Supporting Information

for

Visible-Light-Promoted α-Methoxymethylation and Aminomethylation of Ketones with Methanol as the C1 Source

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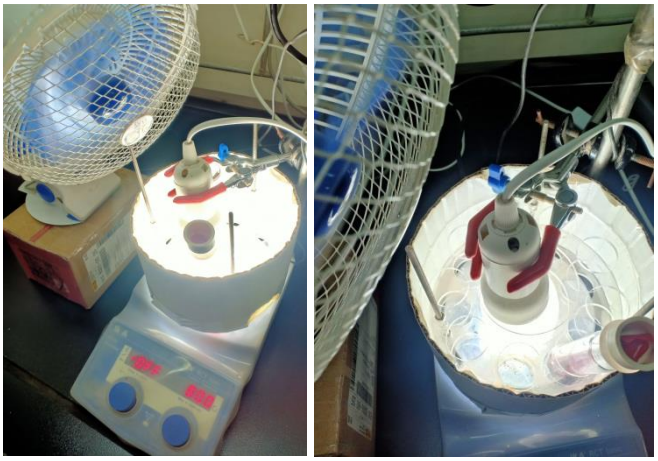
1. General Information

^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on an Agilent Technologies DD2 (600 MHz) or a Varian Mercury–400 Plus spectrometer in $CDCl_3$. Chemical shifts (δ) for NMR were quoted in ppm relative to the solvent peak (7.26 ppm for ^{1}H and 77.00 ppm for ^{13}C in $CDCl_3$). High-resolution mass spectra (HRMS) were performed on a Thermo Orbitrap Elite instrument with an ESI source. Reactions were monitored by thin layer chromatography (TLC) using pre-coated silica gel plates (GF254). Flash column chromatography was performed on silica gel 60 (particle size 200–400 mesh ASTM, purchased from Liangchen, China) and eluted with petroleum ether/ethylacetate or petroleum ether/acetone. The materials obtained from commercial suppliers were used directly without further purification.

The 23 W CFL lamps employed in this work were bought from the supermarket (manufacturer: PHILIPS, type specification: 220 V/23 W/50 Hz). The reaction vessels are borosilicate glass tube. The distance from the light source to the irradiation vessel is about 2.5 cm. The temperature is controlled by a fan and is about 24 °C. The reaction setup is shown below.



2. Experimental Procedures

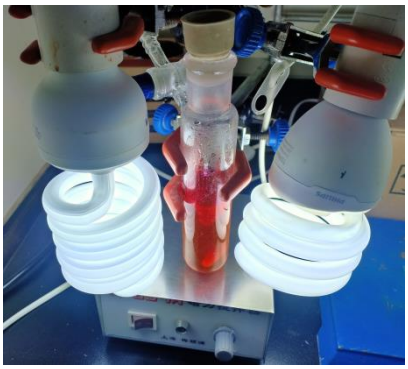
1) General procedure for synthesis of 2

Ketones **1** (0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv) and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 48 h. After completion of the reaction (monitored by TLC), the reaction

solution was concentrated under reduced pressure and the residue was purified by column chromatography on silica gel (PE:EtOAc = 10:1–100:1 or PE:Acetone = 100:1) to afford pure product **2**.

2) Procedure for gram-scale synthesis of 2a

Propiophenone **1a** (1.073 g, 8 mmol), rose bengal (0.529 g, 0.4 mmol, 5 mol%), Cs_2CO_3 (5.213 g, 16 mmol, 2.0 equiv) and MeOH (50 mL) were added into a 80 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under two 32 W compact fluorescent lamps (CFLs) irradiation and ambient air for 60 h. After completion of the reaction (monitored by TLC), the reaction solution was concentrated under reduced pressure and the residue was purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford pure product **2a** (62%, 0.887 g). The reaction setup is shown below.

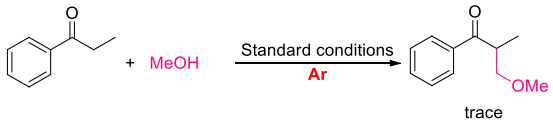


2) General procedure for synthesis of 3.

Ketones **1m** (44.5 mg, 0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv), N-nucleophiles (0.36 mmol, 1.2 equiv) and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 48 h. After completion of the reaction (monitored by TLC), the reaction solution was concentrated under reduced pressure and the residue was purified by column chromatography on silica gel (PE:EtOAc = 5:1–30:1) to afford pure product **3**.

3. Mechanistic Studies

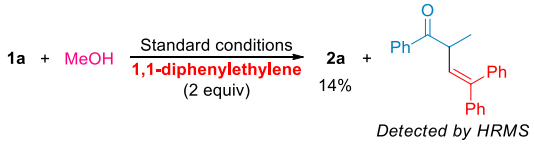
1) The reaction under argon



Ketones **1a** (40.3 mg, 0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv) and degassed MeOH (3 mL) were added into a 10 mL borosilicate glass tube filled with argon. Under argon atmosphere, the reaction mixture was stirred at room temperature under a 23 W compact fluorescent lamp (CFL) irradiation for 48 h. Only a trace amount of product **2a** was detected by TLC.

2) Radical-inhibiting experiments

Ketones **1a** (40.3 mg, 0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv), TEMPO (93.8 mg, 0.6 mmol, 2.0 equiv) and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 48 h. The reaction solution was concentrated under reduced pressure and the residue was purified by column chromatography on silica gel (PE:EtOAc = 50:1) to obtain pure product **2a** (31%).



Ketones **1a** (40.3 mg, 0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv), 1,1-diphenylethylene (108.2 mg, 0.6 mmol, 2.0 equiv), and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 48 h. Then, the reaction mixture was analyzed by HRMS, and the carbon radical trapped by 1,1-diphenylethylene was detected (**Figure S1**, data of $[M+H]^+$ are showed). In addition, after concentration under reduced pressure, **2a** was obtained in 14% yield by column chromatography isolation on silica gel (PE:EtOAc = 30:1).

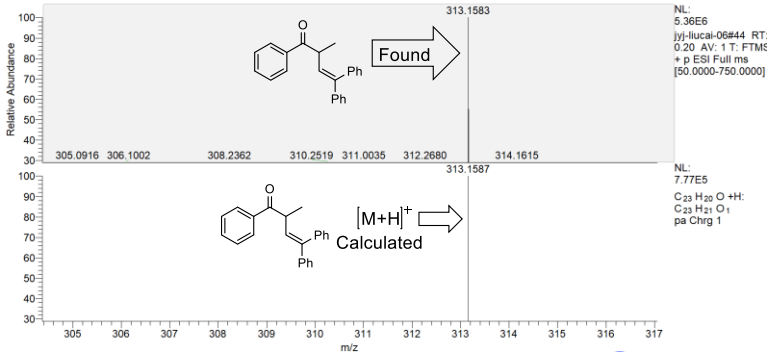
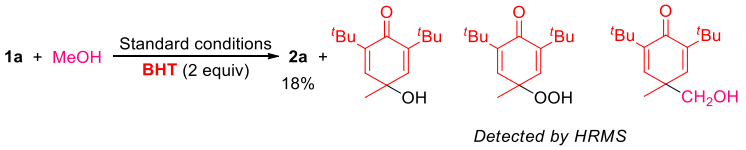


Figure S1



Detected by HRMS

Ketones **1a** (40.3 mg, 0.3 mmol), rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv), BHT (132.2 mg, 0.6 mmol, 2.0 equiv), and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 48 h. Then, the reaction mixture was analyzed by HRMS, and the oxidation products BHT-OH and BHT-OOH, the hydroxymethyl radical trapped by BHT were detected (**Figures S2**–**S4**, data of $[M+H]^+$ or $[M+Na]^+$ are showed). In addition, after concentration under reduced pressure, **2a** was obtained in 18% yield by column chromatography isolation on silica gel (PE:EtOAc = 30:1).

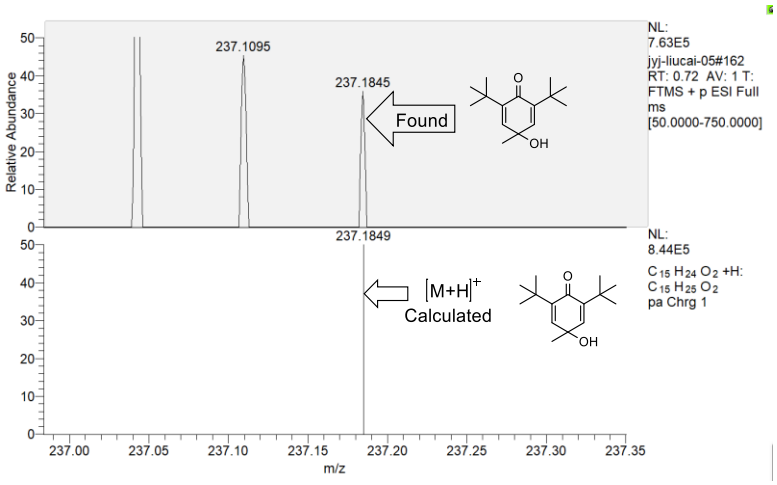


Figure S2

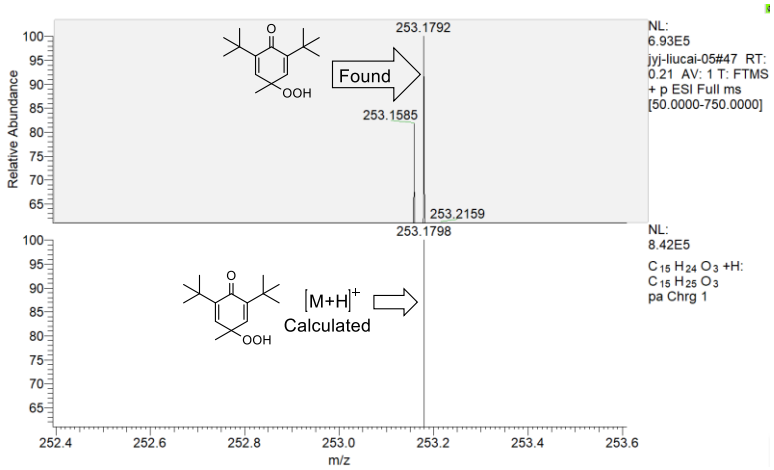


Figure S3

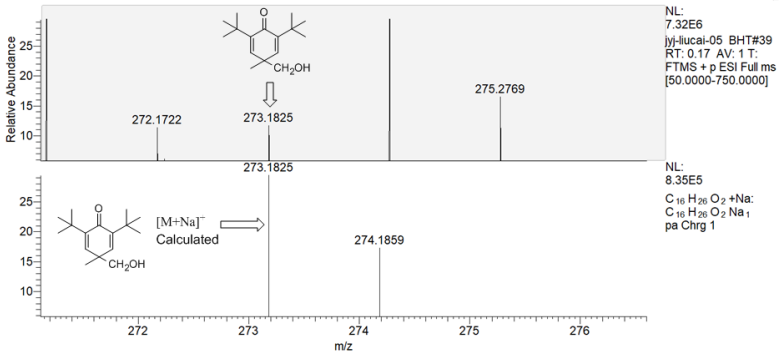


Figure S4

3) EPR experiments

(a) Reaction of PBN in MeOH

N-tert-butyl-*α*-phenylnitrone (PBN, 35.4 mg, 0.2 mmol) and MeOH (3 mL) were placed into an oven-dried 10 mL borosilicate glass tube. The reaction solution was then irradiated with 23 W CFL under ambient air at room temperature for 3 h. The resulting mixture was transferred to an oven-dried EPR tube, which was sealed with a rubber cap, and then analyzed by EPR (**Figure S5**).

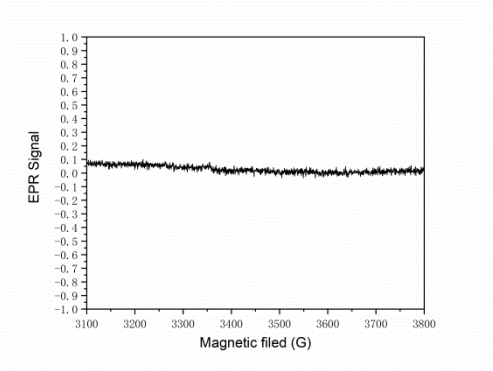


Figure S5. The electron paramagnetic resonance (EPR) spectrum of a mixture of PBN in MeOH.

(b) Reaction of PBN and rose bengal in MeOH

N-tert-butyl-*α*-phenylnitrone (PBN, 35.4 mg, 0.2 mmol), rose bengal (RB, 5.1 mg, 5 mol%) and MeOH (3 mL) were placed into an oven-dried 10 mL borosilicate glass tube. The reaction solution was then irradiated with 23 W CFL under ambient air at room temperature for 3 h. The resulting mixture was transferred to an oven-dried EPR tube, which was sealed with a rubber cap, and then analyzed by EPR (**Figure S6**).

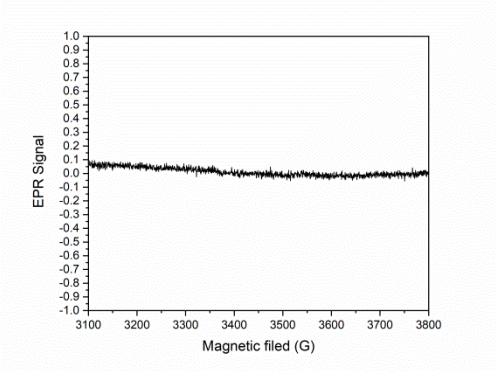
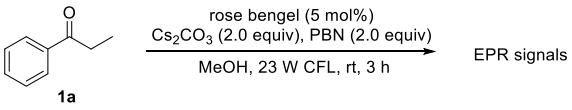


Figure S6. The electron paramagnetic resonance (EPR) spectrum of a mixture of PBN and RB in MeOH.

(c) Reaction of PBN, 1a, Cs_2CO_3 and rose bengal in MeOH.

N-tert-butyl-*α*-phenylnitrone (PBN, 35.4 mg, 0.2 mmol), propiophenone (**1a**, 13.4 mg, 0.1 mmol), Cs_2CO_3 (65.2 mg, 0.2 mmol), rose bengal (RB, 5.1 mg, 5 mol%) and MeOH (3 mL) were placed into an oven-dried 10 mL borosilicate glass tube. The reaction solution was then irradiated with 23 W CFL under ambient air at room temperature for 3 h. The resulting mixture was transferred to an oven-dried EPR tube, which was sealed with a rubber cap, and then analyzed by EPR (**Figure S7**).



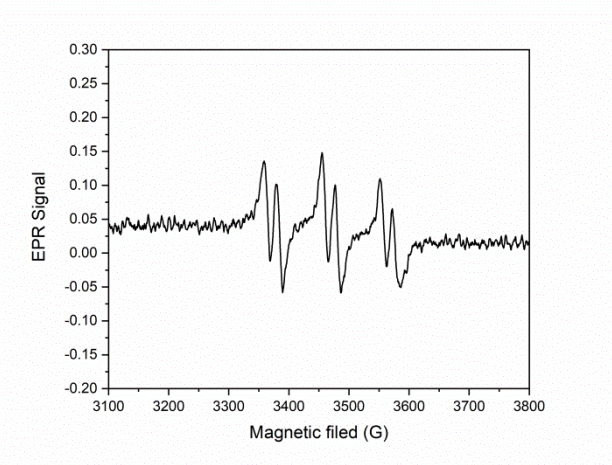
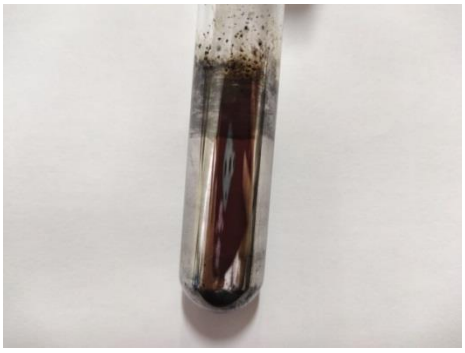


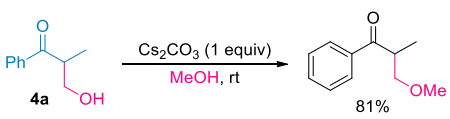
Figure S7. The electron paramagnetic resonance (EPR) spectrum of a mixture of PBN, Ketones, Cs_2CO_3 and RB in MeOH.

4) Silver mirror reaction

A solution of rose bengal (15.3 mg, 0.015 mmol, 5 mol%), Cs_2CO_3 (195.2 mg, 0.6 mmol, 2.0 equiv) in MeOH (3 mL) was stirred at room temperature under 23 W compact fluorescent lamp (CFL) irradiation and ambient air for 24 h. Then, a small amount of the reaction mixture was dropped into a fresh silver ammonia solution in test tube. After shaking, the test tube was warmed in hot water and a layer of metallic silver was found adhering to the inner wall of the test tube. The picture of this phenomenon is shown below.

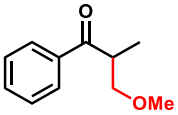


5) The reaction of α-hydroxymethylated propiophenone 4a



α-Hydroxymethylated propiophenone **4a** (49.2 mg, 0.3 mmol), Cs_2CO_3 (97.6 mg, 0.3 mmol, 1.0 equiv) and MeOH (3 mL) were added into a 10 mL borosilicate glass tube. The reaction mixture was stirred at room temperature for 48 h. The reaction solution was concentrated under reduced pressure and the residue was purified by column chromatography on silica gel (PE:EtOAc = 10:1) to obtain pure product **2a** in 81% yield.

4. Characterization Data of Products



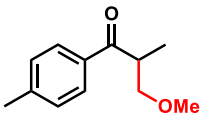
3-Methoxy-2-methyl-1-phenylpropan-1-one (2a)[1]

Prepared according to the general procedure from propiophenone **1a** (40.3 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **2a**.

Colorless oil; yield: 39.6 mg (74%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.98–7.96 (m, 2H), 7.56–7.54 (m, 1H), 7.48–7.44 (m, 2H), 3.83–3.73 (m, 2H), 3.49–3.43 (m, 1H), 3.32 (s, 3H), 1.20 (d, *J* = 10.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.7, 136.6, 133.0, 128.6, 128.3, 75.0, 59.1, 41.2, 14.8.



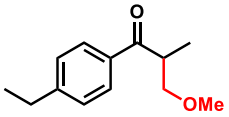
3-Methoxy-2-methyl-1-(*p*-tolyl)propan-1-one (2b)[1]

Prepared according to the general procedure from 1-(*p*-tolyl)propan-1-one **1b** (44.5 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2b**.

Colorless oil; yield: 43.3 mg (75%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.88 (d, *J* = 8.4 Hz, 2H), 7.27–7.25 (m, 2H), 3.77–3.73 (m, 2H), 3.45–3.43 (m, 1H), 3.32 (s, 3H), 2.41 (s, 3H), 1.19 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.3, 143.8, 134.1, 129.3, 128.5, 75.0, 59.1, 41.1, 21.6, 14.9.



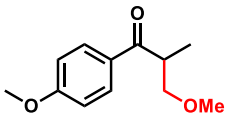
1-(4-Ethylphenyl)-3-methoxy-2-methylpropan-1-one (2c)[1]

Prepared according to the general procedure from 1-(4-ethylphenyl)propan-1-one **1c** (48.7 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2c**.

Colorless oil; yield: 45.2 mg (73%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.91 (d, *J* = 8.4, Hz, 2H), 7.29 (d, *J* = 8.4 Hz, 2H), 3.79–3.74 (m, 2H), 3.46–3.43 (m, 1H), 3.32 (s, 3H), 2.70 (q, *J* = 7.8 Hz, 2H), 1.26 (t, *J* = 7.8 Hz, 3H), 1.20 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.3, 150.0, 134.3, 128.6, 128.1, 75.0, 59.1, 41.1, 28.9, 15.2, 14.9.



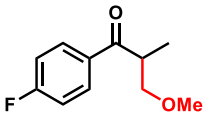
3-Methoxy-1-(4-methoxyphenyl)-2-methylpropan-1-one (2d)[1]

Prepared according to the general procedure from 1-(4-methoxyphenyl)propan-1-one **1d** (49.3 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2d**.

Colorless oil; yield: 36.3 mg (58%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.96 (d, *J* = 9.0 Hz, 2H), 6.93 (d, *J* = 8.4 Hz, 2H), 3.86 (s, 3H), 3.76–3.70 (m, 2H), 3.45–3.41 (m, 1H), 3.31 (s, 3H), 1.18 (d, *J* = 6.0 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.1, 163.5, 130.7, 129.6, 113.7, 75.1, 59.0, 55.4, 40.8, 15.0.



1-(4-Fluorophenyl)-3-methoxy-2-methylpropan-1-one (2e)[1]

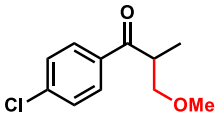
Prepared according to the general procedure from 1-(4-fluorophenyl)propan-1-one **1e** (45.6 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 100:1) to afford the pure product **2e**.

Colorless oil; yield: 24.7 mg (42%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 8.01–7.99 (m, 2H), 7.14–7.11 (m, 2H), 3.75–3.70 (m, 2H), 3.46–3.43 (m, 1H), 3.31 (s, 3H), 1.19 (d, *J* = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.2, 165.7 (d, *J* = 253.1 Hz), 133.1 (d, *J* = 2.9 Hz), 131.0 (d, *J* = 9.2 Hz), 115.7 (d, *J* = 21.6 Hz), 75.0, 59.1, 41.2, 14.7.

^{19}F NMR (376 MHz, $CDCl_3$): δ = -105.85–-105.89



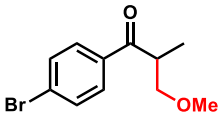
1-(4-Chlorophenyl)-3-methoxy-2-methylpropan-1-one (2f)[1]

Prepared according to the general procedure from 1-(4-chlorophenyl)propan-1-one **1f** (50.5 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 30:1) to afford the pure product **2f**.

Colorless oil; yield: 50.4 mg (79%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.92–7.90 (m, 2H), 7.45–7.42 (m, 2H), 3.75–3.69 (m, 2H), 3.46–3.42 (m, 1H), 3.31 (s, 3H), 1.19 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.6, 139.5, 135.1, 129.8, 128.9, 75.0, 59.1, 41.3, 14.7.



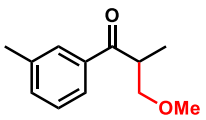
1-(4-Bromophenyl)-3-methoxy-2-methylpropan-1-one (2g)[1]

Prepared according to the general procedure from 1-(4-bromophenyl)propan-1-one **1g** (63.9 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 30:1) to afford the pure product **2g**.

Colorless oil; yield: 53.2 mg (69%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.84–7.82 (m, 2H), 7.61–7.59 (m, 2H), 3.74–3.68 (m, 2H), 3.46–3.43 (m, 1H), 3.30 (s, 3H), 1.18 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.8, 135.4, 131.9, 129.9, 128.2, 74.9, 59.1, 41.3, 14.7.



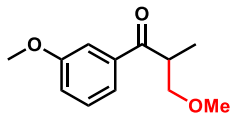
3-Methoxy-2-methyl-1-(*m*-tolyl)propan-1-one (2h)[1]

Prepared according to the general procedure from 1-(*m*-tolyl)propan-1-one **1h** (44.5 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 90:1) to afford the pure product **2h**.

Colorless oil; yield: 38.2 mg (66%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.78–7.76 (m, 2H), 7.36–7.33 (m, 2H), 3.78–3.73 (m, 2H), 3.46–3.44 (m, 1H), 3.32 (s, 3H), 2.41 (s, 3H), 1.19 (d, *J* = 10.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.9, 138.3, 136.7, 133.7, 128.8, 128.4, 125.5, 75.0, 59.1, 41.2, 21.3, 14.9.



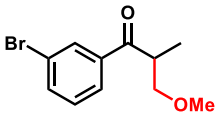
3-Methoxy-1-(3-methoxyphenyl)-2-methylpropan-1-one (2i)[1]

Prepared according to the general procedure from 1-(3-methoxyphenyl)propan-1-one **1i** (49.3 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 50:1) to afford the pure product **2i**.

Colorless oil; yield: 40.6 mg (65%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.56–7.55 (m, 1H), 7.50 (dd, *J* = 2.4, 1.8 Hz, 1H), 7.37 (t, *J* = 8.2 Hz, 1H), 7.12–7.01 (m, 1H), 3.86 (s, 3H), 3.77–3.73 (m, 2H), 3.47–3.44 (m, 1H), 3.32 (s, 3H), 1.20 (d, *J* = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.5, 159.9, 138.1, 129.6, 121.0, 119.6, 112.6, 75.0, 59.1, 55.4, 41.4, 14.9.



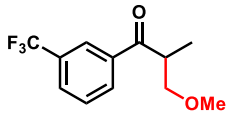
1-(3-Bromophenyl)-3-methoxy-2-methylpropan-1-one (2j)[1]

Prepared according to the general procedure from 1-(3-bromophenyl)propan-1-one **1j** (63.9 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:Acetone = 100:1) to afford the pure product **2j**.

Colorless oil; yield: 52.5 mg (68%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.08 (s, 1H), 7.87 (dd, *J* = 7.8, 1.0 Hz, 1H), 7.67–7.65 (m, 1H), 7.35–7.31 (m, 1H), 3.73–3.67 (m, 2H), 3.46–3.41 (m, 1H), 3.29 (s, 3H), 1.17 (d, *J* = 6.0 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 201.4, 138.4, 135.8, 131.3, 130.1, 126.8, 122.9, 74.8, 59.0, 41.3, 14.6.



3-Methoxy-2-methyl-1-(3-(trifluoromethyl)phenyl)propan-1-one (2k)

Prepared according to the general procedure from 1-(3-(trifluoromethyl)phenyl)propan-1-one **1k** (60.6 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:Acetone = 100:1) to afford the pure product **2k**.

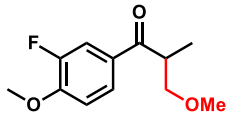
Colorless oil; yield: 29.5 mg (40%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.23 (s, 1H), 8.15 (d, *J* = 7.6 Hz, 1H), 7.81 (d, *J* = 7.6 Hz, 1H), 7.63–7.59 (m, 1H), 3.80–3.71 (m, 2H), 3.50–3.46 (m, 1H), 3.31 (s, 3H), 1.20 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.6, 137.3, 131.5, 131.2 (d, *J* = 32.6 Hz), 129.3 (q, *J* = 3.6 Hz), 129.2, 125.2 (q, *J* = 3.8 Hz), 124.7 (d, *J* = 271.0 Hz), 74.9, 59.1, 41.5, 14.5.

^{19}F NMR (376 MHz, $CDCl_3$): δ = -143.1 (s).

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{12}H_{14}O_2F_3^+$: 247.0946; found: 247.0940.



1-(3-Fluoro-4-methoxyphenyl)-3-methoxy-2-methylpropan-1-one (2l)

Prepared according to the general procedure from 1-(3,4-difluorophenyl)propan-1-one **1l** (51.0 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 50:1) to afford the pure product **2l**.

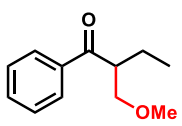
Colorless oil; yield: 46.3 mg (68%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.77–7.75 (m, 1H), 7.71 (dd, *J* = 12.0, 1.8 Hz, 1H), 6.99 (t, *J* = 8.2 Hz, 1H), 3.94 (s, 3H), 3.72–3.65 (m, 2H), 3.43 (dd, *J* = 8.4, 5.4 Hz, 1H), 3.30 (s, 3H), 1.17 (d, *J* = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 200.4, 152.3 (d, *J* = 149.1 Hz), 151.5 (d, *J* = 86.2 Hz), 129.9 (d, *J* = 4.6 Hz), 125.6 (d, *J* = 3.3 Hz), 116.0 (d, *J* = 18.7 Hz), 112.3, 75.0, 59.0, 56.2, 40.9, 14.8.

^{19}F NMR (376 MHz, $CDCl_3$): δ = -134.70–-134.76.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{12}H_{16}FO_3^+$: 227.1078; found: 227.1072.



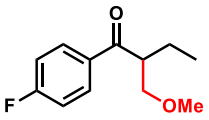
2-(Methoxymethyl)-1-phenylbutan-1-one (2m)[1]

Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2m**.

Pale yellow oil; yield: 39.9 mg (69%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.98–7.97 (m, 2H), 7.57–7.54 (m, 1H), 7.48–7.45 (m, 2H), 3.74–3.67 (m, 2H), 3.52 (dd, *J* = 8.7, 5.1 Hz, 1H), 3.30 (s, 3H), 1.81–1.74 (m, 1H), 1.63–1.58 (m, 1H), 0.89 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.9, 137.7, 132.9, 128.6, 128.3, 73.8, 59.1, 48.1, 22.9, 11.7.



1-(4-Fluorophenyl)-2-(methoxymethyl)butan-1-one (2n)

Prepared according to the general procedure from 1-(4-fluorophenyl)butan-1-one **1n** (49.8 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 80:1) to afford the pure product **2n**.

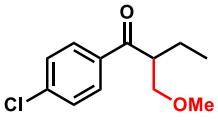
Colorless oil; yield: 39.9 mg (63%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 8.03–7.99 (m, 2H), 7.15–7.11 (m, 2H), 3.70 (t, *J* = 8.4 Hz, 1H), 3.66–3.61 (m, 1H), 3.51 (dd, *J* = 8.7, 5.1 Hz, 1H), 3.29 (s, 3H), 1.80–1.72 (m, 1H), 1.61–1.57 (m, 1H), 0.89 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.5, 165.7 (d, *J* = 253.1 Hz), 134.2 (d, *J* = 2.8 Hz), 131.0 (d, *J* = 9.2 Hz), 115.6 (d, *J* = 21.6 Hz), 73.9, 59.1, 48.1, 22.9, 11.7.

^{19}F NMR (376 MHz, $CDCl_3$): δ = -106.0–-106.1.

HRMS (ESI): *m/z* $[M+Na]^+$ calcd for $C_{12}H_{15}FO_2Na^+$: 233.0948; found: 233.0943.



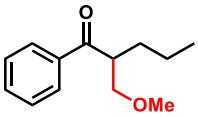
1-(4-Chlorophenyl)-2-(methoxymethyl)butan-1-one (2o)[1]

Prepared according to the general procedure from 1-(4-chlorophenyl)butan-1-one **1o** (54.8 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 30:1) to afford the pure product **2o**.

Colorless oil; yield: 44.9 mg (66%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.92–7.90 (m, 2H), 7.44–7.42 (m, 2H), 3.70–3.60 (m, 2H), 3.51 (dd, *J* = 8.7, 5.1 Hz, 1H), 3.28 (s, 3H), 1.78–1.73 (m, 1H), 1.61–1.56 (m, 1H), 0.88 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.9, 139.4, 136.1, 129.8, 128.9, 73.8, 59.1, 48.2, 22.8, 11.7.



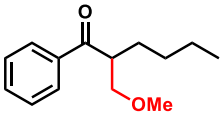
2-(Methoxymethyl)-1-phenylpentan-1-one (2p)[1]

Prepared according to the general procedure from 1-phenylpentan-1-one **1p** (48.7 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2p**.

Colorless oil; yield: 37.9 mg (61%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.97 (dd, *J* = 8.4, 1.2 Hz, 2H), 7.57–7.54 (m, 1H), 7.47–7.45 (m, 2H), 3.79–3.70 (m, 2H), 3.50 (dd, *J* = 9.0, 4.8 Hz, 1H), 3.29 (s, 3H), 1.74–1.68 (m, 1H), 1.53–1.50 (m, 1H), 1.33–1.25 (m, 2H), 0.87 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 203.1, 137.7, 132.9, 128.5, 128.3, 74.2, 59.1, 46.5, 32.0, 20.6, 14.2.



2-(Methoxymethyl)-1-phenylhexan-1-one (2q)

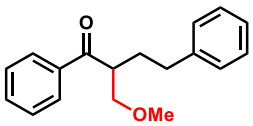
Prepared according to the general procedure from 1-phenylhexan-1-one **1q** (48.7 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2q**.

Colorless oil; yield: 39.3 mg (59%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.99–7.97 (m, 2H), 7.57–7.54 (m, 1H), 7.48–7.45 (m, 2H), 3.76–3.70 (m, 2H), 3.52–3.50 (m, 1H), 3.29 (s, 3H), 1.76–1.70 (m, 1H), 1.57–1.51 (m, 1H), 1.29–1.24 (m, 4H), 0.84 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 203.1, 137.7, 132.9, 128.5, 128.3, 74.2, 59.1, 46.7, 29.54, 29.53, 22.8, 13.8.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{14}H_{21}O_2^+$: 221.1536; found: 221.1532.



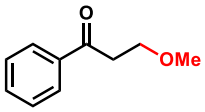
2-(Methoxymethyl)-1,4-diphenylbutan-1-one (2r)[1]

Prepared according to the general procedure from 1,4-diphenylbutan-1-one **1r** (67.2 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 70:1) to afford the pure product **2r**.

Colorless oil; yield: 48.3 mg (60%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.92–7.90 (m, 2H), 7.58–7.55 (m, 1H), 7.47–7.44 (m, 2H), 7.27–7.25 (m, 2H), 7.20–7.17 (m, 1H), 7.13–7.12 (m, 2H), 3.80–3.73 (m, 2H), 3.55 (dd, *J* = 8.4, 5.4 Hz, 1H), 3.30 (s, 3H), 2.67–2.57 (m, 2H), 2.15–2.10 (m, 1H), 1.92–1.86 (m, 1H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.5, 141.4, 137.4, 133.0, 128.5, 128.4, 128.35, 128.34, 126.0, 74.1, 59.1, 46.0, 33.4, 31.3.



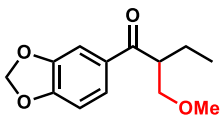
3-Methoxy-1-phenylpropan-1-one (2s)[2]

Prepared according to the general procedure from 3-chloro-1-phenylpropan-1-one **1s** (50.4 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 100:1) to afford the pure product **2s**.

Colorless oil; yield: 16.5 mg (33%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.98–7.96 (m, 2H), 7.58–7.55 (m, 1H), 7.48–7.46 (m, 2H), 3.82 (t, *J* = 6.6 Hz, 2H), 3.38 (s, 3H), 3.24 (t, *J* = 6.6 Hz, 2H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 198.3, 137.0, 133.2, 128.6, 128.1, 67.9, 59.0, 38.7.



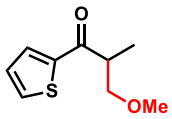
1-(Benzo[*d*][1,3]dioxol-5-yl)-2-(methoxymethyl)butan-1-one (2t)[1]

Prepared according to the general procedure from 1-(benzo[*d*][1,3]dioxol-5-yl)butan-1-one **1t** (57.7 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 50:1) to afford the pure product **2t**.

Colorless oil; yield: 47.6 mg (67%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.59 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.46 (d, *J* = 1.2 Hz, 1H), 6.85 (d, *J* = 7.8 Hz, 1H), 6.04 (s, 2H), 3.69 (t, *J* = 8.4 Hz, 1H), 3.61–3.56 (m, 1H), 3.49 (dd, *J* = 8.7, 5.1 Hz, 1H), 3.29 (s, 3H), 1.78–1.70 (m, 1H), 1.61–1.57 (m, 1H), 0.88 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 200.9, 151.7, 148.2, 132.6, 124.6, 108.2, 107.8, 101.8, 74.0, 59.1, 47.9, 23.1, 11.7.



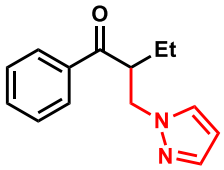
3-Methoxy-2-methyl-1-(thiophen-2-yl)propan-1-one (2u)[1]

Prepared according to the general procedure from 1-(thiophen-2-yl)propan-1-one **1u** (42.0 mg, 0.3 mmol). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **2u**.

Colorless oil; yield: 34.8 mg (63%).

^{1}H NMR (600 MHz, $CDCl_3$): δ = 7.76 (dd, *J* = 3.9, 0.9 Hz, 1H), 7.65 (dd, *J* = 4.8, 1.2 Hz, 1H), 7.14 (dd, *J* = 4.8, 4.2 Hz, 1H), 3.75–3.73 (m, 1H), 3.63–3.57 (m, 1H), 3.45–3.43 (m, 1H), 3.32 (s, 3H), 1.23 (d, *J* = 7.2 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 195.4, 144.2, 133.9, 132.1, 128.1, 74.9, 59.1, 43.1, 14.9.



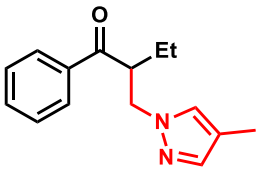
2-((1*H*-Pyrazol-1-yl)methyl)-1-phenylbutan-1-one (3ma)[1]

Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 1*H*-pyrazole (24.5 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **3ma**.

Colorless oil; yield: 49.9 mg (73%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.85 (d, *J* = 8.0 Hz, 2H), 7.53–7.32 (m, 5H), 6.09 (d, *J* = 2.0 Hz, 1H), 4.55 (dd, *J* = 13.4, 8.6 Hz, 1H), 4.28 (dd, *J* = 13.4, 5.4 Hz, 1H), 4.18–4.11 (m, 1H), 1.82–1.71 (m, 1H), 1.66–1.55 (m, 1H), 0.89 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.3, 139.6, 136.8, 133.2, 130.2, 128.5, 128.1, 52.6, 48.2, 23.8, 11.1.



2-((4-Methyl-1*H*-pyrazol-1-yl)methyl)-1-phenylbutan-1-one (3mb)

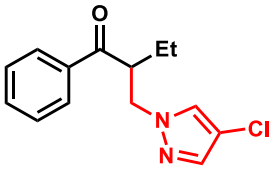
Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 4-methypyrazole (29.5 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **3mb**.

Colorless oil; yield: 45.1 mg (62%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.87 (d, *J* = 7.6 Hz, 2H), 7.56–7.52 (m, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.25 (s, 1H), 7.10 (s, 1H), 4.48 (dd, *J* = 13.6, 8.4 Hz, 1H), 4.22–4.09 (m, 2H), 1.96 (s, 3H), 1.81–1.70 (m, 2H), 1.65–1.54 (m, 1H), 0.89 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.5, 140.1, 137.0, 133.2, 129.2, 128.6, 128.2, 115.5, 52.5, 48.3, 23.9, 11.2, 8.7.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{15}H_{19}N_2O^+$: 243.1492; found: 243.1494.



2-((4-Chloro-1*H*-pyrazol-1-yl)methyl)-1-phenylbutan-1-one (3mc)

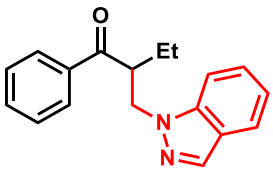
Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 4-chloropyrazole (36.9 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **3mc**.

Colorless oil; yield: 50.5 mg (64%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.89–7.86 (m, 2H), 7.57–7.52 (m, 1H), 7.45–7.41 (m, 2H), 7.37–7.35 (m, 2H), 4.56–4.49 (m, 1H), 4.24–4.07 (m, 2H), 1.82–1.71 (m, 1H), 1.66–1.55 (m, 1H), 0.90 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.8, 138.0, 136.6, 133.4, 128.7, 128.4, 128.2, 109.4, 53.0, 47.9, 23.9, 11.1.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{15}H_{16}N_2O^+$: 263.0946; found: 263.0941.



2-((1*H*-Indazol-1-yl)methyl)-1-phenylbutan-1-one (3md)

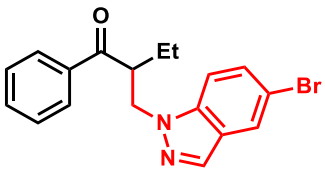
Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 1*H*-indazole (42.5 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **3md**.

Colorless oil; yield: 54.3 mg (65%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.95 (s, 1H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.50–7.45 (m, 2H), 7.38–7.35 (m, 3H), 7.10–7.06 (m, 1H), 4.81 (dd, *J* = 14.0, 8.0 Hz, 1H), 4.49 (dd, *J* = 14.0, 6.0 Hz, 1H), 4.34–4.27 (m, 1H), 1.90–1.79 (m, 1H), 1.72–1.61 (m, 1H), 0.92 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.4, 139.9, 136.8, 133.4, 133.1, 128.4, 128.1, 126.3, 123.6, 120.8, 120.4, 109.2, 49.3, 47.9, 23.9, 11.2.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{18}H_{19}N_2O^+$: 279.1492; found: 279.1490.



2-((5-Bromo-1*H*-indazol-1-yl)methyl)-1-phenylbutan-1-one (3me)

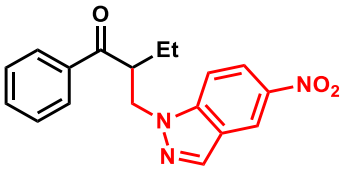
Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 5-bromoindazole (70.9 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **3me**.

Colorless oil; yield: 53.4 mg (50%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.88 (s, 1H), 7.83–7.81 (m, 2H), 7.76–7.75 (m, 1H), 7.52–7.48 (m, 1H), 7.44–7.35 (m, 4H), 4.80 (dd, *J* = 14.0, 8.4 Hz, 1H), 4.45 (dd, *J* = 14.0, 5.6 Hz, 1H), 4.31–4.24 (m 1H), 1.88–1.77 (m, 1H), 1.71–1.60 (m, 1H), 0.92 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 202.3, 138.6, 136.7, 133.3, 132.8, 129.5, 128.6, 128.1, 125.0, 123.2, 113.6, 110.9, 49.5, 47.8, 24.0, 11.3.

HRMS (ESI): m/z $[M+Na]^+$ calcd for $C_{18}H_{17}BrN_2ONa^+$: 379.0416; found: 379.0414.



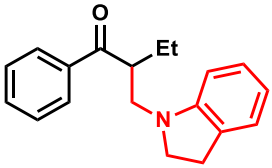
2-((5-Nitro-1*H*-indazol-1-yl)methyl)-1-phenylbutan-1-one (3mf)[1]

Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 5-nitroindazole (58.7 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 10:1) to afford the pure product **3mf**.

Colorless oil; yield: 51.5 mg (53%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.62 (d, *J* = 2.0 Hz, 1H), 8.25 (dd, *J* = 9.6, 2.0 Hz, 1H), 8.15 (s, 1H), 7.82–7.80 (m, 2H), 7.60 (d, *J* = 9.2 Hz, 1H), 7.53–7.48 (m, 1H), 7.40–7.36 (m, 2H), 4.91 (dd, *J* = 13.6, 9.2 Hz, 1H), 4.50 (dd, *J* = 9.8, 5.0 Hz, 1H), 4.35–4.28 (m, 1H), 1.92–1.81 (m, 1H), 1.76–1.65 (m, 1H), 0.97 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.9, 142.3, 141.6, 136.5, 136.3, 133.5, 128.6, 128.1, 122.6, 121.5, 118.7, 109.9, 49.7, 47.7, 24.2, 11.3.



2-(Indolin-1-ylmethyl)-1-phenylbutan-1-one (3mg)

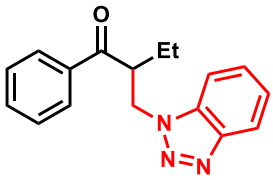
Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and indoline (42.9 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 20:1) to afford the pure product **3mg**.

Colorless oil; yield: 38.6 mg (46%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.96 (d, *J* = 8.0 Hz, 2H), 7.58–7.54 (m, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.12–7.00 (m, 2H), 6.64 (t, *J* = 7.2 Hz, 1H), 6.54 (d, *J* = 8.0 Hz, 1H), 3.85–3.75 (m, 1H), 3.54 (dd, *J* = 13.4, 8.6 Hz, 1H), 3.37–3.21 (m, 3H), 2.86 (t, *J* = 8.2 Hz, 2H), 1.92–1.79 (m, 1H), 1.75–1.64 (m, 1H), 0.96 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 203.6, 152.4, 137.7, 133.0, 129.5, 128.6, 128.2, 127.3, 124.3, 117.3, 106.4, 54.3, 52.0, 46.9, 28.6, 24.2, 11.8.

HRMS (ESI): m/z $[M+H]^+$ calcd for $C_{19}H_{22}NO^+$: 280.1696; found: 280.1693.



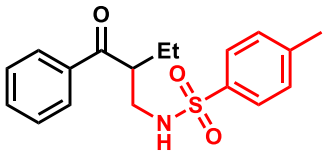
2-((1*H*-Benzo[*d*][1,2,3]triazol-1-yl)methyl)-1-phenylbutan-1-one (3mh)[3]

Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and 1*H*-benzotriazole (42.9 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 5:1) to afford the pure product **3mh**.

Colorless oil; yield: 43.5 mg (52%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.98 (d, *J* = 8.0 Hz, 1H), 7.84 (d, *J* = 7.2 Hz, 2H), 7.62 (d, *J* = 8.4 Hz, 1H), 7.54–7.45 (m, 2H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.32 (t, *J* = 7.6 Hz, 1H), 5.04 (dd, *J* = 13.6, 8.4 Hz, 1H), 4.77 (dd, *J* = 13.6, 5.6 Hz, 1H), 4.41–4.35 (m, 1H), 1.92–1.83 (m, 1H), 1.77–1.71 (m, 1H), 0.98 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 201.5, 145.6, 136.4, 133.5, 133.4, 128.7, 128.2, 127.4, 123.8, 119.8, 109.8, 48.2, 47.9, 24.2, 11.1.



***N*-(2-Benzoylbutyl)-4-methylbenzenesulfonamide (3mi)**

Prepared according to the general procedure from 1-phenylbutan-1-one **1m** (44.5 mg, 0.3 mmol) and *p*-tosylamide (61.6 mg, 0.36 mmol, 1.2 equiv). Purified by column chromatography on silica gel (PE:EtOAc = 30:1) to afford the pure product **3mi**.

Colorless oil; yield: 54.9 mg (55%).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.82 (d, *J* = 8.0 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.57–7.53 (m, 1H), 7.44–7.40 (m, 2H), 7.26–7.22 (m, 2H), 5.14 (t, *J* = 6.6 Hz, 1H), 3.60–3.54 (m, 1H), 3.32–3.26 (m, 1H), 3.20–3.13 (m, 1H), 2.38 (s, 3H), 1.75–1.65 (m, 1H), 1.60–1.49 (m, 1H), 0.86 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (150 MHz, $CDCl_3$): δ = 203.0, 143.2, 137.1, 136.1, 133.4, 129.7, 128.6, 128.2, 126.9, 47.5, 43.0, 23.5, 21.4, 11.2.

HRMS (ESI): m/z $[M+Na]^+$ calcd for $C_{18}H_{21}NO_3SNa^+$: 354.1134; found: 354.1133.

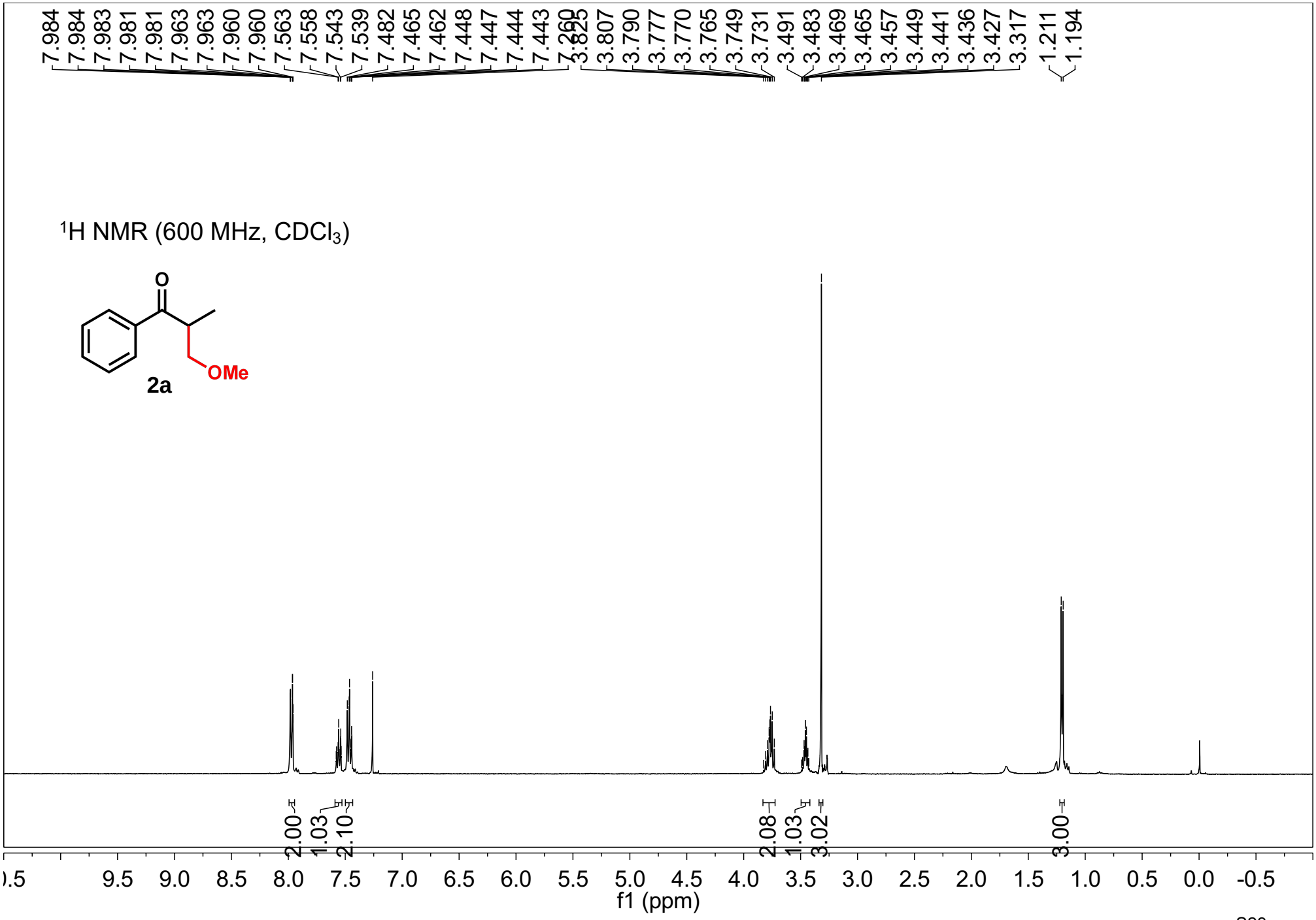
5. References

[1] J. Yang, S. Chen, H. Zhou, C. Wu, B. Ma, J. Xiao, *Org. Lett.* **2018**, *20*, 6774–6779.

[2] H.-P. Lin, N. Ibrahim, O. Provot, M. Alami, A. Hamaze, *RSC Adv.* **2018**, *8*, 11536–11542.

[3] N. Fu, L. Zhang, S. Luo, J.-P. Cheng, *Org. Chem. Front.* **2014**, *1,* 68–72.

6. Cope of NMR Spectra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7.981
7.963
7.963
7.960
7.960
7.563
7.558
7.543
7.539
7.482
7.465
7.462
7.448
7.447
7.444
7.443
7.260
3.825
3.807
3.790
3.777
3.770
3.765
3.749
3.731
3.491
3.483
3.469
3.465
3.457
3.449
3.441
3.436
3.427
3.317
1.211
1.194
1H NMR (600 MHz, CDCl3)
O
OMe
2a
2.00
1.03
2.10
2.08
1.03
3.02
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
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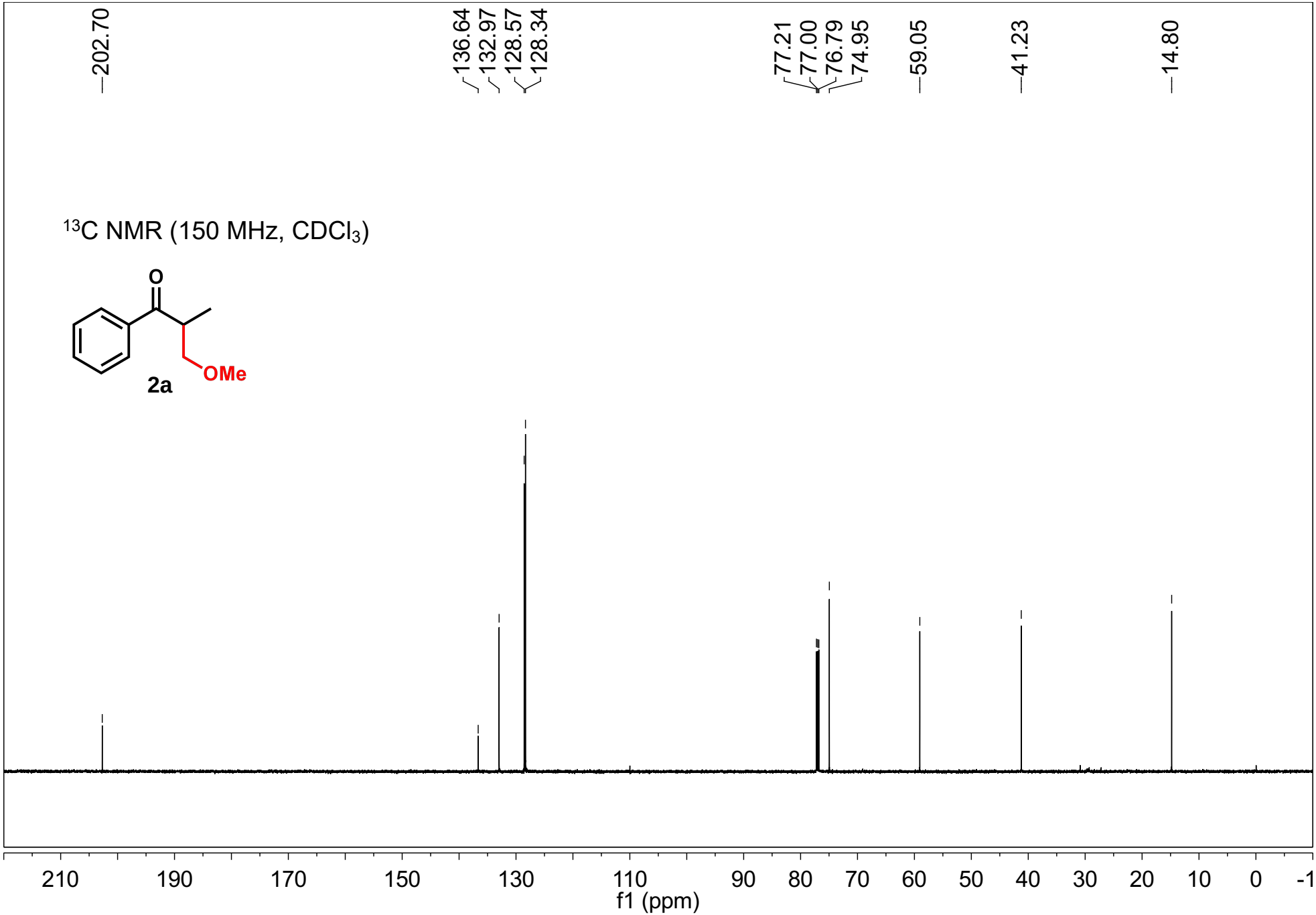
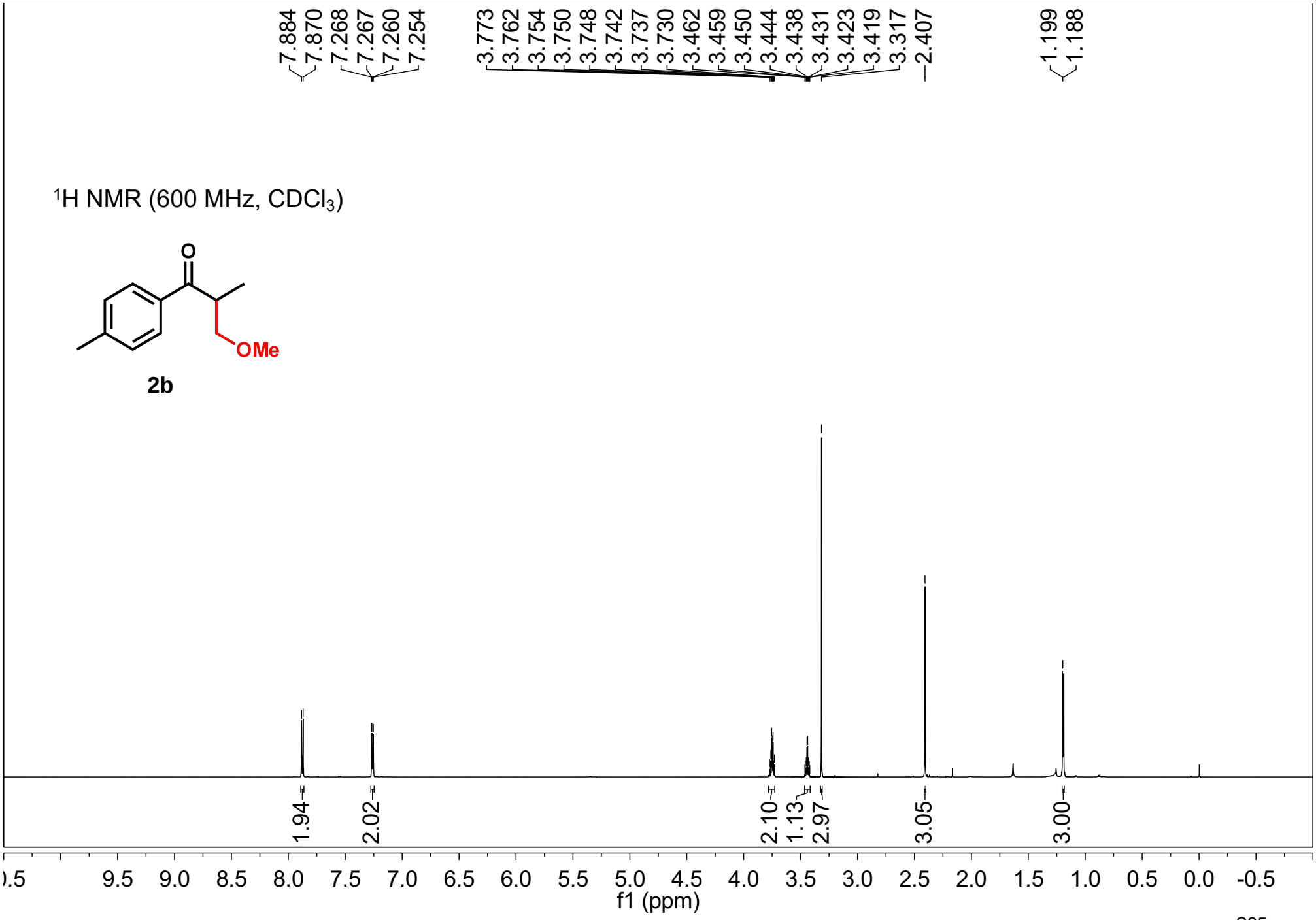
0.5
0.0
-0.5
f1 (ppm)


202.70
136.64
132.97
128.57
128.34
77.21
77.00
76.79
74.95
59.05
41.23
14.80
13C NMR (150 MHz, CDCl3)
O
OMe
2a
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)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7.870
7.268
7.267
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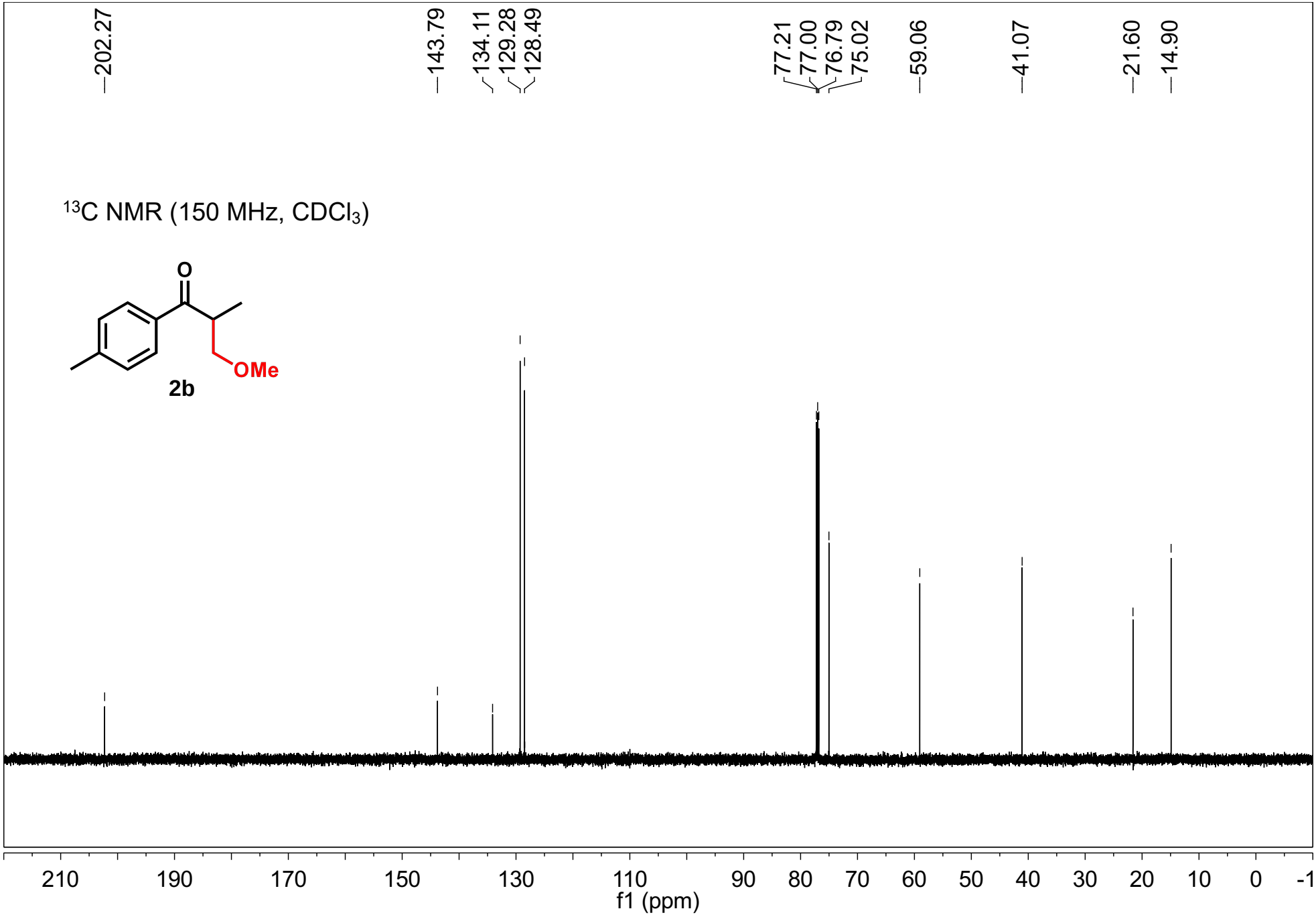
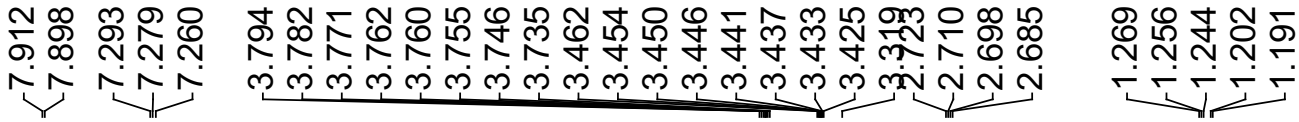
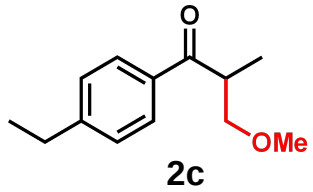
7.254
3.773
3.762
3.754
3.750
3.748
3.742
3.737
3.730
3.462
3.459
3.450
3.444
3.438
3.431
3.423
3.419
3.317
2.407
1.199
1.188
1H NMR (600 MHz, CDCl3)
O
OMe
2b
1.94
2.02
2.10
1.13
2.97
3.05
3.00
f1 (ppm)

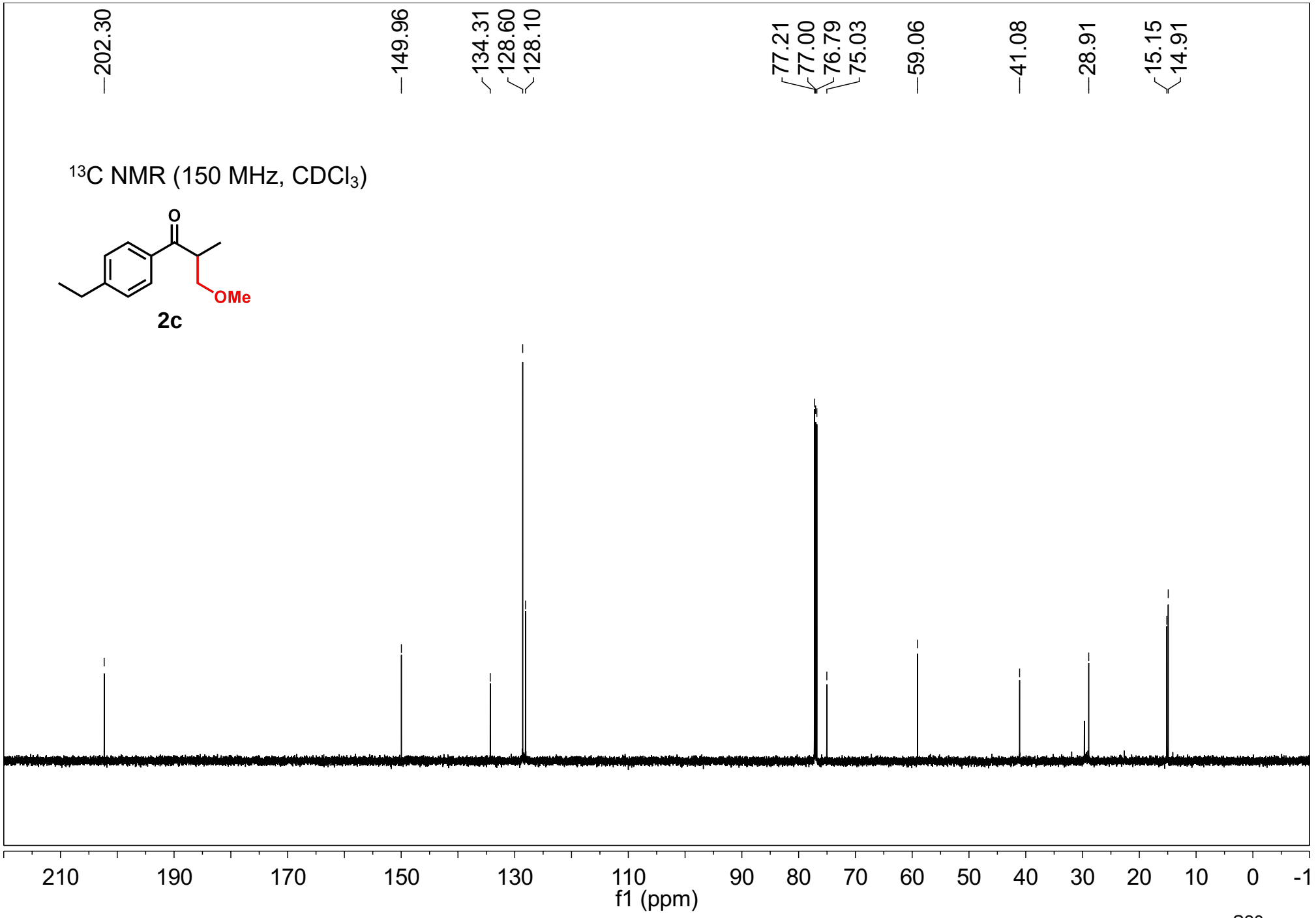

202.27
143.79
134.11
129.28
128.49
77.21
77.00
76.79
75.02
59.06
41.07
21.60
14.90
13C NMR (150 MHz, CDCl3)
O
OMe
2b
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

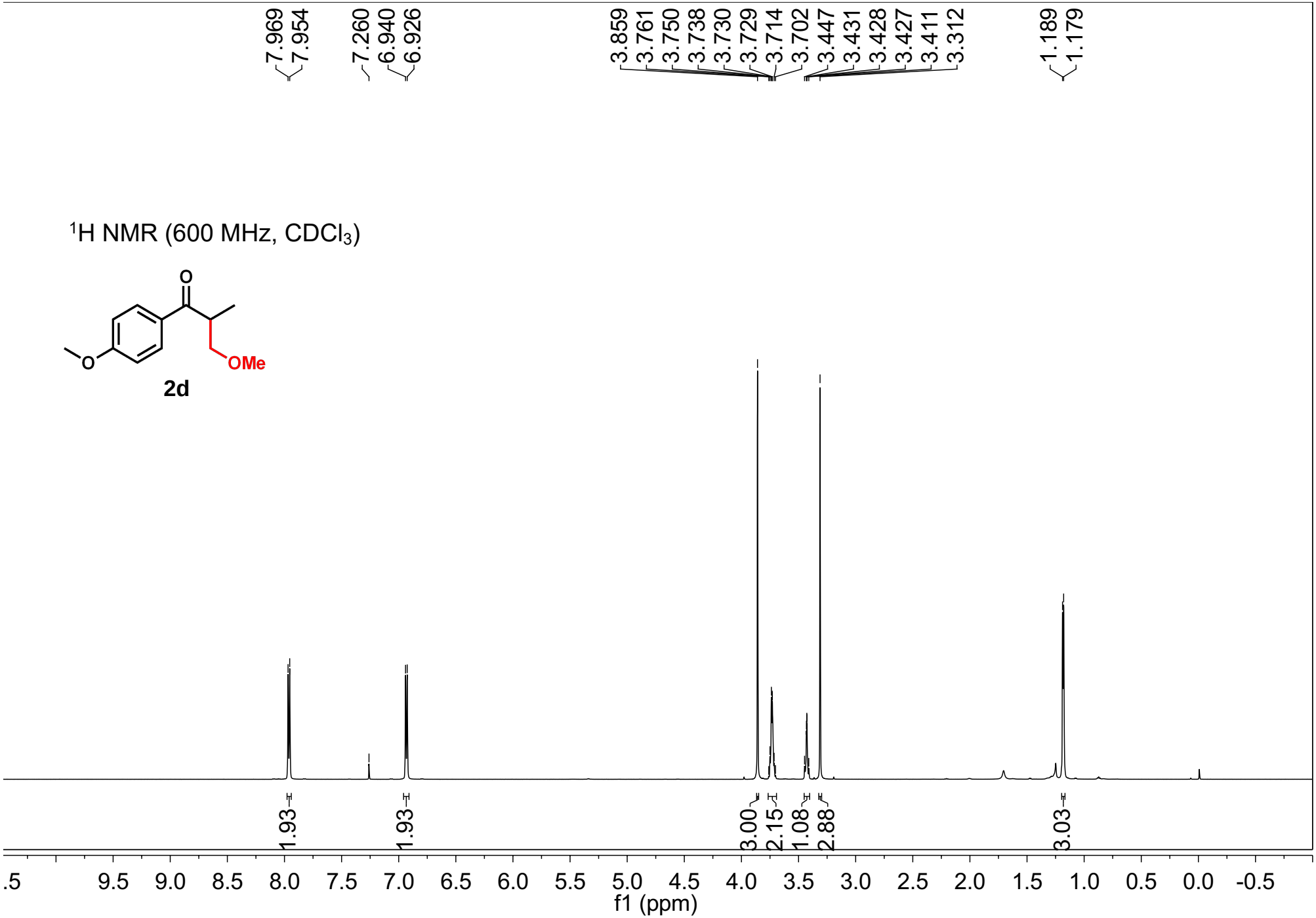


^{1}H NMR (600 MHz, $CDCl_3$)



2c


202.30
149.96
134.31
128.60
128.10
77.21
77.00
76.79
75.03
59.06
41.08
28.91
15.15
14.91
13C NMR (150 MHz, CDCl3)
O
OMe
2c
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)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7.260
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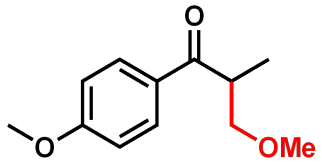
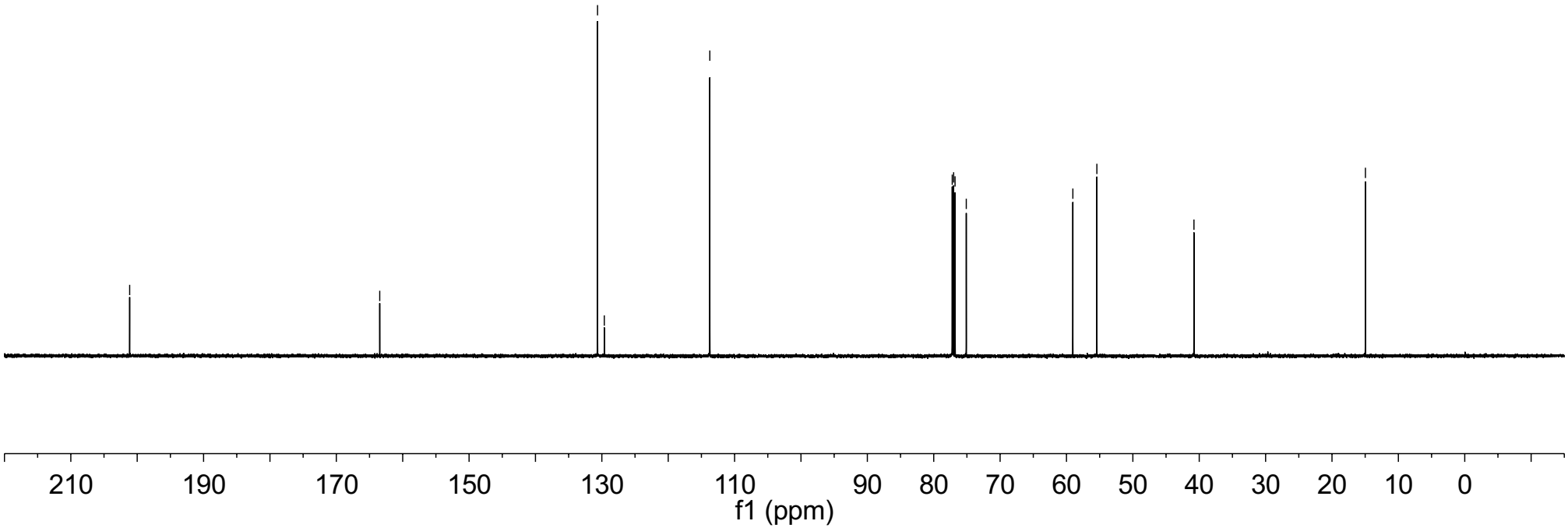
3.738
3.730
3.729
3.714
3.702
3.447
3.431
3.428
3.427
3.411
3.312
1.189
1.179
1H NMR (600 MHz, CDCl3)
O
O
OMe
2d
1.93
1.93
3.00
2.15
1.08
2.88
3.03
f1 (ppm)

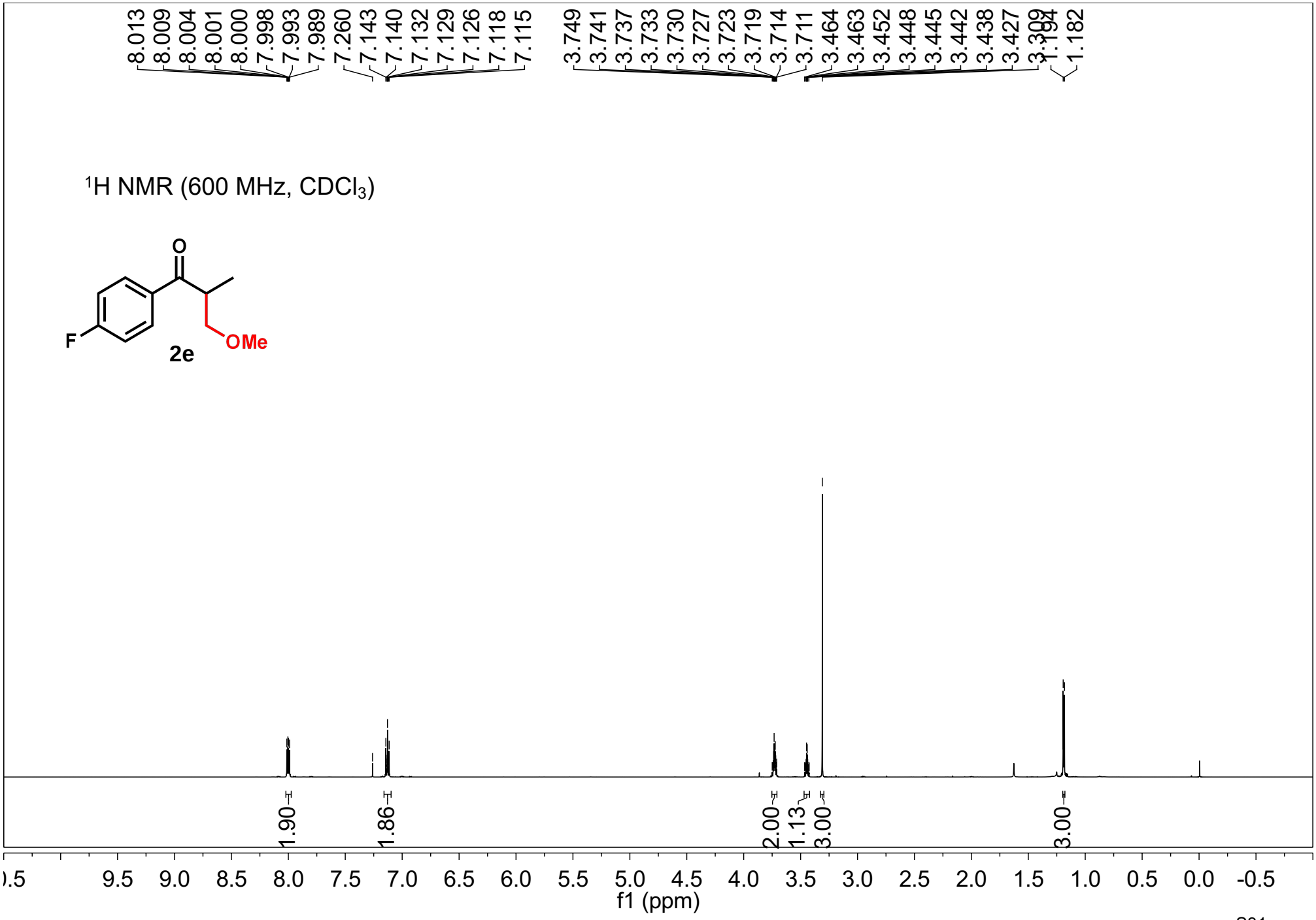
201.13
163.46
130.65
129.63
113.73
77.21
77.00
76.79
75.10
59.04
55.42
40.80
14.96

^{13}C NMR (150 MHz, $CDCl_3$)



2d

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8.009
8.004
8.001
8.000
7.998
7.993
7.989
7.260
7.143
7.140
7.132
7.129
7.126
7.118
7.115
3.749
3.741
3.737
3.733
3.730
3.727
3.723
3.719
3.714
3.711
3.464
3.463
3.452
3.448
3.445
3.442
3.438
3.427
3.309
1.194
1.182
1H NMR (600 MHz, CDCl3)
O
F
OMe
2e
1.90
1.86
2.00
1.13
3.00
3.00
f1 (ppm)

201.177
166.561
164.874
133.147
133.128
131.044
130.983
115.721
115.577
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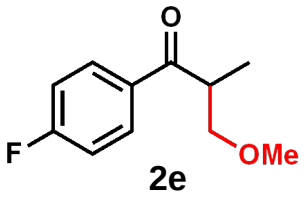
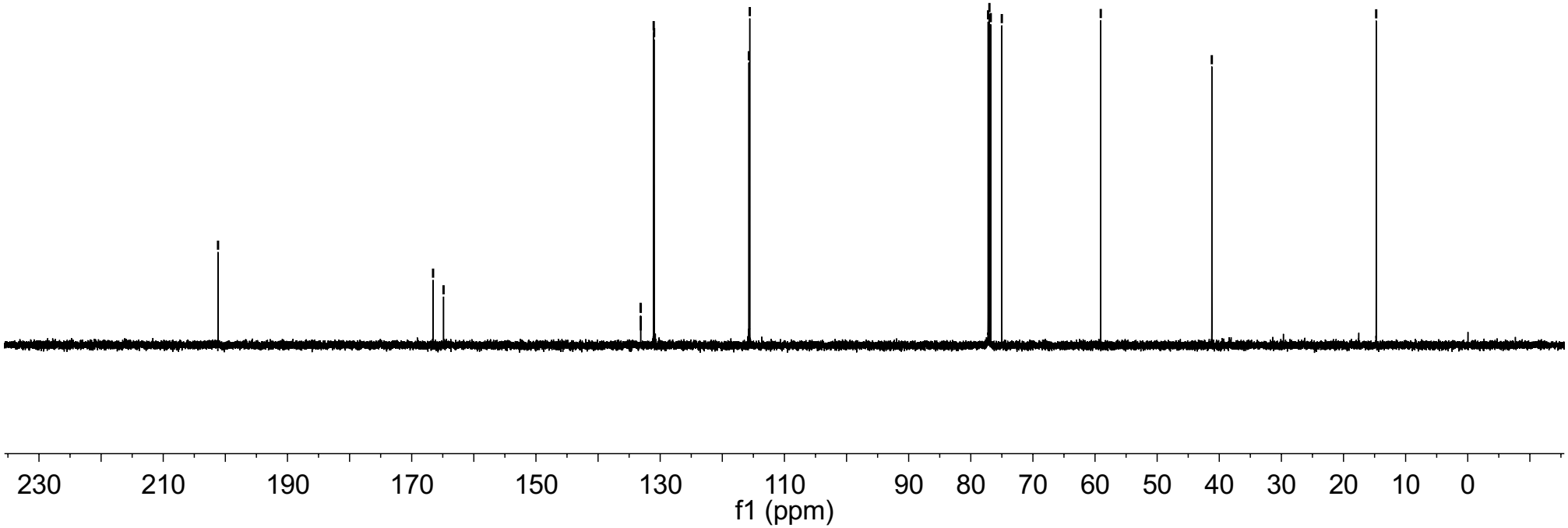
77.000
76.789
75.005
59.076
41.202
14.739

^{13}C NMR (150 MHz, $CDCl_3$)

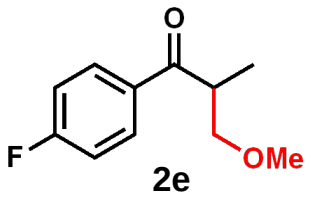


2e

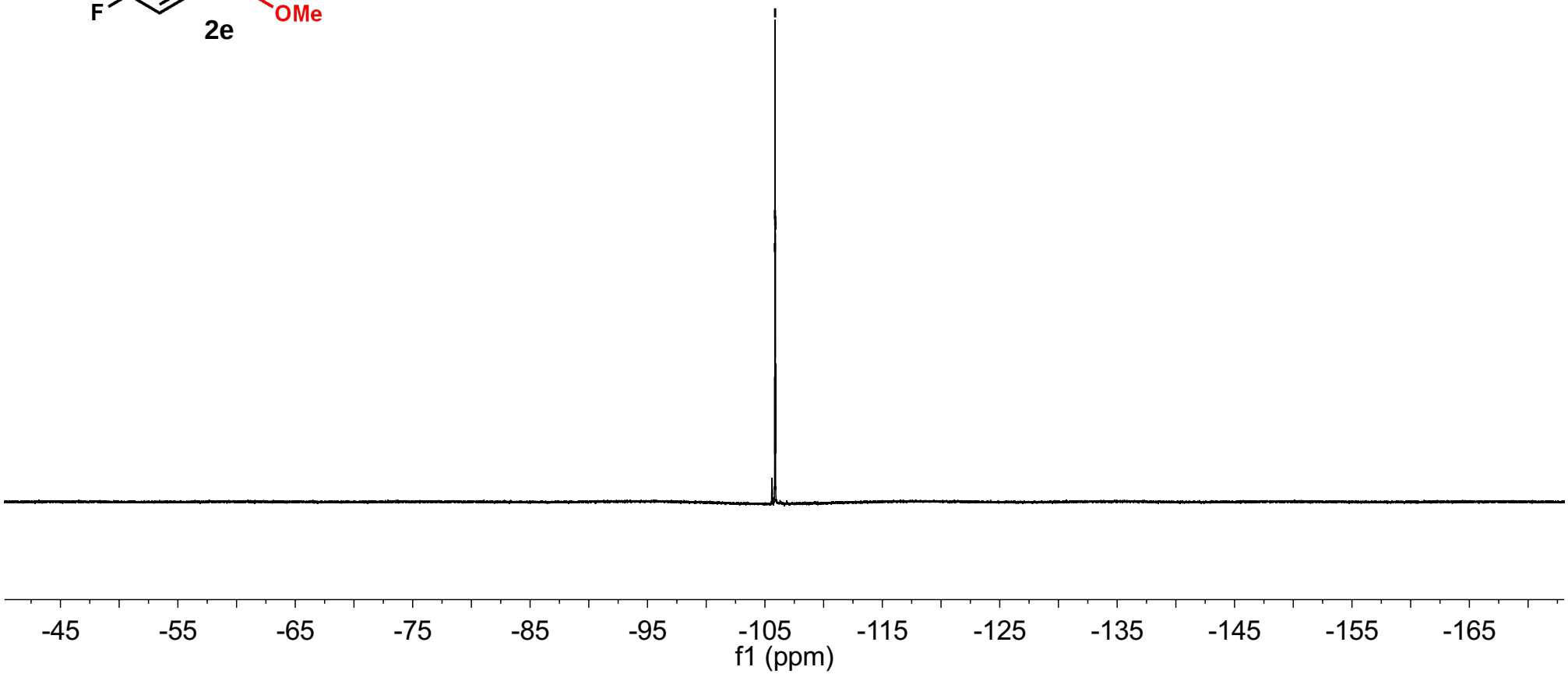


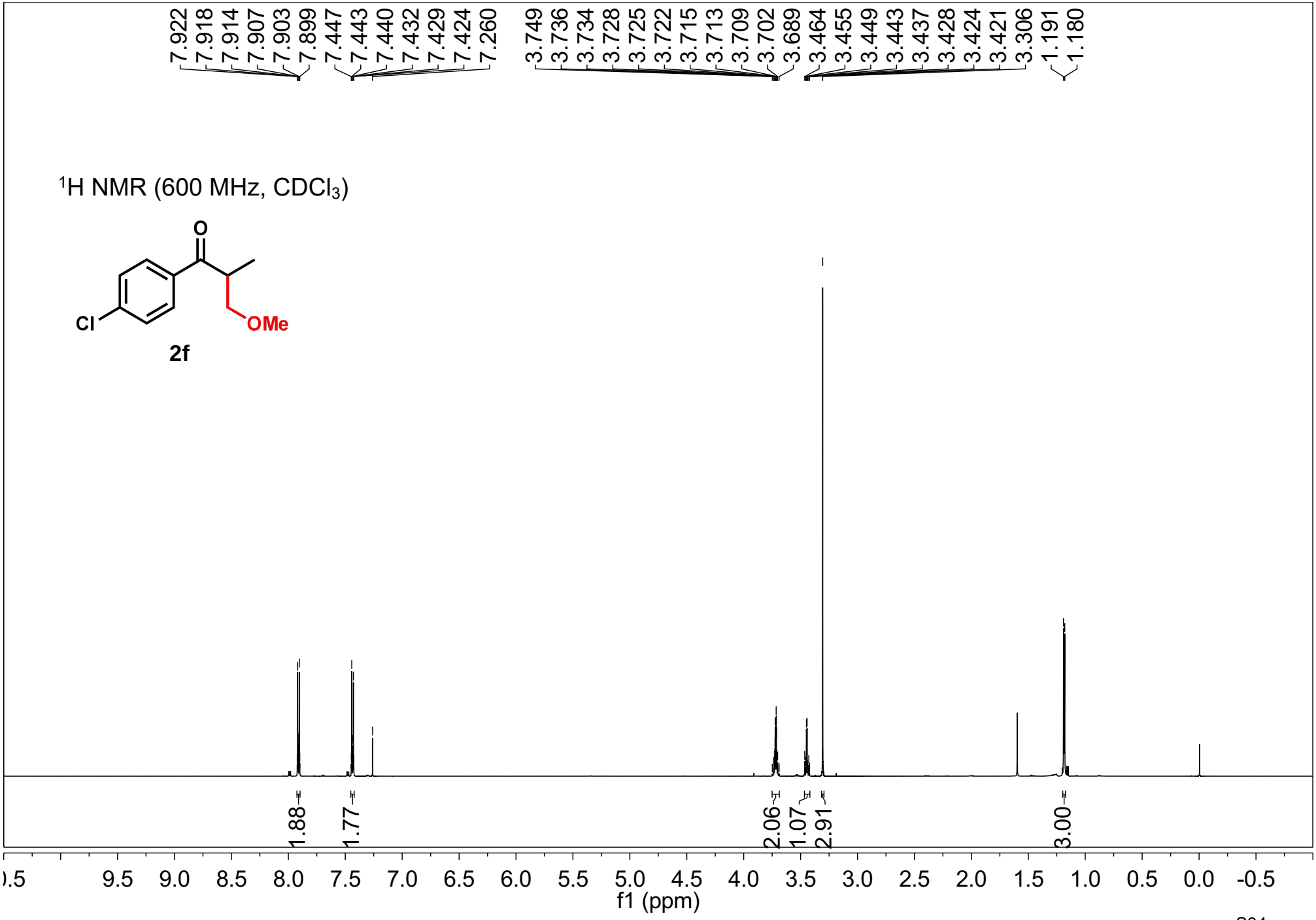
-105.85
-105.85
-105.87
-105.88
-105.89

^{19}F NMR (376 MHz, $CDCl_3$)



2e

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7.903
7.899
7.447
7.443
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7.432
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3.736
3.734
3.728
3.725
3.722
3.715
3.713
3.709
3.702
3.689
3.464
3.455
3.449
3.443
3.437
3.428
3.424
3.421
3.306
1.191
1.180
1H NMR (600 MHz, CDCl3)
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Cl
OMe
2f
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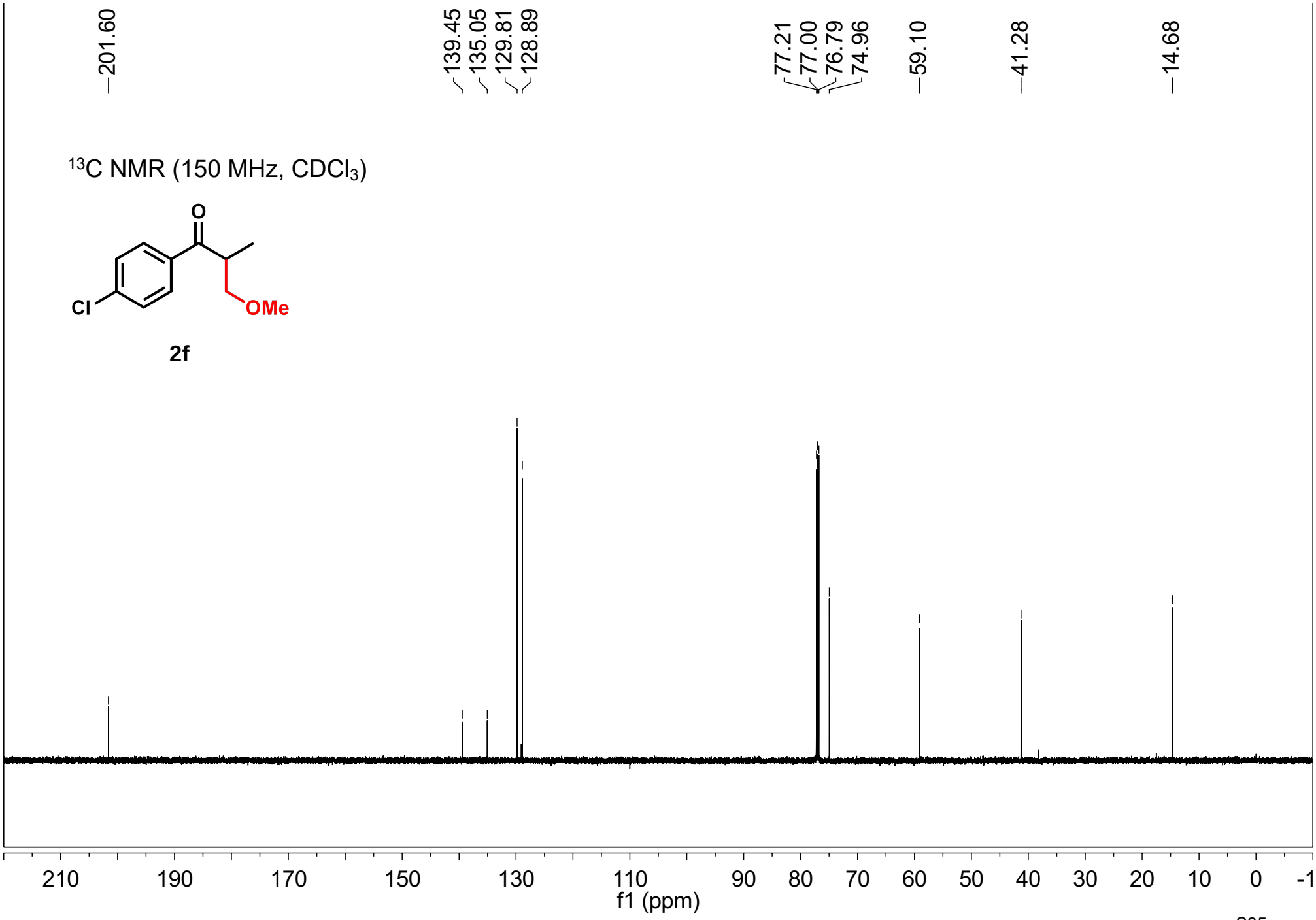
2.06
1.07
2.91
3.00
f1 (ppm)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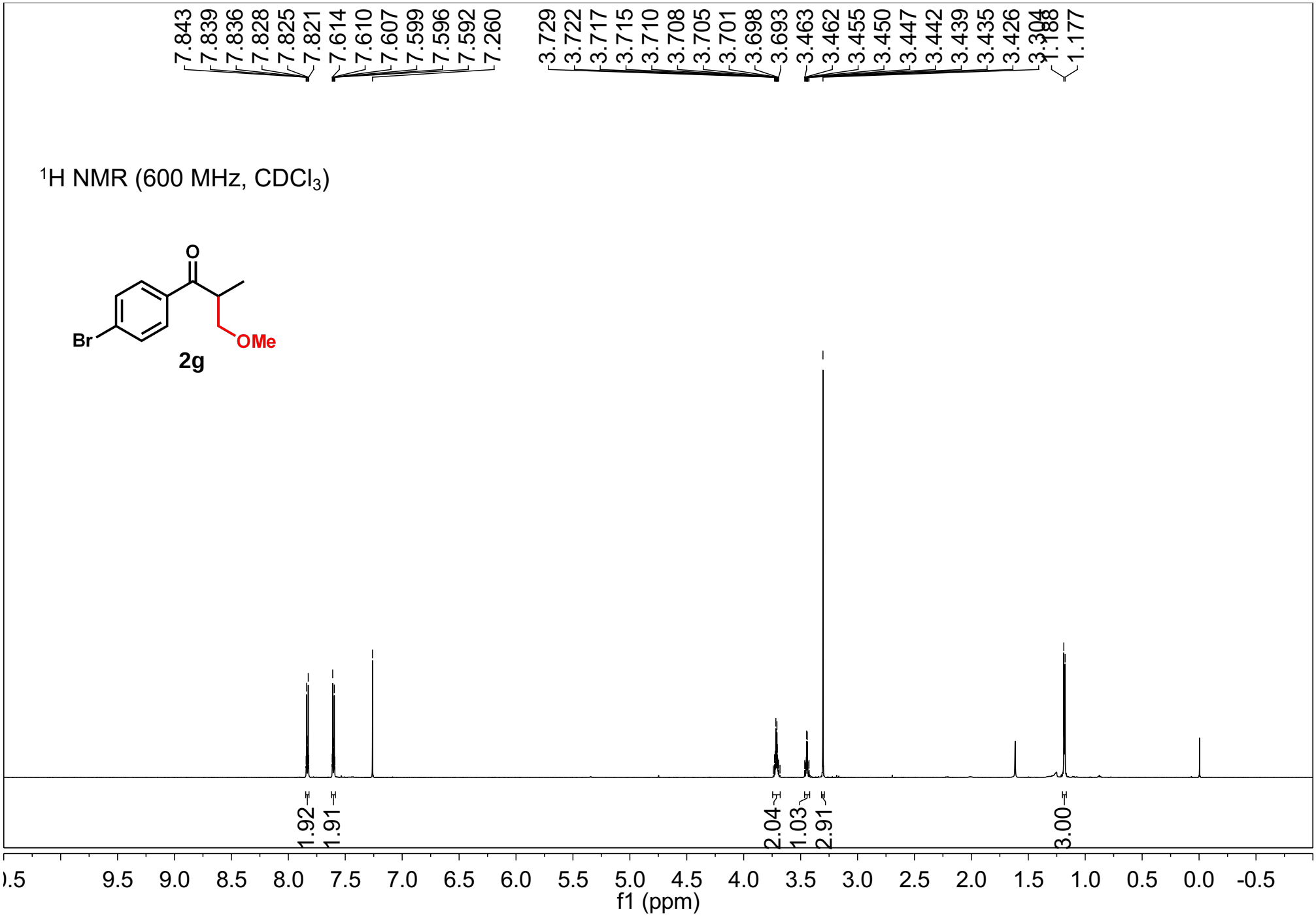
128.89
77.21
77.00
76.79
74.96
59.10
41.28
14.68
13C NMR (150 MHz, CDCl3)
O
Cl
OMe
2f
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)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7.596
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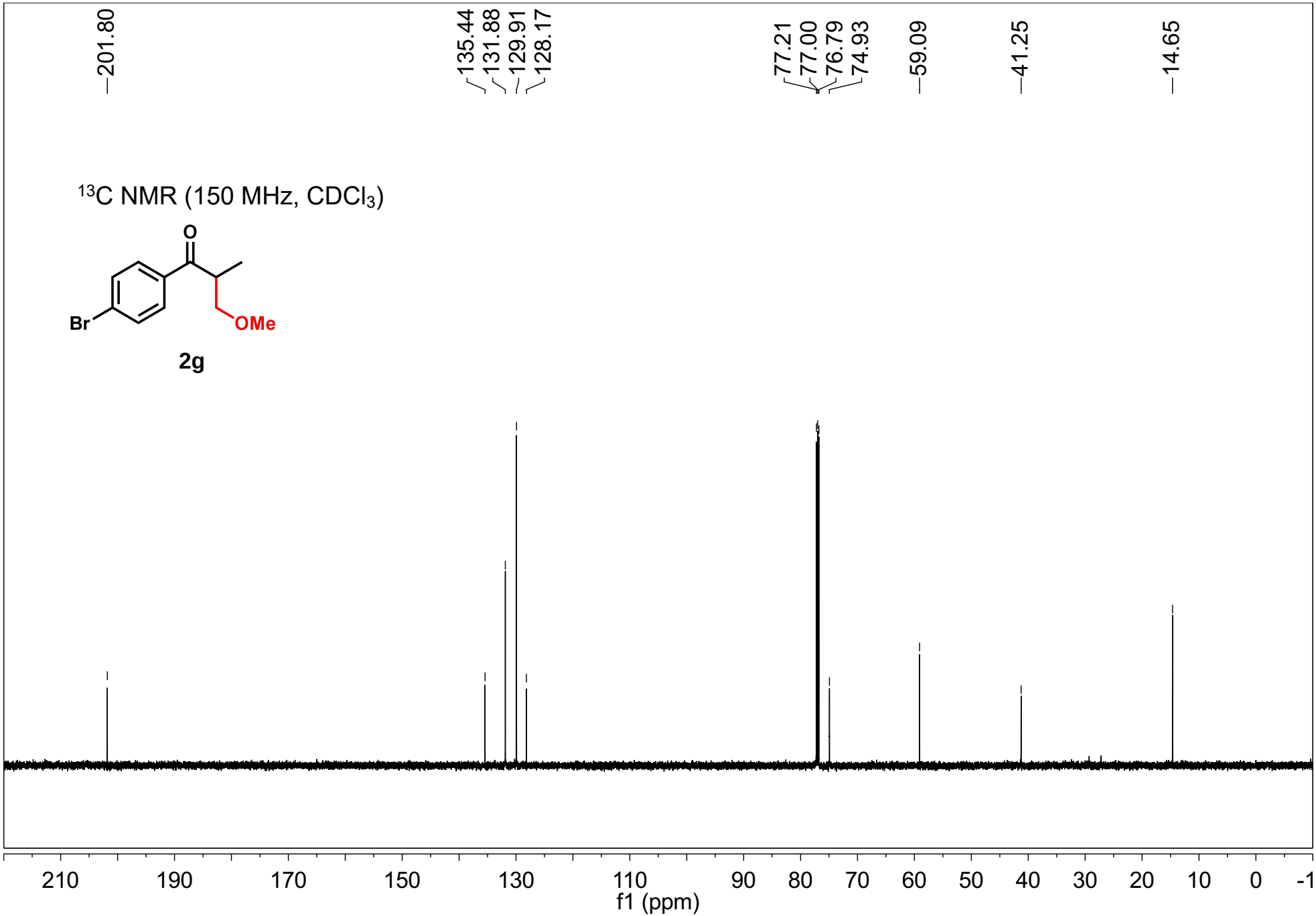
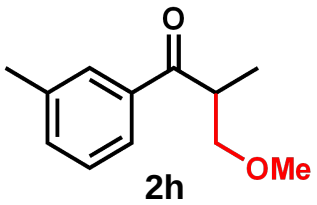
3.722
3.717
3.715
3.710
3.708
3.705
3.701
3.698
3.693
3.463
3.462
3.455
3.450
3.447
3.442
3.439
3.435
3.426
3.304
1.188
1.177
1H NMR (600 MHz, CDCl3)
O
Br
OMe
2g
1.92
1.91
2.04
1.03
2.91
3.00
f1 (ppm)

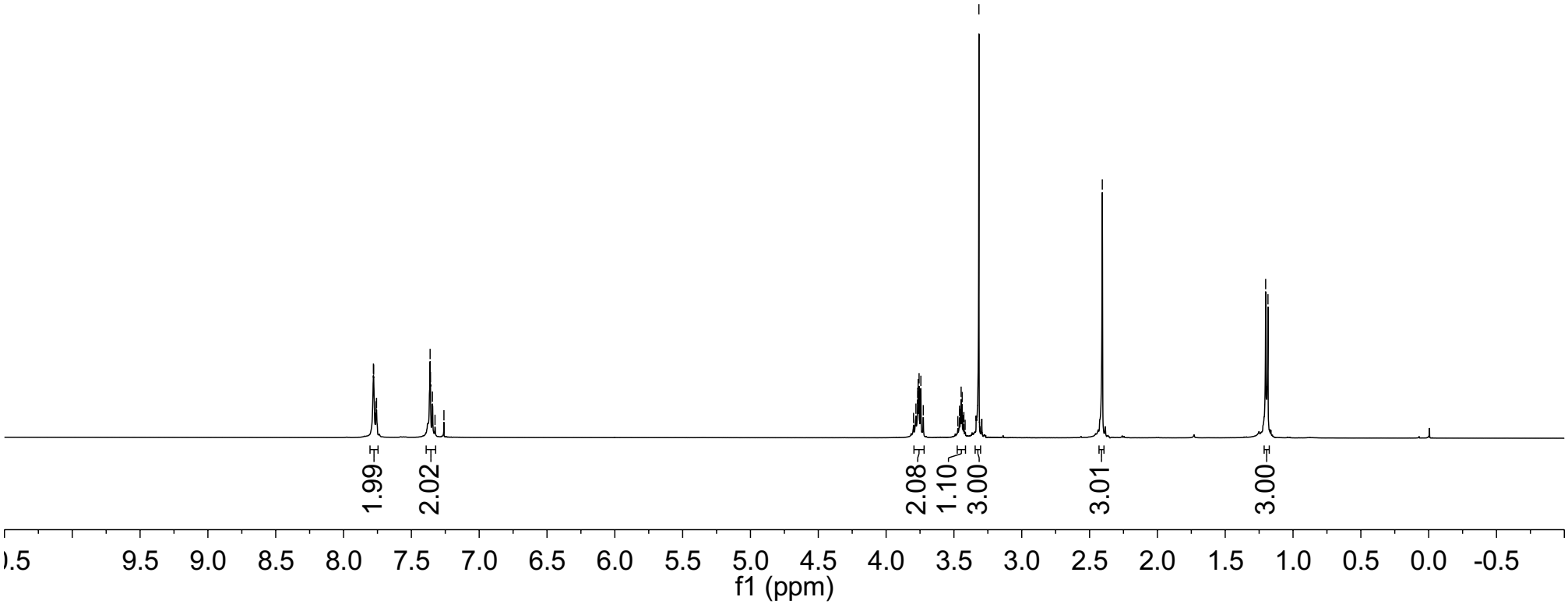

201.80
135.44
131.88
129.91
128.17
77.21
77.00
76.79
74.93
59.09
41.25
14.65
13C NMR (150 MHz, CDCl3)
O
Br
OMe
2g
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

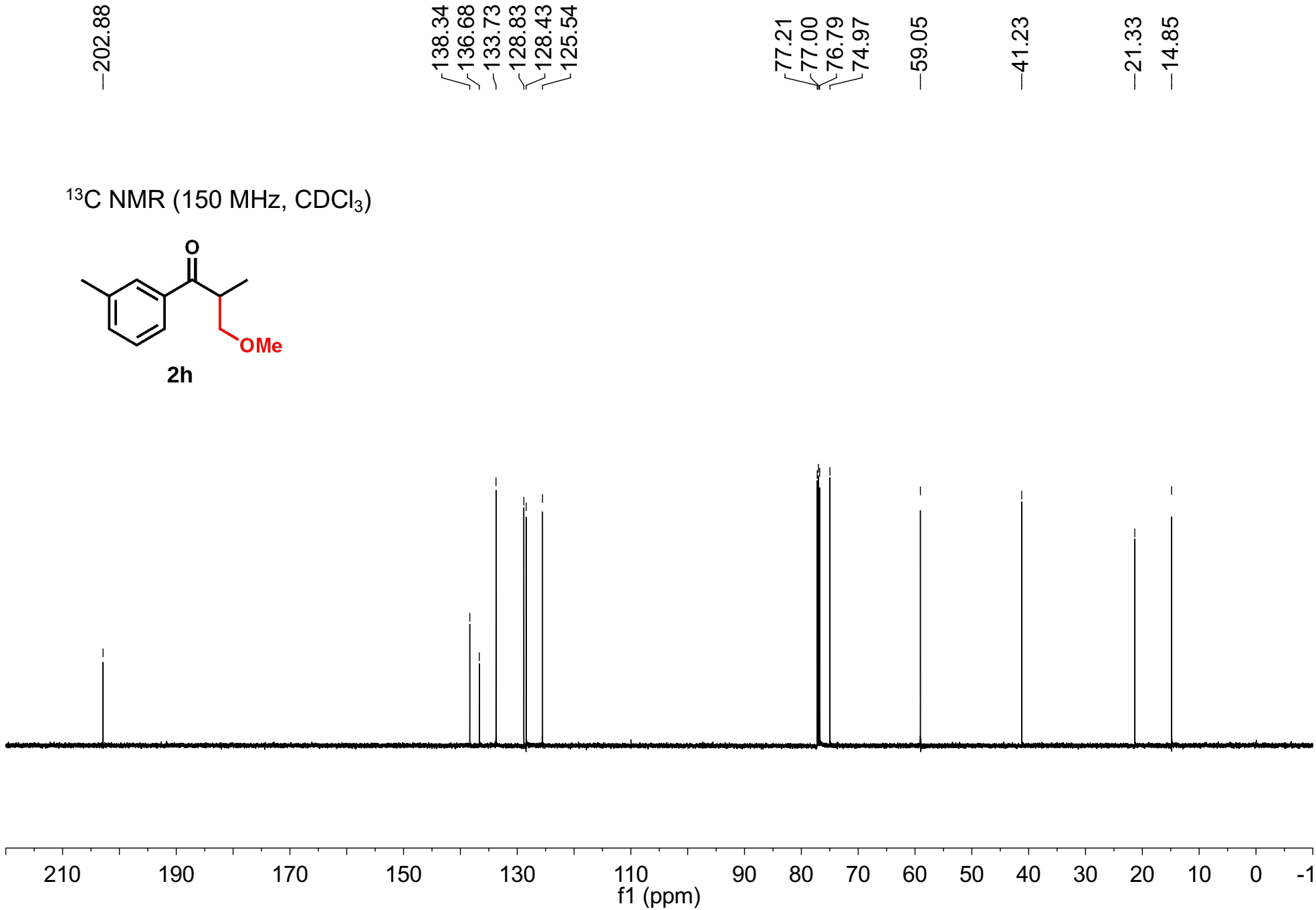
7.780
7.778
7.767
7.761
7.757
7.362
7.359
7.345
7.326
7.260
3.798
3.780
3.767
3.764
3.757
3.744
3.726
3.471
3.459
3.453
3.447
3.439
3.434
3.427
3.418
3.316
2.406
1.202
1.185

^{1}H NMR (400 MHz, $CDCl_3$)



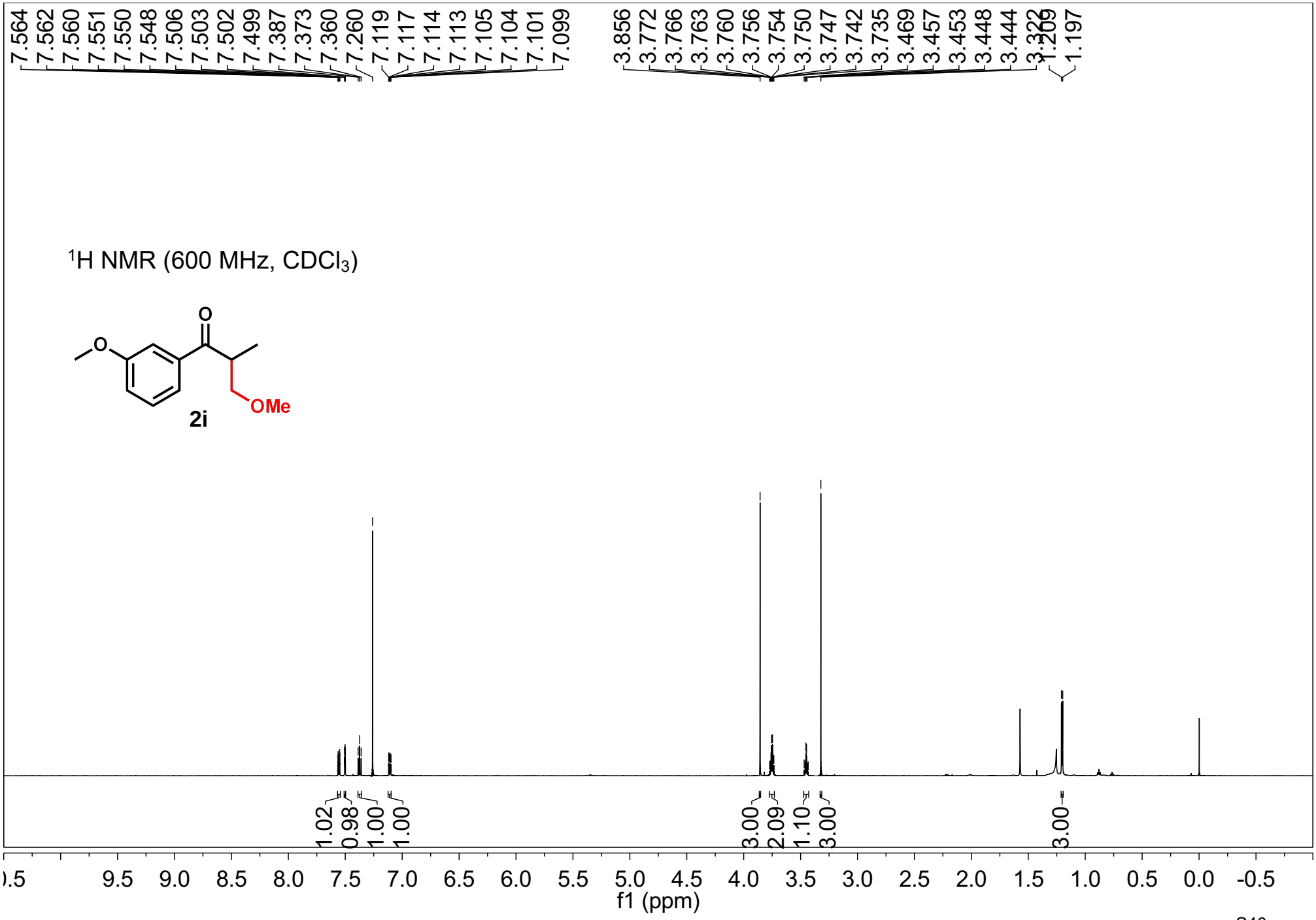
2h

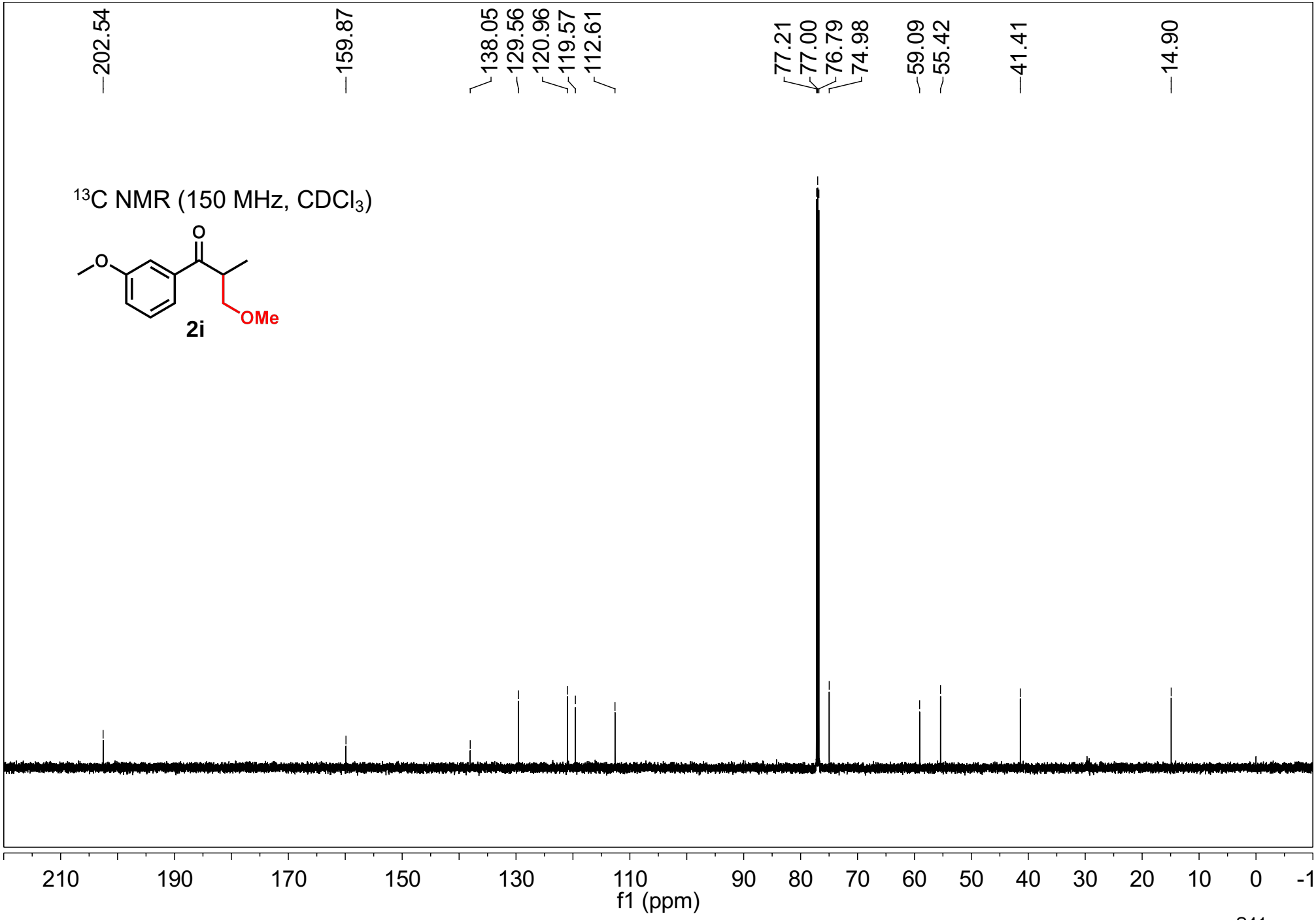


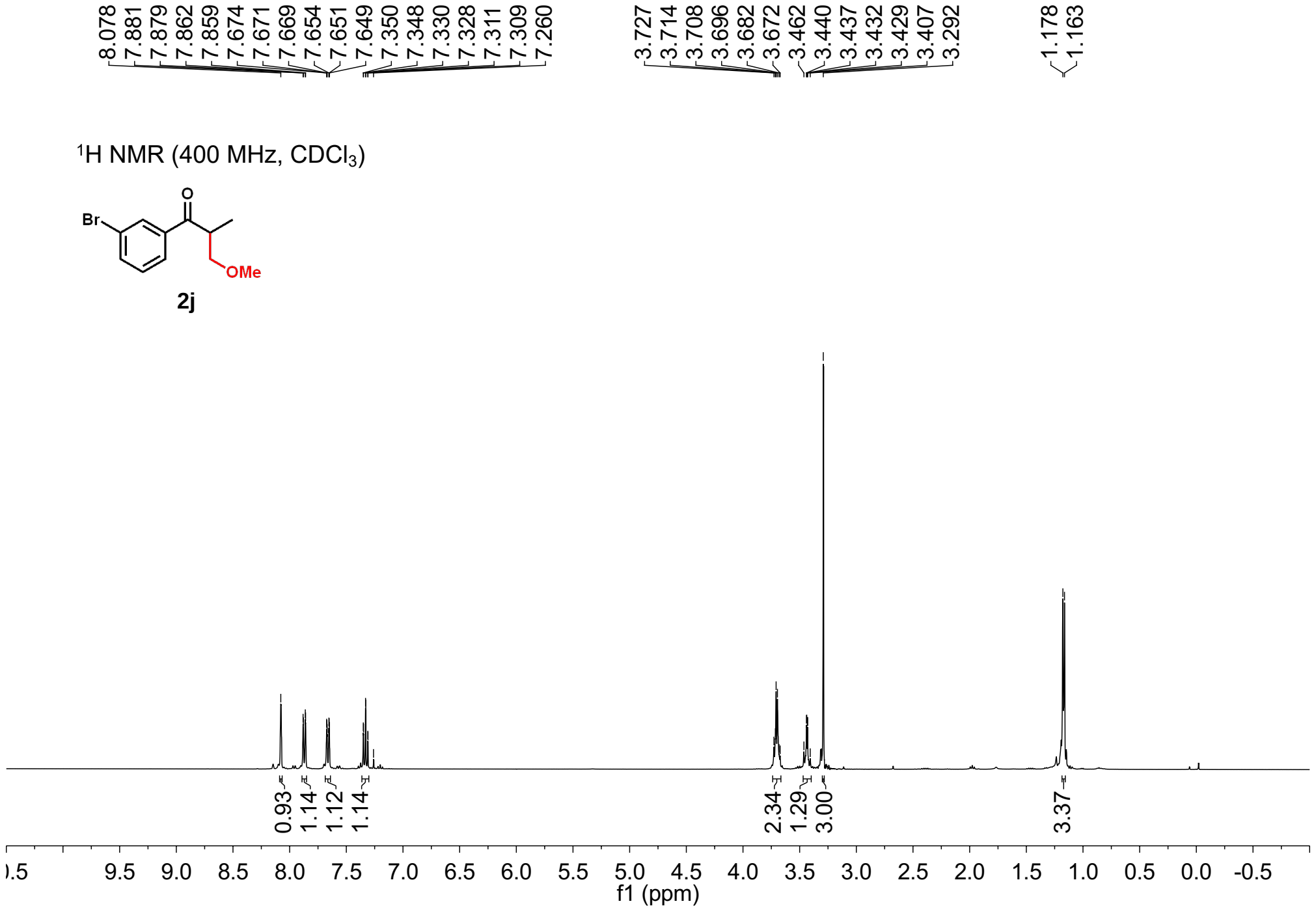


^{13}C NMR (150 MHz, $CDCl_3$)

2h

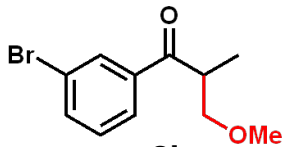

7.564
7.562
7.560
7.551
7.550
7.548
7.506
7.503
7.502
7.499
7.387
7.373
7.360
7.260
7.119
7.117
7.114
7.113
7.105
7.104
7.101
7.099
3.856
3.772
3.766
3.763
3.760
3.756
3.754
3.750
3.747
3.742
3.735
3.469
3.457
3.453
3.448
3.444
3.322
1.209
1.197
1H NMR (600 MHz, CDCl3)
O
O
OMe
2i
1.02
0.98
1.00
1.00
3.00
2.09
1.10
3.00
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


202.54
159.87
138.05
129.56
120.96
119.57
112.61
77.21
77.00
76.79
74.98
59.09
55.42
41.41
14.90
13C NMR (150 MHz, CDCl3)
O
O
OMe
2i
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

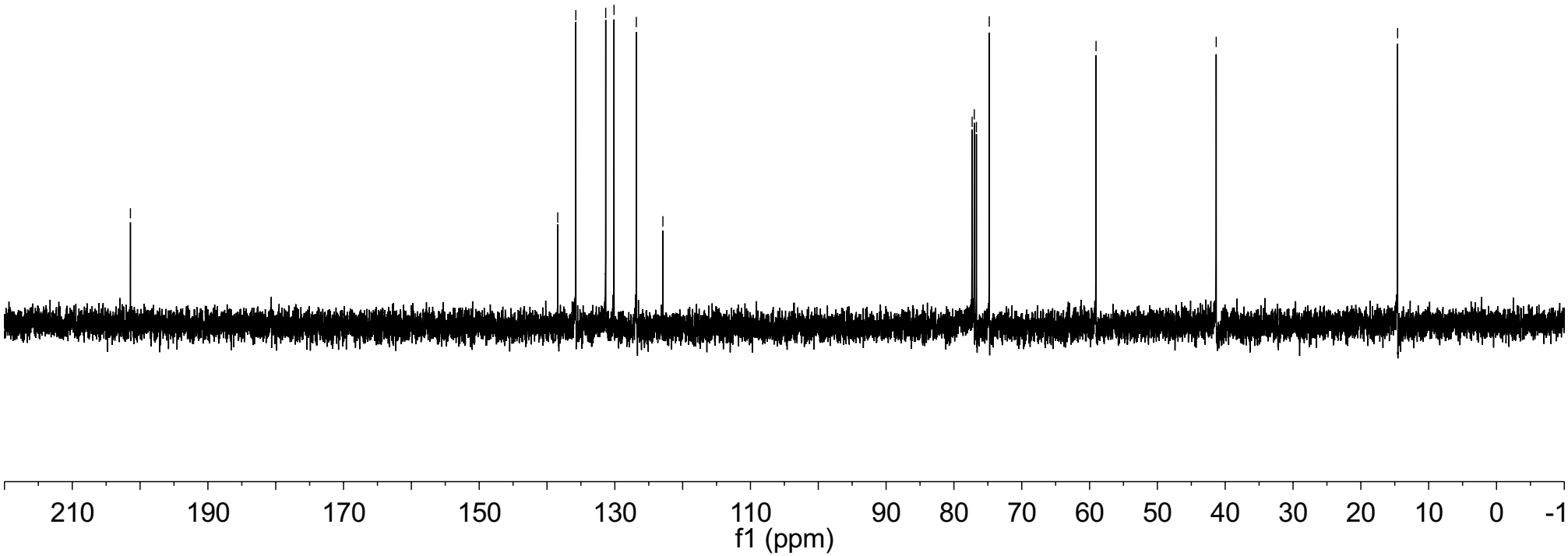

8.078
7.881
7.879
7.862
7.859
7.674
7.671
7.669
7.654
7.651
7.649
7.350
7.348
7.330
7.328
7.311
7.309
7.260
3.727
3.714
3.708
3.696
3.682
3.672
3.462
3.440
3.437
3.432
3.429
3.407
3.292
1.178
1.163
1H NMR (400 MHz, CDCl3)
Br
O
OMe
2j
0.93
1.14
1.12
1.14
2.34
1.29
3.00
3.37
f1 (ppm)

201.42
138.42
135.75
131.34
130.12
126.83
122.91
77.32
77.00
76.68
74.79
59.04
41.33
14.58

^{13}C NMR (100 MHz, $CDCl_3$)



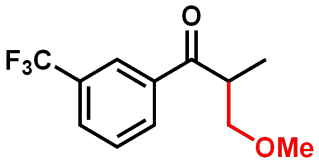
2j



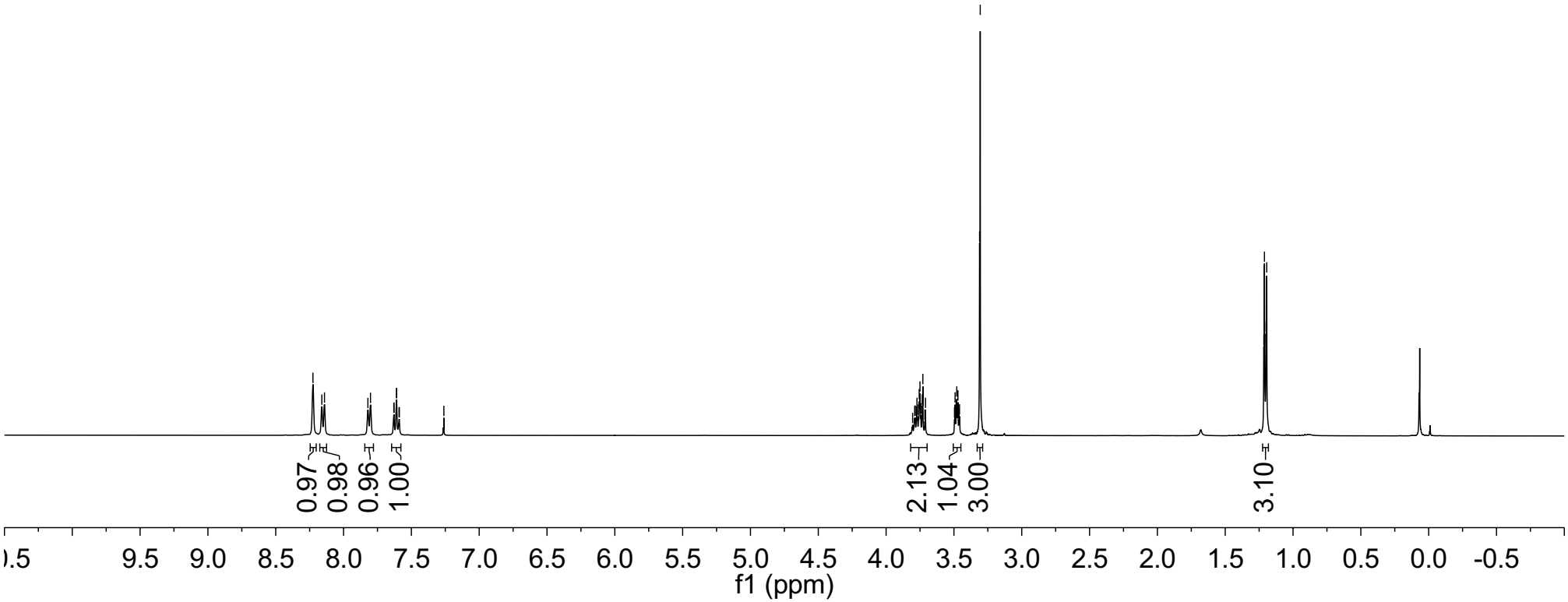
8.226 8.160 8.141 7.820 7.801 7.629 7.628 7.610 7.609 7.590 7.589 7.260

3.789 3.785 3.776 3.772 3.768 3.756 3.750 3.744 3.733 3.729 3.710 3.496 3.491 3.484 3.479 3.475 3.471 3.459 3.311 3.306 1.215 1.211 1.198 1.194

^{1}H NMR (400 MHz, $CDCl_3$)

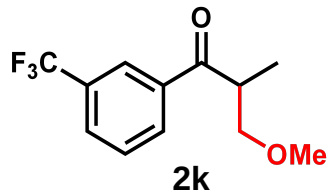


2k

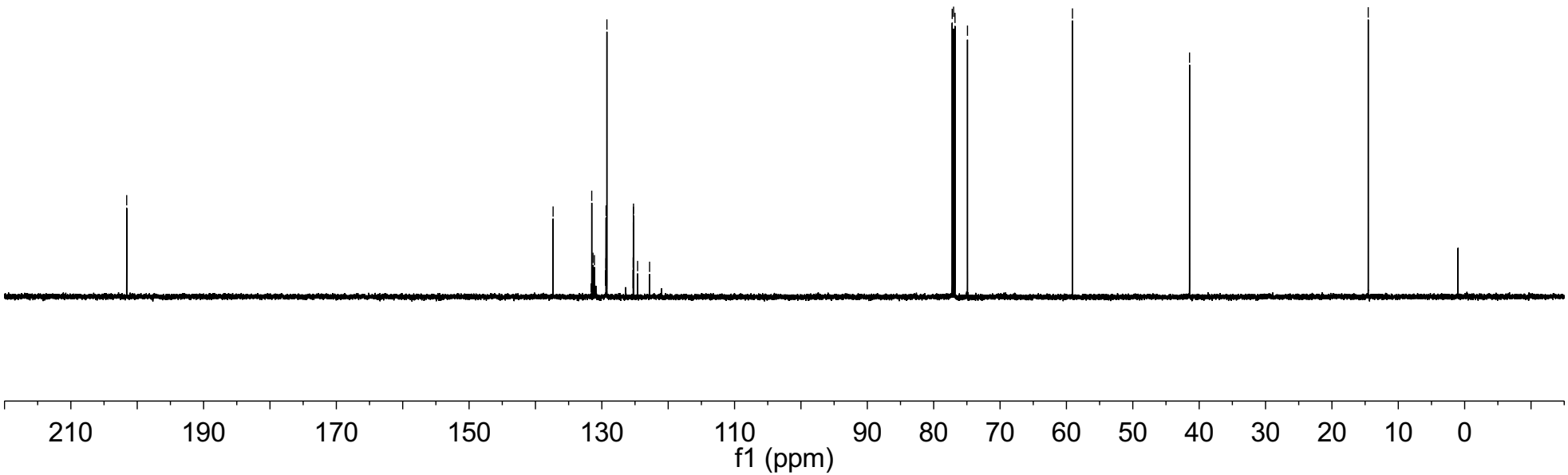


201.586
137.342
131.519
131.333
131.116
129.384
129.360
129.337
129.312
129.234
125.277
125.252
125.226
125.201
124.609
122.802
77.211
77.000
76.788
74.909
59.089
41.452
14.531

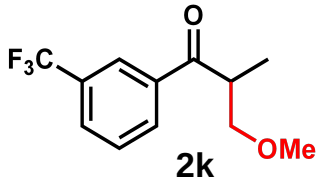
^{13}C NMR (150 MHz, $CDCl_3$)



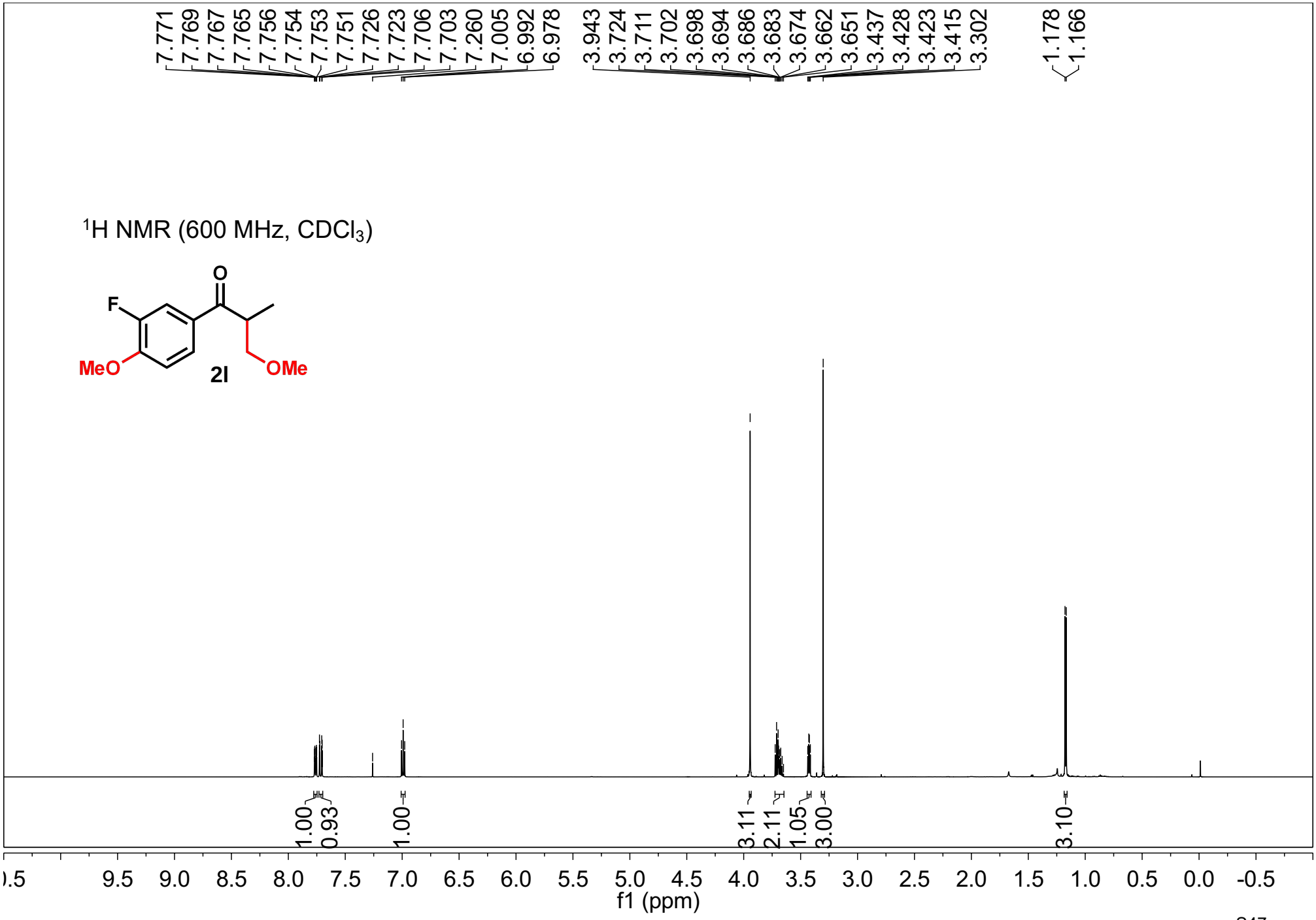
2k



^{19}F NMR (376 MHz, $CDCl_3$)

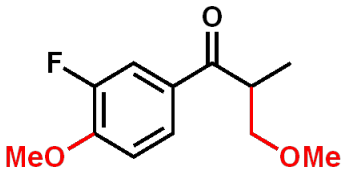


2k

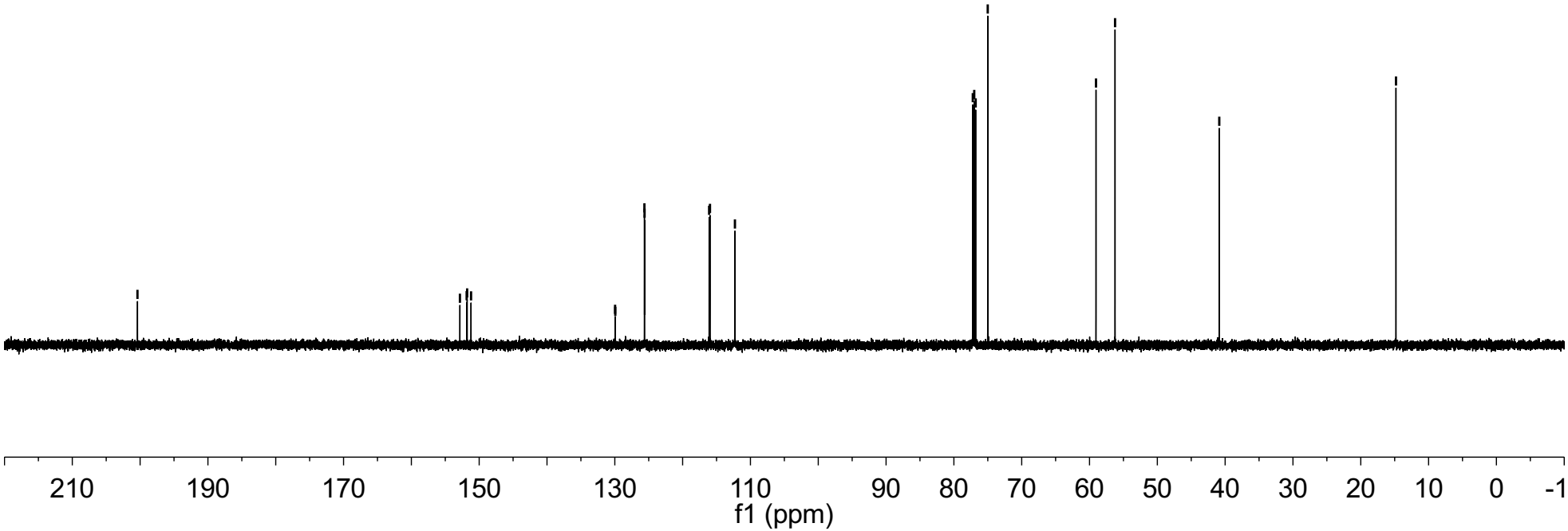

7.771
7.769
7.767
7.765
7.756
7.754
7.753
7.751
7.726
7.723
7.706
7.703
7.260
7.005
6.992
6.978
3.943
3.724
3.711
3.702
3.698
3.694
3.686
3.683
3.674
3.662
3.651
3.437
3.428
3.423
3.415
3.302
1.178
1.166
1H NMR (600 MHz, CDCl3)
O
F
MeO
OMe
2l
1.00
0.93
1.00
3.11
2.11
1.05
3.00
3.10
f1 (ppm)

200.391
152.841
151.847
151.774
151.199
129.960
129.929
125.635
125.613
116.092
115.967
112.287
77.212
77.000
76.788
75.008
59.042
56.232
40.867
14.808

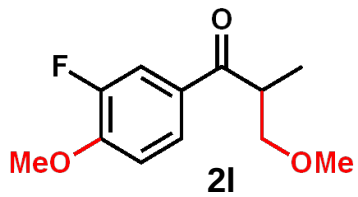
^{13}C NMR (150 MHz, $CDCl_3$)



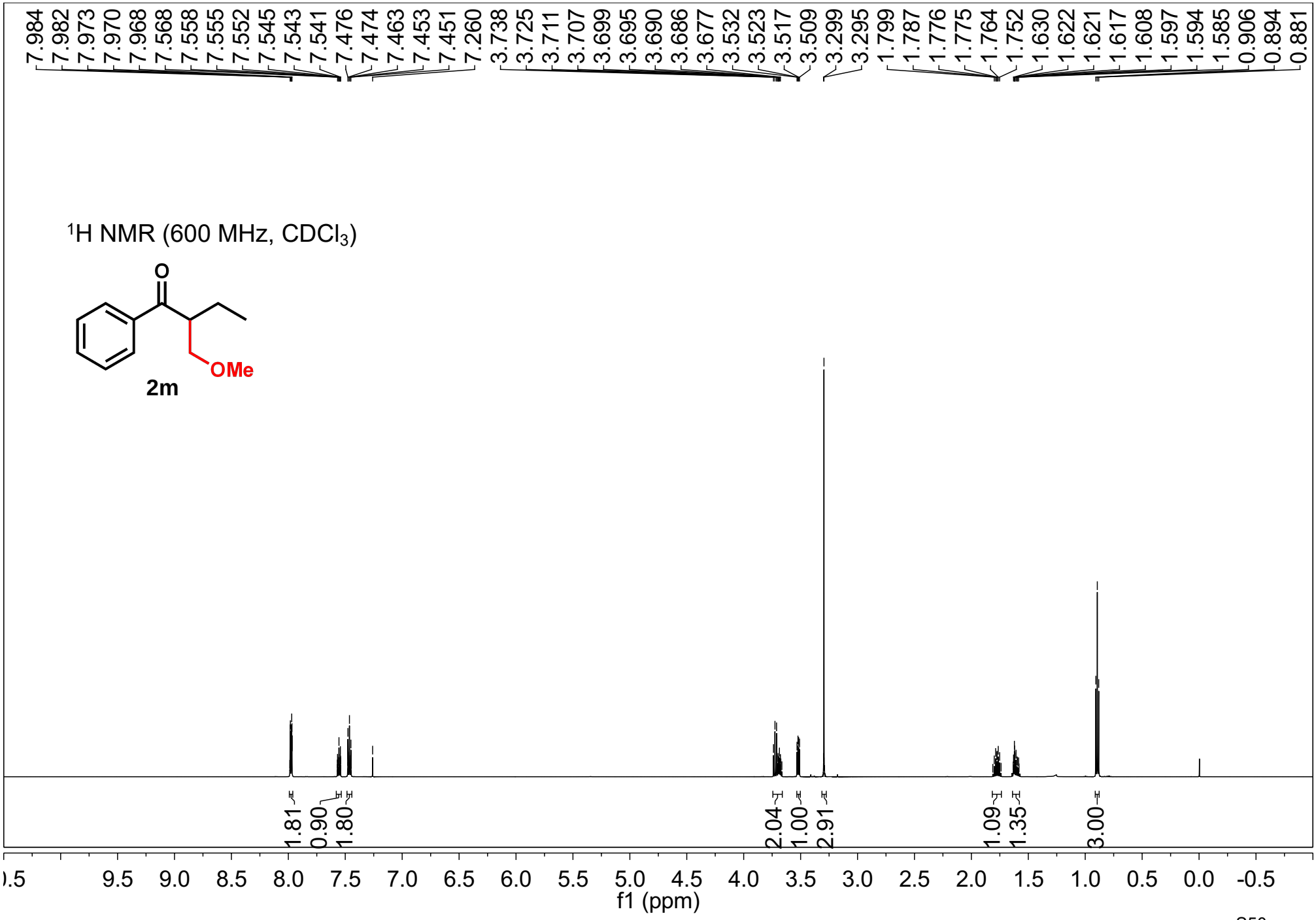
2l

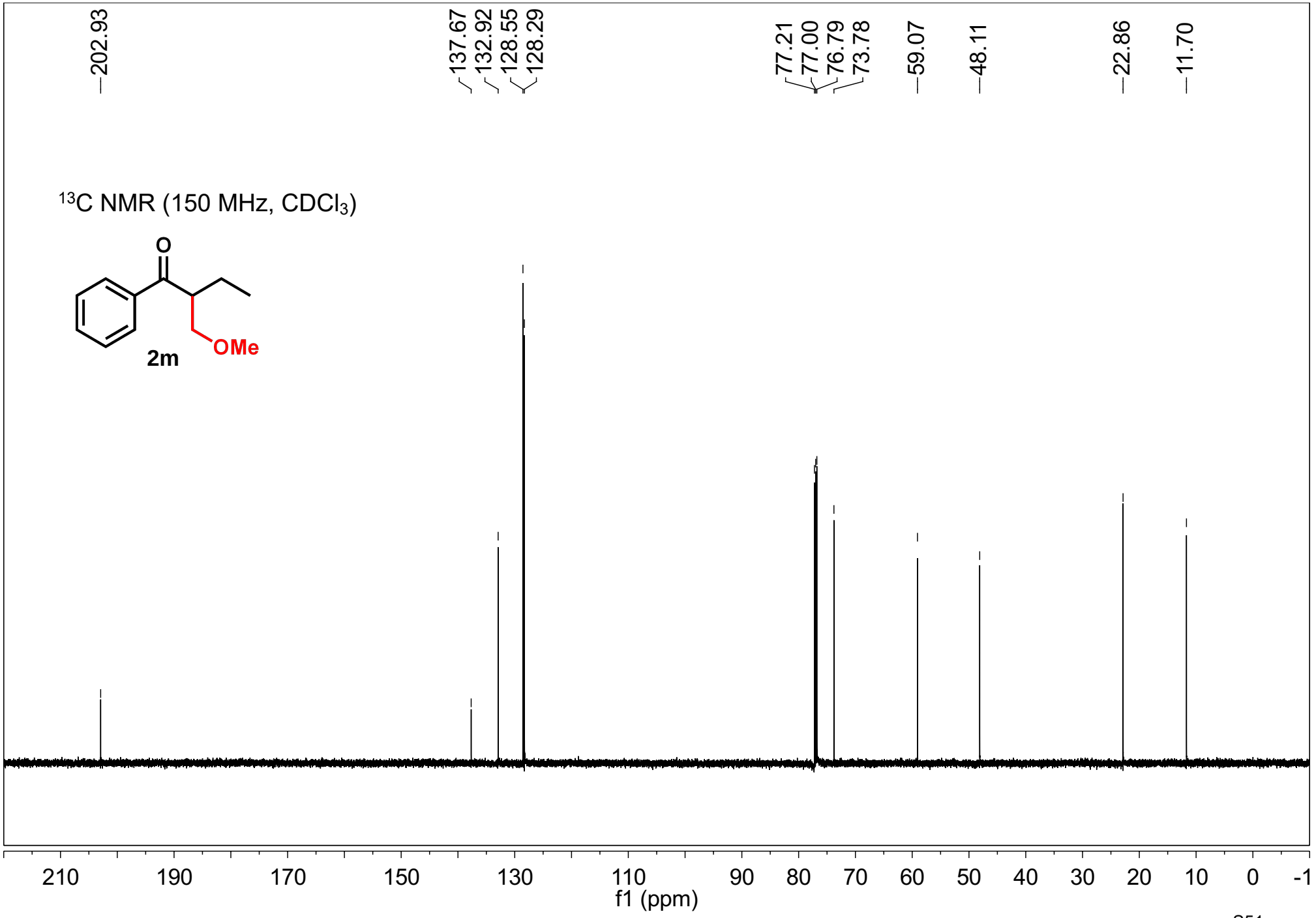


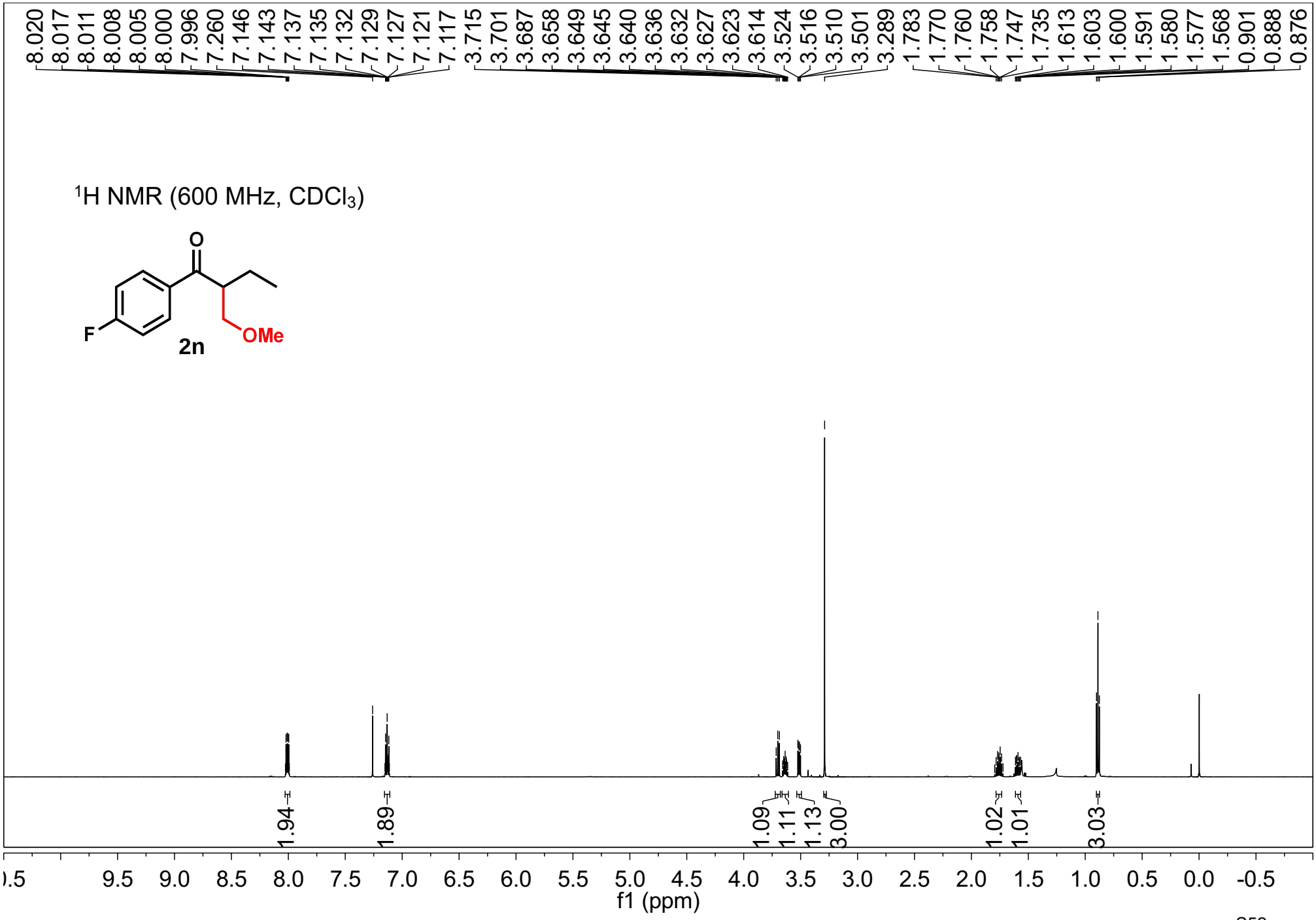
^{19}F NMR (376 MHz, $CDCl_3$)

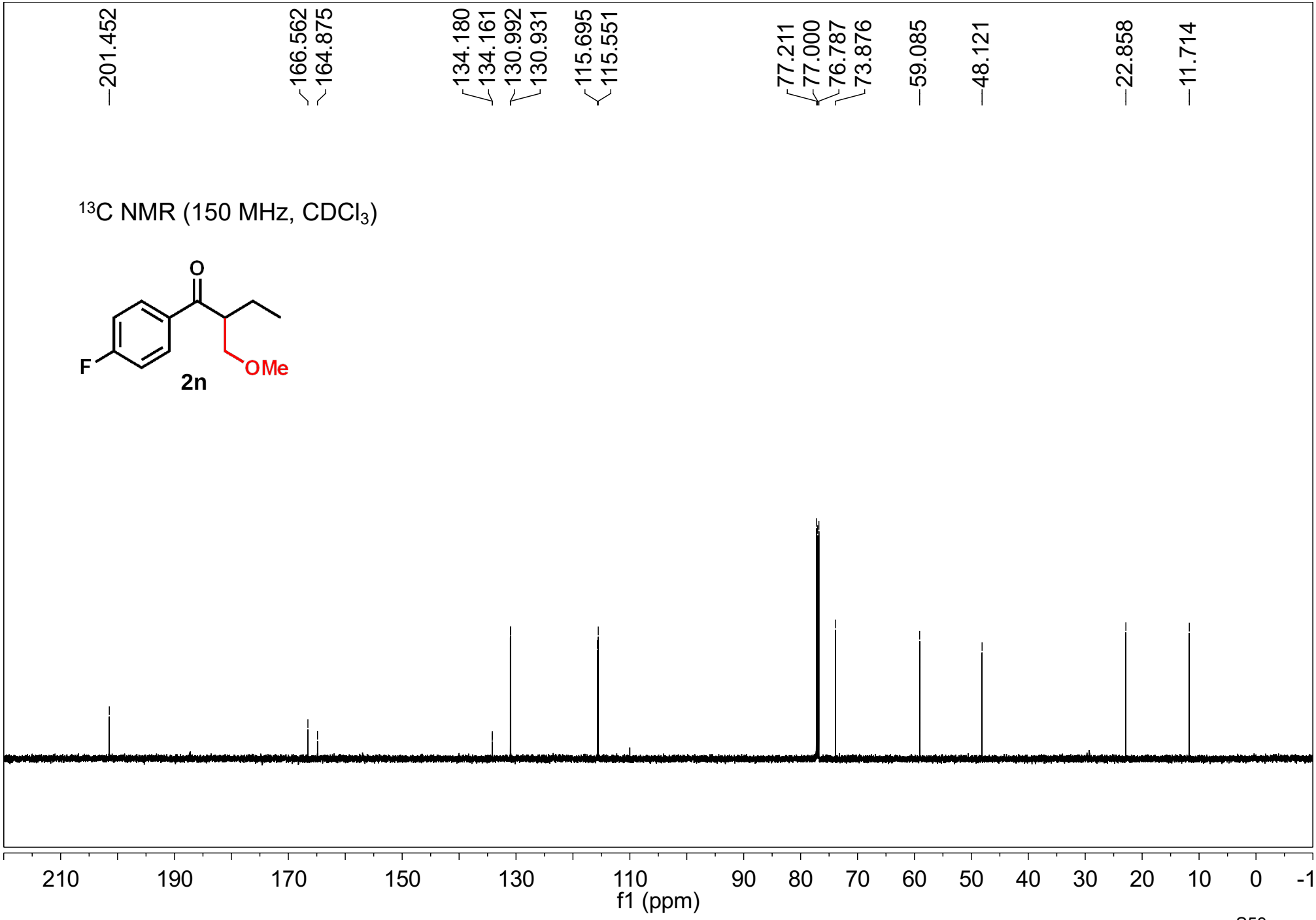


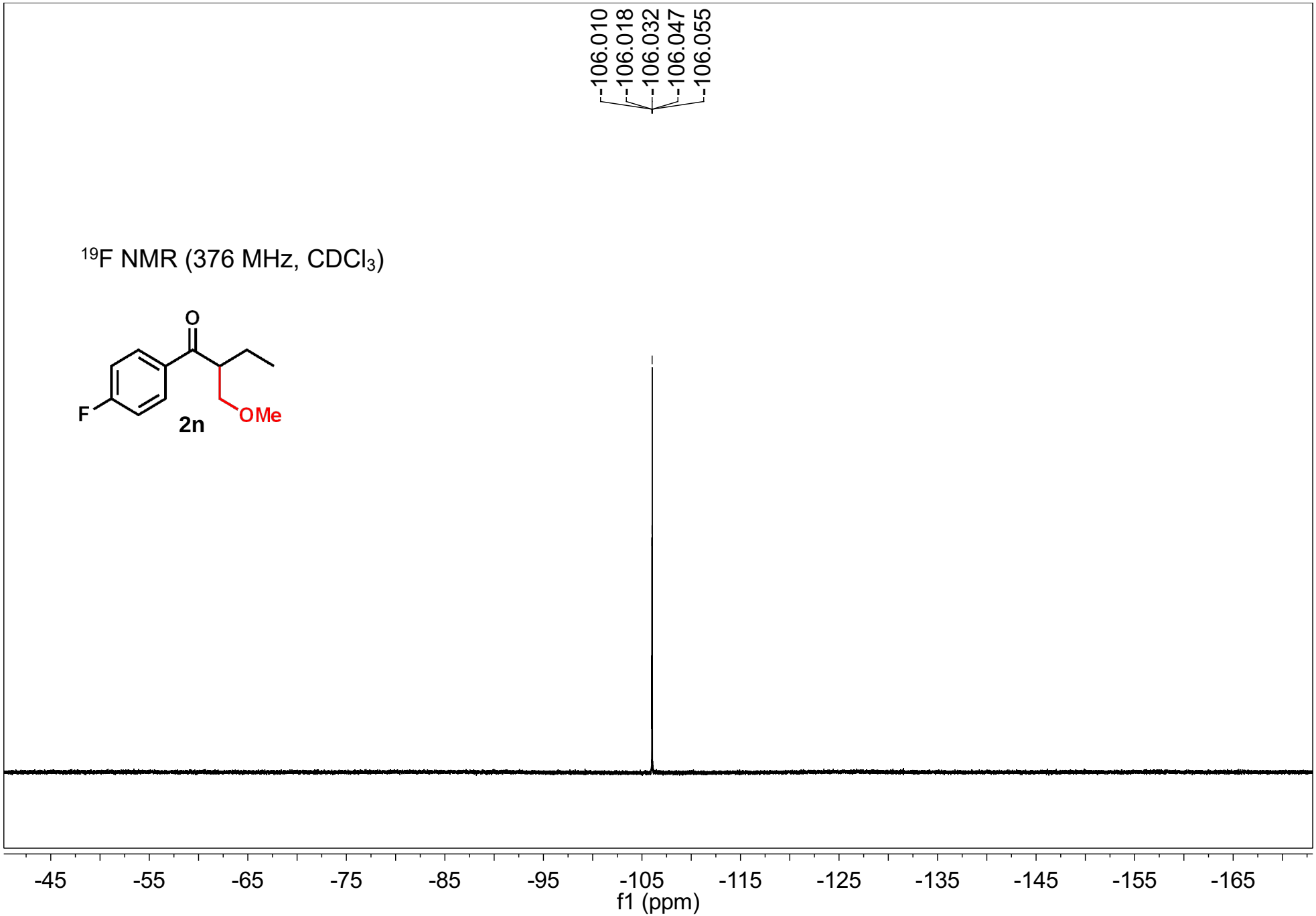
2l

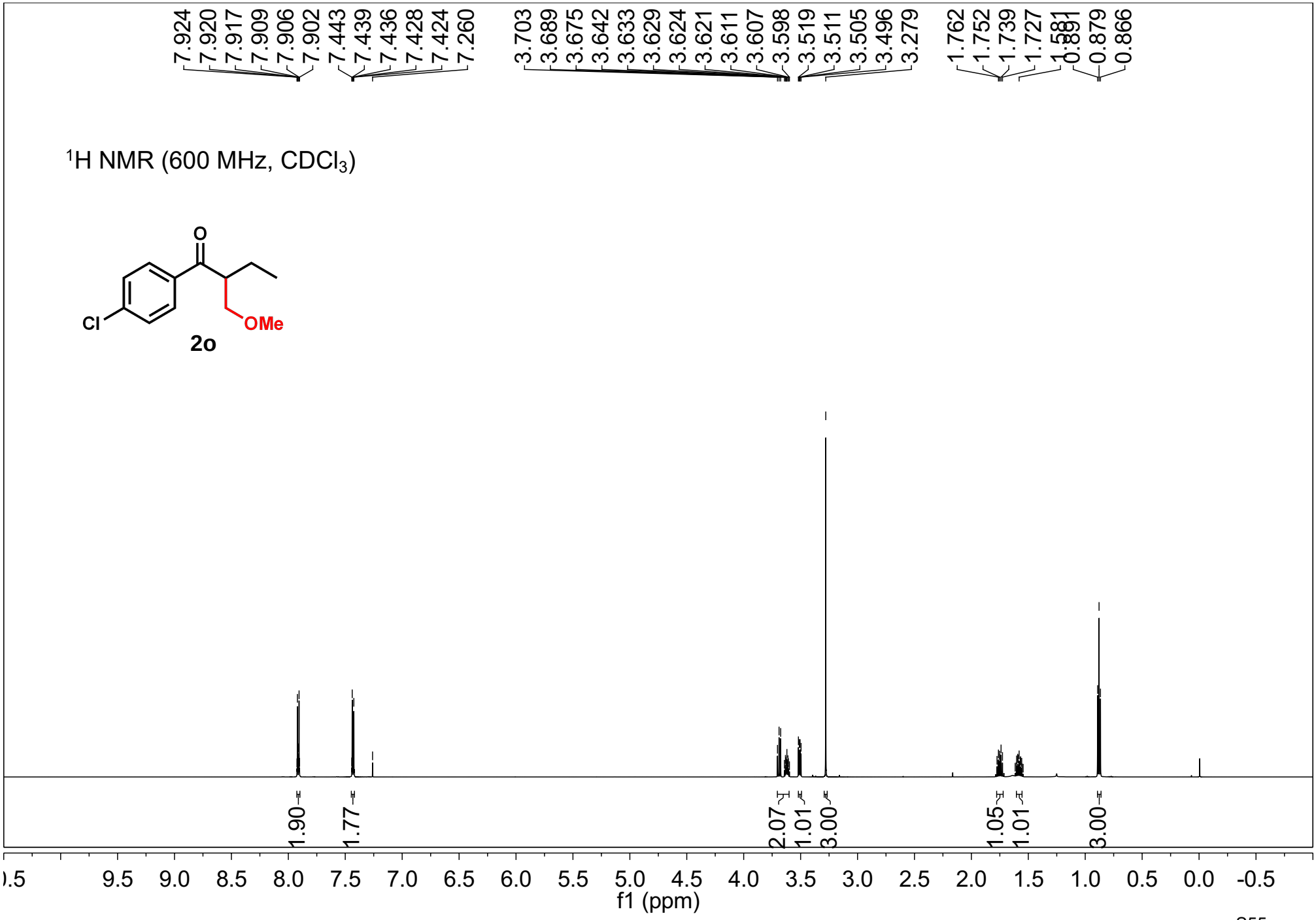

7.984
7.982
7.973
7.970
7.968
7.568
7.558
7.555
7.552
7.545
7.543
7.541
7.476
7.474
7.463
7.453
7.451
7.260
3.738
3.725
3.711
3.707
3.699
3.695
3.690
3.686
3.677
3.532
3.523
3.517
3.509
3.299
3.295
1.799
1.787
1.776
1.775
1.764
1.752
1.630
1.622
1.621
1.617
1.608
1.597
1.594
1.585
0.906
0.894
0.881
1H NMR (600 MHz, CDCl3)
O
OMe
2m
1.81
0.90
1.80
2.04
1.00
2.91
1.09
1.35
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

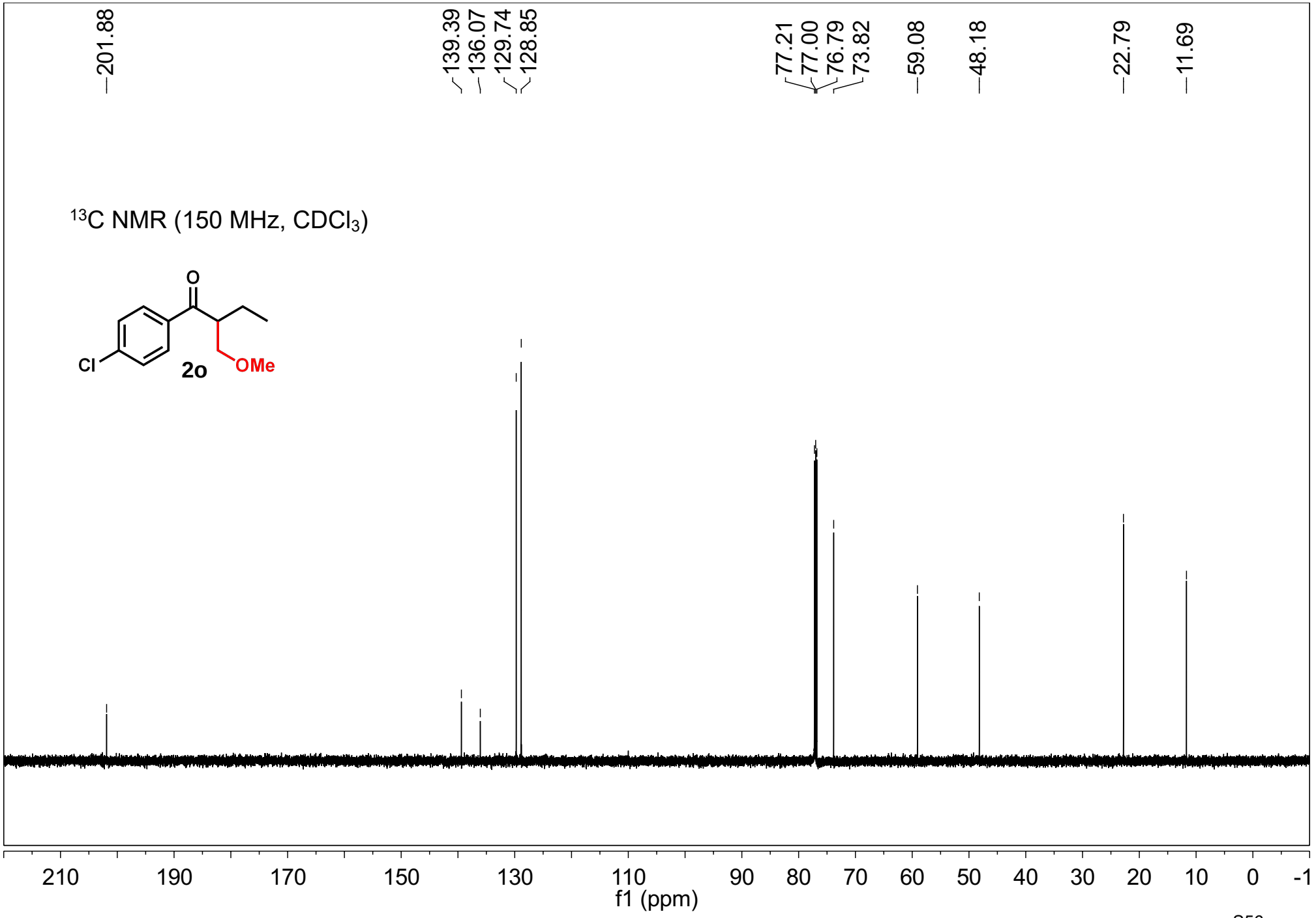

202.93
137.67
132.92
128.55
128.29
77.21
77.00
76.79
73.78
59.07
48.11
22.86
11.70
^{13}C NMR (150 MHz, $CDCl_3$)
O
OMe
2m
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

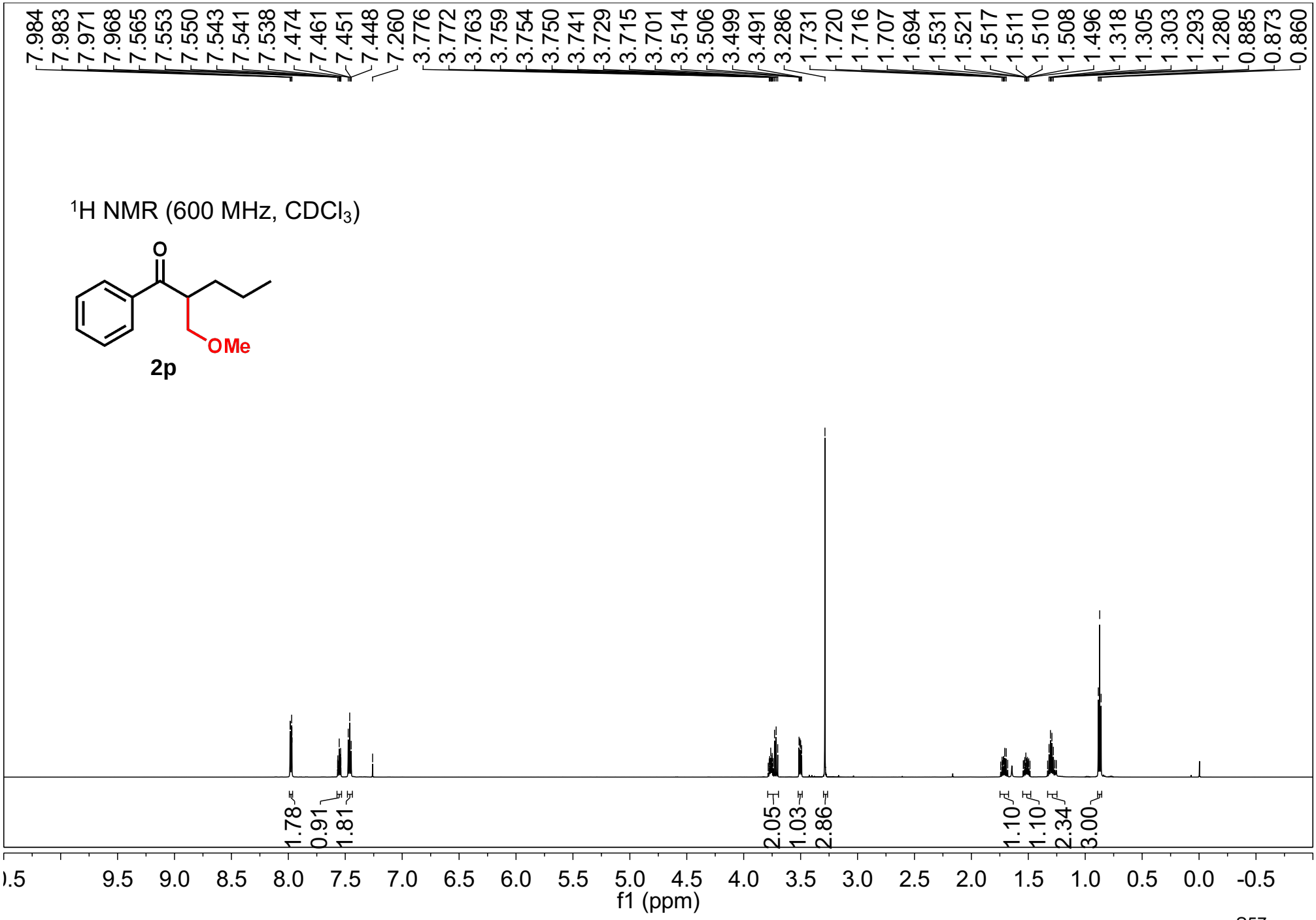

8.020
8.017
8.011
8.008
8.005
8.000
7.996
7.260
7.146
7.143
7.137
7.135
7.132
7.129
7.127
7.121
7.117
3.715
3.701
3.687
3.658
3.649
3.645
3.640
3.636
3.632
3.627
3.623
3.614
3.524
3.516
3.510
3.501
3.289
1.783
1.770
1.760
1.758
1.747
1.735
1.613
1.603
1.600
1.591
1.580
1.577
1.568
0.901
0.888
0.876
1H NMR (600 MHz, CDCl3)
O
F
OMe
2n
1.94
1.89
1.09
1.11
1.13
3.00
1.02
1.01
3.03
f1 (ppm)

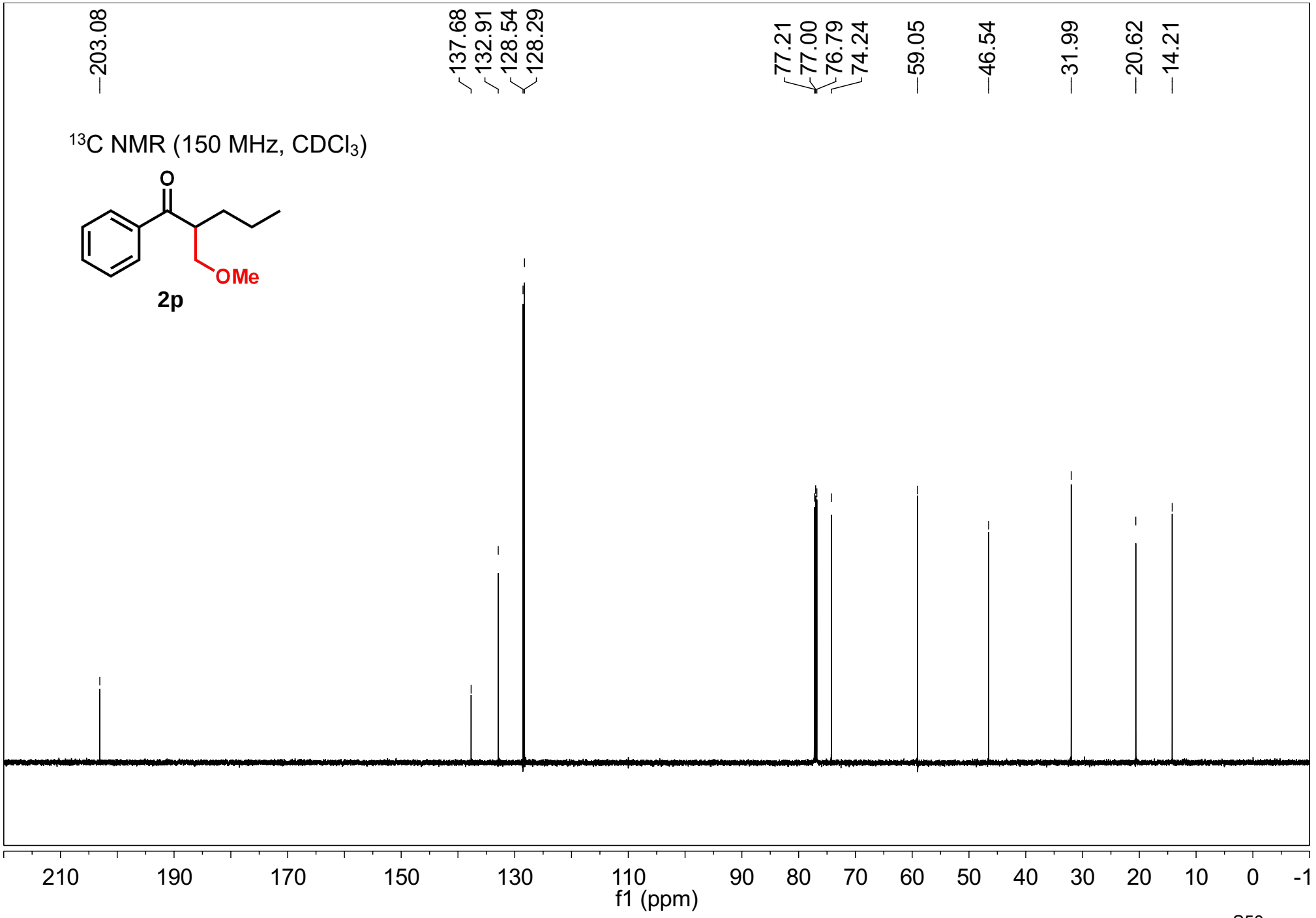

201.452
166.562
164.875
134.180
134.161
130.992
130.931
115.695
115.551
77.211
77.000
76.787
73.876
59.085
48.121
22.858
11.714
13C NMR (150 MHz, CDCl3)
O
F
OMe
2n
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

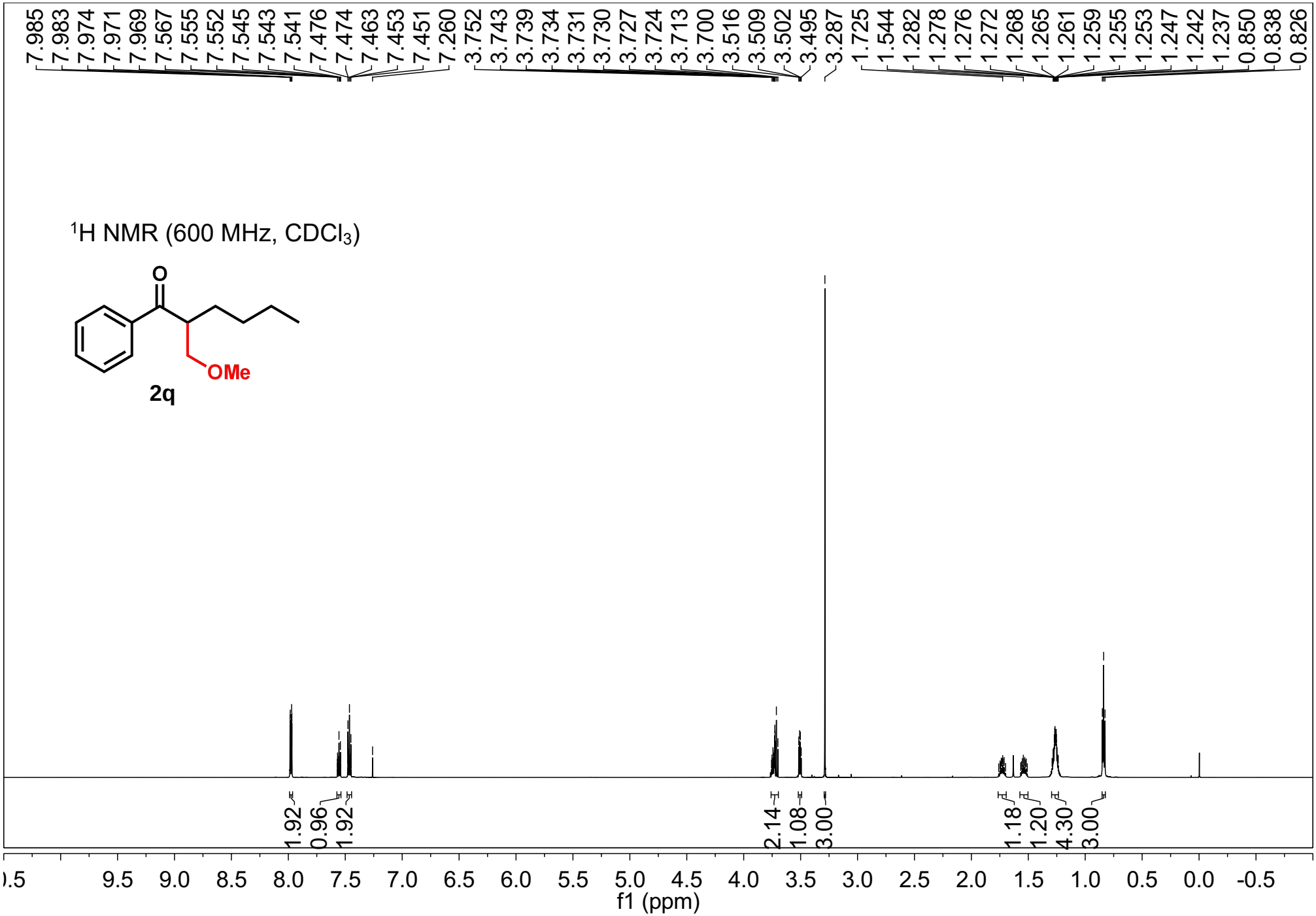

-106.010
-106.018
-106.032
-106.047
-106.055
19F NMR (376 MHz, CDCl3)
O
F
OMe
2n
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
-165
f1 (ppm)

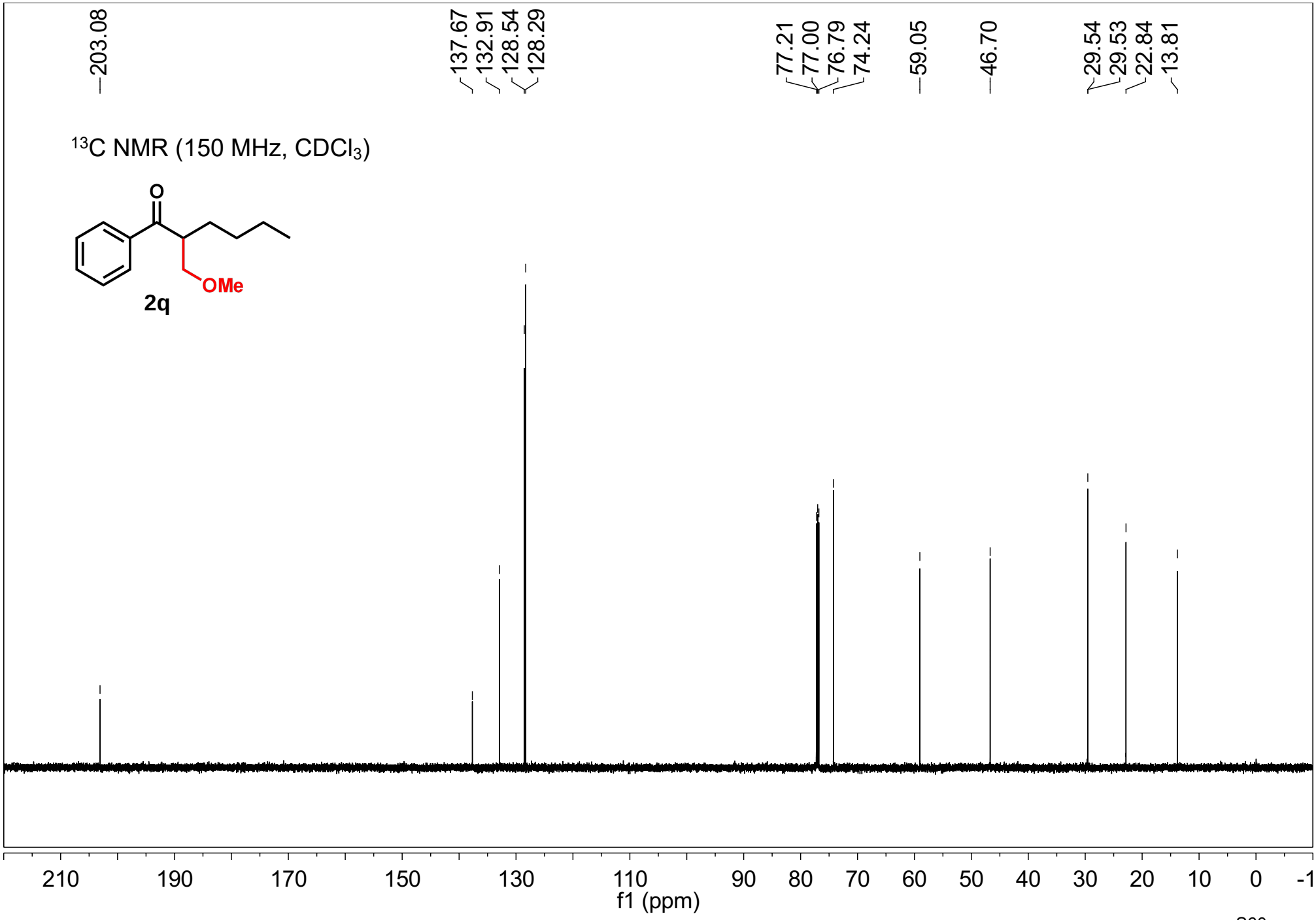

7.924
7.920
7.917
7.909
7.906
7.902
7.443
7.439
7.436
7.428
7.424
7.260
3.703
3.689
3.675
3.642
3.633
3.629
3.624
3.621
3.611
3.607
3.598
3.519
3.511
3.505
3.496
3.279
1.762
1.752
1.739
1.727
1.581
0.891
0.879
0.866
1H NMR (600 MHz, CDCl3)
O
Cl
OMe
2o
1.90
1.77
2.07
1.01
3.00
1.05
1.01
3.00
f1 (ppm)

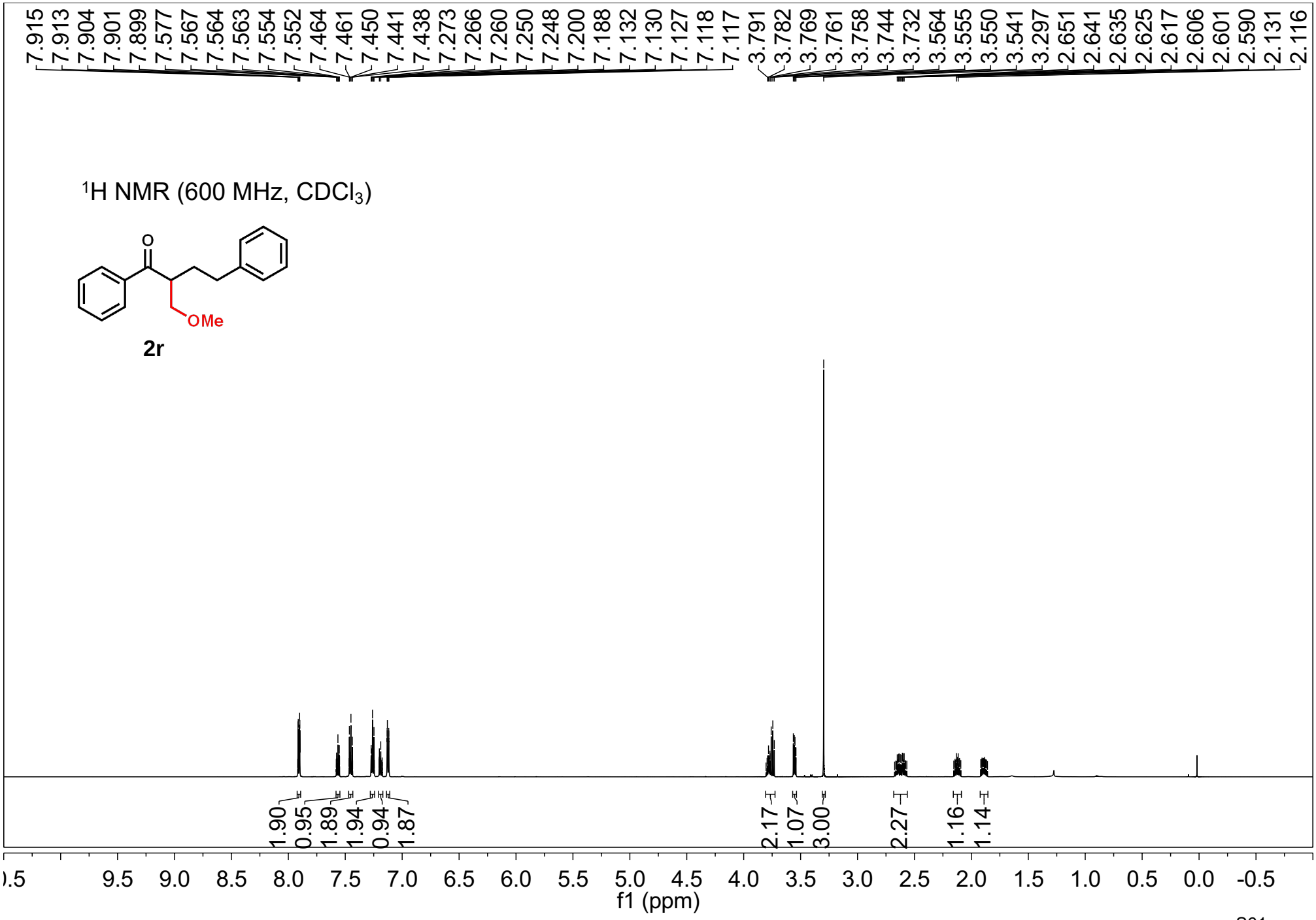

201.88
139.39
136.07
129.74
128.85
77.21
77.00
76.79
73.82
59.08
48.18
22.79
11.69
13C NMR (150 MHz, CDCl3)
O
Cl
OMe
2o
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

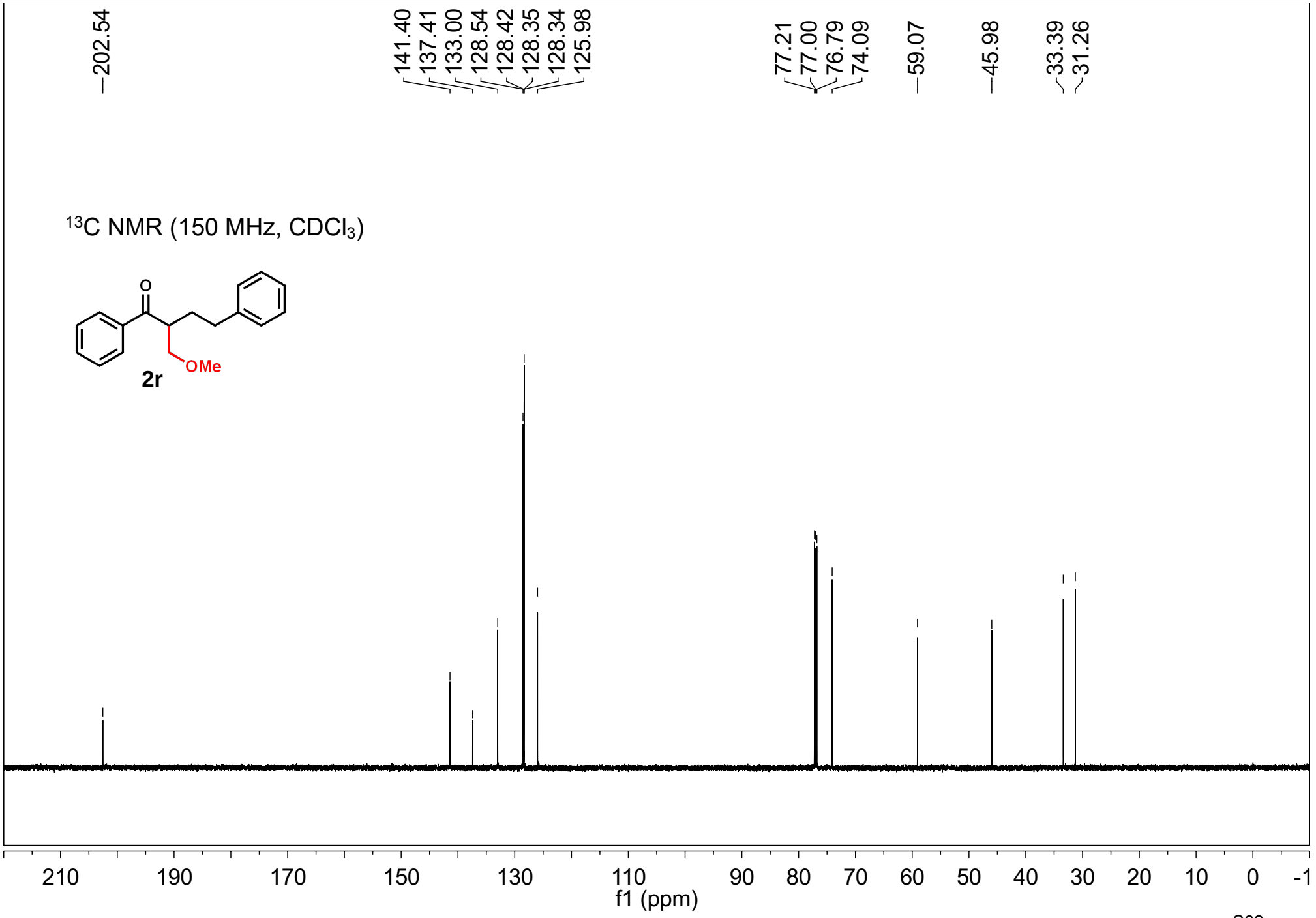

7.984
7.983
7.971
7.968
7.565
7.553
7.550
7.543
7.541
7.538
7.474
7.461
7.451
7.448
7.260
3.776
3.772
3.763
3.759
3.754
3.750
3.741
3.729
3.715
3.701
3.514
3.506
3.499
3.491
3.286
1.731
1.720
1.716
1.707
1.694
1.531
1.521
1.517
1.511
1.510
1.508
1.496
1.318
1.305
1.303
1.293
1.280
0.885
0.873
0.860
^{1}H NMR (600 MHz, $CDCl_3$)
O
OMe
2p
1.78
0.91
1.81
2.05
1.03
2.86
1.10
1.10
2.34
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

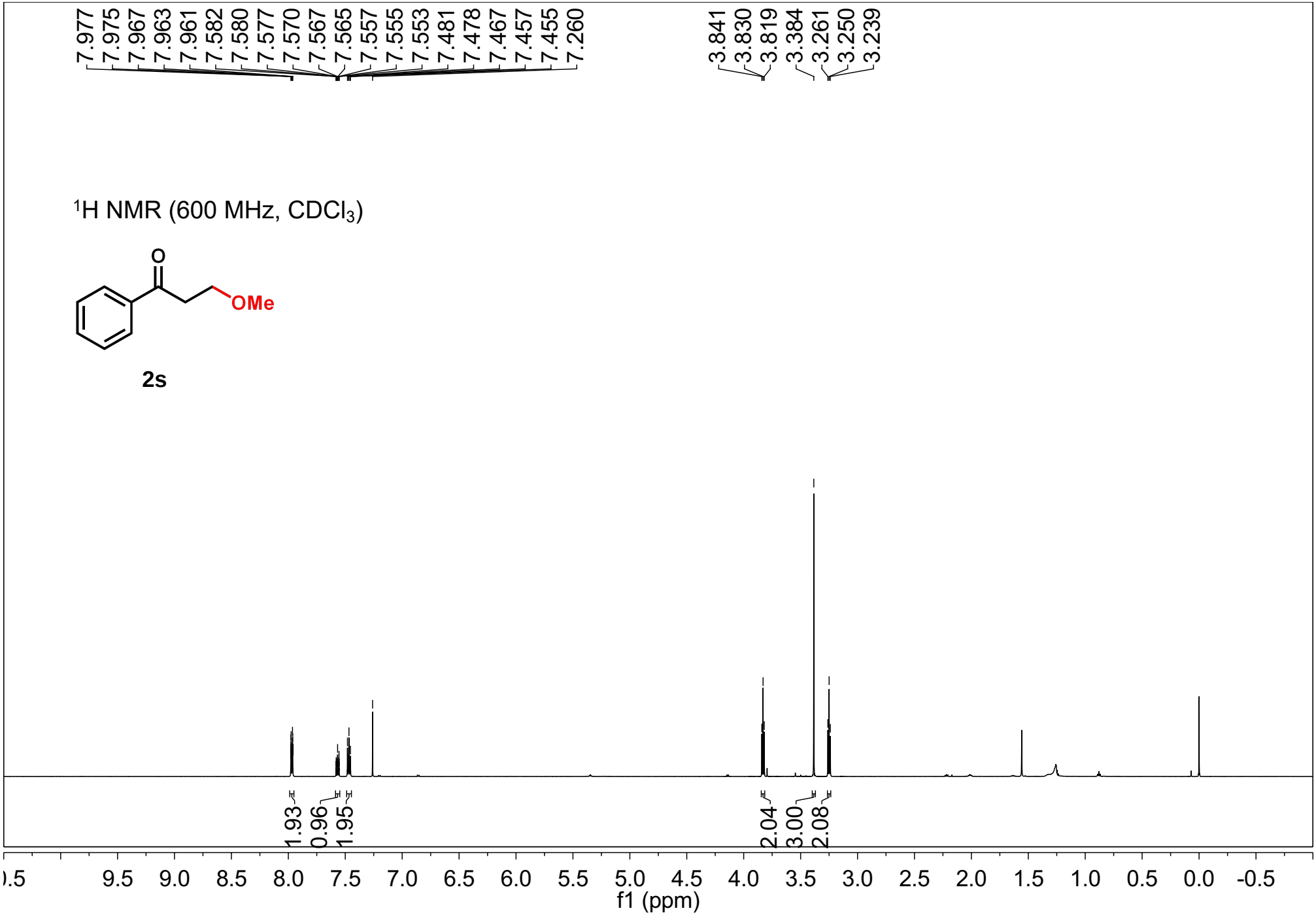

203.08
137.68
132.91
128.54
128.29
77.21
77.00
76.79
74.24
59.05
46.54
31.99
20.62
14.21
13C NMR (150 MHz, CDCl3)
O
OMe
2p
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

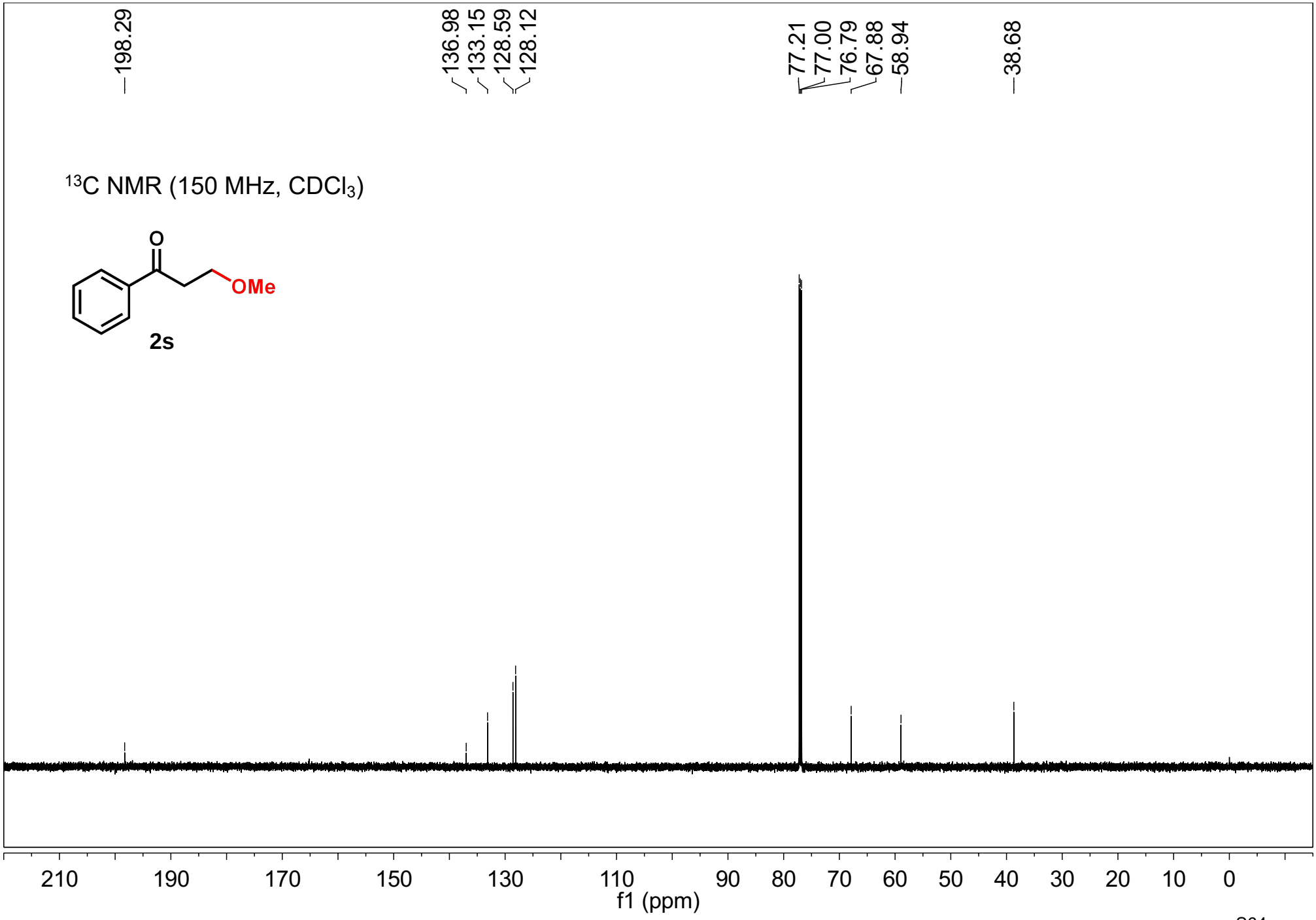

7.985
7.983
7.974
7.971
7.969
7.567
7.555
7.552
7.545
7.543
7.541
7.476
7.474
7.463
7.453
7.451
7.260
3.752
3.743
3.739
3.734
3.731
3.730
3.727
3.724
3.713
3.700
3.516
3.509
3.502
3.495
3.287
1.725
1.544
1.282
1.278
1.276
1.272
1.268
1.265
1.261
1.259
1.255
1.253
1.247
1.242
1.237
0.850
0.838
0.826
1H NMR (600 MHz, CDCl3)
O
OMe
2q
1.92
0.96
1.92
2.14
1.08
3.00
1.18
1.20
4.30
3.00
f1 (ppm)

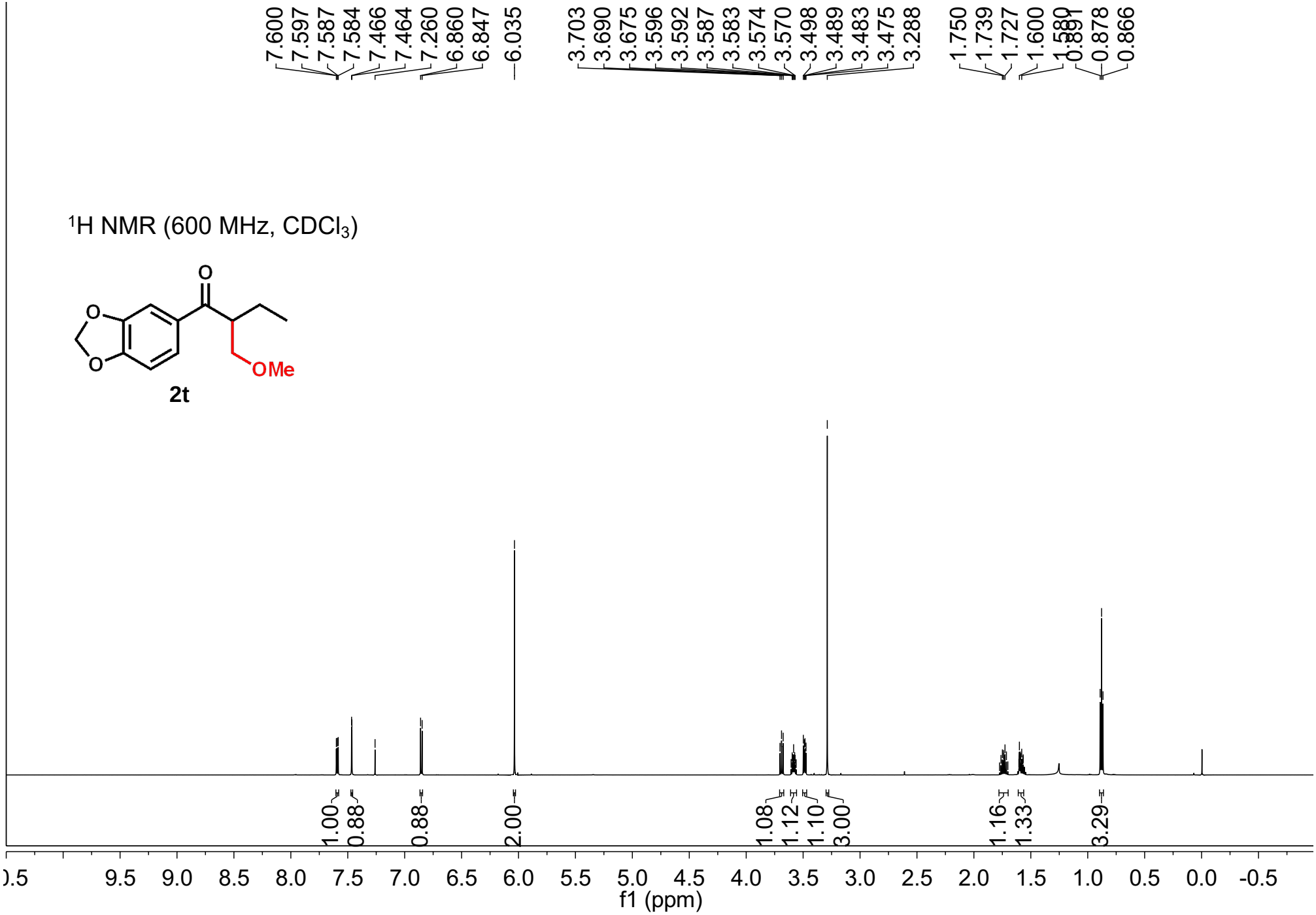

203.08
137.67
132.91
128.54
128.29
77.21
77.00
76.79
74.24
59.05
46.70
29.54
29.53
22.84
13.81
13C NMR (150 MHz, CDCl3)
O
OMe
2q
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

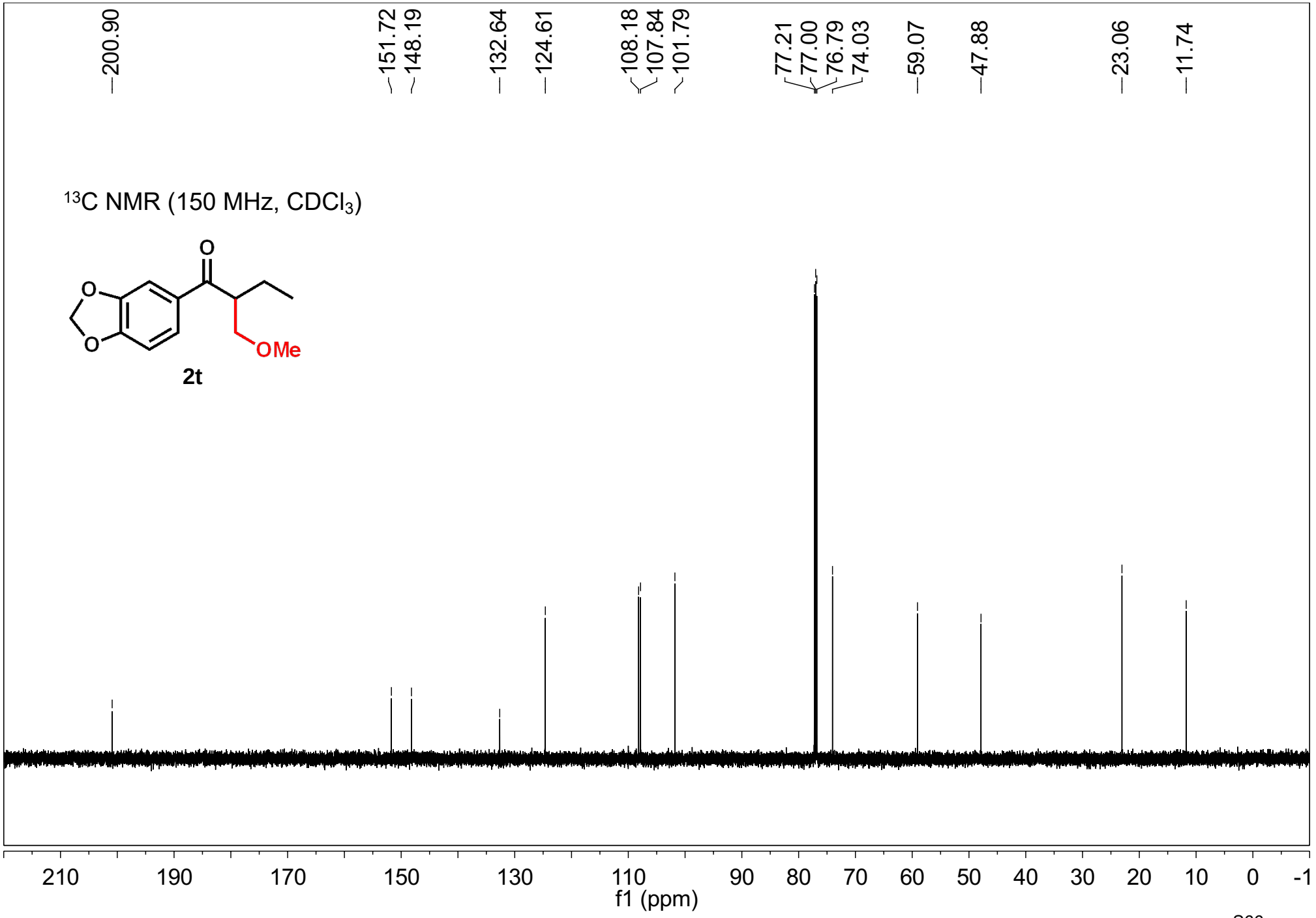

7.915
7.913
7.904
7.901
7.899
7.577
7.567
7.564
7.563
7.554
7.552
7.464
7.461
7.450
7.441
7.438
7.273
7.266
7.260
7.250
7.248
7.200
7.188
7.132
7.130
7.127
7.118
7.117
3.791
3.782
3.769
3.761
3.758
3.744
3.732
3.564
3.555
3.550
3.541
3.297
2.651
2.641
2.635
2.625
2.617
2.606
2.601
2.590
2.131
2.116
1H NMR (600 MHz, CDCl3)
O
OMe
2r
1.90
0.95
1.89
1.94
0.94
1.87
2.17
1.07
3.00
2.27
1.16
1.14
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

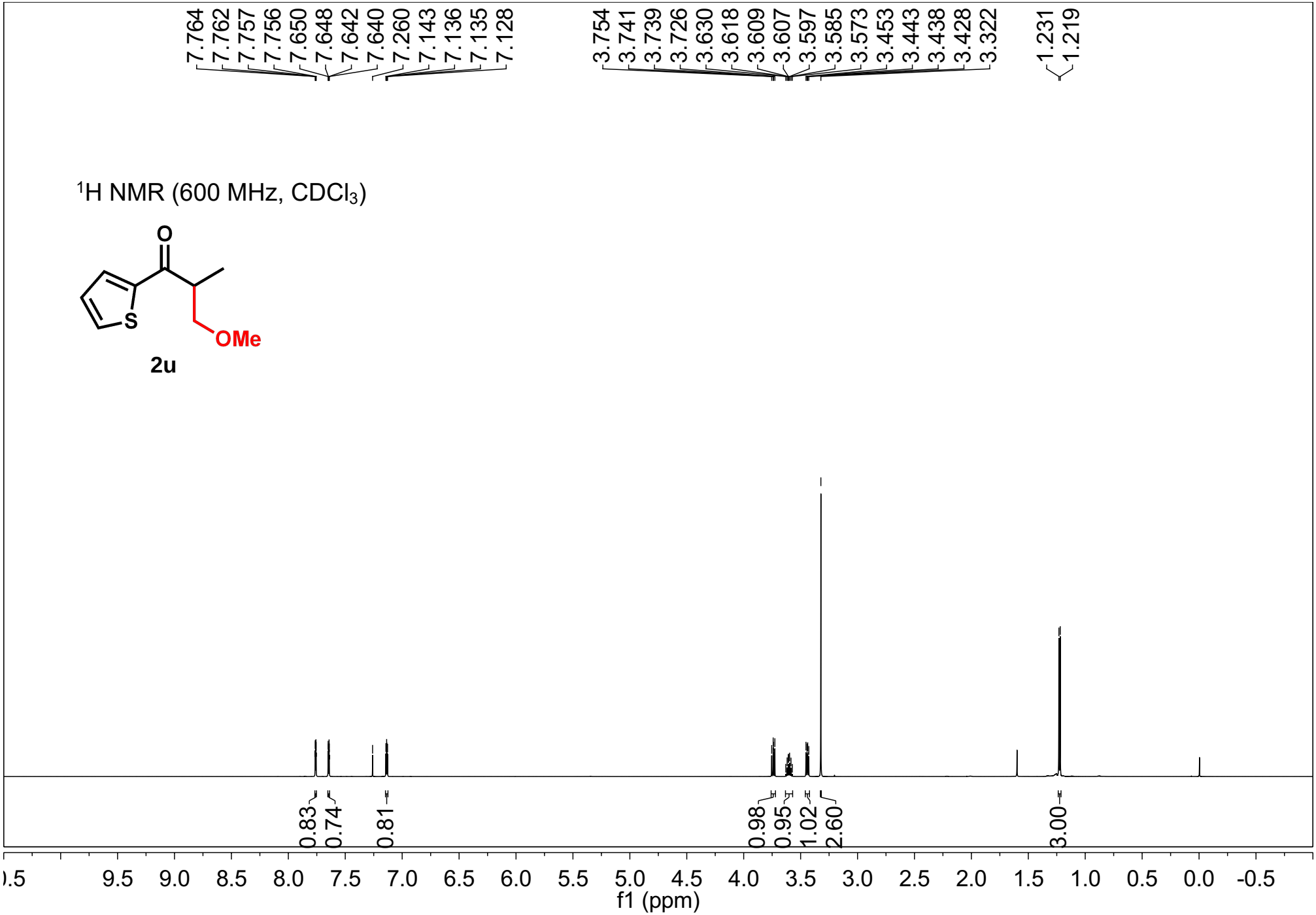

202.54
141.40
137.41
133.00
128.54
128.42
128.35
128.34
125.98
77.21
77.00
76.79
74.09
59.07
45.98
33.39
31.26
^{13}C NMR (150 MHz, CDCl$_3$)
O
OMe
2r
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

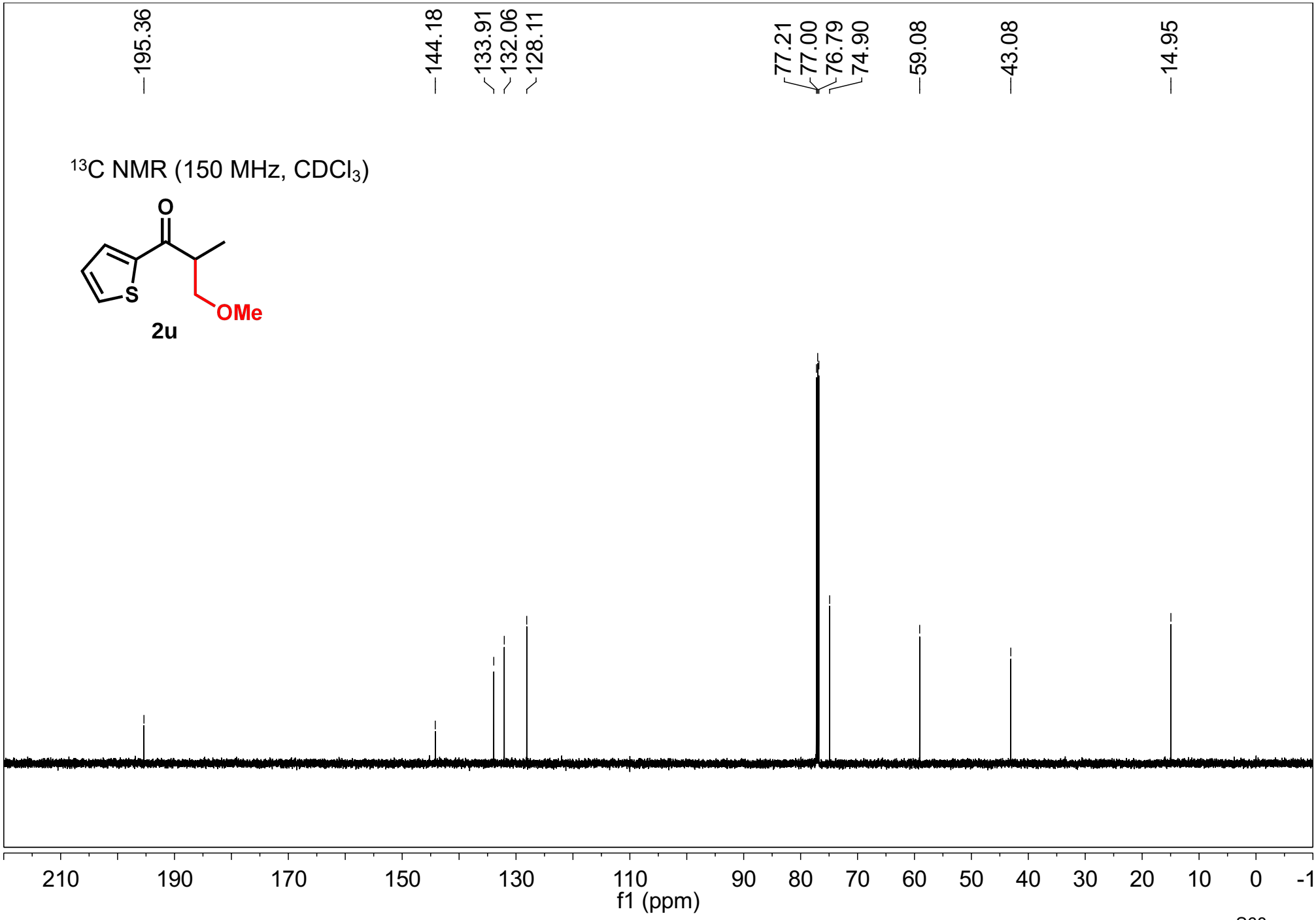

7.977
7.975
7.967
7.963
7.961
7.582
7.580
7.577
7.570
7.567
7.565
7.557
7.555
7.553
7.481
7.478
7.467
7.457
7.455
7.260
3.841
3.830
3.819
3.384
3.261
3.250
3.239
1H NMR (600 MHz, CDCl3)
O
OMe
2s
1.93
0.96
1.95
2.04
3.00
2.08
f1 (ppm)

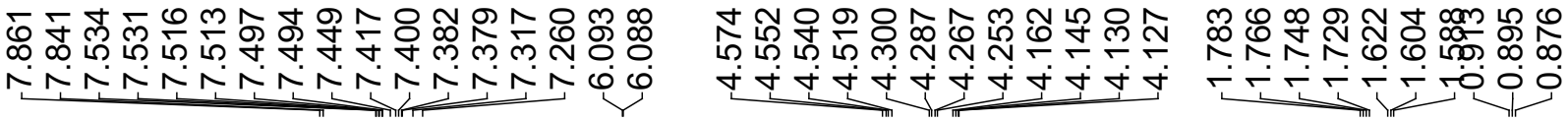

198.29
136.98
133.15
128.59
128.12
77.21
77.00
76.79
67.88
58.94
38.68
13C NMR (150 MHz, CDCl3)
O
OMe
2s
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.600
7.597
7.587
7.584
7.466
7.464
7.260
6.860
6.847
6.035
3.703
3.690
3.675
3.596
3.592
3.587
3.583
3.574
3.570
3.498
3.489
3.483
3.475
3.288
1.750
1.739
1.727
1.600
1.580
0.891
0.878
0.866
1H NMR (600 MHz, CDCl3)
O
O
O
OMe
2t
1.00
0.88
0.88
2.00
1.08
1.12
1.10
3.00
1.16
1.33
3.29
f1 (ppm)

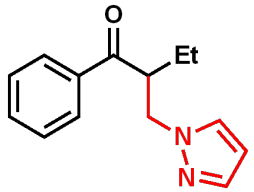

200.90
151.72
148.19
132.64
124.61
108.18
107.84
101.79
77.21
77.00
76.79
74.03
59.07
47.88
23.06
11.74
13C NMR (150 MHz, CDCl3)
O
O
O
OMe
2t
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)


7.764
7.762
7.757
7.756
7.650
7.648
7.642
7.640
7.260
7.143
7.136
7.135
7.128
3.754
3.741
3.739
3.726
3.630
3.618
3.609
3.607
3.597
3.585
3.573
3.453
3.443
3.438
3.428
3.322
1.231
1.219
^{1}H NMR (600 MHz, $CDCl_3$)
O
S
OMe
2u
0.83
0.74
0.81
0.98
0.95
1.02
2.60
3.00
f1 (ppm)

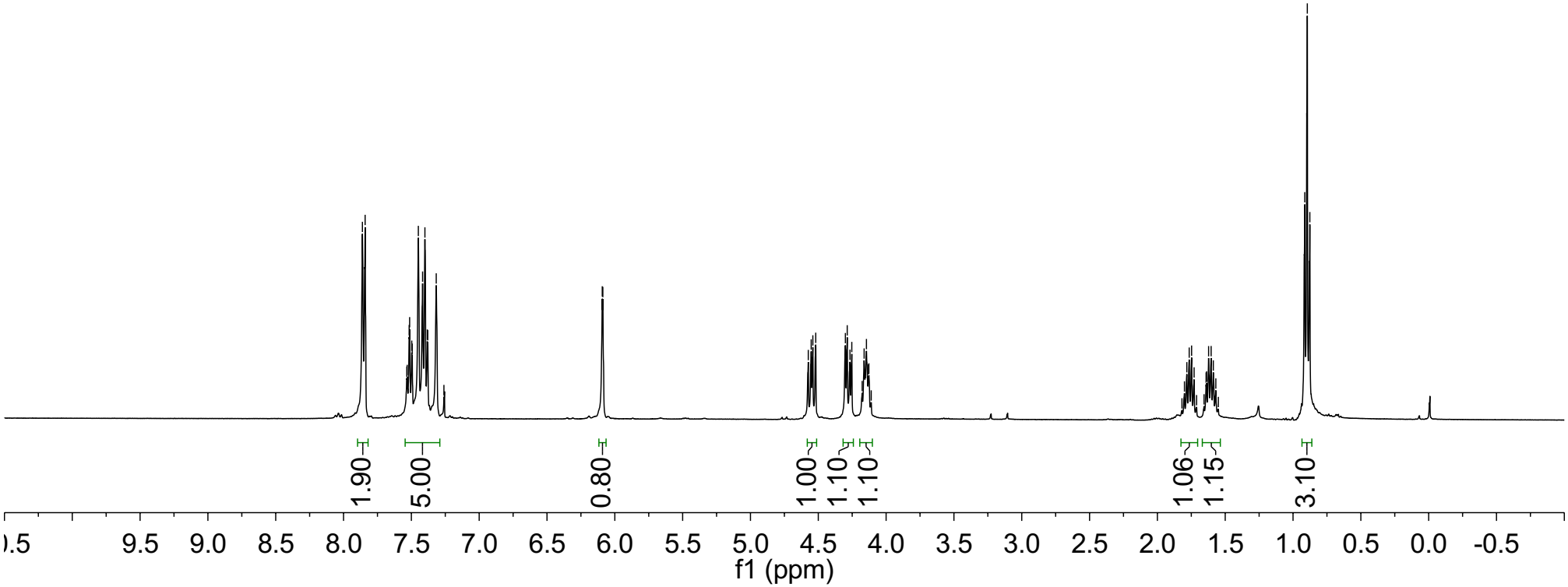

195.36
144.18
133.91
132.06
128.11
77.21
77.00
76.79
74.90
59.08
43.08
14.95
13C NMR (150 MHz, CDCl3)
O
S
OMe
2u
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)

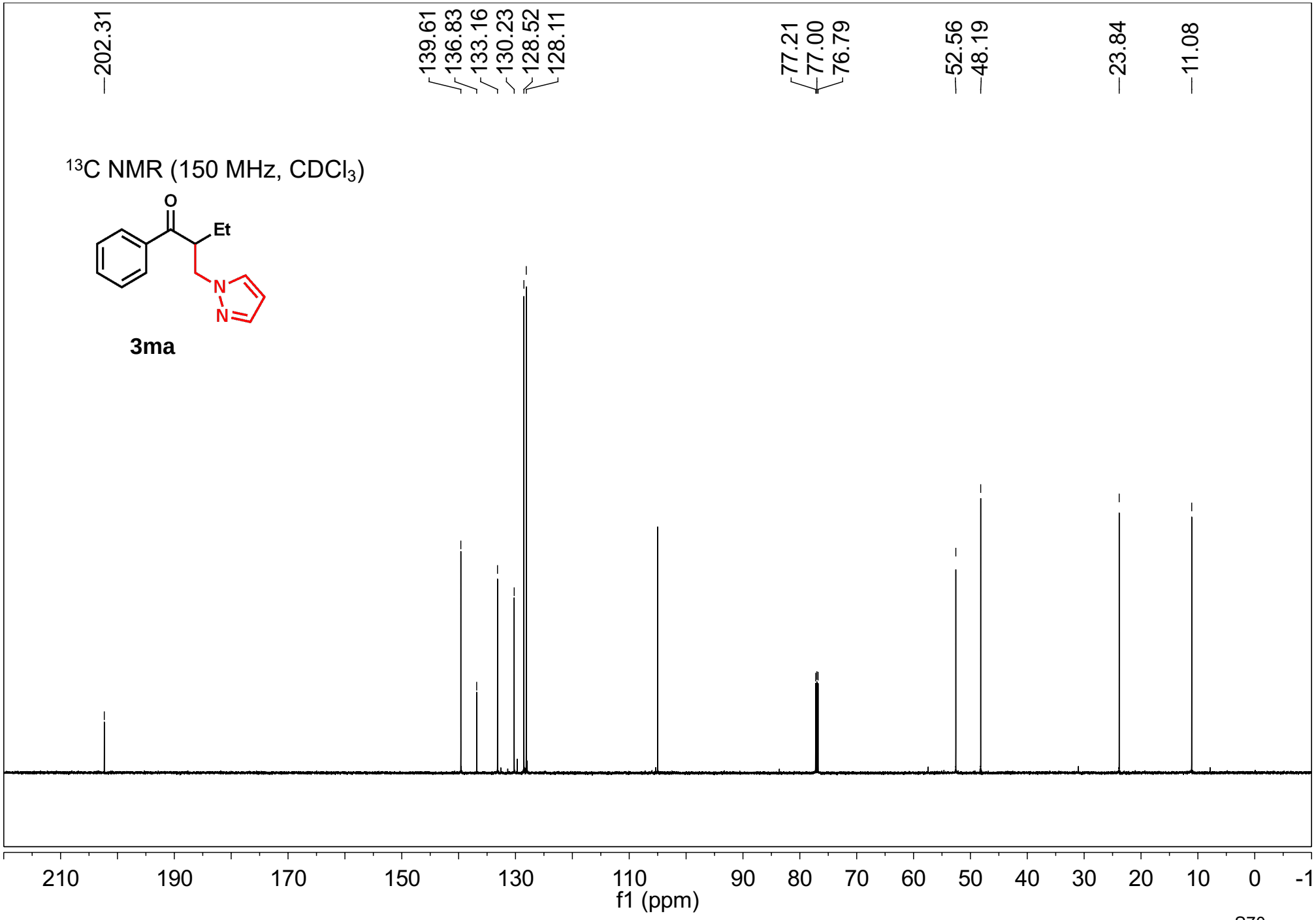


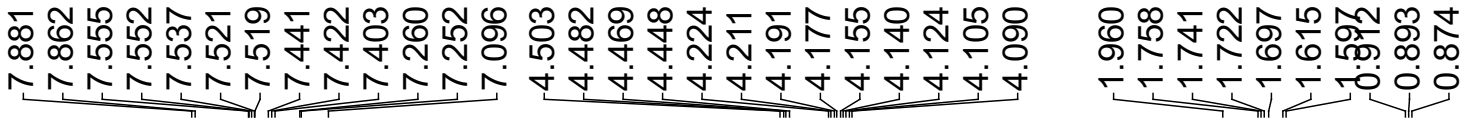
^{1}H NMR (400 MHz, $CDCl_3$)



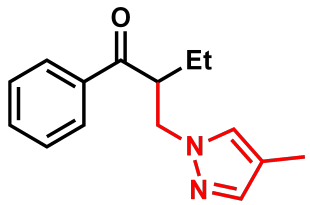
3ma



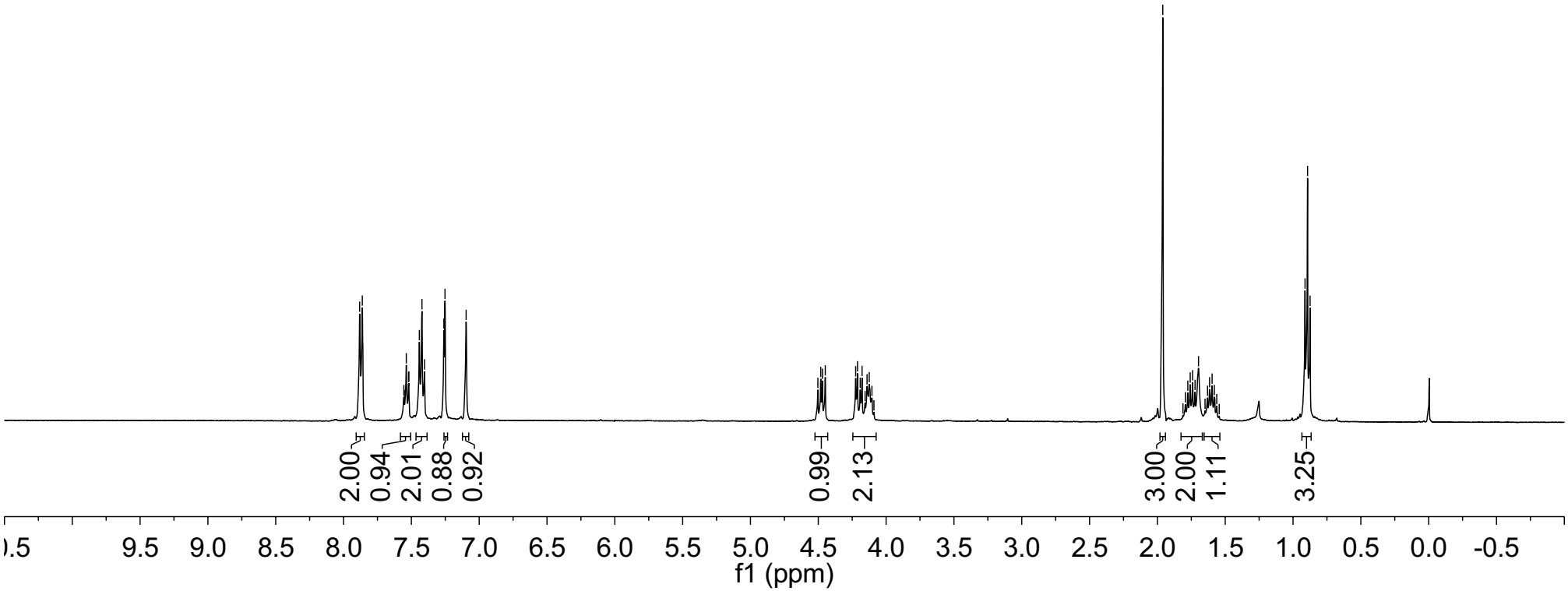

202.31
139.61
136.83
133.16
130.23
128.52
128.11
77.21
77.00
76.79
52.56
48.19
23.84
11.08
13C NMR (150 MHz, CDCl3)
O
Et
N
N
3ma
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)



^{1}H NMR (400 MHz, $CDCl_3$)

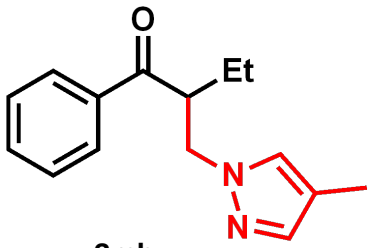


3mb

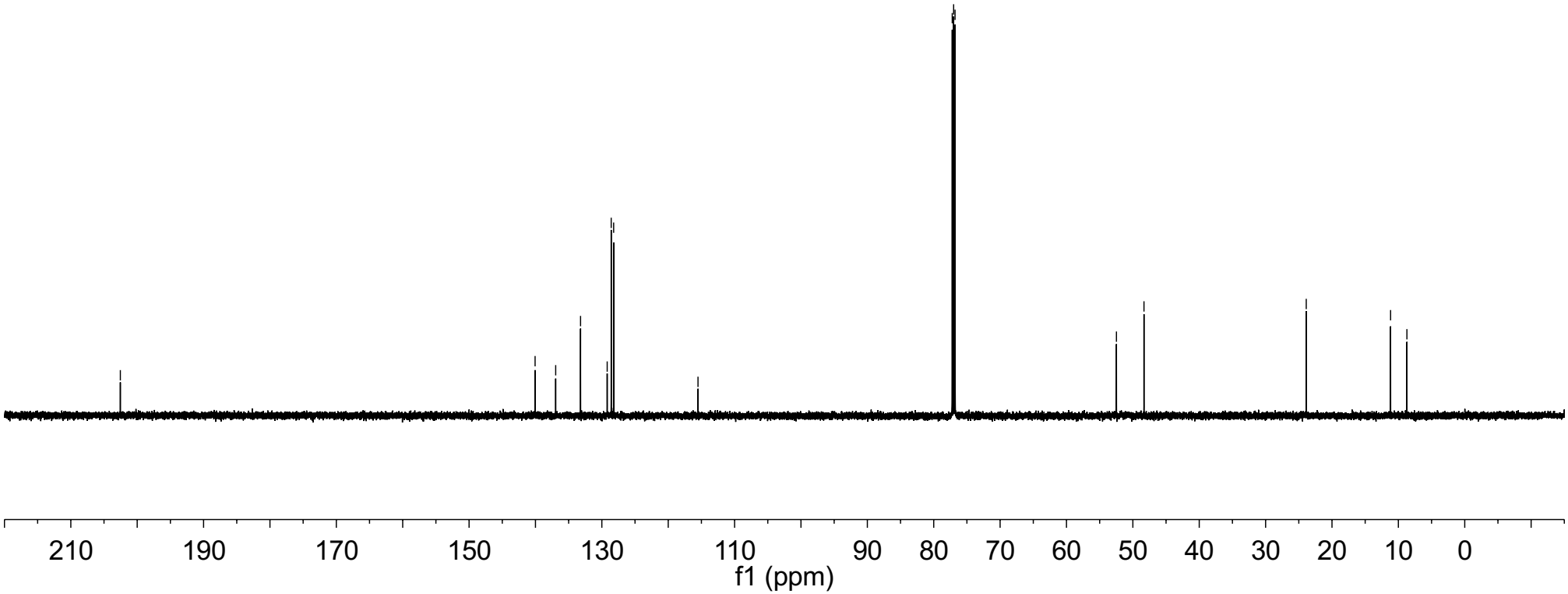


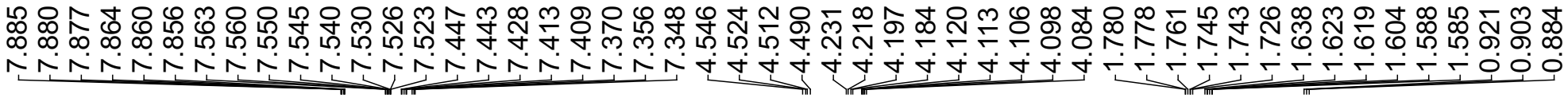
202.54
140.06
136.95
133.21
129.19
128.59
128.22
115.51
77.21
77.00
76.79
52.47
48.32
23.88
11.17
8.71

^{13}C NMR (150 MHz, $CDCl_3$)

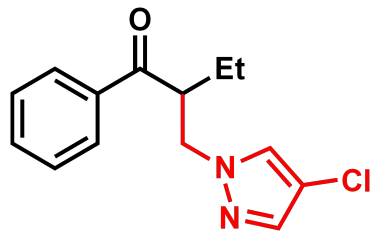


3mb

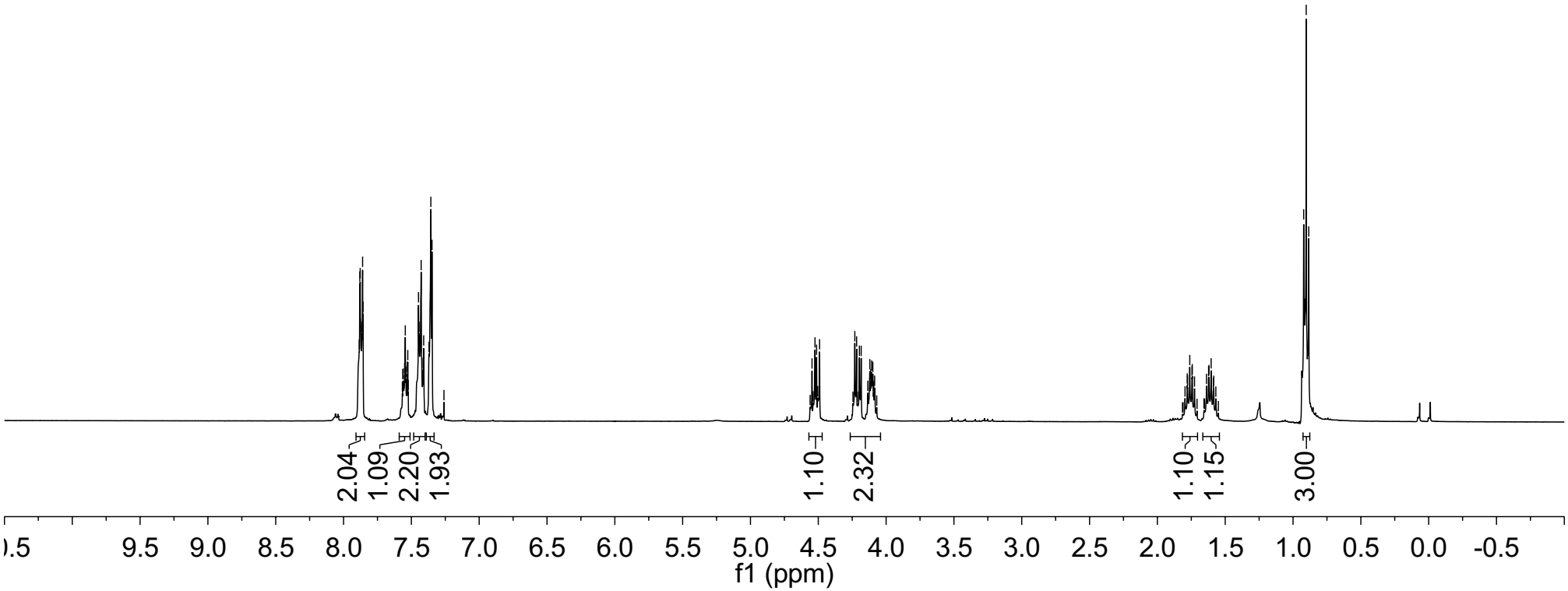


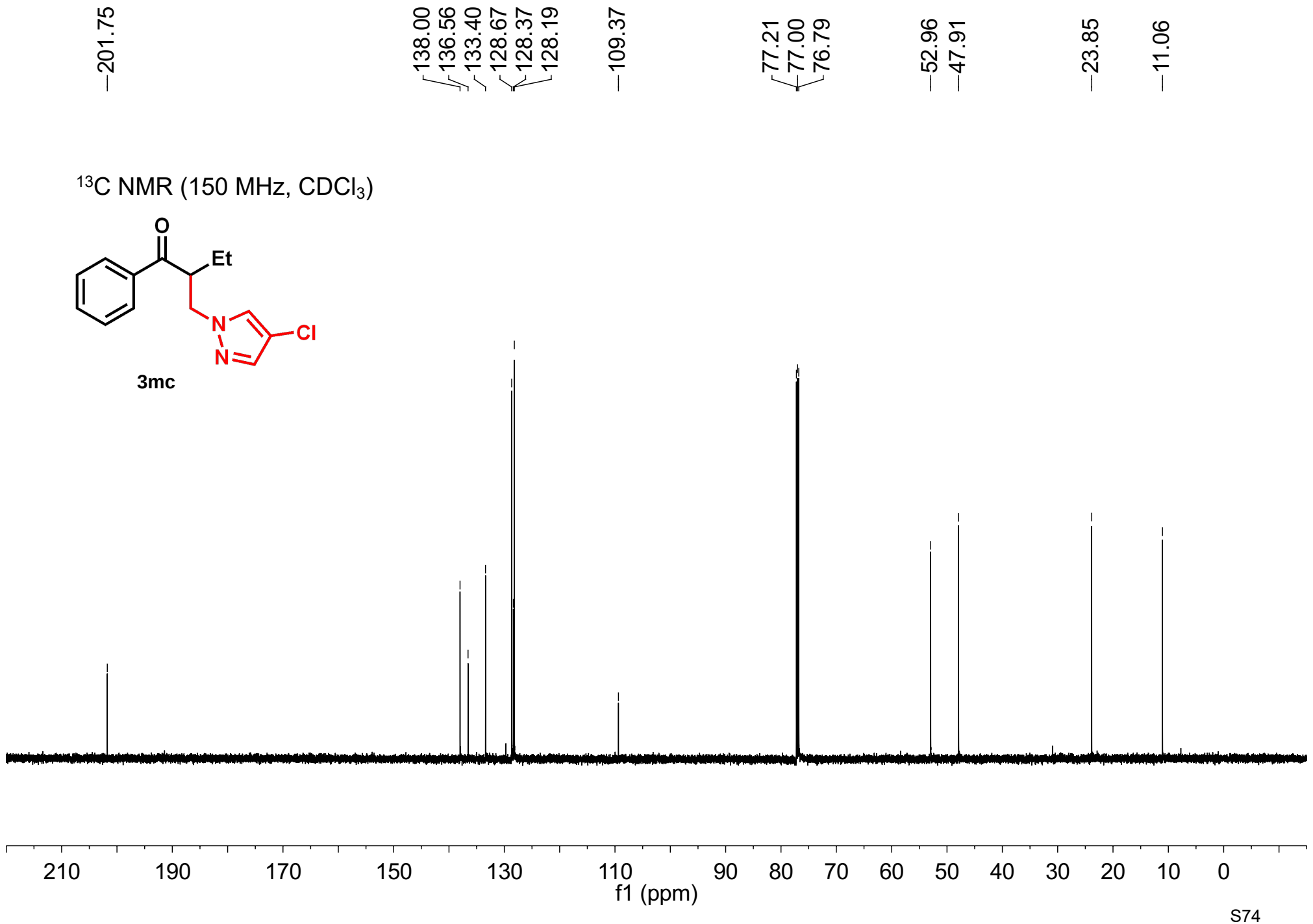


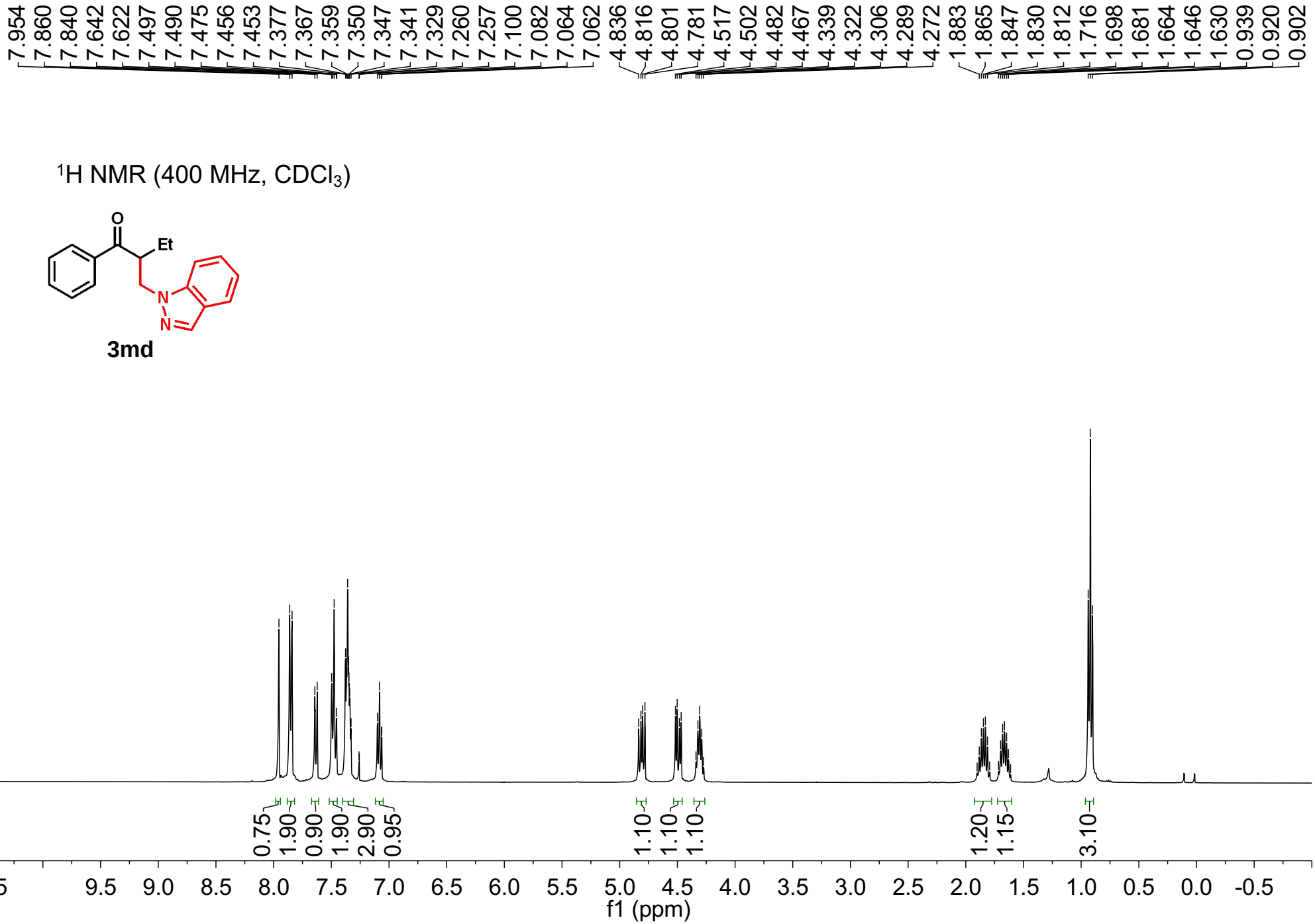
^{1}H NMR (400 MHz, $CDCl_3$)



3mc

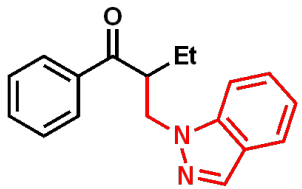



201.75
138.00
136.56
133.40
128.67
128.37
128.19
109.37
77.21
77.00
76.79
52.96
47.91
23.85
11.06
13C NMR (150 MHz, CDCl3)
O
Et
N
N
Cl
3mc
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

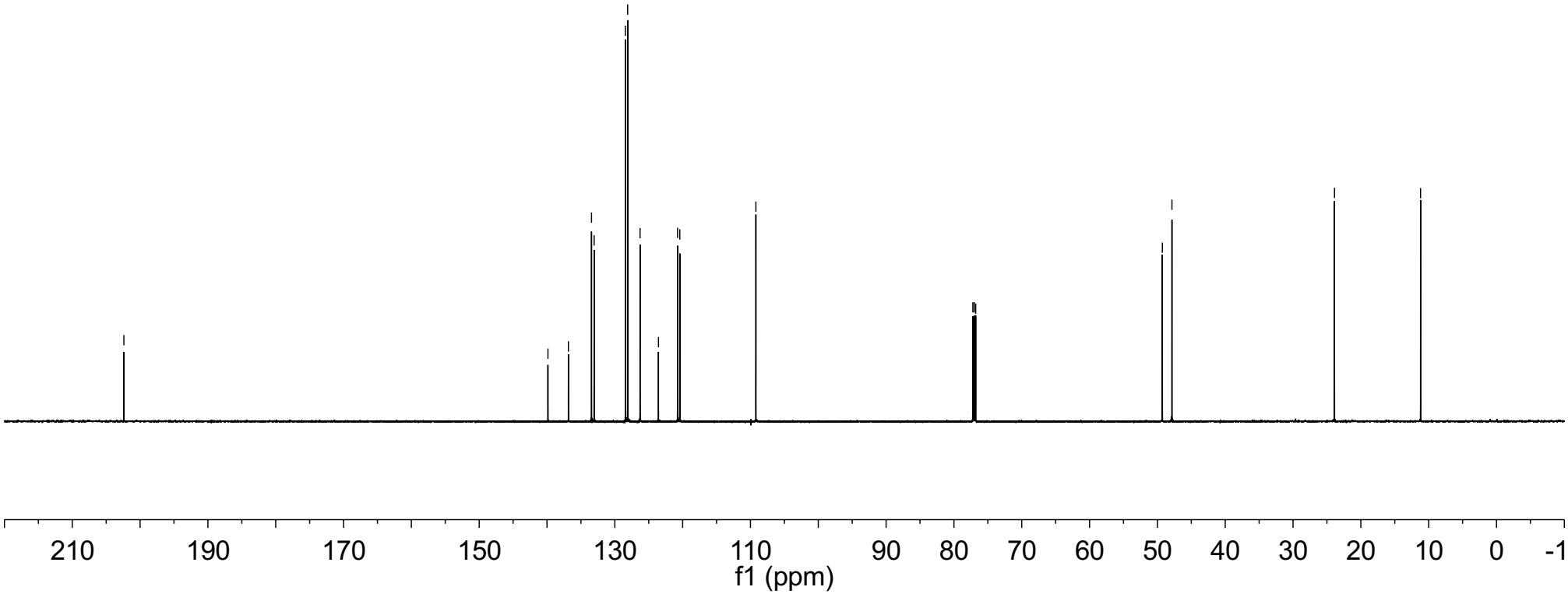

7.954
7.860
7.840
7.642
7.622
7.497
7.490
7.475
7.456
7.453
7.377
7.367
7.359
7.350
7.347
7.341
7.329
7.260
7.257
7.100
7.082
7.064
7.062
4.836
4.816
4.801
4.781
4.517
4.502
4.482
4.467
4.339
4.322
4.306
4.289
4.272
1.883
1.865
1.847
1.830
1.812
1.716
1.698
1.681
1.664
1.646
1.630
0.939
0.920
0.902
^{1}H NMR (400 MHz, $CDCl_3$)
O
Et
N
N
3md
0.75
1.90
0.90
1.90
2.90
0.95
1.10
1.10
1.10
1.20
1.15
3.10
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

202.39
139.86
136.84
133.44
133.05
128.44
128.11
126.28
123.57
120.75
120.42
109.20
77.21
77.00
76.79
49.27
47.85
23.89
11.19

^{13}C NMR (150 MHz, $CDCl_3$)

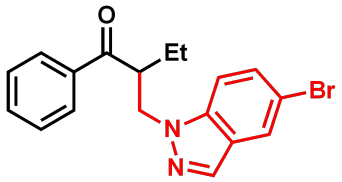


3md

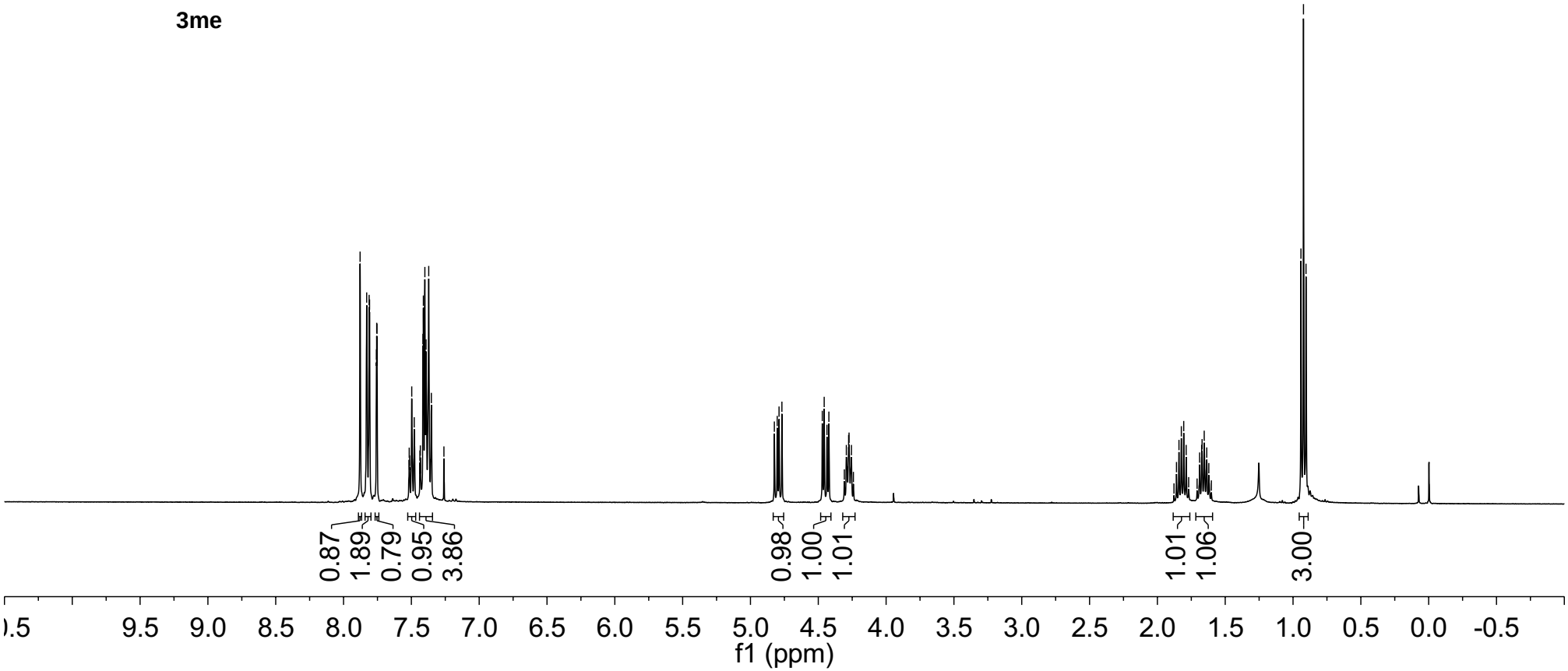


7.878
7.829
7.811
7.808
7.757
7.755
7.754
7.516
7.513
7.497
7.479
7.476
7.437
7.434
7.415
7.411
7.400
7.392
7.372
7.353
7.260
4.824
4.803
4.789
4.768
4.470
4.456
4.436
4.422
4.308
4.293
4.276
4.273
4.256
4.241
1.859
1.841
1.823
1.806
1.788
1.769
1.689
1.674
1.670
1.655
1.636
1.621
0.942
0.923
0.904

^{1}H NMR (400 MHz, $CDCl_3$)

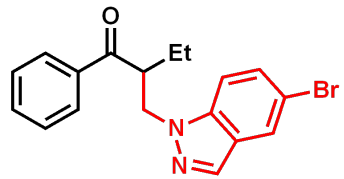


3me

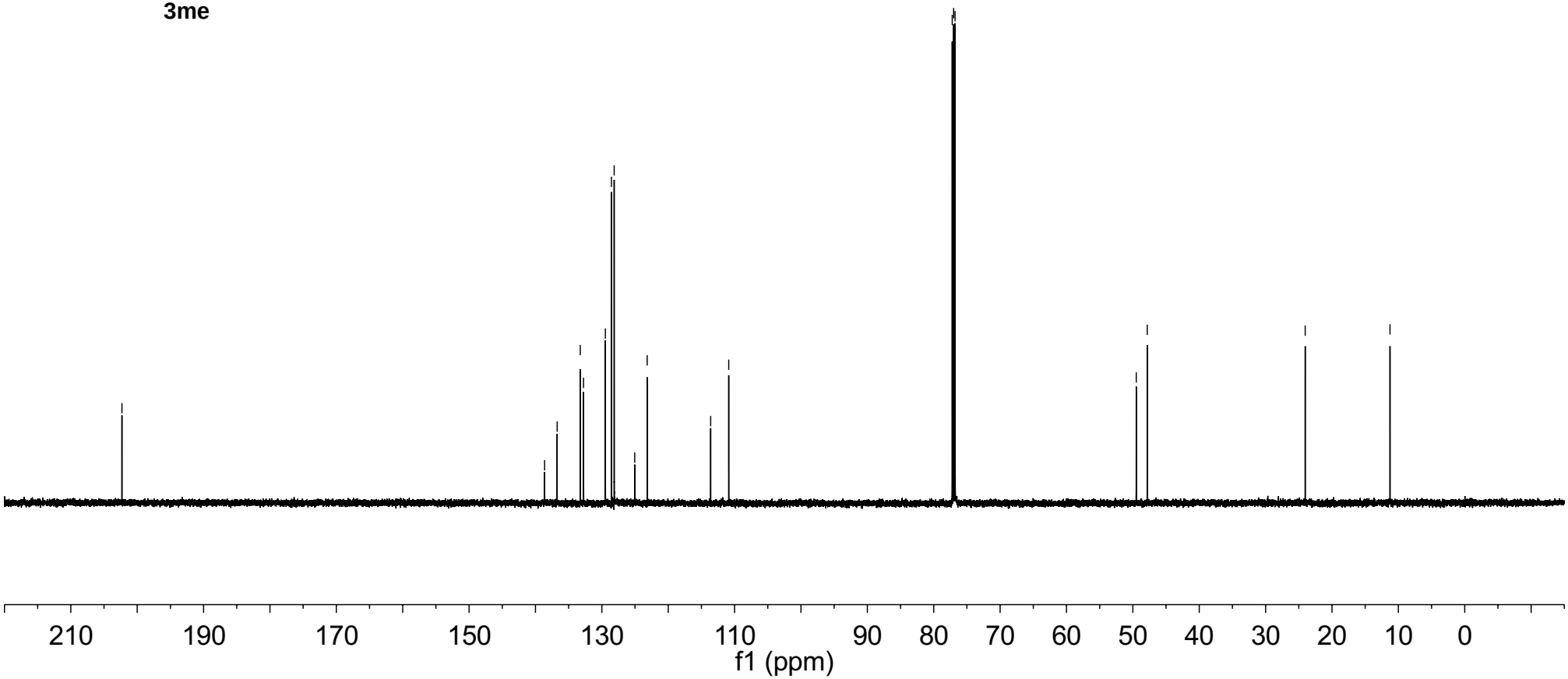


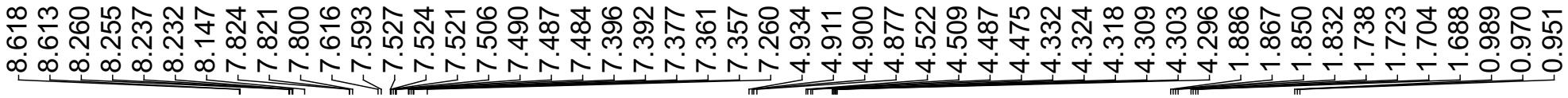
202.30
138.62
136.73
133.25
132.76
129.47
128.55
128.14
125.04
123.17
113.60
110.88
77.21
77.00
76.79
49.49
47.83
24.04
11.26

^{13}C NMR (150 MHz, $CDCl_3$)

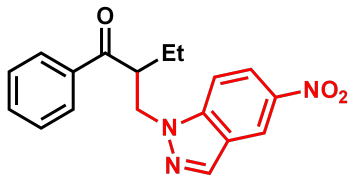


3me

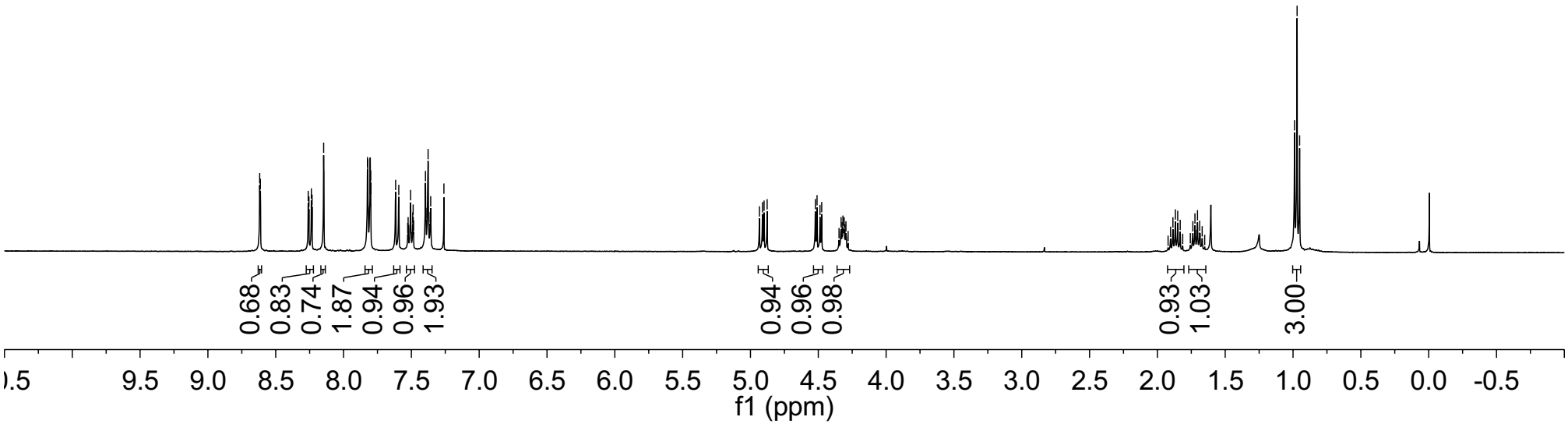




^{1}H NMR (400 MHz, $CDCl_3$)

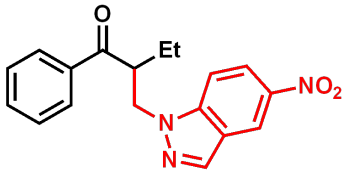


3mf

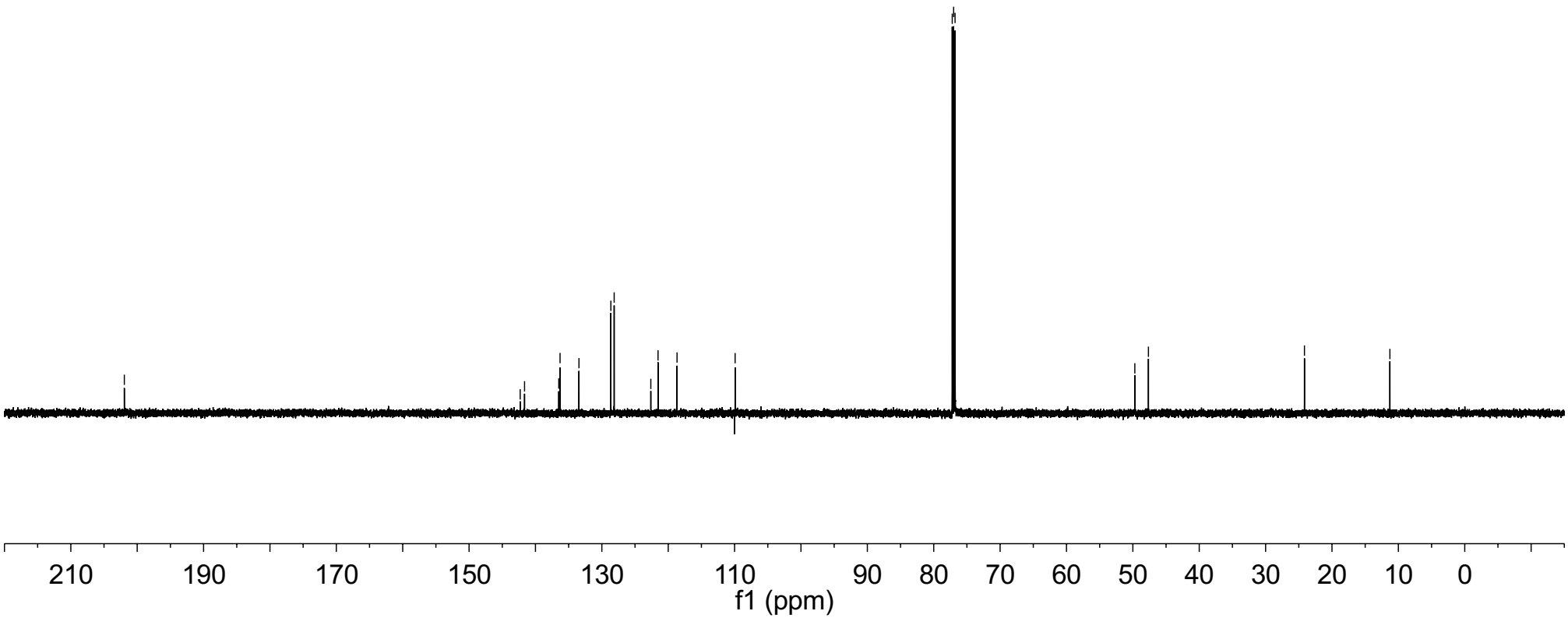


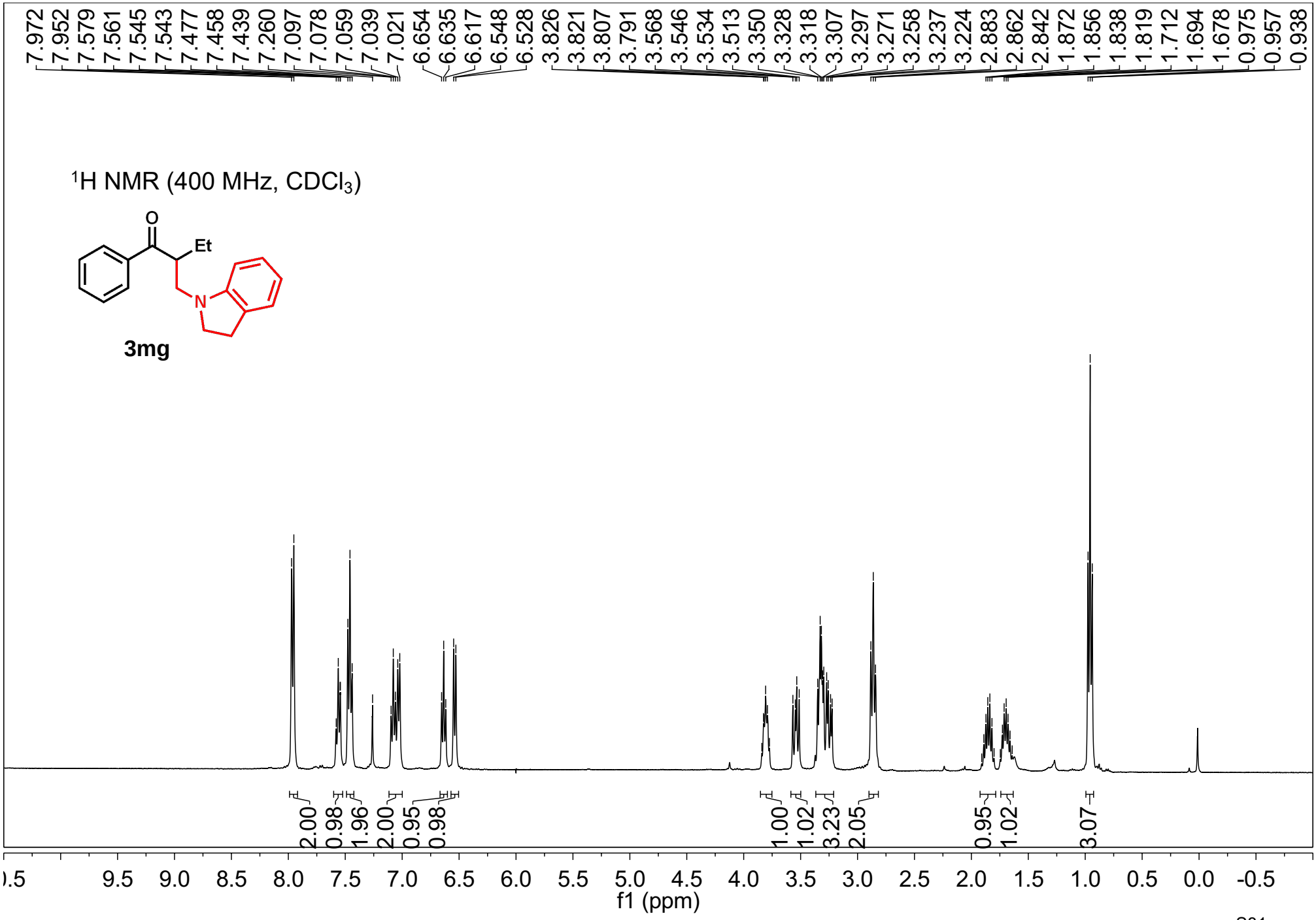
201.94
142.30
141.64
136.49
136.29
133.45
128.64
128.14
122.62
121.53
118.67
109.92
77.21
77.00
76.79
49.71
47.66
24.15
11.28

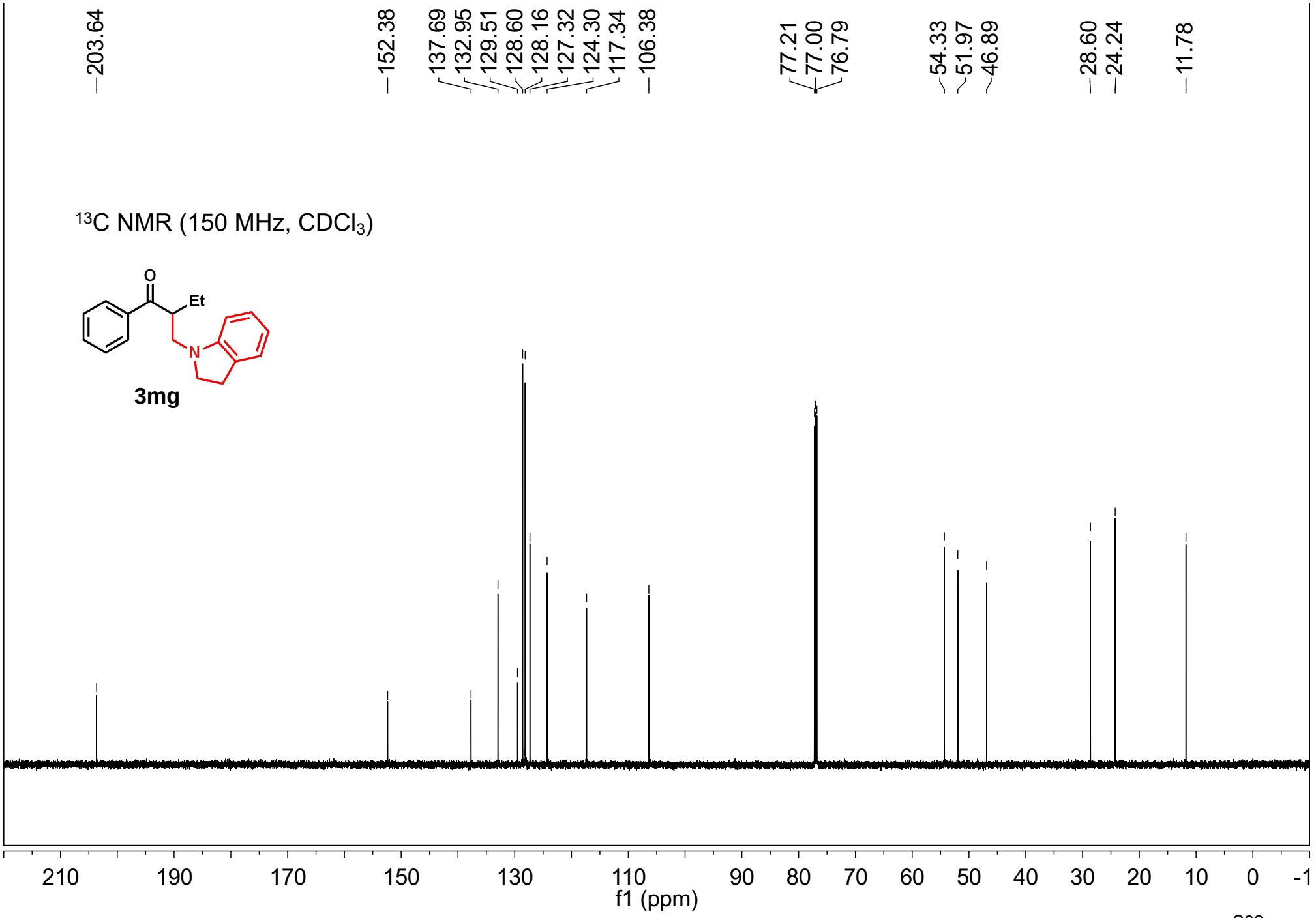
^{13}C NMR (150 MHz, $CDCl_3$)

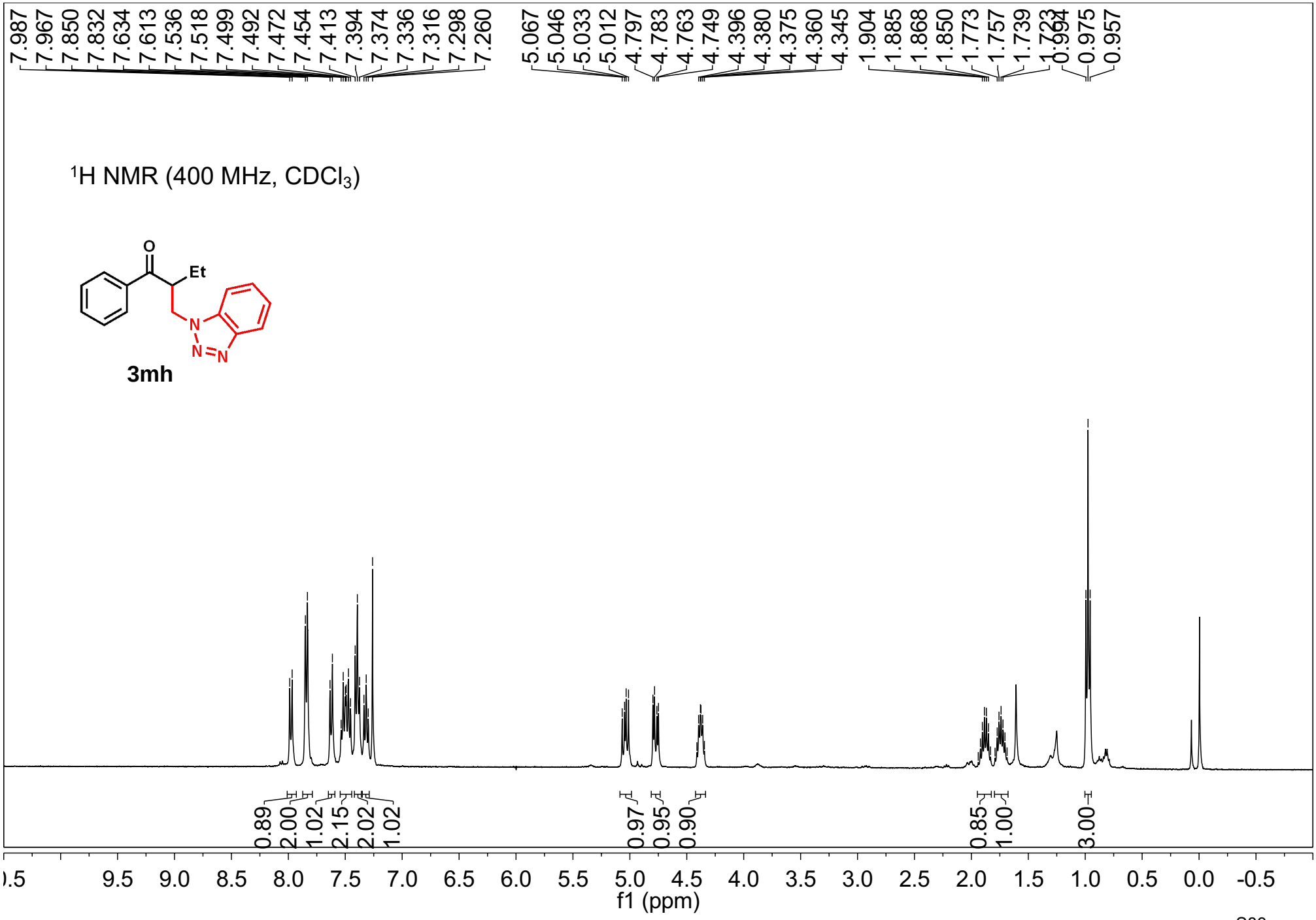


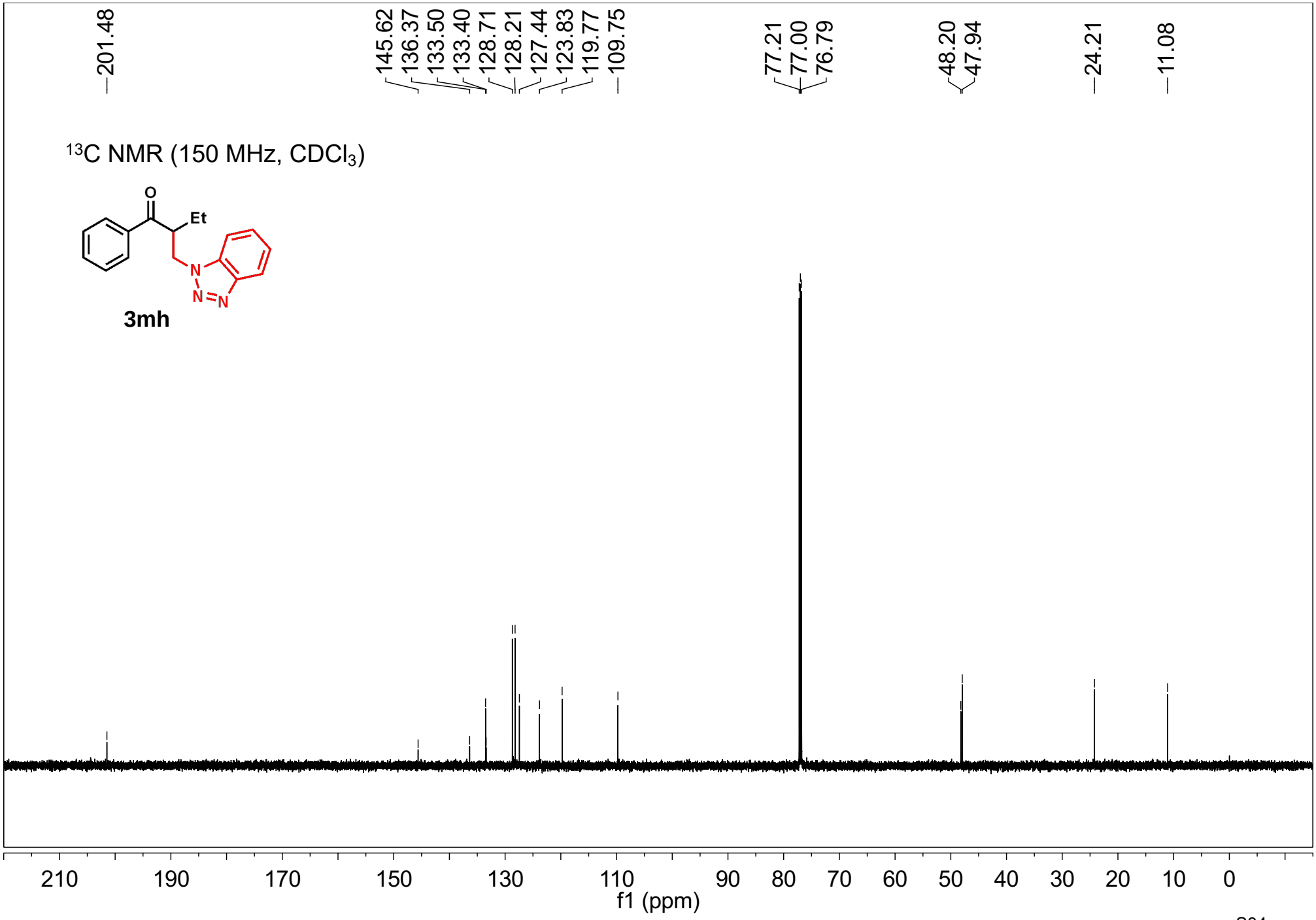
3mf




7.972
7.952
7.579
7.561
7.545
7.543
7.477
7.458
7.439
7.260
7.097
7.078
7.059
7.039
7.021
6.654
6.635
6.617
6.548
6.528
3.826
3.821
3.807
3.791
3.568
3.546
3.534
3.513
3.350
3.328
3.318
3.307
3.297
3.271
3.258
3.237
3.224
2.883
2.862
2.842
1.872
1.856
1.838
1.819
1.712
1.694
1.678
0.975
0.957
0.938
1H NMR (400 MHz, CDCl3)
O
Et
N
3mg
2.00
0.98
1.96
2.00
0.95
0.98
1.00
1.02
3.23
2.05
0.95
1.02
3.07
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

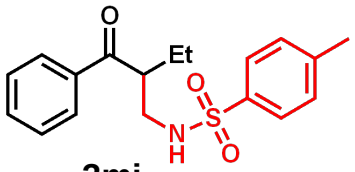

203.64
152.38
137.69
132.95
129.51
128.60
128.16
127.32
124.30
117.34
106.38
77.21
77.00
76.79
54.33
51.97
46.89
28.60
24.24
11.78
13C NMR (150 MHz, CDCl3)
O
Et
N
3mg
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)


7.987
7.967
7.850
7.832
7.634
7.613
7.536
7.518
7.499
7.492
7.472
7.454
7.413
7.394
7.374
7.336
7.316
7.298
7.260
5.067
5.046
5.033
5.012
4.797
4.783
4.763
4.749
4.396
4.380
4.375
4.360
4.345
1.904
1.885
1.868
1.850
1.773
1.757
1.739
1.723
0.994
0.975
0.957
^{1}H NMR (400 MHz, $CDCl_3$)
O
Et
N
N
N
3mh
0.89
2.00
1.02
2.15
2.02
1.02
0.97
0.95
0.90
0.85
1.00
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

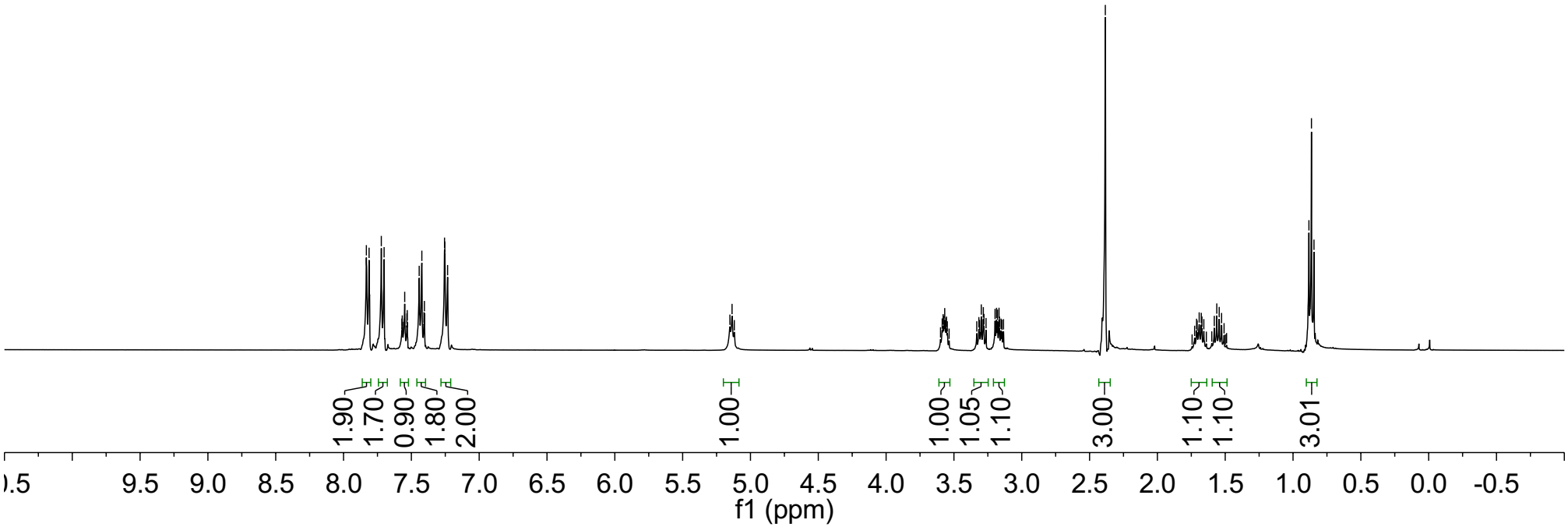

201.48
145.62
136.37
133.50
133.40
128.71
128.21
127.44
123.83
119.77
109.75
77.21
77.00
76.79
48.20
47.94
24.21
11.08
13C NMR (150 MHz, CDCl3)
O
Et
N
N
N
3mh
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

7.832 7.812 7.722 7.701 7.570 7.567 7.549 7.533 7.530 7.442 7.423 7.407 7.404 7.255 7.253 7.233 5.152 5.136 3.586 3.580 3.573 3.568 3.560 3.555 3.316 3.298 3.283 3.279 3.263 3.197 3.186 3.179 3.168 3.164 3.153 3.146 3.134 2.384 1.711 1.692 1.676 1.672 1.658 1.581 1.562 1.544 1.527 0.883 0.864 0.846

^{1}H NMR (400 MHz, $CDCl_3$)

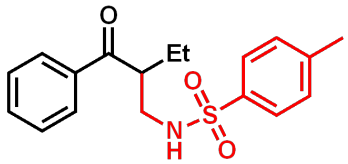


3mi



202.97
143.23
137.09
136.14
133.38
129.66
128.63
128.26
126.90
77.21
77.00
76.79
47.50
43.04
23.46
21.42
11.20

^{13}C NMR (150 MHz, $CDCl_3$)



3mi