

Supporting Information

Palladium single-atom/cluster cocatalyst supported on non-enzymatic browning glucose breaks the activity-selectivity trade-off in C(sp³)-H arylation

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Supplementary Methods

All the reagents were purchased from Aladdin and Alfa without further purification. Thin layer chromatography (TLC) was performed on pre-coated silica gel GF254 plates. The ^1H NMR and ^{13}C NMR spectra were measured on a 600 MHz Bruker Avance III nuclear magnetic resonance spectrometer, using CDCl_3 or DMSO as the solvent with tetramethylsilane (TMS) as the internal standard. Chemical shifts (δ) are expressed in ppm. The structures of known compounds were further corroborated by comparing their ^1H NMR data with those of literature. The HRMS(ESI) analysis was detected on Thermo Scientific Q Exactive Focus or Shimadzu LCMS-IT-TOF.

X-ray diffraction (XRD) spectra were obtained on Regaku Ultima IV. Fourier Transform Infrared spectrometer (FTIR) were obtained on Thermo-Fisher IS5. X-ray photoelectron spectra (XPS) were collected on a Thermo Fischer ESCA LAB 250 spectrometers with monochromatic $\text{Al K}\alpha$ as the X-ray source. Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) of Pd in the solid samples was performed on an Agilent 720. The transmission electron microscope (TEM) and high resolution transmission electron microscopy (HRTEM) images were recorded on a FEI Talos 200A transmission electron microscope employing an accelerating voltage of 200 kV. High-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM), energy-dispersive X-ray spectroscopy (EDS) mapping and aberration corrected high-angle annular dark-field scanning transmission electron microscopy (AC HAADF-STEM) were performed on a Thermo-Fisher Themis Z operated at 300 kV. Pd K-edge X-ray absorption fine structure (XAFS) analyses were performed with Si (111) crystal monochromators at the BL14W Beam line at the Shanghai Synchrotron Radiation Facility (SSRF) (Shanghai, China). Before the analysis at the beamline, samples were placed into aluminum sample holders and sealed using Kapton tape film. The XAFS spectra were recorded at room temperature using a 4-channel Silicon Drift Detector (SDD) Bruker 5040. Pd K-edge extended X-ray absorption fine structure (EXAFS) spectra were recorded in transmission mode. Negligible changes in the line-shape and peak position of Pd K-edge XANES spectra were observed between two scans taken for a specific sample. The spectra were analyzed by the software codes Athena. Solid state ^{13}C NMR and ^{27}Si NMR experiments were performed on a 600 MHz NMR spectrometer (JEOL ECZ600R/S3) equipped with a 14.09T superconducting magnet and a 3.2 mm double-resonance MAS probe (JEOL RESONANCE Inc., Japan).

Supplementary Note 1: The TEM of catalysts

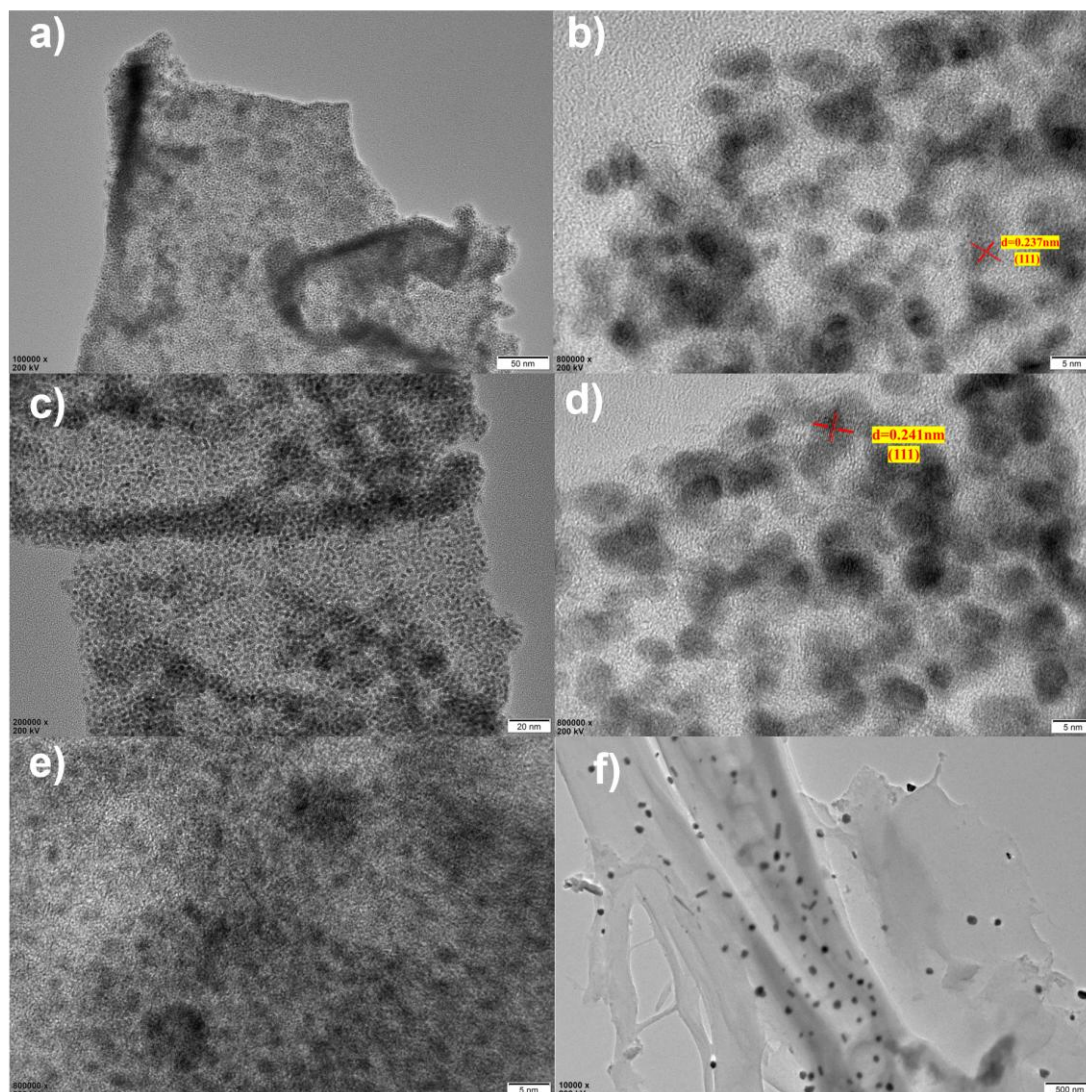


Fig. S1 a) TEM image of fresh Pd/APTE-BTMO-glucose; b) HRTEM image of fresh Pd/APTE-BTMO-glucose; c) TEM image of used (1st) Pd/APTE-BTMO-glucose; d) HRTEM image of used (1st) Pd/APTE-BTMO-glucose; e) TEM image of fresh Pd/APTE-BTMO-cellulose; f) TEM image of used Pd/APTE-BTMO-cellulose.

Supplementary Note 2: The ICP-OES analysis results

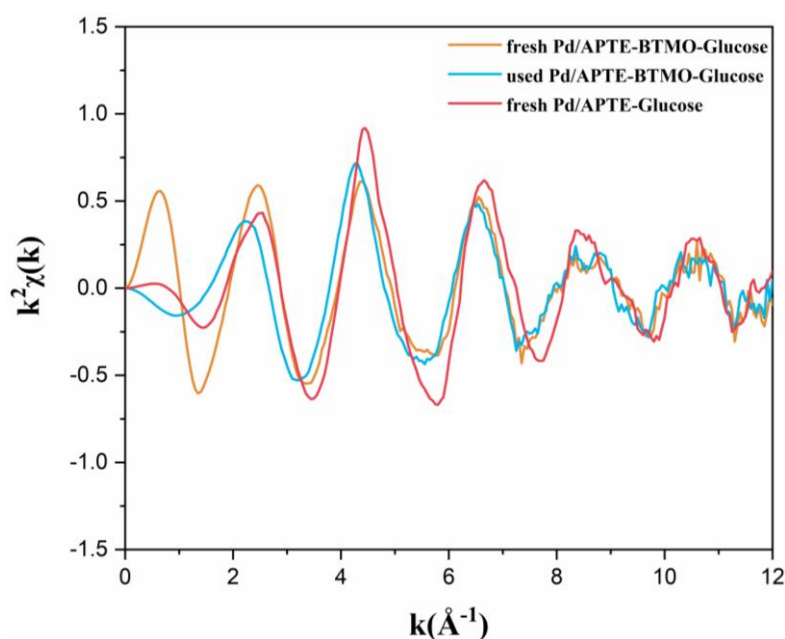
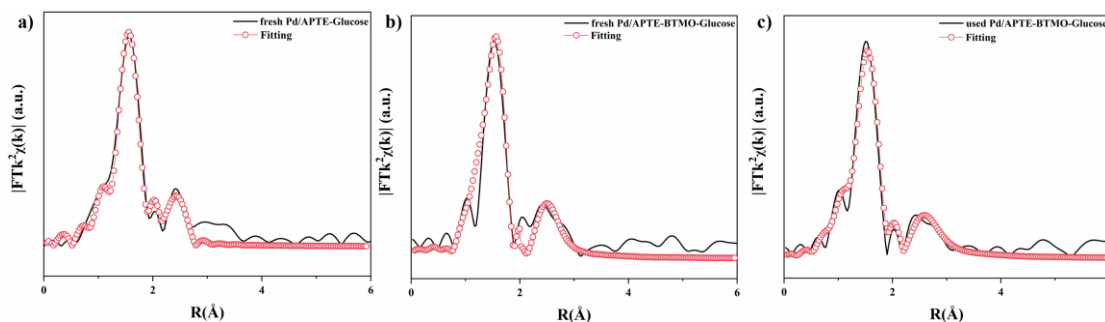
Table S1. Characterization results of ICP-OES for C(sp³)-H arylation reaction

catalyst	Pd content (wt.%)
fresh Pd/APTE -glucose	3.27
used Pd/APTE-glucose (1 st cycle)	2.09
used Pd/APTE-glucose (5 th cycle)	1.96

Table S2. Characterization results of ICP-OES for C(sp²)-H arylation reaction

catalyst	Pd content (wt.%)
fresh Pd/APTE-BTMO-glucose	3.37
used Pd/APTE-BTMO-glucose (1 st cycle)	2.44
used Pd/APTE-BTMO-glucose (5 th cycle)	2.31
fresh Pd/APTE-BTMO-cellulose	3.36
used Pd/APTE-BTMO-cellulose (1 st cycle)	1.63

Supplementary Note 3: Original EXAFS oscillation data and the FEFF-fitted EXAFS spectra

**Fig. S2** Original EXAFS oscillation data**Fig. S3** a) The FEFF-fitted EXAFS spectra of fresh Pd/APTE-glucose; b) The FEFF-fitted EXAFS spectra of fresh Pd/APTE-BTMO-glucose; c) The FEFF-fitted EXAFS spectra of used Pd/APTE-BTMO-glucose.

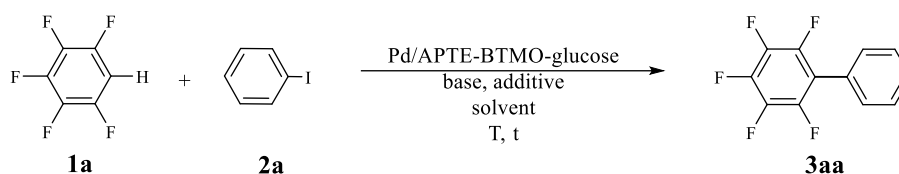
Supplementary Note 4: The EXAFS fitting results

Table S3. Structural parameters of Pd/APTE-BTMO-glucose catalyst extracted from the EXAFS fitting

Catalysts	Scattering pair	CN	R(Å)	$\sigma^2(10^{-3}\text{\AA}^2)$	ΔE	R-factor
Fresh Pd/APTE-glucose	Pd-N	3.8±0.6	2.03	2.1	2.9	0.008
	Pd-Pd	0.8±0.3	2.71	6.8	-3.9	0.011
Fresh Pd/APTE-BTMO-glucose	Pd-N	3.9±0.4	2.03	4.2	8.7	0.011
	Pd-Pd	0.8±0.1	2.78	4.0	2.0	0.019
Used Pd/APTE-BTMO-glucose	Pd-N	4.2±0.4	2.03	4.2	-2.9	0.009
	Pd-Pd	1.3±0.6	2.74	3.0	-8.3	0.016

Supplementary Note 5: Experimental Details

Table S4. Reaction conditions screening ^a



Entry	Base	Additive	Solvent	T (°C)	t (h)	Yield (%) ^c
1	K ₃ PO ₄	pivalic acid	DMF	100	24	68
2	K ₃ PO ₄	pivalic acid	DMF	90	24	54
3	K ₃ PO ₄	pivalic acid	DMF	110	24	78
4	K ₃ PO ₄	pivalic acid	DMF	120	24	64
5	KHCO ₃	pivalic acid	DMF	110	24	83
6	NaHCO ₃	pivalic acid	DMF	110	24	76
7	KOAc	pivalic acid	DMF	110	24	74
8	K ₂ CO ₃	pivalic acid	DMF	110	24	61
9	KHCO ₃	isovaleric acid	DMF	110	24	70
10	KHCO ₃	<i>p</i> -toluic acid	DMF	110	24	61
11	KHCO ₃	acetic acid	DMF	110	24	56
12	KHCO ₃	isobutyric acid	DMF	110	24	88
13	KHCO ₃	isobutyric acid	DMA	110	24	79
14	KHCO ₃	isobutyric acid	THF	110	24	70
15	KHCO ₃	isobutyric acid	DMF	110	8	59
16	KHCO ₃	isobutyric acid	DMF	110	12	71
17	KHCO ₃	isobutyric acid	DMF	110	36	82
18 ^b	KHCO ₃	isobutyric acid	DMF	110	24	NR
19	-	isobutyric acid	DMF	110	24	NR
20	KHCO ₃	-	DMF	110	24	trace

^a Reaction conditions: catalyst (25 mg), polyfluorobenzene **1a** (0.2 mmol), iodobenzene **2a** (0.2 mmol), base (2.0 eq.), additive (0.5 eq.), solvent (1 mL); ^b without catalyst; ^c Isolated yield.

Table S5. The results of hot filtration test for C(sp³)-H arylation reaction ^a

Catalyst	Hot-filtration test	
	Conversion (%)	Conversion (%)
Pd/APTE-glucose	44	45
Pd/APTE-BTMO-cellulose	31	40

Table S6. The results of hot filtration test for C(sp²)-H arylation reaction ^a

Catalyst	Hot-filtration test	
	Conversion (%)	Conversion (%)
Pd/APTE-BTMO-glucose	52	53

Table S7. Heterogeneous/homogeneous Pd catalysts screening ^a

Reaction scheme for C(sp³)-H arylation: 4a (2,3,4,5-tetrafluorophenyl) reacts with 2b (4-iodobiphenyl) in the presence of Pd/APTE-BTMO-glucose, K₂CO₃ (2.0 equiv.), and isobutyric acid (0.5 equiv.) in DMF at 110 °C for 24 h to form 5ab (2,3,4,5-tetrafluoro-2'-(4-phenylbiphen-1-yl)biphenyl).

Reaction scheme for C(sp²)-H arylation: 1a (N-methyl-N-(2-methylphenyl)acetamide) reacts with 2a (4-iodobiphenyl) in the presence of Pd/APTE-BTMO-glucose, K₂CO₃ (3.0 equiv.), and *t*-Amyl-OH:H₂O=16:1 at 115 °C for 24 h to form mono-3aa' and di-3aa'.

Entry	Catalyst	Yield % ^b				TON ^c	Entry	Catalyst	Yield % ^b			TON ^d
		3aa	3aa'	Biphenyl	1a				5ab	Biphenyl	4a	
1	Pd/APTE-BTMO-glucose	60	33	8	6	13	6	Pd/APTE-BTMO-glucose	88	trace	10	26
2	Pd(OAc) ₂ (7 mol%)	61	34	7	5	14	7	Pd/APTE-glucose	69	trace	30	20
3	5 wt.% Pd/C (commercial)	52	23	19	24	11	8	Pd(OAc) ₂ (3.5 mol%)	63	30	36	18
4	Pd/APTE-BTMO-cellulose	55	23	13	14	11	9	5 wt.% Pd/C (commercial)	71	20	19	23
5	Pd/APTE-glucose	49	46	6	5	14	10	Pd/APTE-BTMO-cellulose	81	trace	16	24

^a Reaction conditions: **1a** (0.1 mmol), **2a** (0.3 mmol), catalyst (7 mmol%), K₂CO₃ (3.0 equiv.), and *t*-Amyl-OH : H₂O (16:1, 1 mL) for 24 h at 115 °C; **4a** (0.2 mmol), **2b** (0.2 mmol), catalyst (3.5 mmol%), KHCO₃ (0.4 mmol) and isobutyric acid (0.1 mmol) in solvent DMF (1 mL) for 24 h at 110 °C. ^b Isolated yield. ^c TON calculation was based on the isolated yield of **1a**; ^d TON calculation was based on the isolated yield of **4a**.

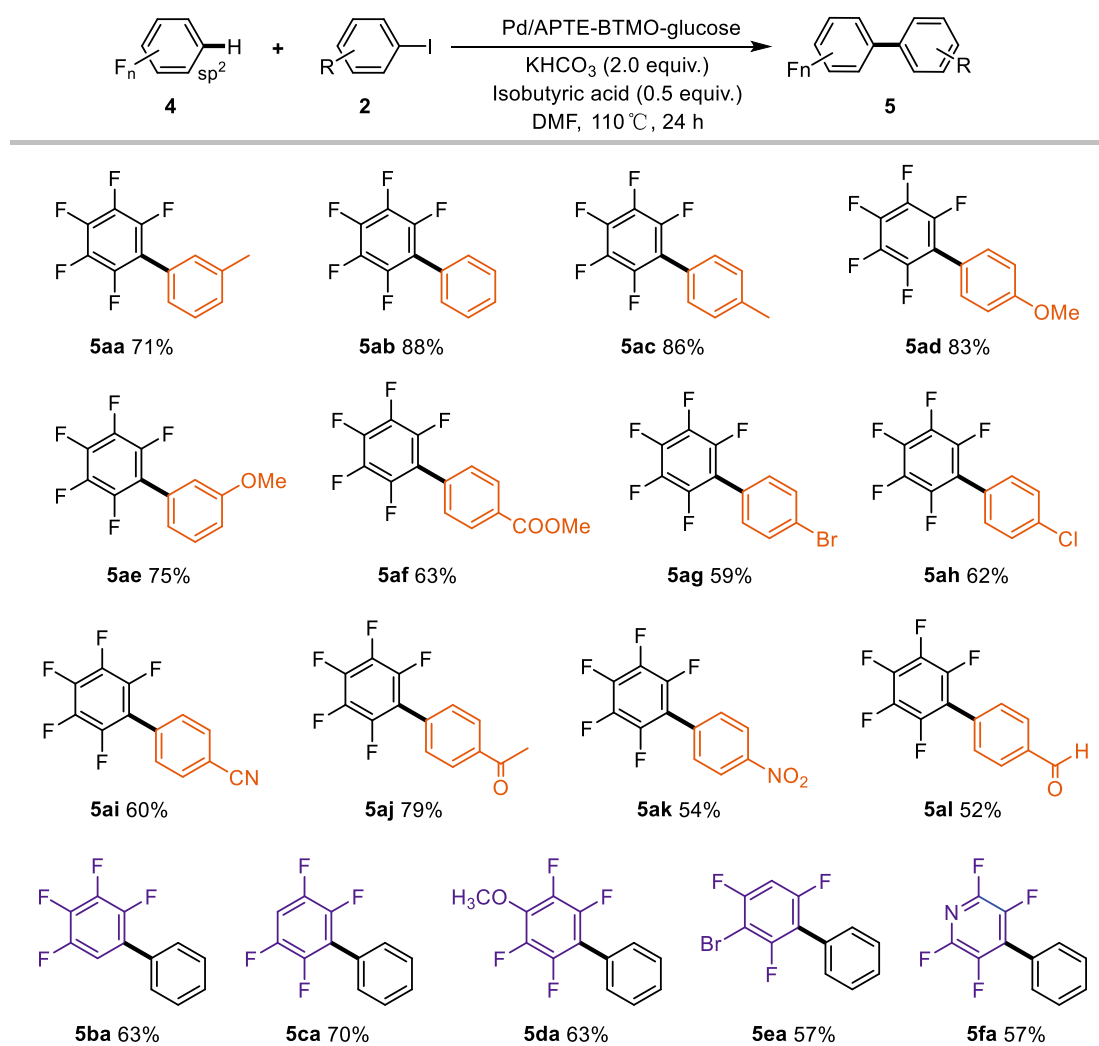
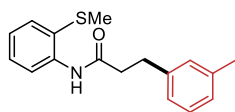
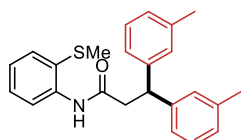


Fig. S4 The scope of Substrates for C(sp²)-H bond arylation: **4** (0.2 mmol), **2** (0.2 mmol), Pd/APTE-BTMO-glucose (25 mg), KHCO₃ (0.4 mmol) and isobutyric acid (0.1 mmol) in solvent DMF (1 mL) for 24 h at 110 °C.

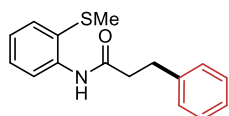
Characterization data for products



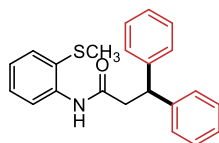
N-(2-(methylthio)phenyl)-3-(m-tolyl)propanamide **3aa**. Yield: 49% (M=285.40, 14.0 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.32 (d, J = 8.3 Hz, 1H), 8.23 (s, 1H), 7.45 (d, J = 7.8 Hz, 1H), 7.28 (t, J = 7.9 Hz, 1H), 7.18 (t, J = 7.5 Hz, 1H), 7.08 – 7.04 (m, 3H), 7.01 (d, J = 7.6 Hz, 1H), 3.04 (t, J = 7.8 Hz, 2H), 2.73 (t, J = 7.8 Hz, 2H), 2.32 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.5, 140.5, 138.4, 138.2, 133.1, 129.2, 129.0, 128.5, 127.1, 125.3, 125.1, 124.3, 120.6, 39.7, 31.4, 21.4, 18.9; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{17}\text{H}_{20}\text{NOS}$ 286.1265, found 286.1233.



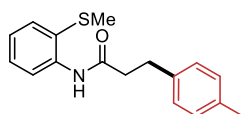
N-(2-(methylthio)phenyl)-3,3-di-m-tolylpropanamide **3aa'**. Yield: 46% (M=375.53, 17.3 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.24 (d, J = 8.3 Hz, 1H), 8.19 (s, 1H), 7.41 (d, J = 7.6 Hz, 1H), 7.23 (d, J = 7.2 Hz, 1H), 7.16 (t, J = 7.9 Hz, 2H), 7.09 (d, J = 6.7 Hz, 4H), 7.02 – 6.97 (m, 3H), 4.59 (t, J = 7.8 Hz, 1H), 3.13 (d, J = 7.8 Hz, 2H), 2.29 (s, 6H), 2.15 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.5, 143.6 (2C), 138.4, 138.2 (2C), 133.2, 129.0, 128.6 (2C), 128.6 (2C), 127.4 (2C), 125.1, 124.6 (2C), 124.3, 120.7, 47.4, 44.7, 21.5, 18.9; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{24}\text{H}_{26}\text{NOS}$ 376.1735, found 376.1696.



N-(2-(methylthio)phenyl)-3-phenylpropanamide **3ab**.¹ Yield: 56% (M=271.38, 15.2 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.33 (d, J = 8.2 Hz, 1H), 8.23 (s, 1H), 7.46 (d, J = 7.7 Hz, 1H), 7.31-7.26 (m, 5H), 7.20 (t, J = 7.2 Hz, 1H), 7.05 (t, J = 7.6 Hz, 1H), 3.09 (t, J = 7.7 Hz, 2H), 2.75 (t, J = 7.7 Hz, 2H), 2.26 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.4, 140.6, 138.3, 133.1, 129.0, 128.6, 128.4, 126.4, 125.1, 124.3, 120.6, 39.7, 31.5, 18.9.

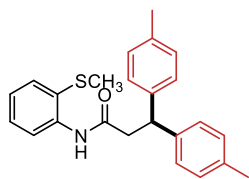


N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ab'**.¹ Yield: 33% (M=347.48, 11.5 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.20 (d, J = 7.6 Hz, 2H), 7.54 (d, J = 8.0 Hz, 2H), 7.44-7.38 (m, 3H), 7.33-7.26 (m, 4H), 7.26-7.19 (m, 2H), 7.03 (t, J = 7.6 Hz, 1H), 4.77 (t, J = 7.7 Hz, 1H), 3.17 (t, J = 7.5 Hz, 2H), 2.17 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.3, 143.5, 138.3, 133.2, 129.0, 128.7, 127.8, 126.6, 125.1, 124.3, 120.6, 47.4, 44.6, 19.0.

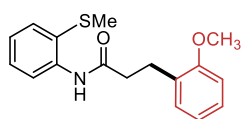


N-(2-(methylthio)phenyl)-3-(p-tolyl)propanamide **3ac**.² Yield: 55% (M=285.40, 15.7 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.33 (d, J = 8.3 Hz, 1H), 8.23 (s, 1H), 7.46 (d, J = 7.7 Hz, 1H), 7.29 (t, J = 7.8 Hz,

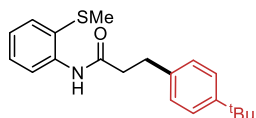
1H), 7.15 (d, $J = 7.7$ Hz, 2H), 7.10 (d, $J = 7.7$ Hz, 2H), 7.05 (t, $J = 7.6$ Hz, 1H), 3.04 (t, $J = 7.7$ Hz, 2H), 2.72 (t, $J = 7.7$ Hz, 2H), 2.31 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.5, 138.4, 137.4, 135.8, 133.1, 129.3, 129.0, 128.2, 125.0, 124.3, 120.6, 39.8, 31.1, 21.0, 18.9.



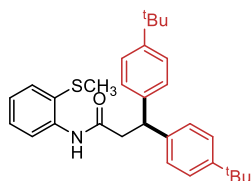
N-(2-(methylthio)phenyl)-3,3-di-p-tolylpropanamide **3ac'**.³ Yield: 34% ($M=375.53$, 12.8 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.25 (d, $J = 8.3$ Hz, 1H), 8.22 (s, 1H), 7.42 (d, $J = 7.7$ Hz, 1H), 7.23 (d, $J = 8.0$ Hz, 1H), 7.17 (d, $J = 7.8$ Hz, 4H), 7.08 (d, $J = 7.8$ Hz, 4H), 7.01 (t, $J = 7.7$ Hz, 1H), 4.61 (t, $J = 7.8$ Hz, 1H), 3.12 (d, $J = 7.8$ Hz, 2H), 2.27 (s, 6H), 2.14 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.5, 140.8, 138.5, 136.1, 133.3, 129.4, 129.0, 127.5, 125.0, 124.2, 120.6, 46.7, 44.8, 21.0, 19.0.



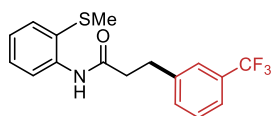
1-(2-methoxyphenyl)-N-(2-(methylthio)phenyl)propanamide **3ad**.⁴ Yield: 76% ($M=301.40$, 22.8 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.34 (d, $J = 8.3$ Hz, 1H), 8.27 (s, 1H), 7.45 (d, $J = 7.8$ Hz, 1H), 7.28 (t, $J = 7.8$ Hz, 1H), 7.21-7.18 (m, 2H), 7.04 (t, $J = 7.6$ Hz, 1H), 6.89-6.85 (m, 2H), 3.84 (s, 3H), 3.07 (t, $J = 7.8$ Hz, 2H), 2.72 (t, $J = 7.8$ Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 171.1, 157.5, 138.5, 133.1, 130.1, 129.6, 129.0, 128.7, 127.7, 124.2, 120.6, 115.4, 110.3, 55.2, 38.1, 26.8, 18.9.



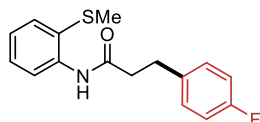
3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae**.⁵ Yield: 52% ($M=327.49$, 17.0 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.34 (d, $J = 8.2$ Hz, 1H), 8.25 (s, 1H), 7.46 (d, $J = 7.8$ Hz, 1H), 7.33 – 7.29 (m, 3H), 7.20 (d, $J = 7.8$ Hz, 2H), 7.05 (t, $J = 7.6$ Hz, 1H), 3.06 (t, $J = 7.7$ Hz, 2H), 2.74 (t, $J = 7.8$ Hz, 2H), 2.24 (s, 3H), 1.30 (s, 9H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.5, 149.2, 138.4, 137.4, 133.1, 129.0, 128.0, 125.5, 125.0, 124.3, 120.6, 39.7, 34.4, 31.4, 30.9, 18.9.



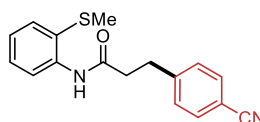
3,3-bis(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae'**. Yield: 30% ($M=459.69$, 13.8 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.27-8.19 (m, 2H), 7.41 (d, $J = 7.5$ Hz, 1H), 7.39-7.34 (m, 1H), 7.29 (d, $J = 8.3$ Hz, 4H), 7.23 (d, $J = 8.2$ Hz, 4H), 7.00 (t, $J = 7.6$ Hz, 1H), 4.62 (t, $J = 7.7$ Hz, 1H), 3.14 (d, $J = 7.8$ Hz, 2H), 2.10 (s, 3H), 1.26 (s, 18H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.6, 149.2, 140.6, 138.5, 133.3, 129.0, 127.3, 125.6, 125.0, 124.2, 120.7, 46.6, 44.9, 34.4, 31.3, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{30}\text{H}_{38}\text{NOS}$ 460.2674, found 460.2617.



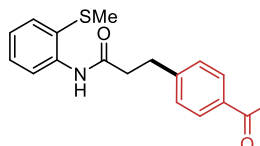
N-(2-(methylthio)phenyl)-3-(3-(trifluoromethyl)phenyl)propanamide **3af**. Yield: 58% (M=339.37, 19.5 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.30 (d, *J* = 8.2 Hz, 1H), 8.21 (s, 1H), 7.52 (s, 1H), 7.47 (t, *J* = 7.9 Hz, 3H), 7.41 (t, *J* = 7.7 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 3.15 (t, *J* = 7.7 Hz, 2H), 2.77 (t, *J* = 7.6 Hz, 2H), 2.28 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 169.7, 141.5, 138.1, 132.9, 132.0, 130.9 (q, *J* = 32.4 Hz, 1C), 129.1, 128.9, 125.2, 125.1 (d, *J* = 4.5 Hz, 1C), 124.5, 123.3 (d, *J* = 4.8 Hz, 1C), 120.7, 39.2, 31.1, 18.8; ¹⁹F NMR (565 MHz, CDCl₃) δ -62.59 (s, 3F); HRMS(ESI): *m/z* [M+H]⁺ calcd for C₁₇H₁₇F₃NOS 340.0983, found 340.0945.



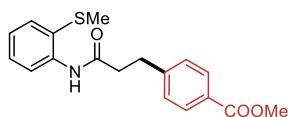
3-(4-fluorophenyl)-N-(2-(methylthio)phenyl)propanamide **3ag**.⁶ Yield: 35% (M=289.37, 10.2 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.31 (d, *J* = 8.2 Hz, 1H), 8.20 (s, 1H), 7.46 (d, *J* = 7.8 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.23 – 7.20 (m, 2H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.97 (t, *J* = 8.6 Hz, 2H), 3.05 (t, *J* = 7.6 Hz, 2H), 2.72 (t, *J* = 7.6 Hz, 2H), 2.28 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 170.1, 161.6 (d, *J* = 244.1 Hz, 1C), 138.2, 136.2, 133.0, 129.8 (d, *J* = 7.9 Hz, 2C), 128.9, 125.1, 124.4, 120.6, 115.4 (d, *J* = 21.2 Hz, 1H), 39.8, 30.6, 18.9; ¹⁹F NMR (565 MHz, CDCl₃) δ -116.93 (s, 1F).



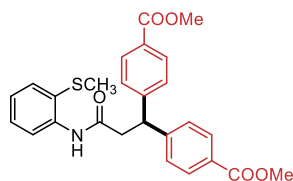
3-(4-cyanophenyl)-N-(2-(methylthio)phenyl)propanamide **3ah**.⁷ Yield: 50% (M=296.39, 14.8 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.27 (d, *J* = 8.2 Hz, 1H), 8.19 (s, 1H), 7.59 (d, *J* = 7.9 Hz, 2H), 7.46 (d, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 7.9 Hz, 2H), 7.28 (d, *J* = 7.8 Hz, 1H), 7.08 (t, *J* = 7.5 Hz, 1H), 3.14 (t, *J* = 7.5 Hz, 2H), 2.76 (t, *J* = 7.5 Hz, 2H), 2.31 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 169.4, 146.3, 137.9, 132.8, 132.4, 129.3, 128.9, 125.3, 124.6, 120.7, 118.9, 110.3, 38.6, 31.3, 18.9.



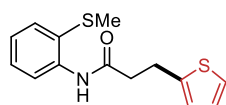
3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)propanamide **3ai**. Yield: 51% (M=313.42, 15.9 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.30 (d, *J* = 8.3 Hz, 1H), 8.22 (s, 1H), 7.90 (d, *J* = 7.9 Hz, 2H), 7.45 (d, *J* = 7.8 Hz, 1H), 7.36 (d, *J* = 7.9 Hz, 2H), 7.29 (t, *J* = 7.9 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 3.15 (t, *J* = 7.6 Hz, 2H), 2.77 (t, *J* = 7.6 Hz, 2H), 2.58 (s, 3H), 2.28 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 197.7, 169.8, 146.3, 138.1, 135.5, 128.9, 128.8, 128.7, 125.2, 124.5, 120.7, 39.0, 31.3, 26.6, 18.9; HRMS(ESI): *m/z* [M+H]⁺ calcd for C₁₈H₂₀NO₂S 314.1215, found 314.1179.



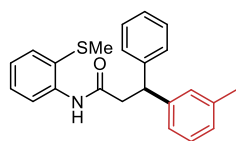
methyl 4-(3-((2-(methylthio)phenyl)amino)-3-oxopropyl)benzoate **3aj**. Yield: 46% (M=329.41, 15.1 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.30 (d, *J* = 8.3 Hz, 1H), 8.22 (s, 1H), 7.97 (d, *J* = 8.2 Hz, 2H), 7.45 (d, *J* = 7.8 Hz, 1H), 7.34 (d, *J* = 7.9 Hz, 2H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 3.90 (s, 3H), 3.14 (t, *J* = 7.6 Hz, 2H), 2.76 (t, *J* = 7.6 Hz, 2H), 2.28 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 169.9, 167.0, 146.0, 138.1, 132.9, 130.0, 128.9, 128.5, 128.4, 125.2, 124.5, 120.7, 52.0, 39.0, 31.4, 18.9; HRMS(ESI): *m/z* [M+H]⁺ calcd for C₁₈H₂₀NO₃S 330.1215, found 330.1128.



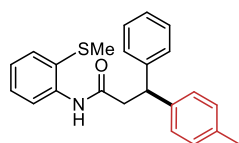
dimethyl 4,4'-(3-((2-(methylthio)phenyl)amino)-3-oxopropane-1,1-diyl)dibenzoate **3aj**. Yield: 19% (M=463.55, 8.7 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.24-8.14 (m, 2H), 7.97 (d, J = 8.3 Hz, 4H), 7.42 (d, J = 7.3 Hz, 1H), 7.36 (d, J = 8.0 Hz, 4H), 7.24 (t, J = 7.2 Hz, 1H), 7.04 (t, J = 7.5 Hz, 1H), 4.84 (t, J = 7.7 Hz, 1H), 3.88 (s, 6H), 3.19 (d, J = 7.7 Hz, 2H), 2.20 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 168.4, 166.7, 147.9, 137.9, 133.0, 130.2, 128.9, 127.9, 125.3, 124.7, 120.8, 52.1, 47.2, 43.8, 18.9; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{26}\text{H}_{26}\text{NO}_5\text{S}$ 464.1531, found 464.1481.



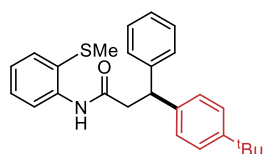
N-(2-(methylthio)phenyl)-3-(thiophen-2-yl)propanamide **3ak**. Yield: 55% (M=277.40, 15.1 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.33 (d, J = 8.2 Hz, 1H), 8.27 (s, 1H), 7.47 (d, J = 7.7 Hz, 1H), 7.29 (t, J = 7.8 Hz, 1H), 7.13 (d, J = 5.1 Hz, 1H), 7.06 (t, J = 7.5 Hz, 1H), 6.92 (t, 1H), 6.88 (d, J = 3.5 Hz, 1H), 3.30 (t, J = 7.4 Hz, 2H), 2.80 (t, J = 7.4 Hz, 2H), 2.30 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.8, 143.1, 138.3, 133.1, 129.0, 127.0, 125.1, 124.9, 124.4, 123.6, 120.7, 39.8, 25.6, 19.0.



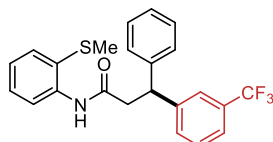
N-(2-(methylthio)phenyl)-3-phenyl-3-(m-tolyl)propanamide **3ba**. Yield: 58% (M=361.50, 20.8 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.24 (d, J = 8.3 Hz, 1H), 8.21 (s, 1H), 7.42 (d, J = 7.7 Hz, 1H), 7.28 (q, J = 8.8, 7.9 Hz, 4H), 7.23 (d, J = 7.8 Hz, 1H), 7.19-7.15 (m, 2H), 7.10 (d, J = 4.9 Hz, 2H), 7.03-6.98 (m, 2H), 4.65 (t, J = 7.8 Hz, 1H), 3.15 (d, J = 7.8 Hz, 2H), 2.29 (s, 3H), 2.15 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.4, 143.7, 143.4, 138.4, 138.3, 133.2, 129.0, 128.7, 128.6, 127.7, 127.4, 126.6, 125.0, 124.7, 124.3, 120.6, 47.4, 44.6, 21.5, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{24}\text{NOS}$ 362.1578, found 362.1538.



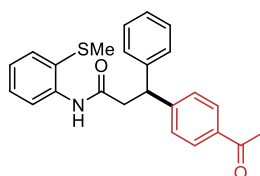
N-(2-(methylthio)phenyl)-3-phenyl-3-(p-tolyl)propanamide **3bc**. Yield: 47% (M=361.50, 16.9 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.24 (d, J = 8.3 Hz, 1H), 8.22 (s, 1H), 7.42 (d, J = 8.0 Hz, 1H), 7.30-7.26 (m, 4H), 7.25-7.22 (m, 1H), 7.20-7.16 (m, 3H), 7.09 (d, J = 7.7 Hz, 2H), 7.01 (t, J = 7.5 Hz, 1H), 4.65 (t, J = 7.8 Hz, 1H), 3.14 (d, J = 7.8 Hz, 2H), 2.28 (s, 3H), 2.15 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.4, 143.8, 140.5, 138.4, 136.2, 133.3, 129.4, 129.0, 128.7, 127.7, 127.6, 126.6, 125.0, 124.3, 120.6, 47.0, 44.7, 21.0, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{24}\text{NOS}$ 362.1578, found 362.1536.



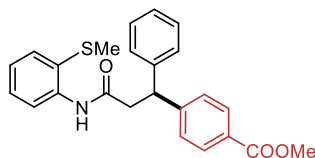
3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3be**. Yield: 50% (M=403.58, 20.3 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.28-8.18 (m, 2H), 7.42 (d, *J* = 7.7 Hz, 1H), 7.32-7.29 (m, 3H), 7.28 (d, *J* = 2.1 Hz, 2H), 7.27-7.25 (m, 1H), 7.25-7.23 (m, 1H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.17 (t, *J* = 7.1 Hz, 1H), 7.01 (t, *J* = 7.5 Hz, 1H), 4.66 (t, *J* = 7.7 Hz, 1H), 3.15 (d, *J* = 6.8 Hz, 2H), 2.13 (s, 3H), 1.26 (s, 9H); ¹³C NMR (151 MHz, CDCl₃) δ 169.5, 149.3, 143.7, 140.4, 138.4, 133.3, 129.0, 128.7, 127.8, 127.3, 126.6, 125.6, 125.0, 124.3, 120.6, 47.0, 44.8, 34.4, 31.3, 19.0; HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₆H₃₀NOS 404.2048, found 404.2006.



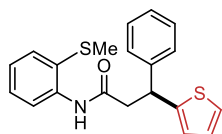
N-(2-(methylthio)phenyl)-3-phenyl-3-(3-(trifluoromethyl)phenyl)propanamide **3bf**. Yield: 48% (M=415.47, 19.8 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.26 – 8.14 (m, 2H), 7.55 (s, 1H), 7.49 (d, *J* = 7.7 Hz, 1H), 7.46 (d, *J* = 7.8 Hz, 1H), 7.43-7.38 (m, 2H), 7.32-7.27 (m, 4H), 7.25-7.17 (m, 2H), 7.03 (t, *J* = 7.6 Hz, 1H), 4.78 (t, *J* = 7.7 Hz, 1H), 3.17 (dd, *J* = 7.7, 3.7 Hz, 2H), 2.18 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 168.7, 144.6, 142.6, 138.0, 133.0, 131.4, 131.0 (q, *J* = 31.8 Hz, 1C), 129.2, 128.9, 127.7, 127.0, 125.3, 125.0, 124.5, 124.3 (q, *J* = 3.8 Hz, 1C), 123.6 (q, *J* = 3.9 Hz, 1C), 123.2, 120.8, 47.1, 44.3, 18.9; ¹⁹F NMR (565 MHz, CDCl₃) δ -62.50 (s, 3F); HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₃H₂₁F₃NOS 416.1296, found 416.1246.



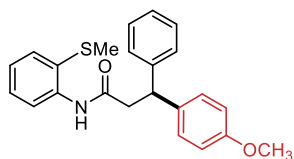
3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bi**. Yield: 37% (M=389.51, 14.4 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.27 – 8.14 (m, 2H), 7.89 (d, *J* = 8.0 Hz, 2H), 7.44-7.39 (m, 3H), 7.32-7.27 (m, 4H), 7.26-7.23 (m, 1H), 7.23-7.19 (m, 1H), 7.03 (t, *J* = 7.6 Hz, 1H), 4.77 (t, *J* = 7.7 Hz, 1H), 3.18 (d, *J* = 7.8 Hz, 2H), 2.55 (s, 3H), 2.19 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 168.8, 149.1, 142.7, 138.1, 135.7, 133.1, 128.9, 128.9, 128.8, 128.0, 127.7, 127.0, 125.2, 124.5, 120.7, 47.3, 44.1, 26.6, 19.0; HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₄H₂₄NO₂S 390.1528, found 390.1485.



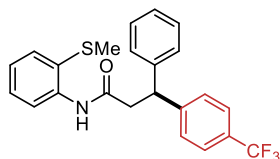
methyl 4-(3-((2-(methylthio)phenyl)amino)-3-oxo-1-phenylpropyl)benzoate **3bj**. Yield: 40% (M=405.51, 16 mg). ¹H NMR (600 MHz, CDCl₃) δ 8.24 – 8.18 (m, 2H), 7.96 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 7.8 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.32 – 7.27 (m, 4H), 7.25 – 7.22 (m, 1H), 7.22 – 7.19 (m, 1H), 7.03 (t, *J* = 7.6 Hz, 1H), 4.77 (t, *J* = 7.7 Hz, 1H), 3.88 (s, 3H), 3.17 (d, *J* = 7.8 Hz, 2H), 2.18 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 168.9, 166.9, 148.8, 142.7, 138.1, 133.1, 130.0, 129.0, 128.9, 128.6, 127.8, 127.7, 126.9, 125.2, 124.5, 120.7, 52.0, 47.3, 44.2, 19.0; HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₄H₂₄NO₃S 406.1477, found 406.1434.



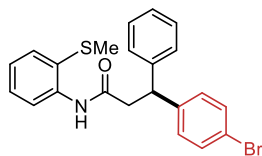
N-(2-(methylthio)phenyl)-3-phenyl-3-(thiophen-2-yl)propanamide **3bk**. Yield: 39% (M=353.50, 13.8mg). ^1H NMR (600 MHz, CDCl_3) δ 8.29-8.19 (m, 2H), 7.43 (d, J = 6.1 Hz, 1H), 7.35 (d, J = 7.7 Hz, 2H), 7.31 (t, J = 7.6 Hz, 2H), 7.26-7.23 (m, 1H), 7.22 (t, J = 7.3 Hz, 1H), 7.15 (dd, J = 4.7, 1.6 Hz, 1H), 7.03 (t, J = 7.5 Hz, 1H), 6.93-6.87 (m, 2H), 4.93 (t, J = 7.6 Hz, 1H), 3.22 (dd, J = 14.5, 7.7 Hz, 1H), 3.12 (dd, J = 14.5, 7.7 Hz, 1H), 2.20 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 168.7, 147.6, 143.2, 138.3, 133.2, 129.0, 128.8, 127.6, 127.1, 126.8, 125.1, 124.5, 124.4, 124.1, 120.7, 46.1, 43.2, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{20}\text{H}_{20}\text{NOS}_2$ 354.0986, found 354.0949.



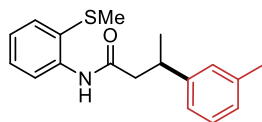
3-(4-methoxyphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bl**. Yield: 45% (M=377.50, 17.0 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.27-8.18 (m, 2H), 7.42 (d, J = 7.5 Hz, 1H), 7.28 (d, J = 4.4 Hz, 4H), 7.24 (d, J = 7.9 Hz, 1H), 7.21 (d, J = 8.3 Hz, 2H), 7.19-7.16 (m, 1H), 7.02 (t, J = 7.6 Hz, 1H), 6.82 (d, J = 8.6 Hz, 2H), 4.64 (t, J = 7.8 Hz, 1H), 3.75 (s, 3H), 3.12 (d, J = 7.0 Hz, 2H), 2.16 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.4, 158.3, 143.9, 138.4, 135.7, 133.2, 129.0, 128.7, 128.7, 127.7, 126.6, 125.1, 124.3, 120.7, 114.1, 55.2, 46.7, 44.9, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{24}\text{NO}_2\text{S}$ 378.1528, found 378.1488.



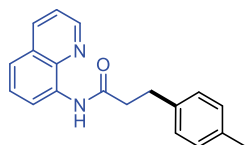
N-(2-(methylthio)phenyl)-3-phenyl-3-(4-(trifluoromethyl)phenyl)propanamide **3bm**. Yield: 42% (M=415.47, 17.3 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.20 (d, J = 7.6 Hz, 2H), 7.54 (d, J = 8.0 Hz, 2H), 7.42 (s, 3H), 7.32 – 7.27 (m, 4H), 7.25 (d, J = 4.2 Hz, 1H), 7.21 (t, J = 7.6 Hz, 1H), 7.03 (t, J = 7.5 Hz, 1H), 4.77 (t, J = 7.7 Hz, 1H), 3.17 (t, J = 7.5 Hz, 2H), 2.17 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 168.8, 147.7, 142.6, 138.0, 133.0, 128.9 (q, J = 32.3 Hz, 1C), 128.9, 128.2, 127.7, 127.0, 125.7 (q, J = 3.6 Hz, 1C), 125.3, 125.1, 124.6, 123.2, 120.8, 47.1, 44.2, 18.8; ^{19}F NMR (565 MHz, CDCl_3) δ -62.50 (s, 3F); HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{21}\text{F}_3\text{NOS}$ 416.1296, found 416.1246.



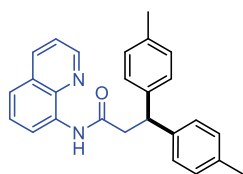
3-(4-bromophenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bn**. Yield: 46% (M=426.37, 19.8 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.21 (t, 2H), 7.43 (d, J = 7.7 Hz, 1H), 7.40 (d, J = 8.1 Hz, 2H), 7.29 (dd, J = 15.9, 8.5 Hz, 4H), 7.24 (d, J = 8.6 Hz, 1H), 7.21 (d, J = 7.1 Hz, 1H), 7.17 (d, J = 8.1 Hz, 2H), 7.03 (t, J = 7.6 Hz, 1H), 4.66 (t, J = 7.8 Hz, 1H), 3.12 (d, J = 17.1 Hz, 2H), 2.18 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 169.0, 143.0, 142.6, 138.1, 133.1, 131.8, 129.5, 129.0, 128.8, 127.7, 126.9, 125.2, 124.5, 120.7, 120.5, 46.8, 44.4, 19.0; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{BrNOS}$ 426.0527, found 426.0482.



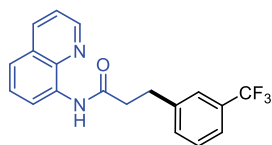
N-(2-(methylthio)phenyl)-3-(m-tolyl)butanamide **3ca**. Yield: 52% (M=299.43, 15.5 mg). ^1H NMR (600 MHz, CDCl_3) δ 8.29 (d, J = 8.3 Hz, 1H), 8.15 (s, 1H), 7.44 (d, J = 7.8 Hz, 1H), 7.30-7.26 (m, 1H), 7.19 (t, J = 7.5 Hz, 1H), 7.12-7.07 (m, 2H), 7.06-6.99 (m, 2H), 3.42-3.33 (m, 1H), 2.72 (dd, J = 14.2, 7.3 Hz, 1H), 2.63 (dd, J = 14.4, 7.6 Hz, 1H), 2.32 (s, 3H), 2.23 (s, 3H), 1.37 (d, J = 7.0 Hz, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.1, 145.7, 138.4, 138.2, 133.1, 128.9, 128.6, 127.6, 127.3, 125.1, 124.3, 123.8, 120.7, 47.0, 37.0, 22.0, 21.5, 18.9; HRMS(ESI): m/z $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{18}\text{H}_{22}\text{NOS}$ 300.1424, found 300.1392.



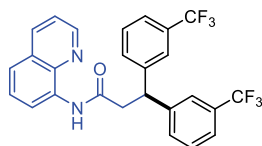
N-(quinolin-8-yl)-3-(p-tolyl)propanamide **3ec**.⁹ Yield: 52% (M=290.37, 15.1 mg). ^1H NMR (600 MHz, CDCl_3) δ 9.79 (s, 1H), 8.79 (d, J = 7.5 Hz, 1H), 8.76 (d, J = 3.0 Hz, 1H), 8.14 (d, J = 8.3 Hz, 1H), 7.53 (t, J = 7.9 Hz, 1H), 7.48 (d, J = 7.5 Hz, 1H), 7.43 (dd, J = 8.3, 4.2 Hz, 1H), 7.19 (d, J = 7.7 Hz, 2H), 7.10 (d, J = 7.7 Hz, 2H), 3.10 (dd, J = 9.1, 6.8 Hz, 2H), 2.88 – 2.83 (m, 2H), 2.30 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.8, 148.0, 138.3, 137.7, 136.4, 135.7, 134.5, 129.2, 128.3, 127.9, 127.4, 121.5, 121.4, 116.6, 39.9, 31.1, 21.0.



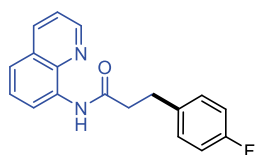
N-(quinolin-8-yl)-3,3-di-p-tolylpropanamide **3ec'**.¹⁰ Yield: 41% (M=380.49, 15.6 mg). ^1H NMR (600 MHz, CDCl_3) δ 9.77 (s, 1H), 8.75 (d, J = 2.7 Hz, 1H), 8.71 (d, J = 7.1 Hz, 1H), 8.13 (d, J = 7.9 Hz, 1H), 7.50 – 7.45 (m, 2H), 7.43 (dd, J = 8.2, 4.3 Hz, 1H), 7.22 (d, J = 7.9 Hz, 4H), 7.07 (d, J = 7.7 Hz, 4H), 4.70 (t, J = 7.8 Hz, 1H), 3.29 (d, J = 7.8 Hz, 2H), 2.25 (s, 6H).



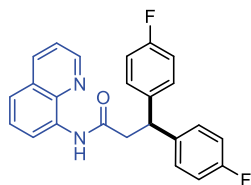
N-(quinolin-8-yl)-3-(3-(trifluoromethyl)phenyl)propanamide **3ef**.¹¹ Yield: 71% (M=344.34, 24.4 mg). ^1H NMR (600 MHz, CDCl_3) δ 9.79 (s, 1H), 8.80-8.73 (m, 2H), 8.15 (d, J = 8.1 Hz, 1H), 7.56-7.55 (m, 1H), 7.53 (d, J = 7.7 Hz, 1H), 7.51-7.47 (m, 2H), 7.47-7.42 (m, 2H), 7.39 (t, J = 7.7 Hz, 1H), 3.20 (t, J = 7.8 Hz, 2H), 2.91 (t, J = 7.8 Hz, 2H); ^{13}C NMR (151 MHz, CDCl_3) δ 170.1, 148.1, 141.7, 138.3, 136.4, 134.3, 132.0, 130.9 (q, J = 31.9 Hz, 1C), 129.0, 128.0, 127.4, 125.2 (q, J = 3.9 Hz, 1C), 124.2 (q, J = 272.6 Hz, 1C), 123.2 (q, J = 3.9 Hz, 1C), 121.6, 121.6, 116.6, 39.3, 31.2; ^{19}F NMR (565 MHz, CDCl_3) δ -62.58 (s, 3F).



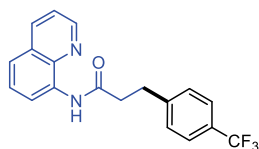
N-(quinolin-8-yl)-3,3-bis(3-(trifluoromethyl)phenyl)propanamide **3ef'**. Yield: 19% (M=488.43, 9.3 mg). ¹H NMR (600 MHz, CDCl₃) δ 9.78 (s, 1H), 8.76 (dd, *J* = 4.3, 1.6 Hz, 1H), 8.70-8.63 (m, 1H), 8.15 (d, *J* = 7.9 Hz, 1H), 7.58 (s, 2H), 7.53-7.49 (m, 4H), 7.48-7.44 (m, 3H), 7.42 (t, *J* = 7.8 Hz, 2H), 4.93 (t, *J* = 7.7 Hz, 1H), 3.35 (d, *J* = 7.7 Hz, 2H); ¹³C NMR (151 MHz, CDCl₃) δ 168.4, 148.1, 143.8, 138.1, 136.5, 134.0, 131.3, 131.2 (q, *J* = 32.1 Hz, 1C), 129.4, 127.9, 127.4, 124.5 (q, *J* = 3.7 Hz, 1C), 124.0 (q, *J* = 270.9 Hz, 1C), 123.9 (q, *J* = 3.9 Hz, 1C), 121.8, 121.6, 116.8, 46.8, 43.9; ¹⁹F NMR (565 MHz, CDCl₃) δ -62.58 (s, 6F); HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₆H₁₉F₆N₂O 489.1401, found 489.1349.



3-(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg**.¹¹ Yield: 58% (M=294.33, 17.1 mg). ¹H NMR (600 MHz, CDCl₃) δ 9.76 (s, 1H), 8.77 (d, *J* = 6.1 Hz, 1H), 8.76 (dd, *J* = 4.3, 1.7 Hz, 1H), 8.14 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.53 (t, *J* = 7.9 Hz, 1H), 7.49 (d, *J* = 6.8 Hz, 1H), 7.43 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.24 (dd, *J* = 8.5, 5.6 Hz, 2H), 6.97 (t, *J* = 8.7 Hz, 2H), 3.11 (t, *J* = 7.7 Hz, 2H), 2.85 (t, *J* = 7.7 Hz, 2H); ¹³C NMR (151 MHz, CDCl₃) δ 170.5, 161.5 (d, *J* = 244.0 Hz, 1C), 148.1, 138.3, 136.4 (d, *J* = 3.3 Hz, 1C), 136.4, 134.4, 129.8 (d, *J* = 7.8 Hz, 2C), 127.9, 127.4, 121.6, 121.5, 116.5, 115.3 (d, *J* = 21.3 Hz, 2C), 39.8, 30.6; ¹⁹F NMR (565 MHz, CDCl₃) δ -117.13 (s, 1F).

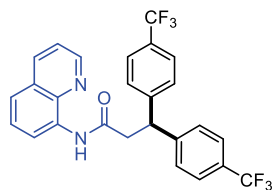


3,3-bis(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg'**. Yield: 31% (M=388.42, 12.1 mg). ¹H NMR (600 MHz, CDCl₃) δ 9.76 (s, 1H), 8.76 (d, *J* = 3.7 Hz, 1H), 8.69 (dd, *J* = 6.4, 2.6 Hz, 1H), 8.15 (d, *J* = 8.2 Hz, 1H), 7.49 (d, *J* = 6.5 Hz, 2H), 7.45 (dd, *J* = 8.3, 4.3 Hz, 1H), 7.29 – 7.26 (m, 3H), 6.97 (t, *J* = 8.5 Hz, 4H), 4.76 (t, *J* = 7.8 Hz, 1H), 3.26 (d, *J* = 7.7 Hz, 2H); ¹³C NMR (151 MHz, CDCl₃) δ 169.2, 161.6 (d, *J* = 245.0 Hz, 2C), 147.9, 139.3 (d, *J* = 3.3 Hz, 2C), 138.0, 136.7, 134.1, 129.2 (d, *J* = 7.9 Hz, 4C), 128.0, 127.5, 121.7, 121.6, 116.9, 115.5 (d, *J* = 21.2 Hz, 4C), 45.7, 44.6; ¹⁹F NMR (565 MHz, CDCl₃) δ -116.41 (s, 2F); HRMS(ESI): *m/z* [M+H]⁺ calcd for C₂₄H₁₉F₂N₂O 389.1465, found 389.1430.

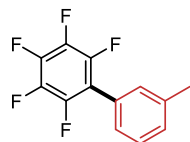


N-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)propanamide **3en**.¹² Yield: 60% (M=344.34, 20.7 mg). ¹H NMR (600 MHz, CDCl₃) δ 9.78 (s, 1H), 8.80 – 8.74 (m, 2H), 8.15 (d, *J* = 8.2 Hz, 1H), 7.54 (t, *J* = 7.2 Hz, 3H), 7.50 (d, *J* = 8.1 Hz, 1H), 7.44 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.41 (d, *J* = 7.9 Hz, 2H), 3.20 (t, *J* = 7.7 Hz, 2H), 2.90 (t, *J* = 7.7 Hz, 2H); ¹³C NMR (151 MHz, CDCl₃) δ 170.1, 148.1, 144.9, 138.3,

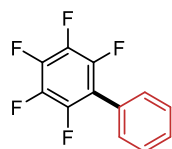
136.4, 134.3, 128.7 (q, $J = 32.7$ Hz, 1C), 128.0, 127.4, 125.5 (q, $J = 3.8$ Hz, 1C), 124.3 (q, $J = 269.9$ Hz, 1C), 121.6, 116.6, 39.1, 31.2; ^{19}F NMR (565 MHz, CDCl_3) δ -62.38 (s, 3F).



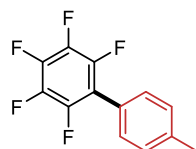
N-(quinolin-8-yl)-3,3-bis(4-(trifluoromethyl)phenyl)propanamide **3en'**. Yield: 31% ($M = 488.43$, 15.1 mg). ^1H NMR (600 MHz, CDCl_3) δ 9.79 (s, 1H), 8.79 – 8.73 (m, 1H), 8.67 (t, $J = 4.5$ Hz, 1H), 8.16 (d, $J = 8.2$ Hz, 1H), 7.56 (d, $J = 8.1$ Hz, 4H), 7.50 (d, $J = 4.5$ Hz, 2H), 7.47 – 7.43 (m, 5H), 4.93 (t, $J = 7.7$ Hz, 1H), 3.35 (d, $J = 7.7$ Hz, 2H); ^{13}C NMR (151 MHz, CDCl_3) δ 168.5, 148.1, 146.9, 138.1, 136.6, 134.0, 129.3 (q, $J = 32.4$ Hz, 1C), 128.2, 128.0, 127.4, 125.8 (q, $J = 3.3$ Hz, 1C), 124.1 (q, $J = 270.0$ Hz, 1C), 121.9, 121.7, 116.8, 46.7, 43.6; ^{19}F NMR (565 MHz, CDCl_3) δ -62.56 (s, 6F); HRMS(ESI): m/z $[M+H]^+$ calcd for $\text{C}_{26}\text{H}_{19}\text{F}_6\text{N}_2\text{O}$ 489.1401, found 489.1344.



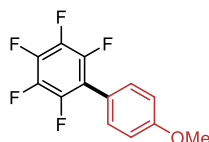
2,3,4,5,6-pentafluoro-3'-methyl-1,1'-biphenyl **5aa**.¹³ Yield: 71% ($M = 258.19$, 36.8 mg). ^1H NMR (600 MHz, Chloroform- d) δ 7.38 (t, $J = 7.6$ Hz, 1H), 7.27 (d, $J = 7.7$ Hz, 1H), 7.21 (d, $J = 12.5$ Hz, 2H), 2.41 (s, 3H); ^{13}C NMR (151 MHz, CDCl_3) δ 144.2(dm, $J = 247.5$ Hz, 2C), 140.3(dm, $J = 253.2$ Hz, 1C), 137.8(dm, $J = 251.5$ Hz, 2C), 138.5, 130.8, 130.1, 128.6, 127.2, 126.3, 116.2(m, 1C), 21.4; ^{19}F NMR (565 MHz, Chloroform- d) δ -143.12 (dd, $J = 23.0$, 8.1 Hz, 2F), -155.97 (t, $J = 21.0$ Hz, 1F), -162.47 (dd, $J = 21.6$, 14.3 Hz, 2F).



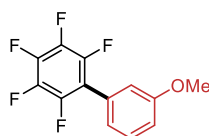
2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ab**.¹⁴ Yield: 88% ($M = 244.16$, 42.9 mg). ^1H NMR (600 MHz, Chloroform- d) δ 7.47 (m, $J = 13.0$, 7.2 Hz, 3H), 7.43 – 7.40 (d, 2H); ^{13}C NMR (151 MHz, Chloroform- d) δ 144.2(dm, $J = 247.6$ Hz, 2C), 140.4(dm, $J = 253.2$ Hz, 1C), 138.0(dm, $J = 251.5$ Hz, 2C), 130.2(t, 1C), 129.4, 128.8, 126.5, 116.0(m, 1C); ^{19}F NMR (565 MHz, Chloroform- d) δ -143.07 – -143.57 (m, 2F), -155.68 (t, $J = 21.0$ Hz, 1F), -162.31 (dd, $J = 22.8$, 8.1 Hz, 2F).



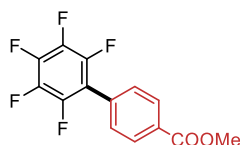
2,3,4,5,6-pentafluoro-4'-methyl-1,1'-biphenyl **5ac**.¹³ Yield: 86% ($M = 258.19$, 44.2 mg). ^1H NMR (600 MHz, Chloroform- d) δ 7.31 (s, 4H), 2.42 (s, 3H); ^{13}C NMR (151 MHz, Chloroform- d) δ 144.0(dm, $J = 247.5$ Hz, 2C), 140.2(dm, $J = 253.5$ Hz, 1C), 139.4, 137.9(dm, $J = 251.5$ Hz, 2C), 130.0(2C), 129.5(2C), 123.4, 116.0(m, 1C), 21.4; ^{19}F NMR (565 MHz, Chloroform- d) δ -143.38 (dd, $J = 23.0$, 8.1 Hz, 2F), -156.15 (t, $J = 21.0$ Hz, 1F), -162.47 (dd, $J = 21.3$, 14.3 Hz, 2F).



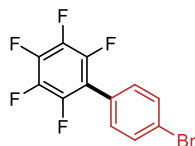
2,3,4,5,6-pentafluoro-4'-methoxy-1,1'-biphenyl **5ad**.¹³ Yield: 83% (M=274.19, 45.5 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.36 (d, *J* = 8.8 Hz, 2H), 7.01 (d, *J* = 8.8 Hz, 2H), 3.86 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 160.3, 144.2(dm, *J* = 246.6 Hz, 2C), 140.4(dm, *J* = 253.2 Hz, 1C), 138.0(dm, *J* = 251.5 Hz, 2C), 138.2, 131.4(t, 2C), 118.4, 116.4, 115.8(m, 1C), 114.3(2C), 55.3; ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -143.64 (dd, *J* = 23.1, 8.2 Hz, 2F), -156.52 (t, *J* = 21.0 Hz, 1F), -162.56 (dd, *J* = 21.4, 14.3 Hz, 2F).



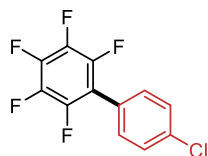
2,3,4,5,6-pentafluoro-3'-methoxy-1,1'-biphenyl **5ae**.¹³ Yield: 75% (M=274.19, 41.1 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.40 (t, *J* = 8.0 Hz, 1H), 7.02 – 6.98 (m, 2H), 6.94 (s, 1H), 3.84 (s, 3H); ¹³C NMR (151 MHz, CDCl₃) δ 159.7, 144.2(dm, *J* = 252.0 Hz, 2C), 140.5(dm, *J* = 253.2 Hz, 1C), 137.6(dm, *J* = 251.5 Hz, 2C), 129.8, 127.5, 122.5(t, 1C), 115.91, 114.93, 55.39; ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -142.78 (dd, *J* = 23.1, 8.1 Hz, 2F), -155.55 (t, *J* = 21.1 Hz, 1F), -162.22 (td, *J* = 22.2, 8.1 Hz, 2F).



methyl 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-3-carboxylate **5af**.¹³ Yield: 63% (M=302.20, 38 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 8.16 (d, *J* = 8.4 Hz, 2H), 7.52 (d, *J* = 8.4 Hz, 2H), 3.96 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 166.4, 144.1(dm, *J* = 248.4 Hz, 2C), 140.8(dm, *J* = 255.0 Hz, 1C), 137.9(dm, *J* = 252.2 Hz, 2C), 131.0, 130.9, 130.3(t, 2C), 129.9(2C), 115.0(m, 1C), 52.3; ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -142.76 (dd, *J* = 22.5, 8.1 Hz, 2F), -154.11 (t, *J* = 20.8 Hz, 1F), -161.58 (td, *J* = 21.9, 8.3 Hz, 2F).

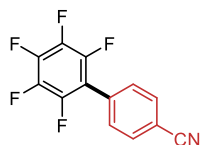


4'-bromo-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ag**.¹⁵ Yield: 59% (M=323.06, 38.1 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.57 (s, 4H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 144.3(dm, *J* = 246.3 Hz, 2C), 140.5(dm, *J* = 255.0 Hz, 1C), 138.0(dm, *J* = 252.2 Hz, 2C), 132.1, 130.6(t, 2C), 128.8, 127.5, 127.2, 115.0(m, 1C); ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -142.96 (dd, *J* = 22.7, 8.2 Hz, 2F), -154.45 (t, *J* = 21.0 Hz, 1F), -161.66 (td, *J* = 22.2, 8.2 Hz, 2F).

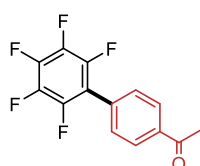


4'-chloro-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ah**.¹⁶ Yield: 62% (M=278.61, 34.5 mg). ¹H NMR (600

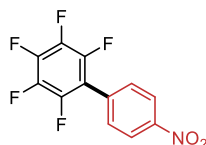
MHz, Chloroform-*d*) δ 7.51 – 7.46 (m, 2H), 7.37 (d, J = 6.6 Hz, 2H); ^{13}C NMR (151 MHz, Chloroform-*d*) δ 144.1(dm, J = 249.9 Hz, 2C), 140.6(dm, J = 255.0 Hz, 1C), 137.9(dm, J = 251.0 Hz, 2C), 135.7, 131.5(t, 2C), 129.1(2C), 124.8, 114.8(m, 1C); ^{19}F NMR (565 MHz, Chloroform-*d*) δ -143.14 (dd, J = 22.6, 8.3 Hz, 2F), -154.82 (d, J = 20.7 Hz, 1F), -161.57 – -162.09 (m, 2F).



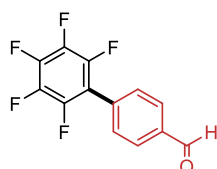
2,3,4,5,6-pentafluoro-[1,1'-biphenyl]-4-carbonitrile **5ai**.¹³ Yield: 60% (M=269.17, 32.3 mg). ^1H NMR (600 MHz, Chloroform-*d*) δ 7.80 (d, J = 8.8 Hz, 2H), 7.57 (d, J = 8.0 Hz, 2H); ^{13}C NMR (151 MHz, Chloroform-*d*) δ 144.1(dm, J = 248.3 Hz, 2C), 141.3(dm, J = 256.1 Hz, 1C), 137.9(dm, J = 251.0 Hz, 2C), 132.5(2C), 131.0(t, 2C), 118.1, 113.4(m, 1C); ^{19}F NMR (565 MHz, Chloroform-*d*) δ -142.75 (dd, J = 22.2, 8.0 Hz, 2F), -152.82 (t, J = 21.0 Hz, 1F), -160.92 (td, J = 22.0, 8.1 Hz, 2F).



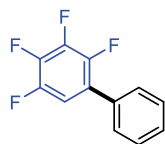
1-(2,3,4,5,6-pentafluoro-[1,1'-biphenyl]-4-yl)ethan-1-one **5aj**.¹³ Yield: 79% (M=286.20, 38.5 mg). ^1H NMR (600 MHz, Chloroform-*d*) δ 8.08 (d, J = 8.5 Hz, 2H), 7.55 (d, J = 8.5 Hz, 2H), 2.66 (s, 3H); ^{13}C NMR (151 MHz, Chloroform-*d*) δ 197.3, 144.1(dm, J = 248.9 Hz, 2C), 140.9(dm, J = 255.3 Hz, 1C), 137.9(dm, J = 252.2 Hz, 2C), 137.5, 131.1, 130.5(t, 2C), 128.6(2C), 114.9(m, 1C), 26.6; ^{19}F NMR (565 MHz, Chloroform-*d*) δ -142.79 (dd, J = 22.2, 8.0 Hz, 2F), -154.02 (t, J = 20.8 Hz, 1F), -161.55 (td, J = 22.1, 8.2 Hz, 2F).



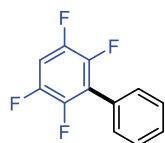
2,3,4,5,6-pentafluoro-4'-nitro-1,1'-biphenyl **5ak**.¹⁵ Yield: 54% (M=289.16, 31.3 mg). ^1H NMR (600 MHz, Chloroform-*d*) δ 8.37 (d, J = 8.8 Hz, 2H), 7.64 (d, J = 8.8 Hz, 2H); ^{13}C NMR (151 MHz, Chloroform-*d*) δ 148.3, 144.1(dm, J = 250.4 Hz, 2C), 141.4(dm, J = 255.3 Hz, 1C), 138.1(dm, J = 252.7 Hz, 2C), 133.0, 131.3(t, 2C), 124.0(2C), 131.8(m, 1C); ^{19}F NMR (565 MHz, Chloroform-*d*) δ -142.50 (dd, J = 22.0, 8.1 Hz, 2F), -152.45 (t, J = 20.8 Hz, 1F), -160.76 (td, J = 21.6, 21.2, 8.1 Hz, 2F).



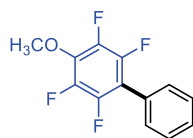
2,3,4,5,6-pentafluoro-[1,1'-biphenyl]-4-carbaldehyde **5al**.¹³ Yield: 52% (M=272.17, 28.1 mg). ^1H NMR (600 MHz, Chloroform-*d*) δ 10.10 (s, 1H), 8.02 (d, J = 8.3 Hz, 2H), 7.62 (d, J = 8.3 Hz, 2H); ^{13}C NMR (151 MHz, Chloroform-*d*) δ 191.5, 144.1(dm, J = 248.9 Hz, 2C), 141.0(dm, J = 255.3 Hz, 1C), 138.0(dm, J = 252.6 Hz, 2C), 136.7, 132.4, 131.0(t, 2C), 129.9(2C), 114.7(m, 1C); ^{19}F NMR (565 MHz, Chloroform-*d*) δ -142.65 (dd, J = 22.4, 8.2 Hz, 2F), -153.50 (t, J = 20.8 Hz, 1F), -161.28 (td, J = 22.0, 8.2 Hz, 2F).



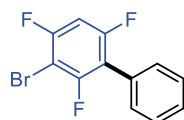
2,3,4,5-tetrafluoro-1,1'-biphenyl **5ba**.¹⁷ Yield: 63% (M=226.17, 28.6 mg). ¹H NMR (600 MHz, CDCl₃) δ 7.50-7.40 (m, 5H), 7.06 (q, *J* = 7.7 Hz, 1H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 147.1(dm, *J* = 257.1 Hz, 1C), 144.7(dm, *J* = 255.3 Hz, 1C), 140.5(m, 1C), 139.7(dm, *J* = 252.6 Hz, 1C), 133.1, 128.9(2C), 128.8(t, 2C), 125.5(m, 1C), 111.4(t, 1C), 111.3(t, 1C); ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -139.64 – -139.68 (m, *J* = 10.5 Hz, 1F), -143.72 – -143.77 (m, *J* = 5.9 Hz, 1F), -155.14 – -155.32 (m, 1F), -157.01 – -157.36 (m, 1F).



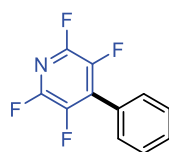
2,3,5,6-tetrafluoro-1,1'-biphenyl **5ca**.¹⁷ Yield: 70% (M=226.17, 31.7 mg). ¹H NMR (600 MHz, CDCl₃) δ 7.52-7.47 (m, 2H), 7.47-7.43 (m, 3H), 7.06 (p, *J* = 8.4 Hz, 1H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 146.3(dm, *J* = 246.5 Hz, 2C), 143.8(dm, *J* = 245.7 Hz, 2C), 130.1(t, 2C), 129.2, 128.6(2C), 127.5(t, 1C), 121.6(t, 1C), 104.9(t, 1C); ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -139.19 (dd, *J* = 22.4, 12.7 Hz, 2F), -143.91 (dd, *J* = 22.2, 13.0 Hz, 2F).



2,3,5,6-tetrafluoro-4-methoxy-1,1'-biphenyl **5da**.¹⁷ Yield: 63% (M=256.20, 32 mg). ¹H NMR (600 MHz, CDCl₃) δ 7.49-7.46 (m, 2H), 7.45-7.41 (m, 3H), 4.12 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 144.3(dm, *J* = 246.0 Hz, 2C), 141.2(dm, *J* = 246.9 Hz, 2C), 137.5(m, 1C), 130.2(t, 2C), 128.9, 128.6(2C), 127.3, 114.3(t, 1C), 62.2(t, 1C); ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -145.19 (dd, *J* = 21.9, 8.6 Hz, 2F), -158.25 (dd, *J* = 22.1, 8.9 Hz, 2F).

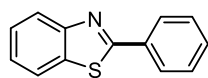


3-bromo-2,4,6-trifluoro-1,1'-biphenyl **5ea**.¹⁸ Yield: 57% (M=287.08, 32.7 mg). ¹H NMR (600 MHz, CDCl₃) δ 7.49 – 7.45 (m, 2H), 7.43 (d, *J* = 6.2 Hz, 1H), 7.42 – 7.39 (m, 2H), 6.88 (t, *J* = 9.0 Hz, 1H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 159.0(dm, *J* = 250.1 Hz, 1C), 158.7(dm, *J* = 249.5 Hz, 1C), 157.3(dm, *J* = 247.5 Hz, 1C), 130.2(2C), 128.8, 128.5(2C), 127.8, 116.1(m, 1C), 101.0(m, 1C), 94.0(m, 1C); ¹⁹F NMR (565 MHz, Chloroform-*d*) δ -103.94 (d, *J* = 5.9 Hz, 1F), -104.84 (d, *J* = 6.4 Hz, 1F), -112.41 (t, *J* = 6.1 Hz, 1F).

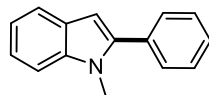


2,3,5,6-tetrafluoro-4-phenylpyridine **5fa**.¹⁷ Yield: 57% (M=227.16, 27.9 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.59 – 7.50 (m, 5H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 143.6(dm, *J* = 244.5 Hz, 2C), 139.4(dm, *J* = 257.2 Hz, 2C), 133.5(m, 1C), 130.6, 129.8(t, 2C), 129.0(2C), 125.9; ¹⁹F NMR (565

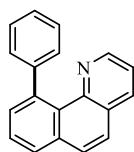
MHz, Chloroform-*d*) δ -90.74 (td, J = 28.9, 13.7 Hz, 2F), -144.81 – -145.42 (m, 2F).



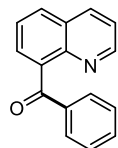
2-phenylbenzo[d]thiazole **6**.¹⁹ Yield: 54% (M=211.28, 22.8 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 8.11 (s, 3H), 7.92 (d, J = 5.7 Hz, 1H), 7.51 (s, 4H), 7.41 (d, J = 6.5 Hz, 1H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 168.2, 154.0, 135.0, 133.5, 131.1, 129.1, 127.6, 126.4, 125.3, 123.2, 121.6.



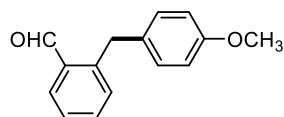
1-methyl-2-phenyl-1H-indole **7**.²⁰ Yield: 52% (M=207.28, 21.4 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.64 (d, J = 7.8 Hz, 1H), 7.50 (dd, J = 24.4, 7.1 Hz, 4H), 7.39 (dd, J = 24.1, 7.6 Hz, 2H), 7.28 – 7.23 (m, 1H), 7.15 (t, J = 7.4 Hz, 1H), 6.57 (s, 1H), 3.75 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 141.6, 138.4, 132.9, 129.4, 128.5, 127.9, 121.7, 120.5, 119.9, 109.6, 101.7, 31.2.



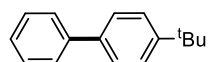
10-phenylbenzo[h]quinoline **8**.²¹ Yield: 53% (M=255.32, 27.0 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 8.57 (s, 1H), 8.20 (s, 1H), 7.93 (dd, J = 24.3, 7.9 Hz, 2H), 7.73 (d, J = 8.9 Hz, 2H), 7.59 (d, J = 6.2 Hz, 1H), 7.41 (d, J = 19.3 Hz, 6H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 146.8, 146.6, 146.2, 141.7, 135.4, 135.0, 131.5, 128.8, 128.4, 128.0, 127.4, 127.3, 125.9, 125.8, 121.1.



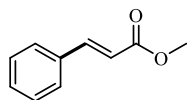
phenyl(quinolin-8-yl)methanone **9**.²² Yield: 57% (M=233.27, 26.6 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 8.85 (s, 1H), 8.22 (d, J = 6.7 Hz, 1H), 7.97 (d, J = 6.8 Hz, 1H), 7.84 (d, J = 6.3 Hz, 2H), 7.75 (s, 1H), 7.64 (d, J = 6.0 Hz, 1H), 7.55 (s, 1H), 7.42 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 197.9, 150.9, 146.2, 139.4, 137.8, 136.0, 133.2, 130.2, 129.7, 128.3, 128.3, 128.2, 125.9, 121.7.



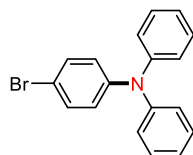
2-(4-methoxybenzyl)benzaldehyde **10**.²³ Yield: 52% (M=226.28, 11.8 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 10.26 (s, 1H), 7.86 (s, 1H), 7.53 (td, J = 6.5 Hz, 1H), 7.41 (td, J = 6.6 Hz, 1H), 7.26 (d, 1H), 7.06 (s, 2H), 6.82 (s, 2H), 4.39 (s, 2H), 3.77 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 192.4, 158.1, 143.5, 133.9, 132.4, 131.9, 131.5, 129.7, 126.9, 114.0, 55.3, 37.2.



4-(tert-butyl)-1,1'-biphenyl **11**.²⁴ Yield: 98% (M=210.32, 41.3 mg). ¹H NMR (600 MHz, CDCl₃) δ 7.65 (d, J = 8.4 Hz, 2H), 7.60 (d, J = 8.3 Hz, 2H), 7.53 (d, J = 8.2 Hz, 2H), 7.48 (t, J = 7.6 Hz, 2H), 7.41 – 7.34 (m, 1H), 1.42 (s, 9H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 150.3, 141.1, 138.4, 128.8, 127.1, 127.0, 126.9, 126.7, 125.8, 125.7, 34.6, 31.4.



methyl cinnamate **12**.²⁵ Yield: 92% (M=162.19, 29.8 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 16.0 Hz, 1H), 7.56 – 7.50 (m, 2H), 7.42 – 7.32 (m, 3H), 6.45 (d, *J* = 16.0 Hz, 1H), 3.81 (s, 3H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 167.4, 144.9, 134.4, 130.3, 128.9, 128.1, 117.8, 51.7.



4-bromo-N,N-diphenylaniline **13**.²⁶ Yield: 71% (M=324.22, 60.0 mg). ¹H NMR (600 MHz, Chloroform-*d*) δ 7.30 (d, *J* = 7.1 Hz, 2H), 7.23 (d, *J* = 5.3 Hz, 4H), 7.09 – 6.99 (m, 6H), 6.93 (d, *J* = 6.2 Hz, 2H); ¹³C NMR (151 MHz, Chloroform-*d*) δ 147.4, 147.1, 132.2, 129.4, 125.2, 124.5, 123.3, 114.8.

References:

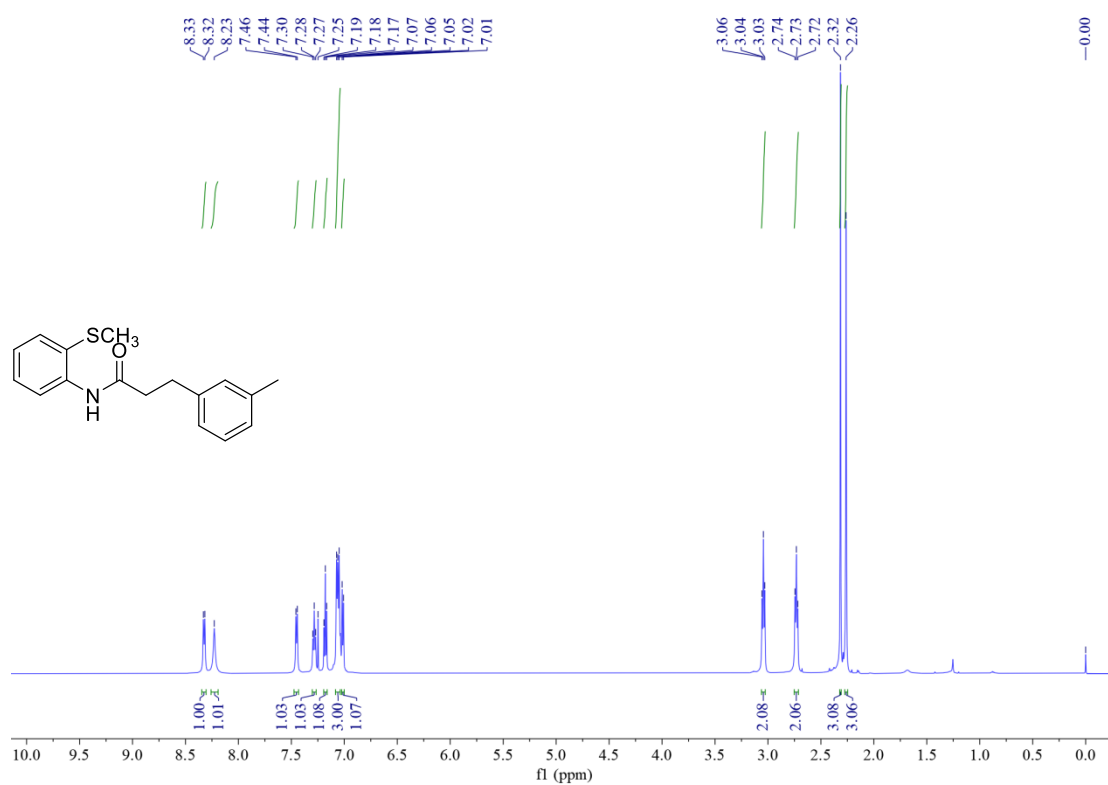
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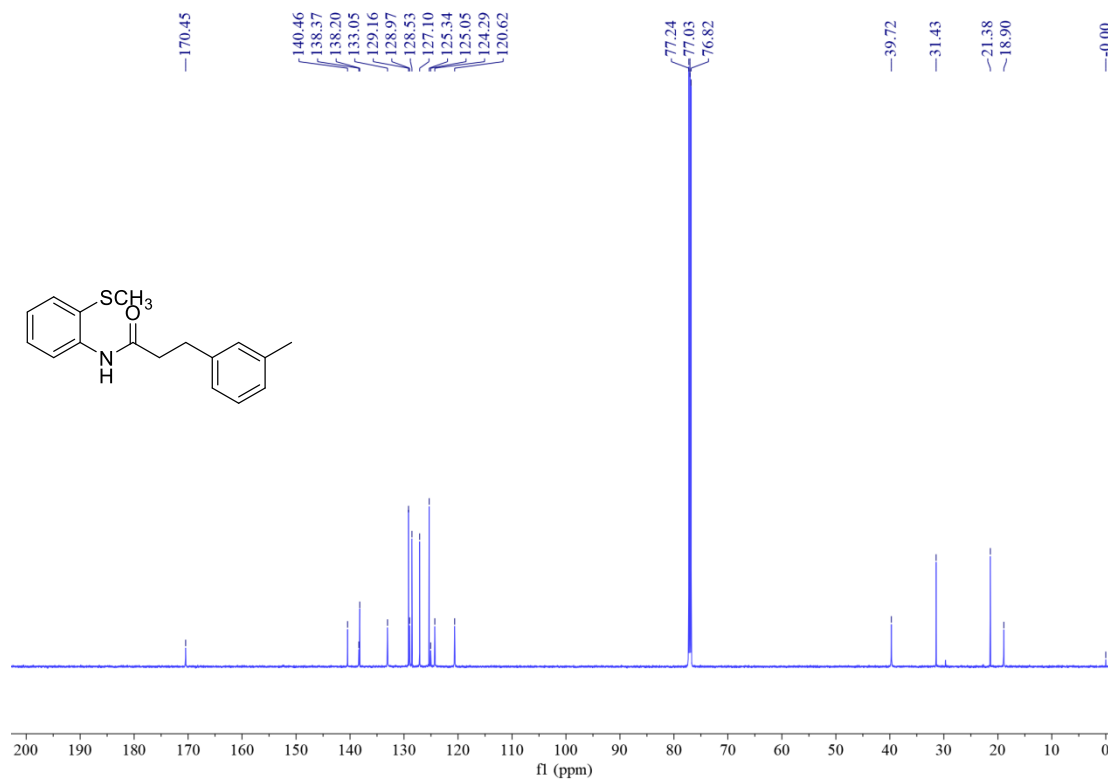
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NMR and HRMS spectra of products

^1H NMR of N-(2-(methylthio)phenyl)-3-(m-tolyl)propanamide **3aa**



^{13}C NMR of N-(2-(methylthio)phenyl)-3-(m-tolyl)propanamide **3aa**



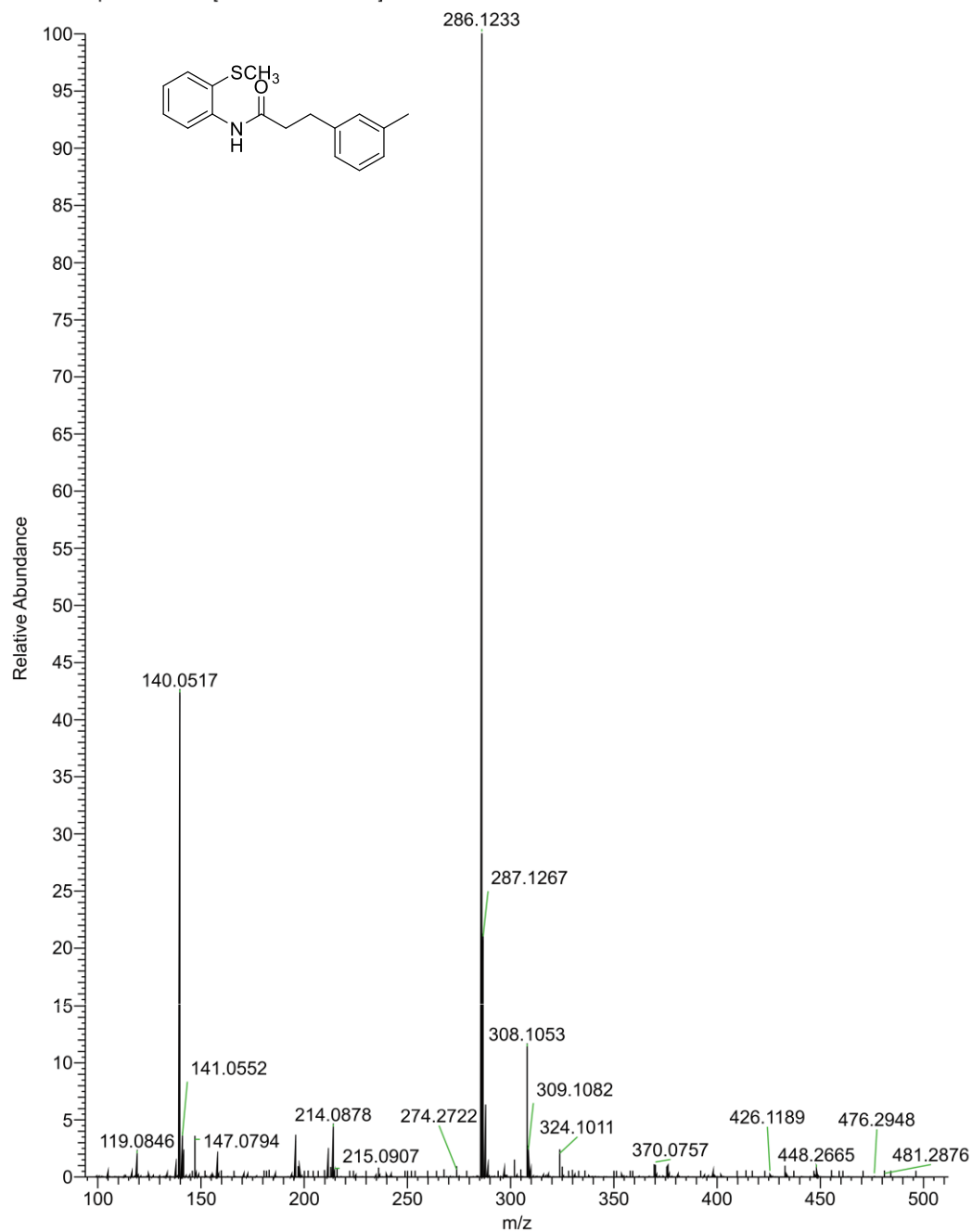
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-(m-tolyl)propanamide **3aa**

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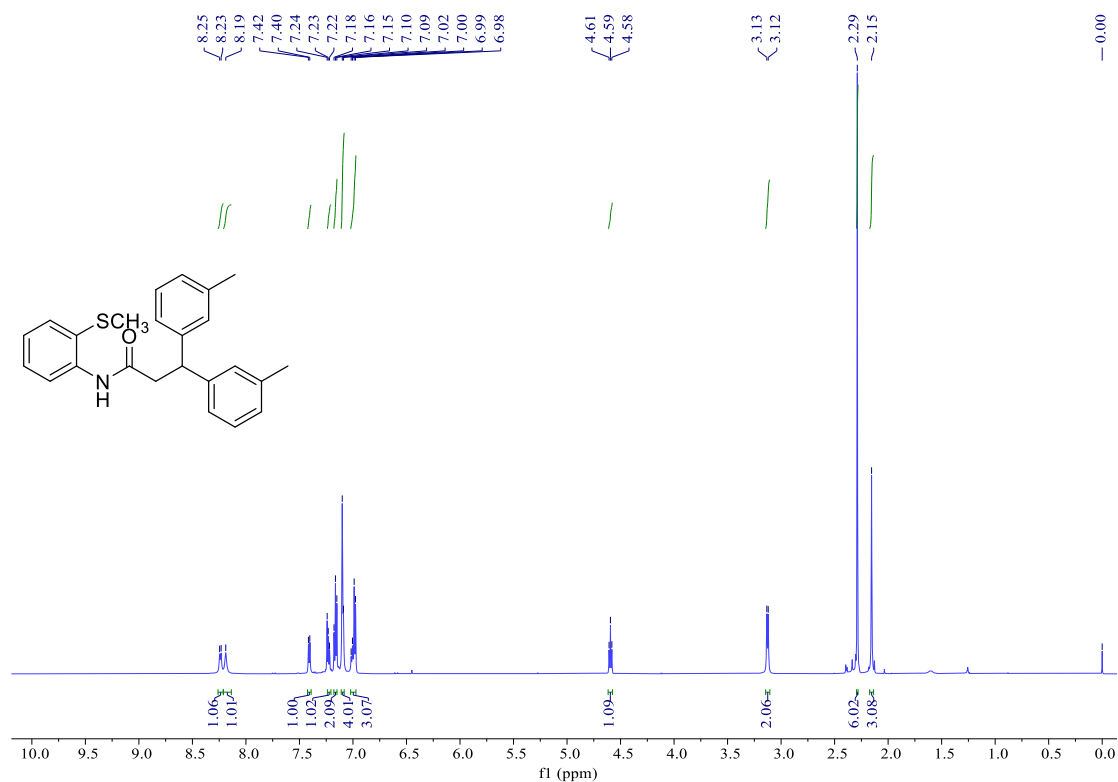
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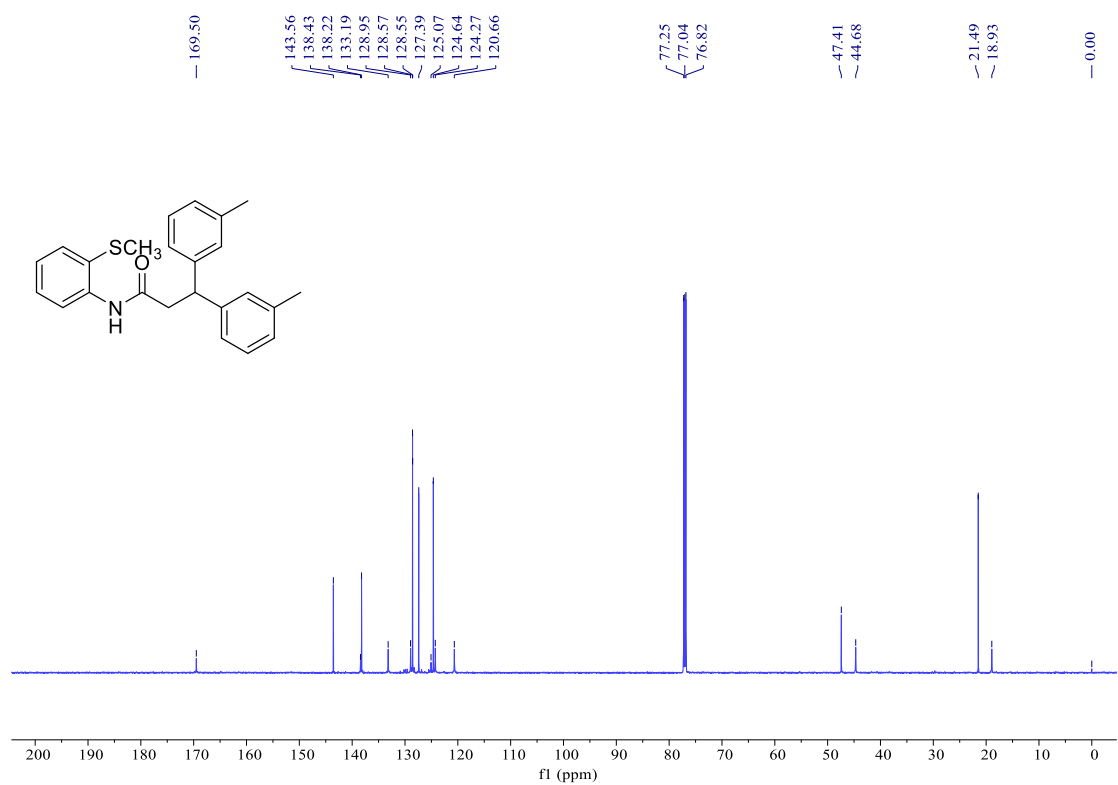
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¹H NMR of N-(2-(methylthio)phenyl)-3,3-di-m-tolylpropanamide **3aa'**



¹³C NMR of N-(2-(methylthio)phenyl)-3,3-di-m-tolylpropanamide **3aa'**



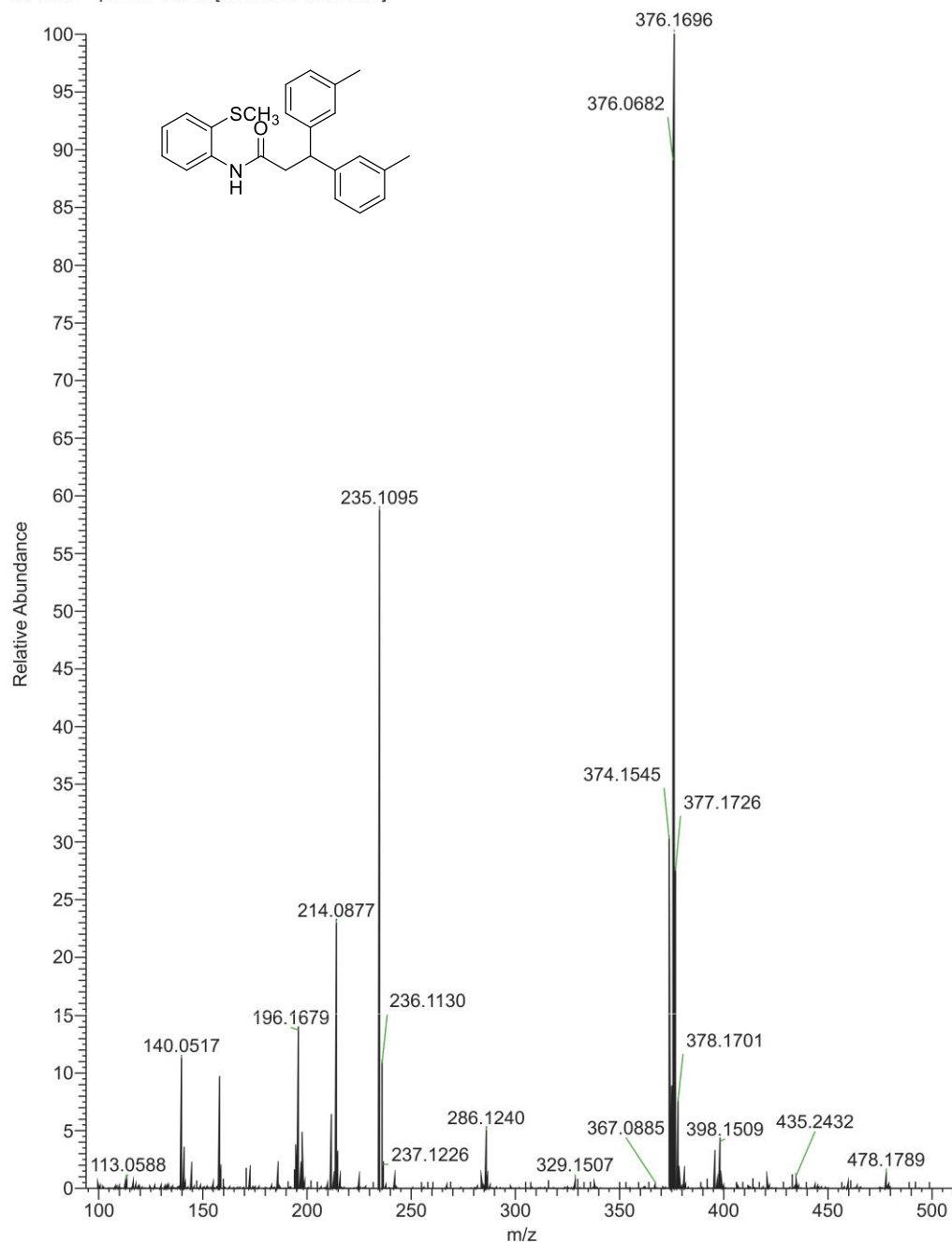
HRMS(ESI) of N-(2-(methylthio)phenyl)-3,3-di-m-tolylpropanamide **3aa'**

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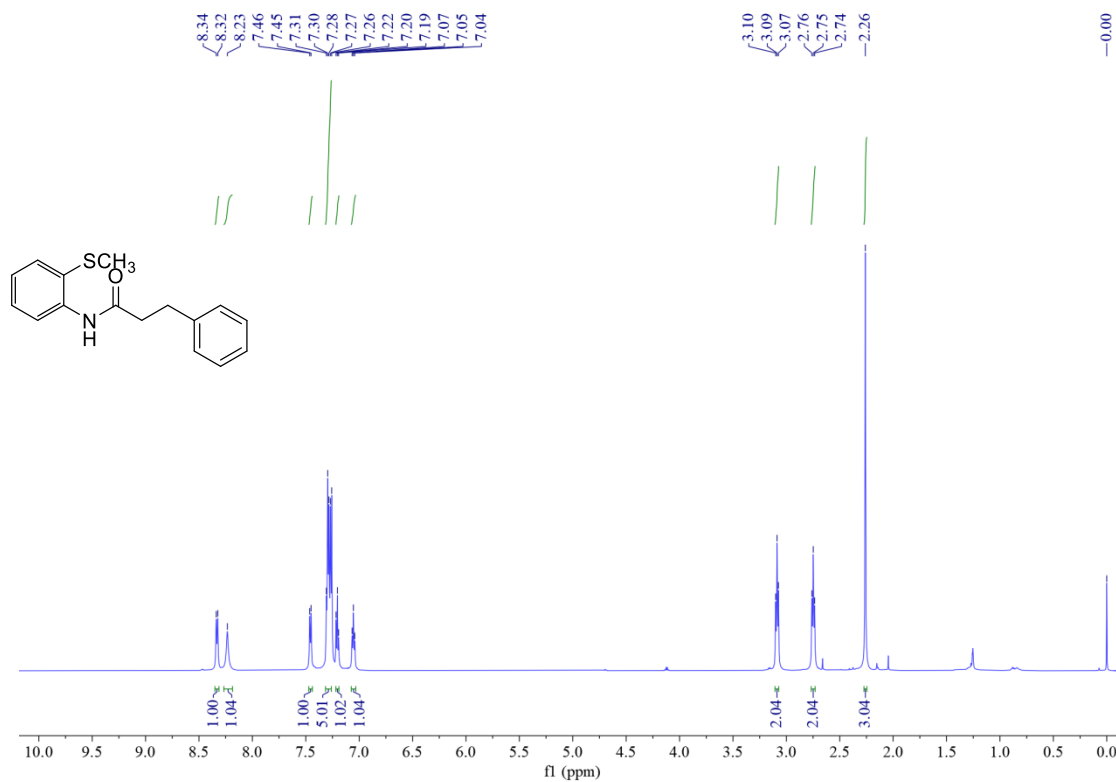
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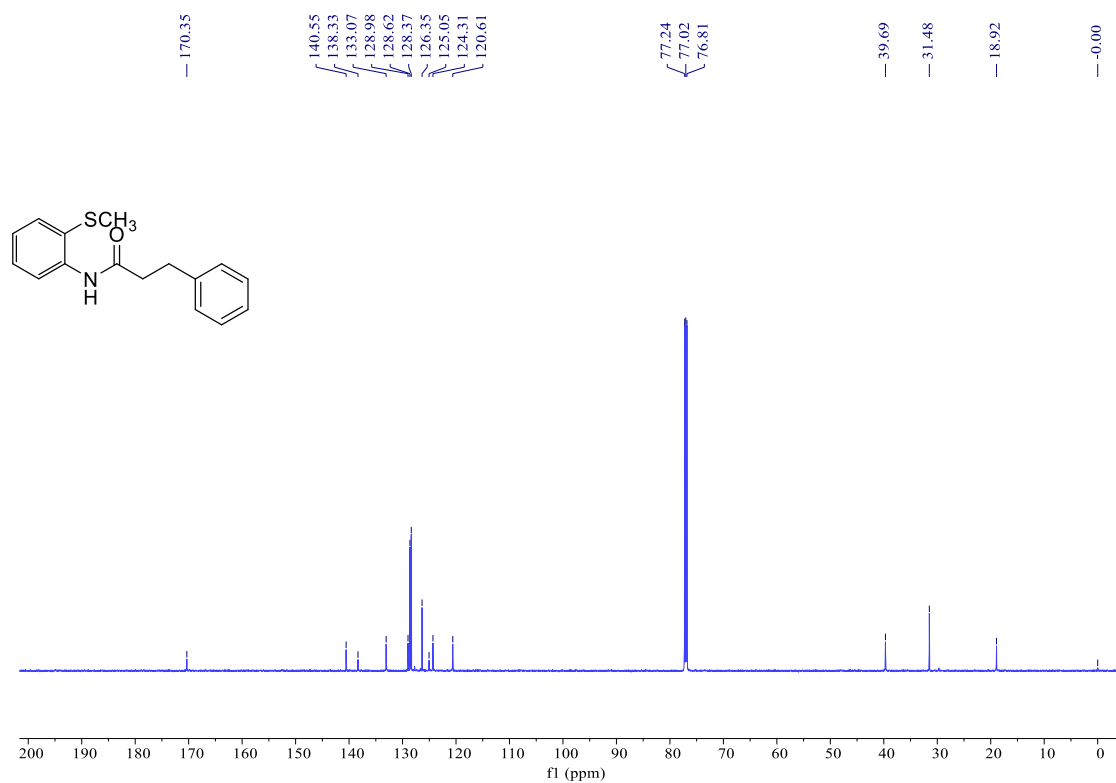
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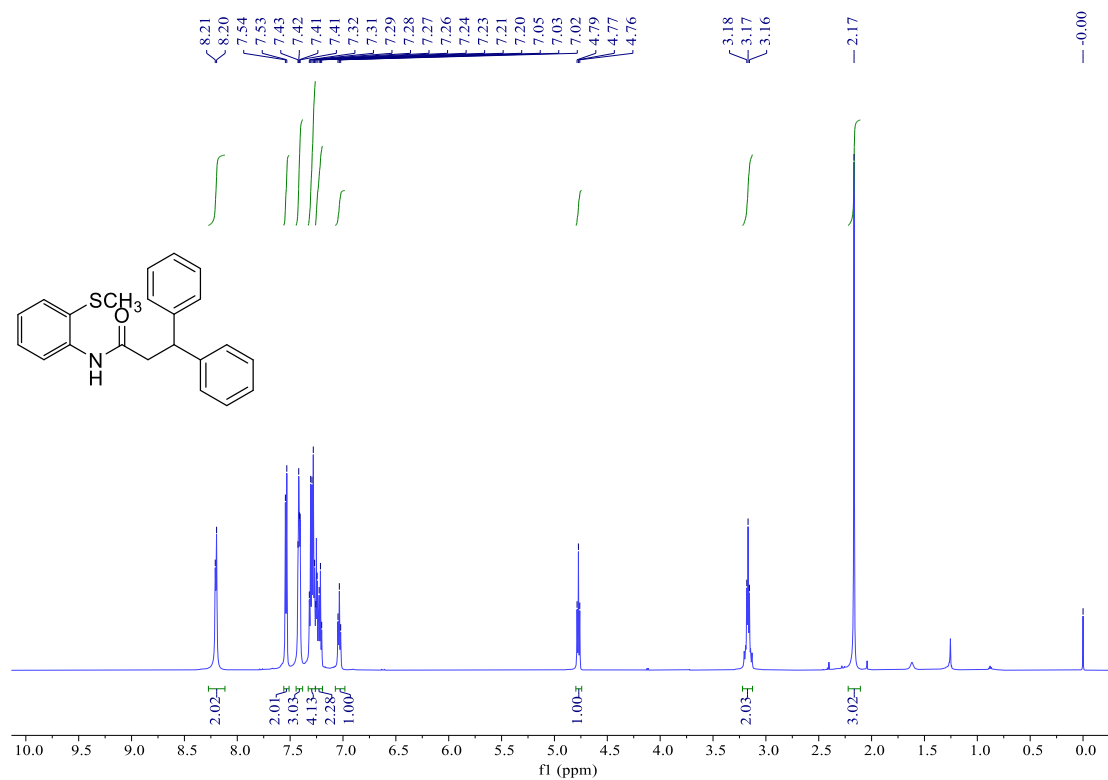
¹H NMR of N-(2-(methylthio)phenyl)-3-phenylpropanamide **3ab**



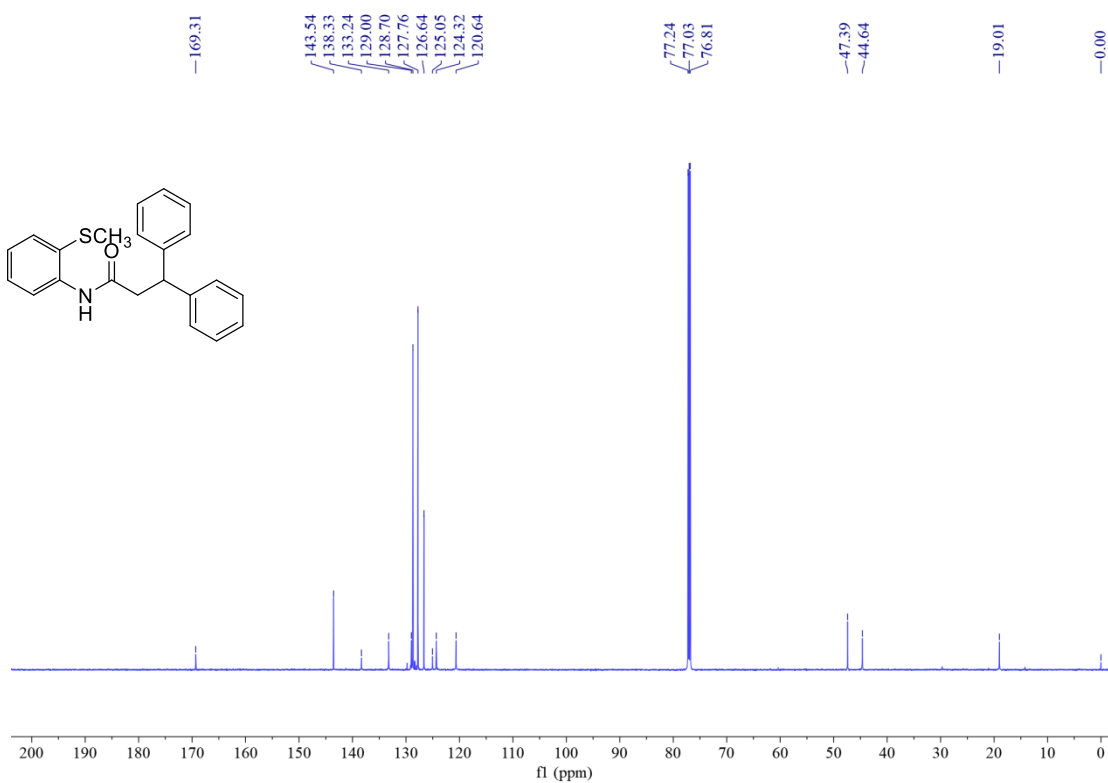
¹³C NMR of N-(2-(methylthio)phenyl)-3-phenylpropanamide **3ab**



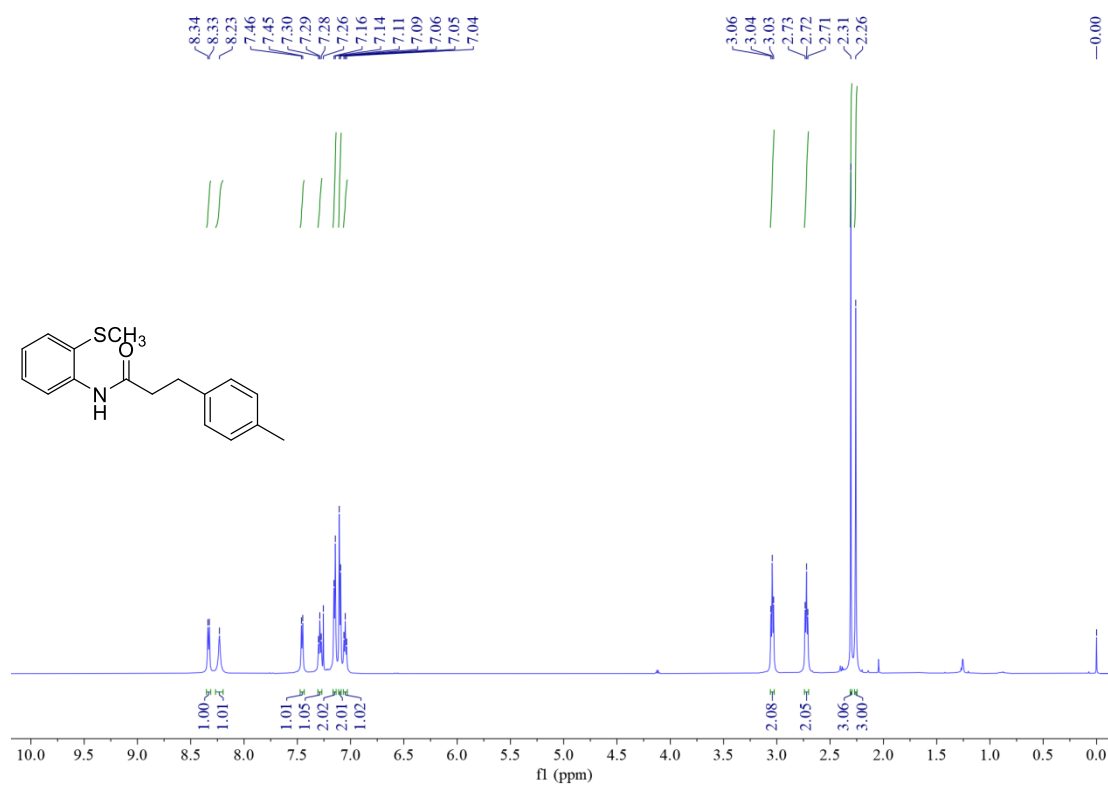
¹H NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ab'**



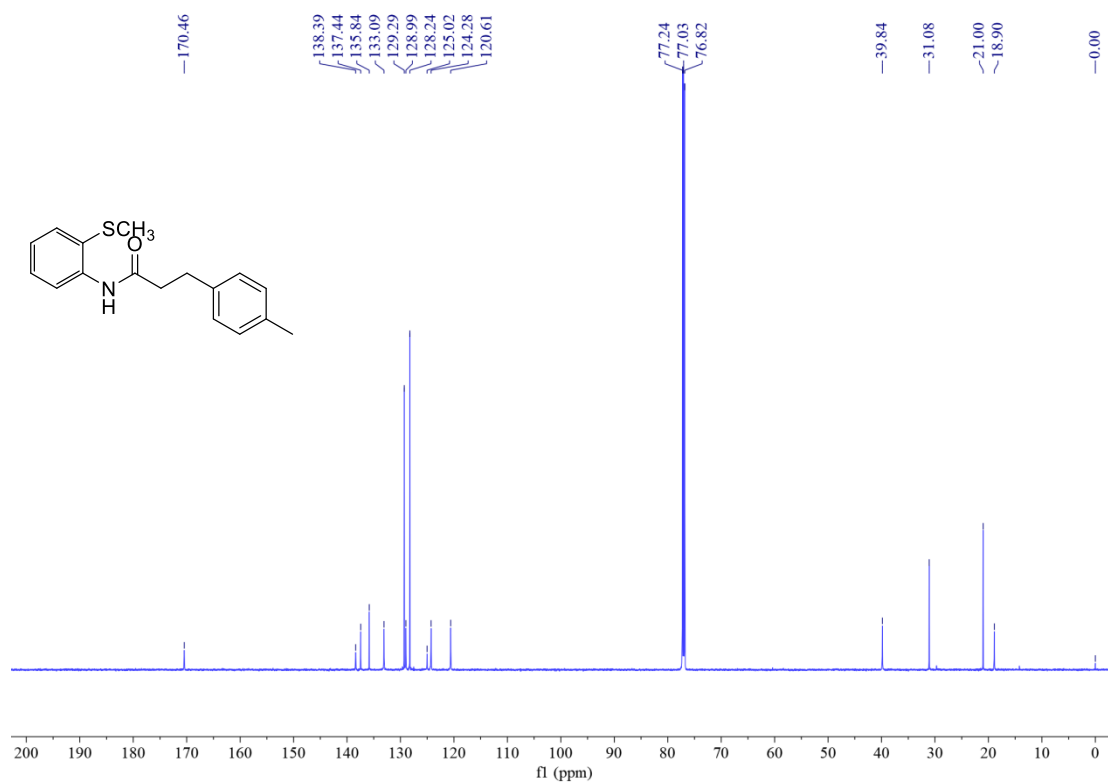
¹³C NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ab'**



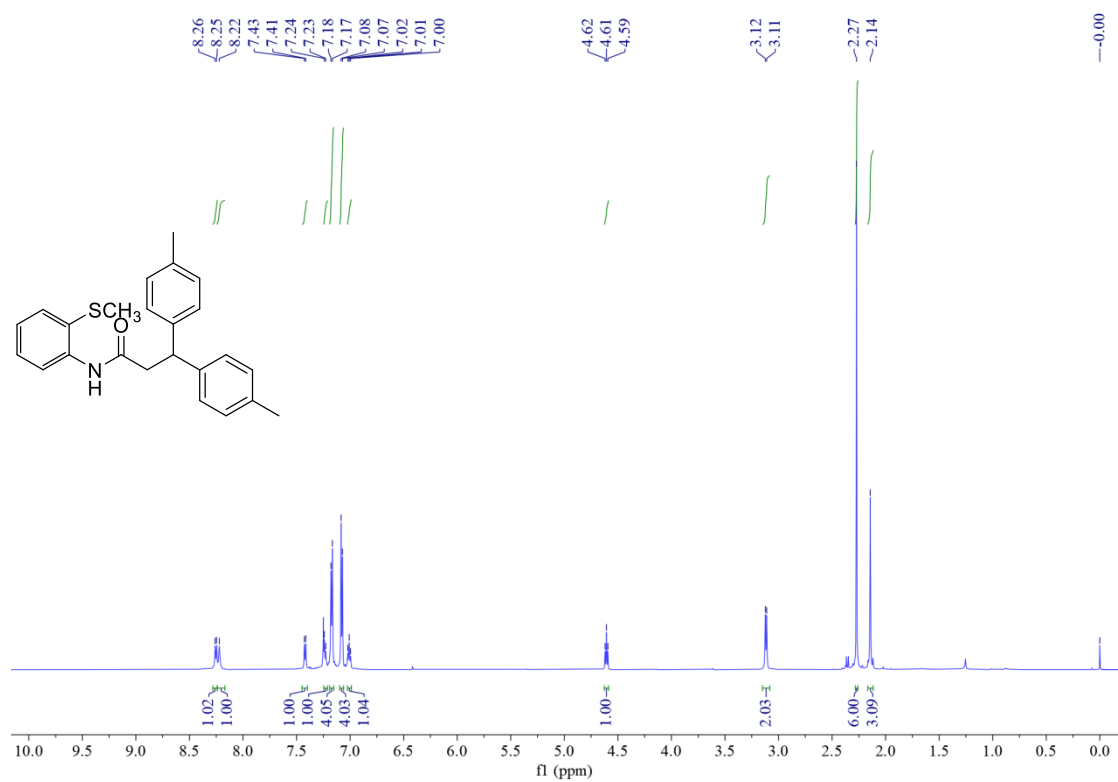
¹H NMR of N-(2-(methylthio)phenyl)-3-(p-tolyl)propanamide **3ac**



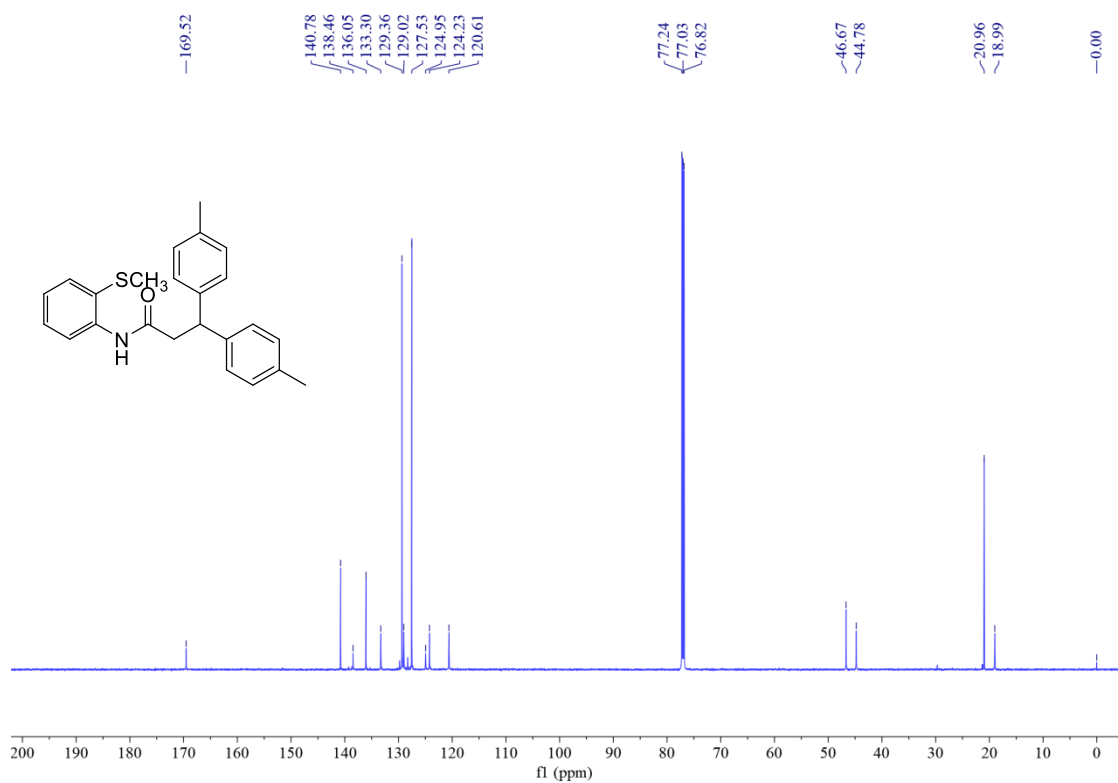
¹³C NMR of N-(2-(methylthio)phenyl)-3-(p-tolyl)propanamide **3ac**



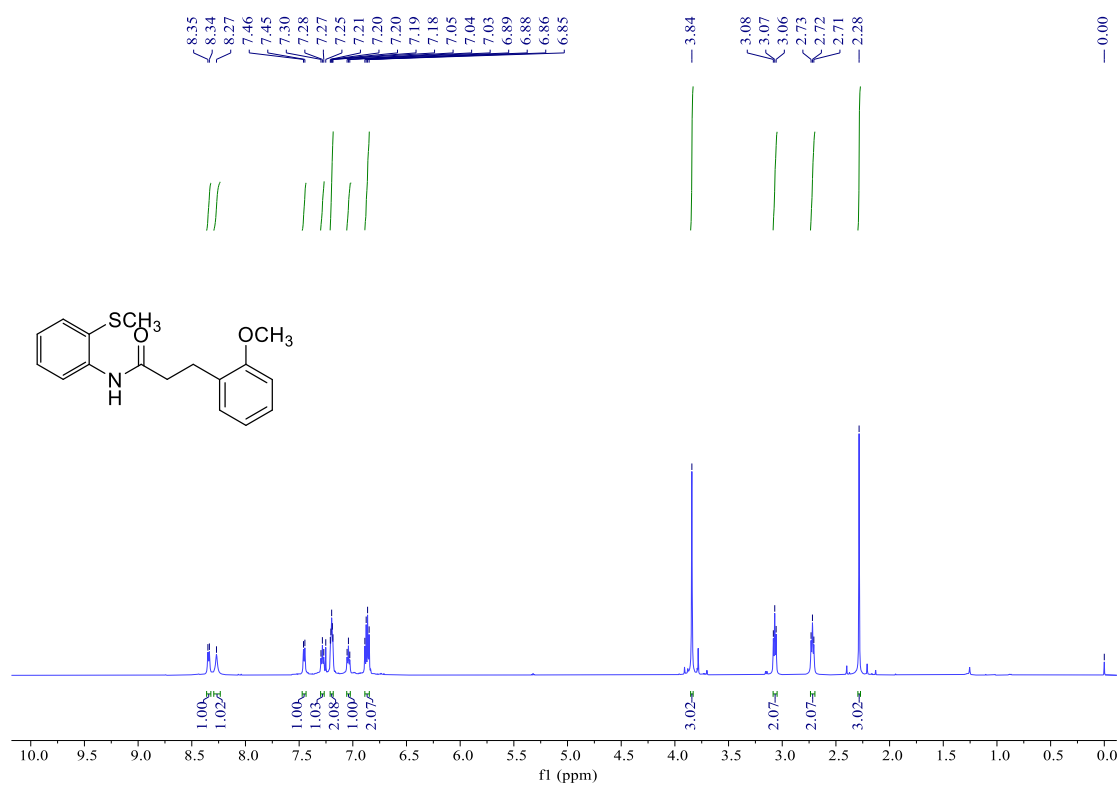
¹H NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ac'**



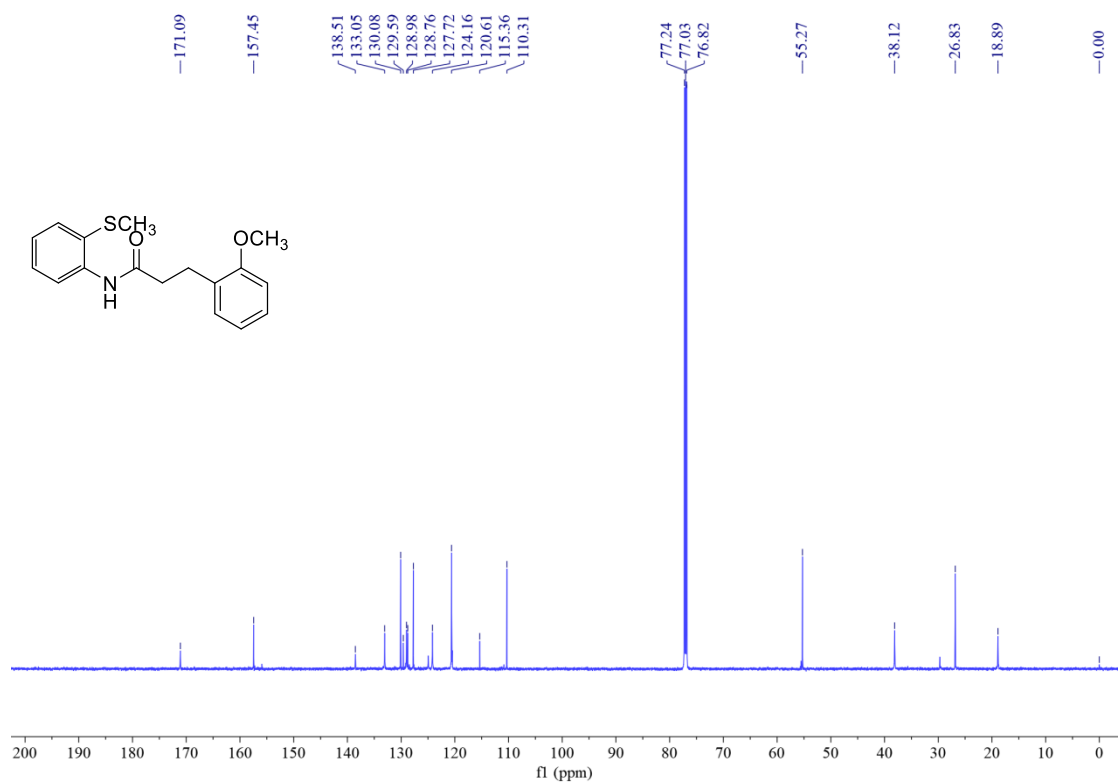
¹³C NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ac'**



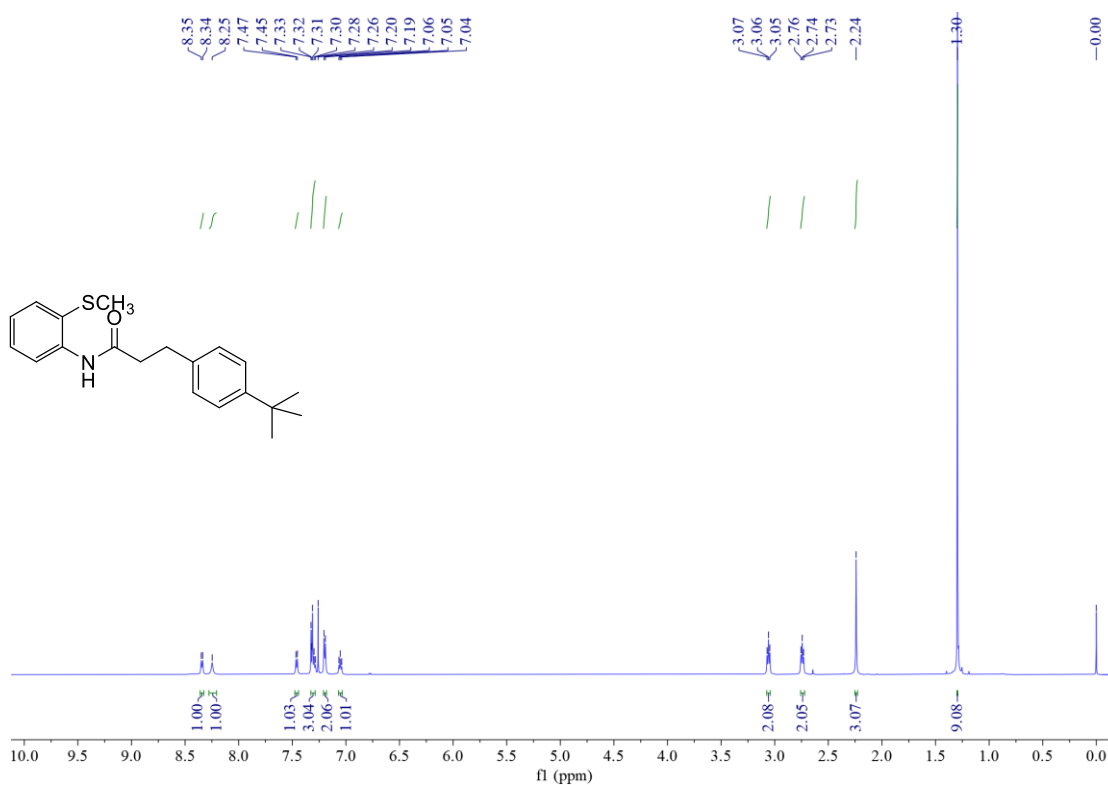
¹H NMR of 3-(2-methoxyphenyl)-N-(2-(methylthio)phenyl)propanamide **3ad**



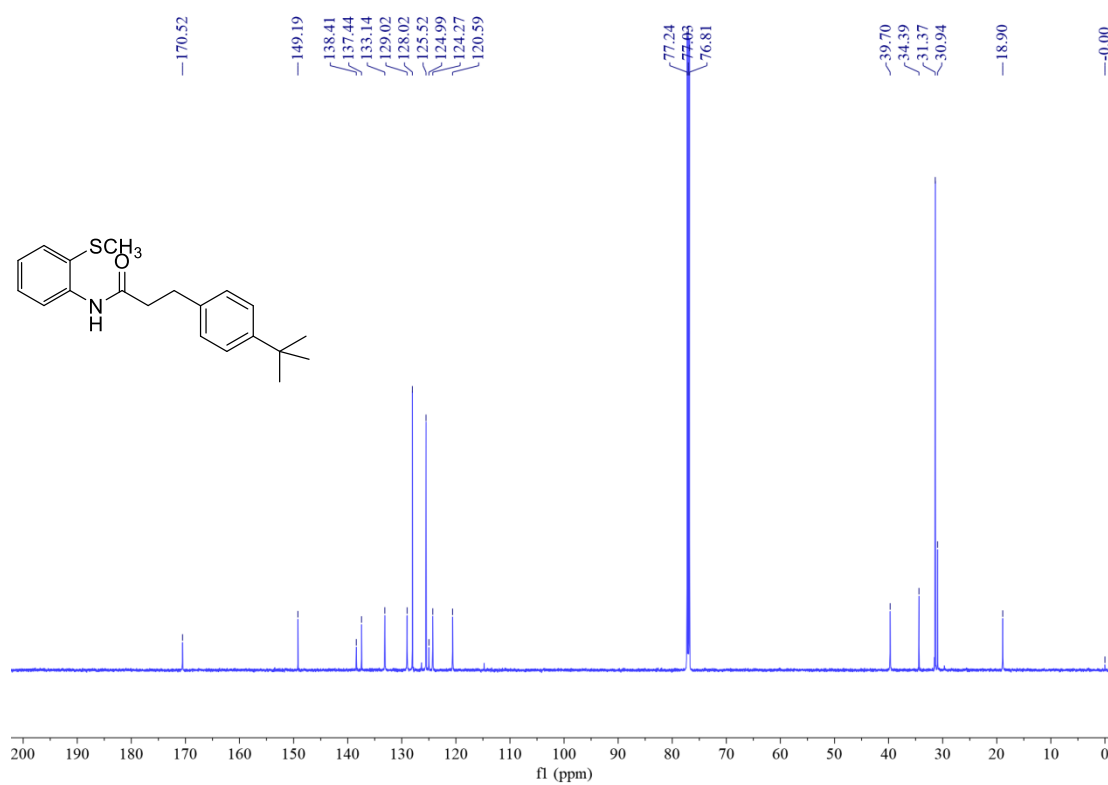
¹³C NMR of 3-(2-methoxyphenyl)-N-(2-(methylthio)phenyl)propanamide **3ad**



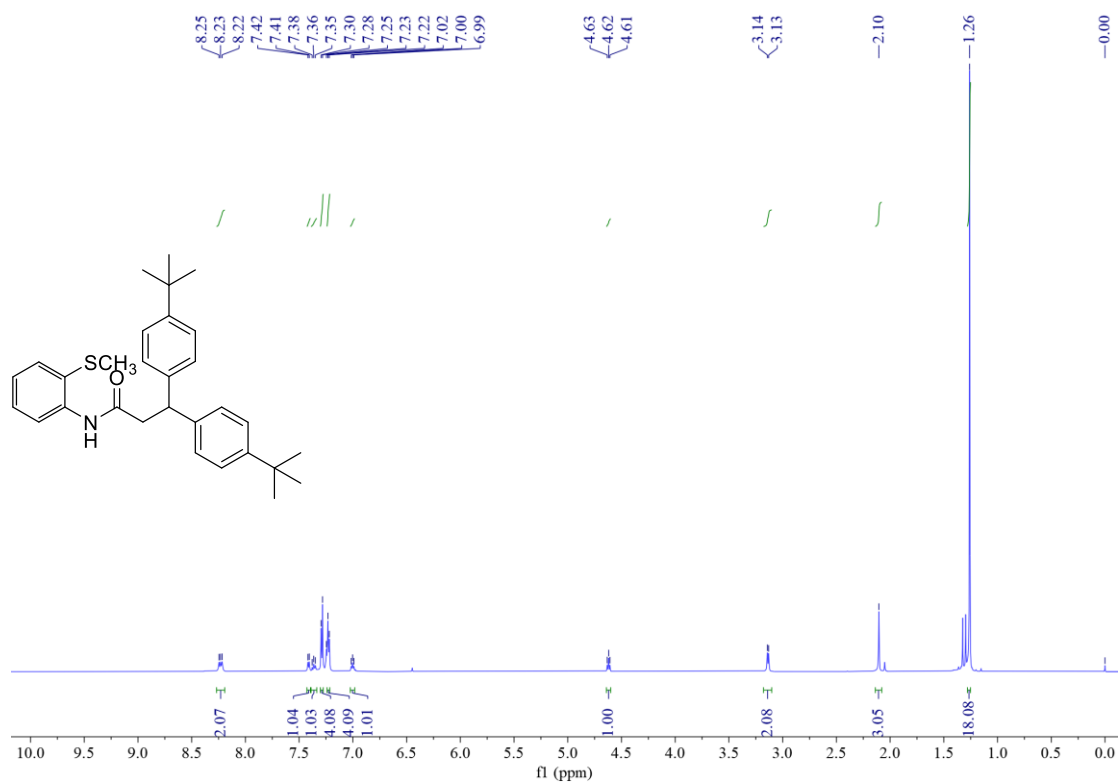
^1H NMR of 3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae**



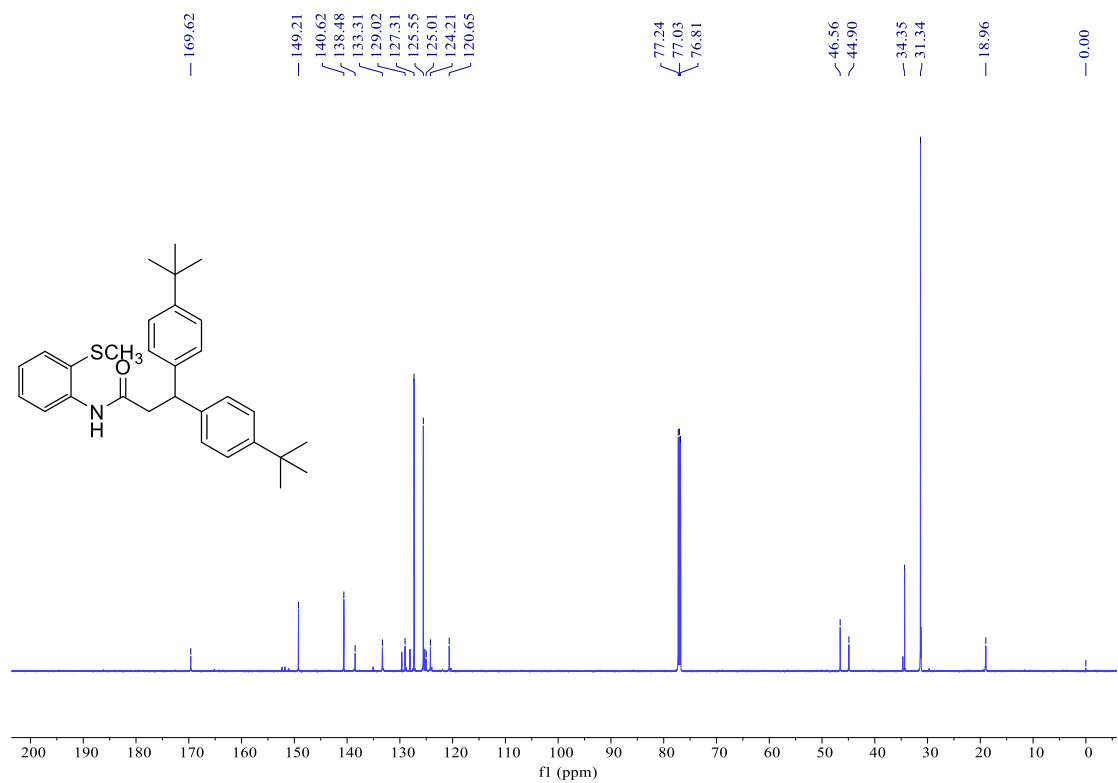
^{13}C NMR of 3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae**



¹H NMR of 3,3-bis(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae'**



¹³C NMR of 3,3-bis(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae'**



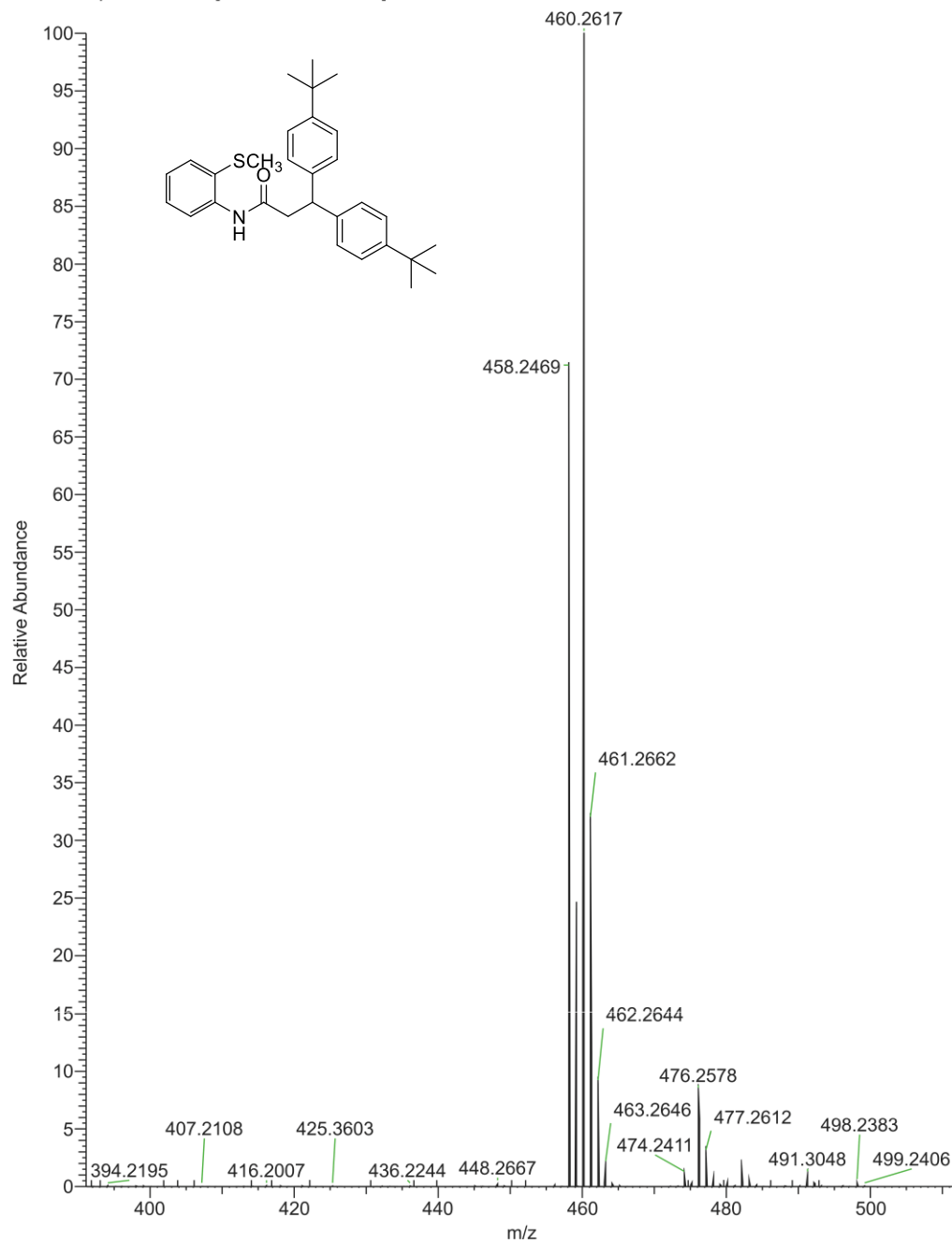
HRMS(ESI) of 3,3-bis(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)propanamide **3ae'**

D:\DATA\2025\25050775683\3\1-100-500.raw

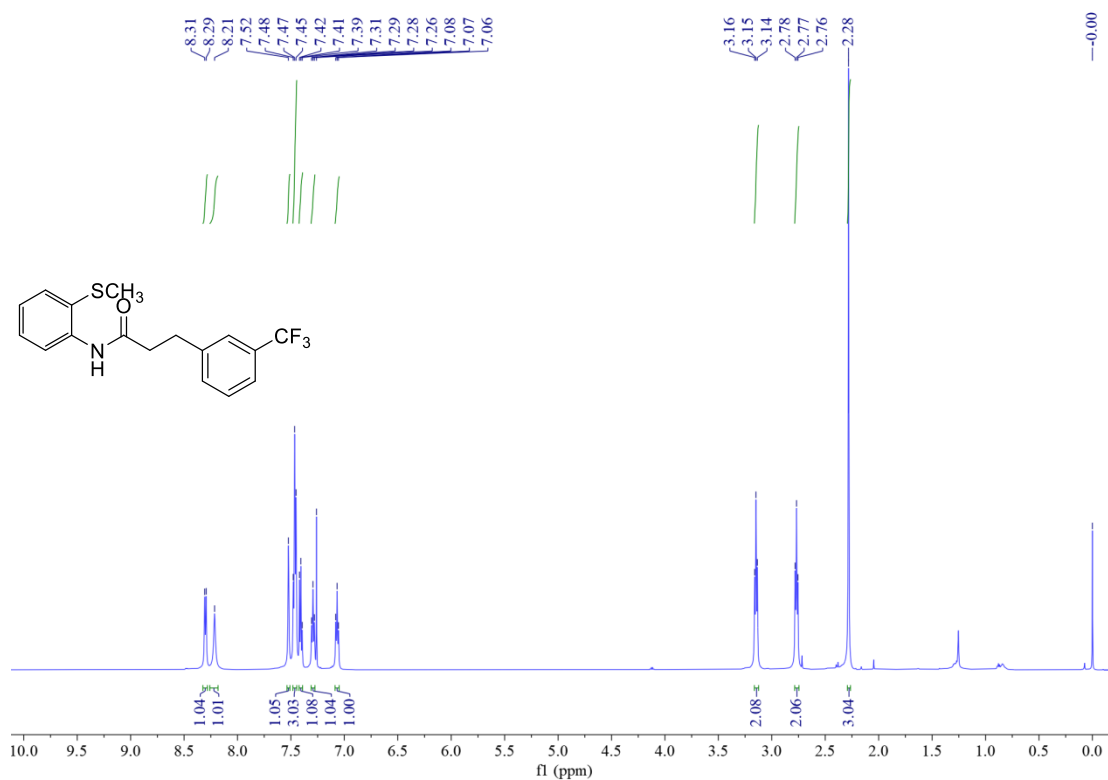
5/14/2025 15:27:34

1-100-500 #915-1406 RT: 0.56-0.86 AV: 492 NL: 9.25E7

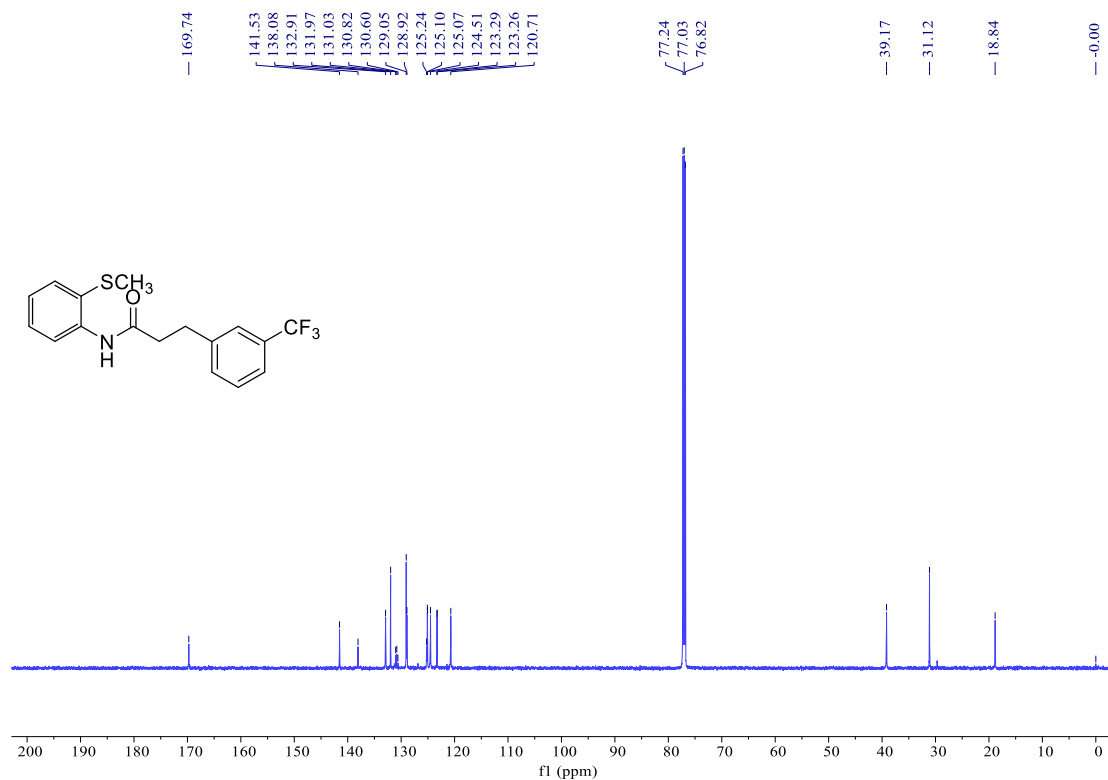
T: FTMS + p ESI Full ms [100.0000-500.0000]



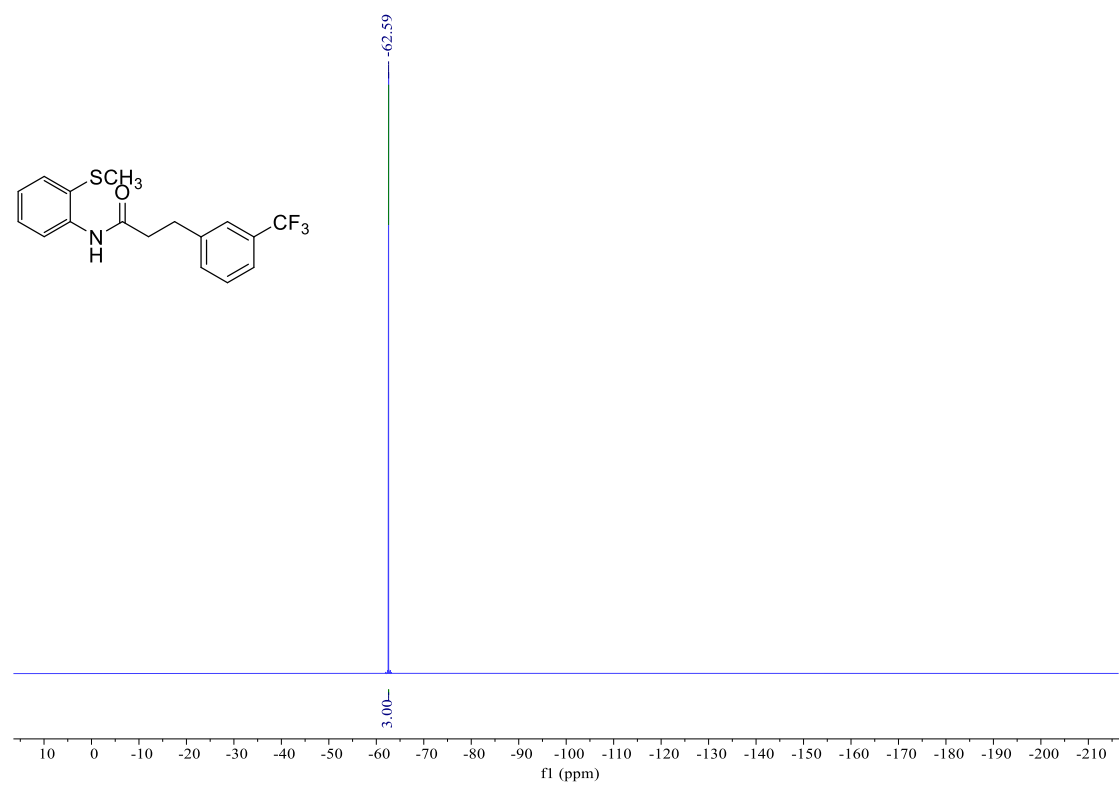
¹H NMR of N-(2-(methylthio)phenyl)-3-(3-(trifluoromethyl)phenyl)propanamide **3af**



¹³C NMR of N-(2-(methylthio)phenyl)-3-(3-(trifluoromethyl)phenyl)propanamide **3af**



^{19}F NMR of N-(2-(methylthio)phenyl)-3-(3-(trifluoromethyl)phenyl)propanamide **3af**



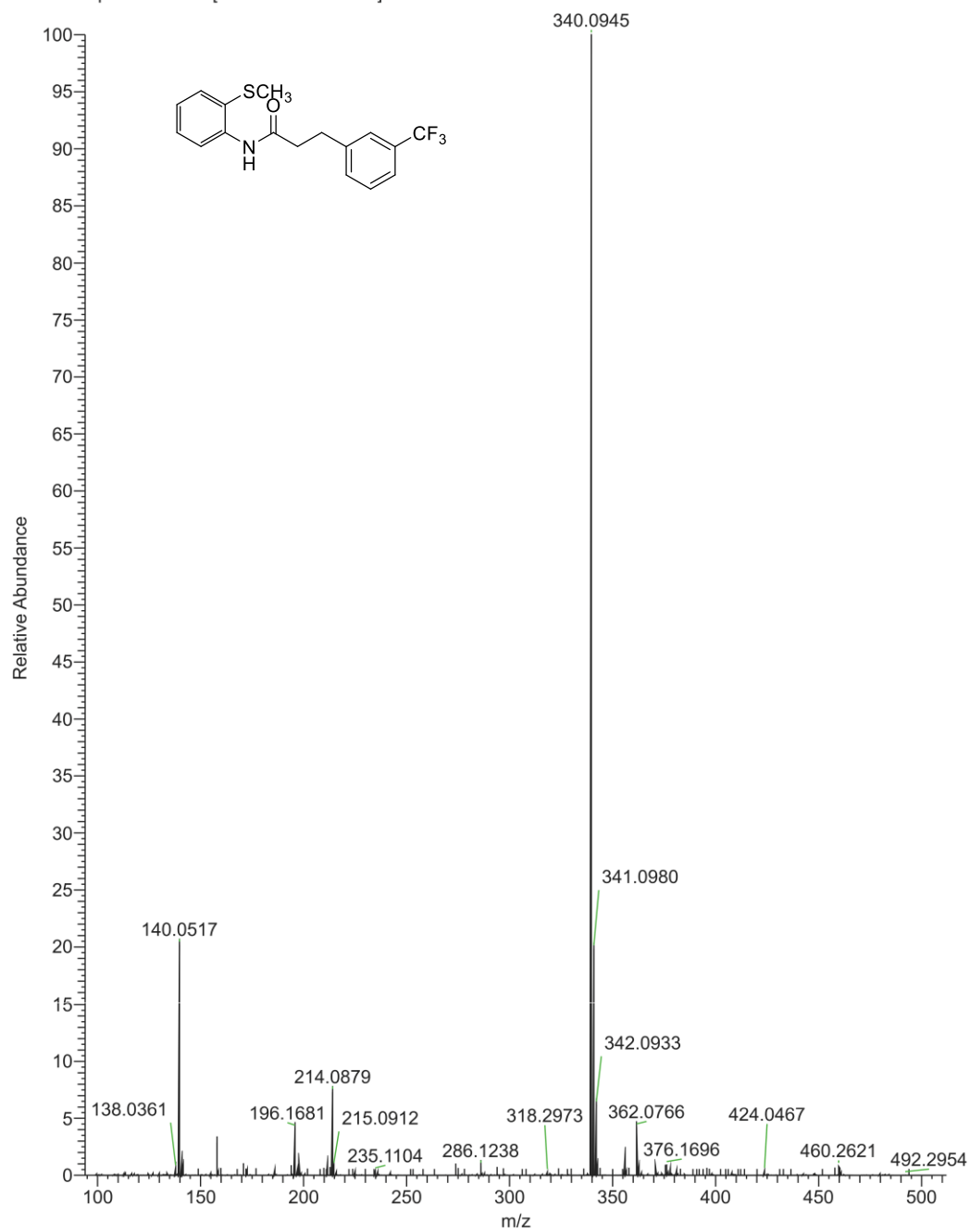
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-(3-(trifluoromethyl)phenyl)propanamide **3af**

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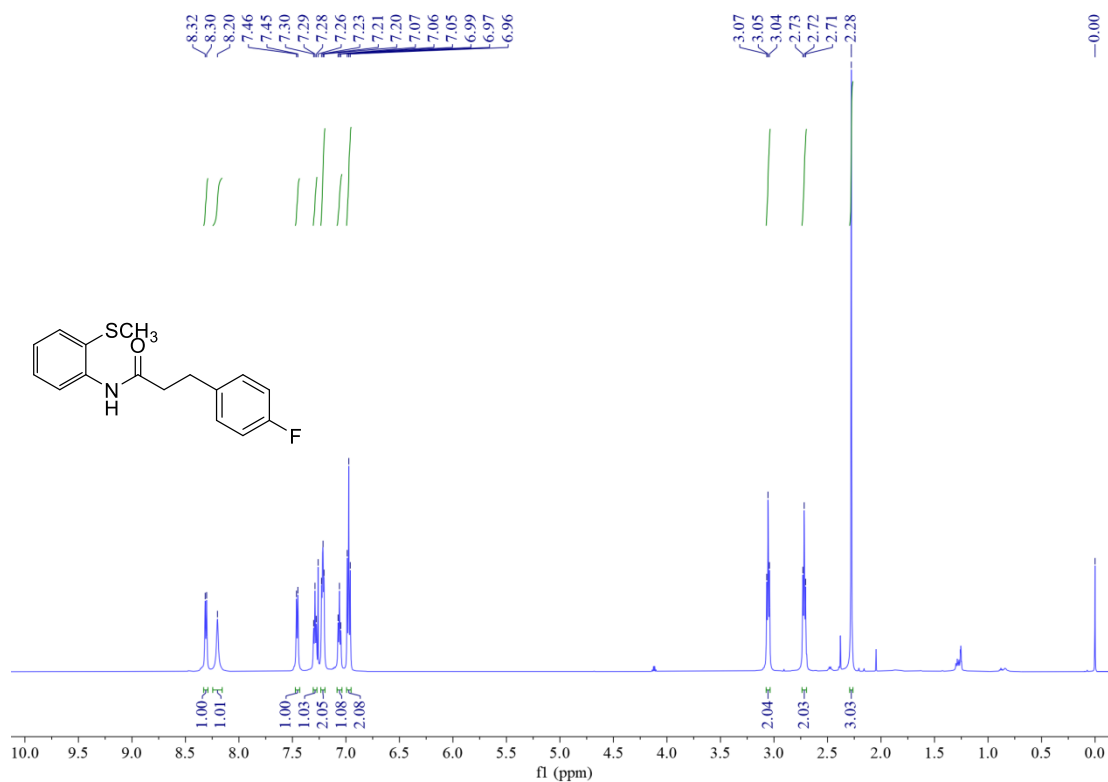
5/14/2025 15:30:23

1-100-500 #869-1340 RT: 0.53-0.82 AV: 472 NL: 4.92E8

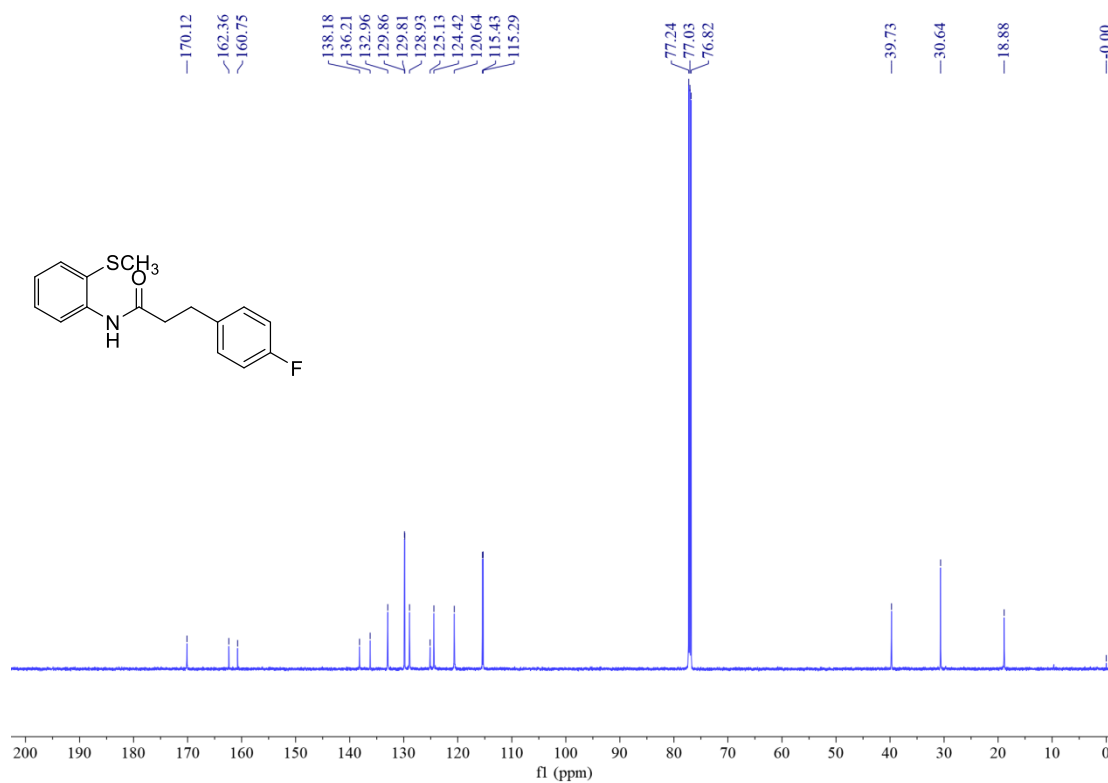
T: FTMS + p ESI Full ms [100.0000-500.0000]



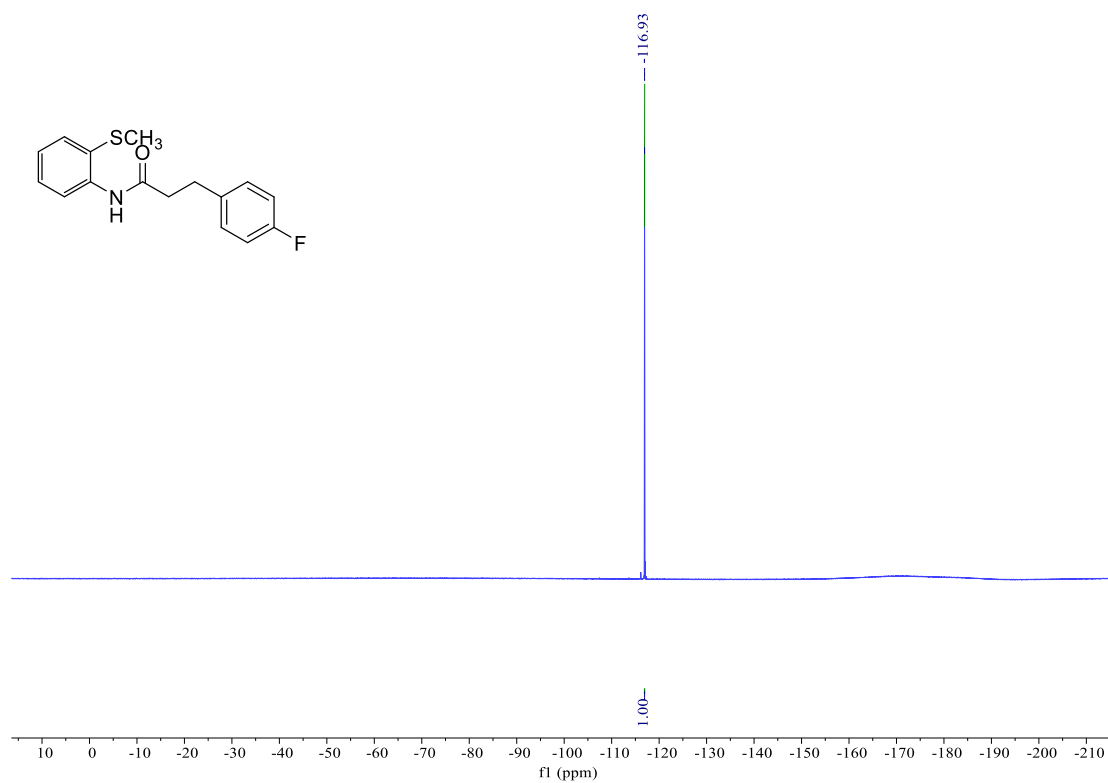
¹H NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ag**



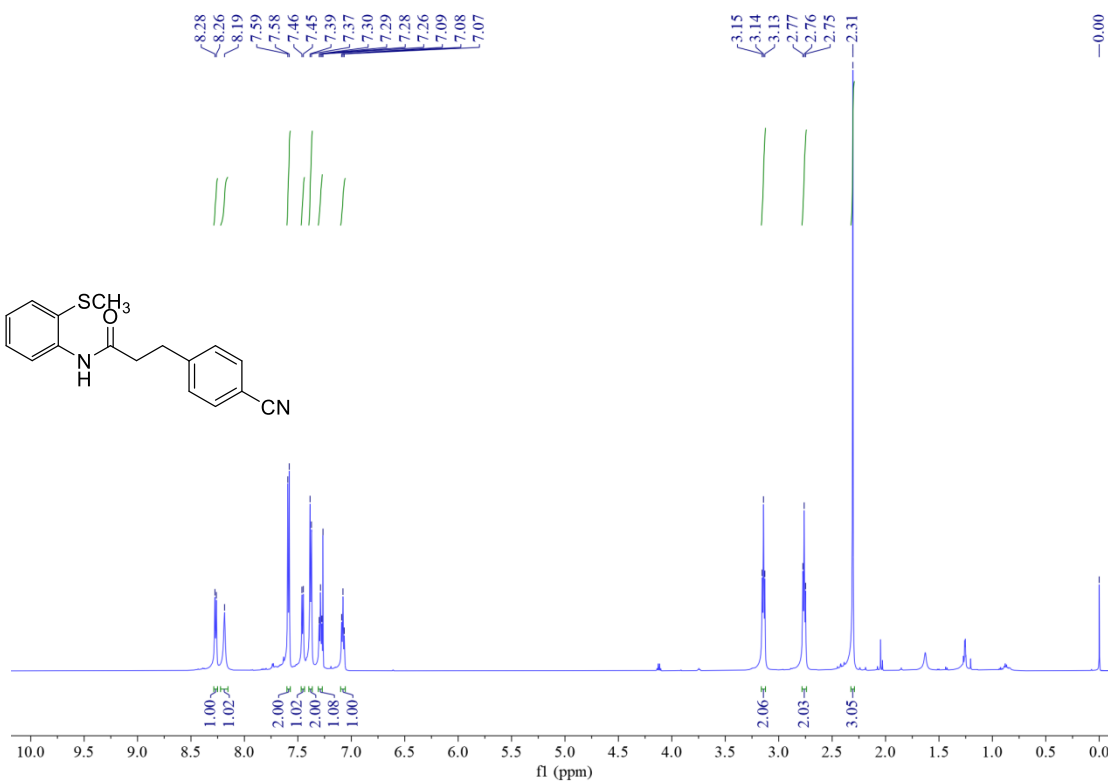
¹³C NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3ag**



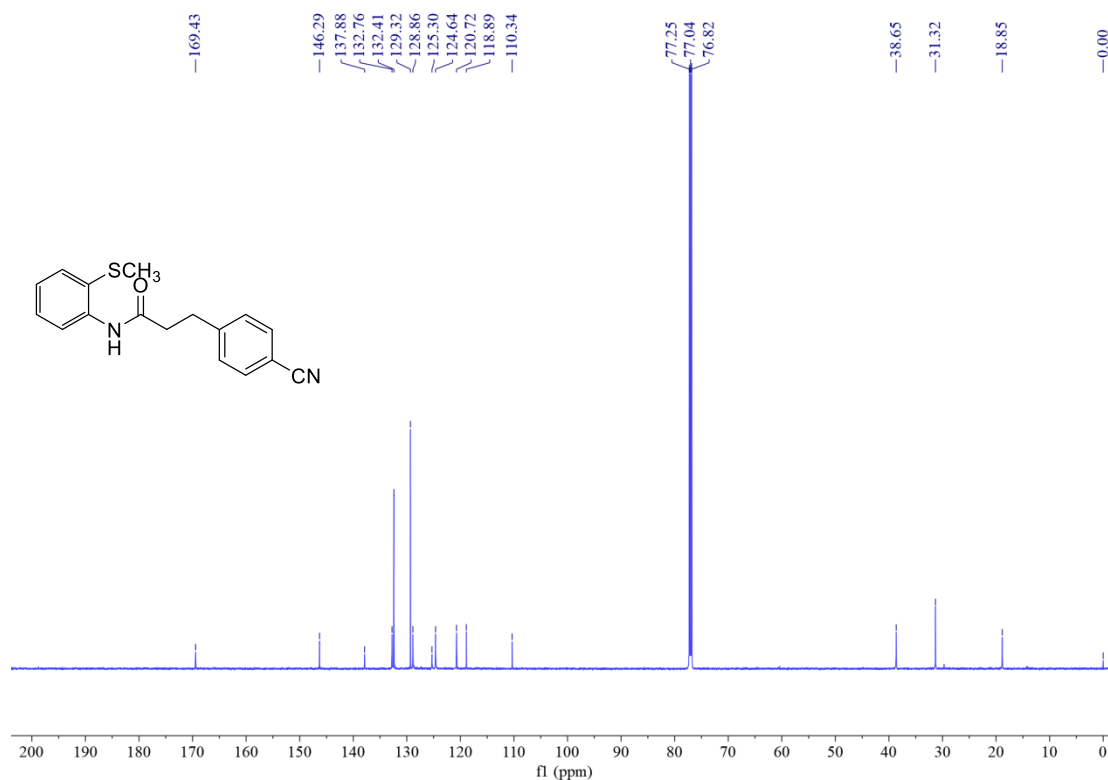
¹⁹F NMR of 3-(4-fluorophenyl)-N-(2-(methylthio)phenyl)propanamide **3ag**



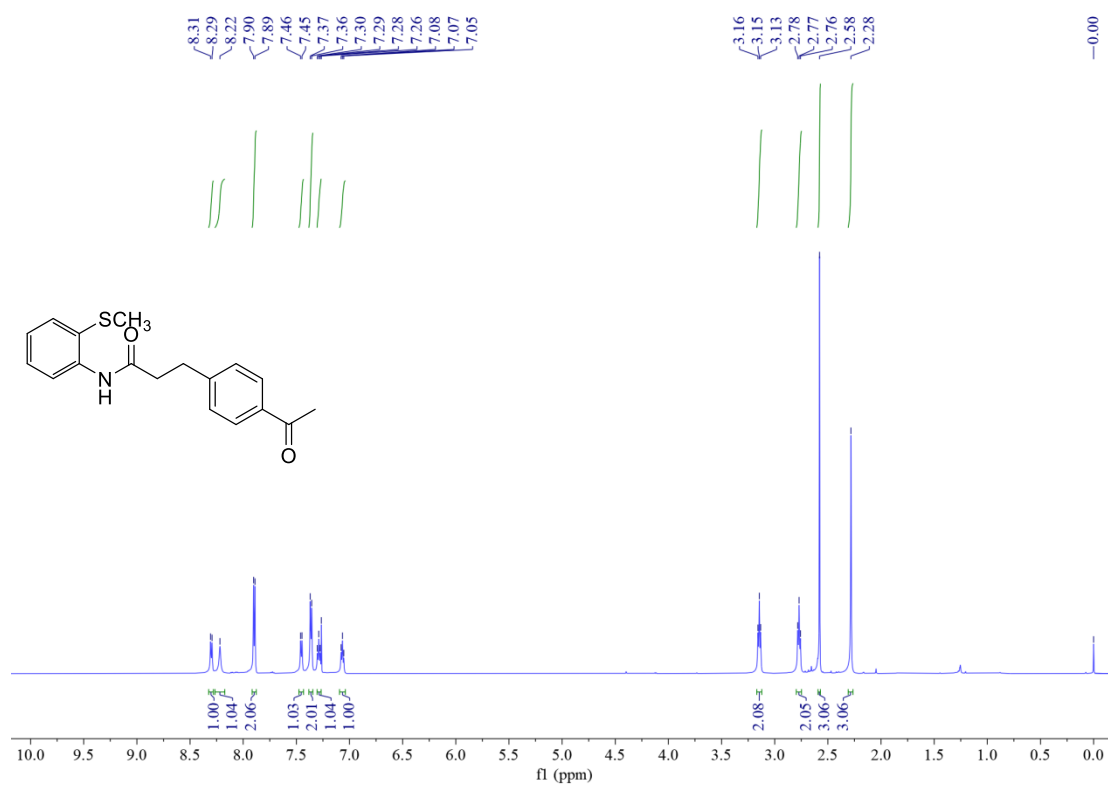
¹H NMR of 3-(4-cyanophenyl)-N-(2-(methylthio)phenyl)propanamide **3ah**



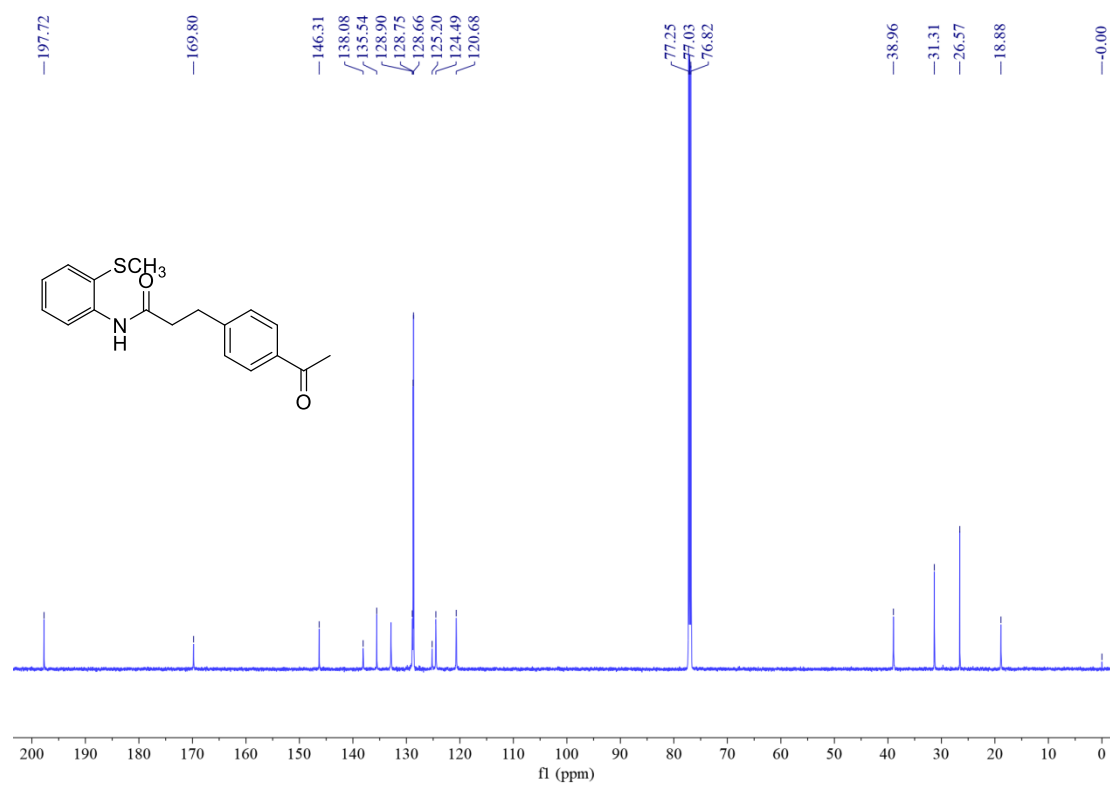
¹³C NMR of 3-(4-cyanophenyl)-N-(2-(methylthio)phenyl)propanamide **3ah**



¹H NMR of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)propanamide **3ai**



¹³C NMR of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)propanamide **3ai**



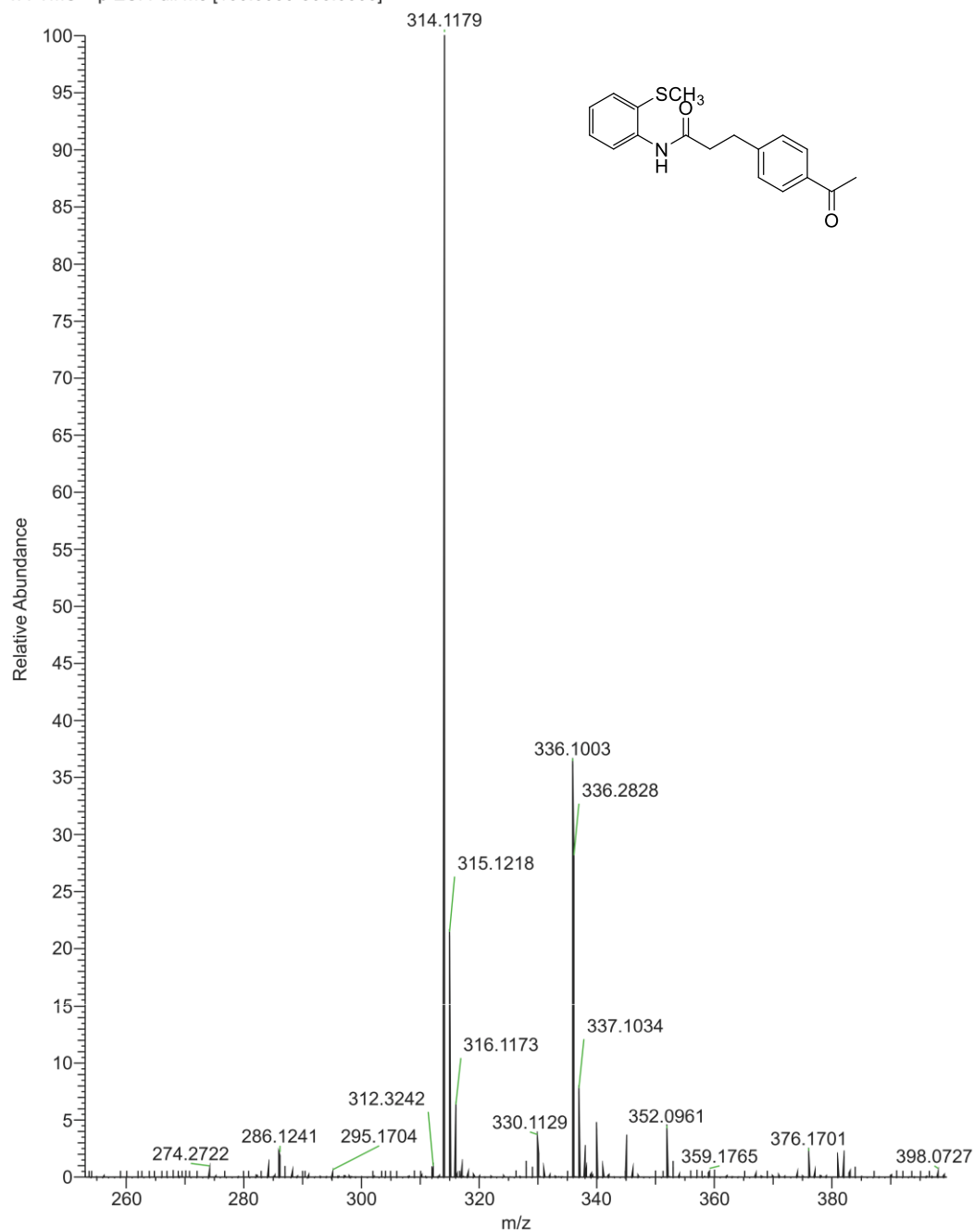
HRMS(ESI) of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)propanamide **3ai**

D:\DATA\2025\25050775683\5\1-100-500.raw

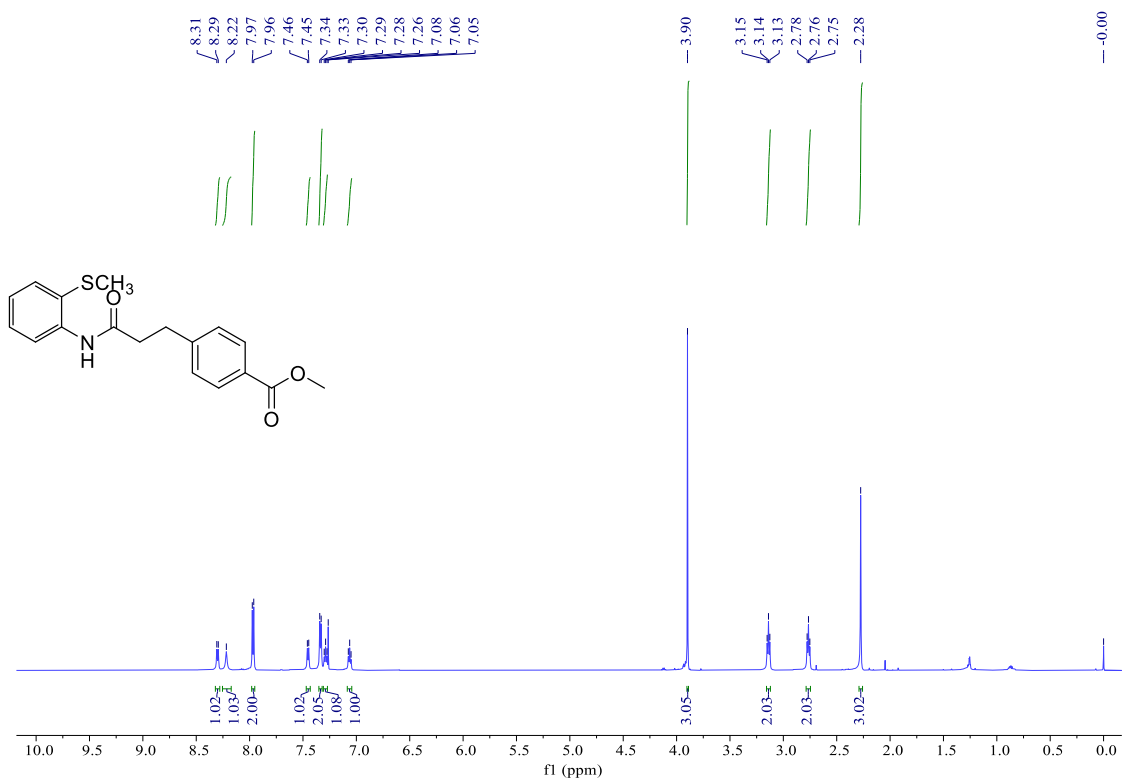
5/14/2025 15:34:15

1-100-500 #966-1242 RT: 0.59-0.76 AV: 277 NL: 1.76E8

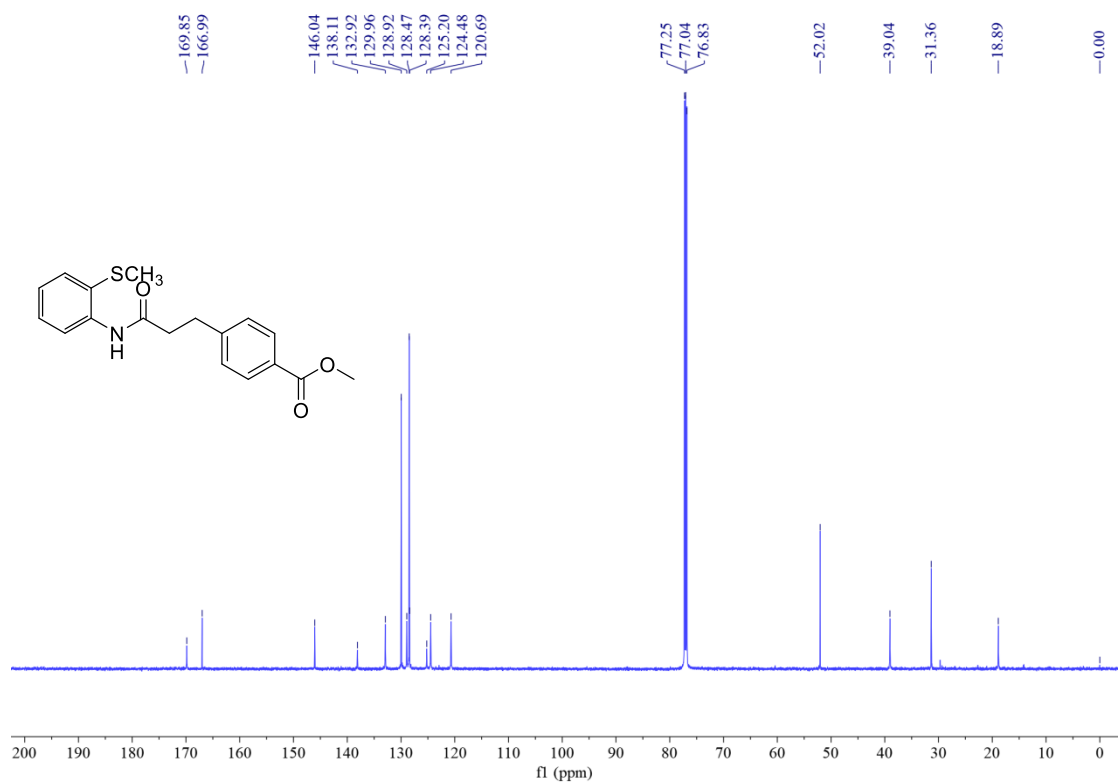
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of methyl 4-(3-((2-(methylthio)phenyl)amino)-3-oxopropyl)benzoate **3aj**



¹³C NMR of methyl 4-(3-((2-(methylthio)phenyl)amino)-3-oxopropyl)benzoate **3aj**



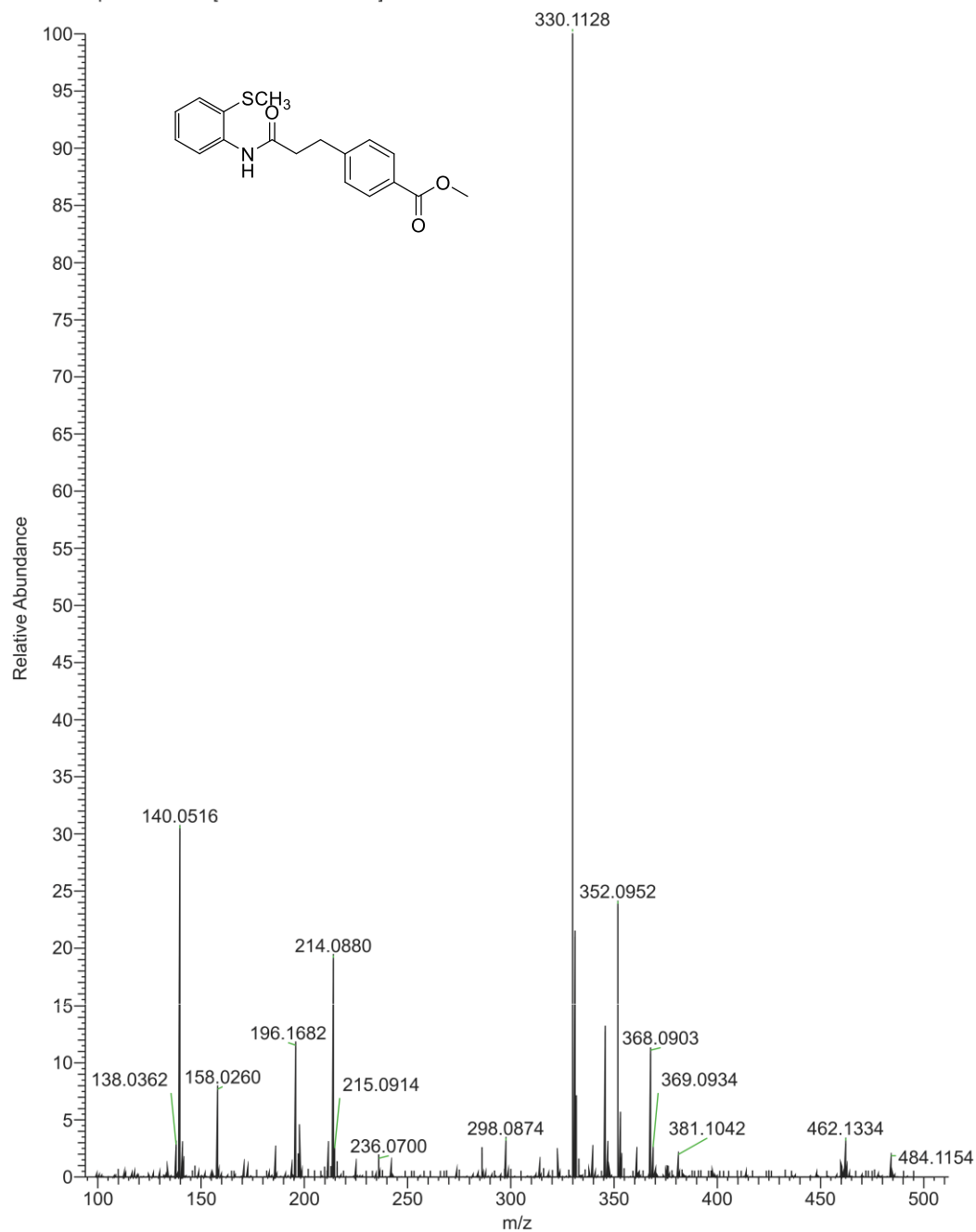
HRMS(ESI) of methyl 4-(3-((2-(methylthio)phenyl)amino)-3-oxopropyl)benzoate **3aj**

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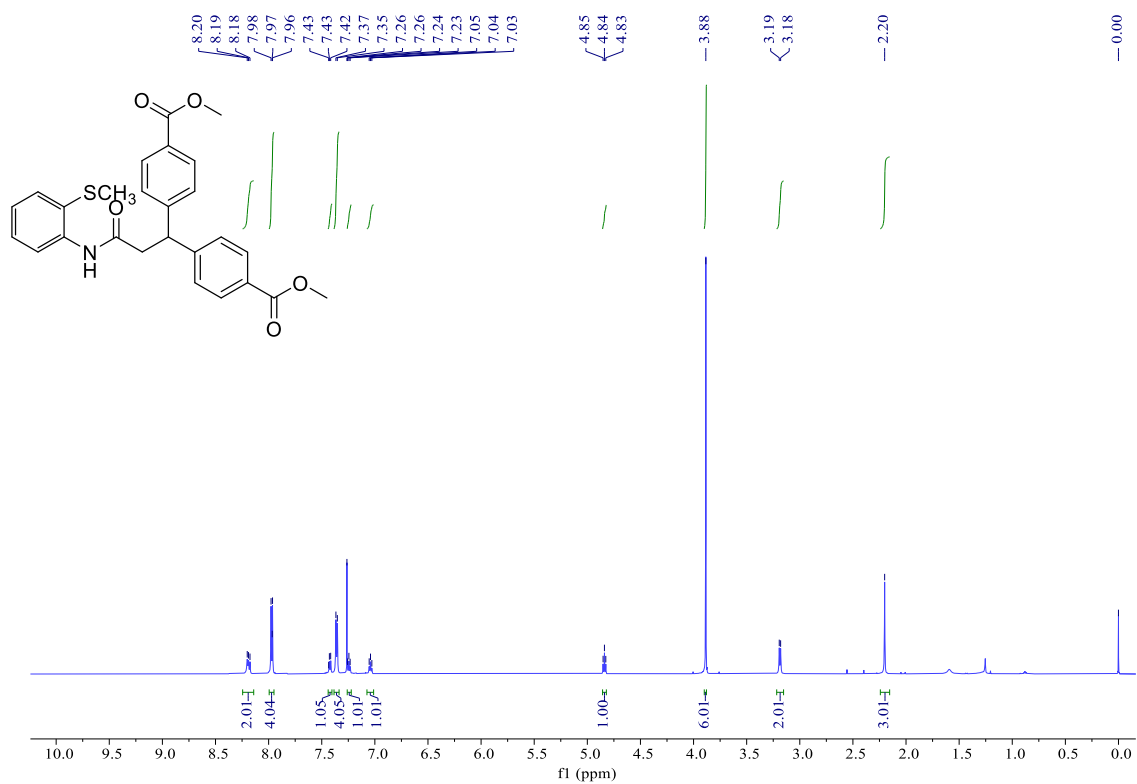
5/14/2025 15:36:45

1-100-500 #896-1294 RT: 0.55-0.79 AV: 399 NL: 1.94E8

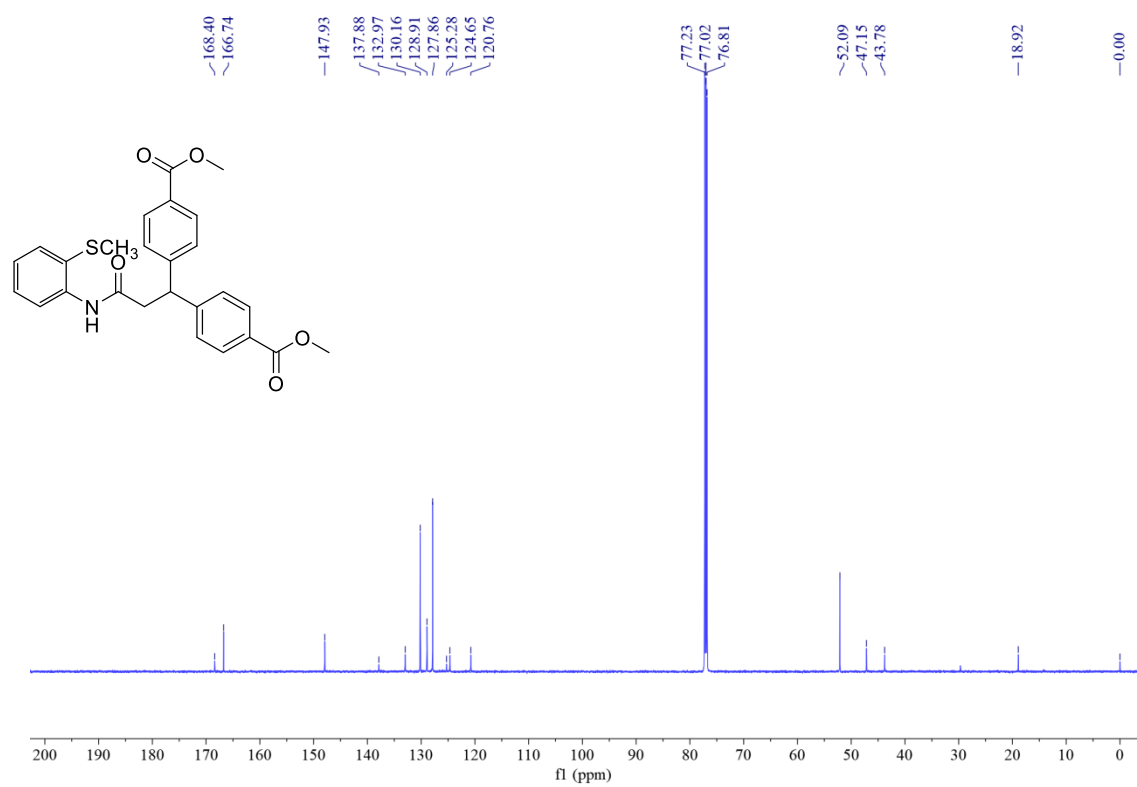
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of dimethyl 4,4'-(3-((2-(methylthio)phenyl)amino)-3-oxopropane-1,1-diyl)dibenzoate **3aj'**



¹³C NMR of dimethyl 4,4'-(3-((2-(methylthio)phenyl)amino)-3-oxopropane-1,1-diyl)dibenzoate **3aj'**



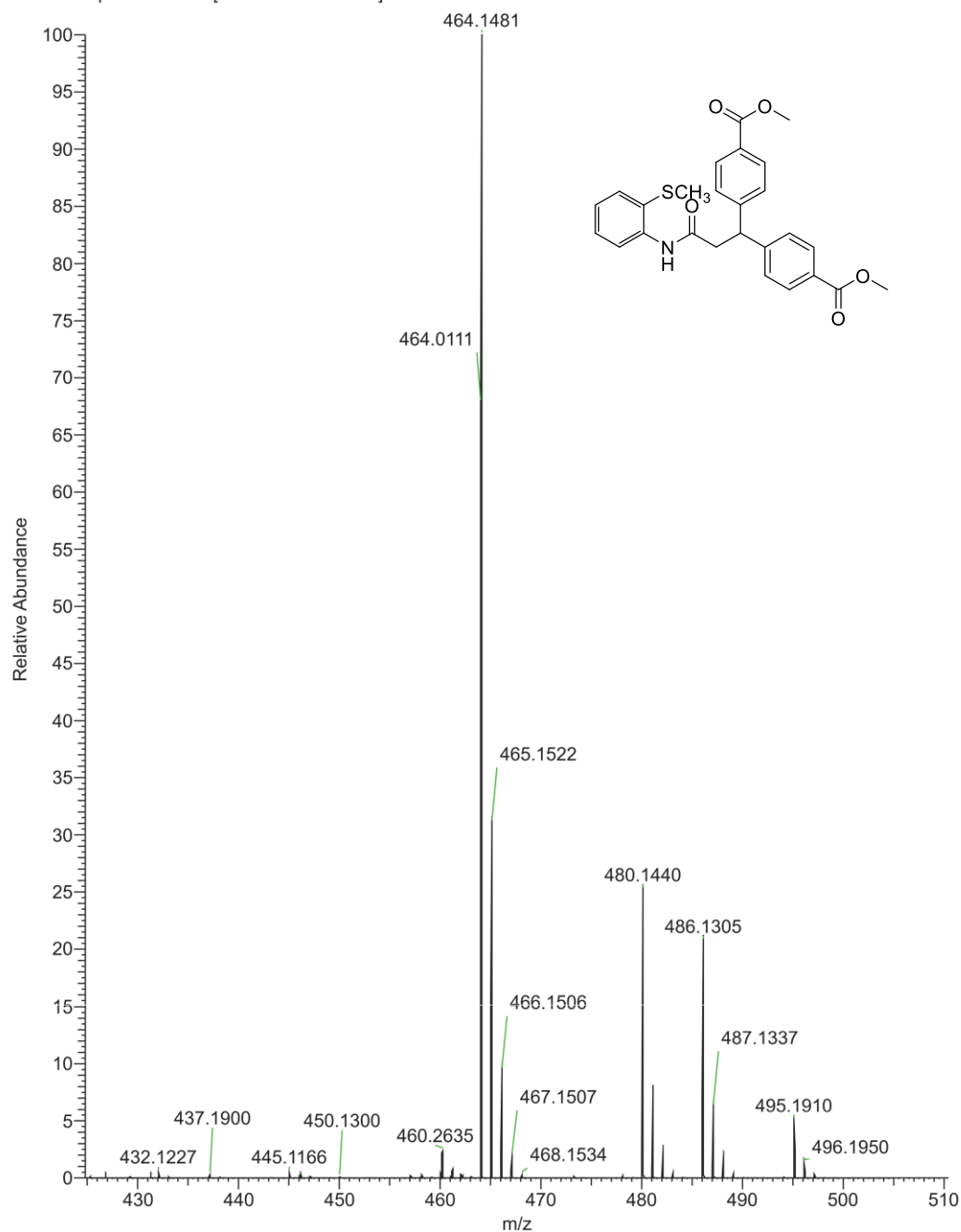
HRMS(ESI) of dimethyl 4,4'-(3-((2-(methylthio)phenyl)amino)-3-oxopropane-1,1-diyl)dibenzoate
3aj'

D:\DATA\2025\25050775683\7\1-100-500.raw

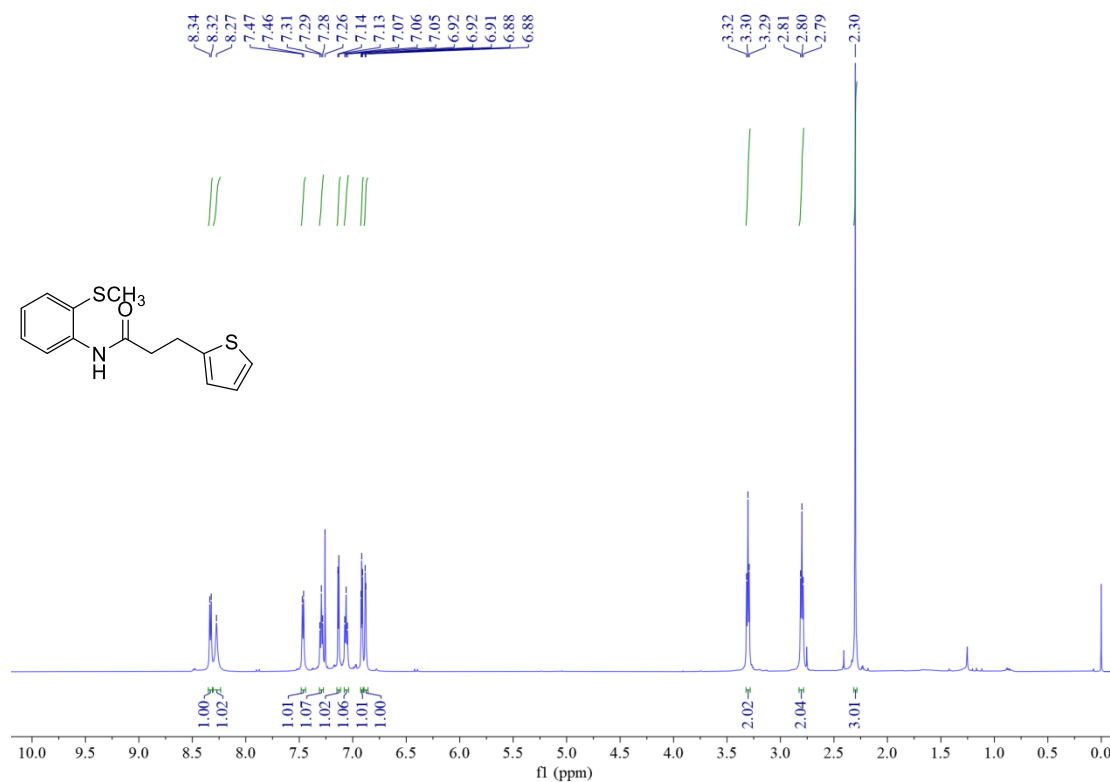
5/14/2025 15:40:10

1-100-500 #928-1242 RT: 0.57-0.76 AV: 315 NL: 7.04E7

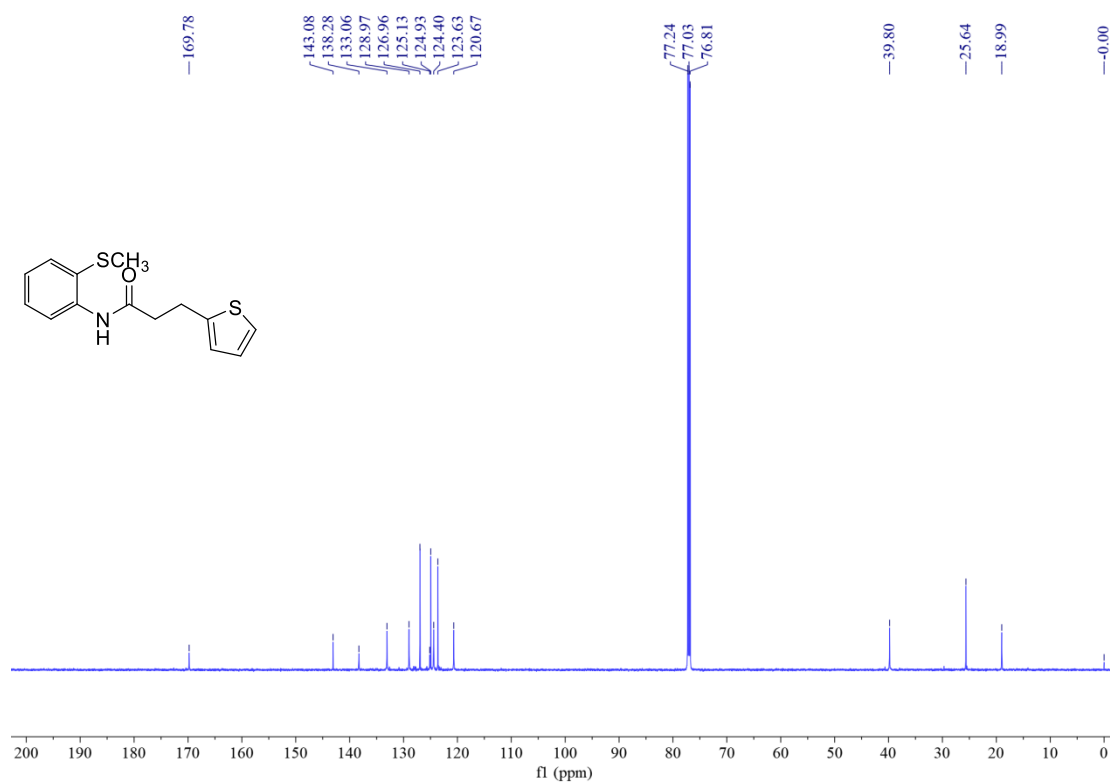
T: FTMS + p ESI Full ms [100.0000-500.0000]



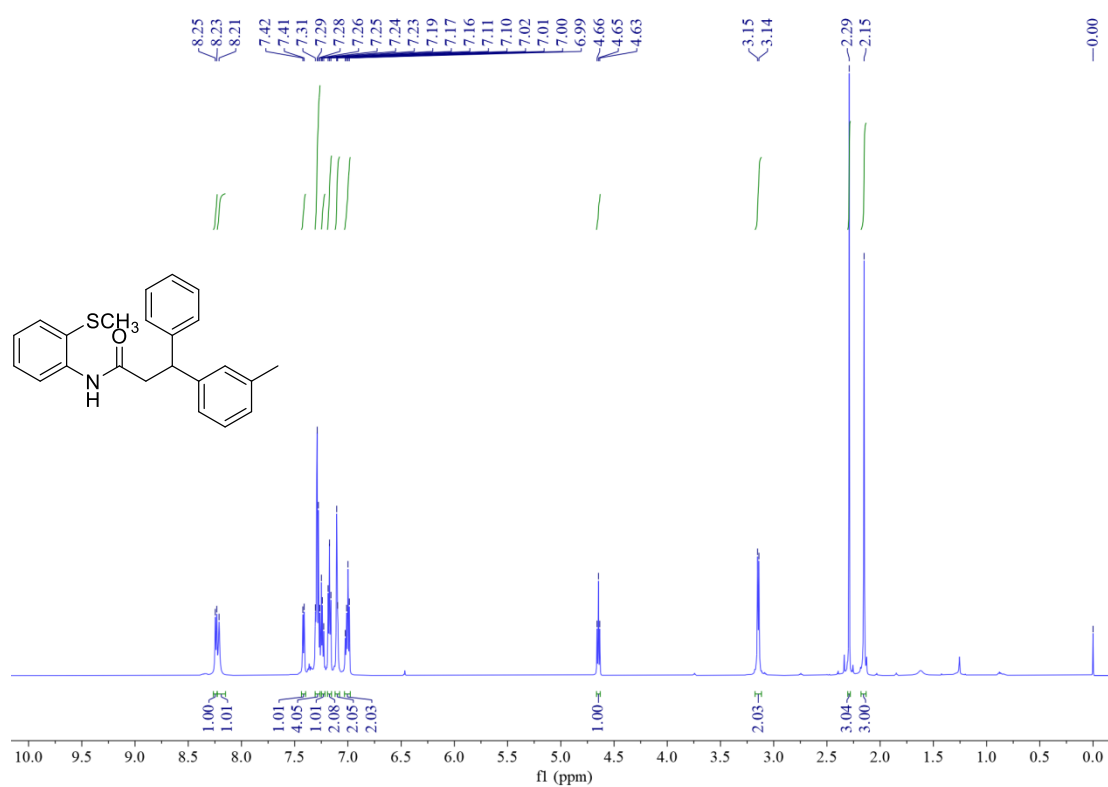
¹H NMR of N-(2-(methylthio)phenyl)-3-(thiophen-2-yl)propanamide **3ak**



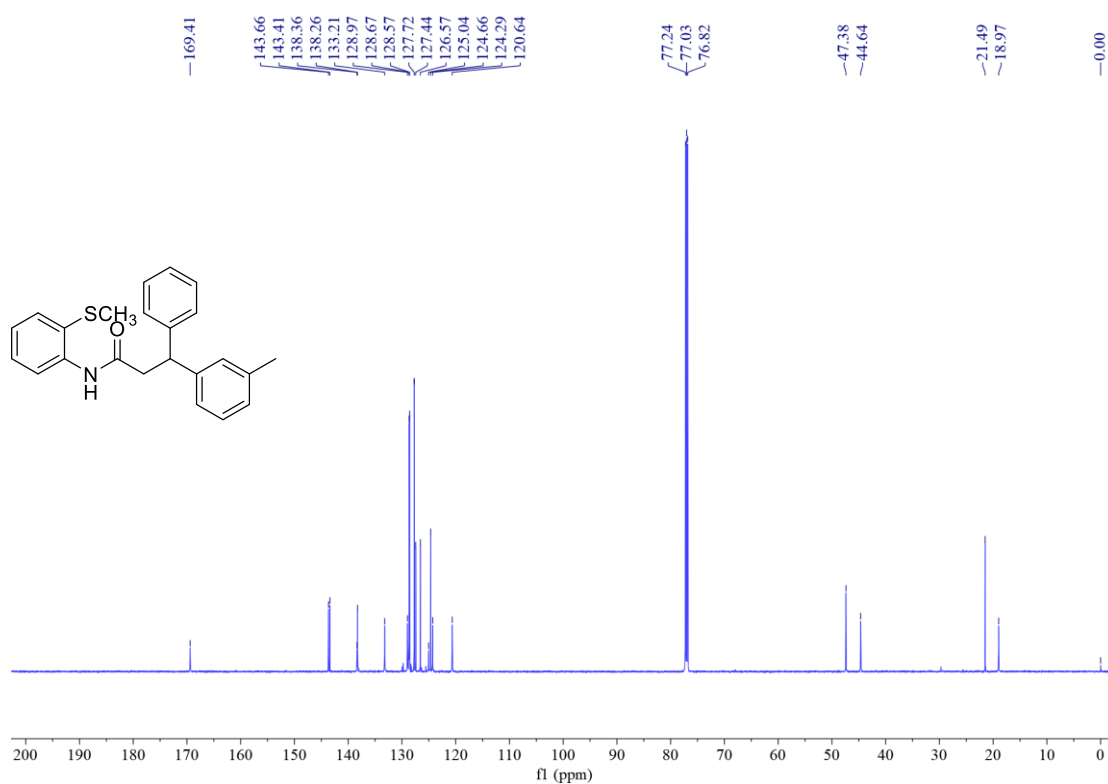
¹³C NMR of N-(2-(methylthio)phenyl)-3-(thiophen-2-yl)propanamide **3ak**



^1H NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(m-tolyl)propanamide **3ba**



^{13}C NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(m-tolyl)propanamide **3ba**



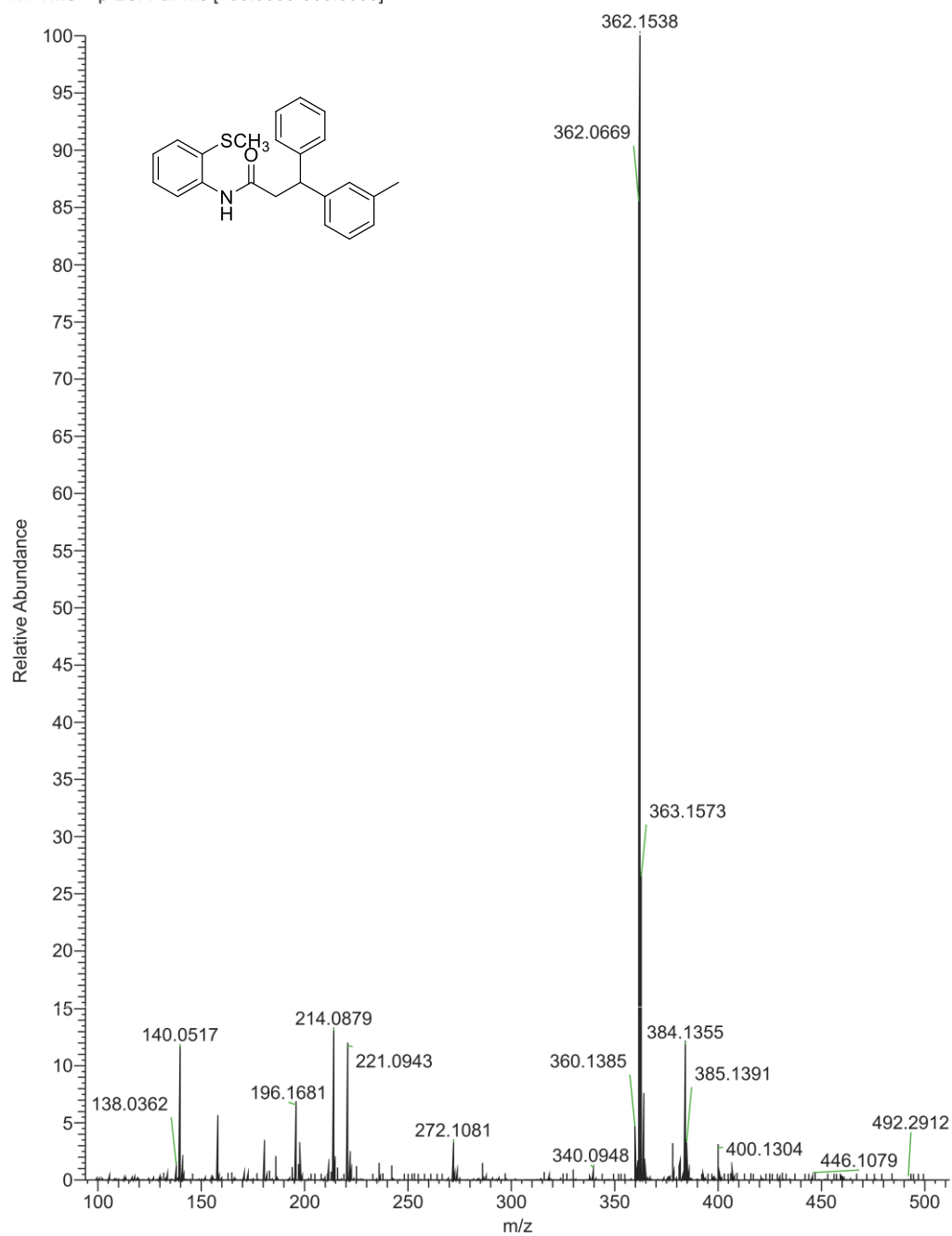
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-phenyl-3-(m-tolyl)propanamide **3ba**

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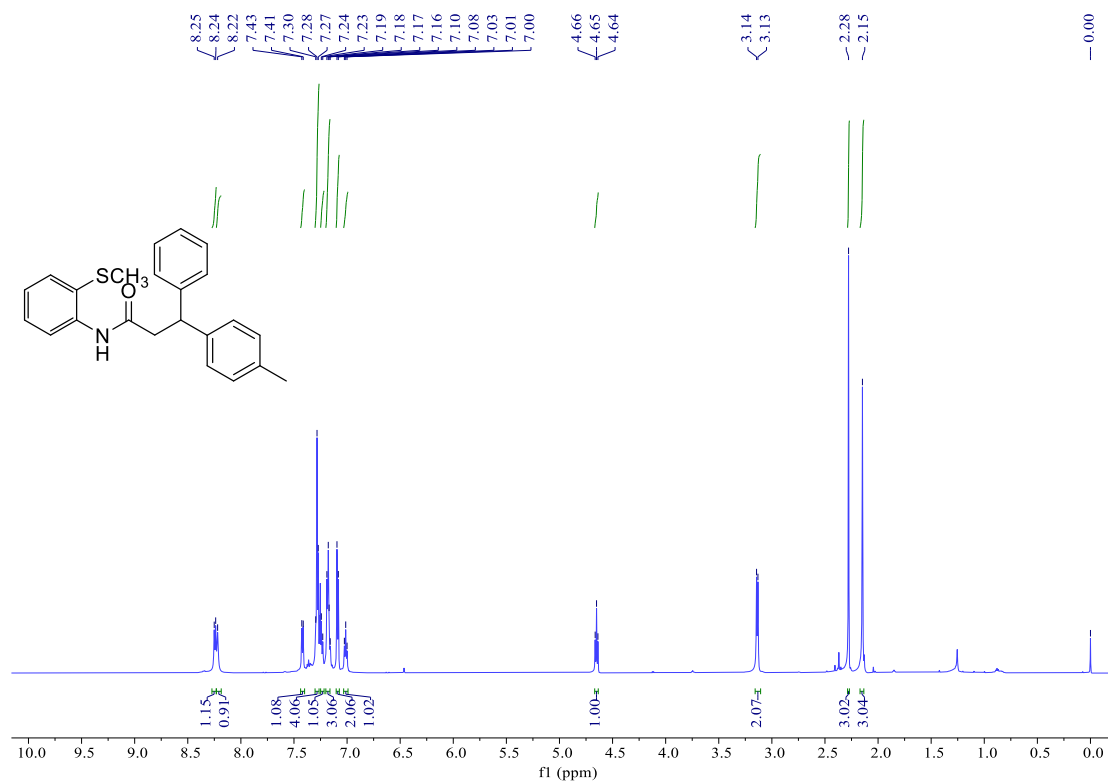
5/14/2025 15:44:22

1-100-500 #946-1307 RT: 0.58-0.8 AV: 362 NL: 2.89E8

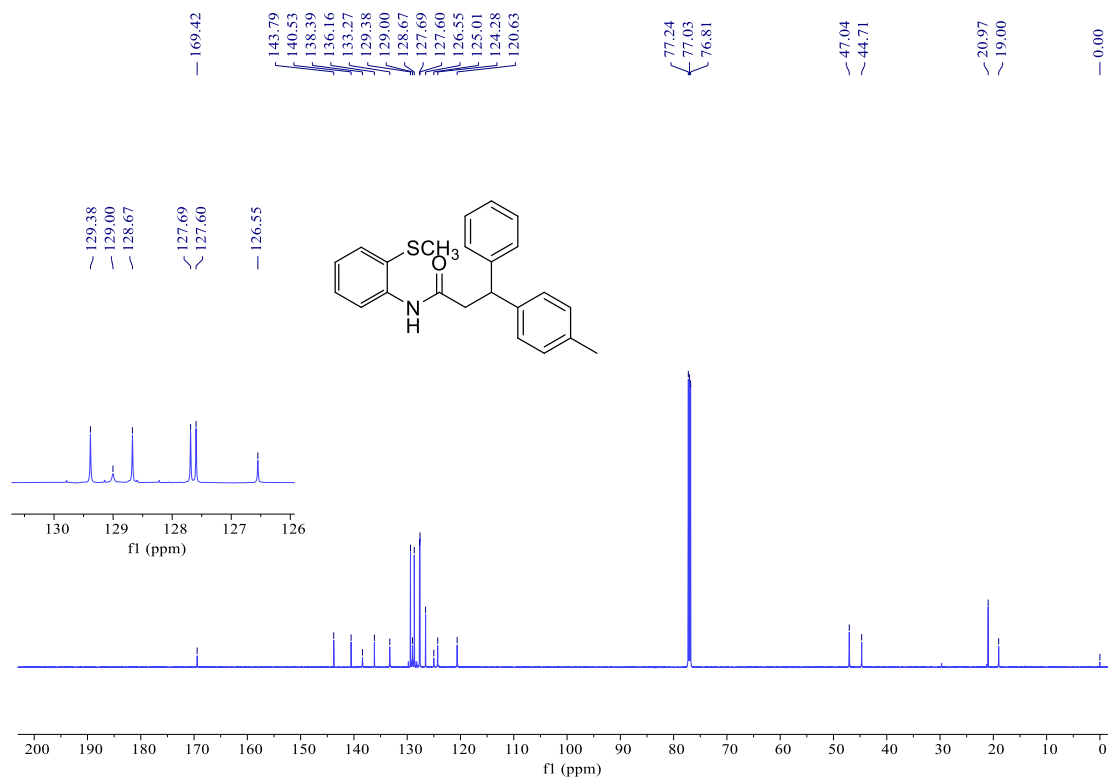
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(p-tolyl)propanamide **3bc**



¹³C NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(p-tolyl)propanamide **3bc**



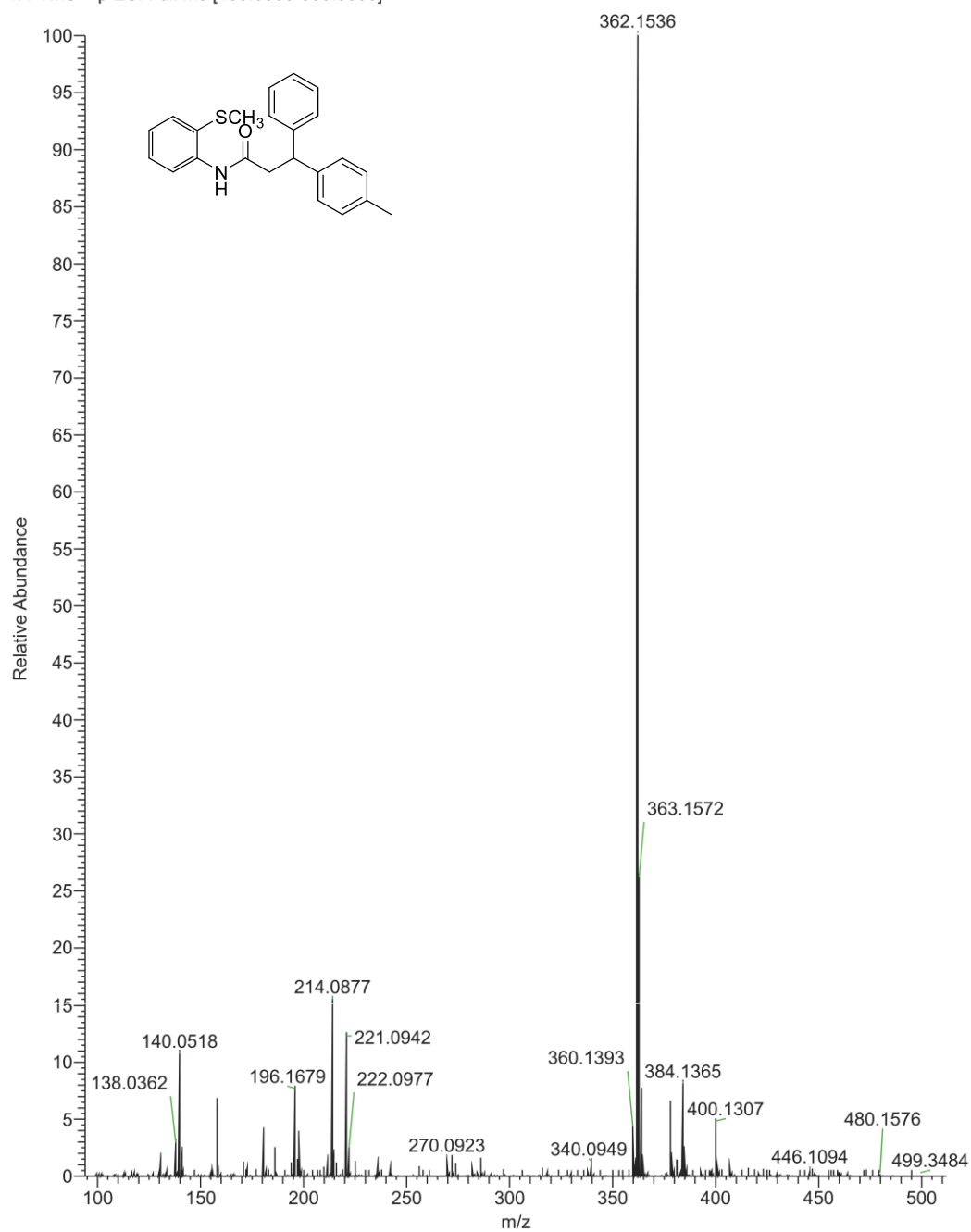
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-phenyl-3-(p-tolyl)propanamide **3bc**

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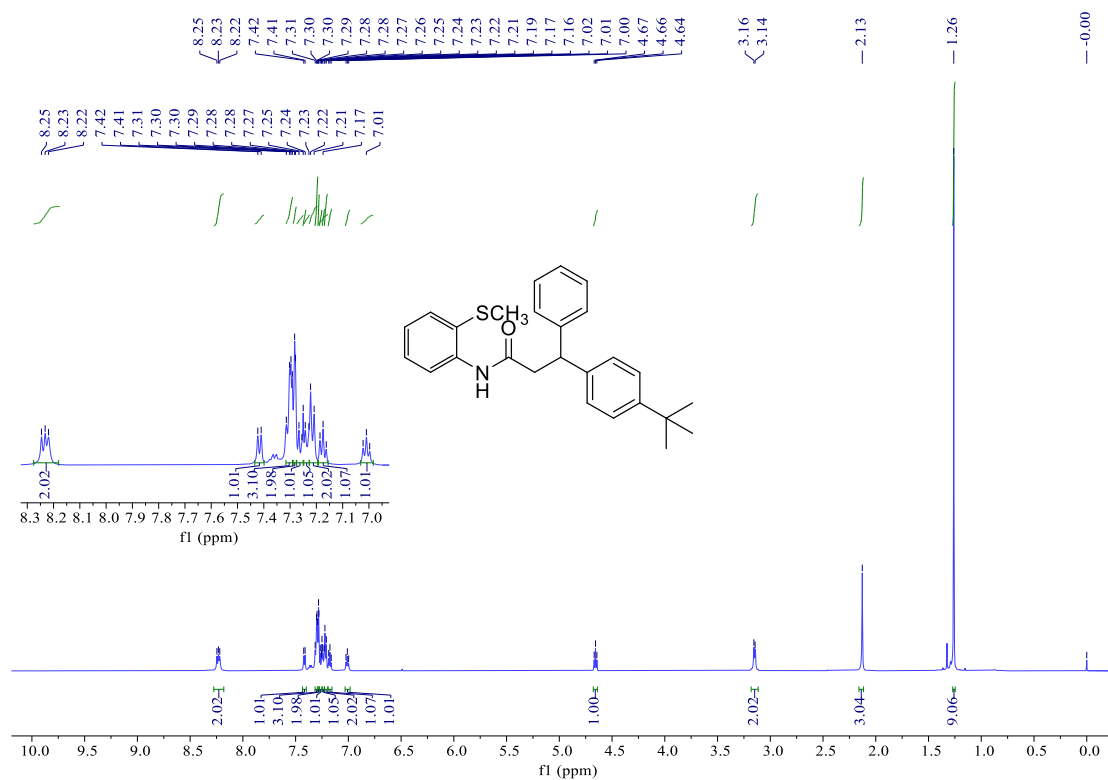
5/14/2025 15:46:46

1-100-500 #940-1406 RT: 0.58-0.86 AV: 467 NL: 2.41E8

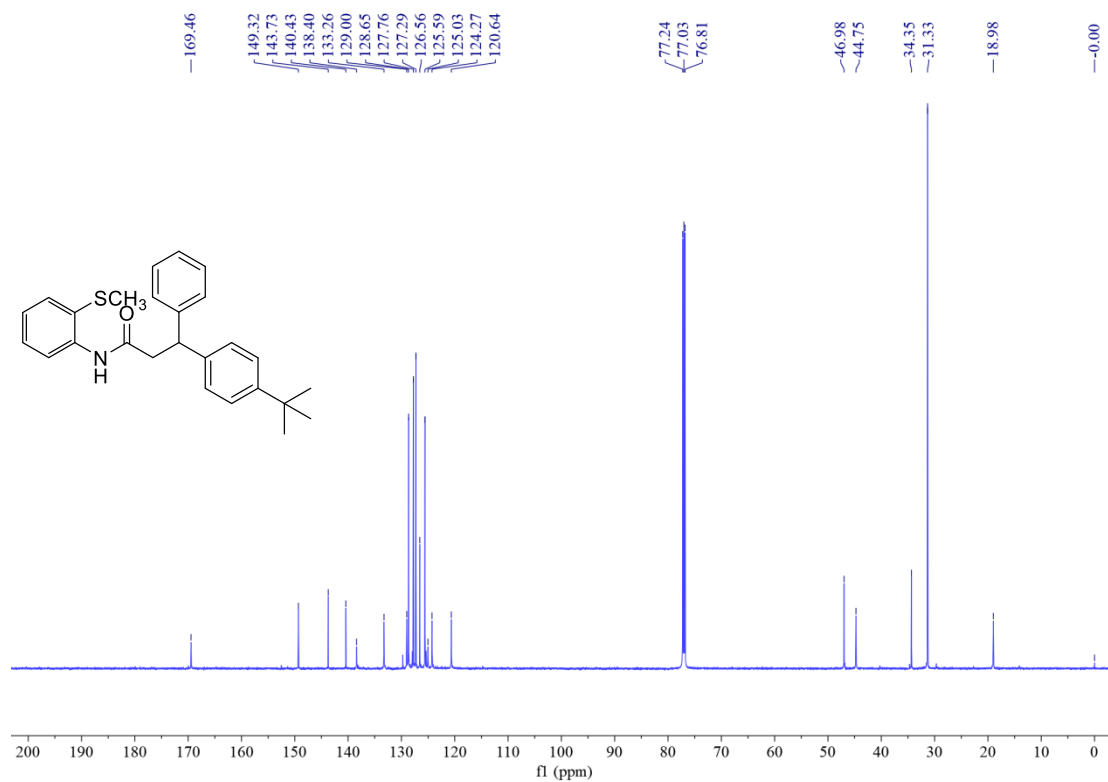
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of 3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3be**



¹³C NMR of 3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3be**



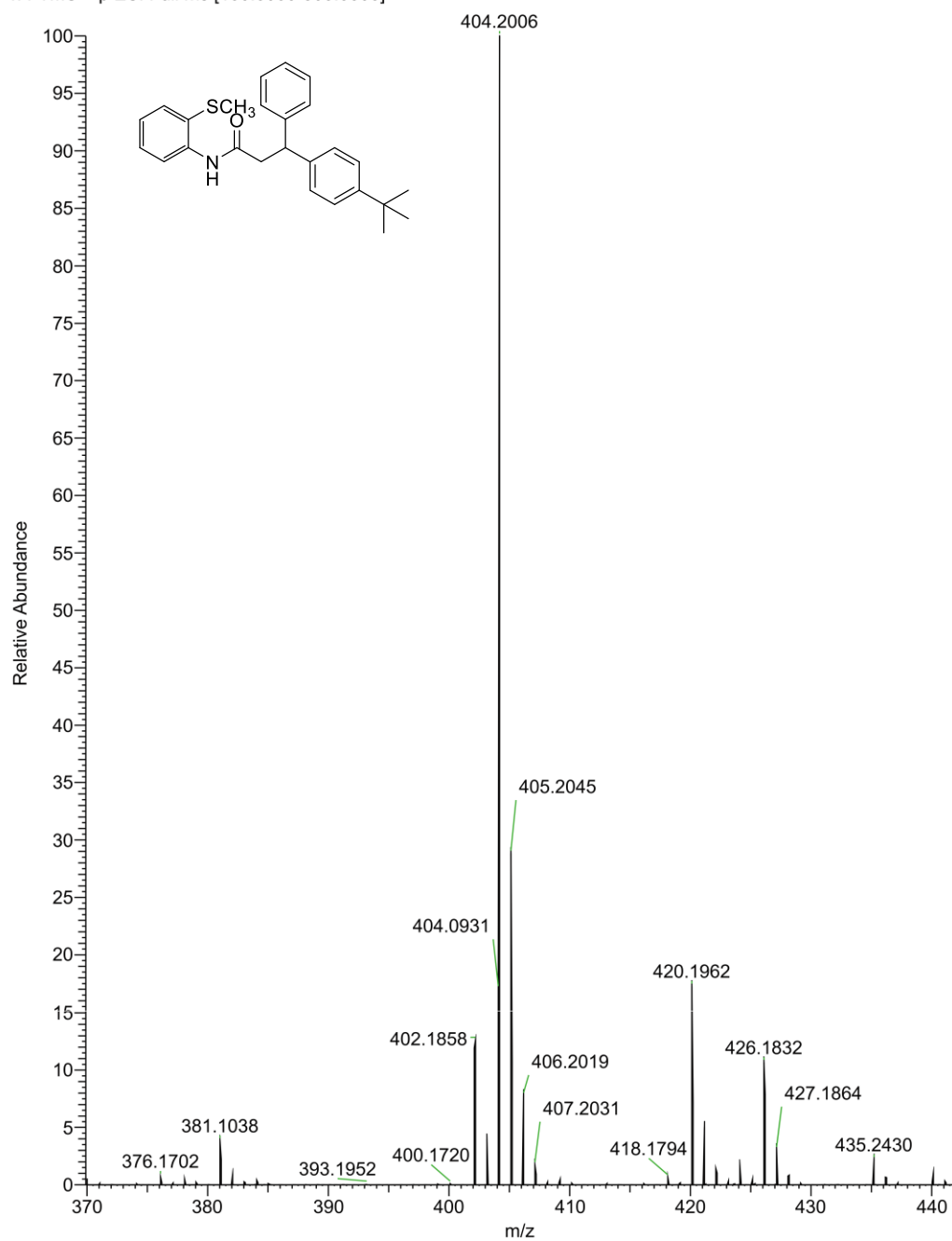
HRMS(ESI) of 3-(4-(tert-butyl)phenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3be**

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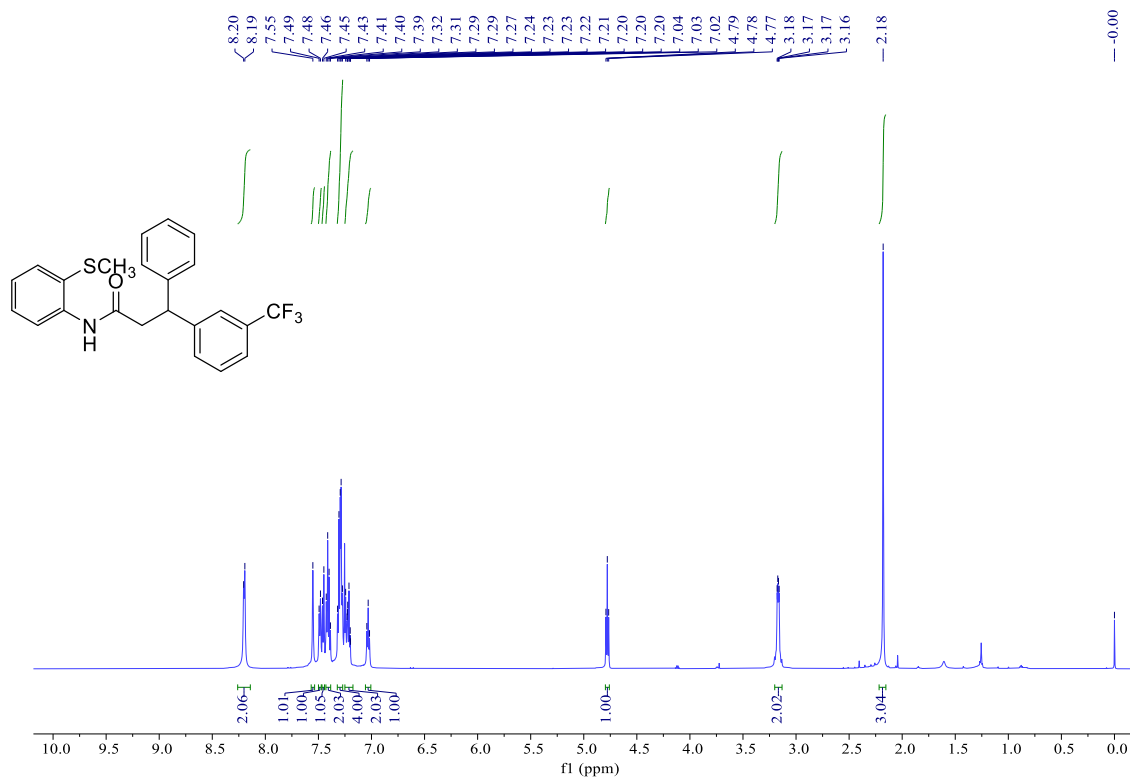
5/14/2025 15:49:51

1-100-500 #891-1310 RT: 0.54-0.8 AV: 420 NL: 9.79E7

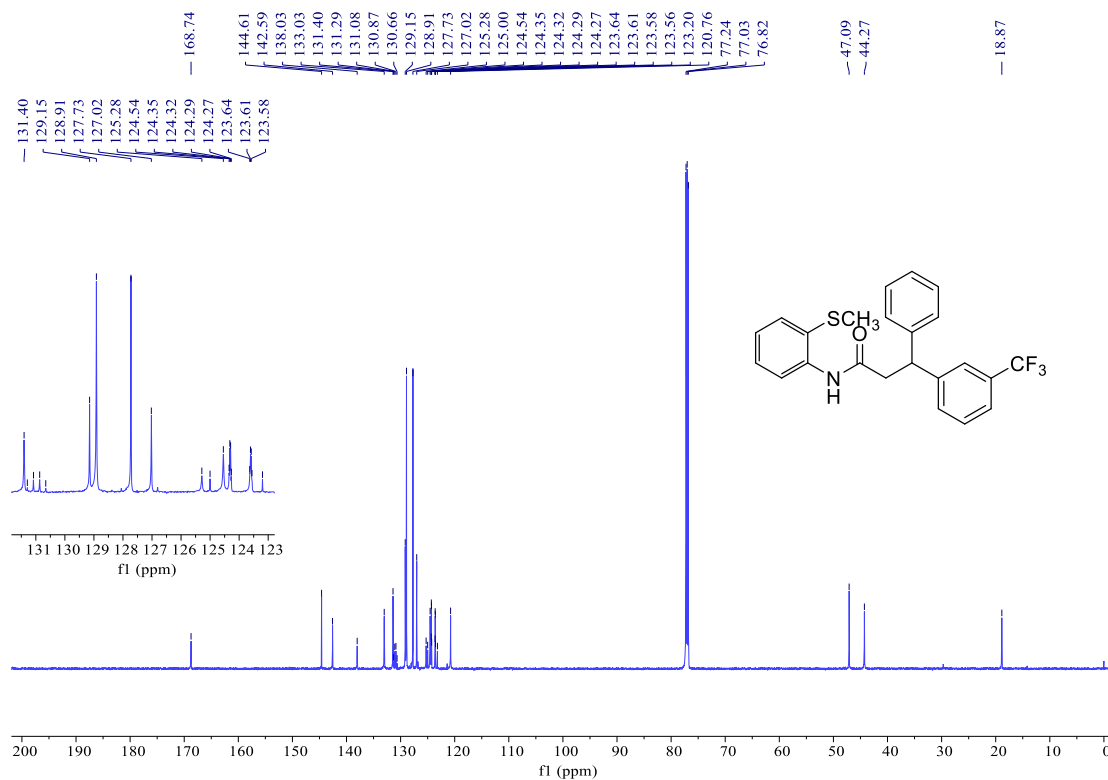
T: FTMS + p ESI Full ms [100.0000-500.0000]



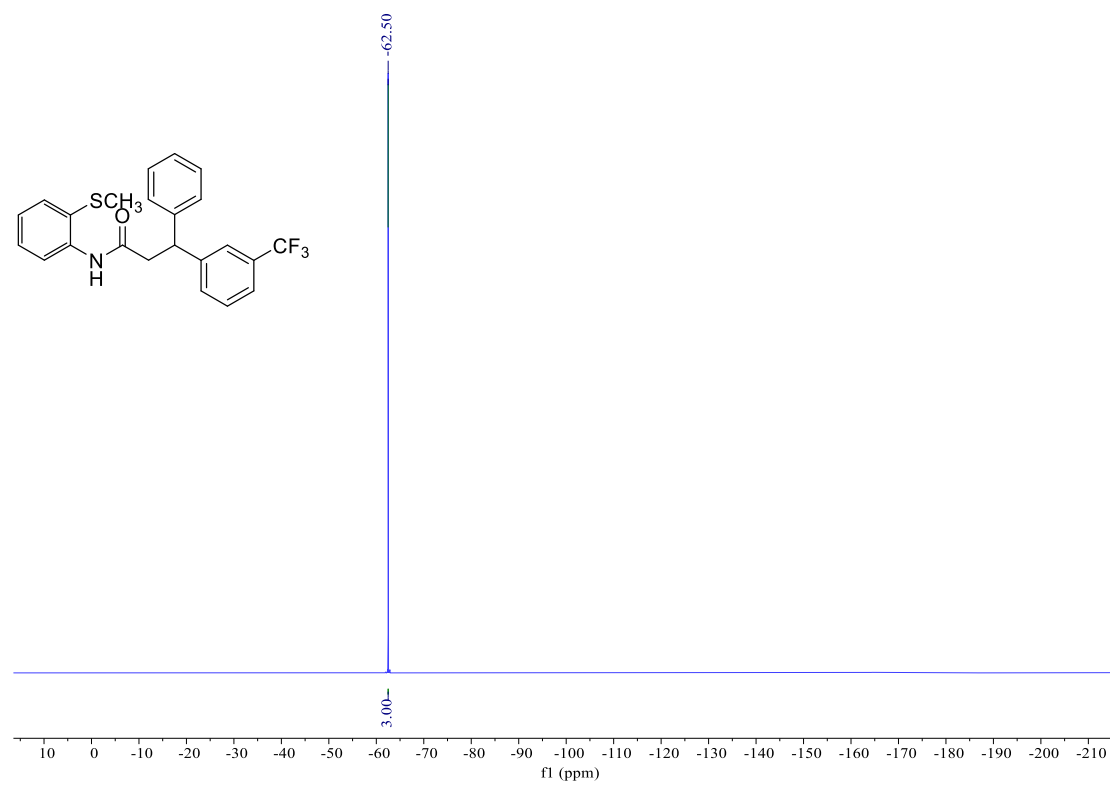
¹H NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(3-(trifluoromethyl)phenyl)propanamide **3bf**



¹³C NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(3-(trifluoromethyl)phenyl)propanamide **3bf**



^{19}F NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(3-(trifluoromethyl)phenyl)propanamide **3bf**



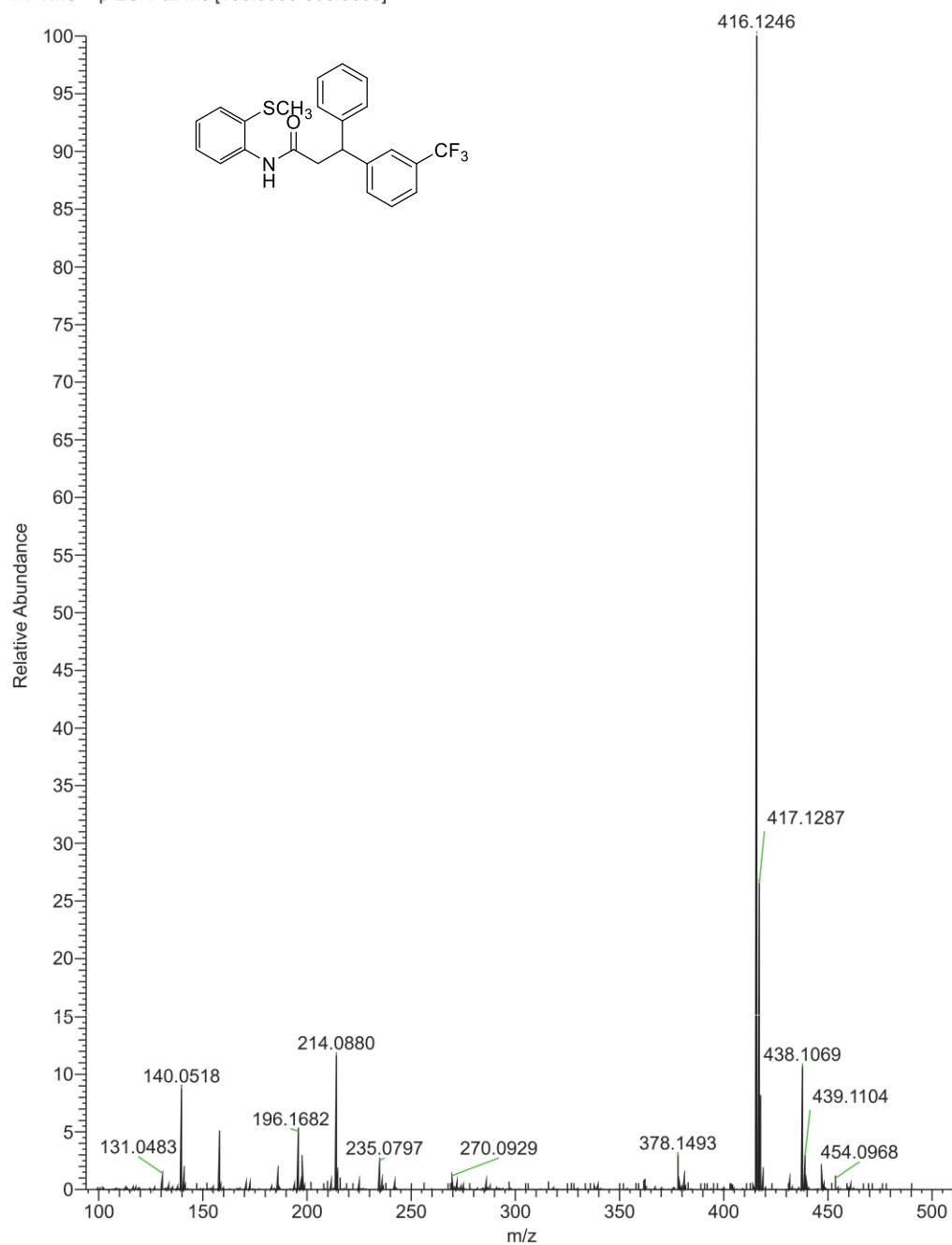
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-phenyl-3-(3-(trifluoromethyl)phenyl)propanamide **3bf**

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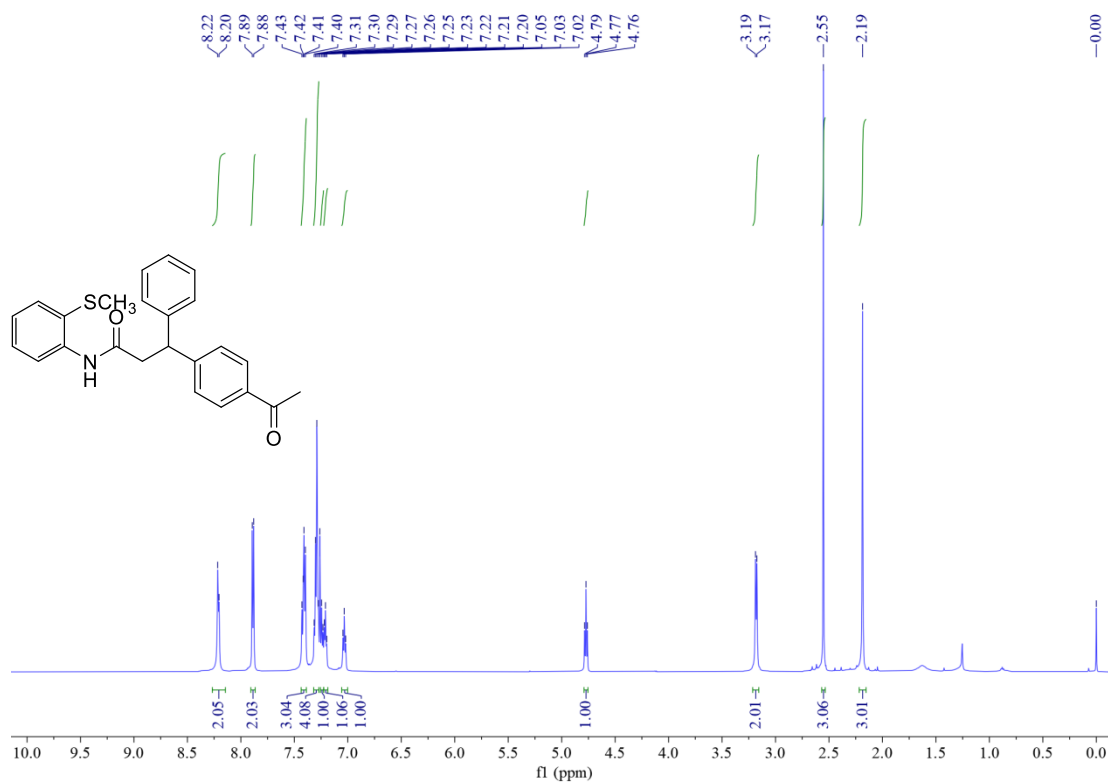
5/14/2025 15:54:38

1-100-500 #895-1406 RT: 0.55-0.86 AV: 512 NL: 3.39E8

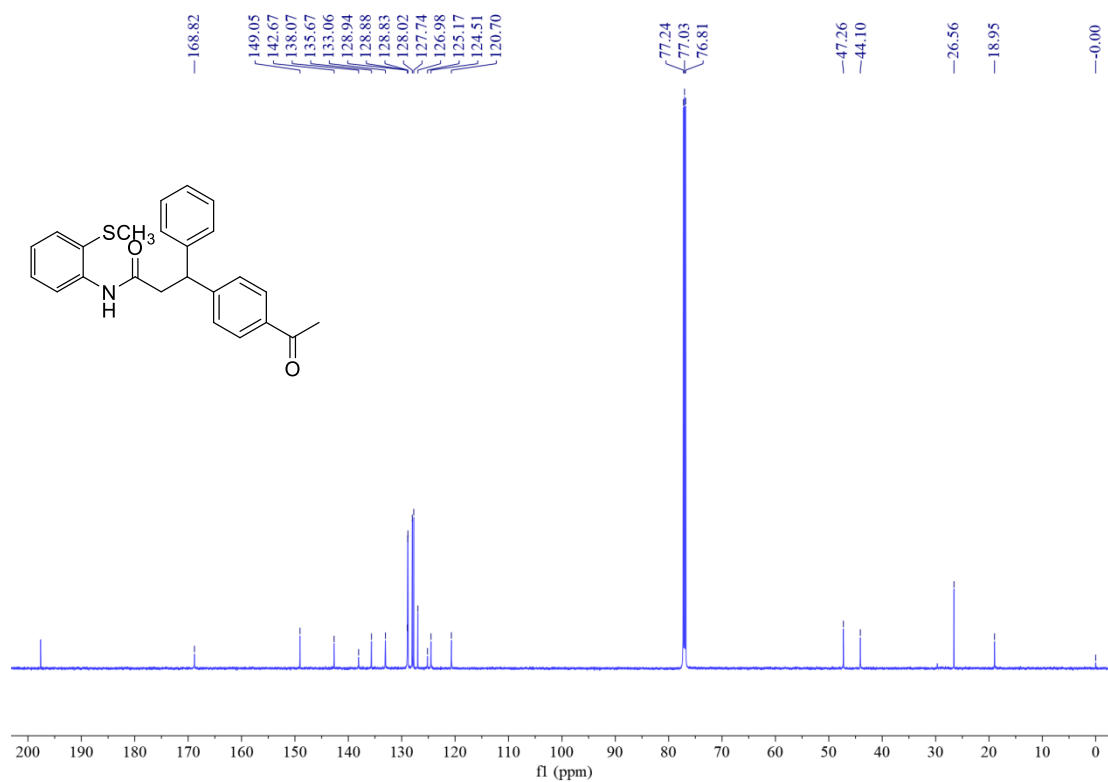
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bi**



¹³C NMR of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bi**



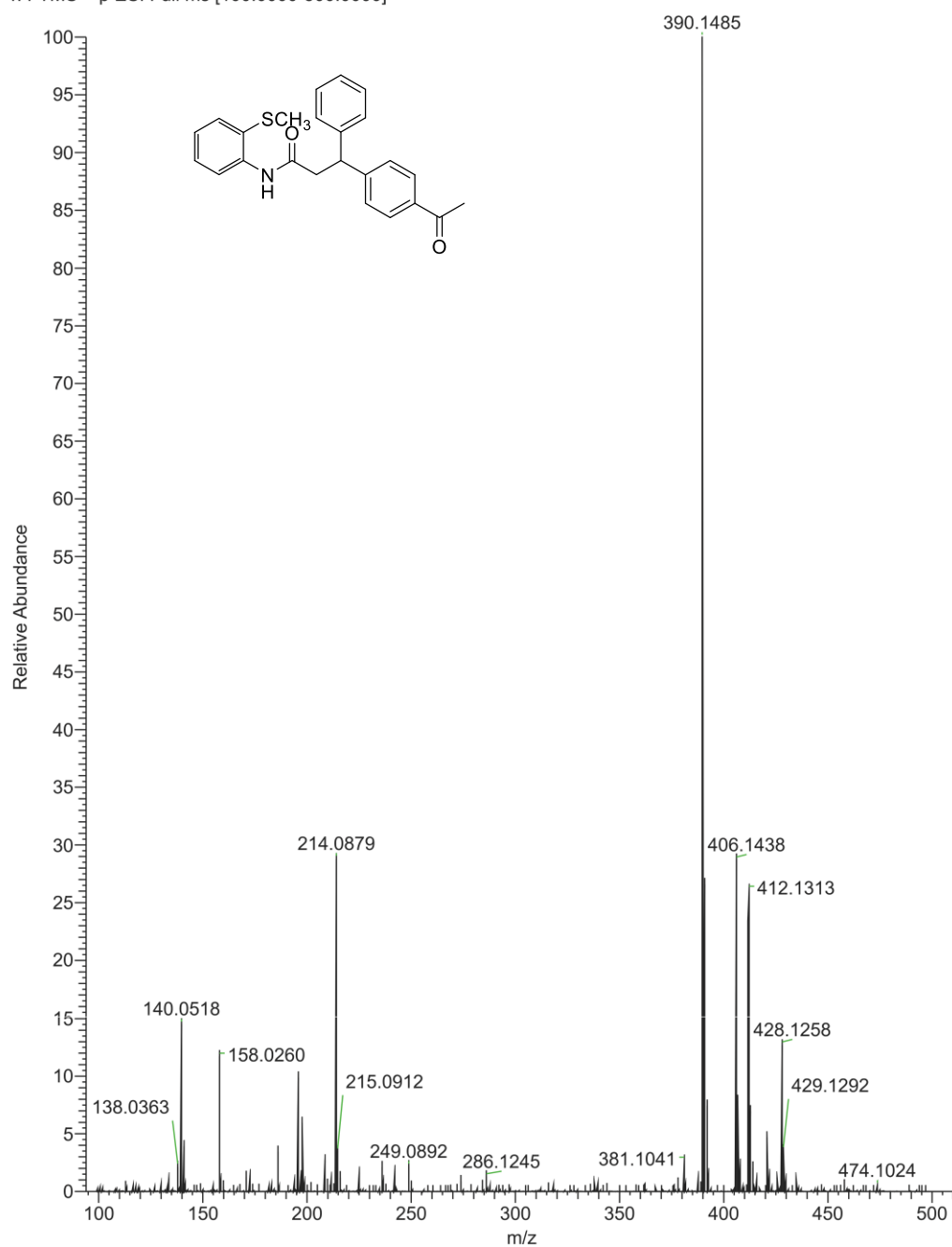
HRMS(ESI) of 3-(4-acetylphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bi**

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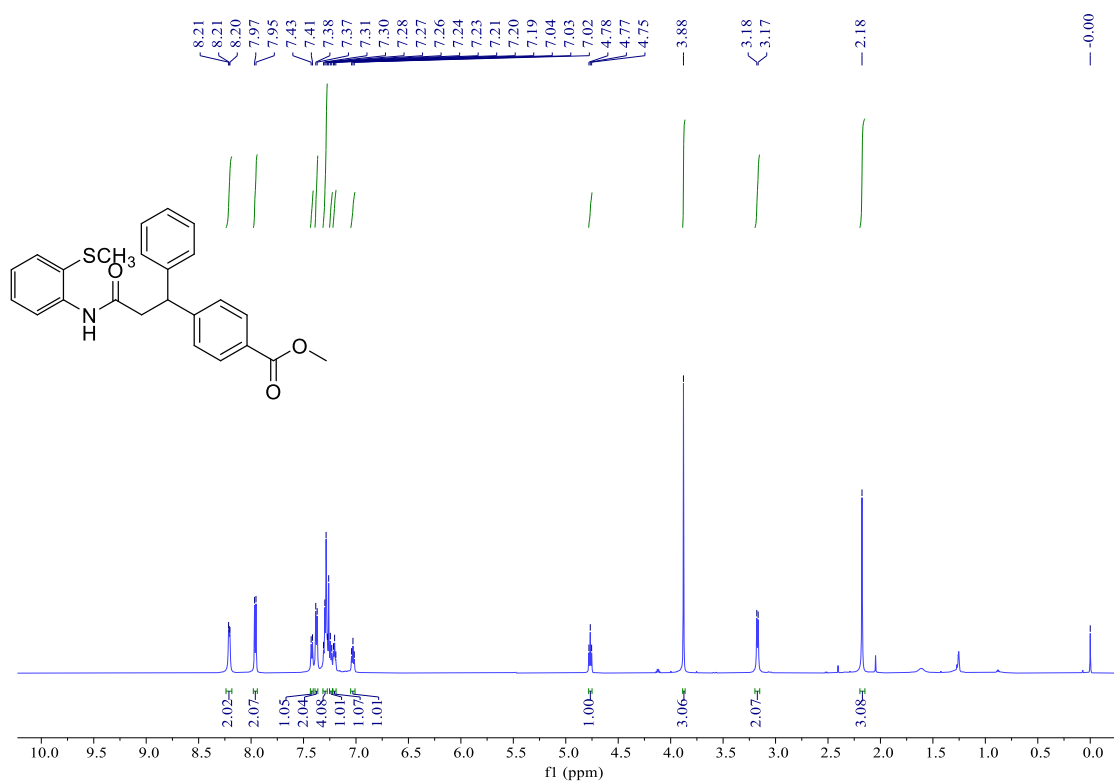
5/14/2025 16:05:09

1-100-500 #950-1241 RT: 0.58-0.76 AV: 292 NL: 1.35E8

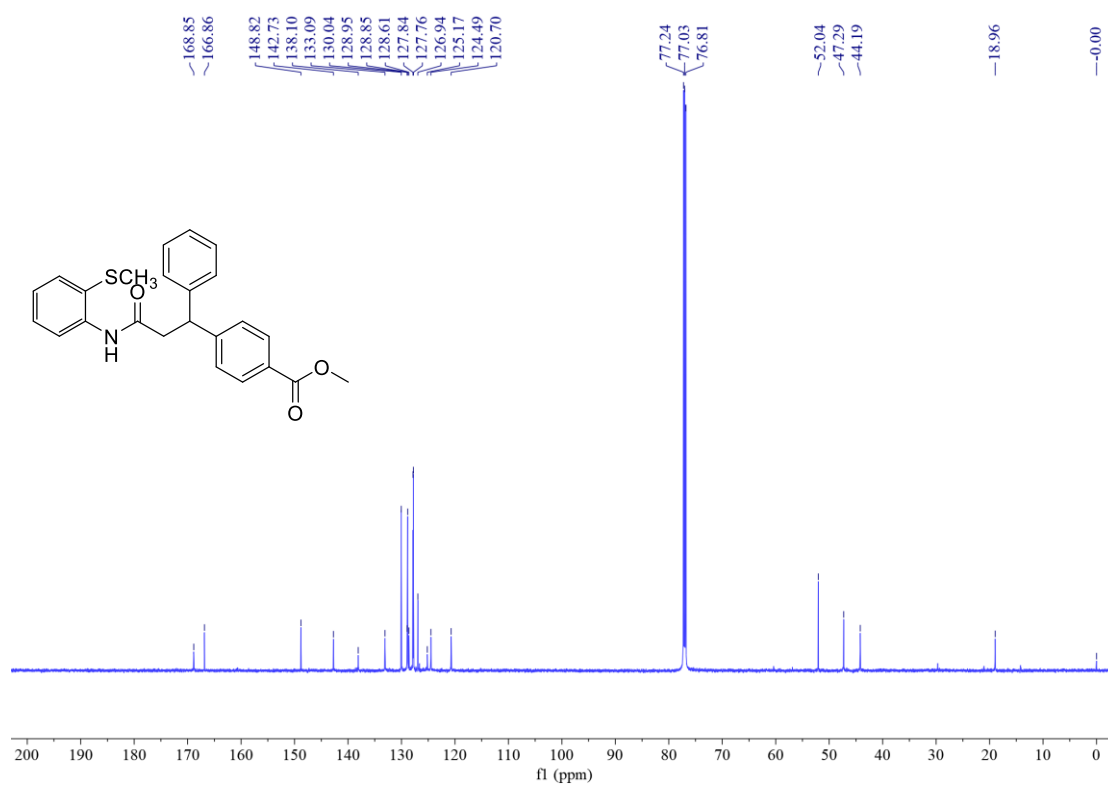
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bj**



¹³C NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bj**



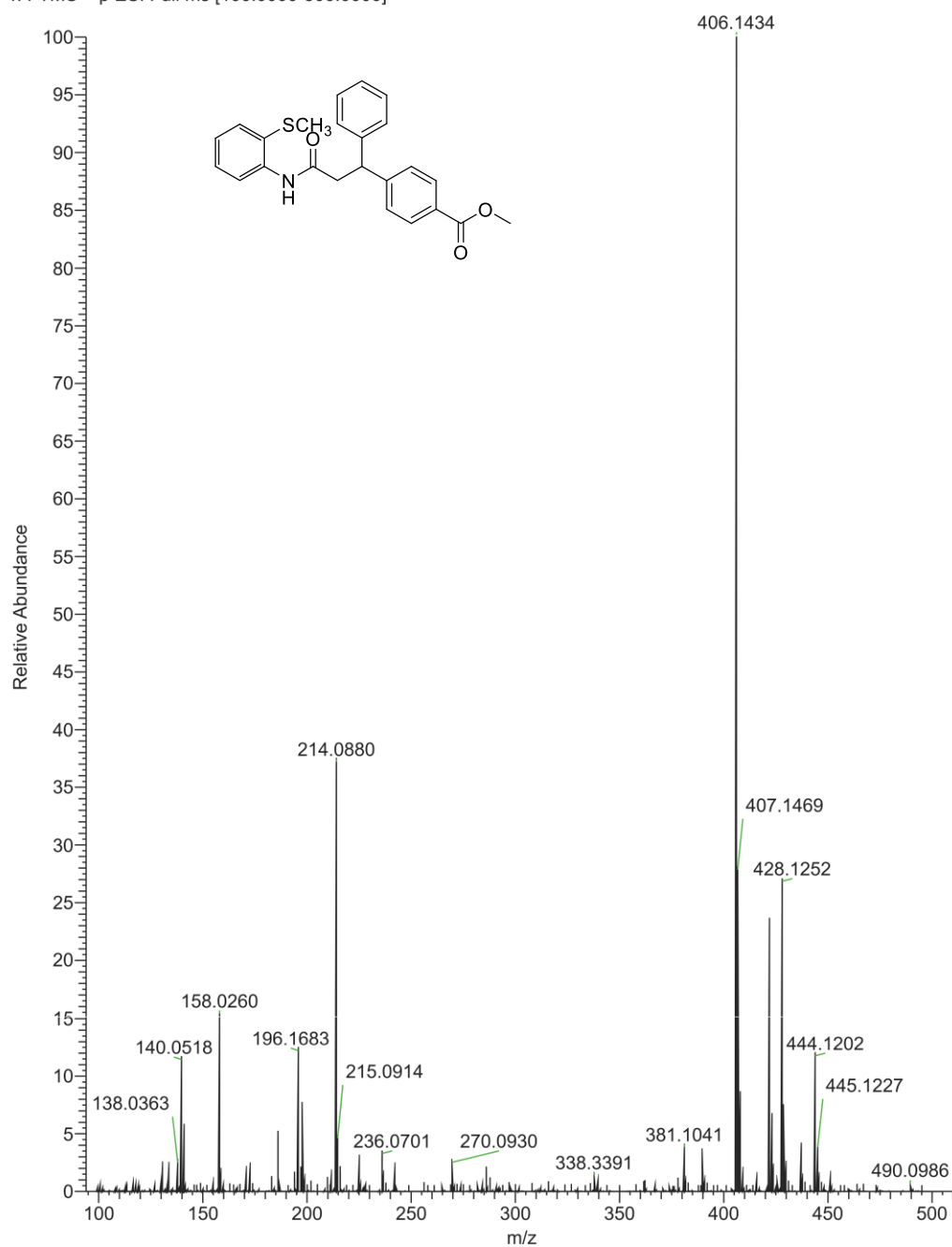
HRMS(ESI) of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bj**

D:\DATA\2025\25050775683\17\1-100-500.raw

5/14/2025 16:07:54

1-100-500 #964-1291 RT: 0.59-0.79 AV: 328 NL: 1.03E8

T: FTMS + p ESI Full ms [100.0000-500.0000]



Chemical structure: CCSC(=O)Nc1ccccc1C(Cc2ccsc2)c3ccccc3

¹H NMR spectrum (ppm):

- 8.25, 8.24, 7.44, 7.43, 7.36, 7.34, 7.32, 7.31, 7.30, 7.26, 7.25, 7.24, 7.22, 7.21, 7.16, 7.15, 7.15, 7.04, 7.03, 7.02, 6.92, 6.91, 6.90
- 4.94, 4.93, 4.92
- 3.24, 3.23, 3.22, 3.21, 3.14, 3.12, 3.11, 3.10
- 2.20
- 0.00

Integration values (from left to right): 2.02, 1.08, 2.05, 2.04, 1.00, 1.02, 1.00, 1.05, 2.02, 1.00, 1.05, 1.08, 3.00

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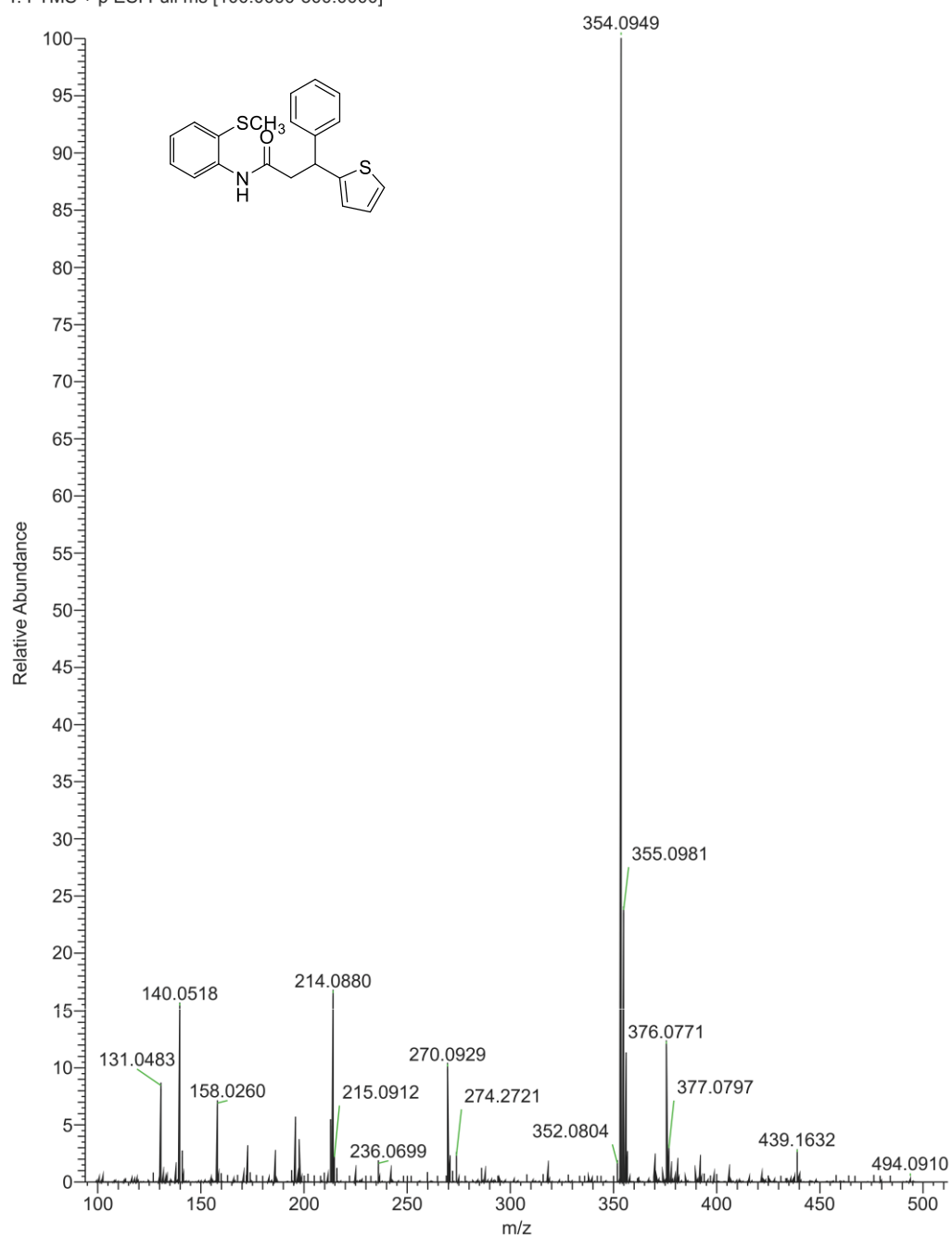
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-phenyl-3-(thiophen-2-yl)propanamide **3bk**

D:\DATA\2025\25050775683\18\1-100-500.raw

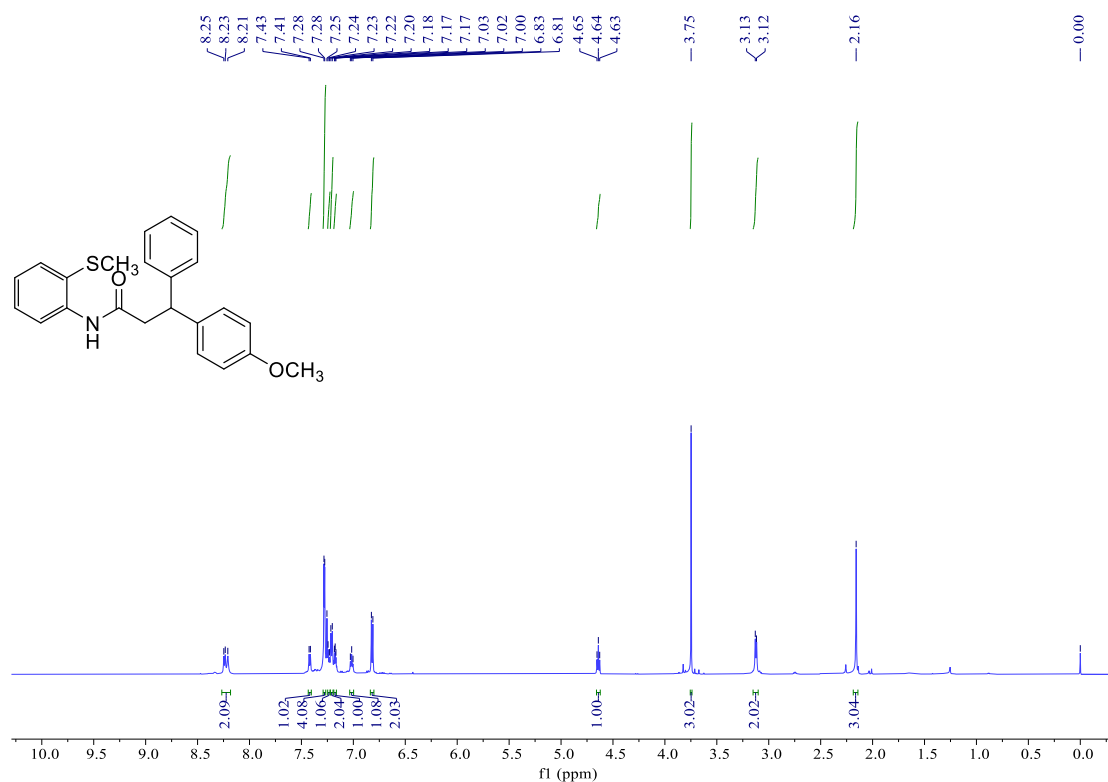
5/14/2025 16:10:34

1-100-500 #944-1405 RT: 0.58-0.86 AV: 462 NL: 2.31E8

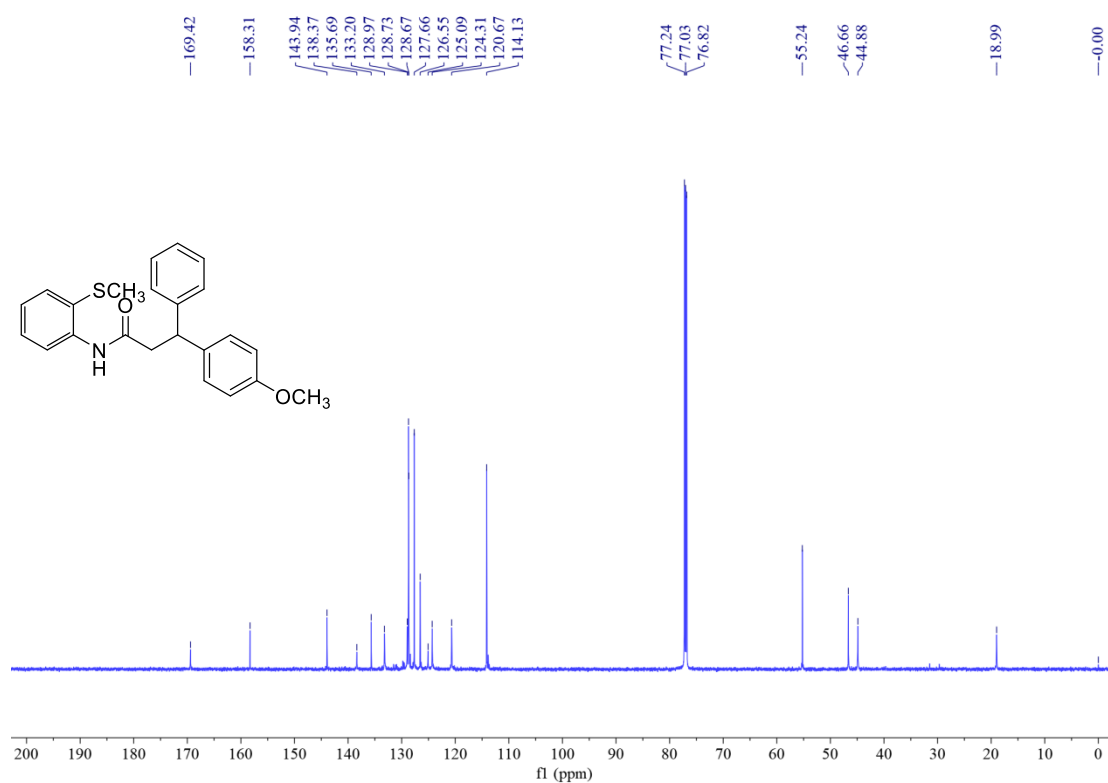
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of 3-(4-methoxyphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bl**



¹³C NMR of 3-(4-methoxyphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bl**



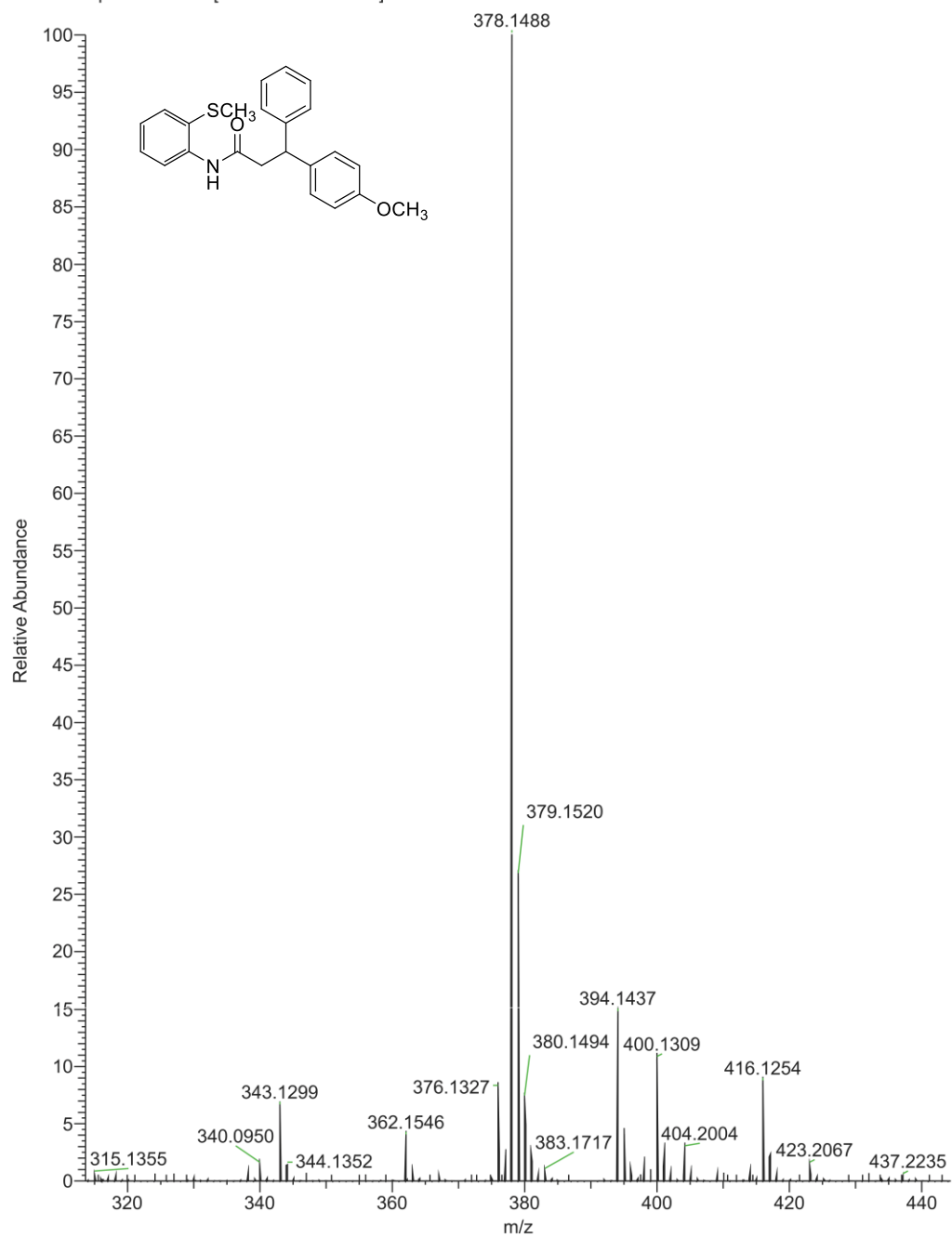
HRMS(ESI) of 3-(4-methoxyphenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bl**

D:\DATA\2025\25050775683\12\1-100-500.raw

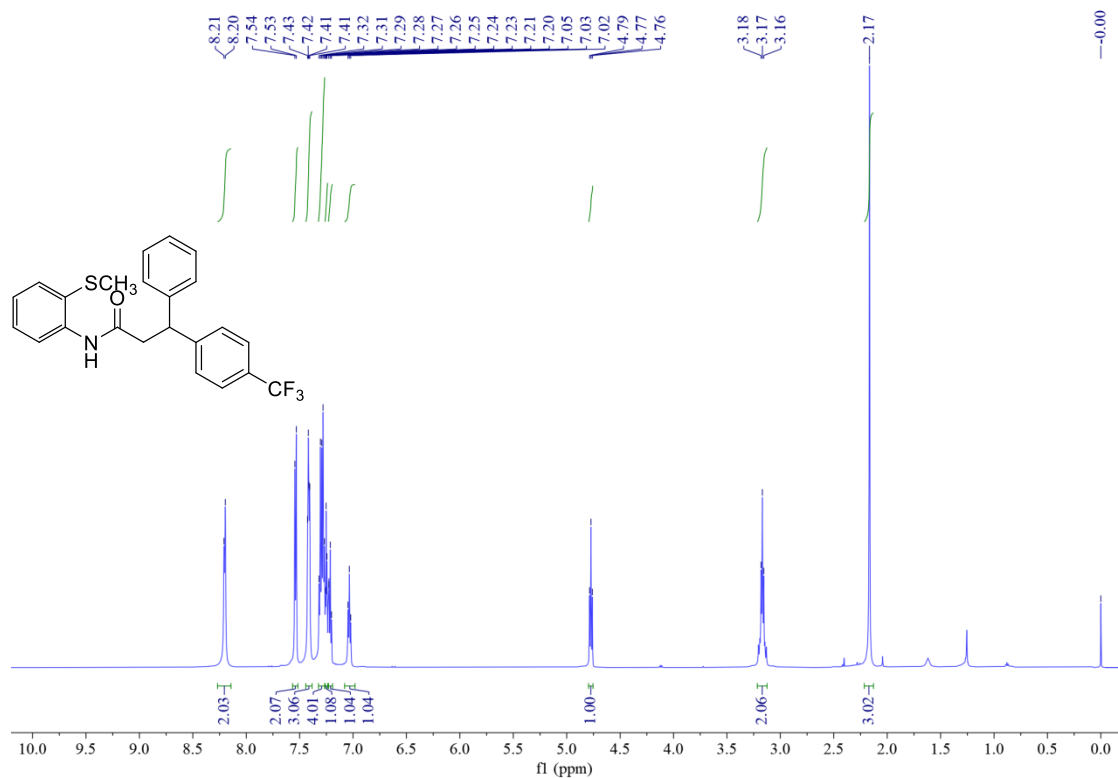
5/14/2025 15:52:21

1-100-500 #890-1274 RT: 0.54-0.78 AV: 385 NL: 1.22E8

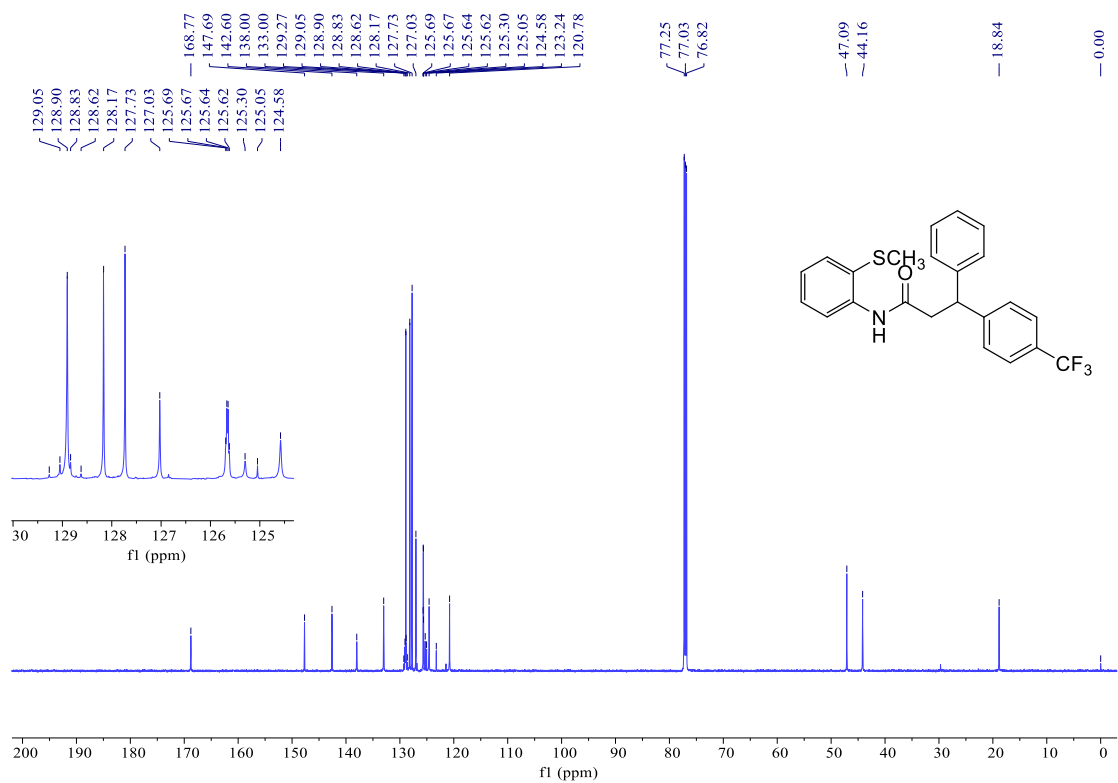
T: FTMS + p ESI Full ms [100.0000-500.0000]



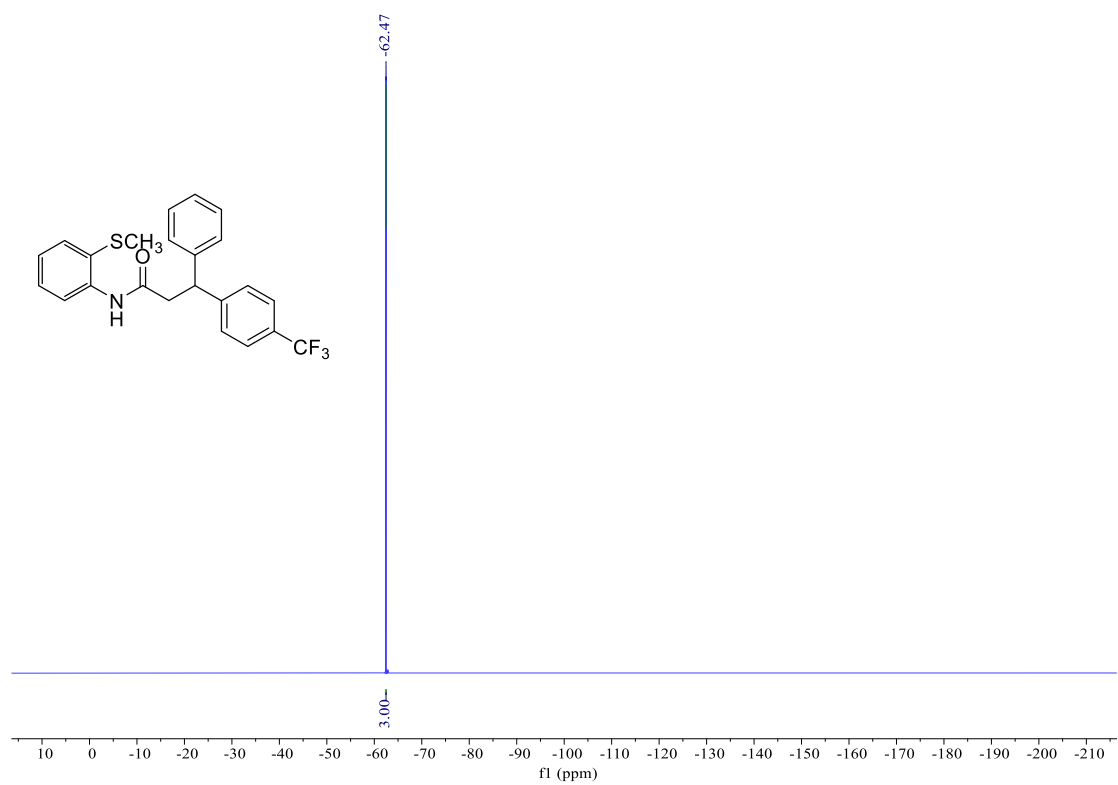
¹H NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bm**



¹³C NMR of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bm**



^{19}F NMR of N-(2-(methylthio)phenyl)-3-phenyl-3-(4-(trifluoromethyl)phenyl)propanamide **3bm**



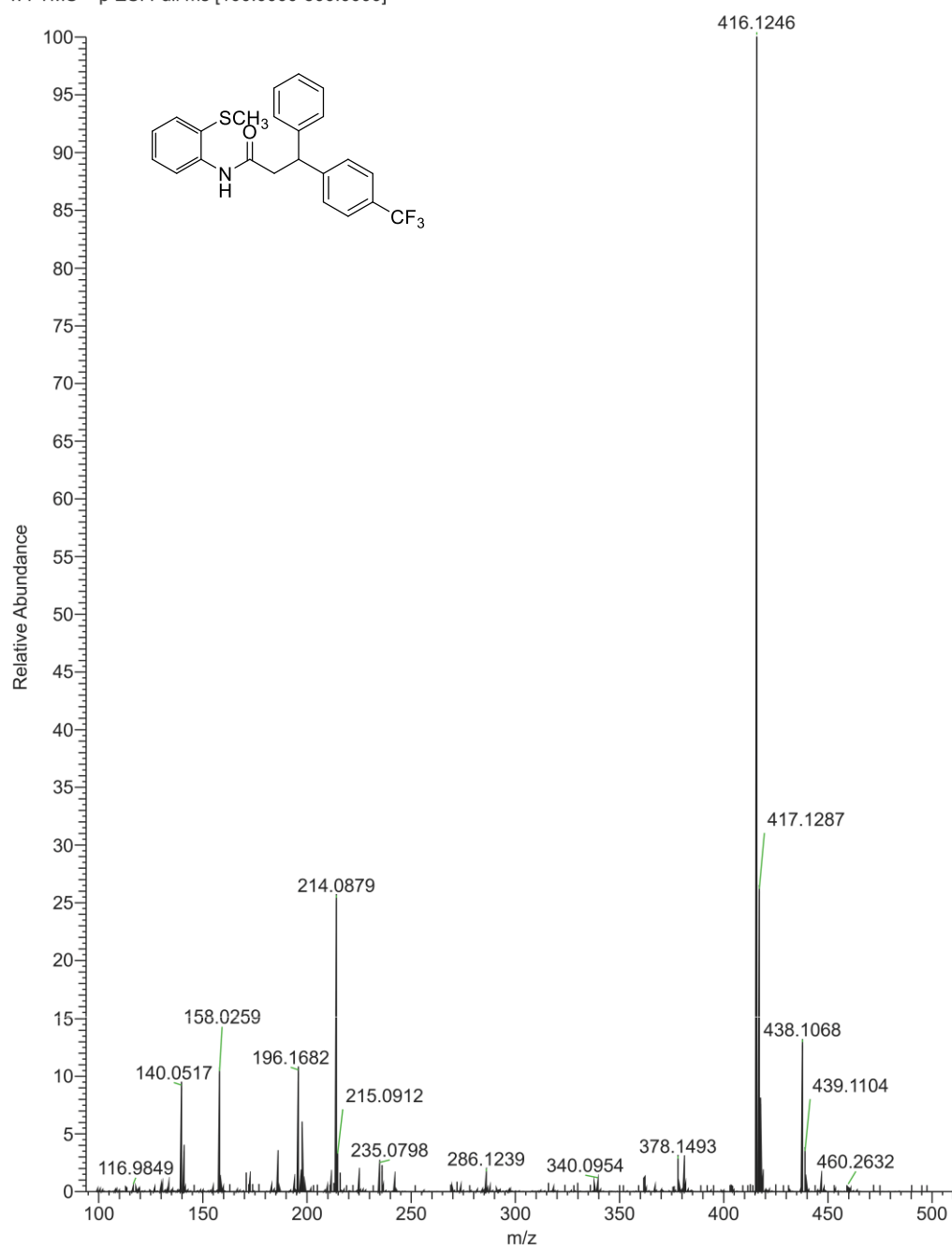
HRMS(ESI) of N-(2-(methylthio)phenyl)-3,3-diphenylpropanamide **3bm**

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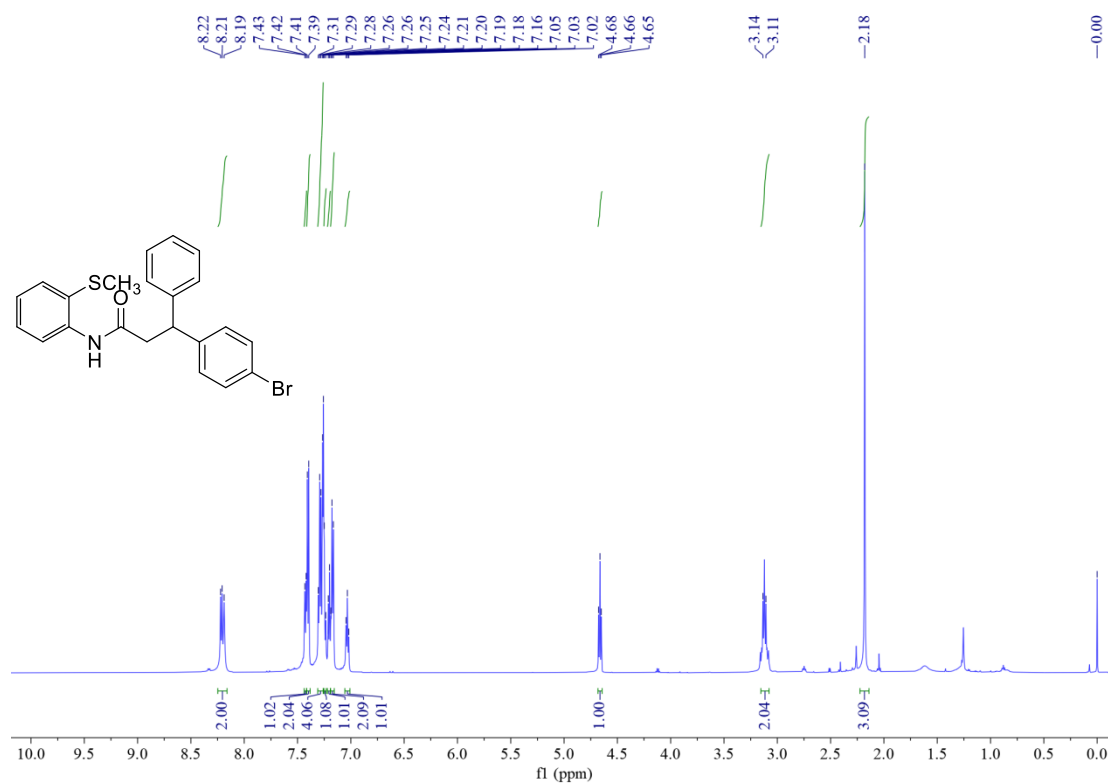
5/14/2025 15:57:50

1-100-500 #911-1425 RT: 0.56-0.87 AV: 515 NL: 1.89E8

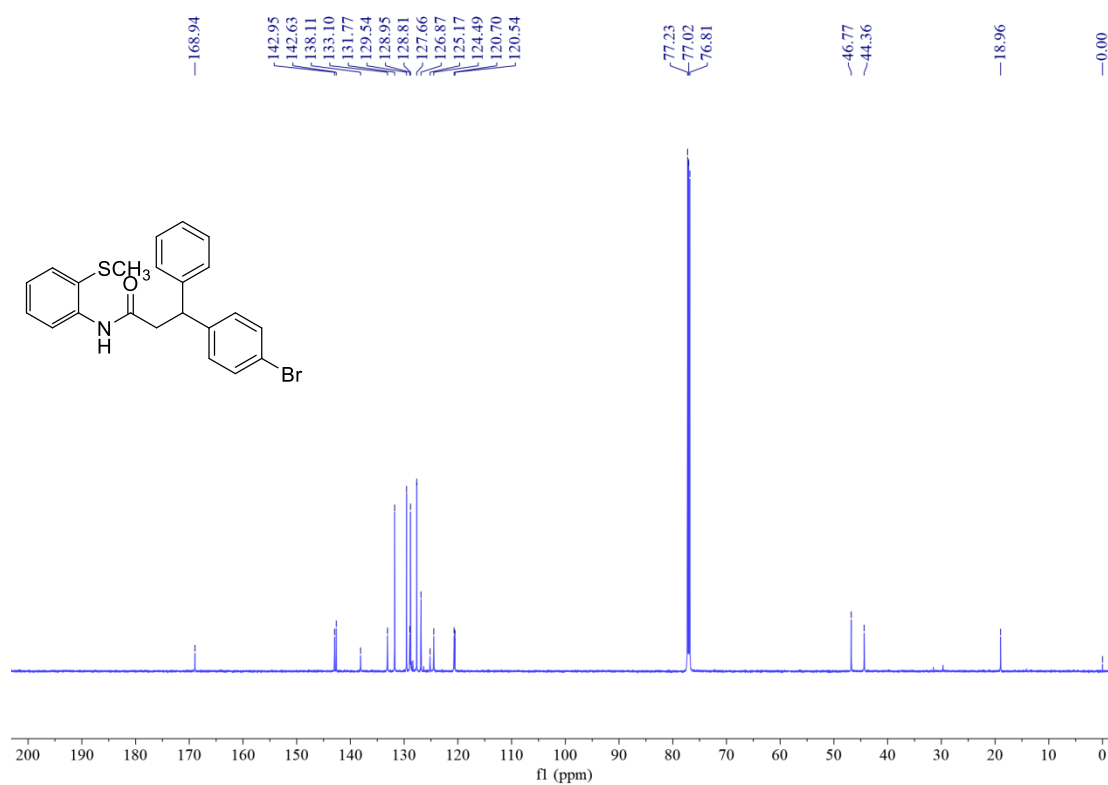
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of 3-(4-bromophenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bn**



¹³C NMR of 3-(4-bromophenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bn**



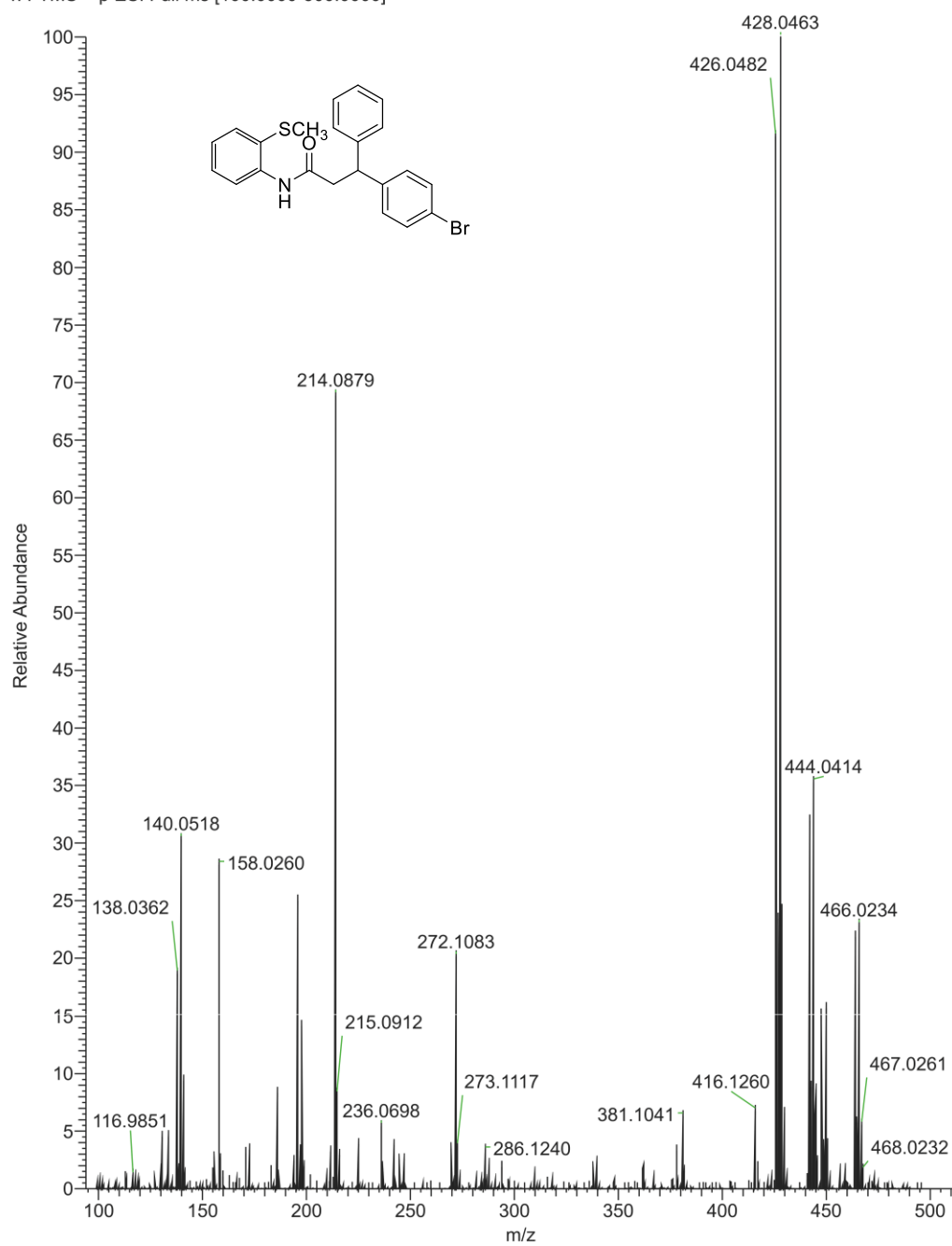
HRMS(ESI) of 3-(4-bromophenyl)-N-(2-(methylthio)phenyl)-3-phenylpropanamide **3bn**

D:\DATA\2025\25050775683\15\1-100-500.raw

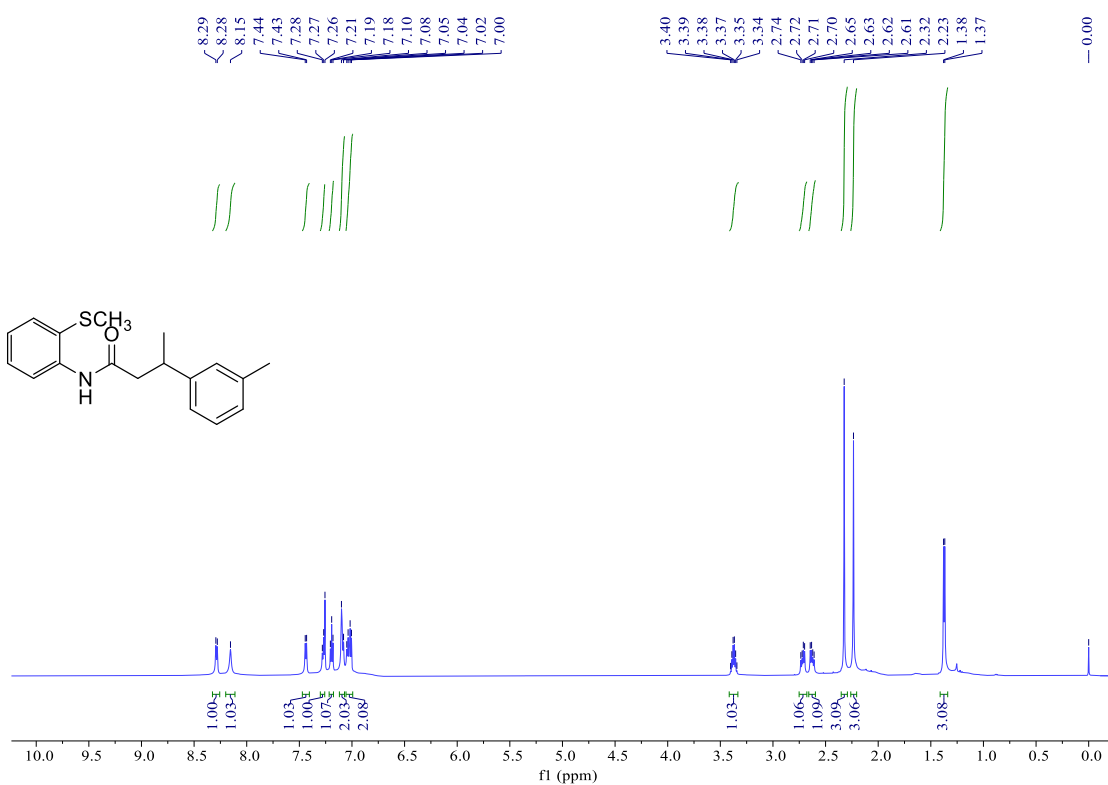
5/14/2025 16:00:36

1-100-500 #934-1258 RT: 0.57-0.77 AV: 325 NL: 5.82E7

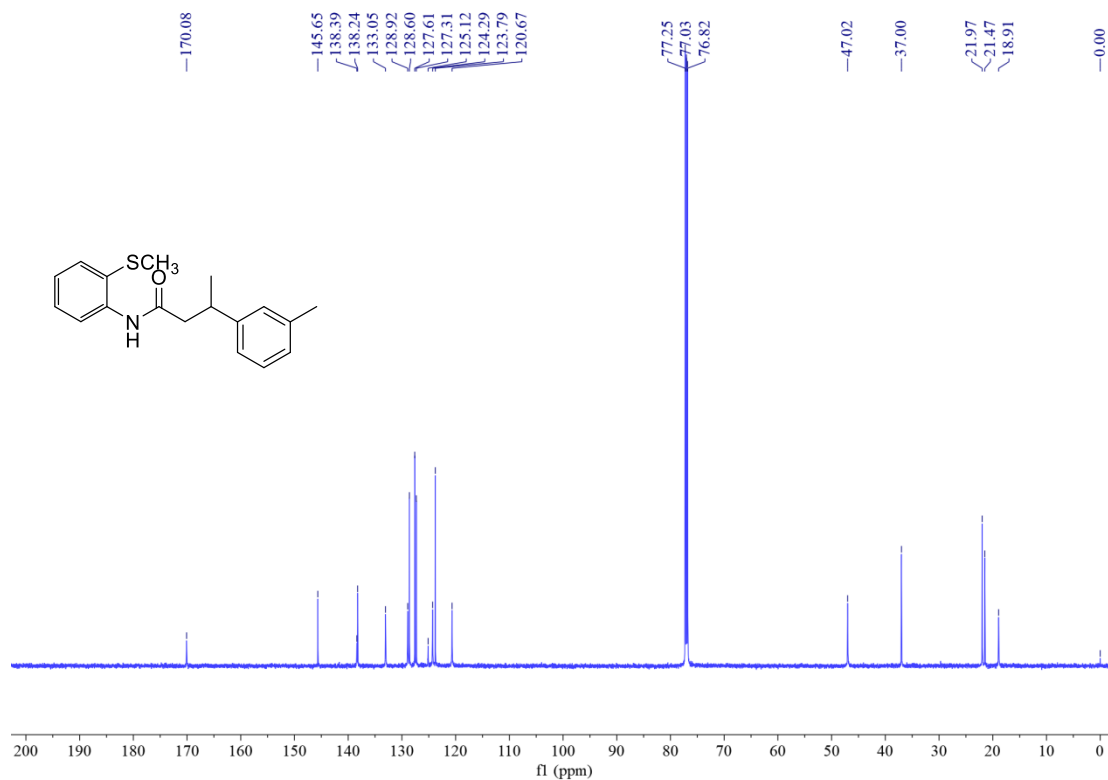
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of N-(2-(methylthio)phenyl)-3-(m-tolyl)butanamide **3ca**



¹³C NMR of N-(2-(methylthio)phenyl)-3-(m-tolyl)butanamide **3ca**



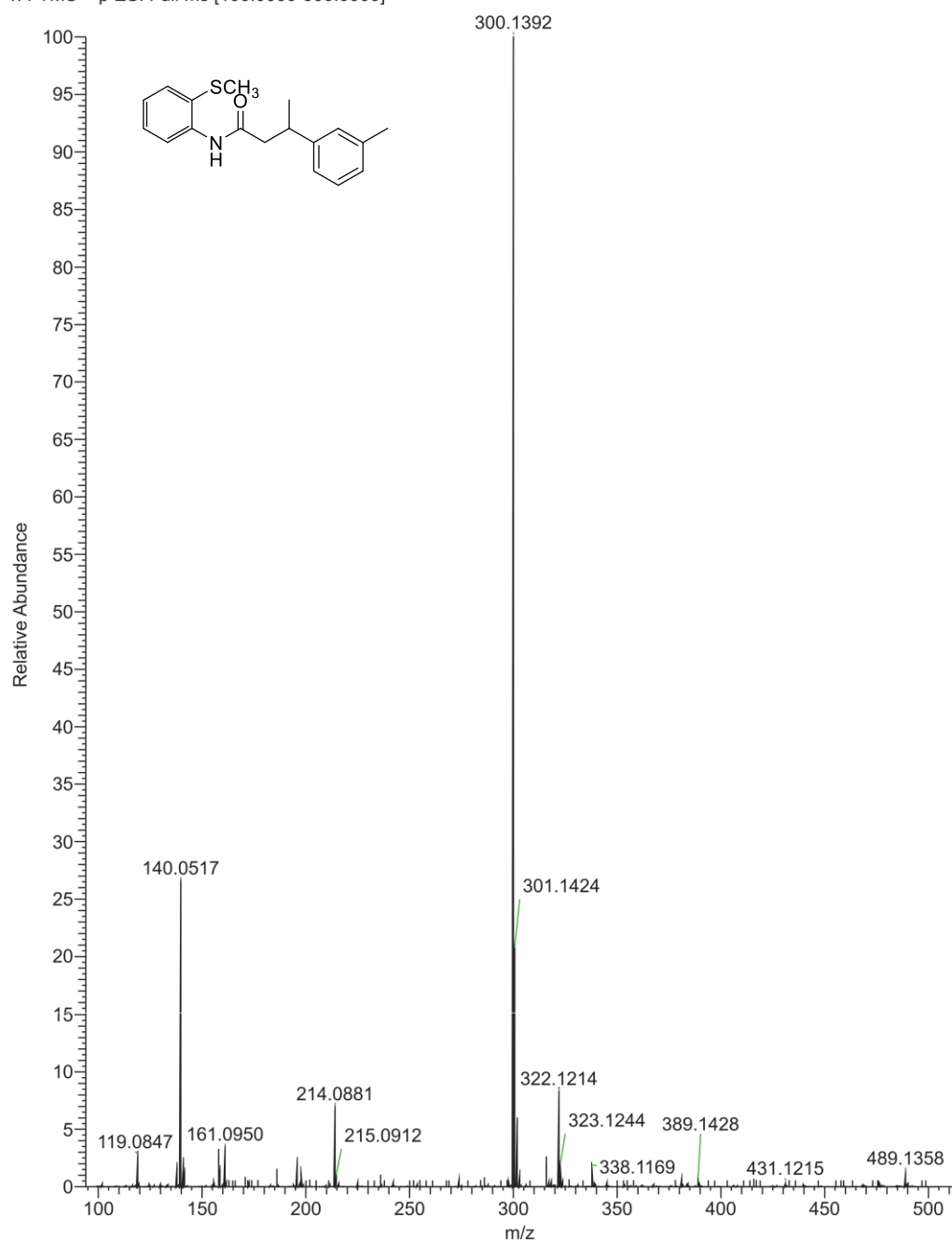
HRMS(ESI) of N-(2-(methylthio)phenyl)-3-(m-tolyl)butanamide **3ca**

D:\DATA\2025\25050775683\22\1-100-500.raw

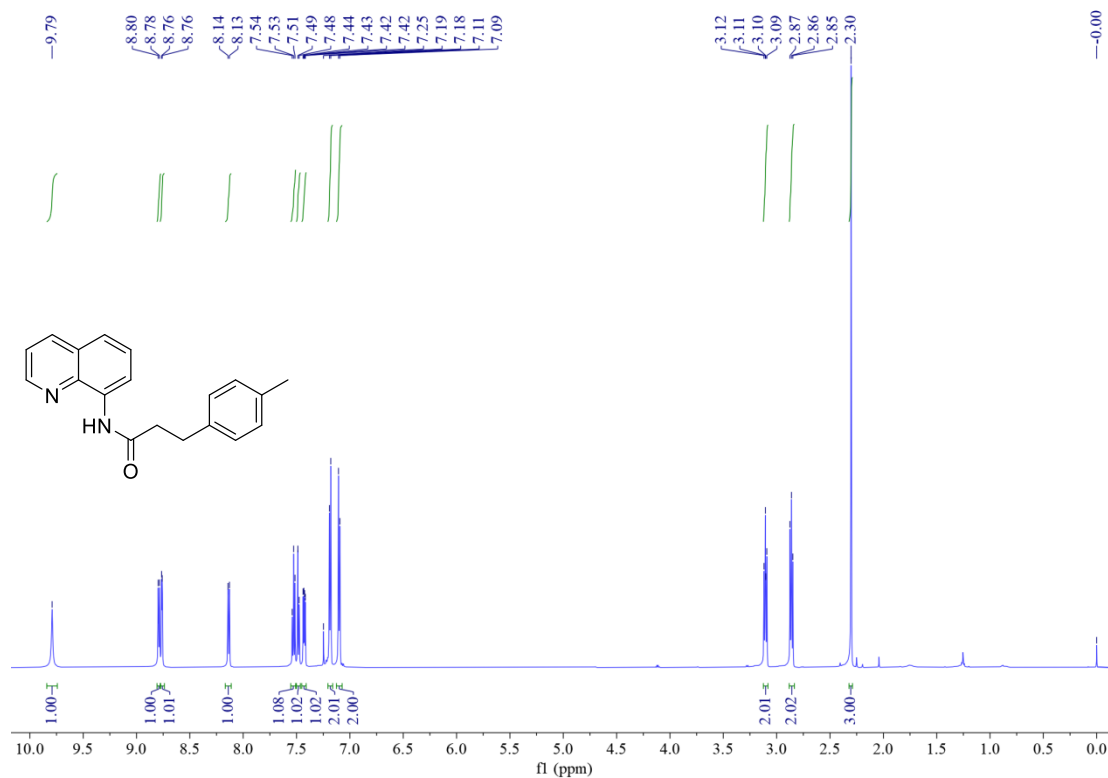
5/14/2025 16:20:36

1-100-500 #967-1409 RT: 0.59-0.86 AV: 443 NL: 5.16E8

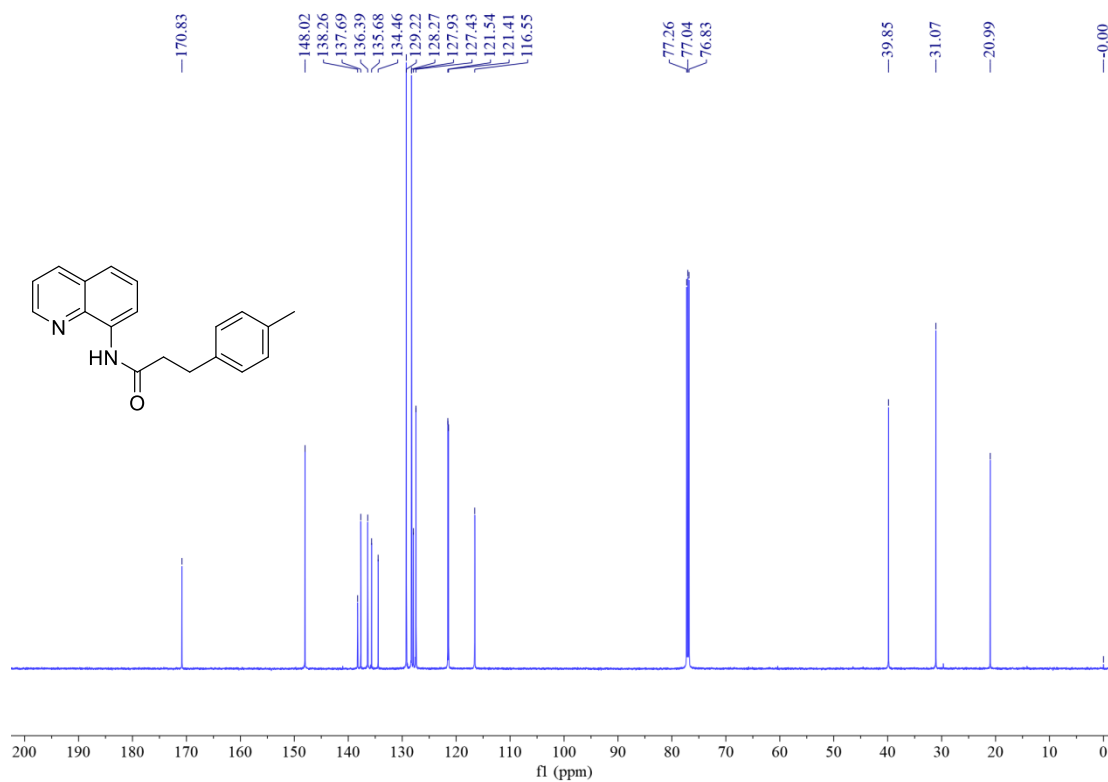
T: FTMS + p ESI Full ms [100.0000-500.0000]



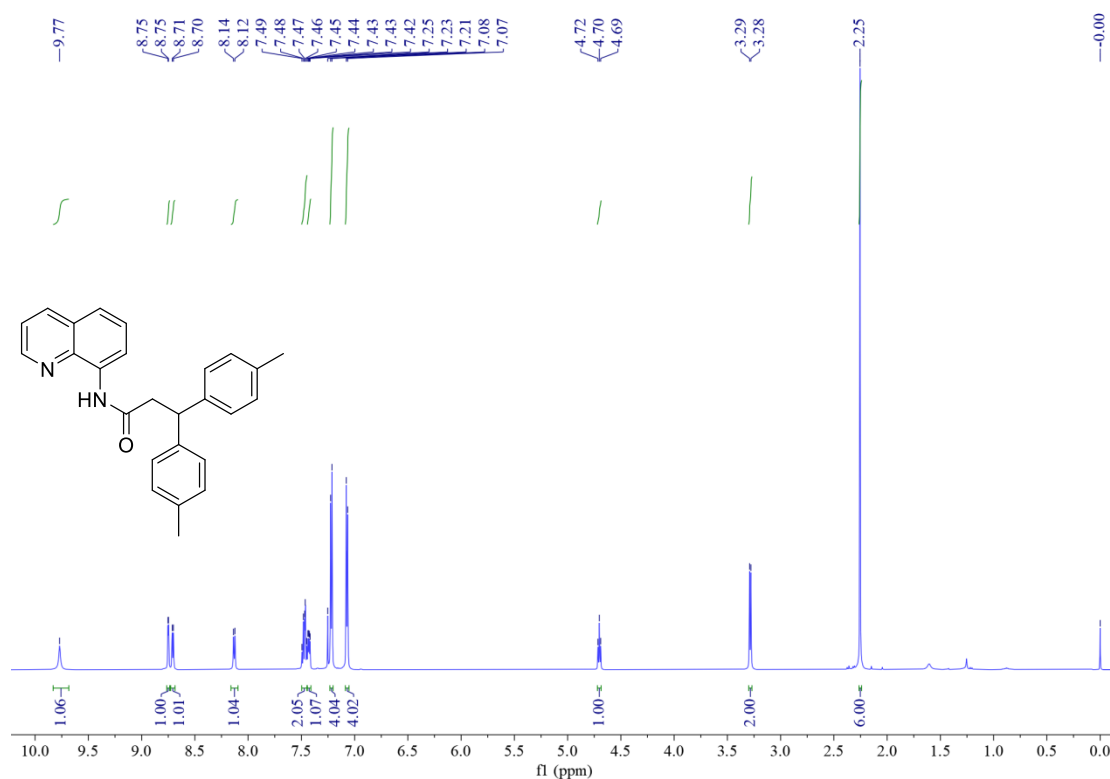
¹H NMR of N-(quinolin-8-yl)-3-(p-tolyl)propanamide **3ec**



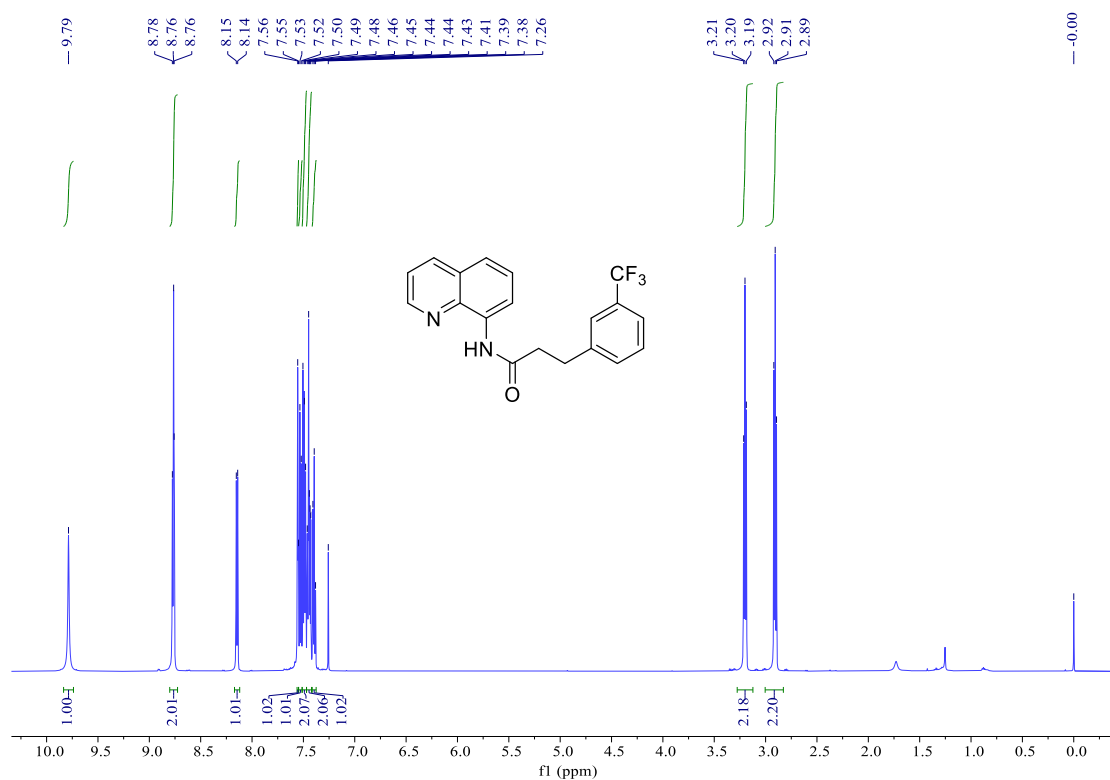
¹³C NMR of N-(quinolin-8-yl)-3-(p-tolyl)propanamide **3ec**



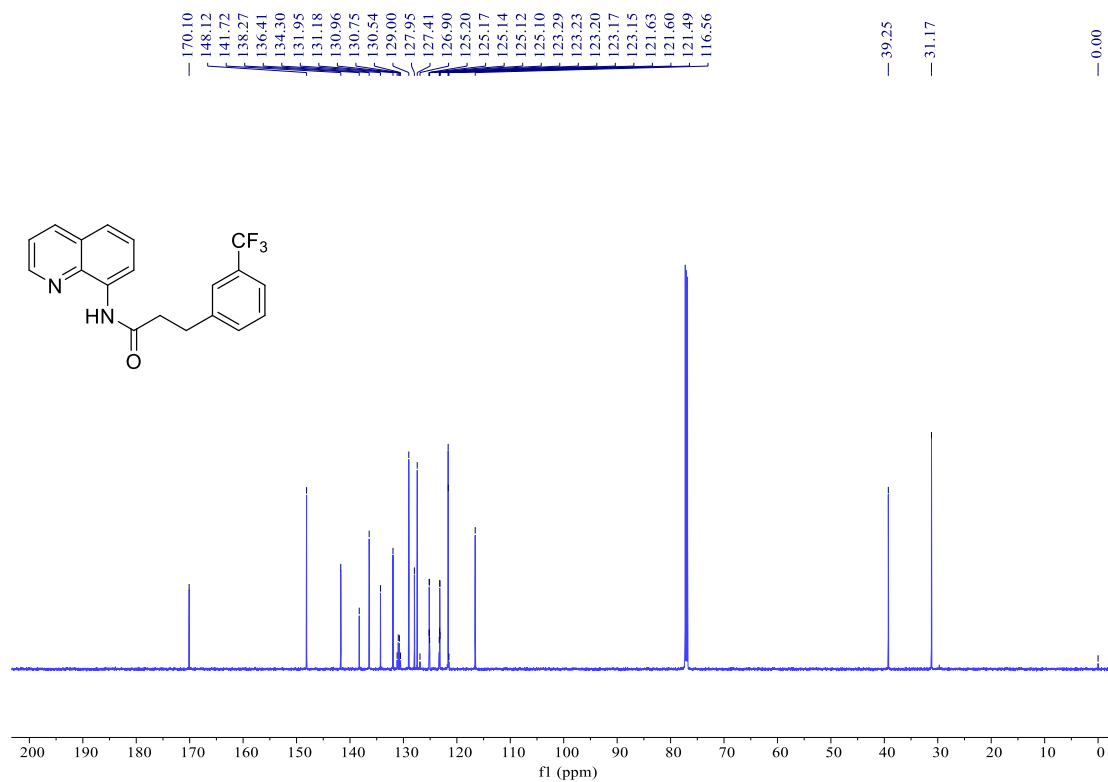
¹H NMR of N-(quinolin-8-yl)-3,3-di-p-tolylpropanamide **3ec**



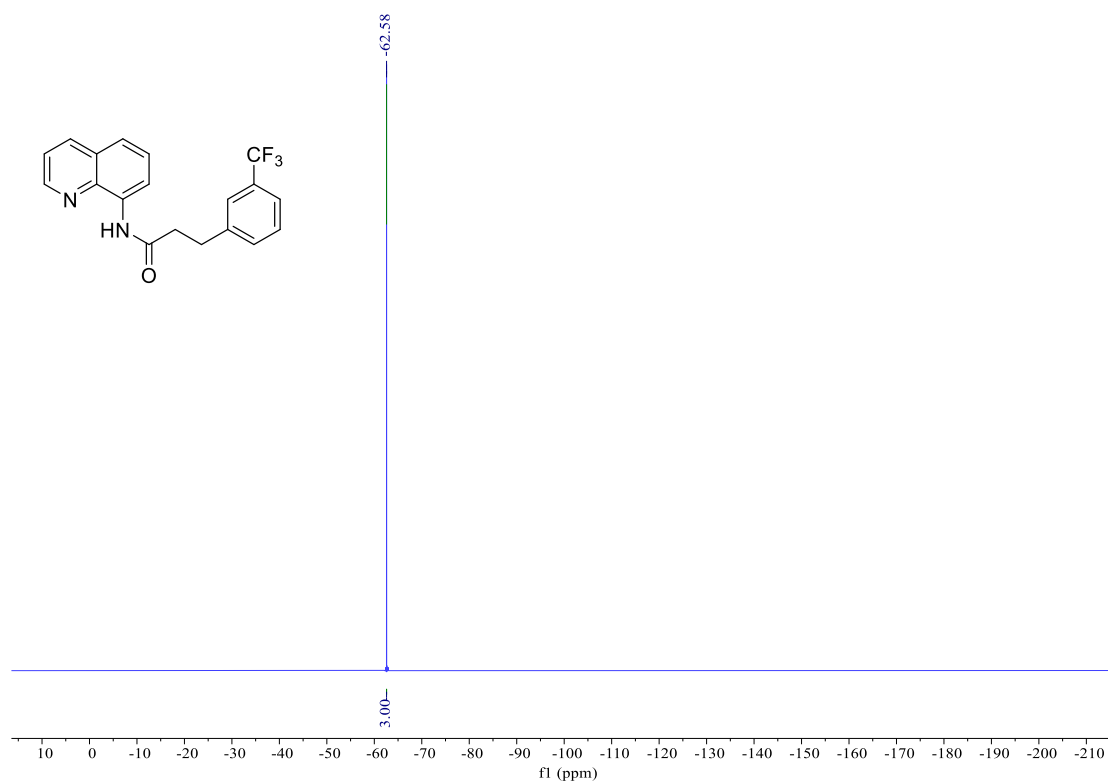
¹H NMR of N-(quinolin-8-yl)-3-(3-(trifluoromethyl)phenyl)propanamide **3ef**



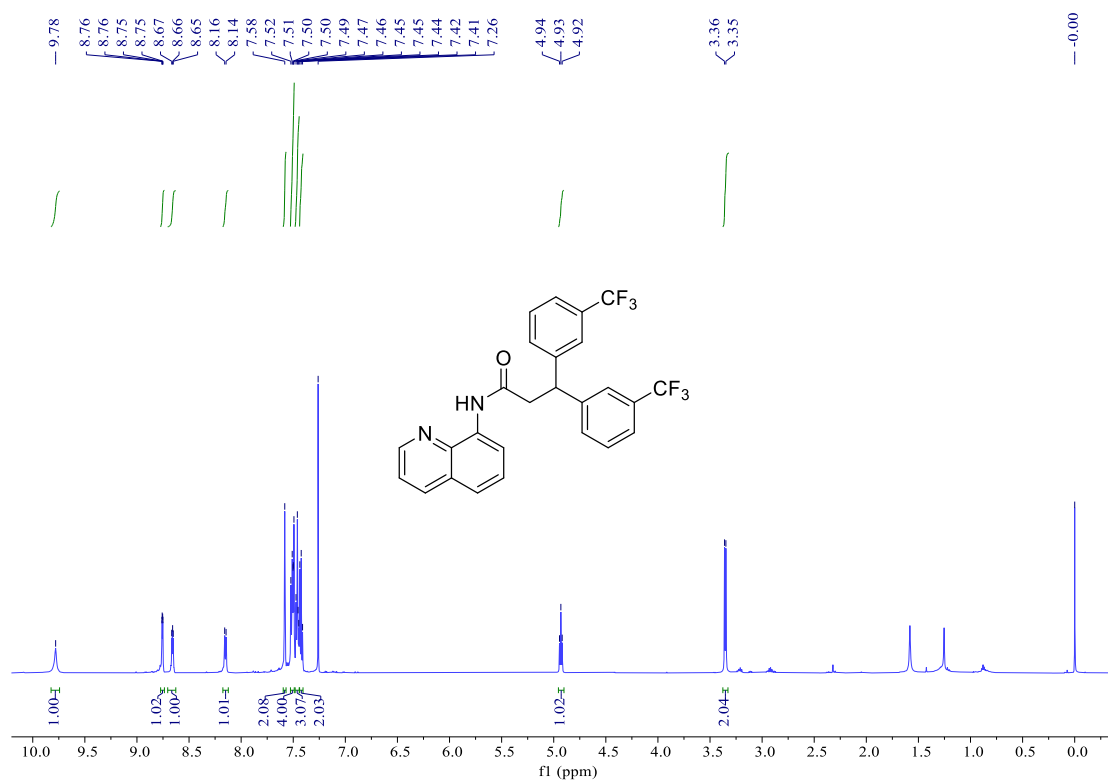
¹³C NMR of N-(quinolin-8-yl)-3-(3-(trifluoromethyl)phenyl)propanamide **3ef**



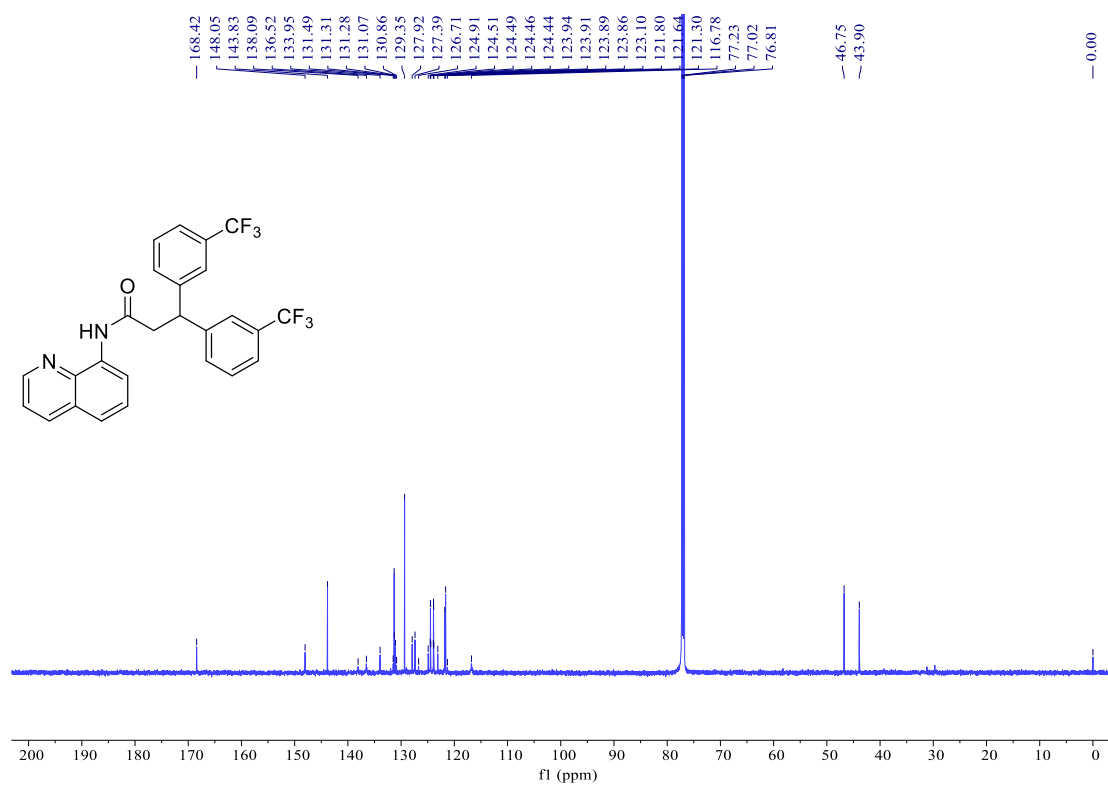
¹⁹F NMR of N-(quinolin-8-yl)-3-(3-(trifluoromethyl)phenyl)propanamide **3ef**



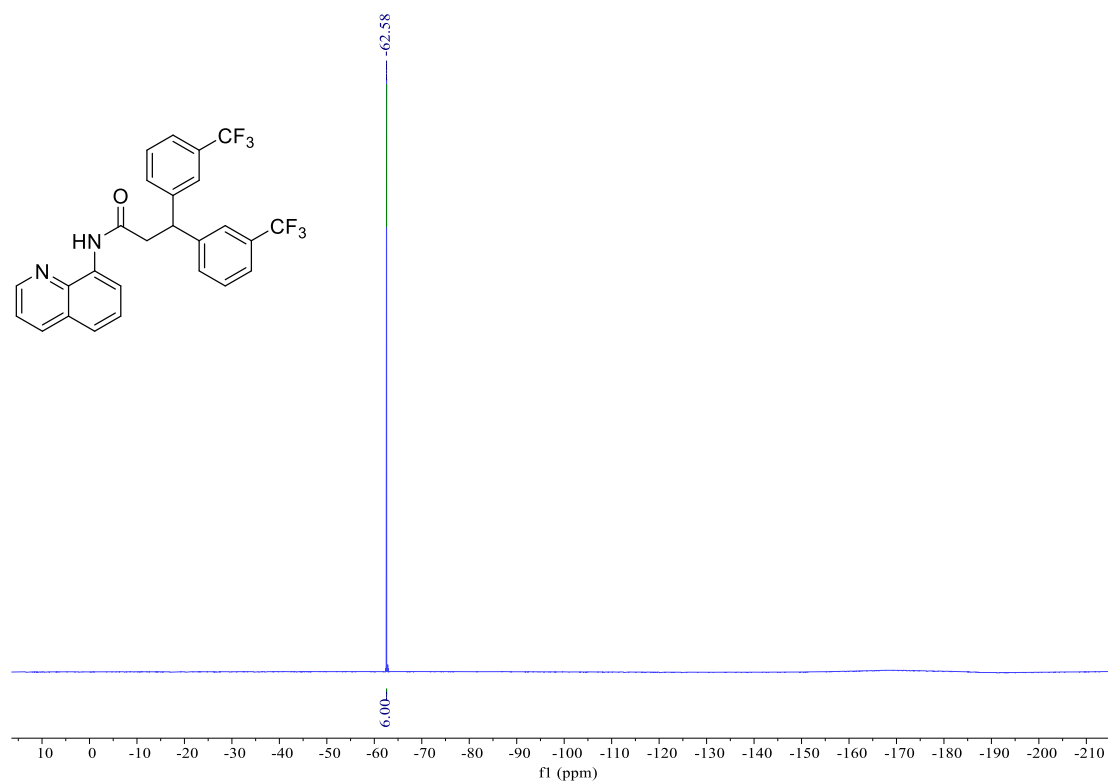
¹H NMR of N-(quinolin-8-yl)-3,3-bis(3-(trifluoromethyl)phenyl)propanamide **3ef**



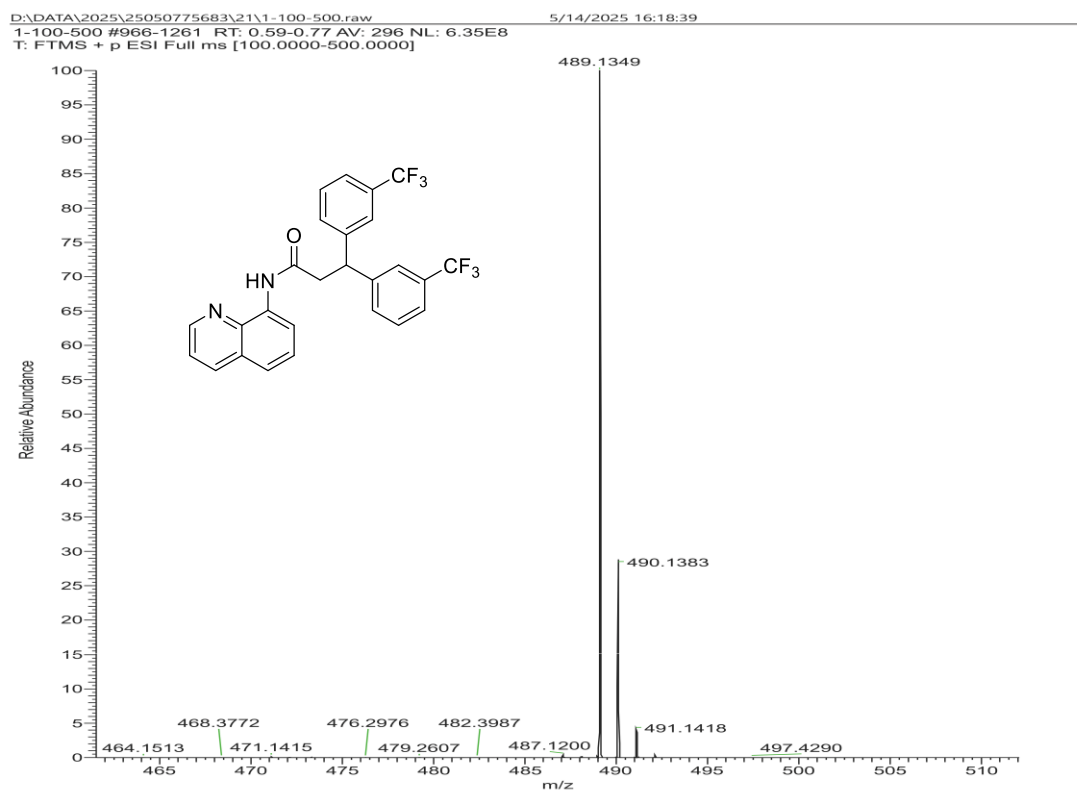
¹³C NMR of N-(quinolin-8-yl)-3,3-bis(3-(trifluoromethyl)phenyl)propanamide **3ef**



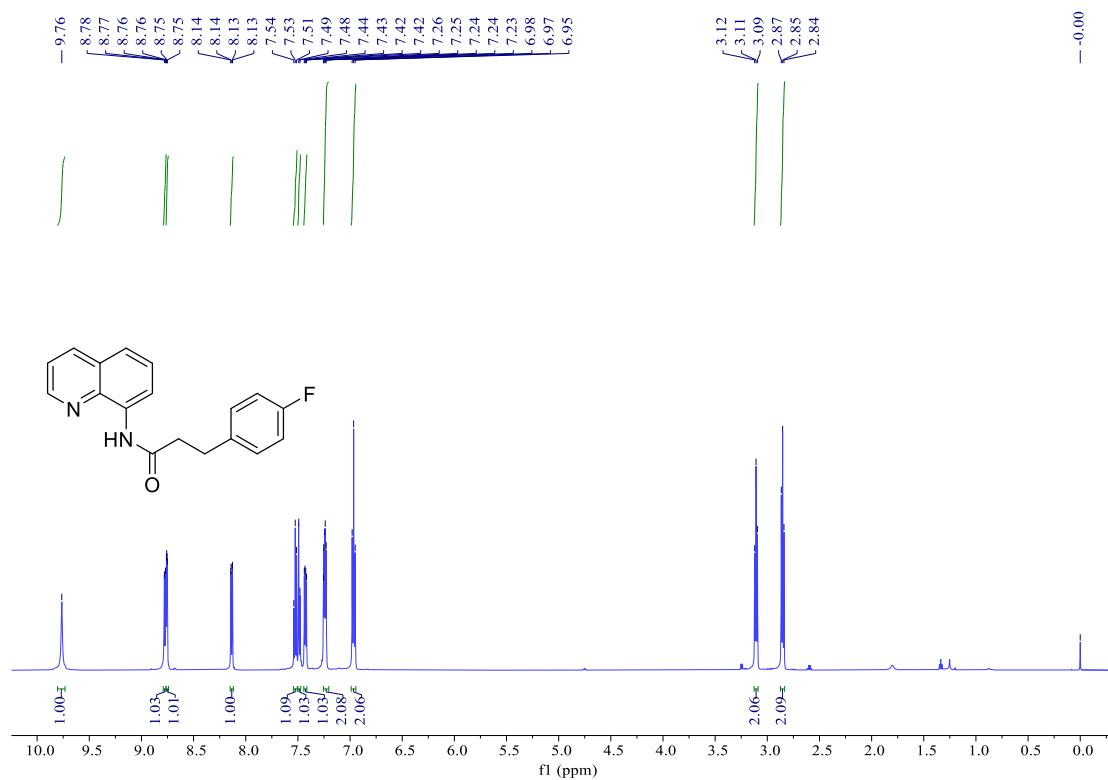
¹⁹F NMR of N-(quinolin-8-yl)-3,3-bis(3-(trifluoromethyl)phenyl)propanamide **3ef**



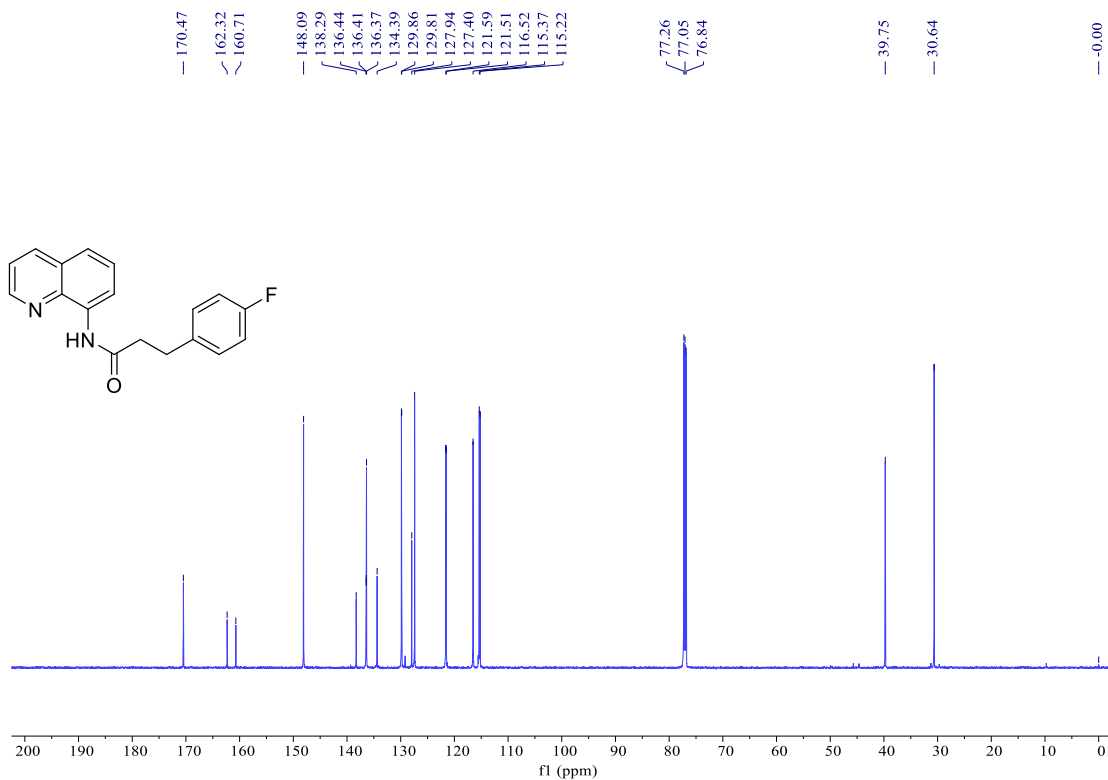
HRMS(ESI) of N-(quinolin-8-yl)-3,3-bis(3-(trifluoromethyl)phenyl)propanamide **3ef**



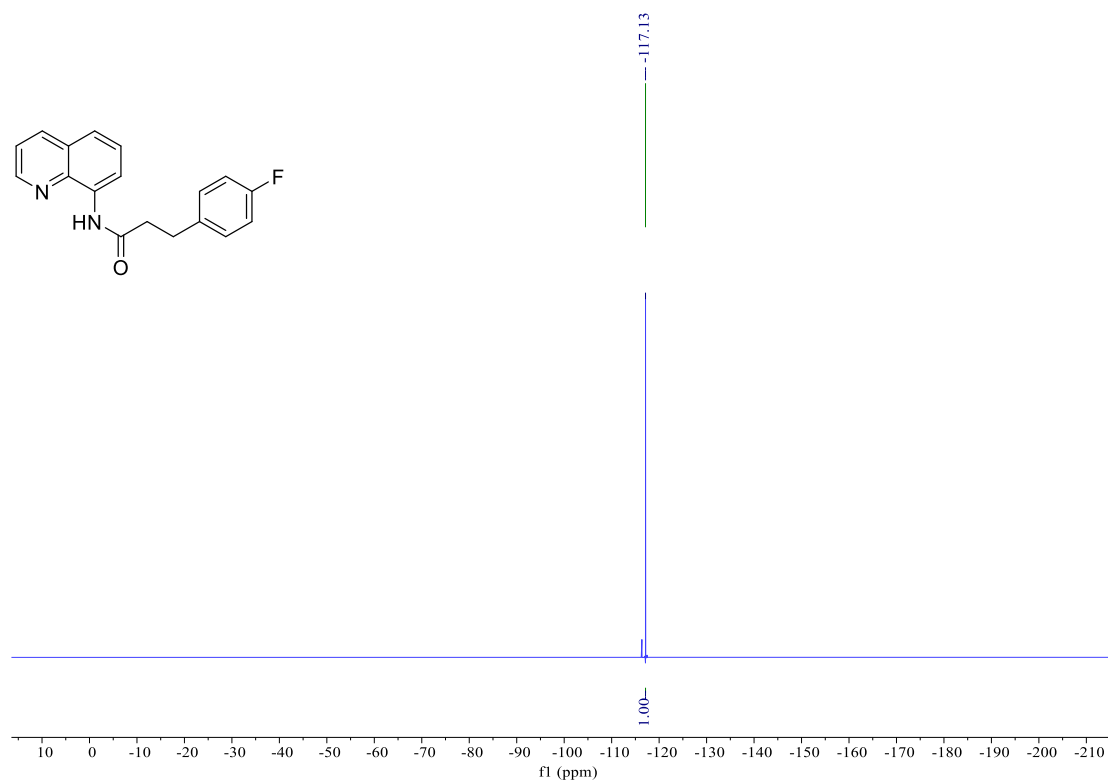
¹H NMR of 3-(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg**



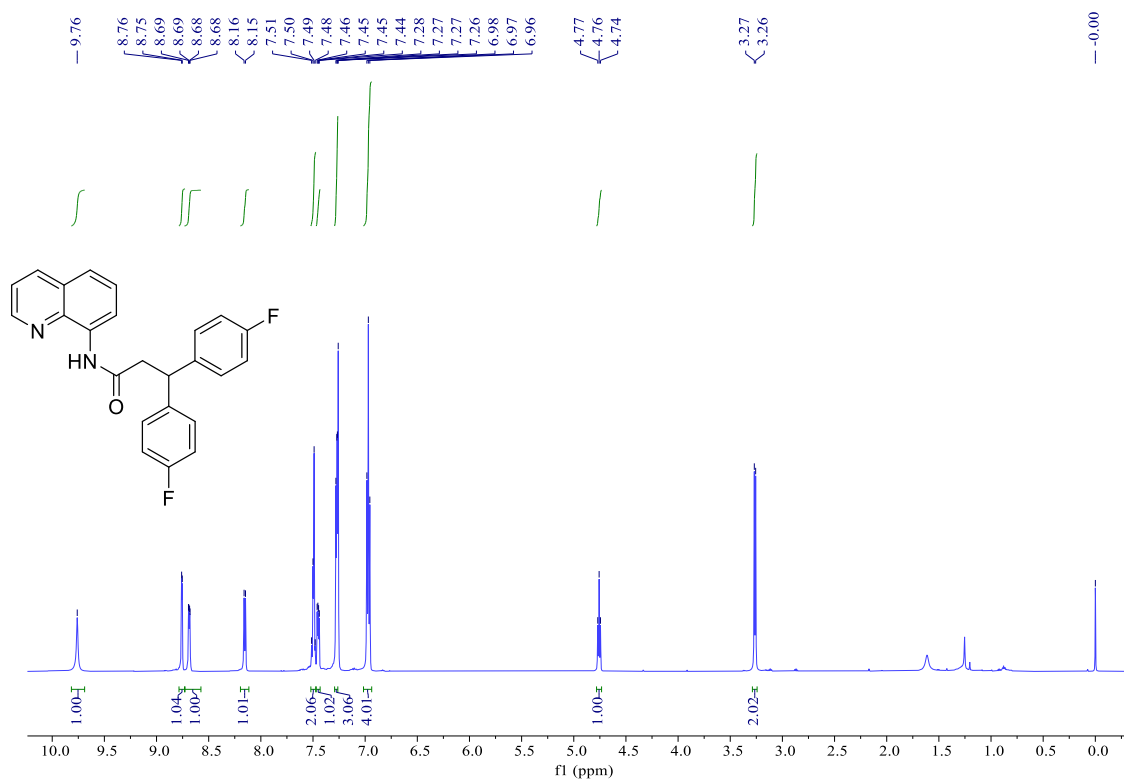
¹³C NMR of 3-(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg**



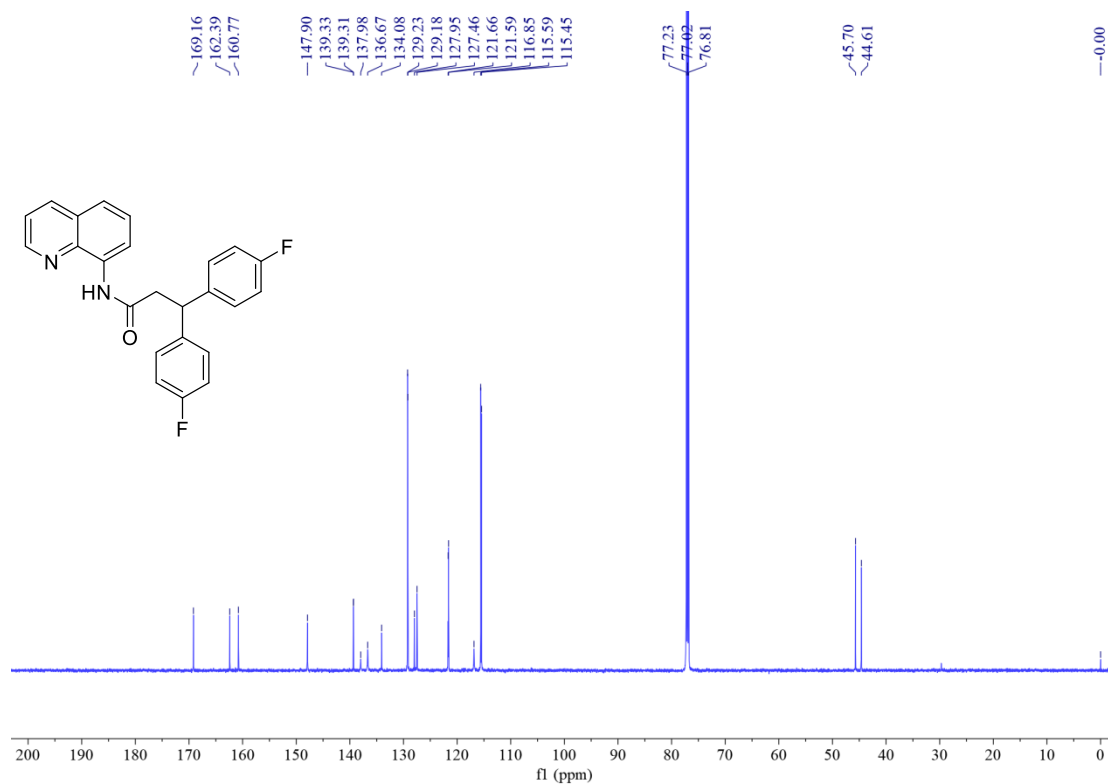
^{19}F NMR of 3-(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg**



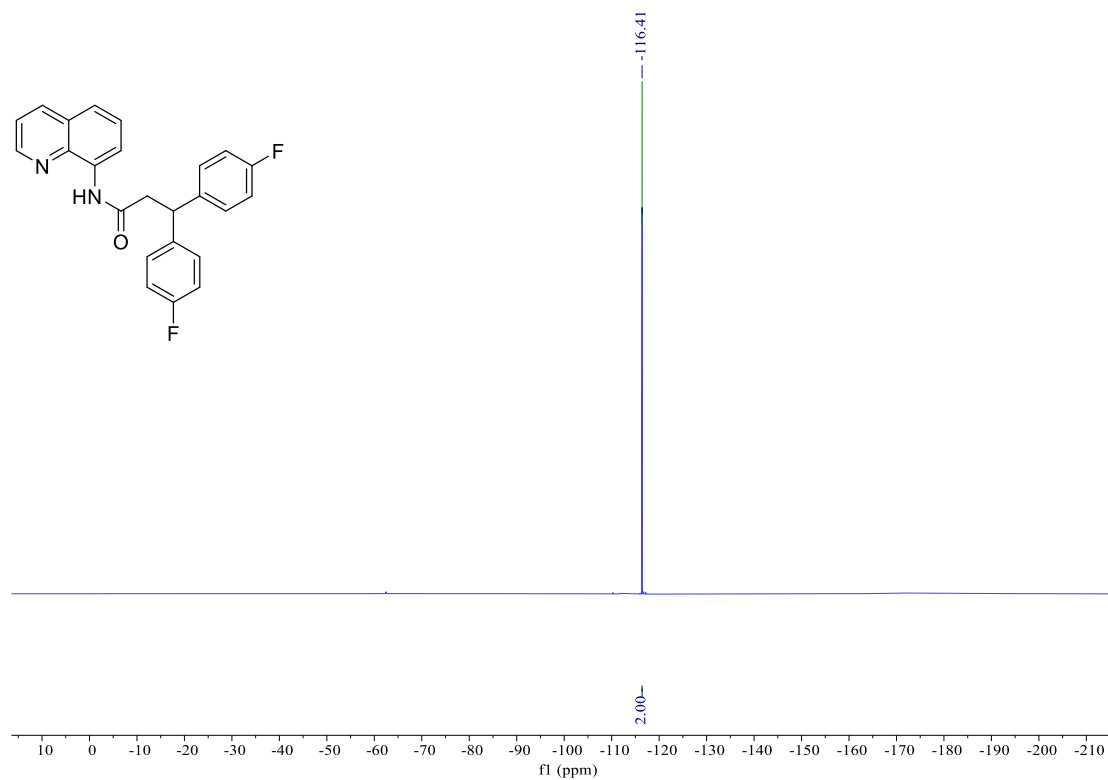
^1H NMR of 3,3-bis(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg'**



^{13}C NMR of 3,3-bis(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg'**



^{19}F NMR of 3,3-bis(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg'**



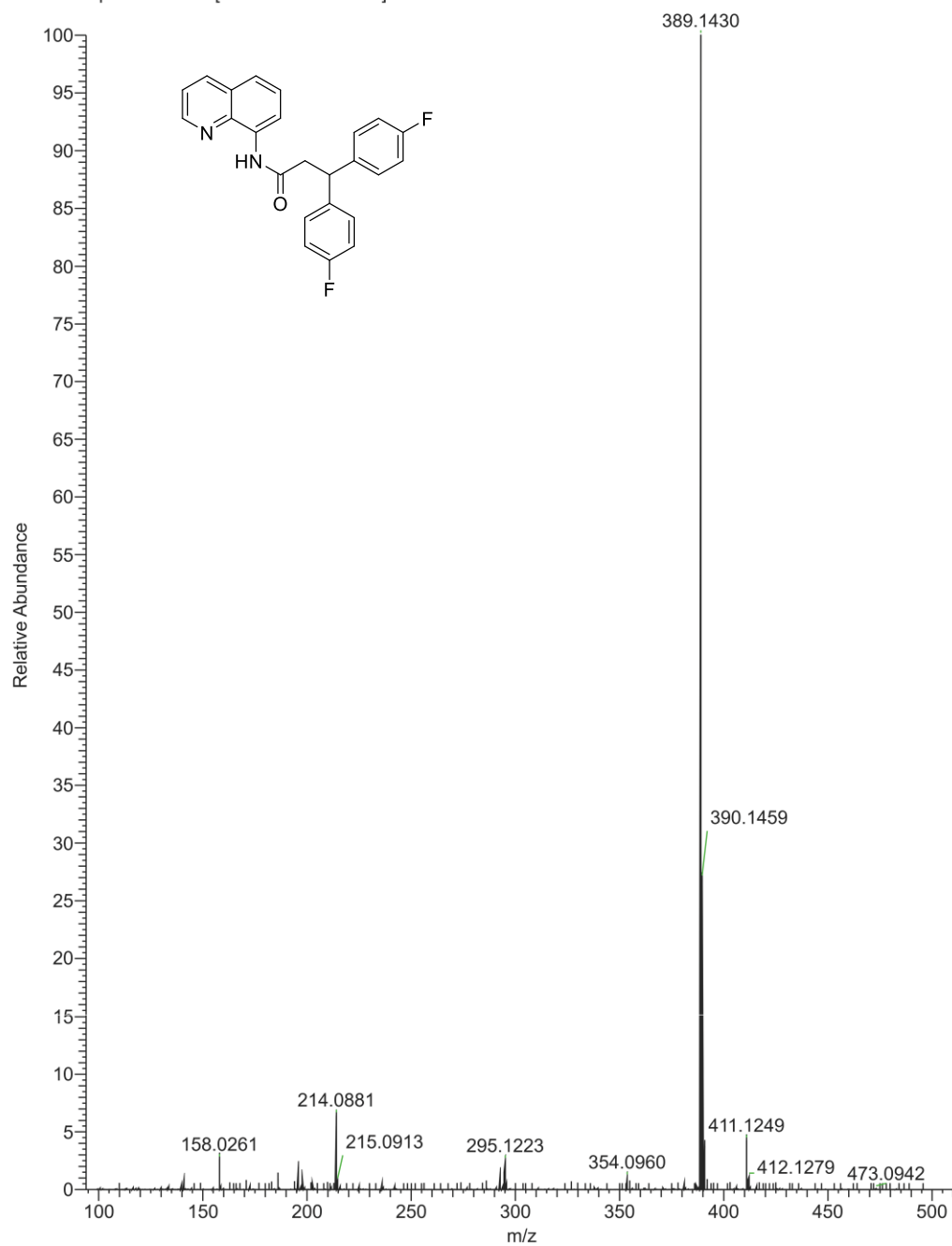
HRMS(ESI) of 3,3-bis(4-fluorophenyl)-N-(quinolin-8-yl)propanamide **3eg**¹

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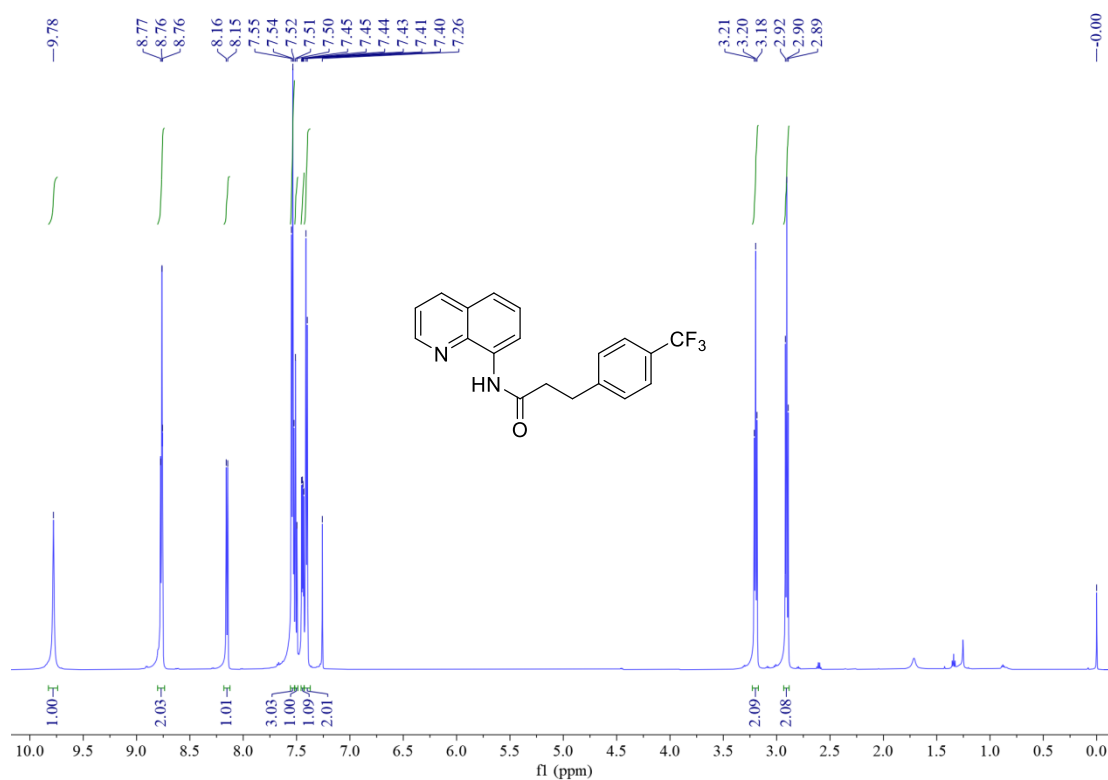
5/14/2025 16:13:00

1-100-500 #916-1274 RT: 0.56-0.78 AV: 359 NL: 5.87E8

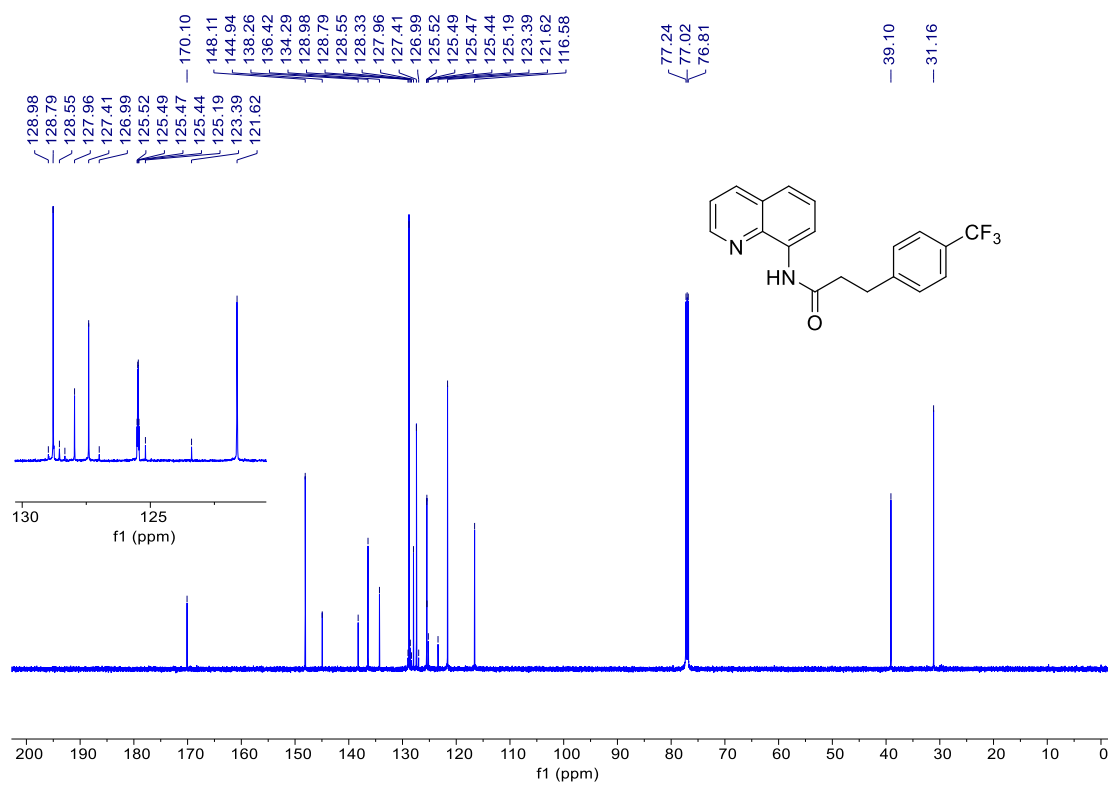
T: FTMS + p ESI Full ms [100.0000-500.0000]



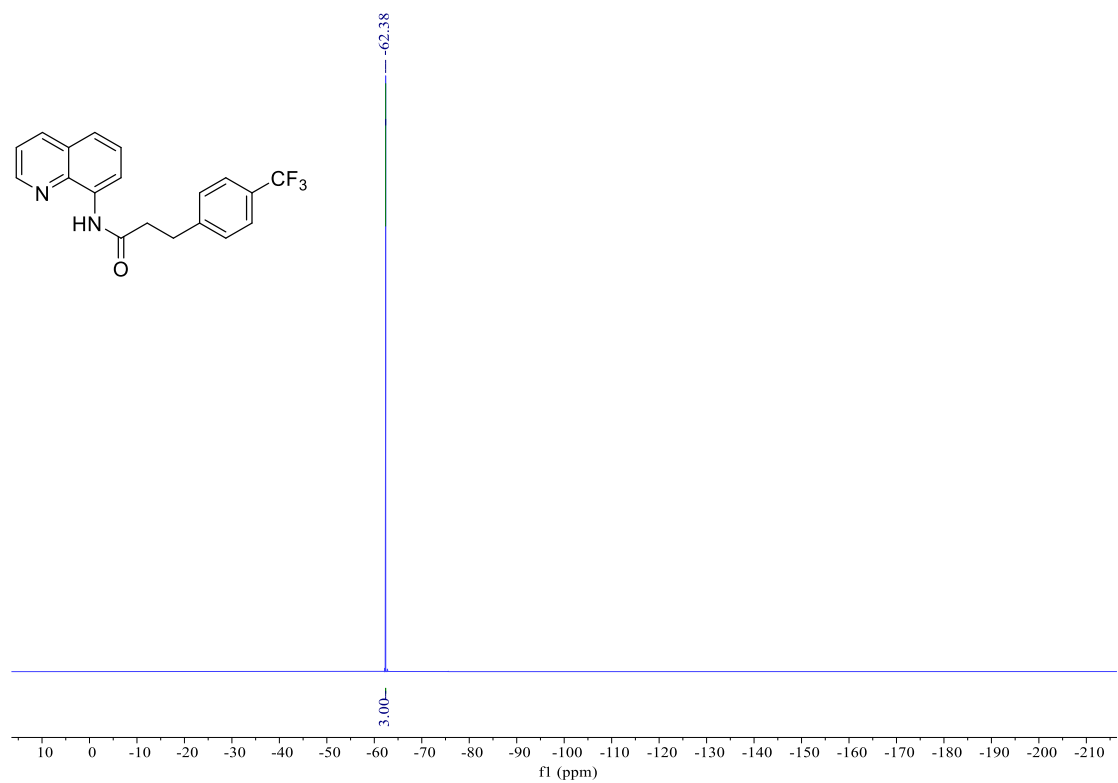
¹H NMR of N-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)propanamide **3en**



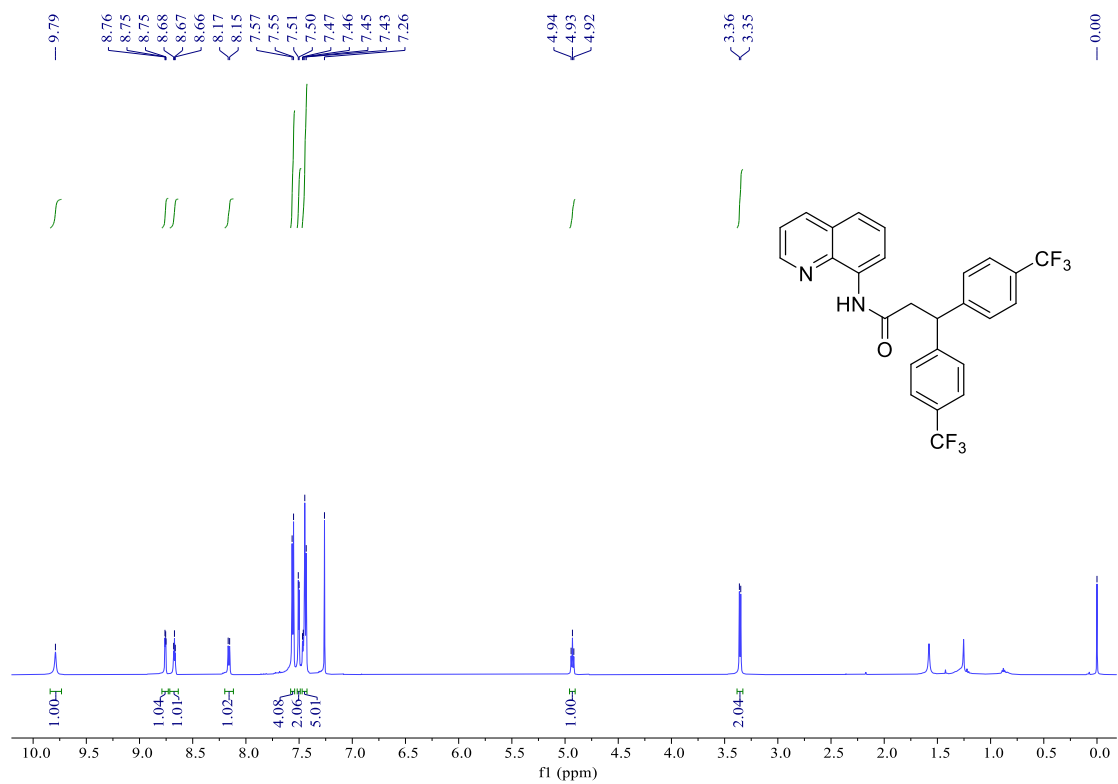
¹³C NMR of N-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)propanamide **3en**



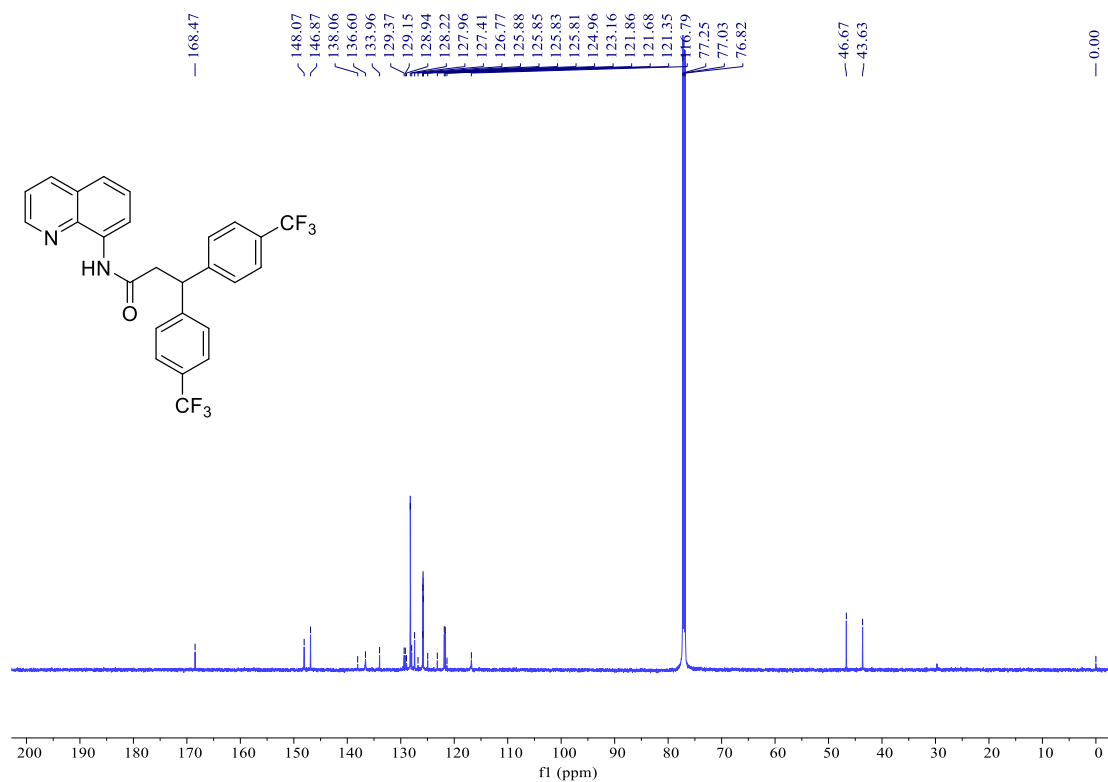
¹⁹F NMR of N-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)propanamide **3en**



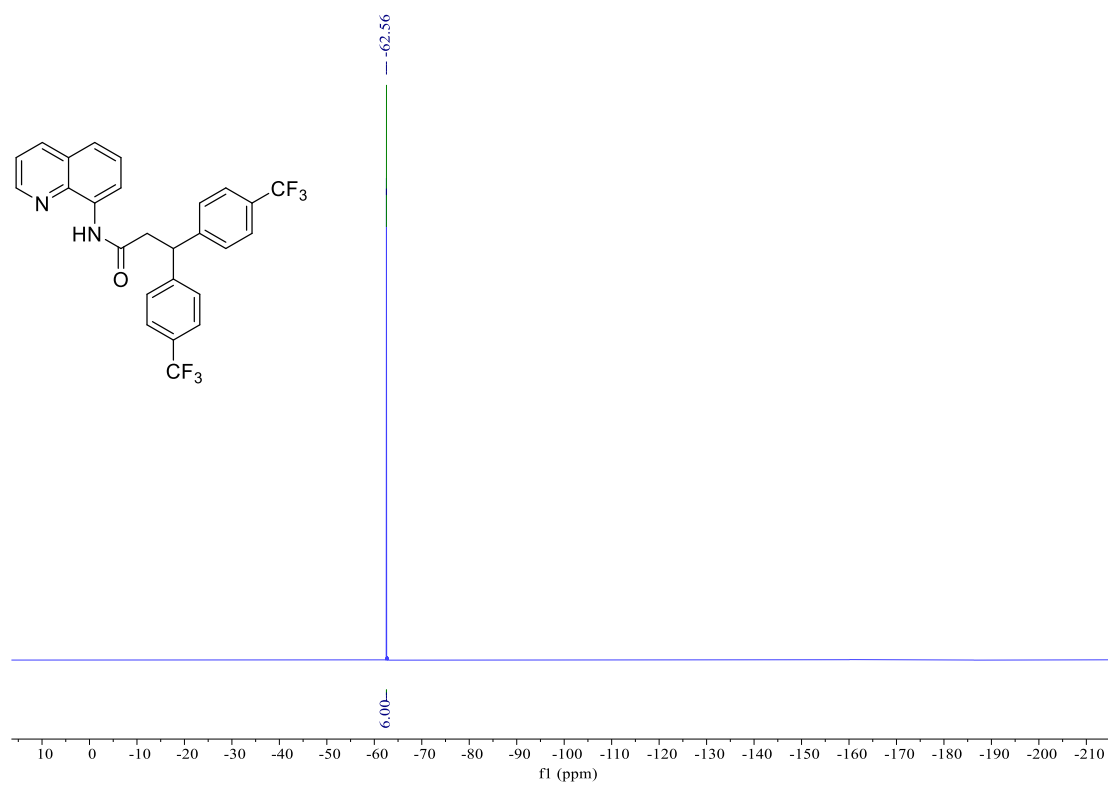
¹H NMR of N-(quinolin-8-yl)-3,3-bis(4-(trifluoromethyl)phenyl)propanamide **3en'**



^{13}C NMR of N-(quinolin-8-yl)-3,3-bis(4-(trifluoromethyl)phenyl)propanamide **3en'**



^{19}F NMR of N-(quinolin-8-yl)-3,3-bis(4-(trifluoromethyl)phenyl)propanamide **3en'**



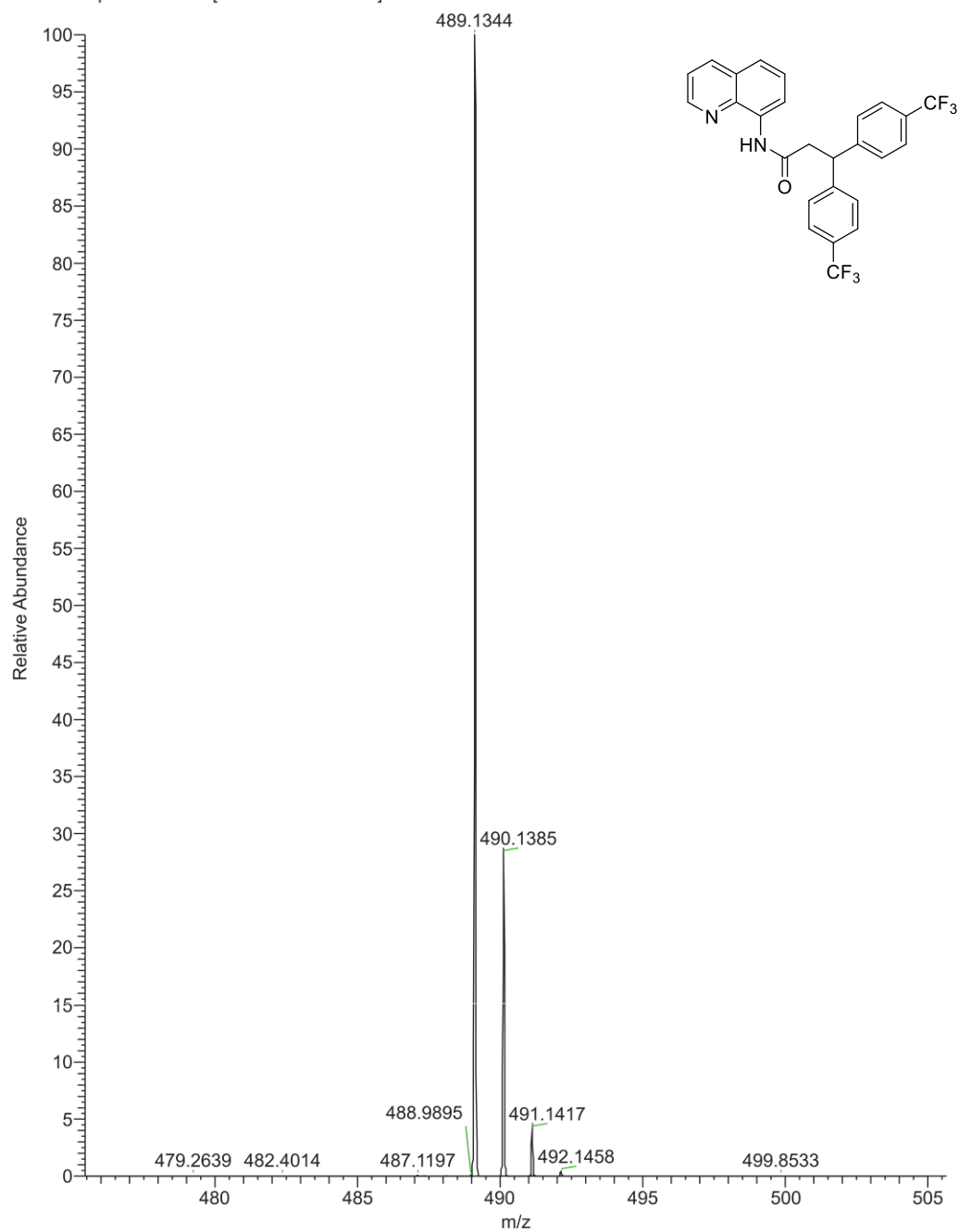
HRMS(ESI) of N-(quinolin-8-yl)-3,3-bis(4-(trifluoromethyl)phenyl)propanamide **3en**[†]

D:\DATA\2025\25050775683\20\1-100-500.raw

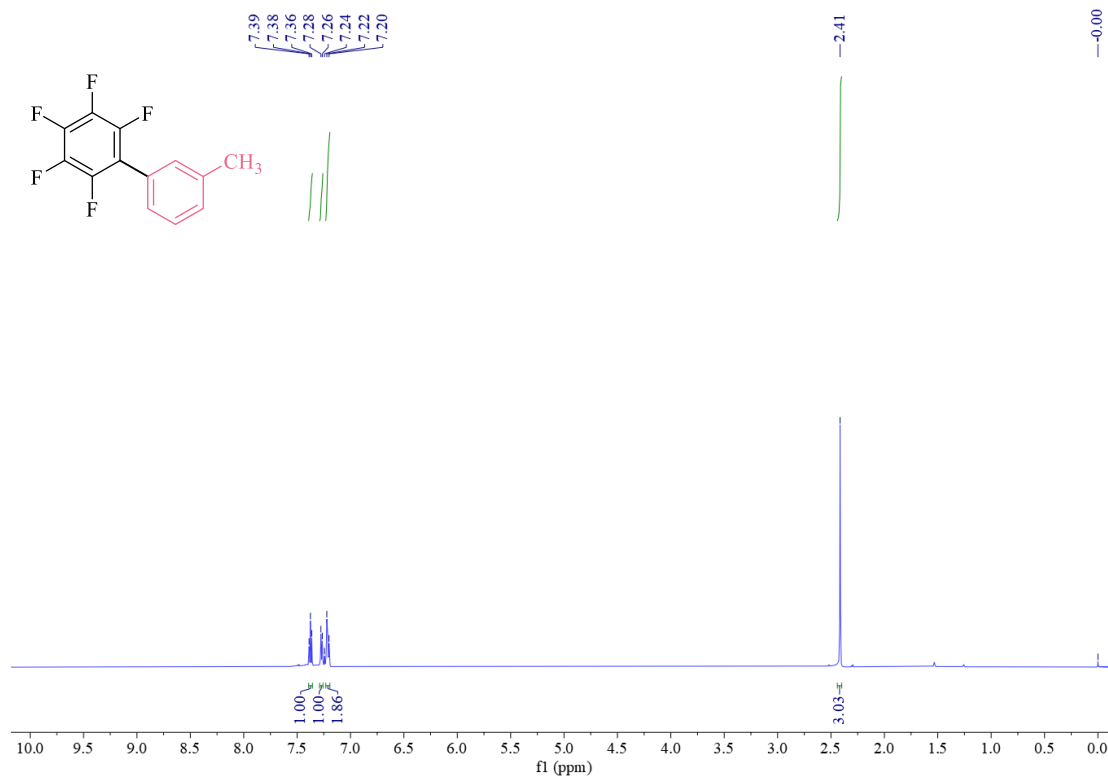
5/14/2025 16:15:52

1-100-500 #943-1340 RT: 0.58-0.82 AV: 398 NL: 3.83E8

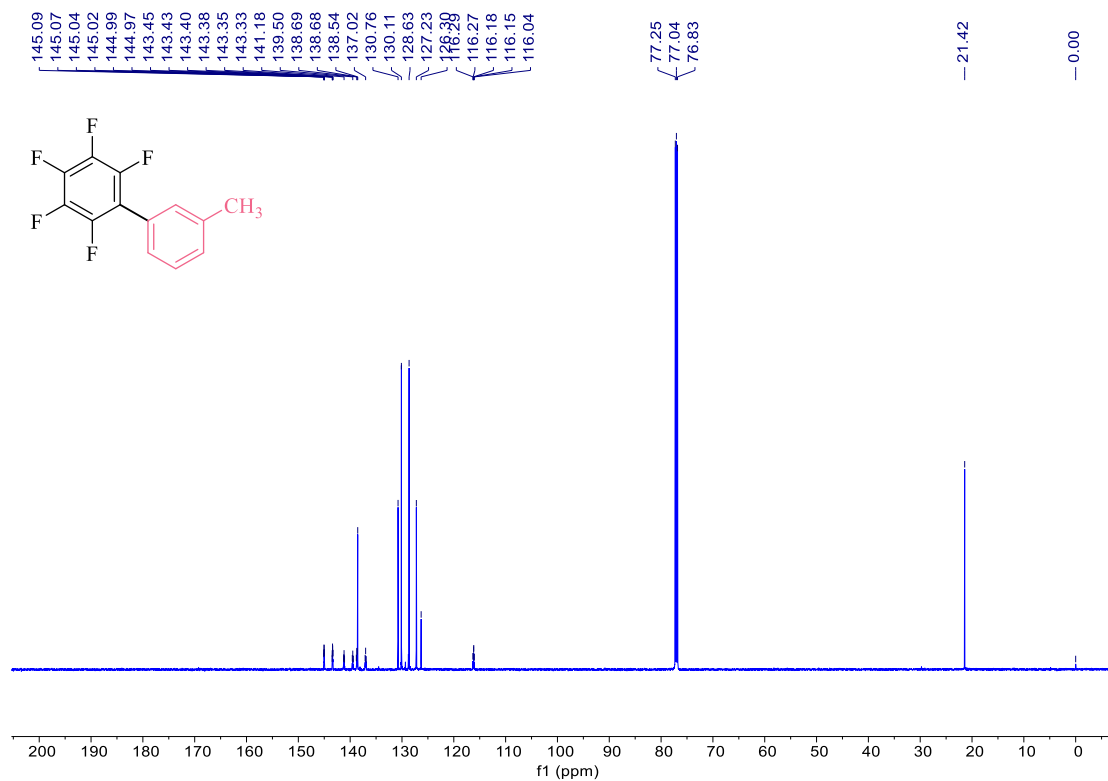
T: FTMS + p ESI Full ms [100.0000-500.0000]



¹H NMR of 2,3,4,5,6-pentafluoro-3'-methyl-1,1'-biphenyl **5aa**



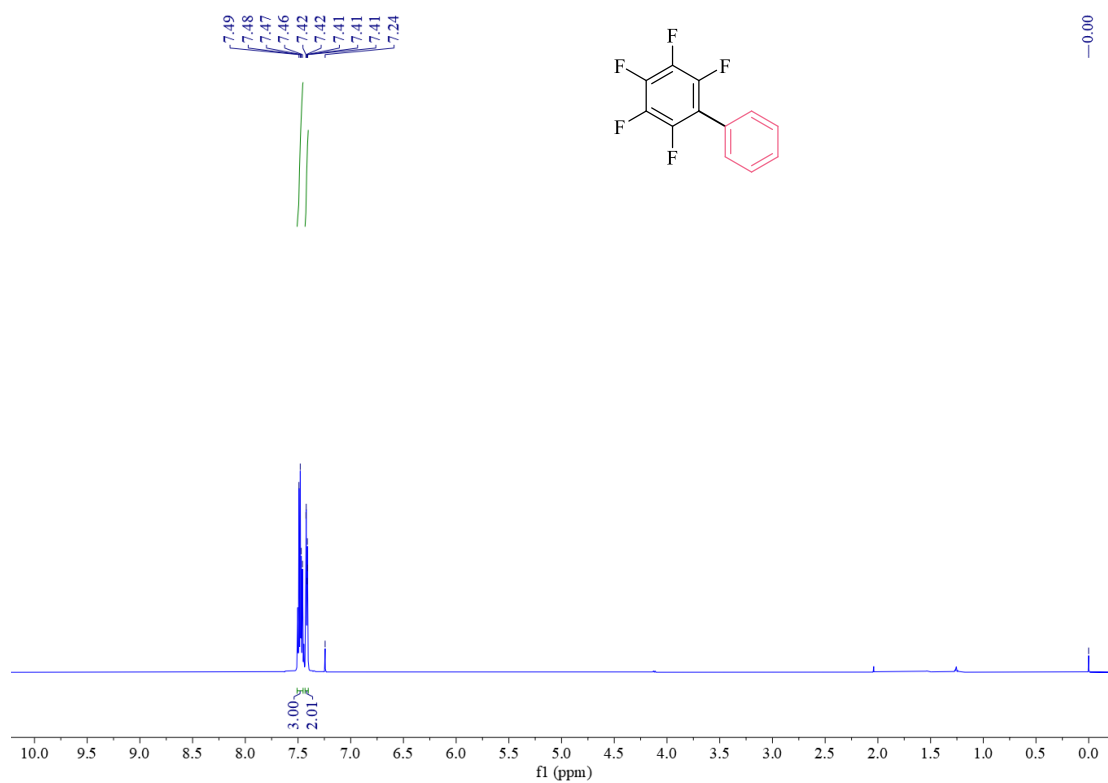
¹³C NMR of 2,3,4,5,6-pentafluoro-3'-methyl-1,1'-biphenyl **5aa**



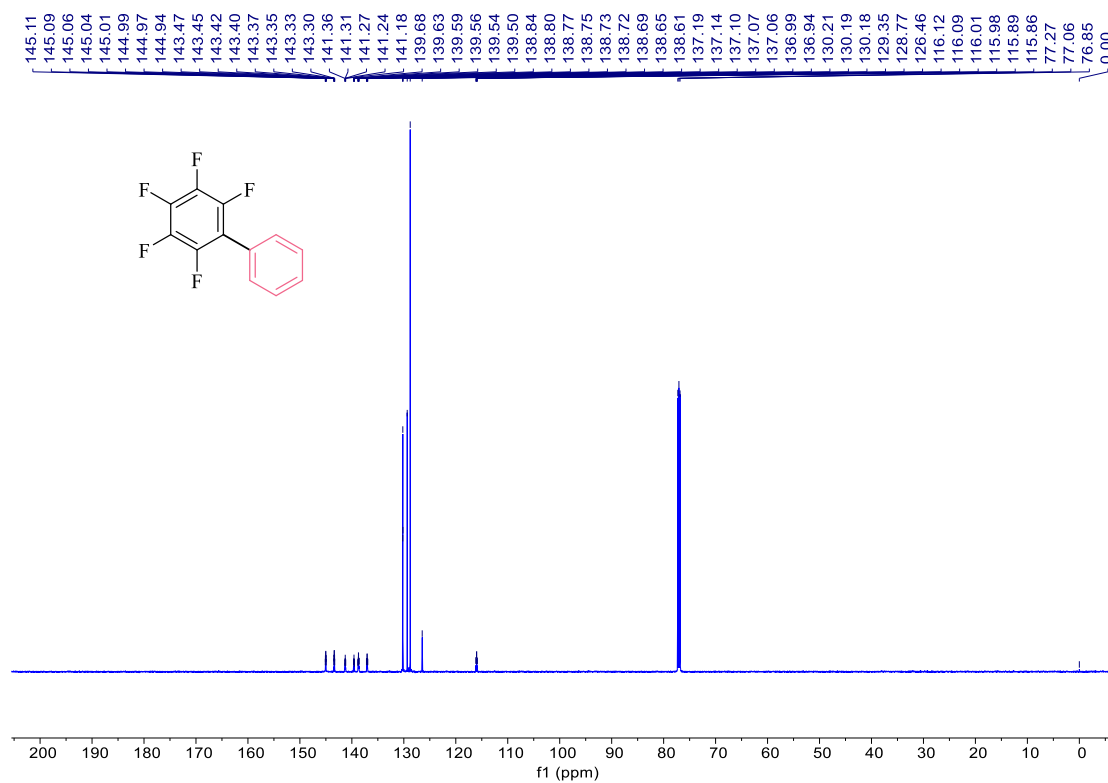
¹⁹F NMR of 2,3,4,5,6-pentafluoro-3'-methyl-1,1'-biphenyl **5aa**



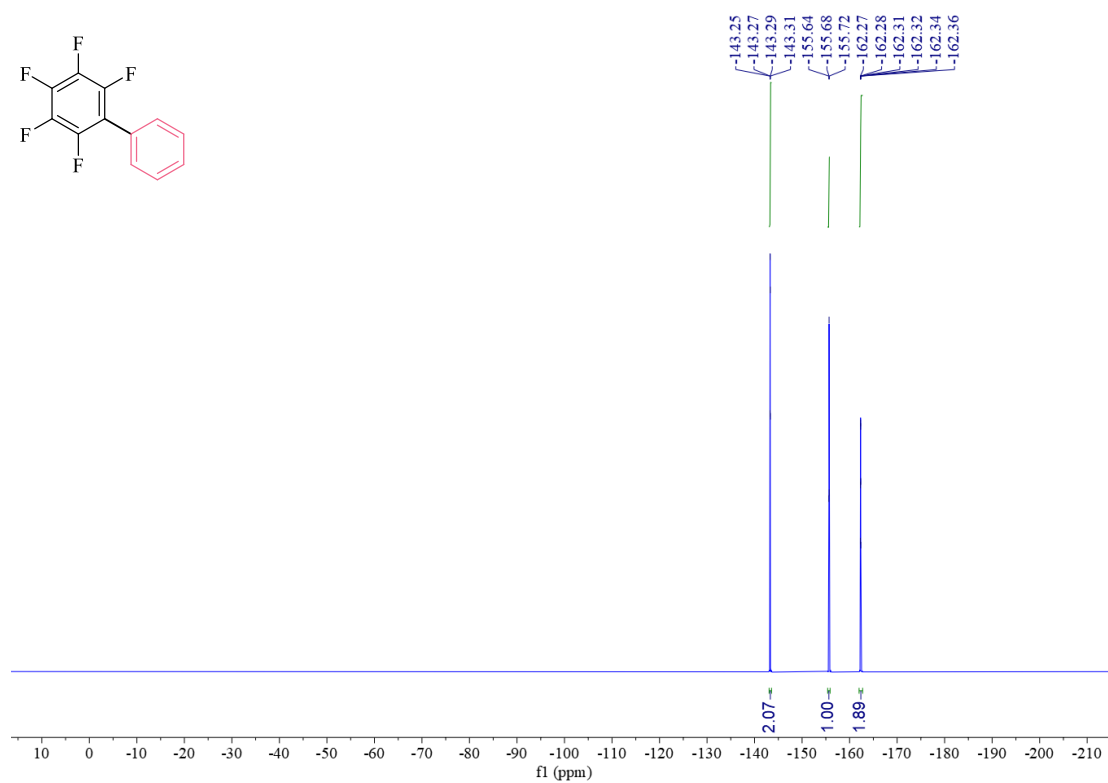
¹H NMR of 2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ab**



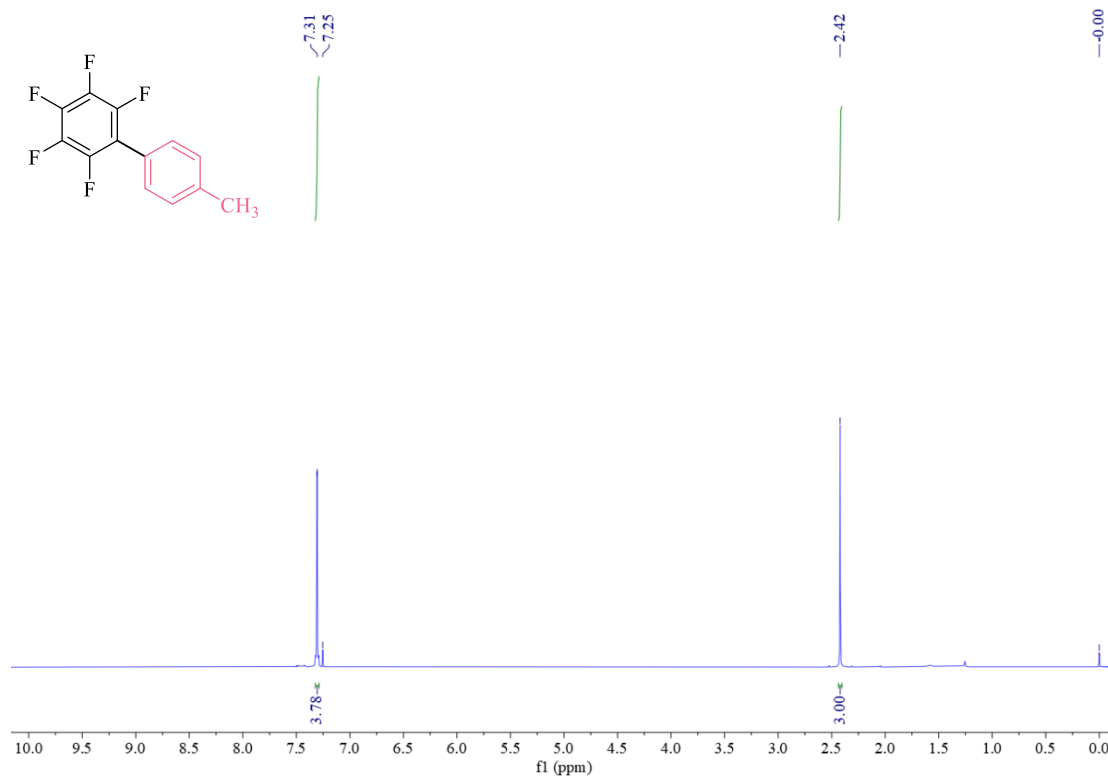
¹³C NMR of 2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ab**



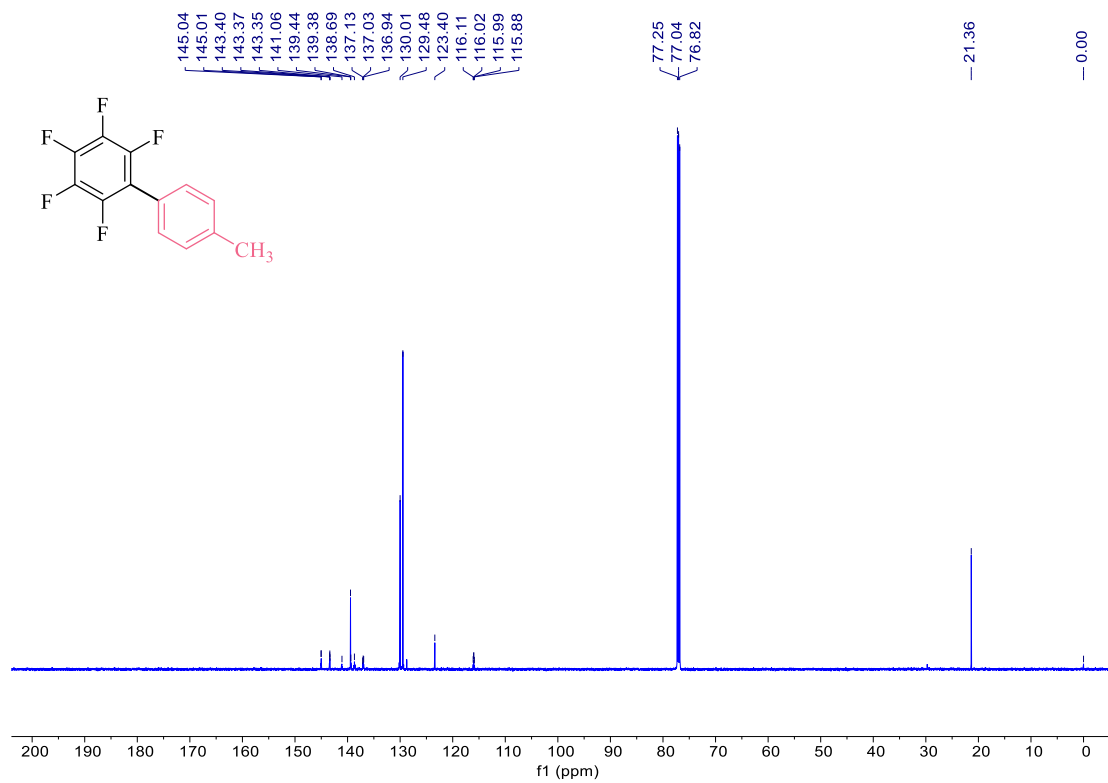
¹⁹F NMR of 2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ab**



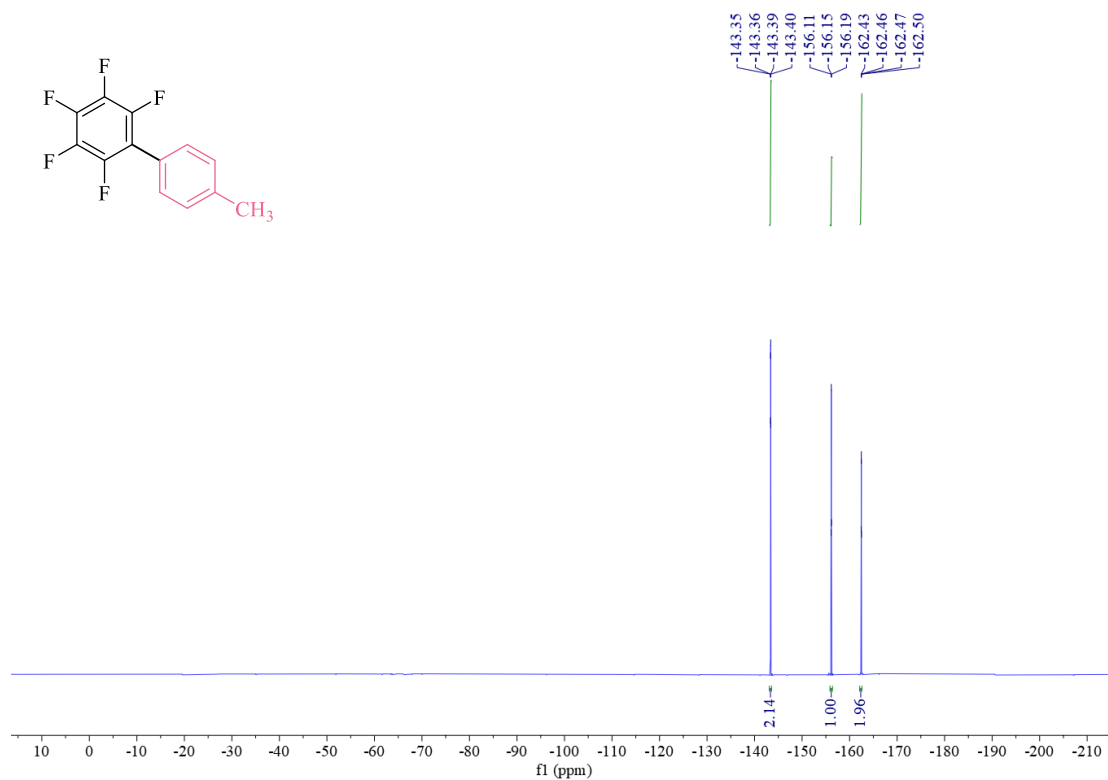
¹H NMR of 2,3,4,5,6-pentafluoro-4'-methyl-1,1'-biphenyl **5ac**



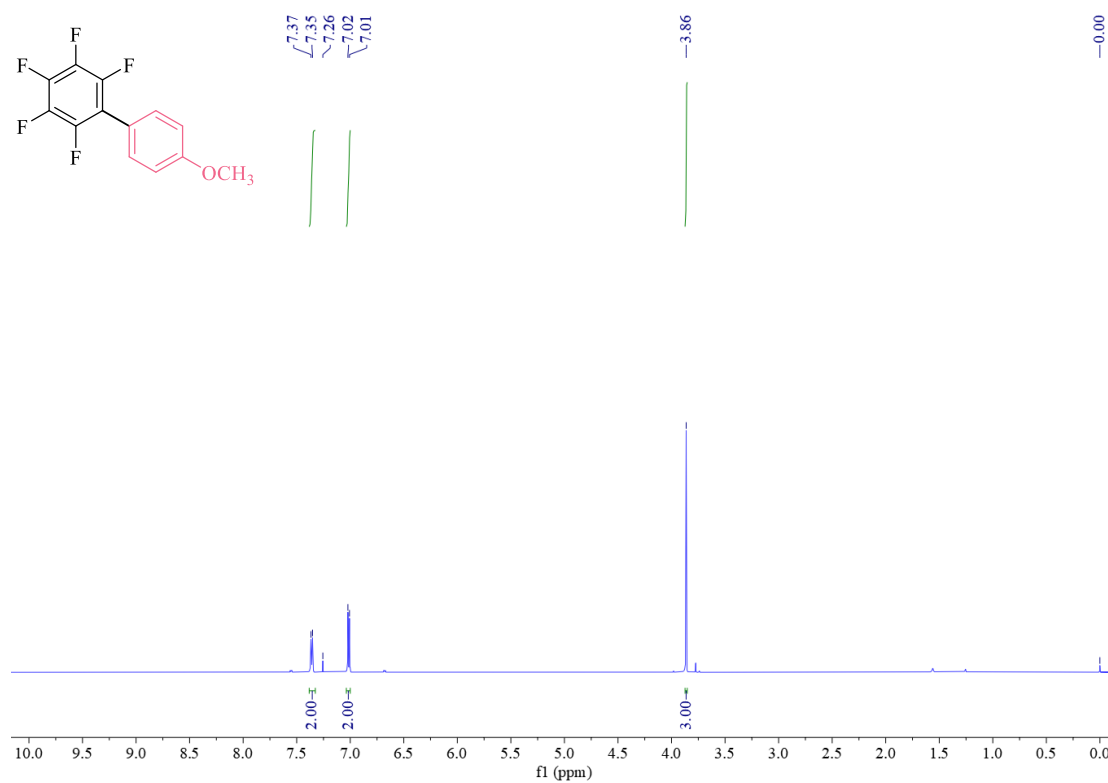
¹³C NMR of 2,3,4,5,6-pentafluoro-4'-methyl-1,1'-biphenyl **5ac**



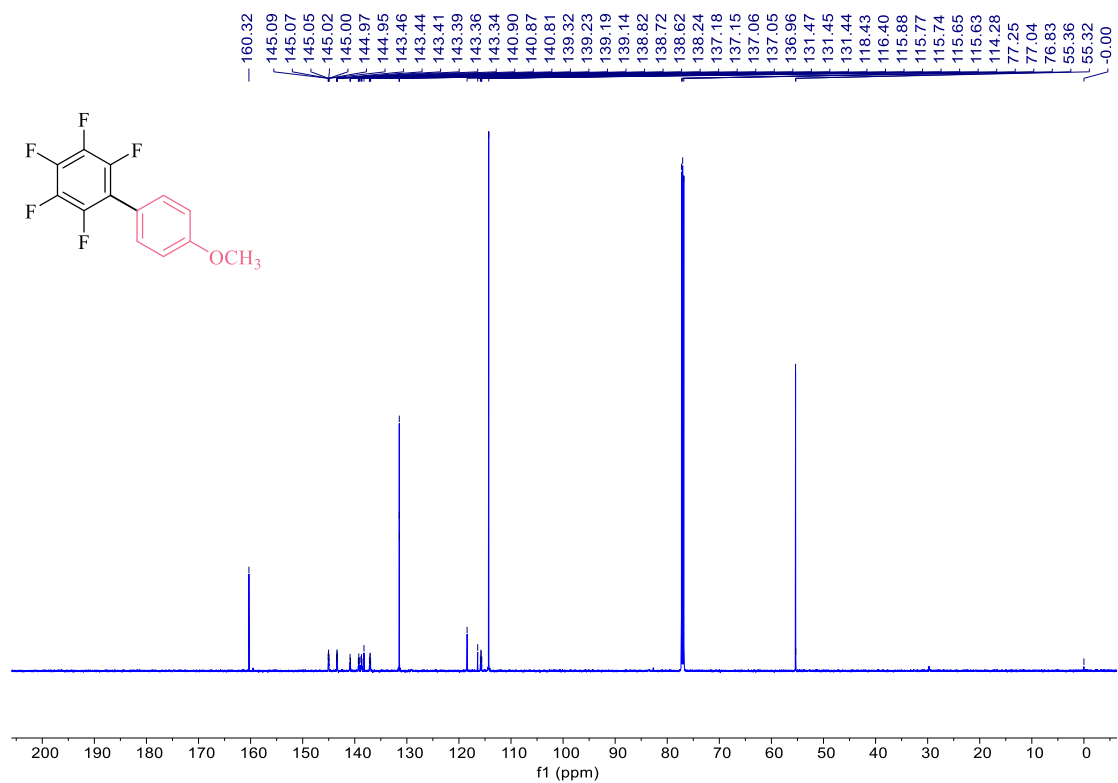
^{19}F NMR of 2,3,4,5,6-pentafluoro-4'-methyl-1,1'-biphenyl **5ac**



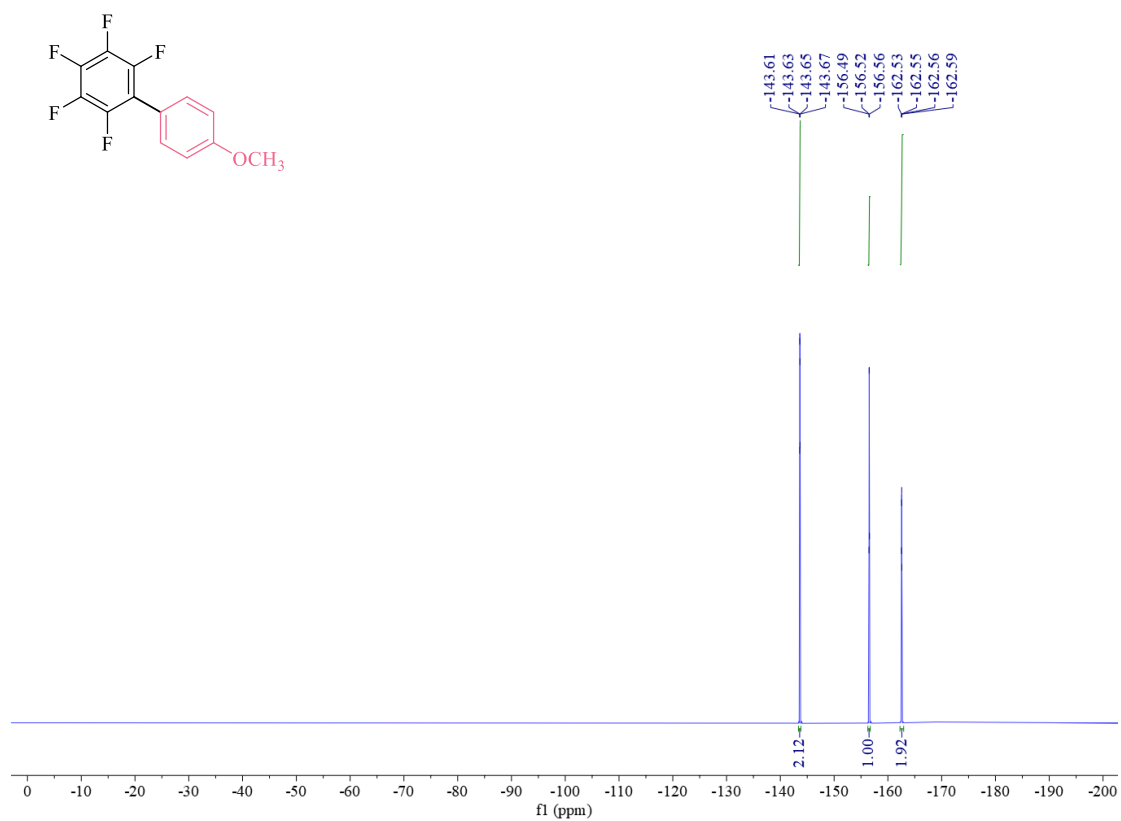
^1H NMR of 2,3,4,5,6-pentafluoro-4'-methoxy-1,1'-biphenyl **5ad**



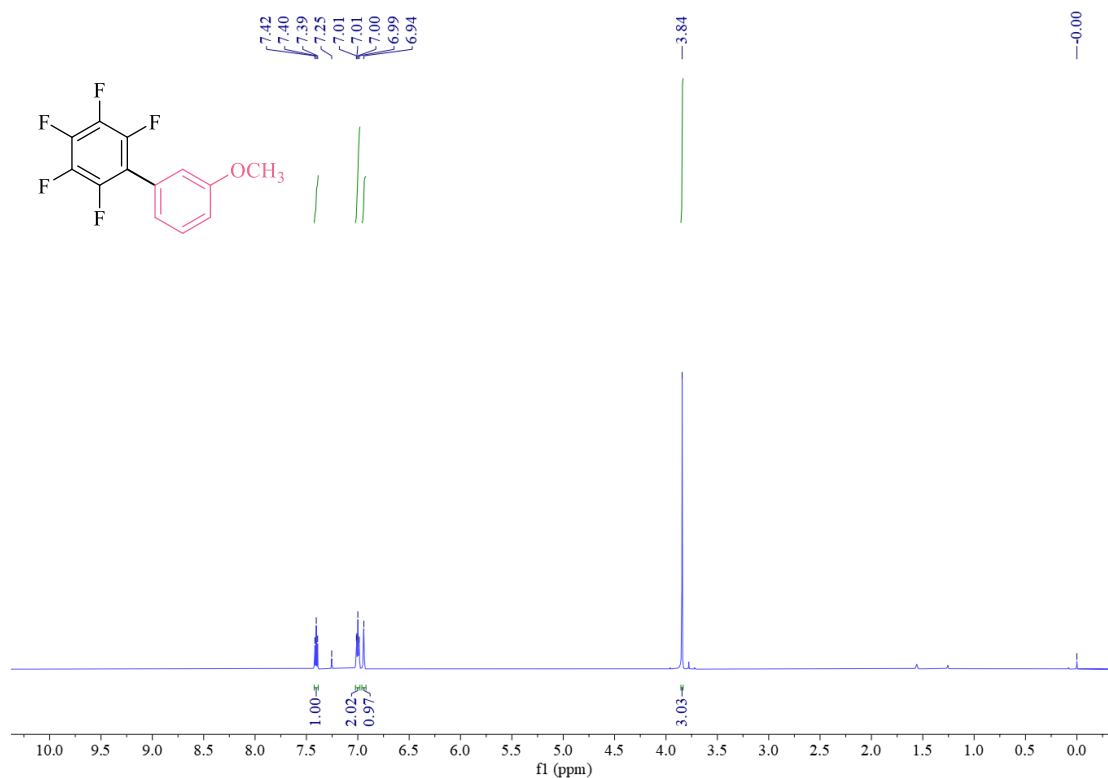
¹³C NMR of 2,3,4,5,6-pentafluoro-4'-methoxy-1,1'-biphenyl **5ad**



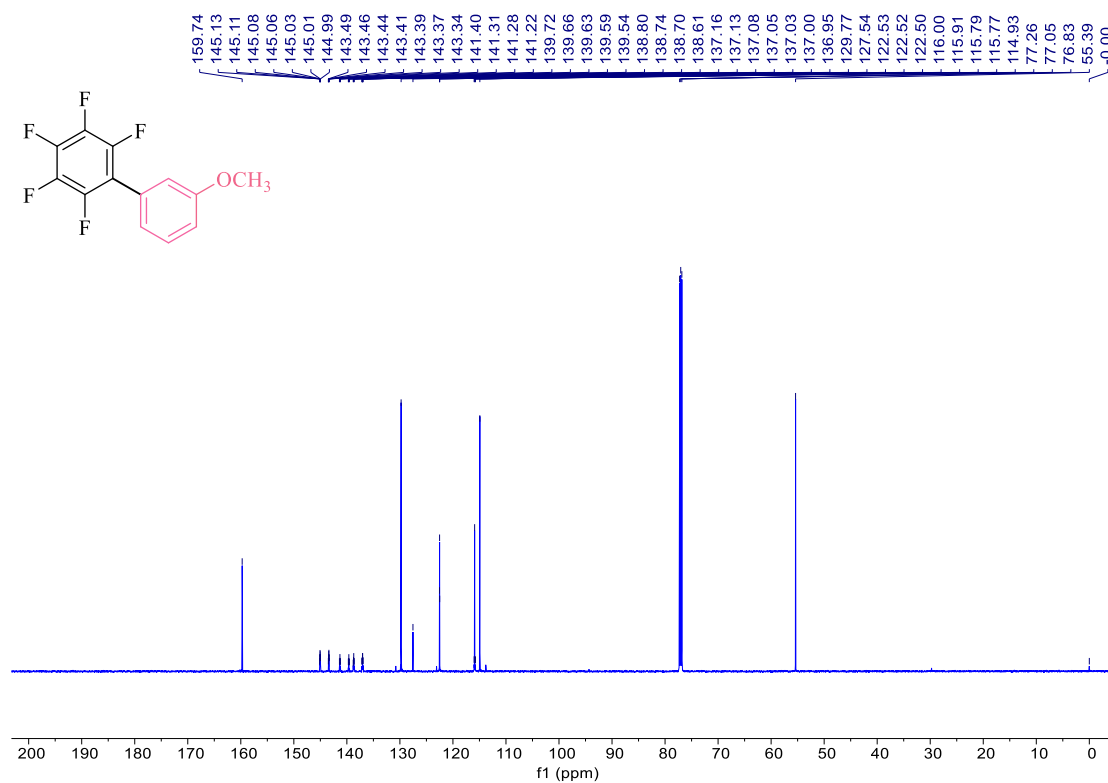
¹⁹F NMR of 2,3,4,5,6-pentafluoro-4'-methoxy-1,1'-biphenyl **5ad**



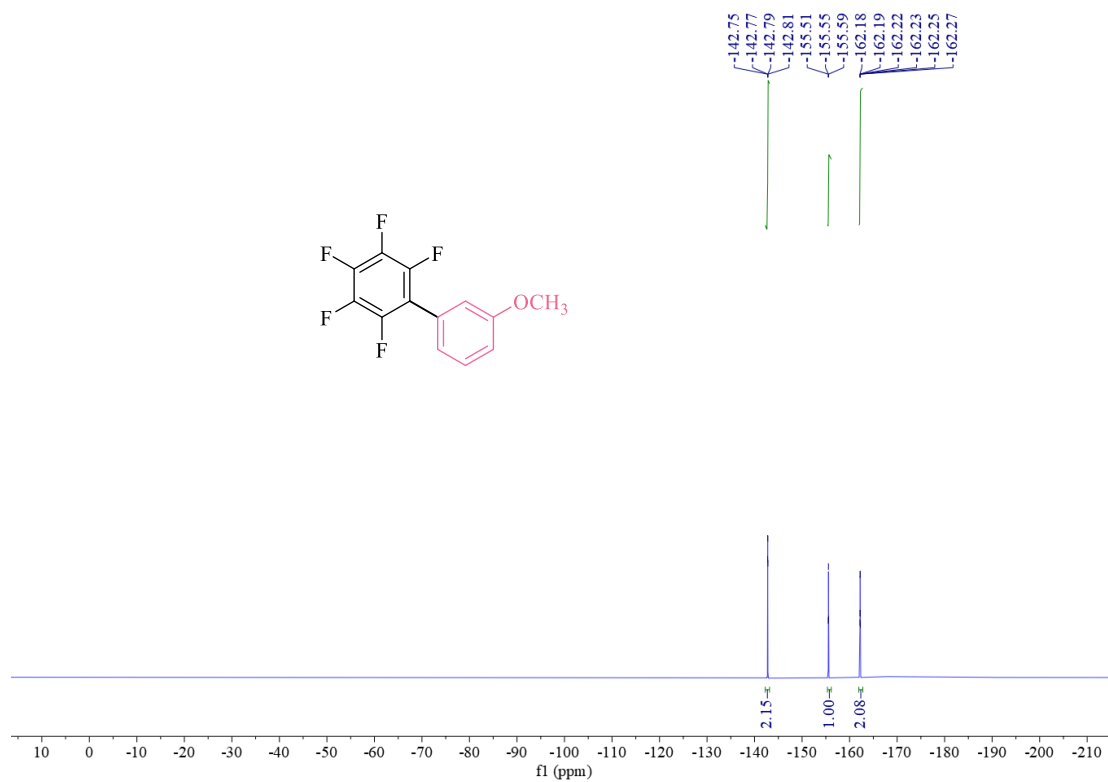
¹H NMR of 2,3,4,5,6-pentafluoro-3'-methoxy-1,1'-biphenyl **5ae**



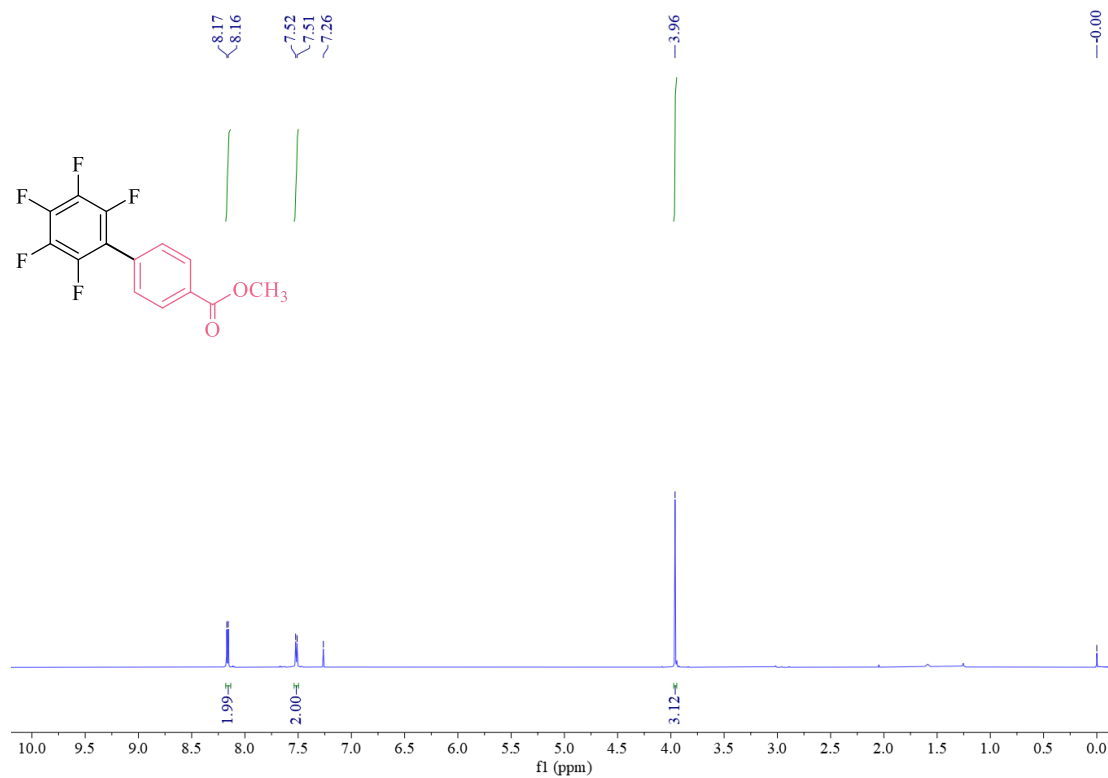
¹³C NMR of 2,3,4,5,6-pentafluoro-3'-methoxy-1,1'-biphenyl **5ae**



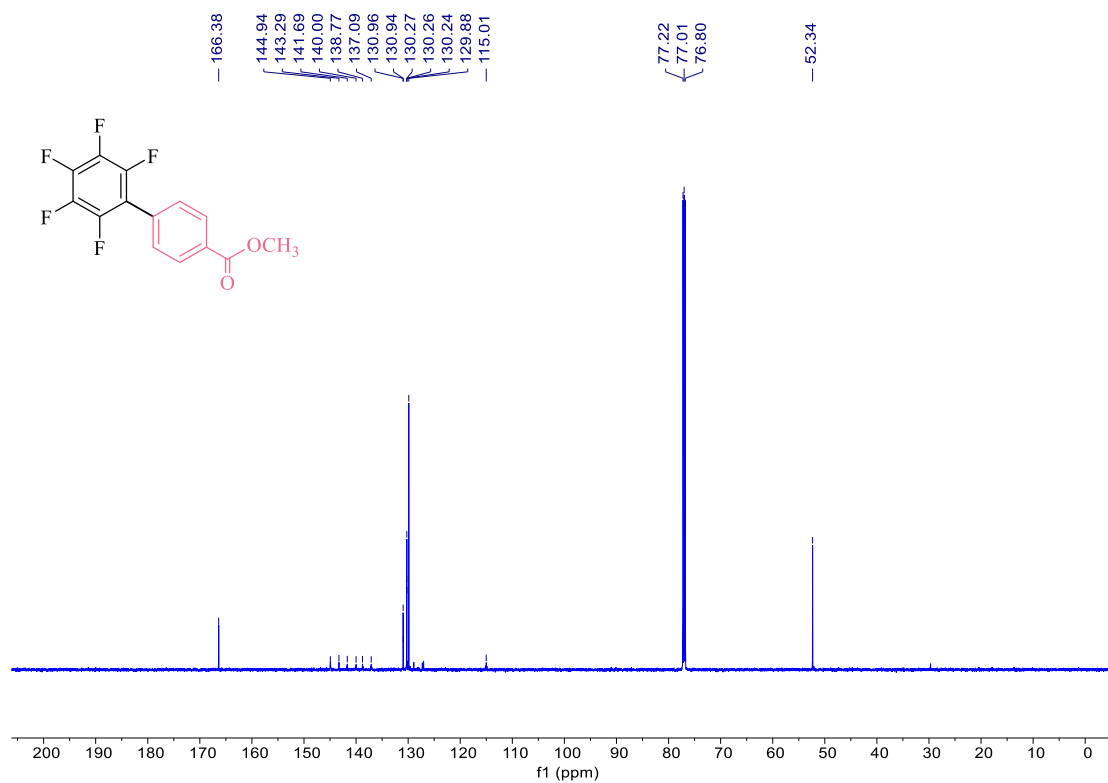
^{19}F NMR of 2,3,4,5,6-pentafluoro-3'-methoxy-1,1'-biphenyl **5ae**



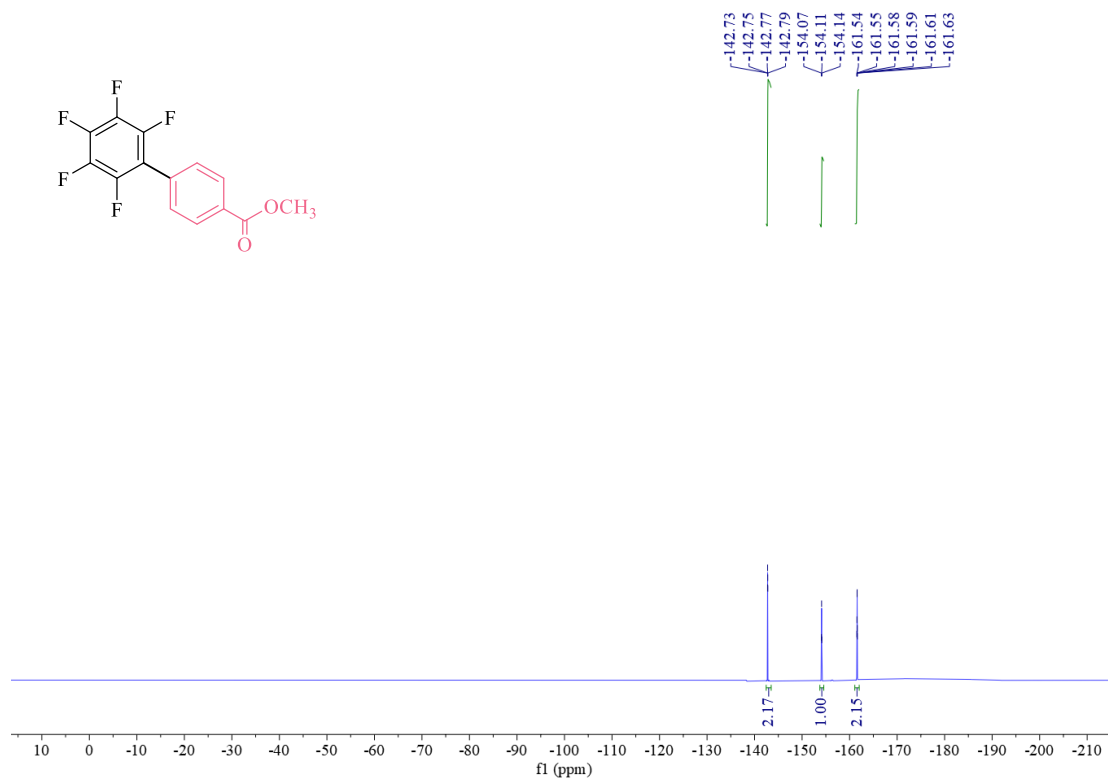
^1H NMR of methyl 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-3-carboxylate **5af**



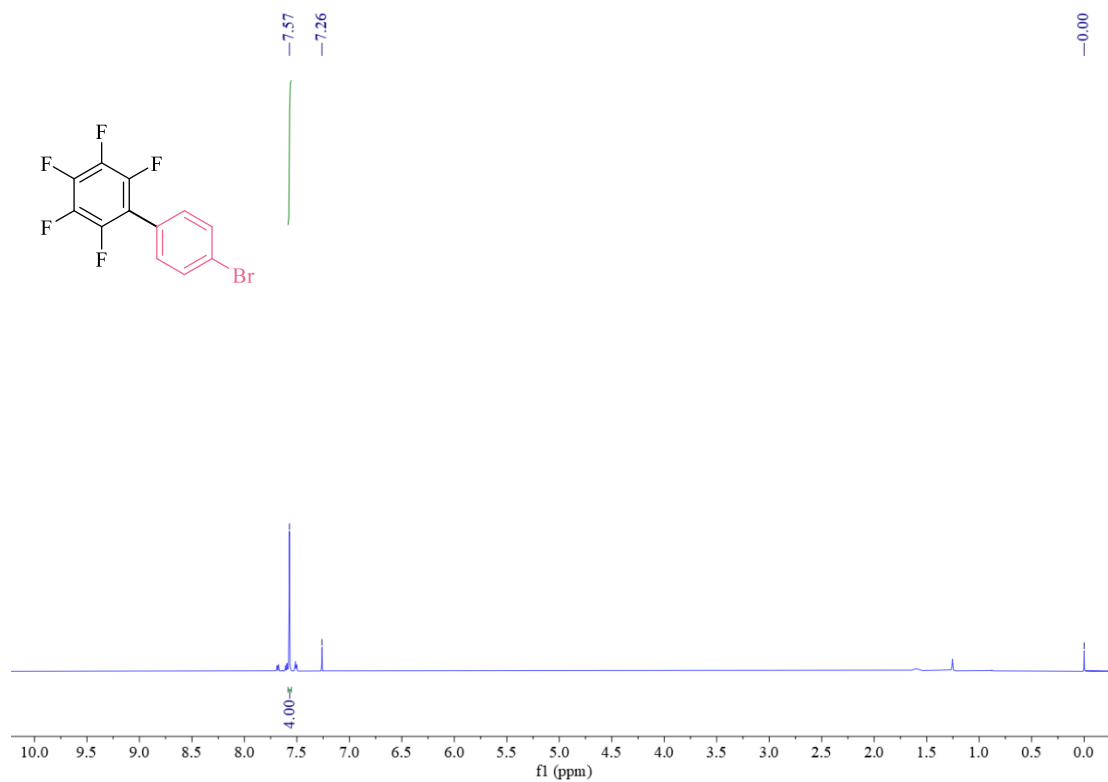
^{13}C NMR of methyl 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-3-carboxylate **5af**



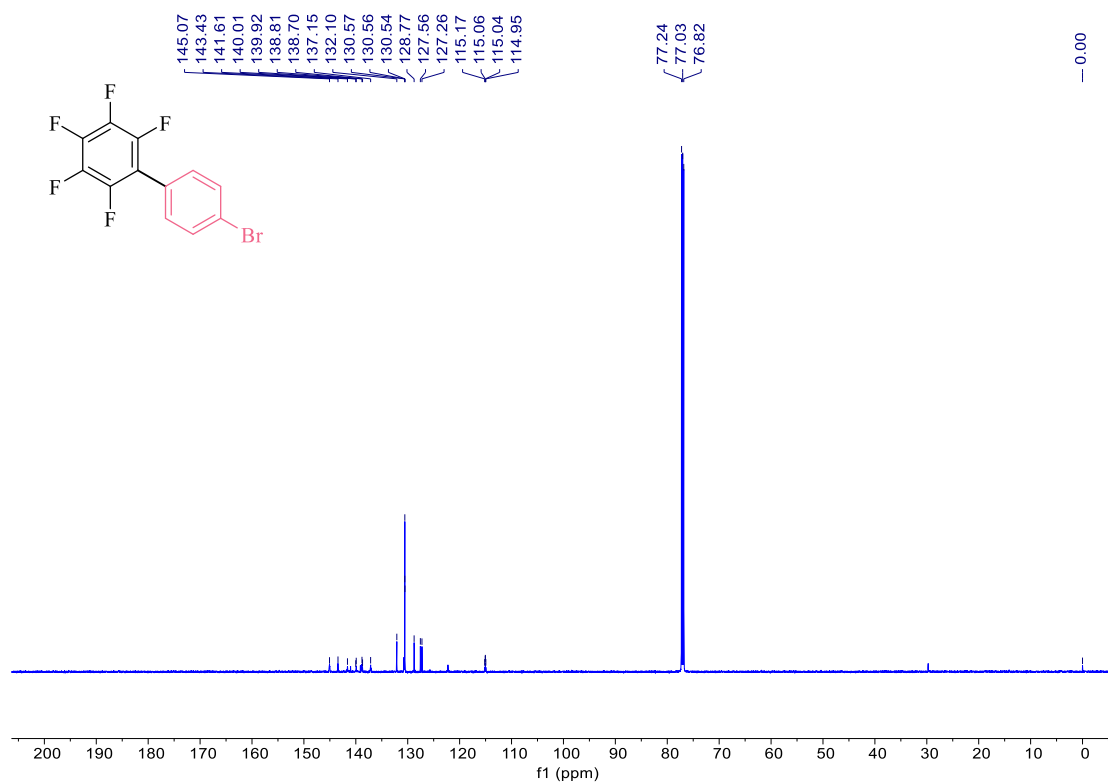
^{19}F NMR of methyl 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-3-carboxylate **5af**



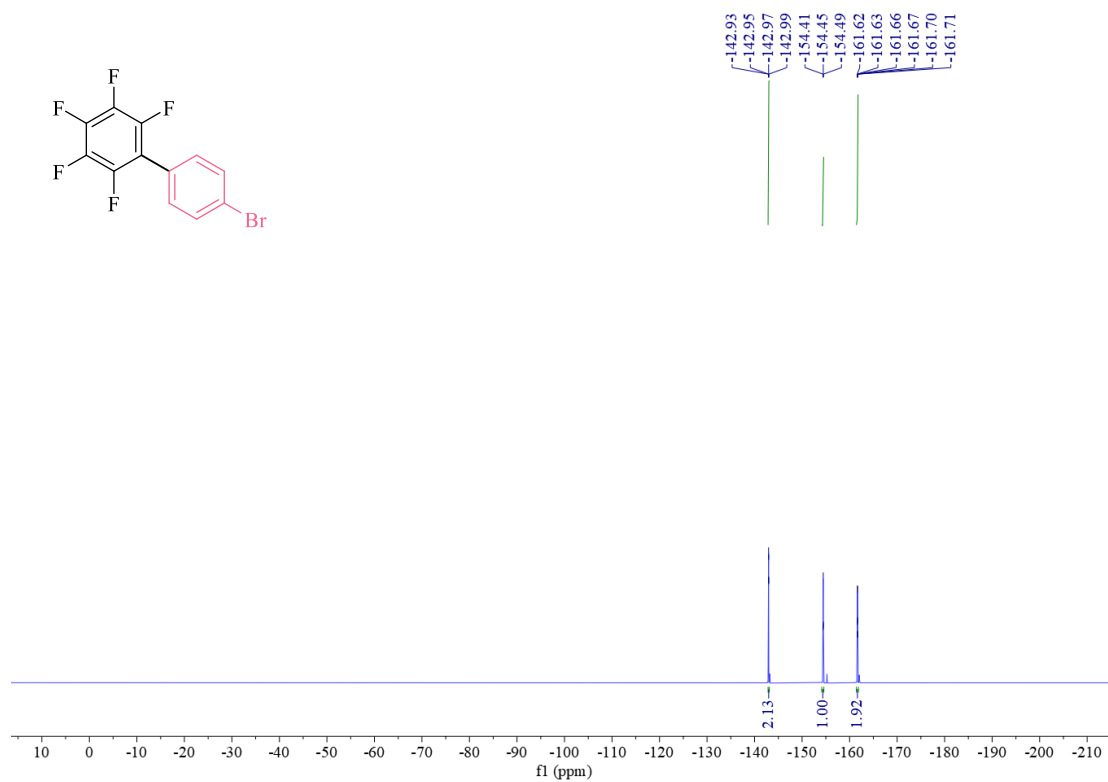
^1H NMR of 4'-bromo-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ag**



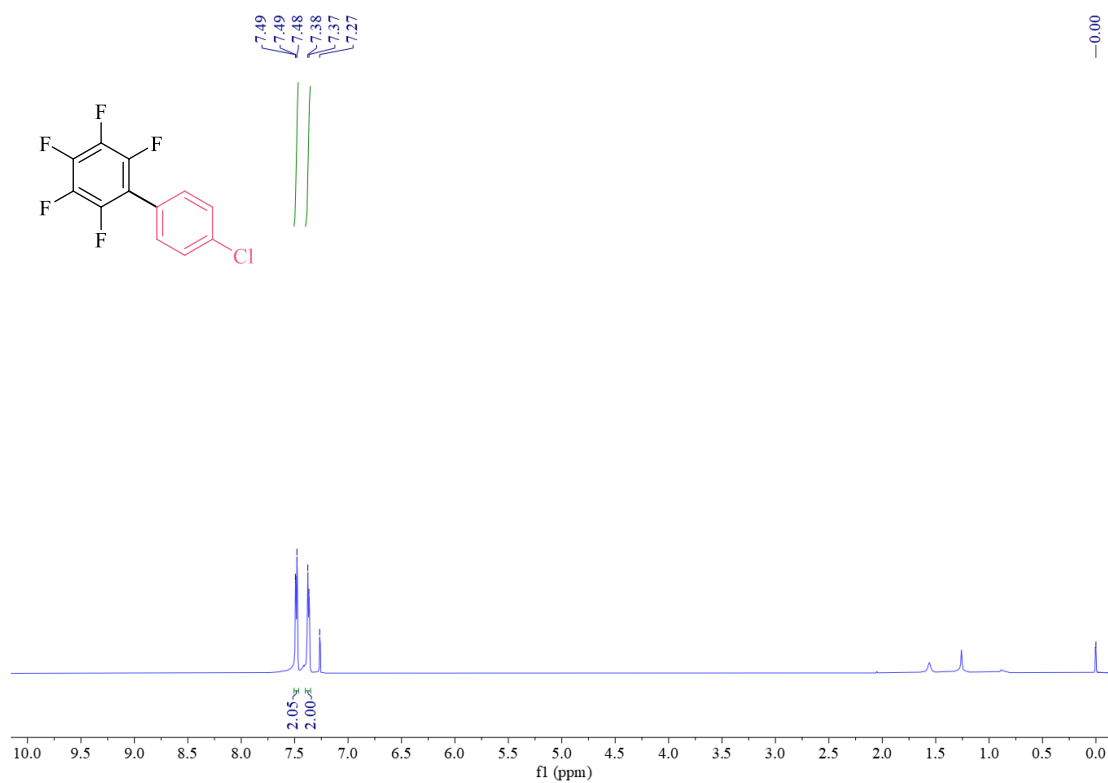
^{13}C NMR of 4'-bromo-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ag**



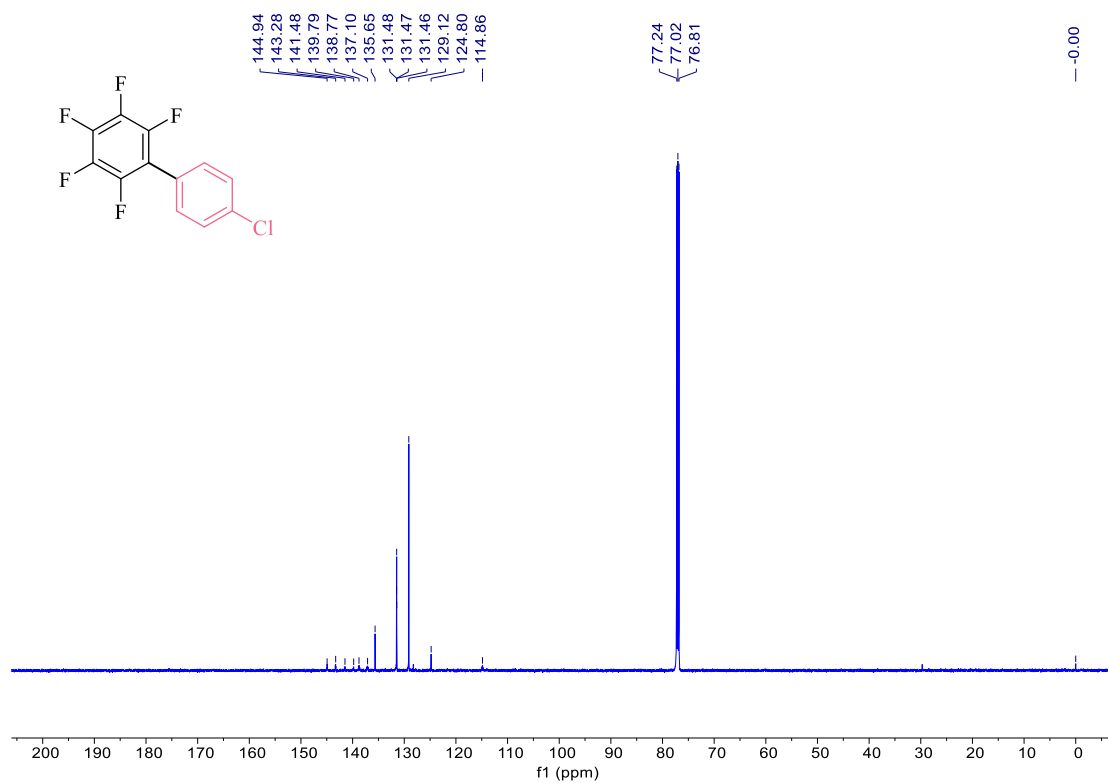
¹⁹F NMR of 4'-bromo-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ag**



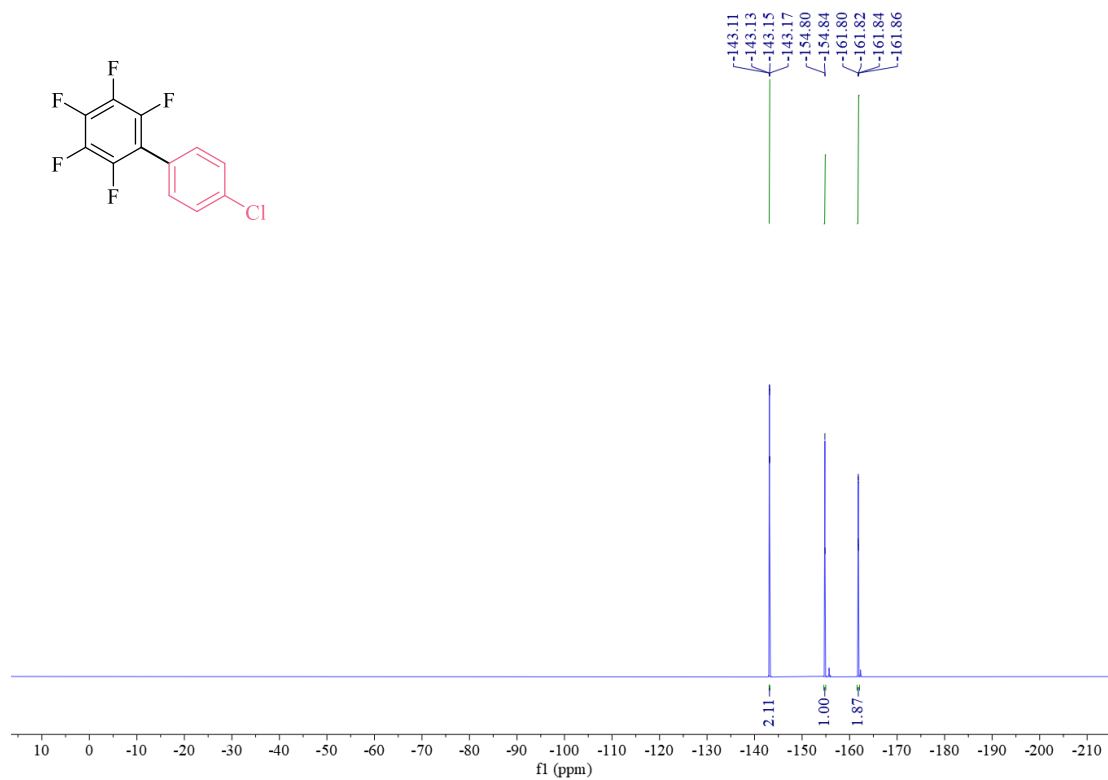
¹H NMR of 4'-chloro-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ah**



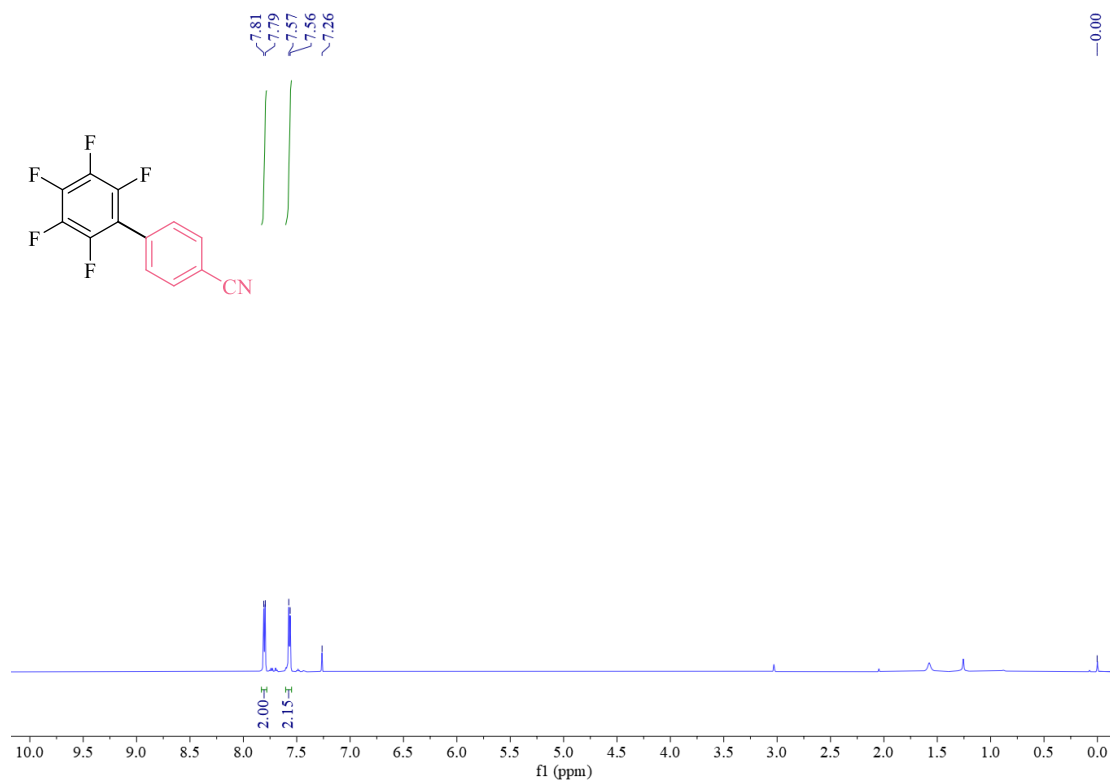
¹³C NMR of 4'-chloro-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ah**



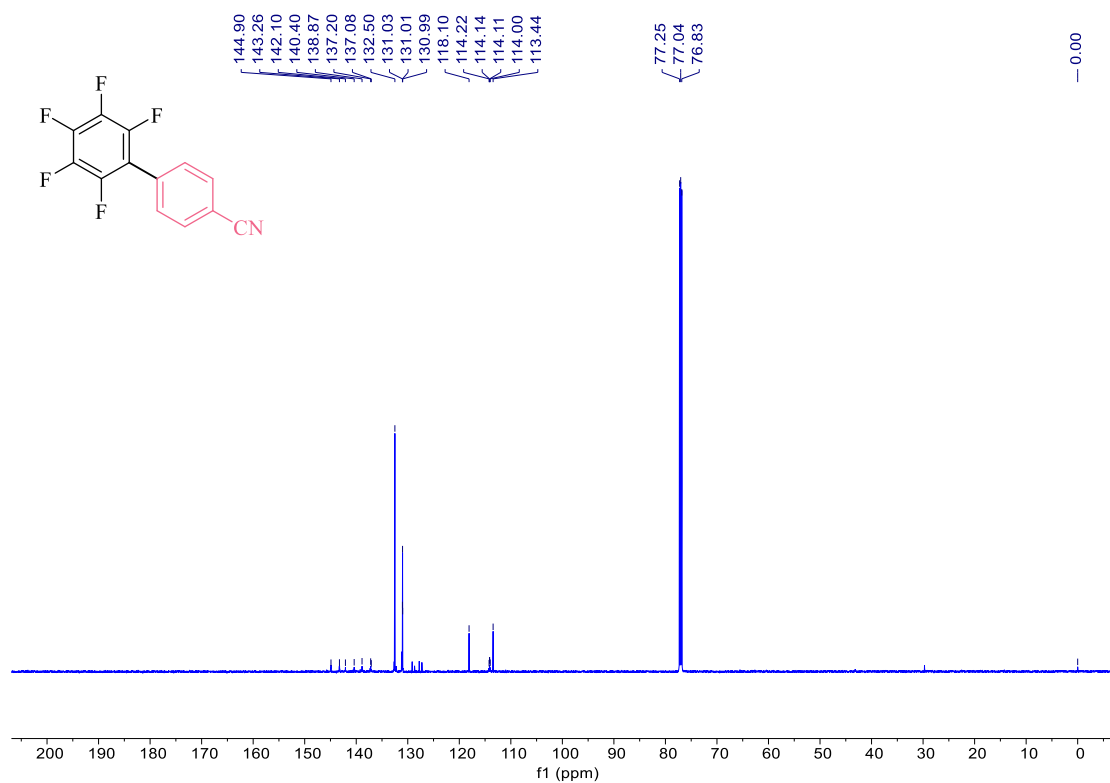
¹⁹F NMR of 4'-chloro-2,3,4,5,6-pentafluoro-1,1'-biphenyl **5ah**



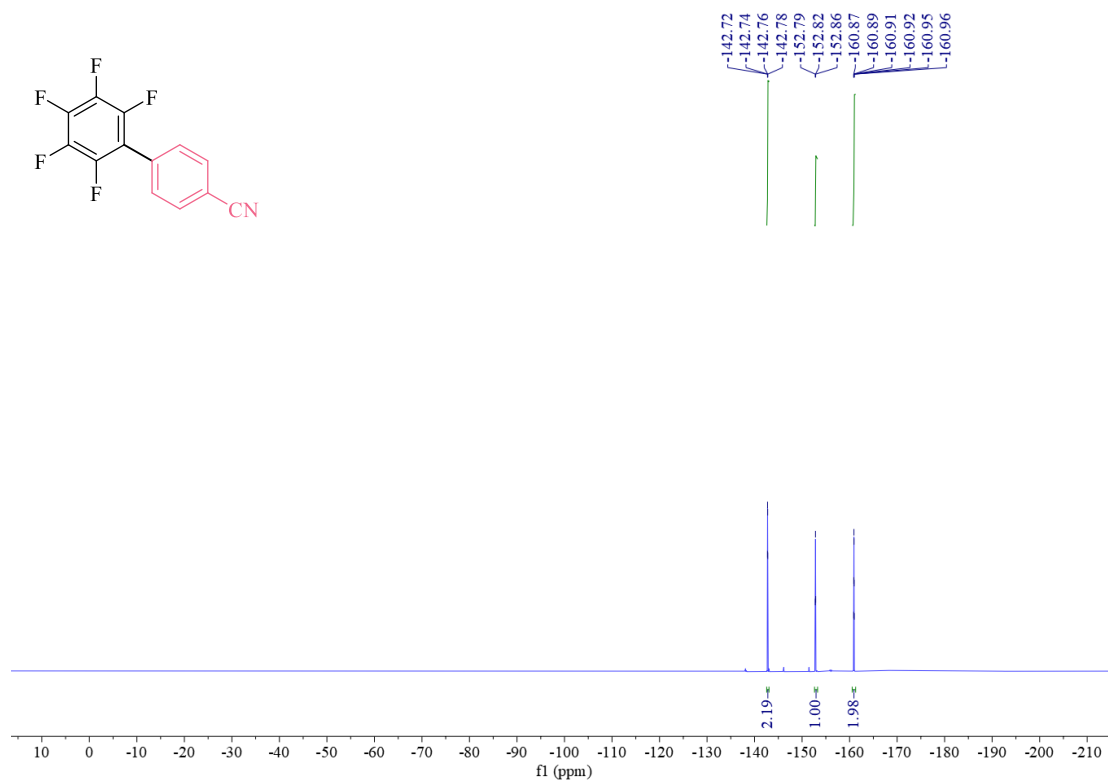
¹H NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbonitrile **5ai**



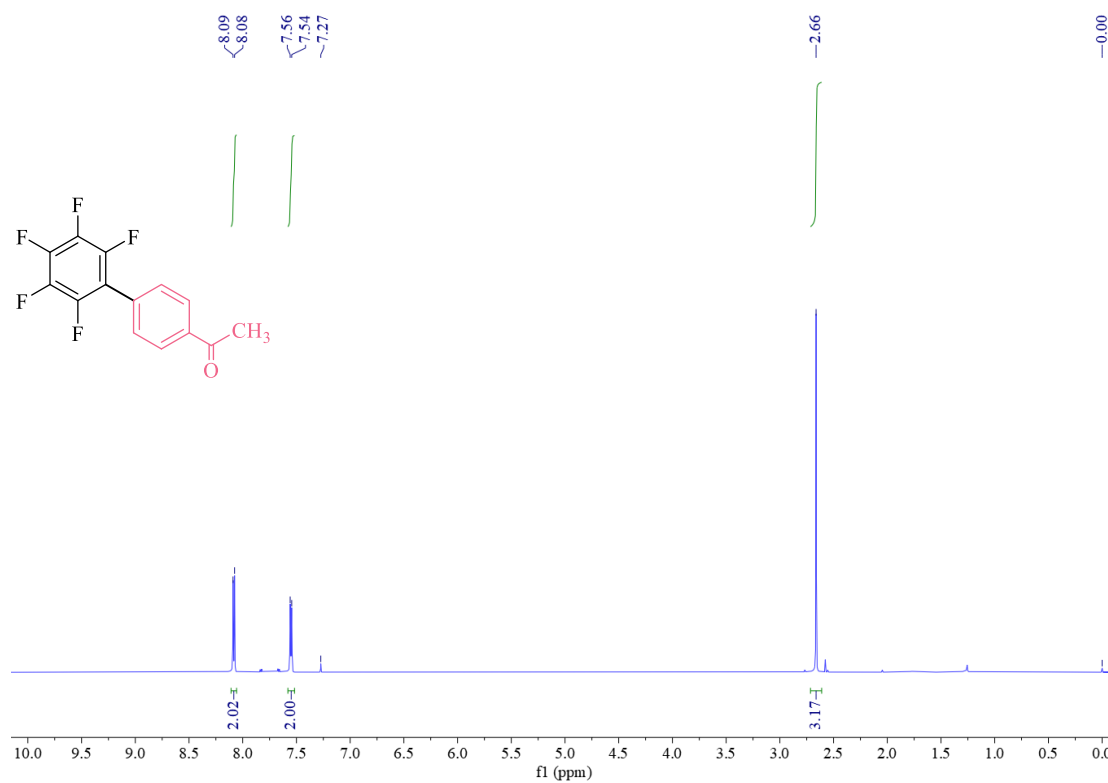
¹³C NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbonitrile **5ai**



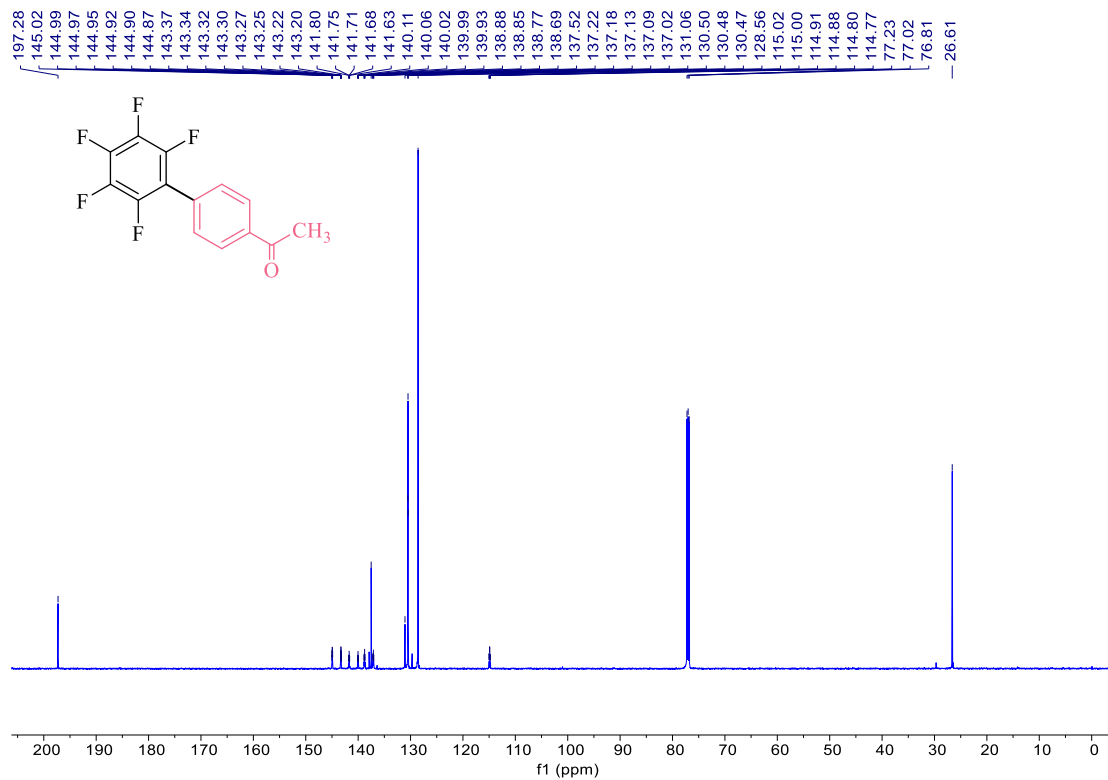
^{19}F NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbonitrile **5ai**



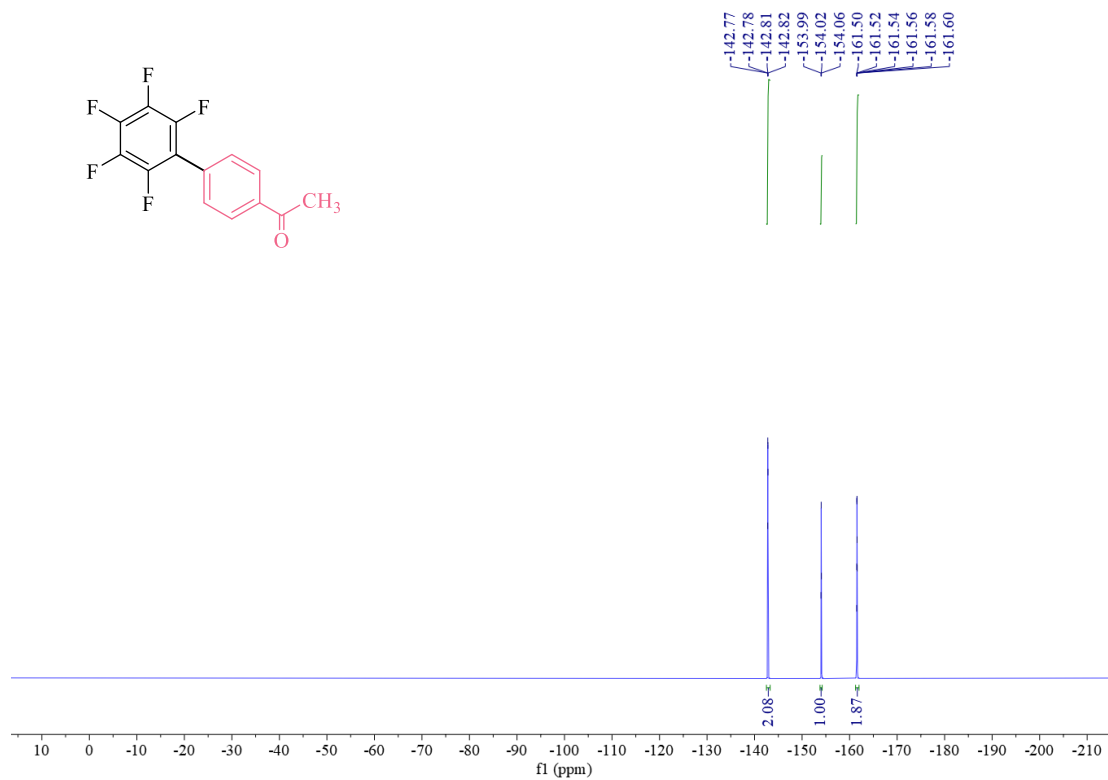
^1H NMR of 1-(2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-yl)ethan-1-one **5aj**



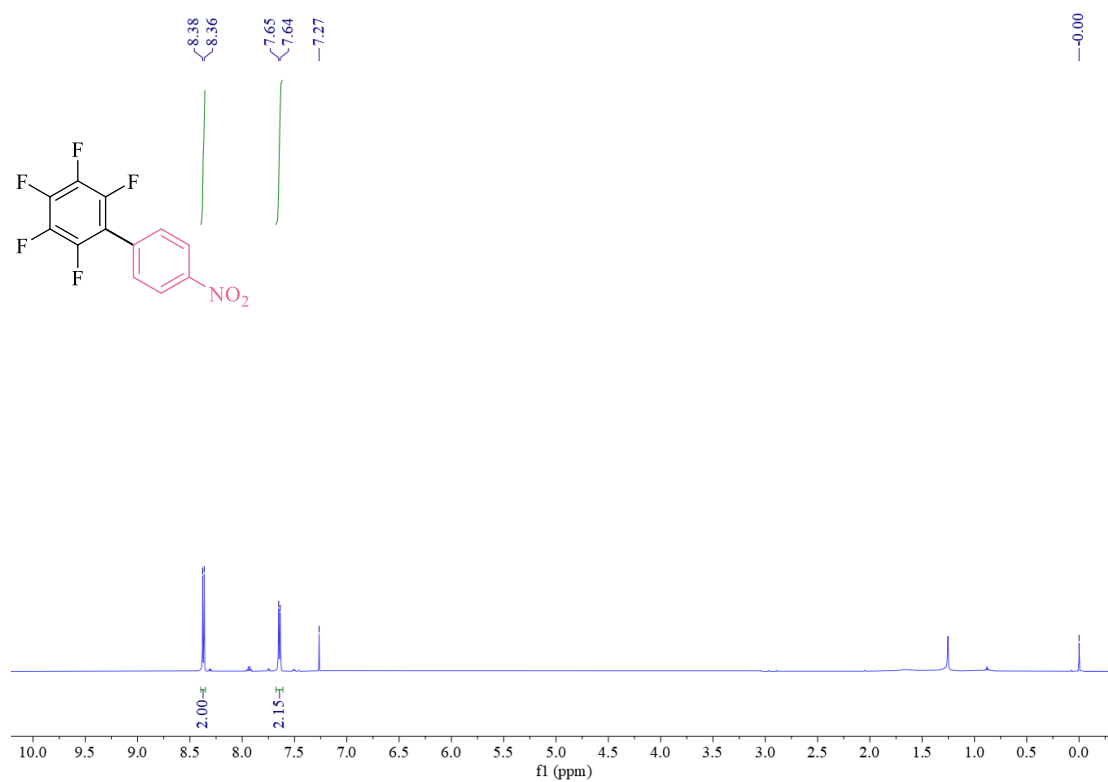
¹³C NMR of 1-(2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-yl)ethan-1-one **5aj**



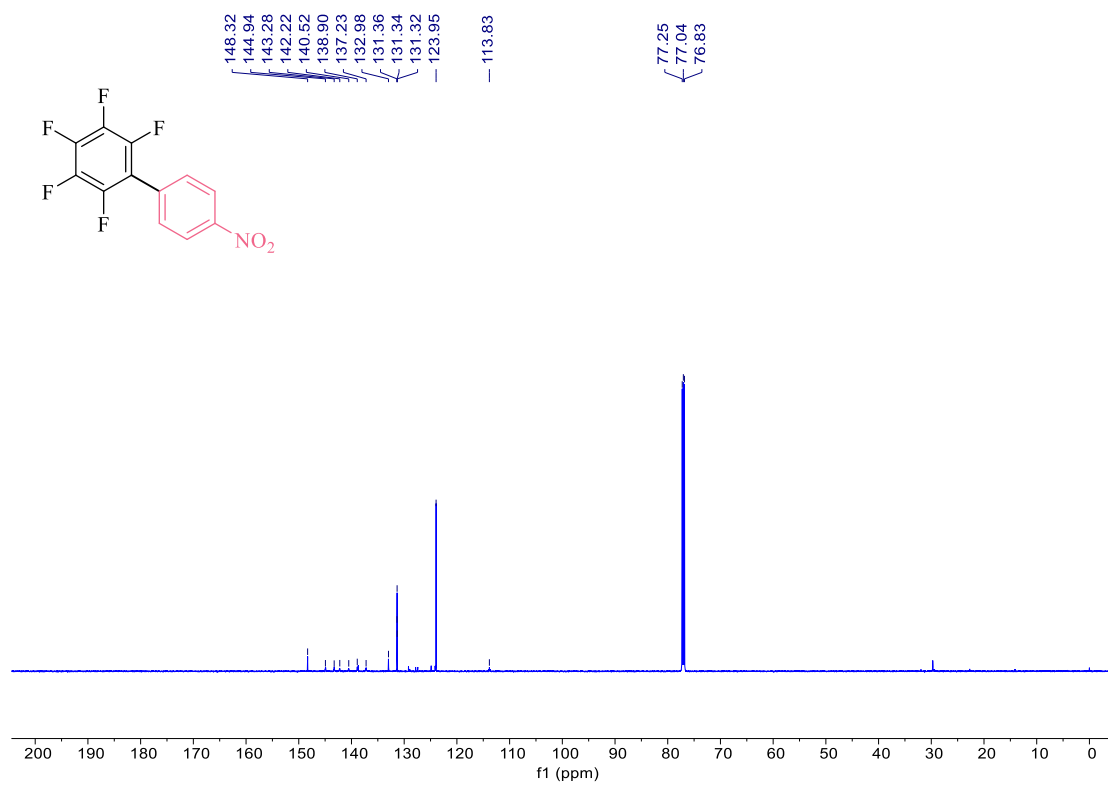
¹⁹F NMR of 1-(2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-yl)ethan-1-one **5aj**



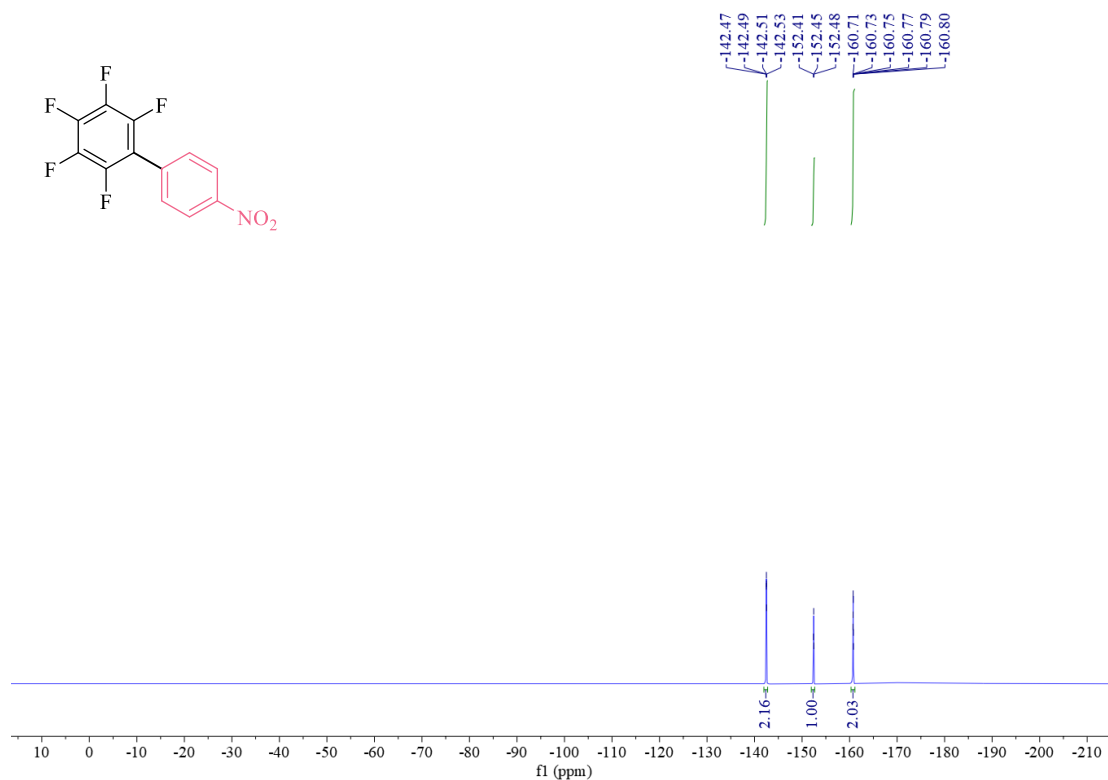
¹H NMR of 2,3,4,5,6-pentafluoro-4'-nitro-1,1'-biphenyl **5ak**



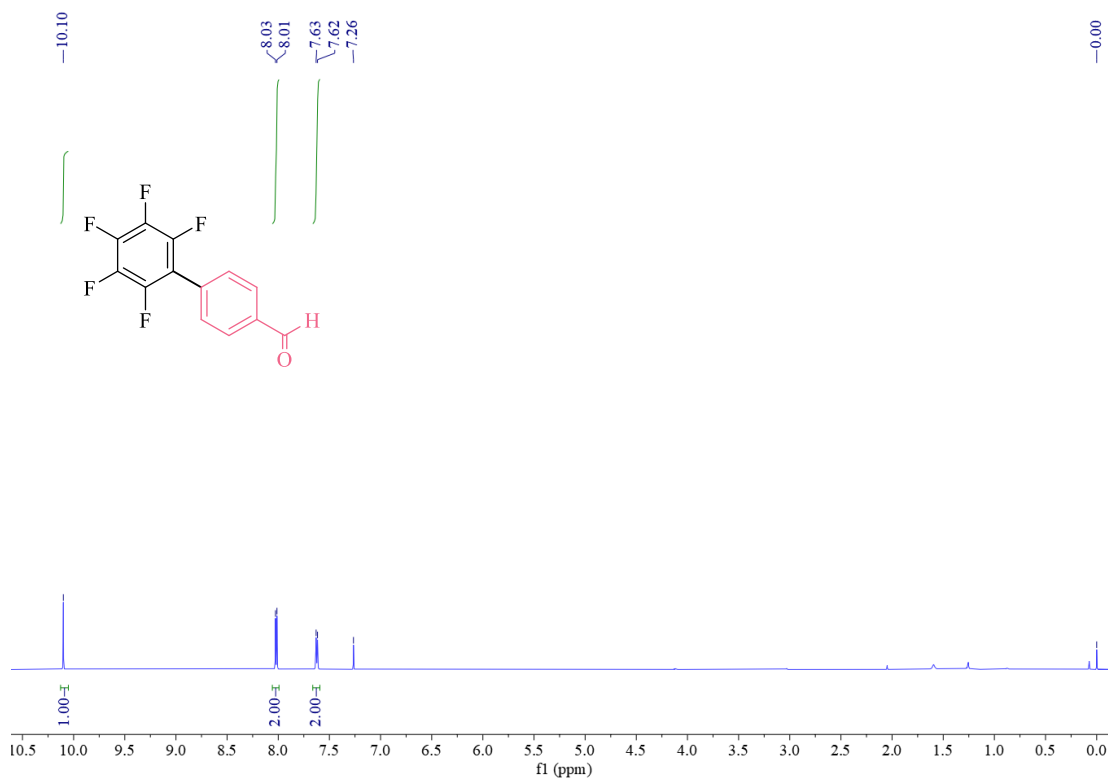
¹³C NMR of 2,3,4,5,6-pentafluoro-4'-nitro-1,1'-biphenyl **5ak**



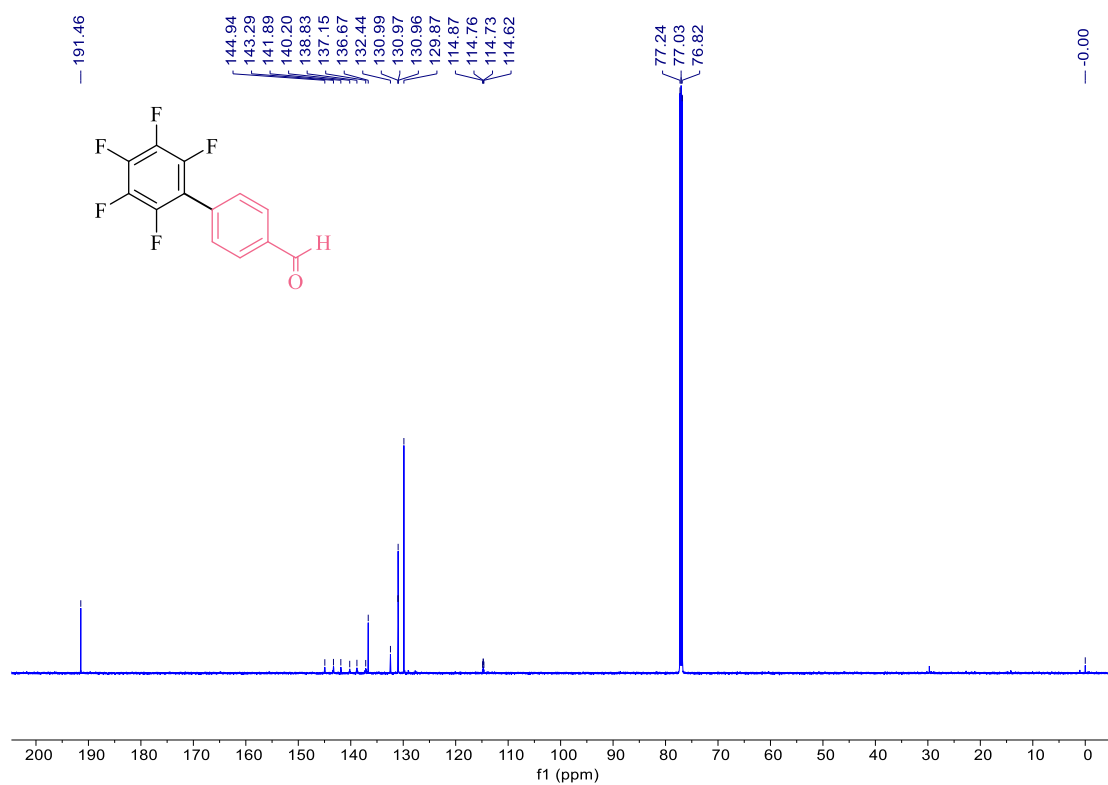
¹⁹F NMR of 2,3,4,5,6-pentafluoro-4'-nitro-1,1'-biphenyl **5ak**



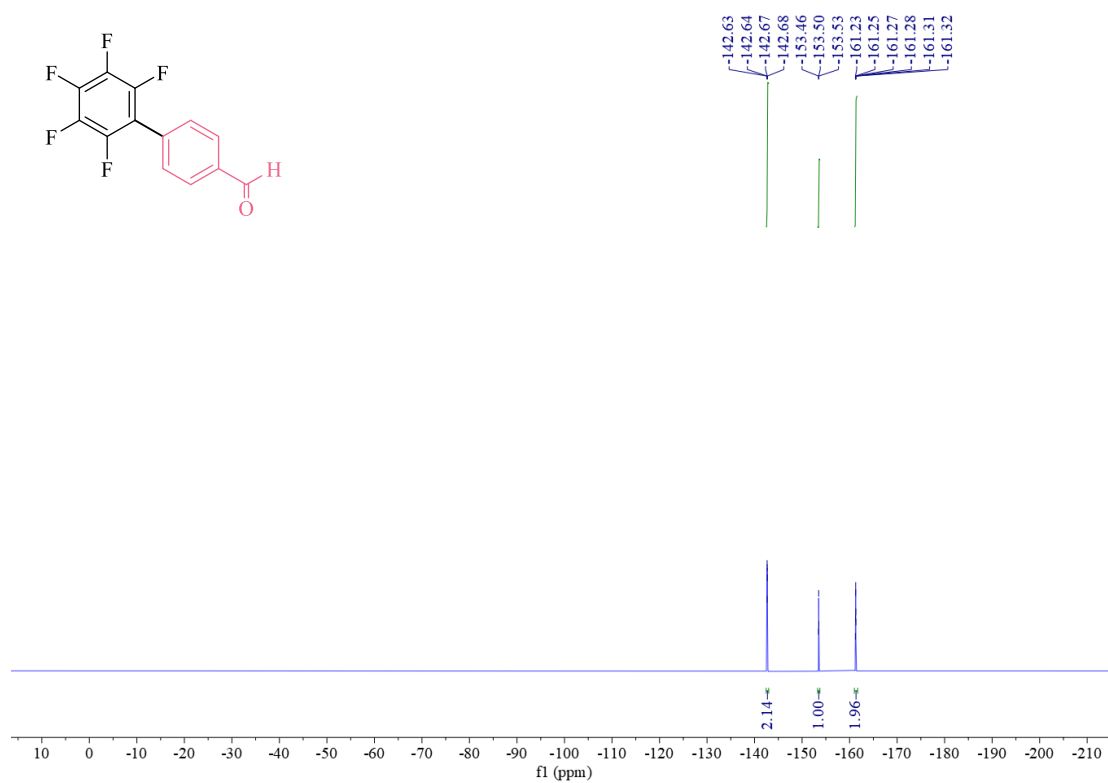
¹H NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbaldehyde **5al**



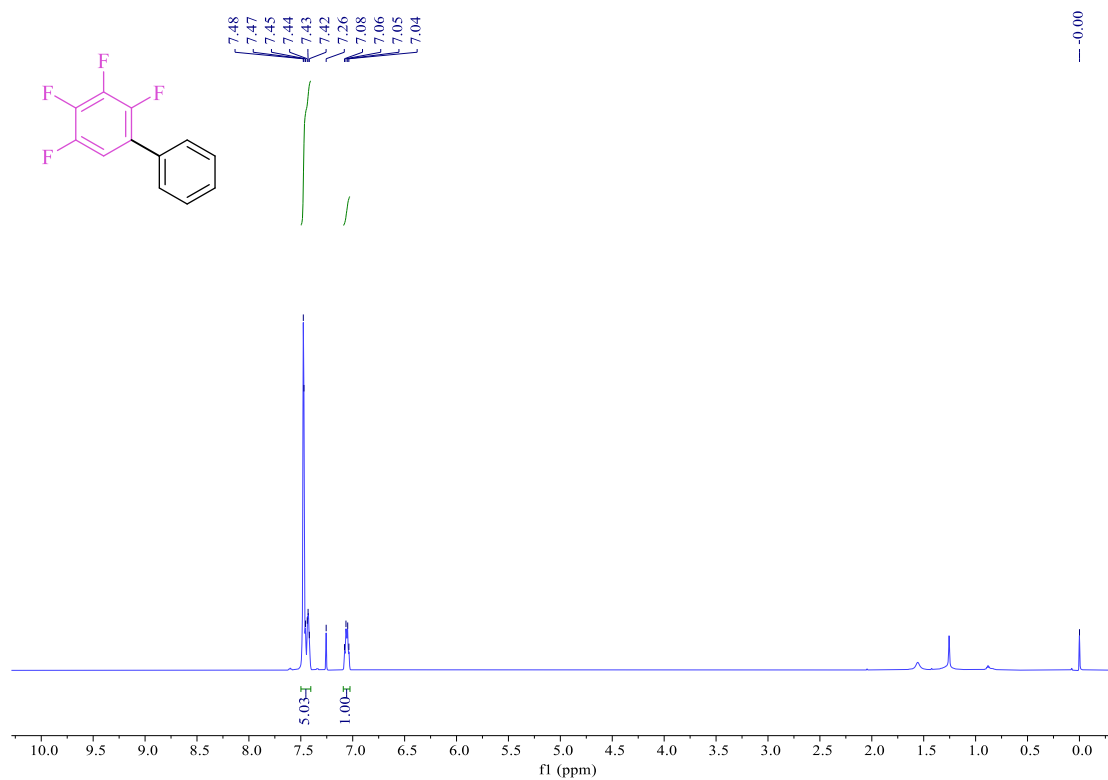
¹³C NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbaldehyde **5al**



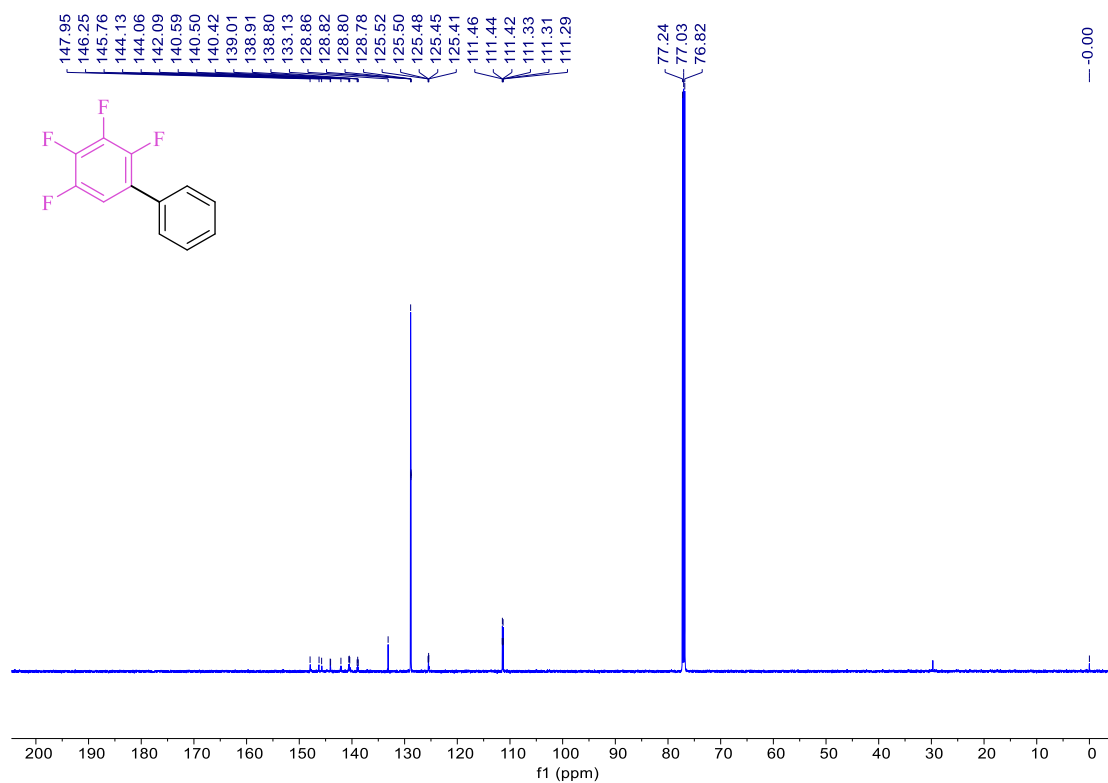
¹⁹F NMR of 2',3',4',5',6'-pentafluoro-[1,1'-biphenyl]-4-carbaldehyde **5al**



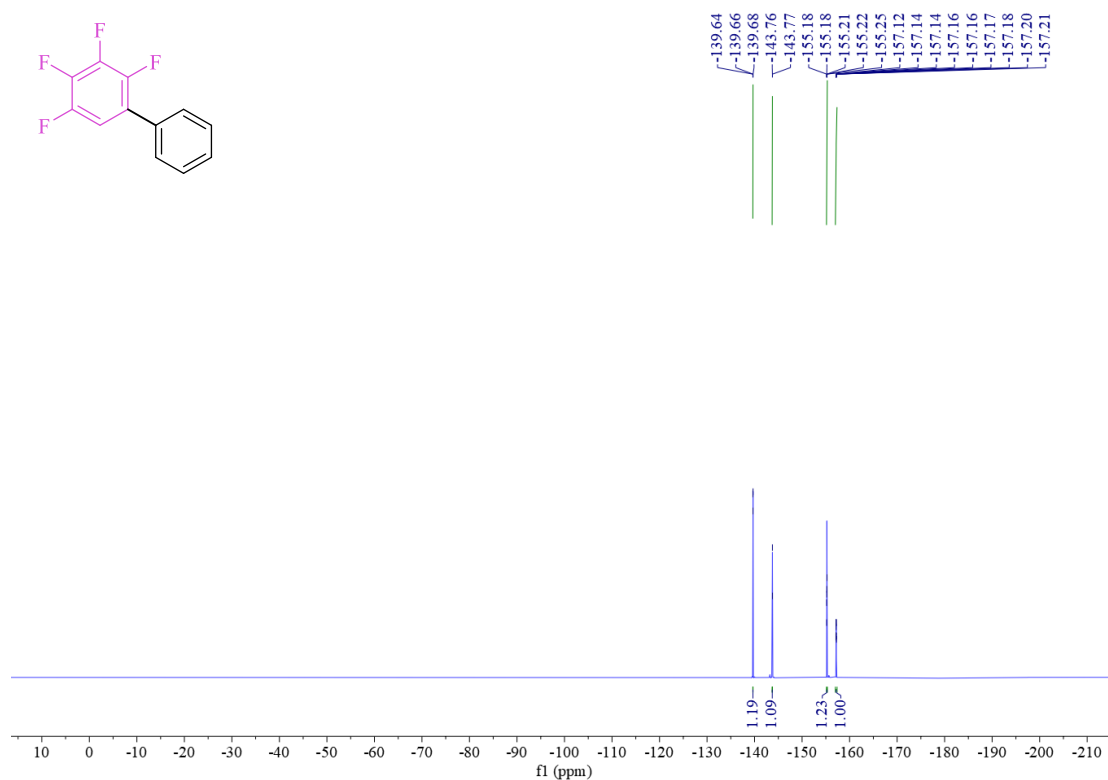
¹H NMR of 2,3,4,5-tetrafluoro-1,1'-biphenyl **5ba**



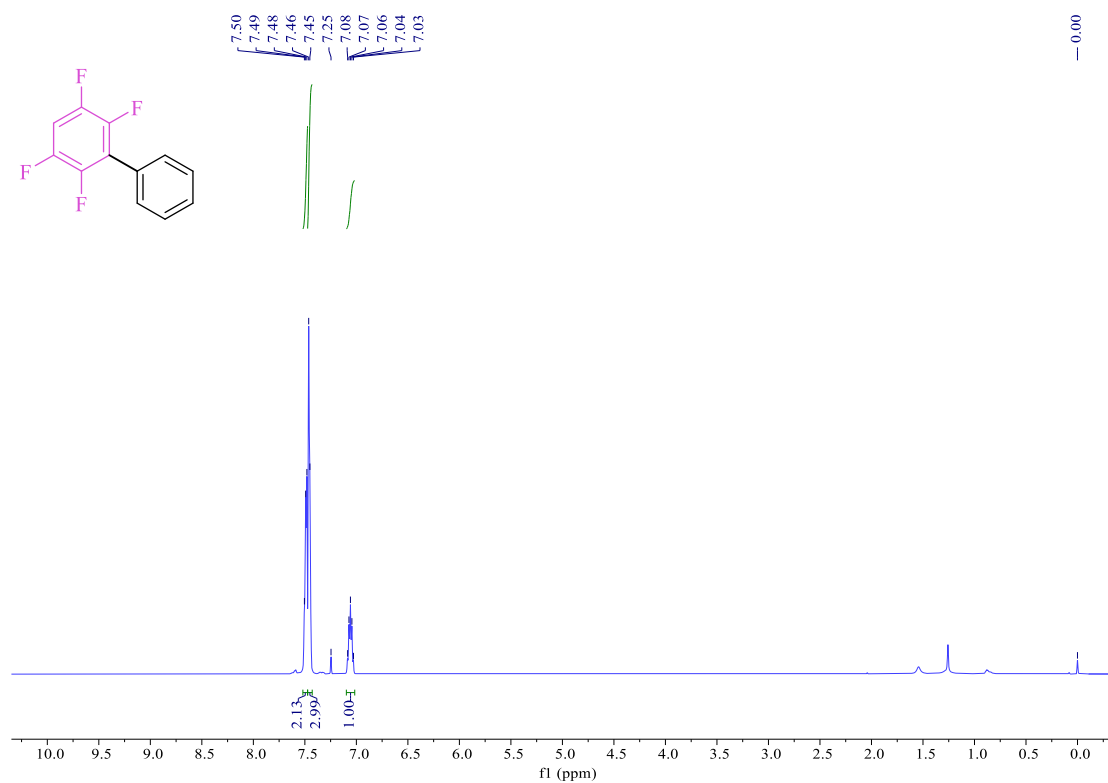
¹³C NMR of 2,3,4,5-tetrafluoro-1,1'-biphenyl **5ba**



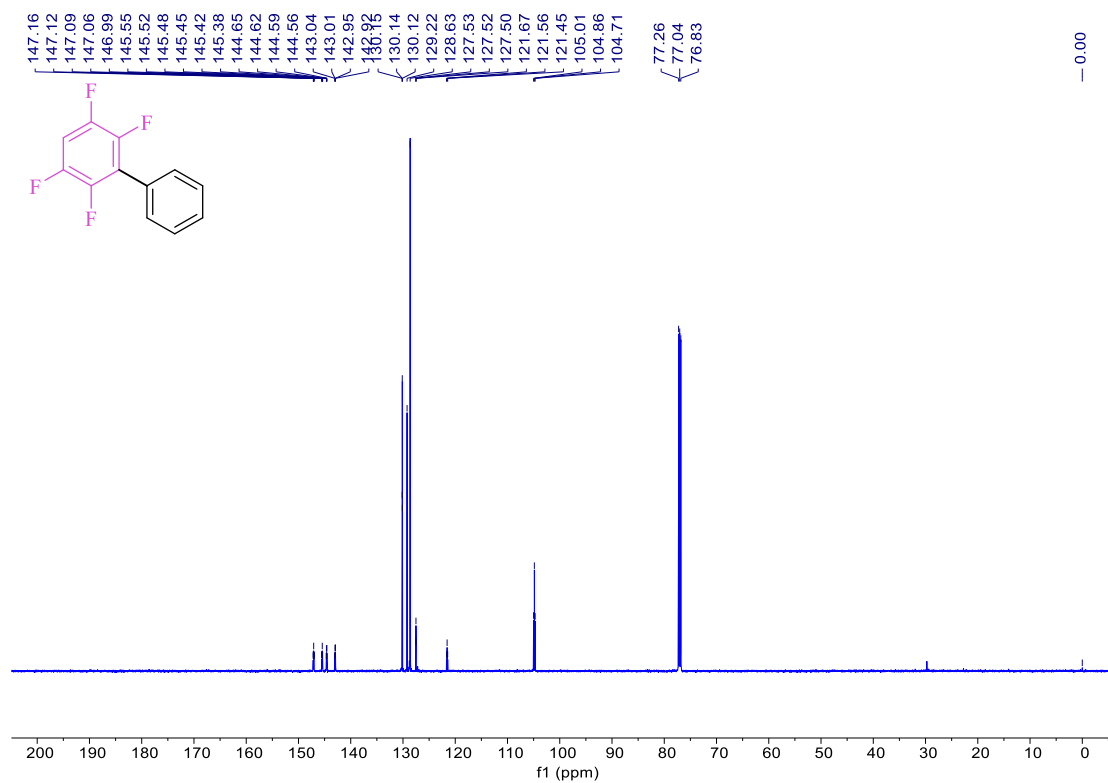
¹⁹F NMR of 2,3,4,5-tetrafluoro-1,1'-biphenyl **5ba**



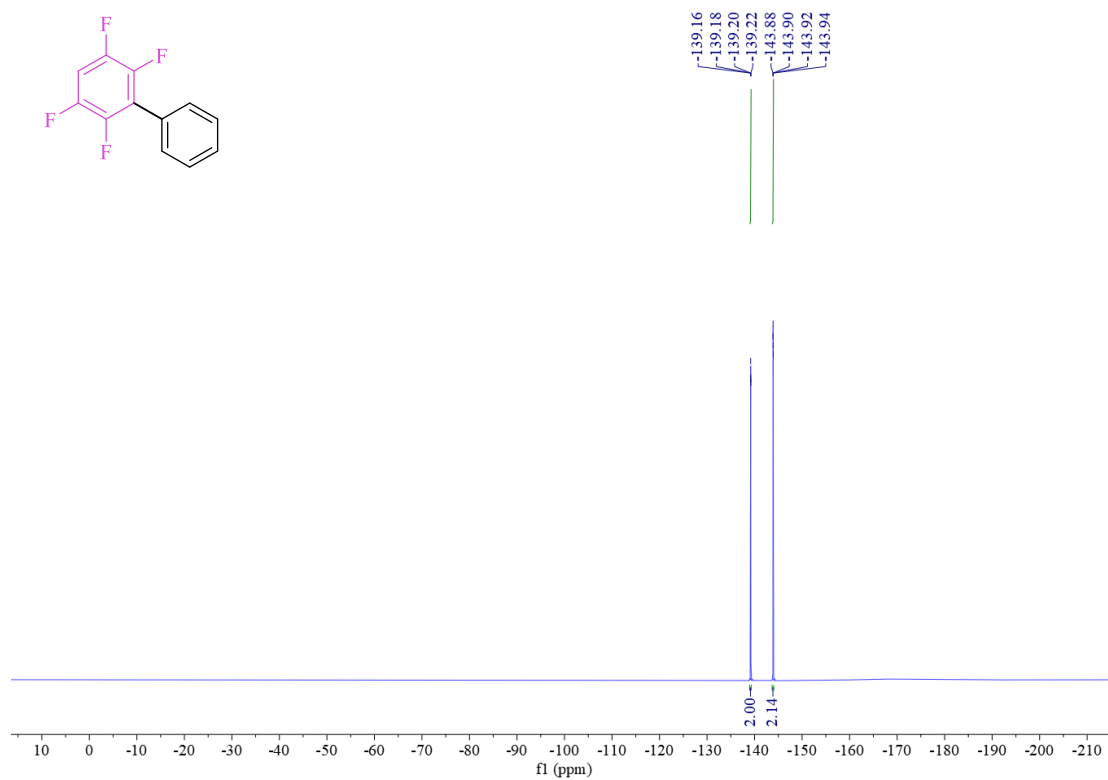
¹H NMR of 2,3,5,6-tetrafluoro-1,1'-biphenyl **5ca**



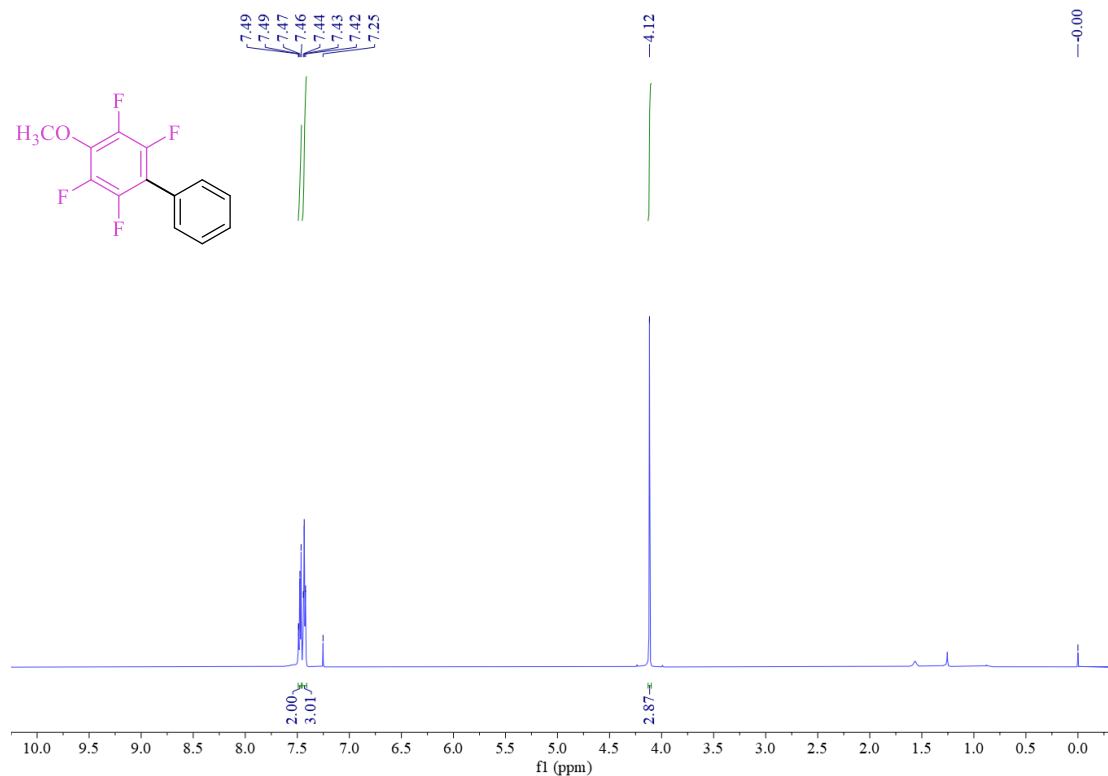
¹³C NMR of 2,3,5,6-tetrafluoro-1,1'-biphenyl **5ca**



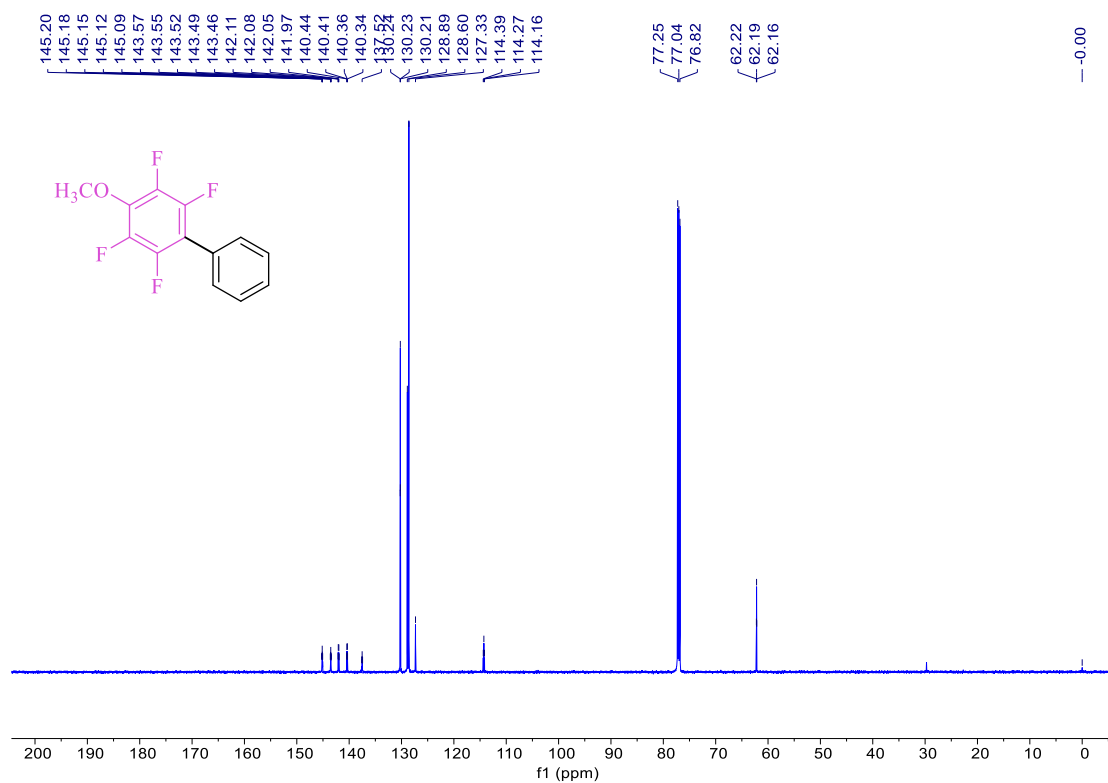
¹⁹F NMR of 2,3,5,6-tetrafluoro-1,1'-biphenyl **5ca**



¹H NMR of 2,3,5,6-tetrafluoro-4-methoxy-1,1'-biphenyl **5da**



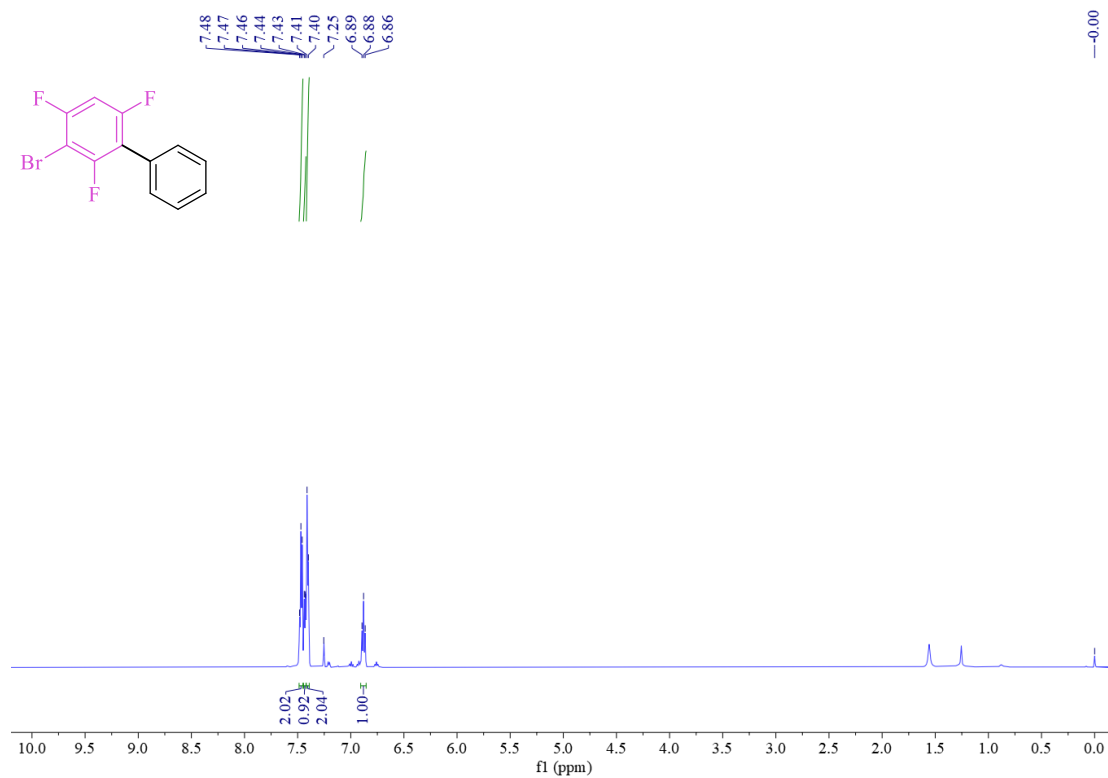
¹³C NMR of 2,3,5,6-tetrafluoro-4-methoxy-1,1'-biphenyl **5da**



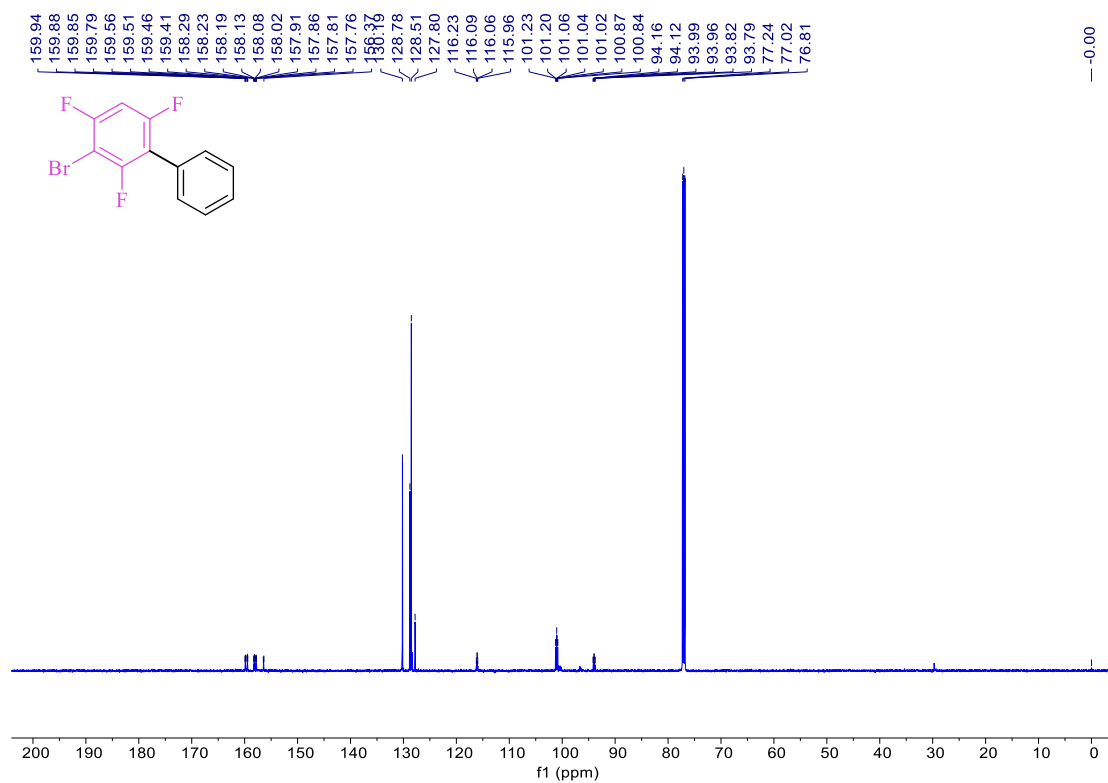
^{19}F NMR of 2,3,5,6-tetrafluoro-4-methoxy-1,1'-biphenyl **5da**



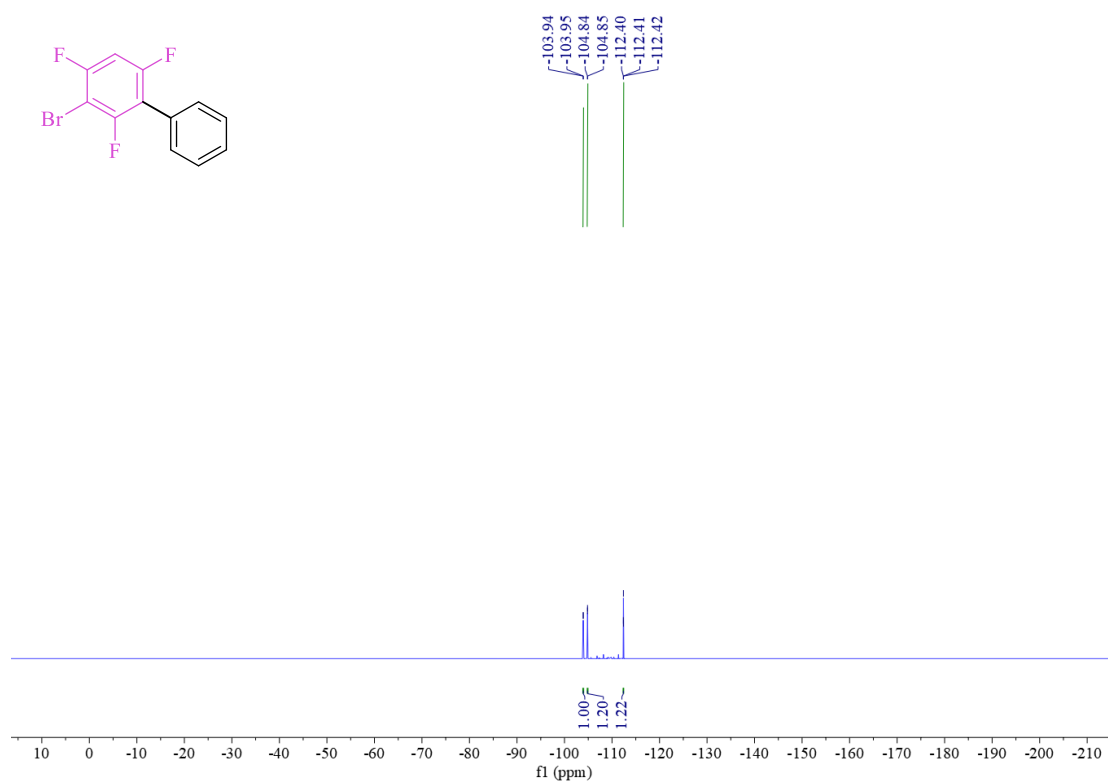
^1H NMR of 3-bromo-2,4,6-trifluoro-1,1'-biphenyl **5ea**



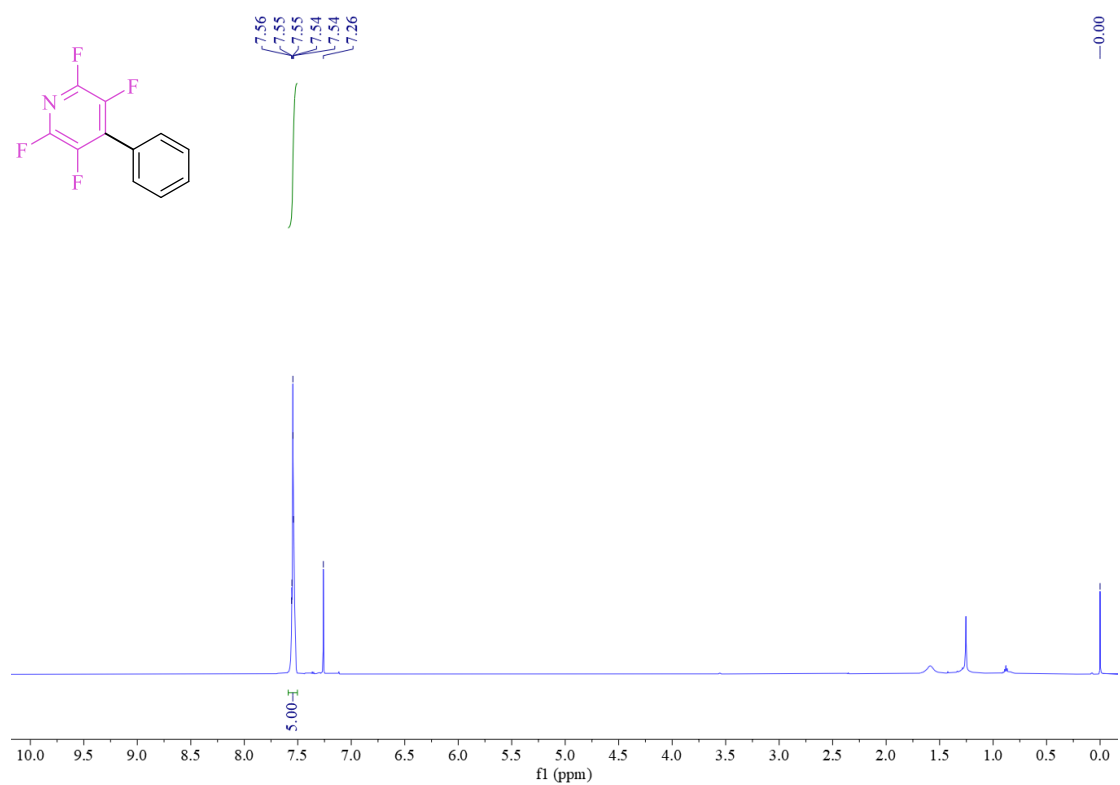
¹³C NMR of 3-bromo-2,4,6-trifluoro-1,1'-biphenyl **5a**



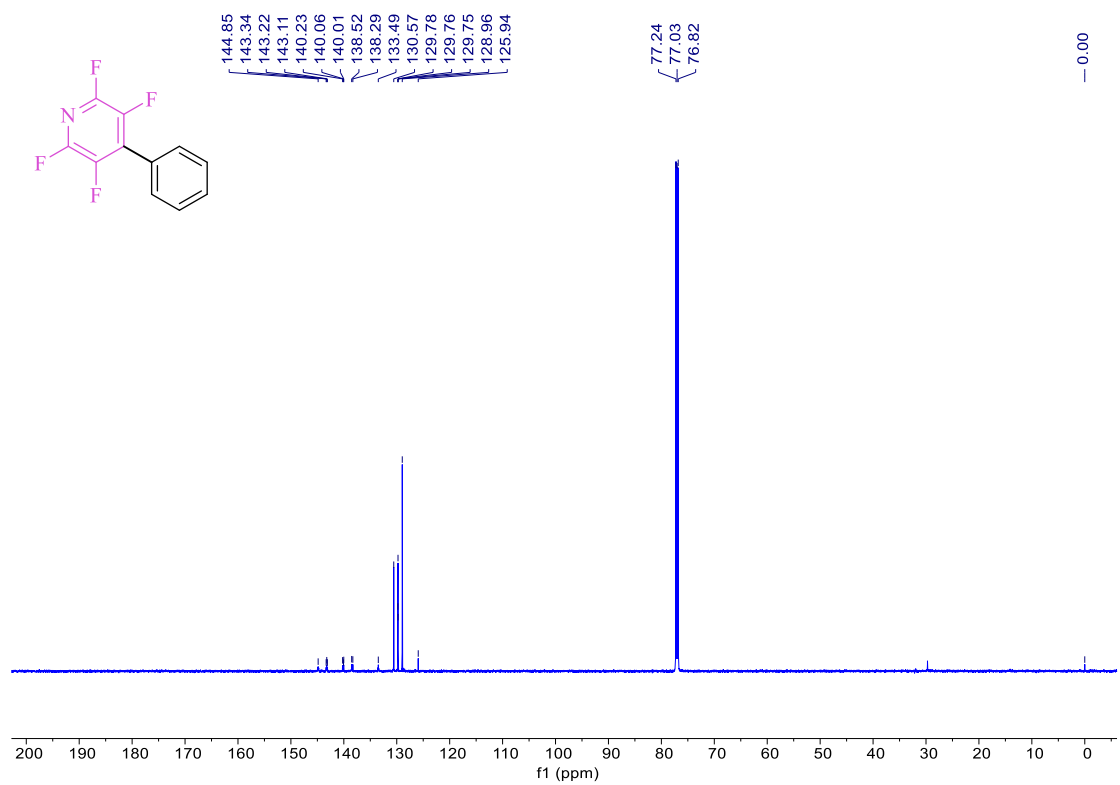
¹⁹F NMR of 3-bromo-2,4,6-trifluoro-1,1'-biphenyl **5a**



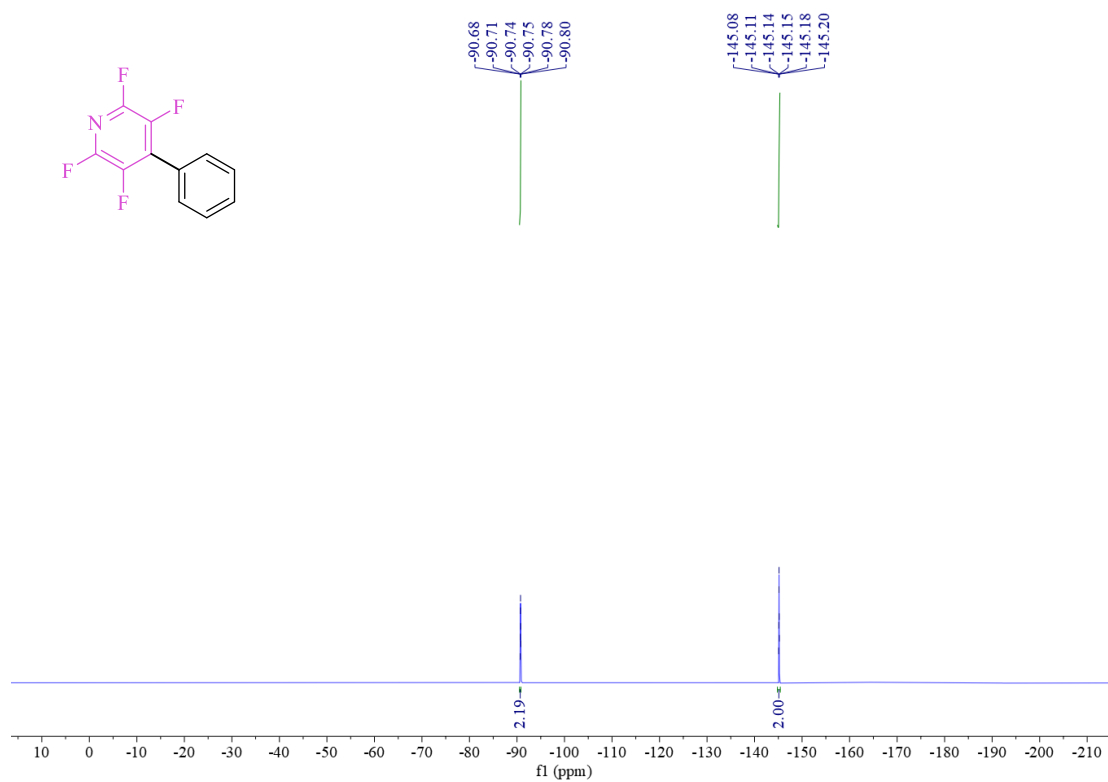
¹H NMR of 2,3,5,6-tetrafluoro-4-phenylpyridine **5fa**



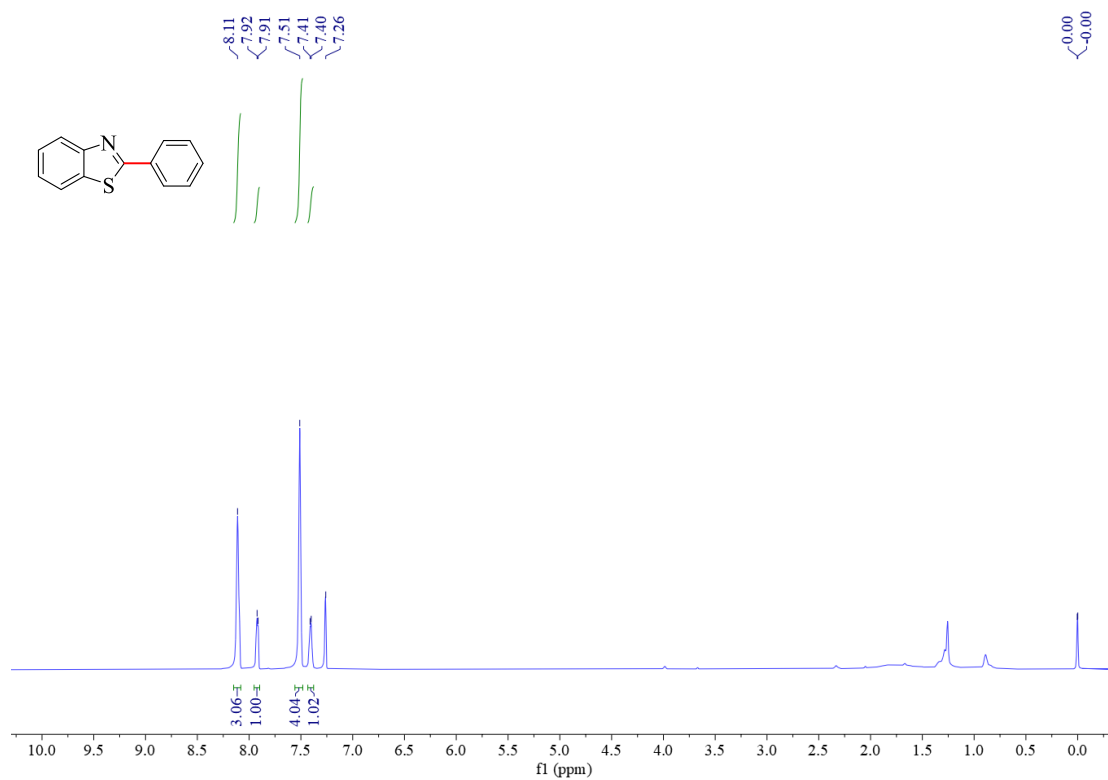
¹³C NMR of 2,3,5,6-tetrafluoro-4-phenylpyridine **5fa**



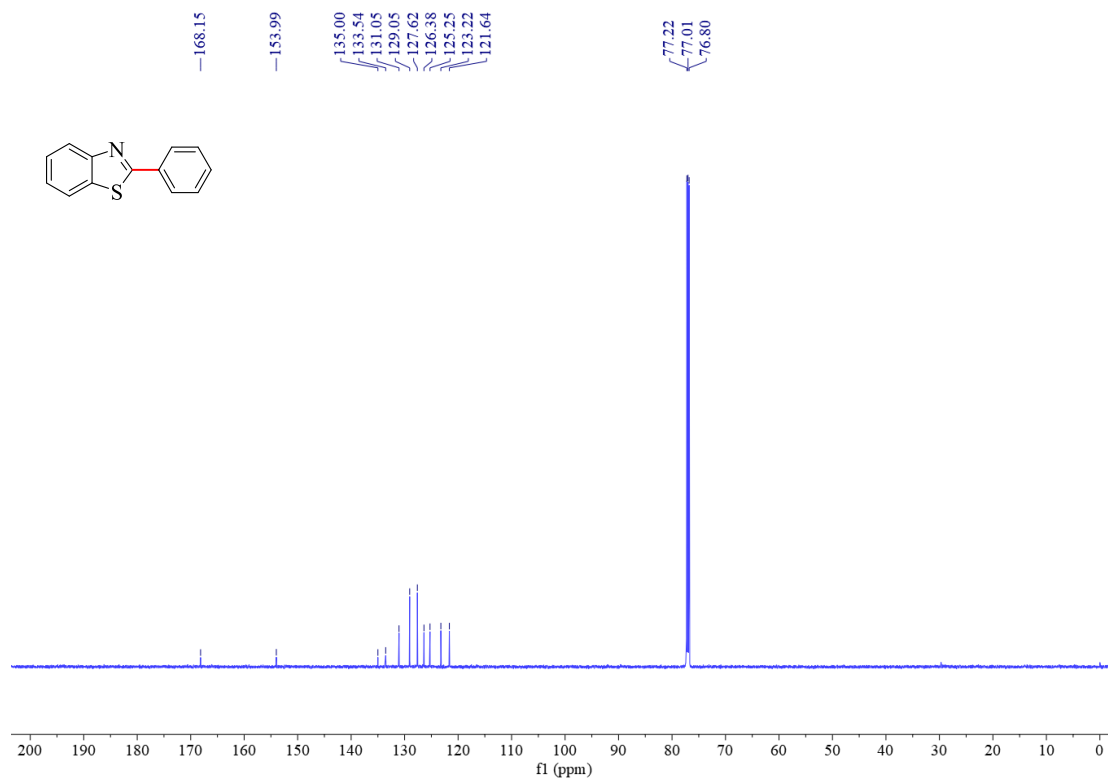
^{19}F NMR of 2,3,5,6-tetrafluoro-4-phenylpyridine **5fa**



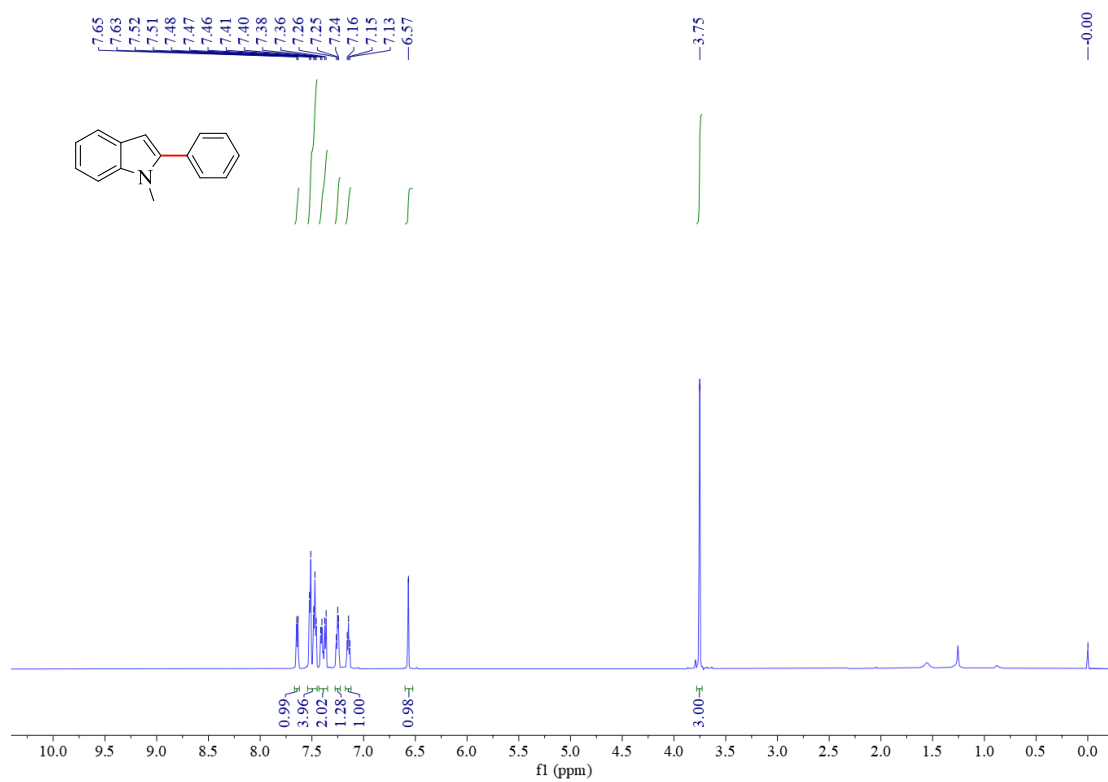
¹H NMR of 2-phenylbenzo[d]thiazole **6**



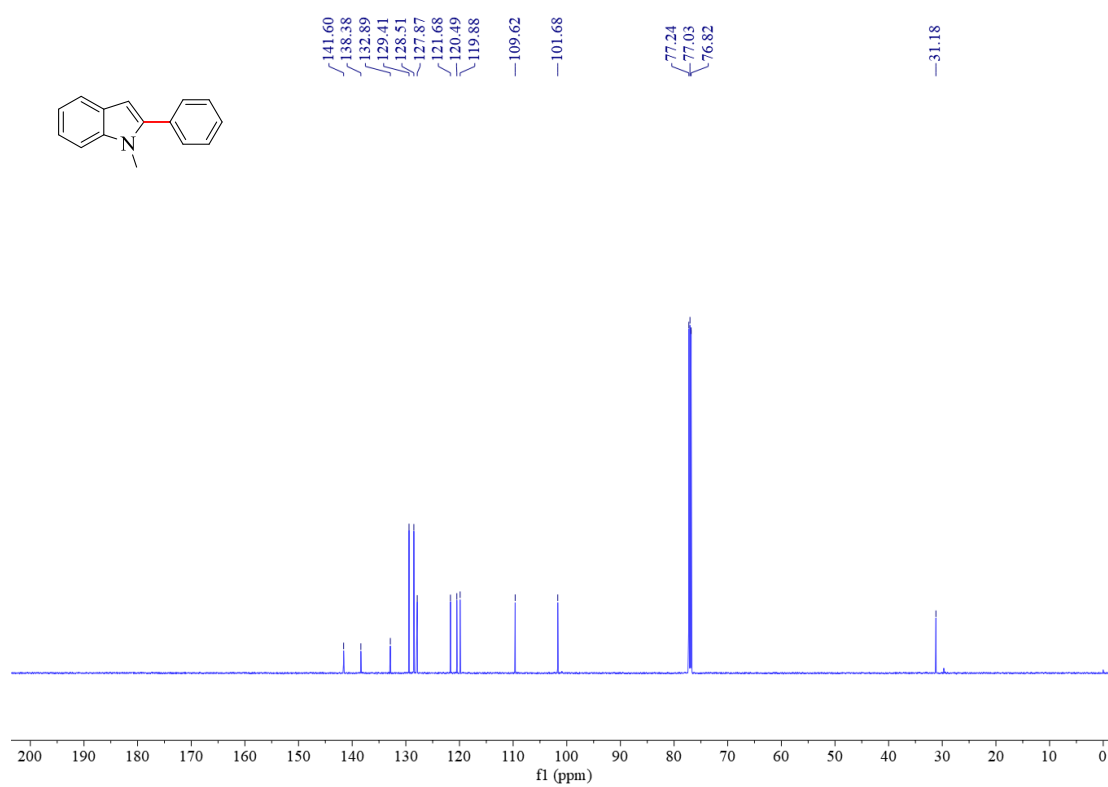
¹³C NMR of 2-phenylbenzo[d]thiazole **6**



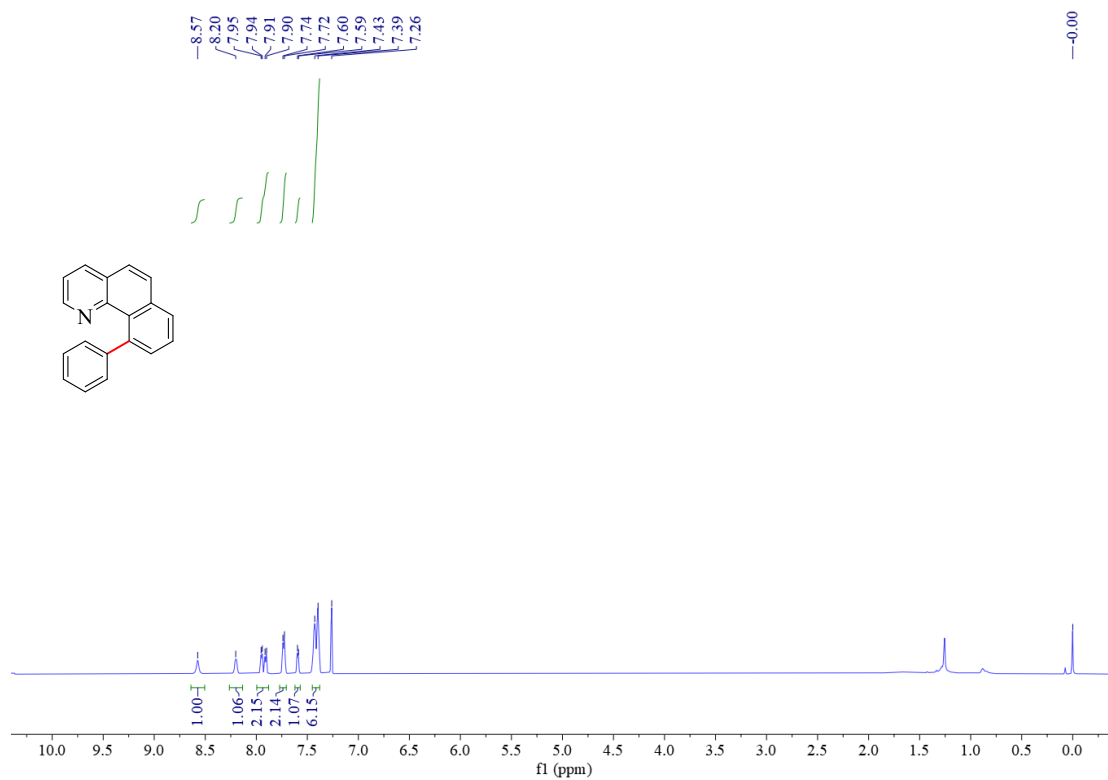
¹H NMR of 1-methyl-2-phenyl-1H-indole **7**



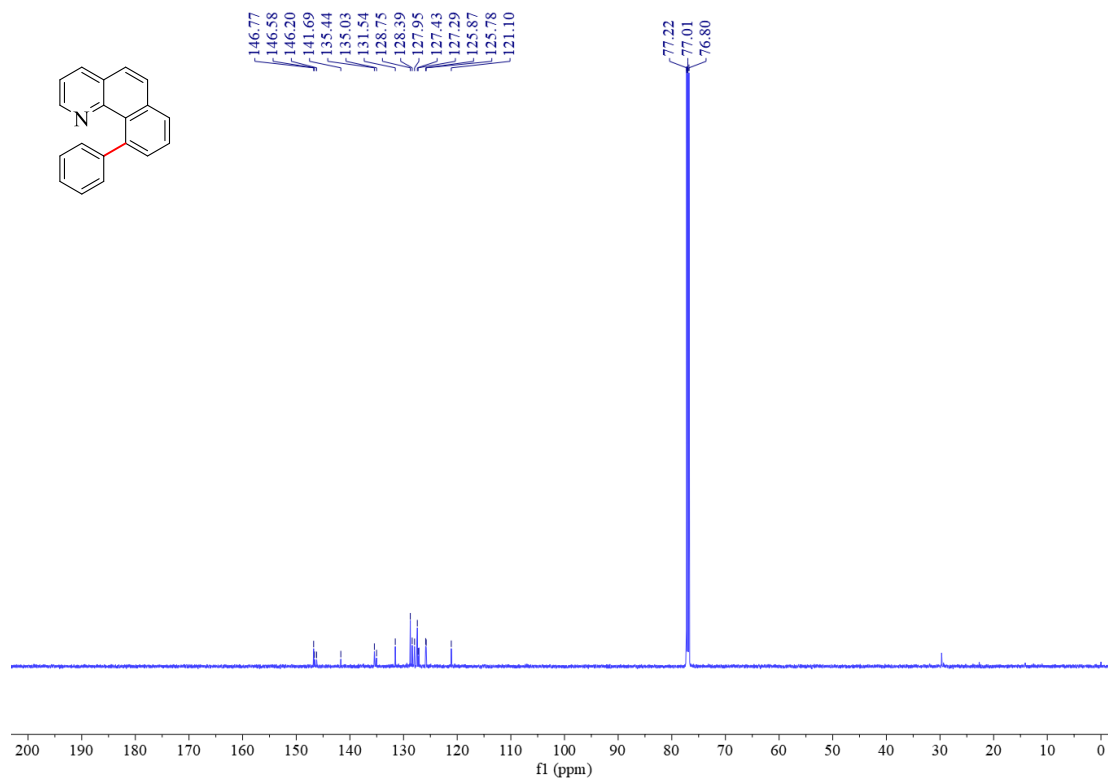
¹³C NMR of 1-methyl-2-phenyl-1H-indole **7**



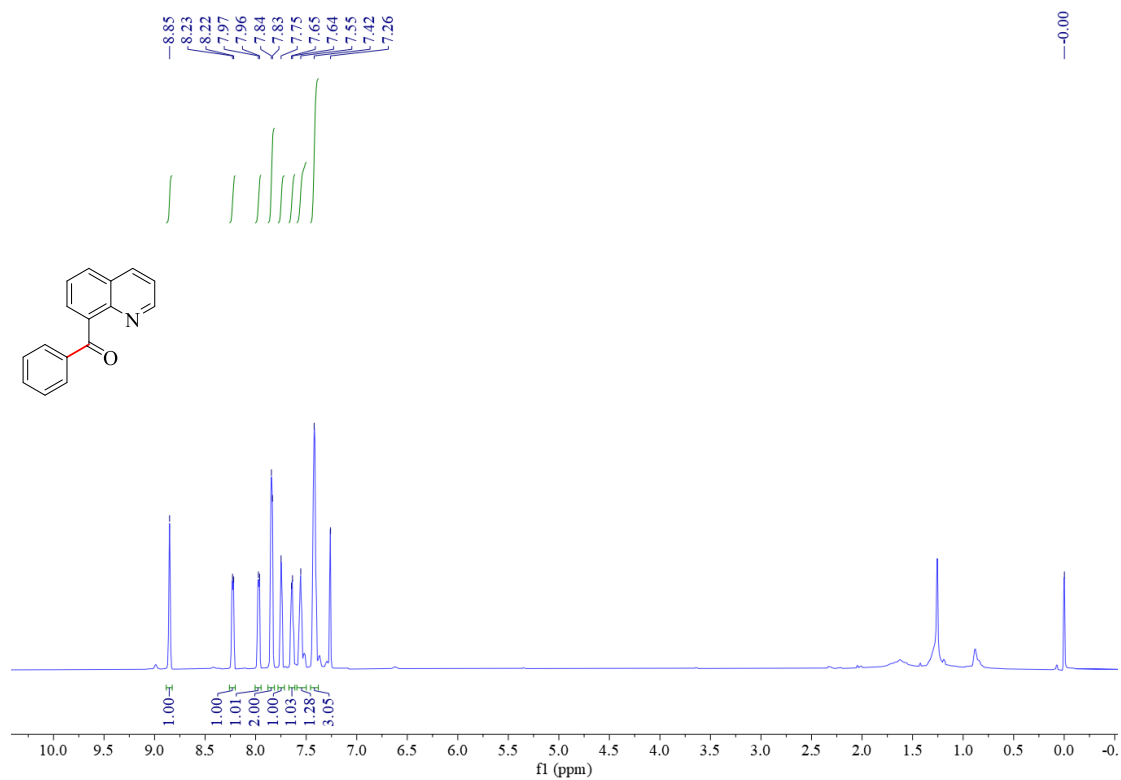
¹H NMR of 10-phenylbenzo[h]quinoline **8**



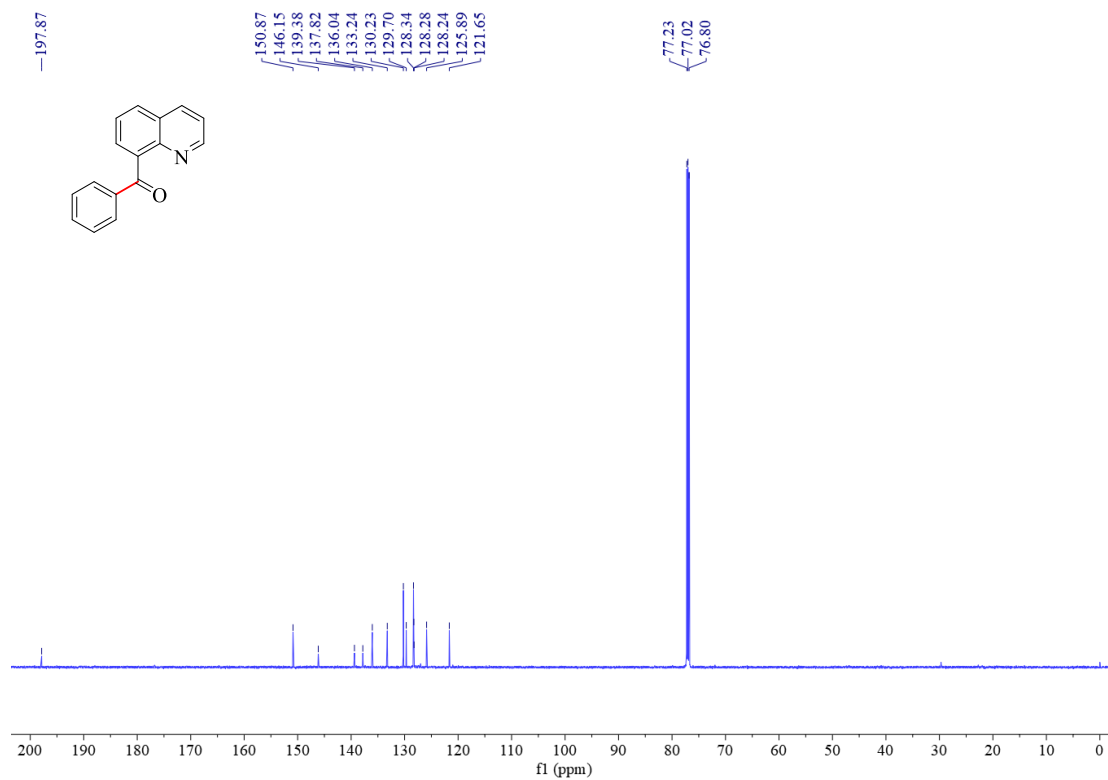
¹³C NMR of 10-phenylbenzo[h]quinoline **8**



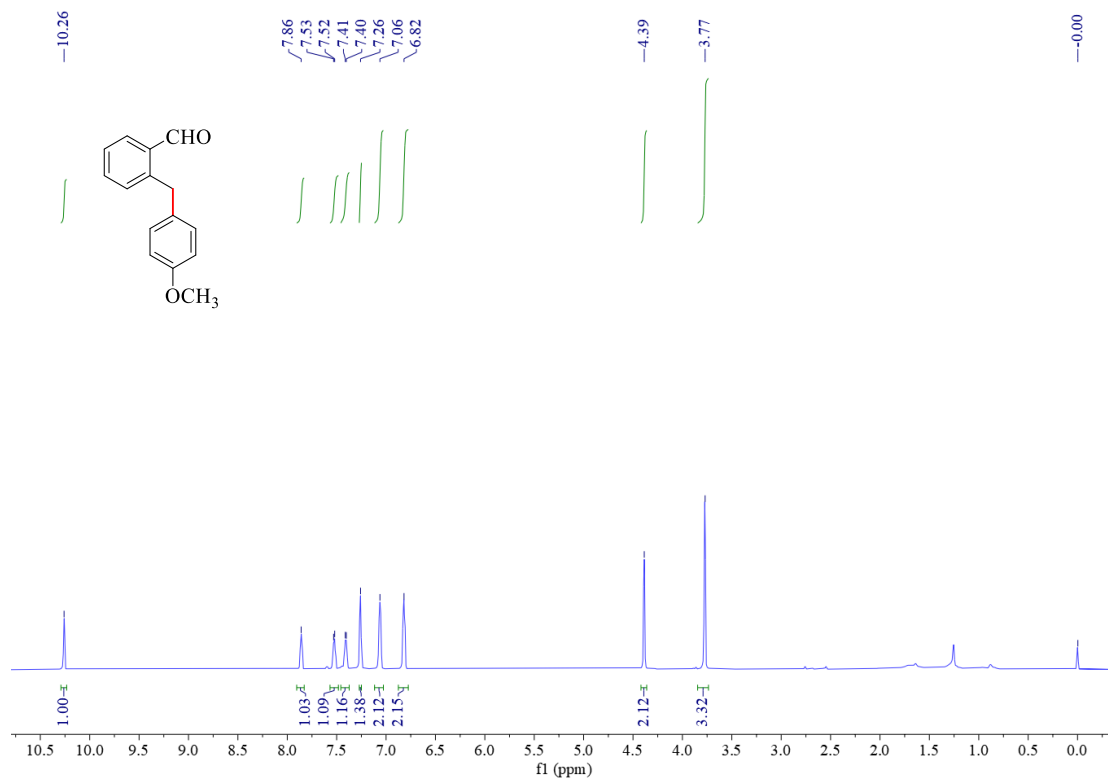
¹H NMR of phenyl(quinolin-8-yl)methanone **9**



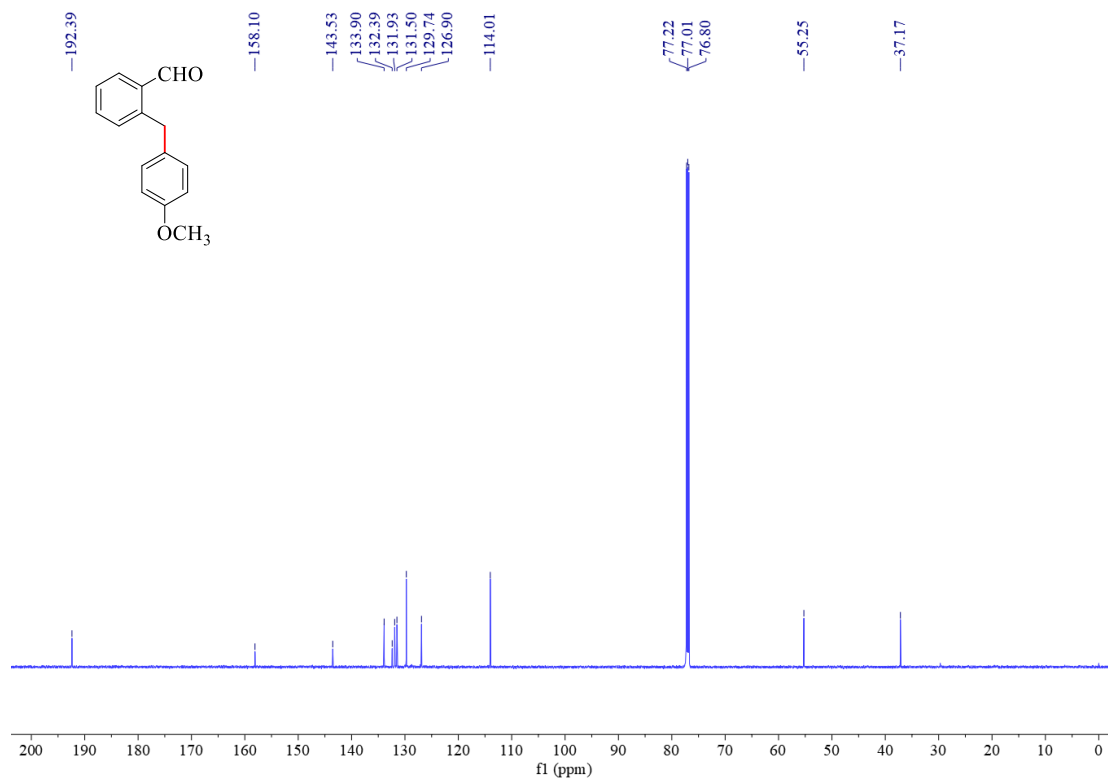
¹³C NMR of phenyl(quinolin-8-yl)methanone **9**



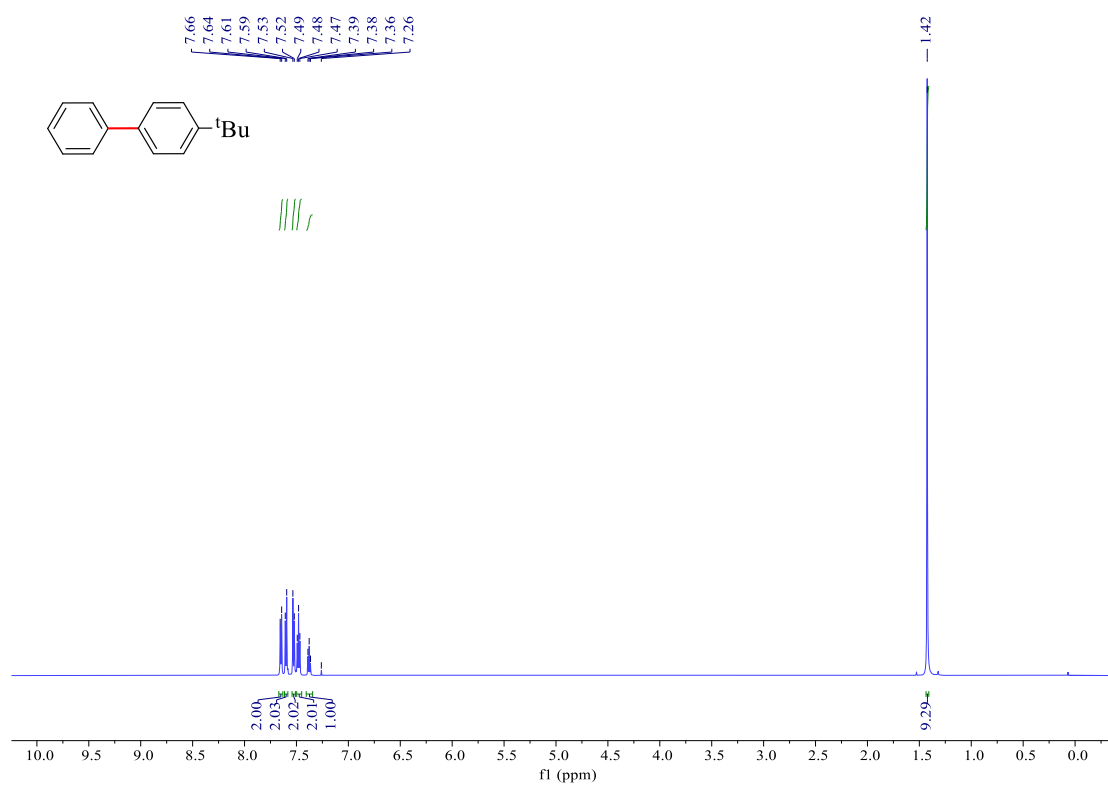
¹H NMR of 2-(4-methoxybenzyl)benzaldehyde **10**



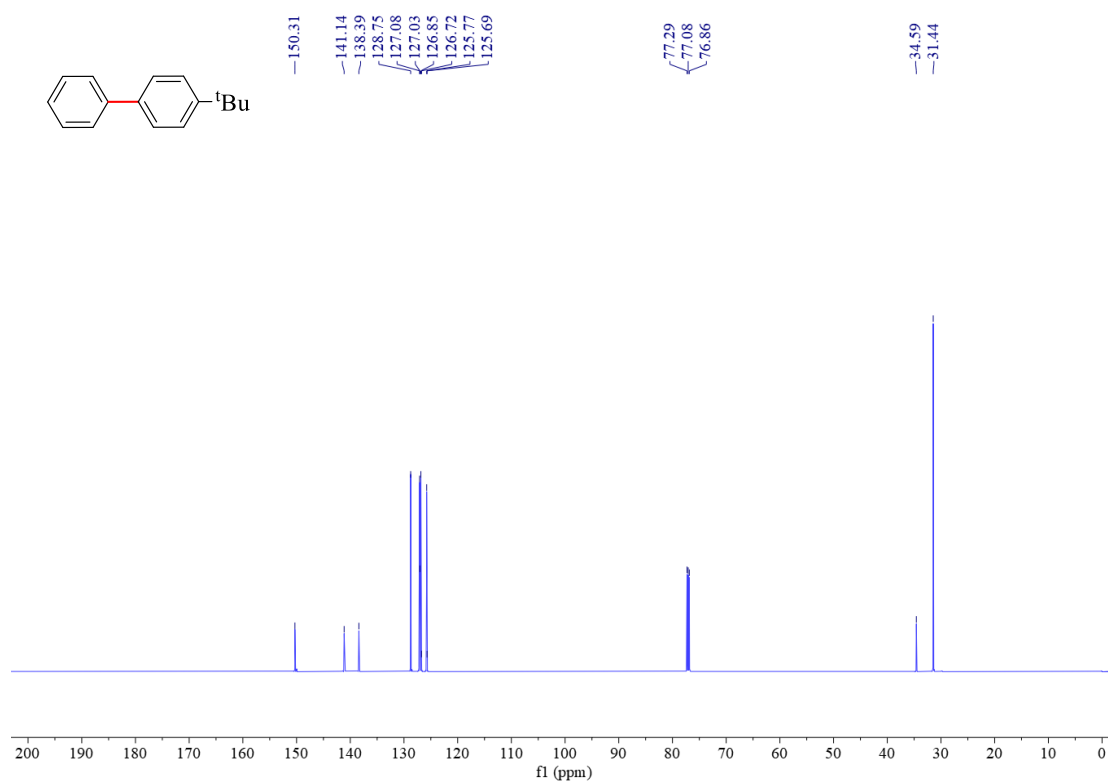
¹³C NMR of 2-(4-methoxybenzyl)benzaldehyde **10**



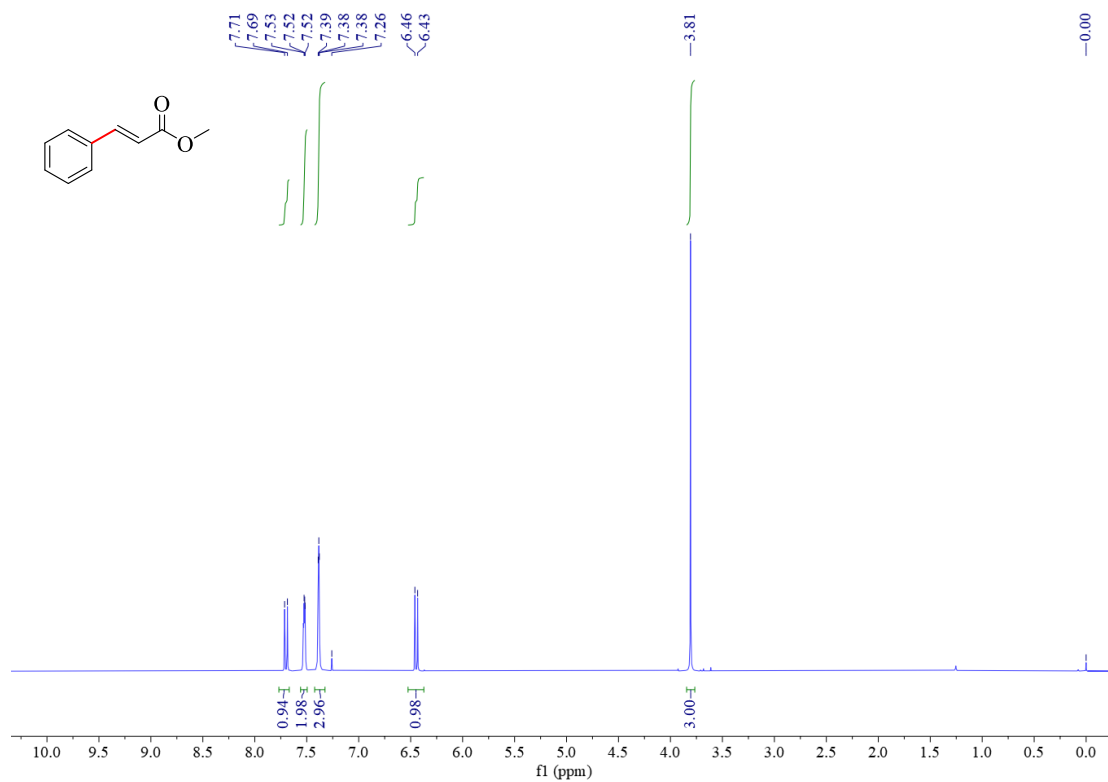
¹H NMR of 4-(tert-butyl)-1,1'-biphenyl **11**



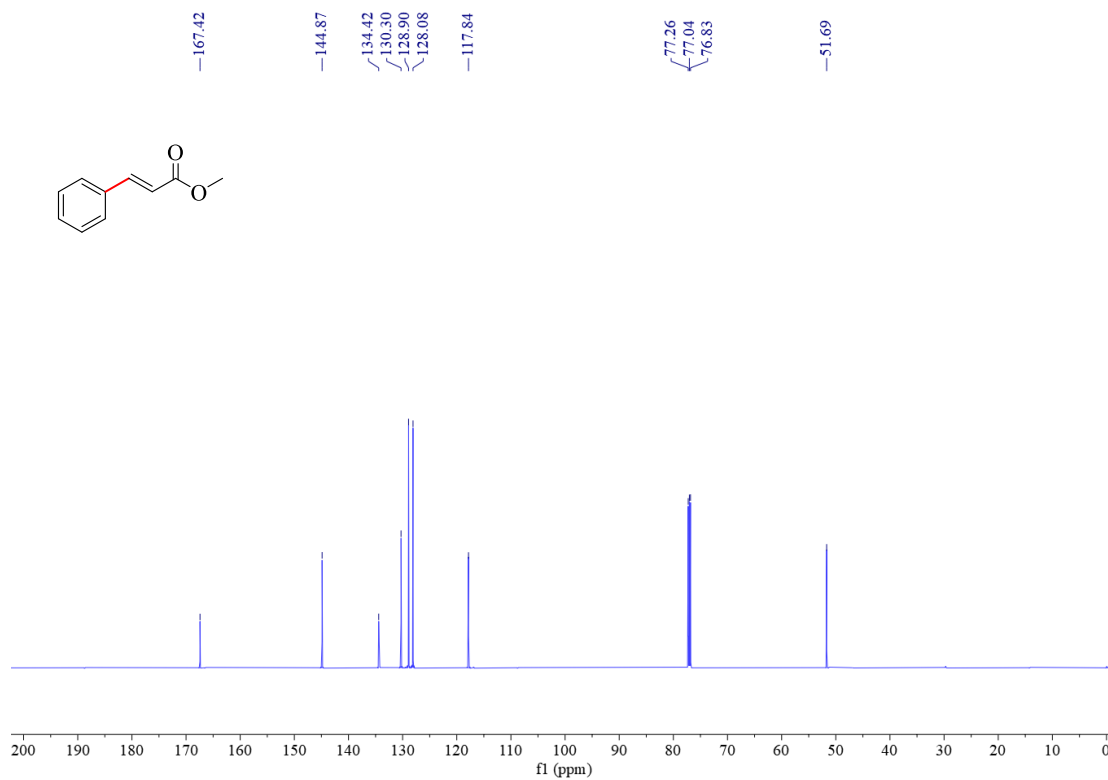
¹³C NMR of 4-(tert-butyl)-1,1'-biphenyl **11**



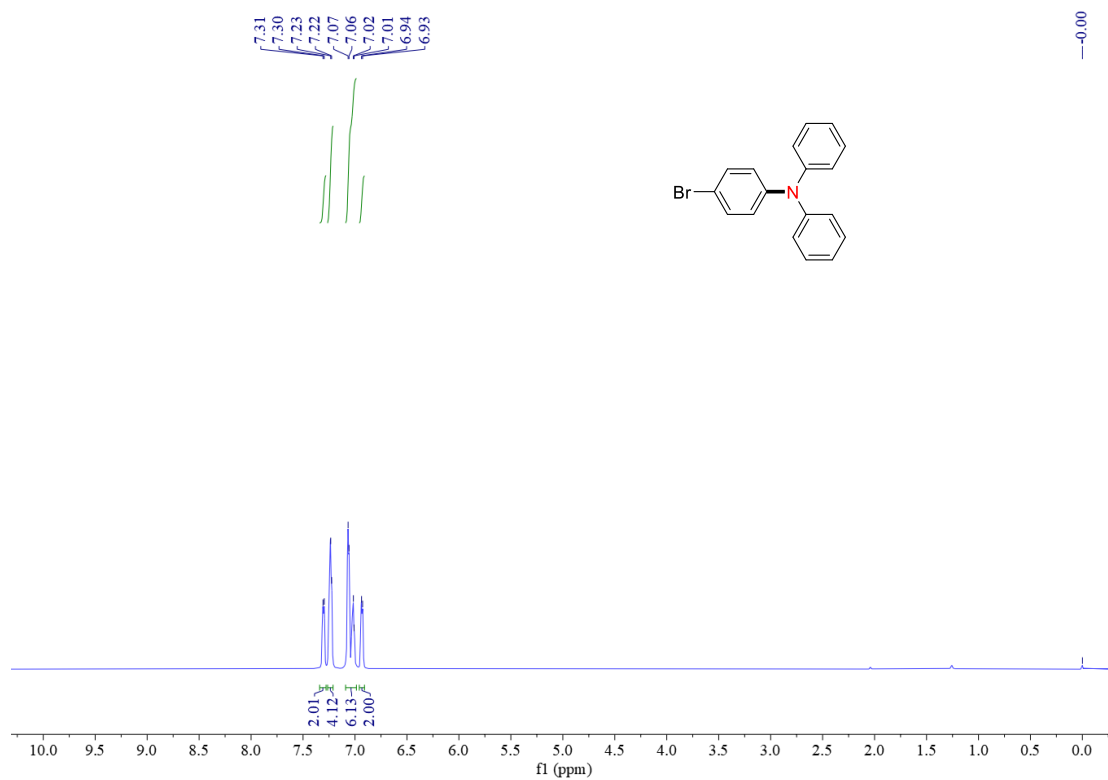
¹H NMR of methyl cinnamate **12**



¹³C NMR of methyl cinnamate **12**



¹H NMR of 4-bromo-N,N-diphenylaniline **13**



¹³C NMR of 4-bromo-N,N-diphenylaniline **13**

