Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supplementary Information for:

Cascade Cyclization versus Chemoselective Reduction: A Solvent-Controlled Product Divergence

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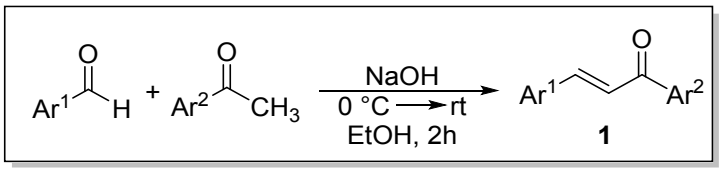
1. General information

All chemicals were purchased from Merck (Germany) and were used without further purification. Melting points were measured on an Electrothermal 9100 apparatus. Mass spectra were recorded on an Agilent Technologies (HP) 5973 mass spectrometer operating at an ionization potential of 20 eV. ^{1}H and ^{13}C NMR spectra were measured ($CDCl_3$ solution) with Bruker DRX-500 AVANCE (at 500 and 125 MHz) instrument. Chromatography columns were prepared from Merck silica gel 230–240 meshes.

2. General procedure for preparation of *α,β*-unsaturated Ketones[1]



To a stirred solution of aromatic aldehyde (20 mmol, 1.0 equiv.) and aromatic ketone (20 mmol, 1.0 equiv.) in 15 mL ethanol at 0 °C was added gradually aq. NaOH (30 mmol, 1.5 equiv.). Then the resulting mixture was allowed to warm to room temperature and stirred for 2 h. Next, the solid product was filtered out and was washed repeatedly with cold water. Finally, recrystallization from ethanol afforded the desired *α,β*-unsaturated ketones.

3. General experimental procedures

3.1. General procedure for the partial reduction, exemplified with 2a

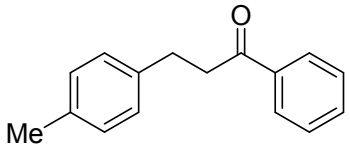
A mixture of 1-phenyl-3-(p-tolyl)prop-2-en-1-one **1** (0.25 mmol, 0.056 g), elemental sulfur (0.75 mmol, 0.024 g) and KOH (0.25 mmol, 0.014 g) in DMF (1 ml) was stirred at 80 °C for 5 h. After the completion of reaction as was indicated by TLC monitoring, the reaction mixture was cooled to ambient temperature. Then, distilled H_2O (5 mL) was added, and the reaction mixture was extracted with ethyl acetate (3 × 6 mL). The combined organic phase was dried over Na_2SO_4. The solvent was removed under the reduced pressure. The residue was purified by column chromatography using *n*-hexane-EtOAc (10:1) as eluent to afford desired product **2a**.

3.2. General procedure for construction of thiophenes, exemplified with 3a

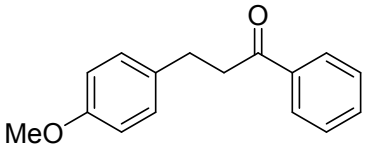
A mixture of 1-phenyl-3-(p-tolyl)prop-2-en-1-one **1** (0.25 mmol, 0.056 g), elemental sulfur (0.75 mmol, 0.024 g) and KOH (0.25 mmol, 0.014 g) in DMSO (1 ml) was stirred at 80 °C for 5 h. After the completion of reaction as was indicated by TLC monitoring, the reaction mixture was cooled to ambient temperature. Then, distilled H_2O (5 mL) was added, and the reaction mixture was extracted with ethyl acetate (3 × 6 mL). The combined organic phase was dried over Na_2SO_4. The solvent was removed under the reduced pressure. The residue was purified by column chromatography using *n*-hexane-EtOAc (6:1) as eluent to afford desired product **3a**.

4. Experimental characterization data

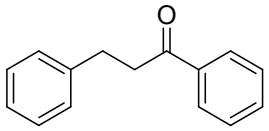
4.1. Ketones



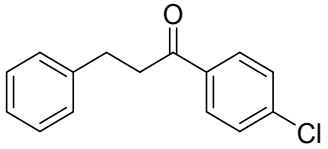
1-Phenyl-3-(p-tolyl)propan-1-one (2a): yield: 52 mg, 93%; white solid; m.p. 39-41 °C [lit.[2] m.p. 33-34 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.37 (s, 3H), 3.08 (t, *J* = 7.7 Hz, 2H), 3.32 (t, *J* = 7.6 Hz, 2H), 7.16 (d, *J* = 7.9 Hz, 2H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 8.00 (d, *J* = 7.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.05, 29.76, 40.63, 128.08, 128.35, 128.63, 129.25, 133.06, 135.64, 136.94, 138.24, 199.34. EI-MS, *m/z* (%): 224 (M^+, 18), 209 (3), 117 (12), 105 (89), 91 (31), 77 (100), 65 (16), 51 (35), 41 (13). Anal. Calcd for $C_{16}H_{16}O$: C, 85.68; H, 7.19; Found: C, 86.00; H, 7.31.



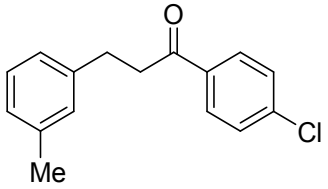
3-(4-Methoxyphenyl)-1-phenylpropan-1-one (2b): yield: 54 mg, 90%; white solid; m.p. 67-69 °C [lit.[3] m.p. 67-70 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.04 (t, *J* = 7.7 Hz, 2H), 3.29 (t, *J* = 7.7 Hz, 2H), 3.80 (s, 3H), 6.86 (d, *J* = 8.7 Hz, 2H), 7.19 (d, *J* = 8.6 Hz, 2H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.97 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.30, 40.71, 55.28, 113.96, 128.05, 128.61, 129.37, 133.04, 133.33, 136.93, 158.02, 199.39. EI-MS, *m/z* (%): 240 (M^+, 28), 135 (13), 121 (75), 105 (65), 91 (31), 77 (100), 65 (15), 51 (33), 41 (5). Anal. Calcd for $C_{16}H_{16}O_2$: C, 79.97; H, 6.71; Found: C, 79.68; H, 6.60.



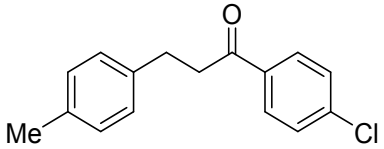
1,3-Diphenylpropan-1-one (2c): yield: 45 mg, 86%; white solid; m.p. 72-74 °C [lit.[4] m.p. 70-72 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.11 (t, *J* = 7.7 Hz, 2H), 3.33 (t, *J* = 7.9 Hz, 2H), 7.24 (t, *J* = 7.3 Hz, 1H), 7.29 (d, *J* = 7.5 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.58 (td, *J* = 8.0, 1.2 Hz, 1H), 7.99 (d, *J* = 8.0 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 30.16, 40.46, 126.17, 128.07, 128.47, 128.57, 128.64, 133.09, 136.90, 141.34, 199.21. EI-MS, *m/z* (%): 210 (M^+, 18), 105 (84), 91 (17), 77 (100), 65 (13), 51 (49), 43 (6). Anal. Calcd for $C_{15}H_{14}O$: C, 85.68; H, 6.71; Found: C, 85.44; H, 6.59.



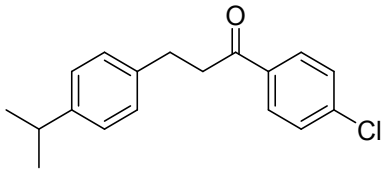
1-(4-Chlorophenyl)-3-phenylpropan-1-one (2d): yield: 52 mg, 85%; white solid; m.p. 73-75 °C [lit.[5] m.p. 74-75 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.08 (t, *J* = 7.7 Hz, 2H), 3.28 (t, *J* = 7.7 Hz, 2H), 7.21-7.27 (m, 3H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.43 (d, *J* = 8.6 Hz, 2H), 7.90 (d, *J* = 8.6 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 30.05, 40.43, 126.22, 128.40, 128.57, 128.92, 129.45, 135.17, 139.51, 141.05, 197.98. EI-MS, *m/z* (%): 246 ($M^{+\,37}$Cl, 11), 244 ($M^{+\,35}$Cl, 33), 209 (6), 139 (100), 125 (5), 111 (62), 104 (22), 91 (28), 77 (39), 69 (22), 51 (23), 41 (12). Anal. Calcd for $C_{15}H_{13}ClO$: C, 73.62; H, 5.35; Found: C, 73.96; H, 5.47.



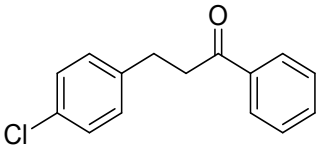
1-(4-Chlorophenyl)-3-(m-tolyl)propan-1-one (2e): yield: 56 mg, 87%; pale orange solid; m.p. 65-67 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.37 (s, 3H), 3.05 (t, *J* = 7.8 Hz, 2H), 3.29 (t, *J* = 7.7 Hz, 2H), 7.04-7.10 (m, 3H), 7.22 (t, *J* = 7.5 Hz, 1H), 7.46 (d, *J* = 8.6 Hz, 2H), 7.93 (d, *J* = 8.8 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.41, 30.00, 40.53, 125.39, 126.98, 128.50, 128.93, 129.23, 129.48, 135.21, 138.19, 139.50, 141.01, 198.07. EI-MS, *m/z* (%): 260 ($M^{+\,37}$Cl, 65), 258 ($M^{+\,35}$Cl, 92), 139 (100), 128 (15), 119 (94), 111 (97), 103 (47), 91 (86), 75 (84), 65 (56), 51 (56), 41 (31). Anal. Calcd for $C_{16}H_{15}ClO$: C, 74.27; H, 5.84; Found: C, 74.50; H, 5.93.



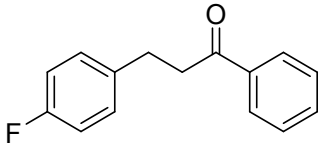
1-(4-Chlorophenyl)-3-(p-tolyl)propan-1-one (2f): yield: 59 mg, 91%; white solid; m.p. 82-85 °C [lit.[6] m.p. 75-77 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.34 (s, 3H), 3.04 (t, *J* = 7.7 Hz, 2H), 3.26 (t, *J* = 7.7 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 8.1 Hz, 2H), 7.44 (d, *J* = 8.7 Hz, 2H), 7.90 (d, *J* = 8.7 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.01, 29.64, 40.58, 128.28, 128.91, 129.25, 129.46, 135.21, 135.73, 137.96, 139.47, 198.08. EI-MS, *m/z* (%): 260 (M^+ ^{37}Cl, 16), 258 (M^+ ^{35}Cl, 45), 243 (8), 223 (6), 139 (100), 131 (4), 119 (45), 111 (73), 103 (19), 91 (41), 84 (7), 75 (39), 65 (19), 51 (15), 41 (8). Anal. Calcd for $C_{16}H_{15}ClO$: C, 74.27; H, 5.84; Found: C, 74.60; H, 5.96.



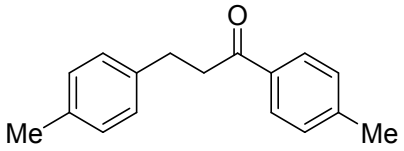
1-(4-Chlorophenyl)-3-(4-isopropylphenyl)propan-1-one (2g): yield: 64 mg, 89%; pale yellow solid; m.p. 42-44 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 1.28 (d, *J* = 6.9 Hz, 6H), 2.92 (sept, *J* = 6.9 Hz, 1H), 3.06 (t, *J* = 7.7 Hz, 2H), 3.29 (t, *J* = 7.7 Hz, 2H), 7.20 (s, 4H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.92 (d, *J* = 8.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 24.06, 29.66, 33.73, 40.55, 126.62, 128.34, 128.92, 129.49, 135.23, 138.35, 139.48, 146.83, 198.15. EI-MS, *m/z* (%): 288 (M^+ ^{37}Cl, 27), 286 (M^+ ^{35}Cl, 72), 279 (7), 271 (39), 249 (9), 241 (55), 167 (17), 149 (43), 139 (100), 132 (31), 125 (6), 117 (54), 105 (33), 91 (43), 75 (24), 65 (7), 57 (22), 50 (13), 43 (52). Anal. Calcd for $C_{18}H_{19}ClO$: C, 75.38; H, 6.68; Found: C, 75.66; H, 6.78.



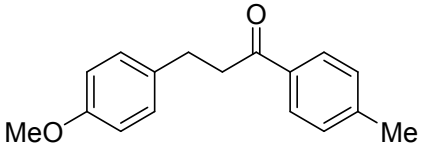
3-(4-Chlorophenyl)-1-phenylpropan-1-one (2h): yield: 51 mg, 83%; white solid; m.p. 57-59 °C [lit.[4] m.p. 56-58]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.07 (t, *J* = 7.5 Hz, 2H), 3.31 (t, *J* = 7.5 Hz, 2H), 7.21 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 8.5 Hz, 2H), 7.48 (t, *J* = 7.8 Hz, 2H), 7.59 (t, *J* = 7.5 Hz, 1H), 7.98 (dd, *J* = 8.1, 1.0 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.39, 40.14, 128.03, 128.61, 128.66, 129.85, 131.89, 133.18, 136.78, 139.77, 198.83. EI-MS, *m/z* (%): 246 (M^+ ^{37}Cl, 34), 244 (M^+ ^{35}Cl, 80), 209 (8), 191 (4), 165 (4), 139 (9), 125 (24), 105 (100), 89 (8), 77 (71), 63 (4), 51 (15). Anal. Calcd for $C_{15}H_{13}ClO$: C, 73.62; H, 5.35; Found: C, 73.89; H, 5.46.



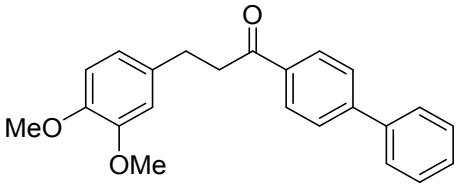
3-(4-Fluorophenyl)-1-phenylpropan-1-one (2i): yield: 46 mg, 81%; white solid; m.p. 67-69 °C [lit.[2] m.p. 65-66 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.08 (t, *J* = 7.6 Hz, 2H), 3.31 (t, *J* = 7.6 Hz, 2H), 7.00 (t, *J* = 8.7 Hz, 2H), 7.24 (dd, *J* = 8.5 , 5.6 Hz , 2H), 7.49 (t, *J* = 7.8 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.98 (d, *J* = 7.7 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.28, 40.43, 115.26 (d, *J* = 21.0 Hz), 128.03, 128.64, 129.84 (d, *J* = 8.0 Hz), 133.14, 136.83, 136.89, 161.42 (d, *J* = 243.0 Hz), 199.04. EI-MS, *m/z* (%): 228 (M^+, 68), 210 (2), 149 (4), 123 (6), 109 (20), 105 (100), 95 (4), 77 (54), 63 (2), 51 (15), 41 (2). Anal. Calcd for $C_{15}H_{13}FO$: C, 78.93; H, 5.74; Found: C, 79.22; H, 5.87.



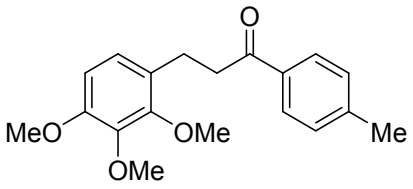
1,3-Di-p-tolylpropan-1-one (2j): yield: 55 mg, 92%; orange solid; m.p. 68-70 °C [lit.[7] m.p. 64 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.40 (s, 3H), 2.47 (s, 3H), 3.10 (t, *J* = 7.7 Hz, 2H), 3.32 (t, *J* = 7.6 Hz, 2H), 7.18 (d, *J* = 7.8 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 7.9 Hz, 2H), 7.94 (d, *J* = 8.2 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.08, 21.68, 29.88, 40.54, 128.24, 128.38, 129.27, 129.34, 134.52, 135.60, 138.39, 143.81, 198.98. EI-MS, *m/z* (%): 238 (M^+, 70), 223 (100), 205 (7), 195 (16), 178 (7), 165 (5), 145 (14), 131 (30), 119 (90), 105 (59), 91 (59), 77 (62), 65 (90), 51 (28), 41 (42). Anal. Calcd for $C_{17}H_{18}O$: C, 85.67; H, 7.61; Found: C, 85.94; H, 7.75.



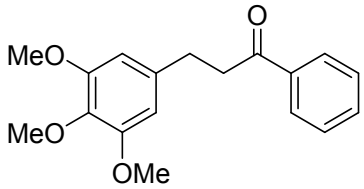
3-(4-Methoxyphenyl)-1-(p-tolyl)propan-1-one (2k): yield: 56 mg, 88%; white solid; m.p. 61-63 °C [lit.[8] m.p. 57-58 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.42 (s, 3H), 3.02 (t, *J* = 7.7 Hz, 2H), 3.26 (t, *J* = 7.7 Hz, 2H), 3.80 (s, 3H), 6.86 (d, *J* = 8.7 Hz, 2H), 7.18 (d, *J* = 8.7 Hz, 2H), 7.26 (d, *J* = 8.2 Hz, 2H), 7.87 (d, *J* = 8.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.65, 29.41, 40.61, 55.28, 113.97, 128.21, 129.31, 129.39, 133.46, 134.50, 143.80, 158.03, 199.05. EI-MS, *m/z* (%): 254 (M^+, 44), 239 (6), 134 (17), 119 (94), 103 (13), 91 (100), 77 (30), 65 (46), 51 (12), 41 (6). Anal. Calcd for $C_{17}H_{18}O_2$: C, 80.28; H, 7.13; Found: C, 80.59; H, 7.22.



1-([1,1'-Biphenyl]-4-yl)-3-(3,4-dimethoxyphenyl)propan-1-one (2l): yield: 74 mg, 85%; pale brown solid; m.p. 116-118 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.08 (t, *J* = 7.6 Hz, 2H), 3.35 (t, *J* = 7.7 Hz, 2H), 3.89 (s, 3H), 3.91 (s, 3H), 6.79-6.88 (m, 3H), 7.43 (t, *J* = 7.4 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.66 (d, *J* = 7.6 Hz, 2H), 7.71 (d, *J* = 7.9 Hz, 2H), 8.06 (d, *J* = 7.9 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.91, 40.77, 55.89, 55.98, 111.42, 111.92, 120.23, 127.27, 127.27, 128.26, 128.67, 128.98, 133.97, 135.64, 139.87, 145.76, 147.47, 148.97, 199.00. EI-MS, *m/z* (%): 346 (M^+, 47), 181 (73), 165 (48), 152 (100), 135 (4), 127 (9), 107 (13), 91 (14), 77 (21), 65 (8), 51 (6), 41 (2). Anal. Calcd for $C_{23}H_{22}O_3$: C, 79.74; H, 6.40; Found: C, 80.01; H, 6.50.

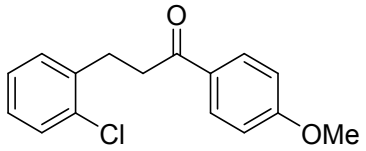


1-(P-tolyl)-3-(2,3,4-trimethoxyphenyl)propan-1-one (2m): yield: 68 mg, 87%; orange solid; m.p. 59-61 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.42 (s, 3H), 3.00 (t, *J* = 7.8 Hz, 2H), 3.25 (t, *J* = 7.8 Hz, 2H), 3.86 (s, 3H), 3.91 (s, 3H), 3.93 (s, 3H), 6.63 (d, *J* = 8.5 Hz, 1H), 6.91 (d, *J* = 8.4 Hz, 1H), 7.27 (d, *J* = 8.0 Hz, 2H), 7.91 (d, *J* = 8.3 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.62, 25.22, 39.76, 56.02, 60.75, 60.90, 107.27, 124.03, 127.23, 128.25, 129.24, 134.47, 142.34, 143.69, 151.96, 152.37, 199.47. EI-MS, *m/z* (%): 314 (M^+, 74), 296 (3), 225 (3), 195 (18), 181 (90), 166 (37), 153 (7), 136 (11), 119 (80), 105 (11), 91 (76), 77 (13), 65 (31), 51 (8), 44 (100). Anal. Calcd for $C_{19}H_{22}O_4$: C, 72.59; H, 7.05; Found: C, 72.22; H, 6.91.

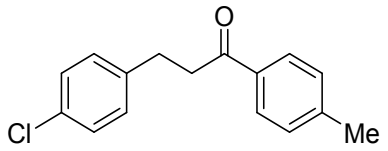


1-Phenyl-3-(3,4,5-trimethoxyphenyl)propan-1-one (2n): yield: 67 mg, 89%; white solid; m.p. 77-79 °C [lit.[9] m.p. 59-61 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.02 (t, *J* = 7.6 Hz, 2H), 3.30 (t, *J* = 7.6 Hz, 2H), 3.82 (s, 3H), 3.84 (s, 6H), 6.47 (s, 2H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.96 (d, *J* = 7.3 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 30.60, 40.56, 56.08, 60.83, 105.41, 128.02, 128.62, 133.11, 136.35, 136.88, 137.10, 153.22, 199.24. EI-MS,

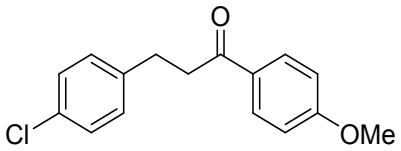
m/z (%): 300 (M^+, 29), 195 (48), 181 (22), 164 (10), 151 (6), 137 (7), 121 (7), 105 (76), 91 (15), 77 (100), 65 (12), 51 (26), 41 (11). Anal. Calcd for $C_{18}H_{20}O_4$: C, 71.98; H, 6.71; Found: C, 71.65; H, 6.59.



3-(2-Chlorophenyl)-1-(4-methoxyphenyl)propan-1-one (2o): yield: 54 mg, 79%; white solid; m.p. 47-49 °C [lit.[10] m.p. 48.5 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.18 (t, *J* = 7.1 Hz, 2H), 3.26 (t, *J* = 7.4 Hz, 2H), 3.85 (s, 3H), 6.93 (d, *J* = 8.5 Hz, 2H), 7.16 (t, *J* = 7.6 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.32 (d, *J* = 7.4 Hz, 1H), 7.36 (d, *J* = 7.8 Hz, 1H), 7.96 (d, *J* = 8.5 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 28.53, 38.09, 55.45, 113.77, 127.01, 127.73, 129.55, 129.89, 130.34, 130.82, 133.95, 139.04, 163.52, 197.46. EI-MS, *m/z* (%): 276 (M^+ ^{37}Cl,<1), 274 (M^+ ^{35}Cl, 4), 239 (100), 224 (3), 210 (3), 195 (4), 178 (6), 165 (15), 152 (7), 145 (4), 135 (86), 125 (52), 119 (12), 107 (80), 99 (12), 92 (83), 77 (83), 63 (59), 51 (62), 41 (3). Anal. Calcd for $C_{16}H_{15}ClO_2$: C, 69.95; H, 5.50; Found: C, 70.26; H, 5.66.

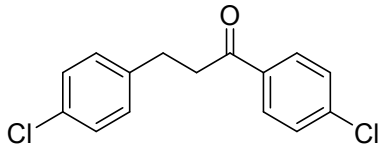


3-(4-Chlorophenyl)-1-(p-tolyl)propan-1-one (2p): yield: 55 mg, 85%; white solid; m.p. 97-99 °C [lit.[11] m.p. 101-102 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.42 (s, 3H), 3.04 (t, *J* = 7.5 Hz, 2H), 3.26 (t, *J* = 7.6 Hz, 2H), 7.19 (d, *J* = 8.4 Hz, 2H), 7.26 (d, *J* = 7.9 Hz, 4H), 7.86 (d, *J* = 8.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.64, 29.47, 40.01, 128.14, 128.58, 129.32, 129.83, 131.83, 134.31, 139.86, 143.97, 198.49. EI-MS, *m/z* (%): 260 (M^+ ^{37}Cl, 7), 258 (M^+ ^{35}Cl, 21), 243 (12), 165 (3), 138 (10), 127 (5), 119 (100), 111 (5), 103 (34), 91 (83), 77 (30), 65 (41), 51 (15), 41 (5). Anal. Calcd for $C_{16}H_{15}ClO$: C, 74.27; H, 5.84; Found: C, 74.53; H, 5.98.

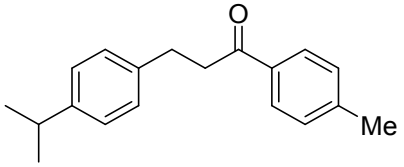


3-(4-Chlorophenyl)-1-(4-methoxyphenyl)propan-1-one (2q): yield: 60 mg, 87%; white solid; m.p. 71-73°C [lit.[12] m.p. 68-70 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.05 (t, *J* = 7.6 Hz, 2H), 3.24 (t, *J* = 7.6 Hz, 2H), 3.87 (s, 3H), 6.94 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.3 Hz, 2H), 7.27 (d, *J* = 8.5 Hz, 2H), 7.95 (d, *J* = 8.3 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.57,

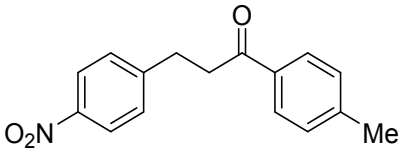
39.76, 55.48, 113.79, 128.57, 129.87, 130.30, 131.79, 139.98, 163.55, 197.38. EI-MS, *m/z* (%): 276 ($M^{+\,37}Cl$, 14), 274 ($M^{+\,35}Cl$, 41), 243 (3), 165 (5), 135 (100), 125 (34), 111 (6), 103 (39), 92 (61), 77 (84), 63 (34), 51 (16), 41 (3). Anal. Calcd for $C_{16}H_{15}ClO_2$: C, 69.95; H, 5.50; Found: C, 70.30; H, 5.63.



1,3-Bis(4-chlorophenyl)propan-1-one (2r): yield: 58 mg, 83%; white solid; m.p. 84-86 °C [lit.[13] m.p. 81-82 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.06 (t, *J* = 7.5 Hz, 2H), 3.27 (t, *J* = 7.6 Hz, 2H), 7.20 (d, *J* = 8.5 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 7.45 (d, *J* = 8.6 Hz, 2H), 7.91 (d, *J* = 8.7 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.30, 40.12, 128.65, 128.98, 129.44, 129.82, 131.98, 135.07, 139.52, 139.64, 197.58. EI-MS, *m/z* (%): 282 ($M^{+\,37}Cl_2$, 3), 280 ($M^{+\,37}Cl\ ^{35}Cl$, 18), 278 ($M^{+\,35}Cl_2$, 27), 243 (12), 225 (3), 178 (4), 165 (5), 139 (100), 125 (36), 111 (94), 103 (49), 89 (24), 75 (76), 63 (19), 50 (30), 41 (4). Anal. Calcd for $C_{15}H_{12}Cl_2O$: C, 64.54; H, 4.33; Found: C, 64.22; H, 4.24.

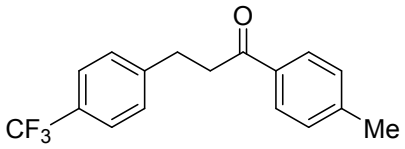


3-(4-Isopropylphenyl)-1-(p-tolyl)propan-1-one (2s): yield: 60 mg, 90%; pale brown solid; m.p. 38-40 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 1.33 (d, *J* = 6.9 Hz, 6H), 2.47 (s, 3H), 2.97 (sept, *J* = 6.9 Hz, 1H), 3.11 (t, *J* = 7.8 Hz, 2H), 3.34 (t, *J* = 7.8 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 7.27 (d, *J* = 8.5 Hz, 2H), 7.31 (d, *J* = 7.9 Hz, 2H), 7.94 (d, *J* = 8.0 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.68, 24.14, 29.88, 33.79, 40.49, 126.61, 128.25, 128.42, 129.34, 134.52, 138.77, 143.81, 146.69, 199.02. EI-MS, *m/z* (%): 266 (M^+, 47), 251 (29), 223 (9), 147 (3), 131 (11), 119 (100), 105 (12), 91 (63), 77 (9), 65 (26), 51 (6), 43 (17). Anal. Calcd for $C_{19}H_{22}O$: C, 85.67; H, 8.32; Found: C, 86.00; H, 8.45.

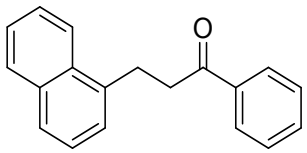


3-(4-Nitrophenyl)-1-(p-tolyl)propan-1-one (2t): yield: 52 mg, 77%; orange solid; m.p. 107-109 °C [lit.[11] m.p. 110-112 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.44 (s, 3H), 3.20 (t, *J* = 7.4 Hz, 2H), 3.35 (t, *J* = 7.4 Hz, 2H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 8.3 Hz, 2H), 7.87 (d, *J* = 8.0 Hz, 2H), 8.17 (d, *J* = 8.4 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.67, 29.84, 39.28,

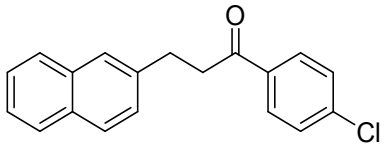
123.76, 128.13, 129.37, 129.41, 134.09, 144.27, 146.53, 149.33, 197.79. EI-MS, *m/z* (%): 269 (M^+, 76), 254 (53), 178 (4), 165 (4), 119 (100), 103 (11), 91 (89), 77 (11), 65 (26), 51 (6), 41 (4). Anal. Calcd for $C_{16}H_{15}NO_3$: C, 71.36; H, 5.61; N, 5.20; Found: C, 71.77; H, 5.73; N, 5.38.



1-(P-tolyl)-3-(4-(trifluoromethyl)phenyl)propan-1-one (2u): yield: 61 mg, 83%; white solid; m.p. 85-87 °C [lit.[14] m.p. 79-80 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.43 (s, 3H), 3.15 (t, *J* = 7.5 Hz, 2H), 3.32 (t, *J* = 7.6 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.40 (d, *J* = 8.1 Hz, 2H), 7.57 (d, *J* = 8.2 Hz, 2H), 7.89 (d, *J* = 8.0 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.58, 29.85, 39.66, 124.37 (q, *J* = 270.5 Hz), 125.41 (q, *J* = 3.8 Hz), 128.15, 128.58 (q, *J* = 33.5 Hz), 128.84, 129.36, 134.26, 144.08, 145.65, 198.20. EI-MS, *m/z* (%): 292 (M^+, 53), 277 (35), 172 (4), 159 (5), 133 (5), 119 (100), 105 (6), 91 (68), 65 (25), 51 (5), 41 (3). Anal. Calcd for $C_{17}H_{15}F_3O$: C, 69.85; H, 5.17; Found: C, 69.58; H, 5.08.

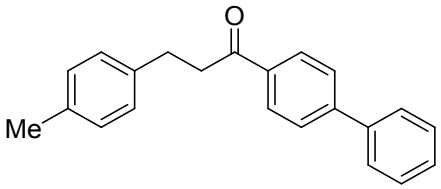


3-(Naphthalen-1-yl)-1-phenylpropan-1-one (2v): yield: 57 mg, 88%; white solid; m.p. 56-58 °C [lit.[15] m.p. 51-52 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.45 (t, *J* = 7.6 Hz, 2H), 3.58 (t, *J* = 7.9 Hz, 2H), 7.43-7.48 (m, 4H), 7.50-7.60 (m, 3H), 7.75-7.79 (m, 1H), 7.90 (d, *J* = 8.0 Hz, 1H), 7.98 (dd, *J* = 8.5 ,1.2 Hz, 2H), 8.09 (d, *J* = 8.2 Hz, 1H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 27.23, 39.76, 123.55, 125.65, 125.69, 126.13, 126.19, 127.04, 128.08, 128.64, 128.96, 131.73, 133.13, 133.98, 136.85, 137.40, 199.30. EI-MS, *m/z* (%): 260 (M^+, 58), 241 (4), 215 (2), 181 (2), 165 (3), 155 (52), 141 (56), 128 (27), 115 (37), 105 (89), 95 (6), 77 (100), 63 (7), 51 (31), 41 (19). Anal. Calcd for $C_{19}H_{16}O$: C, 87.66; H, 6.20; Found: C, 87.90; H, 6.35.

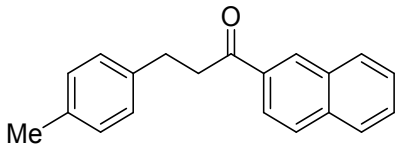


1-(4-Chlorophenyl)-3-(naphthalen-2-yl)propan-1-one (2w): yield: 63 mg, 85%; white solid; m.p. 71-73 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.42 (t, *J* = 7.8 Hz, 2H), 3.57 (t, *J* = 7.8 Hz, 2H), 7.41-7.46 (m, 4H), 7.51-7.59 (m, 2H), 7.78 (dd, *J* = 7.2, 2.4 Hz , 1H), 7.91 (d, *J* = 8.7 Hz, 3H), 8.08 (d, *J* = 7.2 Hz, 1H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 27.15, 39.73, 123.45, 125.67, 125.67, 126.17, 126.21, 127.12, 128.94, 129.00, 129.48, 131.67, 133.98, 135.15, 137.14,

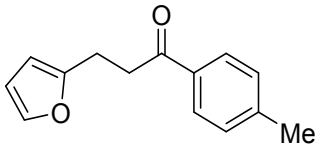
139.57, 198.07. EI-MS, *m/z* (%): 296 (M^+ ^{37}Cl, 16), 294 (M^+ ^{35}Cl, 51), 275 (2), 239 (2), 215 (2), 181 (2), 165 (3), 153 (84), 139 (100), 127 (41), 111 (84), 101 (8), 89 (10), 75 (54), 63 (10), 50 (17), 41 (3). Anal. Calcd for $C_{19}H_{15}ClO$: C, 77.42; H, 5.13; Found: C, 77.09; H, 5.00.



1-([1,1'-Biphenyl]-4-yl)-3-(p-tolyl)propan-1-one (2x): yield: 66 mg, 88%; white solid; m.p. 133-135 °C. ^1H NMR (500 MHz, $CDCl_3$): δ = 2.37 (s, 3H), 3.10 (t, *J* = 7.8 Hz, 2H), 3.35 (t, *J* = 7.8 Hz, 2H), 7.17 (d, *J* = 8.1 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 7.44 (t, *J* = 7.3 Hz, 1H), 7.51 (t, *J* = 7.8 Hz, 2H), 7.67 (d, *J* = 8.5 Hz, 2H), 7.72 (d, *J* = 7.7 Hz, 2H), 8.07 (d, *J* = 8.3 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.05, 29.82, 40.70, 127.27, 127.29, 128.25, 128.35, 128.68, 128.98, 129.26, 135.62, 135.67, 138.25, 139.91, 145.73, 198.96. EI-MS, *m/z* (%): 300 (M^+, 66), 285 (3), 223 (3), 181 (100), 167 (13), 152 (89), 119 (16), 105 (37), 91 (16), 77 (21), 57 (11), 43 (13). Anal. Calcd for $C_{22}H_{20}O$: C, 87.96; H, 6.71; Found: C, 88.22; H, 6.83.

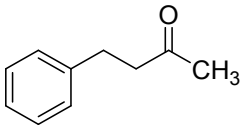


1-(Naphthalen-2-yl)-3-(p-tolyl)propan-1-one (2y): yield: 58 mg, 85%; white solid; m.p. 116-119 °C [lit.[16] m.p. 108-109 °C]. ^1H NMR (500 MHz, $CDCl_3$): δ = 2.39 (s, 3H), 3.15 (t, *J* = 7.7 Hz, 2H), 3.45 (t, *J* = 7.8 Hz, 2H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.58 (td, *J* = 7.0, 1.3 Hz, 1H), 7.63 (td, *J* = 7.0, 1.3 Hz, 1H), 7.91 (t, *J* = 7.7 Hz, 2H), 7.97 (d, *J* = 8.4 Hz, 1H), 8.09 (dd, *J* = 8.6 , 1.8 Hz , 1H), 8.50 (s, 1H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.08, 29.92, 40.76, 123.90, 126.81, 127.82, 128.41, 128.48, 128.48, 129.30, 129.60, 129.75, 132.58, 134.25, 135.62, 135.70, 138.31, 199.32. EI-MS, *m/z* (%): 274 (M^+, 96), 259 (5), 215 (3), 182 (4), 155 (100), 141 (16), 127 (99), 115 (13), 105 (30), 91 (13), 77 (22), 65 (5), 51 (5), 41 (3). Anal. Calcd for $C_{20}H_{18}O$: C, 87.56; H, 6.61; Found: C, 87.85; H, 6.76.

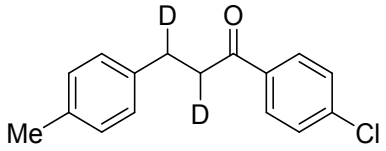


3-(Furan-2-yl)-1-(p-tolyl)propan-1-one (2z): yield: 47 mg, 88%; pale brown solid; m.p. 79-81 °C. ^1H NMR (500 MHz, $CDCl_3$): δ = 2.44 (s, 3H), 3.11 (t, *J* = 7.6 Hz, 2H), 3.33 (t, *J* = 7.6 Hz, 2H), 6.08 (d, *J* = 3.2 Hz, 1H), 6.31 (dd, *J* = 3.0, 2.0 Hz, 1H), 7.28 (d, *J* = 7.9 Hz, 2H), 7.34

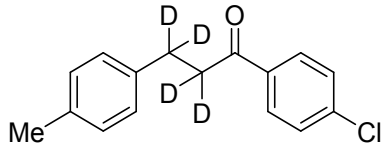
(s, 1H), 7.91 (d, J = 8.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.64, 22.60, 36.81, 105.29, 110.27, 128.18, 129.32, 134.32, 141.08, 143.93, 154.92, 198.27. EI-MS, *m/z* (%): 214 (M^+, 56), 199 (6), 185 (2), 171 (2), 158 (3), 128 (4), 119 (100), 105 (6), 91 (83), 81 (23), 65 (55), 53 (21), 41 (18). Anal. Calcd for $C_{14}H_{14}O_2$: C, 78.48; H, 6.59; Found: C, 78.27; H, 6.50.



4-Phenylbutan-2-one (2aa)[4]: yield: 30 mg, 81%; light yellow liquid. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.14 (s, 3H), 2.77 (t, J = 7.7 Hz, 2H), 2.92 (t, J = 7.7 Hz, 2H), 7.20-7.24 (m, 3H), 7.31 (t, J = 7.6 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 29.76, 30.01, 45.09, 126.14, 128.35, 128.53, 141.08, 207.79. EI-MS, *m/z* (%): 148 (M^+, 83), 133 (19), 119 (15), 105 (100), 91 (74), 81 (33), 69 (66), 57 (33), 43 (82). Anal. Calcd for $C_{10}H_{12}O$: C, 81.04; H, 8.16; Found: C, 81.28; H, 8.29.

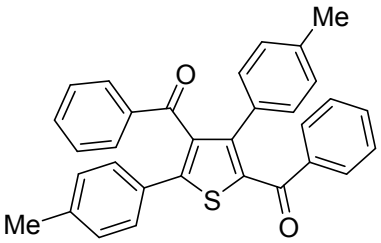


1-(4-Chlorophenyl)-3-(p-tolyl)propan-1-one-2,3-d_2 (2f-d_1): yield: 57 mg, 87%; white solid; m.p. 86-88 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.36 (s, 3H), 3.01-3.08 (m, 1H), 3.22-3.30 (m, 1H), 7.14 (d, J = 8.0 Hz, 2H), 7.17 (d, J = 8.1 Hz, 2H), 7.45 (d, J = 8.6 Hz, 2H), 7.92 (d, J = 8.3 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.01, 29.64 (br, CHD), 40.61 (br, CHD), 128.29, 128.93, 129.26, 129.48, 135.22, 135.76, 137.93, 139.47, 198.13. EI-MS, *m/z* (%): 262 (M^+ ^{37}Cl, 8), 260 (M^+ ^{35}Cl, 17), 244 (4), 225 (3), 165 (2), 139 (100), 119 (27), 111 (70), 105 (26), 91 (24), 84 (3), 75 (42), 65 (17), 50 (15), 41 (5).

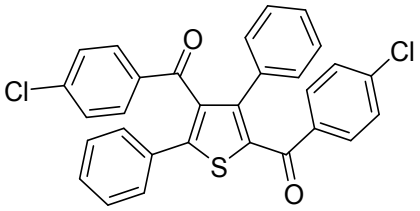


1-(4-Chlorophenyl)-3-(p-tolyl)propan-1-one-2,2,3,3-d_4 (2f-d_2): yield: 59 mg, 90%; white solid; m.p. 84-86 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.37 (s, 3H), 3.03-3.07 (m, 0.34H), 3.24-3.29 (m, 0.44H), 7.15 (d, J = 7.9 Hz, 2H), 7.18 (d, J = 7.9 Hz, 2H), 7.45 (d, J = 8.4 Hz, 2H), 7.93 (d, J = 8.4 Hz, 2H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.04, 29.10 (br, CD_2), 40.10 (br, CD_2), 128.30, 128.94, 129.28, 129.50, 135.24, 135.75, 137.90, 139.49, 198.23. EI-MS, *m/z* (%): 264 (M^+ ^{37}Cl, 16), 262 (M^+ ^{35}Cl, 53), 247 (7), 227 (6), 139 (100), 130 (4), 120 (26), 111 (60), 106 (29), 93 (15), 85 (3), 80 (10), 75 (28), 65 (11), 50 (12), 41 (5).

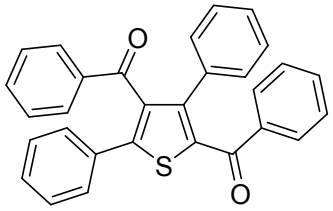
4.2. Thiophenes



(3,5-Di-p-tolylthiophene-2,4-diyl)bis(phenylmethanone) (3a): yield: 51 mg, 86%; white solid; m.p. 151-153 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.09 (s, 3H), 2.29 (s, 3H), 6.74 (d, *J* = 7.7 Hz, 2H), 6.96 (d, *J* = 7.5 Hz, 2H), 7.09 (d, *J* = 7.8 Hz, 2H), 7.17 (t, *J* = 7.5 Hz, 2H), 7.22 (t, *J* = 7.7 Hz, 2H), 7.32 (t, *J* = 8.2 Hz, 1H), 7.36 (t, *J* = 7.5 Hz, 1H), 7.39 (d, *J* = 7.7 Hz, 2H), 7.63 (d, *J* = 7.1 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.01, 21.22, 127.78, 128.27, 128.46, 128.62, 129.56, 129.58, 129.64, 129.75, 130.28, 131.24, 132.10, 133.34, 136.91, 137.11, 137.53, 137.57, 138.41, 139.29, 146.22, 148.02, 189.96, 194.97. EI-MS, *m/z* (%): 472 (M^+, 39), 457 (8), 395 (4), 367 (4), 317 (3), 289 (3), 245 (4), 202 (11), 105 (81), 77 (100), 57 (11), 43 (15). Anal. Calcd for $C_{32}H_{24}O_2S$: C, 81.33; H, 5.12; Found: C, 81.70; H, 5.28.

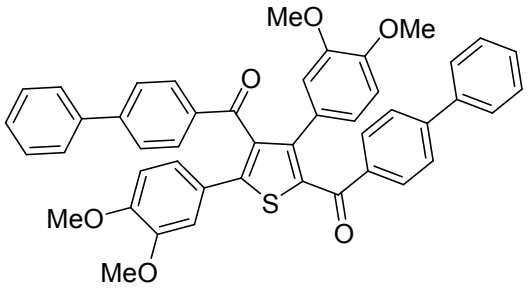


(3,5-Diphenylthiophene-2,4-diyl)bis((4-chlorophenyl)methanone) (3b): yield: 53 mg, 83%; pale brown solid; m.p. 141-143 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.97-7.05 (m, 5H), 7.12 (d, *J* = 8.6 Hz, 2H), 7.17 (d, *J* = 8.6 Hz, 2H), 7.30-7.35 (m, 3H), 7.40-7.50 (m, 2H), 7.50-7.61 (m, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 128.01, 128.13, 128.19, 128.72, 128.78, 129.00, 129.47, 129.86, 130.85, 130.85, 131.95, 133.77, 135.30, 135.53, 137.55, 138.16, 138.70, 140.00, 145.74, 148.52, 188.64, 193.26. EI-MS, *m/z* (%): 516 (M^+ $^{37}Cl_2$, 5), 514 (M^+ ^{37}Cl ^{35}Cl, 27), 512 (M^+ $^{35}Cl_2$, 42), 373 (7), 308 (7), 201 (14), 189 (25), 139 (100), 111 (83), 75 (23), 51 (3). Anal. Calcd for $C_{30}H_{18}Cl_2O_2S$: C, 70.18; H, 3.53; Found: C, 70.51; H, 3.66.

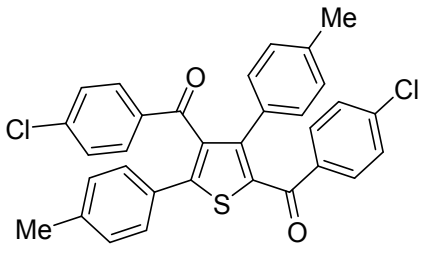


(3,5-Diphenylthiophene-2,4-diyl)bis(phenylmethanone) (3c): yield: 47 mg, 85%; pale yellow solid; m.p. 129-131 °C [lit.[17] m.p. 158-160 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.93-

6.96 (m, 3H), 7.06-7.10 (m, 2H), 7.16 (t, *J* = 7.8 Hz, 2H), 7.21 (t, *J* = 7.9 Hz, 2H), 7.28-7.32 (m, 4H), 7.35 (t, *J* = 7.4 Hz, 1H), 7.43-7.53 (m, 2H), 7.60-7.65 (m, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 127.76, 127.82, 127.82, 128.27, 128.82, 128.87, 129.19, 129.55, 129.58, 129.90, 132.24, 132.34, 133.40, 134.12, 137.05, 137.36, 137.64, 138.74, 145.91, 147.99, 189.92, 194.66. EI-MS, *m/z* (%): 444 (M^+, 37), 415 (1), 367 (5), 339 (6), 309 (3), 289 (6), 261 (3), 232 (3), 189 (22), 163 (3), 121 (3), 105 (75), 77 (100), 51 (17). Anal. Calcd for $C_{30}H_{20}O_2S$: C, 81.06; H, 4.53; Found: C, 79.78; H, 4.39.

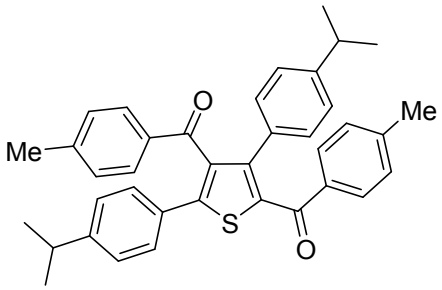


(3,5-Bis(3,4-dimethoxyphenyl)thiophene-2,4-diyl)bis([1,1'-biphenyl]-4-ylmethanone) (3d): yield: 71 mg, 79%; pale yellow solid; m.p. 154-156 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.62 (s, 3H), 3.66 (s, 3H), 3.82 (s, 3H), 3.87 (s, 3H), 6.44 (d, *J* = 8.3 Hz, 1H), 6.68 (d, *J* = 8.2 Hz, 1H), 6.72 (s, 1H), 6.83 (d, *J* = 8.4 Hz, 1H), 7.11 (s, 1H), 7.17 (dd, *J* = 8.5 ,2.1 Hz, 1H), 7.38-7.41 (m, 4H), 7.42-7.46 (m, 4H), 7.48-7.54 (m, 6H), 7.72 (d, *J* = 8.0 Hz, 2H), 7.76 (d, *J* = 8.1 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 55.64, 55.70, 55.81, 55.89, 110.54, 111.36, 111.80, 113.26, 121.53, 123.18, 125.06, 126.51, 126.81, 127.11, 127.20, 127.22, 128.10, 128.39, 128.87, 128.93, 130.03, 130.20, 135.85, 136.19, 136.89, 138.18, 139.51, 139.97, 145.02, 145.54, 146.20, 147.64, 148.17, 148.78, 148.96, 149.96, 189.72, 195.20. EI-MS, *m/z* (%): 716 (M^+, 100), 701 (3), 519 (2), 488 (2), 433 (2), 281 (13), 266 (11), 244 (3), 181 (60), 152 (83), 127 (4), 77 (5), 43 (2). Anal. Calcd for $C_{46}H_{36}O_6S$: C, 77.07; H, 5.06; Found: C, 77.29; H, 5.18.

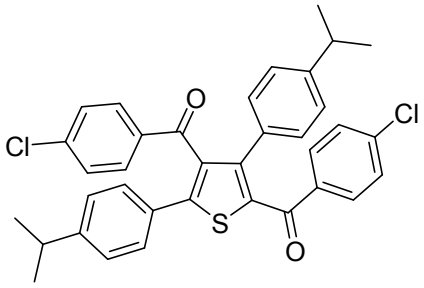


(3,5-Di-p-tolylthiophene-2,4-diyl)bis((4-chlorophenyl)methanone) (3e): yield: 57 mg, 84%; white solid; m.p. 123-125 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.14 (s, 3H), 2.32 (s, 3H), 6.78 (d, *J* = 7.6 Hz, 2H), 6.91 (d, *J* = 7.8 Hz, 2H), 7.12 (m, 4H), 7.19 (d, *J* = 8.4 Hz, 2H), 7.36 (d, *J* = 7.9 Hz, 2H), 7.52 (d, *J* = 8.3 Hz, 2H), 7.55 (d, *J* = 8.6 Hz, 2H). ^{13}C NMR (125

MHz, $CDCl_3$): δ = 21.04, 21.26, 128.06, 128.59, 128.68, 128.73, 129.16, 129.71, 129.75, 130.83, 130.87, 130.91, 135.35, 135.69, 136.93, 137.81, 138.18, 138.49, 139.67, 139.92, 146.04, 148.65, 188.74, 193.56. EI-MS, *m/z* (%): 544 (M^+ $^{37}Cl_2$, 10), 542 (M^+ ^{37}Cl ^{35}Cl, 22), 540 (M^+ $^{35}Cl_2$, 12), 525 (7), 401 (7), 317 (5), 202 (12), 139 (100), 111 (74), 75 (14), 50 (2). Anal. Calcd for $C_{32}H_{22}Cl_2O_2S$: C, 70.98; H, 4.10; Found: C, 70.69; H, 4.00.

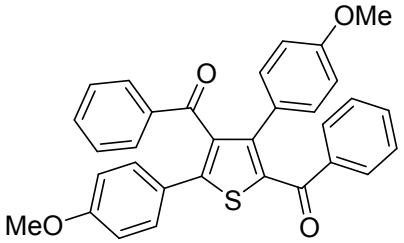


(3,5-Bis(4-isopropylphenyl)thiophene-2,4-diyl)bis(p-tolylmethanone) (3f): yield: 59 mg, 85%; white solid; m.p. 133-135 °C. ^1H NMR (500 MHz, $CDCl_3$): δ = 1.03 (d, *J* = 6.9 Hz, 6H), 1.22 (d, *J* = 6.9 Hz, 6H), 2.25 (s, 3H), 2.27 (s, 3H), 2.65 (sept, *J* = 6.9 Hz, 1H), 2.87 (sept, *J* = 6.9 Hz, 1H), 6.77 (d, *J* = 7.9 Hz, 2H), 6.93 (d, *J* = 8.0 Hz, 2H), 6.97 (d, *J* = 8.1 Hz, 2H), 7.01 (d, *J* = 7.9 Hz, 2H), 7.16 (d, *J* = 8.3 Hz, 2H), 7.45 (d, *J* = 8.3 Hz, 2H), 7.49 (d, *J* = 8.2 Hz, 2H), 7.54 (d, *J* = 8.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.46, 21.60, 23.69, 23.72, 33.65, 33.83, 125.64, 126.93, 128.33, 128.71, 128.94, 129.72, 129.83, 130.02, 130.53, 131.74, 134.90, 134.90, 137.45, 138.46, 142.56, 144.12, 145.92, 147.80, 148.30, 149.93, 189.95, 194.78. EI-MS, *m/z* (%): 556 (M^+, 81), 541 (9), 513 (23), 497 (3), 437 (3), 315 (2), 289 (2), 119 (100), 91 (73), 65 (13), 43 (56). Anal. Calcd for $C_{38}H_{36}O_2S$: C, 81.98; H, 6.52; Found: C, 82.27; H, 6.65.

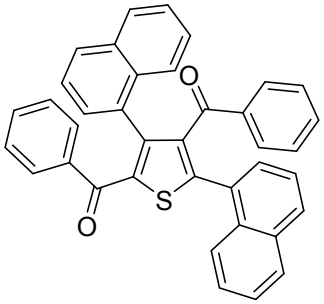


(3,5-Bis(4-isopropylphenyl)thiophene-2,4-diyl)bis((4-chlorophenyl)methanone) (3g): yield: 63 mg, 84%; white solid; m.p. 171-173 °C. ^1H NMR (500 MHz, $CDCl_3$): δ = 1.07 (d, *J* = 6.9 Hz, 6H), 1.23 (d, *J* = 7.0 Hz, 6H), 2.68 (sept, *J* = 6.9 Hz, 1H), 2.89 (sept, *J* = 6.9 Hz, 1H), 6.79 (d, *J* = 8.2 Hz, 2H), 6.92 (d, *J* = 8.2 Hz, 2H), 7.06 (d, *J* = 8.6 Hz, 2H), 7.17 (d, *J* = 8.6 Hz, 2H), 7.19 (d, *J* = 7.2 Hz, 2H), 7.43 (d, *J* = 8.3 Hz, 2H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.54 (d, *J* = 8.6 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 23.70, 23.73, 33.71, 33.87, 125.91, 127.09, 127.89, 128.60, 128.78, 129.54, 130.10, 130.73, 130.92, 131.22, 135.54, 135.71, 137.46,

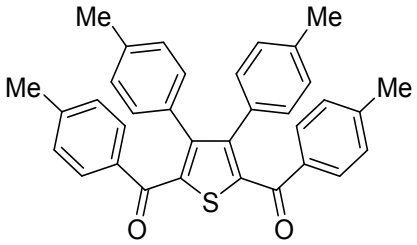
137.78, 138.10, 139.74, 146.25, 149.17, 149.41, 150.50, 189.01, 193.56. EI-MS, *m/z* (%): 600 (M^+ $^{37}Cl_2$, 14), 598 (M^+ ^{37}Cl ^{35}Cl, 56), 596 (M^+ $^{35}Cl_2$, 73), 581 (14), 553 (21), 537 (2), 457 (2), 443 (2), 287 (3), 241 (2), 139 (100), 111 (44), 91 (2), 75 (3), 43 (21). Anal. Calcd for $C_{36}H_{30}Cl_2O_2S$: C, 72.36; H, 5.06; Found: C, 72.69; H, 5.20.



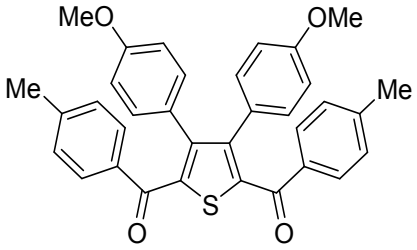
(3,5-Bis(4-methoxyphenyl)thiophene-2,4-diyl)bis(phenylmethanone) (3h): yield: 52 mg, 82%; pale yellow solid; m.p. 139-140°C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.59 (s, 3H), 3.76 (s, 3H), 6.46 (d, *J* = 8.5 Hz, 2H), 6.81 (d, *J* = 8.6 Hz, 2H), 6.99 (d, *J* = 8.6 Hz, 2H), 7.17 (t, *J* = 7.6 Hz, 2H), 7.21 (t, *J* = 7.7 Hz, 2H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.35 (t, *J* = 7.1 Hz, 1H), 7.44 (d, *J* = 8.6 Hz, 2H), 7.59-7.64 (m, 4H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 55.04, 55.27, 113.26, 114.31, 124.81, 126.65, 127.78, 128.31, 129.52, 129.60, 130.11, 131.20, 132.12, 133.41, 136.50, 137.07, 137.55, 138.10, 145.85, 147.98, 159.08, 160.36, 190.04, 195.19. EI-MS, *m/z* (%): 504 (M^+, < 1), 444 (7), 339 (2), 308 (2), 261 (2), 189 (15), 105 (53), 77 (100), 57 (19), 43 (31). Anal. Calcd for $C_{32}H_{24}O_4S$: C, 76.17; H, 4.79; Found: C, 76.41; H, 4.95.



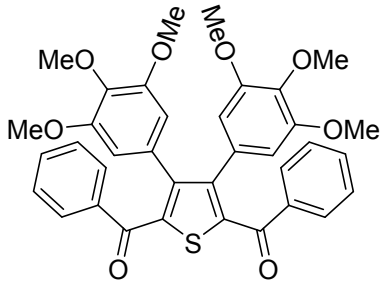
(3,5-Di(naphthalen-1-yl)thiophene-2,4-diyl)bis(phenylmethanone) (3i): yield: 57 mg, 84%; white solid; m.p. 122-124 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.86-6.93 (m, 4H), 7.06 (t, *J* = 7.6 Hz, 1H), 7.10-7.17 (m, 2H), 7.33-7.39 (m, 4H), 7.41-7.44 (m, 2H), 7.45-7.48 (m, 3H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 7.9 Hz, 1H), 7.58 (d, *J* = 8.4 Hz, 1H), 7.67 (d, *J* = 7.1 Hz, 1H), 7.81 (t, *J* = 6.9 Hz, 2H), 7.94 (d, *J* = 8.5 Hz, 1H), 8.20 (d, *J* = 8.4 Hz, 1H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 124.54, 124.85, 125.44, 125.60, 125.60, 126.27, 126.38, 126.90, 127.19, 127.42, 128.07, 128.31, 128.54, 128.58, 128.86, 128.92, 129.38, 129.57, 129.87, 131.88, 132.07, 132.19, 132.25, 132.50, 133.03, 133.42, 136.78, 137.49, 140.05, 142.10, 143.87, 147.82, 190.09, 192.91. EI-MS, *m/z* (%): 544 (M^+, < 1), 84 (100), 70 (3), 49 (56). Anal. Calcd for $C_{38}H_{24}O_2S$: C, 83.80; H, 4.44; Found: C, 84.17; H, 4.60.



(3,4-Di-p-tolylthiophene-2,5-diyl)bis(p-tolylmethanone) (3j): yield: 55 mg, 88%; pale yellow solid; m.p. 202-204 °C [lit.[18] m.p. 145-147 °C]. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.20 (s, 6H), 2.34 (s, 6H), 6.86 (s, 8H), 7.07 (d, *J* = 7.9 Hz, 4H), 7.65 (d, *J* = 7.3 Hz, 4H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.16, 21.64, 128.47, 128.74, 130.03, 130.26, 131.66, 134.75, 137.12, 140.25, 143.74, 145.34, 189.94. EI-MS, *m/z* (%): 500 (M^+, 73), 486 (23), 472 (3), 409 (3), 381 (6), 317 (3), 289 (3), 204 (6), 183 (5), 119 (90), 91 (100), 65 (26), 43 (5). Anal. Calcd for $C_{34}H_{28}O_2S$: C, 81.57; H, 5.64; Found: C, 81.25; H, 5.51.

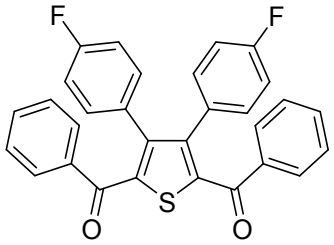


(3,4-Bis(4-methoxyphenyl)thiophene-2,5-diyl)bis(p-tolylmethanone) (3k): yield: 54 mg, 81%; yellow solid; m.p. 173-175 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.34 (s, 6H), 3.70 (s, 6H), 6.59 (d, *J* = 8.7 Hz, 4H), 6.88 (d, *J* = 8.8 Hz, 4H), 7.07 (d, *J* = 7.9 Hz, 4H), 7.63 (d, *J* = 8.3 Hz, 4H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.64, 55.10, 113.28, 127.01, 128.75, 130.03, 131.65, 134.70, 140.08, 143.73, 144.84, 158.89, 190.06. EI-MS, *m/z* (%): 532 (M^+, 31), 517 (2), 413 (2), 349 (2), 321 (2), 249 (3), 220 (8), 163 (5), 148 (3), 119 (92), 105 (1), 91 (100), 77 (2), 65 (21), 43 (2). Anal. Calcd for $C_{34}H_{28}O_4S$: C, 76.67; H, 5.30; Found: C, 77.01; H, 5.46.

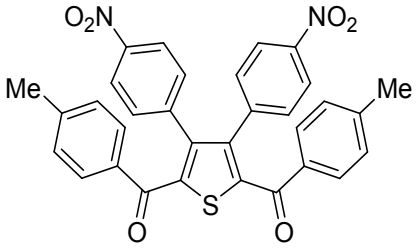


(3,4-Bis(3,4,5-trimethoxyphenyl)thiophene-2,5-diyl)bis(phenylmethanone) (3l): yield: 65 mg, 83%; yellow solid; m.p. 148-150 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 3.49 (s, 12H), 3.65 (s, 6H), 6.14 (s, 4H), 7.22 (t, *J*= 7.8 Hz, 4H), 7.37 (t, *J* = 7.5 Hz, 2H), 7.66 (d, *J* = 7.6 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 56.02, 60.71, 108.35, 128.00, 129.41, 129.79, 132.94,

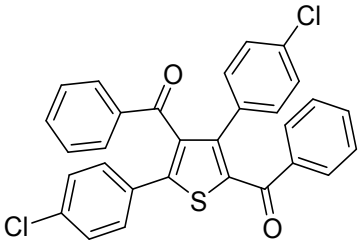
137.07, 137.68, 141.31, 144.56, 152.50, 190.47. EI-MS, *m/z* (%): 624 (M^+, 100), 609 (11), 547 (6), 368 (3), 313 (3), 236 (3), 105 (72), 77 (19). Anal. Calcd for $C_{36}H_{32}O_8S$: C, 69.22; H, 5.16; Found: C, 69.48; H, 5.27.



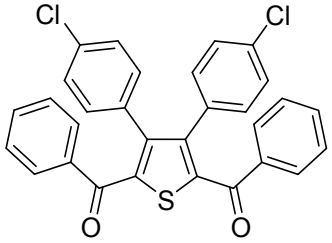
(3,4-Bis(4-fluorophenyl)thiophene-2,5-diyl)bis(phenylmethanone) (3m): yield: 48 mg, 80%; white solid; m.p. 167-168 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.75 (t, *J* = 8.6 Hz, 4H), 6.92 (dd, *J*= 8.4, 5.4 Hz, 4H), 7.28 (t, *J* = 7.6 Hz, 4H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.70 (d, *J* = 7.7 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 115.01 (d, *J* = 21.7 Hz), 128.17, 129.69, 130.23 (d, *J* = 3.4 Hz), 132.14 (d, *J* = 8.2 Hz), 133.11, 137.01, 141.16, 144.28, 162.15 (d, *J* = 247.3 Hz), 189.94. ^{19}F NMR (470 MHz, $CDCl_3$): δ = -113.42 – -113.48 (m, 1F). EI-MS, *m/z* (%): 480 (M^+, 91), 403 (20), 375 (9), 325 (9), 227 (8), 201 (20), 123 (6), 105 (100), 77 (74), 57 (11). Anal. Calcd for $C_{30}H_{18}F_2O_2S$: C, 74.99; H, 3.78; Found: C, 75.25; H, 3.90.



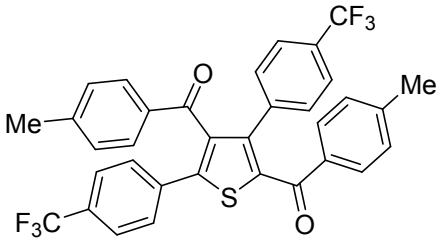
(3,4-Bis(4-nitrophenyl)thiophene-2,5-diyl)bis(p-tolylmethanone) (3n): yield: 53 mg, 75%; white solid; m.p. 186-188 °C.^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.36 (s, 6H), 7.15 (d, *J* = 8.1 Hz, 4H), 7.17 (d, *J* = 8.8 Hz, 4H), 7.67 (d, *J* = 8.2 Hz, 4H), 7.98 (d, *J* = 8.8 Hz, 4H).^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.72, 123.33, 129.23, 129.94, 131.08, 134.24, 140.67, 141.80, 142.53, 145.08, 147.18, 188.21. EI-MS, *m/z* (%): 562 (M^+, 38), 545 (5), 533 (3), 515 (5), 471 (4), 187 (3), 119 (100), 91 (77), 65 (15). Anal. Calcd for $C_{32}H_{22}N_2O_6S$: C, 68.32; H, 3.94; N, 4.98; Found: C, 68.66; H, 4.11; N, 5.25.



(3,5-Bis(4-chlorophenyl)thiophene-2,4-diyl)bis(phenylmethanone) (3o): yield: 29 mg, 45%; pale brown solid; m.p. 147-149 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.96 (d, *J* = 8.4 Hz, 2H), 7.03 (d, *J*= 8.5 Hz, 2H), 7.16-7.32 (m, 6H), 7.41 (t, *J* = 7.3 Hz, 2H), 7.44 (d, *J* = 8.5 Hz, 2H), 7.62 (d, *J* = 8.0 Hz, 2H), 7.65 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 128.07, 128.08, 128.55, 129.22, 129.52, 129.56, 130.00, 130.55, 131.09, 132.47, 132.69, 133.90, 134.14, 135.57, 136.73, 137.24, 138.05, 138.91, 144.56, 146.49, 189.44, 194.31. EI-MS, *m/z* (%): 516 (M^+ $^{37}Cl_2$, 15), 514 (M^+ ^{37}Cl ^{35}Cl, 65), 512 (M^+ $^{35}Cl_2$, 82), 477 (4), 435 (12), 407 (6), 357 (8), 308 (6), 217 (19), 199 (6), 187 (9), 168 (5), 105 (100), 77 (64), 51 (4). Anal. Calcd for $C_{30}H_{18}Cl_2O_2S$: C, 70.18; H, 3.53; Found: C, 70.51; H, 3.69.

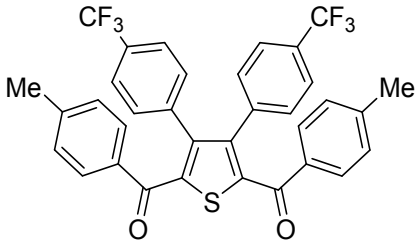


(3,4-Bis(4-chlorophenyl)thiophene-2,5-diyl)bis(phenylmethanone) (3p): yield: 23 mg, 36%; white solid; m.p. 187-189 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 6.89 (d, *J* = 8.4 Hz, 4H), 7.04 (d, *J*= 8.3 Hz, 4H), 7.29 (t, *J* = 7.7 Hz, 4H), 7.46 (t, *J* = 7.5 Hz, 2H), 7.71 (d, *J* = 8.2 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 128.21, 128.24, 129.70, 131.62, 132.58, 133.21, 133.98, 136.99, 141.23, 144.07, 189.69. EI-MS, *m/z* (%): 516 (M^+ $^{37}Cl_2$, 12), 514 (M^+ ^{37}Cl ^{35}Cl, 55), 512 (M^+ $^{35}Cl_2$, 72), 477 (6), 435 (9), 407 (5), 357 (4), 308 (4), 217 (9), 187 (4), 167 (4), 123 (4), 105 (100), 77 (79), 51 (9). Anal. Calcd for $C_{30}H_{18}Cl_2O_2S$: C, 70.18; H, 3.53; Found: C, 70.47; H, 3.65.

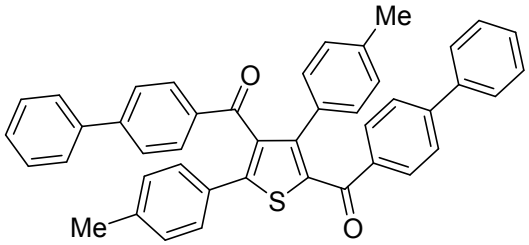


(3,5-Bis(4-(trifluoromethyl)phenyl)thiophene-2,4-diyl)bis(p-tolylmethanone) (3q): yield: 32 mg, 42%; white solid; m.p. 159-161 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.30 (s, 6H), 7.02 (d, *J* = 8.1 Hz, 2H), 7.06 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.3 Hz, 2H), 7.26 (d, *J* = 8.3 Hz, 2H), 7.53 (dd, *J* = 8.3 ,2.9 Hz, 4H), 7.58 (d, *J* = 8.6 Hz, 2H), 7.63 (d, *J* = 8.1 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.43, 21.67, 123.78 (q, *J* = 270.8 Hz), 124.74 (q, *J* = 3.7 Hz), 125.24 (q, *J* = 270.9 Hz), 125.94 (q, *J* = 3.7 Hz), 128.77, 129.03, 129.39, 129.63, 129.68, 129.73, 129.89, 130.18, 134.22, 134.44, 135.59, 135.60, 137.66, 139.43, 139.59, 143.93, 143.95,

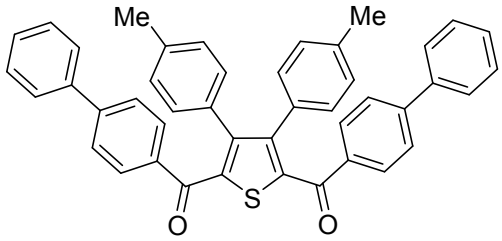
145.30, 188.90, 193.61. ^{19}F NMR (470 MHz, $CDCl_3$): δ = -62.92 (s, 3F), -62.95 (s, 3F). EI-MS, *m/z* (%): 608 (M^+, 12), 589 (1), 517 (2), 447 (2), 425 (4), 258 (5), 119 (87), 91 (100), 65 (26), 43 (4). Anal. Calcd for $C_{34}H_{22}F_6O_2S$: C, 67.10; H, 3.64; Found: C, 67.41; H, 3.78.



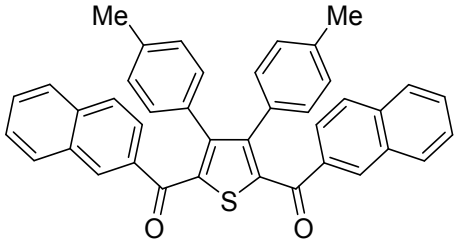
(3,4-Bis(4-(trifluoromethyl)phenyl)thiophene-2,5-diyl)bis(p-tolylmethanone) (3r): yield: 24 mg, 32%; white solid; m.p. 192-194 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.32 (s, 6H), 7.08 (t, *J* = 7.4 Hz, 8H), 7.32 (d, *J* = 8.0 Hz, 4H), 7.60 (d, *J* = 8.3 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.49, 123.83 (q, *J* = 270.9 Hz), 124.85 (q, *J* = 3.6 Hz), 128.95, 129.73 (q, *J* = 32.6 Hz), 129.84, 130.72, 134.36, 137.84, 142.00, 143.49, 144.44, 189.03. ^{19}F NMR (470 MHz, $CDCl_3$): δ = -62.83 (s, 6F). EI-MS, *m/z* (%): 608 (M^+, 15), 517 (2), 447 (2), 258 (3), 119 (100), 91 (67), 65 (15), 41 (3). Anal. Calcd for $C_{32}H_{24}O_2S$: C, 81.33; H, 5.12; Found: C, 81.70; H, 5.28. Anal. Calcd for $C_{34}H_{22}F_6O_2S$: C, 67.10; H, 3.64; Found: C, 67.46; H, 3.83.



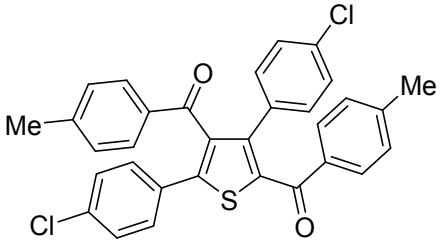
(3,5-Di-p-tolylthiophene-2,4-diyl)bis([1,1'-biphenyl]-4-ylmethanone) (3s): yield: 33 mg, 42%; white solid; m.p. 135-137 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.08 (s, 3H), 2.32 (s, 3H), 6.79 (d, *J* = 7.8 Hz, 2H), 7.03 (d, *J* = 7.9 Hz, 2H), 7.14 (d, *J* = 7.9 Hz, 2H), 7.37-7.41 (m, 4H), 7.43-7.46 (m, 4H), 7.46-7.49 (m, 4H), 7.53 (t, *J* = 7.4 Hz, 4H), 7.72 (d, *J* = 8.1 Hz, 2H), 7.74 (d, *J* = 8.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.05, 21.26, 126.50, 126.93, 127.18, 127.19, 128.05, 128.30, 128.57, 128.65, 128.86, 128.90, 129.66, 129.87, 130.18, 130.28, 130.38, 131.34, 135.86, 136.23, 137.22, 137.69, 138.45, 139.36, 139.62, 140.11, 144.88, 145.84, 146.16, 147.98, 189.61, 194.58. EI-MS, *m/z* (%): 624 (M^+, 79), 609 (7), 471 (4), 443 (5), 365 (4), 317 (7), 235 (16), 202 (6), 181 (75), 152 (100), 127 (7), 77 (6). Anal. Calcd for $C_{44}H_{32}O_2S$: C, 84.58; H, 5.16; Found: C, 84.95; H, 5.33.



(3,4-Di-p-tolylthiophene-2,5-diyl)bis([1,1'-biphenyl]-4-ylmethanone) (3t): yield: 30 mg, 38%; pale yellow solid; m.p. 209-211 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.17 (s, 6H), 6.85 (d, *J* = 8.4 Hz, 4H), 6.88 (d, *J* = 8.4 Hz, 4H), 7.40 (t, *J* = 7.1 Hz, 2H), 7.45-7.49 (m, 8H), 7.55 (d, *J* = 7.3 Hz, 4H), 7.79 (d, *J* = 8.4 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.14, 126.68, 127.23, 128.19, 128.50, 128.90, 130.38, 130.38, 131.56, 135.92, 137.33, 139.97, 140.75, 145.45, 145.62, 189.97. EI-MS, *m/z* (%): 624 (M^+, 100), 609 (20), 441 (6), 427 (5), 235 (4), 214 (4), 181 (34), 152 (53), 127 (4), 77 (5). Anal. Calcd for $C_{32}H_{24}O_2S$: C, 81.33; H, 5.12; Found: C, 81.70; H, 5.28. Anal. Calcd for $C_{44}H_{32}O_2S$: C, 84.58; H, 5.16; Found: C, 84.87; H, 5.29.

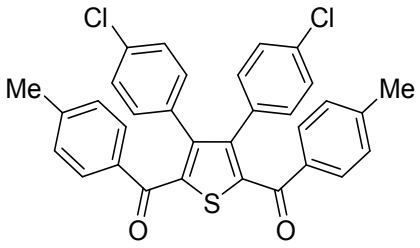


(3,4-Di-p-tolylthiophene-2,5-diyl)bis(naphthalen-2-ylmethanone) (3u): yield: 57 mg, 80%; pale yellow solid; m.p. 214-216 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.04 (s, 6H), 6.77 (d, *J* = 7.9 Hz, 4H), 6.91 (d, *J* = 8.1 Hz, 4H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.75 (d, *J* = 8.6 Hz, 2H), 7.80 (d, *J* = 8.3 Hz, 4H), 7.86 (dd, *J* = 8.5 , 1.8 Hz , 2H), 8.25 (s, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 20.98, 124.92, 126.55, 127.65, 128.07, 128.46, 128.52, 129.48, 130.20, 131.63, 131.96, 132.33, 134.49, 135.35, 137.26, 140.74, 145.78, 190.25. EI-MS, *m/z* (%): 572 (M^+, 52), 558 (17), 544 (4), 415 (7), 401 (4), 317 (4), 222 (4), 201 (5), 155 (49), 127 (100), 101 (4), 77 (7). Anal. Calcd for $C_{40}H_{28}O_2S$: C, 83.89; H, 4.93; Found: C, 83.61; H, 4.75.



(3,5-Bis(4-chlorophenyl)thiophene-2,4-diyl)bis(p-tolylmethanone) (3v): yield: 32 mg, 47%; white solid; m.p. 89-91 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.31 (s, 3H), 2.34 (s, 3H),

6.98 (d, *J* = 8.4 Hz, 2H), 7.05 (m, 6H), 7.28 (d, *J* = 8.5 Hz, 2H), 7.44 (d, *J* = 8.5 Hz, 2H), 7.53 (d, *J* = 8.0 Hz, 2H), 7.57 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.61, 21.72, 128.09, 128.78, 129.19, 129.34, 129.76, 129.79, 129.91, 130.69, 131.02, 132.61, 134.04, 134.32, 134.58, 135.39, 138.07, 138.97, 143.81, 144.11, 145.06, 145.54, 189.13, 194.07. EI-MS, *m/z* (%): 544 (M^+ $^{37}Cl_2$, 17), 542 (M^+ ^{37}Cl ^{35}Cl, 75), 540 (M^+ $^{35}Cl_2$, 100), 505 (4), 449 (7), 421 (5), 357 (6), 224 (6), 119 (23), 91 (16), 65 (3). Anal. Calcd for $C_{32}H_{22}Cl_2O_2S$: C, 70.98; H, 4.10; Found: C, 71.24; H, 4.26.



(3,4-Bis(4-chlorophenyl)thiophene-2,5-diyl)bis(p-tolylmethanone) (3w): yield: 25 mg, 37%; pale yellow solid; m.p. 170-172 °C. ^{1}H NMR (500 MHz, $CDCl_3$): δ = 2.36 (s, 6H), 6.90 (d, *J* = 8.5 Hz, 4H), 7.06 (d, *J* = 8.5 Hz, 4H), 7.11 (d, *J* = 7.8 Hz, 4H), 7.63 (d, *J* = 8.3 Hz, 4H). ^{13}C NMR (125 MHz, $CDCl_3$): δ = 21.69, 128.20, 128.96, 129.96, 131.60, 132.75, 133.88, 134.45, 140.99, 143.67, 144.36, 189.28. EI-MS, *m/z* (%): 544 (M^+ $^{37}Cl_2$, 9), 542 (M^+ ^{37}Cl ^{35}Cl, 40), 540 (M^+ $^{35}Cl_2$, 46), 505 (4), 449 (4), 421 (6), 357 (4), 224 (14), 189 (6), 119 (100), 91 (88), 65 (20). Anal. Calcd for $C_{32}H_{24}O_2S$: C, 81.33; H, 5.12; Found: C, 81.70; H, 5.28. Anal. Calcd for $C_{32}H_{22}Cl_2O_2S$: C, 70.98; H, 4.10; Found: C, 71.31; H, 4.29.

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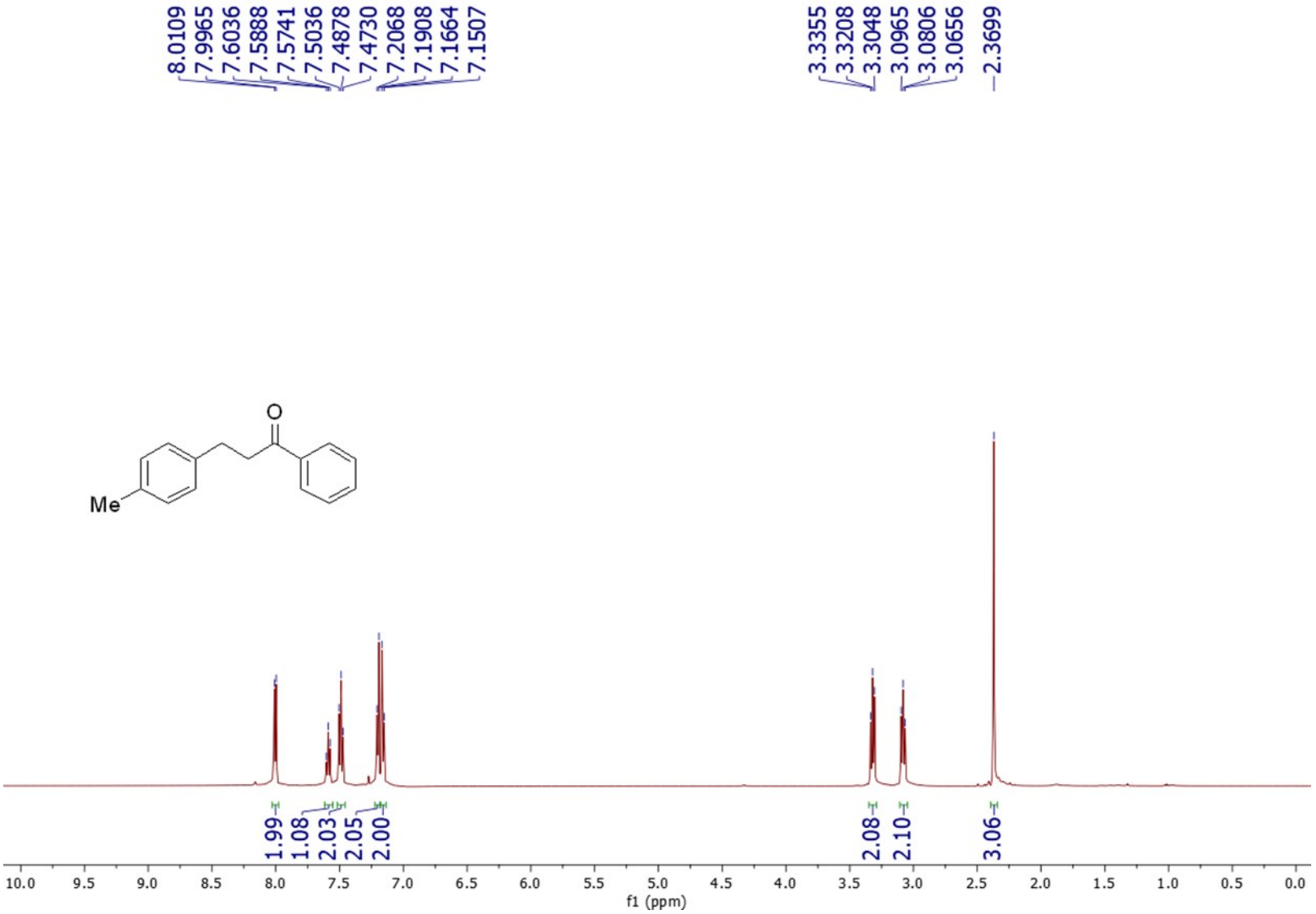
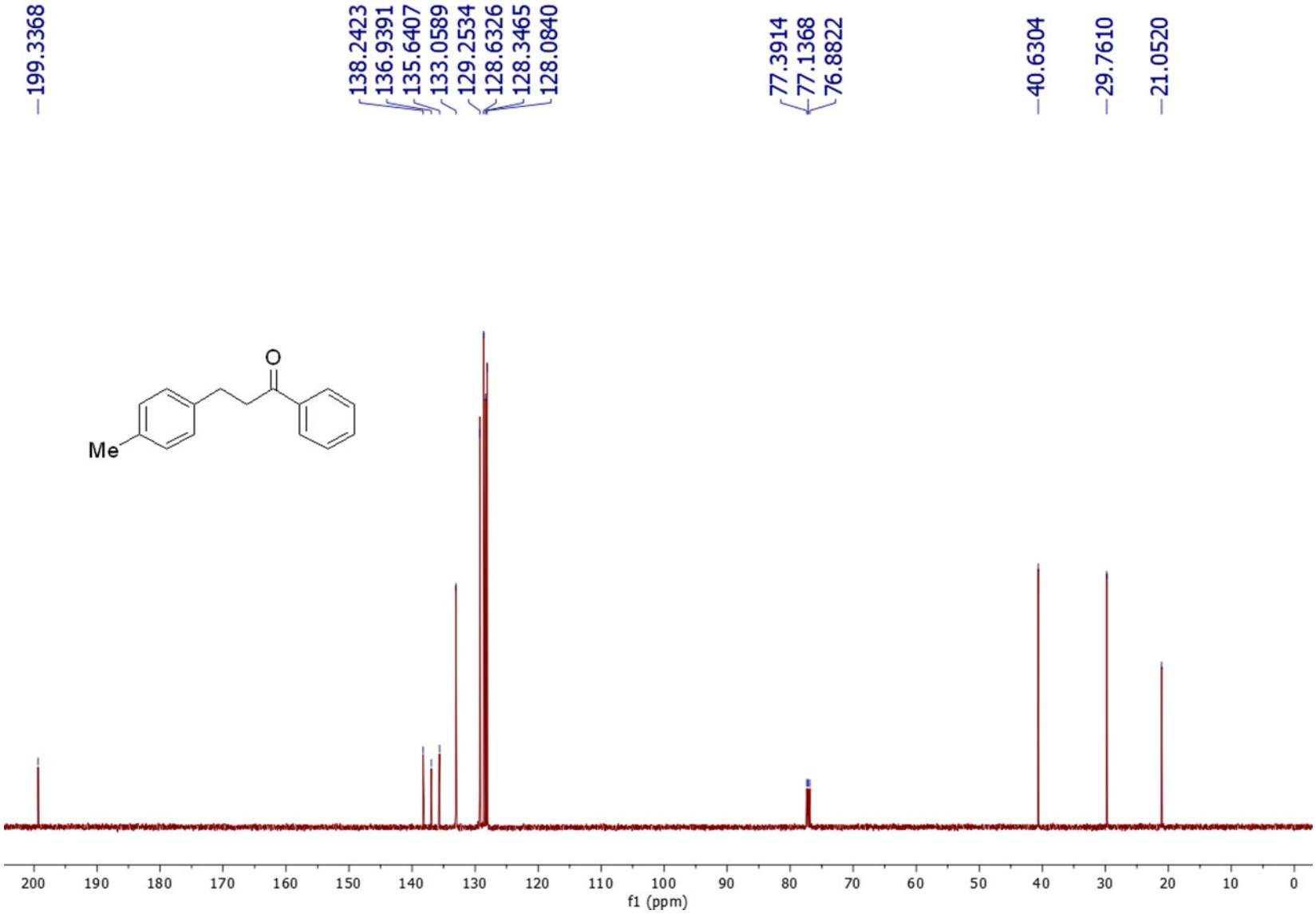
6. ^{1}H and ^{13}C NMR spectra of products

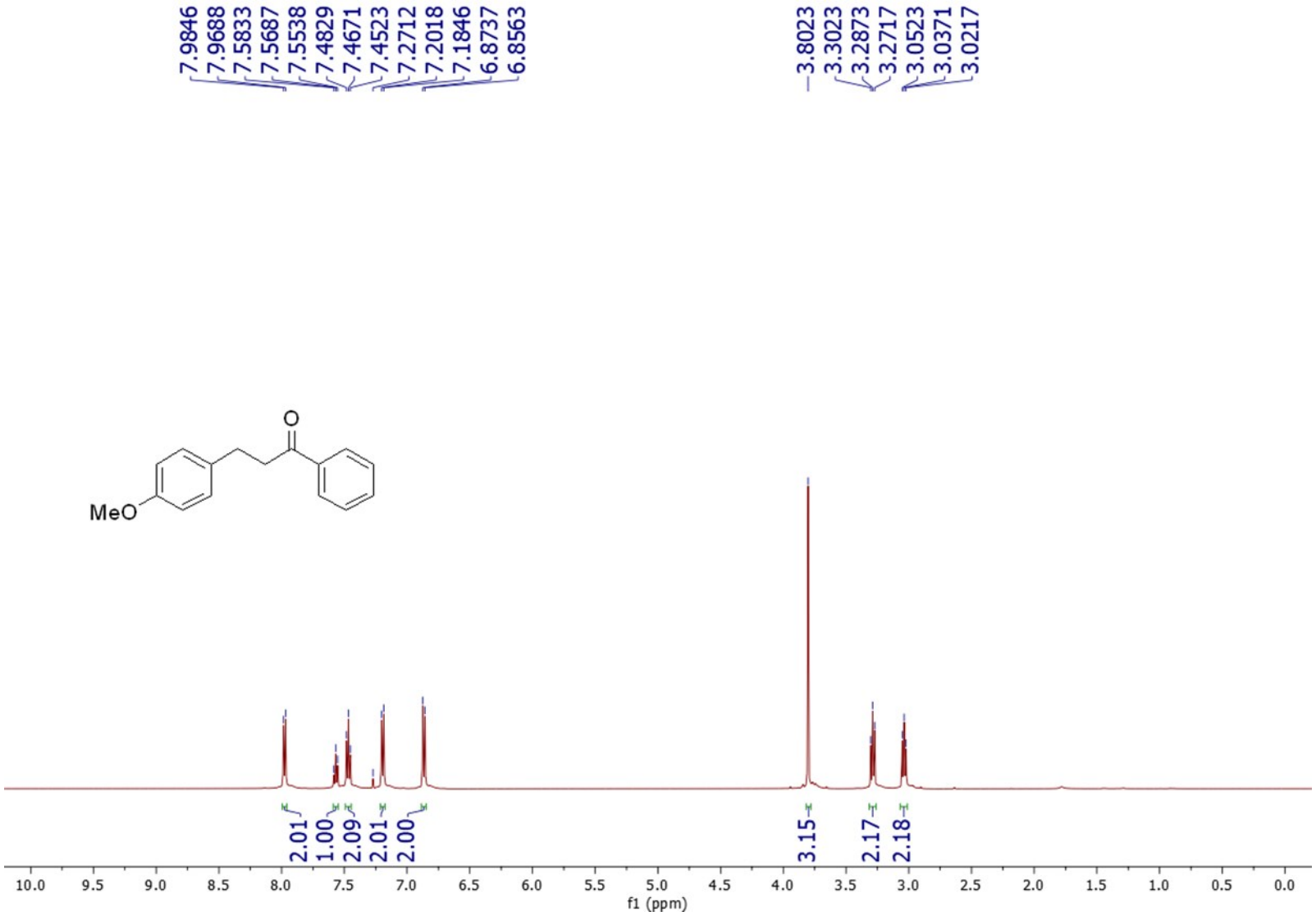
^{1}H NMR spectrum of **2a**



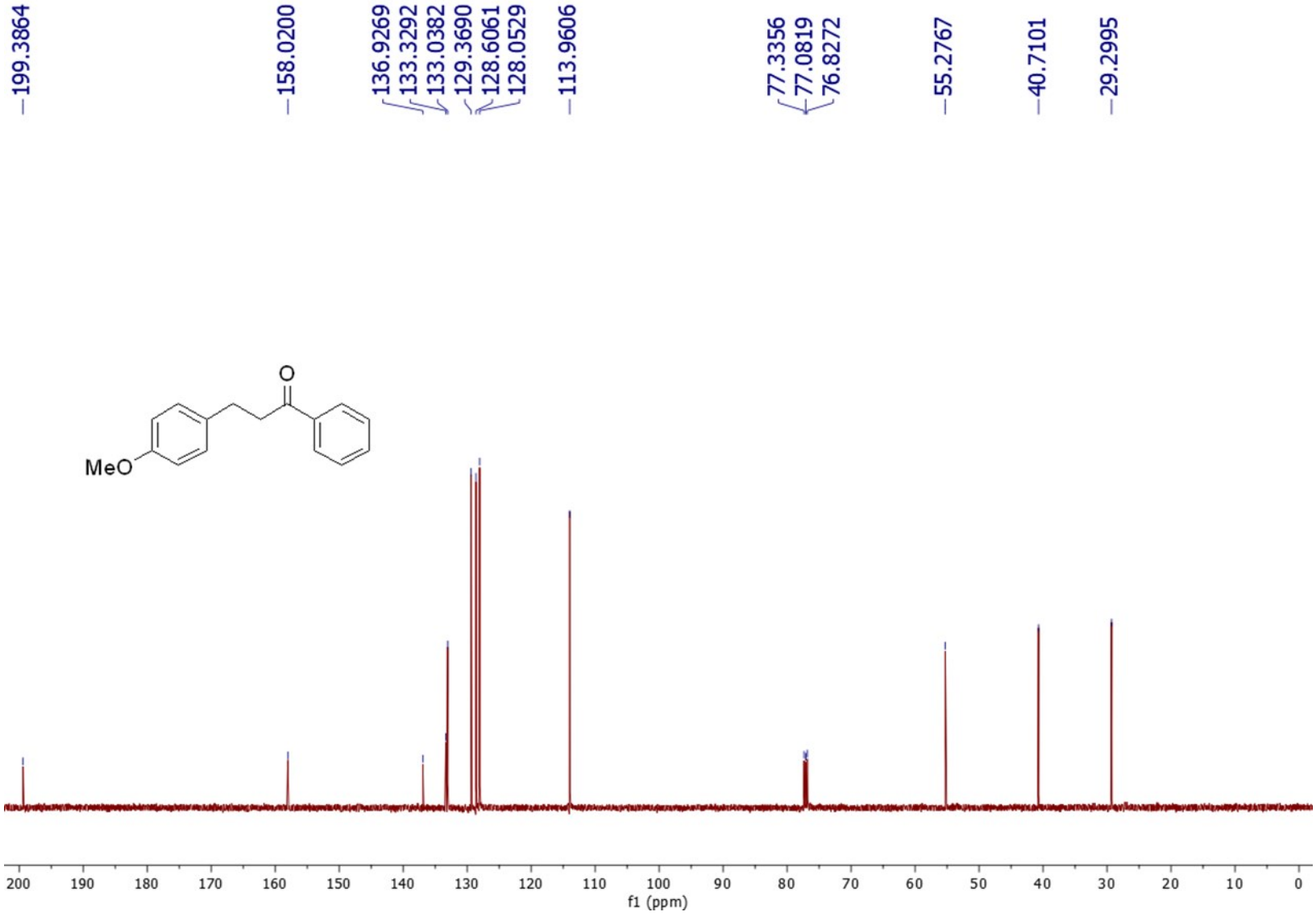
^{13}C NMR spectrum of **2a**



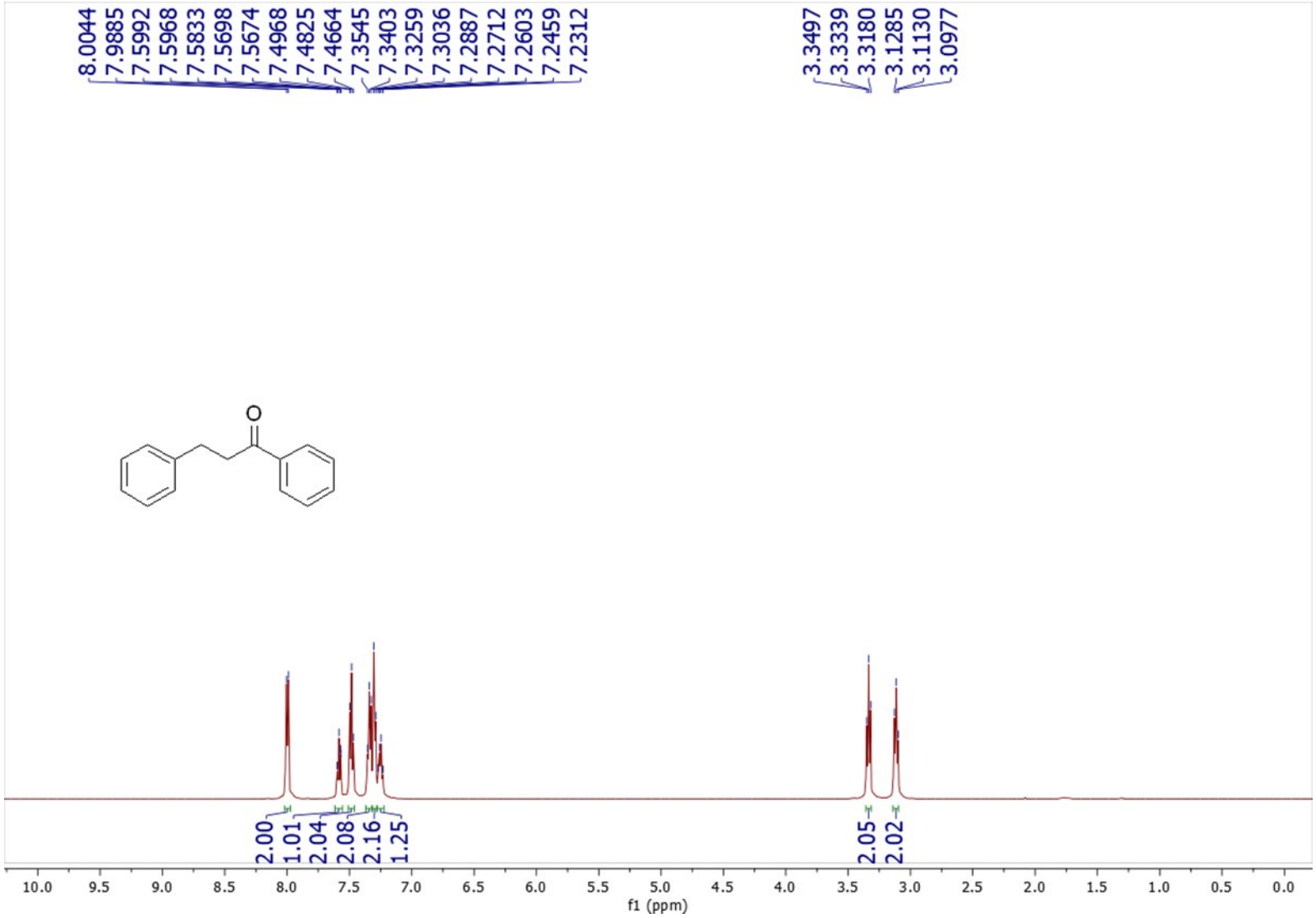
^{1}H NMR spectrum of **2b**



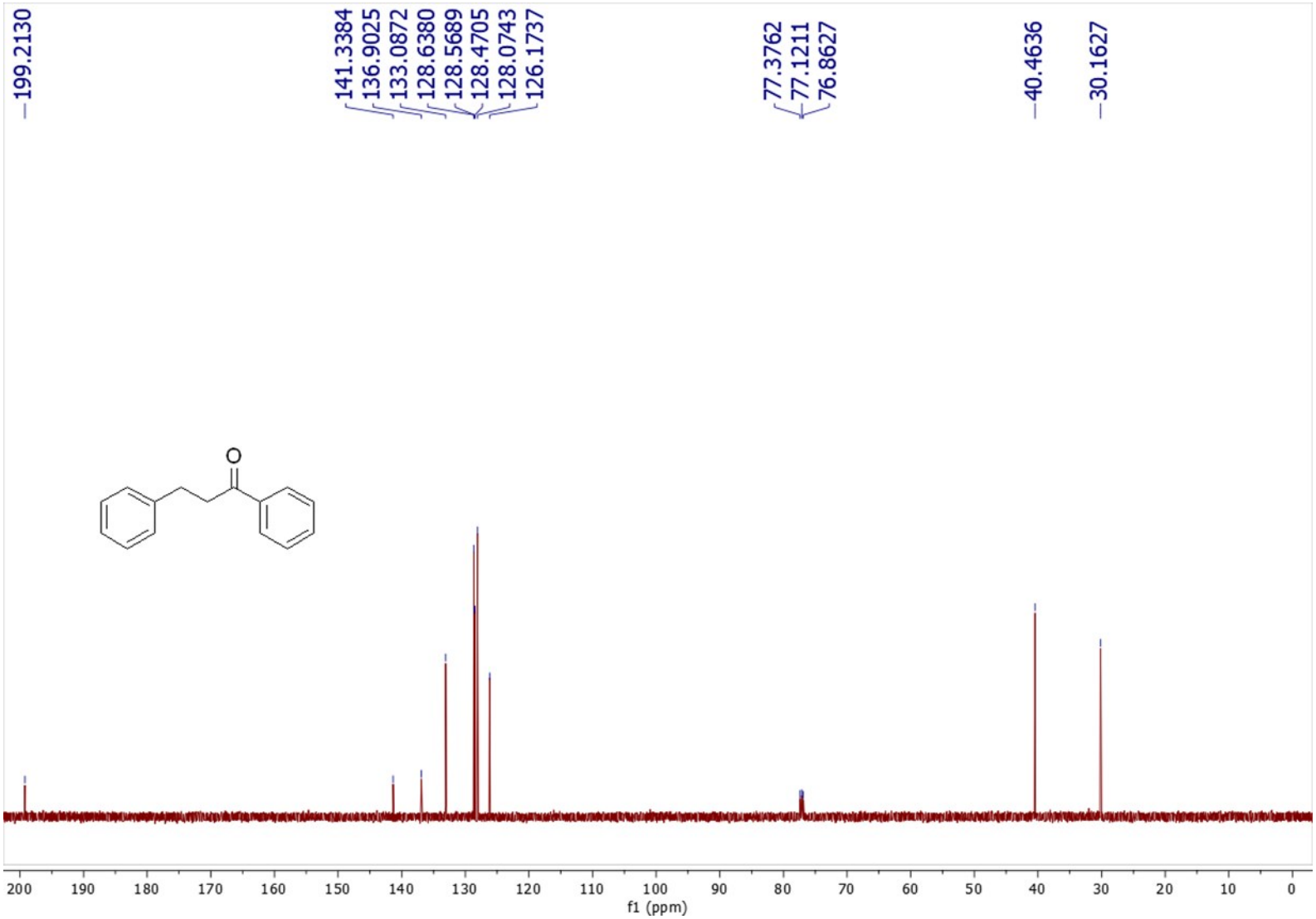
^{13}C NMR spectrum of **2b**



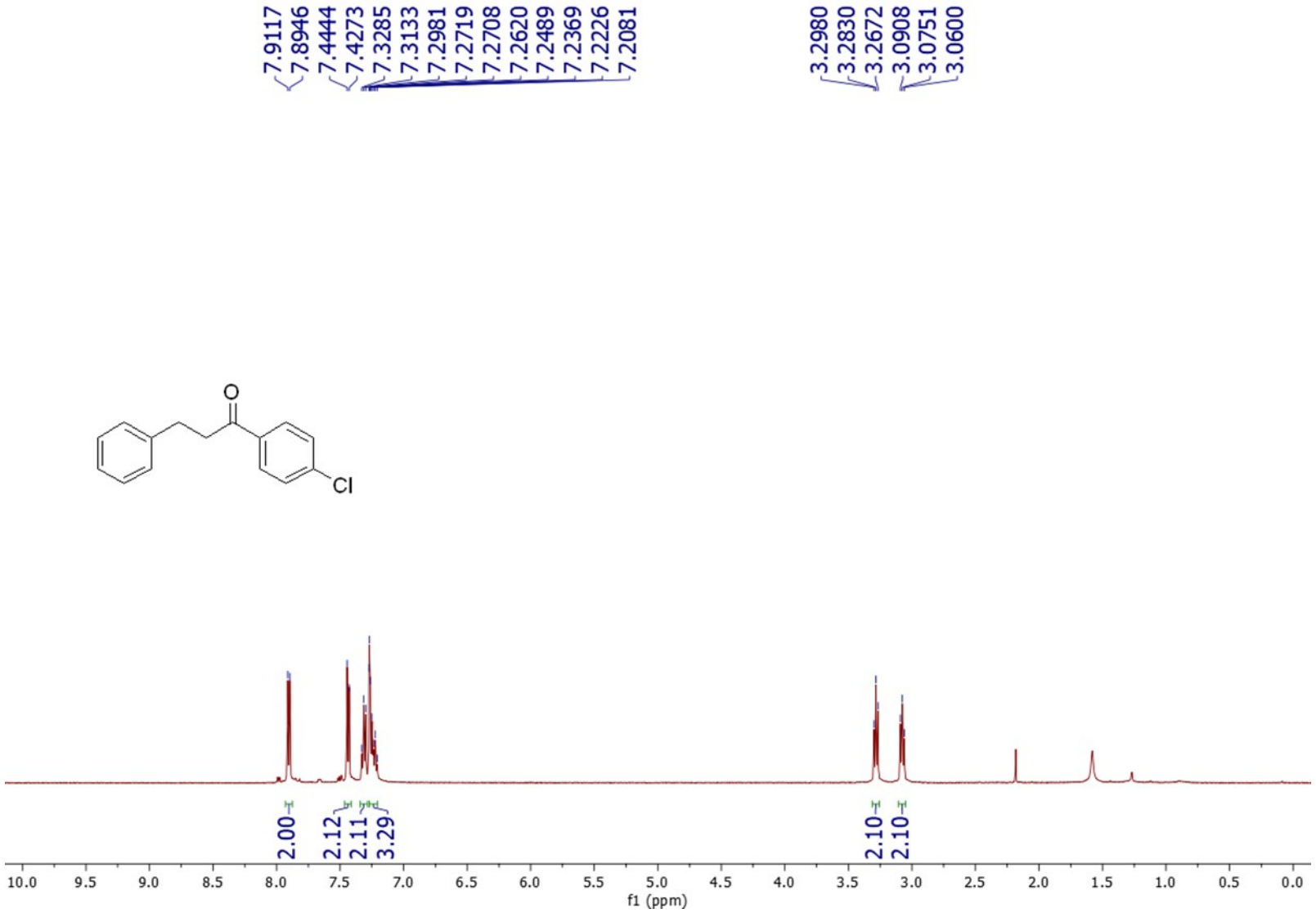
^{1}H NMR spectrum of **2c**



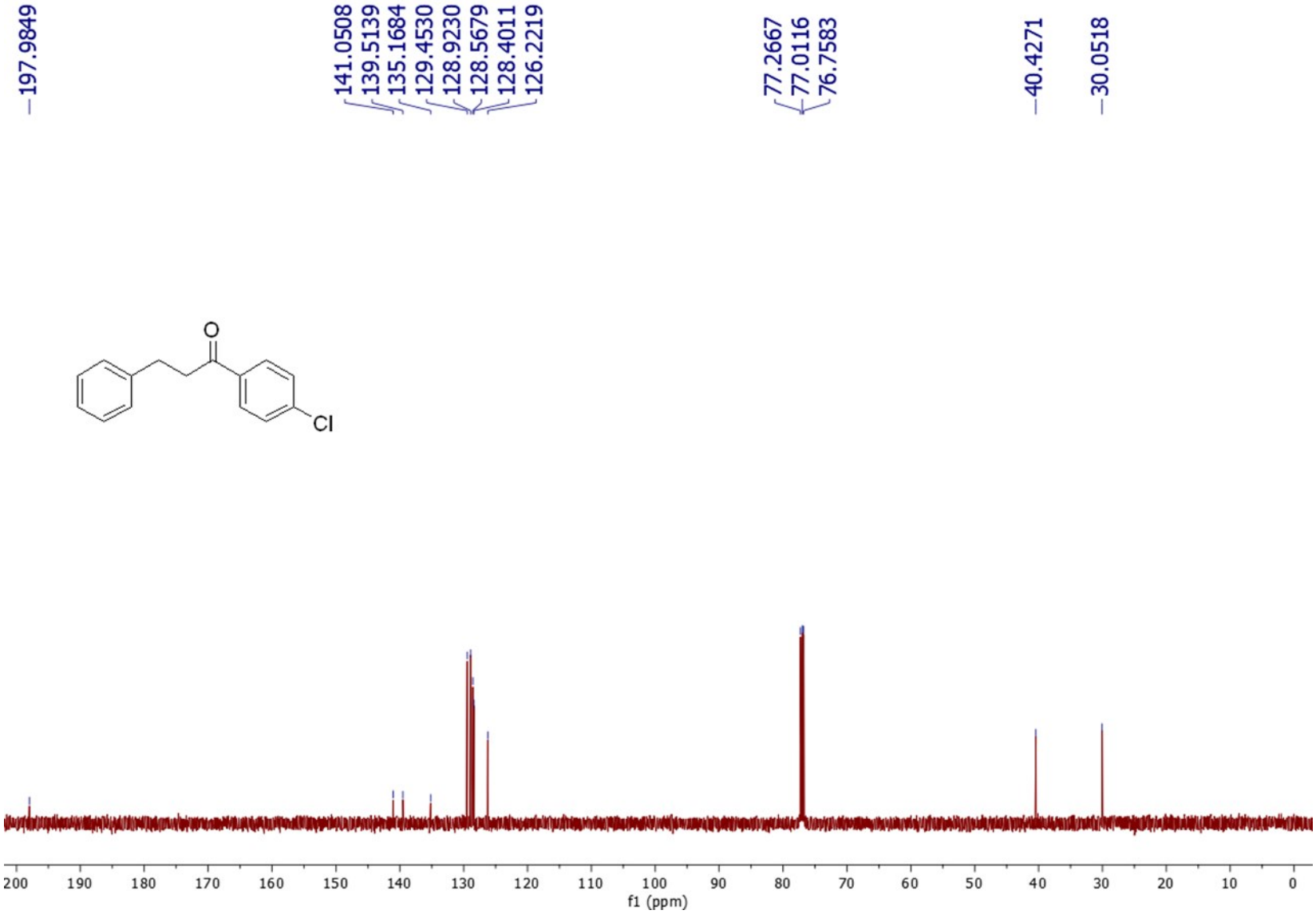
^{13}C NMR spectrum of **2c**



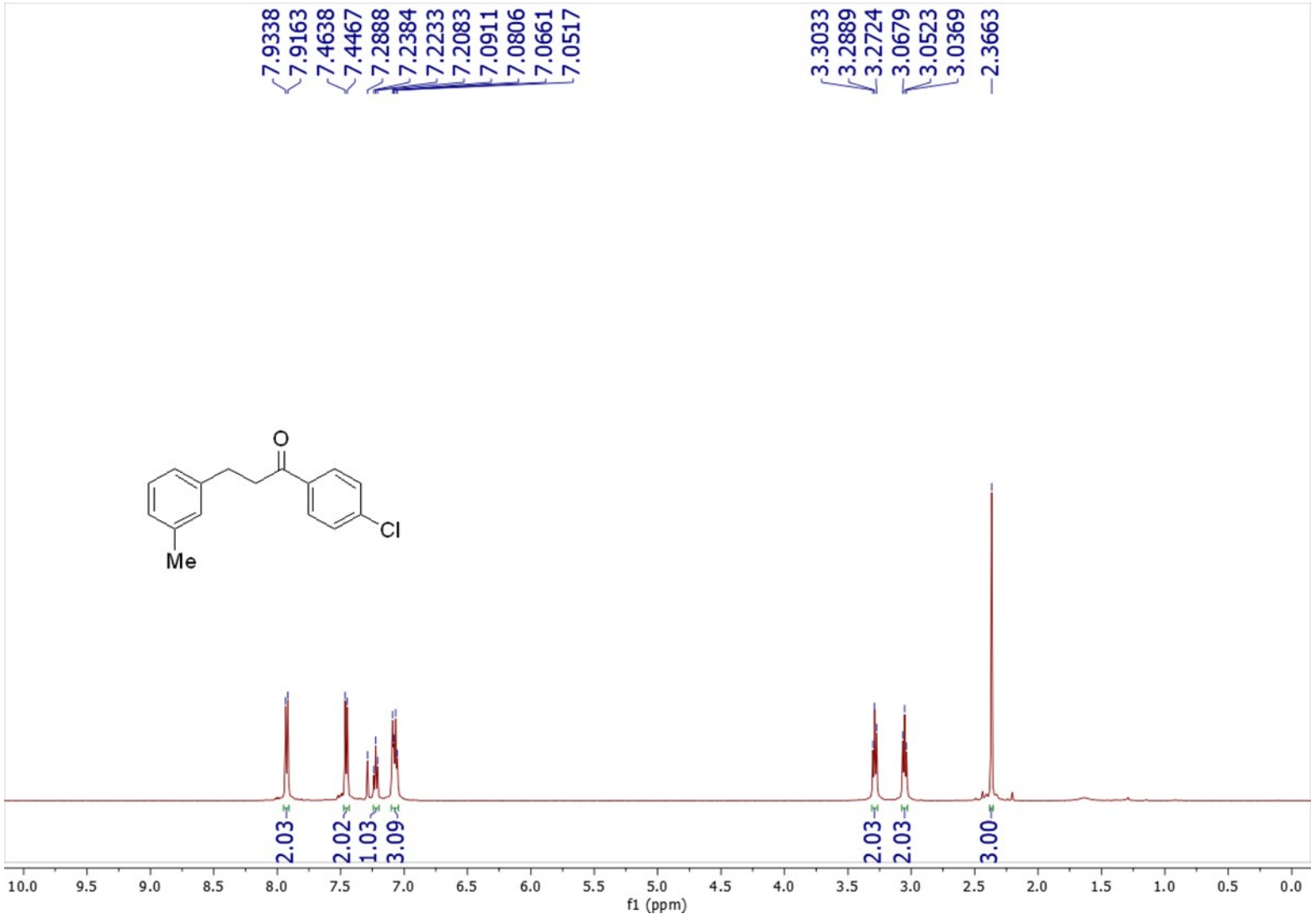
^{1}H NMR spectrum of **2d**



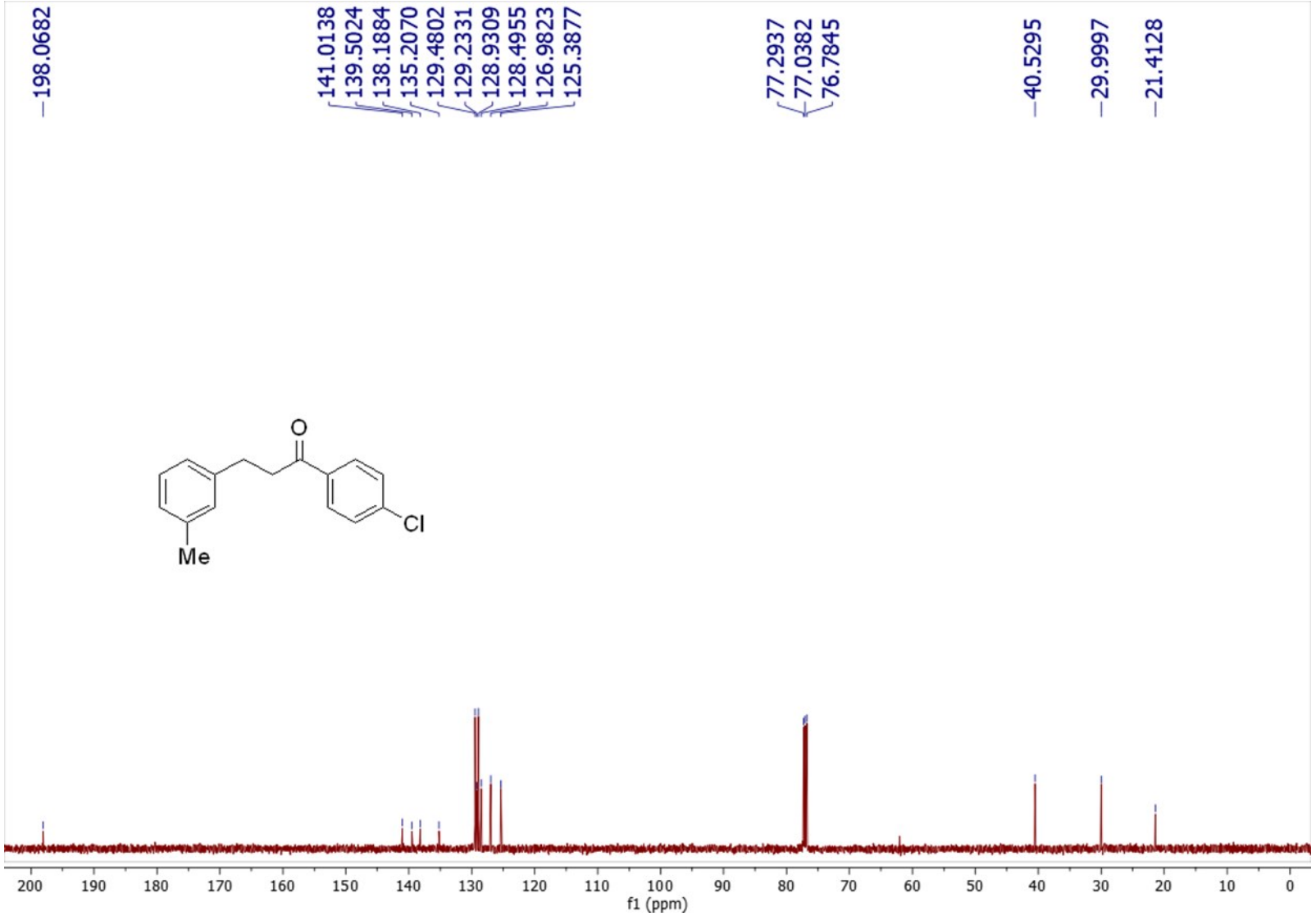
^{13}C NMR spectrum of **2d**



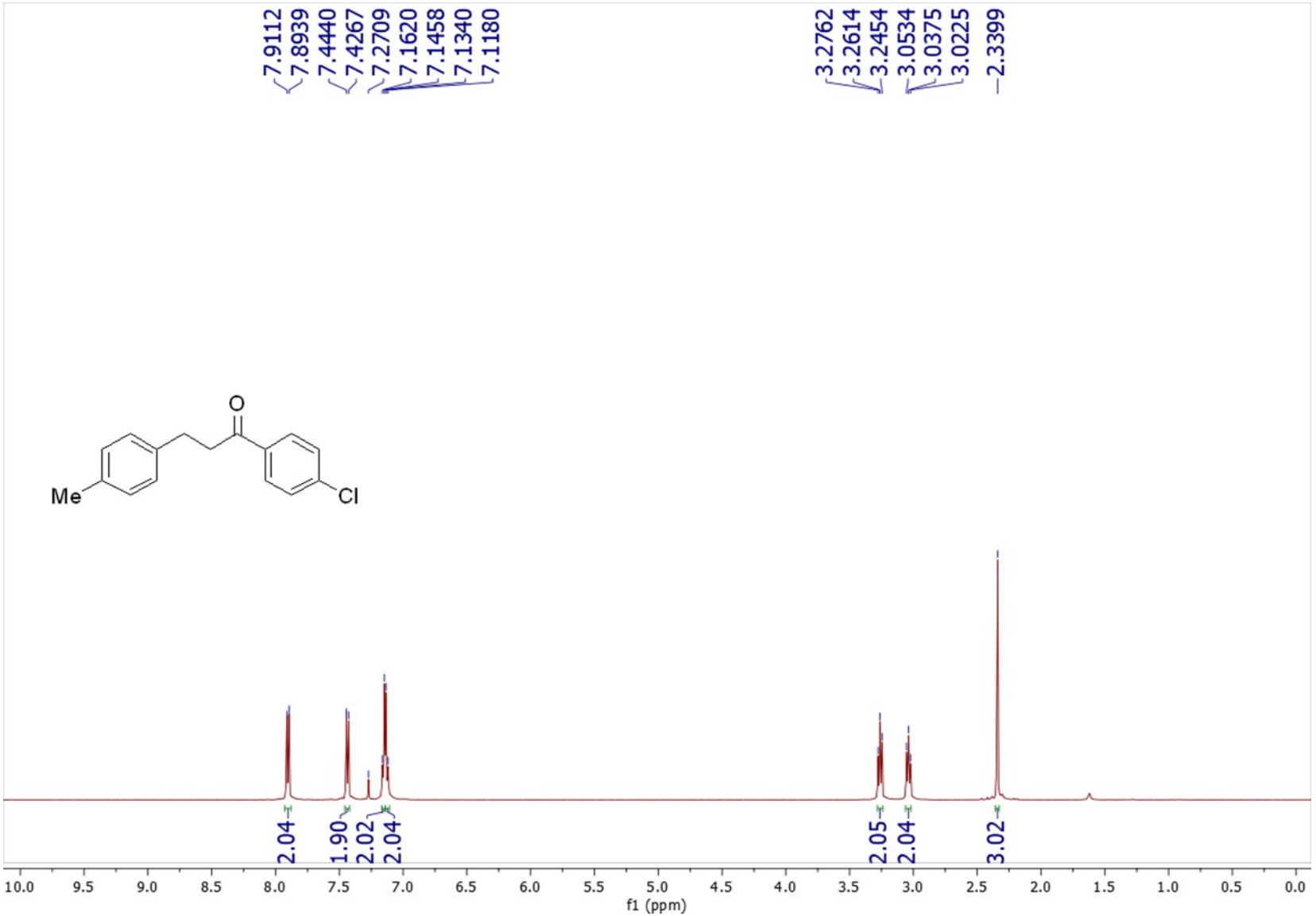
^{1}H NMR spectrum of **2e**



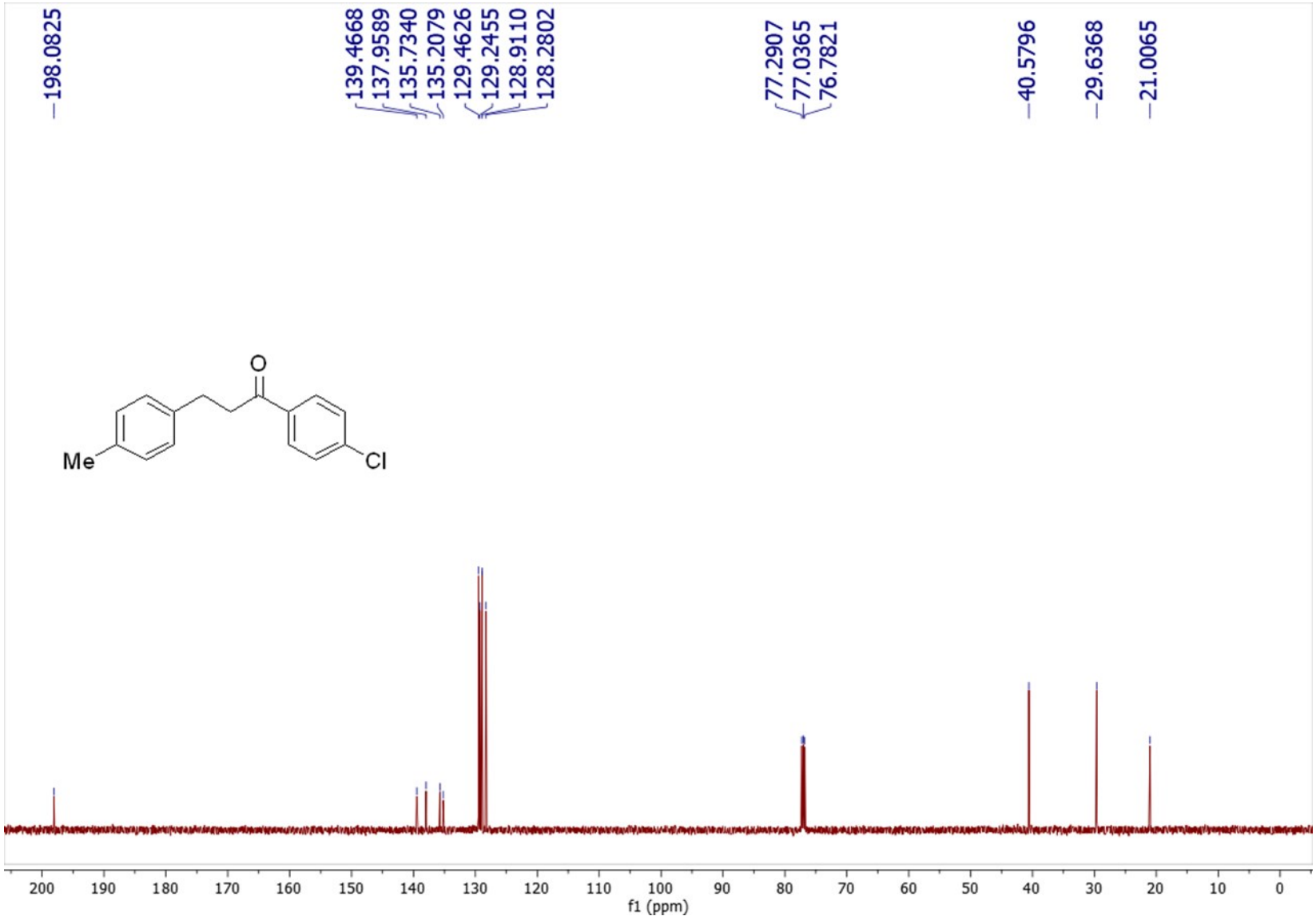
^{13}C NMR spectrum of **2e**



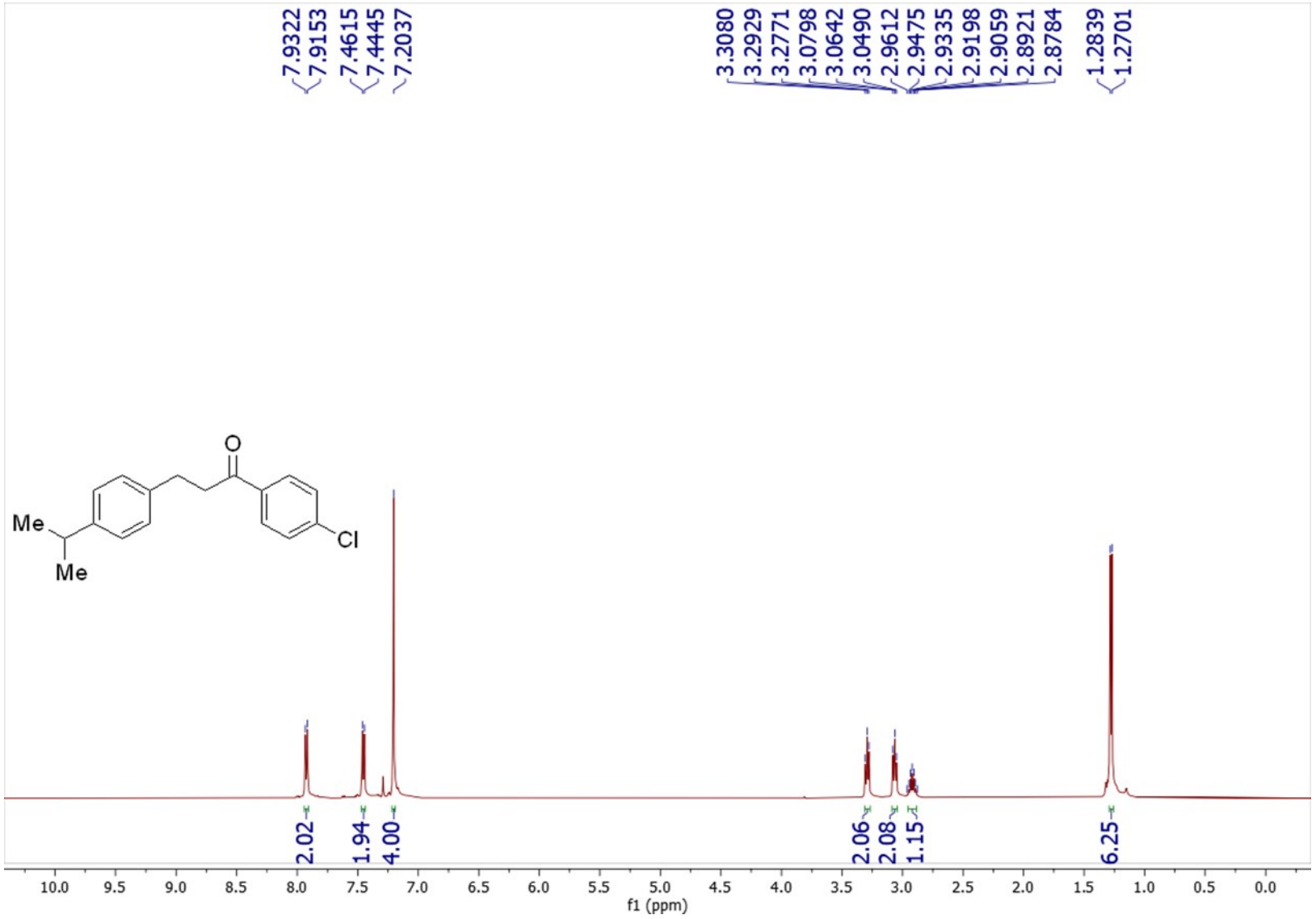
^{1}H NMR spectrum of **2f**



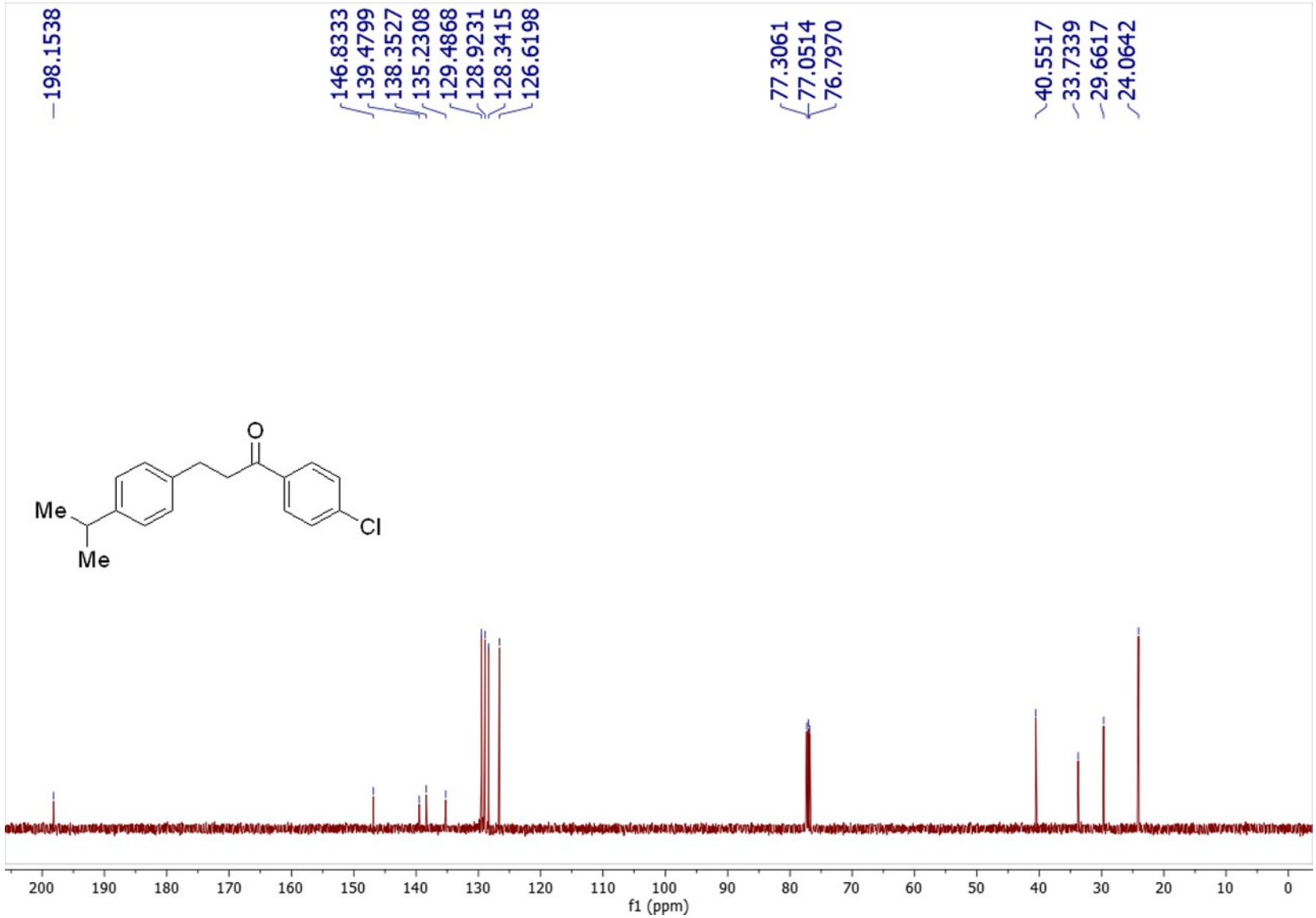
^{13}C NMR spectrum of **2f**



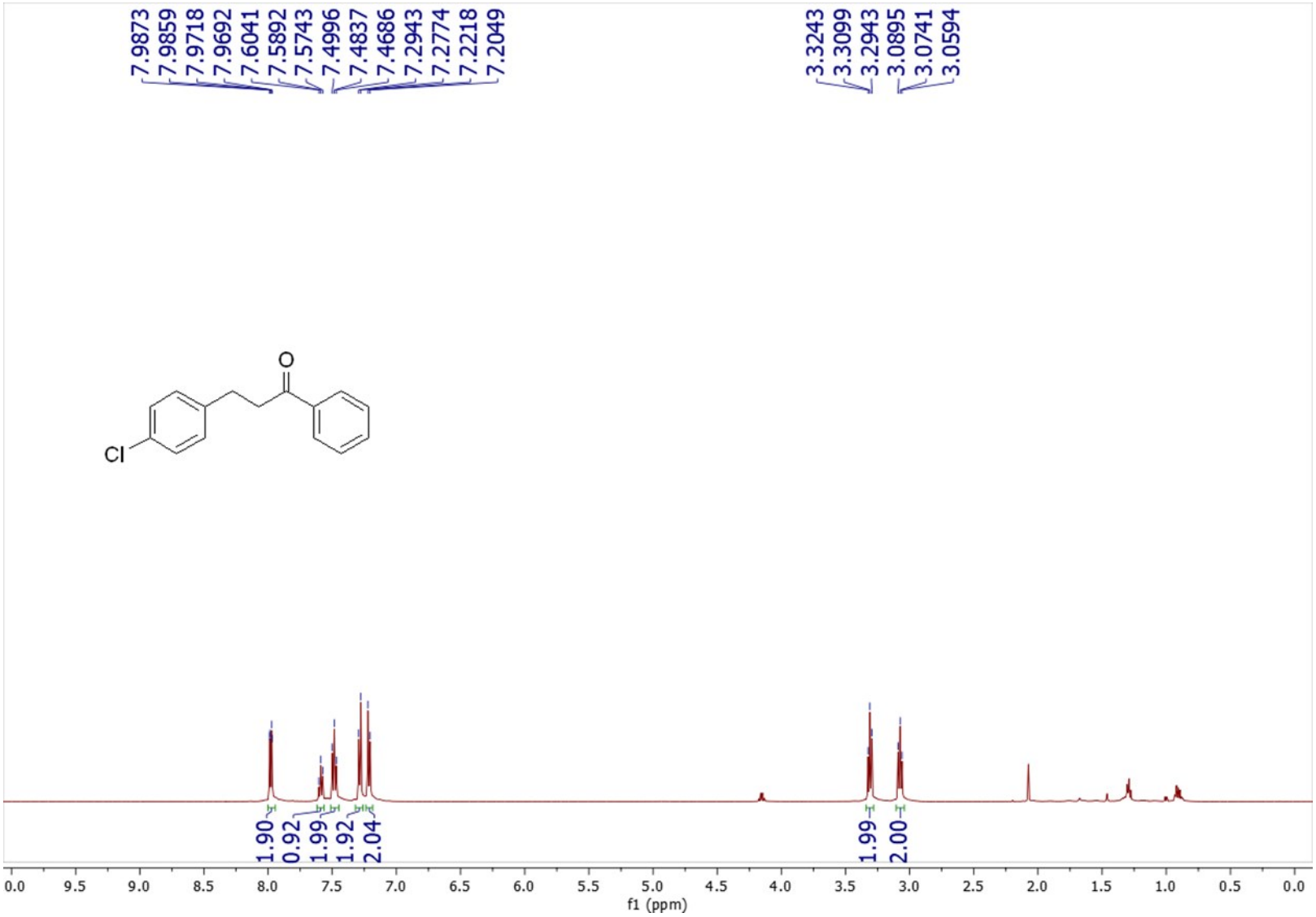
^{1}H NMR spectrum of **2g**



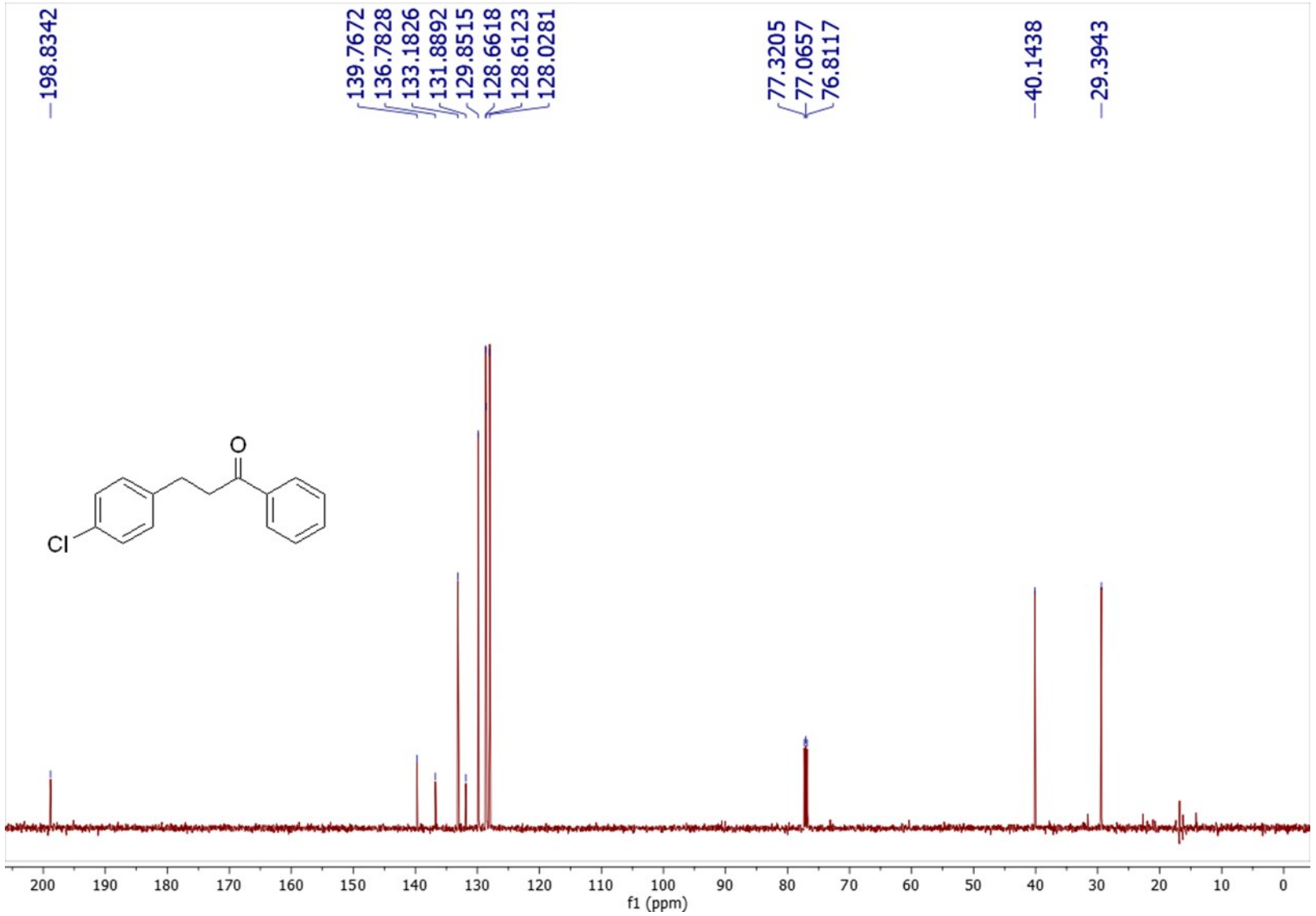
^{13}C NMR spectrum of **2g**



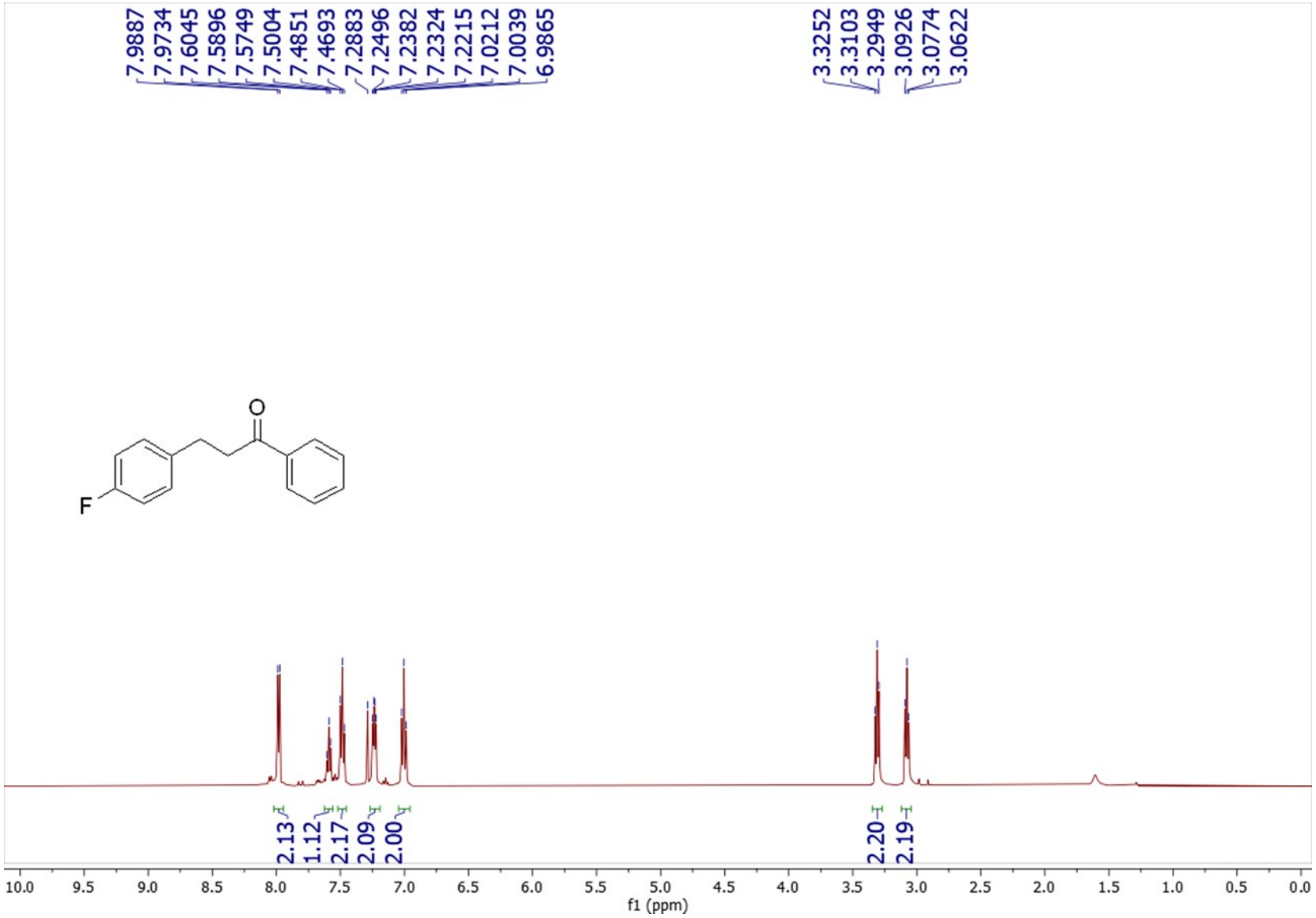
^{1}H NMR spectrum of **2h**



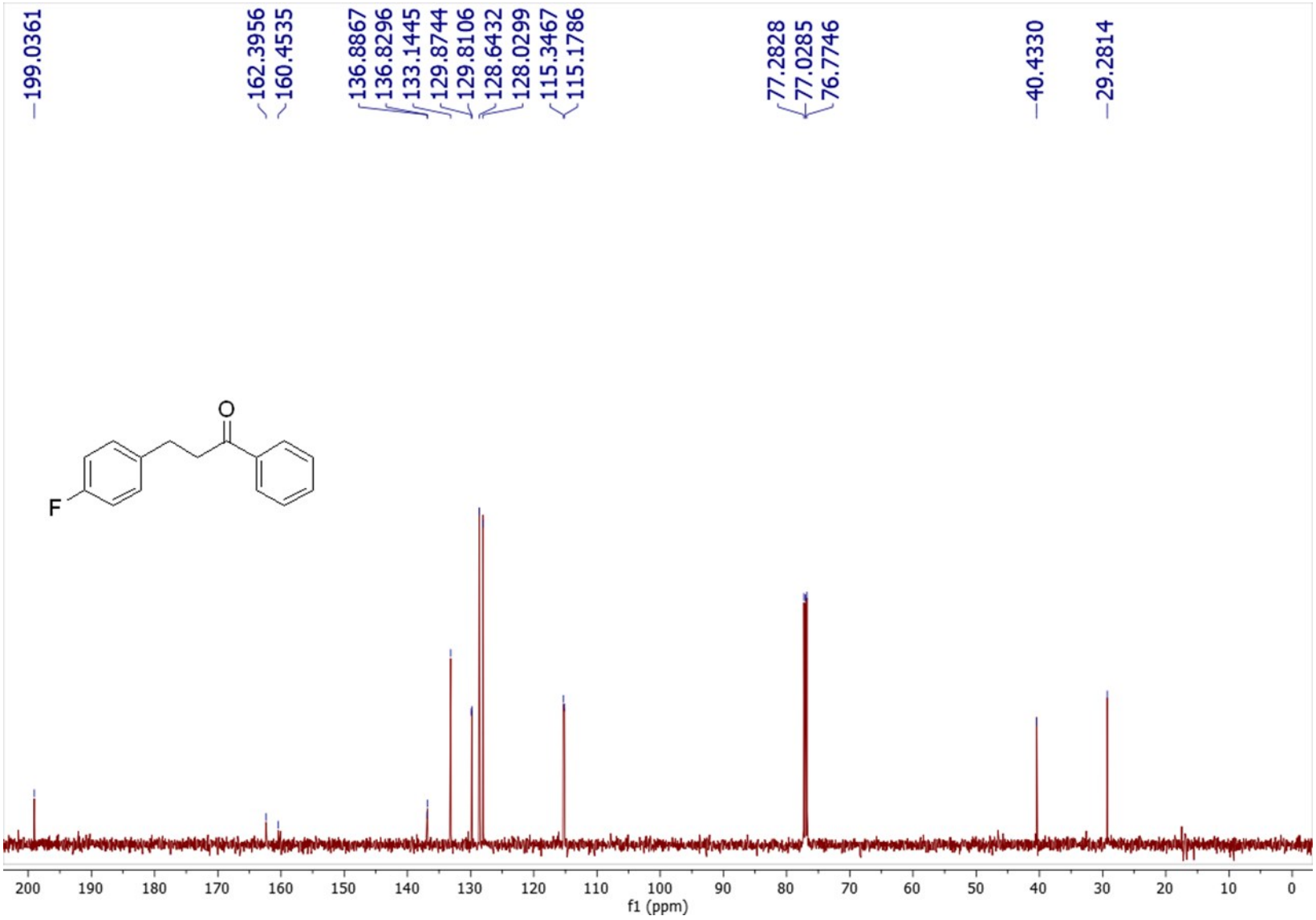
^{13}C NMR spectrum of **2h**



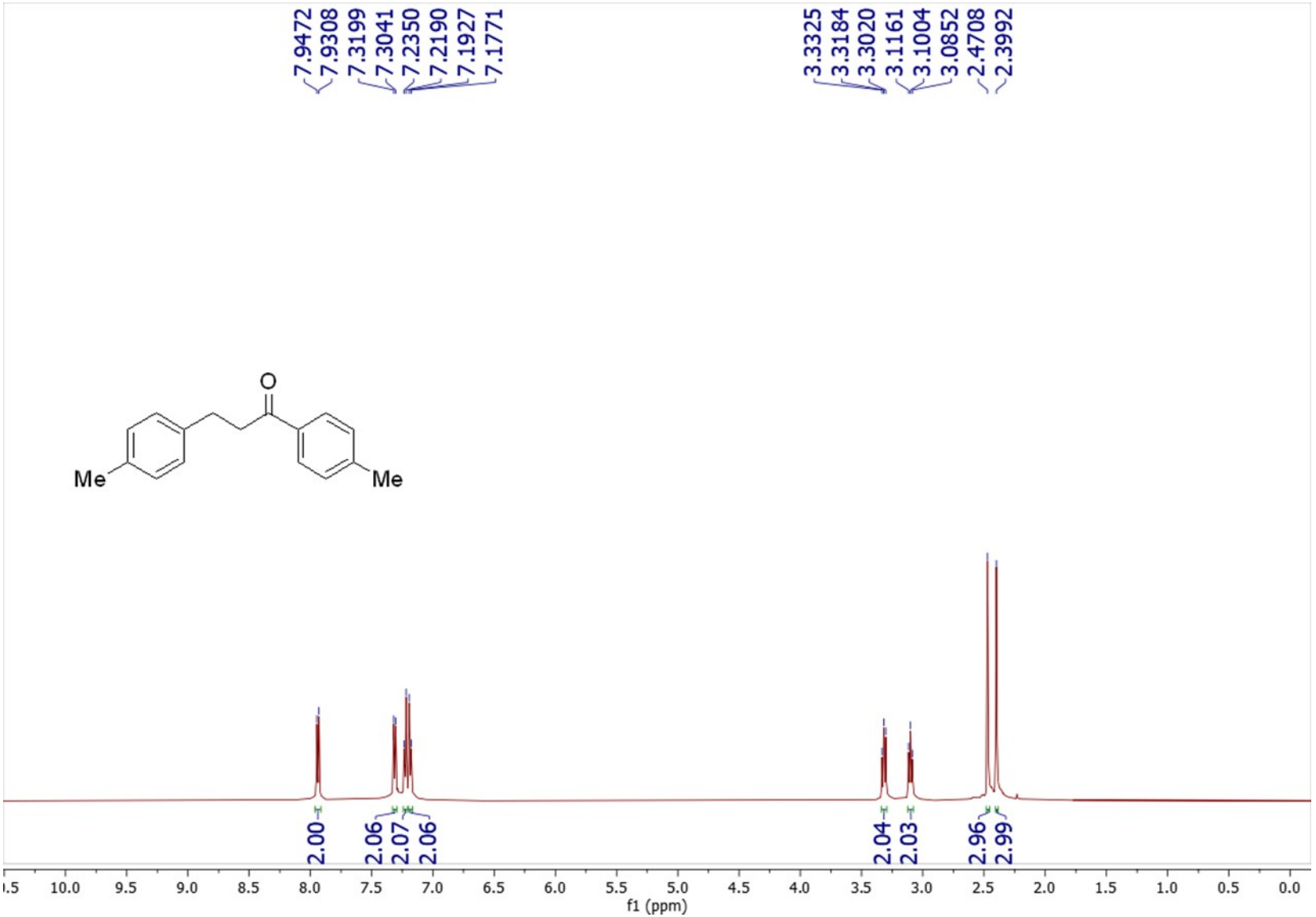
^{1}H NMR spectrum of **2i**



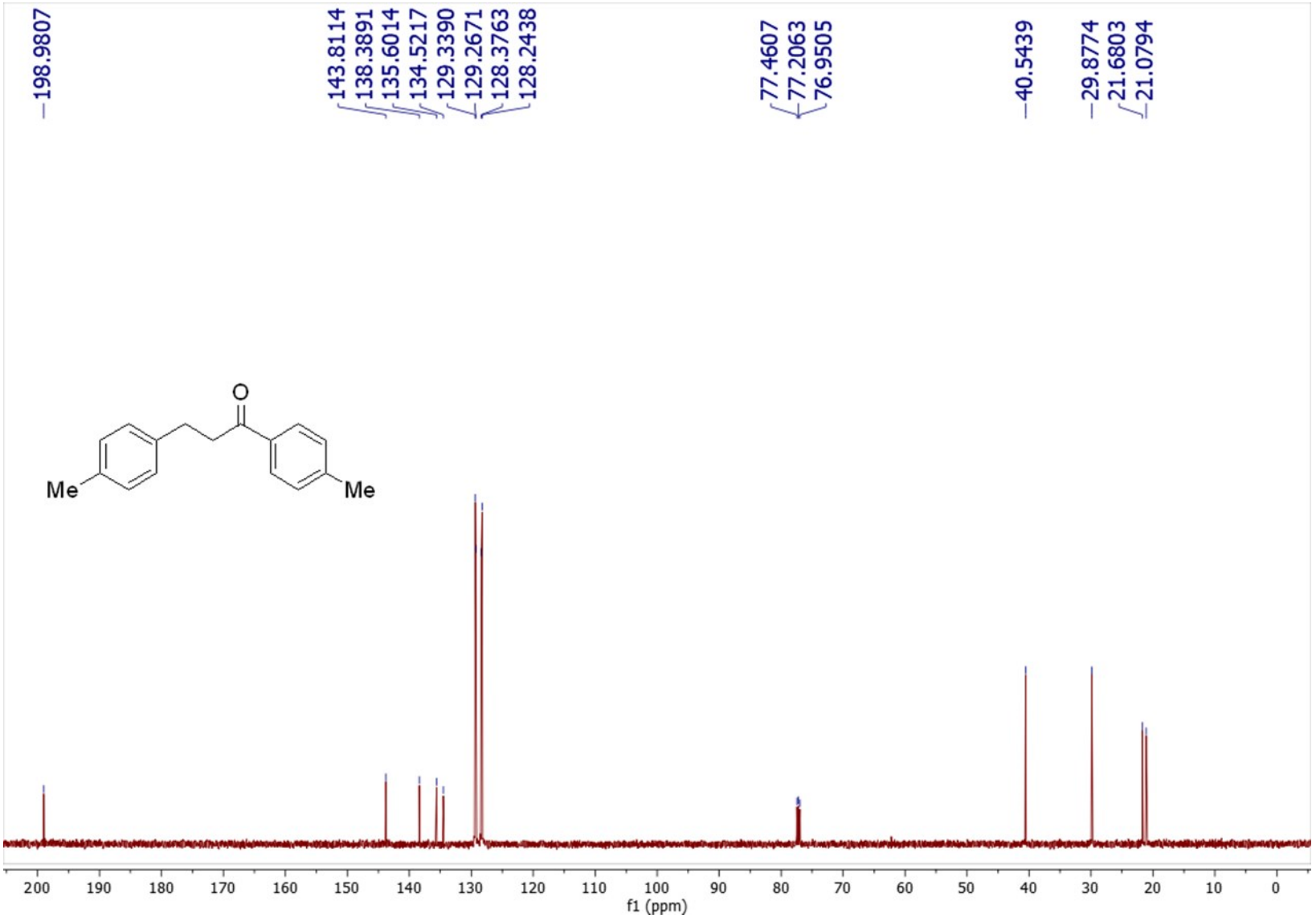
^{13}C NMR spectrum of **2i**



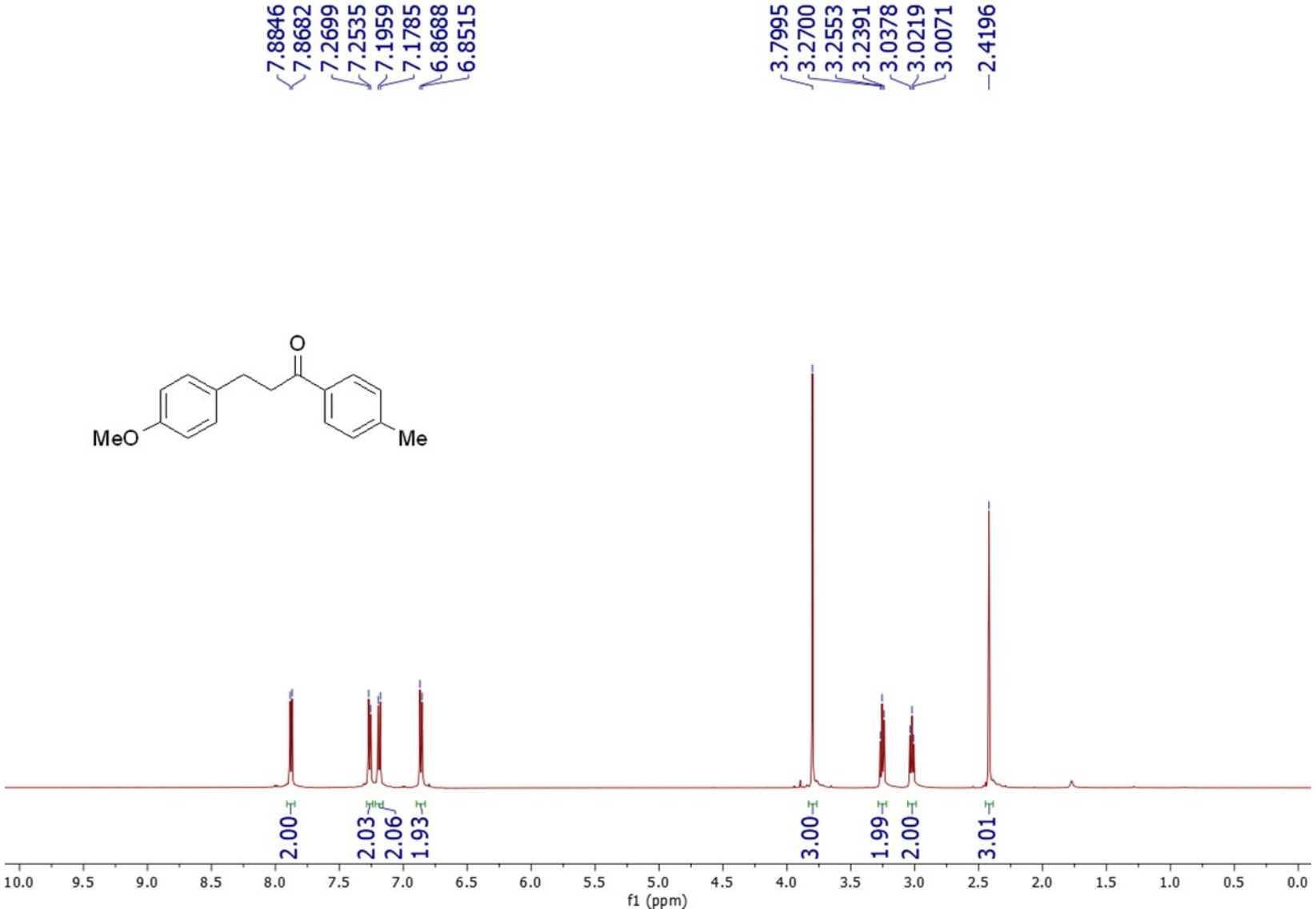
^{1}H NMR spectrum of **2j**



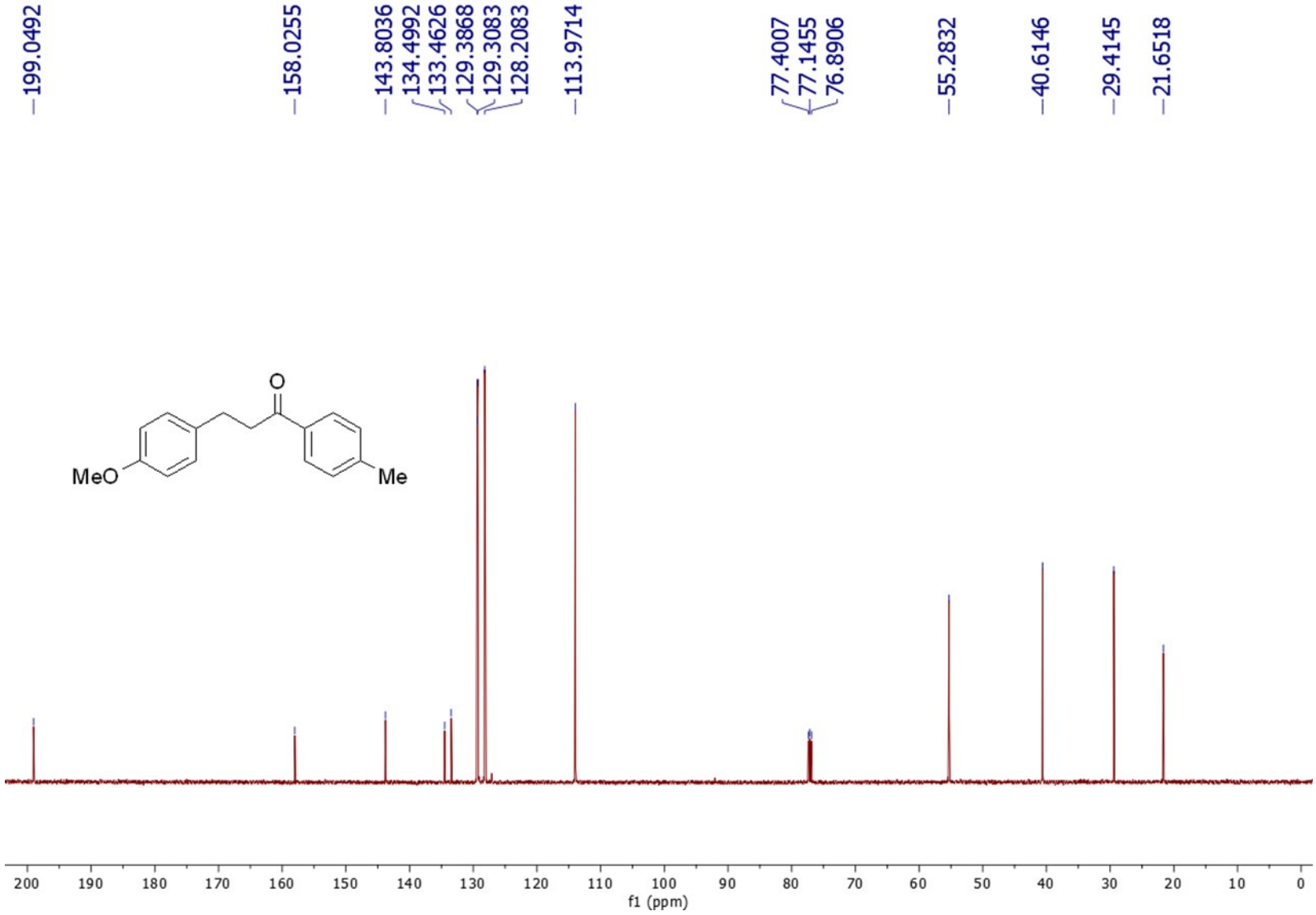
^{13}C NMR spectrum of **2j**



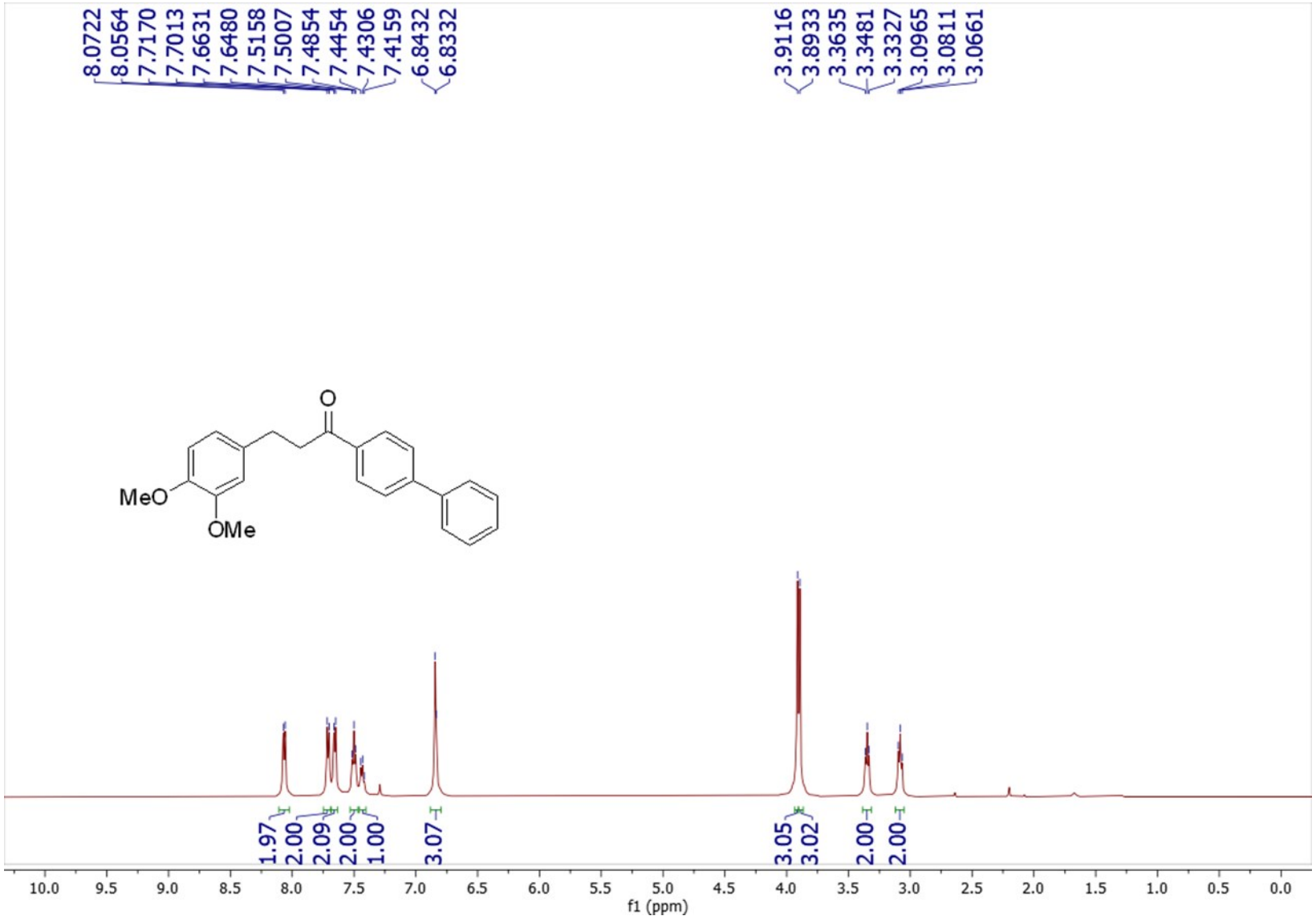
^{1}H NMR spectrum of **2k**



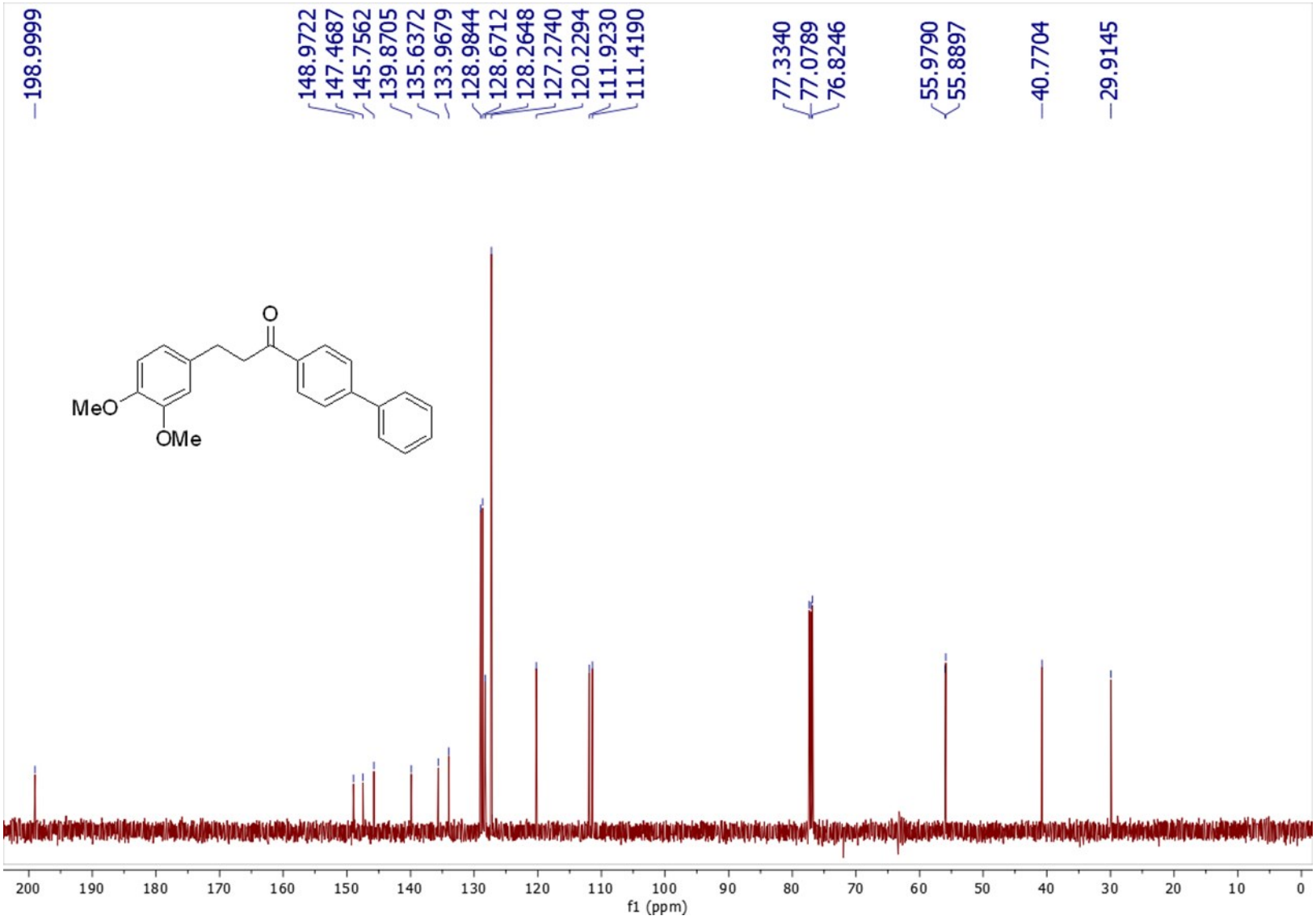
^{13}C NMR spectrum of **2k**



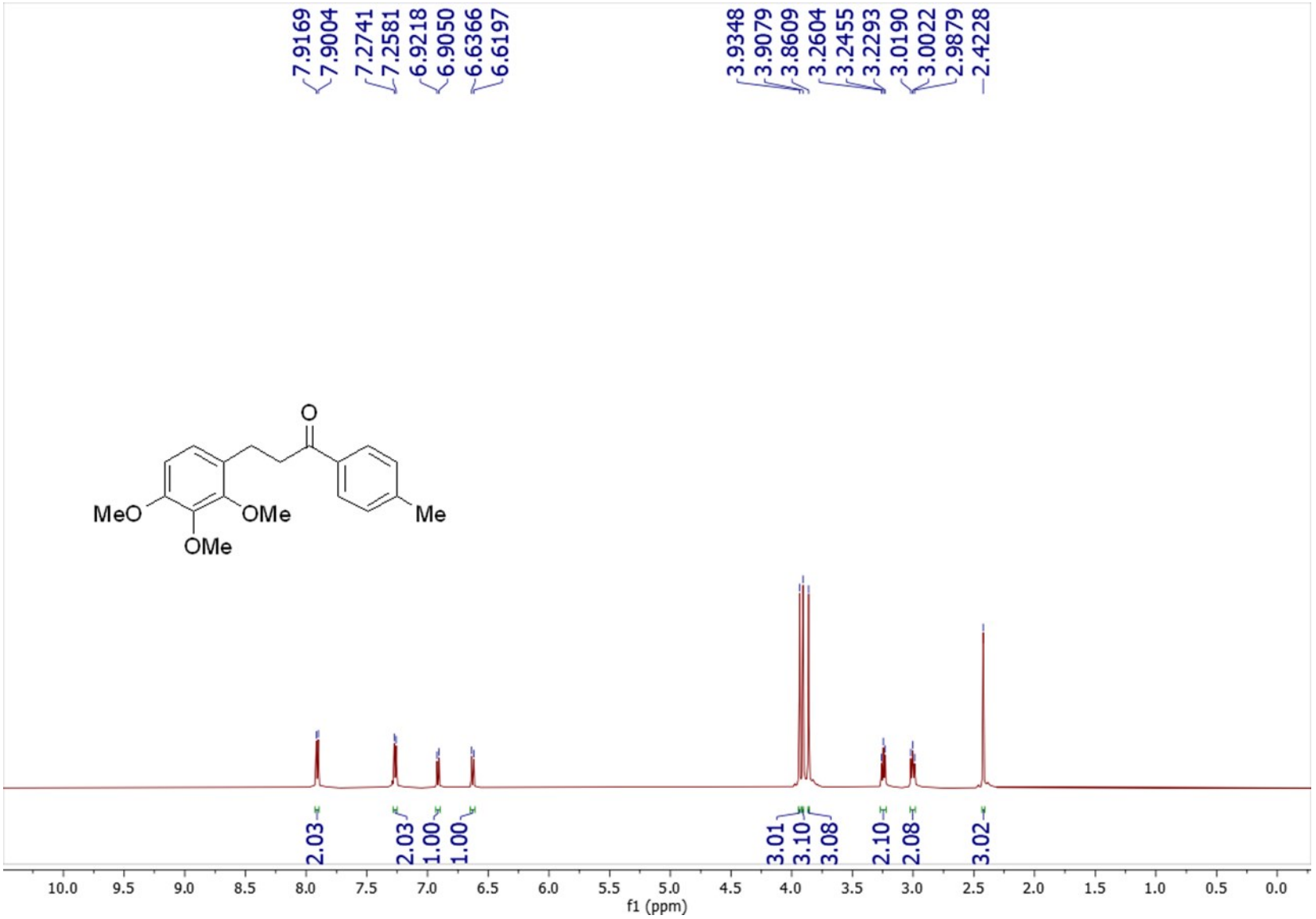
^{1}H NMR spectrum of **2l**



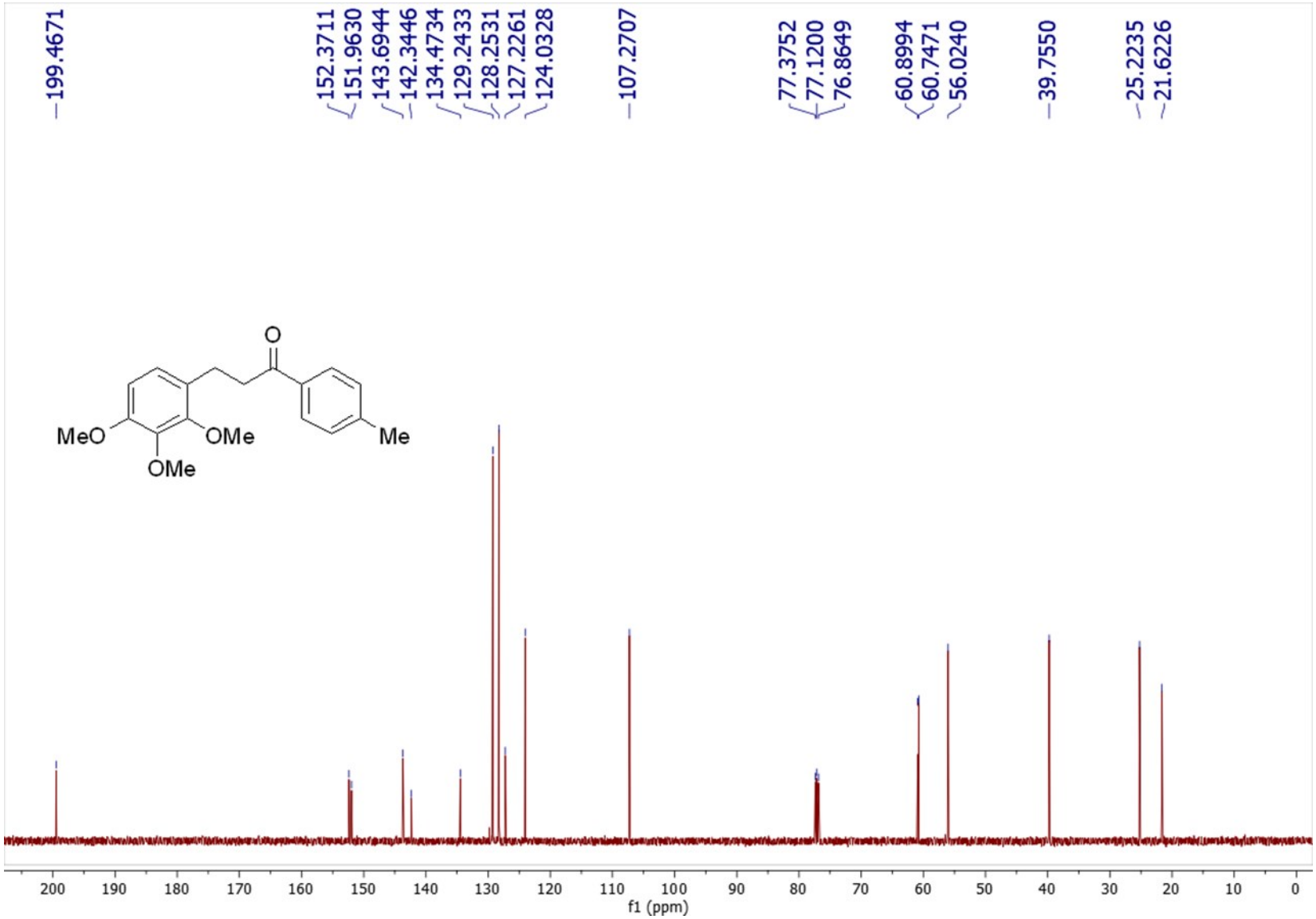
^{13}C NMR spectrum of **2l**



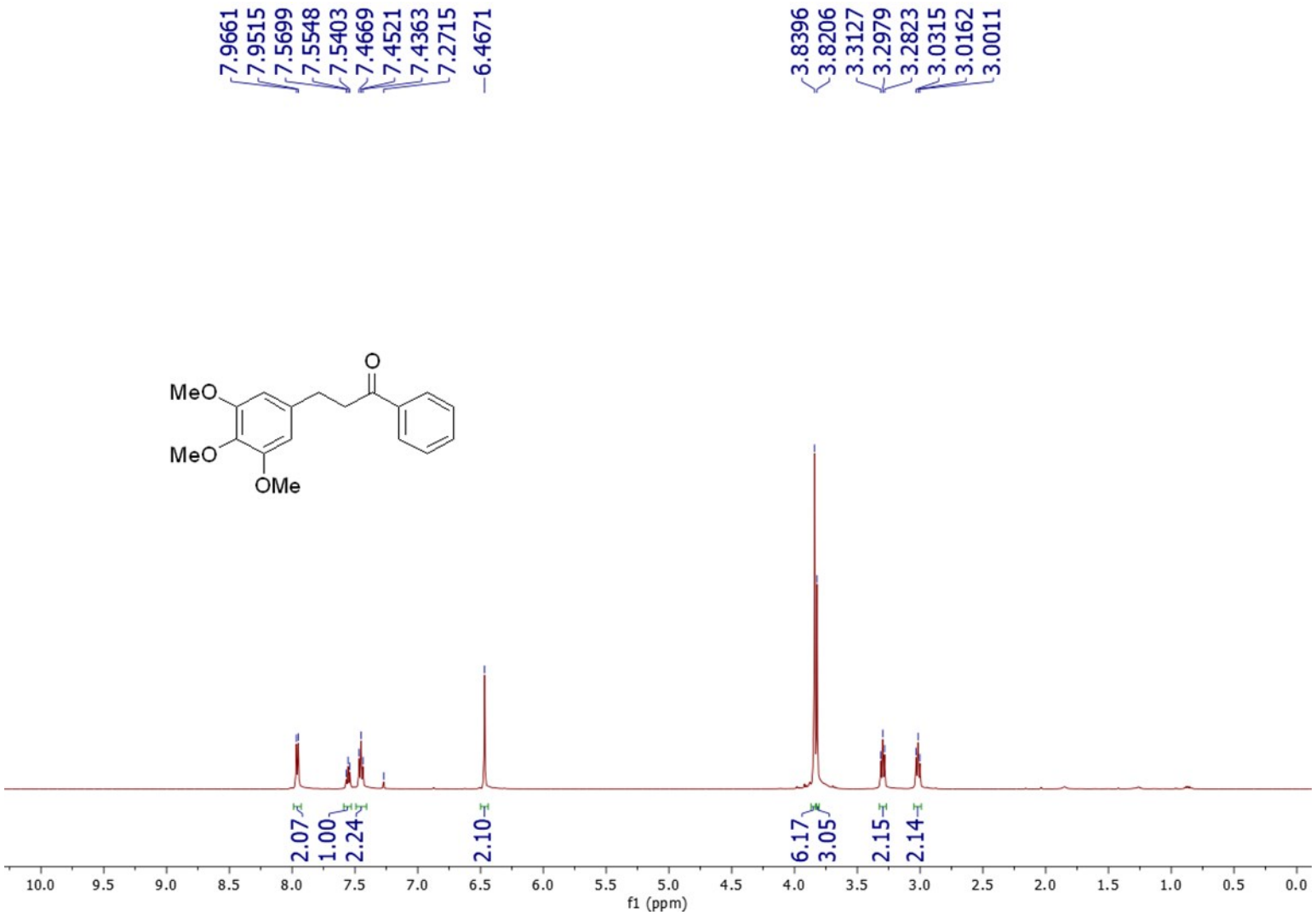
^{1}H NMR spectrum of **2m**



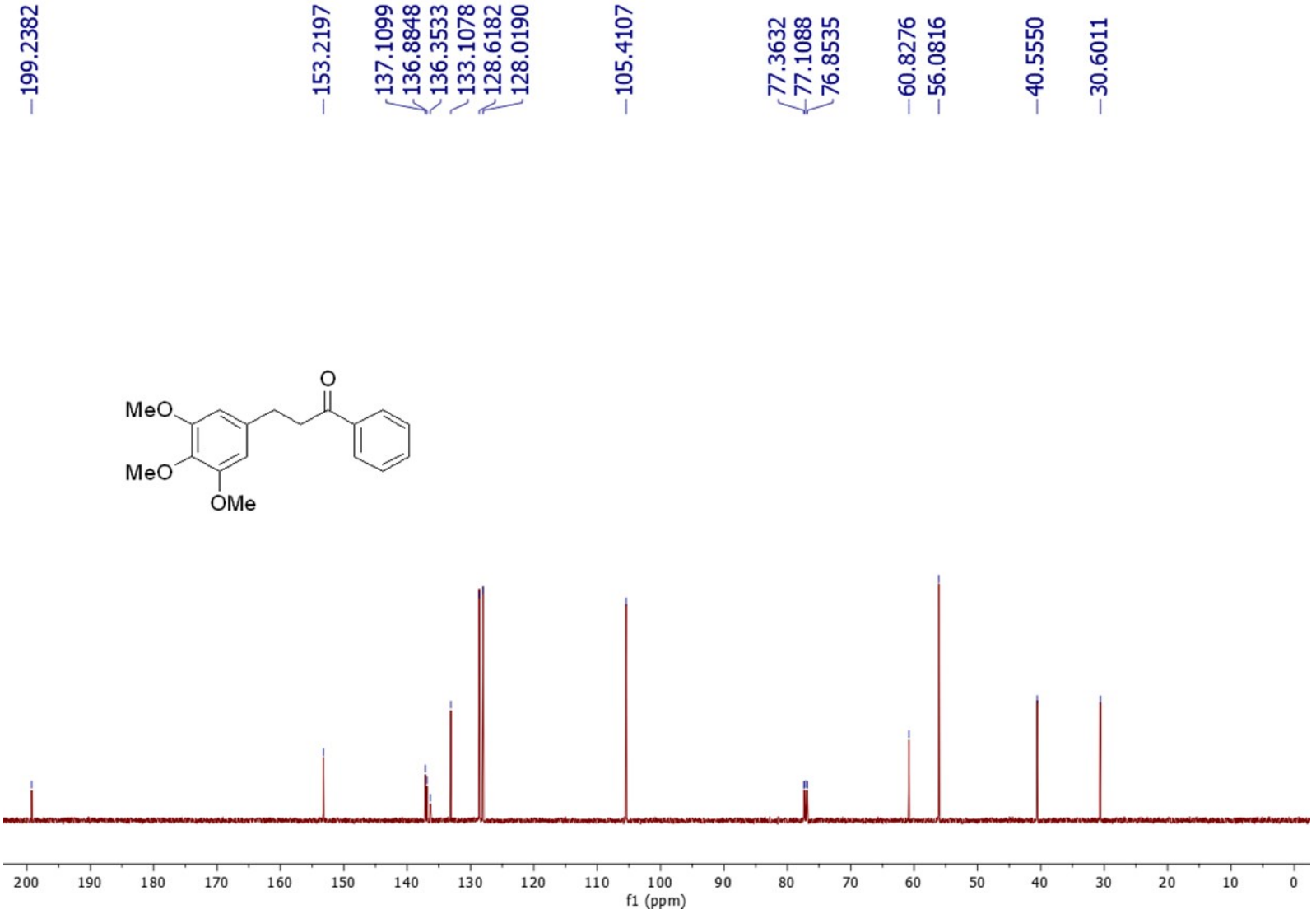
^{13}C NMR spectrum of **2m**



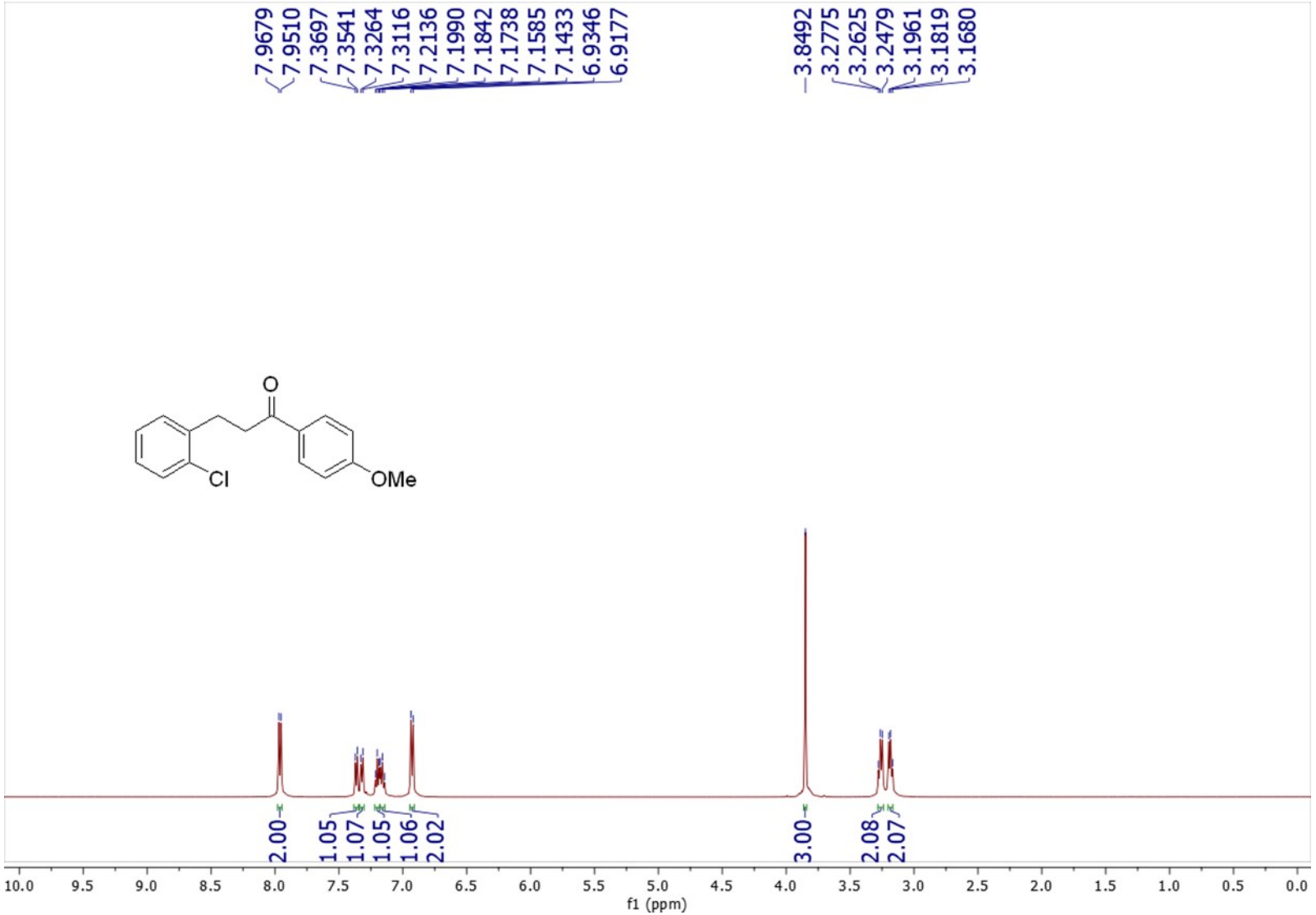
^{1}H NMR spectrum of **2n**



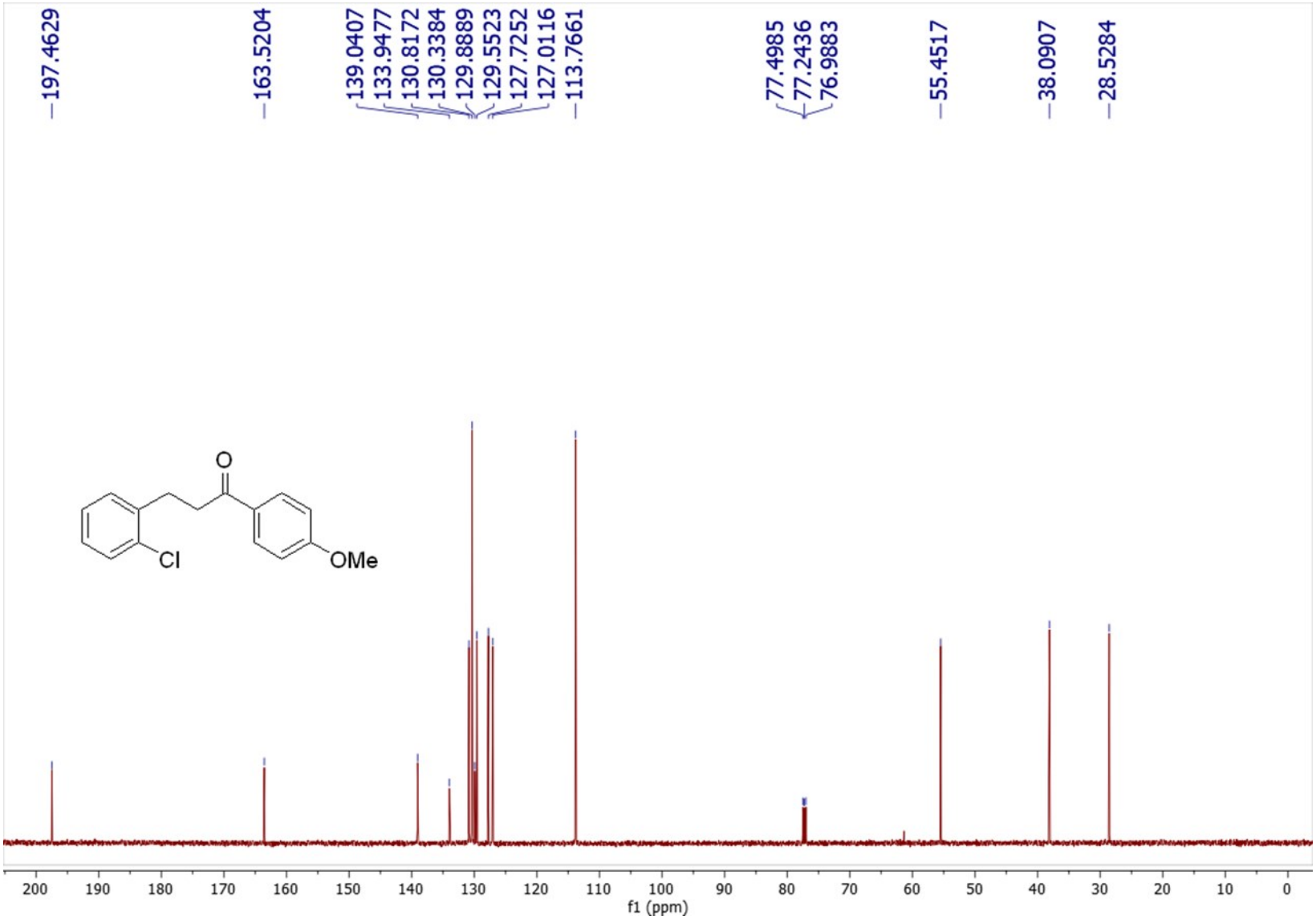
^{13}C NMR spectrum of **2n**



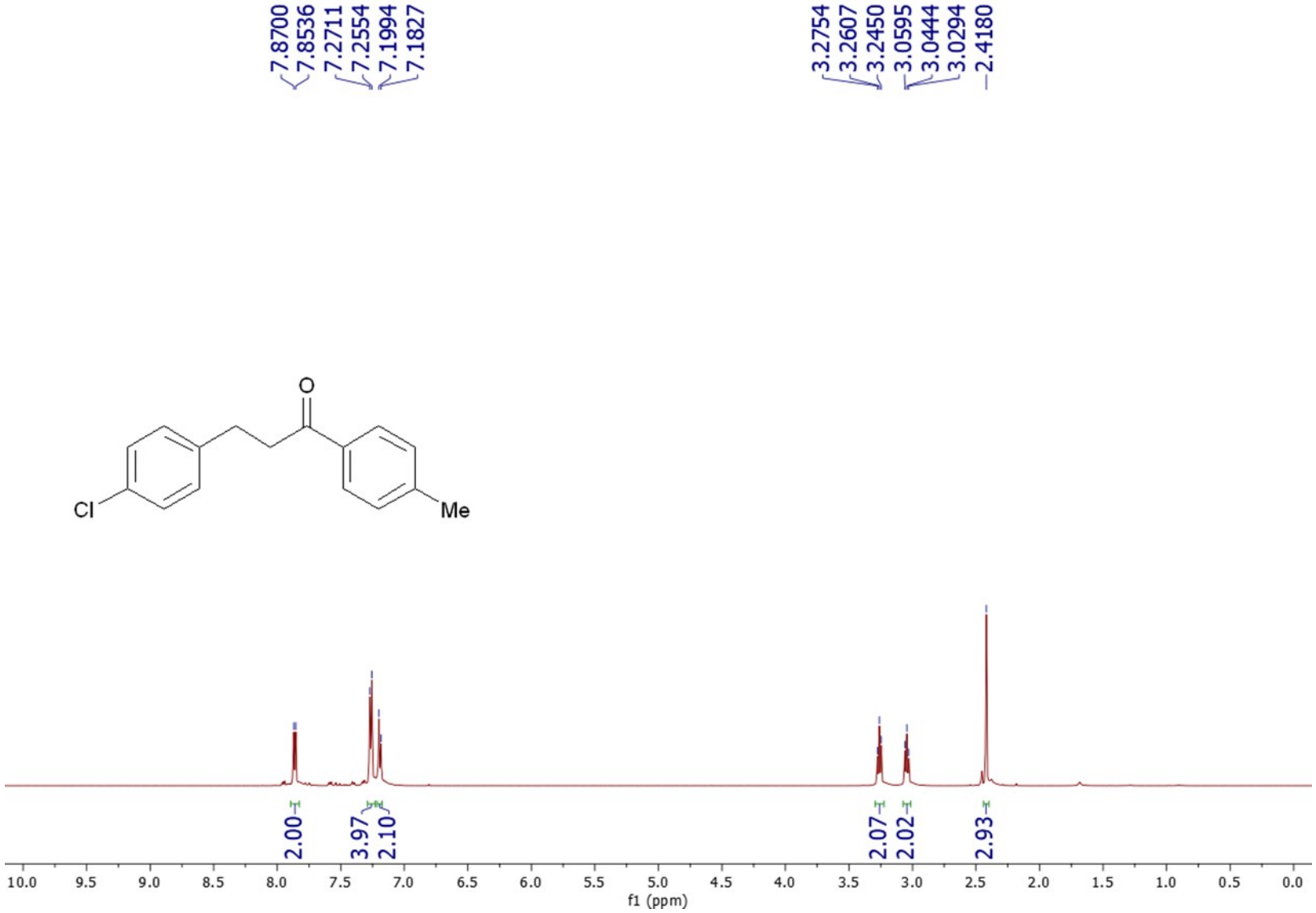
^{1}H NMR spectrum of **2o**



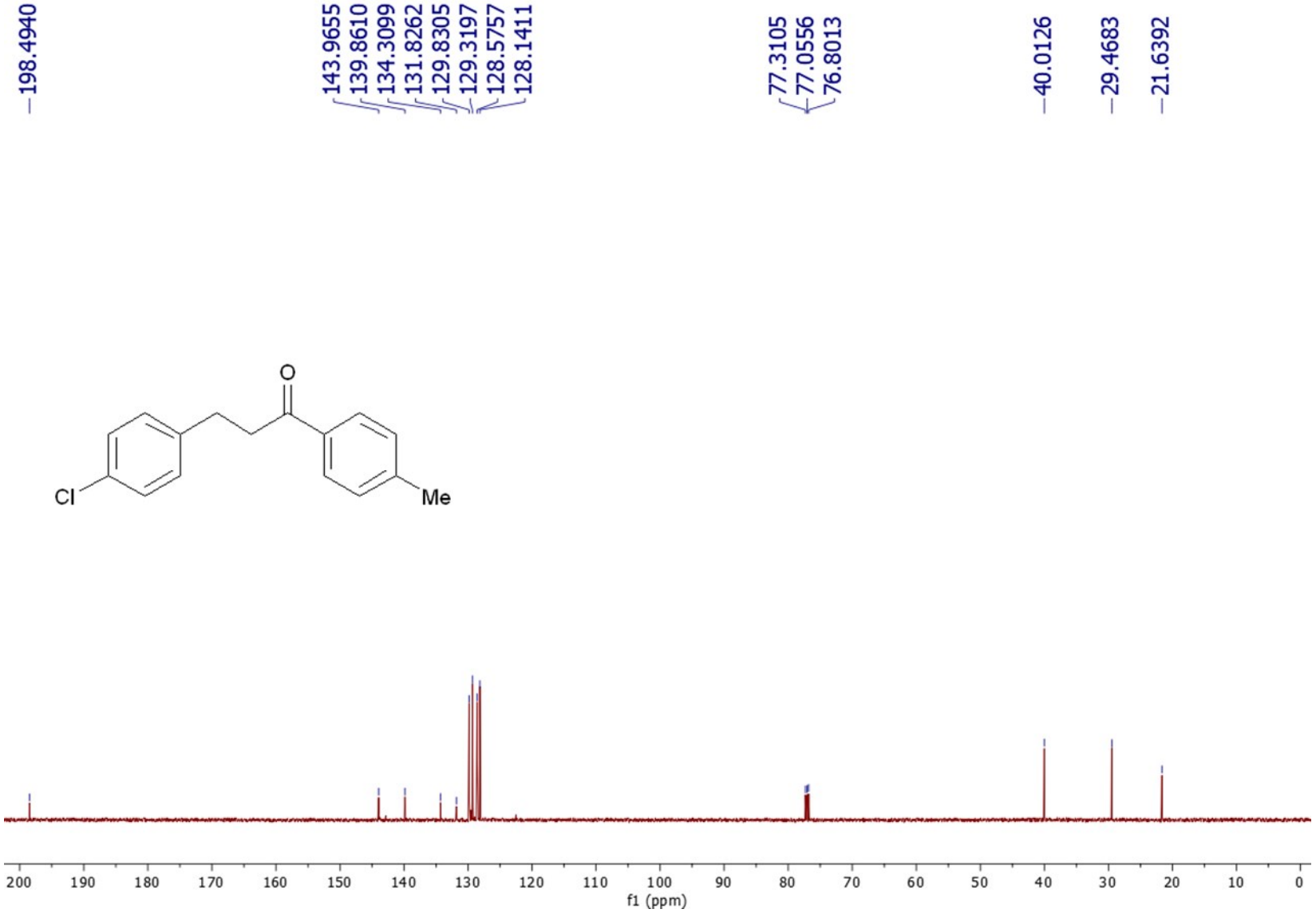
^{13}C NMR spectrum of **2o**



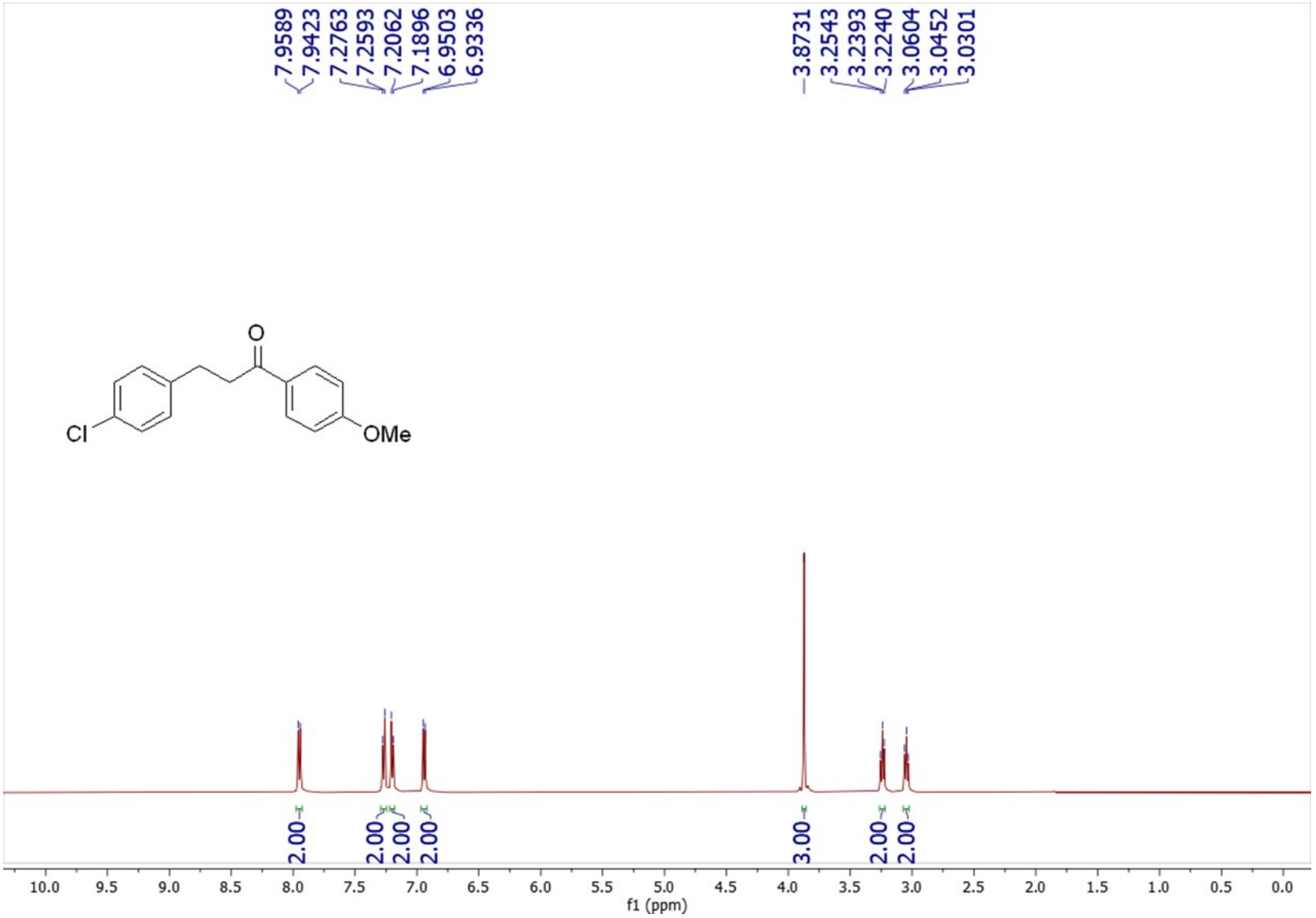
^{1}H NMR spectrum of **2p**



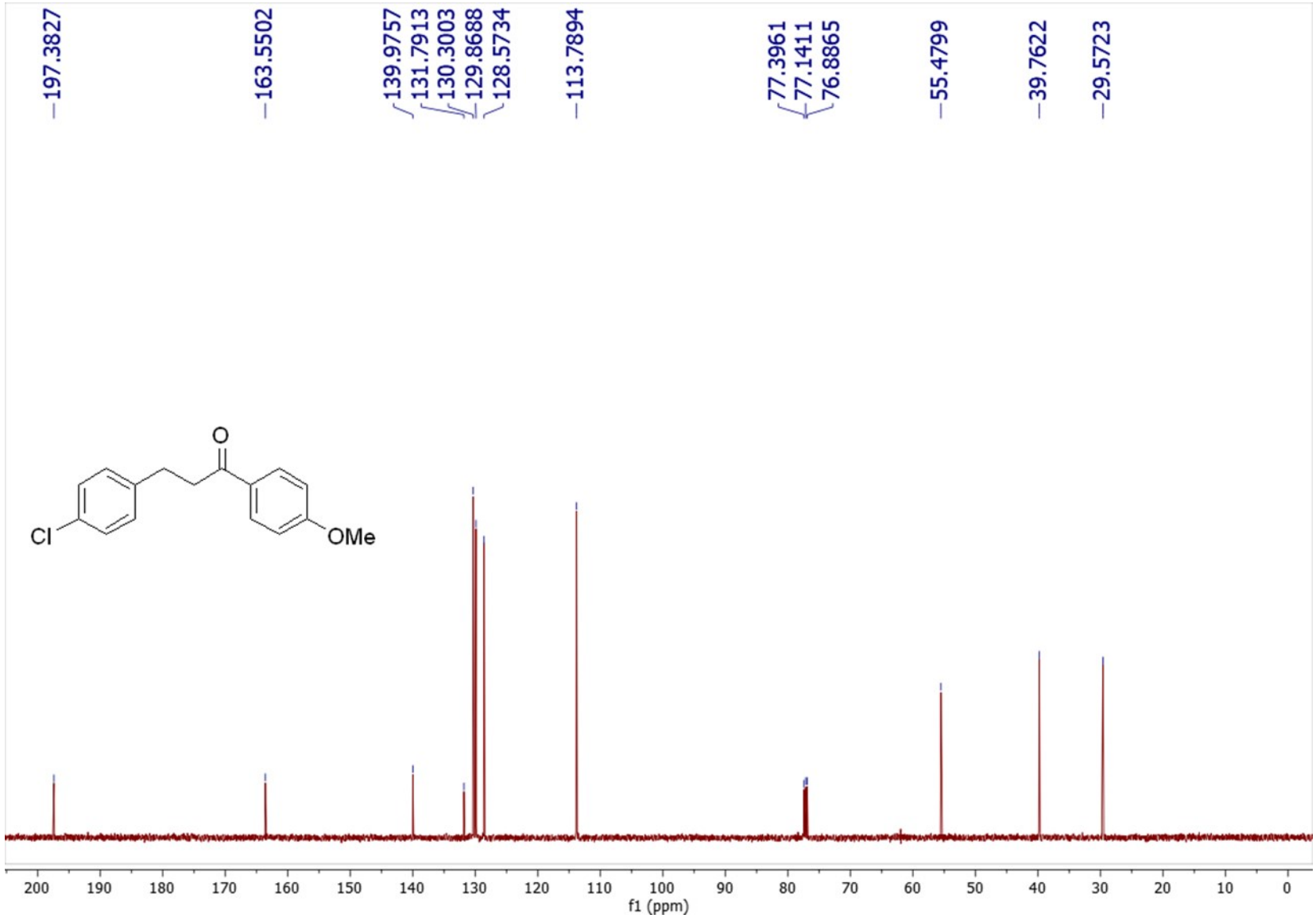
^{13}C NMR spectrum of **2p**



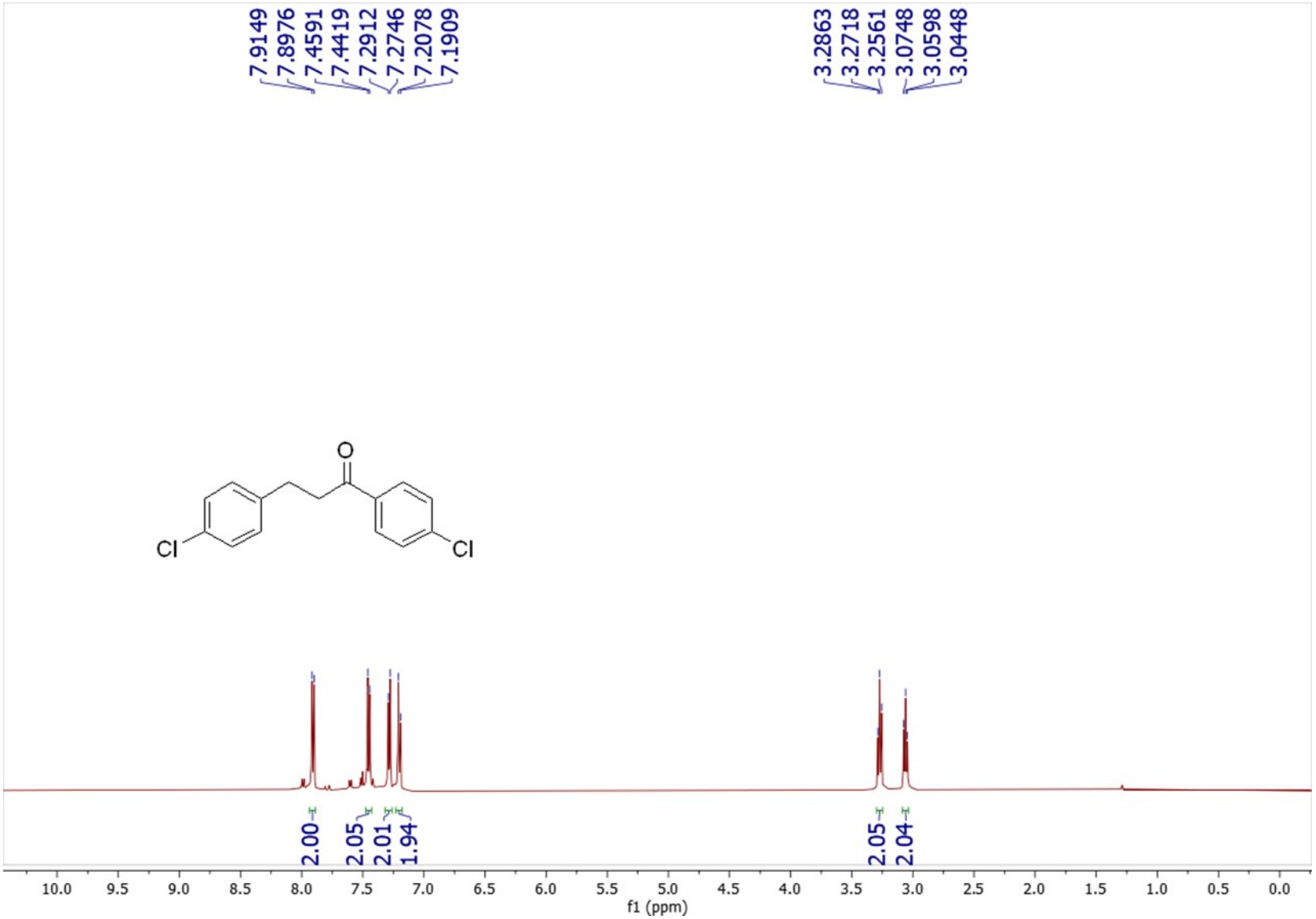
^{1}H NMR spectrum of **2q**



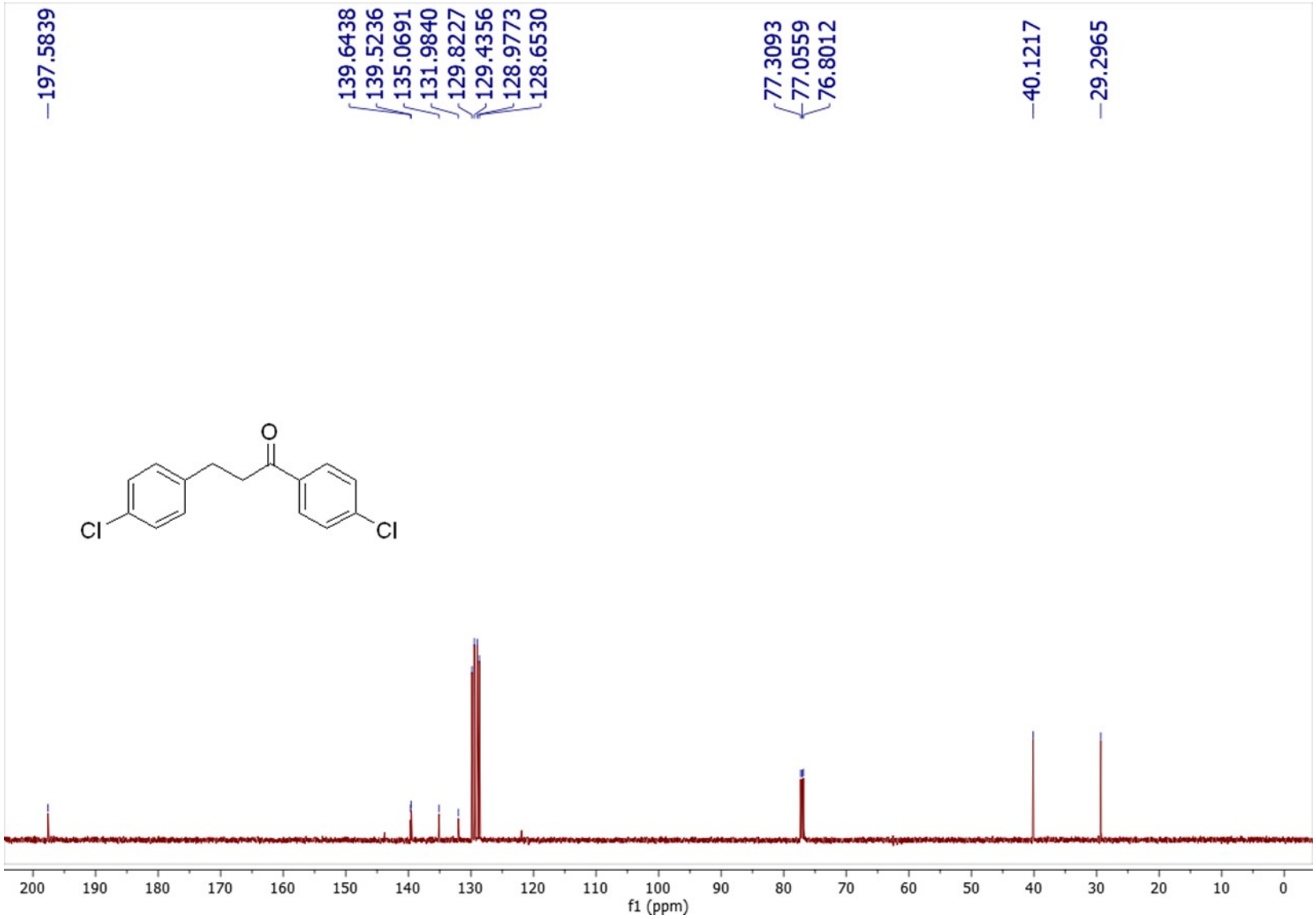
^{13}C NMR spectrum of **2q**



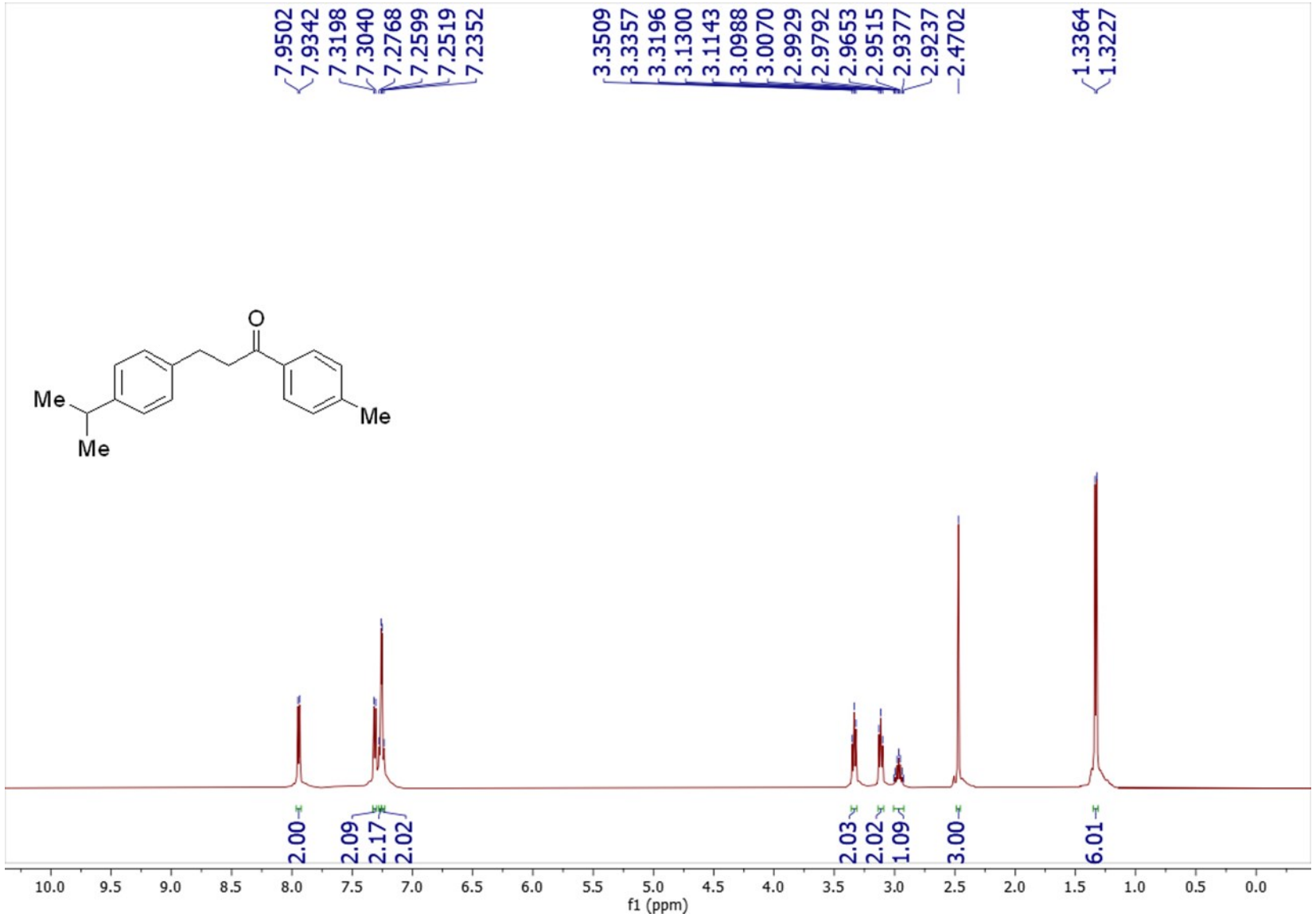
^{1}H NMR spectrum of **2r**



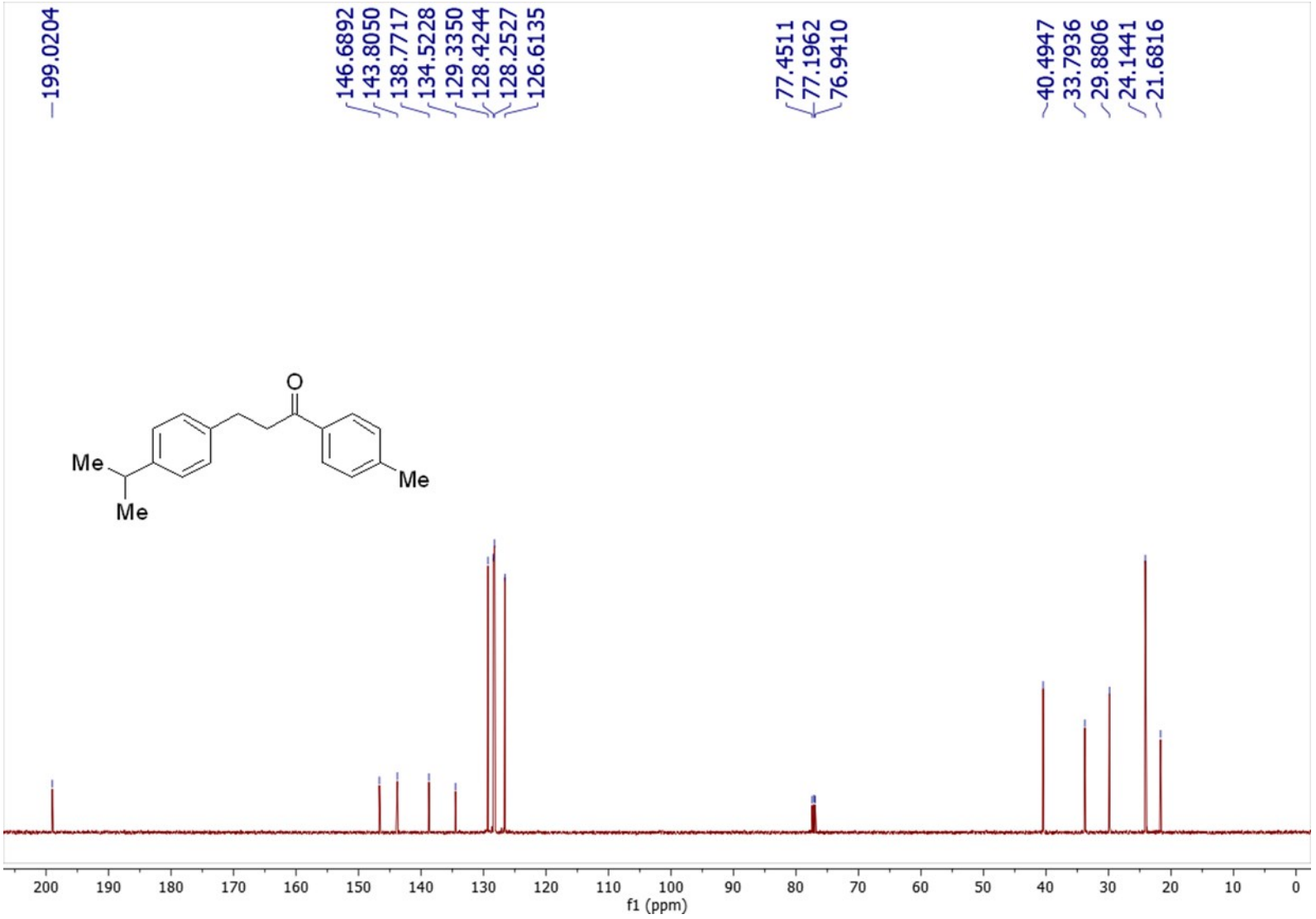
^{13}C NMR spectrum of **2r**



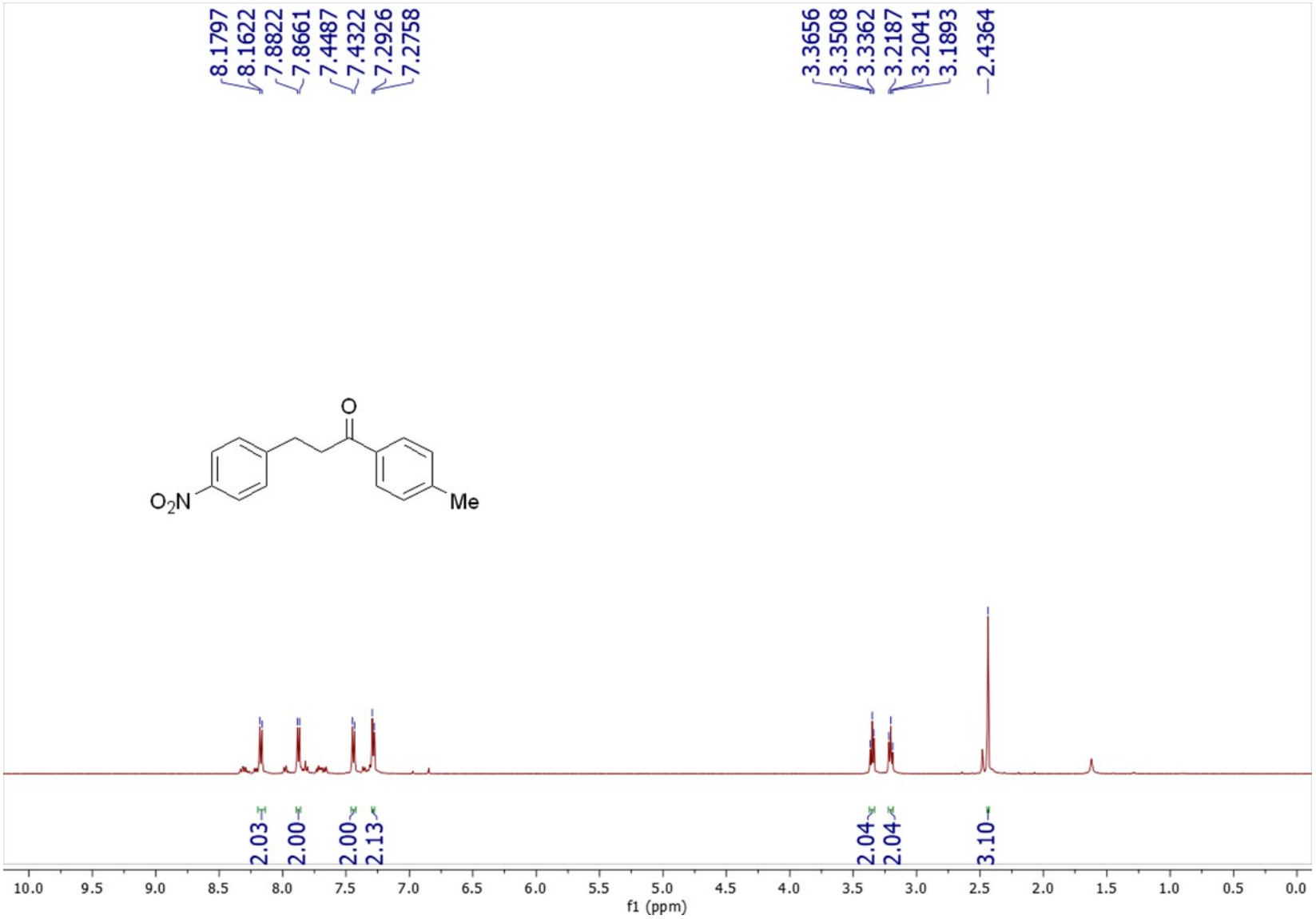
^{1}H NMR spectrum of **2s**



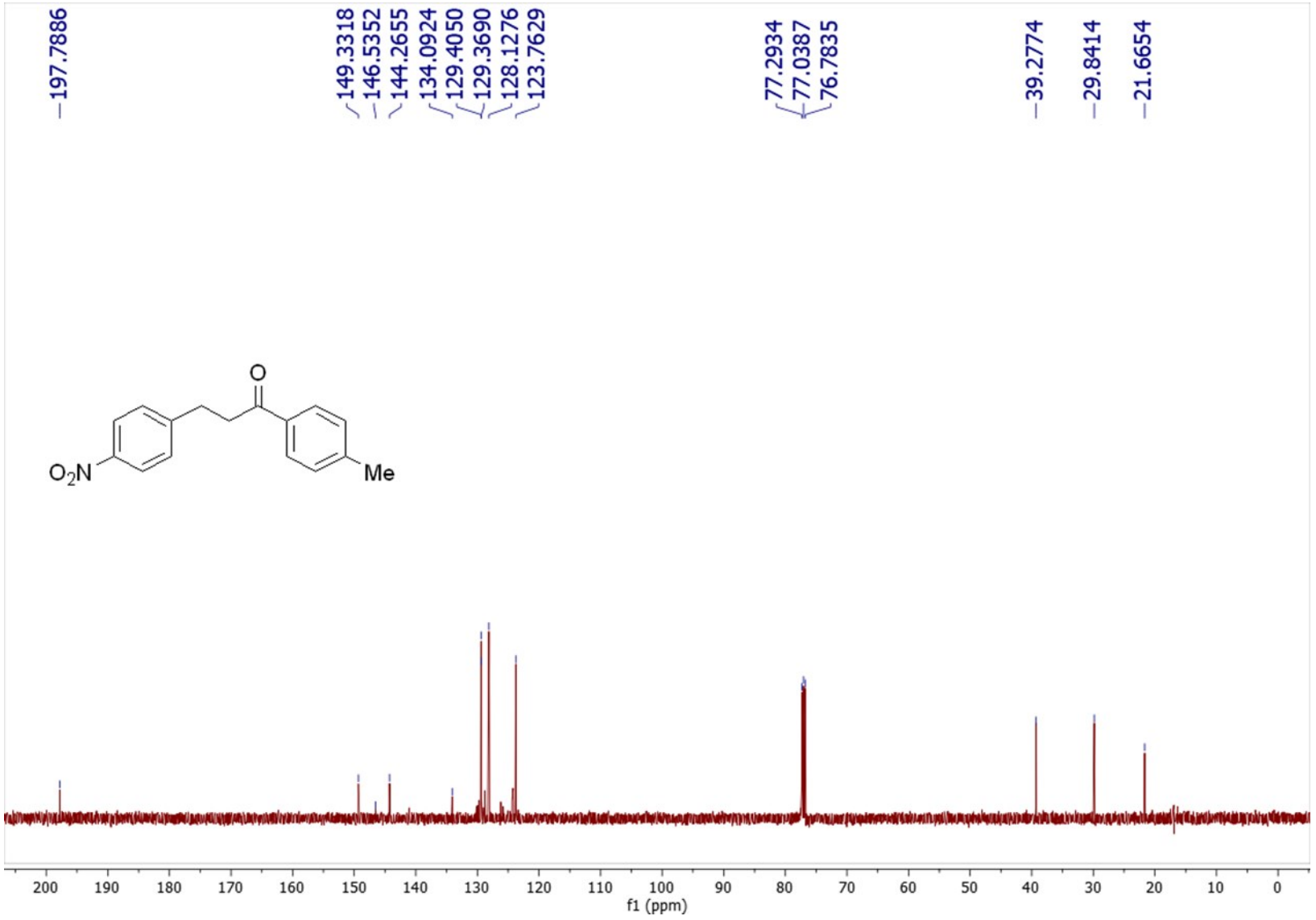
^{13}C NMR spectrum of **2s**



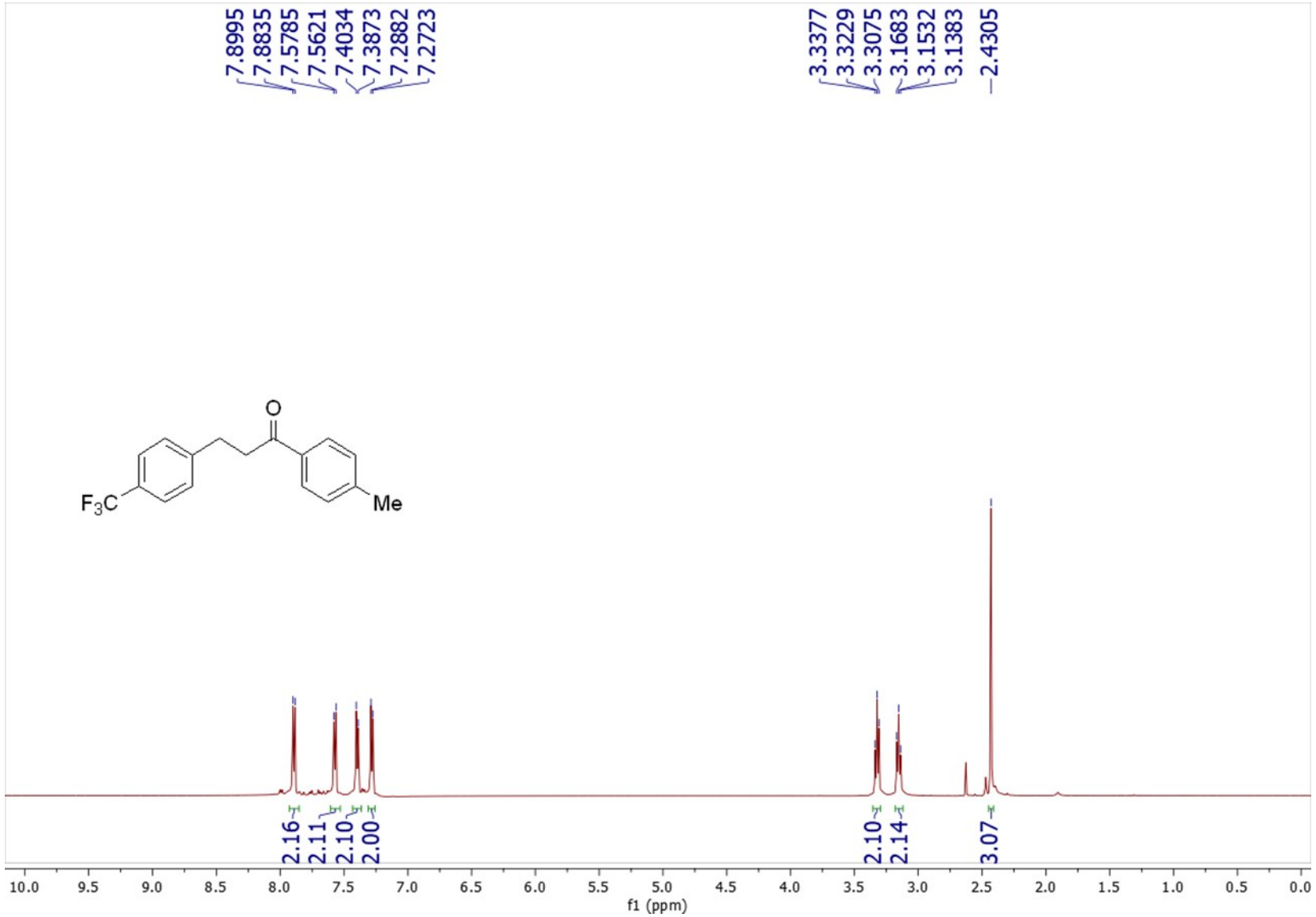
^{1}H NMR spectrum of **2t**



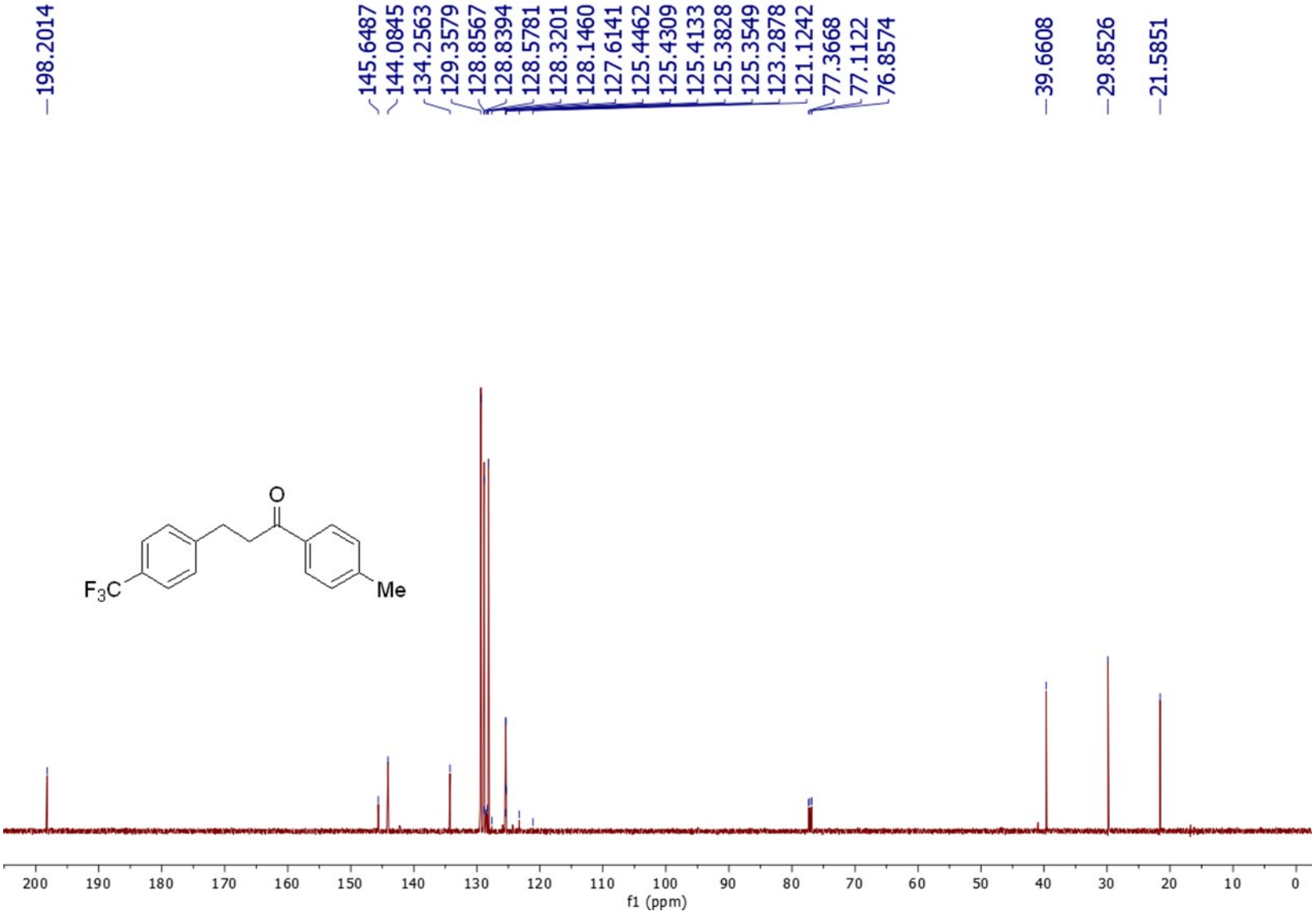
^{13}C NMR spectrum of **2t**



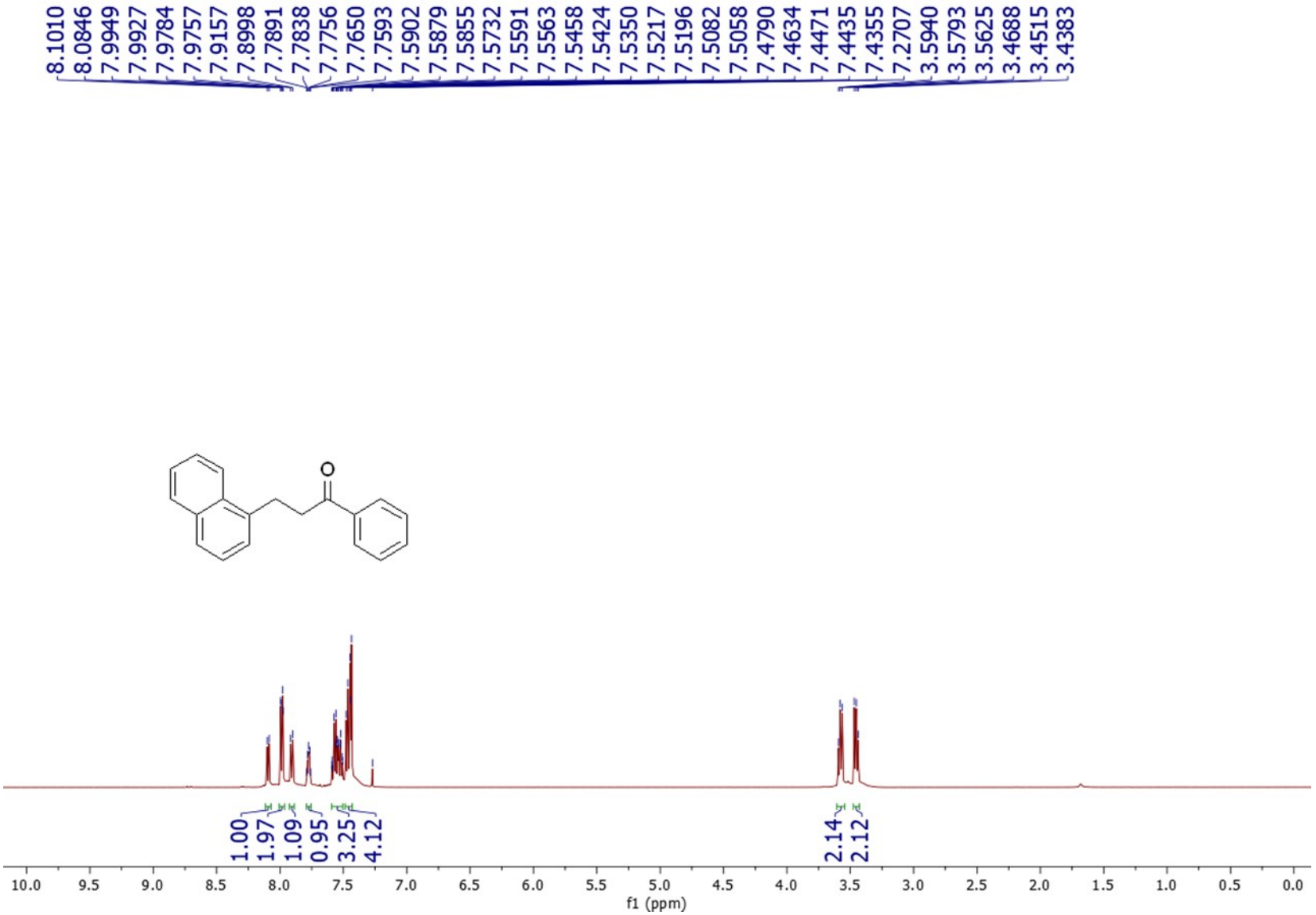
^{1}H NMR spectrum of **2u**



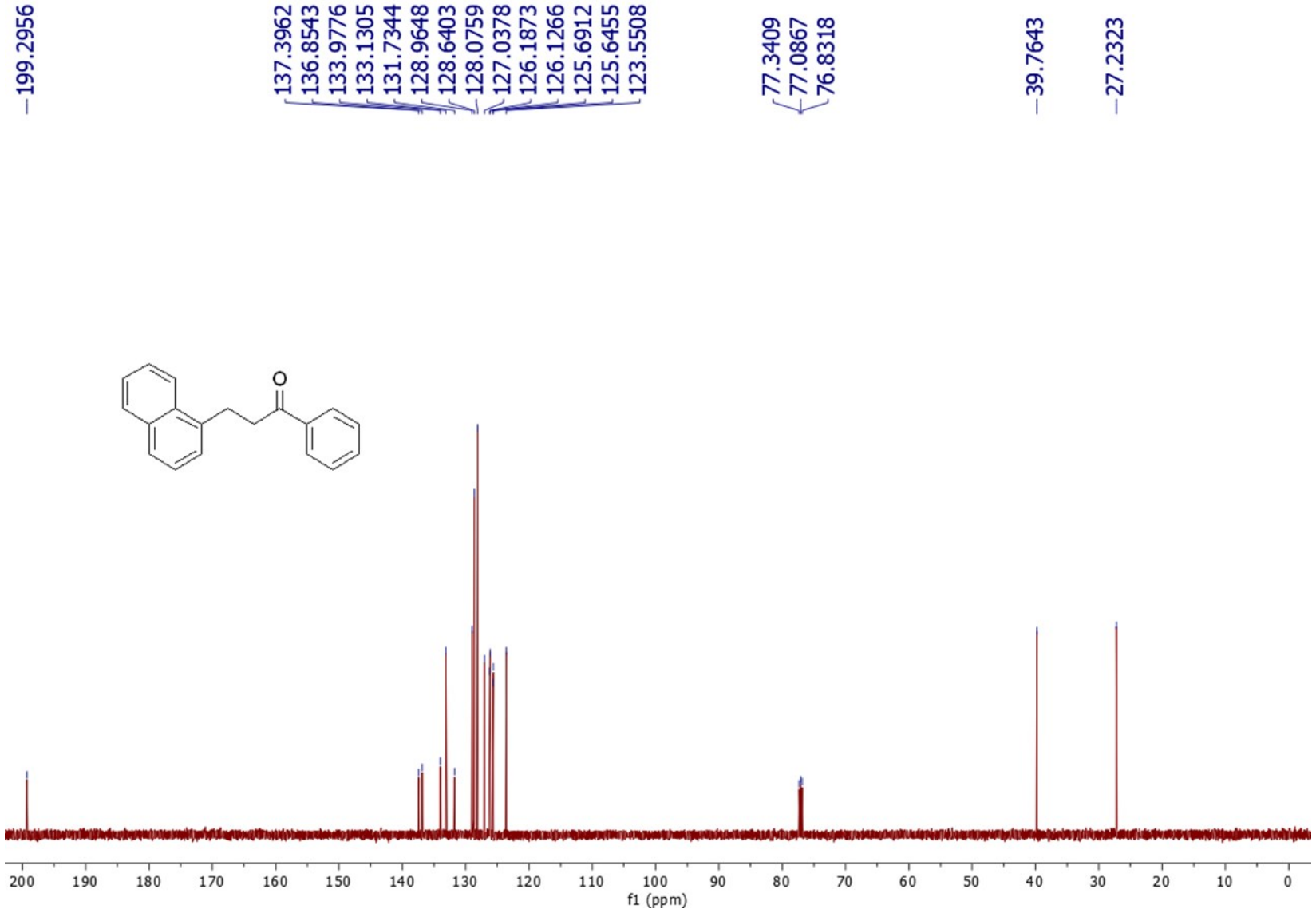
^{13}C NMR spectrum of **2u**



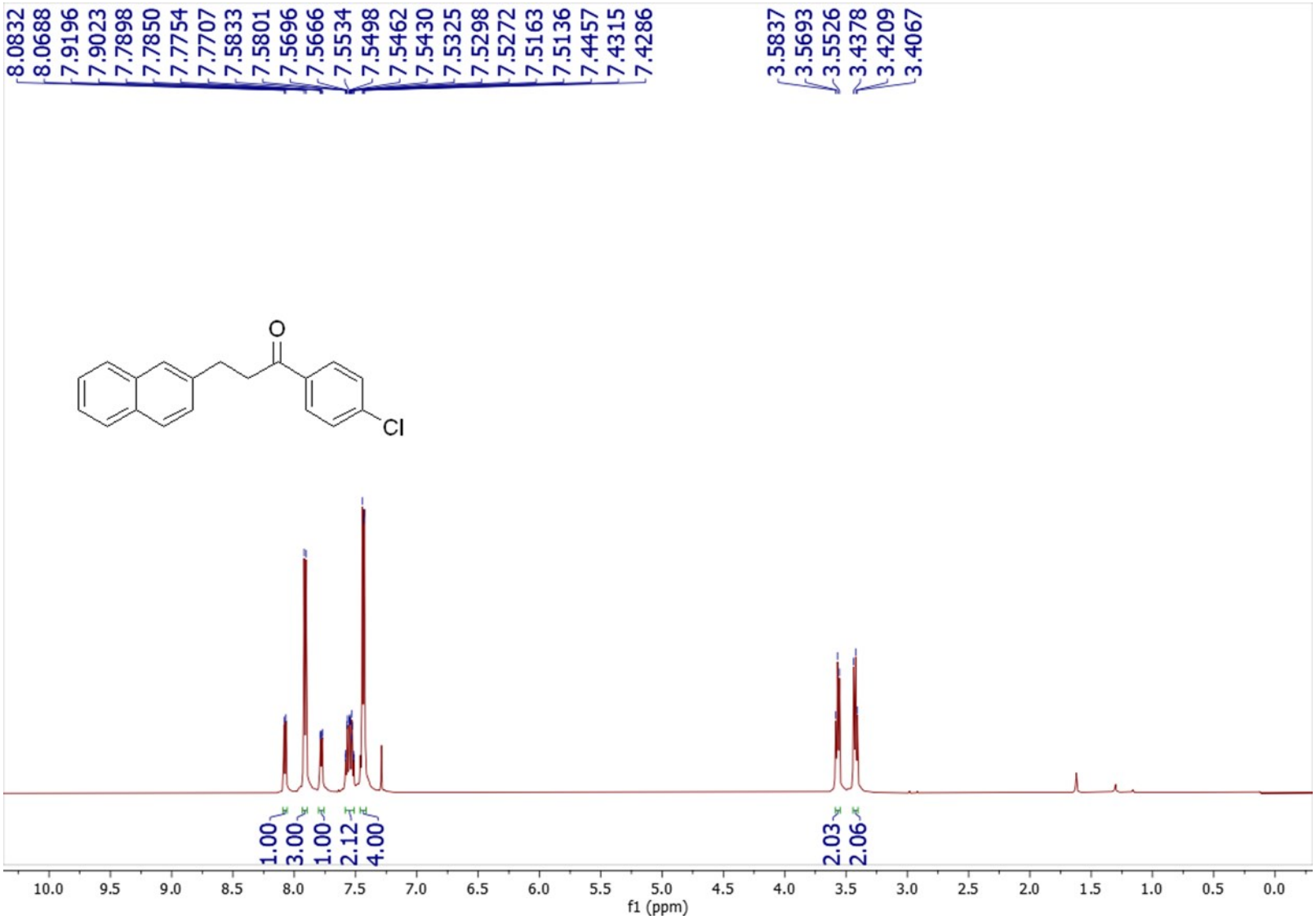
^{1}H NMR spectrum of **2v**



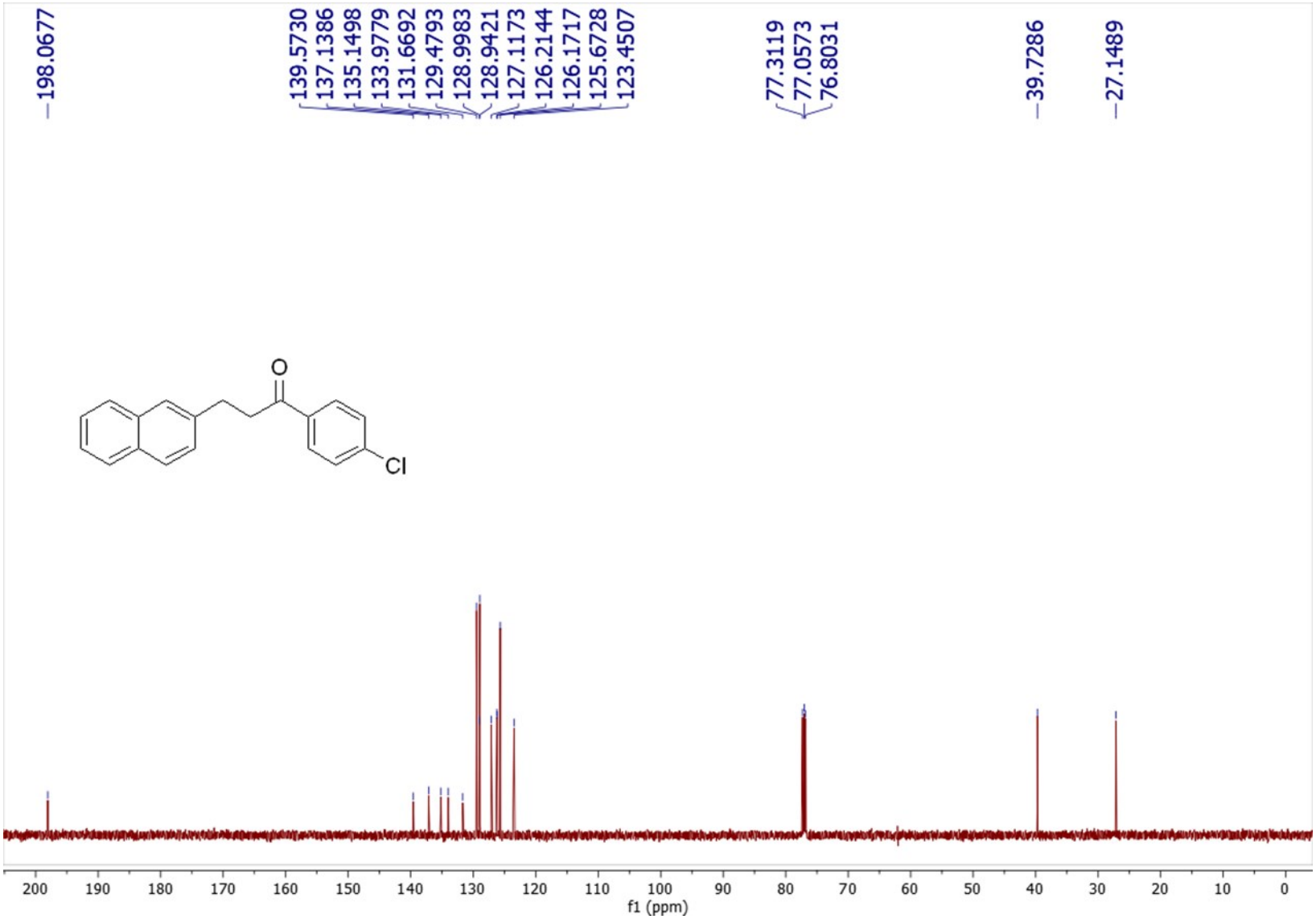
^{13}C NMR spectrum of **2v**



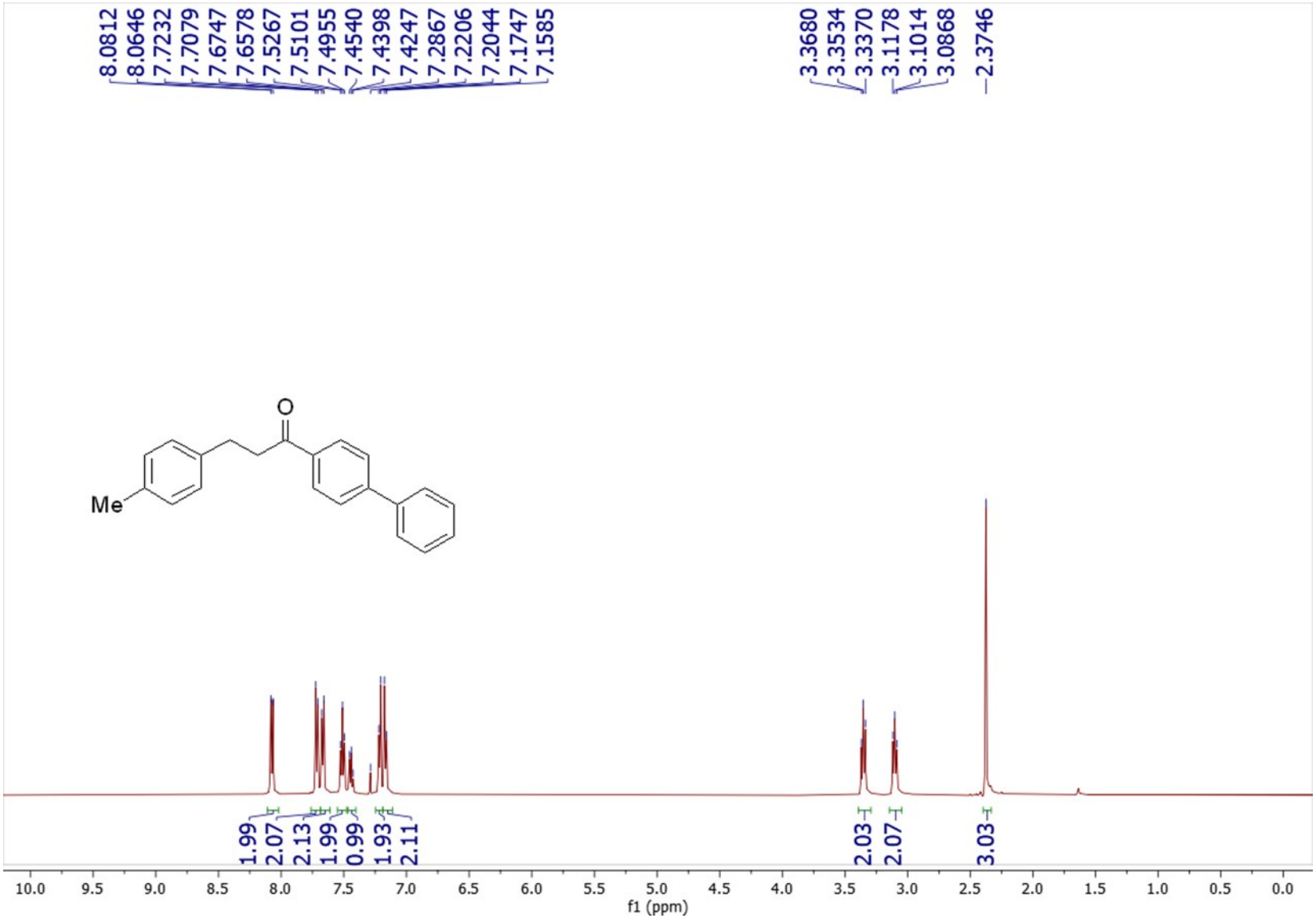
^{1}H NMR spectrum of **2w**



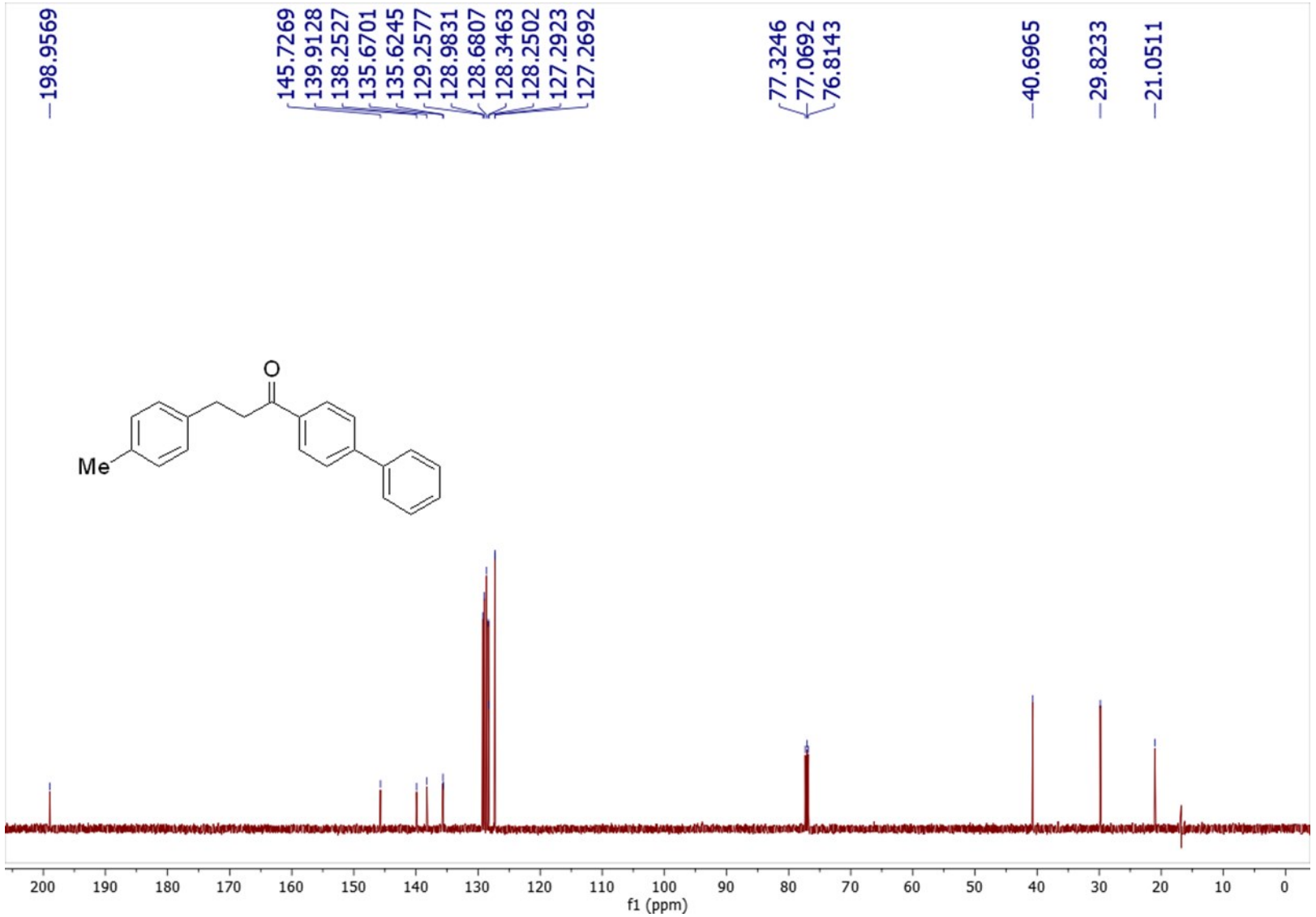
^{13}C NMR spectrum of **2w**



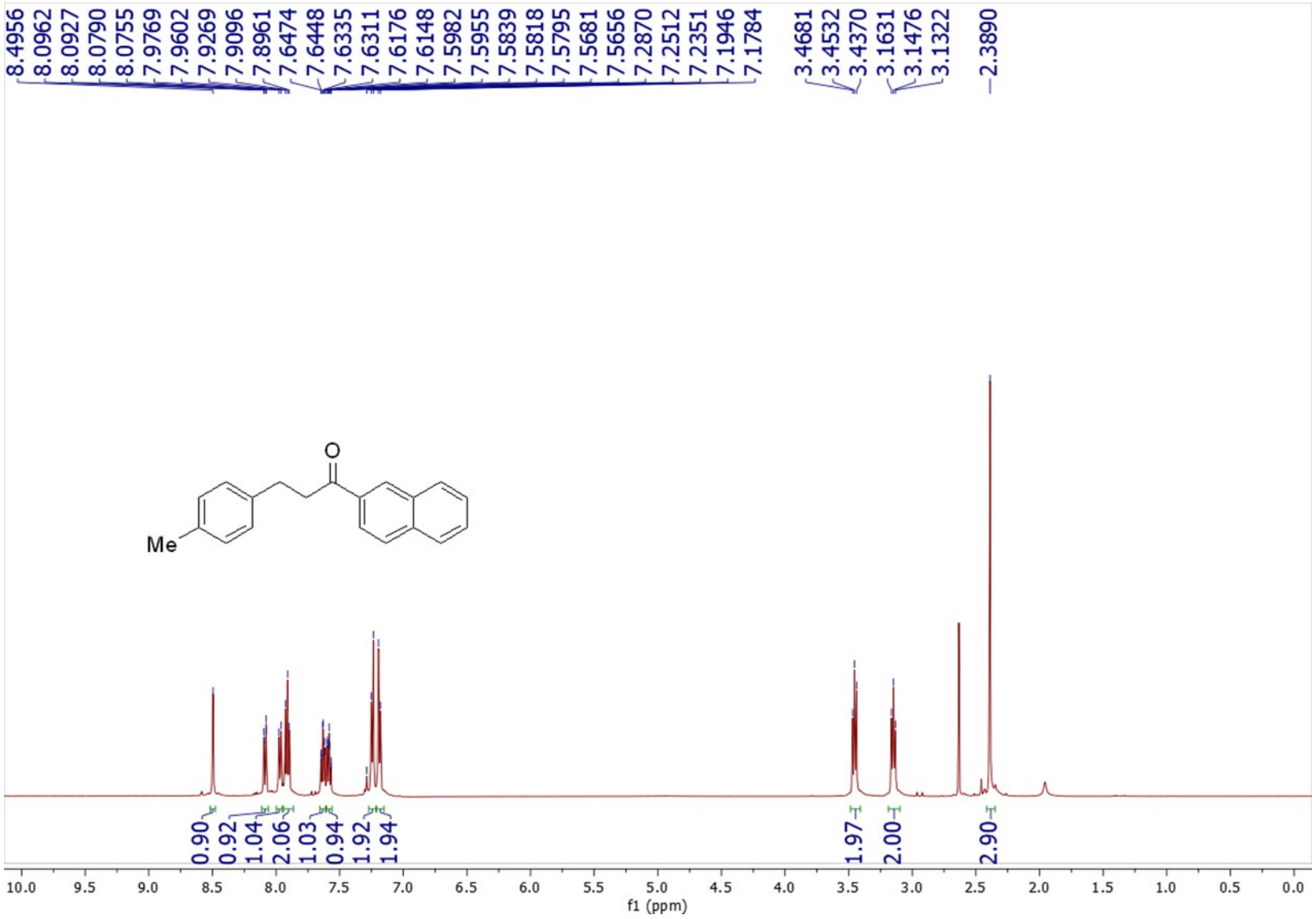
^{1}H NMR spectrum of **2x**



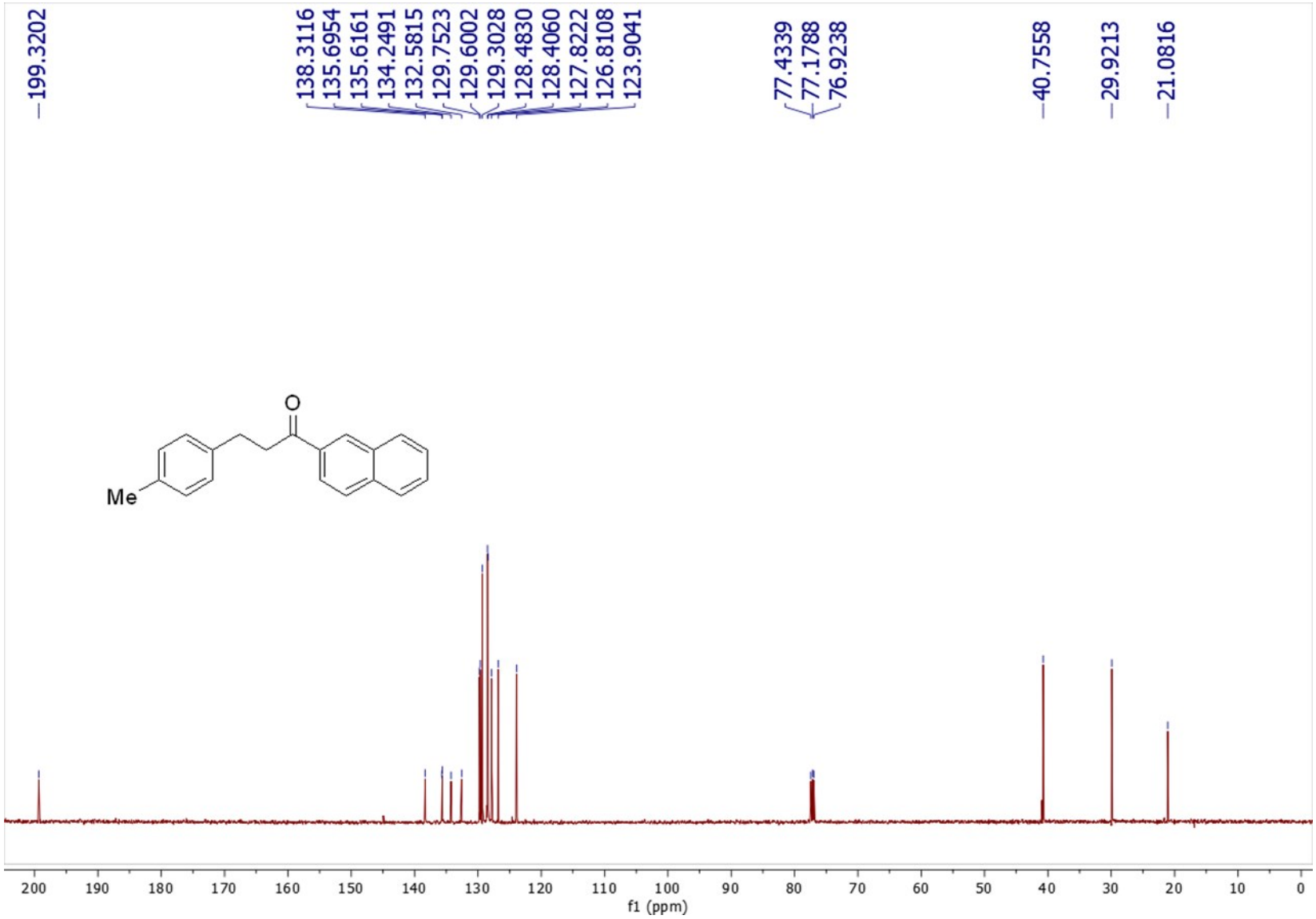
^{13}C NMR spectrum of **2x**



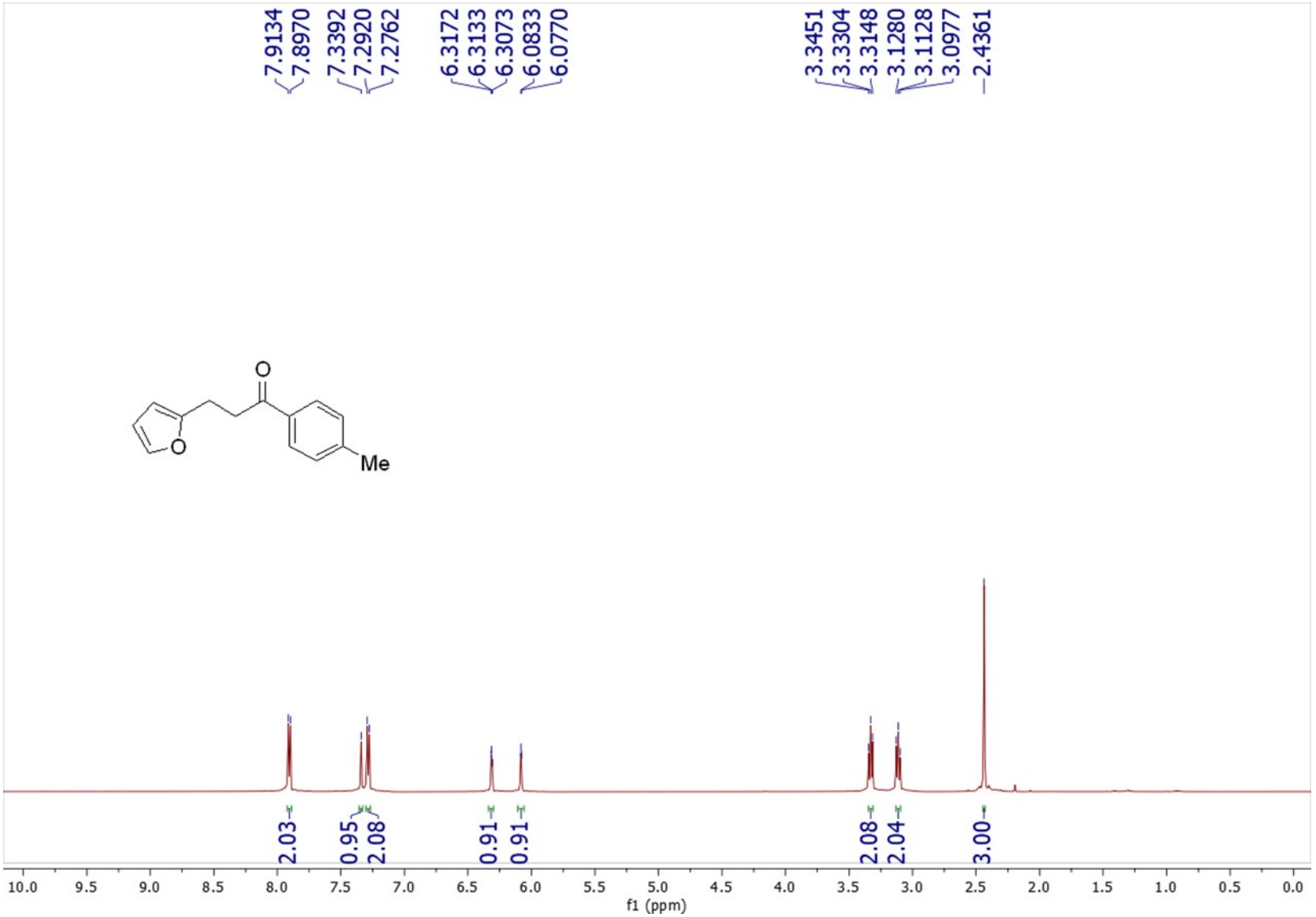
^{1}H NMR spectrum of **2y**



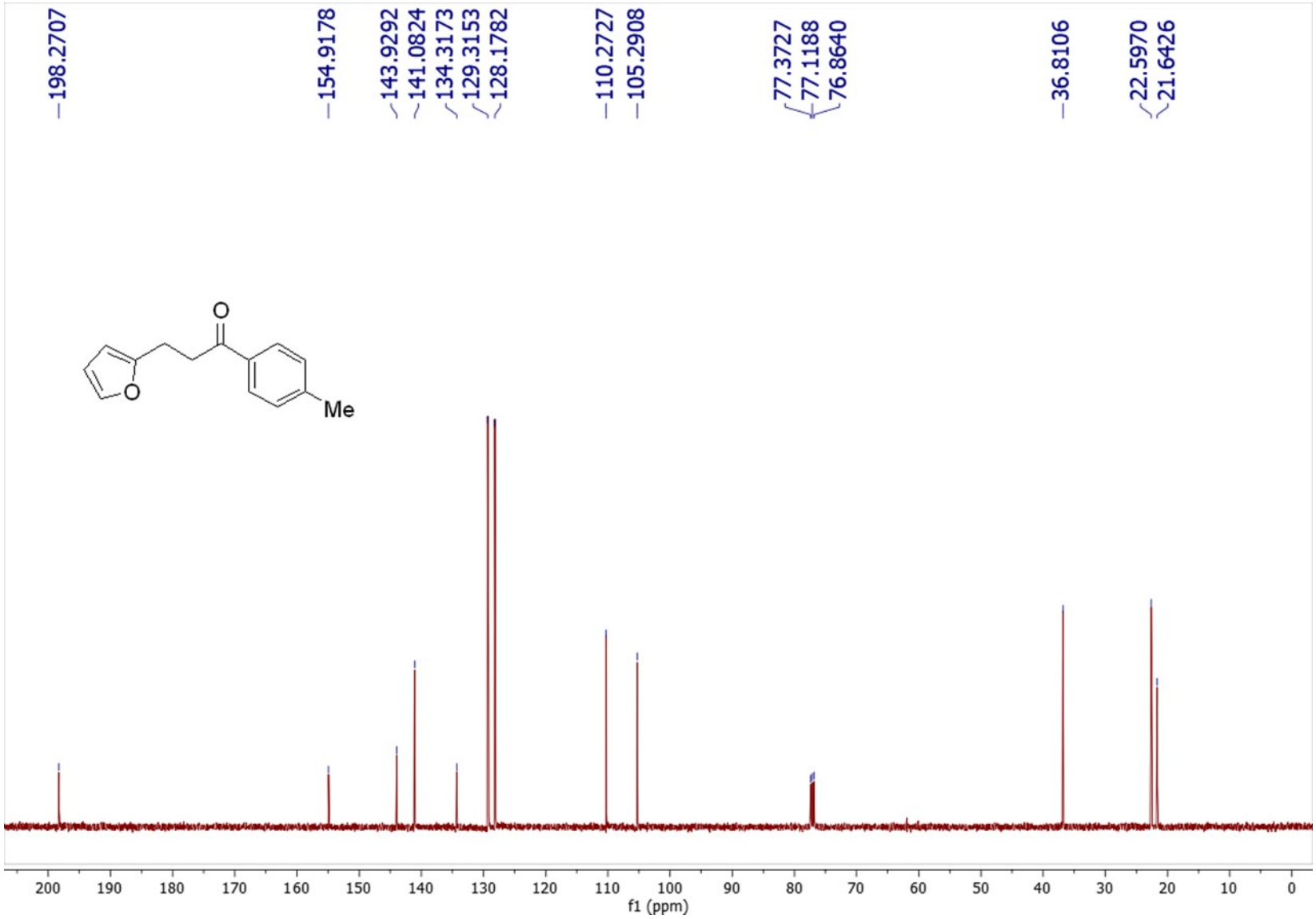
^{13}C NMR spectrum of **2y**



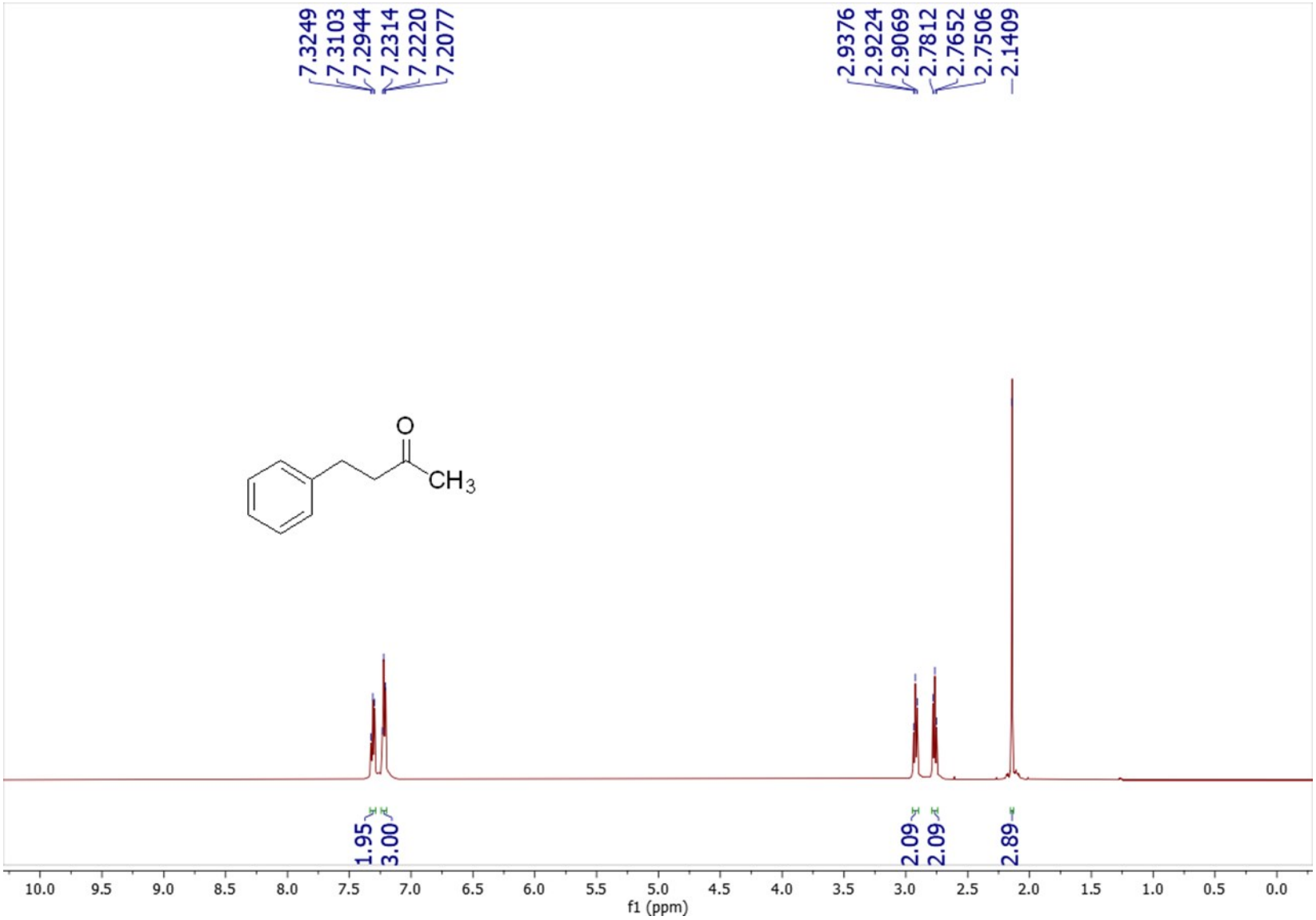
^{1}H NMR spectrum of **2z**



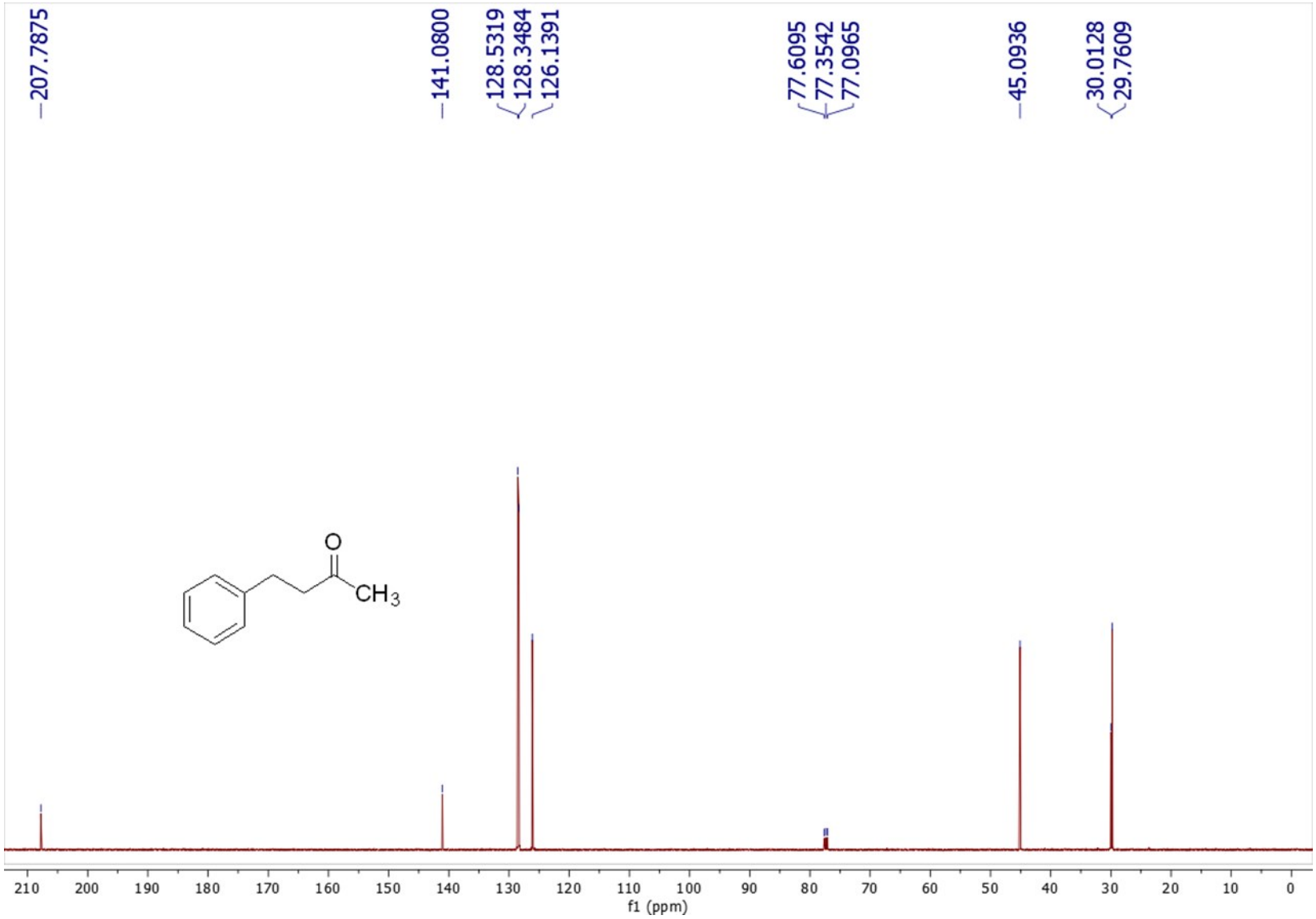
^{13}C NMR spectrum of **2z**



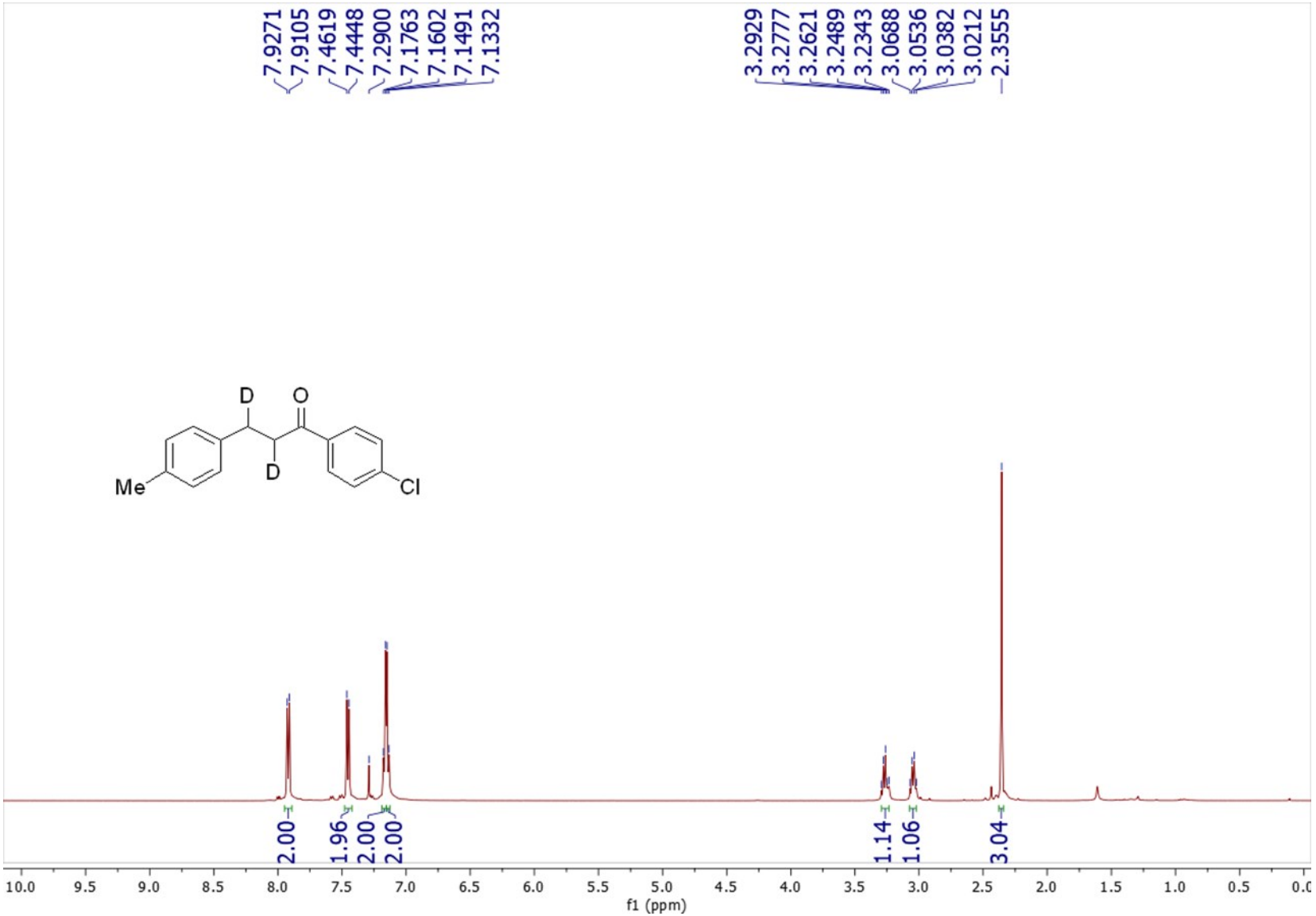
[1]H NMR spectrum of **2aa**



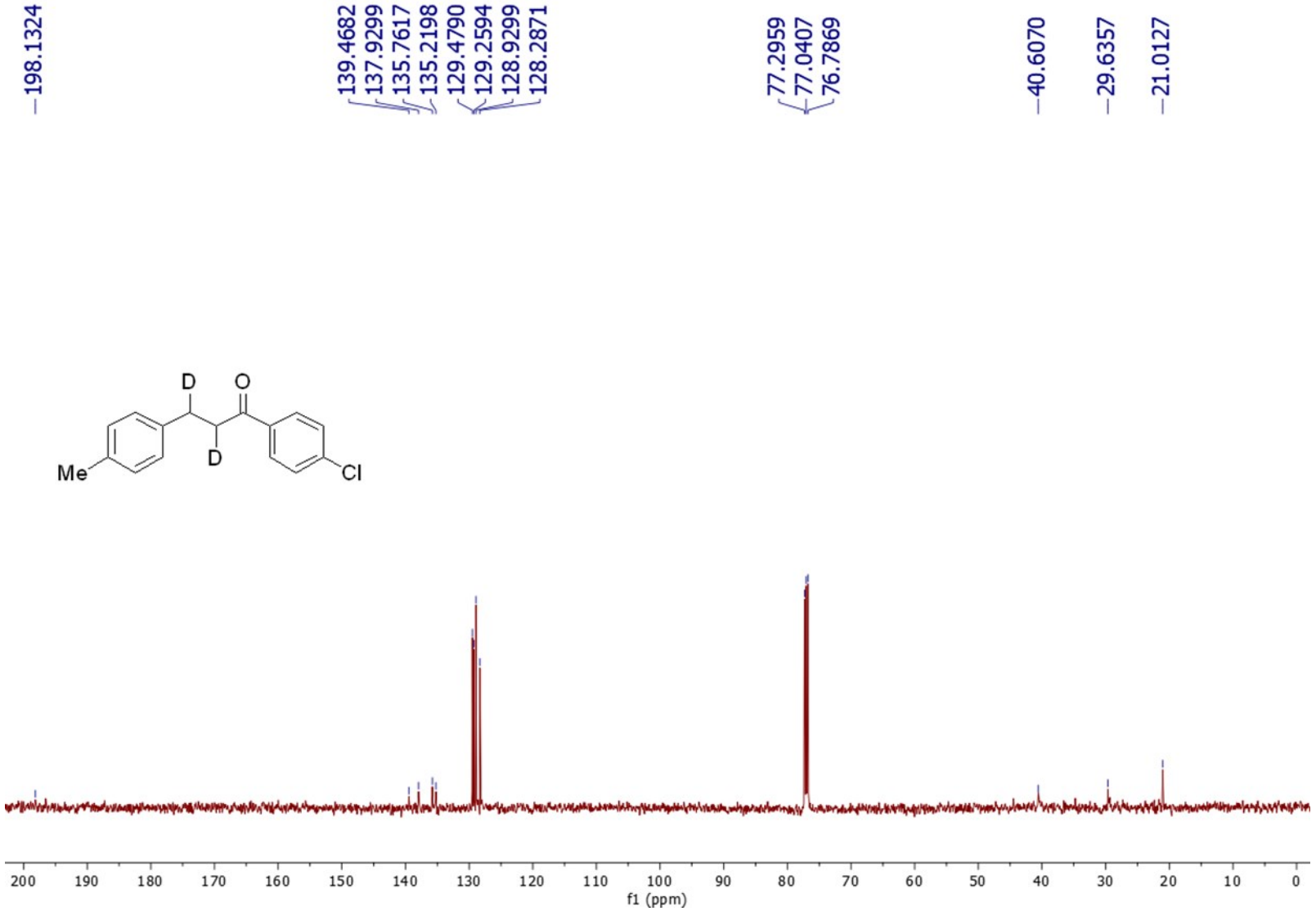
^{13}C NMR spectrum of **2aa**



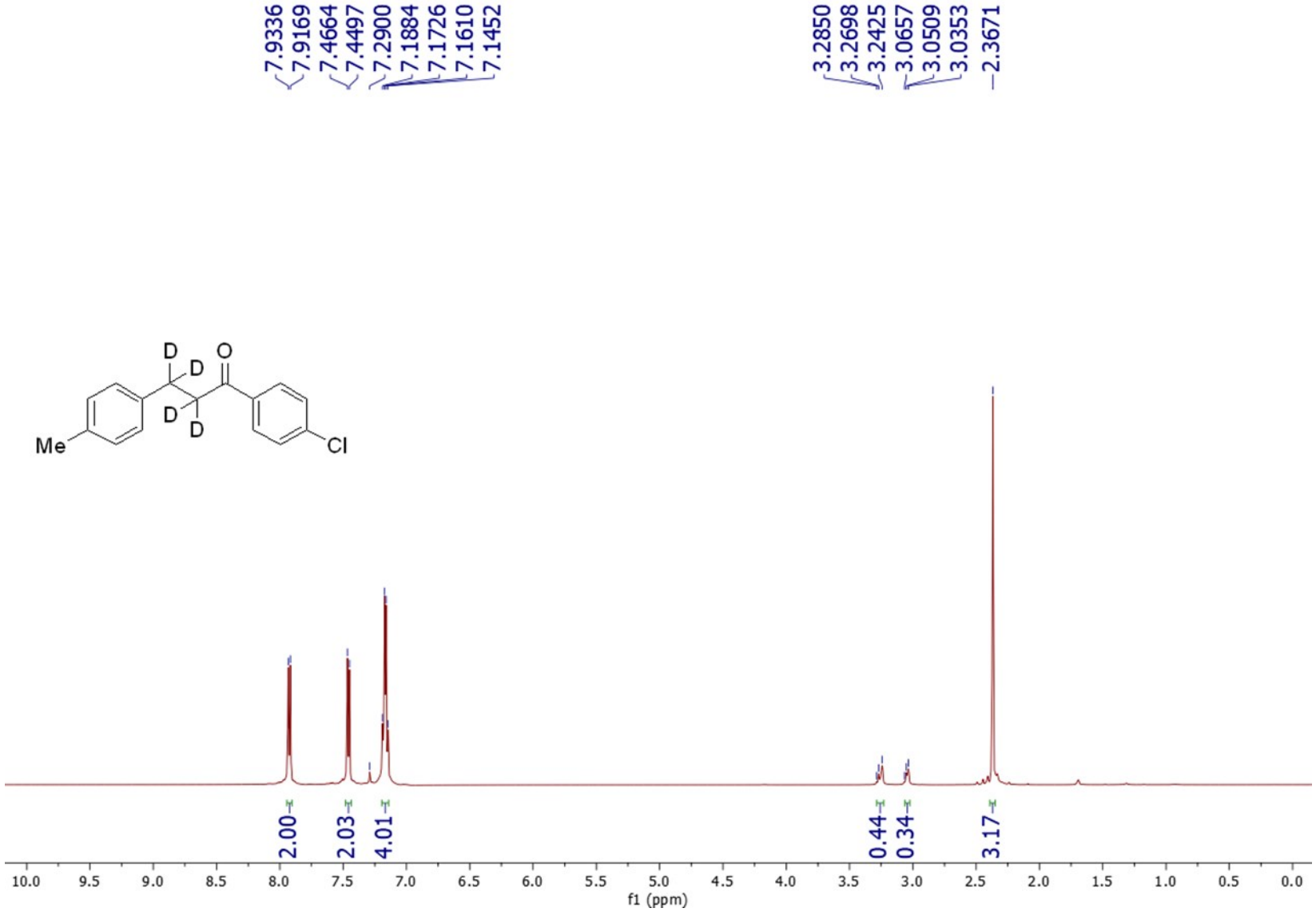
^{1}H NMR spectrum of **2f-d$_1$**



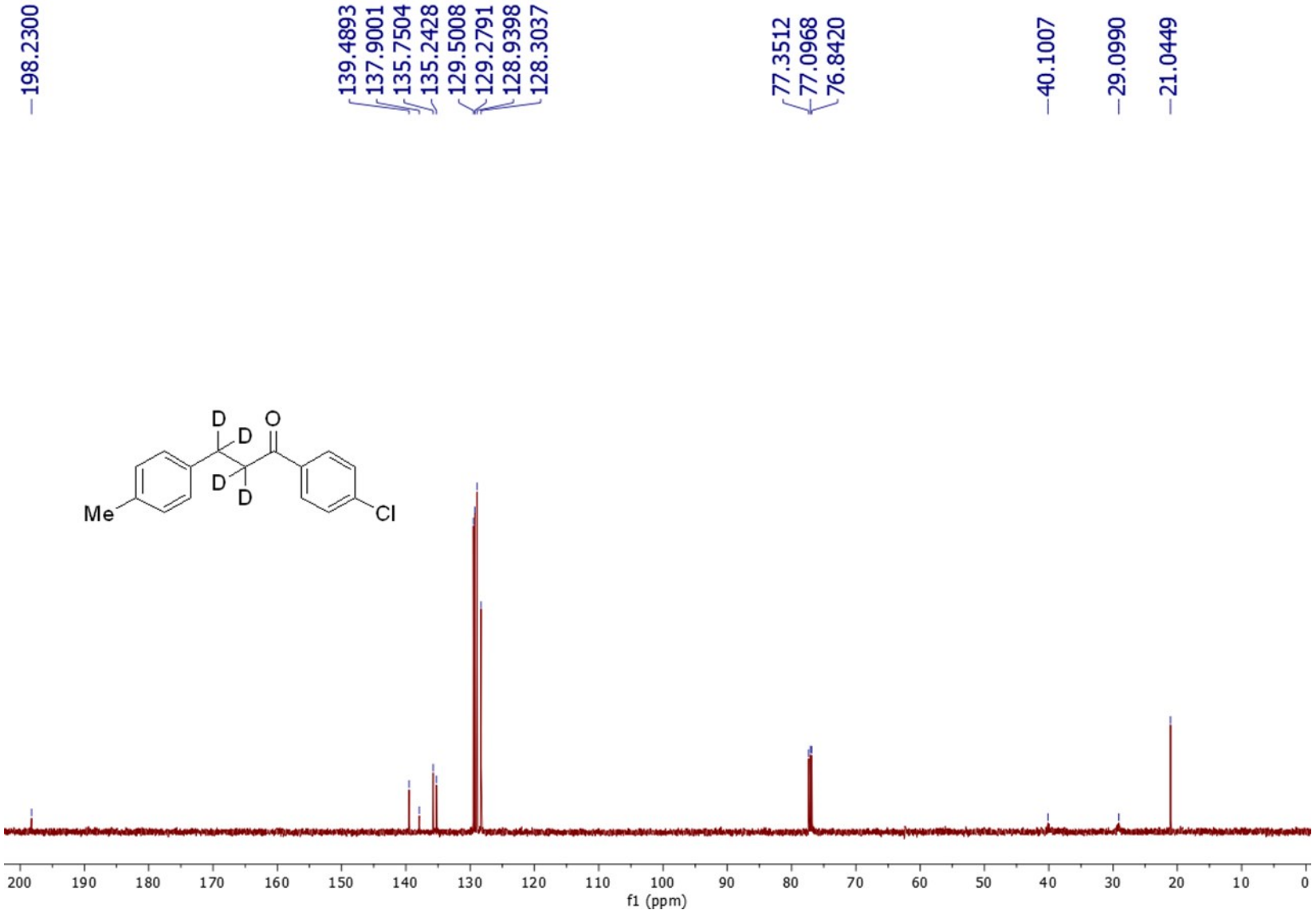
^{13}C NMR spectrum of **2f-d$_1$**



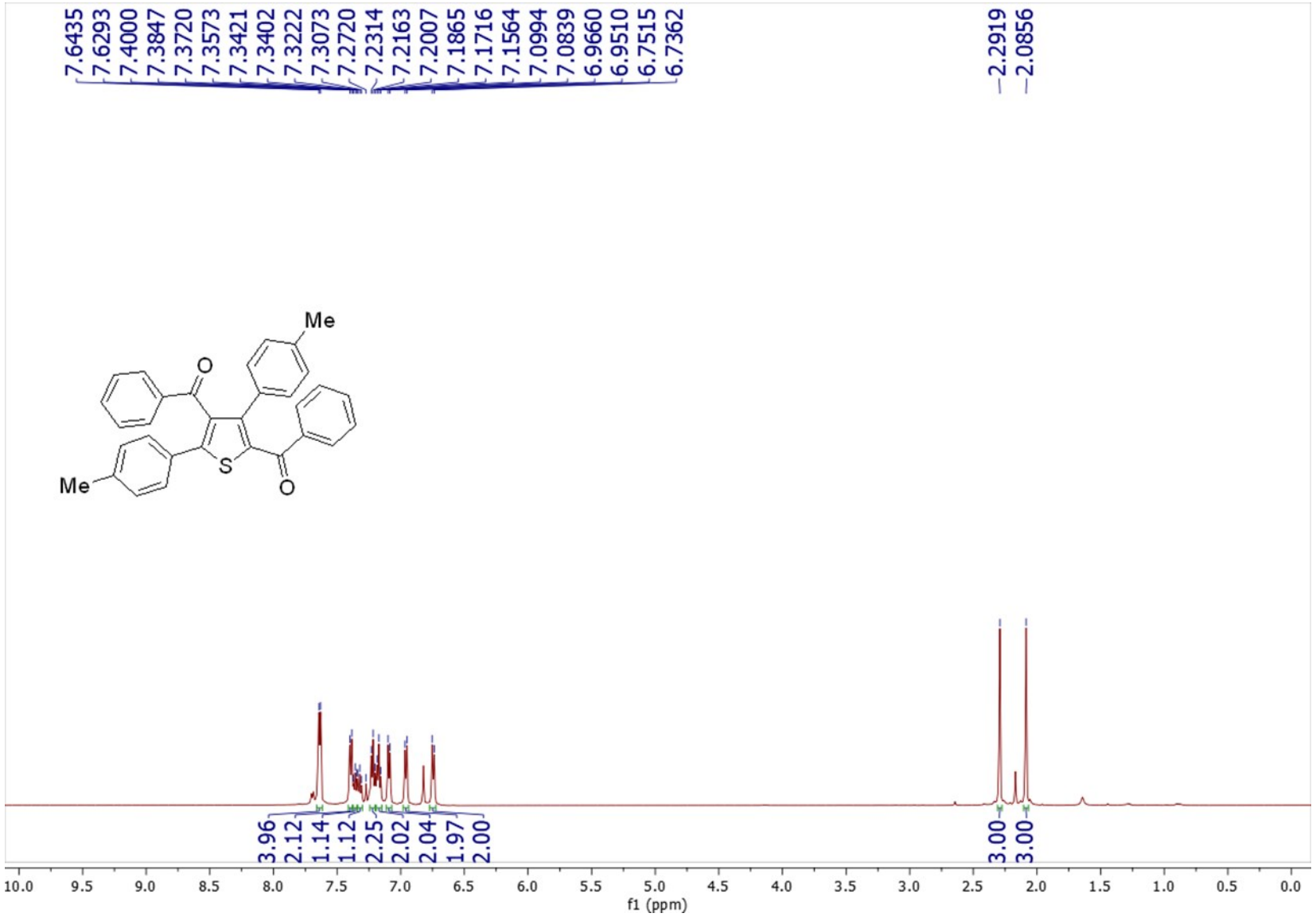
^{1}H NMR spectrum of **2f-d$_2$**



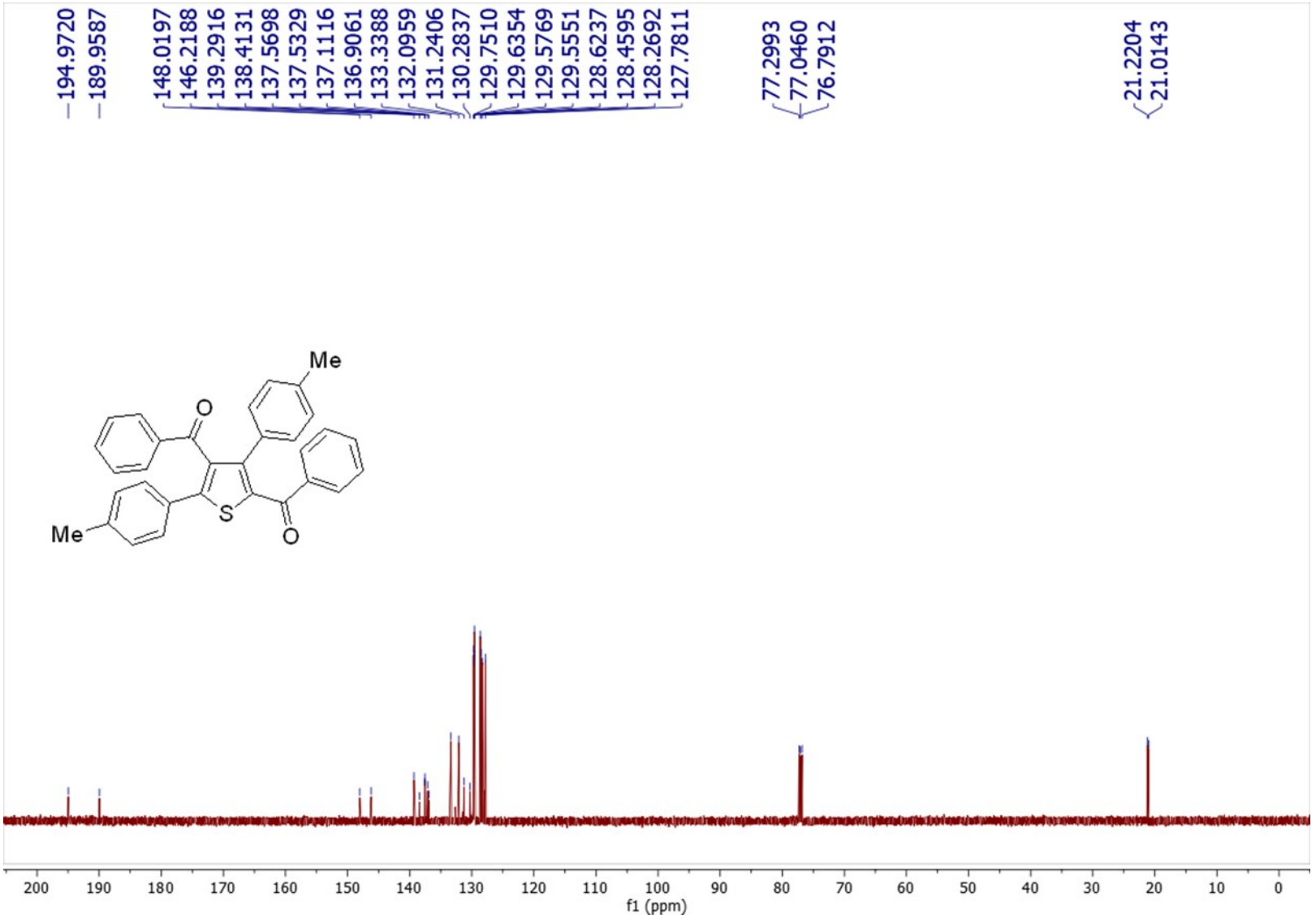
^{13}C NMR spectrum of **2f-d$_2$**



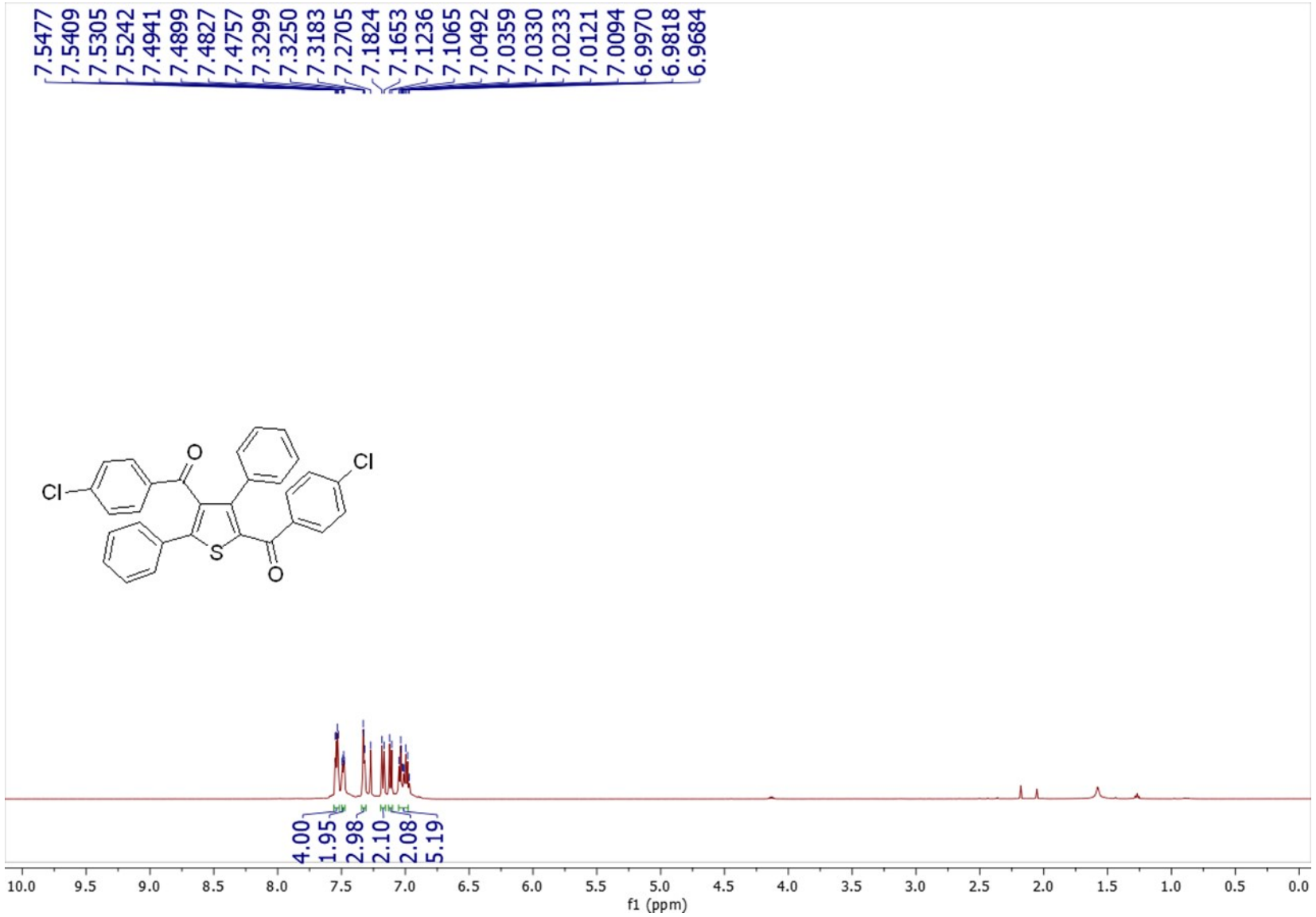
^{1}H NMR spectrum of **3a**



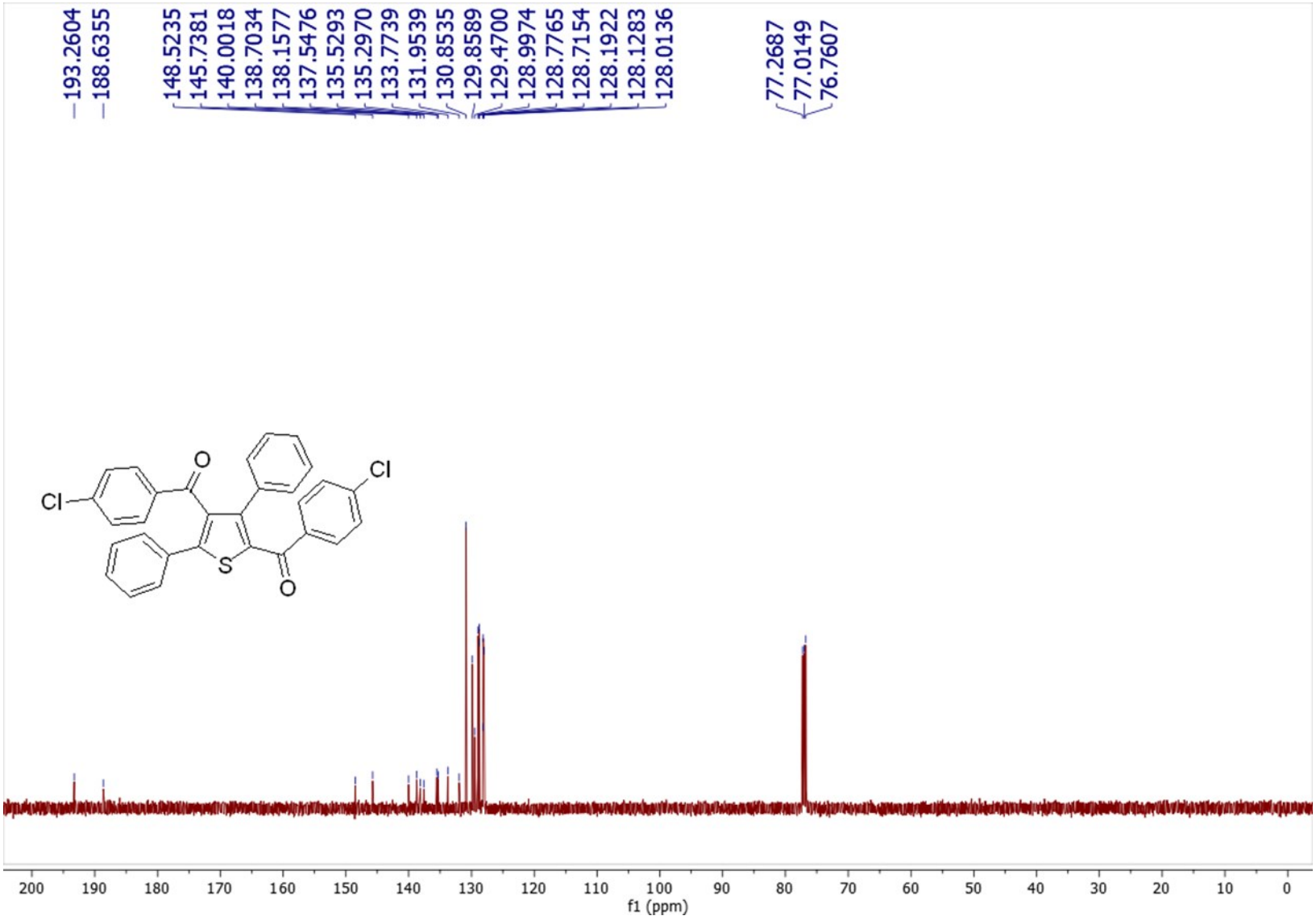
^{13}C NMR spectrum of **3a**



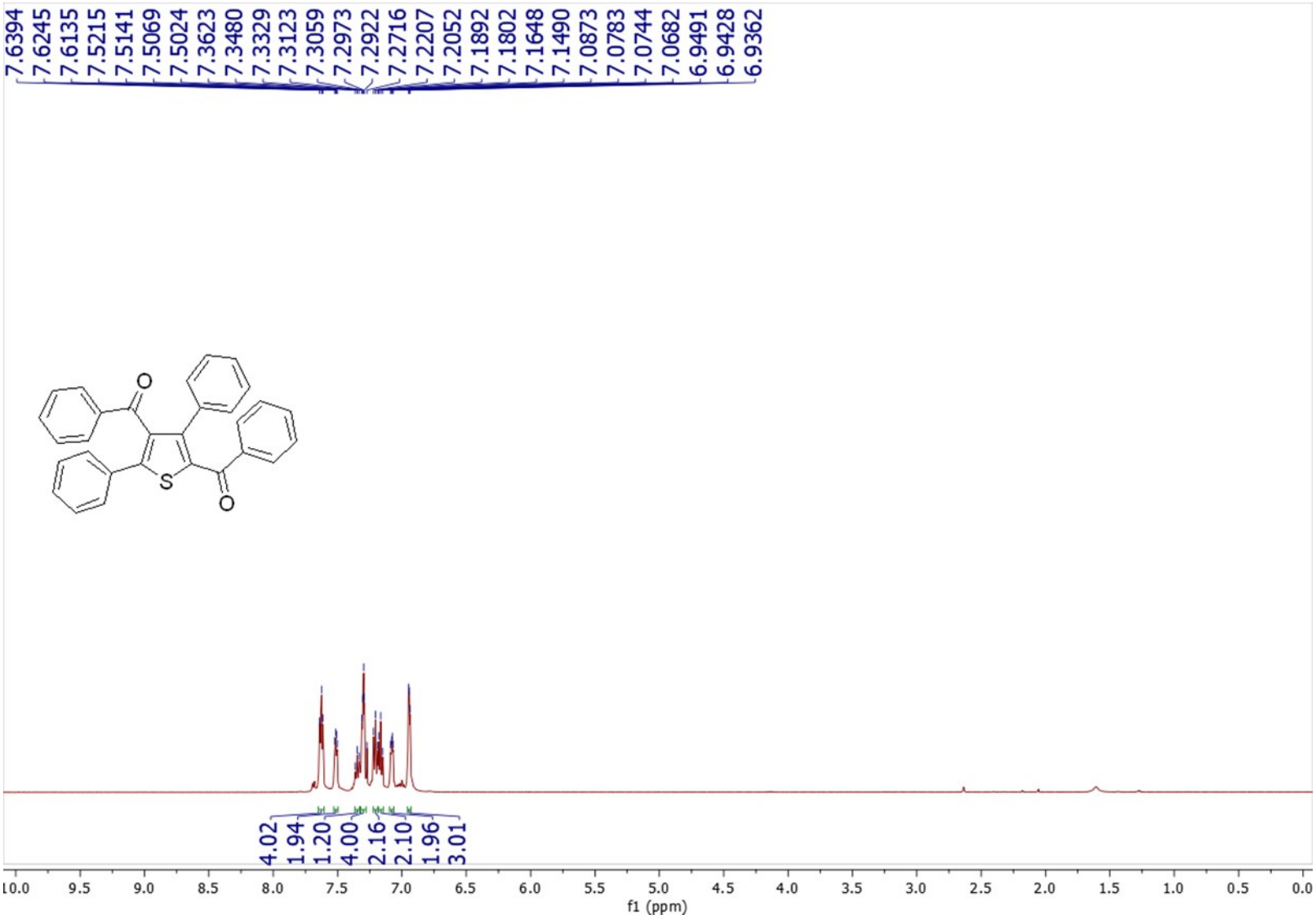
[1]H NMR spectrum of **3b**



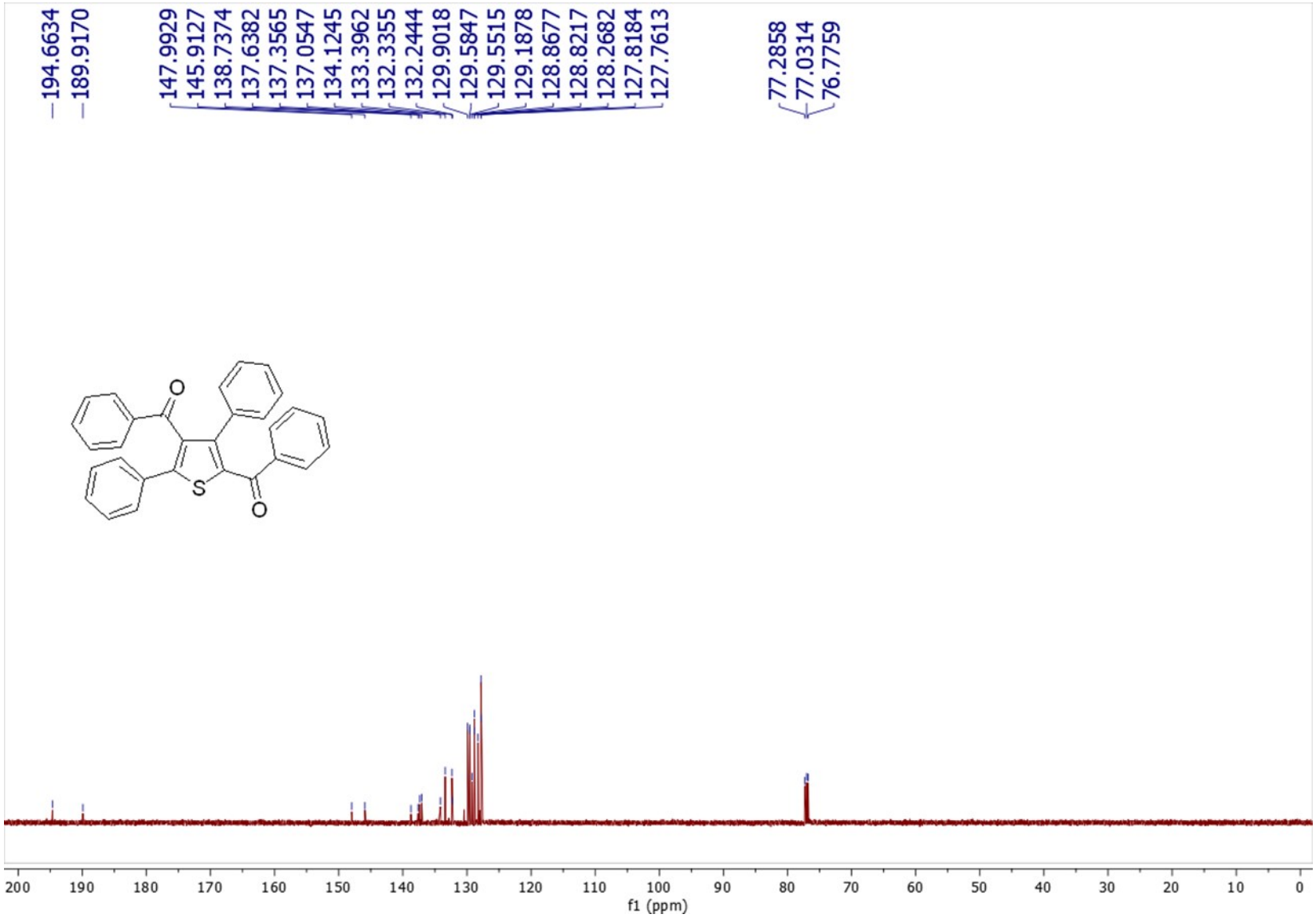
^{13}C NMR spectrum of **3b**



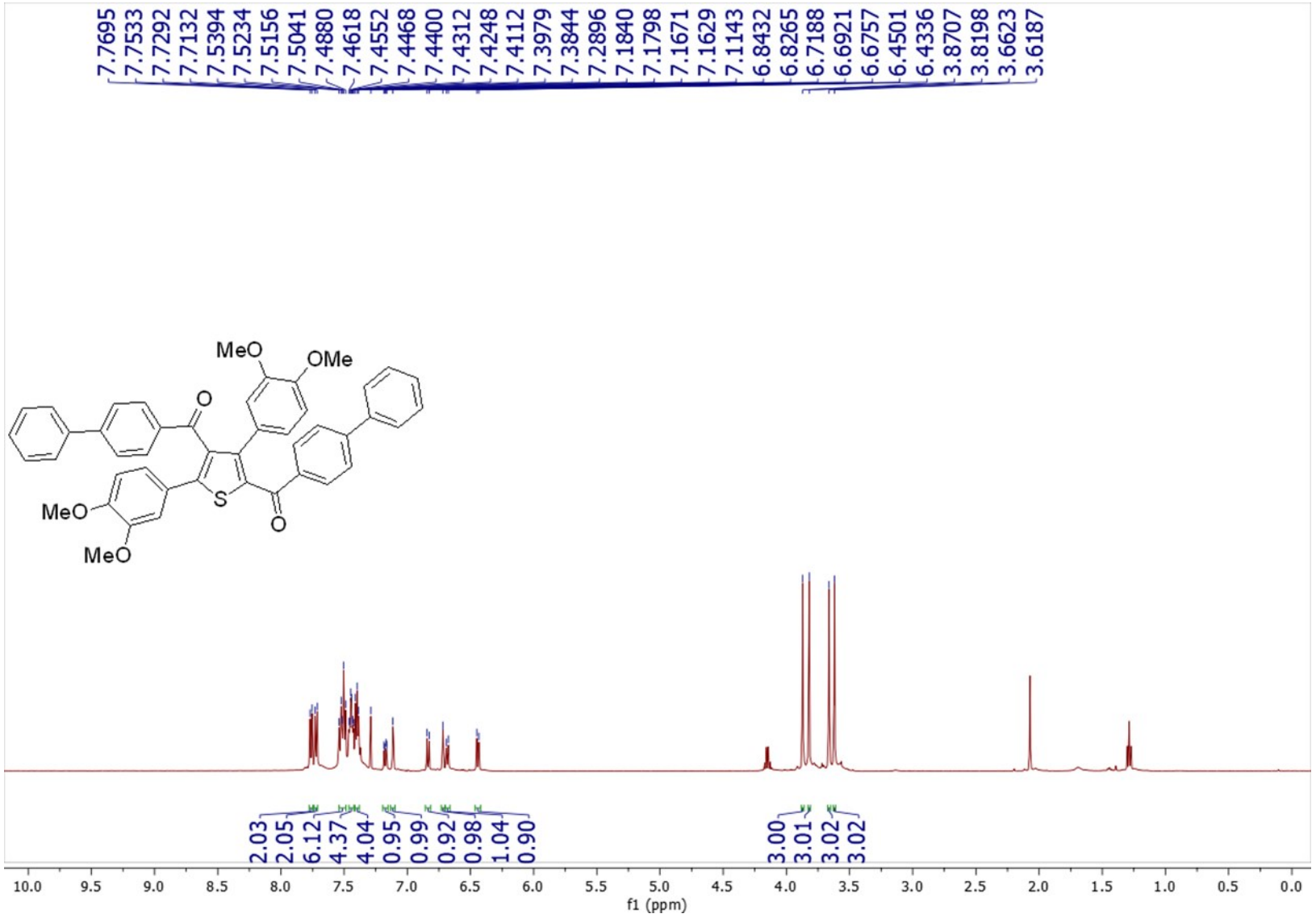
^{1}H NMR spectrum of **3c**



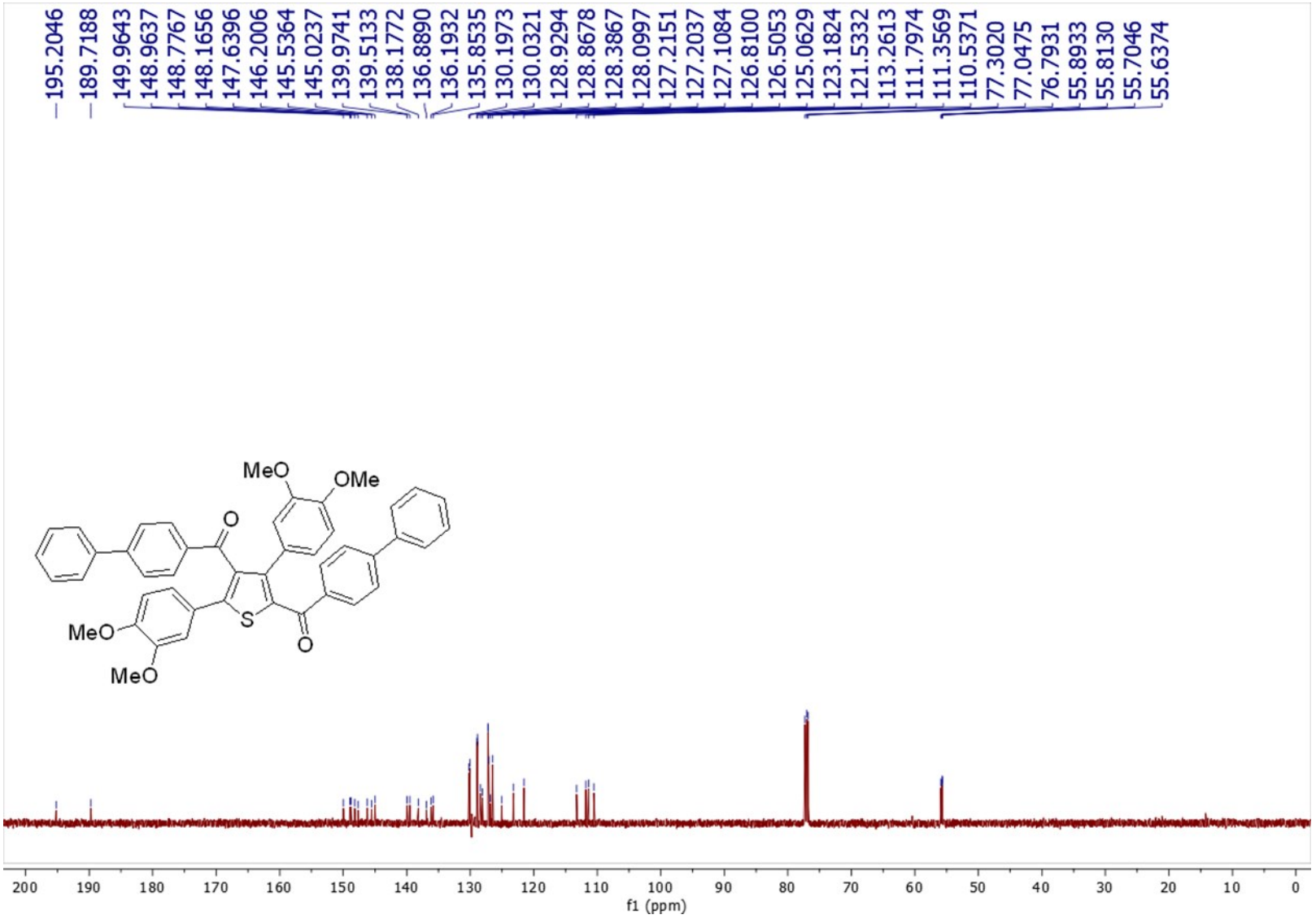
^{13}C NMR spectrum of **3c**



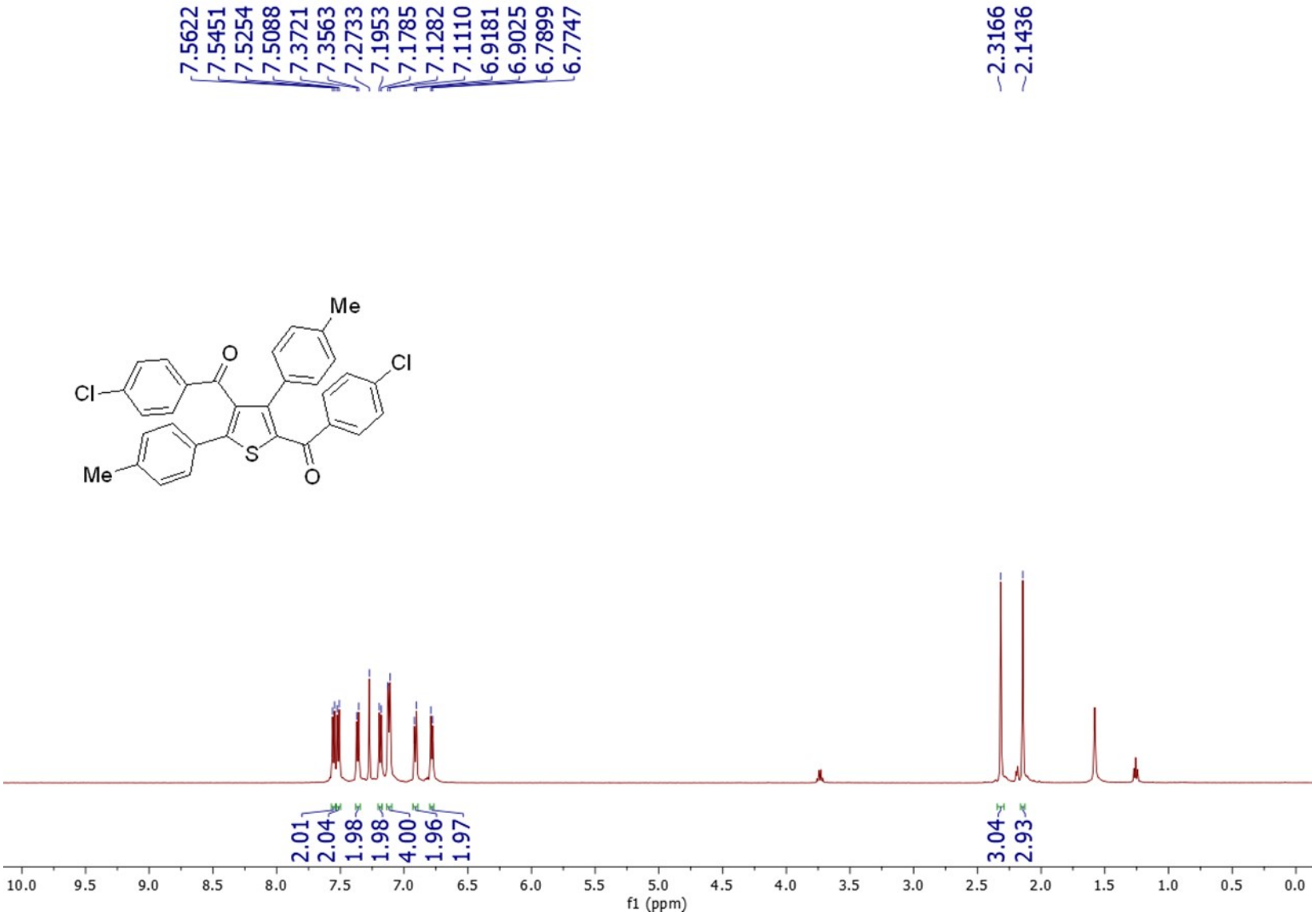
^{1}H NMR spectrum of **3d**



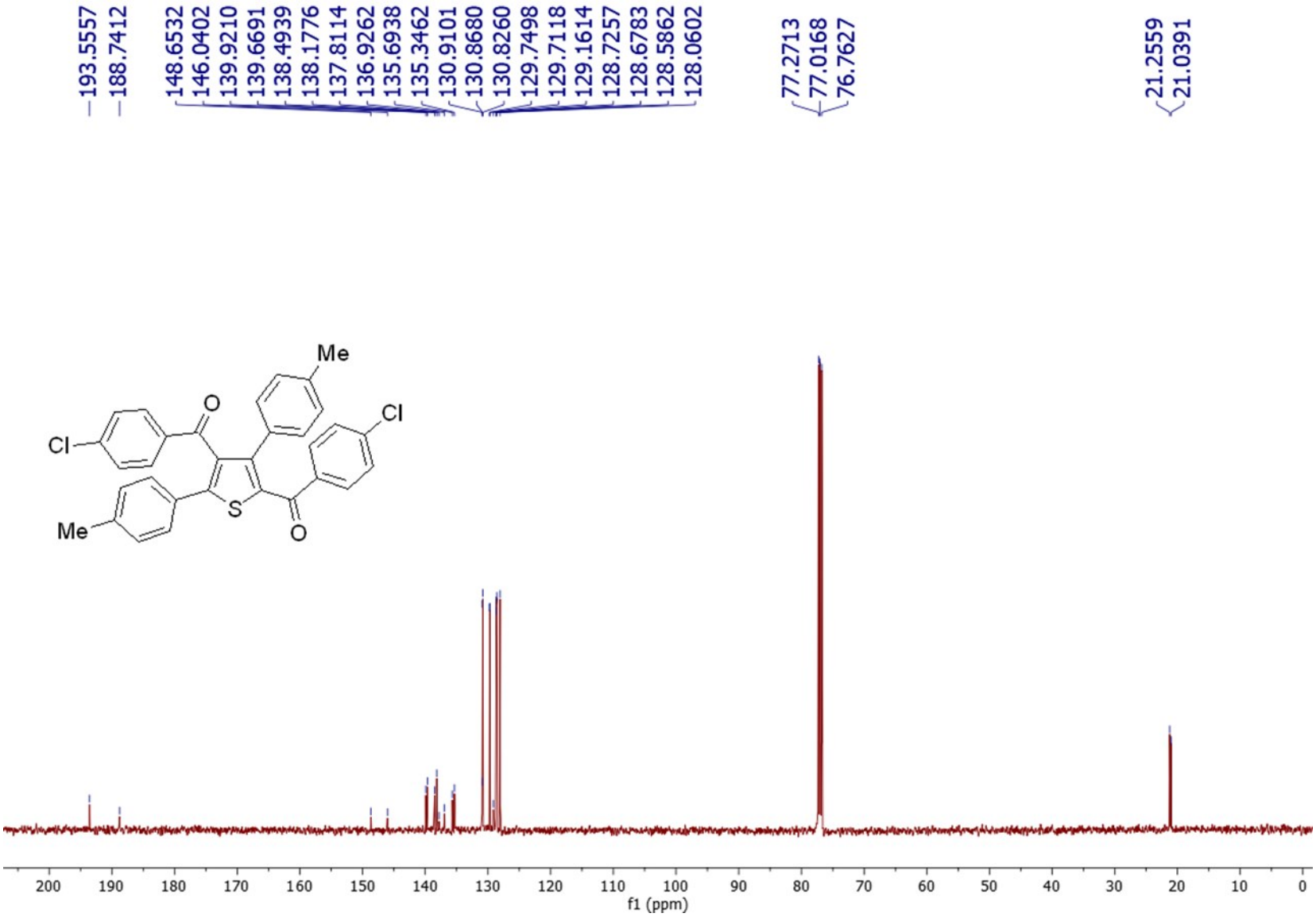
^{13}C NMR spectrum of **3d**



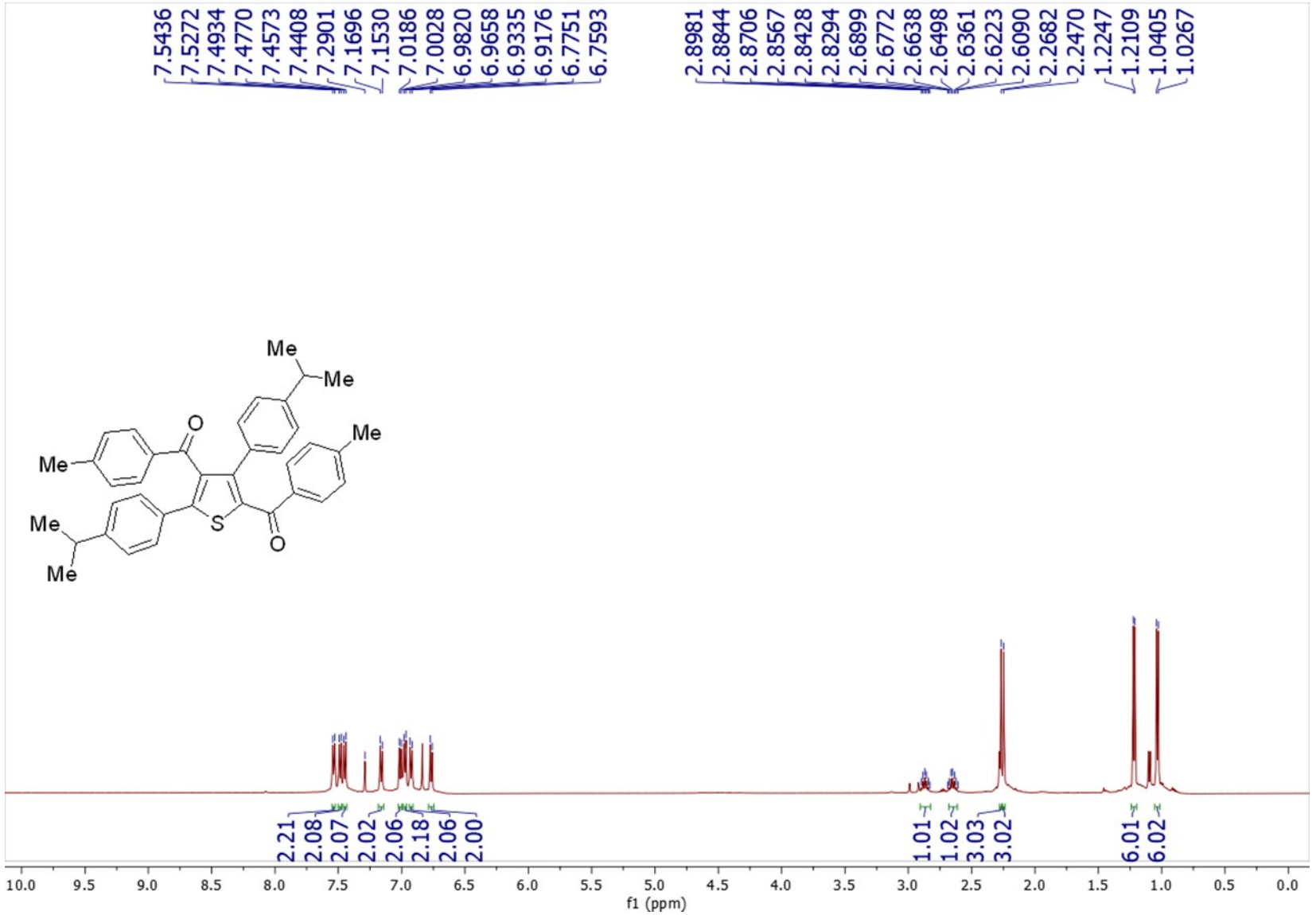
^{1}H NMR spectrum of **3e**



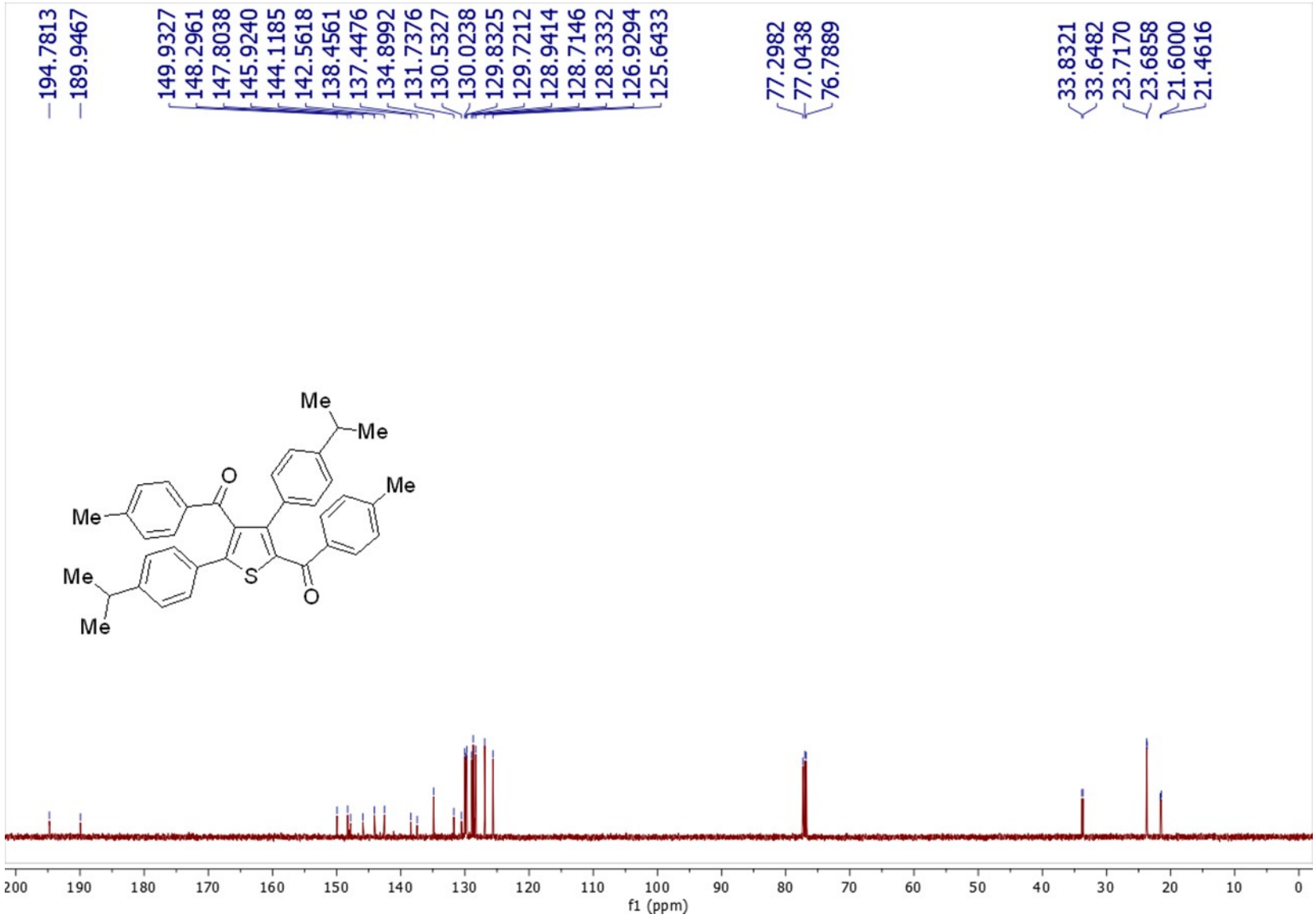
^{13}C NMR spectrum of **3e**



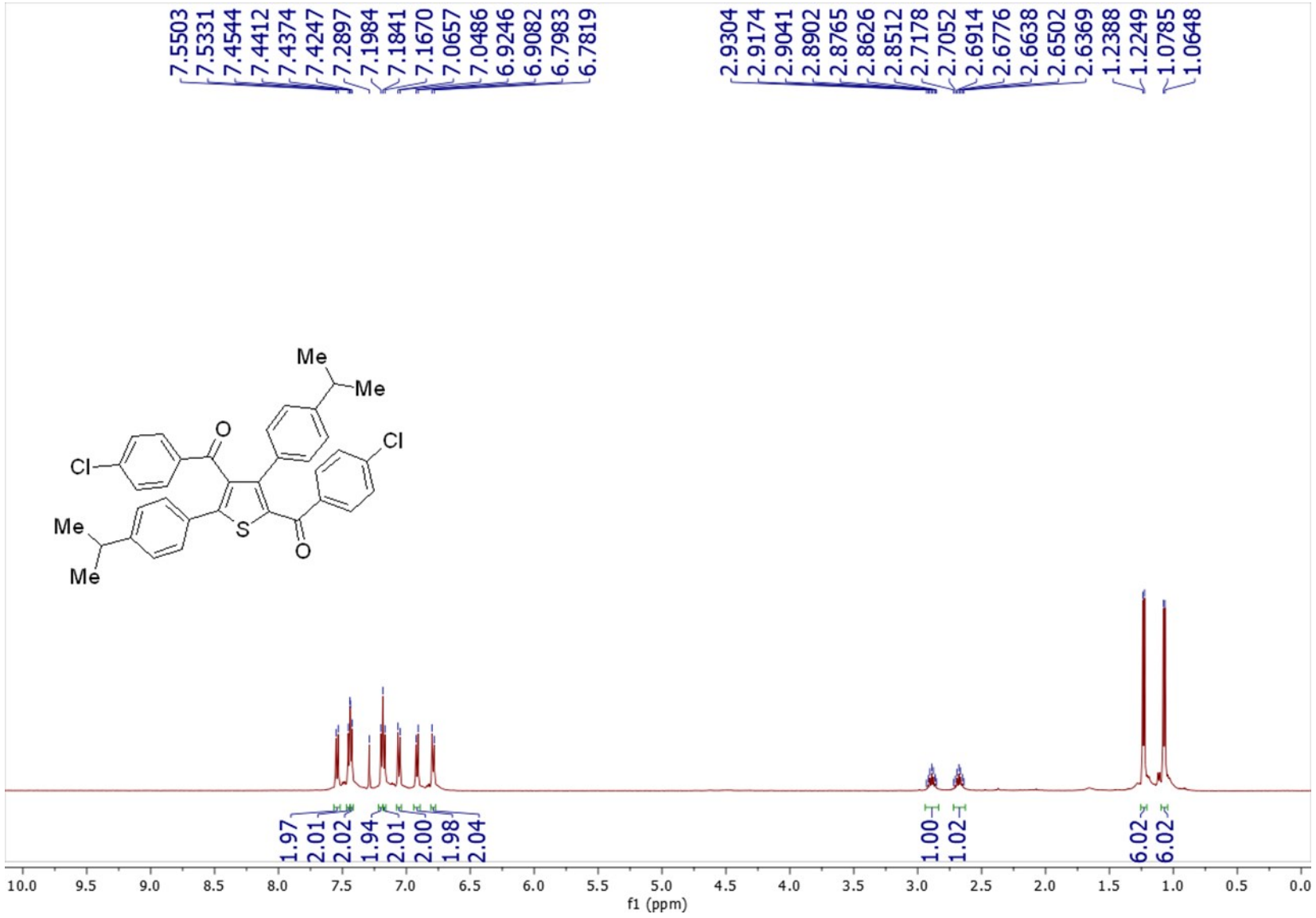
^{1}H NMR spectrum of **3f**



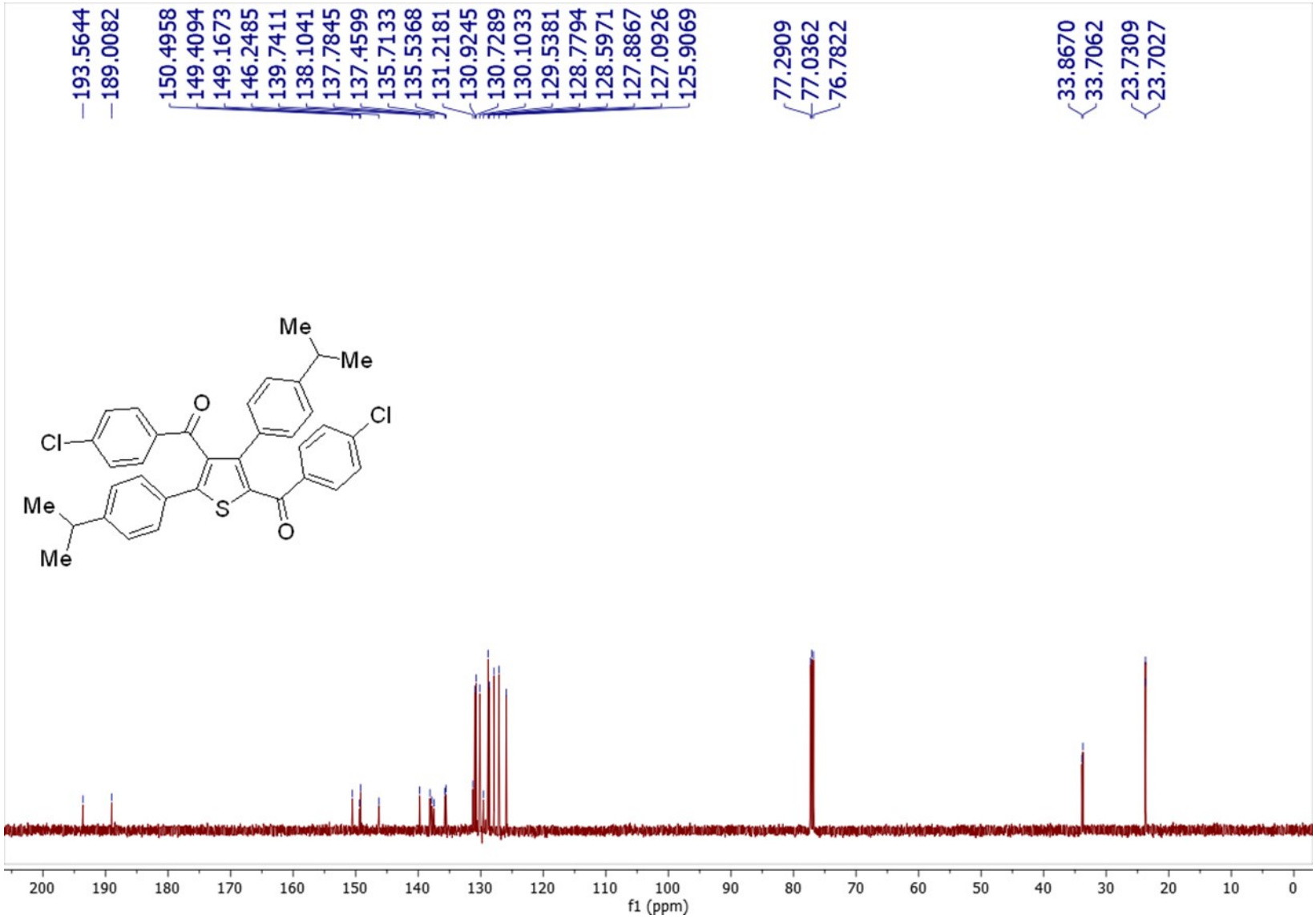
^{13}C NMR spectrum of **3f**



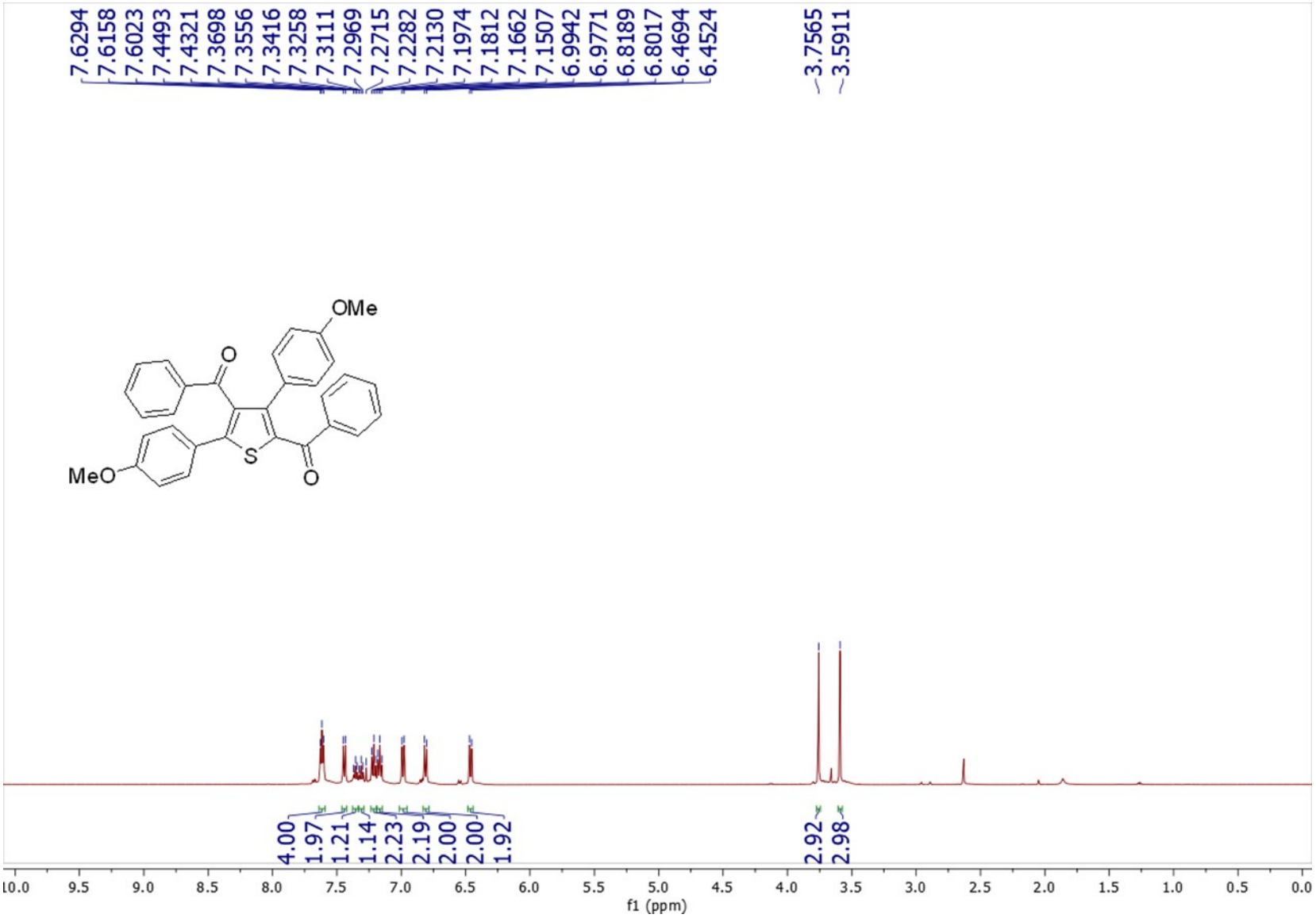
^{1}H NMR spectrum of **3g**



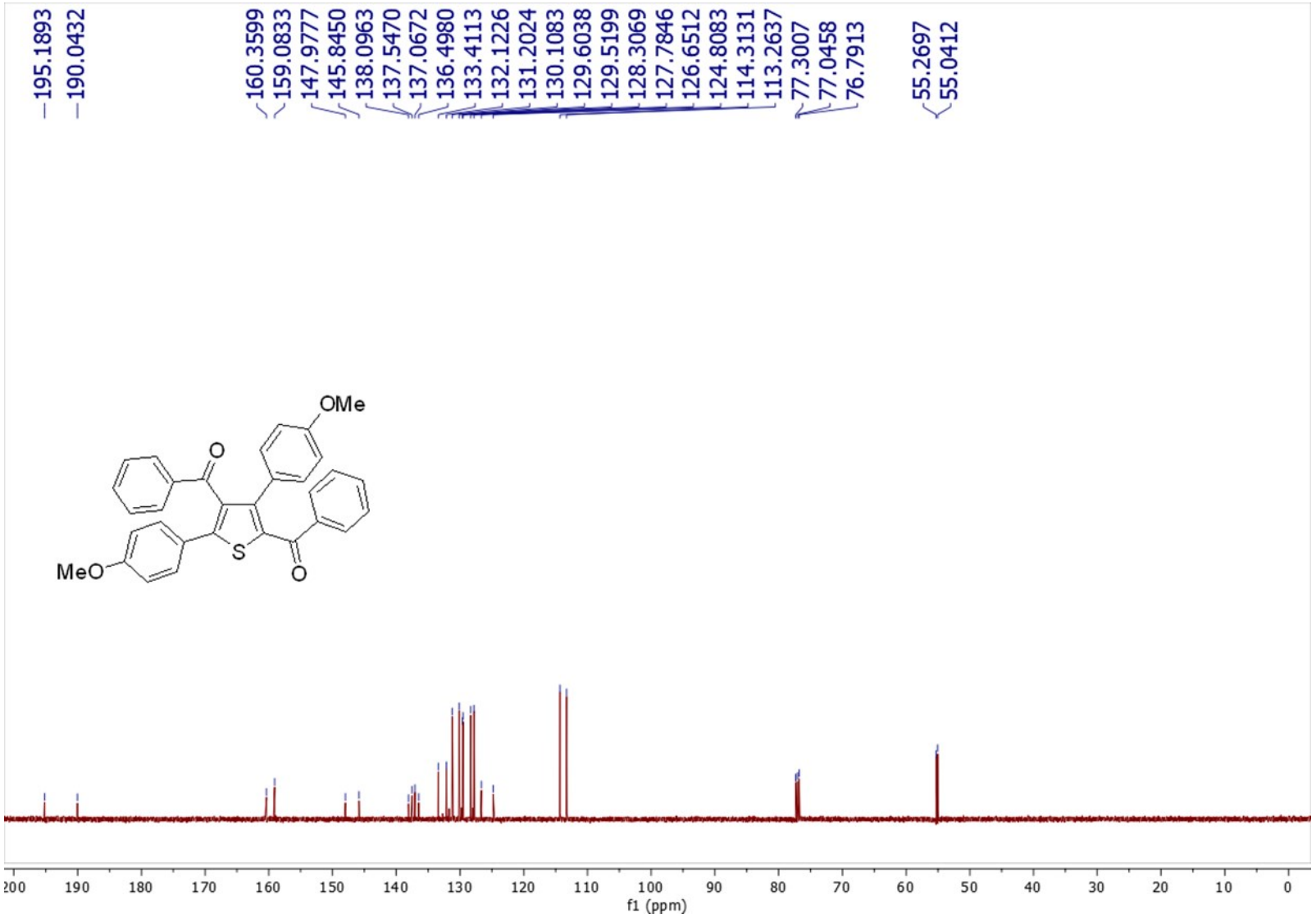
^{13}C NMR spectrum of **3g**



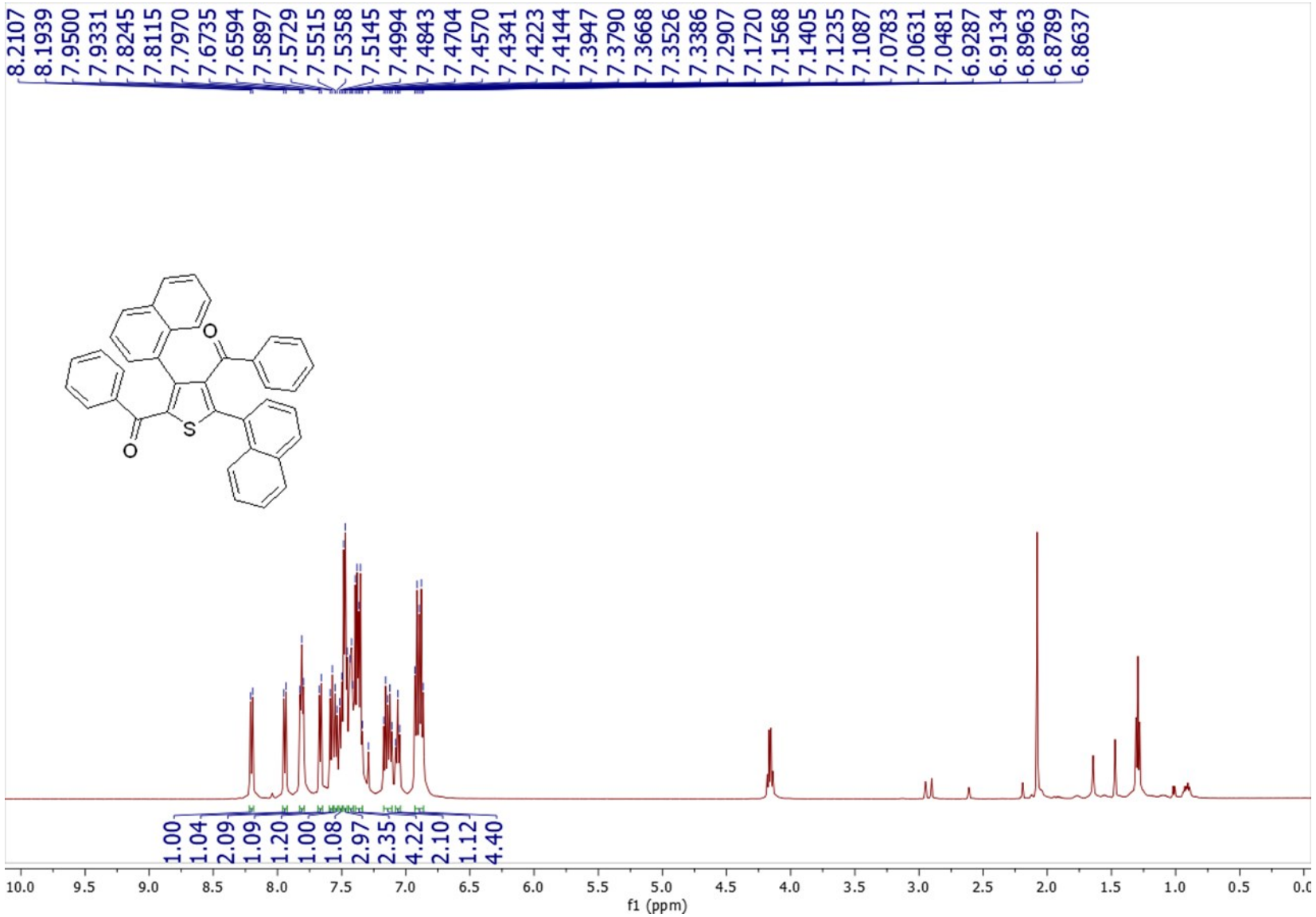
[1]H NMR spectrum of **3h**



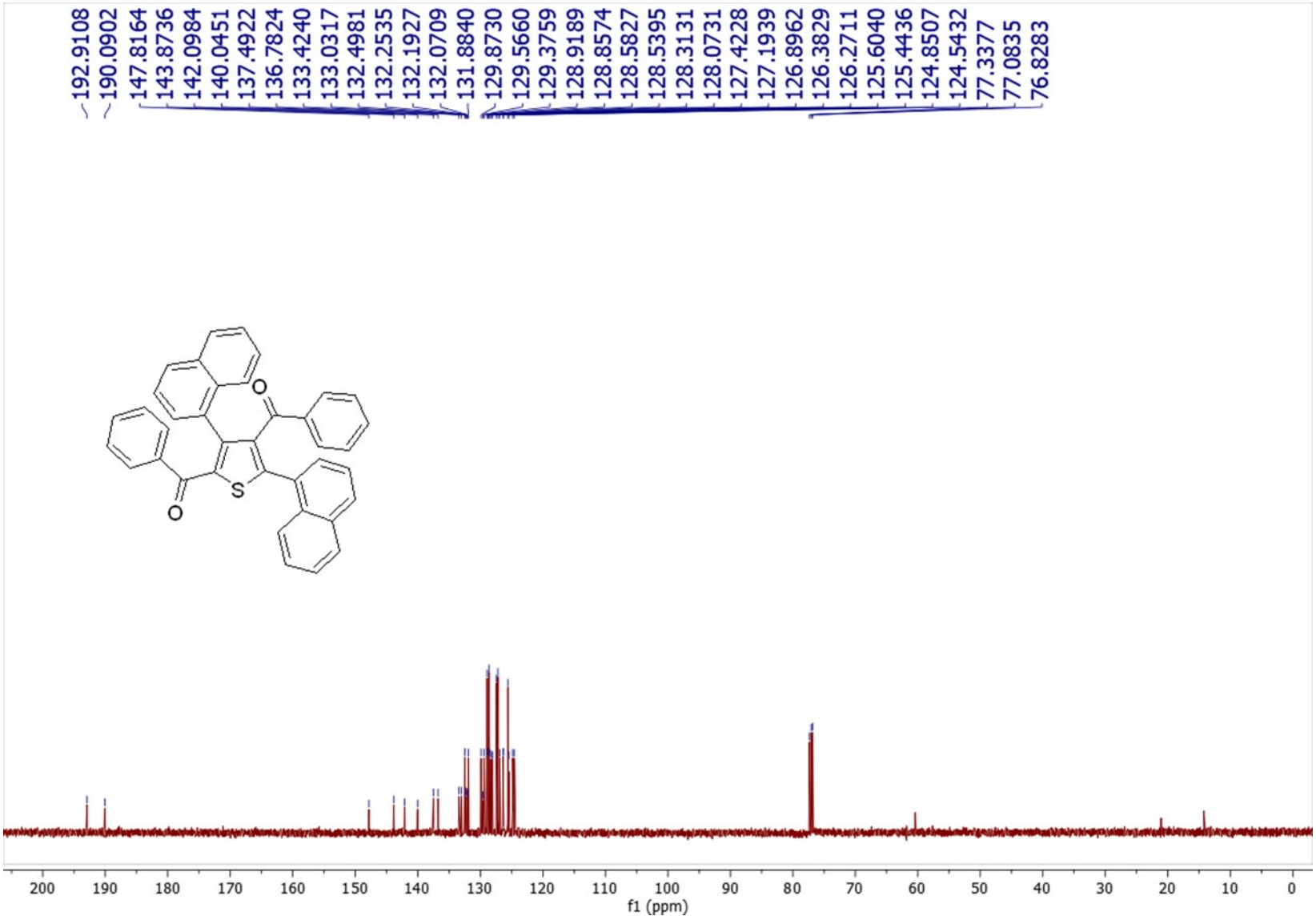
^{13}C NMR spectrum of **3h**



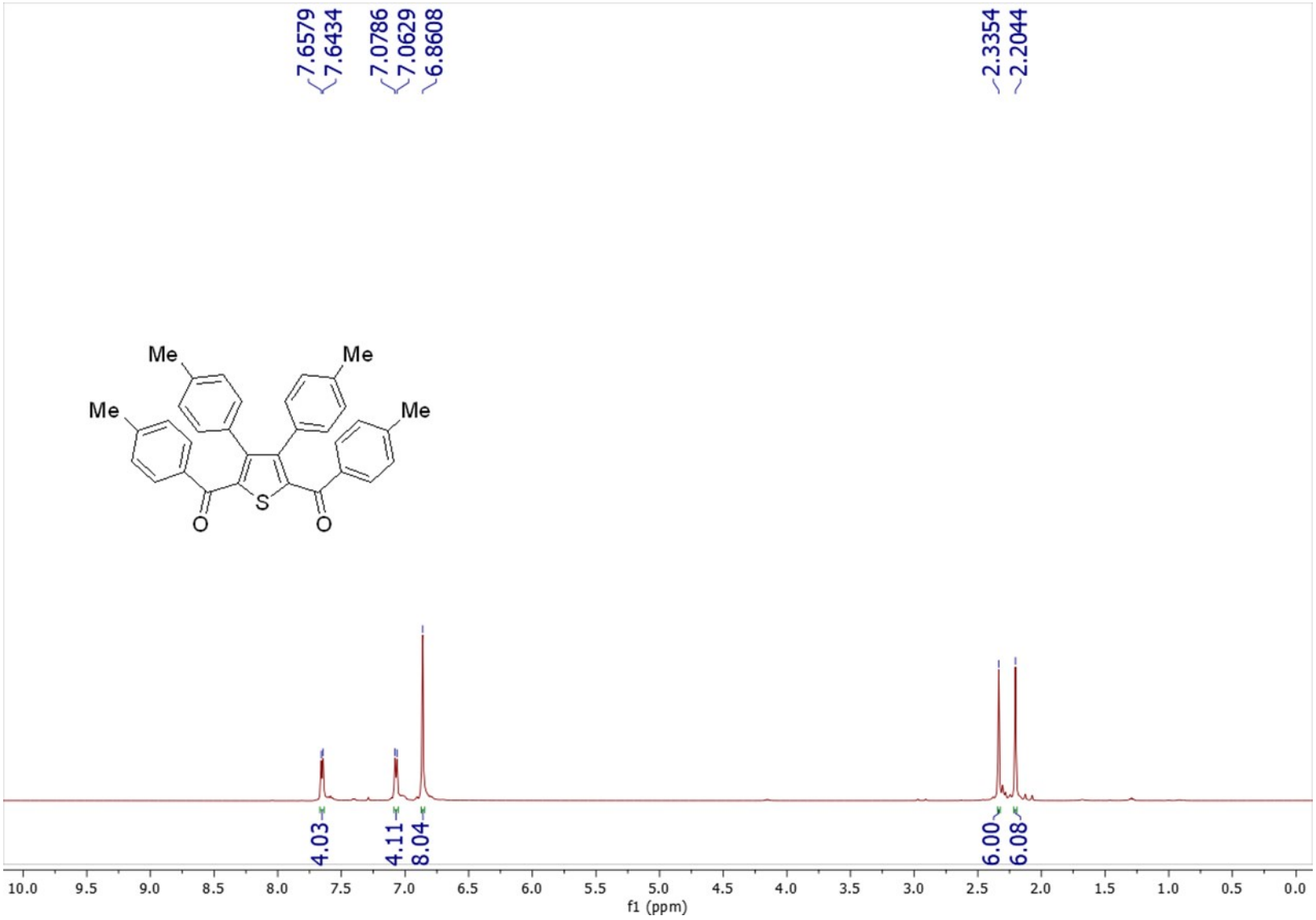
^{1}H NMR spectrum of **3i**



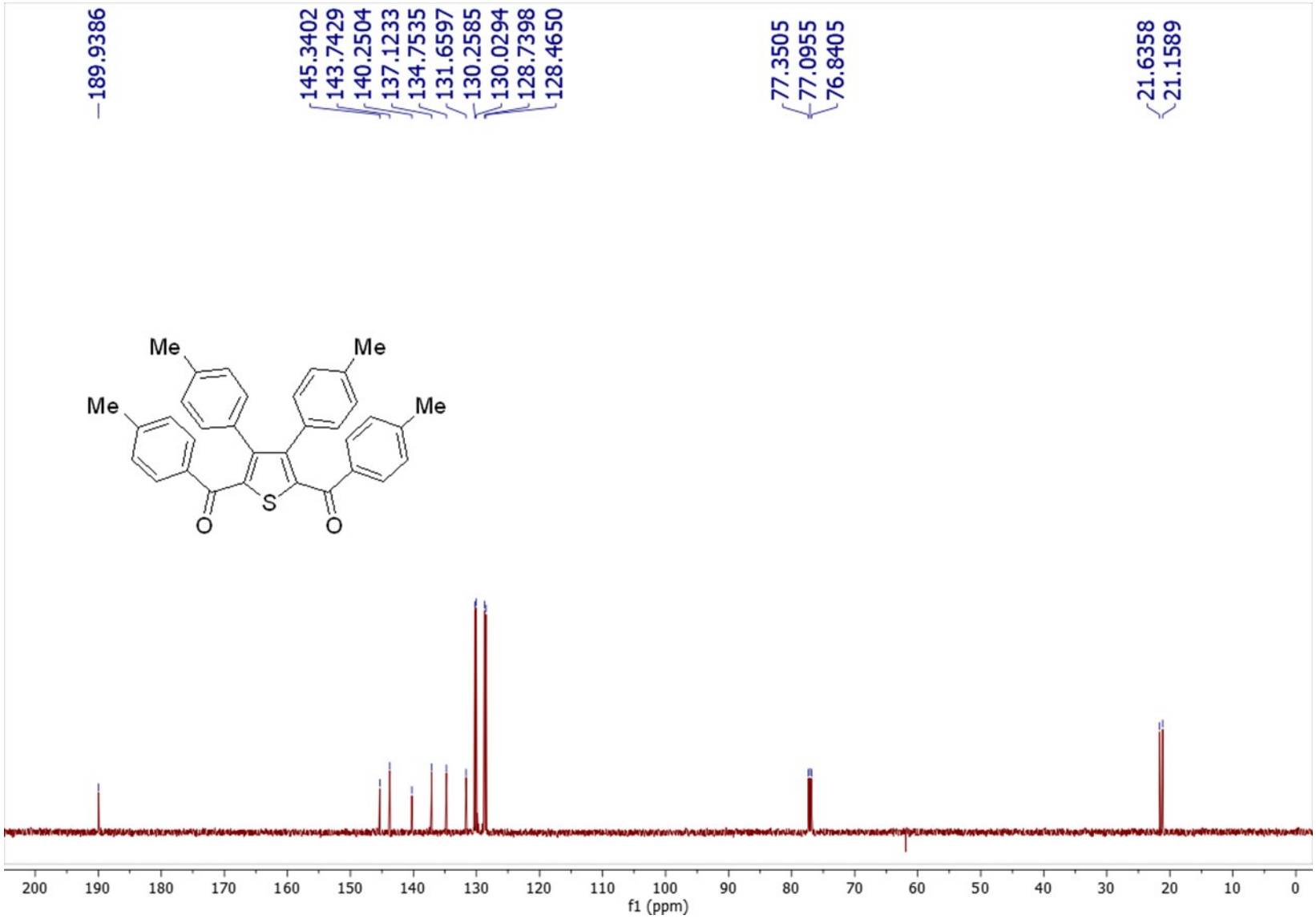
^{13}C NMR spectrum of **3i**



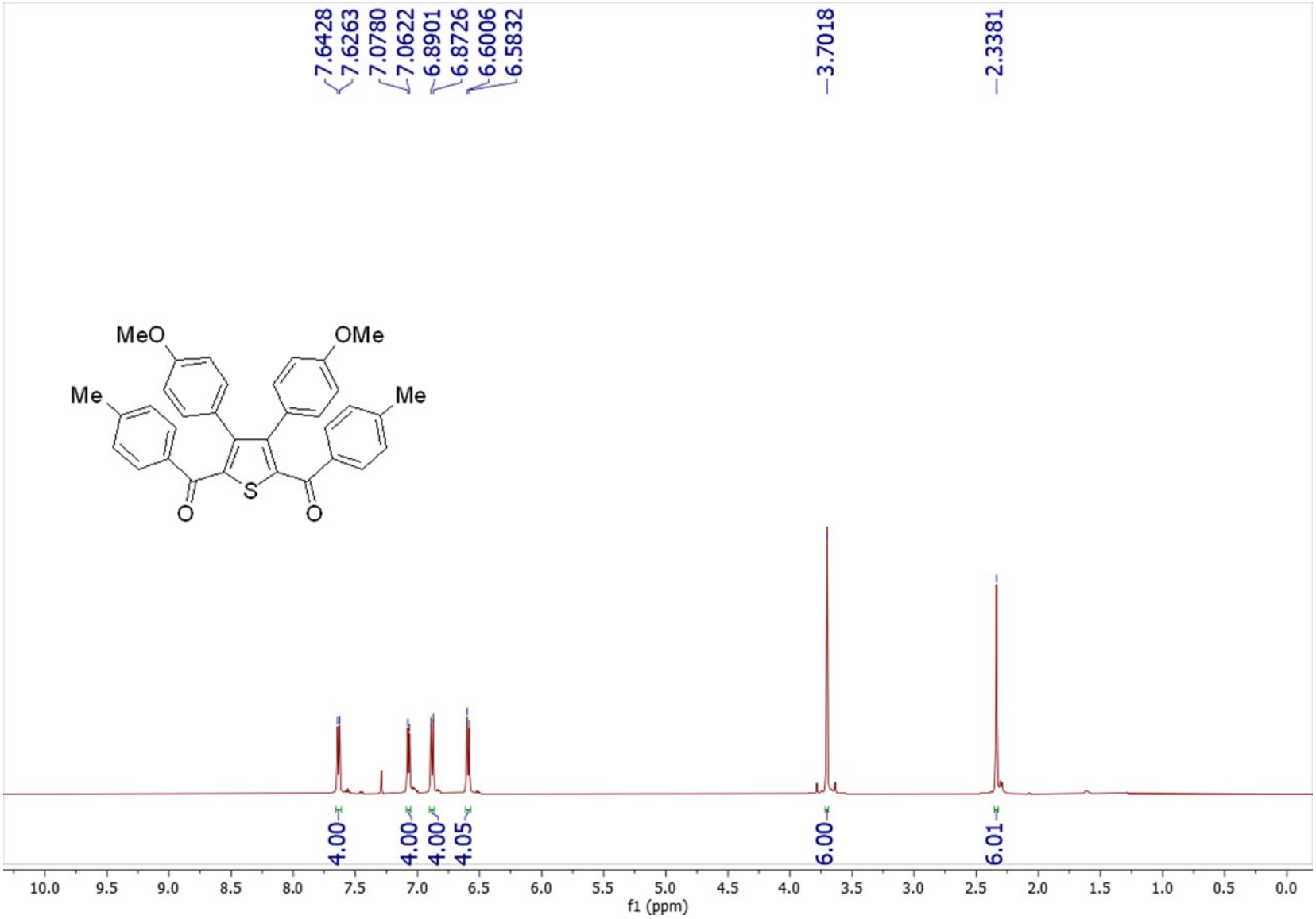
^{1}H NMR spectrum of **3j**



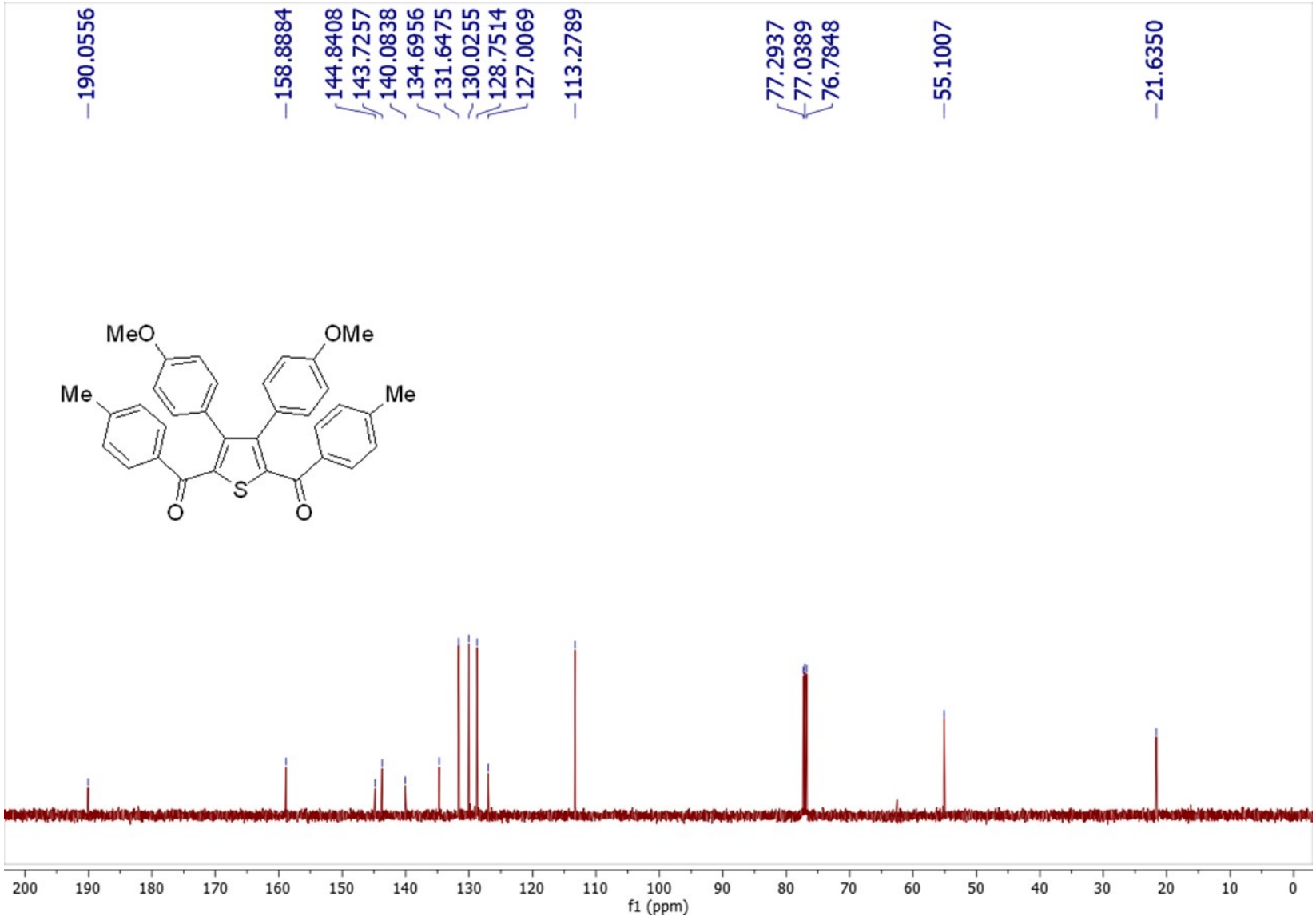
^{13}C NMR spectrum of **3j**



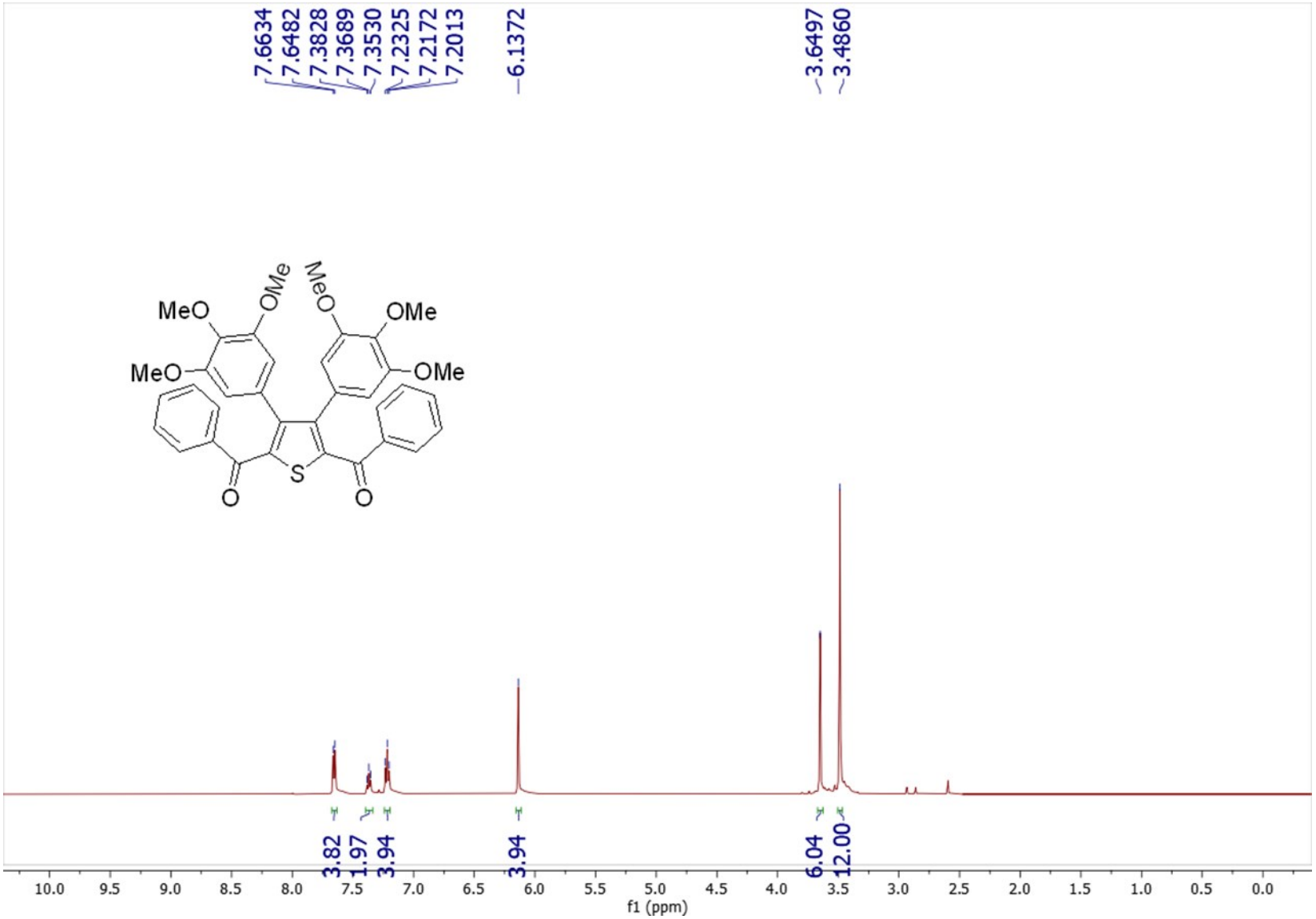
^{1}H NMR spectrum of **3k**



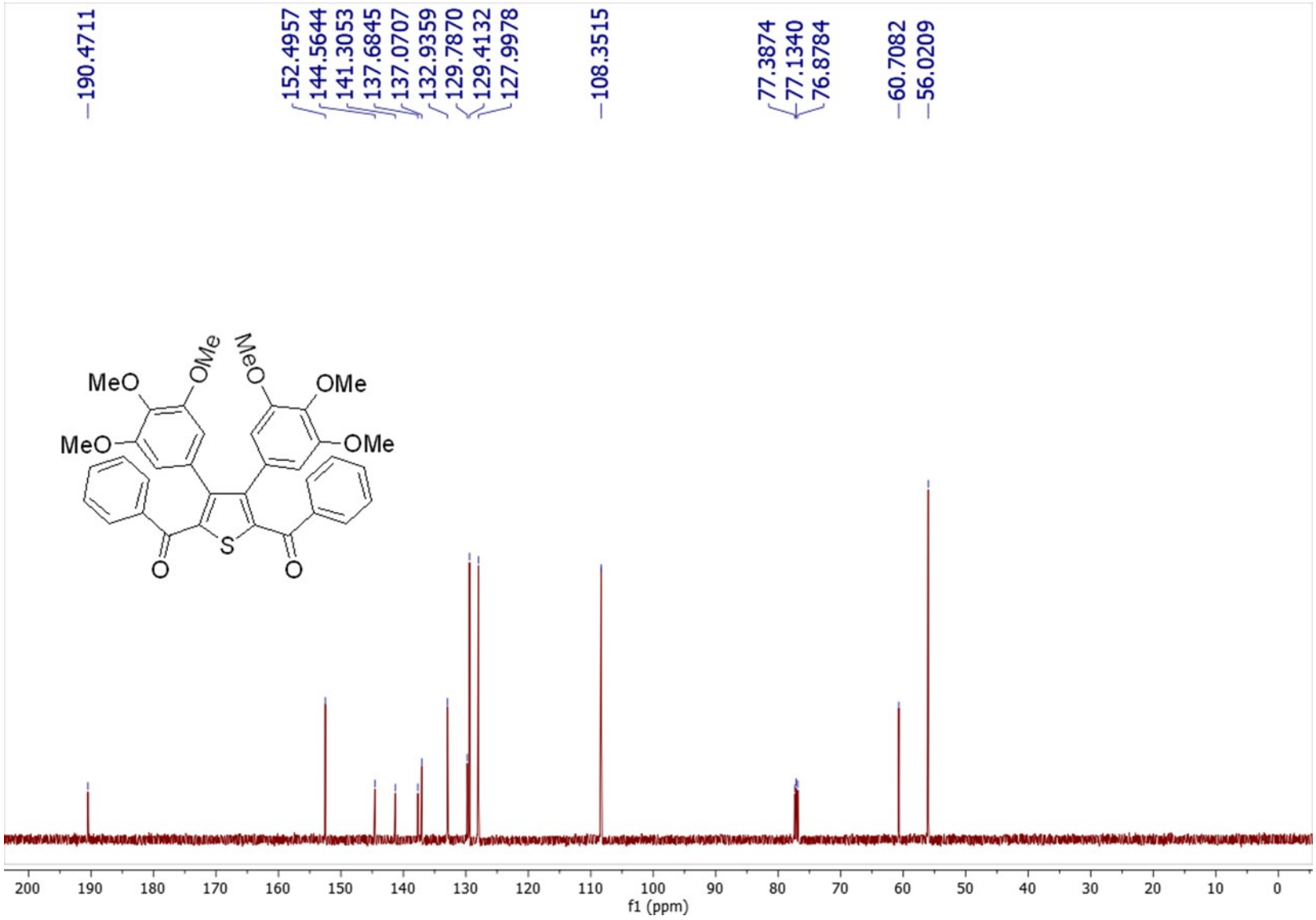
^{13}C NMR spectrum of **3k**



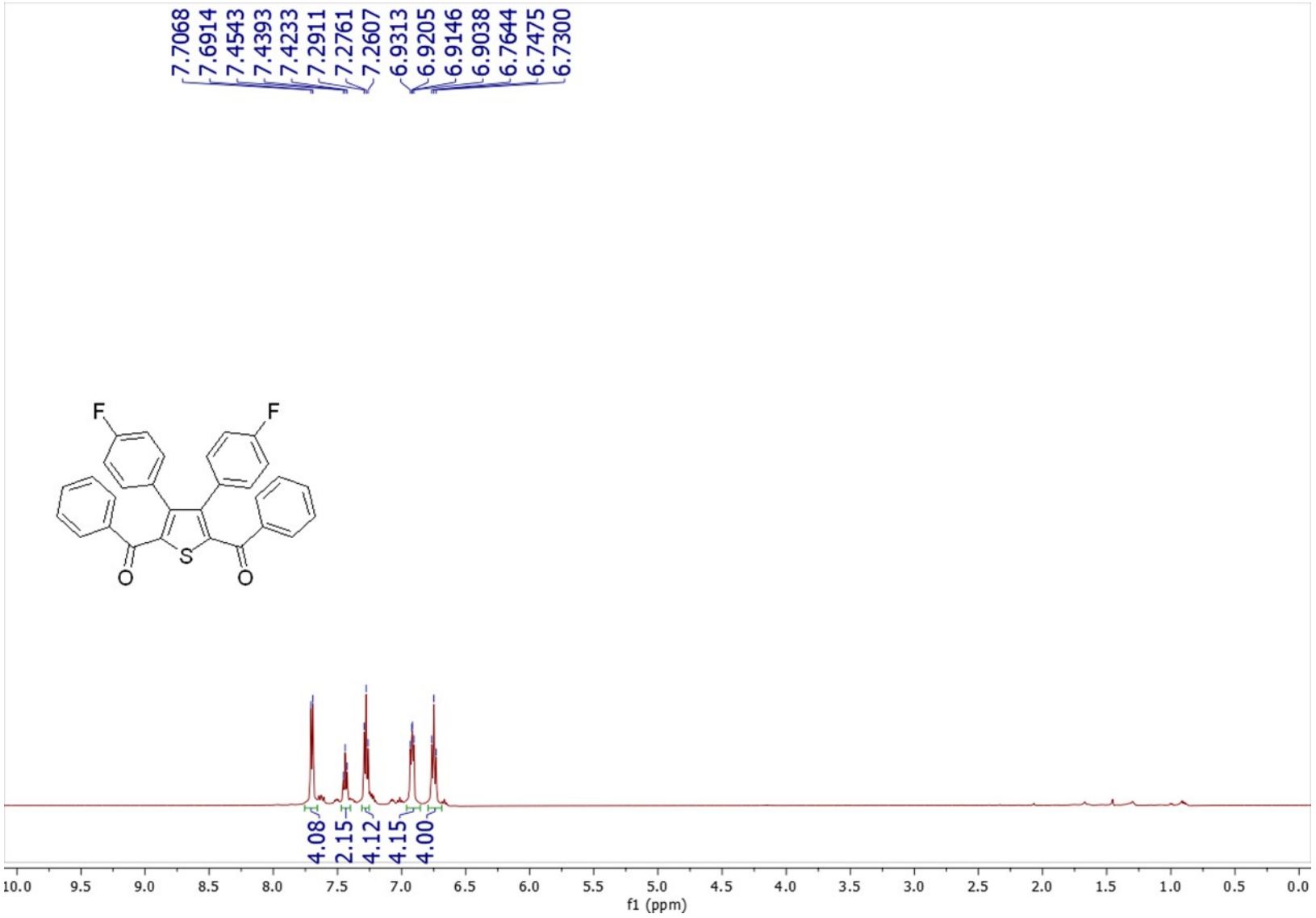
^{1}H NMR spectrum of **3l**



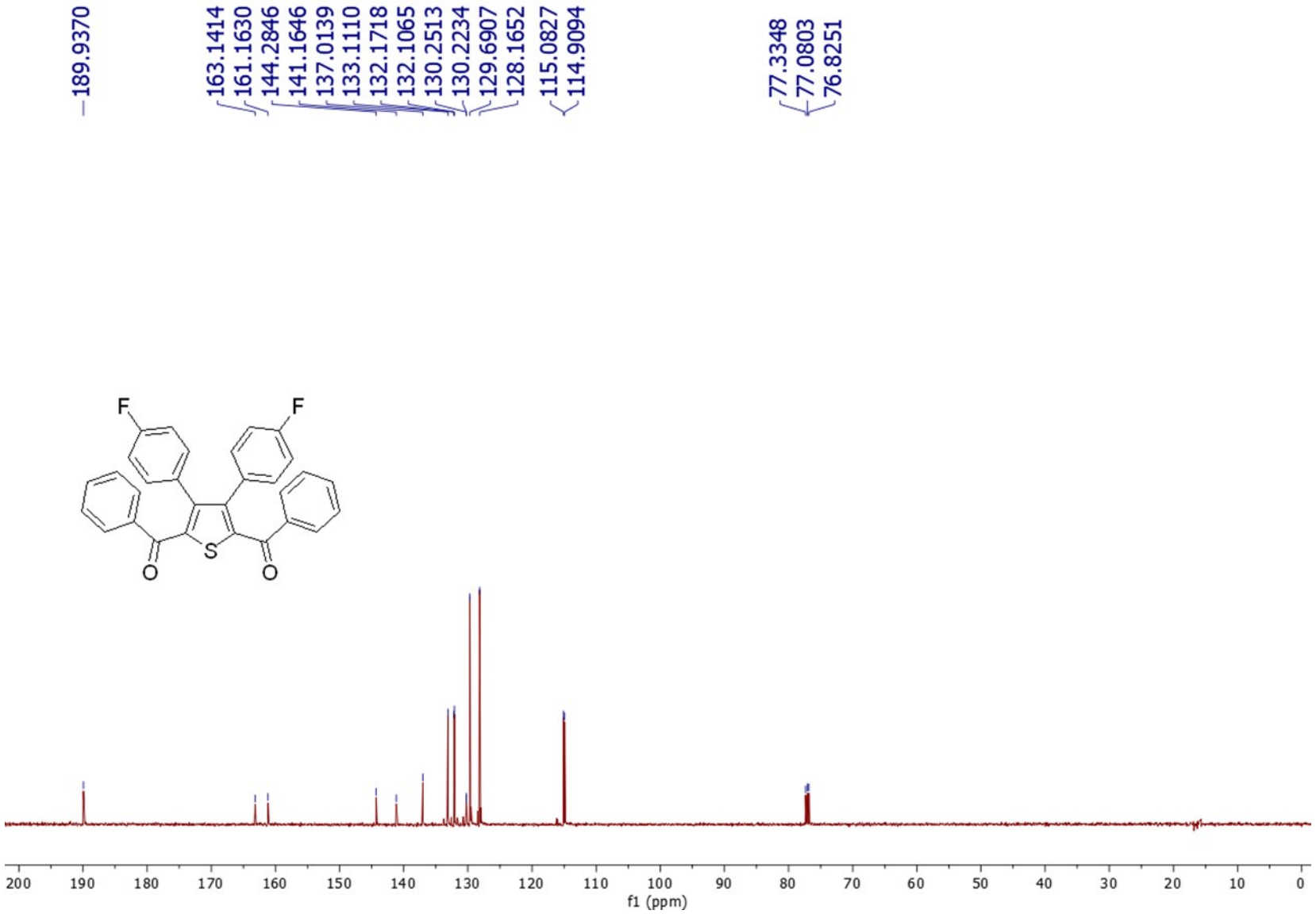
^{13}C NMR spectrum of **3l**



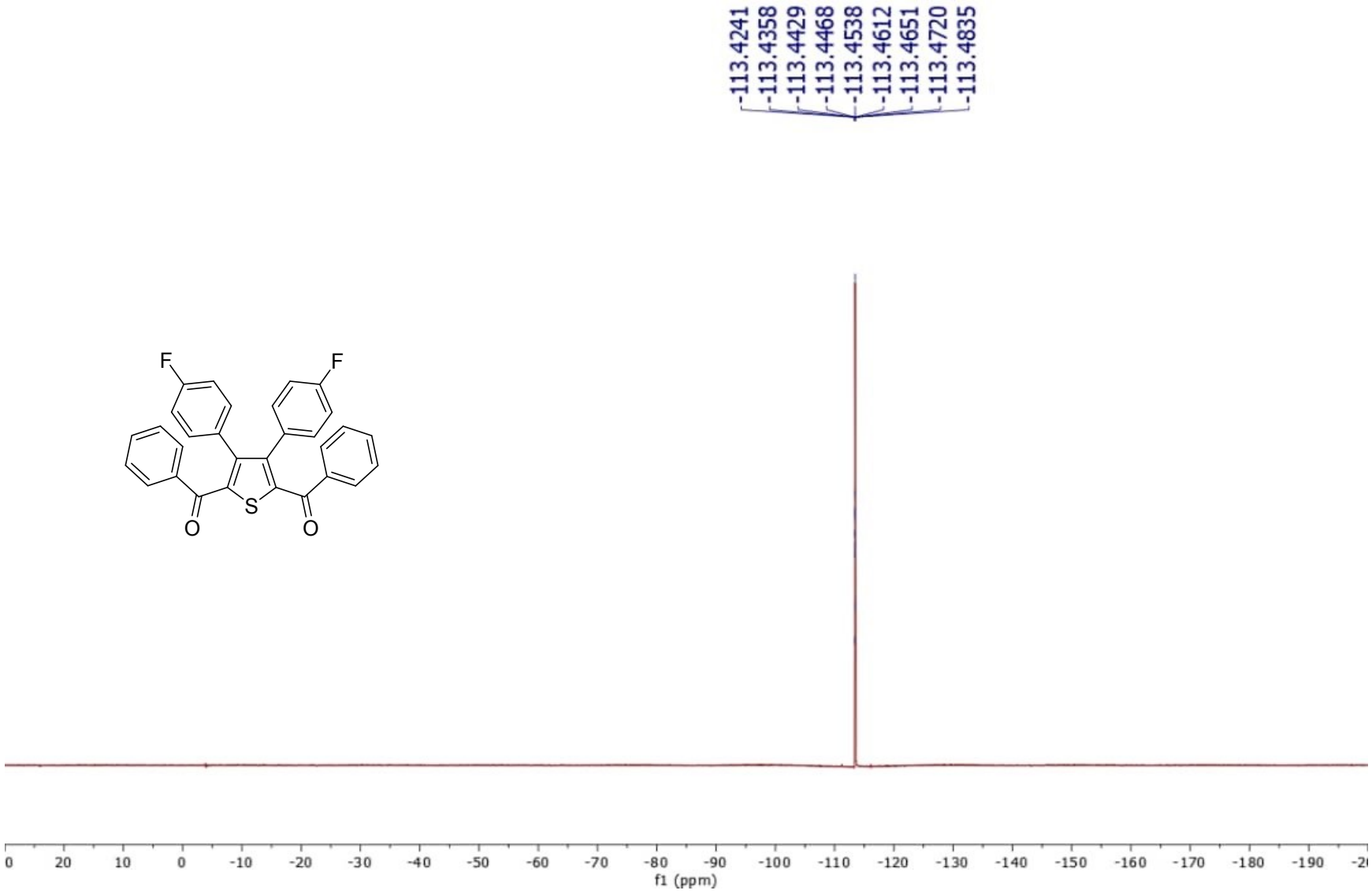
^{1}H NMR spectrum of **3m**



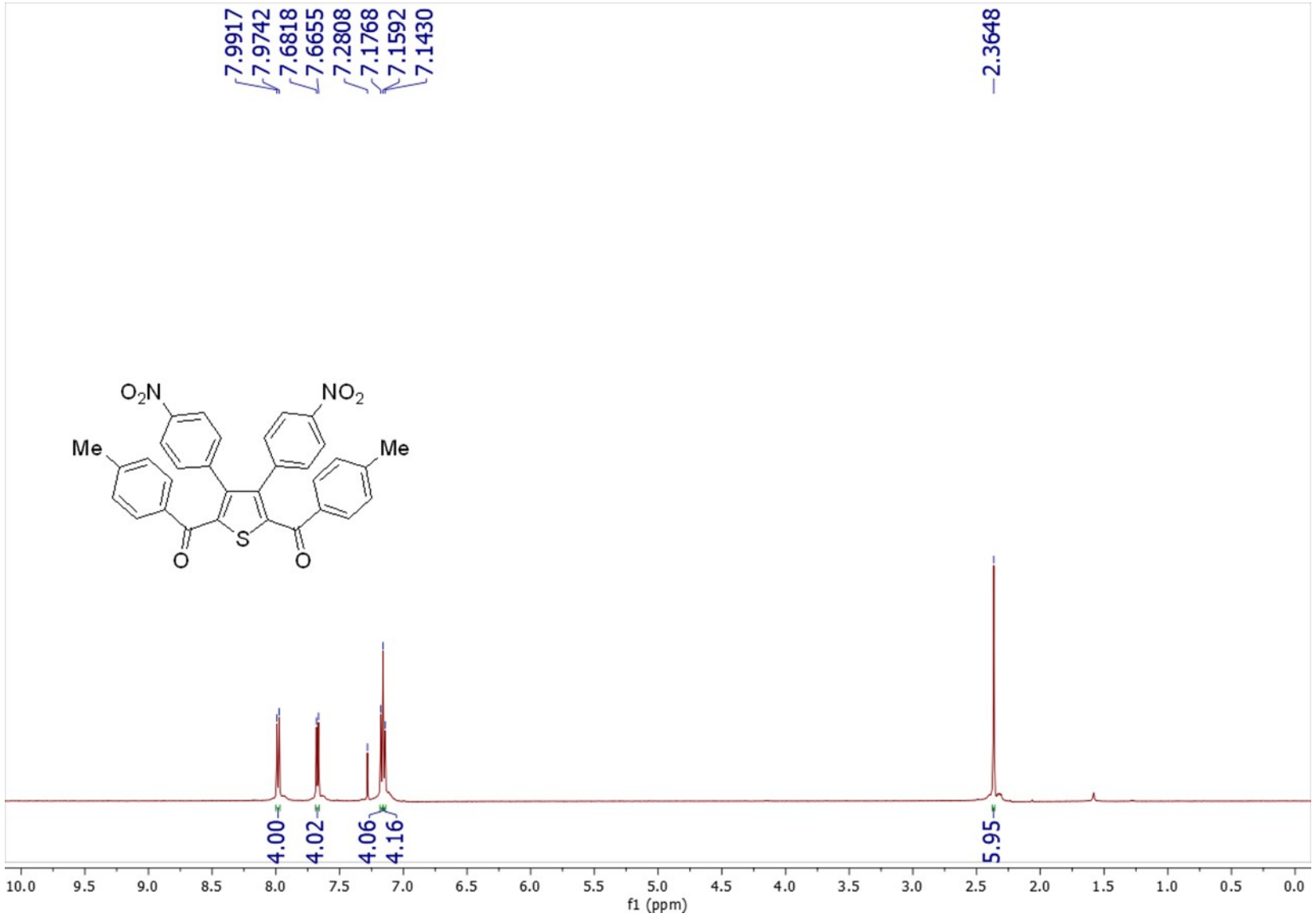
^{13}C NMR spectrum of **3m**



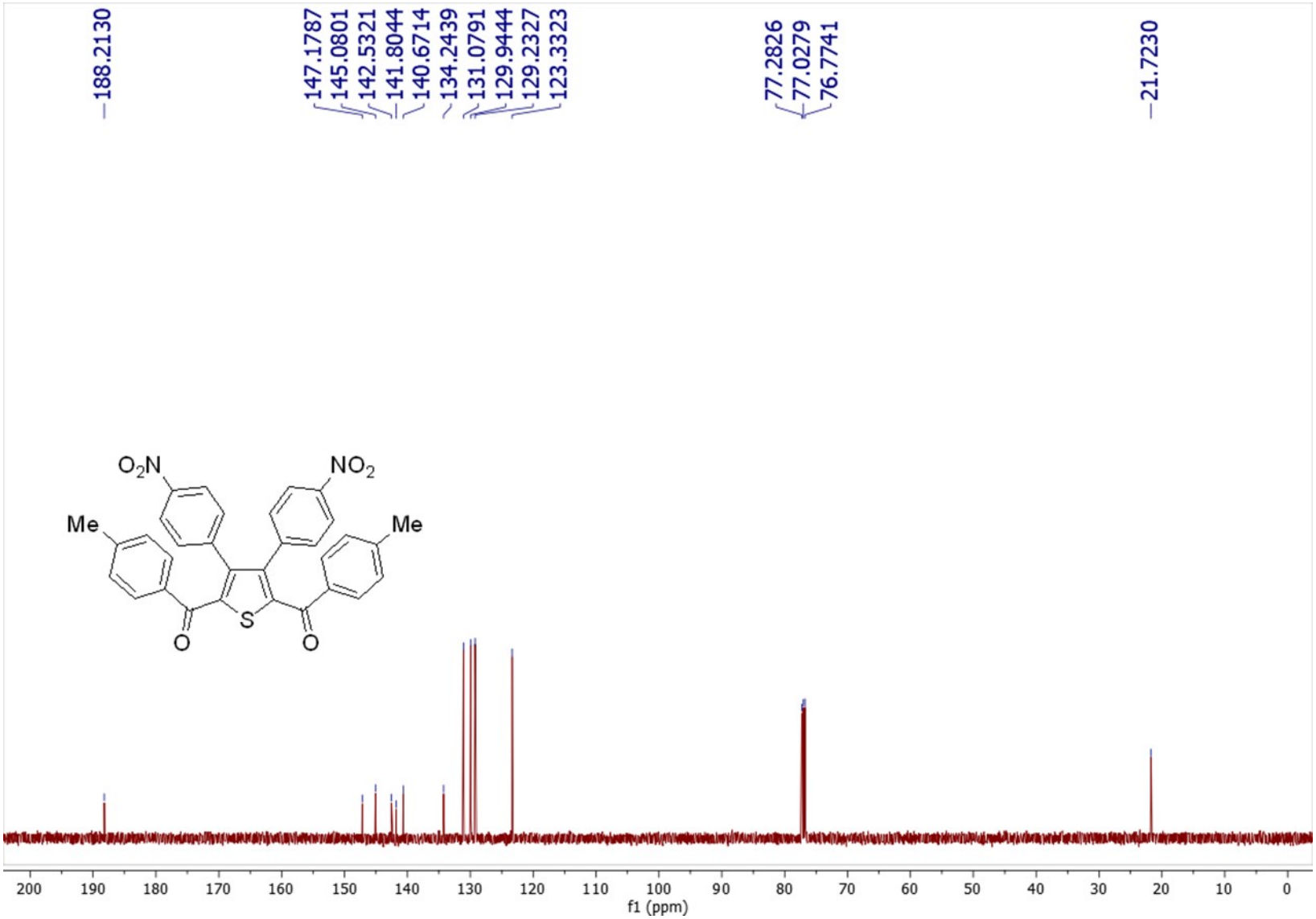
^{19}F NMR spectrum of **3m**



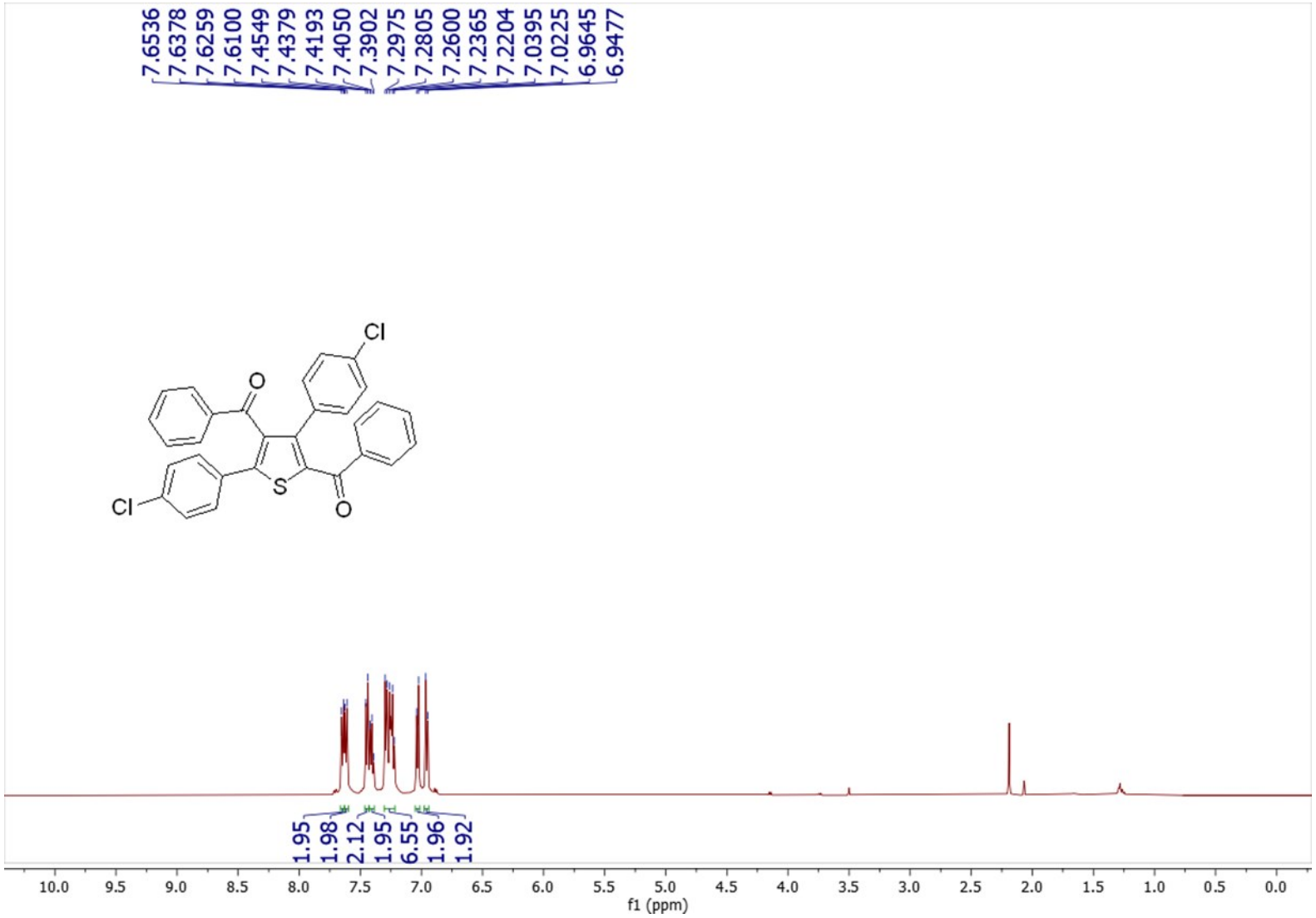
^{1}H NMR spectrum of **3n**



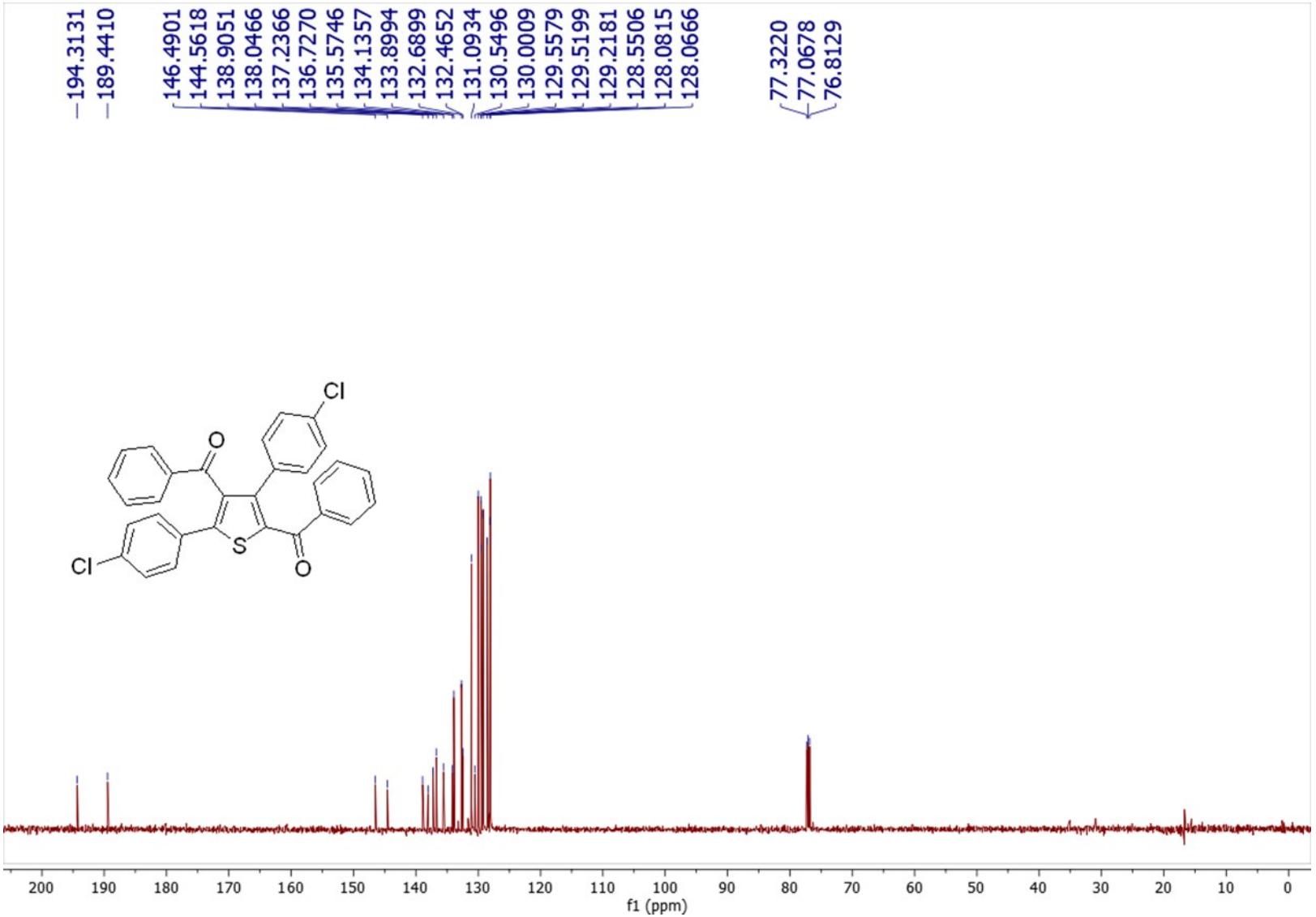
^{13}C NMR spectrum of **3n**



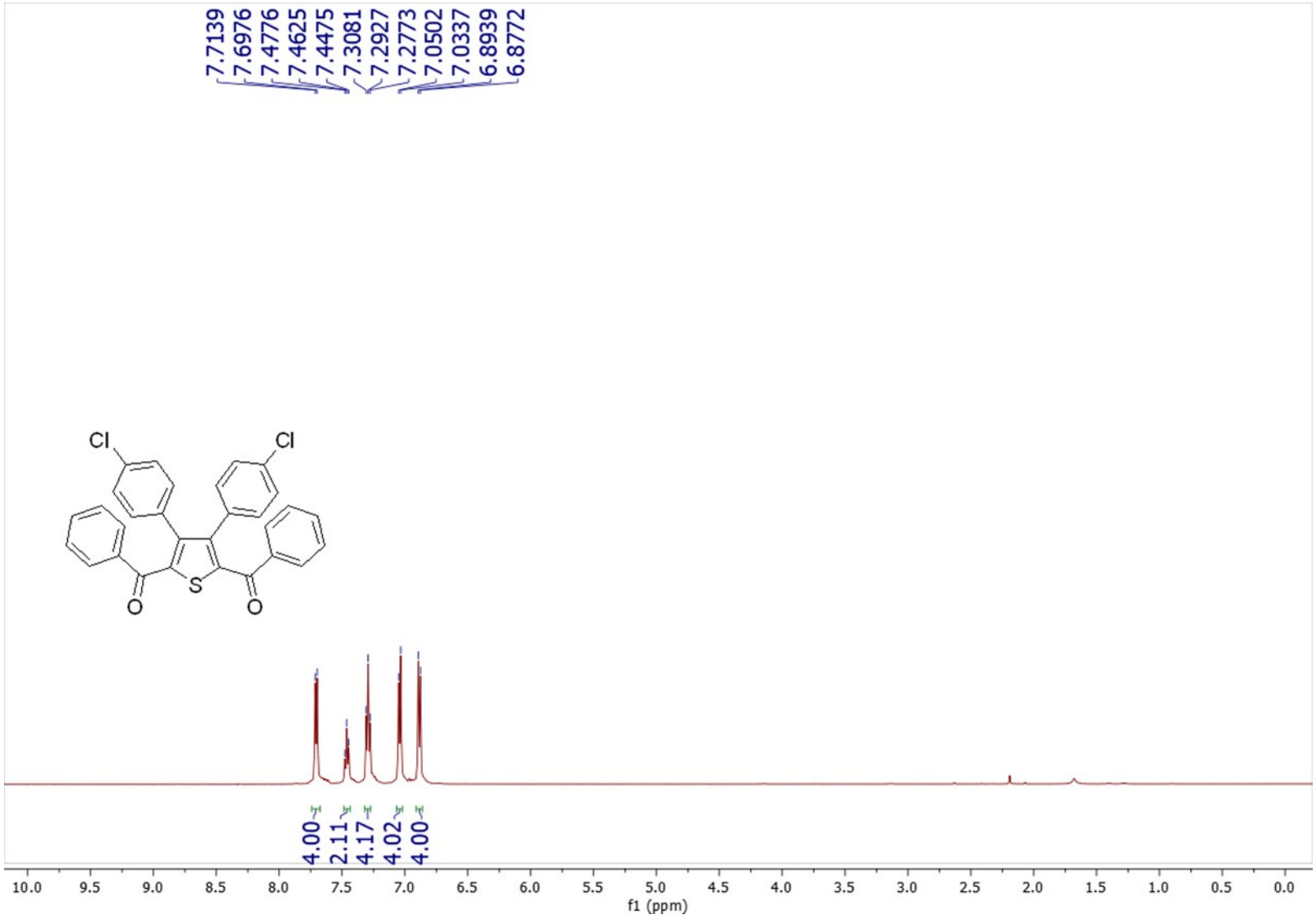
^{1}H NMR spectrum of **3o**



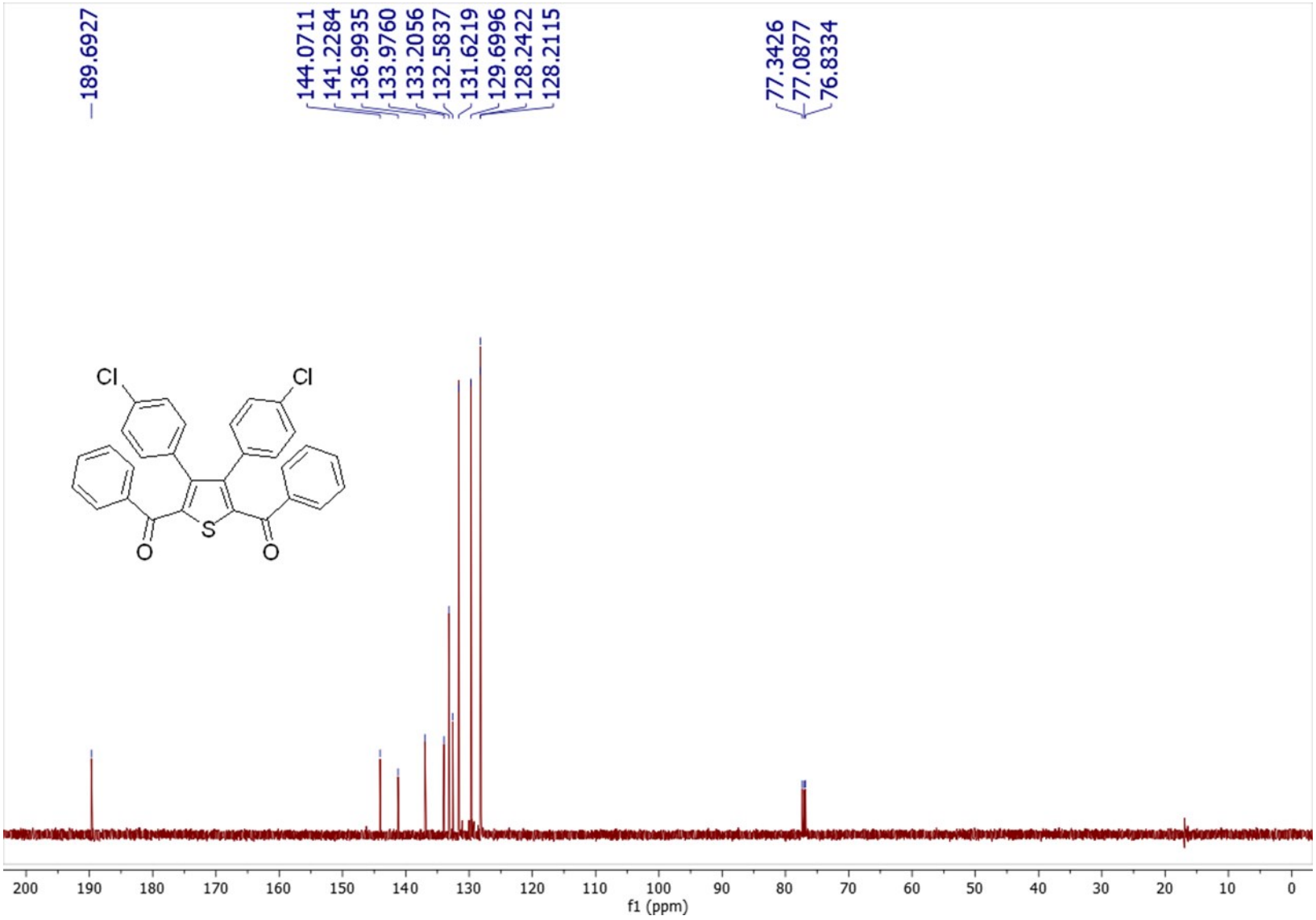
^{13}C NMR spectrum of **3o**



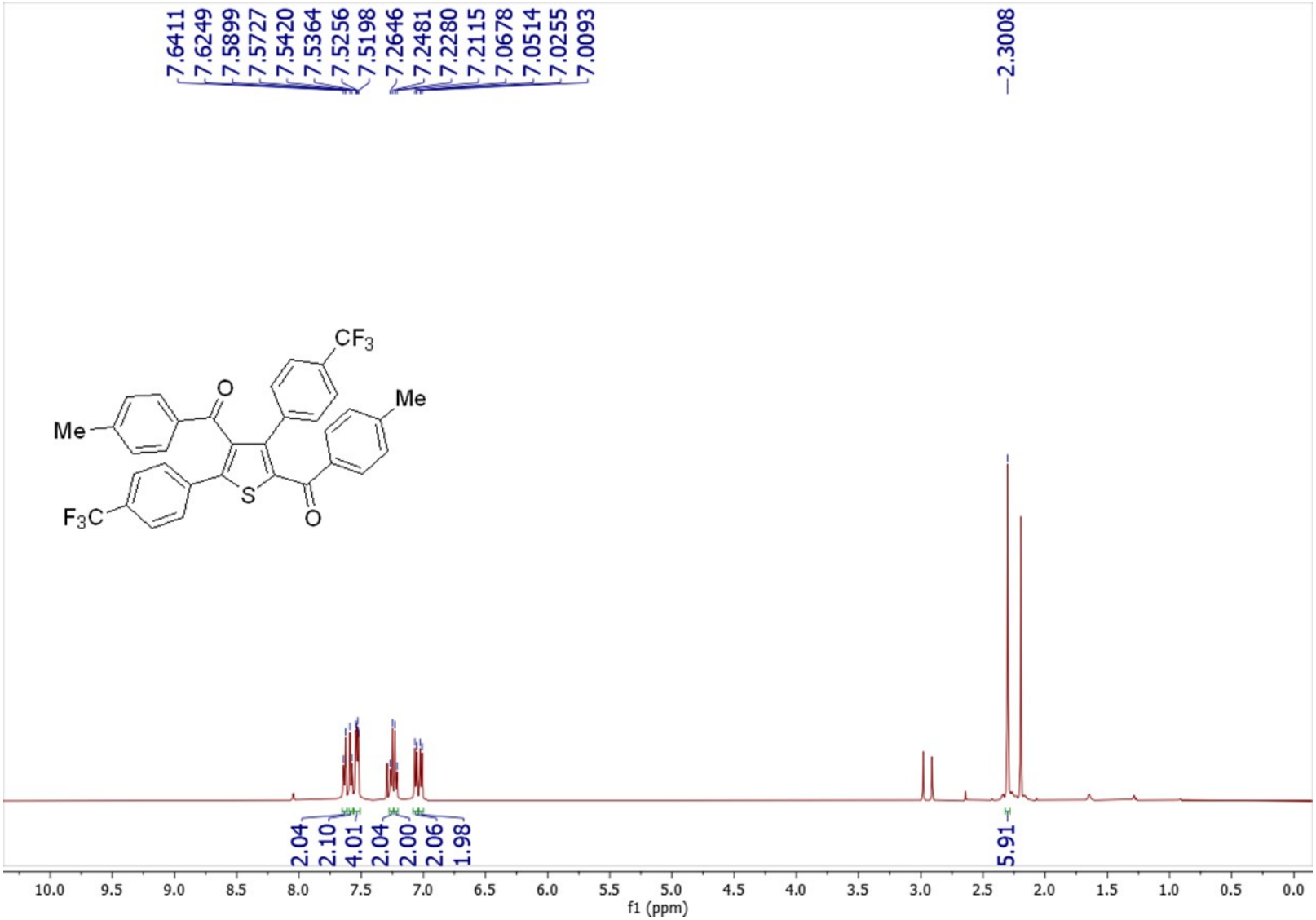
^{1}H NMR spectrum of **3p**



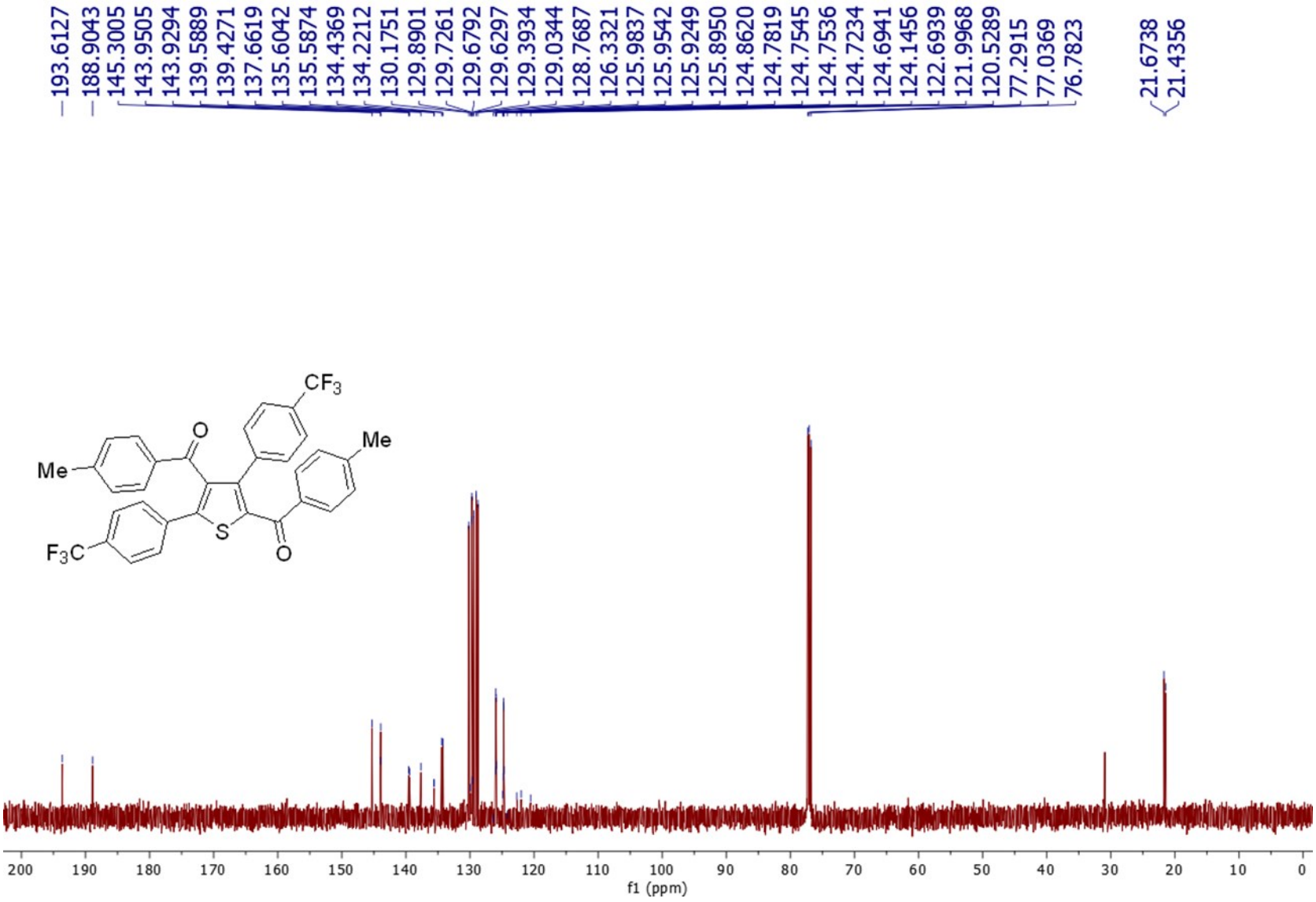
^{13}C NMR spectrum of **3p**



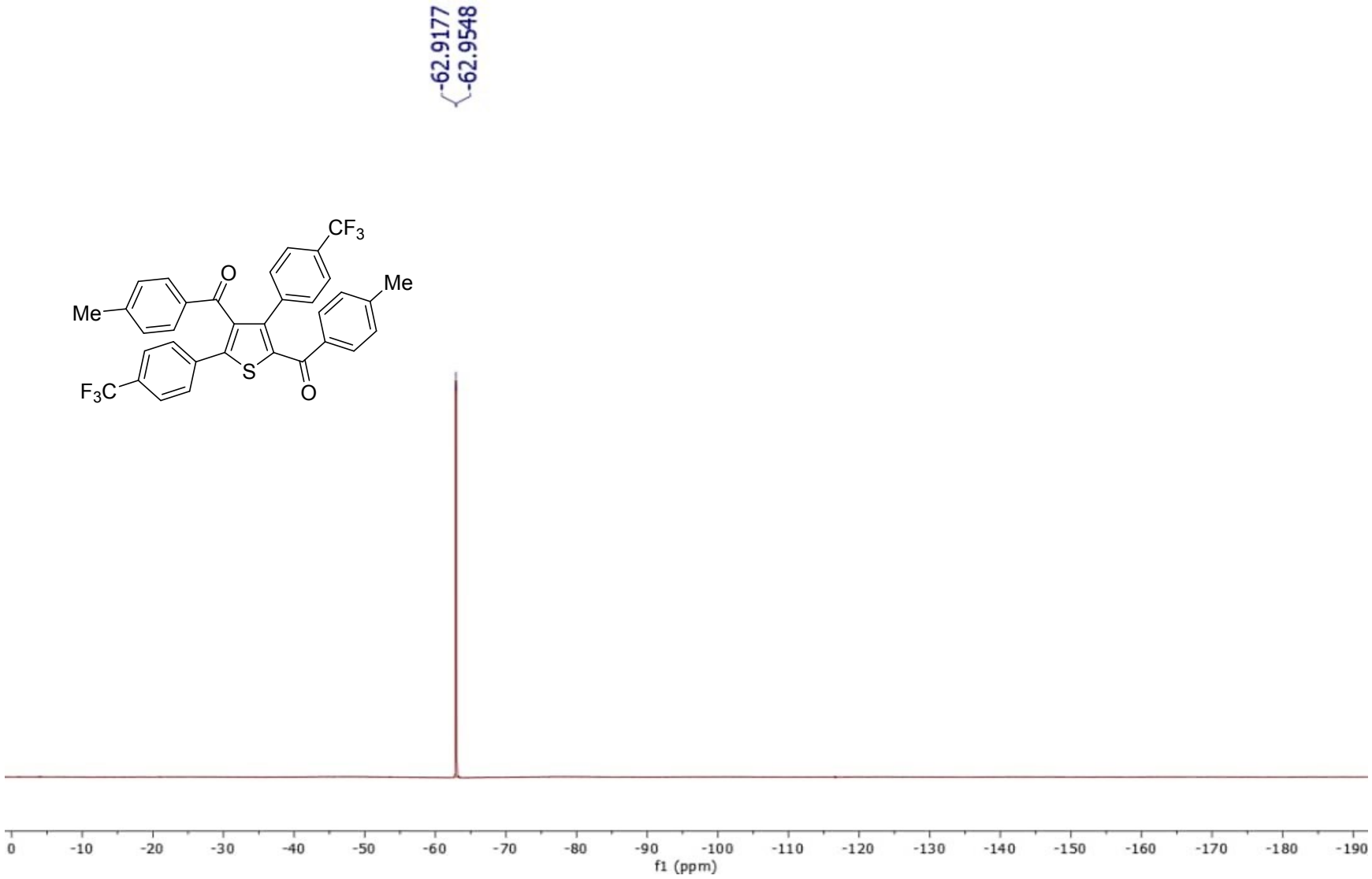
^{1}H NMR spectrum of **3q**



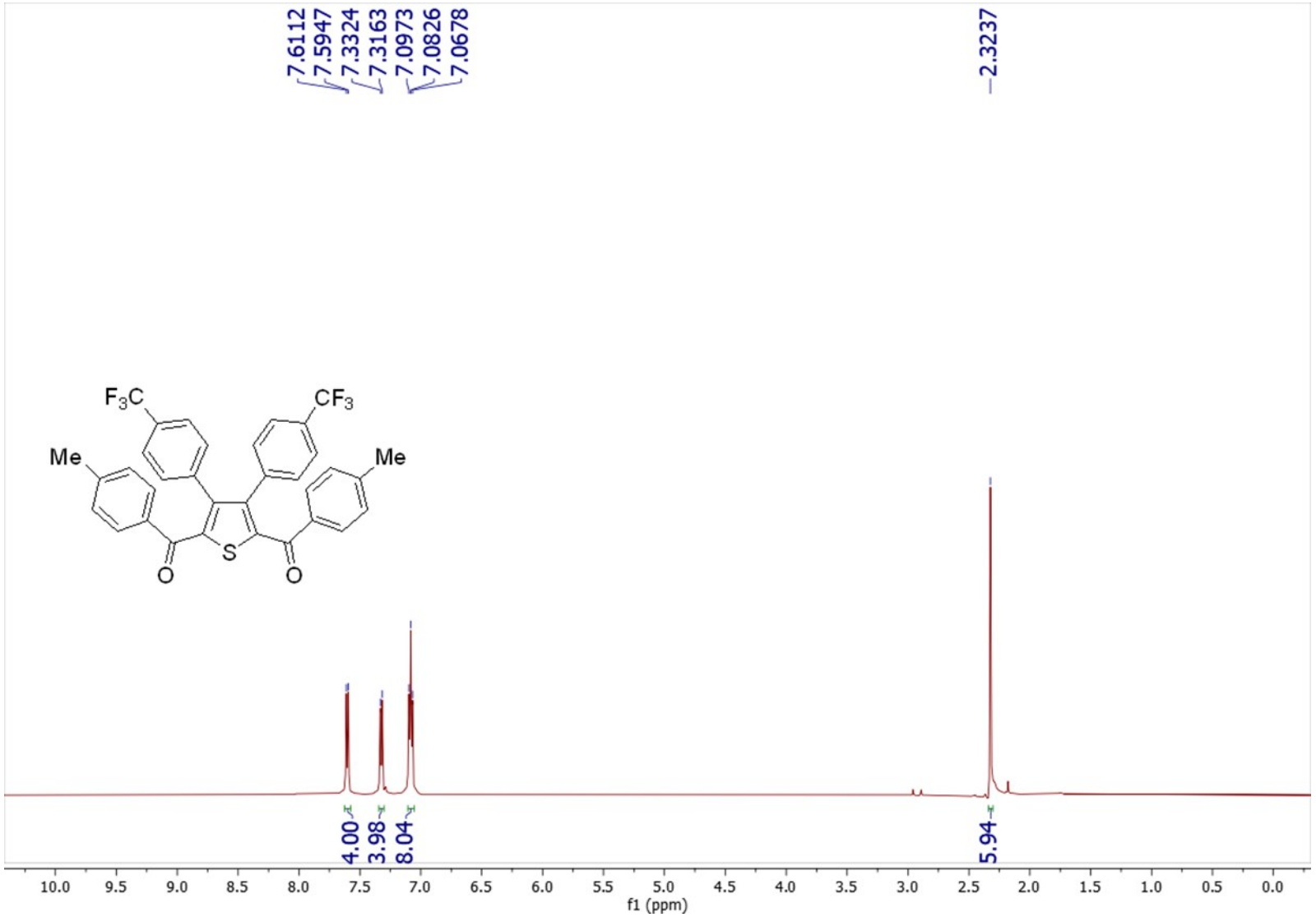
^{13}C NMR spectrum of **3q**



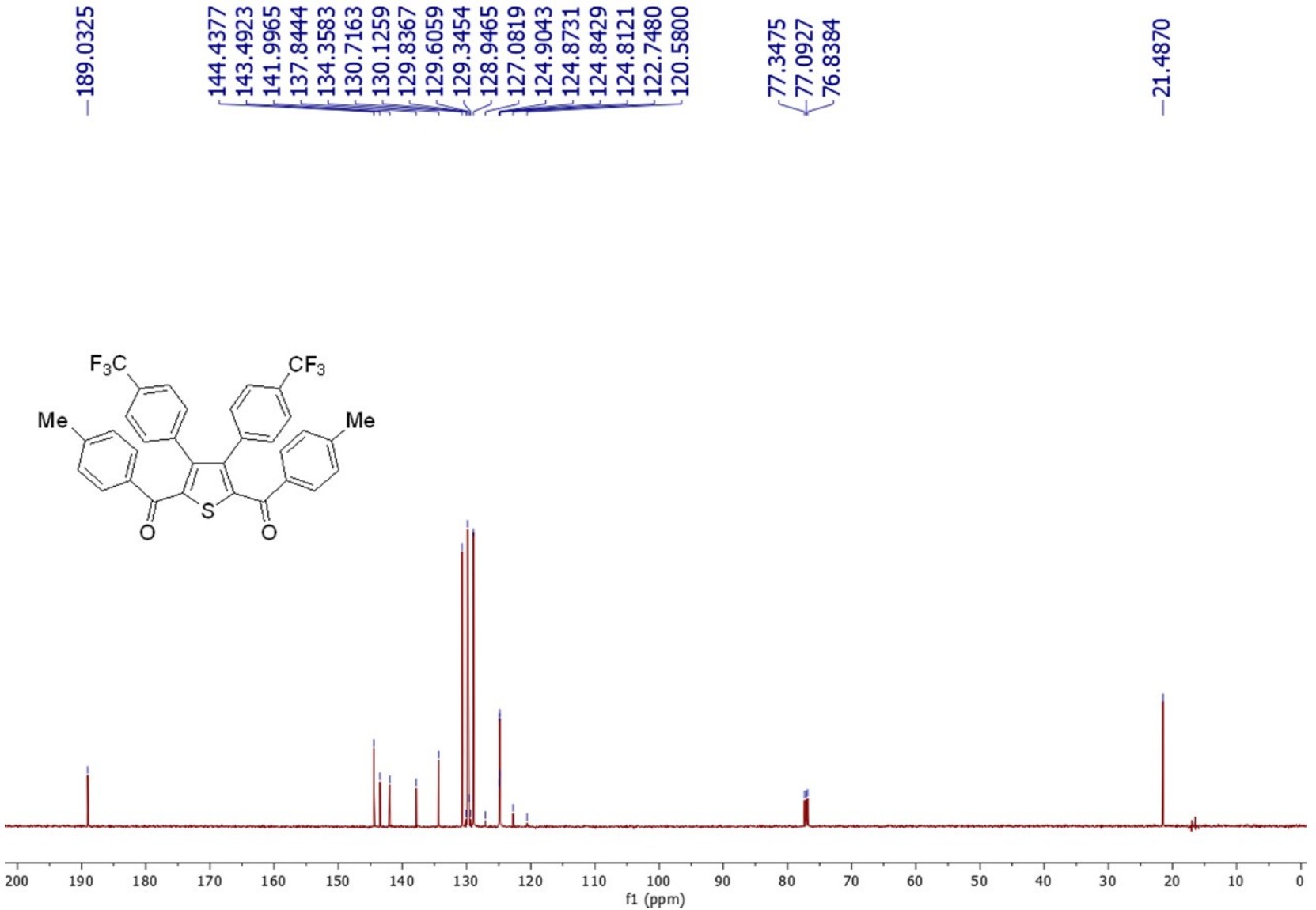
^{19}F NMR spectrum of **3q**



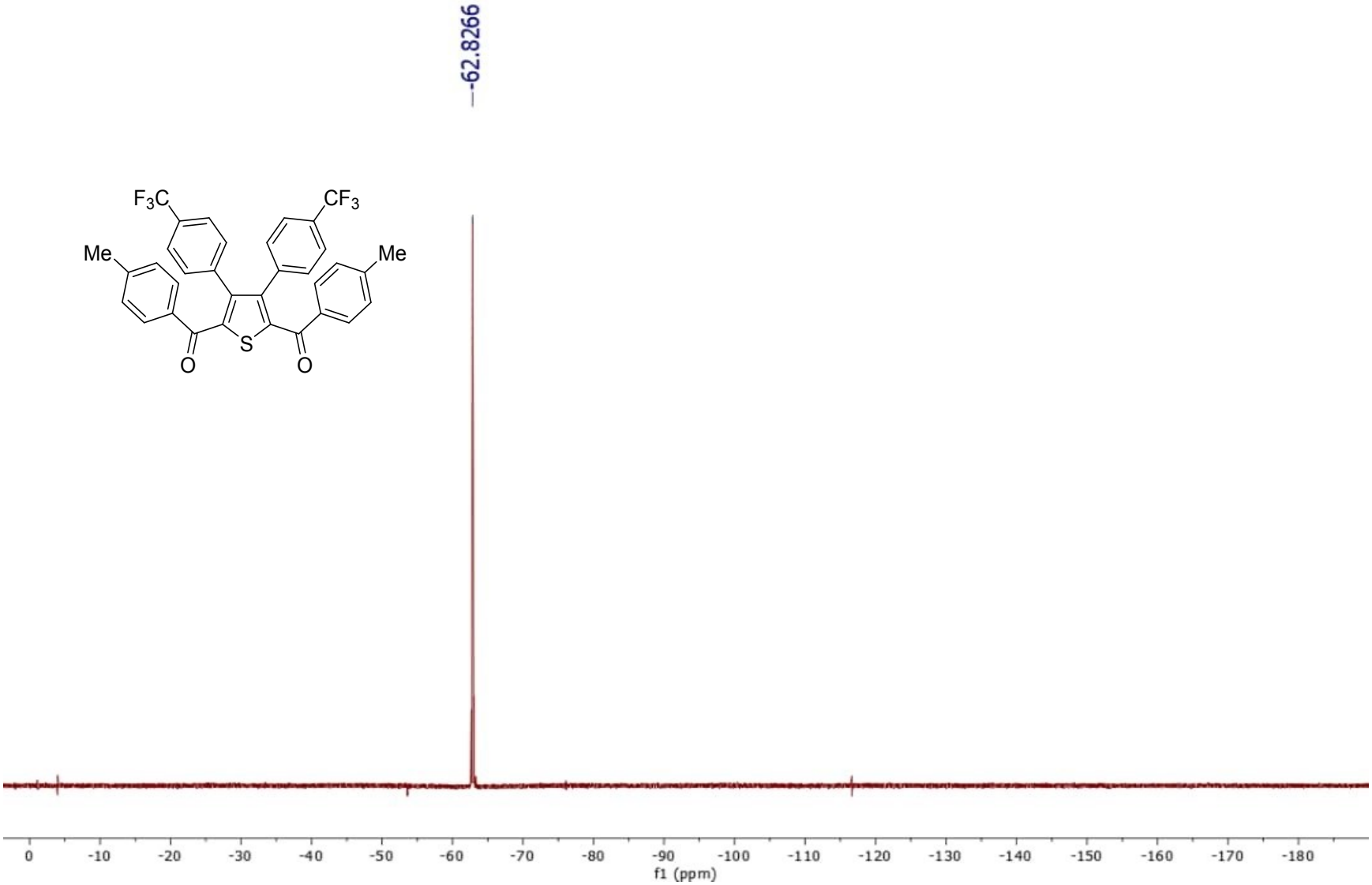
^{1}H NMR spectrum of **3r**



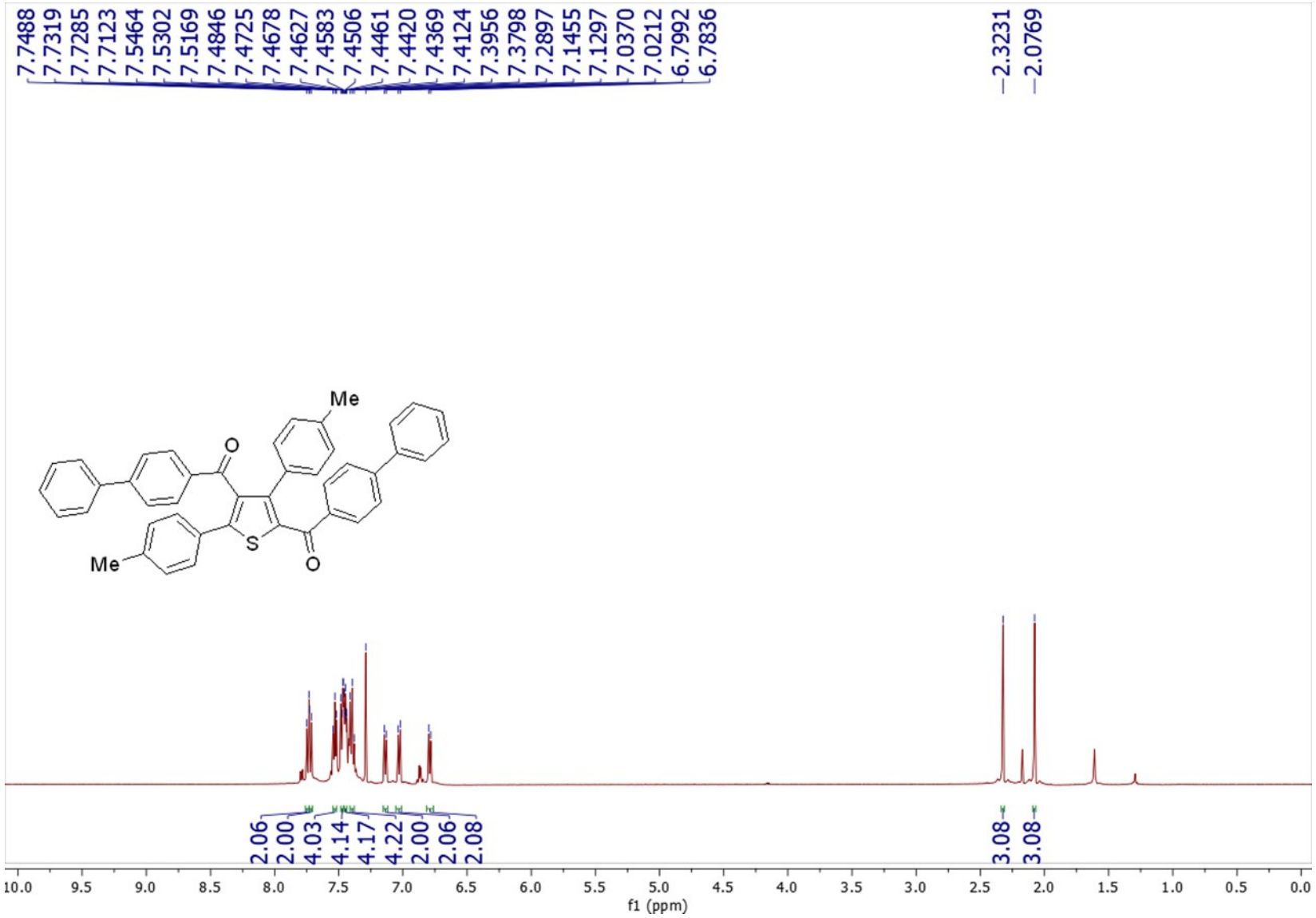
^{13}C NMR spectrum of **3r**



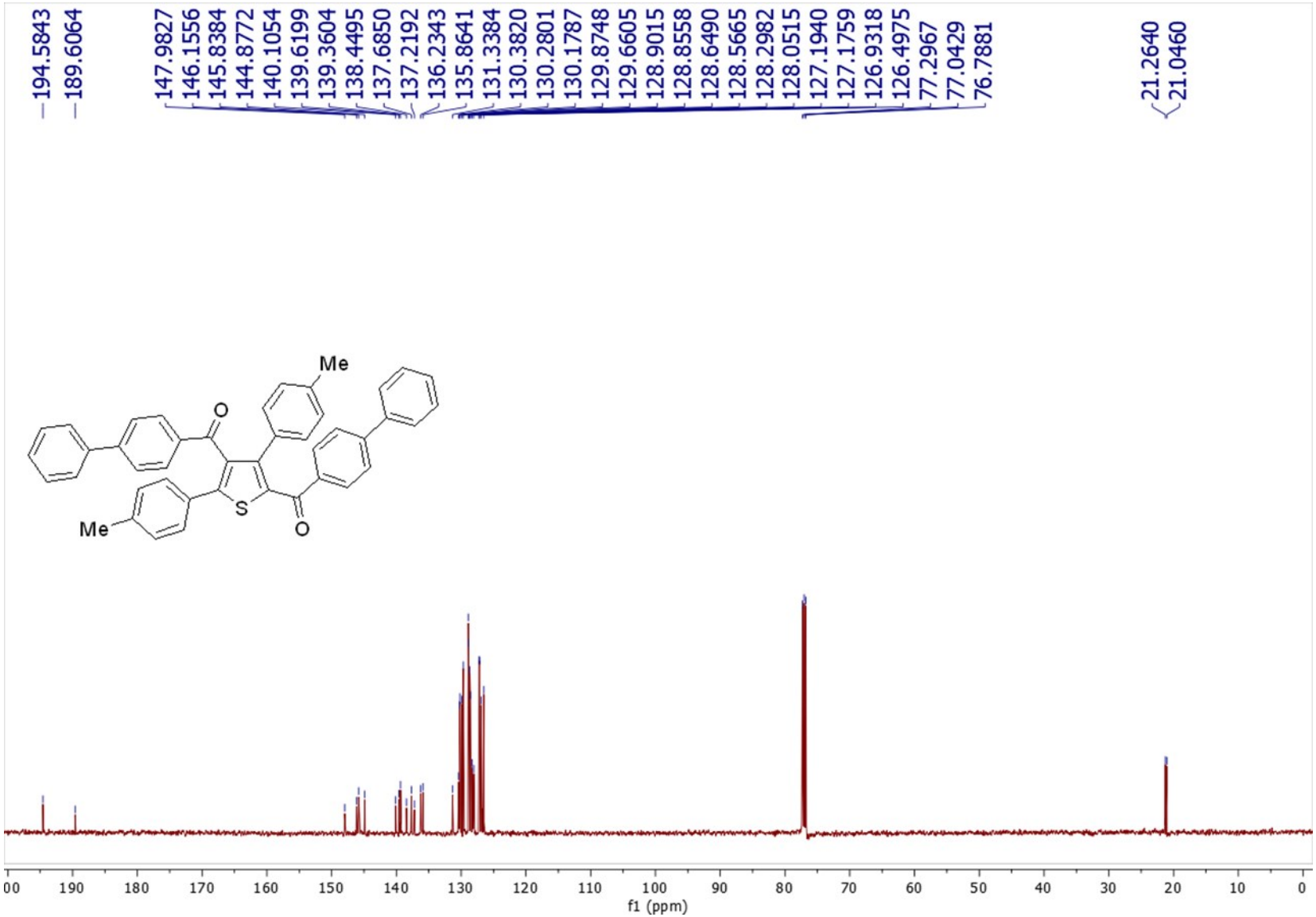
^{19}F NMR spectrum of **3r**



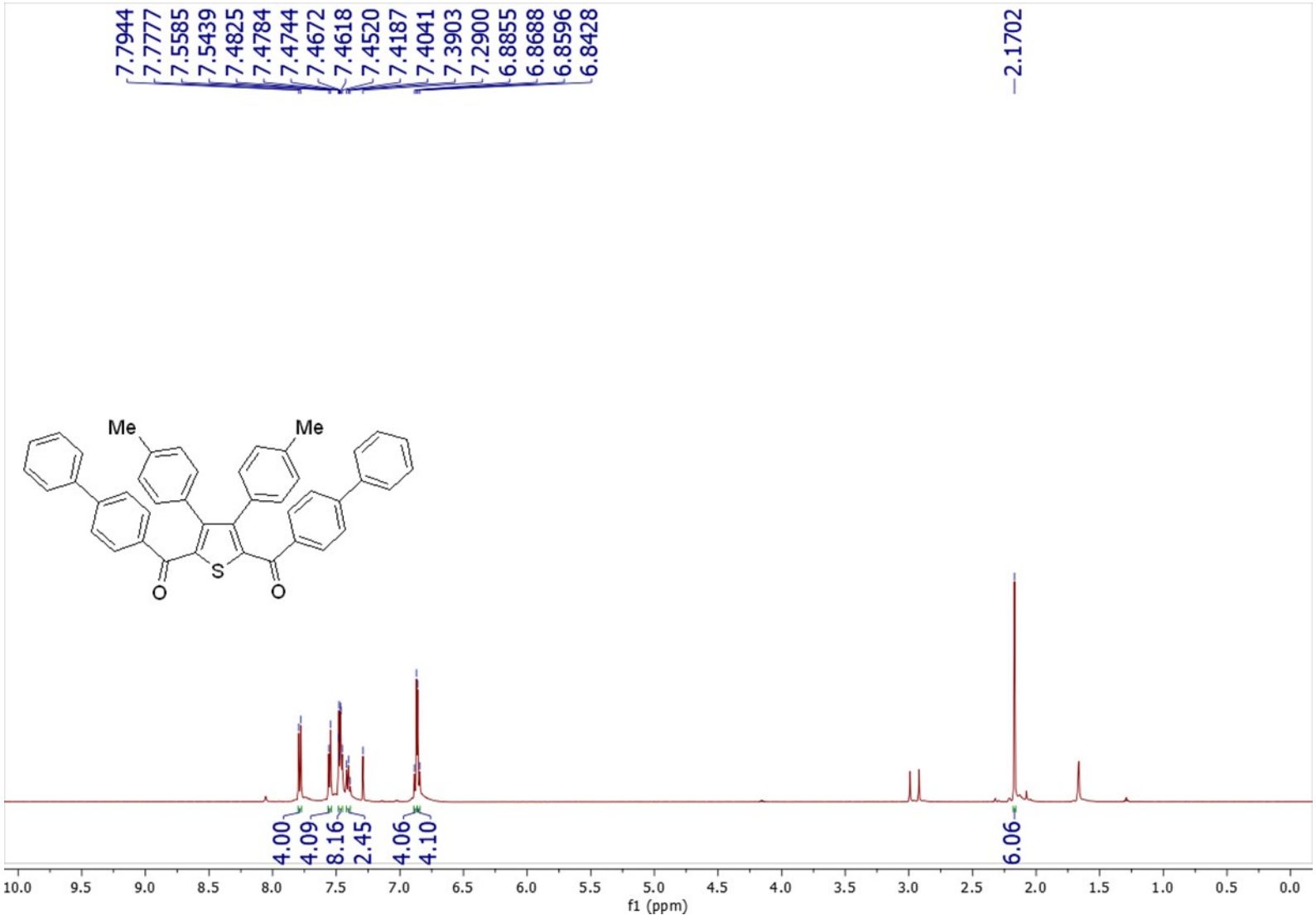
^{1}H NMR spectrum of **3s**



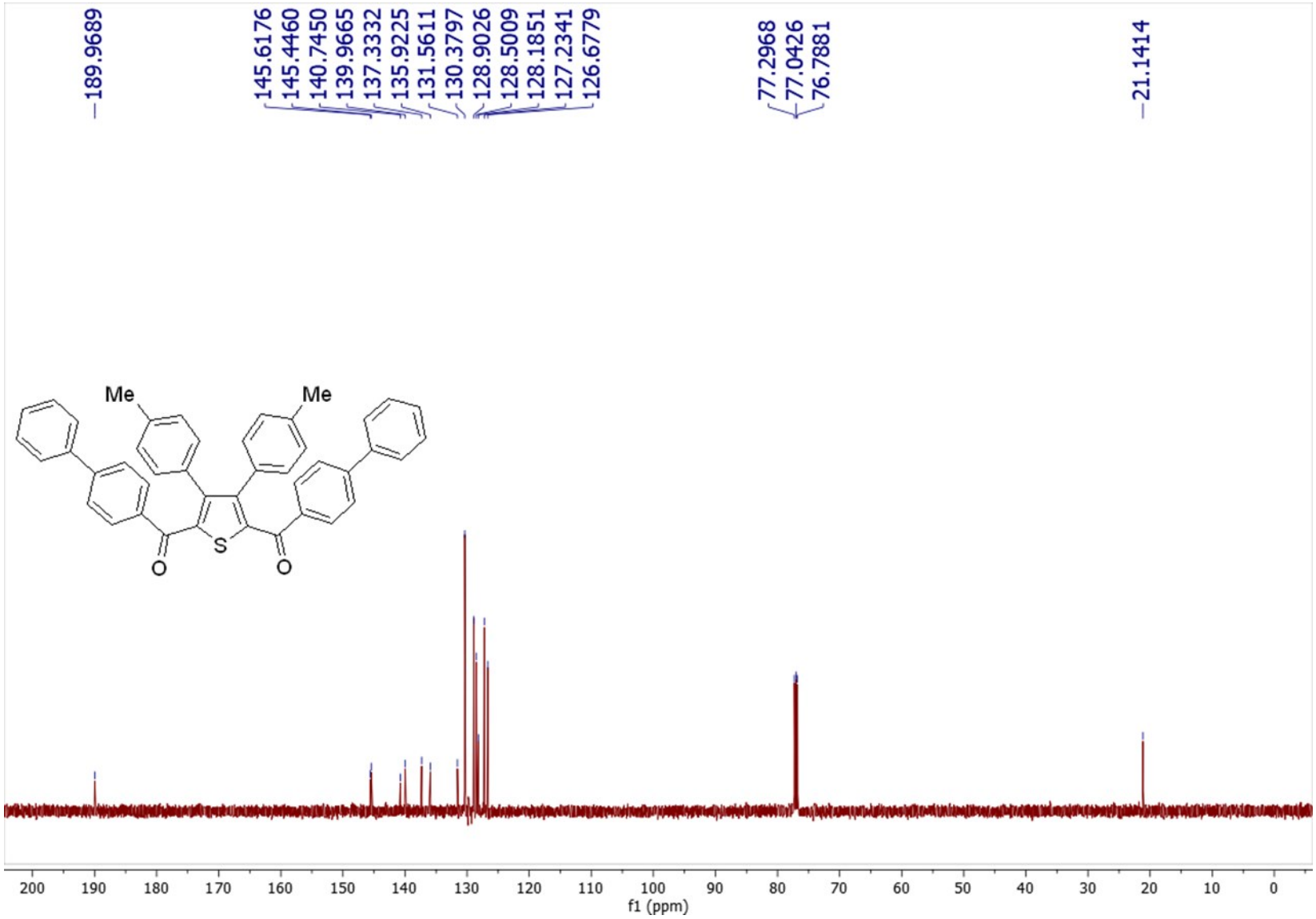
^{13}C NMR spectrum of **3s**



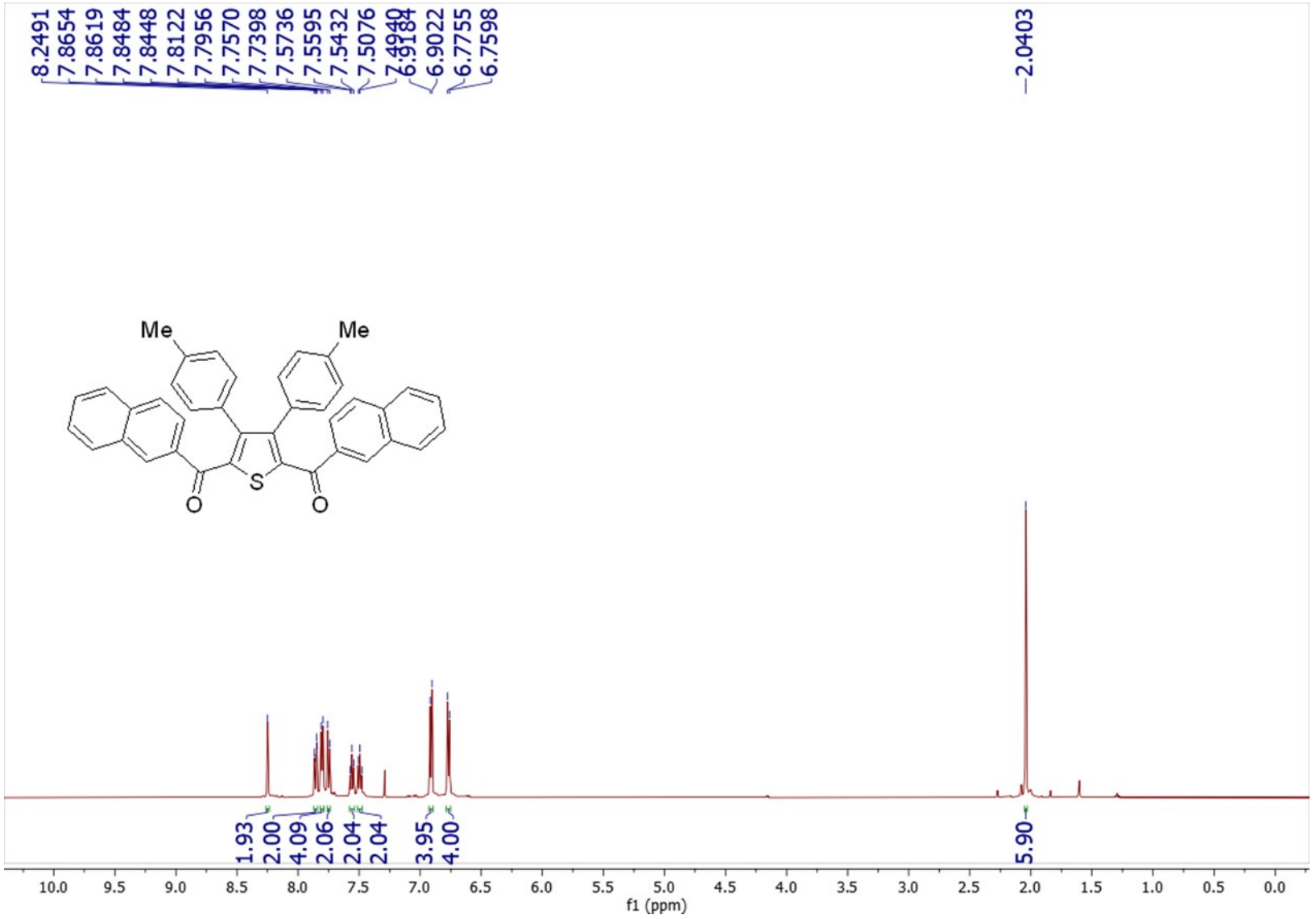
^{1}H NMR spectrum of **3t**



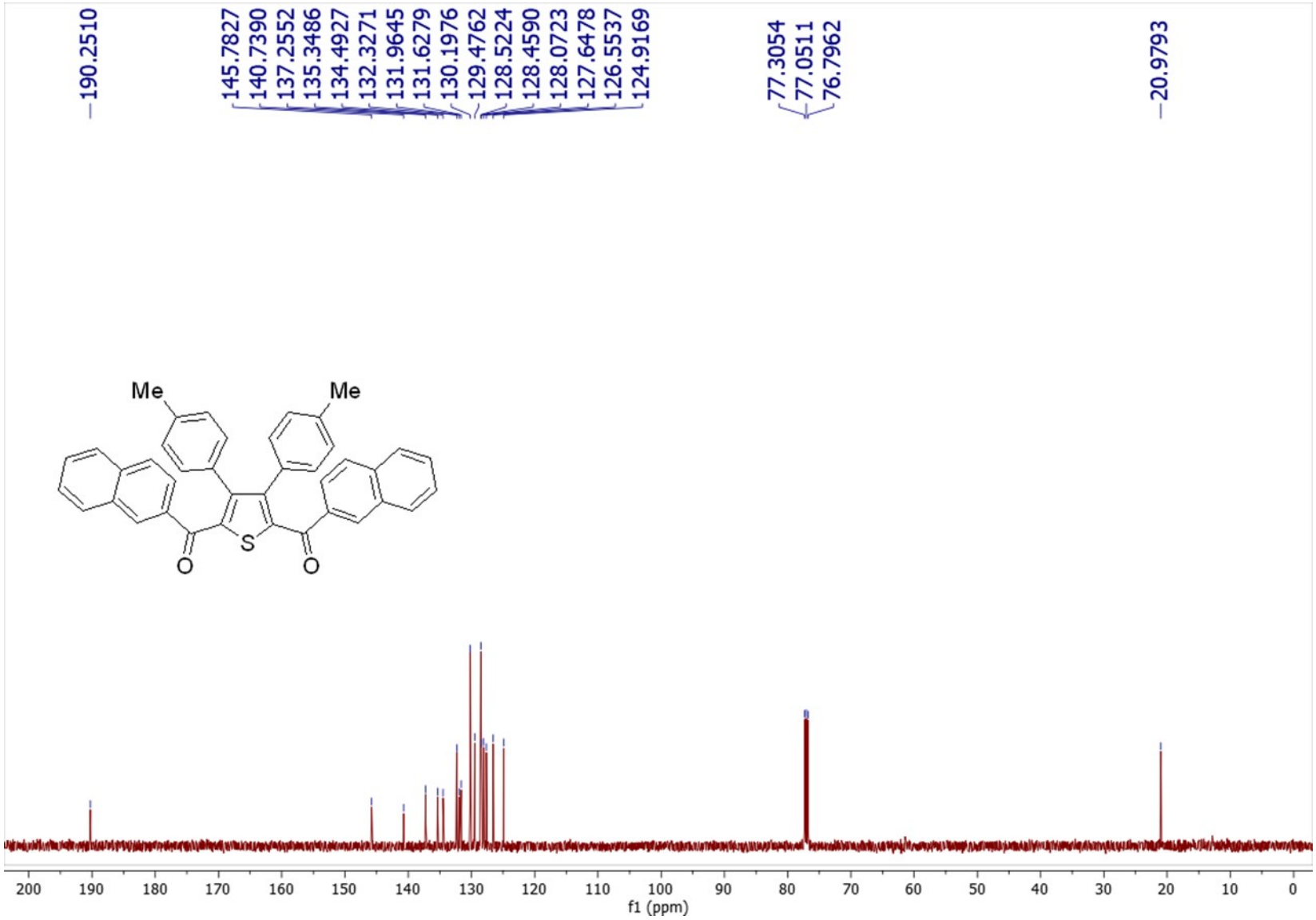
^{13}C NMR spectrum of **3t**



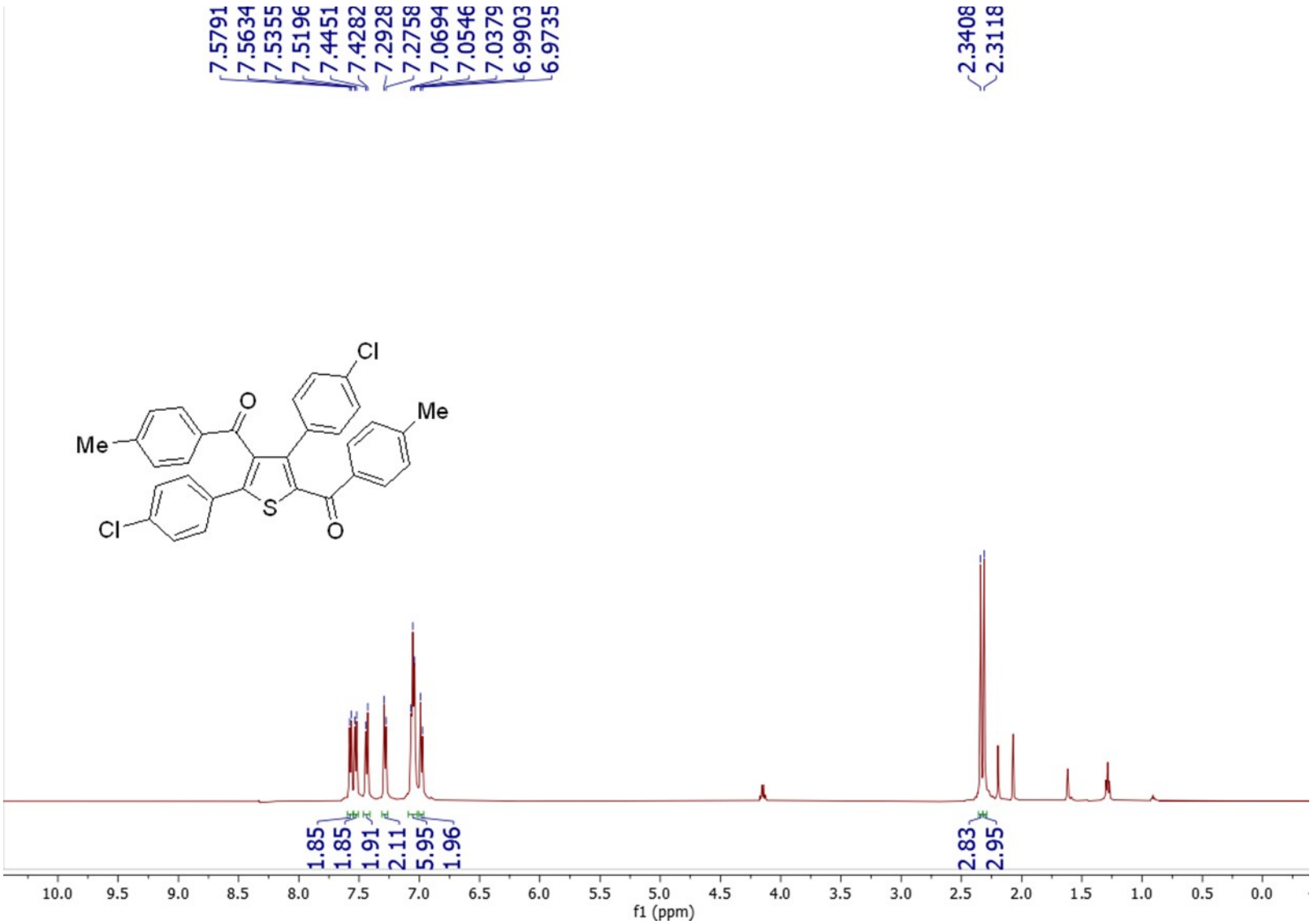
^{1}H NMR spectrum of **3u**



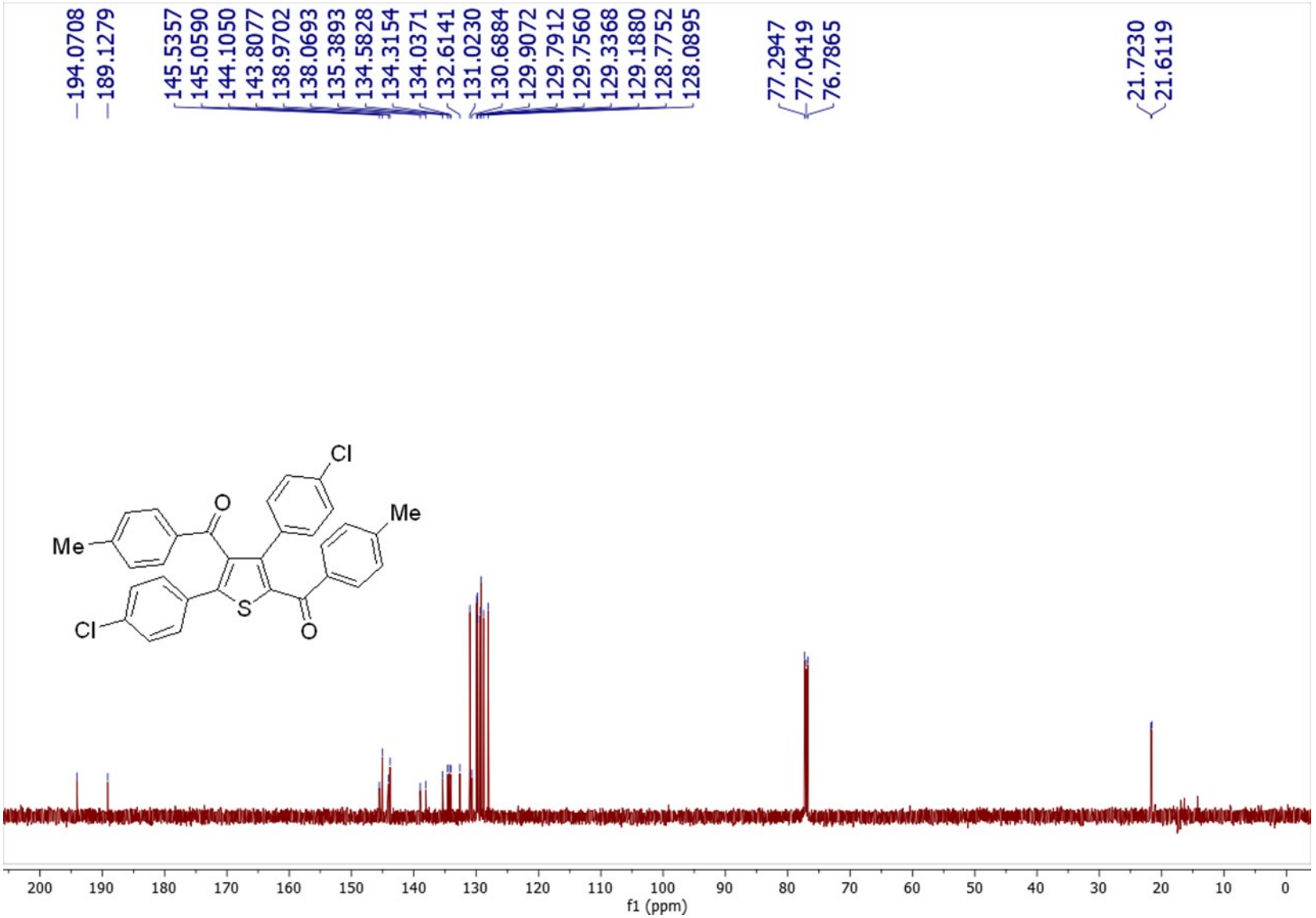
^{13}C NMR spectrum of **3u**



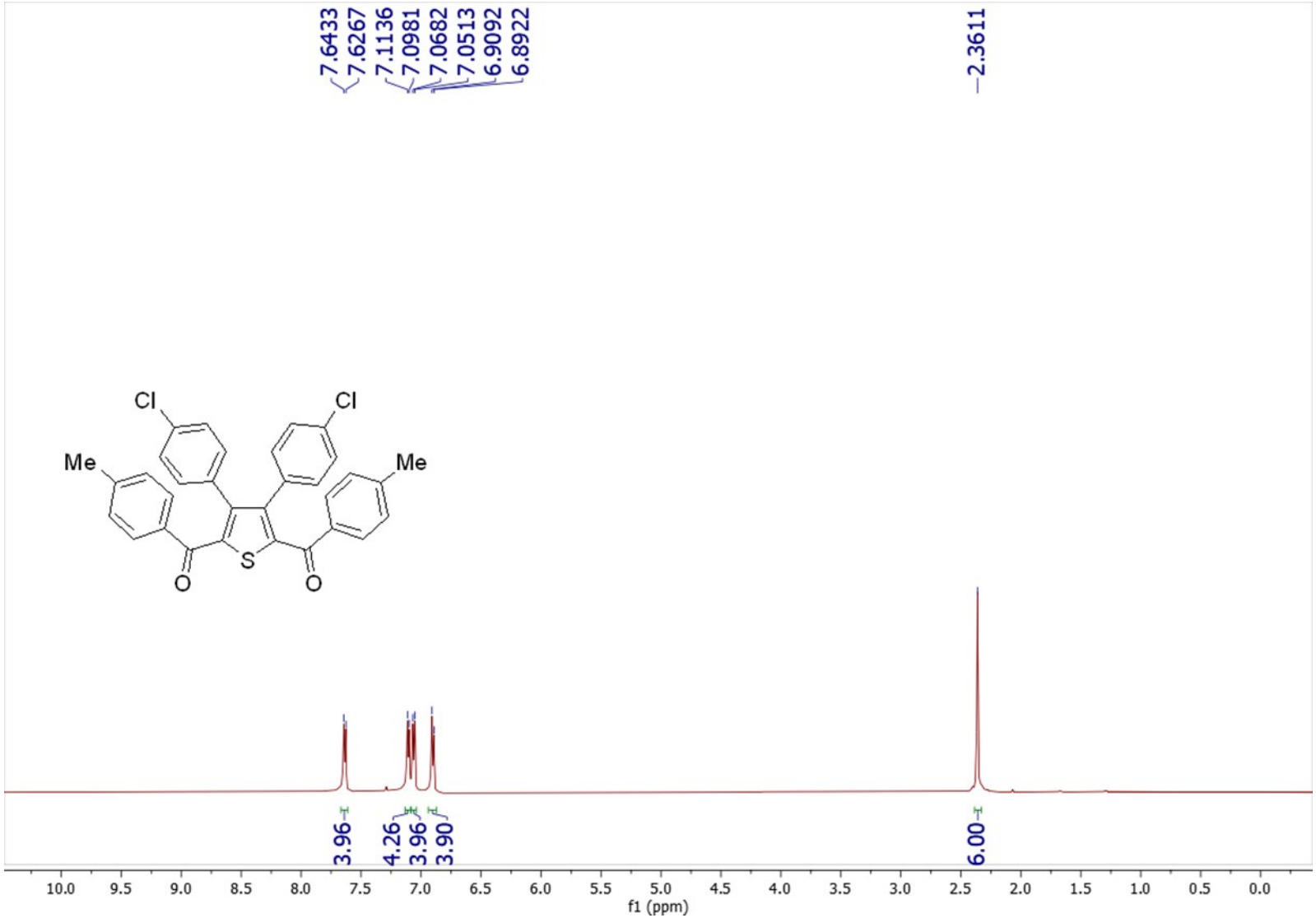
^{1}H NMR spectrum of **3v**



^{13}C NMR spectrum of **3v**



[1]H NMR spectrum of **3w**



^{13}C NMR spectrum of **3w**