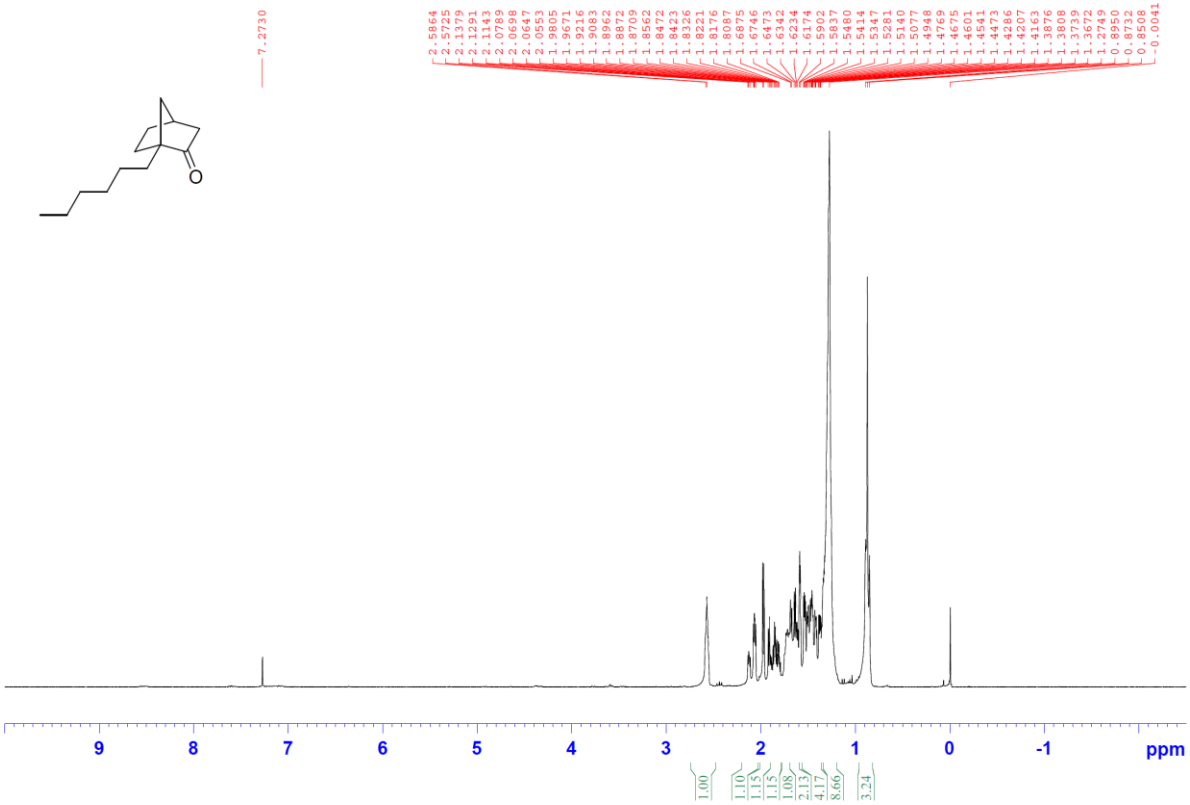
	U11	U22	U33	U23	U13	U12
O(1)	64(1)	76(1)	115(2)	50(1)	-21(1)	-19(1)
O(2)	57(1)	57(1)	52(1)	10(1)	3(1)	-14(1)
O(3)	55(1)	48(1)	44(1)	-2(1)	6(1)	-17(1)
C(1)	38(1)	53(1)	79(2)	17(1)	-13(1)	-17(1)
C(2)	48(1)	40(1)	95(2)	-2(1)	3(1)	-3(1)
C(3)	42(1)	44(1)	47(1)	-9(1)	-9(1)	0(1)
C(4)	45(1)	45(1)	34(1)	-4(1)	1(1)	1(1)
C(5)	67(2)	60(1)	40(1)	8(1)	-4(1)	4(1)
C(6)	59(2)	46(1)	60(1)	6(1)	3(1)	11(1)
C(7)	46(1)	41(1)	40(1)	-4(1)	5(1)	2(1)
C(8)	37(1)	47(1)	45(1)	0(1)	-2(1)	0(1)
C(9)	41(1)	37(1)	34(1)	1(1)	0(1)	-5(1)
C(10)	60(2)	63(2)	62(1)	-21(1)	6(1)	-18(1)
C(11)	61(2)	67(2)	49(1)	-14(1)	13(1)	4(1)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (A^2 x 10^3) for **28a**.

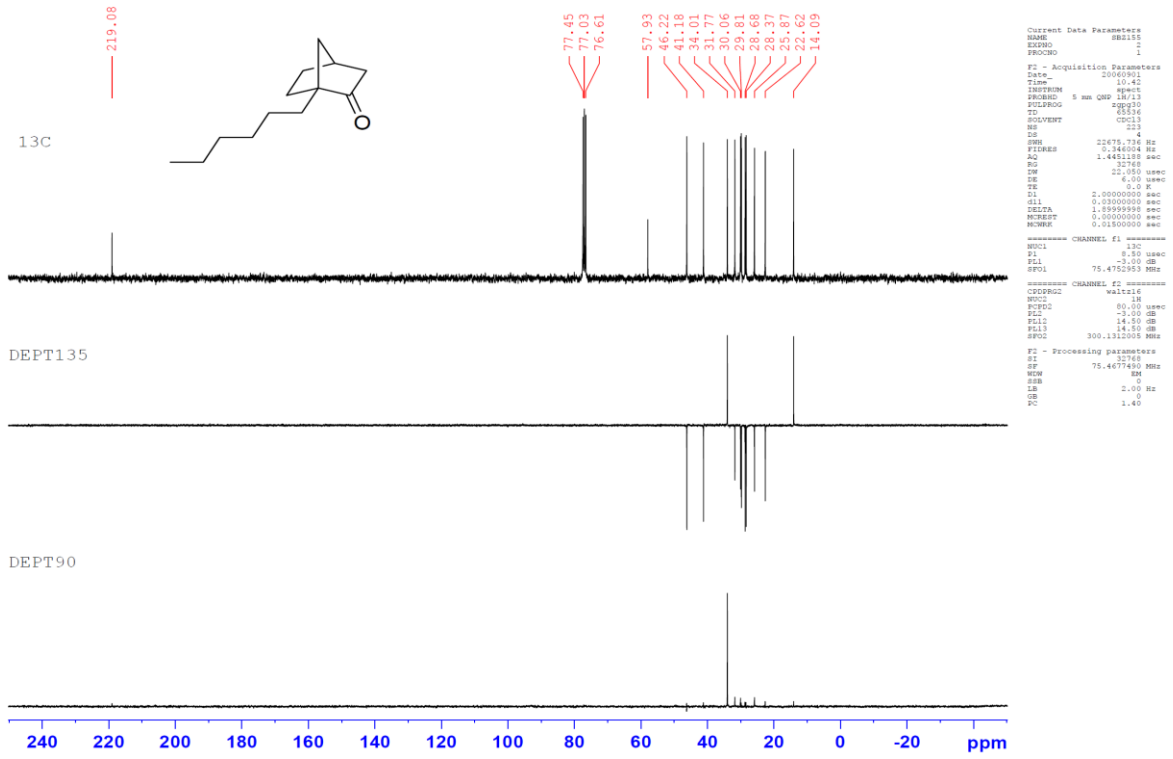
	x	y	z	U(eq)
H(2A)	1700	4994	7051	73
H(2B)	4001	5228	7608	73
H(3A)	770	5749	5513	54
H(5A)	1388	6539	3924	67
H(5B)	3439	6894	4425	67
H(6A)	1818	7304	6991	66
H(6B)	-213	6939	6527	66
H(7A)	1887	6793	10130	50
H(8A)	-761	6161	8189	52
H(9A)	4745	6155	9309	45
H(10A)	7466	7325	9811	92
H(10B)	7133	6774	10916	92
H(10C)	5283	7195	10758	92
H(11A)	5932	5656	5704	88
H(11B)	6398	6221	4770	88
H(11C)	4751	5840	3542	88

III. Copies of NMR spectra for new compounds

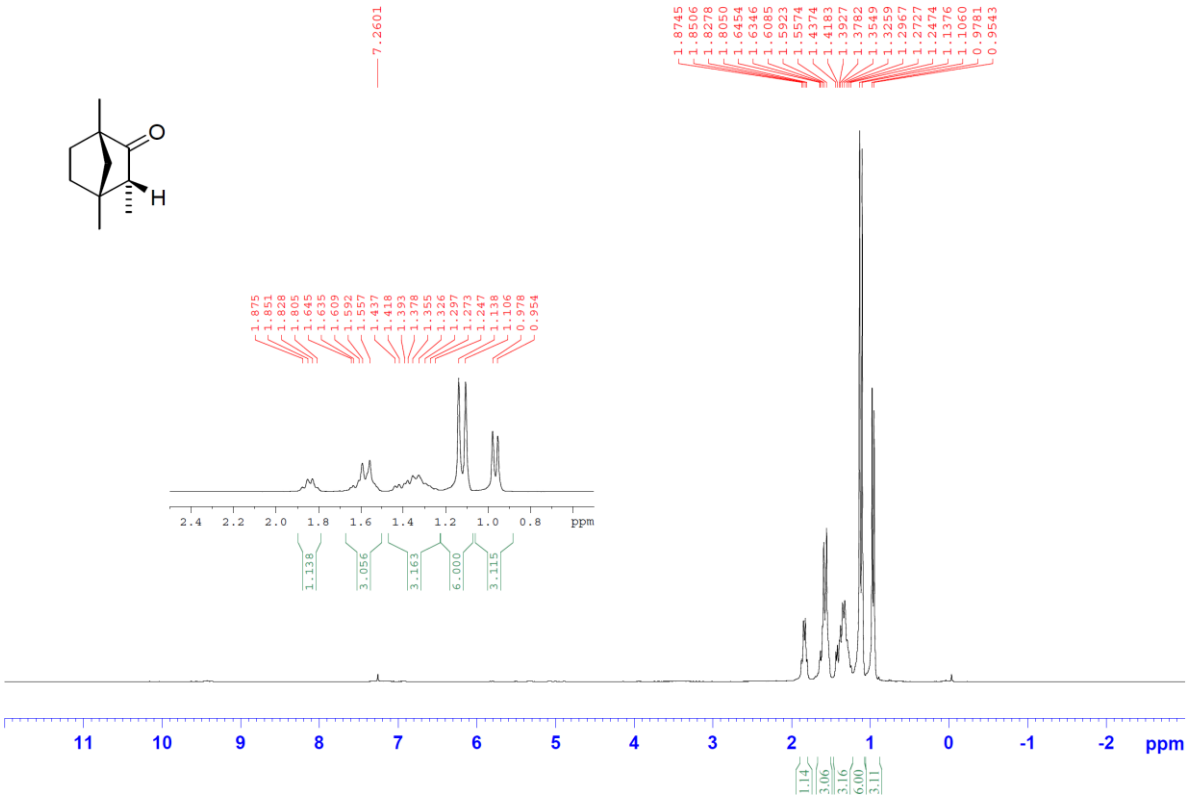
^{1}H NMR spectrum of compound **15a** in $CDCl_3$



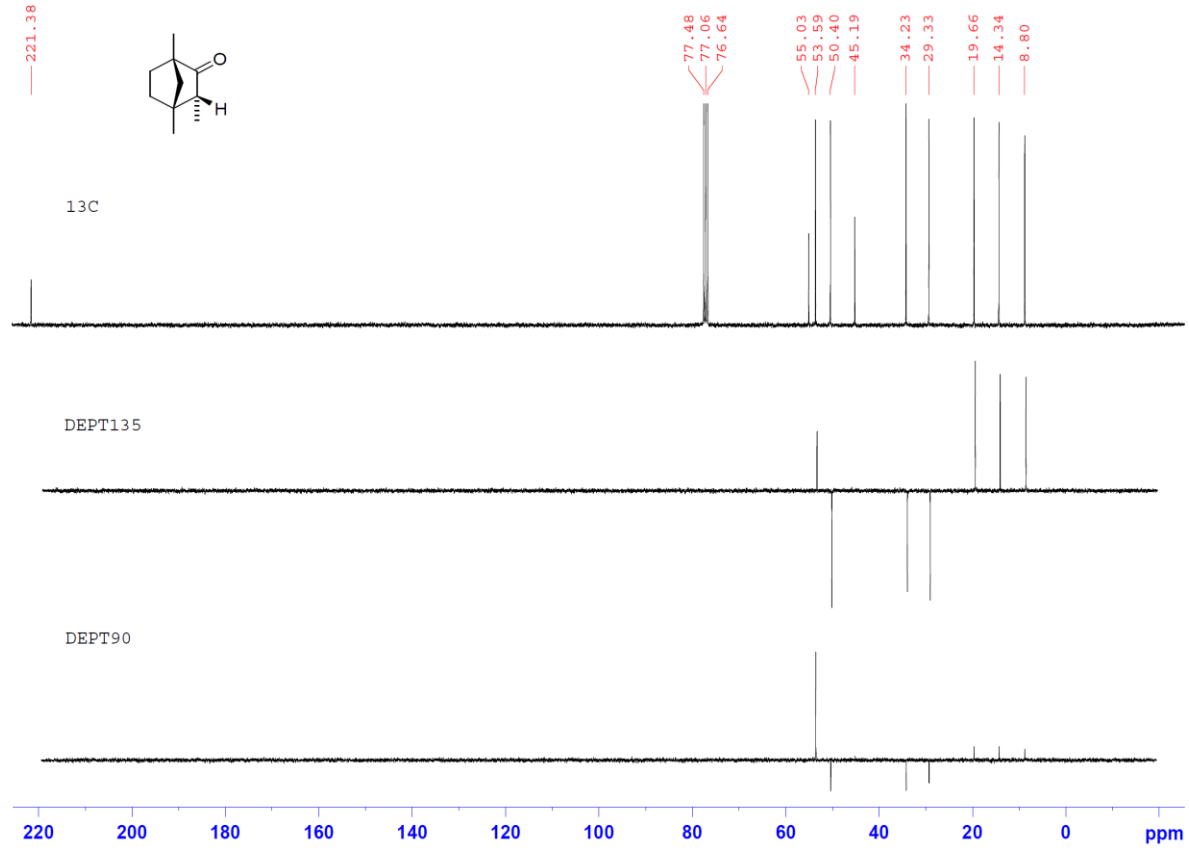
^{13}C NMR spectrum of compound **15a** in $CDCl_3$



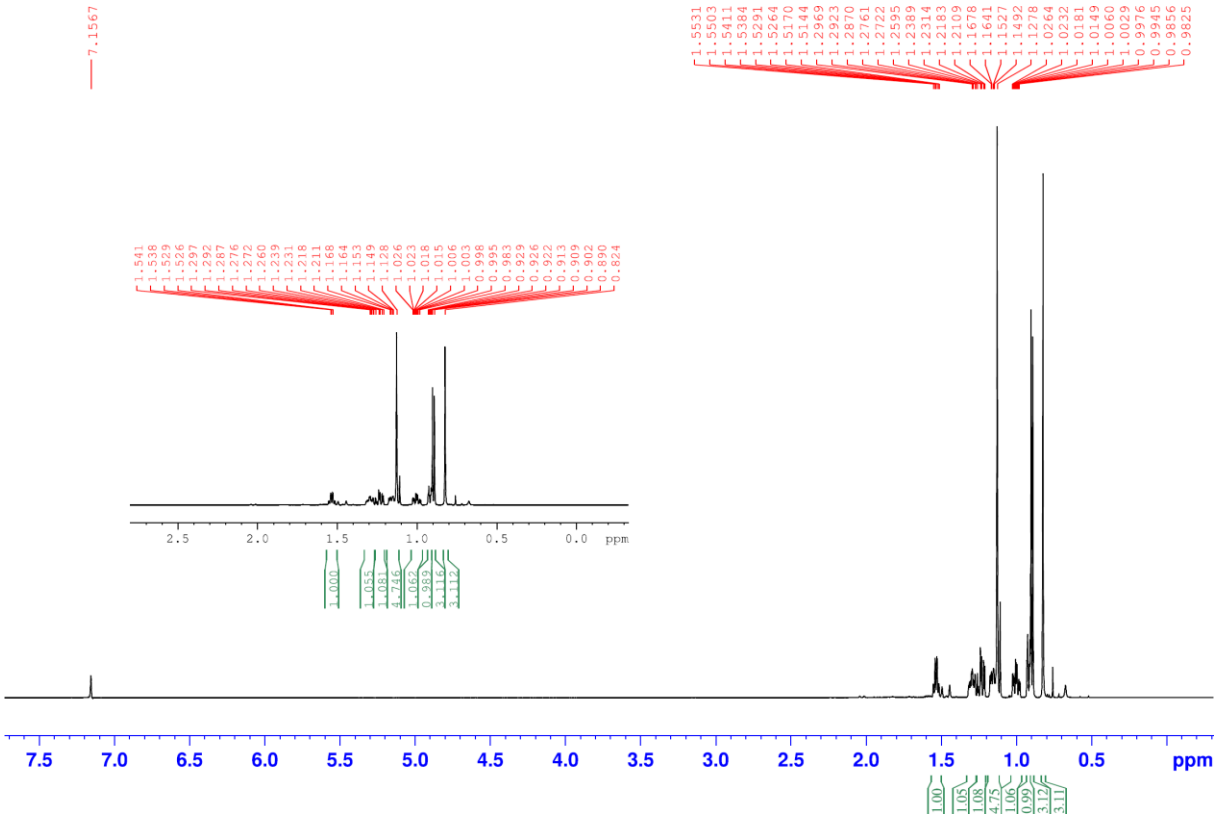
^{1}H NMR spectrum of compound *endo*-**15b** in $CDCl_3$



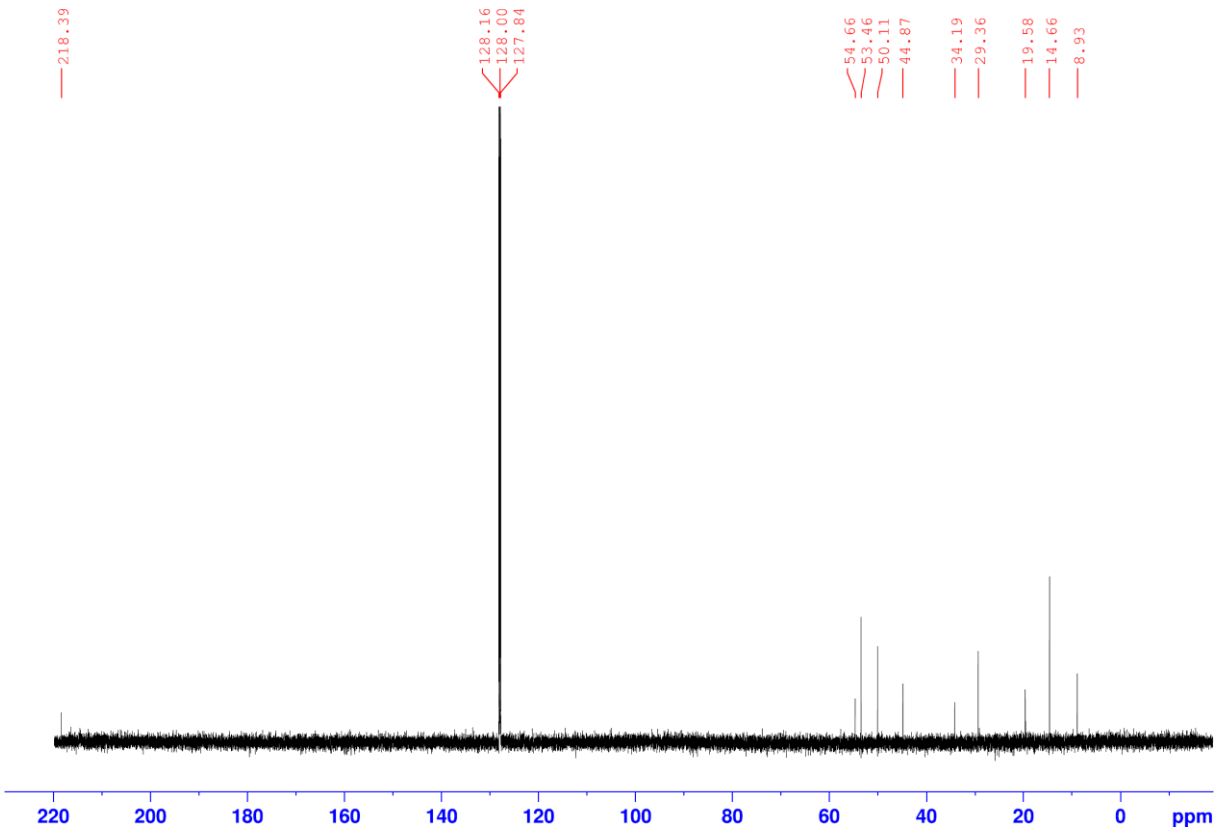
^{13}C NMR spectrum of compound *endo*-**15b** in $CDCl_3$



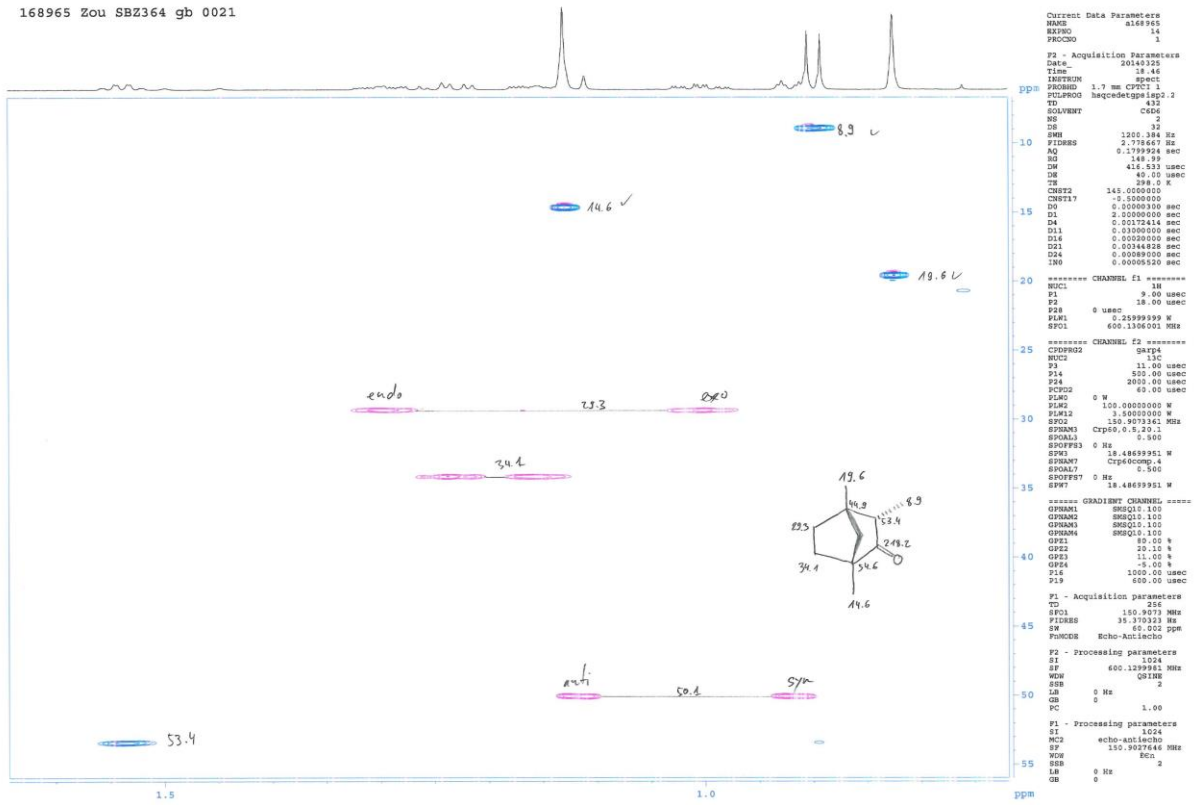
^{1}H NMR spectrum of compound *endo*-**15b** in C_6D_6



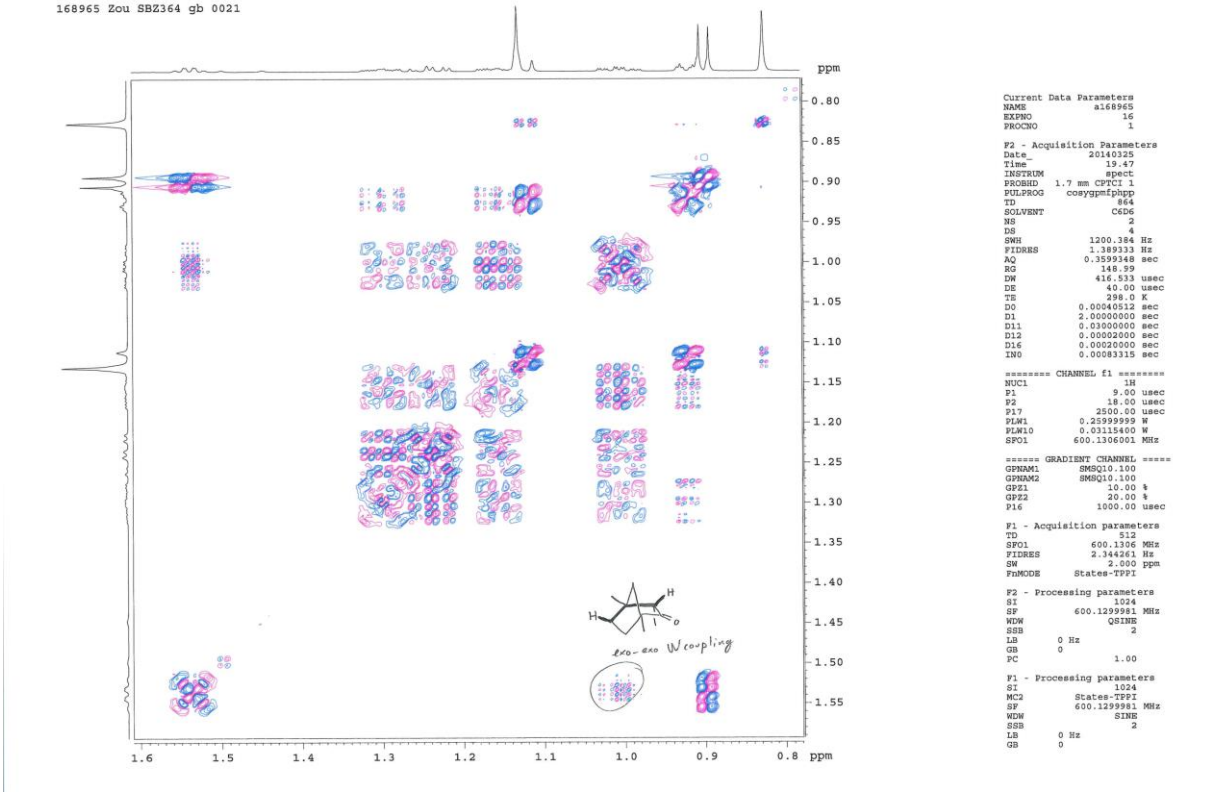
^{13}C NMR spectrum of compound *endo*-**15b** in C_6D_6



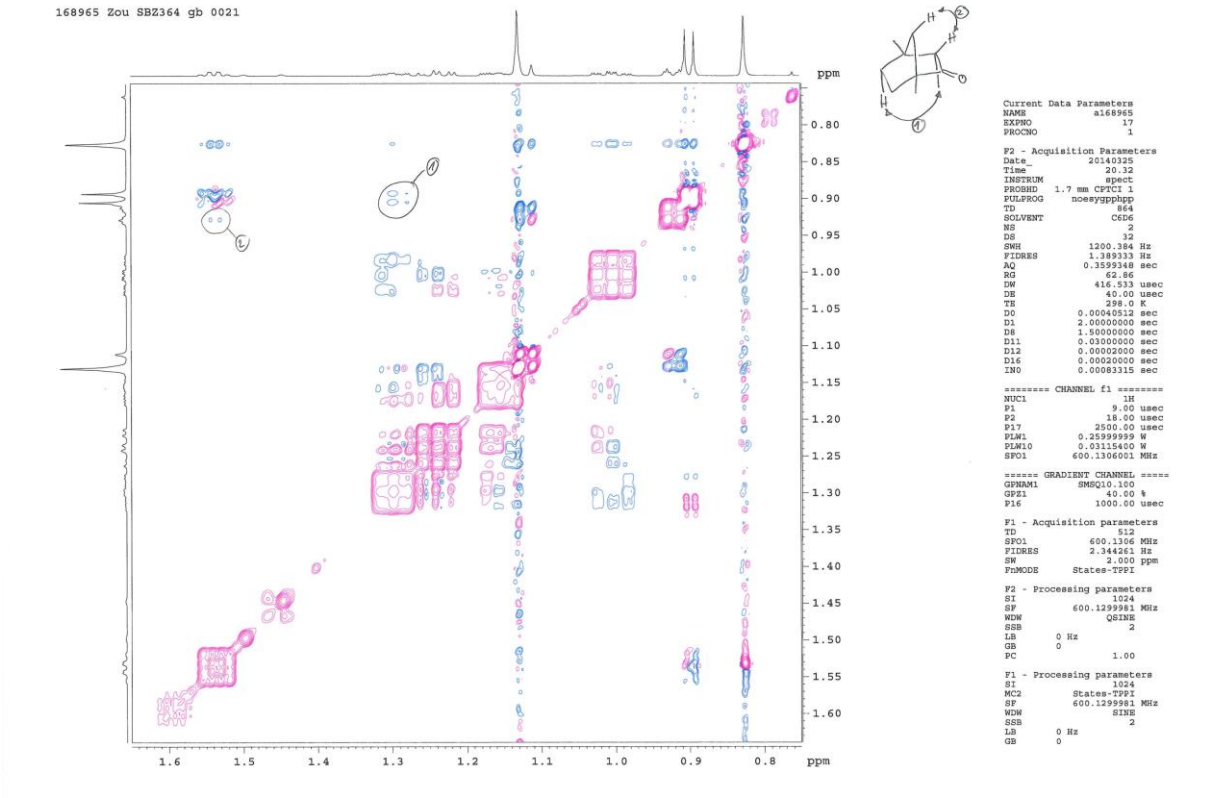
HSQC spectrum of compound *endo*-**15b** in C_6D_6



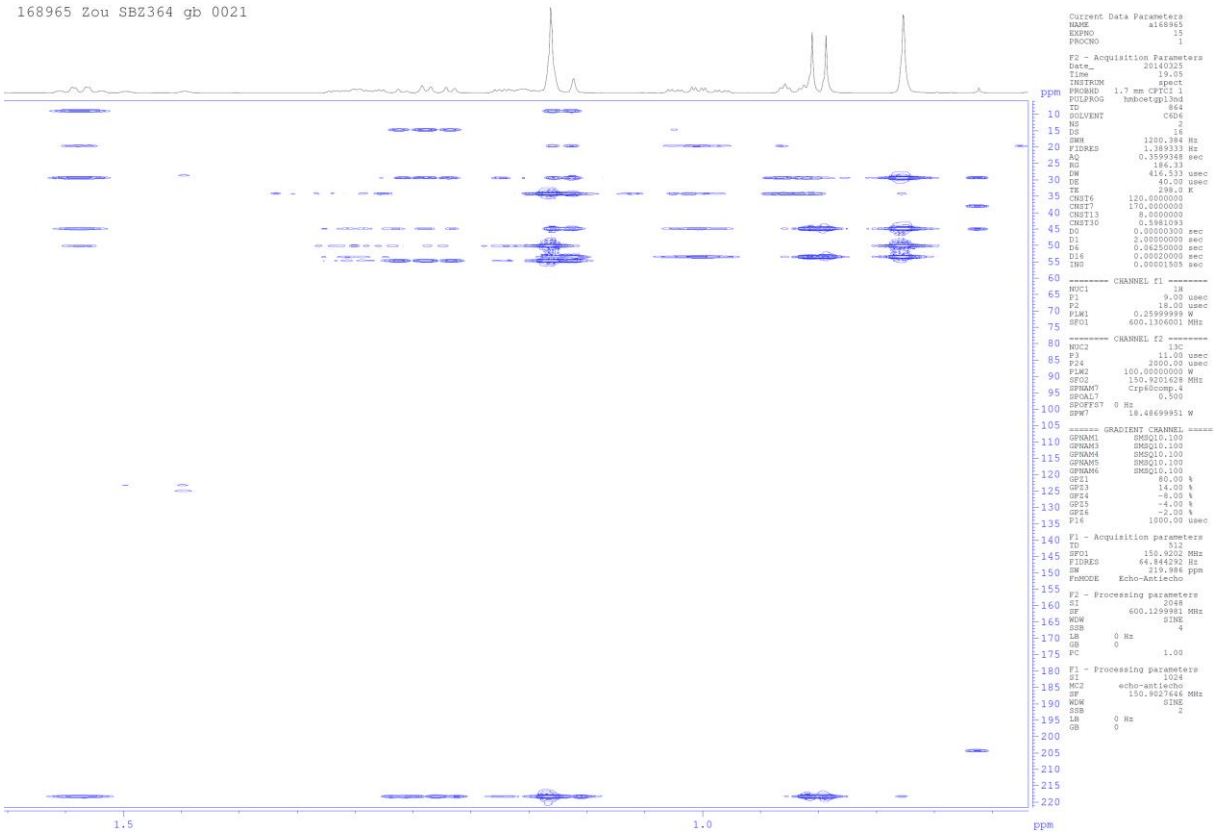
COSY spectrum of compound *endo*-**15b** in C_6D_6



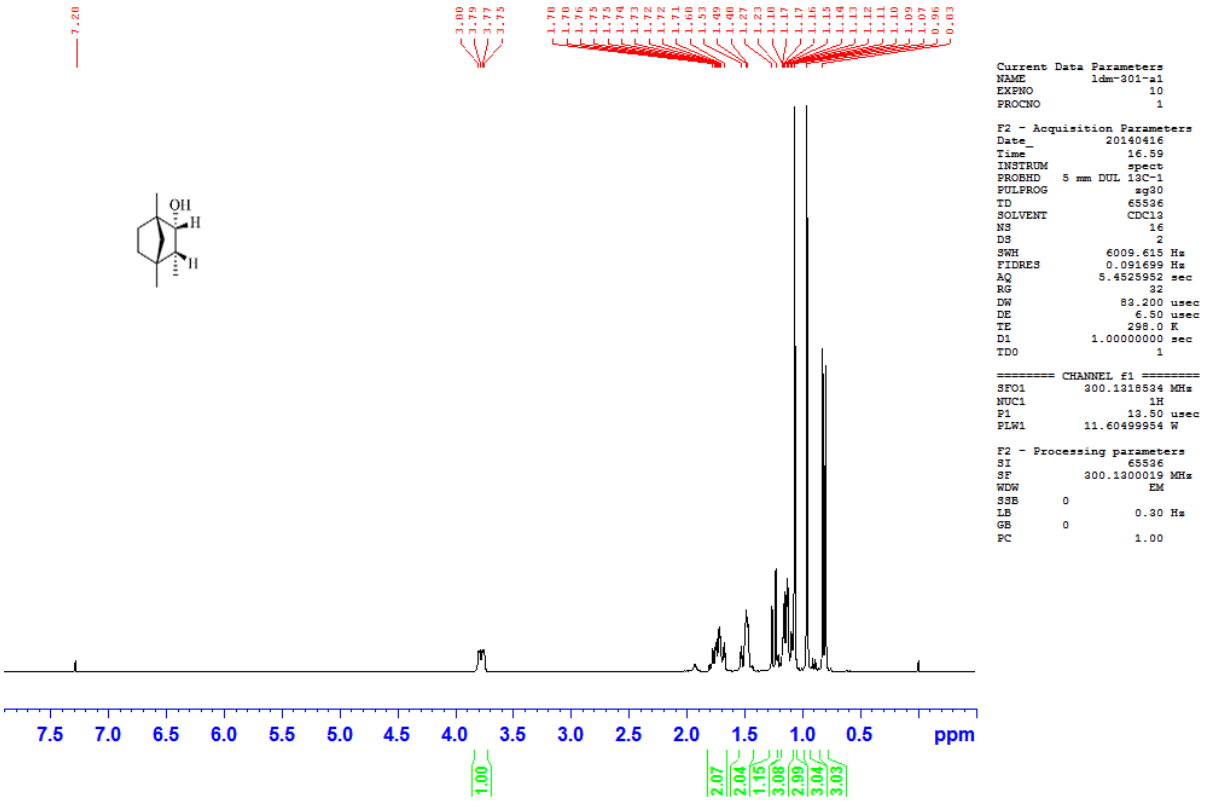
NOESY spectrum of compound *endo*-**15b** in C_6D_6



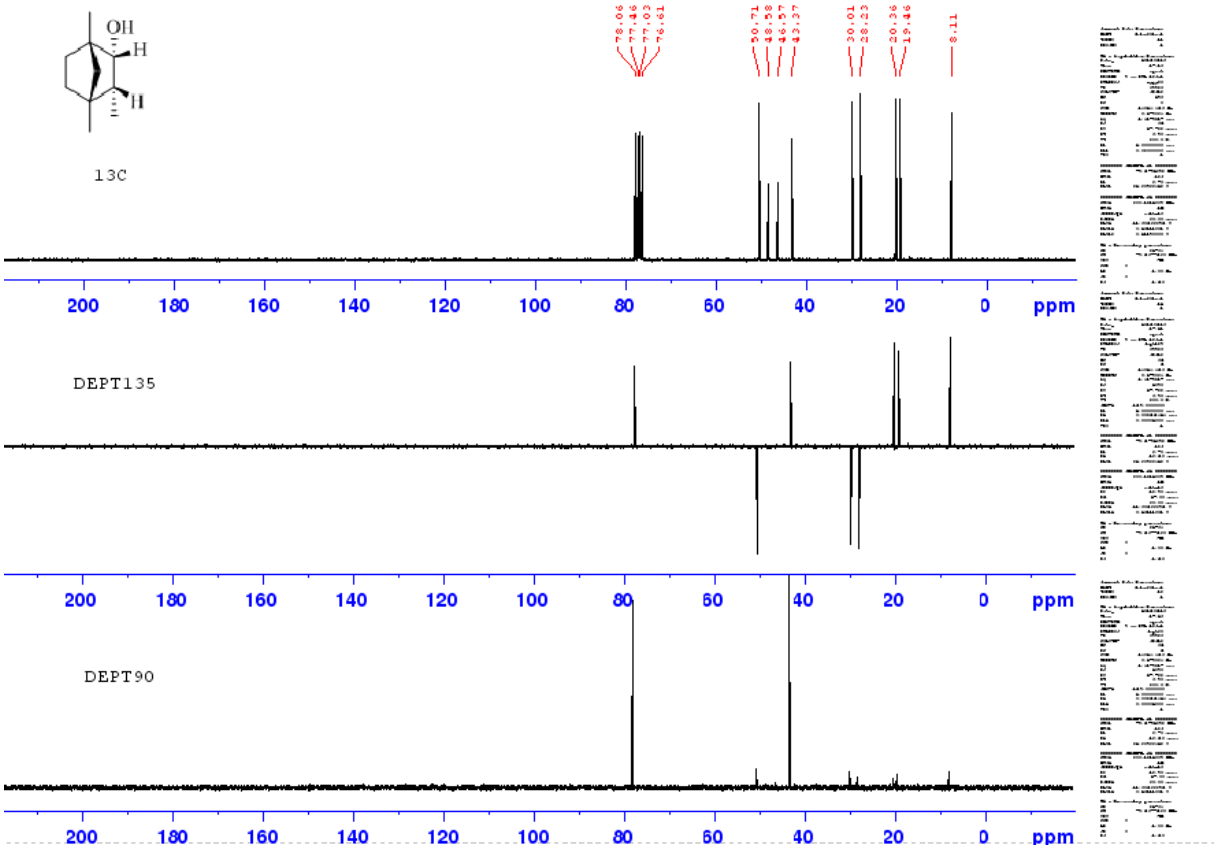
HMBC spectrum of compound *endo*-**15b** in C_6D_6



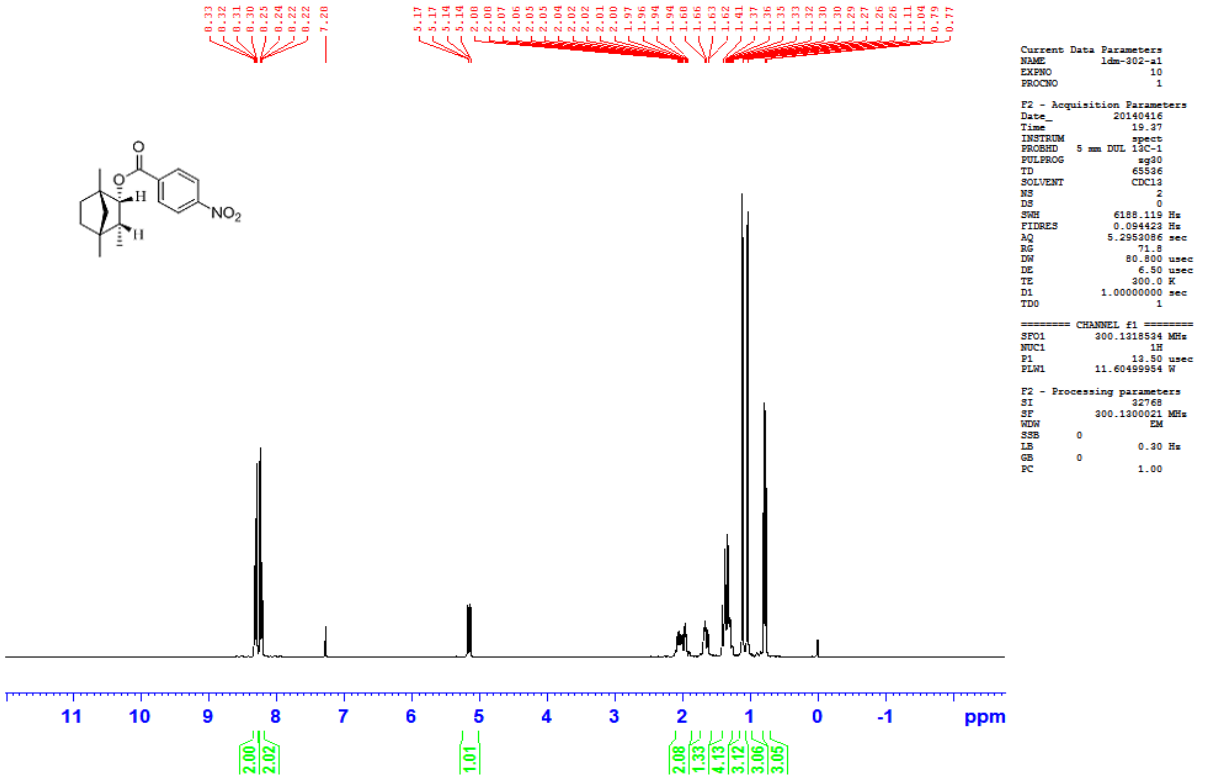
^{1}H NMR spectrum of compound **15b'** in $CDCl_3$



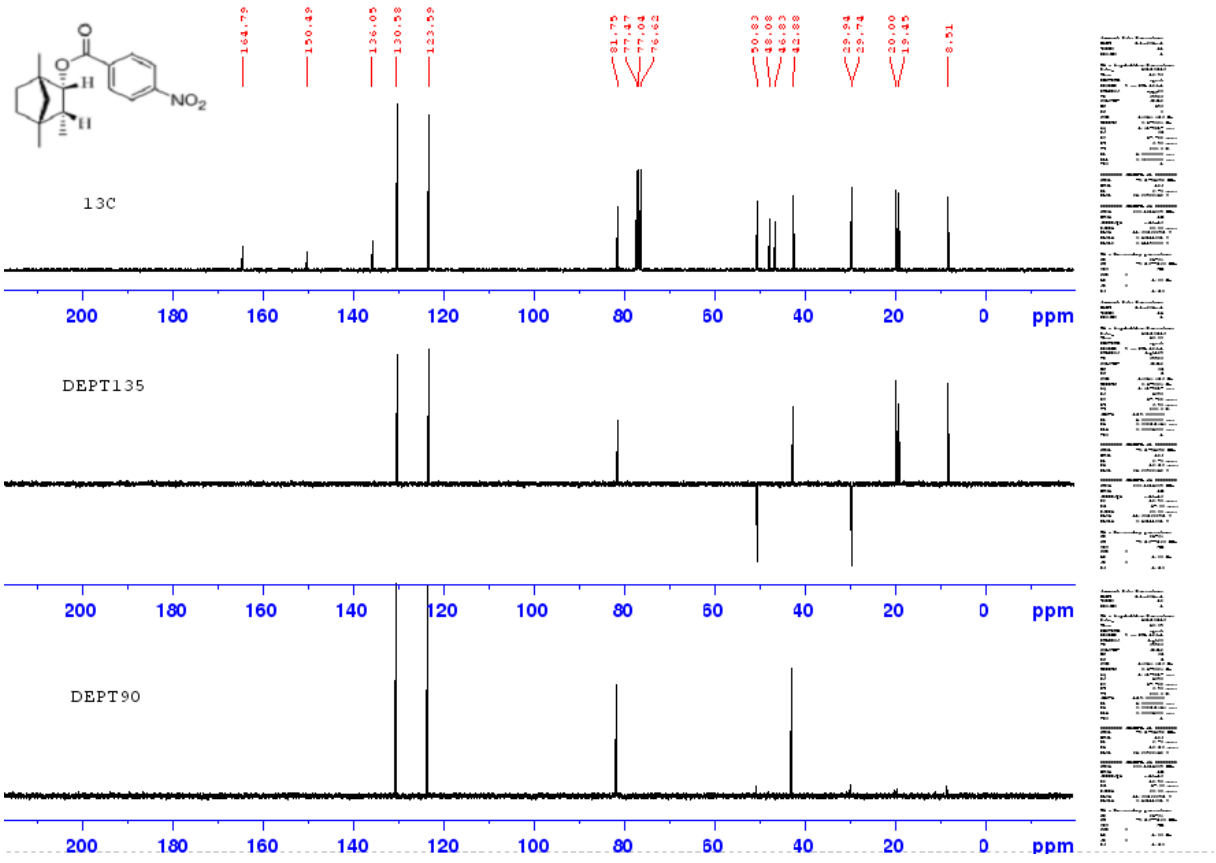
^{13}C NMR spectrum of compound **15b'** in $CDCl_3$



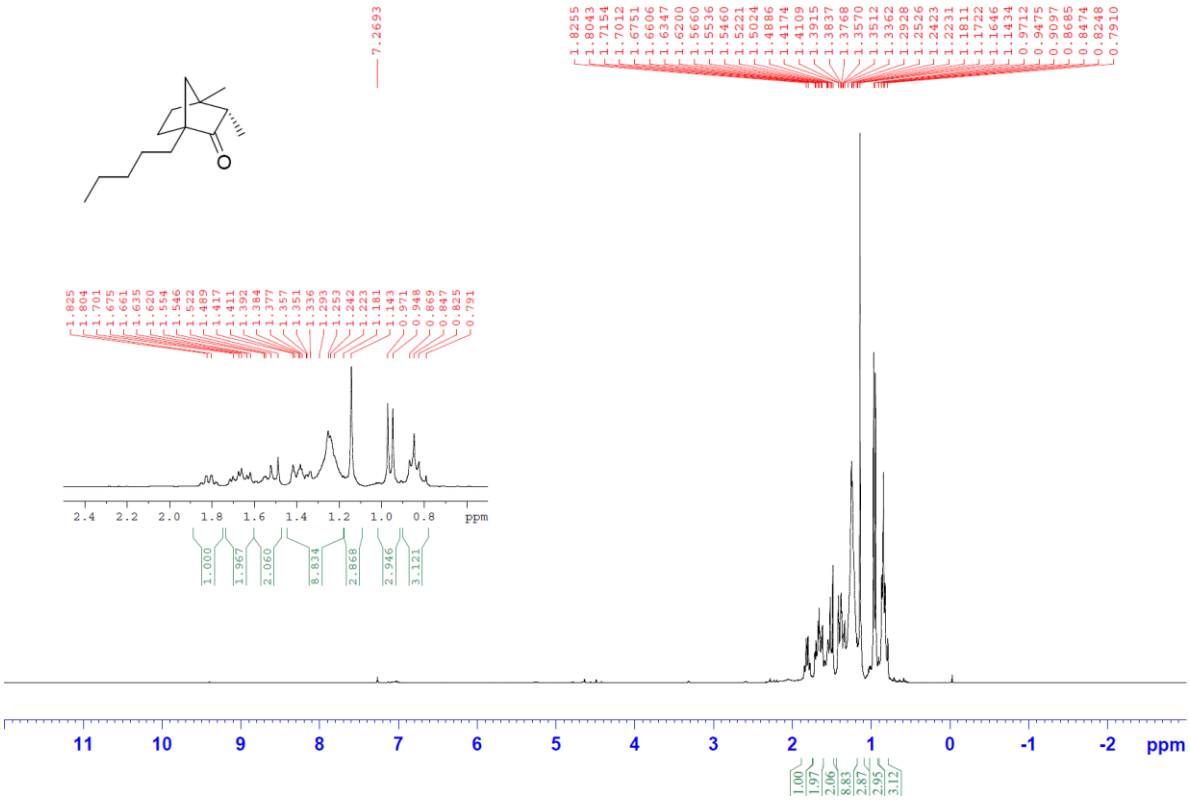
^{1}H NMR spectrum of compound **15b"** in $CDCl_3$



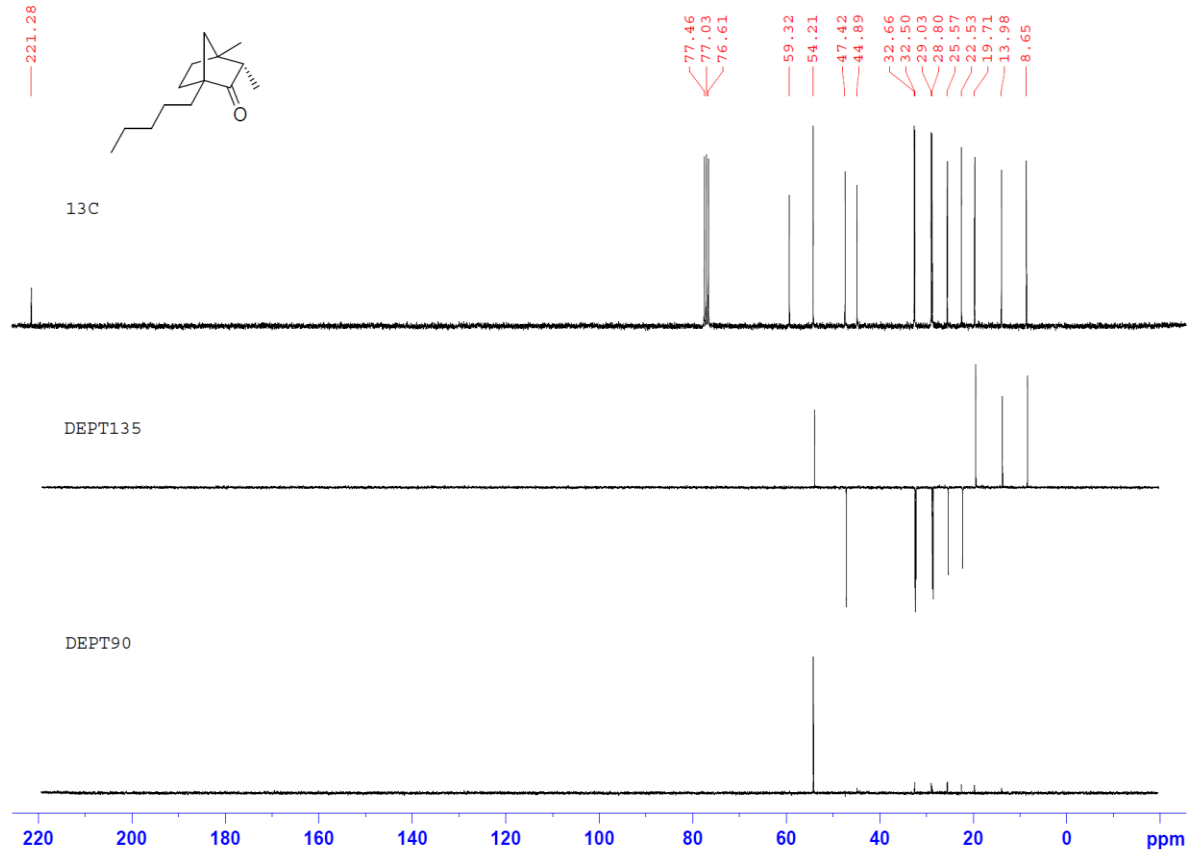
^{13}C NMR spectrum of compound **15b"** in $CDCl_3$



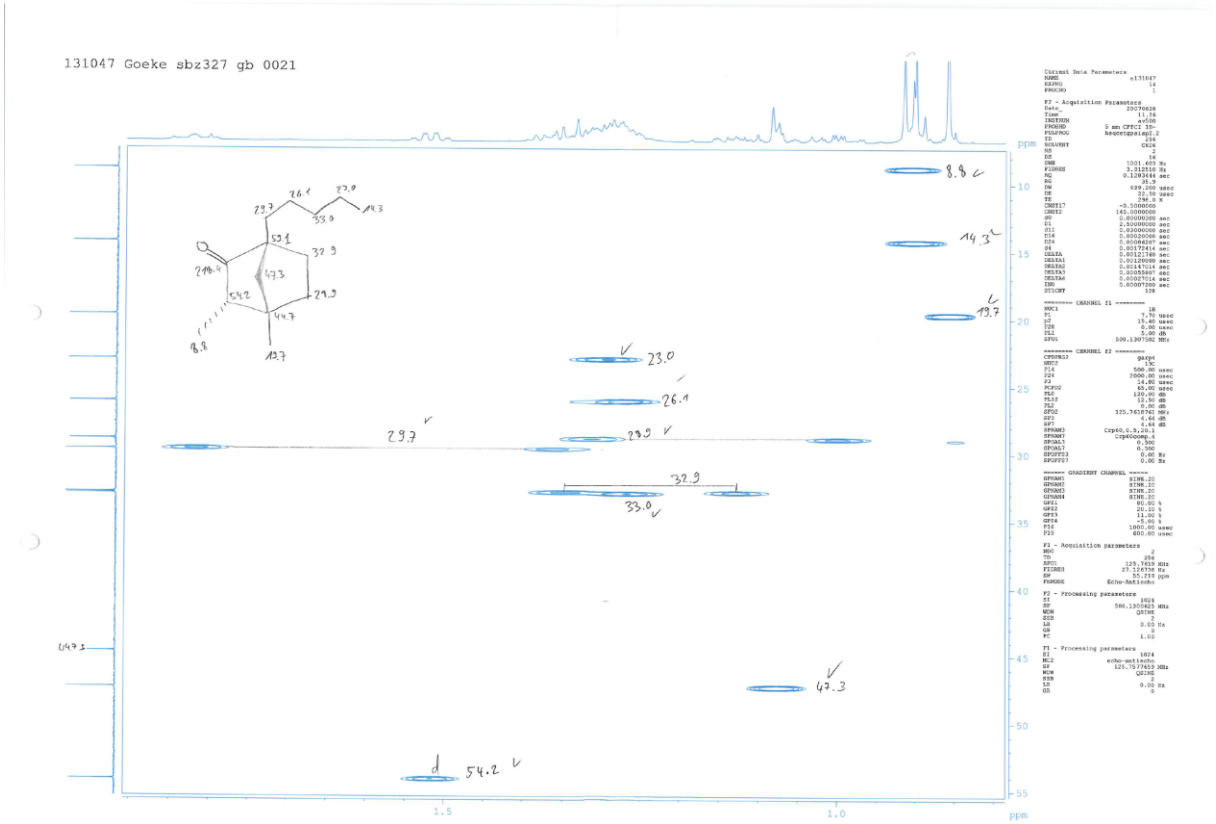
^{1}H NMR spectrum of compound **15c** in $CDCl_3$



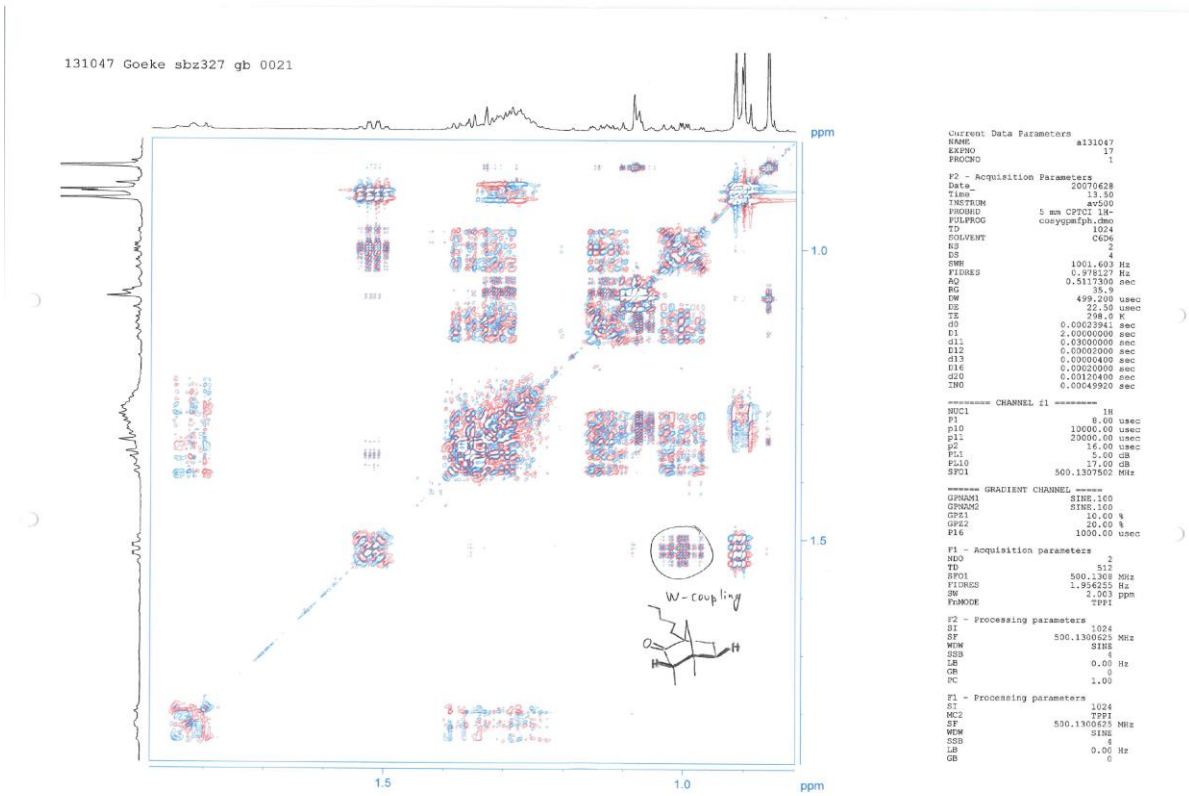
^{13}C NMR spectrum of compound **15c** in $CDCl_3$



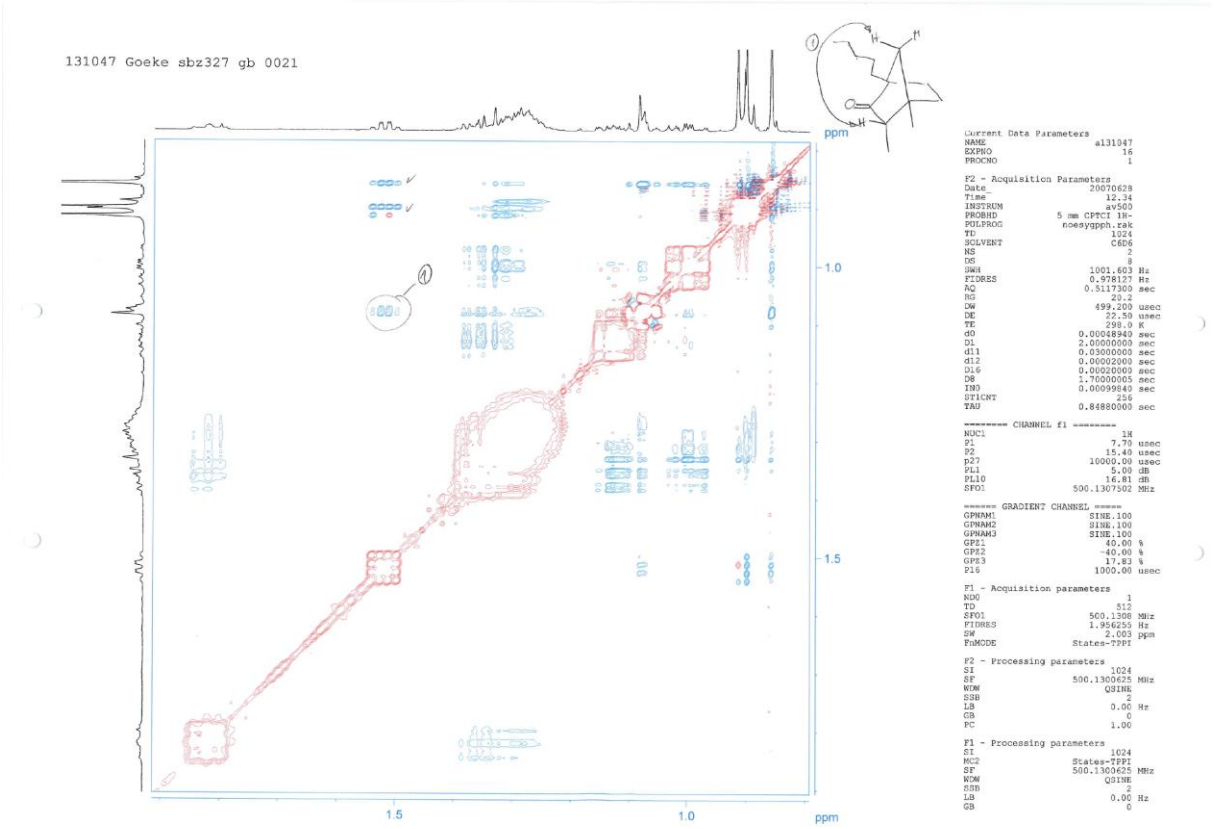
HSQC spectrum of compound **15c** in C_6D_6



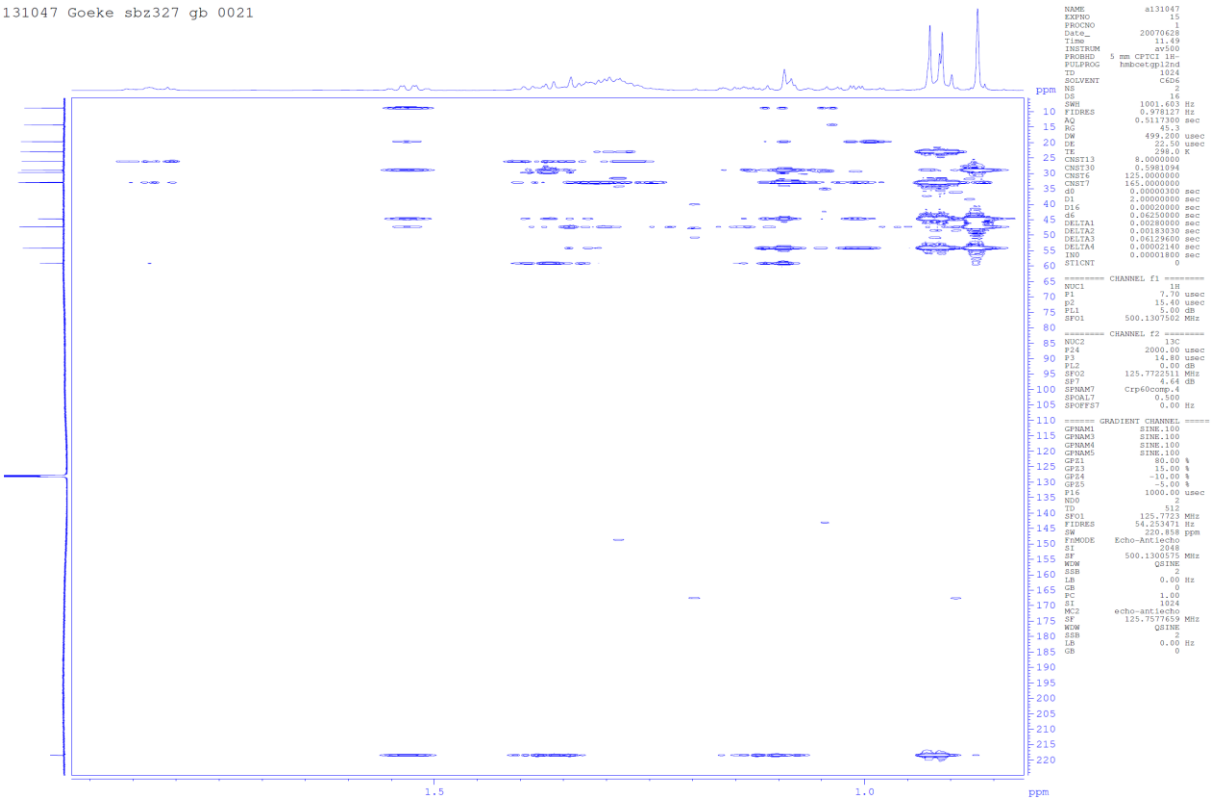
COSY spectrum of compound **15c** in C_6D_6



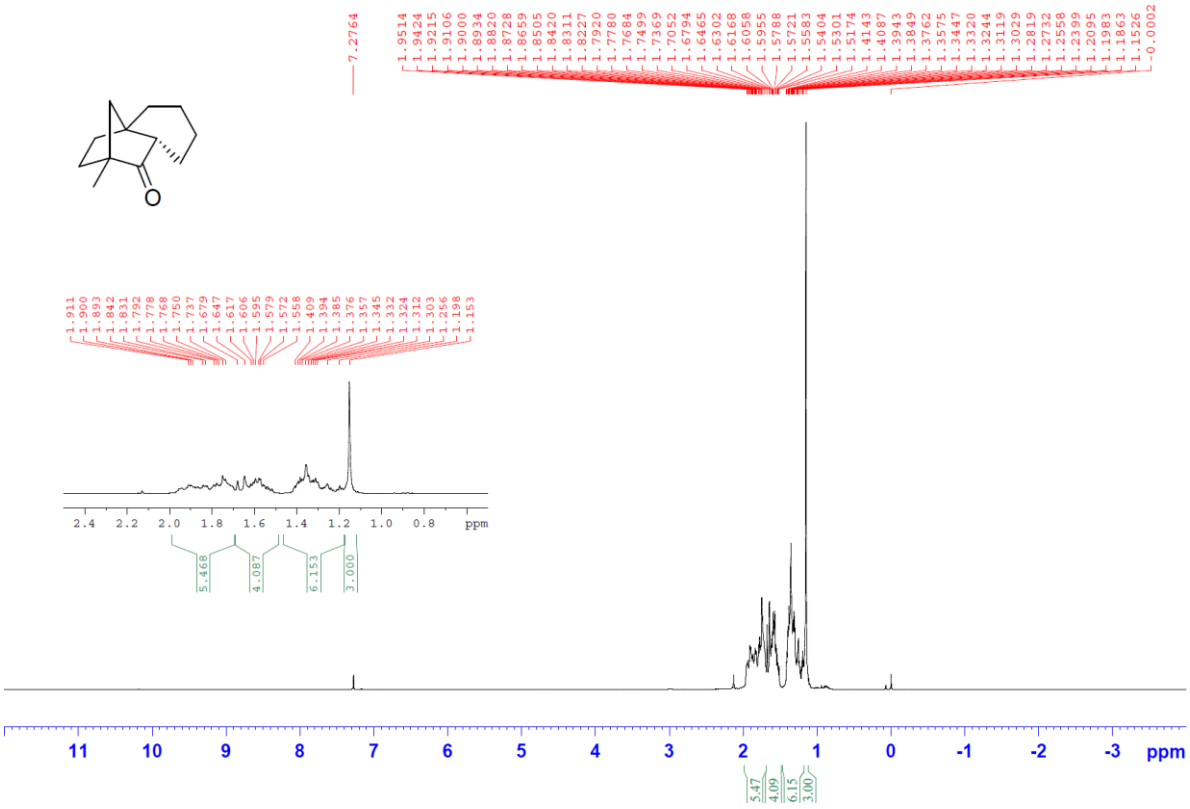
NOESY spectrum of compound **15c** in C_6D_6



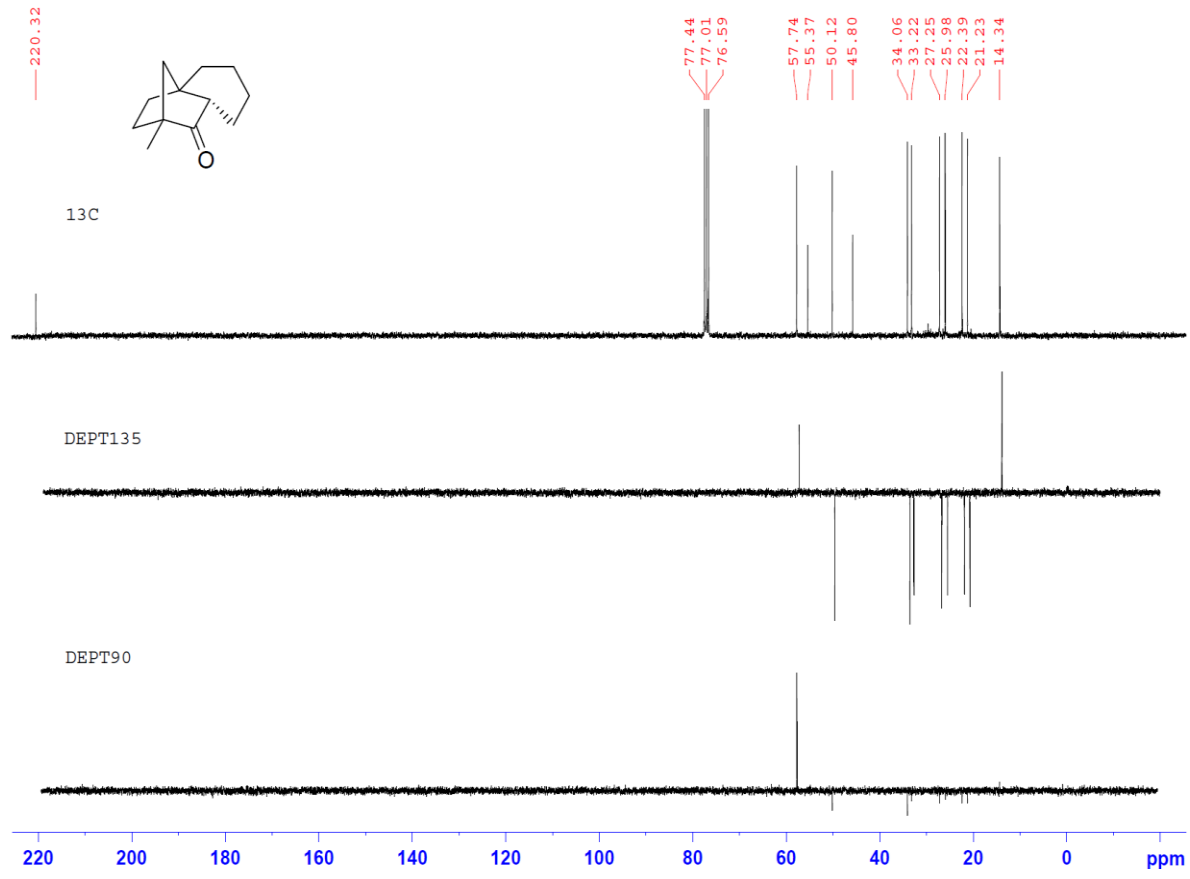
HMBC spectrum of compound **15c** in C_6D_6



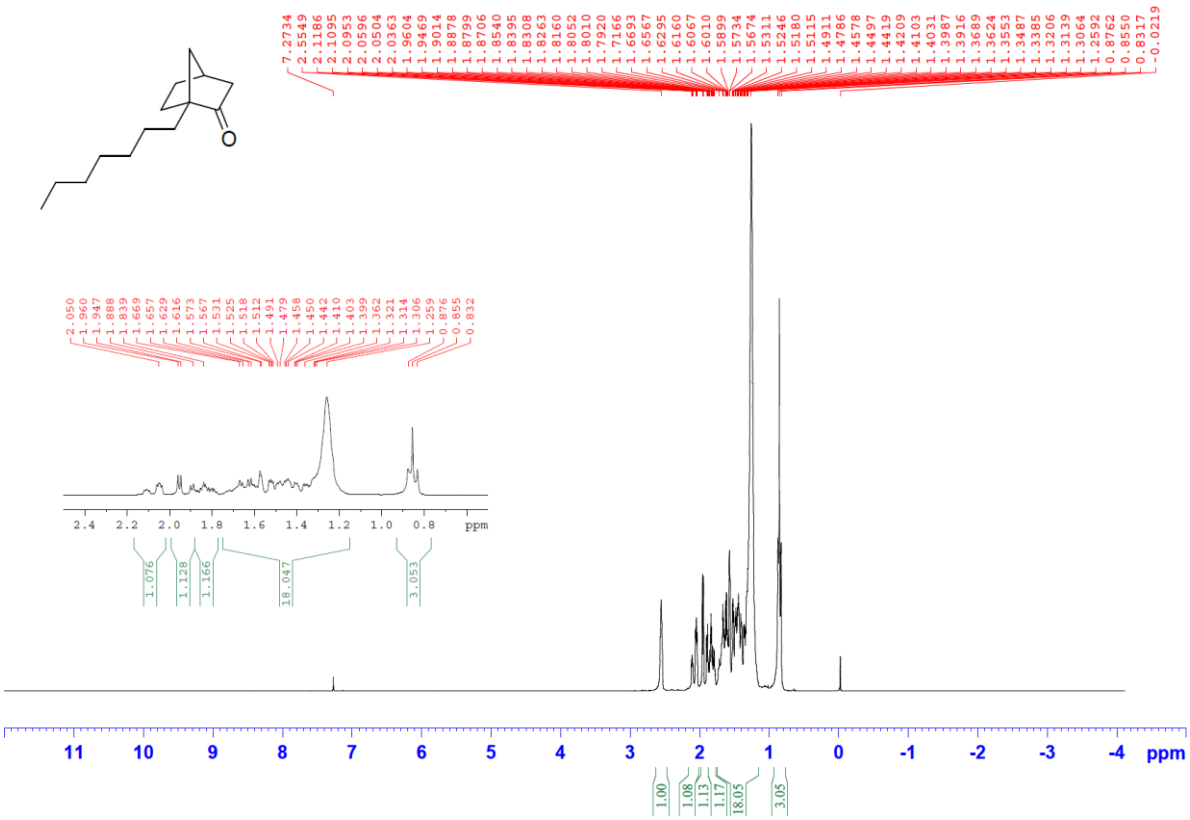
^{1}H NMR spectrum of compound **15d** in $CDCl_3$



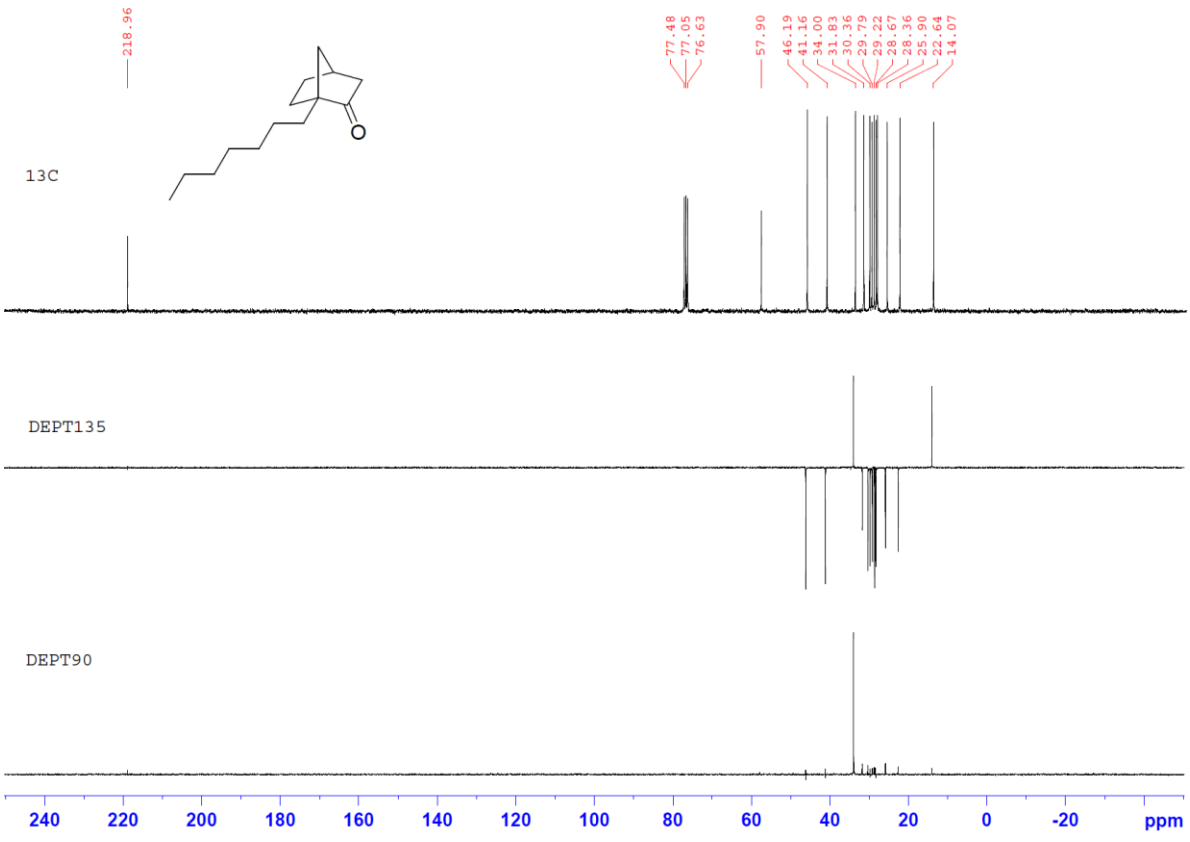
^{13}C NMR spectrum of compound **15d** in $CDCl_3$



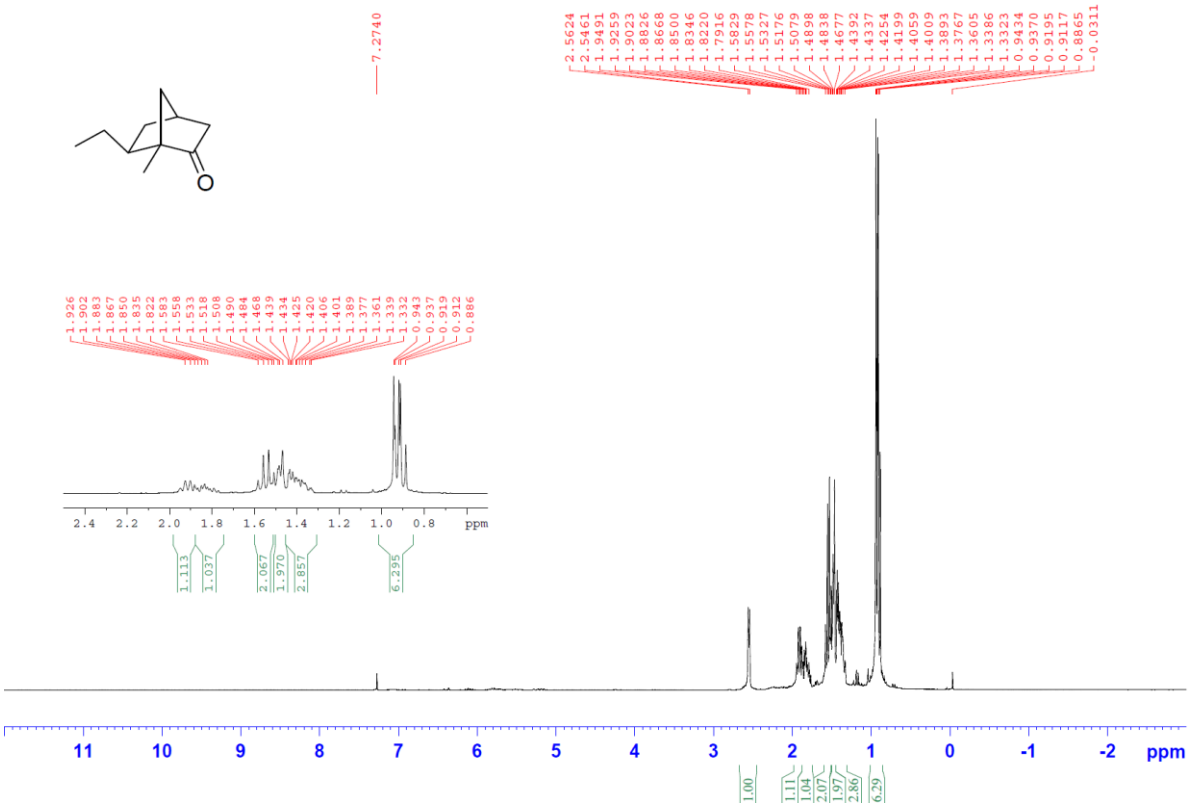
^{1}H NMR spectrum of compound **15e** in $CDCl_3$



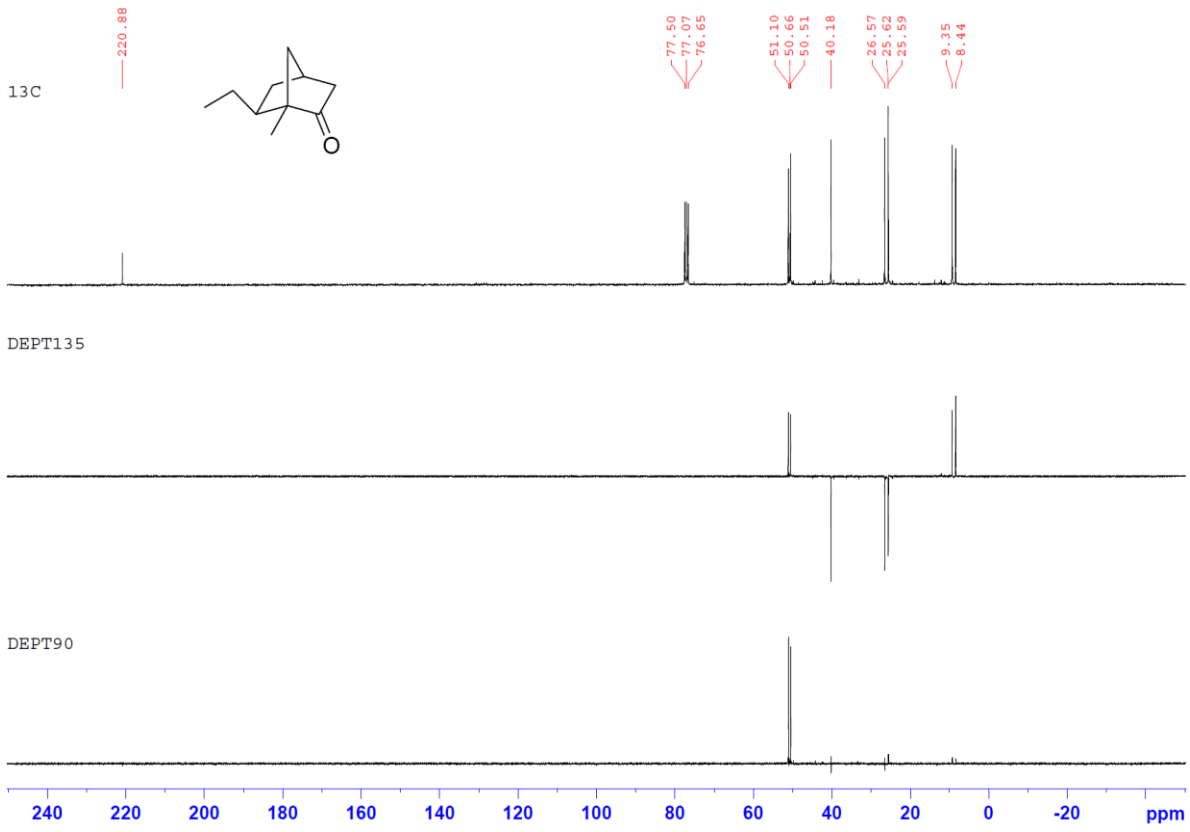
^{13}C NMR spectrum of compound **15e** in $CDCl_3$



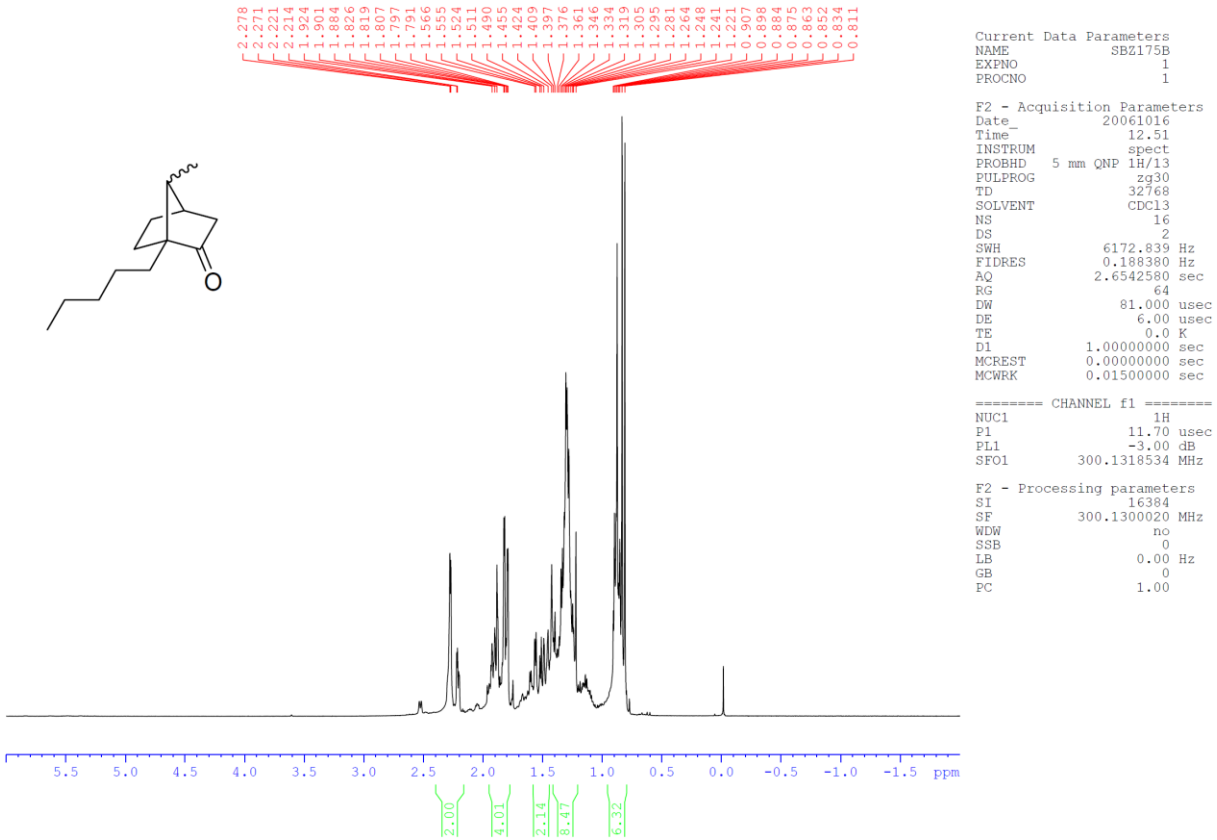
^{1}H NMR spectrum of compound **15f** in $CDCl_3$



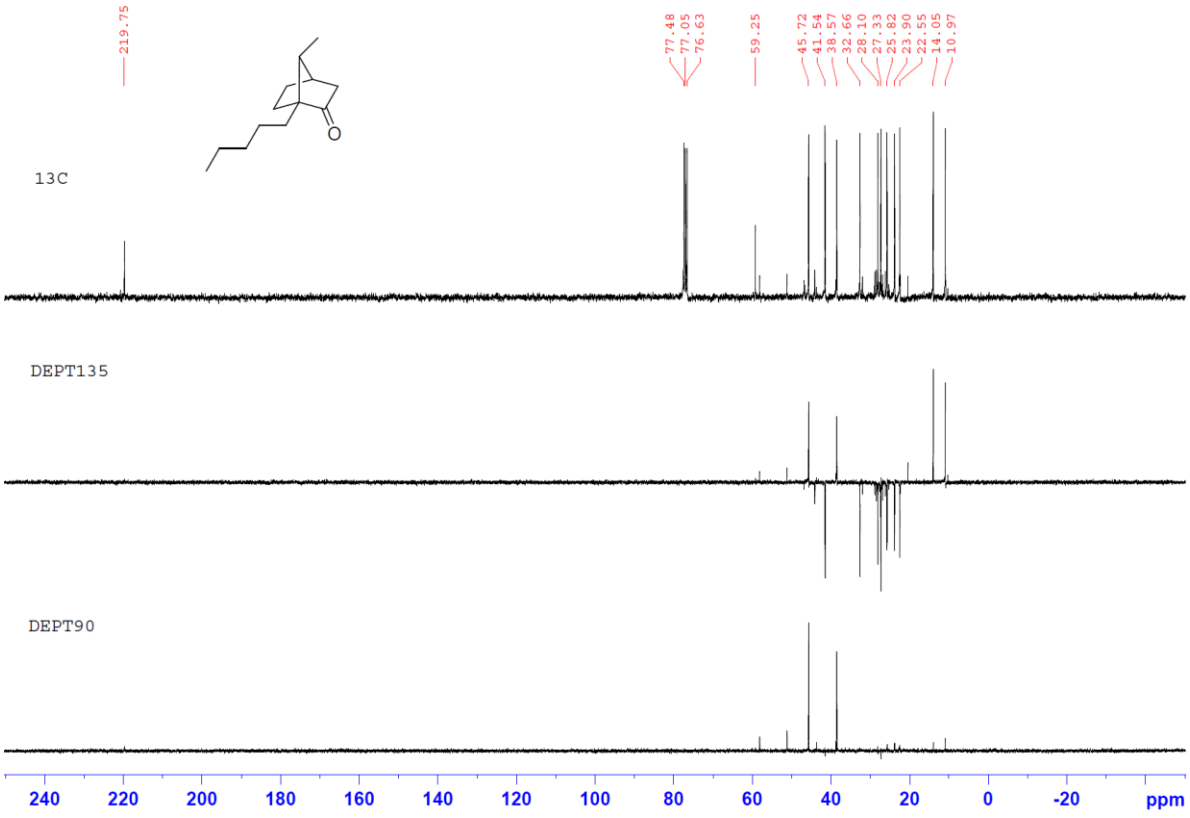
^{13}C NMR spectrum of compound **15f** in $CDCl_3$



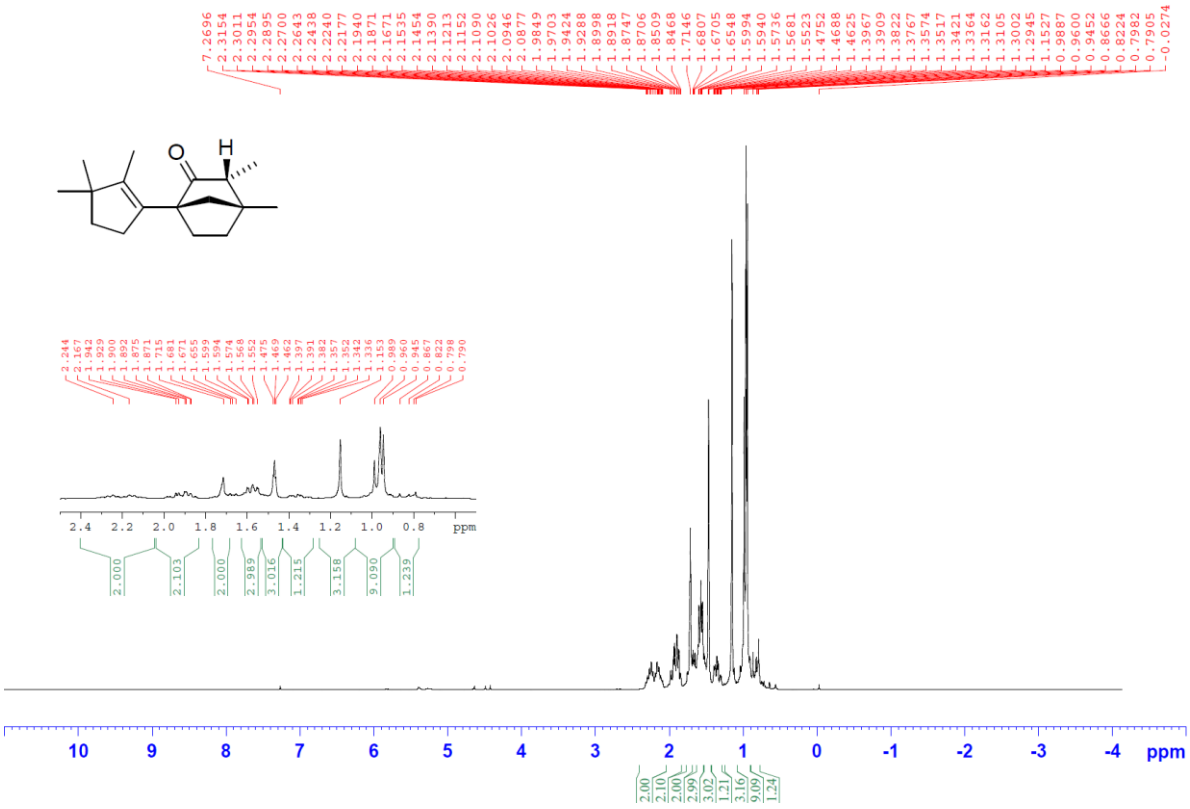
^{1}H NMR spectrum of compound **15g** in $CDCl_3$



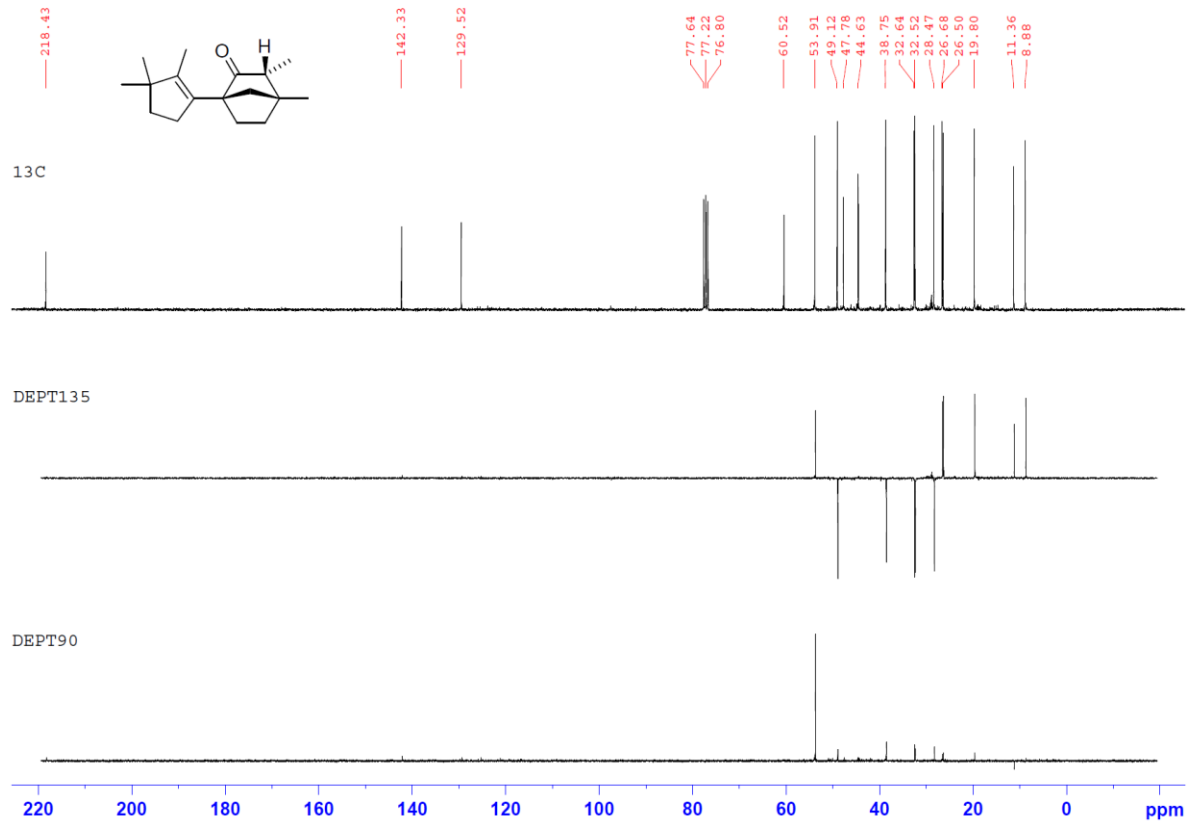
^{13}C NMR spectrum of compound **15g** in $CDCl_3$



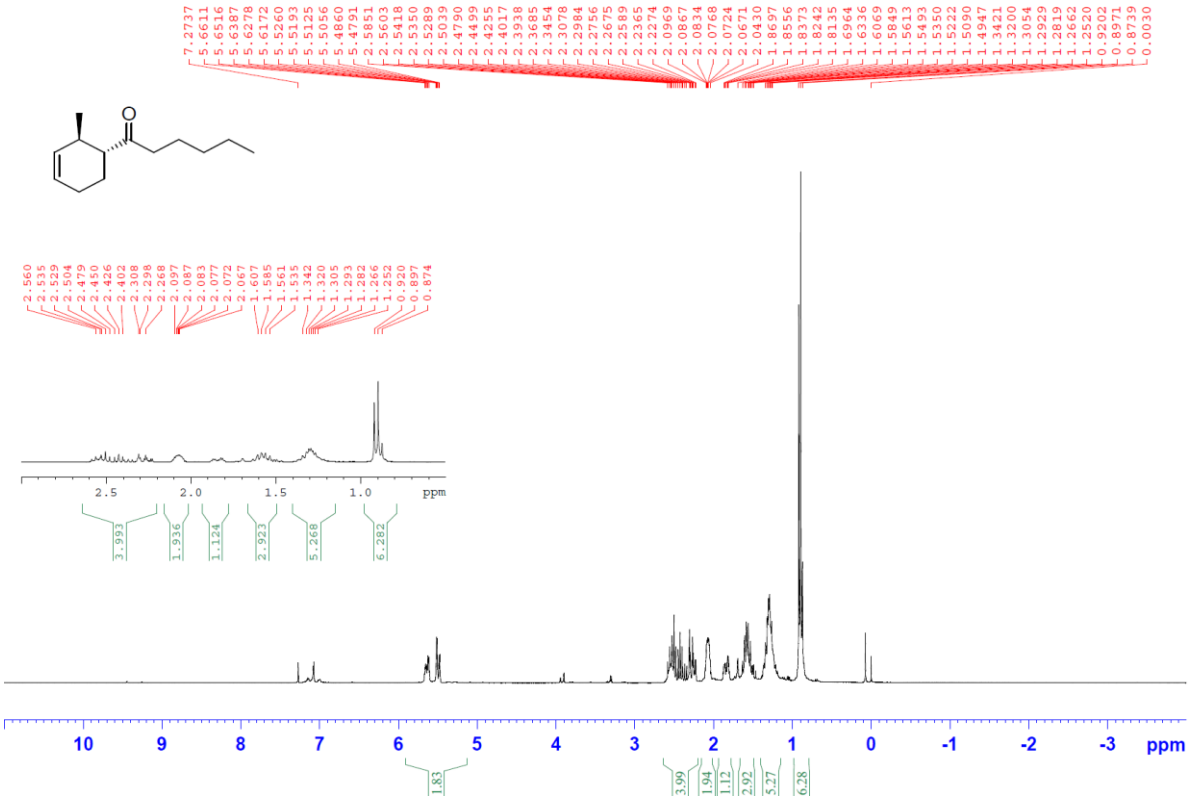
^{1}H NMR spectrum of compound **15h** in $CDCl_3$



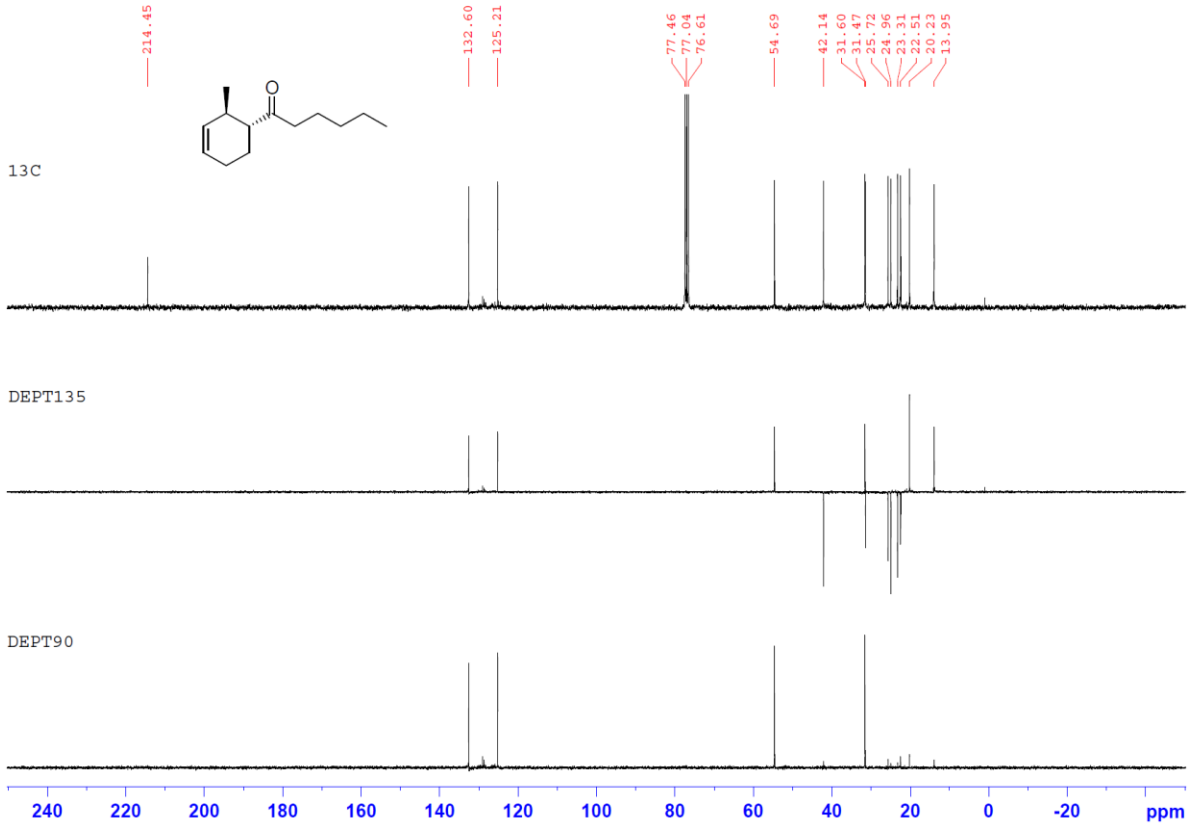
^{13}C NMR spectrum of compound **15h** in $CDCl_3$



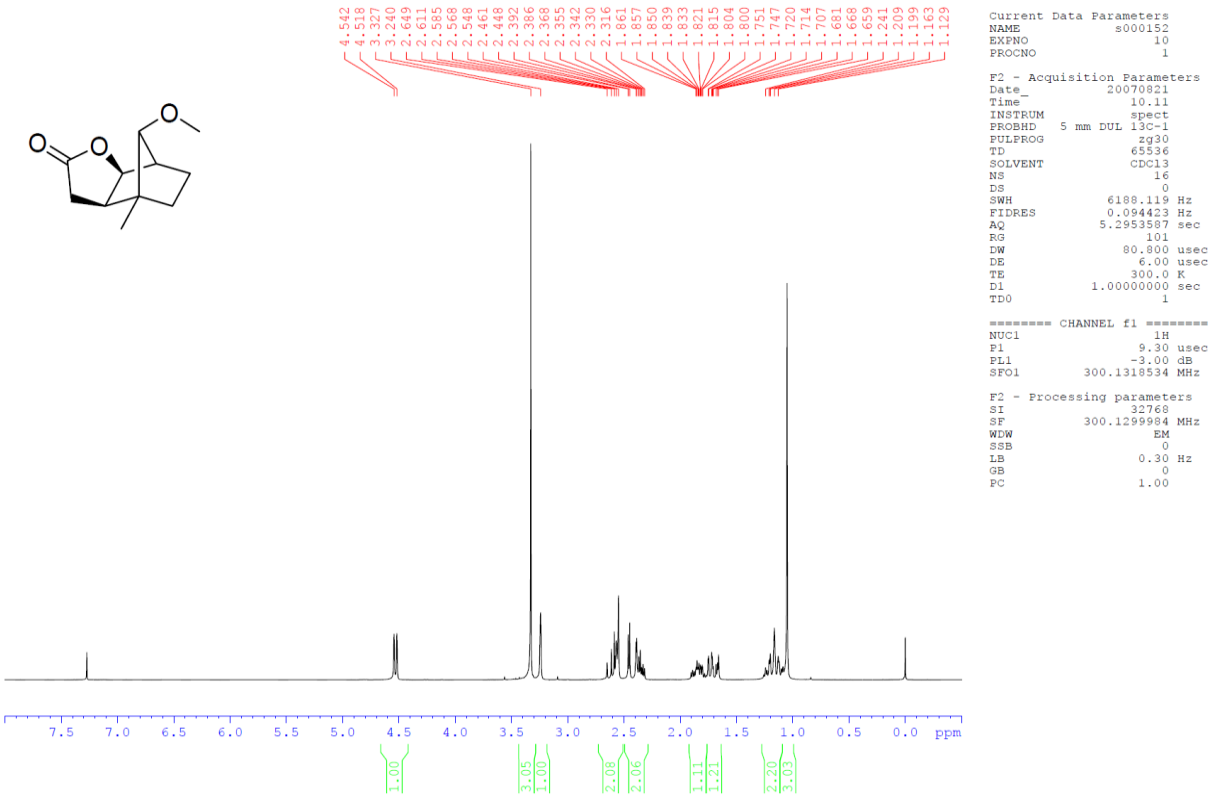
^{1}H NMR spectrum of compound **22** in $CDCl_3$



^{13}C NMR spectrum of compound **22** in $CDCl_3$



^{1}H NMR spectrum of compound **28a** in $CDCl_3$

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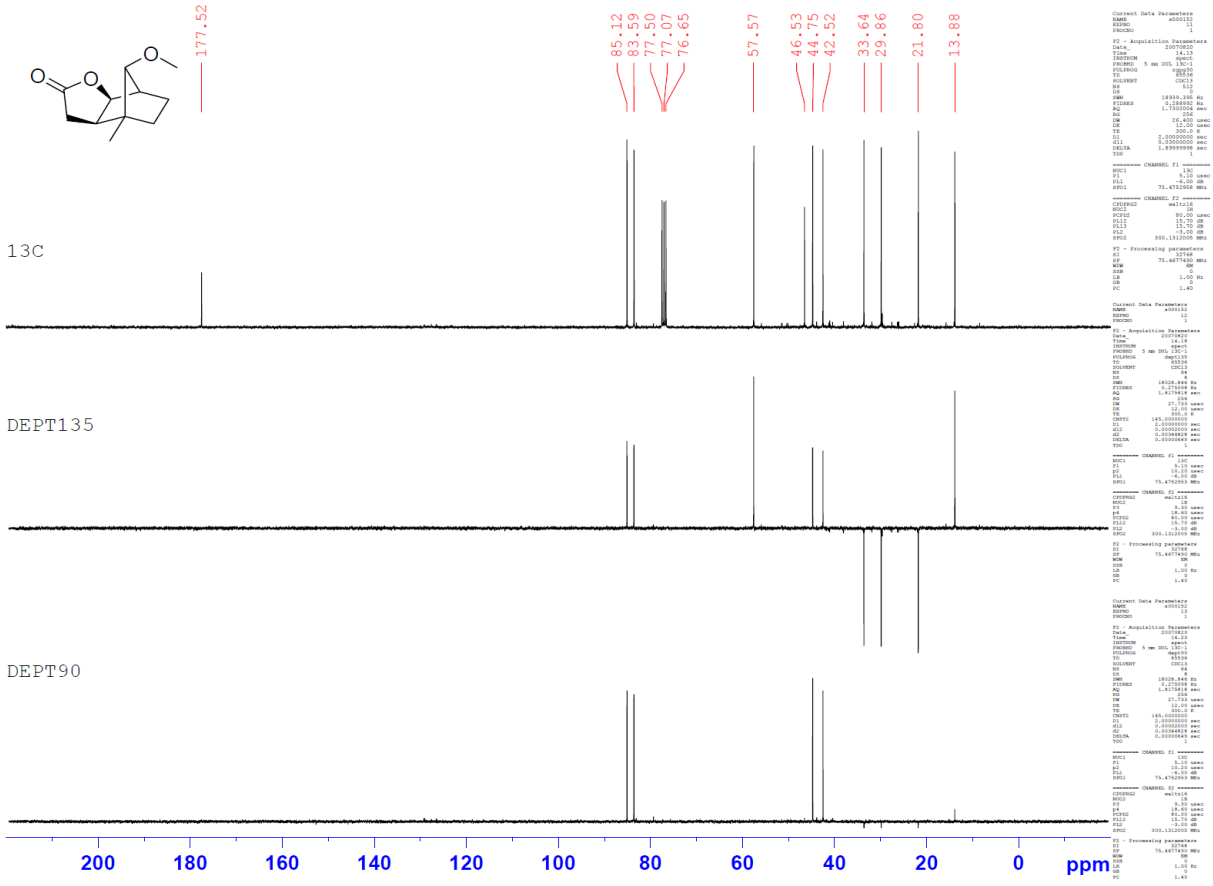
^{13}C NMR spectrum of compound **28a** in $CDCl_3$



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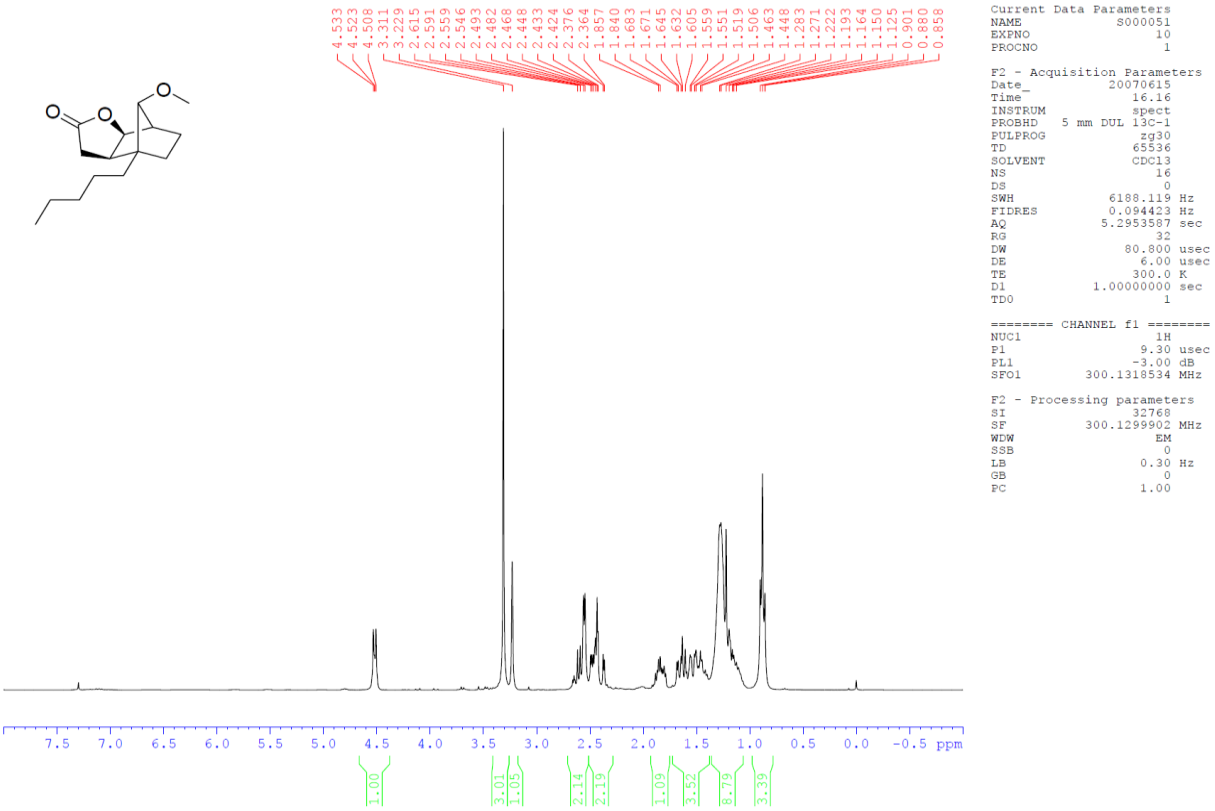

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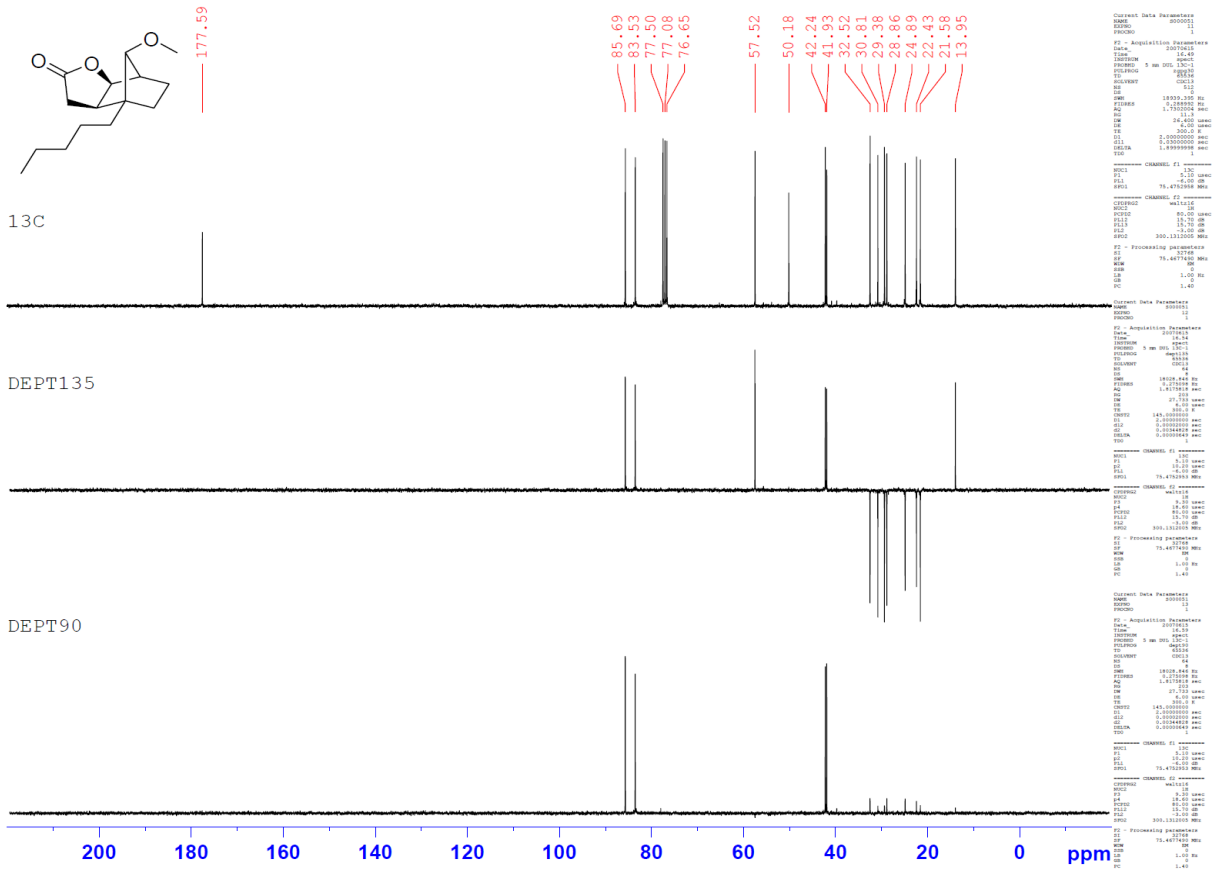
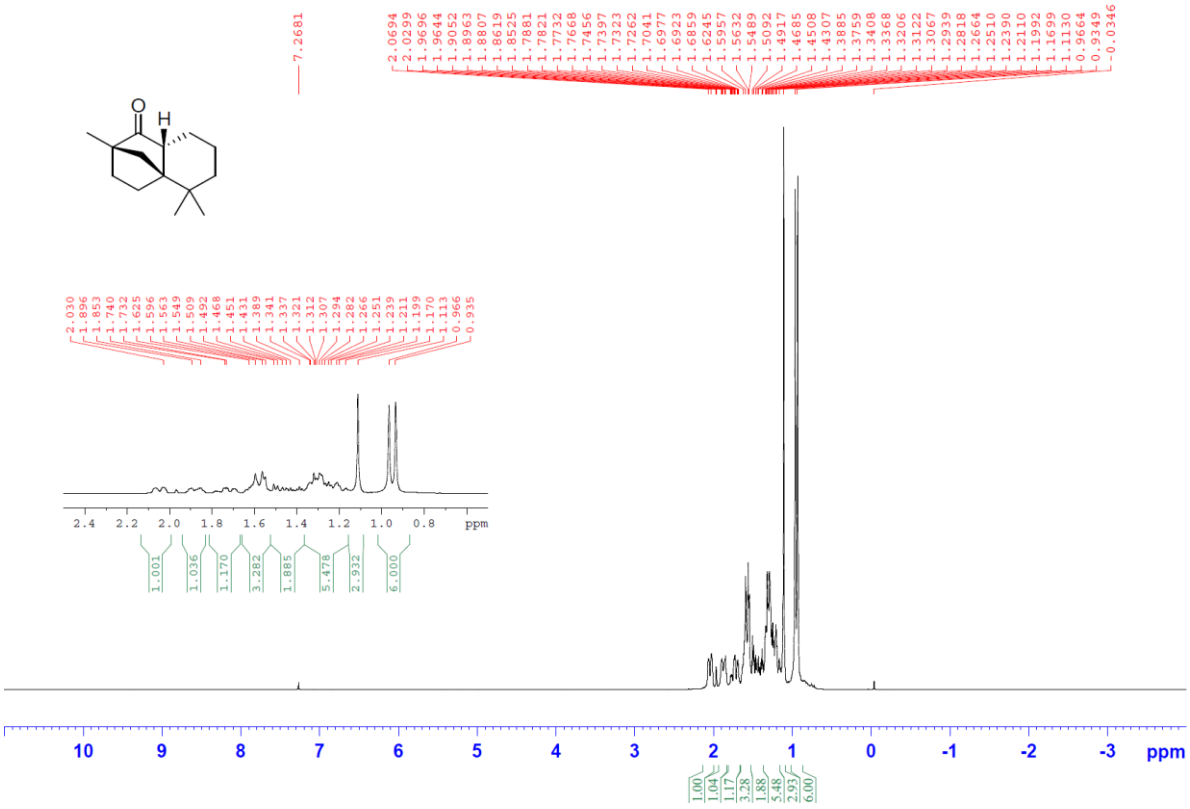
^{13}C NMR spectrum of compound **28b** in $CDCl_3$



^{1}H NMR spectrum of compound **31** in $CDCl_3$



^{13}C NMR spectrum of compound **31** in $CDCl_3$