Supporting information

Regioselective Synthesis of 1,2,4-trisubstituted Imidazole from a Mechanistic and Synthetic prospective

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Contents:-

Experimental:-

General Method 1H-pyrazole-1-carboximidamide hydrochloride (**1a**), 3,5-dimethyl-1H-pyrazole -1-carboximidamide nitrate (**1b**) and phenacyl bromide (**2a**-**2f**) were purchased from Sigma-Aldrich and were used without further purification. Phenacyl bromide **2g** has been prepared by bromination in glacial acetic acid. Anhydrous THF was freshly distilled over sodium metal and benzophenone according to the procedure reported in literature. Purification of a few compounds was performed using preparative separation column chromatography (Merck silica gel 60-120 mesh). Analytical TLC was carried out on pre-coated aluminum plates (Merck silica gel 60, F254). The synthesized compounds were characterized for IR recorded in KBr on SHIMADZU IR AFFINITY I-FTIR spectrophotometer. Melting points were carried out in open capillaries with an electrical melting point apparatus and are uncorrected. The ^{1}H NMR and ^{13}CNMR were recorded on Bruker Avance III 400 nano bay in deutrated solvent like DMSO and $CDCl_3$ at 400 and 100 MHz, respectively. Chemical shifts were quoted in **δ** values (ppm) relative to tetramethylsilane (TMS **δ** = 0) as internal standard for ^{1}H NMR spectra and the solvent peak for ^{13}CNMR. Coupling constant values are given in Hz. Peaks splitting patterns in ^{1}H NMR are reported as follow: s, singlet; bs, broad singlet; d, doublet; bd, broad doublet; t, triplet; bt, broad triplet; m, multiplet. High resolution mass spectra (HRMS) of all the synthesized compounds were recorded on SciexTOF5600^{+}.

General Procedure for synthesis of compound 3 and 4: A two neck 100 ml round bottom flask, equipped with reflux condenser and pressure equalizing funnel is charged with 1H-pyrazole-1-carboximidamide hydrochloride (1 mmol) in 10 ml of THF:H_2O (5:1) solvent. Then slow and portion wise addition of potassium carbonate (2.5 mmol) with vigorous refluxing is carried out. A solution of phenacyl bromide (2.2 mmol) in THF is constantly added drop wise *via* pressure equalizing funnel over a period of 20

min while refluxing. The progress of reaction is monitored by thin layer chromatography (TLC). After completion of the reaction, THF is removed under reduced pressure using rotatory evaporator Crude product is filtered and transferred to a 100 ml round bottom flask and stirred in 50 ml of hexane for one hour. Isolated product is purified by column chromatography (60-120 mesh silica, hexane/ethylacetate 90/10). % yield of compound **3** and **4** is given in Table 1.

Table 1 % Yield of compounds **3** and **4**.

Entry	*X*	*Y*	*Ar*	*Phenacyl Bromide [mmol]2(a-g)*	*% Yield*	
					3	***4***
1	HCl	H	Phenyl	1.2 (2a)	39	< 5%
				2.5 (2a)	< 5%	44
2	HCl	H	4-methylphenyl	1.2 (2b)	16	26
				2.5 (2b)	< 5%	34
3	HCl	H	4-bromophenyl	1.2 (2c)	14	26
				2.5 (2c)	< 5%	38
4	HCl	H	4-methoxyphenyl	1.2 (2d)	NP	40
				2.5 (2d)	NP	51
5	HCl	H	4-chlorophenyl	1.2 (2e)	NP	29
				2.5 (2e)	< 5%	40
6	HCl	H	4-flurophenyl	1.2 (2f)	< 5%	31
				2.5 (2f)	< 5%	43
7	HCl	H	3-nitrophenyl	1.2 (2g)	38	NP
				2.5 (2g)	46	NP
8	HNO_3	Me	Phenyl	1.2 (2a)	49	< 5%
				2.5 (2a)	< 5%	45
9	HNO_3	Me	4-methylphenyl	1.2(2b)	13	36
				2.5 (2b)	11	46
10	HNO_3	Me	4-bromophenyl	1.2(2c)	11	35
				2.5 (2c)	< 5%	49
11	HNO_3	Me	4-methoxyphenyl	1.2 (2d)	NP	48
				2.5 (2d)	NP	65
12	HNO_3	Me	4-chlorophenyl	1.2 (2e)	< 5%	40
				2.5 (2e)	< 5%	52
13	HNO_3	Me	4-flurophenyl	1.2 (2f)	< 5%	44
				2.5 (2f)	< 5%	55
14	HNO_3	Me	3-nitrophenyl	1.2 (2g)	50	NP
				2.5 (2g)	53	NP

NP – corresponding product has not been formed.

Characterization Data of Synthesized Compounds :-

1-(5-Phenyl-1H-imidazol-2-yl)-1H-pyrazole (3a)

White floppy solid, mp: 158-160°C. ^{1}H NMR (400 MHz, DMSO) δ = 12.81 (s, 1H, N-**H**, D_2O exchangable), 8.40 (bs, 1H, pyrazole C_5-**H**), 7.82 – 7.83 (m, 2H, phenyl C_3-**H,** C_5-**H**), 7.80 (bs, 1H, pyrazole C_3-**H**), 7.59 (s, 1H, imidazole **H**), 7.37 (t, *J* = 7.6, Hz, 2H, phenyl C_3-**H**, C_5-**H**), 7.22 (t, *J* = 7.6, 7.2 Hz, 1H, phenyl C_4-**H**), 6.58 (t, J = 2.4, 2.0, 1H, pyrazole C_4-**H**). ^{13}C NMR (100 MHz, DMSO) δ = 141.89, 141.77, 138.78, 134.56, 128.93, 128.42, 126.83, 124.70, 112.39, 108.25. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3445.30, 2364.83, 2345.47, 1600.06, 1399.12. HRMS: m/z Cacld. $(M + H)^+$ for $C_{12}H_{10}O_4$: 211.0978 found 211.0975.

1-Phenyl-2-(4-phenyl-2-(1H-pyrazol-1-yl)-1H-imidazol-1-yl)ethanone (4a)

White floppy solid, mp: 130-132°C.^{1}H NMR (400 MHz, DMSO) δ = 8.36 (d, *J* = 2.4 Hz, 1H, pyrazole C_5-**H**), 8.02 (d, *J* = 7.2 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.79 (d, *J* = 7.2 Hz, 2H, imidazole phenyl C_2-**H**, C_6-**H**), 7.72 (t, *J* = 7.4, 7.6 Hz, 1H, imidazole N_1-aryl C_4-**H**), 7.67 (s, 1H, imidazole **H**), 7.64 (d, *J* = 1.2 Hz, 1H, pyrazole C_3-**H**), 7.59 (t, *J* = 7.6 Hz, 2H, imidazole N_1-aryl C_3-**H**, C_5-**H**), 7.41 (t, *J* = 7.6 Hz, 2H, imidazole phenyl C_3-**H**, C_5-**H**), 7.26 (t, *J* = 7.6, 7.2 Hz, 1H, imidazole phenyl C_4-**H**), 6.51 (t, J = 2.0 Hz, 1H, pyrazole C_4-**H**), 5.98 (s, 2H, C**H**$_2$). ^{13}C NMR (100 MHz, DMSO) δ = 193.14, 142.20, 140.82, 137.35, 134.69, 134.49, 134.04, 130.97, 129.48, 129.12, 128.44, 127.19, 124.64, 118.57, 107.70, 54.40. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3050.48, 2918.30, 1693.50, 1552.70, 1506.41. HRMS: m/z Cacld. $(M + H)^+$ for $C_{20}H_{16}N_4O$: 329.1397 found 329.1317.

1-(5-(p-Tolyl)-1H-imidazol-2-yl)-1H-pyrazole (3b)

White solid, mp: 120-124°C.^{1}H NMR (400 MHz, DMSO) δ = 12.76 (s, 1H, N-**H**, D_2O exchangable), 8.39 (d, *J* = 2.4 Hz, 1H, pyrazole C_5-**H**), 7.82 (bs, 1H, imidazole **H**), 7.70 (d, *J* = 8.0 Hz, 2H, imidazole 4-methylphenyl C_2-**H**, C_6-**H**), 7.52 (d, *J* = 1.6 Hz, 1H, pyrazole ring C_3-**H**), 7.18 (d, *J* = 8.0 Hz, 2H, imidazole 4-methylphenyl C_3-**H**, C_5-**H**), 6.57 (t, *J* = 2.4, 2.0 Hz, 1H, pyrazole C_4-**H**), 2.32 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 141.84, 141.62, 138.85, 135.89, 131.81, 129.49, 128.39, 124.66, 111.76, 108.20, 21.25. Due to poor yield of the compound IR and HRMS data of the compound is not available.

2-(2-(1H-Pyrazol-1-yl)-4-(p-tolyl)-1H-imidazol-1-yl)-1-(p-tolyl)ethanone (4b)

Skin coloured solid, mp: 139-142°C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.26 (dd, *J* = 2.8 Hz, 1H, pyrazole C_5-**H**), 7.84 (d, *J* = 8.4 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.68 (d, *J* = 8.0 Hz, 2H, imidazole 4-methylphenyl C_2-**H**, C_6-**H**), 7.53 (d, *J* = 1.2 Hz, 1H, pyrazole ring C_3-**H**), 7.29 (d, *J* = 8.0 Hz, 2H, imidazole N_1-aryl C_3-**H**, C_5-**H**), 7.18 (d, *J* = 8.0 Hz, 2H, imidazole 4-methylphenyl C_3-H, C_5-**H**), 7.07 (s, 1H, imidazole **H**), 6.36 (dd, *J* = 2.4 Hz, 1H, **pyrazole C4-H**), 5.78 (s, 2H, C**H**$_2$), 2.43 (s, 3H, C**H**$_3$), 2.36 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 191.56, 144.97, 141.60, 140.64, 138.94, 136.66, 132.02, 130.81, 130.43, 129.62, 129.25, 128.17, 124.79, 116.07, 106.88, 53.44, 21.78, 21.26. IR (KBr, ν_{max}/cm^{-1}): 3116.21, 2976.42, 1689.67, 1606.72-1501.94. HRMS: m/z Cacld. $(M + H)^+$ for $C_{22}H_{20}N_4O$: 357.1710 found 357.1630.

1-(5-(4-Bromophenyl)-1H-imidazol-2-yl)-1H-pyrazole (3c)

White solid, mp: 139-142°C. ^{1}H NMR (400 MHz, DMSO) δ = 12.90 (s, 1H, N-**H**, D_2O exchangable), 8.39 (d, *J* = 2.0 Hz, 1H, pyrazole C_5-**H**), 7.82 (d, *J* = 1.2 Hz, 1H, pyrazole C_3-**H**), 7.76 (d, *J* = 8.5 Hz, 2H, 4-bromophenyl C_3-**H**, C_5-**H**), 7.64 (s, 1H, imidazole **H**), 7.55 (d, *J* = 8.5

Hz, 2H, 4-bromophenyl C_2-**H**, C_6-**H**), 6.58 (t, *J* = 2.0, 2.4 Hz, 1H, pyrazole C_4-**H**). ^{13}C NMR (101 MHz, DMSO) δ = 146.69, 142.39, 138.46, 136.61, 131.46, 124.36, 117.78, 113.19. Due to poor yield of the compound IR and HRMS data of the compound is not available.

1-(4-Bromophenyl)-2-(4-(4-bromophenyl)-2-(1H-pyrazol-1-yl)-1H-imidazol-1-yl)ethanone (4c)

Yellowish solid, mp: 160-164◦C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.29 (dd, *J* = 2.8 Hz, 1H, pyrazole C_5-**H**), 7.83 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_3-**H**, C_5-**H**), 7.68 (d, *J* = 1.2 Hz, 2H, imidazole 4-bromophenyl C_3/C_5-**H**), 7.66 (d, *J* = 8.2 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.52 (t, *J* = 8.2 Hz, 2H, imidazole 4-bromophenyl C_2-**H**, C_6-**H**), 7.50 (d, *J* = 1.9 Hz, 1H, pyrazole C_3-**H**), 7.13 (s, 1H, imidazole **H**), 6.39 (dd, *J* = 2.5, 1.8 Hz, 1H, pyrazole C_4-**H**), 5.81 (s, 2H, C**H**$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 191.07, 141.78, 137.90, 133.18, 132.46, 132.36, 131.68, 130.25, 129.54, 129.37, 126.42, 120.78, 116.62, 107.14, 53.63. IR (KBr, ν_{max}/cm^{-1}): 3114.82, 2922.16, 1697.36, 1544.98 1508.33. HRMS: m/z Cacld. $(M + H)^+$ for $C_{20}H_{14}N_4OBr_2$: 484.9607 found 484.9300.

1-(4-Methoxyphenyl)-2-(4-(4-methoxyphenyl)-2-(1H-pyrazol-1-yl)-1H-imidazol-1-yl)etha-none (4d)

Purple solid (isolated in pure form and there was no need of column chromatography for further purification). mp: 180-184°C. ^{1}H NMR (400 MHz, DMSO) δ = 8.33 (d, *J* = 2.4 Hz, 1H, pyrazole C_5-**H**), 7.99 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.71 (d, *J* = 8.8 Hz, 2H, imidazole 4-methoxyphenyl C_2-**H**, C_6-**H**), 7.64 (d, *J* = 1.2 Hz, 1H, pyrazole C_3-**H**), 7.53 (s, 1H, imidazole **H**), 7.10 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 6.98 (d, *J* = 8.8 Hz, 2H, imidazole 4-

methoxyphenyl C_3-**H**, C_5-**H**), 6.49 (t, J = 2.4, 2.0 Hz, 1H, pyrazole **C_4-H**), 5.89 (s, 2H, C**H_2**), 3.87 (s, 3H, OC**H_3**), 3.79 (s, 3H, OC**H_3**). ^{13}C NMR (100 MHz, DMSO) δ = 191.40, 164.18, 158.70, 142.09, 140.64, 137.30, 130.99, 130.80, 127.52, 126.80, 125.93, 117.35, 114.69, 114.54, 107.57, 56.13, 55.56, 53.88. IR (KBr, ν_{max}/cm^{-1}): 3126.219, 2966.52, 1691.57, 1600.92-1506.41, 1242.16. HRMS: m/z Cacld. $(M + H)^+$ for $C_{22}H_{20}N_4O_3$: 389.1608 found 389.1519.

1-(4-Chlorophenyl)-2-(4-(4-chlorophenyl)-2-(1H-pyrazol-1-yl)-1H-imidazol-1-yl)ethanone (4e)

White solid. mp: 134°C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.28 (dd, *J* = 2.4 Hz, 1H, pyrazole C_5-**H**), 7.90 (d, *J* = 8.4 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.72 (d, *J* = 8.4 Hz, 2H, imidazole 4-chlorophenyl C_3-**H,** C_5-**H**), 7.52 (d, *J* = 1.2 Hz, 1H, pyrazole C_3-**H**), 7.49 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_2-H, C_6-H), 7.35 (d, *J* = 8.4 Hz, 2H, imidazole 4-chlorophenyl C_2-**H,** C_6-**H**), 7.10 (s, 1H, imidazole **H**), 6.39 (dd, *J* = 2.4, Hz, 1H, pyrazole C_4-**H**), 5.80 (s, 2H, C**H_2**). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 190.88, 141.76, 140.73, 140.61, 137.86, 132.76, 132.65, 132.01, 130.23, 129.47, 129.35, 128.74, 126.09, 116.57, 107.12, 53.63. IR (KBr, ν_{max}/cm^{-1}): 3110.43, 2920.23, 1699.29, 1550.77 - 1481.33. HRMS: m/z Cacld. $(M + H)^+$ for $C_{20}H_{14}N_4OCl_2$: 397.0617 found 397.0520.

1-(4-Fluorophenyl)-2-(4-(4-fluorophenyl)-2-(1H-pyrazol-1-yl)-1H-imidazol-1-yl)ethanone (4f)

White solid. mp: 155-157°C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 8.31 (dd, *J* = 2.8 Hz, 1H, pyrazole C_5-**H**), 8.03 (dd, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.78 (dd, *J* = 8.8 Hz, 2H, imidazole 4-fluorophenyl C_3-**H,** C_5-**H**), 7.55 (d, *J* = 1.2 Hz, 1H, pyrazole C_3-**H**), 7.22 (t, *J* = 8.8, 8.4 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.10 (dd, *J* = 10.0, 7.6 Hz, 3H, imidazole 4-fluorophenyl C_2-**H,** C_6-**H** and imidazole **H**), 6.42 (dd, *J* = 2.4, Hz, 1H, pyrazole C_4-**H**), 5.84 (s,

2H, C**H**$_2$). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 190.49, 167.53, 163.36, 141.73, 138.13, 130.94, 130.80, 130.29, 129.72, 126.50, 116.34, 116.08, 115.58, 115.36, 107.07, 53.51. IR (KBr, ν_{max}/cm^{-1}): 3084.69, 2960.10, 1672.62, 1568.82, 1508.87. HRMS: m/z Cacld. $(M + H)^+$ for $C_{20}H_{14}N_4OF_2$: 365.1208 found 365.1130.

1-(5-(3-Nitrophenyl)-1H-imidazol-2-yl)-1H-pyrazole (3g)

Yellow solid. mp: 184-187°C. ^{1}H NMR (400 MHz, DMSO) δ = 13.07 (s, 1H, N-**H**, D_2O exchangable), 8.62 (d, *J* = 1.6 Hz, 1H, pyrazole C_5-**H**), 8.48 (d, *J* = 2.4 Hz, 1H, pyrazole C_3-**H**), 8.27 – 8.25 (m, 1H, 3-nitrophenyl **H**), 8.08 (dd, J = 1.6, 1H, 3-nitrophenyl **H**), 7.88 (dd, *J* = 1.80 Hz, 2H, imidazole **H** and imidazole 3-nitrophenyl), 7.68 (t, *J* = 8.0 Hz, 1H, 3-nitrophenyl **H**), 6.60 (t, J = 2.4, 2.0, 1H, pyrazole C_4-**H**). ^{13}C NMR (100 MHz, DMSO) δ = 148.85, 142.21, 142.15, 136.63, 136.41, 130.88, 130.54, 128.66, 121.33, 118.71, 114.55, 108.48. IR (KBr, ν_{max}/cm^{-1}): 3447.37, 3054.13, 2363.98, 2345.44, 1590.23, 1349.74. HRMS: m/z Cacld. $(M + H)^+$ for $C_{12}H_{19}N_5O_2$: 256.0829 found 256.0830.

3,5-Dimethyl-1-(5-phenyl-1H-imidazol-2-yl)-1H-pyrazole (3h)

Light Yellow solid. mp: 193-194°C. ^{1}H NMR (400 MHz, DMSO) δ = 12.59 (s, 1H, N-**H**, D_2O exchangable), 7.80 (d, *J* = 7.6 Hz, 2H, phenyl C_2-**H**, C_6-**H**), 7.56 (bs, 1H, imidazole **H**), 7.36 (t, *J* = 7.6 Hz, 2H, phenyl C_3-**H**, C_5-**H**), 7.21 (t, *J* = 7.6, 7.2 Hz, 1H, phenyl C_4-**H**), 6.12 (s, 1H, pyrazole C_4-**H**), 2.60 (s, 3H, C**H**$_3$), 2.23 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 149.41, 141.87, 140.86, 138.64, 134.83, 128.89, 126.66, 124.62, 111.78, 108.11, 13.71, 13.05. IR (KBr, ν_{max}/cm^{-}

^{1}): 3439.09, 3068.46, 2929.78, 2366.32, 2345.72, 1572.17, 1399.34. HRMS: m/z Cacld. $(M + H)^{+}$ for $C_{14}H_{14}N_4$: 239.1291 found 239.1293.

2-(2-(3, 5-Dimethyl-1H-pyrazol-1-yl)-4-phenyl-1H-imidazol-1-yl)-1-phenylethanone (4h)

White solid. mp: 152-154°C. ^{1}H NMR (400 MHz, DMSO) δ = 7.96 (d, *J* = 7.2 Hz, 2H, imidazole N_1-aryl C_2-**H**, C_6-**H**), 7.78 (d, *J* = 7.2 Hz, 2H, imidazole phenyl C_2-**H,** C_6-**H**), 7.72 – 7.68 (m, 2H, imidazole **H** and N_1-aryl C_4-**H**), 7.69 (t, *J* = 7.6 Hz, 2H, phenyl C_2-**H,** C_6-**H**), 7.40 (t, *J* = 7.6, 8.0 Hz, 2H, imidazole phenyl C_3-**H,** C_5-**H**), 7.25 (t, *J* = 7.6, 7.2 Hz, 1H, imidazole phenyl C_4-**H**), 6.01 (s, 1H, pyrazole C_4-**H**), 5.70 (s, 2H, C**H**$_2$), 2.38 (s, 3H, C**H**$_3$), 1.93 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 193.19, 149.7, 142.63, 140.19, 137.47, 134.73, 134.44, 134.19, 129.42, 129.15, 128.36, 127.17, 124.59, 118.24, 107.19, 53.30, 13.45, 12.06. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3048.59, 2922.80, 2864.52, 1699.42, 1562.20 and 1509.81. HRMS: m/z Cacld. $(M + H)^{+}$ for $C_{22}H_{20}N_4O$: 357.1710 found 357.1630.

3,5-Dimethyl-1-(5-(p-tolyl)-1H-imidazol-2-yl)-1H-pyrazole (3i)

Yellow solid. mp: 178-182°C. ^{1}H NMR (400 MHz, DMSO) δ = 12.50 (s, 1H, N-**H**, D_2O exchangable), 7.68 (d, *J* = 8.0 Hz, 2H, 4-methylphenyl C_2-**H,** C_6-**H**), 7.47 (s, 1H, imidazole **H**), 7.17 (d, *J* = 8.0 Hz, 2H, 4-methylphenyl C_3-**H,** C_5-**H**), 6.11 (s, 1H, pyrazole C_4-**H**), 2.58 (s, 3H, C**H**$_3$), 2.30 (s, 3H, C**H**$_3$), 2.23 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 149.41, 141.64, 140.86, 138.70, 135.77, 132.00, 129.48, 124.57, 111.18, 108.07, 21.24, 13.71, 12.99. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3457.51, 3182.55, 2924.09, 2818.15, 1583.56, 1492.90, 1415.75, 1388.75. HRMS: m/z Cacld. $(M + H)^{+}$ for $C_{15}H_{16}N_4$: 253.1448 found 253.1463.

2-(2-(3,5-Dimethyl-1H-pyrazol-1-yl)-4-(p-tolyl)-1H-imidazol-1-yl)-1-(p-tolyl)ethanone (4i)

Chocolate coloured solid. mp: 150-153°C. ^{1}H NMR (400 MHz, DMSO) δ = 7.86 (d, *J* = 8.2 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.66 (d, *J* = 8.1 Hz, 2H, imidazole 4-methylphenyl C_2-**H,** C_6-**H**), 7.63 (s, 1H, imidazole **H**), 7.37 (d, *J* = 8.0 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.21 (d, *J* = 8.0 Hz, 2H, imidazole 4-methylphenyl C_3-**H,** C_5-**H**), 6.01 (s, 1H, pyrazole C_4-**H**), 5.65 (s, 2H, C**H**$_2$), 2.40 (s, 3H, C**H**$_3$), 2.37 (s, 3H, C**H**$_3$), 2.32 (s, 3H, C**H**$_3$), 1.95 (s, 3H, C**H**$_3$).^{13}C NMR (100 MHz, DMSO) δ 192.63, 149.64, 144.95, 142.56, 140.08, 137.56, 136.22, 132.26, 131.55, 129.92, 129.68, 128.47, 124.56, 117.67, 107.09, 53.13, 21.69, 21.27, 13.52, 12.06. IR (KBr, ν_{max}/cm^{-1}): 3016.32, 2981.62, 2856.28, 1692.57, 1616.32 - 1521.44. HRMS: m/z Cacld. $(M + H)^+$ for $C_{24}H_{24}N_4O$: 385.2023 found 385.1939.

1-(4-Bromophenyl)-2-(4-(4-bromophenyl)-2-(3,5-dimethyl-1H-pyrazol-1-yl)-1H-imidazol-1-yl) ethanone (4j)

Light brown solid. mp: 250-252°C. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.76 (d, *J* = 8.4 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.65 (dd, *J* = 8.6, 6.6 Hz, 4H, imidazole N_1-aryl C_2-**H,** C_6-**H** and imidazole 4-bromophenyl C_3-**H,** C_5-**H**), 7.49 (d, *J* = 8.4 Hz, 1H, **imidazole** 4-bromophenyl C_2-**H,** C_6-**H**), 7.18 (s, 1H, imidazole **H**), 5.89 (s, 1H, pyrazole C_4-**H**), 5.53 (s, 2H, C**H**$_2$), 2.47 (s, 3H, C**H**$_3$), 2.06 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 190.93, 150.57, 143.21, 138.01, 133.16, 132.71, 132.31, 131.62, 130.22, 129.46, 129.38, 126.36, 120.62, 116.17, 107.10, 52.67, 13.40, 12.11. IR (KBr, ν_{max}/cm^{-1}): 3051.39, 2991.59, 2877.79, 1639.50, 1548.84 - 1483.26. HRMS: m/z Cacld. $(M + H)^+$ for $C_{22}H_{18}N_4OBr_2$: 512.9920 , 515.2285 found 514.9886.

2-(2-(3,5-Dimethyl-1H-pyrazol-1-yl)-4-(4-methoxyphenyl)-1H-imidazol-1-yl)-1-(4-methoxy pheyl)ethanone (4k)

Buff coloured solid. mp: 210-212°C. ^{1}H NMR (400 MHz, DMSO) δ = 7.93 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.68 (d, *J* = 8.8 Hz, 2H, imidazole 4-methoxyphenyl C_2-**H,** C_6-**H**), 7.56 (s, 1H, imidazole **H**), 7.07 (d, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 6.97 (d, *J* = 8.4 Hz, 1H, imidazole 4-methoxyphenyl **C_3-H, C_5-H**), 6.00 (s, 1H, pyrazole C_4-**H**), 5.60 (s, 2H, C**H**$_2$), 3.86 (s, 3H, OC**H**$_3$), 3.78 (s, 3H, OC**H**$_3$), 2.34 (s, 3H, C**H**$_3$), 1.97 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 191.40, 164.20, 158.83, 149.70, 142.70, 140.08, 137.65, 130.68, 127.83, 127.22, 125.99, 116.94, 114.66, 106.98, 79.55, 56.11, 55.67, 52.70, 13.44, 11.87. IR (KBr, ν_{max}/cm^{-1}): 3001.24, 2939.52, 2853.36, 1685.79, 1598.99, 1550.77, 1242.16. HRMS: m/z Cacld. $(M + H)^+$ for $C_{24}H_{26}N_4O_3$: 417.1921 found 417.1900.

1-(4-Chlorophenyl)-2-(4-(4-chlorophenyl)-2-(3,5-dimethyl-1H-pyrazol-1-yl)-1H-imidazol-1-yl)ethanone (4l)

Light brown solid. mp: 128-132°C. ^{1}H NMR (400 MHz, DMSO) δ = 7.99 (d, *J* = 8.4 Hz, 2H, imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.80 (d, *J* = 8.8 Hz, 2H, imidazole 4-chlorophenyl C_3-**H,** C_5-**H**), 7.75 (s, 1H, imidazole **H**), 7.66 (d, *J* = 8.4 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.46 (d, *J* = 8.8 Hz, 2H, imidazole 4-chlorophenyl C_2-**H,** C_6-**H**), 6.03 (s, 1H, pyrazole C_4-**H**), 5.70 (s, 2H, C**H**$_2$), 2.39 (s, 3H, C**H**$_3$), 1.90 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 192.25, 149.92, 142.73, 140.38, 139.31, 136.52, 133.68, 133.21, 131.53, 130.22, 129.48, 129.08, 126.35, 118.63, 107.31, 53.34, 13.32, 12.01. IR (KBr, ν_{max}/cm^{-1}): 3062.54, 2918.33, 2848.62, 1687.19, 1545.87- 1478.43. HRMS: m/z Cacld. $(M + H)^+$ for $C_{22}H_{18}N_4OCl_2$: 425.0930 found 425.0837.

2-(2-(3,5-Dimethyl-1H-pyrazol-1-yl)-4-(4-fluorophenyl)-1H-imidazol-1-yl)-1-(4-fluorophenyl)ethanone (4m)

Off white solid. mp: 198°C. ^{1}H NMR (400 MHz, DMSO) δ = 8.06 (dd, *J* = 8.8 Hz, 2H. imidazole N_1-aryl C_3-**H,** C_5-**H**), 7.81 (dd, *J* = 8.8 Hz, 2H, imidazole 4-flurophenyl C_3-**H,** C_5-**H**), 7.68 (s, 1H, imidazole **H**), 7.41 (t, *J* = 8.8 Hz, 2H, imidazole N_1-aryl C_2-**H,** C_6-**H**), 7.24 (t, *J* = 8.5 Hz, 2H, imidazole 4-flurophenyl C_2-**H,** C_6-**H**), 6.02 (s, 1H, pyrazole C_4-**H**), 5.69 (s, 2H, C**H**$_2$), 2.39 (s, 3H, C**H**$_3$), 1.93 (s, 3H, C**H**$_3$).^{13}C NMR (100 MHz, DMSO) δ 191.84, 167.10, 162.82, 160.40, 149.70, 142.55, 140.22, 136.60, 131.51, 130.82, 126.47, 118.00, 116.49, 115.96, 107.25, 53.30, 13.46, 12.15. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3080.59, 2955.20, 2884.12, 1675.42, 1572.80, 1512.71, 1485.63. HRMS: m/z Cacld. $(M + H)^+$ for $C_{22}H_{18}N_4OF_2$: 393.1521 found 393.1427.

3,5-Dimethyl-1-(5-(3-nitrophenyl)-1H-imidazol-2-yl)-1H-pyrazole (3n)

Yellow solid. mp: 202-206°C. ^{1}H NMR (400 MHz, DMSO) δ = 12.79 (s, 1H, N-**H**, D_2O exchangable), 8.58 (t, J = 2.0, 1H, 3-nitrophenyl **H**), 8.24 (d, *J* = 7.6 Hz, 1H, 3-nitrophenyl **H**), 8.05 (dd, *J* = 1.6 Hz, 1H, 3-nitrophenyl **H**), 7.85 (bs, 1H, imidazole **H**), 7.66 (t, *J* = 8.0 Hz, 1H, 3-nitrophenyl **H**), 6.15 (s, 1H, pyrazole C_4-**H**), 2.62 (s, 3H, C**H**$_3$), 2.24 (s, 3H, C**H**$_3$). IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3447.91, 3023.75, 2987.41, 2867.29, 2363.88, 2345.32, 1578.44, 1345.98. HRMS: m/z Cacld. $(M + H)^+$ for $C_{14}H_{13}N_5O_2$: 284.1142 found 284.1158.

2-(3,5-Dimethyl-1H-pyrazol-1-yl)-1-(p-tolyl)ethanone (18)

White fluffy solid. mp: 139-143°C. ^{1}H NMR (400 MHz, DMSO) δ = 7.94 (d, *J* = 8.1 Hz, 1H, 4-methylphenyl C_2-**H**, C_6-**H**), 7.39 (d, *J* = 7.9 Hz, 1H, 4-methylphenyl C_3-**H**, C_5-**H**), 5.86 (s, 1H, pyrazole C_4-**H**), 5.63 (s, 2H, C**H**$_2$), 2.41 (s, 3H, C**H**$_3$), 2.09 (s, 3H, C**H**$_3$), 2.08 (s, 3H, C**H**$_3$). ^{13}C NMR (100 MHz, DMSO) δ = 193.81, 146.52, 144.90, 140.43, 132.58, 129.90, 128.68, 105.32, 55.46, 21.71, 13.75, 10.96. IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3037.89, 2922.16, 2850.7, 1685.89, 1685.89, 1554.63, 1454.33. HRMS: m/z Cacld. $(M + H)^+$ for $C_{14}H_{16}N_2O$: 229.1335 found 229.1348.

2-(2-(3,5-Dimethyl-1H-pyrazol-1-yl)-4-(p-tolyl)-1H-imidazol-1-yl)-1-(p-tolyl)ethanone(4i) and 2-(3,5-dimethyl-1H-pyrazol-1-yl)-1-(p-tolyl)ethanone (18):-

White solid. ^{1}H NMR (400 MHz, DMSO) δ = 7.94 (d, *J* = 8.0 Hz, 2H), 7.86 (d, *J* = 6.0 Hz, 0.33H), 7.67 (s, 0.13H), 7.64 (d, *J* = 4.8 Hz, 0.26H), 7.39 (d, *J* = 7.6 Hz, 2H), 7.36 (s, 0.22H), 7.21 (d, *J* = 7.6 Hz, 0.32H), 6.01 (s, 0.15H), 5.86 (s, 1H), 5.65 (s, 0.28H), 5.63 (s, 2H), 2.41 (s, 3H), 2.36 (s, 0.53H), 2.32 (s, 0.67H), 2.09 (s, 6H), 1.95 (s, 0.42H). (Due to very small proportion of compound 4i in the mixture NMR instrument (400 MHz) did not sense its carbons, consequently ^{13}C NMR of the mixture is similar to ^{13}C NMR of compound 18). IR (KBr, $\boldsymbol{\nu}_{max}$/cm^{-1}): 3037.89, 2981.95, 2922.16, 2850.79, 1685.89, 1554.63, 1487.12, 1454.33, 1354.03, 1234.44, 1186.22, 981.77, 815.59, 777.31. HRMS: m/z Cacld. $(M + H)^{+}$ for $C_{24}H_{24}N_4O$ and $C_{14}H_{16}N_2O$: 385.2023; 229.1335 found 385.2022 and 229.1348.

X-ray single crystal data for compound 4b

Table 2 Crystallographic data of 2-(2-(1H-pyrazol-1-yl)-4-(p-tolyl)-1H-imidazol-1-yl)-1-(p-tolyl)ethanone (**4b**)

Formula	$C_{22}H_{20}N_4O$
Formula weight	356.42
Temperature(K)	293(2)
Radiation MoKα	(λ = 0.71073)
Crystal system	Orthorhombic
Space group	$P2_12_12_1$
a [A]	5.9889(2)
b [A]	12.3150(4)
c [A]	25.5355(11)
alpha [°]	90
beta [°]	90
gamma [°]	90
V [A^3]	1883.33(12)
Z	4
D (calc) [g/cm^3]	1.257
F (000)	752.0
2 Θ range for data collection min-max [°]	6.382 to 54.874

Table 3. Selected bond distances and bond angles of molecule 4b.

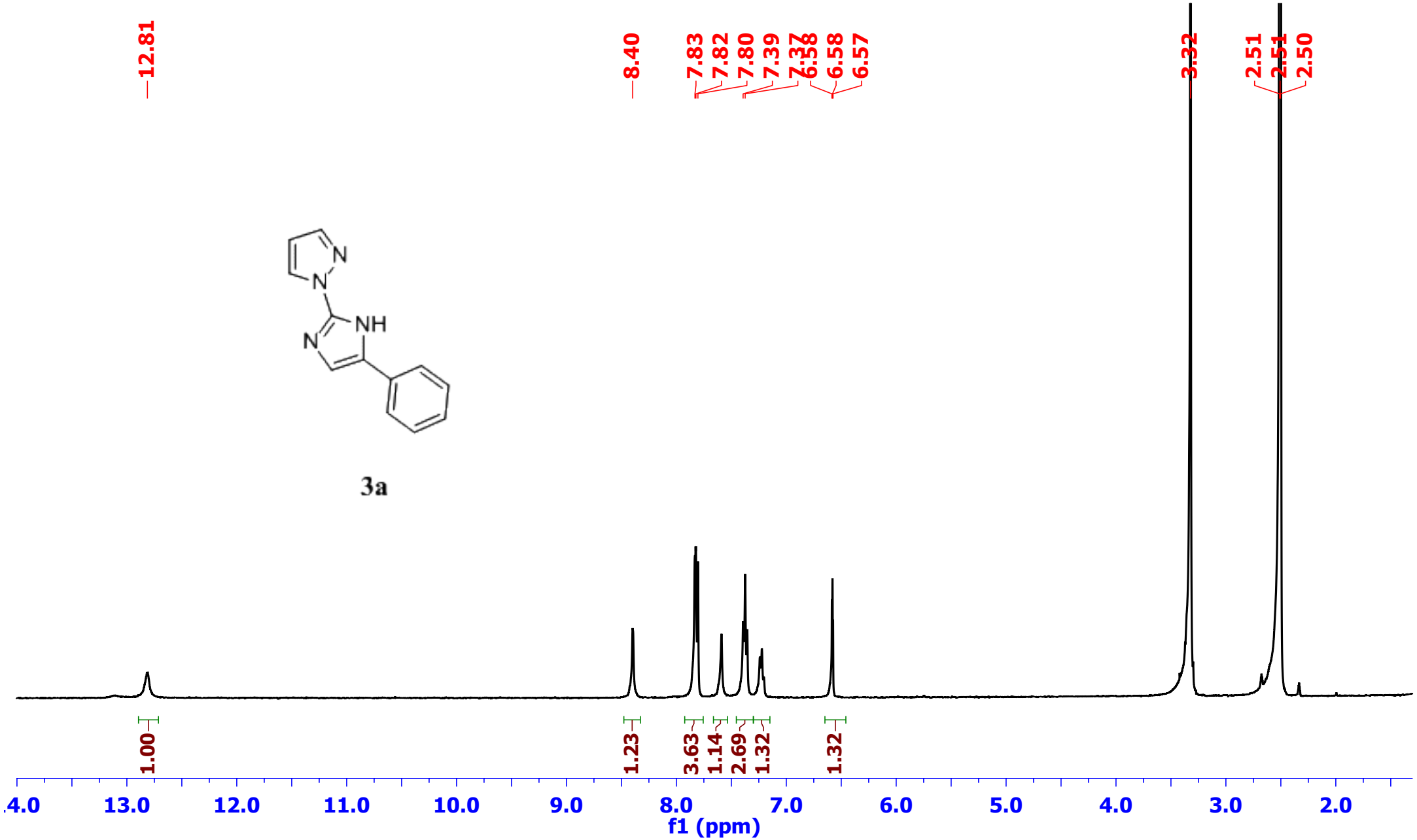
O8 C7	1.205(3)	C4 C5	1.381(4)	N22 N26	1.363(3)
C4 C3	1.392(4)	N22 C17	1.401 (3)	C4 C10	1.509(4)
N22 C23	1.363(3)	C2 C3	1.375(4)	N18 C17	1.297(3)
C11 C19	1.459(4)	N18 C19	1.391(3)	C11 C12	1.391(4)
N21 C17	1.356(3)	C11 C16	1.387(4)	N21 C9	1.454(3)
C19 C20	1.357(4)	N21 C20	1.368(3)	C23 C24	1.353(4)
N26 C25	1.314(4)	C12 C13	1.378(4)	C7 C1	1.480(3)
C14 C13	1.381(4)	C7 C9	1.519(4)	C14 C27	1.508(4)
C1 C6	1.385(4)	C14 C15	1.367(4)	C1 C2	1.383(3)
C24 C25	1.386(5)	C6 C5	1.374(3)	C16 C15	1.369(4)
N26 N22 C17	123.2(2)	C3 C2 C1	120.8(3)	C23 N22 N26	112.3(3)
C6 C5 C4	121.1(3)	C17 N18 C19	104.6(2)	C16 C11 C19	122.2(3)
C1 N21 C9	129.7(2)	C17 N21 C9	129.7(2)	C16 C11 C12	116.4(3)
N18 C19 C11	121.1(2)	C20 C19 N18	109.0(3)	C25 N26 N22	103.1(3)
C20 C19 C11	129.9(3)	O8 C7 C1	122.0(2)	N21 C9 C7	110.6(2)
O8 C7 C9	120.2(3)	C19 C20 N21	107.6(2)	C1 C7 C9	117.8(2)
C24 C23 N22	106.1(3)	C6 C1 C7	122.2(2)	C2 C3 C4	121.0(3)

C2 C1 C7	119.5(2)	C13 C12 C11	120.8(3)	C2 C1 C6	118.3(2)
C13 C14 C27	120.7(3)	N18 C17 N22	121.8(2)	C15 C14 C13	116.7(3)
N18 C17 N21	113.9(2)	C15 C14 C27	122.6(3)	N21 C17 N22	124.1(2)
C12 C13 C14	122.2(3)	C5 C6 C1	120.9(2)	C23 C24 C25	105.3(3)
C5 C4 C3	117.9(3)	N26 C25 C24	113.1(3)	C5 C4 C10	121.0(3)
C15 C16 C11	121.9(3)	C3 C4 C10	121.1(3)	C14 C15 C16	122.0(3)

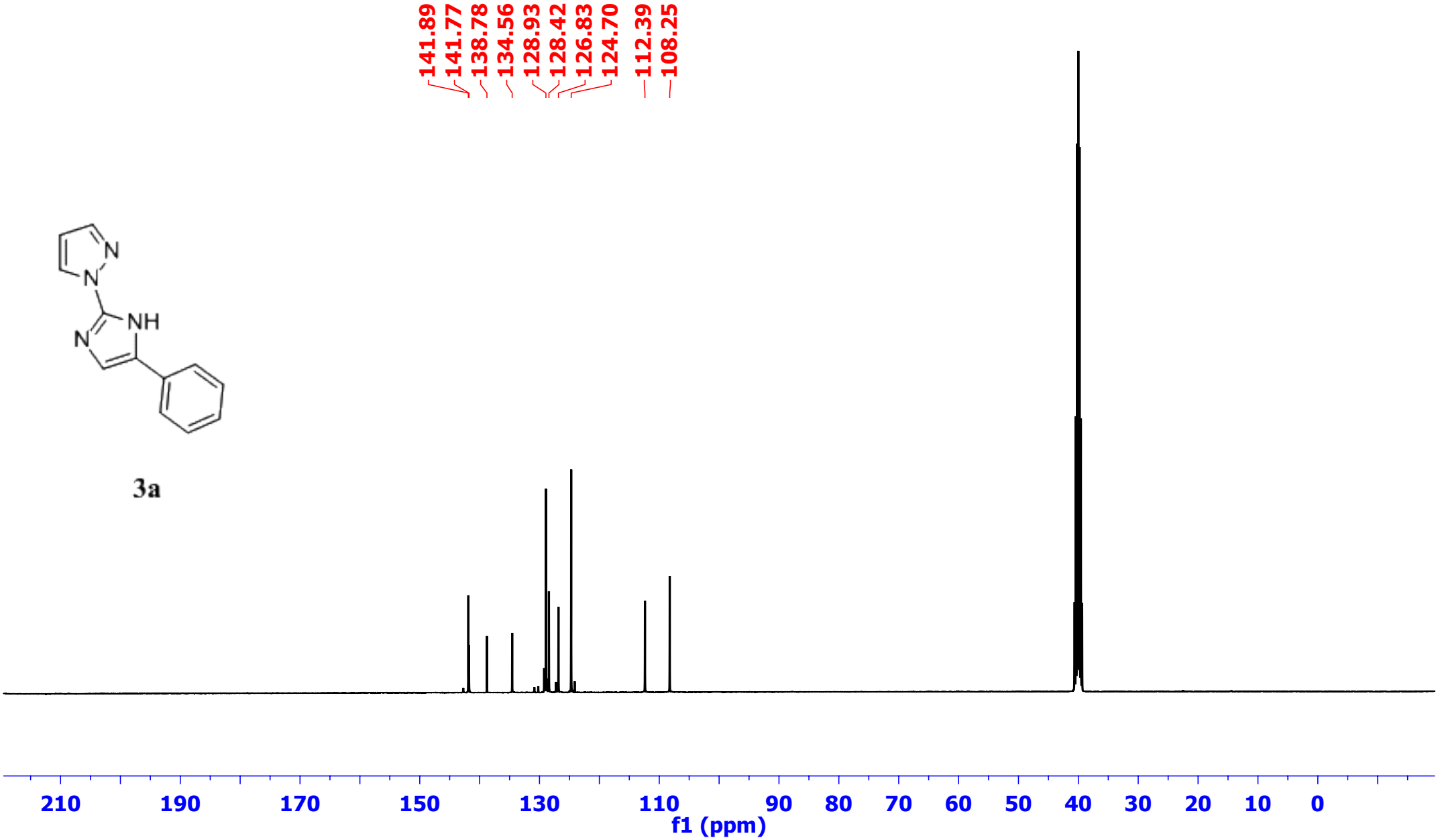
Table 4. Bond angles for molecule 4b.

Atom/Atom/ Atom	**Bond Angle**	**Atom/Atom/ Atom**	**Bond Angle**
N26 N22 C17	123.2(2)	C3 C2 C1	120.8(3)
C23 N22 N26	112.3(3)	C6 C5 C4	121.1(3)
C23 N22 C17	124.5(3)	C12 C11 C19	121.4(3)
C17 N18 C19	104.6(2)	C16 C11 C19	122.2(3)
C17 N21 C9	129.7(2)	C16 C11 C12	116.4(3)
C17 N21 C20	104.9(2)	N18 C19 C11	121.1(2)
C20 N21 C_9	124.1(2)	C20 C19 N18	109.0(3)
C25 N26 N22	103.1(3)	C20 C19 C11	129.9(3)

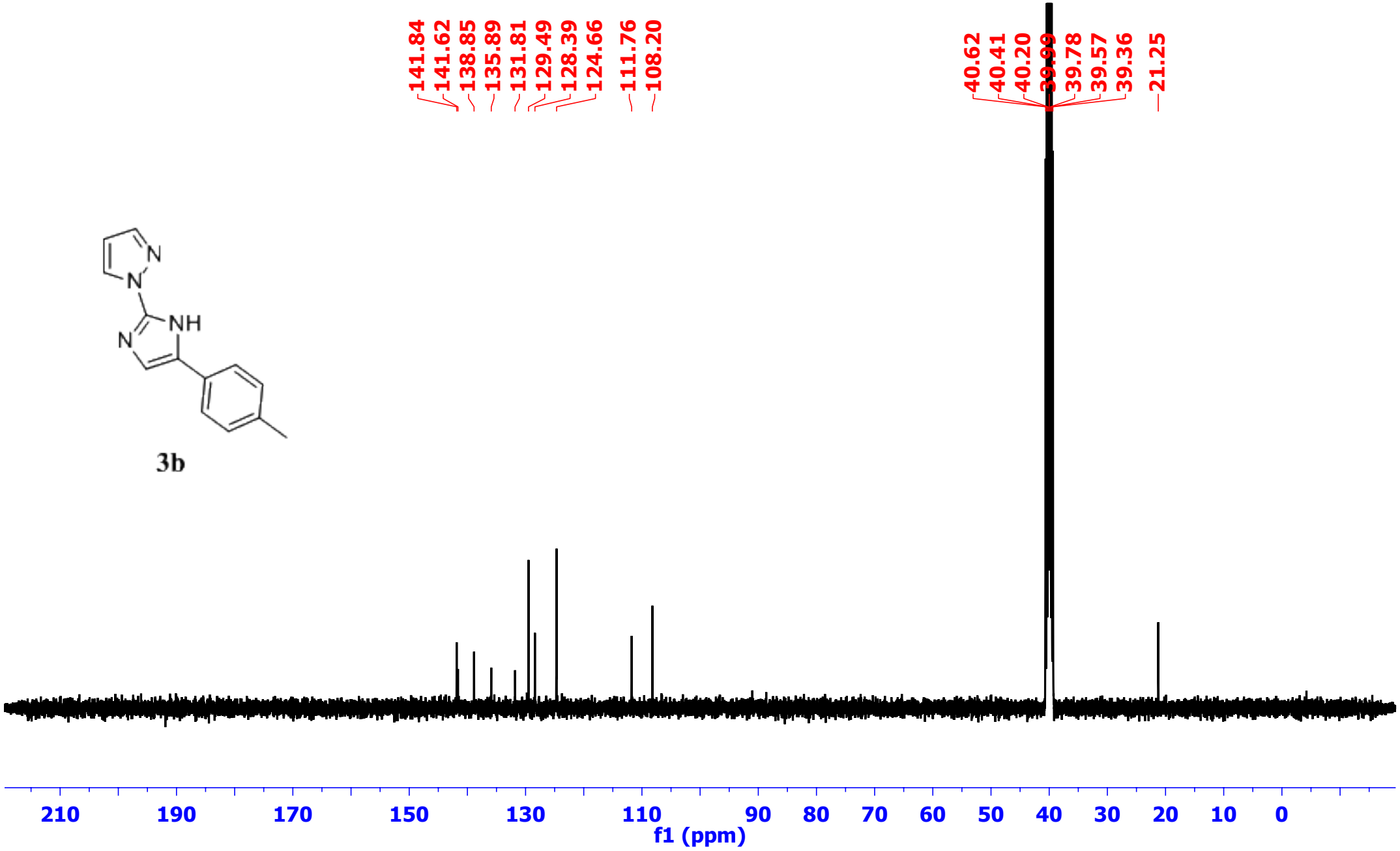
O8 C7 C1	122.0(2)	N21 C9 C7	110.6(2)
O8 C7 C9	120.2(3)	C19 C20 N21	107.6(2)
C1 C7 C9	117.8(2)	C24 C23 N22	106.1(3)
C6 C1 C7	122.2(2)	C2 C3 C4	121.0(3)
C2 C1 C7	119.5(2)	C13 C12 C11	120.8(3)
C2 C1 C6	118.3(2)	C13 C14 C27	120.7(3)
N18 C17 N22	121.8(2)	C15 C14 C13	116.7(3)
N18 C17 N21	113.9(2)	C15 C14 C27	122.6(3)
N21 C17 N22	124.1(2)	C12 C13 C14	122.2(3)
C5 C6 C1	120.9(2)	C23 C24 C25	105.3(3)
C5 C4 C3	117.9(3)	N26 C25 C24	113.1(3)
C5 C4 C10	121.0(3)	C15 C16 C11	121.9(3)
C3 C4 C10	121.1(3)	C14 C15 C16	122.0(3)



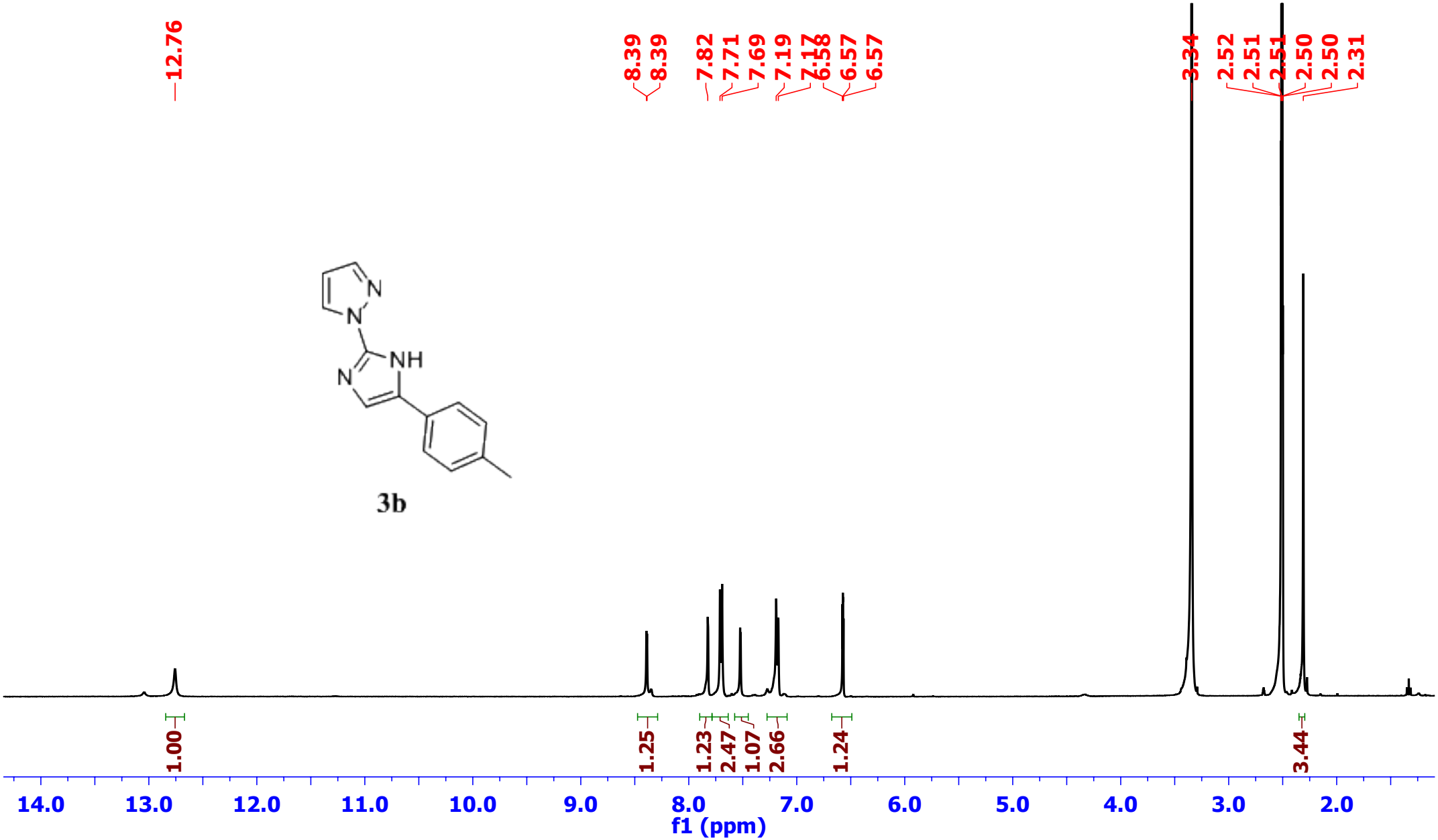
[1]H NMR of compound 3a in DMSO



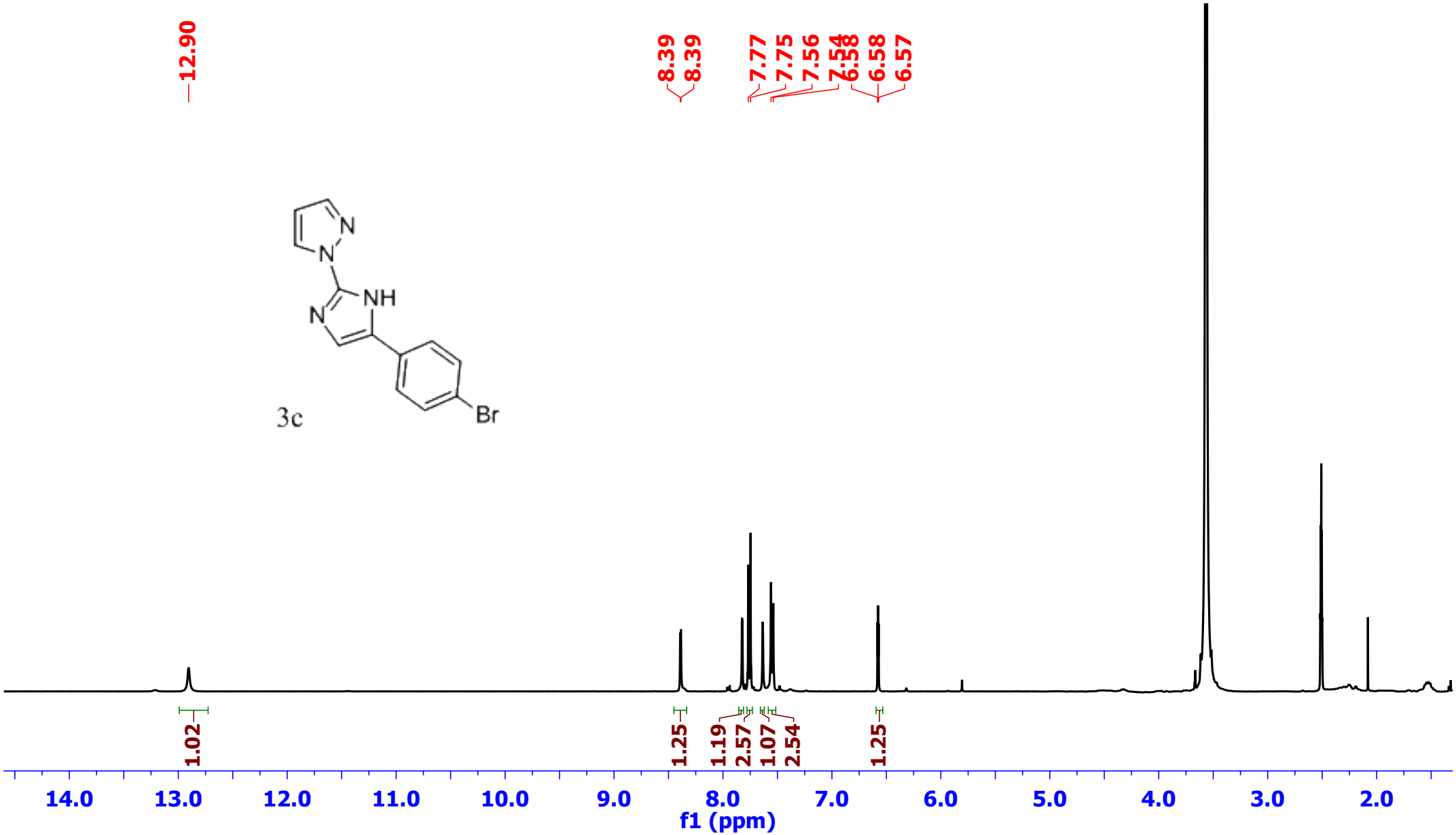
^{13}C NMR of compound 3a in DMSO



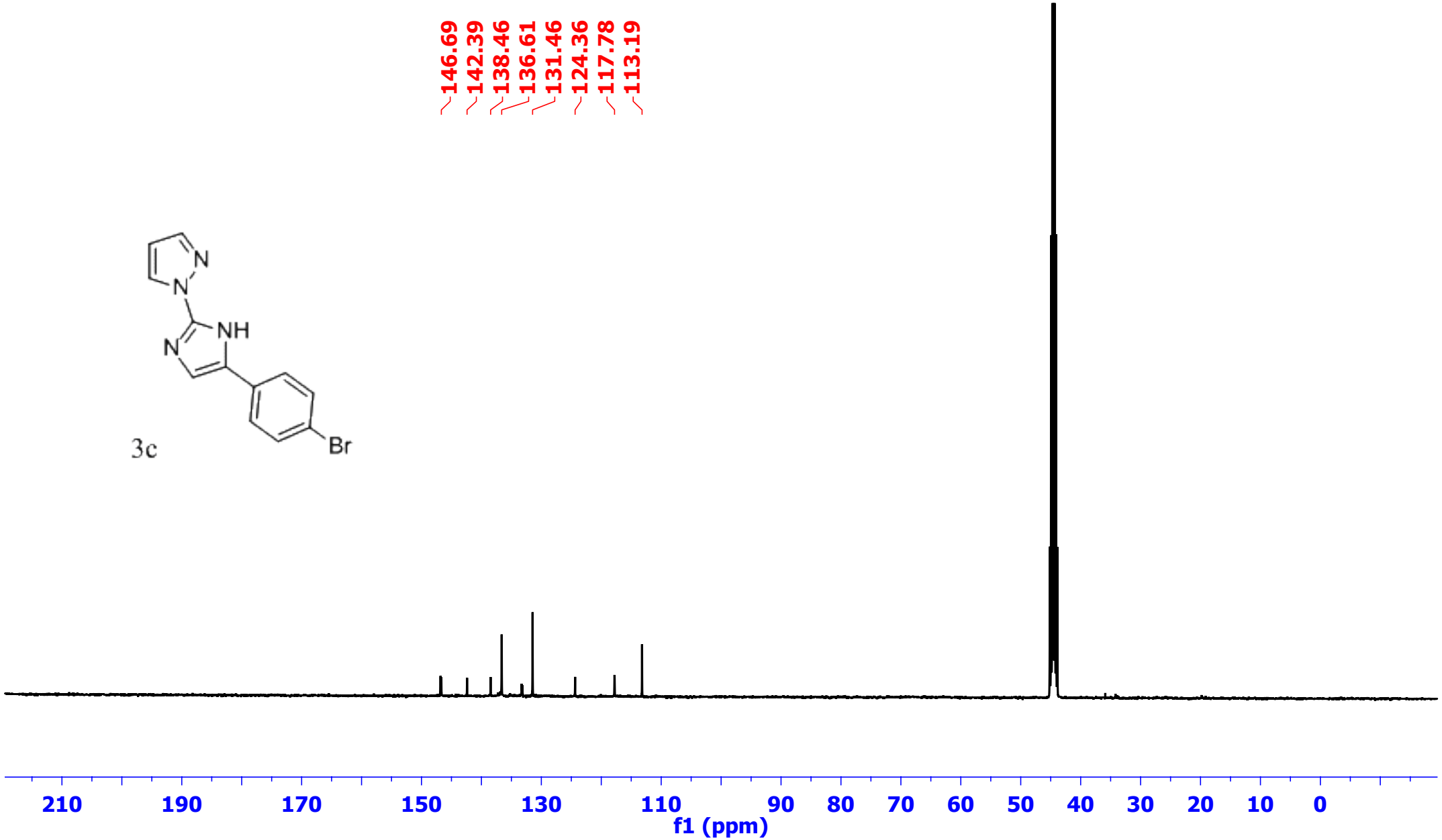
^{13}C NMR of compound 3b in DMSO



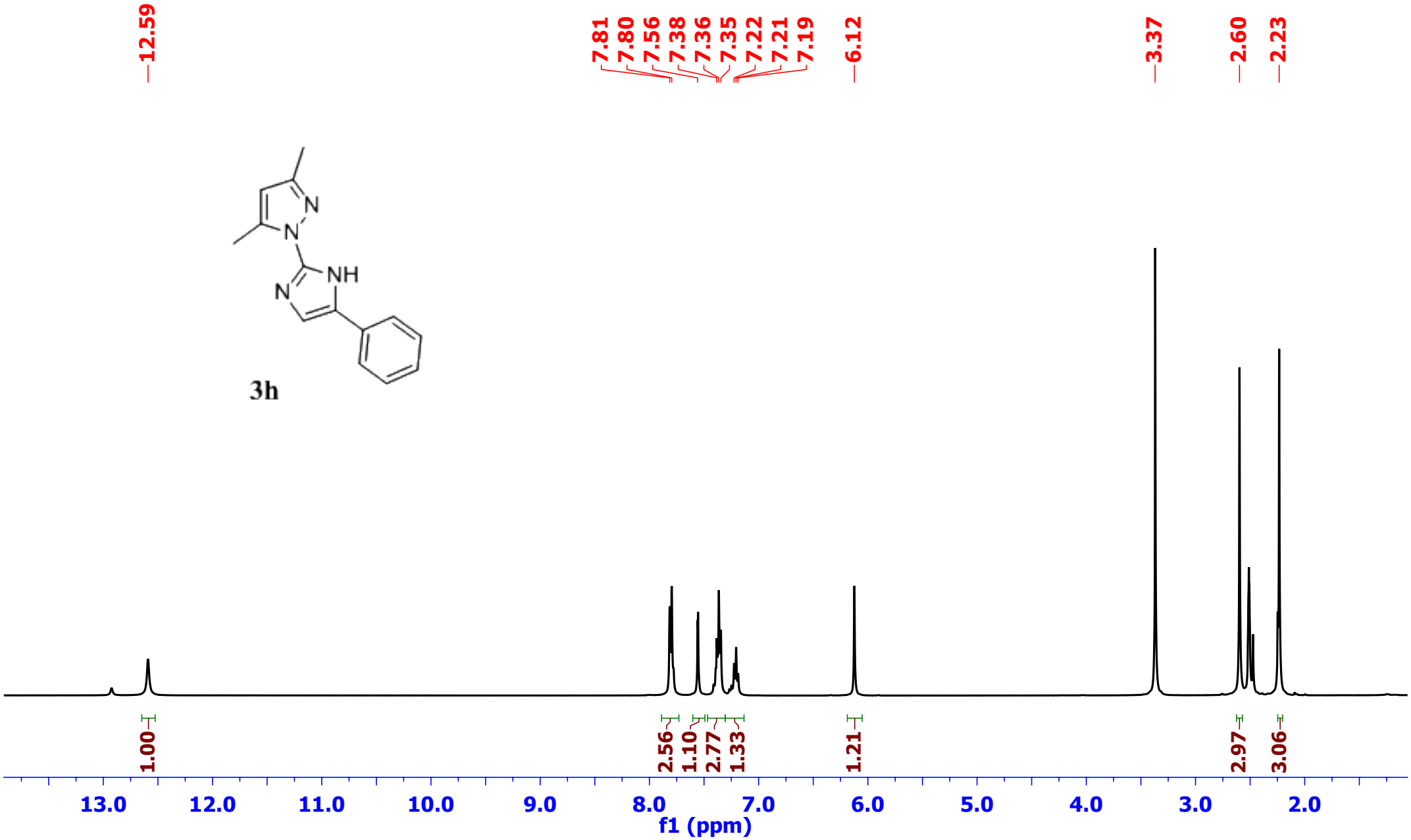
^{1}H NMR of compound 3b in DMSO



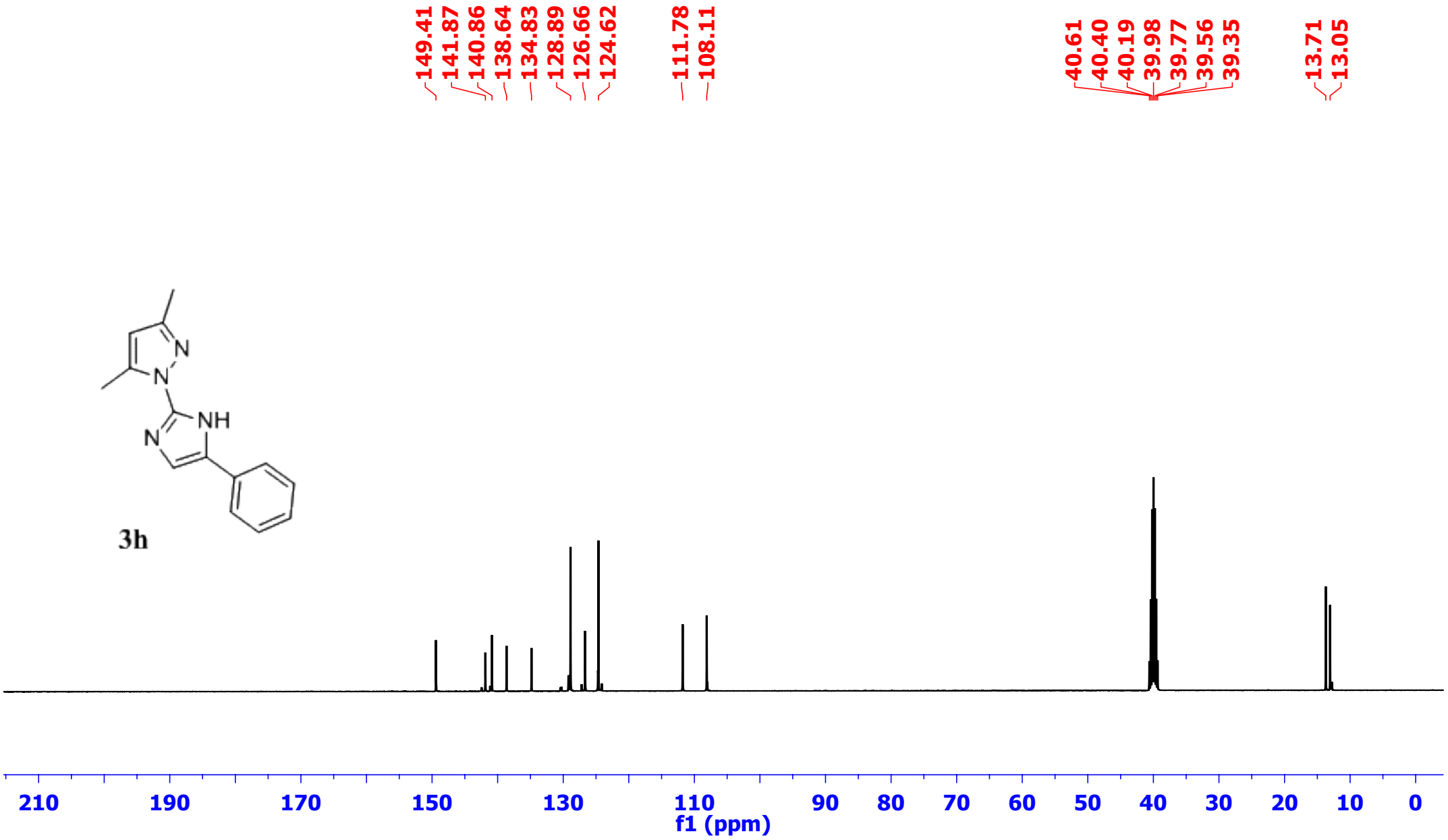
^{1}H NMR of compound 3c in DMSO



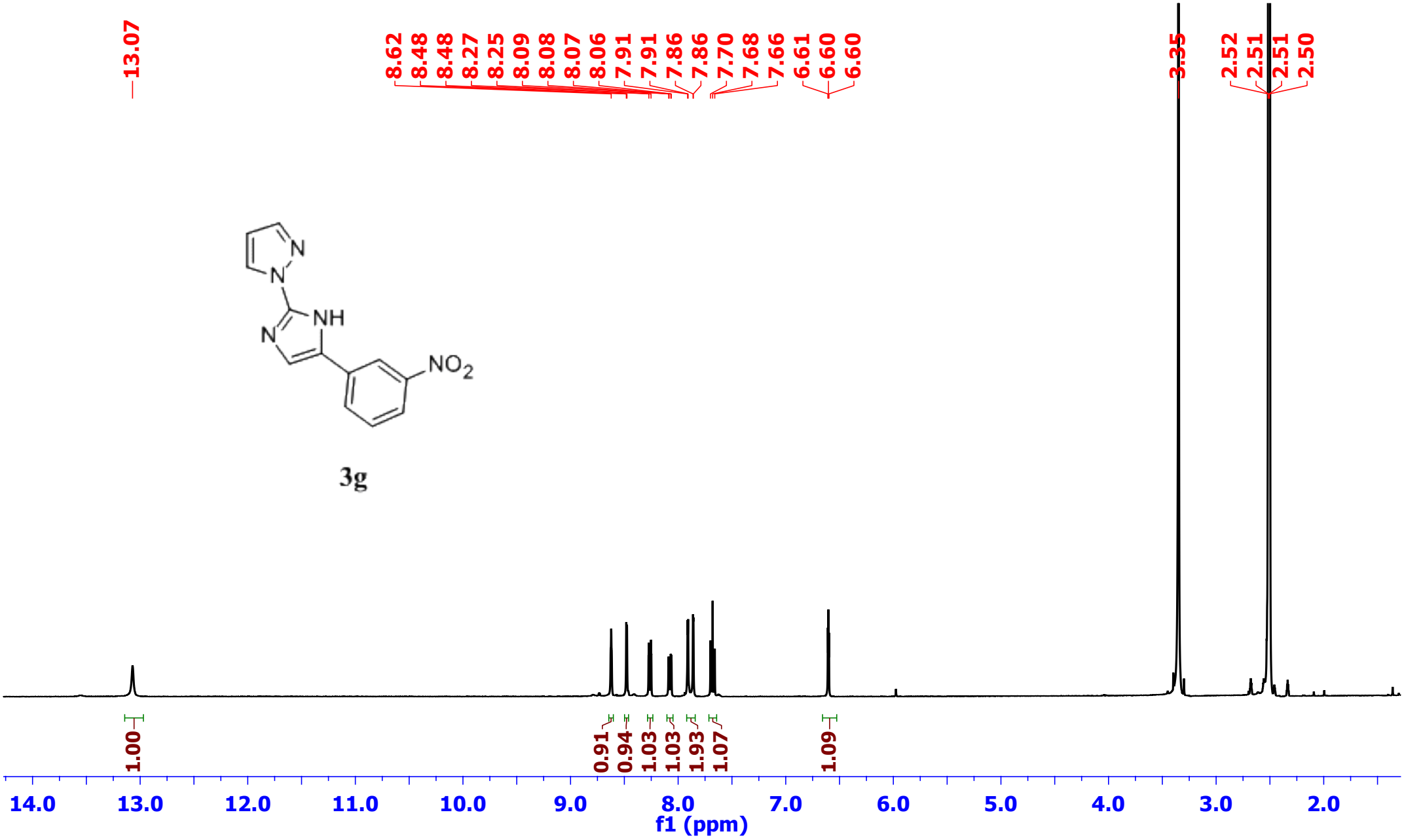
^{13}C NMR of compound 3c in DMSO



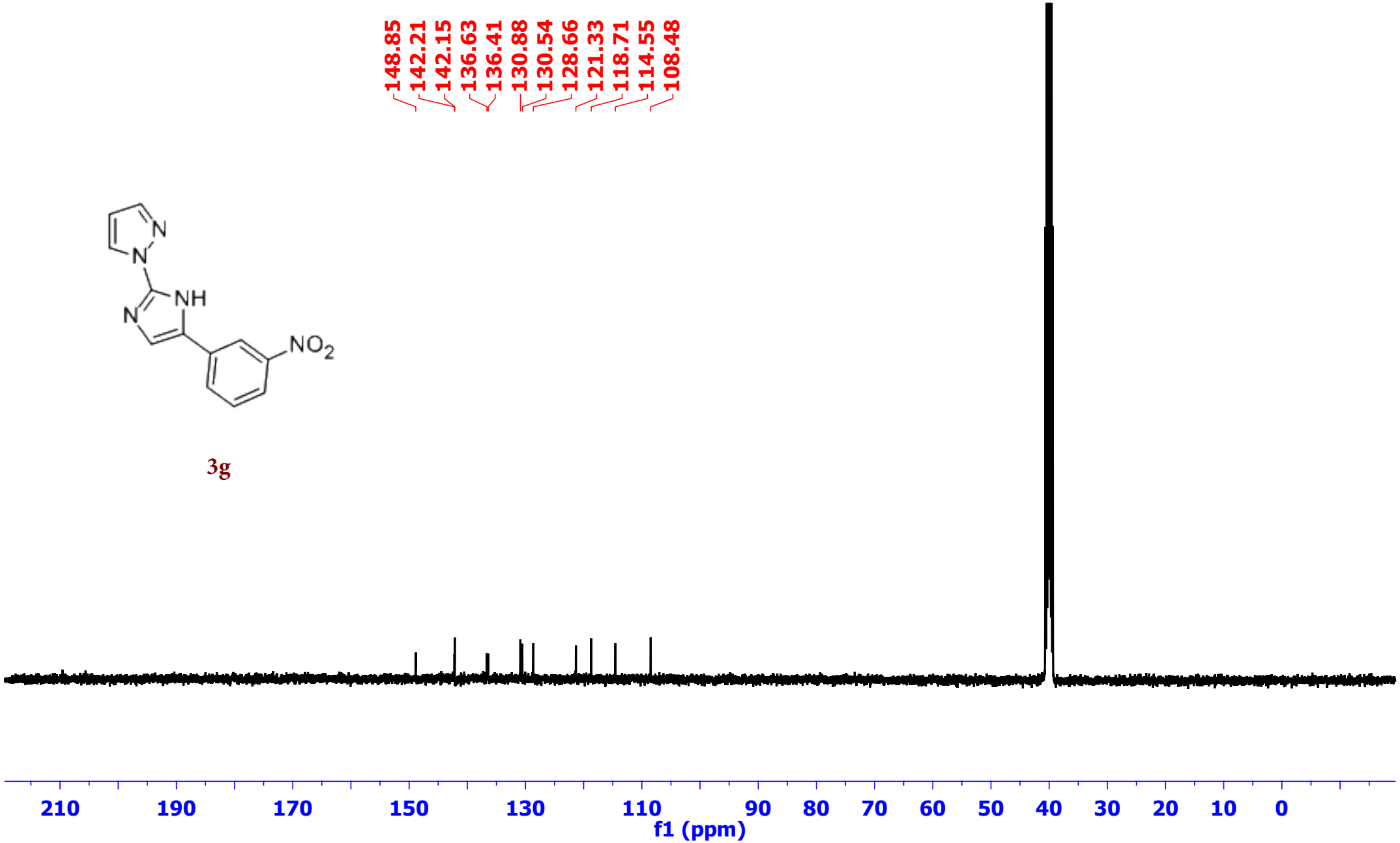
^{1}H NMR of compound 3h in DMSO



^{13}C NMR of compound 3h in DMSO

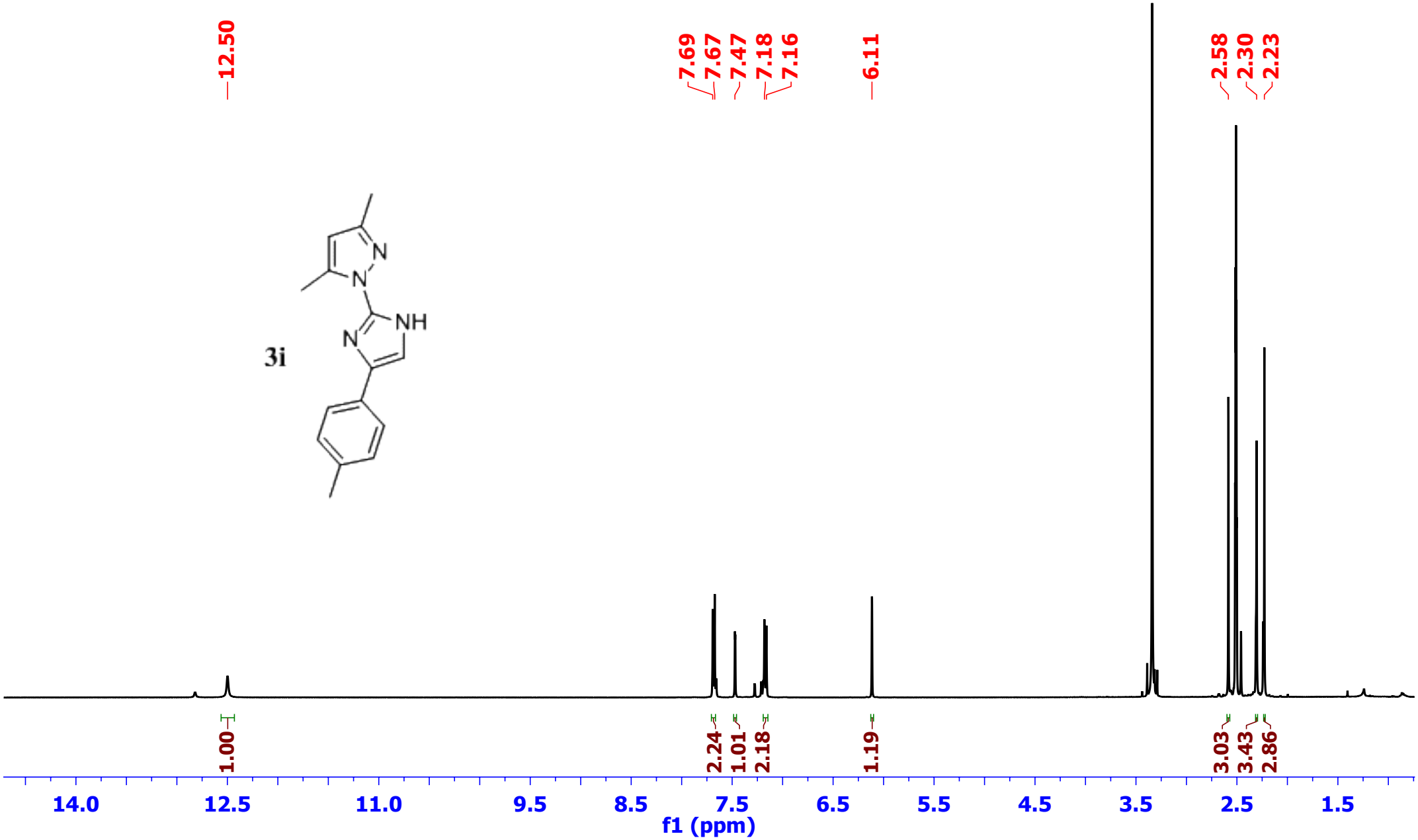


^{1}H NMR of compound 3g in DMSO

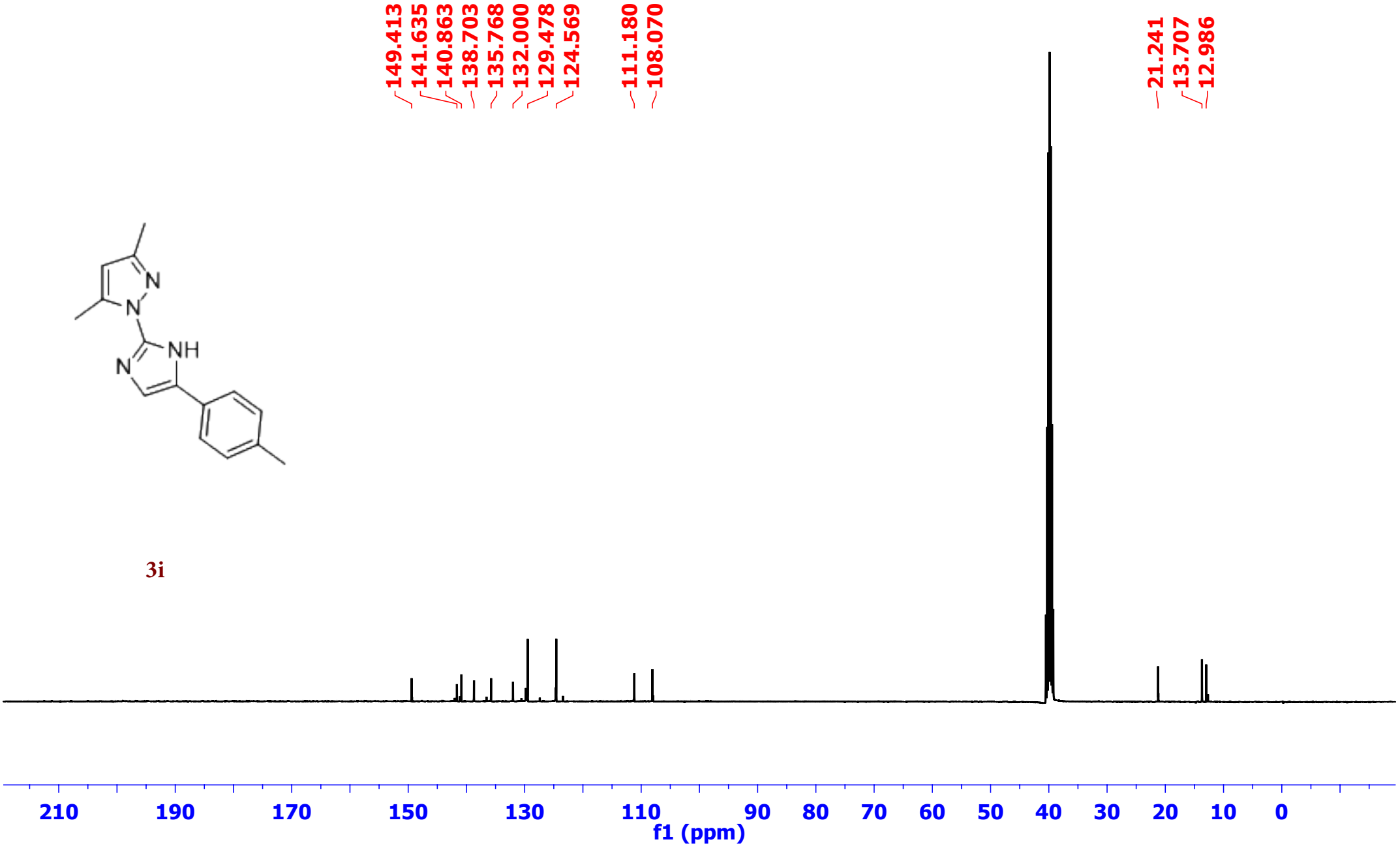


3g

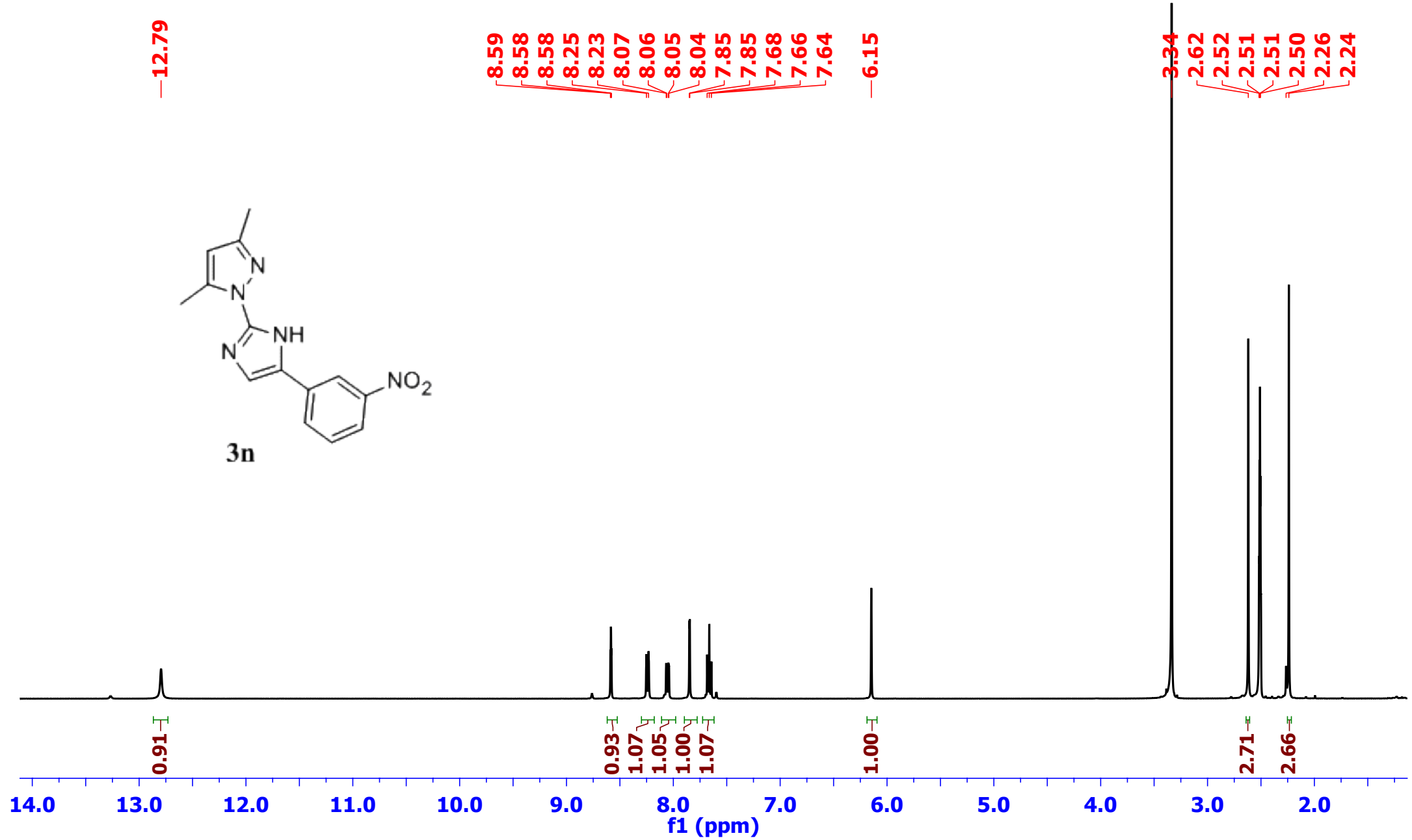
^{13}CNMR of compound 3g in DMSO



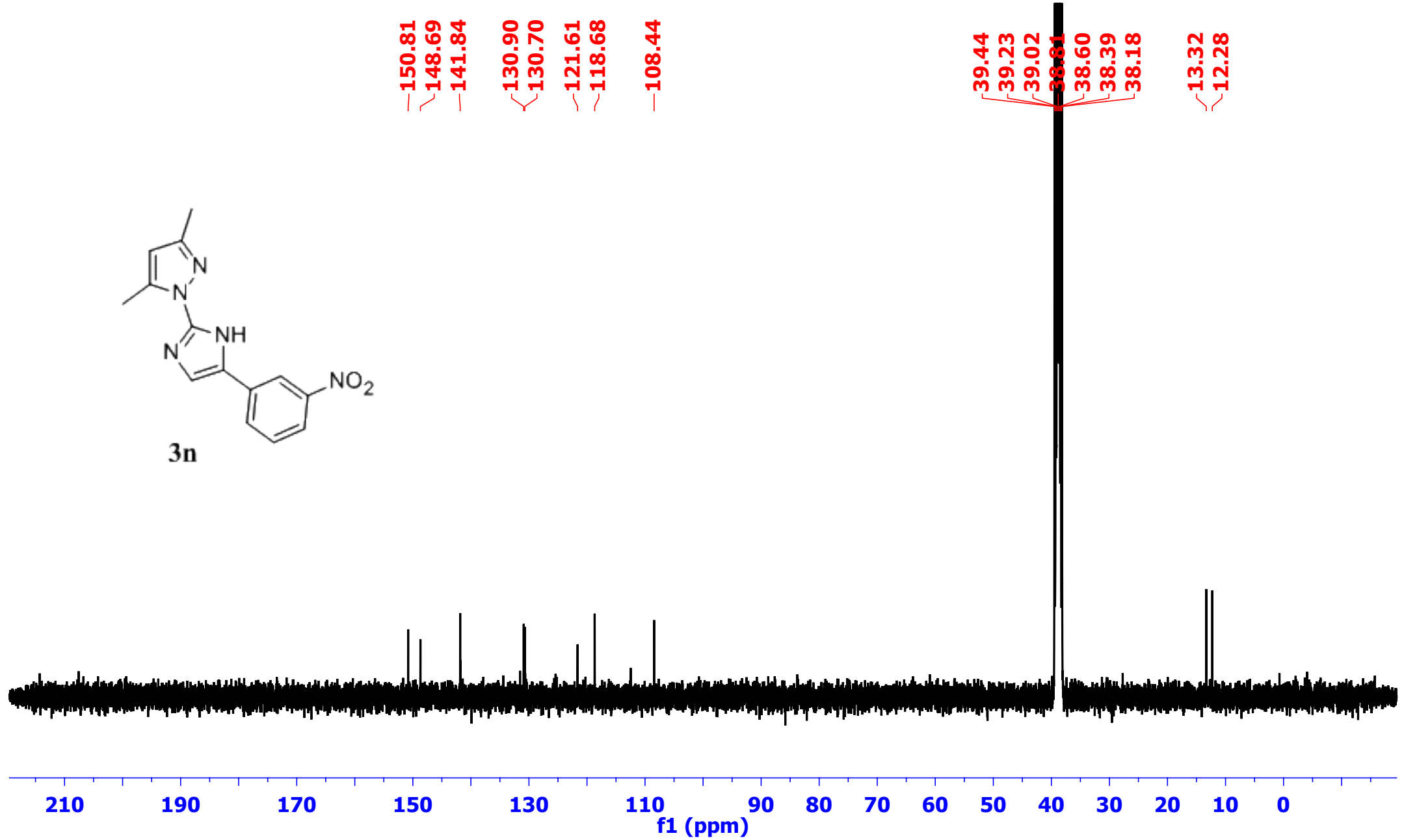
^{1}H NMR of compound 3i in DMSO



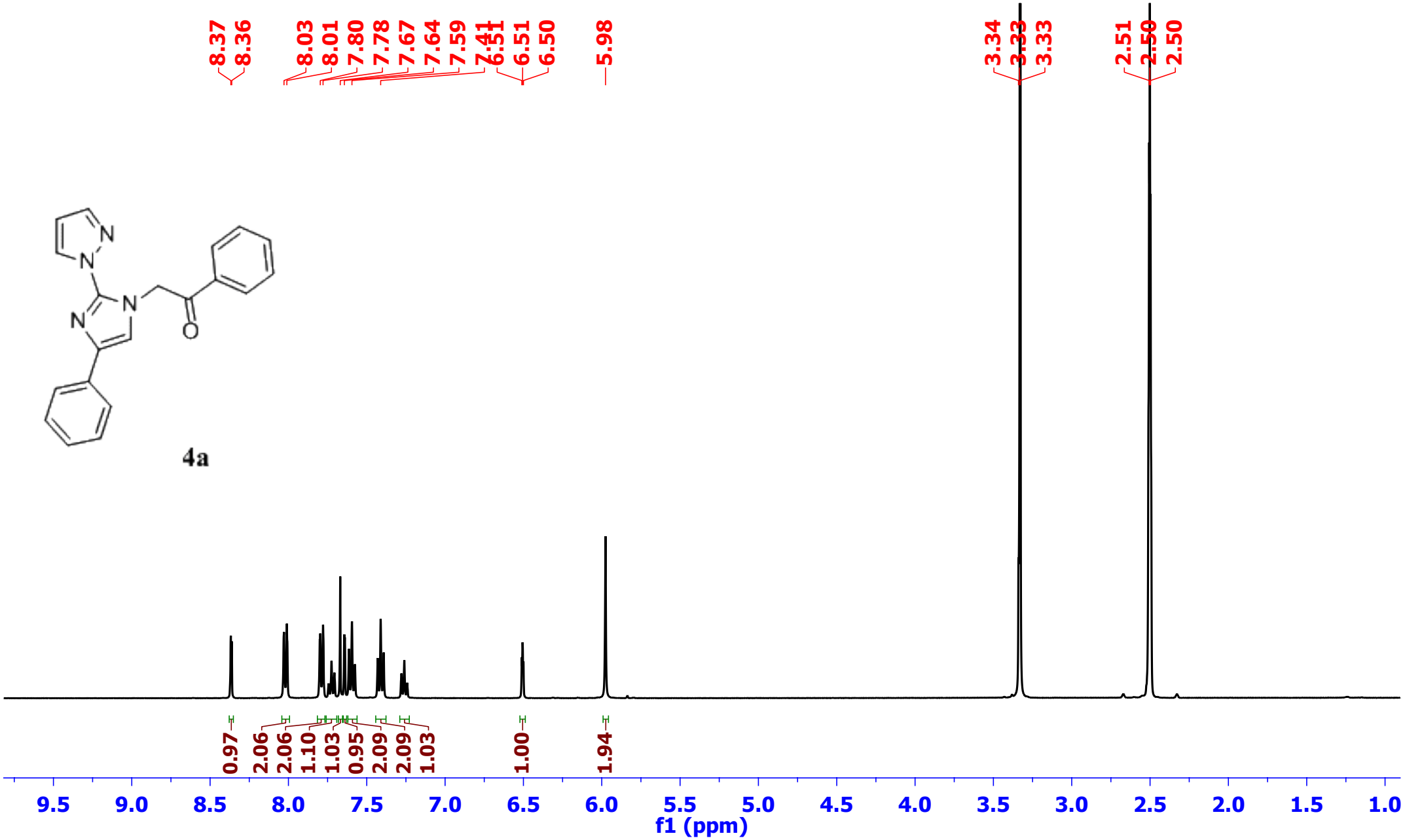
^{13}C NMR of compound 3i



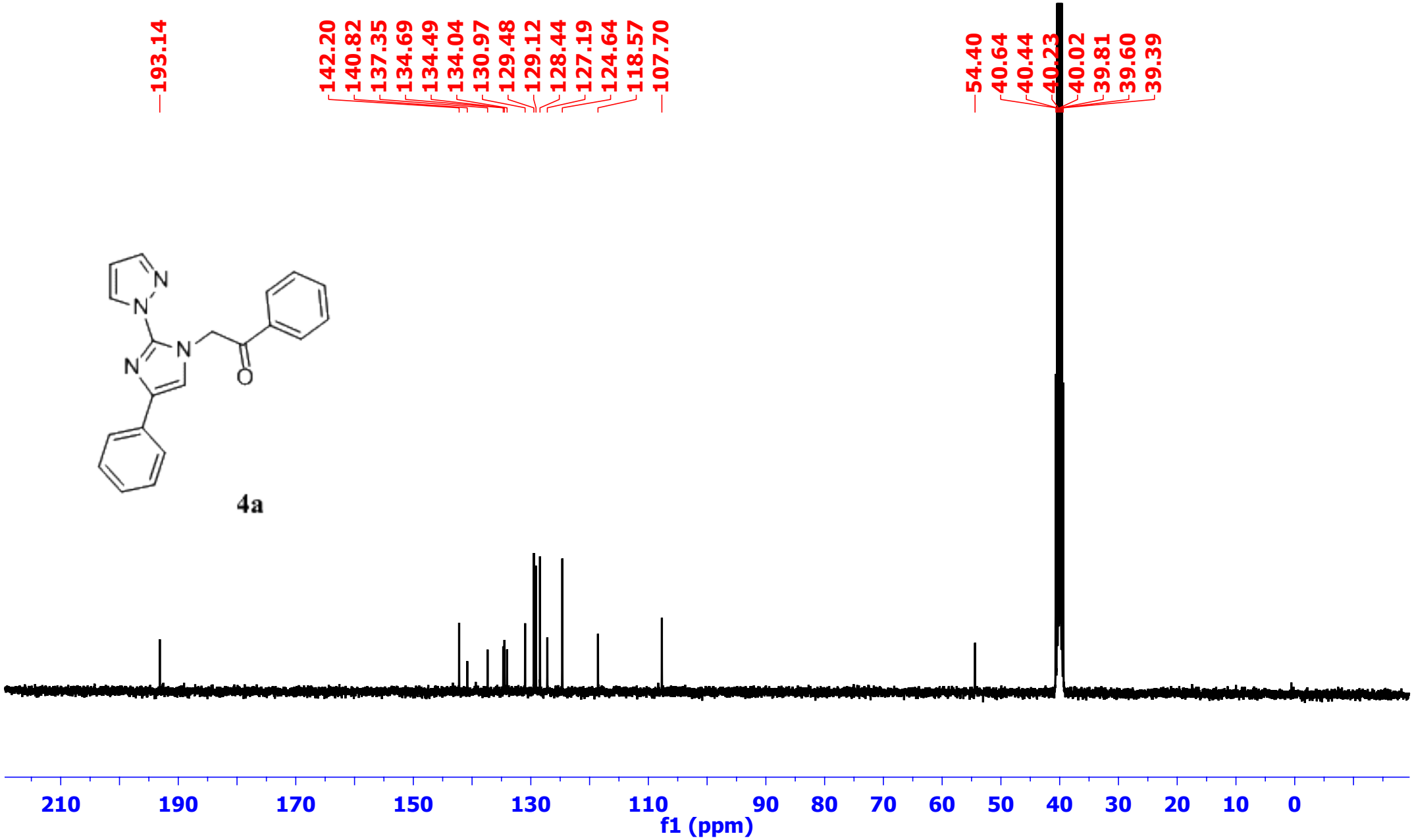
^{1}H NMR of compound 3n in DMSO



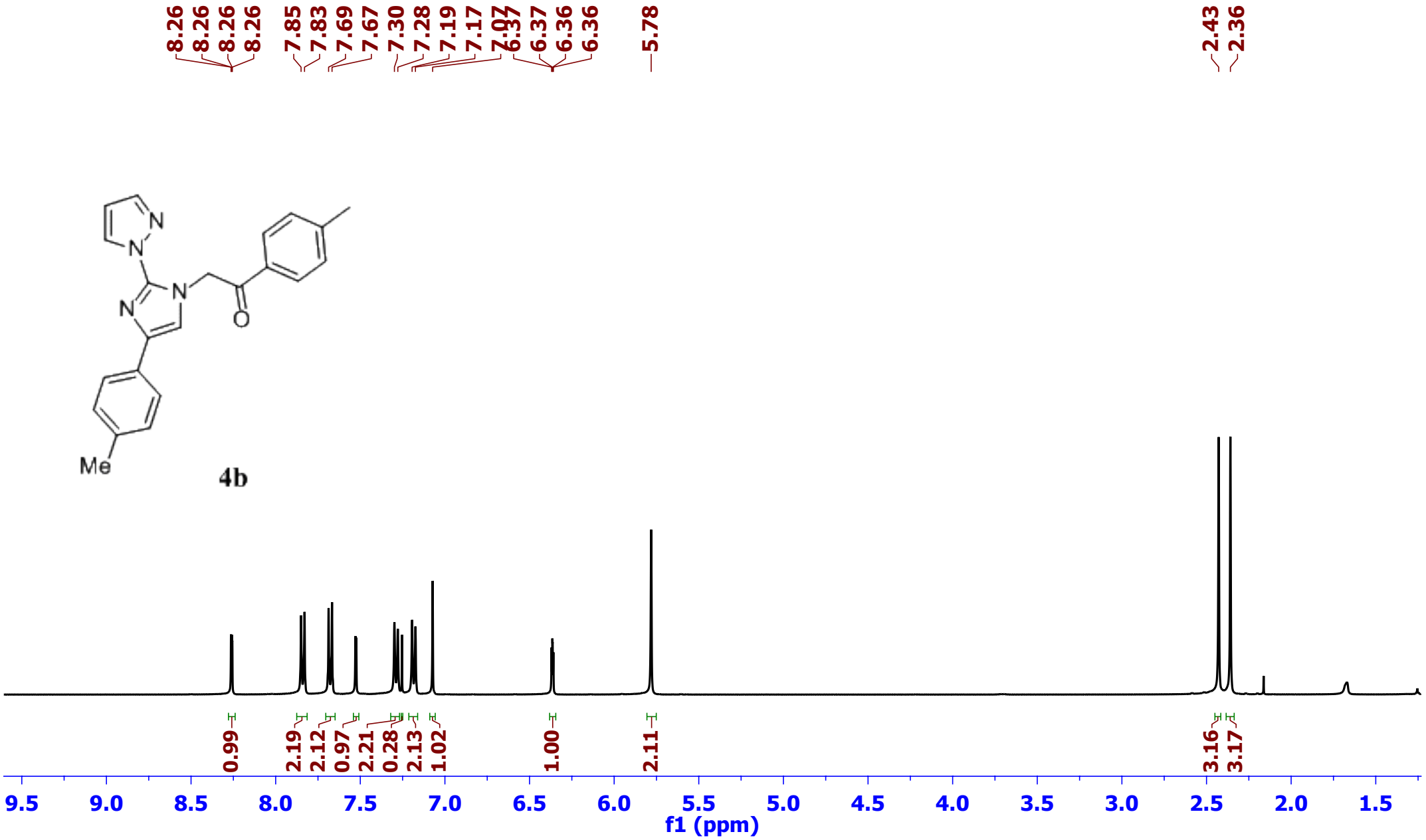
^{13}C NMR of compound 3n in DMSO



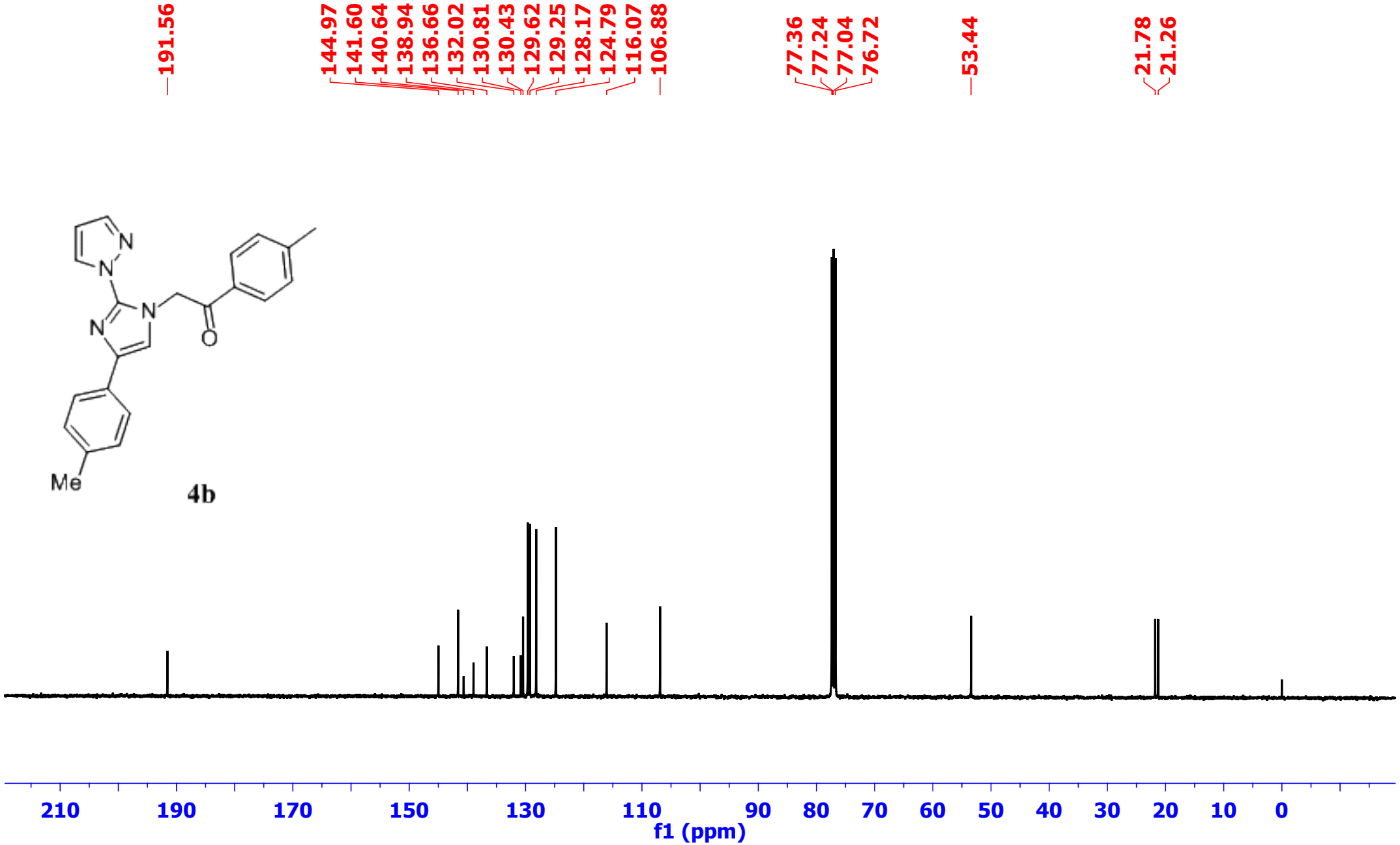
^{1}H NMR of compound 4a in DMSO



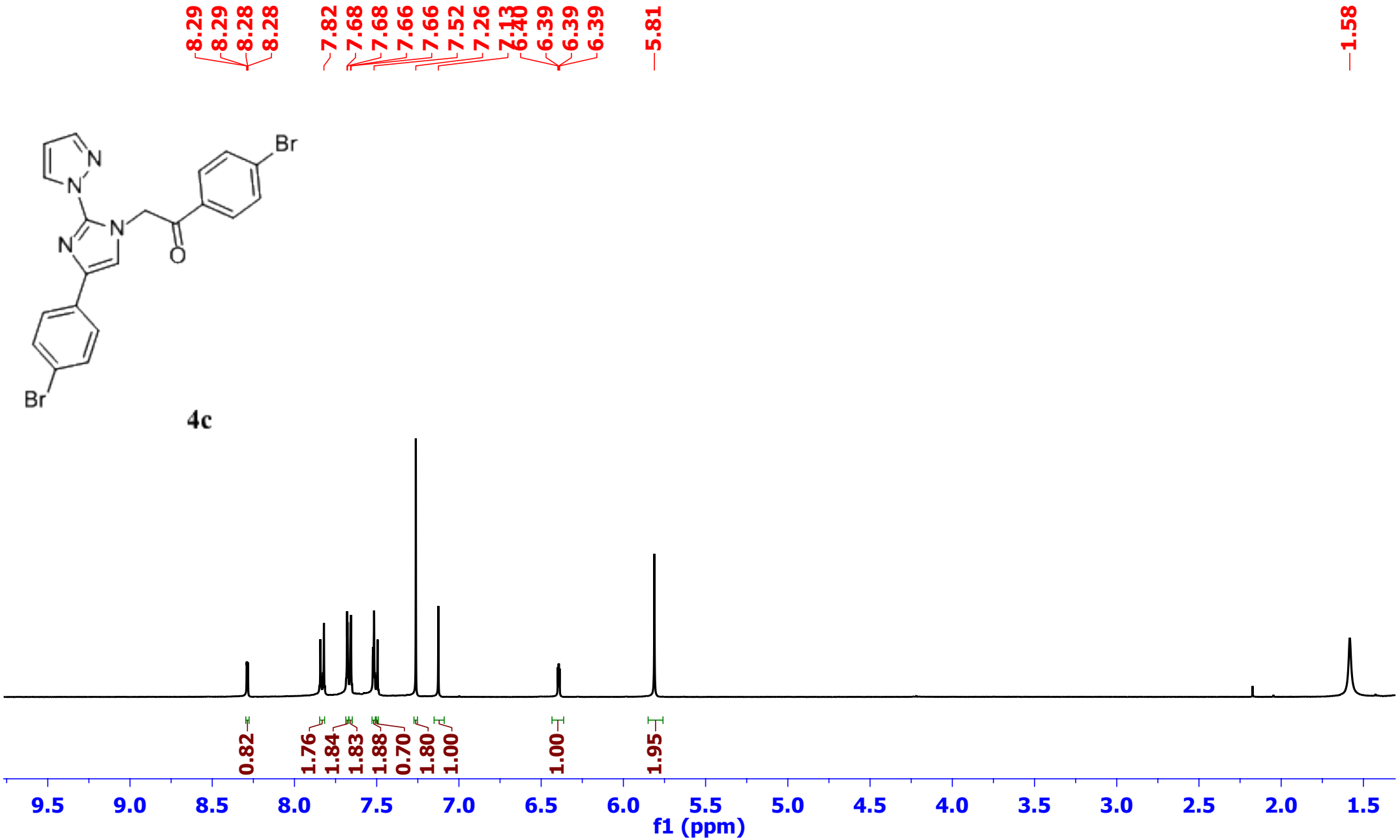
13C NMR of compound 4a in DMSO



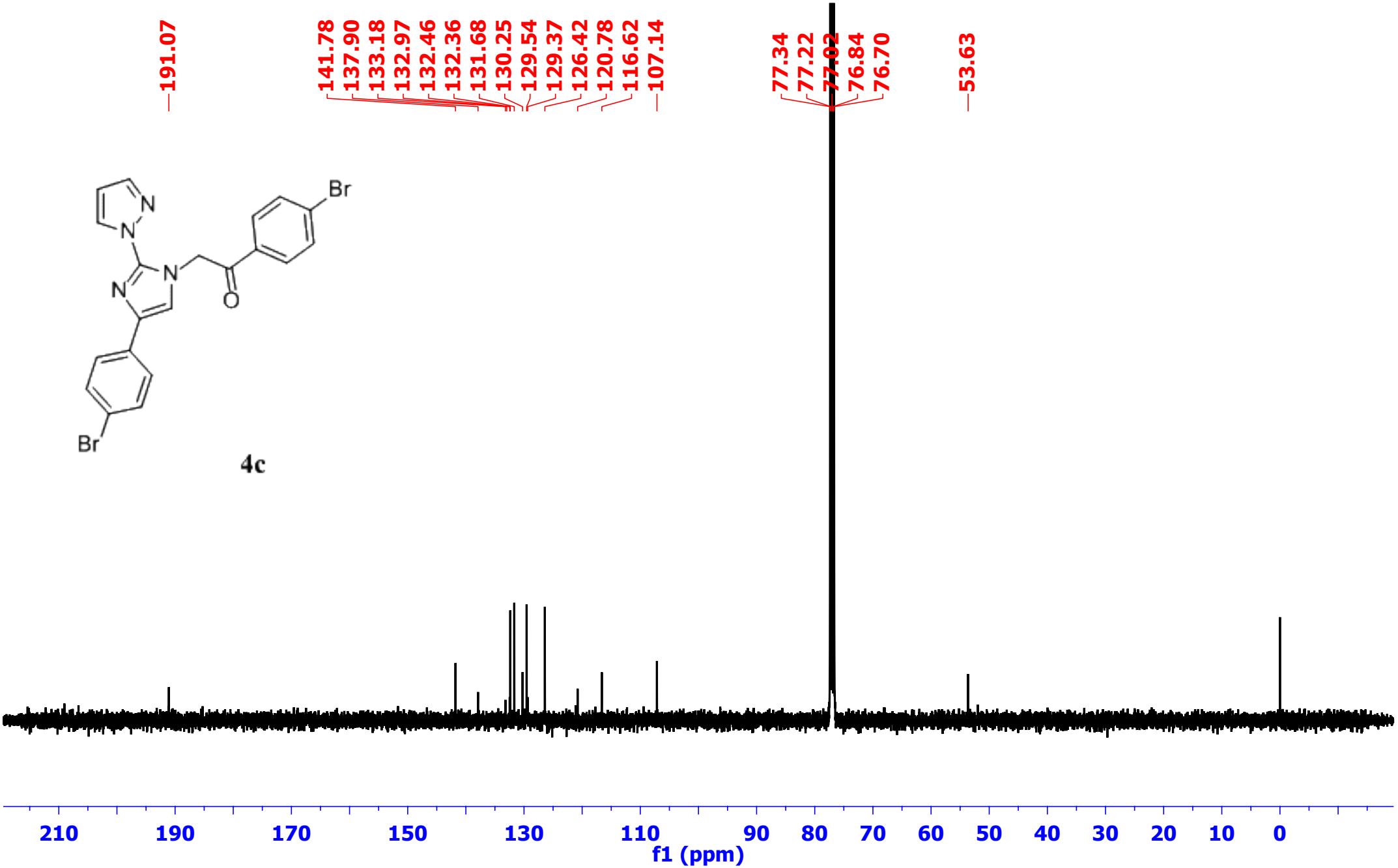
^{1}H NMR of compound 4b in$CDCl_3$



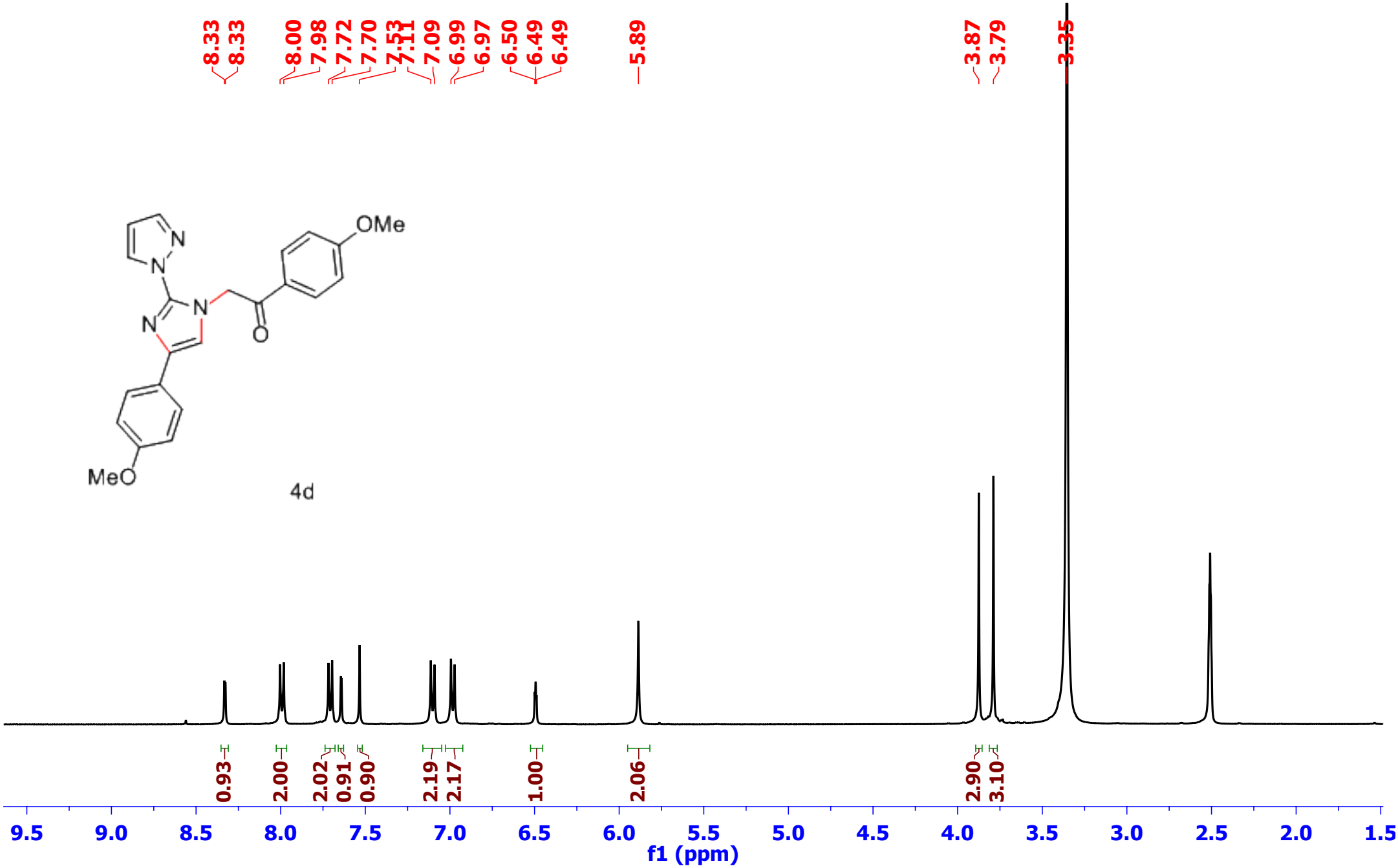
^{13}C NMR of compound 4d in $CDCl_3$



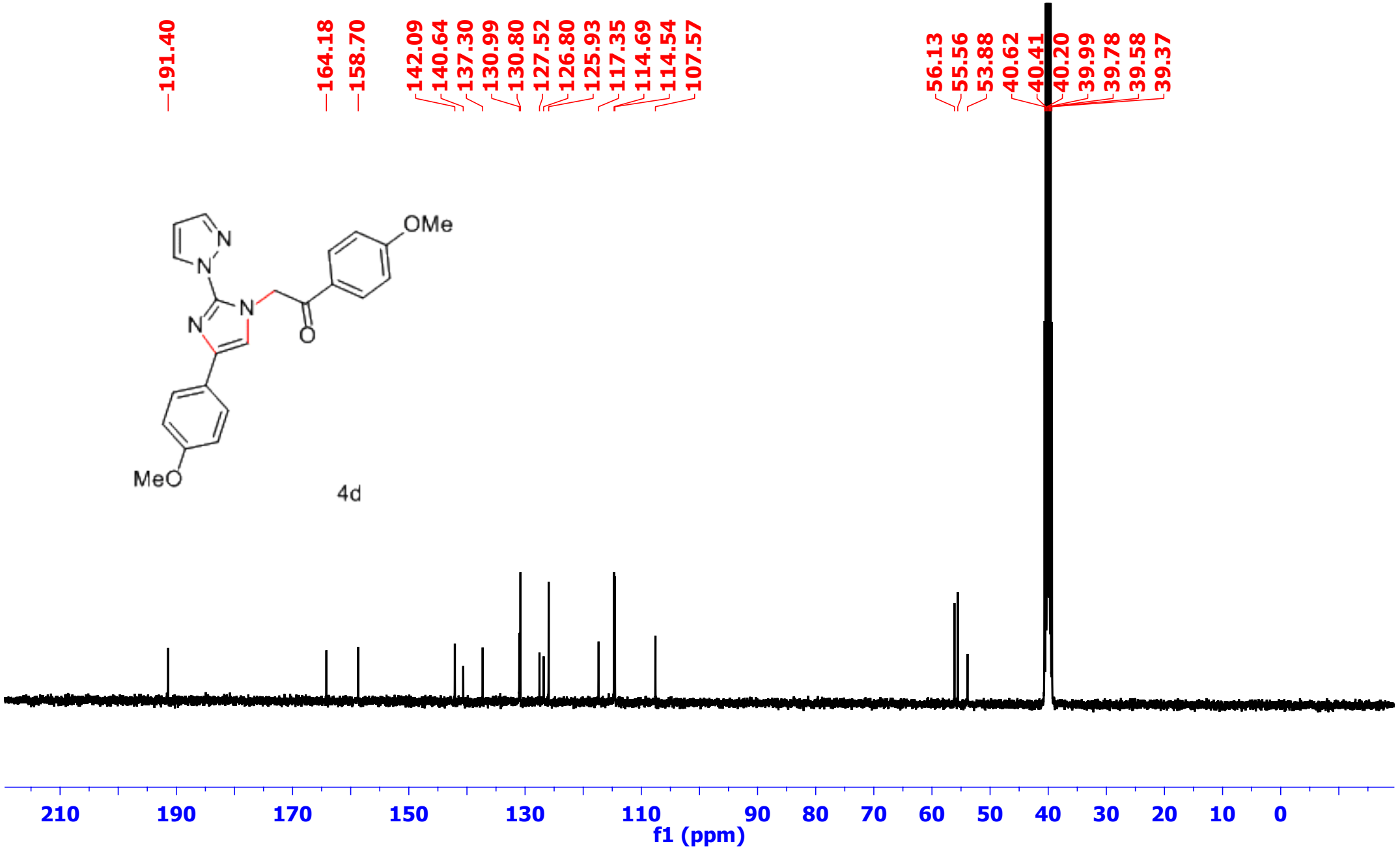
^{1}H NMR of compound 4c in $CDCl_3$



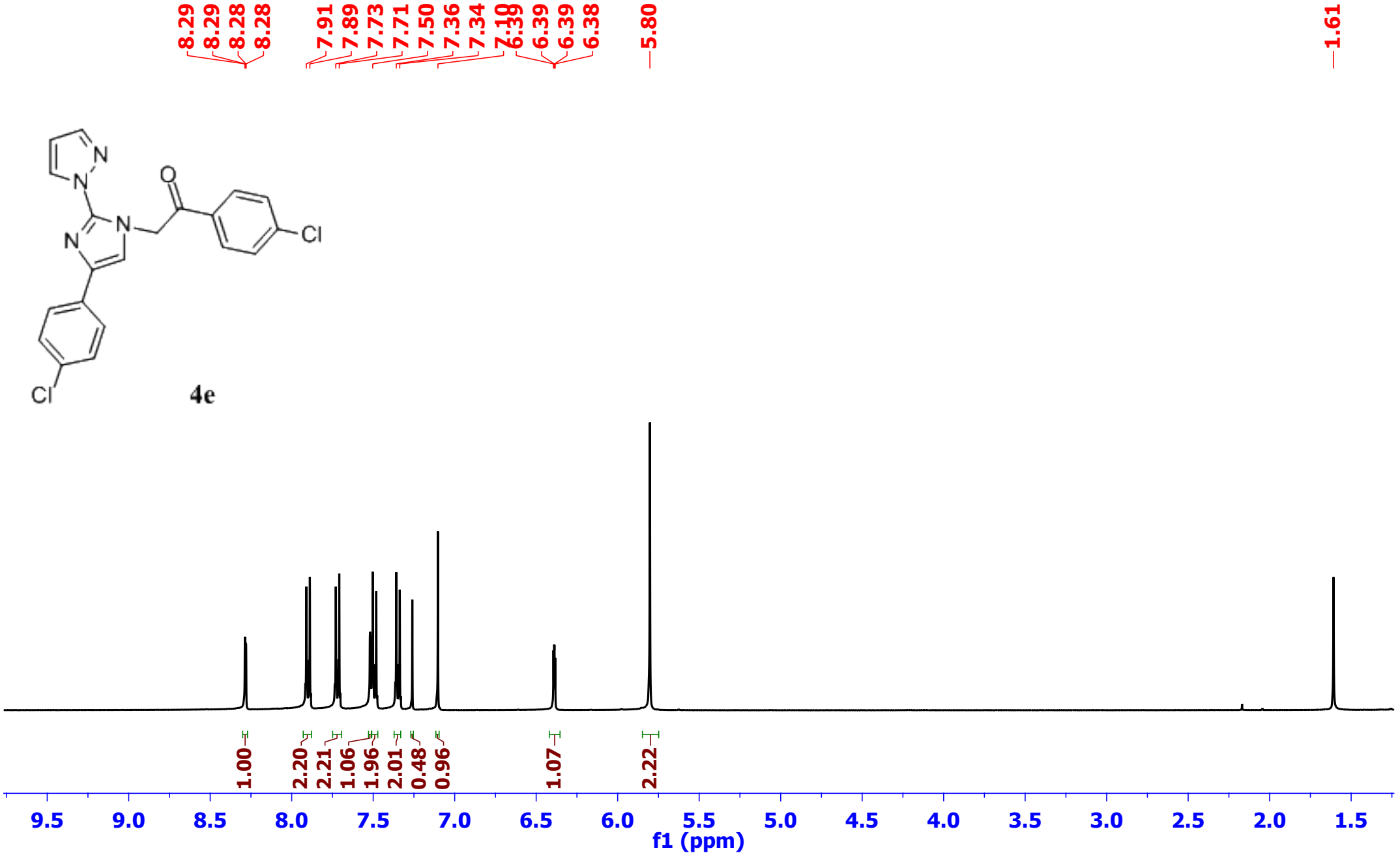
^{13}C NMR of compound 4c in $CDCl_3$



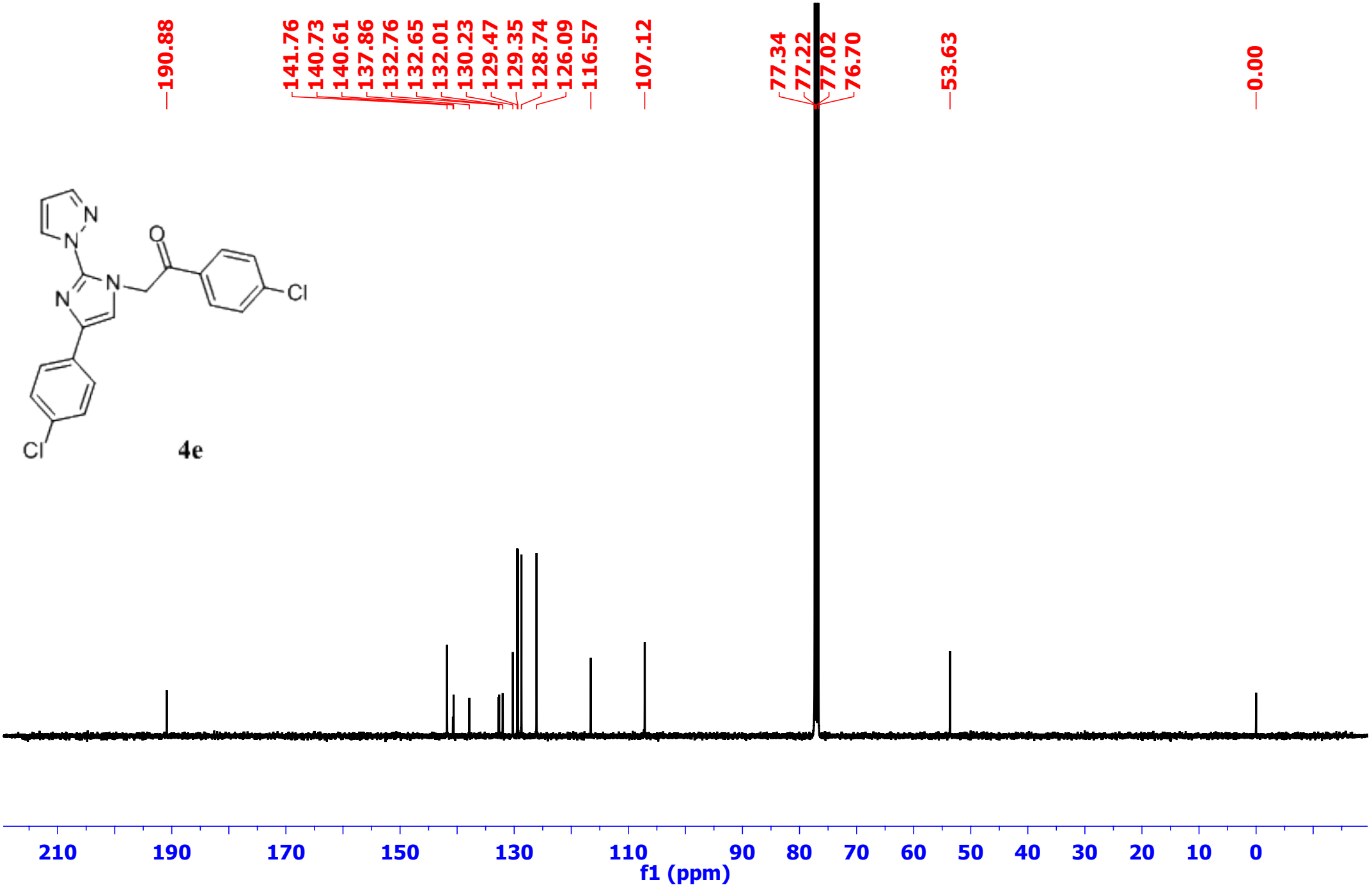
^{1}H NMR of compound 4d in DMSO



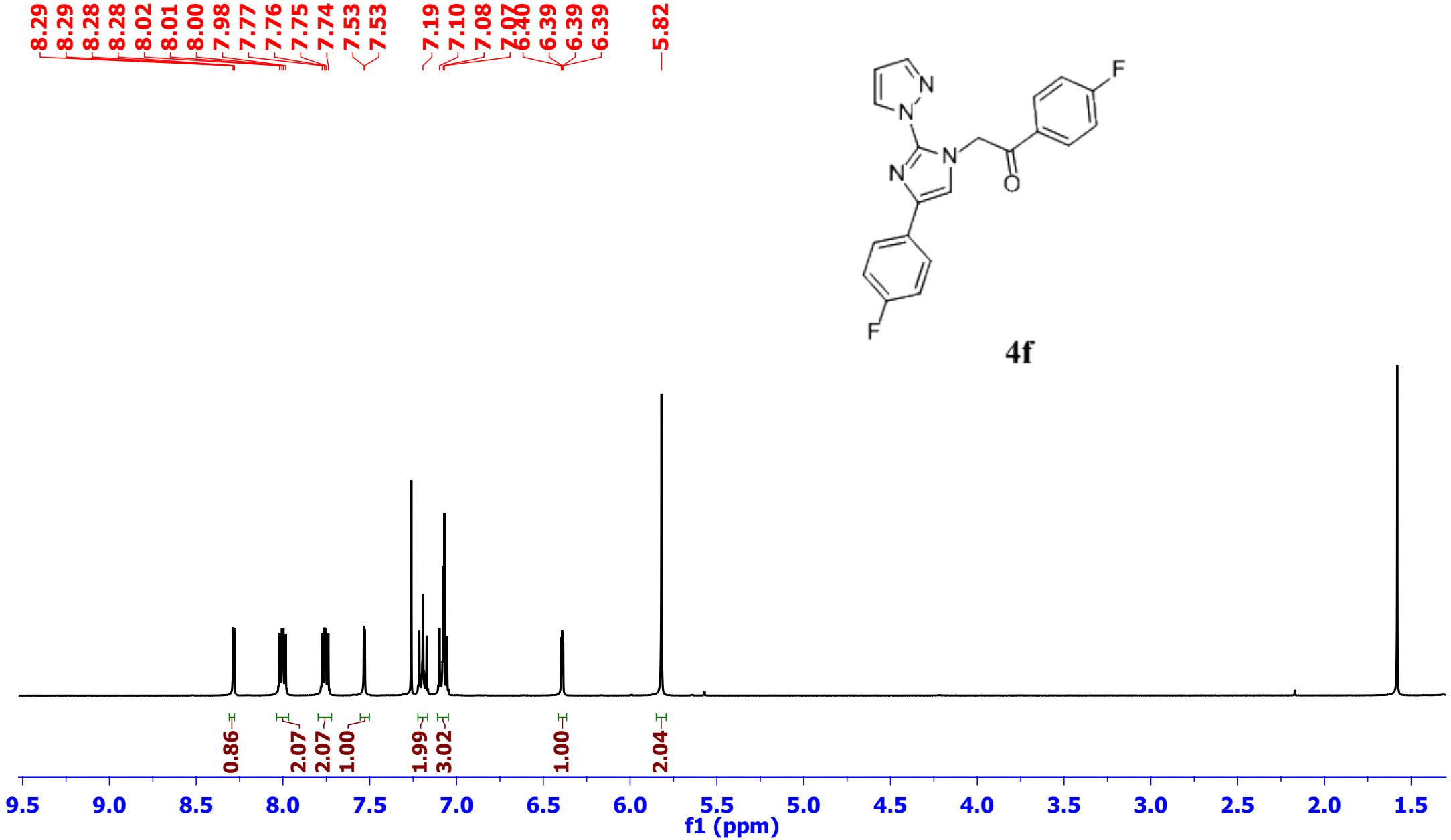
^{13}C NMR of compound 4d in DMSO



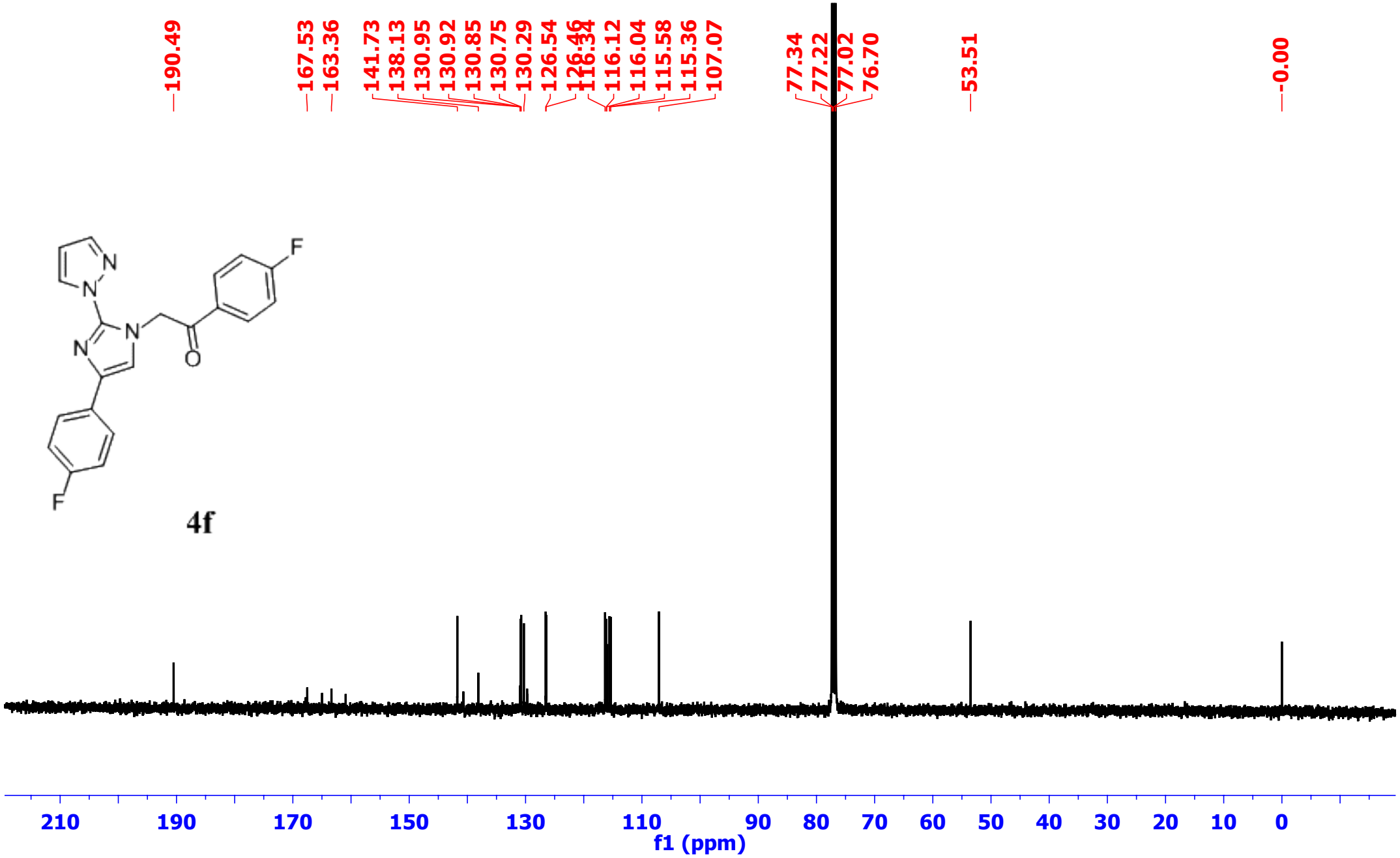
^{1}H NMR of compound 4e in $CDCl_3$



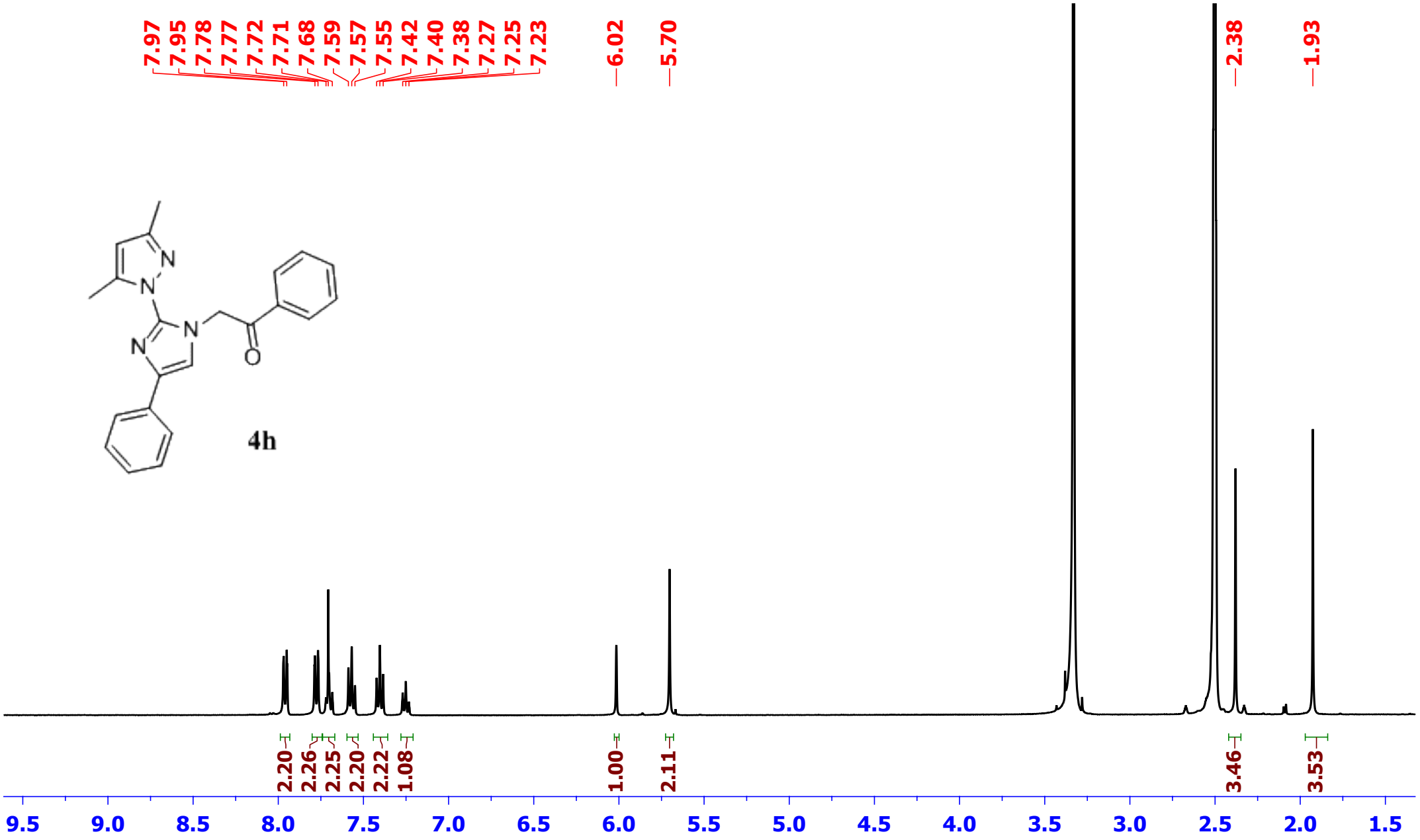
^{13}C NMR of compound 4e in $CDCl_3$



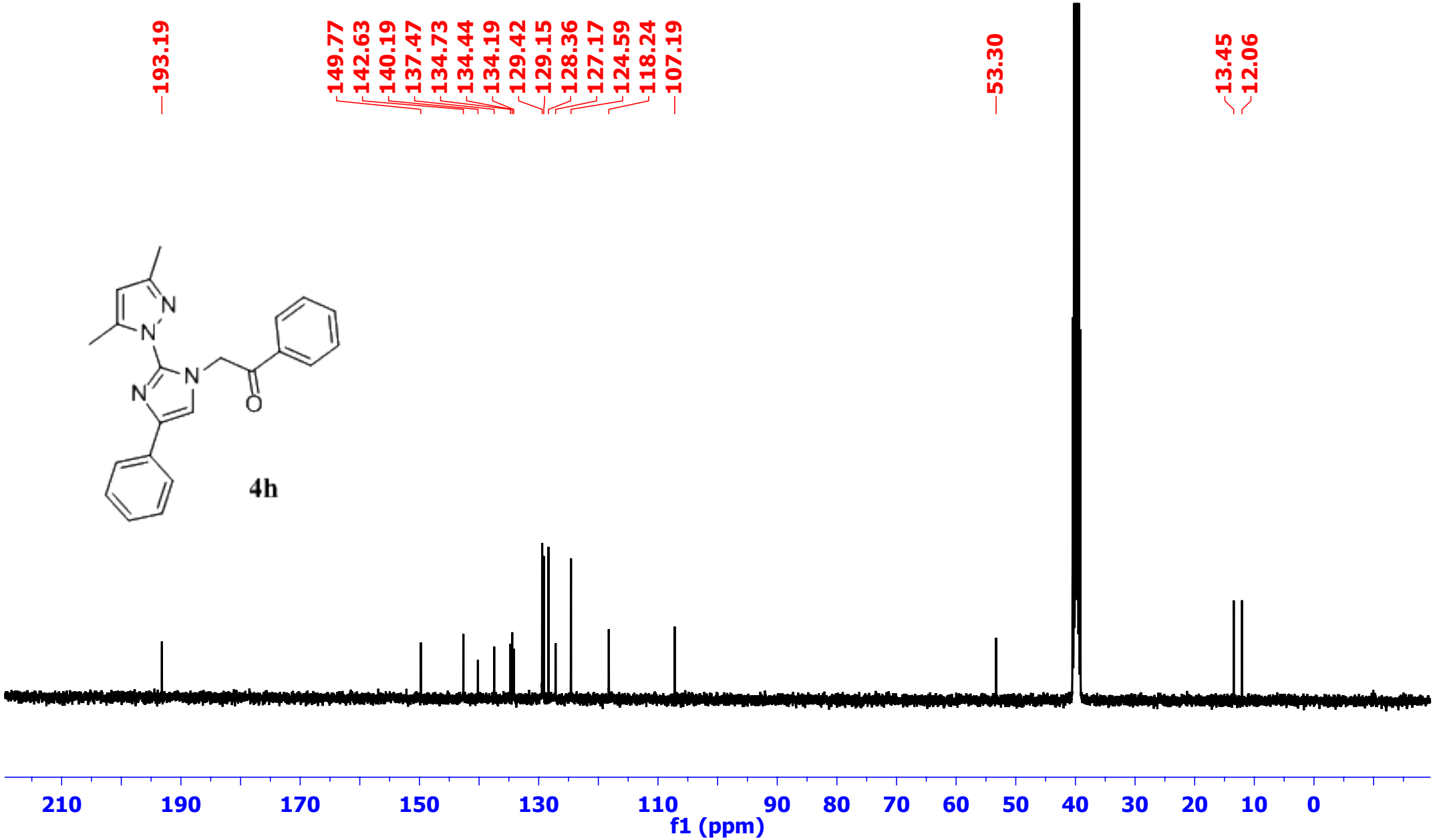
^{1}H NMR of compound 4f in $CDCl_3$



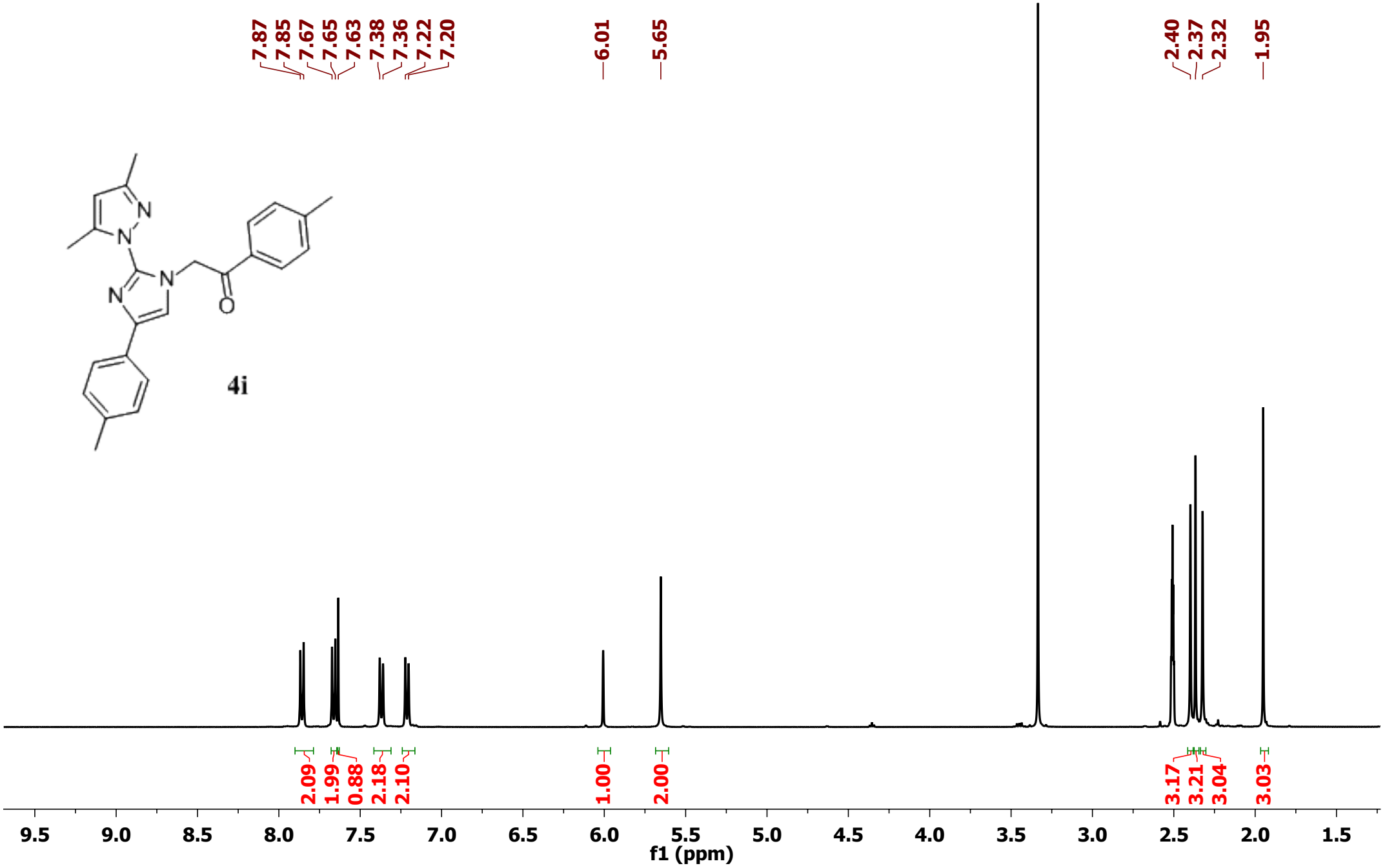
^{13}C NMR of compound 4f in $CDCl_3$

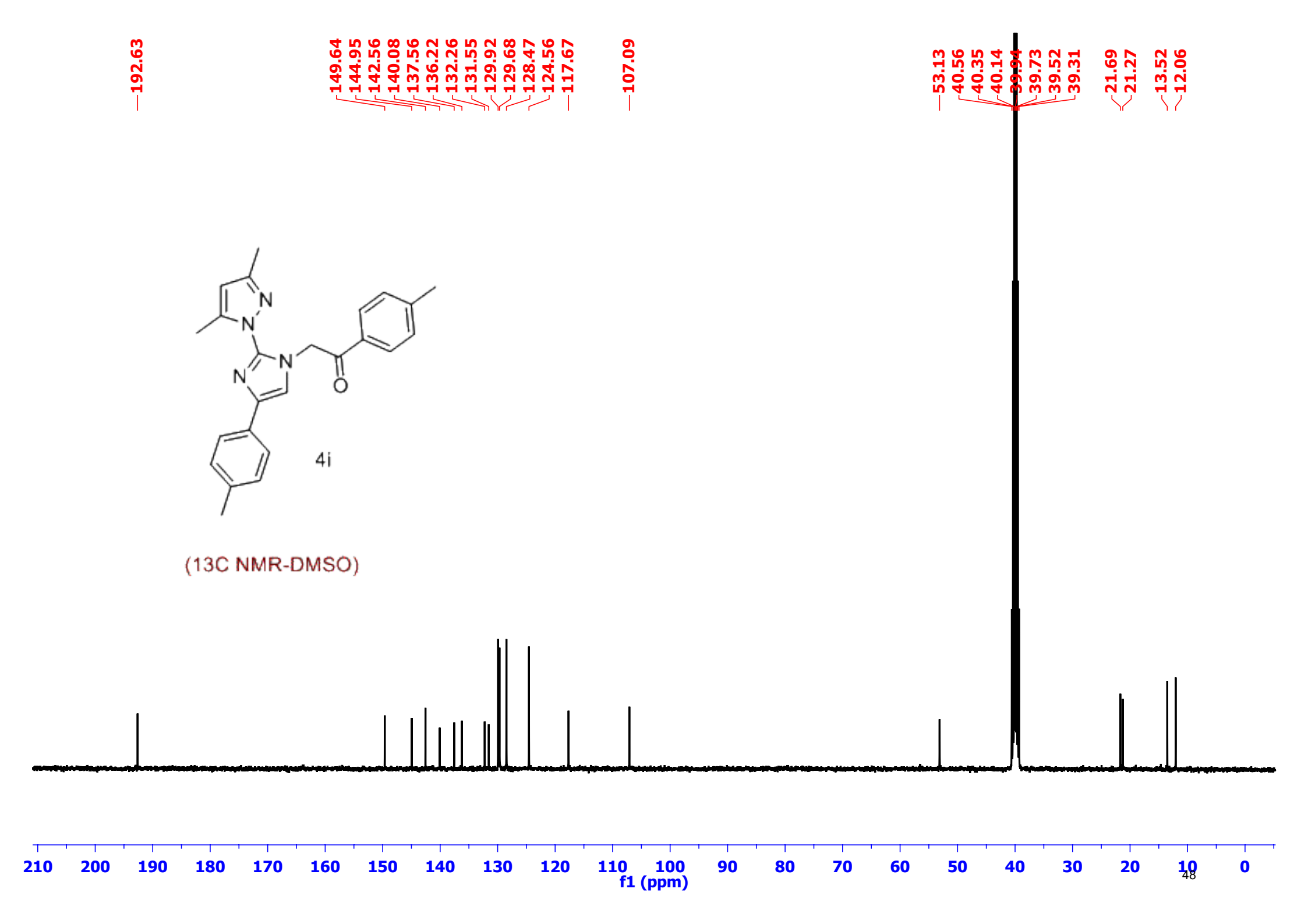


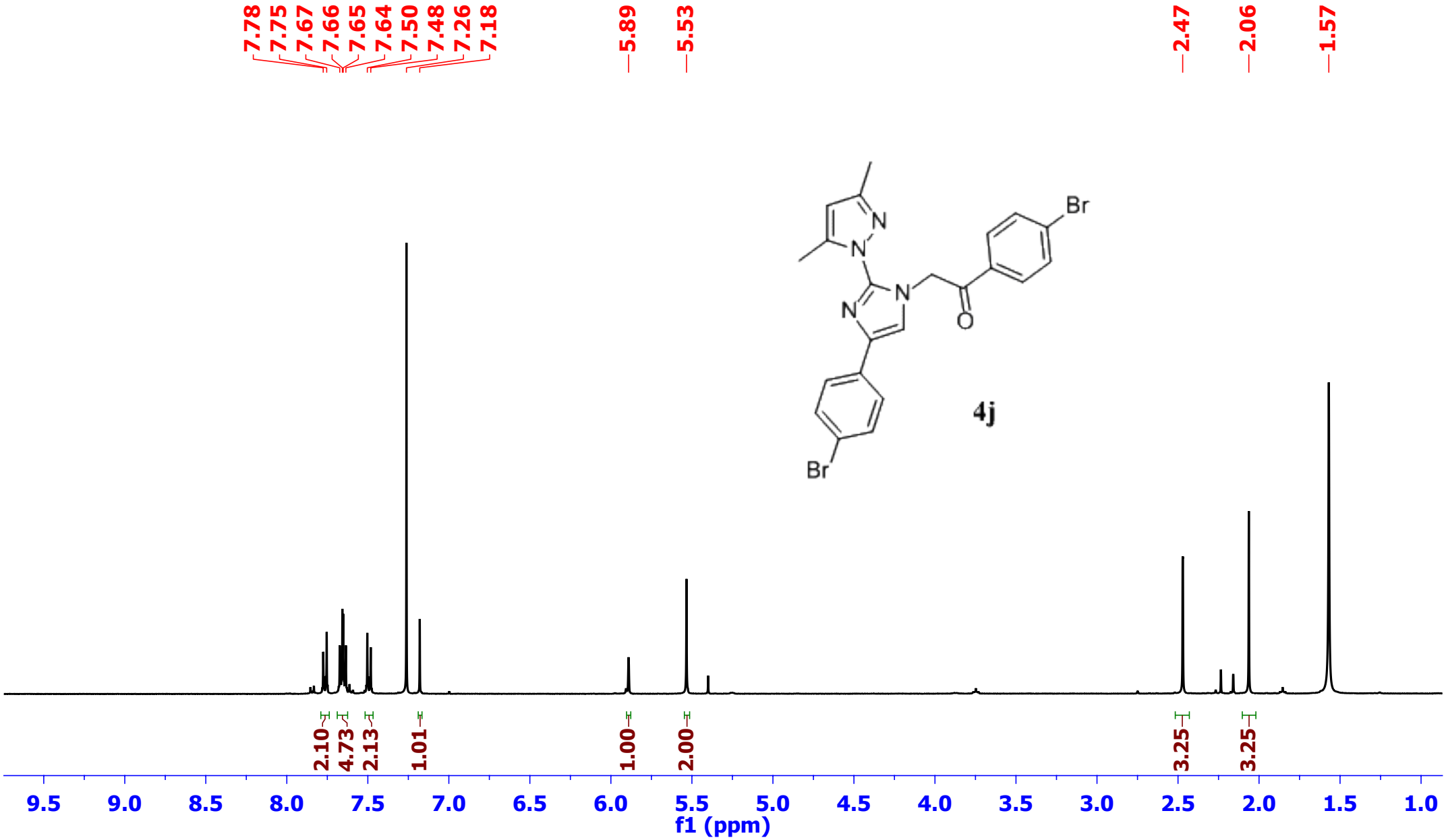
^{1}H NMR of compound 4h in DMSO



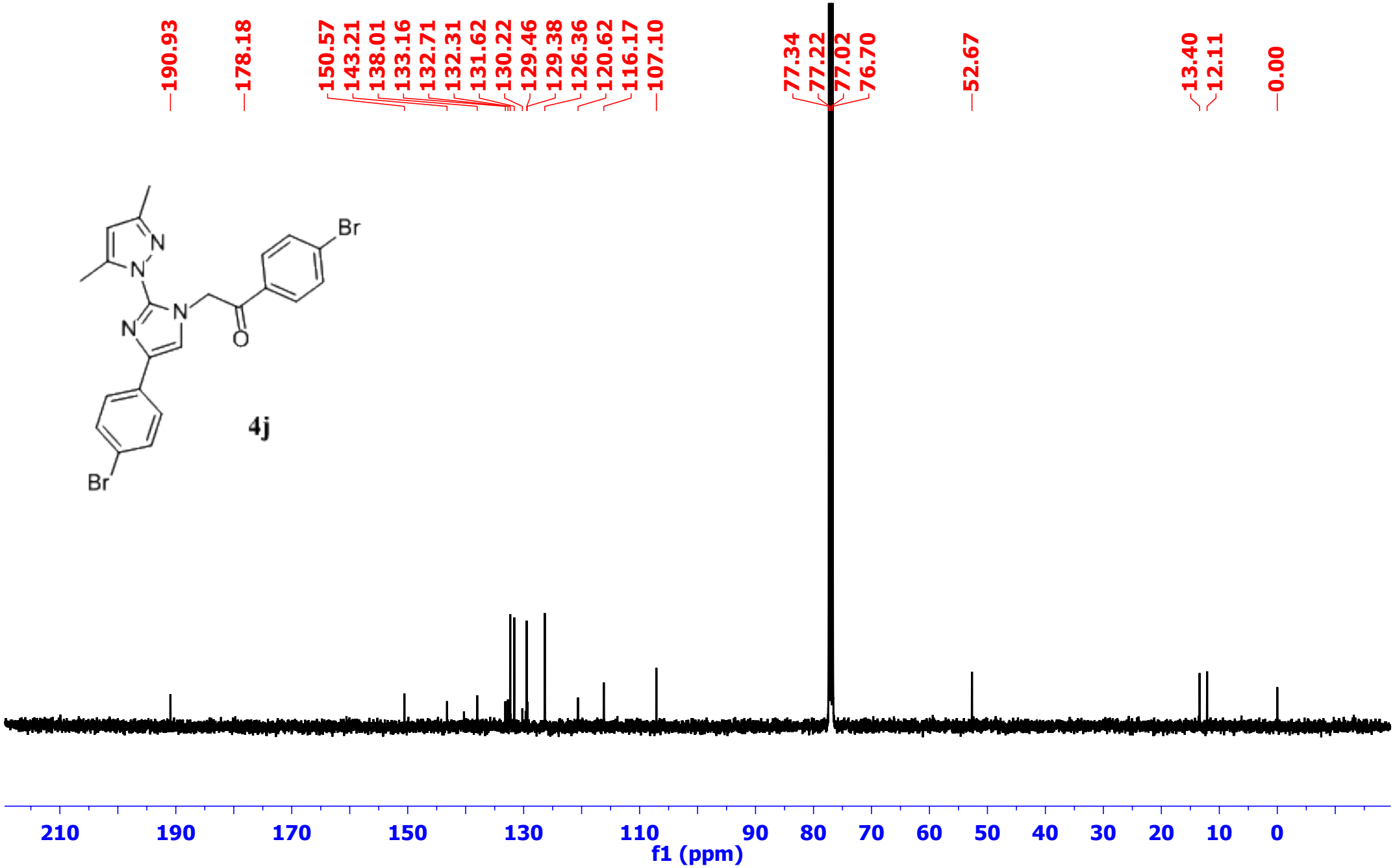
^{13}C NMR of compound 4h in DMSO


7.87
7.85
7.67
7.65
7.63
7.38
7.36
7.22
7.20
6.01
5.65
2.40
2.37
2.32
1.95
4i
2.09
1.99
0.88
2.18
2.10
1.00
2.00
3.17
3.21
3.04
3.03
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)

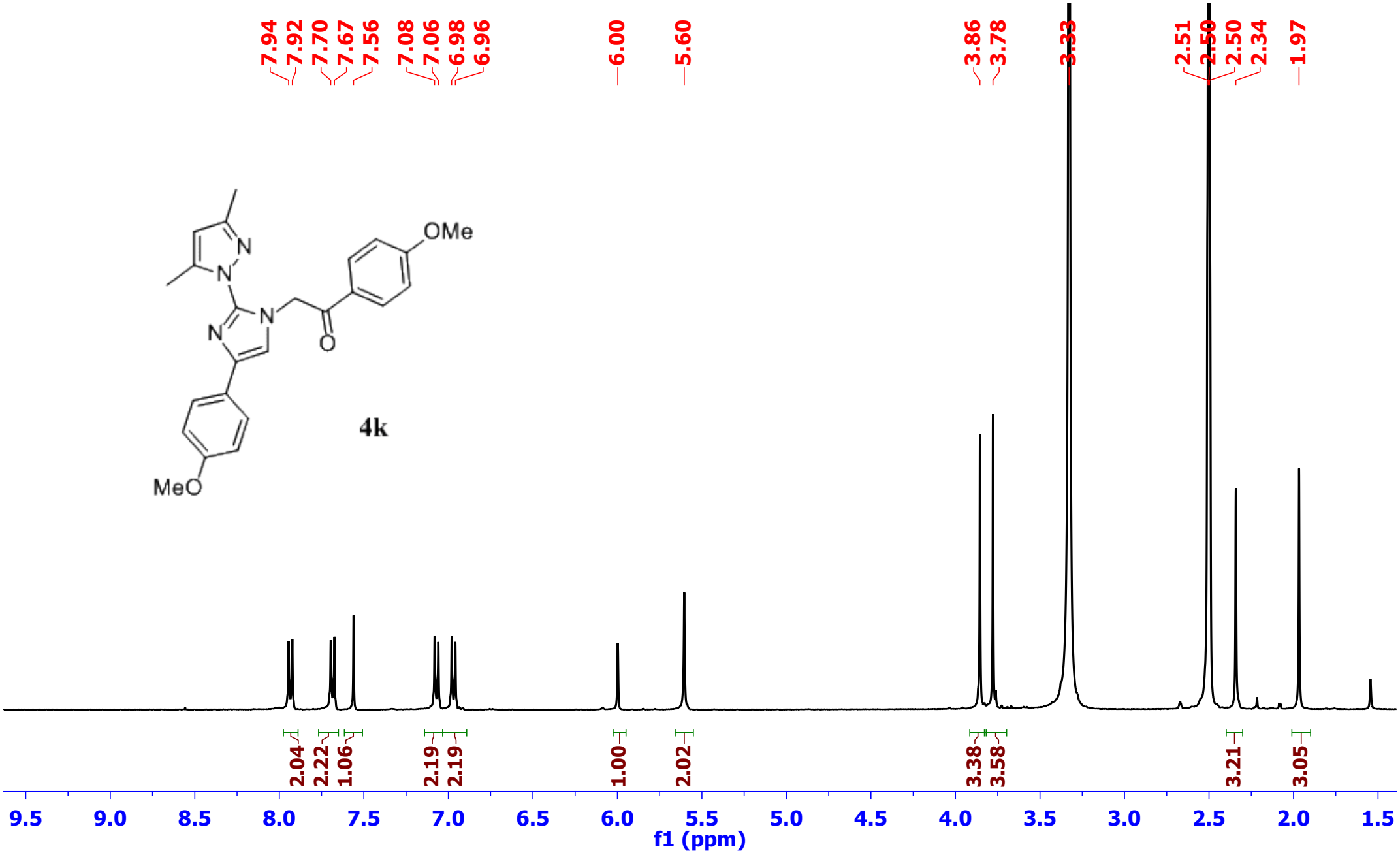

192.63
149.64
144.95
142.56
140.08
137.56
136.22
132.26
131.55
129.92
129.68
128.47
124.56
117.67
107.09
53.13
40.56
40.35
40.14
39.94
39.73
39.52
39.31
21.69
21.27
13.52
12.06
4i
(13C NMR-DMSO)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



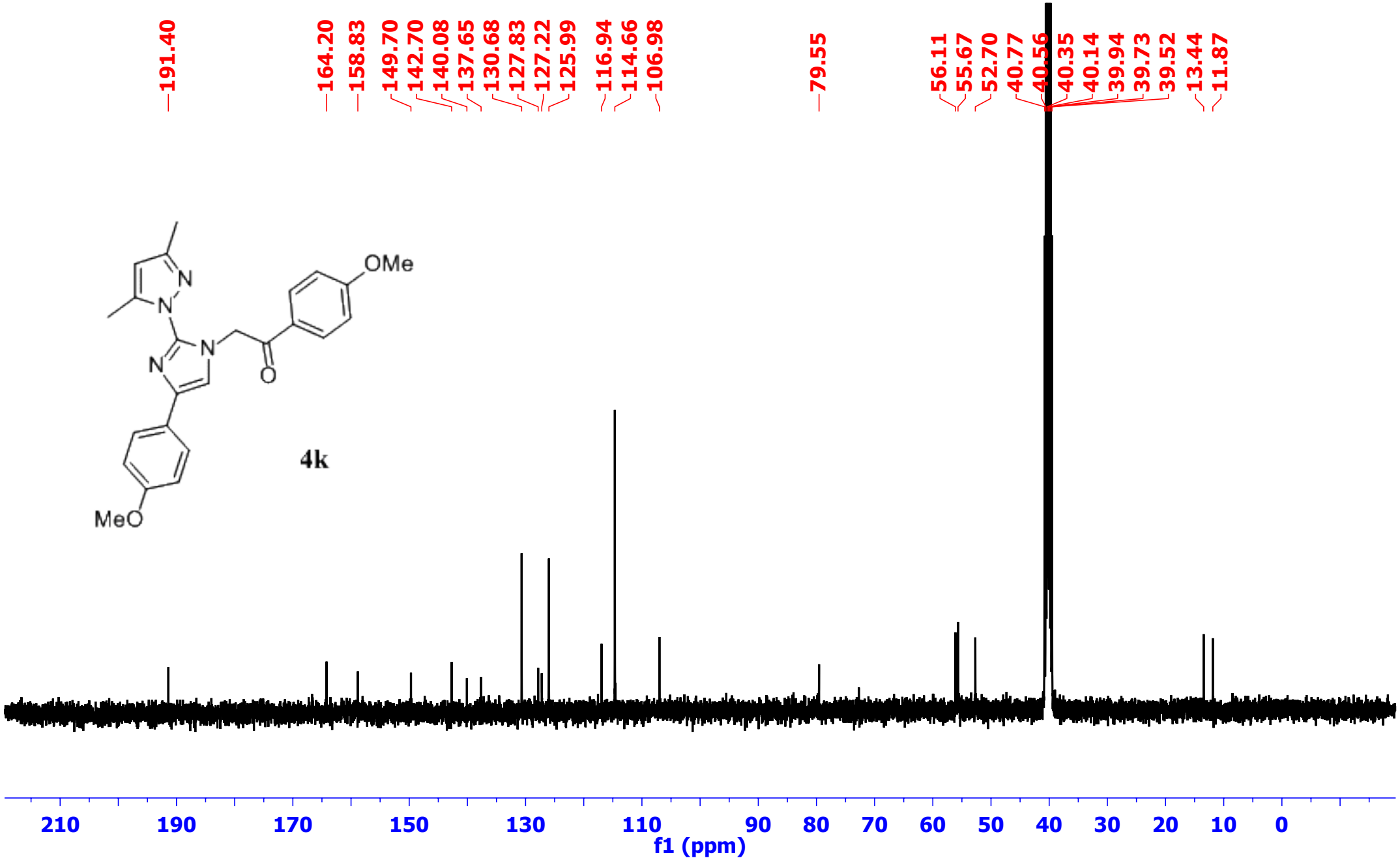
^{1}H NMR of compound 4j in CDCl3



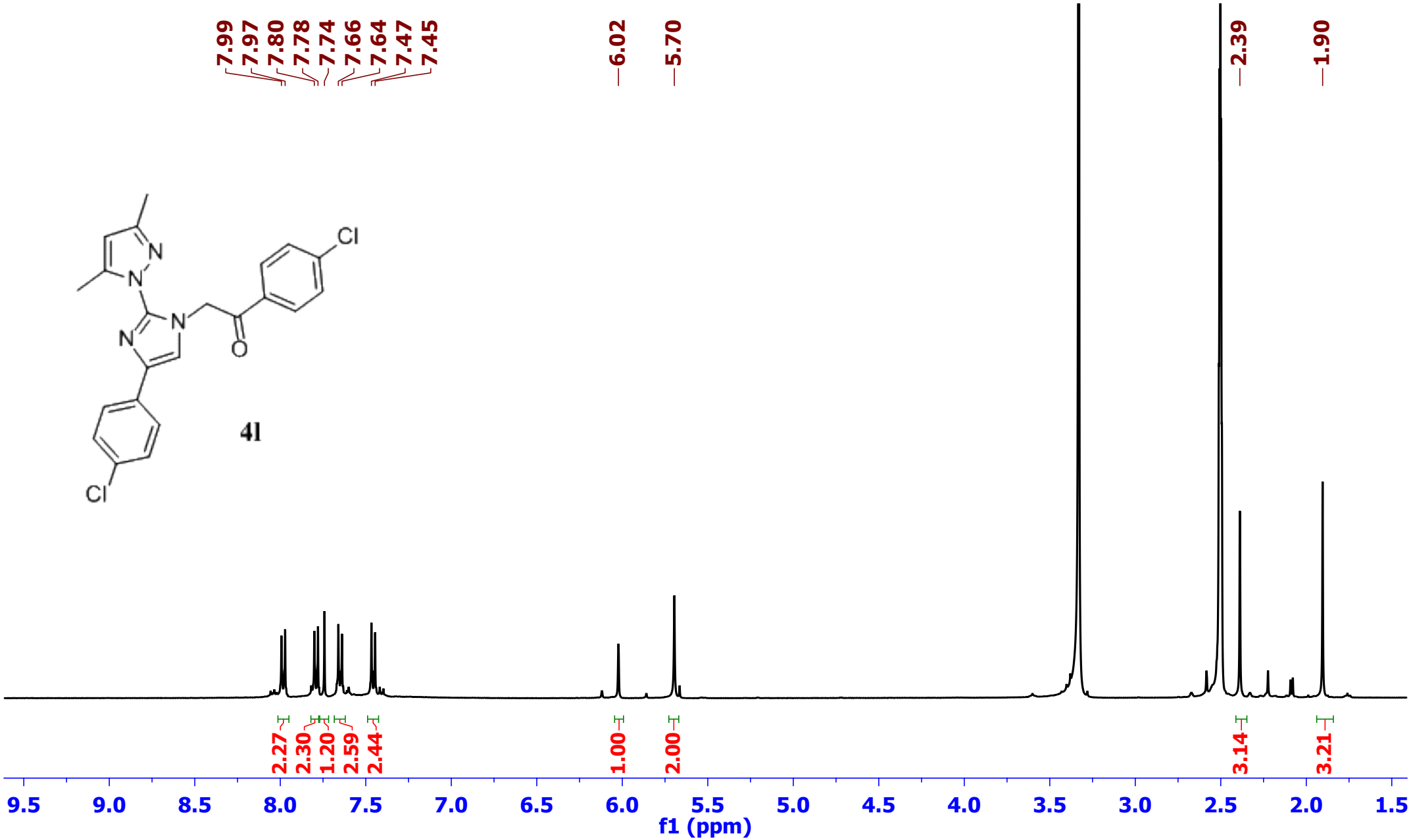
^{13}C NMR of compound 4j in CDCl3



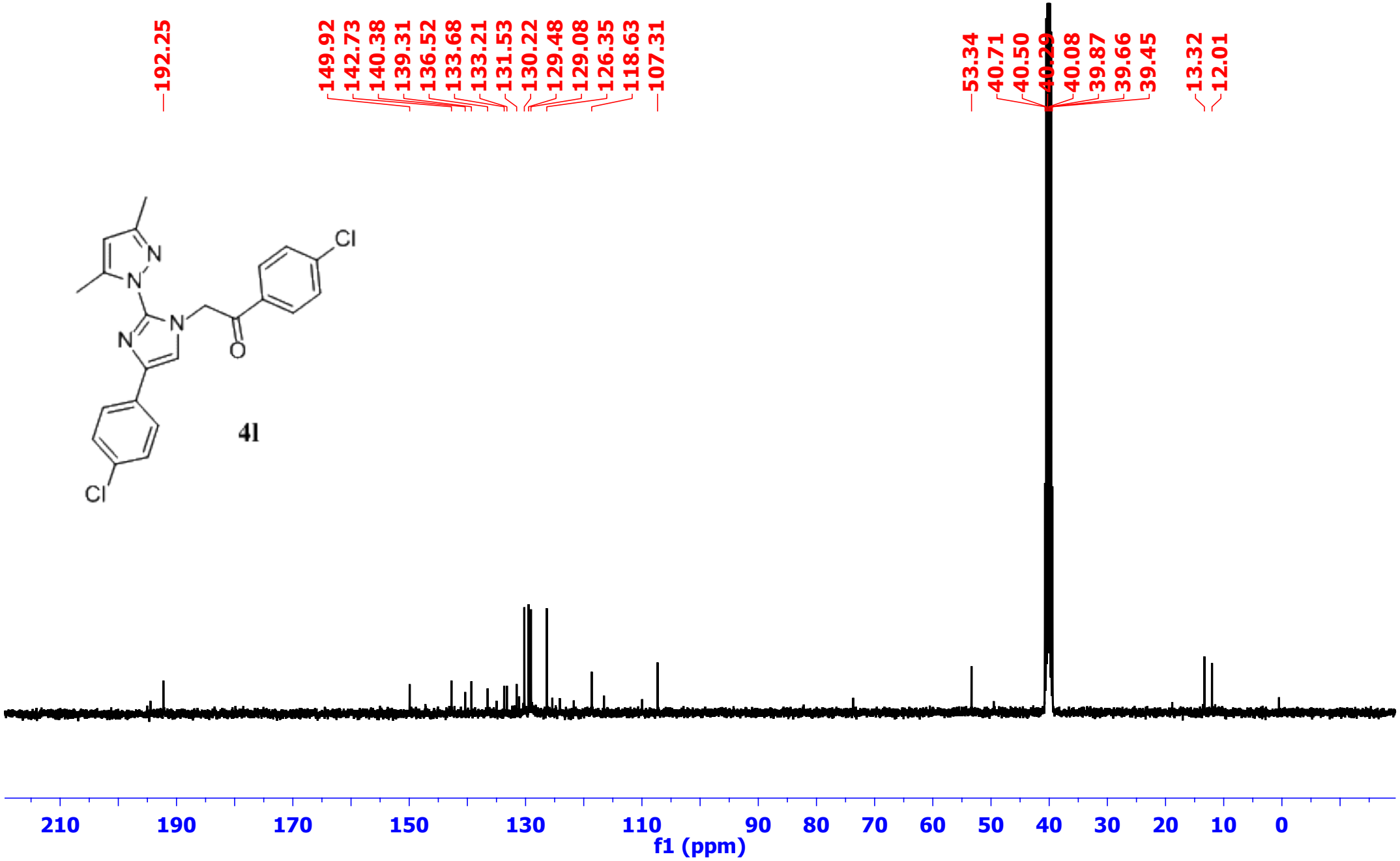
^{1}H NMR of compound 4kin DMSO



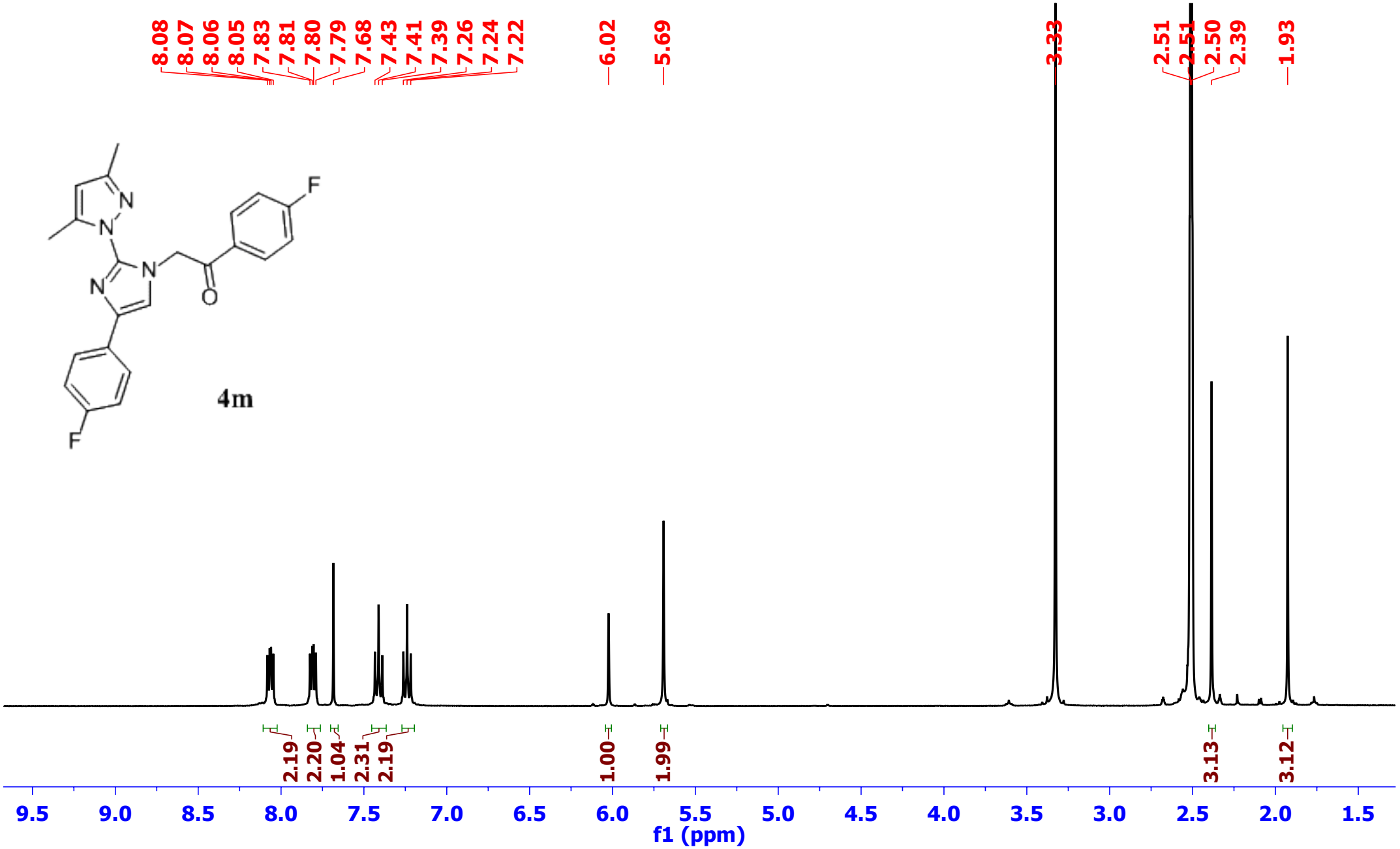
^{13}C NMR of compound 4k in DMSO



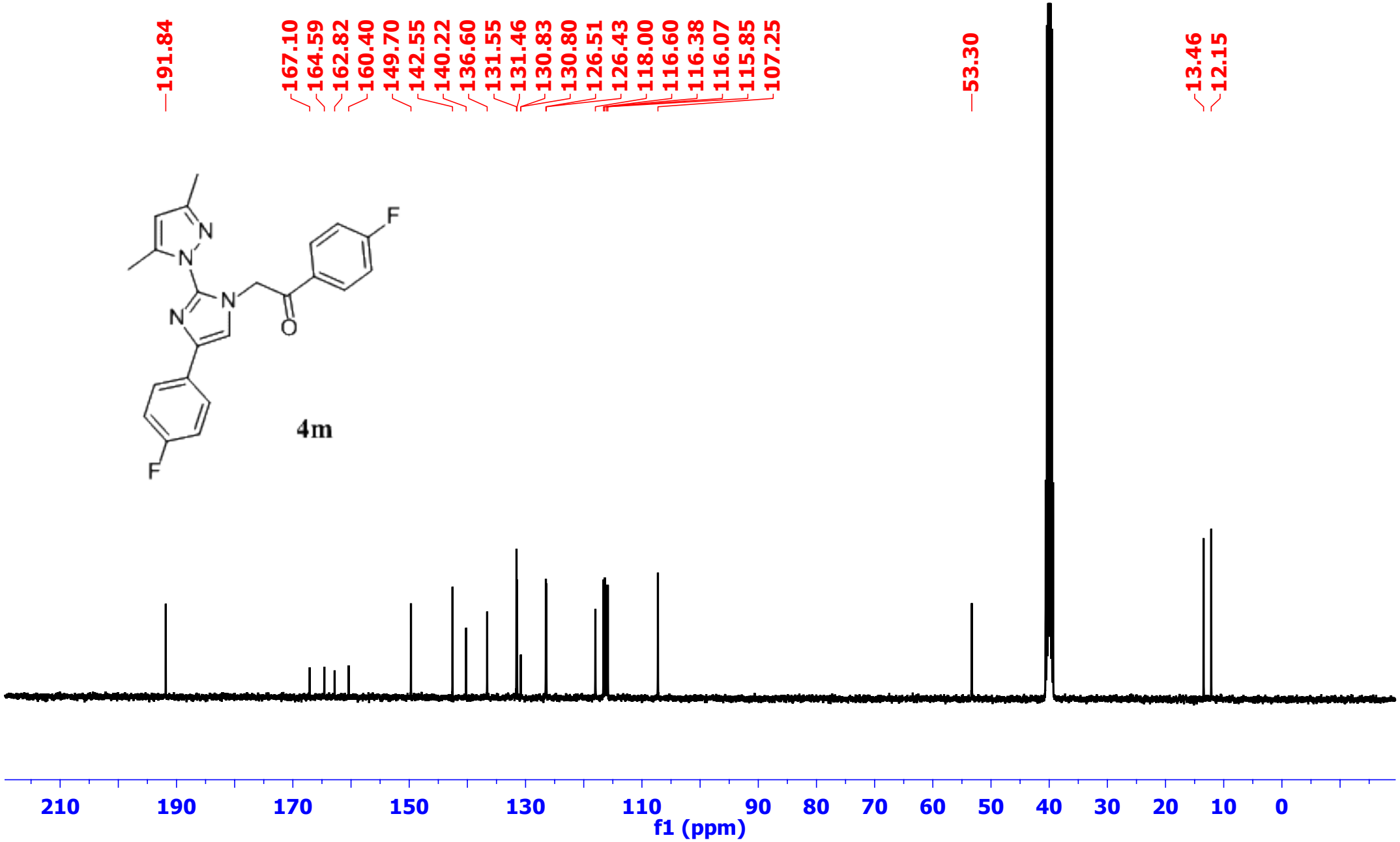
^{1}H NMR of compound 4l in DMSO



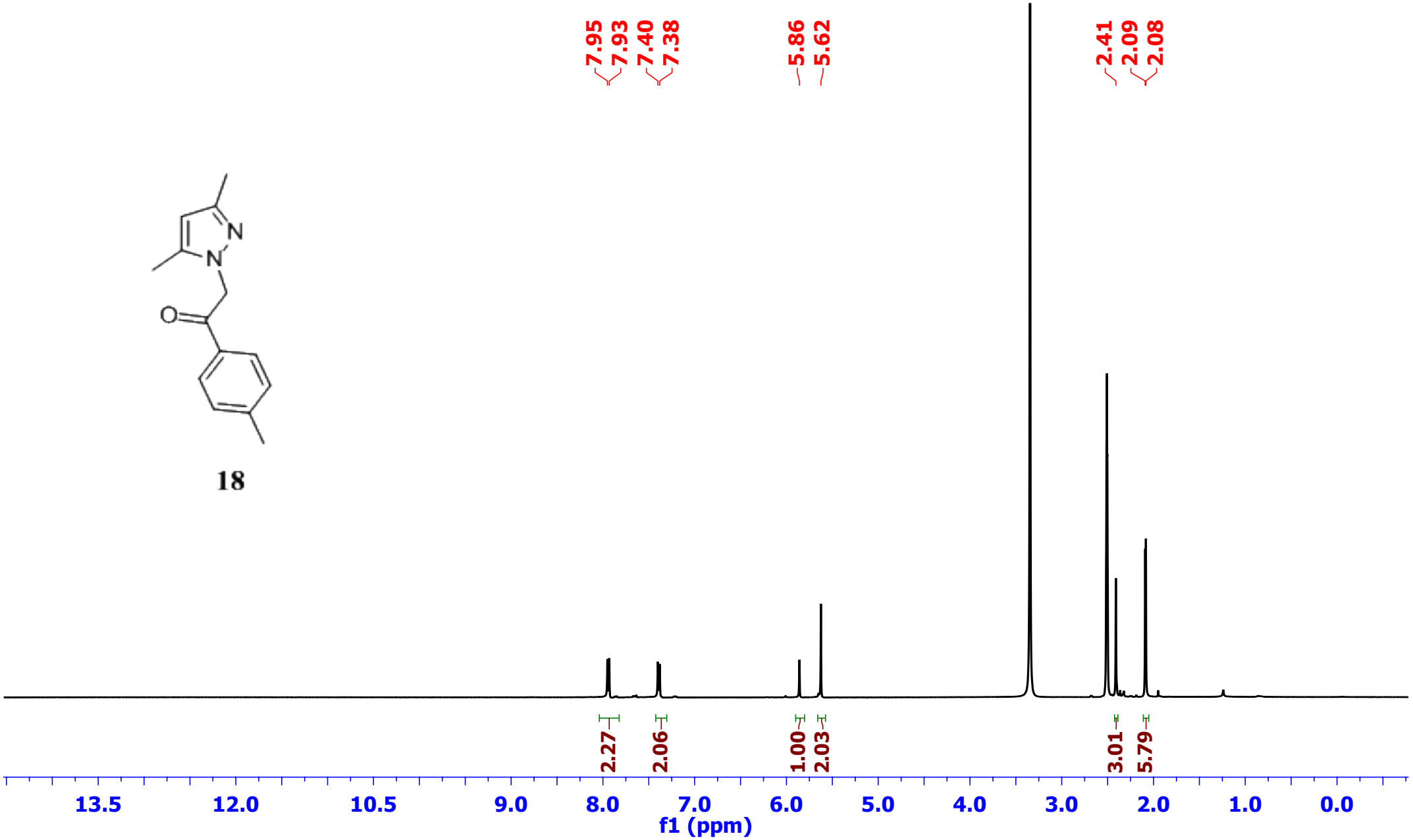
^{13}C NMR of compound 4l in DMSO



^{1}H NMR of compound 4min DMSO

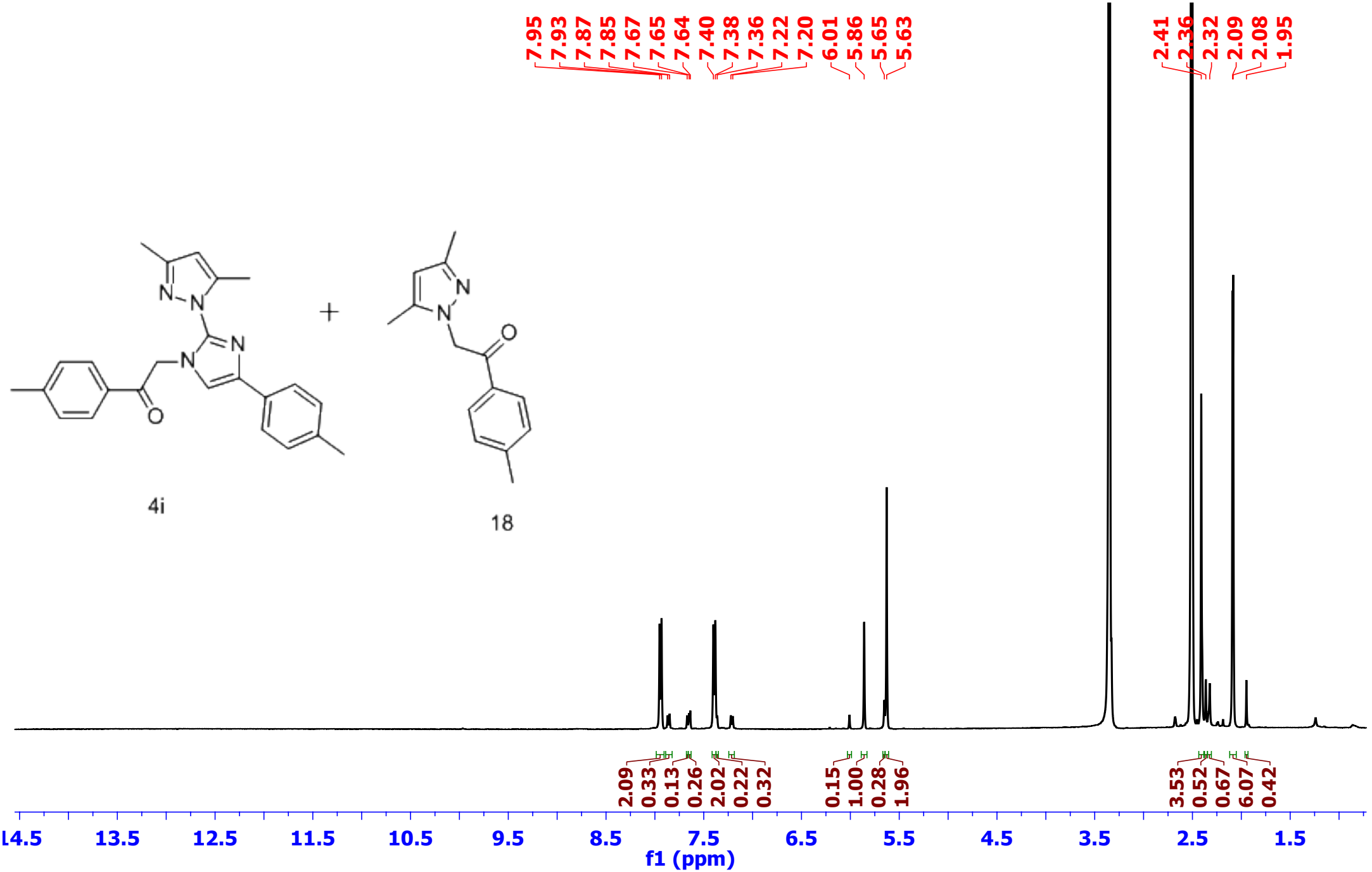


^{13}C NMR of compound 4m in DMSO

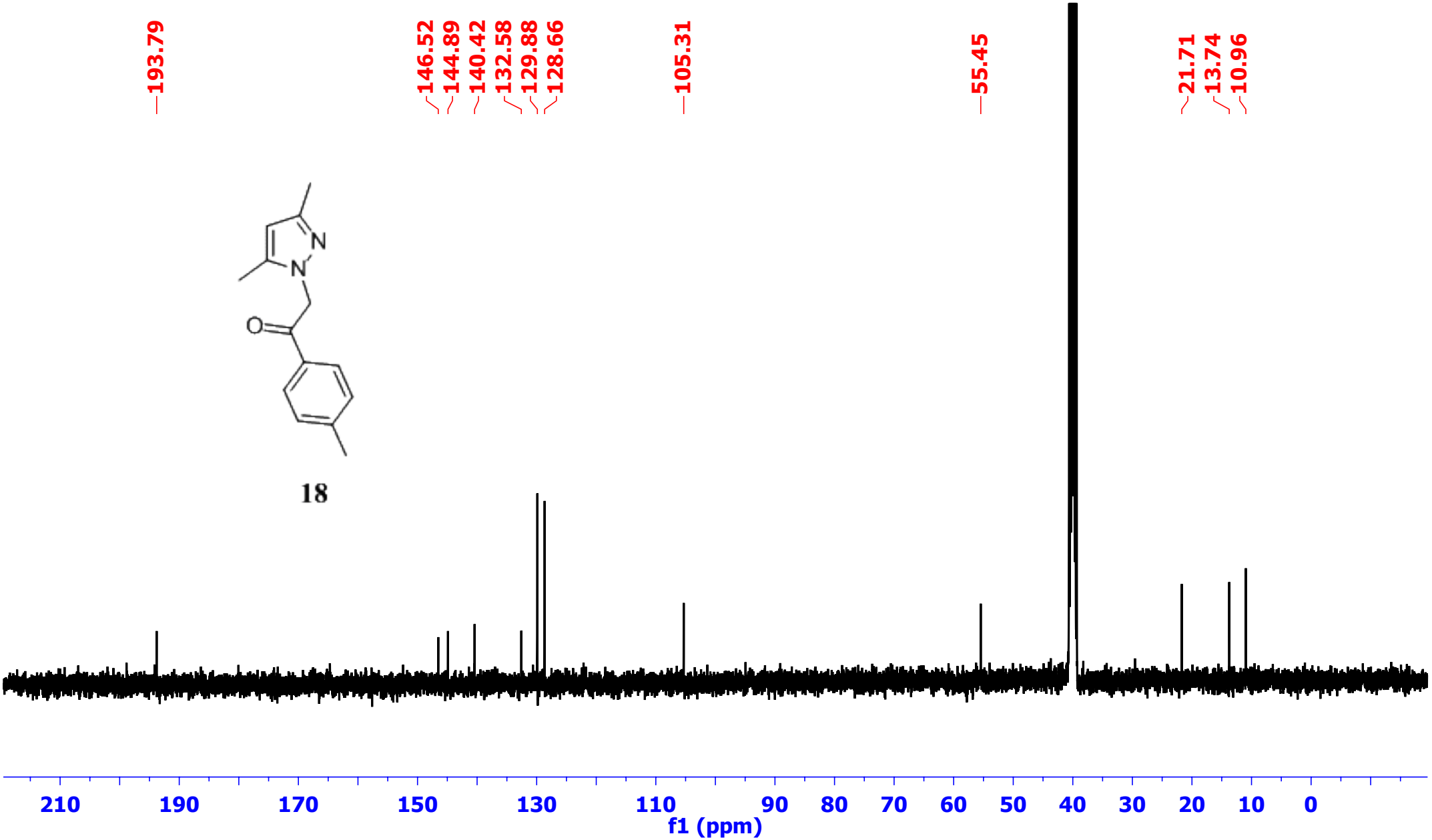


18

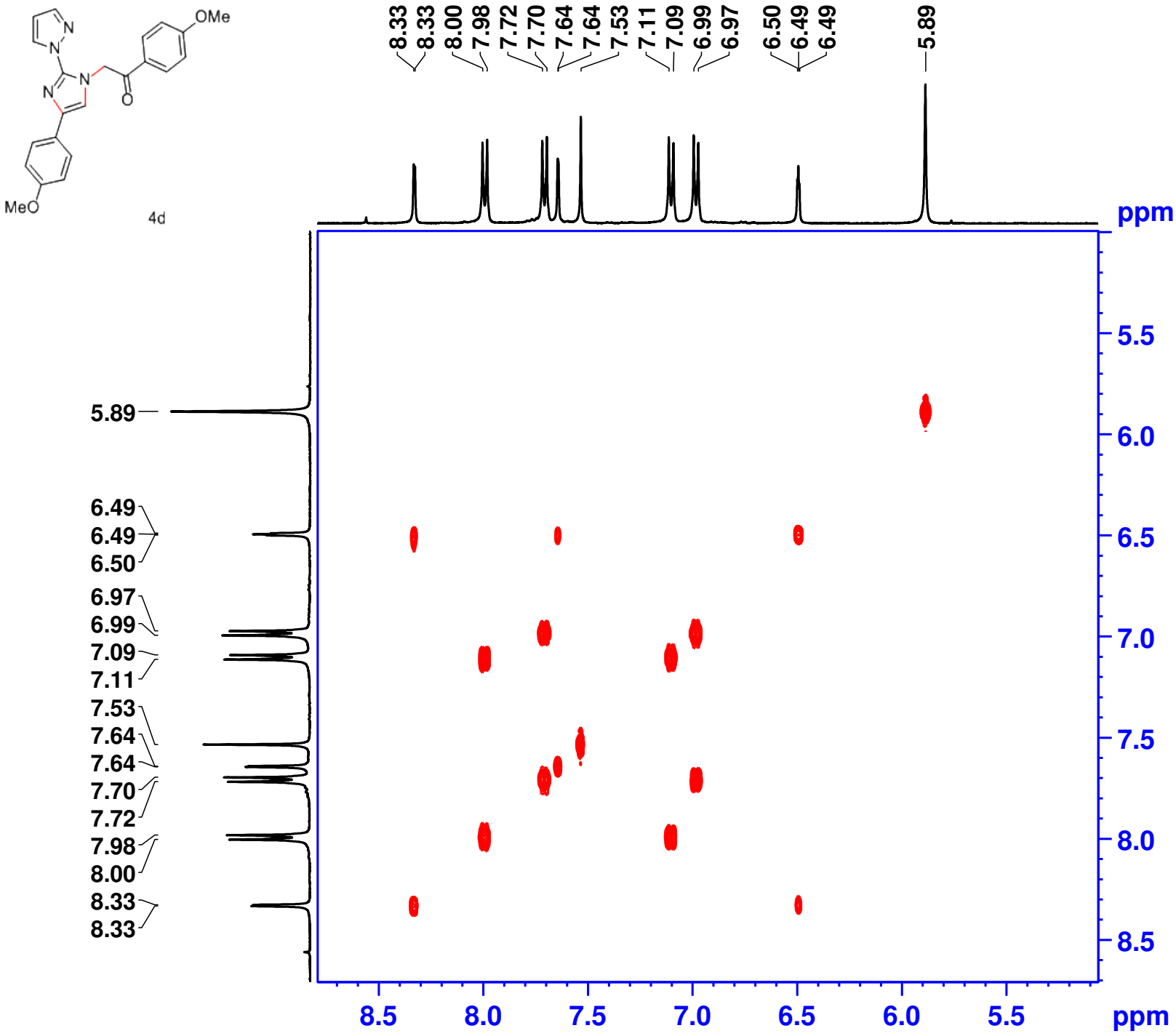
^{1}H NMR of compound 18 in DMSO



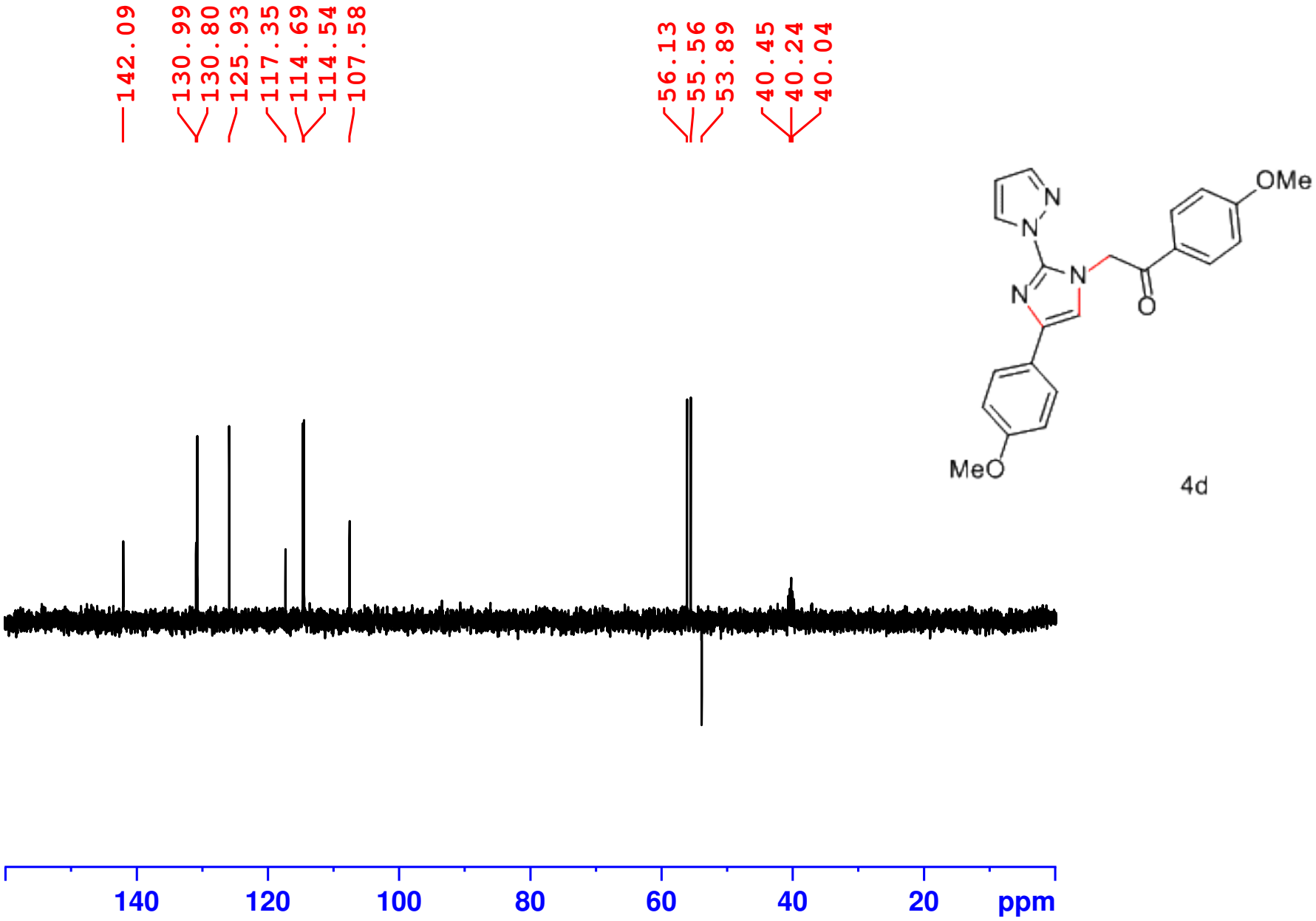
^{1}H NMR of mixture containing18 and 4i



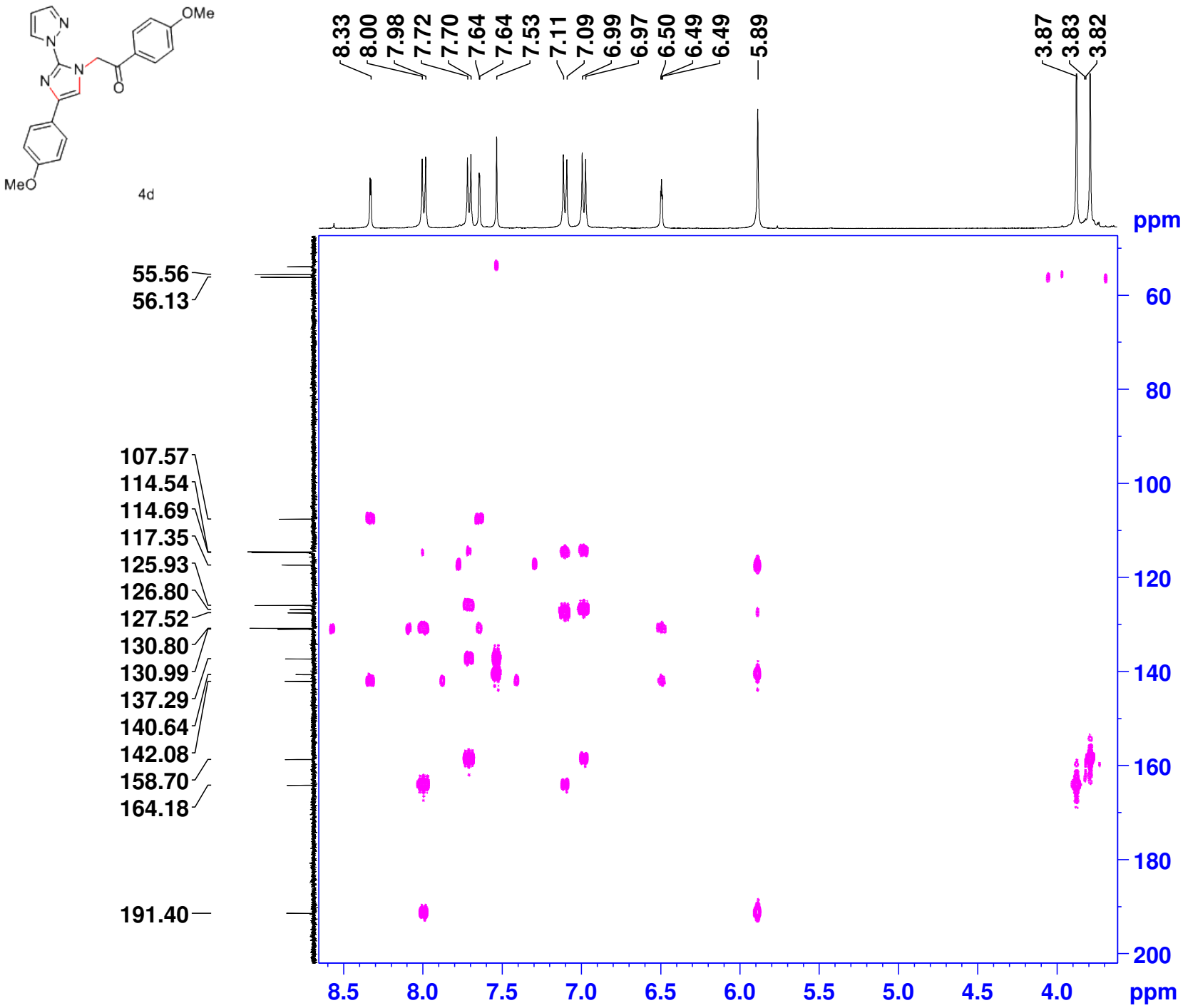
^{13}C NMR of compound 18 in DMSO



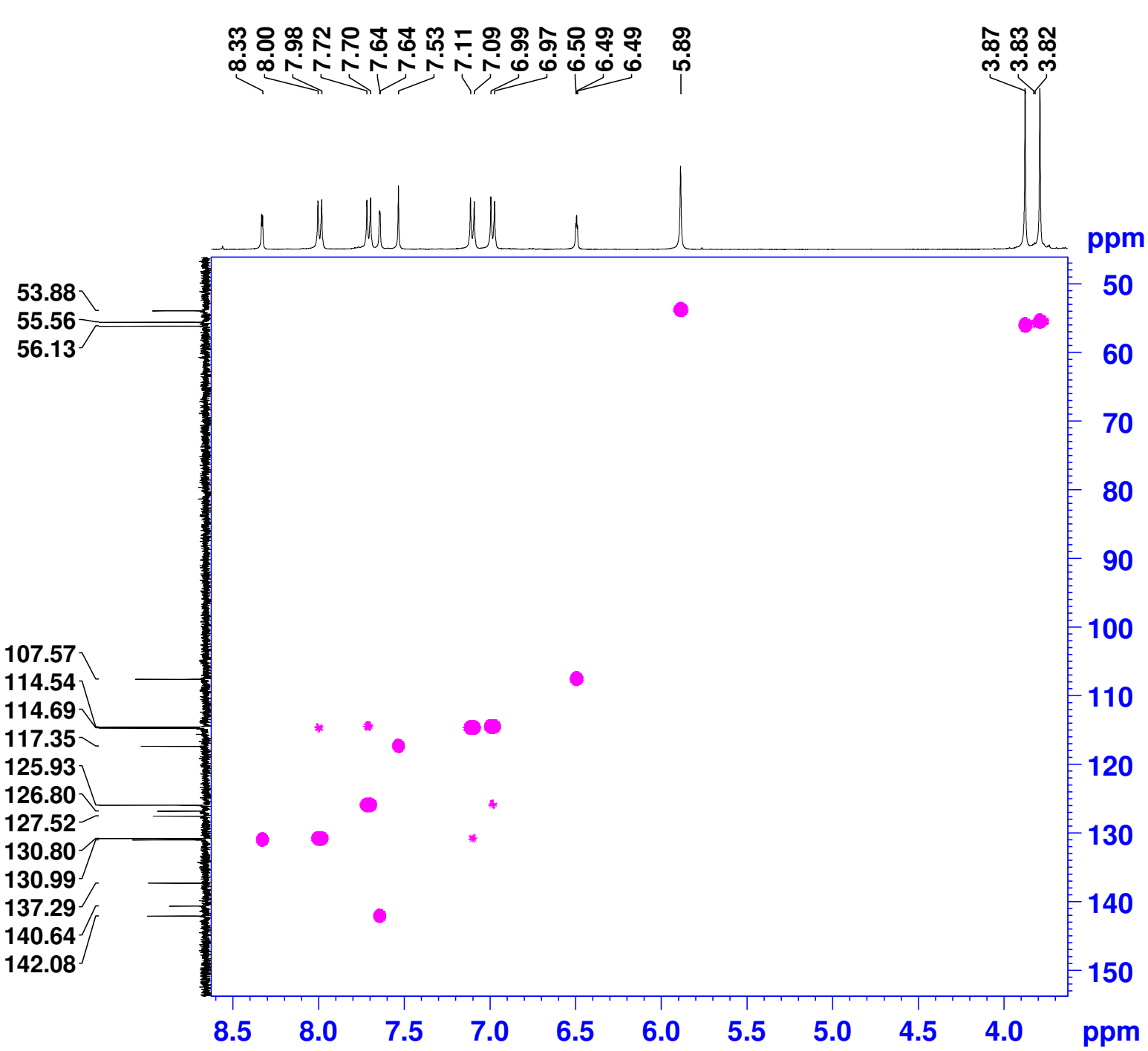
COSY NMR of compound 4d

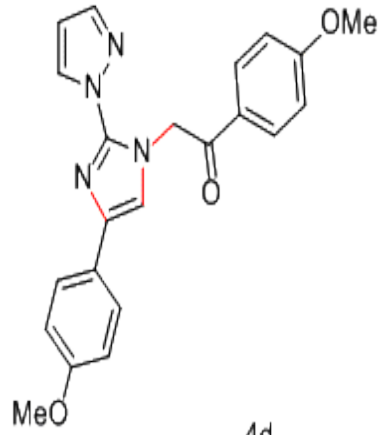


DEPT135 of compound 4d in DMSO



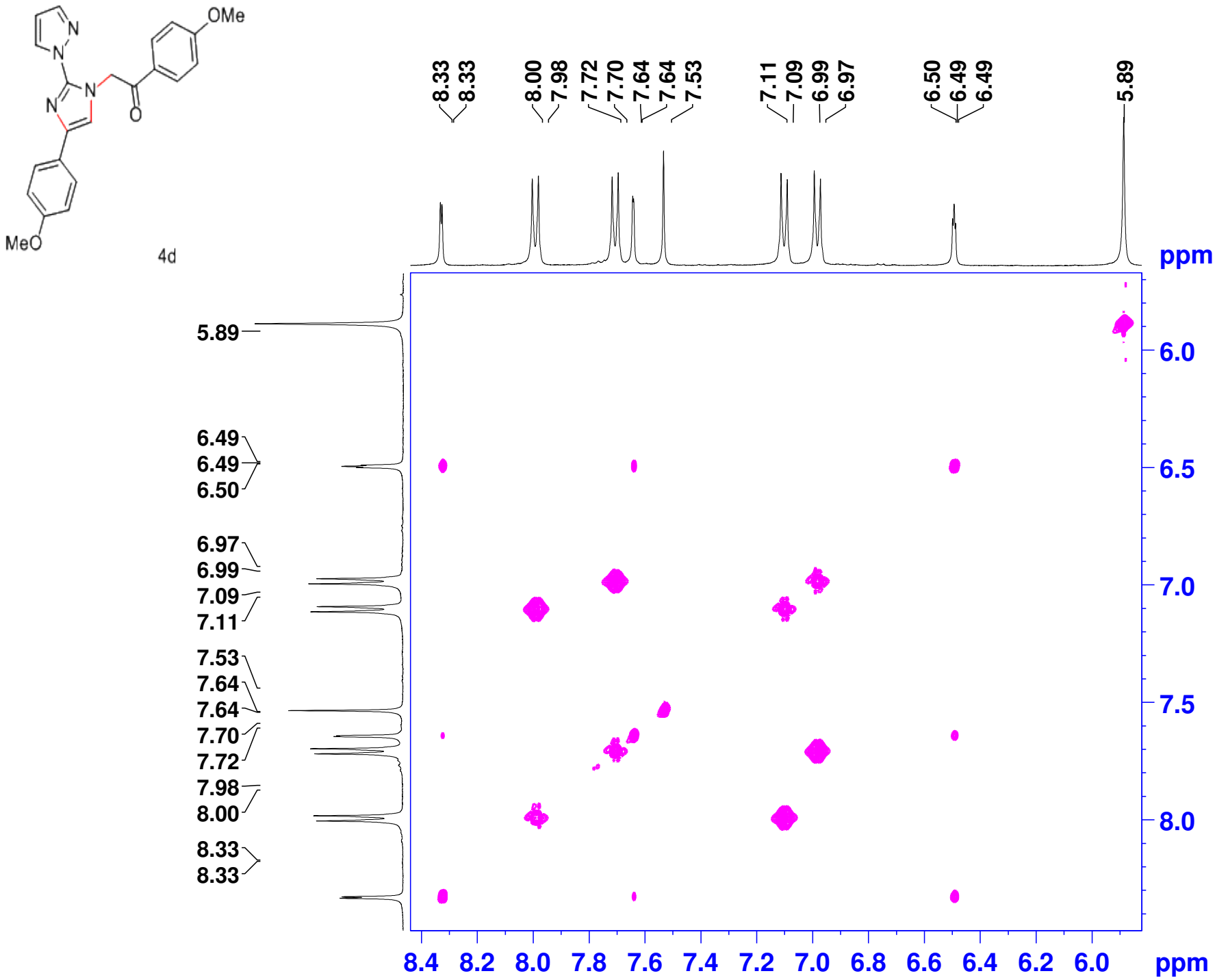
HMBC of compound 4d in DMSO



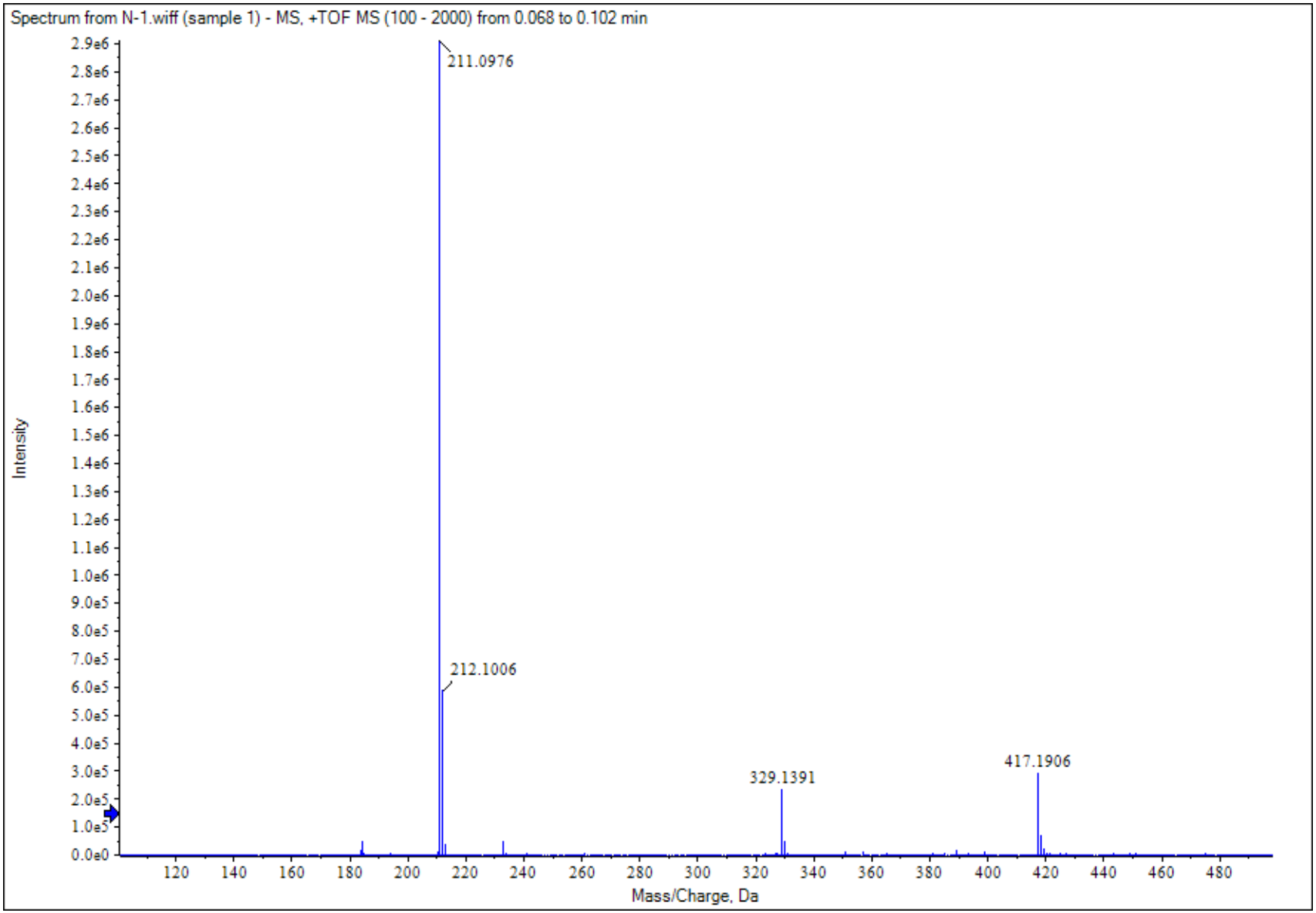


4d

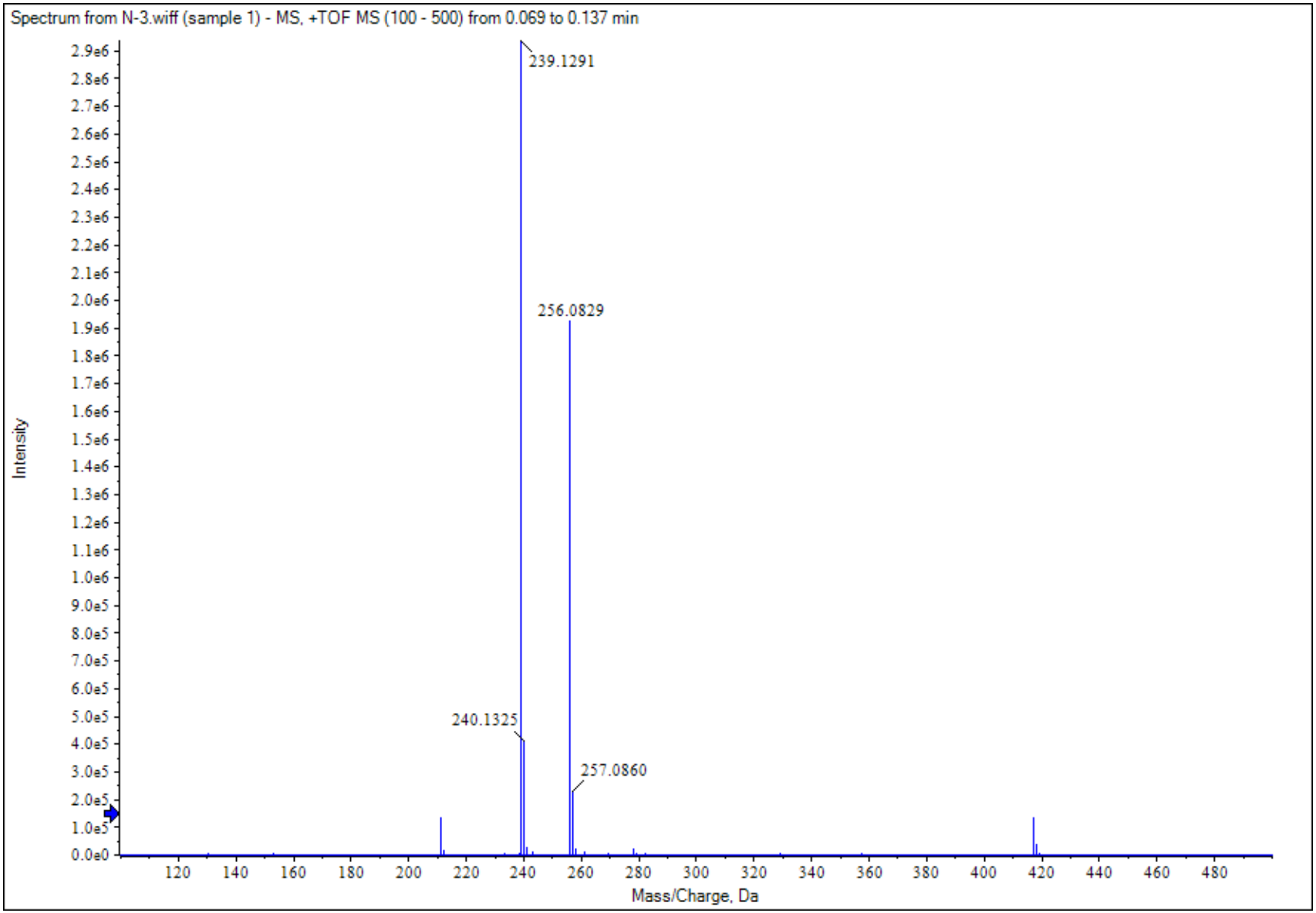
HSQC of compound 4d



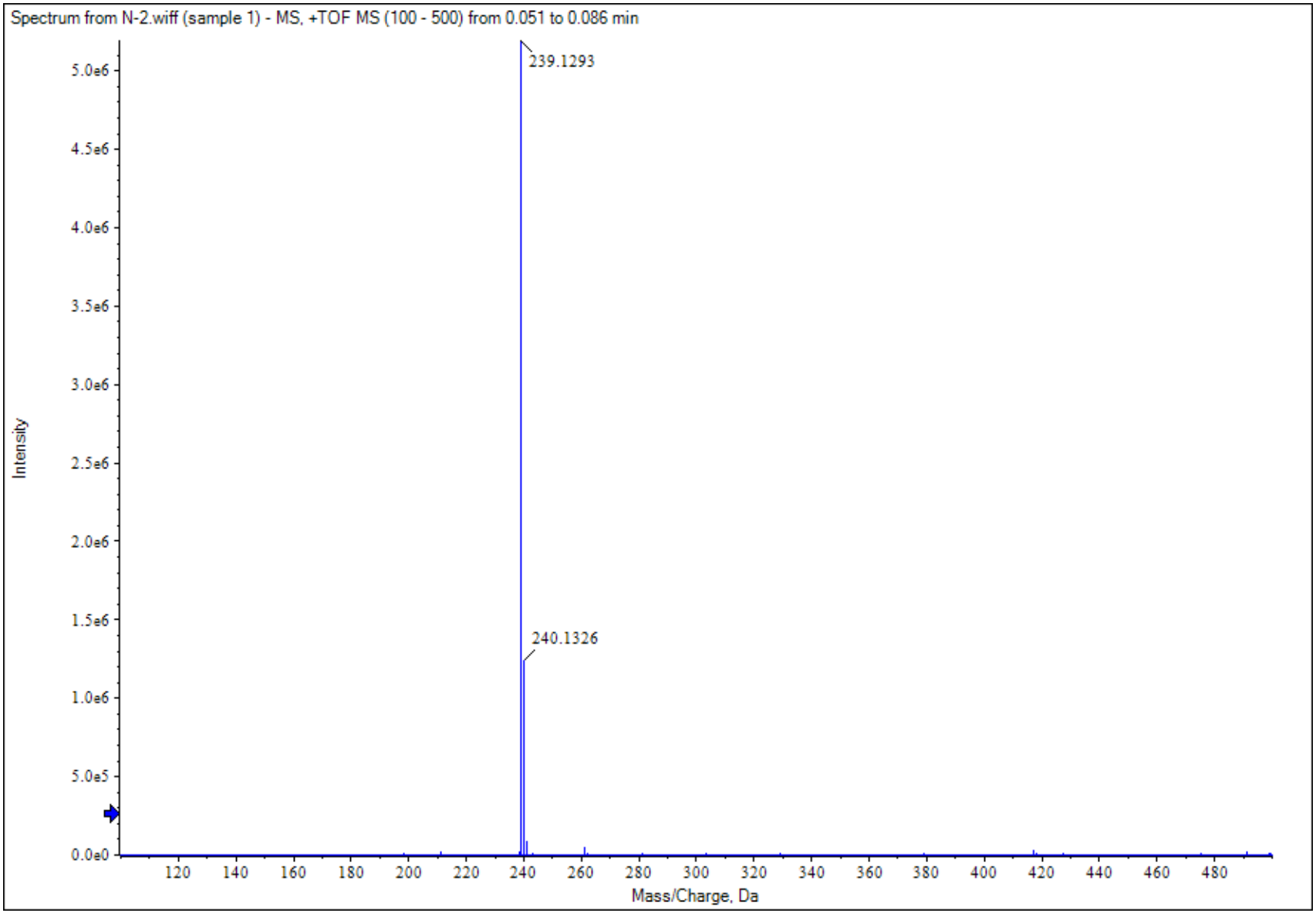
TOCSY of compound 4d



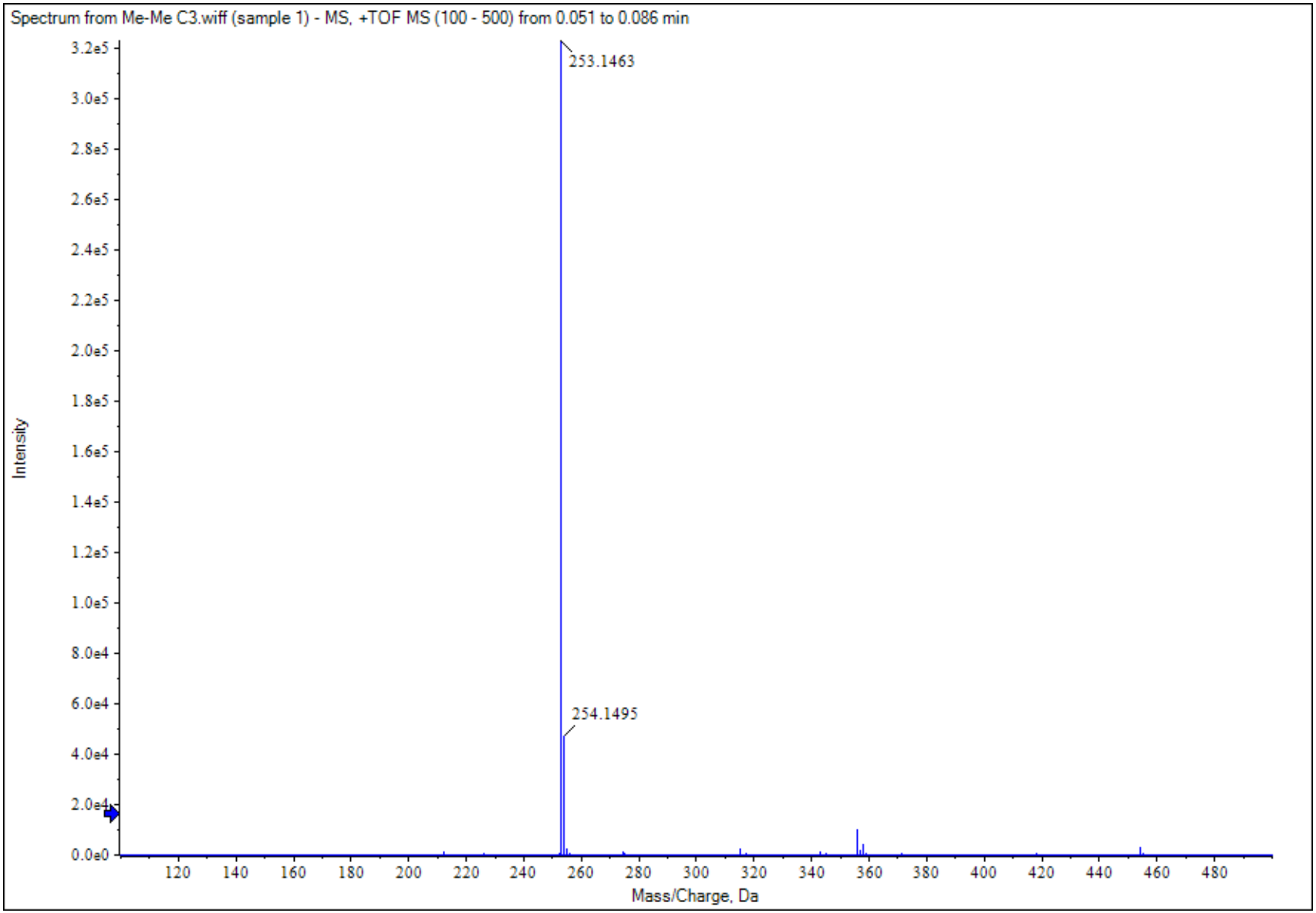
HRMS of compound 3a



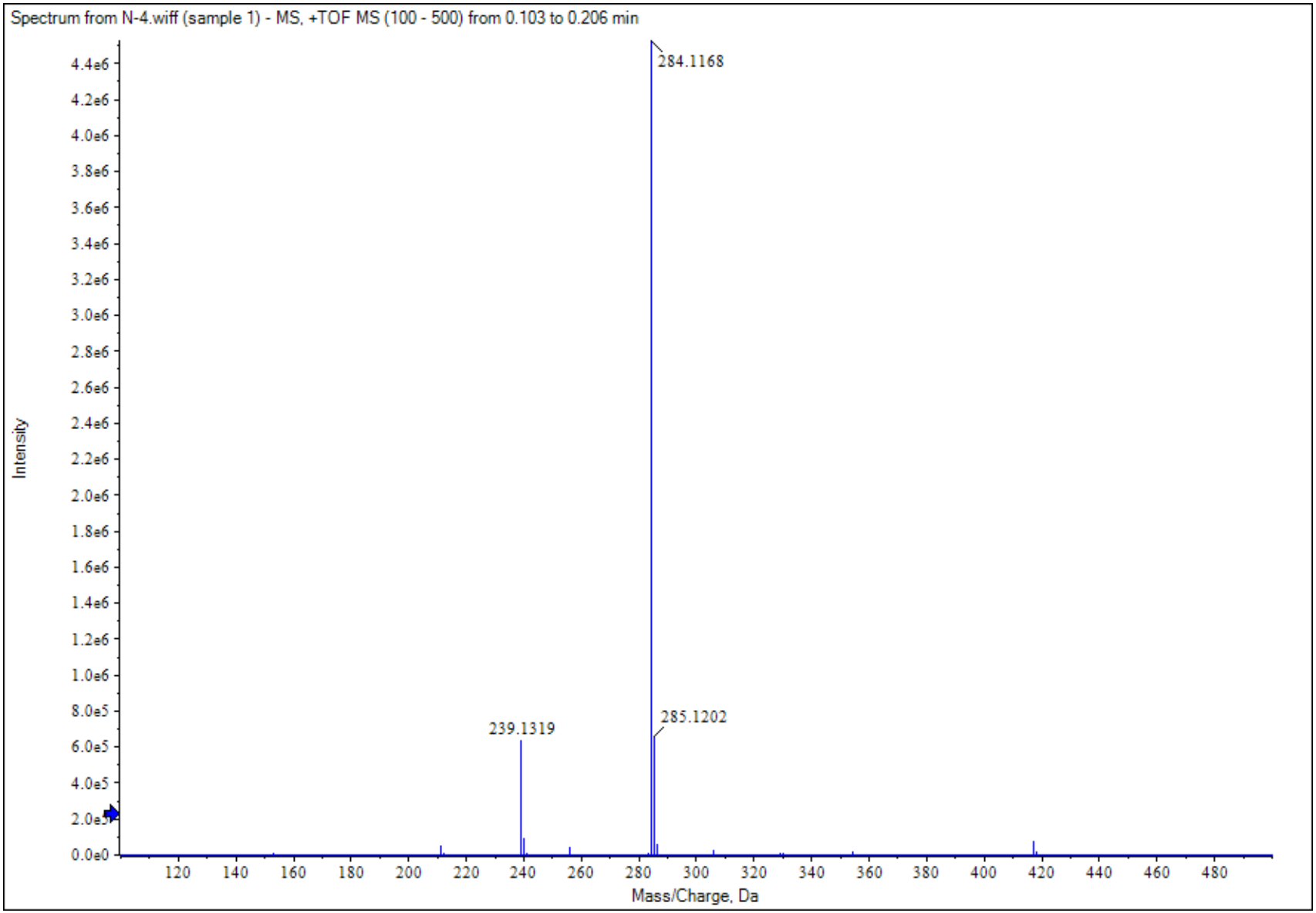
HRMS of compound 3g



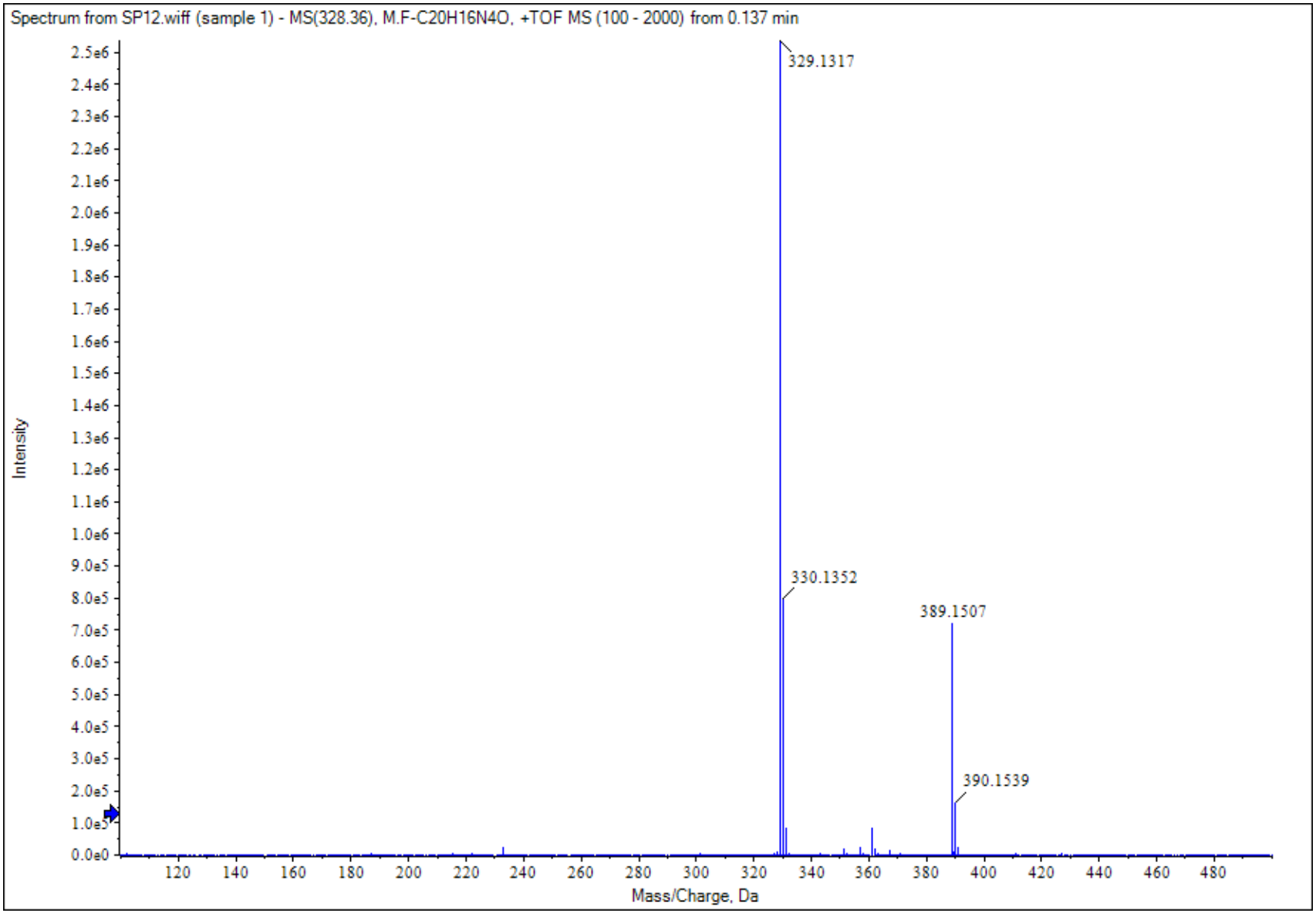
HRMS of compound 3h



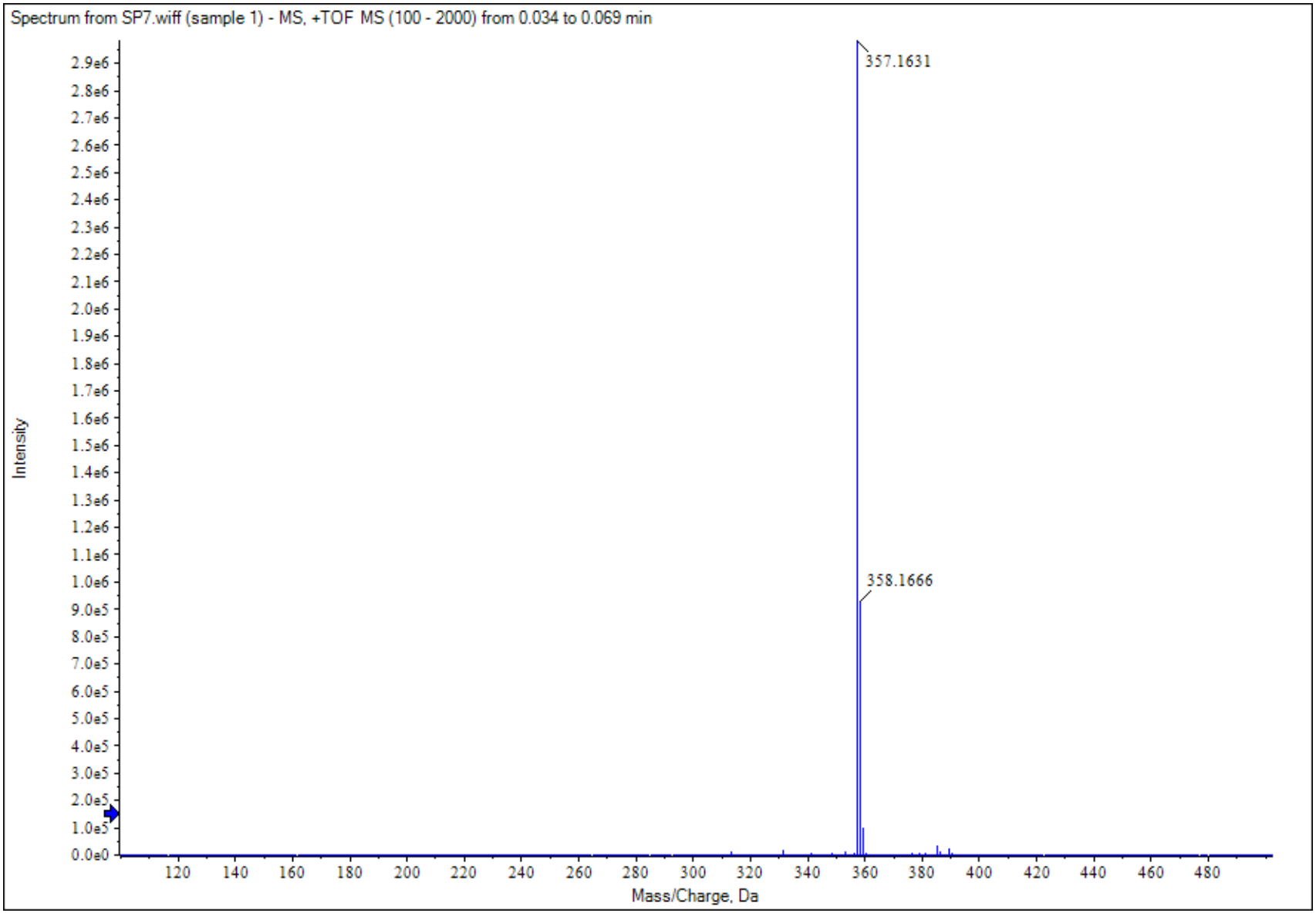
HRMS of compound 3i



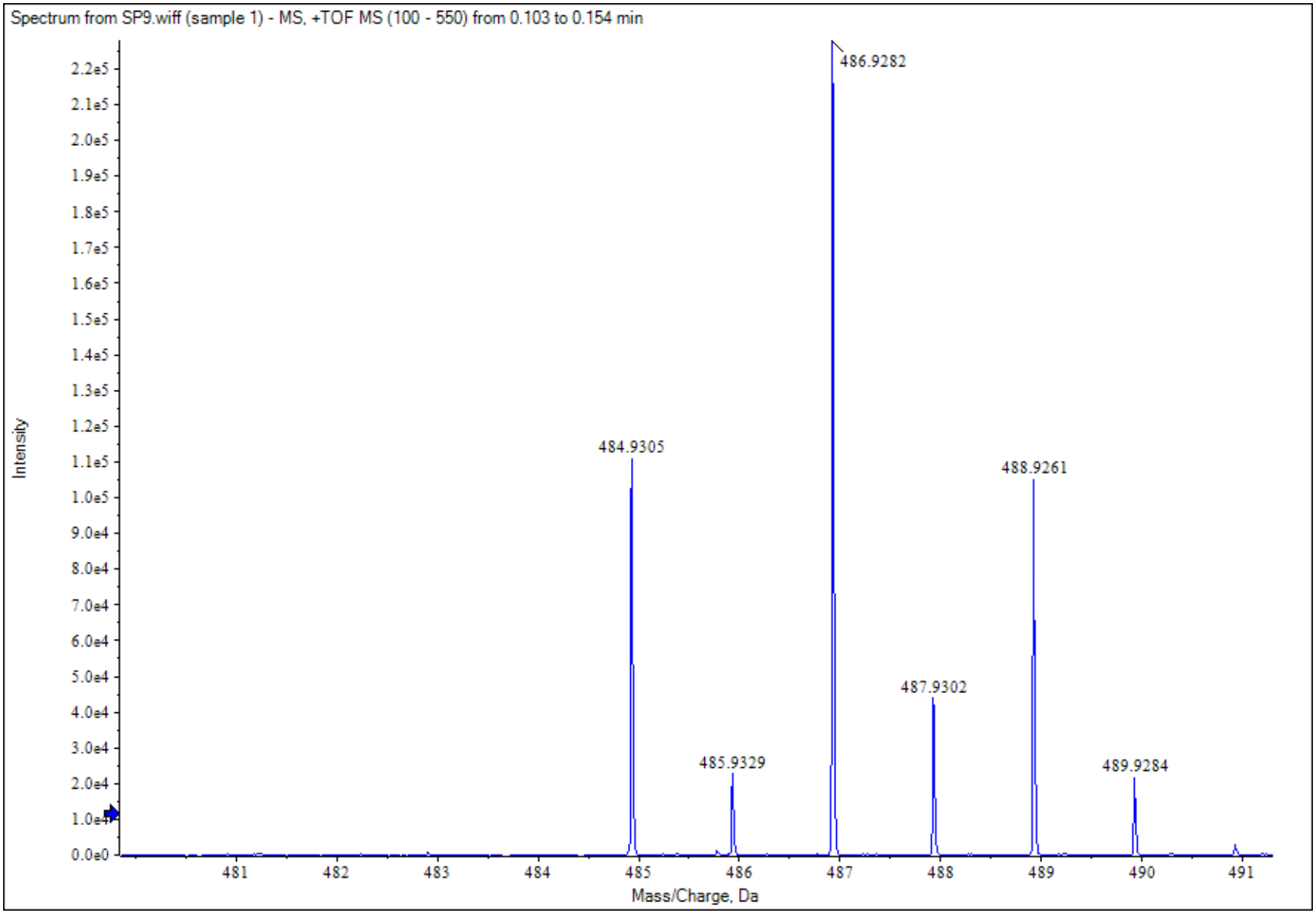
HRMS of compound 3n



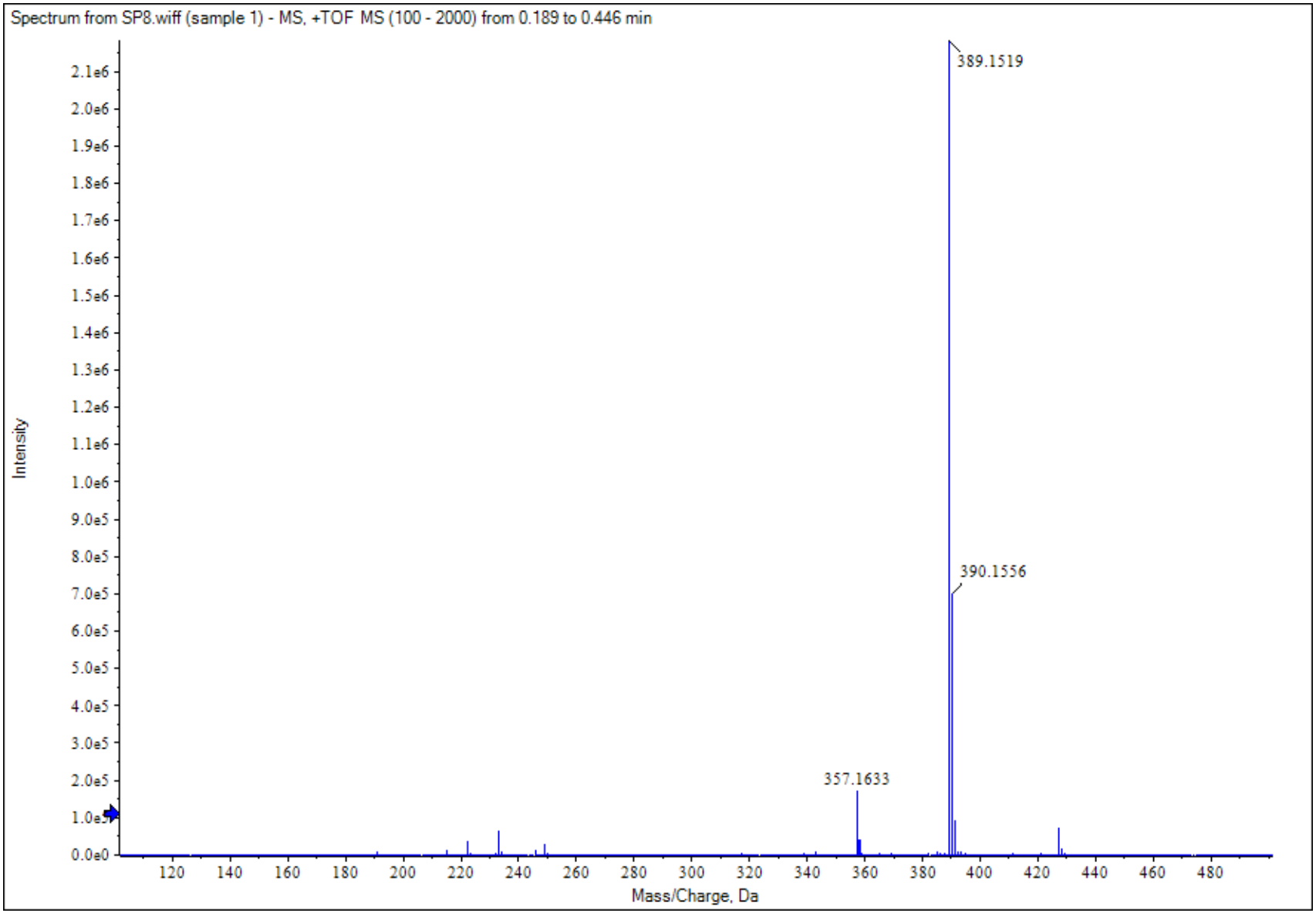
HRMS of compound 4a



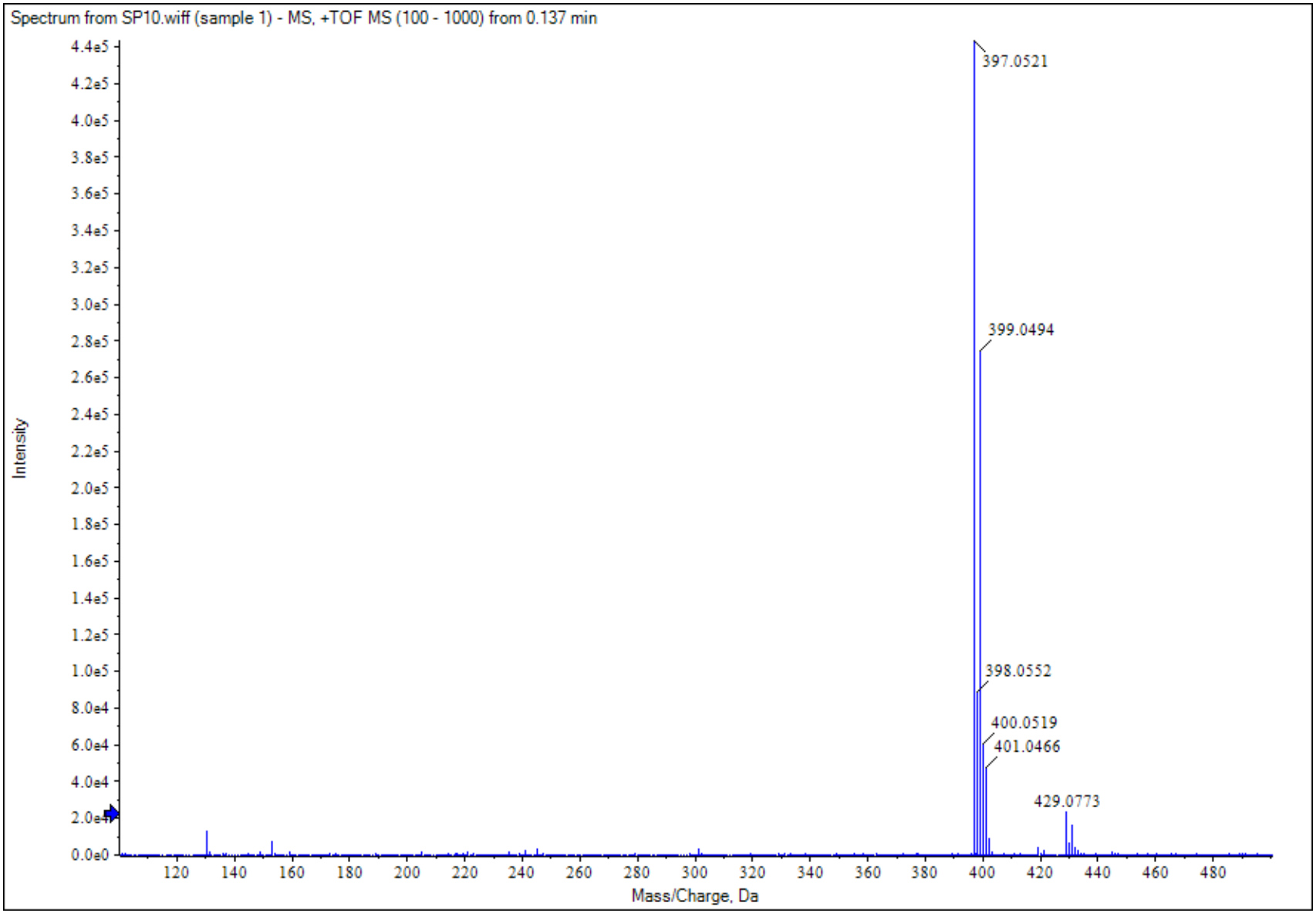
HRMS of compound 4b



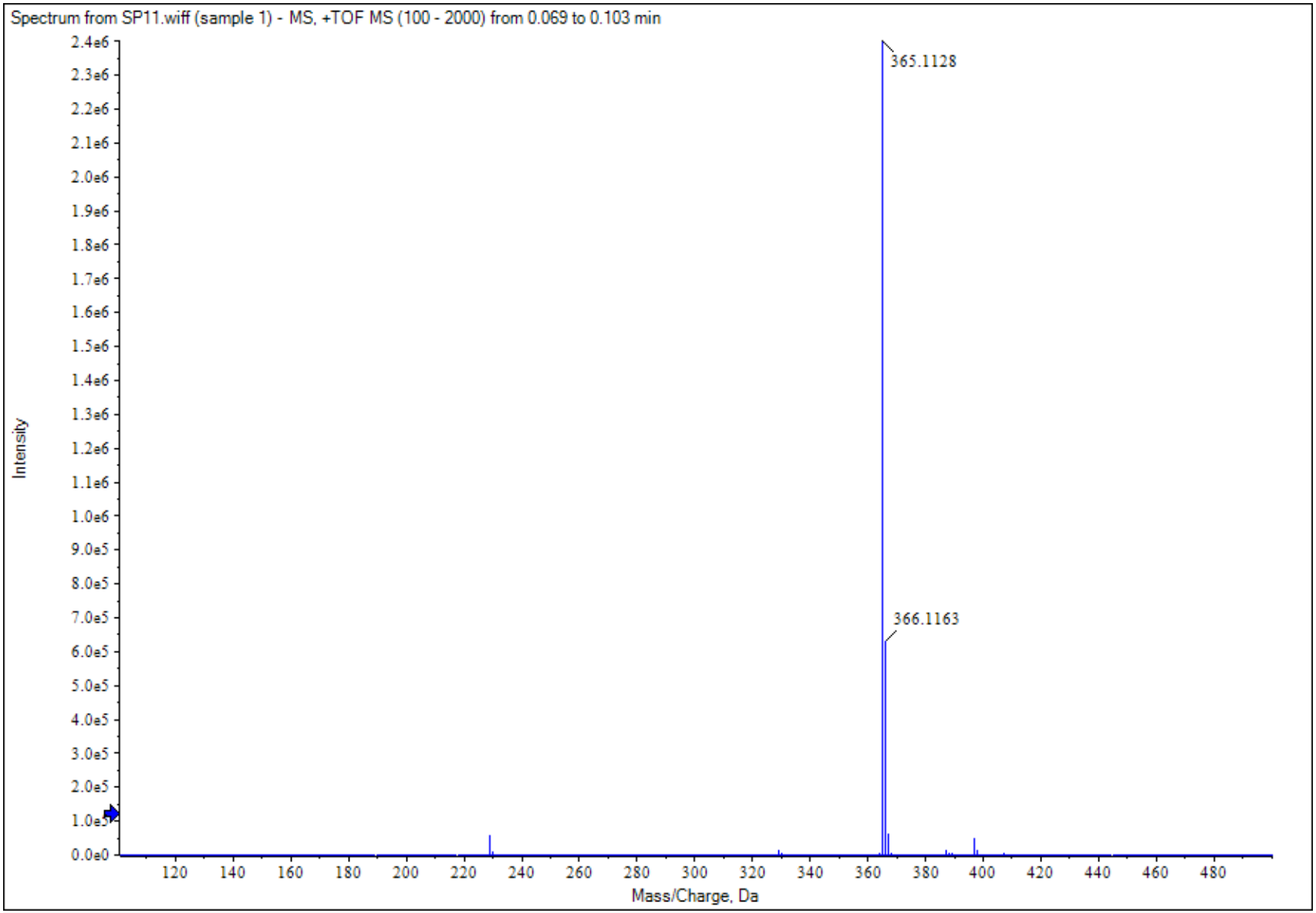
HRMS of compound 4c



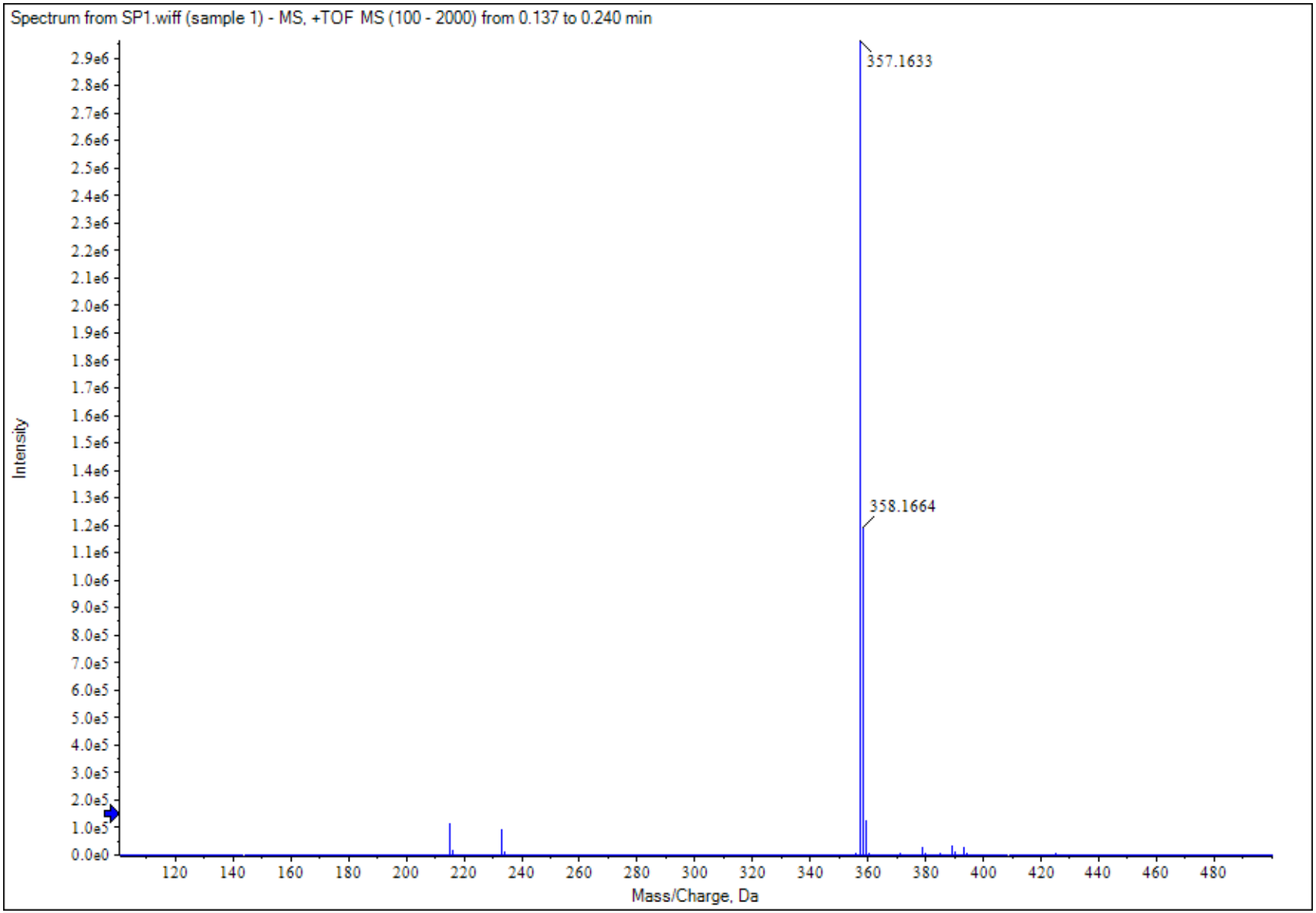
HRMS of compound 4d



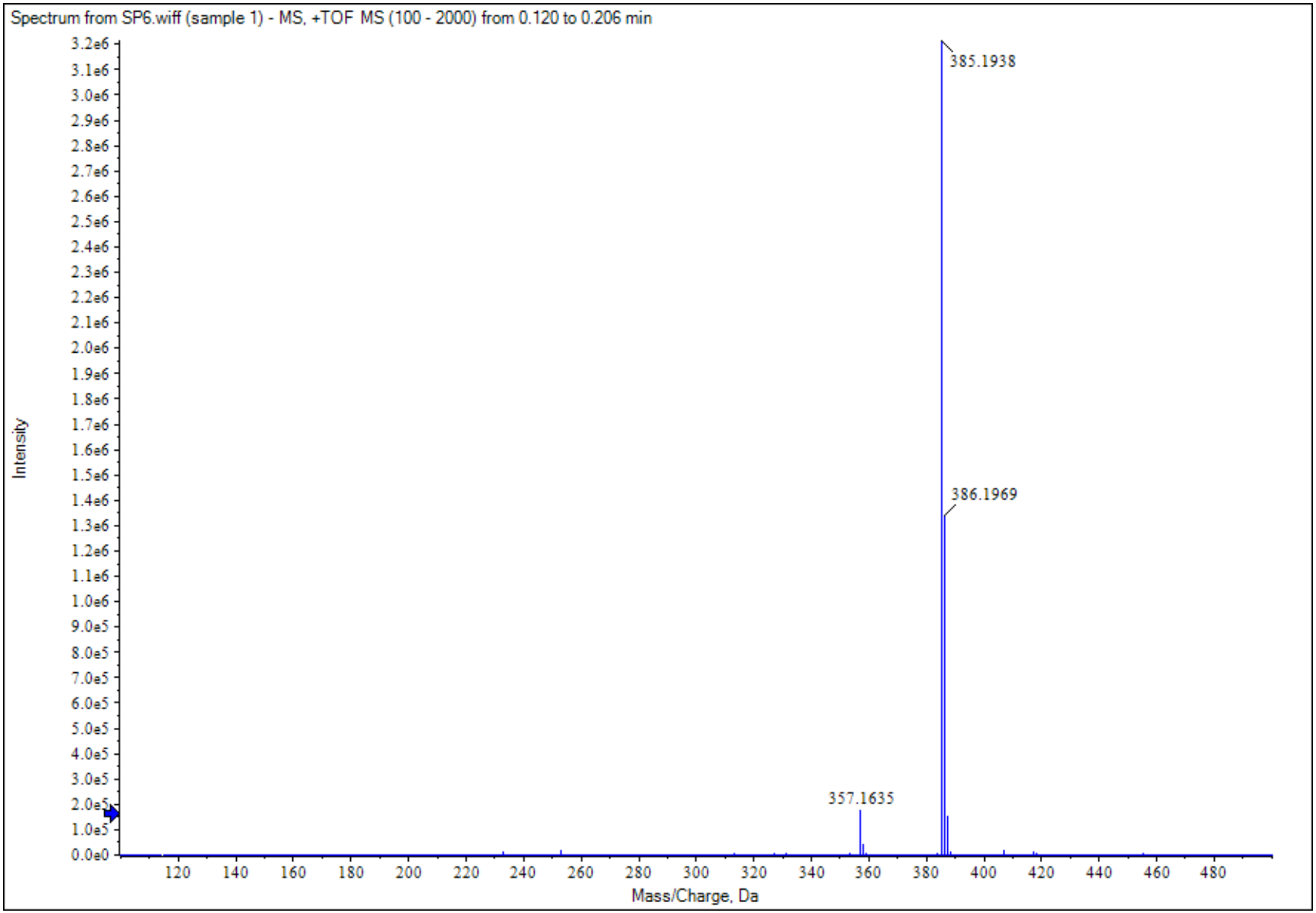
HRMS of compound 4e



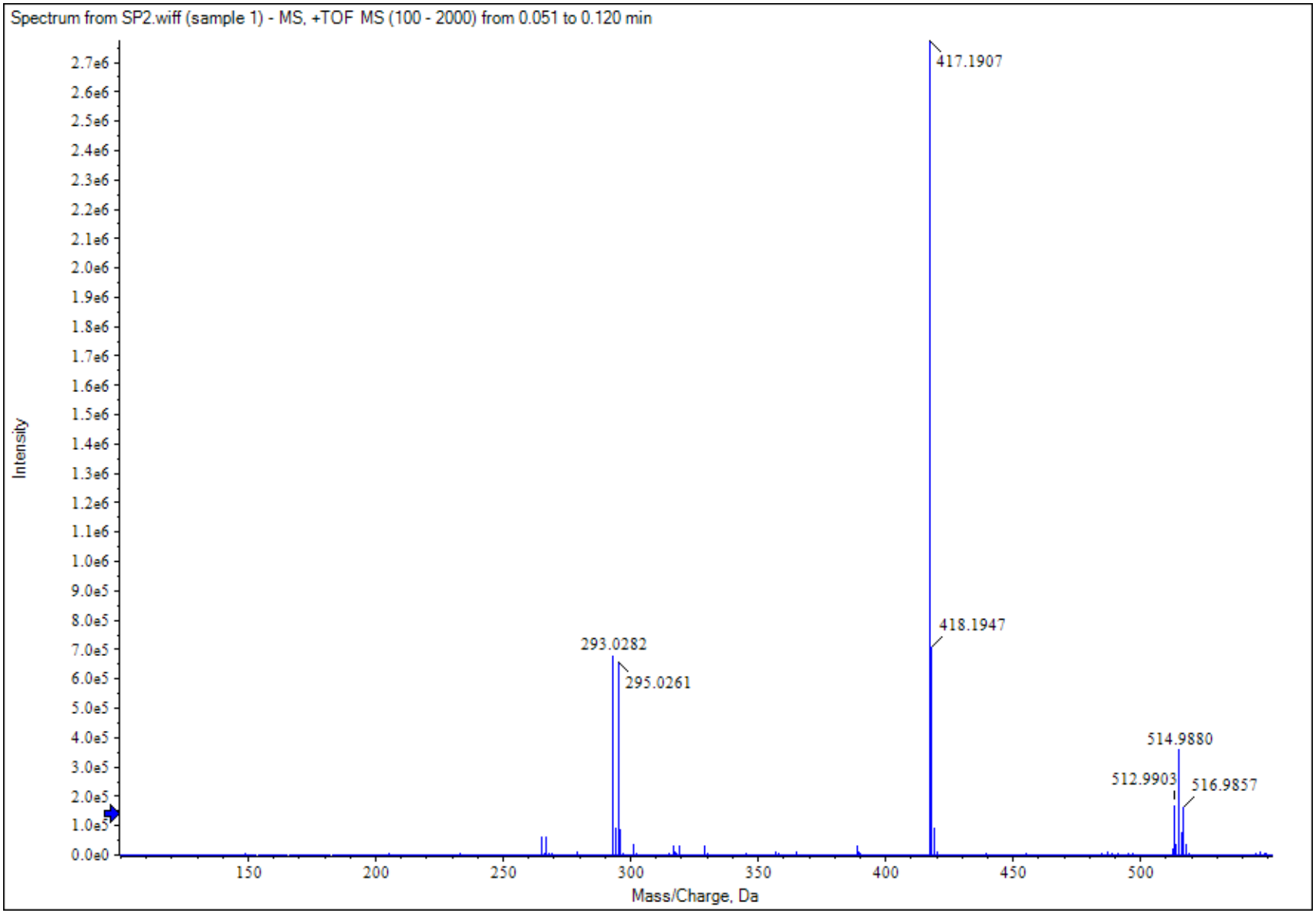
HRMS of compound 4f



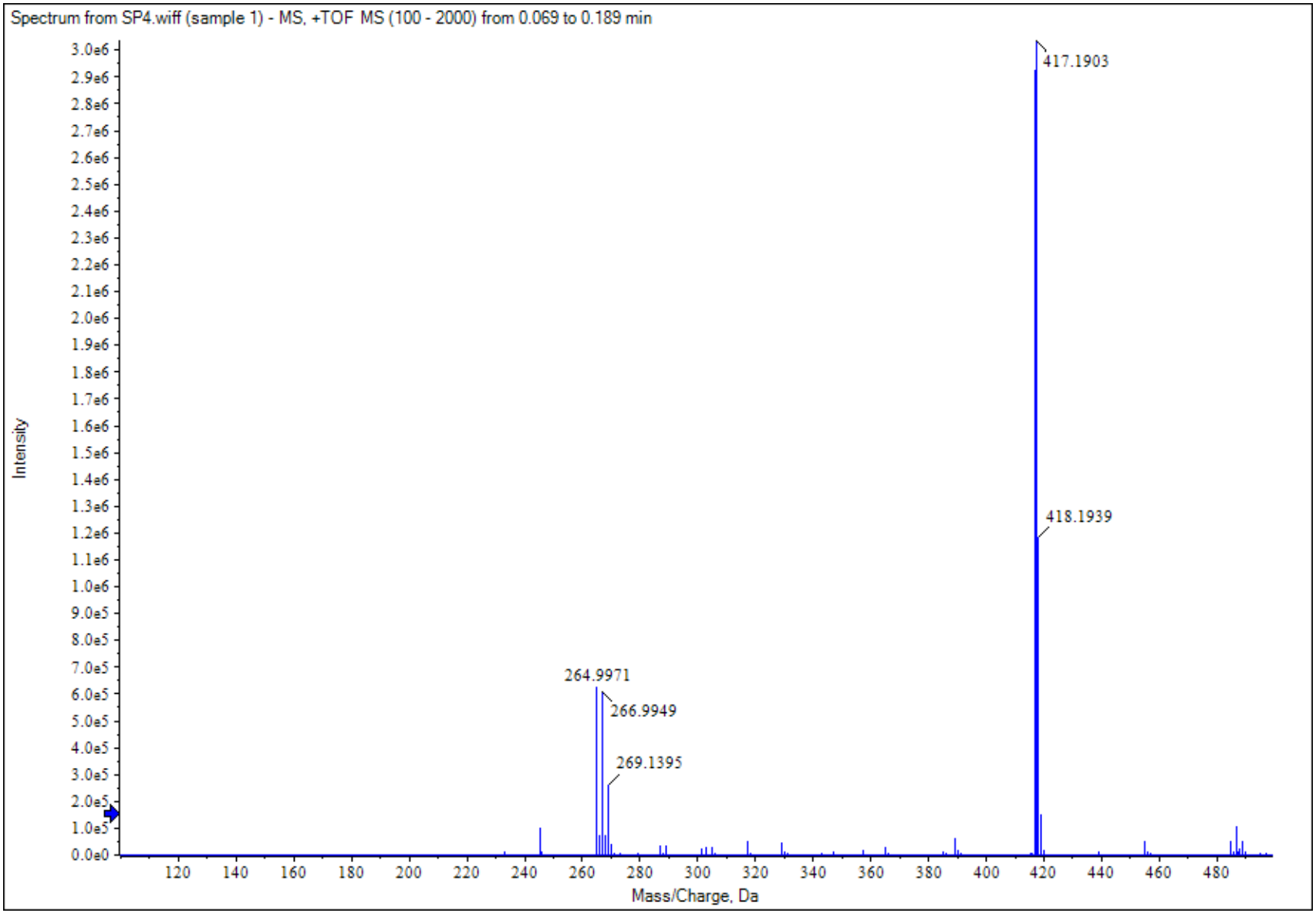
HRMS of compound 4h



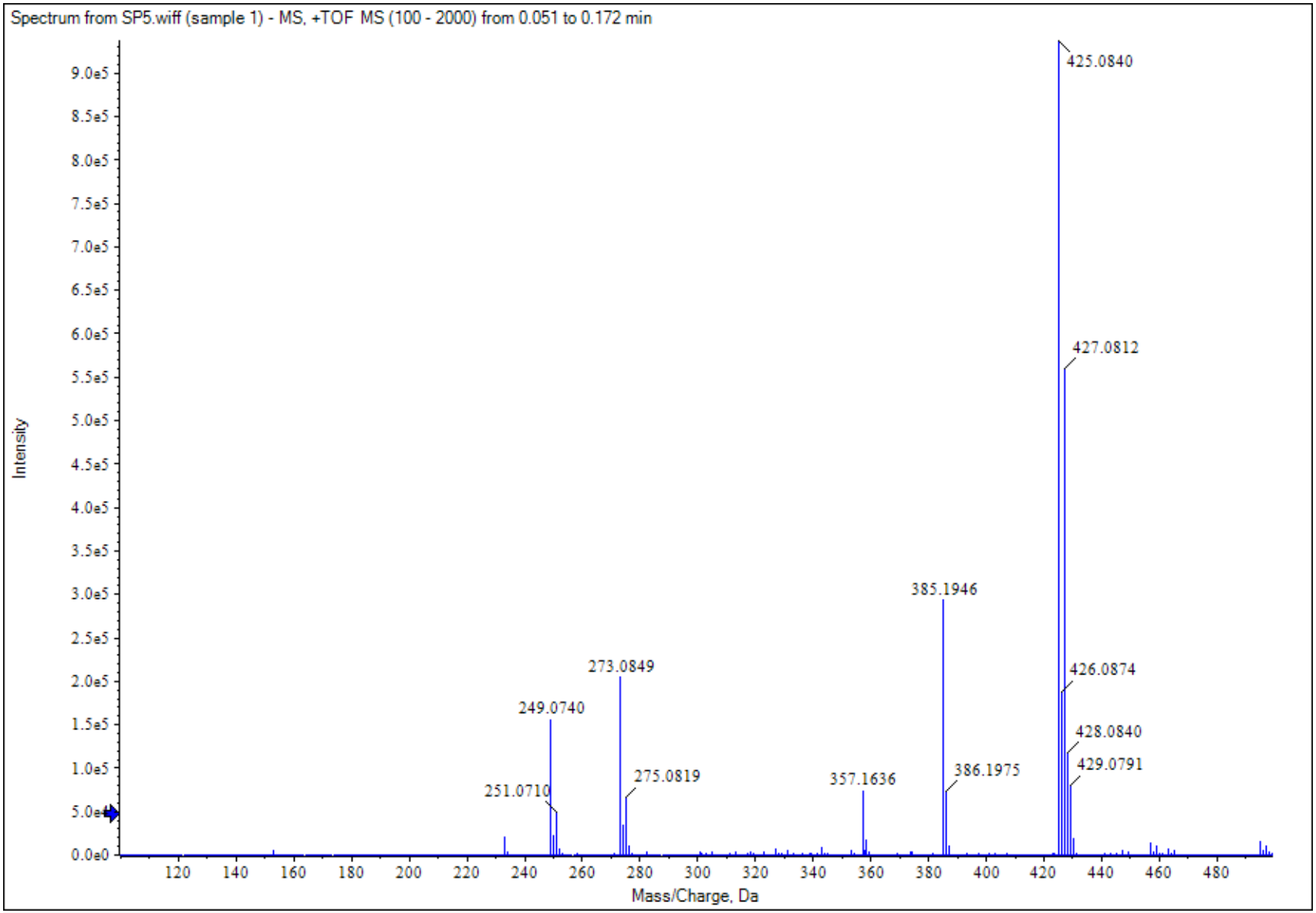
HRMS of compound 4i



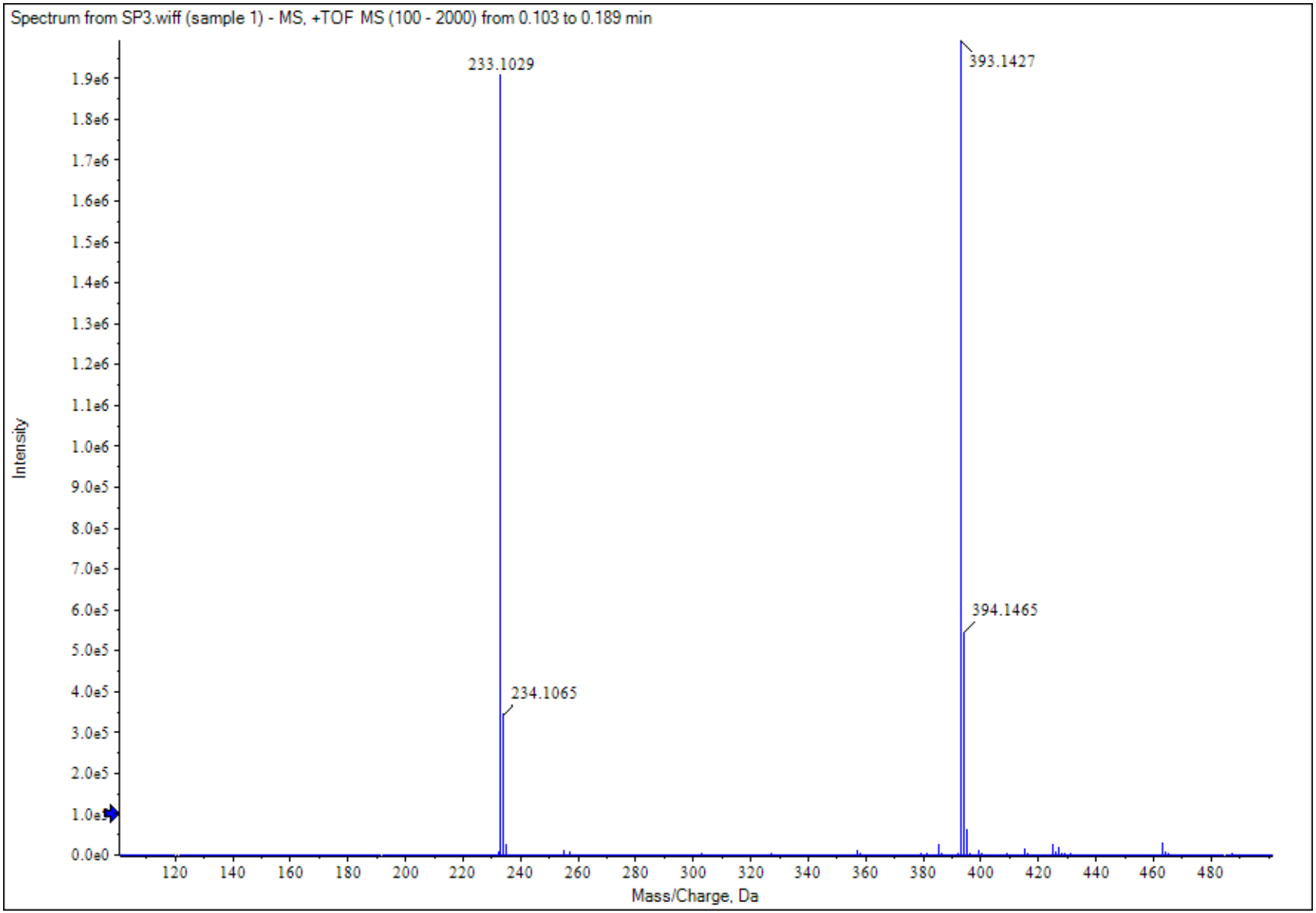
HRMS of compound 4j



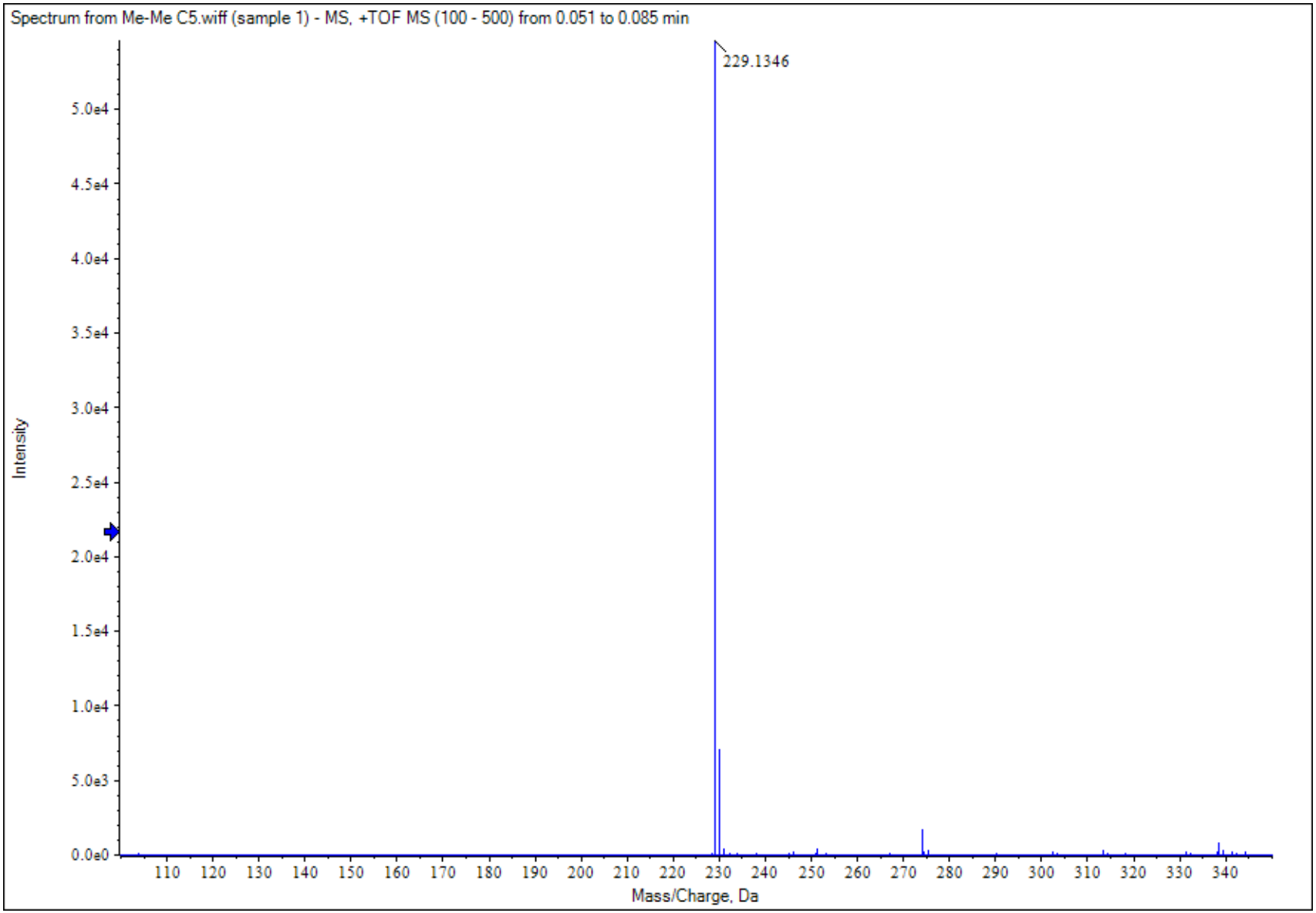
HRMS of compound 4k



HRMS of compound 4l



HRMS of compound 4m



HRMS of compound 18