Supporting Information

Highly Efficient Iron-Catalyzed Conjugate·Reduction of α,β-Unsaturated Ketones·with Polymethylhydrosiloxane

Hang Wang, Libo Chen, Yushuang Chen* and Yulong Zhang*

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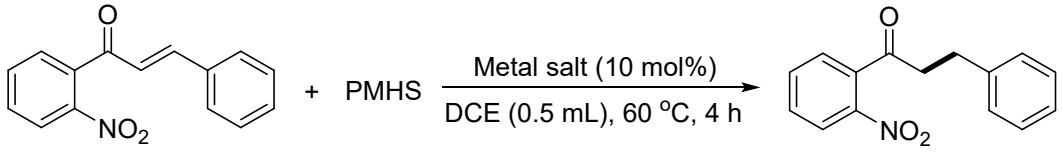
I. General Information

$FeCl_3$, PMHS, and $(CF_3)_2CHOH$ were purchased from Adamas. All others reagents were purchased from commercial suppliers (Macklin, Knowles, KESHI, Aladdin and Energy Chemical) and used without further purification.

All compounds (starting materials and products) were characterized by ^1H NMR, ^{13}C NMR, IR spectroscopy and high-resolution mass spectroscopy. ^1H NMR spectra were recorded on Bruker 300 or 400 MHz spectrometer and are referenced relative to residual $CDCl_3$ proton signals at δ 7.26 ppm. ^{19}F NMR spectra were recorded on a Bruker 300 MHz spectrometer and are referenced to $CFCl_3$ (δ 0.0 ppm). Data for ^1H and ^{19}F NMR are reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad), integration, and coupling constant (Hz).^{13}C NMR spectra were recorded on a Bruker 300 MHz spectrometer and are referenced to $CDCl_3$ at δ 77.16 ppm. The ^{13}C NMR spectra were obtained with ^1H decoupling. Data for ^{13}C NMR are reported in terms of chemical shift and multiplicity where appropriate. IR spectra were obtained on a Bruker Alpha and was reported in terms of frequency of absorption (cm^{-1}). High Resolution Mass spectra were obtained from on an Agilent 6540 Q-TOF mass spectrometer, operating electrospray ionization (ESI) mode.

II. Optimization of the Reaction Conditions

Table S1. The screen of metal salts [a]



1a **2a**

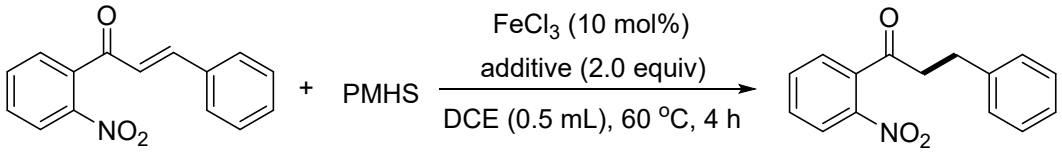
Entry	Metal salt	Yield (**2a**)[b]
1	none	0%
2	$Co(acac)_2$	trace
3	$VO(acac)_2$	0%
4	$Ni(acac)_2$	0%
5	$MoO_2(acac)_2$	0%
6	$Mn(acac)_3$	trace

7	$Fe(acac)_3$	0%
8	$Cu(OAc)_2$	0%
9	$Co(OAc)_2$	0%
10	$Fe(OAc)_2$	0%
11	$Zn(OAc)_2$	0%
12	$CuPF_6{\cdot}4CH_3CN$	14%
13	$MnBr_2{\cdot}4H_2O$	0%
14	$Sm(OTf)_3$	16%
15	$Ni(OTf)_2$	20%
16	$Sc(OTf)_3$	25%
17	$Cu(OTf)_2$	59%
18	$FeCl_3$	84%

[a] Conditions: **1a** (50.7 mg, 0.20 mmol, 1.0 equiv), metal salt (0.020 mmol, 10 mol%), PMHS (100 μL, 2.2 equiv) in DCE (0.5 mL) at 60 ℃ for 4 h.

[b] Isolated yield.

Table S2. The screen of additive [a]



1a **2a**

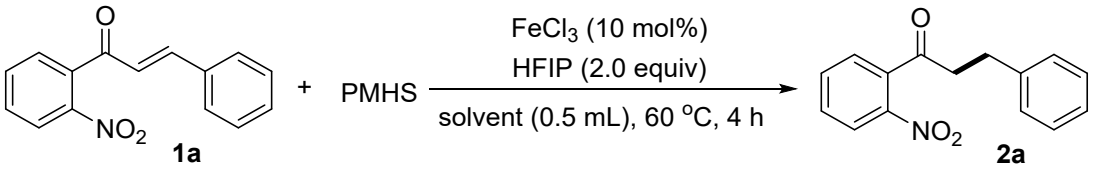
Entry	additive	Catalyst	Yield (**2a**)[b]
1	NH_4F	$FeCl_3$	0%
2	CsF	$FeCl_3$	0%
3	Cs_2CO_3	$FeCl_3$	0%
4	LiF	$FeCl_3$	42%
5	NaF	$FeCl_3$	63%
6	KF	$FeCl_3$	0%
7	K_3PO_4	$FeCl_3$	0%

8	DABCO	$FeCl_3$	0%
9	NH_4Cl	$FeCl_3$	0%
10	NH_4OAc	$FeCl_3$	0%
11	NaOAc	$FeCl_3$	0%
12	TMG	$FeCl_3$	< 5%
13	DBU	$FeCl_3$	0%
14	DIPEA	$FeCl_3$	0%
15	morpholine	$FeCl_3$	trace
16	$NaHCO_3$	$FeCl_3$	0%
17	$(CF_3)_2CHOH$	$FeCl_3$	93%
18	$(CF_3)_2CHOH$	-	0%

[a] Conditions: **1a** (50.7 mg, 0.20 mmol, 1.0 equiv), $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol%), additive (2.0 equiv), PMHS (100 μL, 2.2 equiv) in DCE (0.5 mL) at 60 ℃ for 4 h.

[b] Isolated yield.

Table S3. The screen of solvent [a]



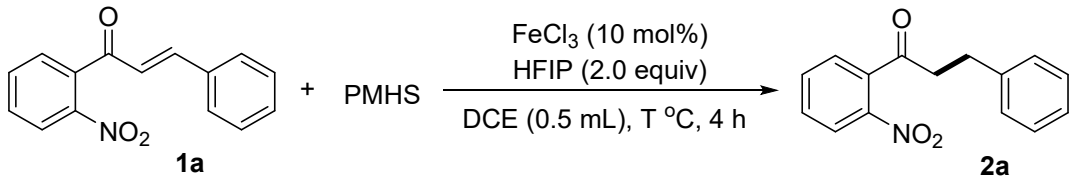
Entry	solvent	Yield (**2a**)[b]
1	DCE	93%
2	THF	0%
3	toluene	88%
4	CH_3CN	0%
5	$CHCl_3$	47%
6	1,4-dioxane	0%
7	DMAc	0%
8	NMP	trace

9	EtOH	0%
10	PhOMe	86%
11	MTBE	0%
12	Ph_2O	84%
13	DMSO	0%

[a] Conditions: **1a** (50.7 mg, 0.20 mmol, 1.0 equiv), $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol%), $(CF_3)_2CHOH$ (60 μL, 2.0 equiv), PMHS (100 μL, 2.2 equiv) in solvent (0.5 mL) at 60 ℃ for 4 h.

[b] Isolated yield.

Table S4. The screen of temperature [a]

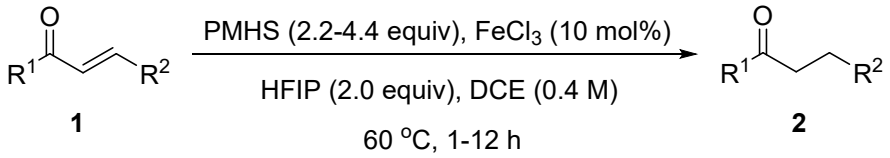


Entry	T	Yield (**2a**)[b]
1	25 ℃	86%
2	35 ℃	88%
3	60 ℃	93%
4	90 ℃	90%

[a] Conditions: **1a** (50.7 mg, 0.20 mmol, 1.0 equiv), $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol%), $(CF_3)_2CHOH$ (60 μL, 2.0 equiv), PMHS (100 μL, 2.2 equiv) in DCE (0.5 mL) at T ℃ for 4 h.

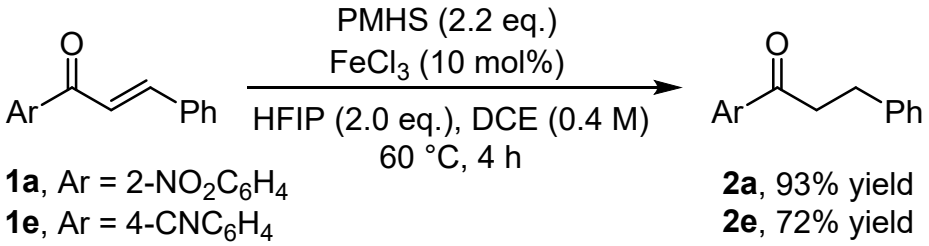
[b] Isolated yield.

III. General Procedure for Fe-Catalyzed Conjugate Reduction of Chalcone Derivatives

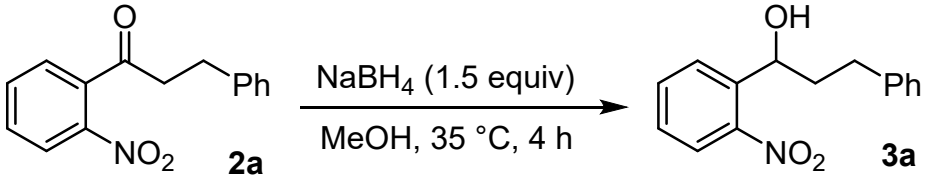


General procedure: Substituted enones **1** (0.20 mmol, 1.0 equiv) and $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol%) were dissolved in dry $ClCH_2CH_2Cl$ (0.5 mL, 0.4 M solution). Then, $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv) and PMHS (100.0-200.0 μL, 2.2-4.4 equiv) were added. The mixture was stirred in an oil bath at 60 ℃ for 1-12 h (the mixture was stirred at 400 rpm). After the reaction was complete, the mixture was extracted with EtOAc (5 mL × 3). The organic layer was concentrated to give the crude product. The mixture was purified by flash column chromatography (petroleum ether/EtOAc) to get the desired product **2**.

IV. Procedure for the scale-up reaction and the transformation of product.

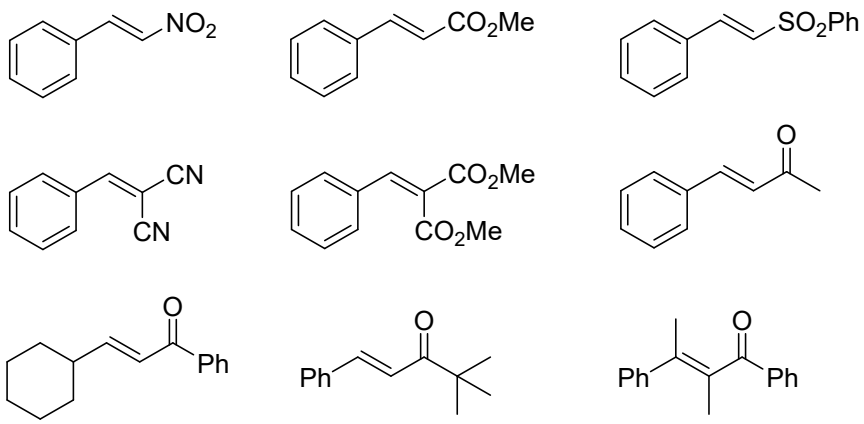


General procedure: An oven-dried 100 mL round-bottom flask was charged with **1a** (1.52 g, 6.0 mmol, 1.0 equiv), $FeCl_3$ (97.3 mg, 0.60 mmol, 10 mol%), $(CF_3)_2CHOH$ (1.8 mL, 2.0 equiv), PMHS (3.0 mL, 2.2 equiv) and DCE (15 mL). The mixture was stirred in an oil bath at 60 ℃ for 4 h (the mixture was stirred at 400 rpm). After the reaction was complete, the mixture was extracted with EtOAc (20 mL × 3). The organic layer was concentrated to give the crude product. The product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound **2a** as a colorless liquid (1.42 g, 93% yield). The same procedure for substrate **1e**.

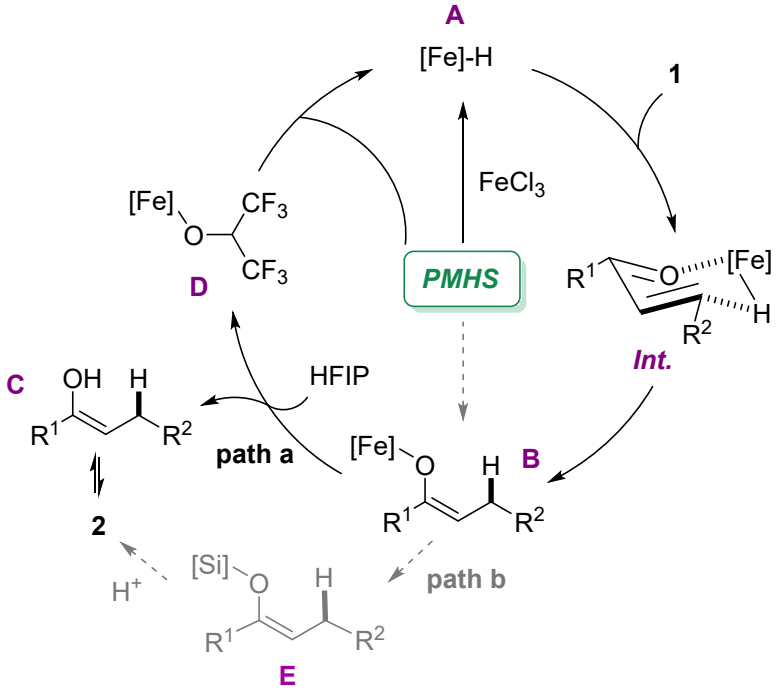


General procedure: Compound **2a** (153.2 mg, 0.60 mmol) was dissolved in MeOH (3 mL) and $NaBH_4$ (34.0 mg, 0.90 mmol, 1.5 equiv) was added. The mixture was stirred at 35 ℃ for 4 h, after the reaction was complete, the mixture was extracted with EtOAc. The organic layer was concentrated to give the crude product. The product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the derivative compound 138.0 mg of **3a** as a colorless liquid (90% yield).

V. Unsuccessful substrate scope



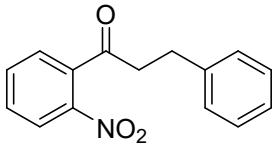
VI. Proposed mechanism



First, the precatalyst $FeCl_3$ could be reduced by PMHS to form iron hydride species **A**.

Then the α,β-unsaturated ketone **1** could coordinate with species A followed by the insertion into a Fe–H bond to generate species **B** via a possible six-membered ring intermediate. Later, HFIP induced the proto-demetallation to generate species **C** followed by tautomerization to deliver the desired product **2** (path a). Besides, without the additive, the iron enolate species **B** would react with PMHS via σ-bond metathesis to afford a silyl enolate **E**. Subsequently, the target product **2** was obtained by the hydrolysis of **E** in the quenching step (path b). Such an explanation is consistent with the experimental finding that a higher yield was observed when the HFIP was added which could accelerate the regeneration of reactive species **A**.

VII.The analytical and spectral characterization data of products.



2a

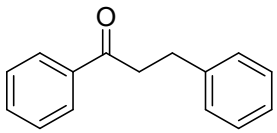
1-(2-Nitrophenyl)-3-phenylpropan-1-one. From **1a** (50.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 4 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (47.2 mg, 93% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.18 – 8.11 (m, 1H), 7.77 – 7.68 (m, 1H), 7.62 – 7.57 (m, 1H), 7.32 – 7.26 (m, 6H), 3.17 – 3.13 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.8, 145.6, 140.5, 138.0, 134.4, 130.6, 128.6, 128.6, 128.4, 128.4, 127.3, 126.3, 124.4, 44.7, 30.1.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{14}NO_3^+]$: 256.0968, found 256.0971.

IR (neat, cm^{-1}) 3028, 2866, 1703, 1604, 1573, 1523, 1453, 1344, 1205, 853, 788, 741, 697.



2b

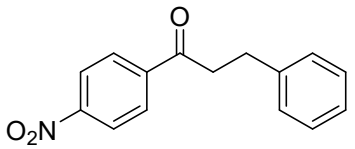
1,3-Diphenylpropan-1-one. From **1b** (41.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 4 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (29.2 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.87 (m, 1H), 7.86 – 7.85 (m, 1H), 7.47 – 7.43 (m, 1H), 7.37 – 7.33 (m, 2H), 7.21 – 7.19 (m, 2H), 7.17 – 7.15 (m, 2H), 7.13 – 7.11 (m, 1H), 3.20 (t, J = 8.0 Hz, 2H), 2.98 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.2, 141.4, 136.9, 133.2, 128.7, 128.7, 128.7, 128.7, 128.5, 128.5, 128.1, 128.1, 126.2, 40.5, 30.2.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{15}O^+]$: 211.1117, found 211.1120.

IR (neat, cm^{-1}) 3061, 3026, 2924, 1680, 1595, 1580, 1494, 1448, 1364, 1290, 1205, 972, 908, 741, 699.



2c

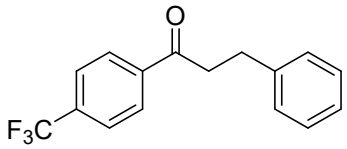
1-(4-Nitrophenyl)-3-phenylpropan-1-one. From **1c** (50.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (37.1 mg, 72% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.34 – 8.31 (m, 2H), 8.14 – 8.11 (m, 2H), 7.37 – 7.32 (m, 2H), 7.30 – 7.23 (m, 3H), 3.39 (t, J = 7.5 Hz, 2H), 3.13 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.7, 150.3, 141.2, 140.6, 129.1, 129.1, 128.7, 128.7, 128.4, 128.4, 126.4, 123.9, 123.9, 41.0, 29.9.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{14}NO_3^+]$: 256.0968, found 256.0970.

IR (neat, cm^{-1}) 3028, 2923, 1692, 1603, 1524, 1496, 1453, 1344, 1198, 907, 853, 727.



2d

1-(4-(Trifluoromethyl)phenyl)-3-phenylpropan-1-one. From **1d** (55.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (40.3 mg, 72% yield).

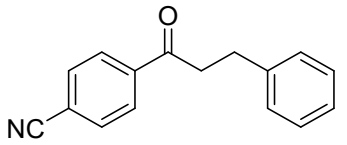
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 – 7.94 (m, 2H), 7.63 – 7.61 (m, 2H), 7.23 – 7.20 (m, 2H), 7.17 – 7.14 (m, 2H), 7.12 – 7.07 (m, 1H), 3.23 (t, J = 8.0 Hz, 2H), 2.99 (t, J = 8.0 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 197.1, 139.8, 138.5, 133.3 (q, J = 32.3 Hz), 127.6, 127.6, 127.4, 127.4, 127.3, 127.3, 125.3, 124.6 (q, J = 4.0 Hz), 122.6 (q, J = 273.7 Hz), 39.7, 28.9.

^{19}F NMR (282 MHz, $CDCl_3$) δ -63.1.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{16}H_{14}F_3O^+]$: 279.0991, found 279.0994.

IR (neat, cm^{-1}) 3029, 2930, 1691, 1604, 1584, 1496, 1454, 1410, 1323, 1166, 1125, 1065, 1015, 846, 746, 699.



2e

4-(3-Phenylpropanoyl) benzonitrile. From **1e** (46.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 3 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (36.1 mg, 76% yield).

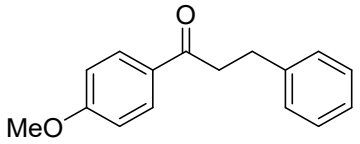
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.92 (m, 1H), 7.91 – 7.90 (m, 1H), 7.65 – 7.64

(m, 1H), 7.63 – 7.62 (m, 1H), 7.22 – 7.18 (m, 2H), 7.15 – 7.13 (m, 2H), 7.12 – 7.09 (m, 1H), 3.21 (t, J = 8.0 Hz, 2H), 2.97 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.9, 140.7, 139.7, 132.6, 132.6, 128.7, 128.7, 128.5, 128.5, 128.4, 128.4, 126.4, 118.0, 116.3, 40.8, 29.9.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{13}NONa^+]$: 258.0889, found 258.0891.

IR (neat, cm^{-1}) 3062, 3028, 2927, 2230, 1688, 1605, 1453, 1403, 1205, 800, 732, 698.



2f

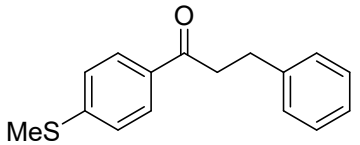
1-(4-Methoxyphenyl)-3-phenylpropan-1-one. From **1f** (47.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL, 4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 8 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (32.2 mg, 67% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.82 (m, 2H), 7.22 – 7.18 (m, 2H), 7.17 – 7.14 (m, 2H), 7.12 – 7.08 (m, 1H), 3.75 (s, 3H), 3.15 (t, J = 8.0 Hz, 2H), 2.96 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.9, 163.5, 141.5, 130.3, 130.3, 130.0, 128.5, 128.5, 128.5, 128.5, 126.1, 113.7, 113.7, 55.5, 40.2, 30.3.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{16}O_2Na^+]$: 263.1043, found 263.1048.

IR (neat, cm^{-1}) 3027, 2962, 2933, 1668, 1600, 1574, 1509, 1453, 1419, 1258, 1026, 905, 839, 727, 697.



2g

1-(4-(Methylthio) phenyl)-3-phenylpropan-1-one. From **1g** (50.9 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$

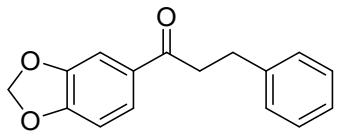
(3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL, 4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 12 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/20) to afford the title compound as a colorless liquid (33.9 mg, 66% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 – 7.77 (m, 1H), 7.76 – 7.75 (m, 1H), 7.22 – 7.18 (m, 2H), 7.16 – 7.15 (m, 2H), 7.15 – 7.13 (m, 2H), 7.12 – 7.09 (m, 1H), 3.15 (t, *J* = 8.0 Hz, 2H), 2.96 (t, *J* = 8.0 Hz, 2H), 2.40 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.3, 145.9, 141.3, 133.1, 128.6, 128.6, 128.5, 128.5, 128.5, 128.5, 126.2, 125.0, 125.0, 40.3, 30.2, 14.8.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{16}OSNa^+]$: 279.0814, found 279.0816.

IR (neat, cm^{-1}) 3063, 3027, 2922, 2858, 1661, 1588, 1554, 1490, 1451, 1399, 1209, 1076, 968, 908, 819, 773, 747, 697.



2h

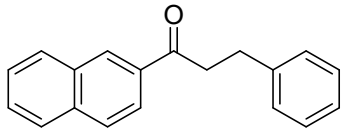
1-(benzo[*d*][1,3]dioxol-6-yl)-3-phenylpropan-1-one. From **1h** (50.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL, 4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 10 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (33.2 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 1H), 7.37 – 7.36 (m, 1H), 7.24 – 7.20 (m, 2H), 7.18 – 7.16 (m, 2H), 7.15 – 7.11 (m, 1H), 6.77 – 6.75 (m, 1H), 5.96 (s, 2H), 3.15 (t, *J* = 8.0 Hz, 2H), 2.97 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.3, 151.8, 148.2, 141.4, 131.8, 128.6, 128.6, 128.5, 128.5, 126.2, 124.3, 107.9, 107.9, 101.9, 40.2, 30.4.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{14}O_3Na^+]$: 277.0835, found 277.0840.

IR (neat, cm^{-1}) 3026, 2921, 2857, 1675, 1604, 1503, 1487, 1439, 1352, 1243, 1096, 1035, 931, 840, 807, 748, 698.



2i

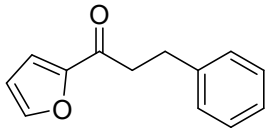
1-(Naphthalen-6-yl)-3-phenylpropan-1-one. From **1i** (51.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 9 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (31.2 mg, 60% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 – 8.32 (m, 1H), 7.93 – 7.90 (m, 1H), 7.81 – 7.79 (m, 1H), 7.76 – 7.72 (m, 2H), 7.48 – 7.39 (m, 2H), 7.23 – 7.21 (m, 1H), 7.20 – 7.16 (m, 3H), 7.13 – 7.08 (m, 1H), 3.31 (t, *J* = 8.0 Hz, 2H), 3.02 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.2, 141.4, 135.6, 134.2, 132.6, 129.7, 129.6, 128.6, 128.6, 128.5, 128.5, 128.5, 128.5, 127.8, 126.8, 126.2, 123.9, 40.6, 30.3.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{19}H_{17}O^+]$: 261.1274, found 261.1274.

IR (neat, cm^{-1}) 3059, 3026, 2923, 2851, 1679, 1627, 1598, 1453, 1260, 1123, 907, 731, 697.



2j

1-(Furan-2-yl)-3-phenylpropan-1-one. From **1j** (39.6 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (150.0 μL, 3.3 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 4 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (26.1 mg, 65% yield).

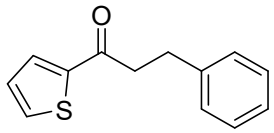
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.45 (m, 1H), 7.21 – 7.17 (m, 2H), 7.15 – 7.13 (m, 2H), 7.12 – 7.08 (m, 1H), 7.07 – 7.06 (m, 1H), 6.42 – 6.40 (m, 1H), 3.05 (t, *J* = 8.0

Hz, 2H), 2.95 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 188.5, 152.6, 146.4, 141.0, 128.5, 128.5, 128.4, 128.4, 126.2, 117.1, 112.2, 40.2, 30.0.

HRMS (ESI) m/z: [M + Na]$^+$ Calculated for [$C_{13}H_{12}O_2Na^+$]: 223.0730, found 223.0731.

IR (neat, cm^{-1}) 3062, 3027, 2928, 1672, 1603, 1568, 1467, 1394, 1260, 1012, 882, 754, 697.



2k

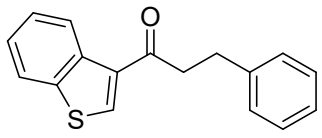
3-Phenyl-1-(thiophen-2-yl) propan-1-one. From **1k** (42.8 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (150.0 μL, 3.3 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 5 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (27.1 mg, 63% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.74 – 7.72 (m, 1H), 7.67 – 7.65 (m, 1H), 7.35 – 7.28 (m, 4H), 7.25 – 7.23(m, 1H), 7.16 – 7.14 (m, 1H), 3.28 (t, J = 7.5 Hz, 2H), 3.11 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 192.2, 144.2, 141.0, 133.6, 131.9, 128.6, 128.6, 128.5, 128.5, 128.1, 126.2, 41.2, 30.4.

HRMS (ESI) m/z: [M + Na]$^+$ Calculated for [$C_{13}H_{12}OSNa^+$]: 239.0501, found 239.0503.

IR (neat, cm^{-1}) 3063, 3028, 2928, 1657, 1603, 1518, 1496, 1414, 906, 721, 698.



2l

1-(Benzo[*b*]thiophen-2-yl)-3-phenylpropan-1-one. From **1l** (52.9 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL,

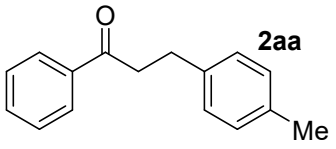
4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 8 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/20) to afford the title compound as a colorless liquid (32.8 mg, 63% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.86 (m, 3H), 7.49 – 7.41 (m, 2H), 7.36 – 7.31 (m, 5H), 3.38 (t, *J* = 7.5 Hz, 2H), 3.15 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 193.7, 143.5, 142.5, 140.9, 139.1, 129.0, 128.6, 128.6, 128.5, 128.5, 127.5, 126.3, 126.0, 125.0, 123.0, 41.1, 30.4.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{17}H_{14}OSNa^+]$: 289.0658, found 289.0660.

IR (neat, cm^{-1}) 3024, 2954, 2920, 2863, 1665, 1600, 1566, 1496, 1453, 1290, 1210, 1160, 905, 844, 726, 698.



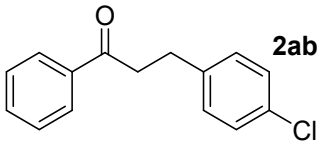
1-Phenyl-3-p-tolylpropan-1-one. From **1aa** (44.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (150.0 μL, 3.3 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 3 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (31.3 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.85 (m, 2H), 7.47 – 7.43 (m, 1H), 7.36 – 7.33 (m, 2H), 7.06 – 7.04 (m, 2H), 7.02 – 7.00 (m, 2H), 3.18 (t, *J* = 8.0 Hz, 2H), 2.93 (t, *J* = 8.0 Hz, 2H), 2.23 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.3, 138.3, 136.9, 135.7, 133.1, 129.3, 129.3, 128.7, 128.7, 128.4, 128.4, 128.1, 128.1, 40.7, 29.8, 21.1.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{16}ONa^+]$: 247.1093, found 247.1094.

IR (neat, cm^{-1}) 3022, 2922, 2861, 1683, 1597, 1580, 1514, 1448, 1203, 973, 810, 740, 688.



3-(4-Chlorophenyl)-1-phenylpropan-1-one. From **1ab** (48.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 8 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (34.7 mg, 72% yield).

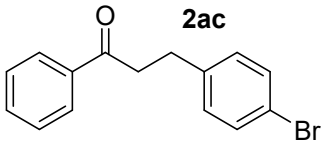
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00 – 7.98 (m, 2H), 7.63 – 7.58 (m, 1H), 7.52 – 7.47 (m, 2H), 7.31 – 7.29 (m, 2H), 7.24 – 7.21 (m, 2H), 3.32 (t, J = 7.5 Hz, 2H), 3.08 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.9, 139.8, 136.7, 133.2, 131.9, 129.9, 129.9, 128.7, 128.7, 128.6, 128.6, 128.0, 128.0, 40.2, 29.4.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{14}{}^{35}ClO^+]$: 245.0728, found 245.0733.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{14}{}^{37}ClO^+]$: 247.0698, found 247.0699.

IR (neat, cm^{-1}) 3027, 2931, 1684, 1597, 1580, 1492, 1448, 1091, 1015, 907, 814, 731, 688.



3-(4-Bromophenyl)-1-phenylpropan-1-one. From **1ac** (57.4 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 5 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (40.3 mg, 70% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00 – 7.97 (m, 2H), 7.60 – 7.57 (m, 1H), 7.51 – 7.43 (m, 4H), 7.18 – 7.15 (m, 2H), 3.31 (t, J = 7.5 Hz, 2H), 3.06 (t, J = 7.5 Hz, 2H).

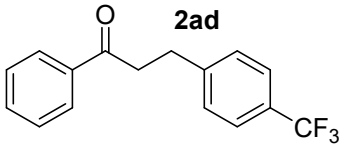
^{13}C NMR (75 MHz, $CDCl_3$) δ 198.8, 140.3, 136.7, 133.2, 131.6, 131.6, 130.3, 130.3,

128.7, 128.7, 128.0, 128.0, 119.9, 40.1, 29.4.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{13}{}^{79}BrONa^+]$: 311.0042, found 311.0043.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{13}{}^{81}BrONa^+]$: 313.0022, found 313.0025.

IR (neat, cm^{-1}) 3060, 2926, 1682, 1597, 1580, 1487, 1448, 1403, 1205, 1071, 1011, 908, 811, 731, 688.



3-(4-(trifluoromethyl)phenyl)-1-phenylpropan-1-one. From **1ad** (55.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 °C for 6 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (40.2 mg, 72% yield).

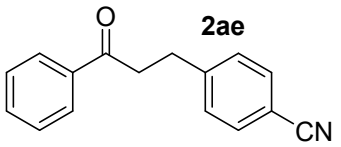
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.86 (m, 2H), 7.50 – 7.45 (m, 3H), 7.39 – 7.35 (m, 2H), 7.29 – 7.27 (m, 2H), 3.24 (t, J = 8.0 Hz, 2H), 3.05 (t, J = 8.0 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 197.5, 144.4, 135.7, 132.2, 127.8, 127.8, 127.6, 127.6, 127.2 (q, J = 32.3 Hz), 127.0, 127.0, 124.4 (q, J = 4.0 Hz), 123.3 (q, J = 273.7 Hz), 38.8, 28.8.

^{19}F NMR (282 MHz, $CDCl_3$) δ -62.3.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{13}F_3ONa^+]$: 301.0811, found 301.0816.

IR (neat, cm^{-1}) 3063, 2930, 1685, 1618, 1598, 1581, 1449, 1323, 1106, 1066, 1018, 908, 828, 742, 692.



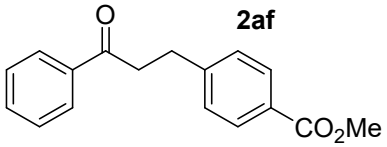
4-(3-Oxo-3-phenylpropyl)benzonitrile. From **1ae** (46.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (150.0 μL, 3.3 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 10 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (31.2 mg, 66% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.99 – 7.97 (m, 2H), 7.63 – 7.60 (m, 3H), 7.52 – 7.47 (m, 2H), 7.41 – 7.39 (m, 2H), 3.36 (t, *J* = 7.5 Hz, 2H), 3.17 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.3, 147.0, 136.5, 133.4, 132.3, 132.3, 129.4, 129.4, 128.7, 128.7, 128.0, 128.0, 119.0, 110.1, 39.5, 30.0.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{13}NONa^+]$: 258.0889, found 258.0893.

IR (neat, cm^{-1}) 3062, 3037, 2926, 2227, 1683, 1606, 1505, 1448, 1205, 1018, 909, 825, 729, 689.



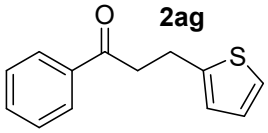
Methyl 4-(3-oxo-3-phenylpropyl)benzoate. From **1af** (53.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 4 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (36.2 mg, 68% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.87 (m, 2H), 7.87 – 7.86 (m, 2H), 7.49 – 7.45 (m, 1H), 7.39 – 7.35 (m, 2H), 7.25 – 7.23 (m, 2H), 3.81 (s, 3H), 3.24 (t, *J* = 8.0 Hz, 2H), 3.04 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.7, 167.0, 146.8, 136.7, 133.2, 129.9, 129.9, 128.7, 128.7, 128.5, 128.5, 128.0, 128.0, 121.6, 52.1, 39.8, 30.0.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{17}H_{16}O_3Na^+]$: 291.0992, found 291.0993.

IR (neat, cm^{-1}) 3031, 2952, 1711, 1682, 1606, 1434, 1277, 1178, 1099, 907, 766, 731, 687.



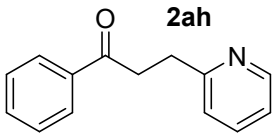
1-Phenyl-3-(thiophen-2-yl) propan-1-one. From **1ag** (42.9 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL, 4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 5 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (27.9 mg, 64% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.58 (m, 1H), 7.52 – 7.51 (m, 1H), 7.22 – 7.19 (m, 2H), 7.16 – 7.15 (m, 2H), 7.13 – 7.09 (m, 1H), 7.02 – 7.00 (m, 1H), 3.14 (t, *J* = 8.0 Hz, 2H), 2.98 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.6, 143.9, 136.7, 133.2, 128.7, 128.7, 128.1, 128.1, 126.9, 124.7, 123.4, 40.6, 24.2.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{13}H_{12}OSNa^+]$: 239.0501, found 239.0501.

IR (neat, cm^{-1}) 3062, 2903, 2853, 1683, 1597, 1580, 1493, 1447, 1260, 1020, 798, 740, 687.



1-Phenyl-3-(pyridin-2-yl) propan-1-one. From **1ah** (41.8 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 8 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (19.1 mg, 46% yield).

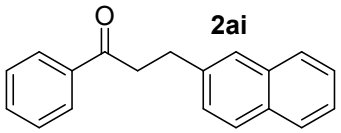
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.51 – 8.49 (m, 1H), 8.00 – 7.97 (m, 2H), 7.62 – 7.58

(m, 1H), 7.46 – 7.43 (m, 3H), 7.29 – 7.23 (m, 1H), 7.12 – 7.08 (m, 1H), 3.68 (t, J = 7.5 Hz, 2H), 3.51 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.6, 162.9, 149.2, 136.9, 136.4, 133.1, 128.6, 128.6, 128.1, 128.1, 124.2, 121.6, 43.6, 38.1.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{14}H_{14}NO^+]$: 212.1070, found 212.1075.

IR (neat, cm^{-1}) 3059, 2961, 1682, 1594, 1580, 1569, 1448, 1359, 1261, 1208, 1047, 837, 748, 688.



2ai

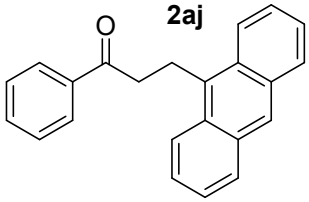
3-(Naphthalen-3-yl)-1-phenylpropan-1-one. From **1ai** (51.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 6 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (38.2 mg, 73% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.87 (m, 1H), 7.86 – 7.85 (m, 1H), 7.71 – 7.67 (m, 3H), 7.58 – 7.57 (m, 1H), 7.46 – 7.42 (m, 1H), 7.37 – 7.33 (m, 3H), 7.32 – 7.31 (m, 1H), 7.30 – 7.27 (m, 1H), 3.28 (t, J = 8.0 Hz, 2H), 3.13 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.2, 138.8, 136.9, 133.7, 133.2, 132.1, 128.7, 128.7, 128.2, 128.1, 128.1, 127.7, 127.6, 127.2, 126.6, 126.1, 125.4, 40.4, 30.3.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{19}H_{16}ONa^+]$: 283.1093, found 283.1097.

IR (neat, cm^{-1}) 3055, 2961, 2927, 1682, 1597, 1579, 1507, 1448, 1204, 975, 811, 740, 688.



2aj

3-(Anthracen-9-yl)-1-phenylpropan-1-one. From **1aj** (61.6 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$

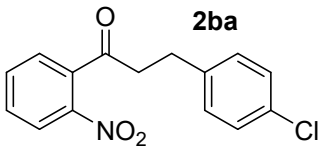
(3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (200.0 μL, 4.4 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 8 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (42.4 mg, 67% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.41 – 8.39 (m, 1H), 8.34 – 8.32 (m, 2H), 8.08 – 8.06 (m, 2H), 8.01 – 7.99 (m, 2H), 7.58 – 7.53 (m, 5H), 7.50 – 7.46 (m, 2H), 4.14 (t, *J* = 7.5 Hz, 2H), 3.50 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.4, 136.7, 133.5, 133.3, 131.7, 131.7, 129.6, 129.4, 129.4, 128.7, 128.7, 128.1, 128.1, 126.2, 126.2, 126.0, 126.0, 125.0, 125.0, 124.1, 124.1, 39.7, 22.0.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{23}H_{18}ONa^+]$: 333.1250, found 333.1251.

IR (neat, cm^{-1}) 3053, 2964, 1681, 1622, 1596, 1579, 1446, 1347, 1260, 1203, 840, 728, 687.



3-(4-Chlorophenyl)-1-(2-nitrophenyl) propan-1-one. From **1ba** (57.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (52.1 mg, 90% yield).

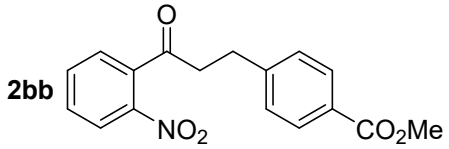
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.13 – 8.10 (m, 1H), 7.74 – 7.69 (m, 1H), 7.63 – 7.59 (m, 1H), 7.34 – 7.31 (m, 1H), 7.27 – 7.24 (m, 2H), 7.19 – 7.16 (m, 2H), 3.10 – 3.08 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.3, 145.5, 139.0, 137.8, 134.4, 132.0, 130.7, 129.8, 129.8, 128.6, 128.6, 127.3, 124.5, 44.4, 29.3.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{35}ClNa^+]$: 312.0398, found 312.0401.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{37}ClNa^+]$: 314.0368, found 314.0374.

IR (neat, cm^{-1}) 2962, 2926, 2861, 1704, 1600, 1574, 1524, 1491, 1344, 1090, 1015, 853, 814, 787, 748, 699.



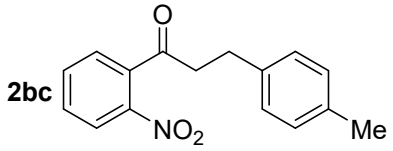
Methyl 4-(3-(2-nitrophenyl)-3-oxopropyl)benzoate. From **1bb** (62.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (54.4 mg, 86% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.15 – 8.12 (m, 1H), 7.98 – 7.96 (m, 2H), 7.74 – 7.69 (m, 1H), 7.64 – 7.59 (m, 1H), 7.33 – 7.30 (m, 3H), 3.91 (s, 3H), 3.22 – 3.10 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.2, 167.0, 146.0, 145.5, 137.8, 134.4, 130.6, 129.9, 129.9, 128.5, 128.5, 128.3, 127.2, 124.5, 52.1, 44.1, 30.0.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{17}H_{16}NO_5^+]$: 314.1023, found 314.1024.

IR (neat, cm^{-1}) 3033, 2999, 2953, 1708, 1610, 1574, 1525, 1435, 1345, 1217, 1080, 1103, 1019, 984, 909, 855, 732.



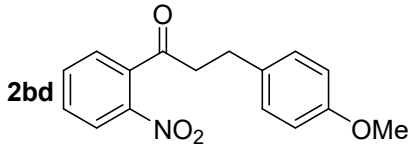
1-(2-Nitrophenyl)-3-p-tolylpropan-1-one. From **1bc** (53.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (48.3 mg, 89% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14 – 8.11 (m, 1H), 7.75 – 7.70 (m, 1H), 7.64 – 7.59 (m, 1H), 7.36 – 7.34 (m, 1H), 7.19 – 7.16 (m, 4H), 3.13 – 3.12 (m, 4H), 2.37 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.9, 145.6, 138.0, 137.4, 135.8, 134.4, 130.6, 129.3, 129.3, 128.3, 128.3, 127.4, 124.4, 44.8, 29.7, 21.0.

HRMS (ESI) m/z: [M + Na]$^+$ Calculated for [$C_{16}H_{15}NO_3Na^+$]: 292.0944, found 292.0944.

IR (neat, cm^{-1}) 2964, 2922, 1705, 1527, 1345, 1260, 1084, 1046, 906, 853, 729, 699.



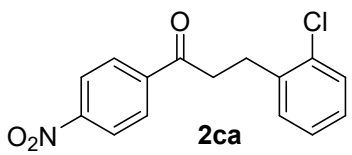
3-(4-Methoxyphenyl)-1-(2-nitrophenyl) propan-1-one. From **1bd** (37.4 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 °C for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/6) to afford the title compound as a colorless liquid (47.9 mg, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 – 7.97 (m, 1H), 7.59 – 7.55 (m, 1H), 7.49 – 7.45 (m, 1H), 7.19 – 7.17 (m, 1H), 7.04 – 7.01 (m, 2H), 6.73 – 6.70 (m, 2H), 3.66 (s, 3H), 2.98 – 2.92 (m, 4H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.9, 158.1, 145.6, 138.0, 134.4, 132.5, 130.6, 129.4, 129.4, 127.3, 124.4, 114.0, 114.0, 55.3, 44.9, 29.2.

HRMS (ESI) m/z: [M + Na]$^+$ Calculated for [$C_{16}H_{15}NO_4Na^+$]: 308.0893, found 308.0896.

IR (neat, cm^{-1}) 3033, 2959, 2934, 1707, 1611, 1575, 1527, 1511, 1345, 1244, 1032, 825, 729.



3-(2-Chlorophenyl)-1-(4-nitrophenyl) propan-1-one. From **1ca** (57.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (38.3 mg, 66% yield).

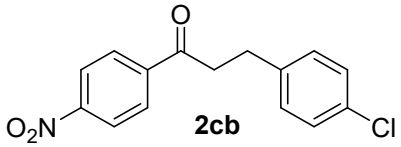
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.34 – 8.31 (m, 2H), 8.15 – 8.12 (m, 2H), 7.41 – 7.38 (m, 1H), 7.35 – 7.32 (m, 1H), 7.24 – 7.22 (m, 1H), 7.21 – 7.18 (m, 1H), 3.39 (t, *J* = 7.5 Hz, 2H), 3.22 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.5, 150.3, 141.1, 138.2, 133.9, 130.9, 129.7, 129.1, 129.1, 128.1, 127.1, 123.9, 123.9, 39.0, 28.2.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{35}ClNa^+]$: 312.0398, found 312.0399.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{37}ClNa^+]$: 314.0368, found 314.0370.

IR (neat, cm^{-1}) 3072, 2962, 2859, 1692, 1602, 1522, 1475, 1443, 1343, 1199, 1107, 1051, 979, 853, 789, 740.



2cb

3-(4-Chlorophenyl)-1-(4-nitrophenyl) propan-1-one. From **1cb** (57.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (39.2 mg, 67% yield).

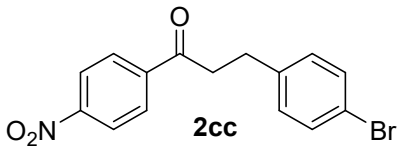
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 – 8.28 (m, 2H), 8.13 – 8.10 (m, 2H), 7.28 – 7.19 (m, 4H), 3.36 (t, *J* = 7.5 Hz, 2H), 3.08 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.3, 150.3, 141.1, 139.1, 132.1, 129.8, 129.8, 129.0, 129.0, 128.7, 128.7, 123.9, 123.9, 40.7, 29.1.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{35}ClNa^+]$: 312.0398, found 312.0402.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{37}ClNa^+]$: 314.0368, found 314.0372.

IR (neat, cm^{-1}) 3051, 2924, 2853, 1686, 1599, 1520, 1488, 1404, 1345, 1266, 1095, 906, 859, 811, 735.



2cc

3-(4-Bromophenyl)-1-(4-nitrophenyl) propan-1-one. From **1cc** (66.4 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 °C for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (42.2 mg, 64% yield).

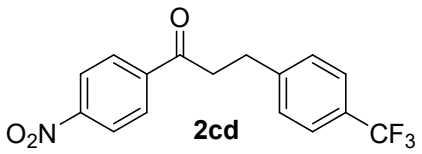
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.32 – 8.29 (m, 2H), 8.13 – 8.10 (m, 2H), 7.44 – 7.41 (m, 2H), 7.17 – 7.14 (m, 2H), 3.36 (t, J = 7.5 Hz, 2H), 3.07 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.2, 150.3, 141.1, 139.6, 131.7, 131.7, 130.2, 130.2, 129.0, 129.0, 123.9, 123.9, 120.1, 40.6, 29.1.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{79}BrNa^+]$: 355.9893, found 355.9897.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}NO_3{}^{81}BrNa^+]$: 357.9872, found 357.9872.

IR (neat, cm^{-1}) 3111, 2926, 2854, 1687, 1600, 1521, 1487, 1404, 1343, 1261, 1196, 1071, 1010, 906, 852, 808, 729.



3-(4-(Trifluoromethyl) phenyl)-1-(4-nitrophenyl) propan-1-one. From **1cd** (64.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (47.7 mg, 74% yield).

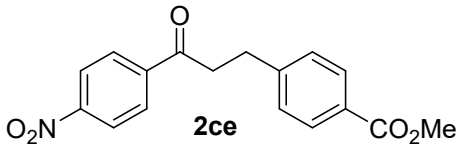
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 – 8.20 (m, 2H), 8.03 – 8.00 (m, 2H), 7.48 – 7.46 (m, 2H), 7.30 – 7.28 (m, 2H), 3.30 (t, *J* = 8.0 Hz, 2H), 3.08 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.0, 150.4, 144.8, 141.0, 129.0, 129.0, 128.8, 128.8, 128.7 (q, *J* = 32.3 Hz), 125.5 (q, *J* = 3.8 Hz), 124.2 (q, *J* = 270.0 Hz), 123.9, 123.9, 40.4, 29.5.

^{19}F NMR (282 MHz, $CDCl_3$) δ -62.4.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{12}F_3NO_3Na^+]$: 346.0661, found 346.0662.

IR (neat, cm^{-1}) 3112, 2962, 2856, 1689, 1600, 1523, 1413, 1346, 1319, 1260, 1161, 1105, 1085, 1016, 907, 789, 734.



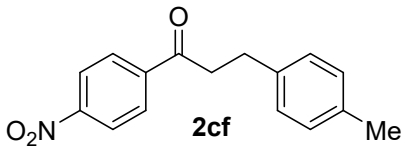
Methyl 4-(3-(4-nitrophenyl)-3-oxopropyl) benzoate. From **1ce** (62.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (40.0 mg, 65% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.33 – 8.30 (m, 2H), 8.13 – 8.10 m, 2H), 8.00 – 7.97 (m, 2H), 7.36 – 7.33 (m, 2H), 3.92 (s, 3H), 3.40 (t, *J* = 7.5 Hz, 2H), 3.17 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.1, 166.9, 150.4, 146.1, 141.0, 130.0, 130.0, 129.1, 129.1, 128.5, 128.5, 128.4, 123.9, 123.9, 52.1, 40.4, 29.7.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{17}H_{16}NO_5^+]$: 314.1023, found 314.1024.

IR (neat, cm^{-1}) 2955, 2852, 1715, 1695, 1607, 1525, 1436, 1345, 1279, 1107, 1020, 906, 854, 728.



2cf

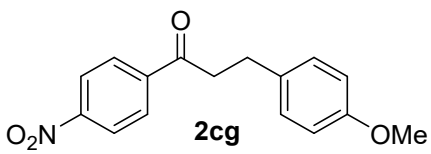
1-(4-Nitrophenyl)-3-p-tolylpropan-1-one. From **1cf** (53.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (35.5 mg, 66% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 – 8.20 (m, 2H), 8.02 – 7.99 (m, 2H), 7.07 – 7.05 (m, 2H), 7.04 – 7.02 (m, 2H), 3.24 (t, *J* = 8.0 Hz, 2H), 2.97 (t, *J* = 8.0 Hz, 2H), 2.24 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.8, 150.3, 141.3, 137.6, 135.9, 129.3, 129.3, 129.1, 129.1, 128.3, 128.3, 123.9, 123.9, 41.1, 29.5, 21.1.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{15}NO_3Na^+]$: 292.0944, found 292.0945.

IR (neat, cm^{-1}) 3112, 2920, 2855, 1686, 1599, 1519, 1407, 1345, 1318, 1199, 973, 865, 810, 796, 731.



2cg

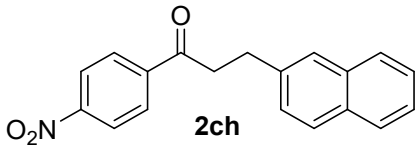
3-(4-Methoxyphenyl)-1-(4-nitrophenyl) propan-1-one. From **1cg** (56.7 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (36.8 mg, 64% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 – 8.28 (m, 2H), 8.12 – 8.09 (m, 2H), 7.20 – 7.17 (m, 2H), 6.87 – 6.84 (m, 2H), 3.80 (s, 3H), 3.34 (t, *J* = 7.5 Hz, 2H), 3.05 (t, *J* = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.9, 158.1, 150.2, 141.3, 132.6, 129.4, 129.4, 129.1, 129.1, 123.9, 123.9, 114.0, 114.0, 55.3, 41.2, 29.0.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{15}NO_4Na^+]$: 308.0893, found 308.0897.

IR (neat, cm^{-1}) 3076, 2959, 2925, 1689, 1604, 1511, 1344, 1244, 1030, 820, 796.



2ch

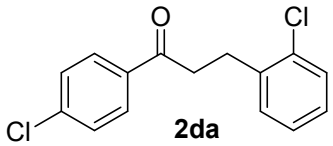
3-(Naphthalen-3-yl)-1-(4-nitrophenyl) propan-1-one. From **1ch** (37.4 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (37.3 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 – 8.16 (m, 1H), 8.15 – 8.14 (m, 1H), 7.99 – 7.97 (m, 1H), 7.96 – 7.95 (m, 1H), 7.71 – 7.66 (m, 3H), 7.58 – 7.57 (m, 1H), 7.36 – 7.32 (m, 2H), 7.29 – 7.26 (m, 1H), 3.31 (t, *J* = 8.0 Hz, 2H), 3.15 (t, *J* = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.6, 150.3, 141.2, 138.1, 133.6, 132.2, 129.1, 129.1, 128.3, 127.7, 127.5, 127.0, 126.6, 126.2, 125.5, 123.9, 123.9, 40.9, 30.0.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{19}H_{15}NO_3Na^+]$: 328.0944, found 328.0945.

IR (neat, cm^{-1}) 3050, 2924, 2854, 1686, 1600, 1518, 1404, 1342, 1260, 1195, 1103, 1012, 907, 854, 804, 735.



2da

3-(2-Chlorophenyl)-1-(4-chlorophenyl) propan-1-one. From **1da** (55.4 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1.5 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (31.0 mg, 55% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.92 – 7.90 (m, 2H), 7.45 – 7.41 (m, 2H), 7.38 – 7.36 (m, 1H), 7.32 – 7.31 (m, 1H), 7.21 – 7.19 (m, 2H), 3.31 – 3.27 (m, 2H), 3.20 – 3.18 (m, 2H).

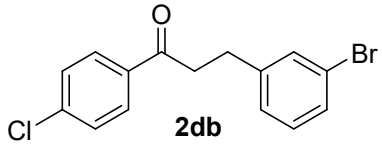
^{13}C NMR (75 MHz, $CDCl_3$) δ 197.7, 139.5, 138.6, 135.0, 133.9, 130.8, 129.6, 129.5, 129.5, 128.9, 128.9, 127.9, 127.0, 38.4, 28.3.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}O^{35}Cl_2Na^+]$: 301.0157, found 301.0158.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}O^{35}Cl^{37}ClNa^+]$: 303.0128, found 303.0130.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}O^{37}Cl_2Na^+]$: 305.0098, found 305.0101.

IR (neat, cm^{-1}) 3063, 2938, 1684, 1588, 1572, 1488, 1443, 1400, 1203, 1090, 1013, 976, 907, 831, 750, 729.



2db

3-(3-Bromophenyl)-1-(4-chlorophenyl) propan-1-one. From **1db** (64.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (35.3 mg, 55% yield).

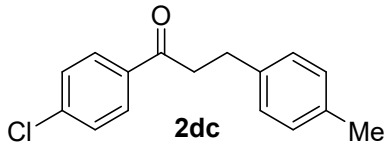
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 – 7.80 (m, 1H), 7.79 – 7.78 (m, 1H), 7.35 – 7.34 (m, 1H), 7.33 – 7.31 (m, 2H), 7.26 – 7.23 (m, 1H), 7.10 – 7.06 (m, 2H), 3.16 (t, J = 8.0 Hz, 2H), 2.94 (t, J = 8.0 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 197.4, 143.5, 139.6, 135.0, 131.5, 130.1, 129.5, 129.5, 129.4, 129.0, 129.0, 127.2, 122.6, 40.0, 29.5.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}O^{35}Cl^{79}BrNa^+]$: 344.9652, found 344.9653.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{15}H_{12}O^{35}Cl^{81}BrNa^+]$: 346.9632, found 346.9632.

IR (neat, cm^{-1}) 3060, 2929, 1683, 1588, 1568, 1487, 1400, 1203, 1090, 978, 906, 778, 729.



2dc

1-(4-Chlorophenyl)-3-p-tolylpropan-1-one. From **1dc** (51.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 1 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (29.0 mg, 56% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.95 – 7.92 (m, 2H), 7.48 – 7.45 (m, 2H), 7.21 – 7.18 (m, 4H), 3.30 (t, J = 7.5 Hz, 2H), 3.07 (t, J = 7.5 Hz, 2H), 2.38 (s, 3H).

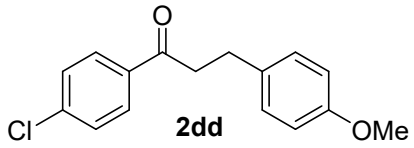
^{13}C NMR (75 MHz, $CDCl_3$) δ 198.1, 139.5, 138.0, 135.8, 135.2, 129.5, 129.5, 129.3,

129.3, 128.9, 128.9, 128.3, 128.3, 40.6, 29.7, 21.1.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{15}O^{35}ClNa^+]$: 281.0704, found 281.0706.

HRMS (ESI) m/z: $[M + Na]^+$ Calculated for $[C_{16}H_{15}O^{37}ClNa^+]$: 283.0674, found 283.0677.

IR (neat, cm^{-1}) 3023, 2915, 2857, 1674, 1587, 1570, 1515, 1486, 1200, 1092, 906, 806, 728.



2dd

1-(4-Chlorophenyl)-3-(4-methoxyphenyl) propan-1-one. From **1dd** (54.5 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 °C for 5 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (31.0 mg, 57% yield).

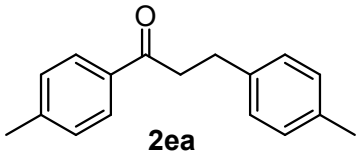
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.93 – 7.90 (m, 2H), 7.46 – 7.43 (m, 2H), 7.21 – 7.19 (m, 2H), 6.90 – 6.87 (m, 2H), 3.82 (s, 3H), 3.27 (t, J = 7.5 Hz, 2H), 3.04 (t, J = 7.5 Hz, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 198.1, 158.0, 139.5, 135.2, 133.1, 129.5, 129.5, 129.4, 129.4, 128.9, 128.9, 114.0, 114.0, 55.3, 40.7, 29.2.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{16}H_{16}O_2{}^{35}Cl^+]$: 275.0833, found 275.0833.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{16}H_{16}O_2{}^{37}Cl^+]$: 277.0804, found 277.0807.

IR (neat, cm^{-1}) 2999, 2933, 2835, 1684, 1611, 1588, 1511, 1464, 1441, 1244, 1090, 1034, 908, 818, 729.



2ea

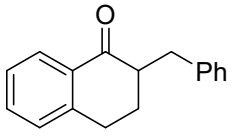
1,3-dip-tolylpropan-1-one. From **1ea** (47.3 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol%), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 2 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (26.1 mg, 54% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 – 7.76 (m, 2H), 7.16 – 7.14 (m, 2H), 7.06 – 7.04 (m, 2H), 7.02 – 7.00 (m, 2H), 3.16 (t, *J* = 8.0 Hz, 2H), 2.93 (t, *J* = 8.0 Hz, 2H), 2.31 (s, 3H), 2.23 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.0, 143.8, 138.4, 135.6, 134.5, 129.3, 129.3, 129.3, 129.3, 128.4, 128.4, 128.2, 128.2, 40.6, 29.9, 21.7, 21.1.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{17}H_{19}O^+]$: 239.1430, found 239.1431.

IR (neat, cm^{-1}) 3022, 2916, 2861, 1678, 1605, 1572, 1514, 1447, 1179, 976, 908, 799, 730.



2fa

2-benzyl-3,4-dihydronaphthalen-1(2*H*)-one.

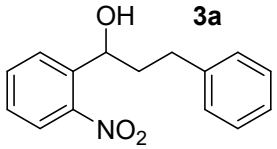
From **1fa** (46.8 mg, 0.20 mmol, 1.0 equiv), the title compound was prepared following the general procedure using $FeCl_3$ (3.2 mg, 0.020 mmol, 10 mol %), $(CF_3)_2CHOH$ (60.0 μL, 2.0 equiv), PMHS (100.0 μL, 2.2 equiv) and DCE (0.5 mL). The reaction mixture was stirred at 60 ℃ for 4 h. The crude product was purified by column chromatography on silica gel (EtOAc/PE = 1/10) to afford the title compound as a colorless liquid (28.1 mg, 60% yield).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.15 – 8.10 (m, 1H), 7.54 – 7.49 (m, 1H), 7.39 – 7.35 (m, 3H), 7.30 – 7.26 (m, 4H), 3.59 – 3.53 (m, 1H), 2.98 – 2.95 (m, 2H), 2.84 – 2.67 (m, 2H), 2.19 – 2.12 (m, 1H), 1.87 – 1.77 (m, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.4, 144.1, 140.1, 133.3, 132.5, 129.3, 129.3, 128.8, 128.5, 128.5, 127.6, 126.7, 126.2, 49.5, 35.7, 28.7, 27.7.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{17}H_{17}O^+]$: 237.1274, found 237.1275.

IR (neat, cm^{-1}) 3062, 2927, 2861, 1679, 1599, 1495, 1453, 1291, 1219, 1156, 1029, 933, 739, 700.



3a

1-(2-nitrophenyl)-3-phenylpropan-1-ol.

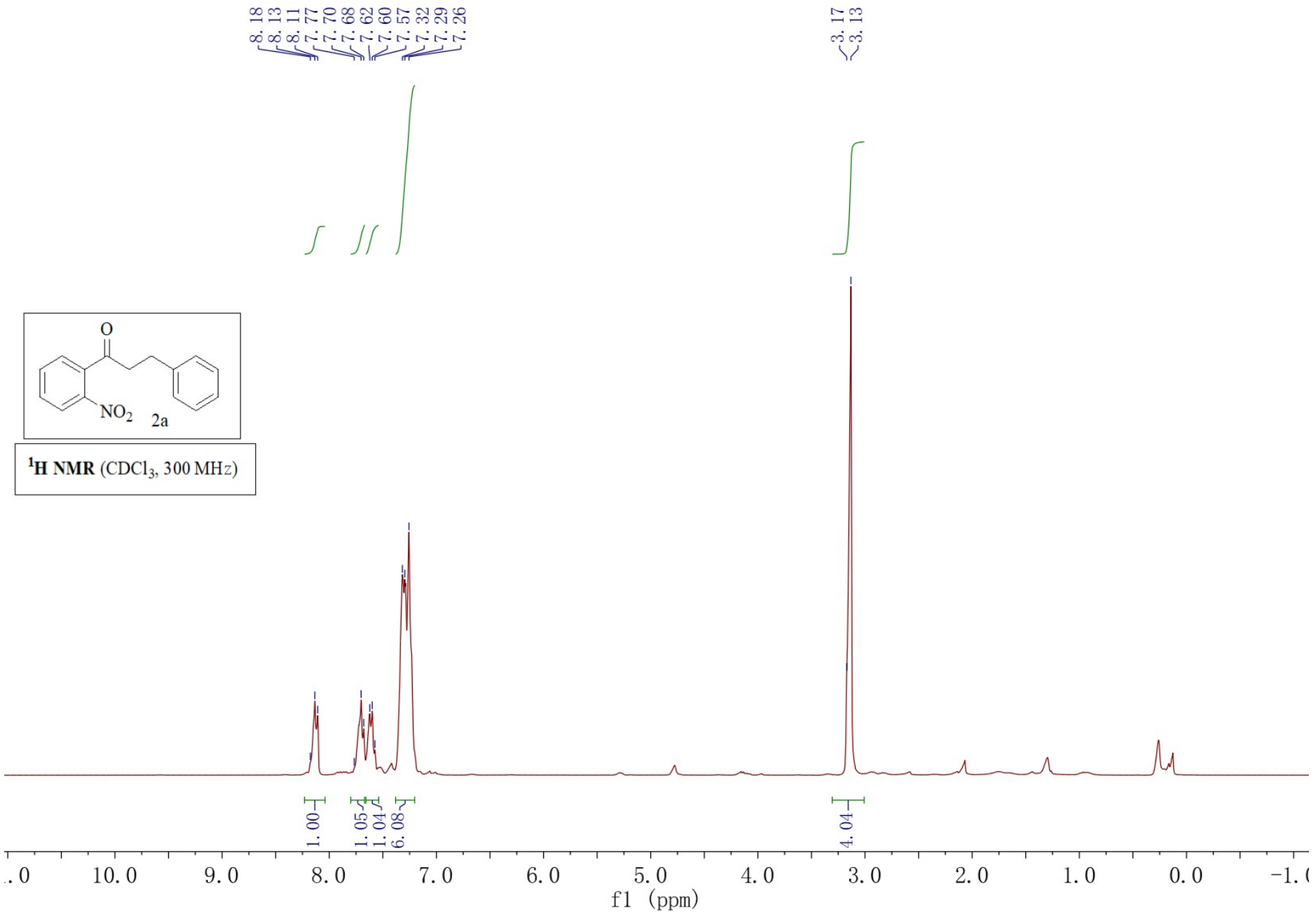
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.94 – 7.91 (m, 1H), 7.85 – 7.83 (m, 1H), 7.67 – 7.62 (m, 1H), 7.45 – 7.40 (m, 1H), 7.36 – 7.31 (m, 2H), 7.27 – 7.24 (m, 3H), 5.28 (dd, *J* = 6.0, 7.5 Hz, 1H), 3.01 – 2.91 (m, 2H), 2.87 – 2.77 (m, 1H), 2.20 – 2.02 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 147.7, 141.5, 140.2, 133.6, 128.5, 128.5, 128.5, 128.5, 128.2, 128.1, 126.1, 124.4, 69.0, 39.8, 32.6.

HRMS (ESI) m/z: $[M + H]^+$ Calculated for $[C_{15}H_{16}NO_3^+]$: 258.1125, found 258.1125.

IR (neat, cm^{-1}) 3552, 3424, 3027, 2924, 2859, 1607, 1578, 1520, 1453, 1342, 1190, 1057, 909, 857, 787, 737, 698.

VIII. Spectroscopic Data (NMR and IR Spectrum)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7.68
7.62
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7.32
7.29
7.26
3.17
3.13
O
NO2
2a
1H NMR (CDCl3, 300 MHz)
1.00
1.05
1.04
6.08
4.04
10.0
9.0
8.0
7.0
6.0
5.0
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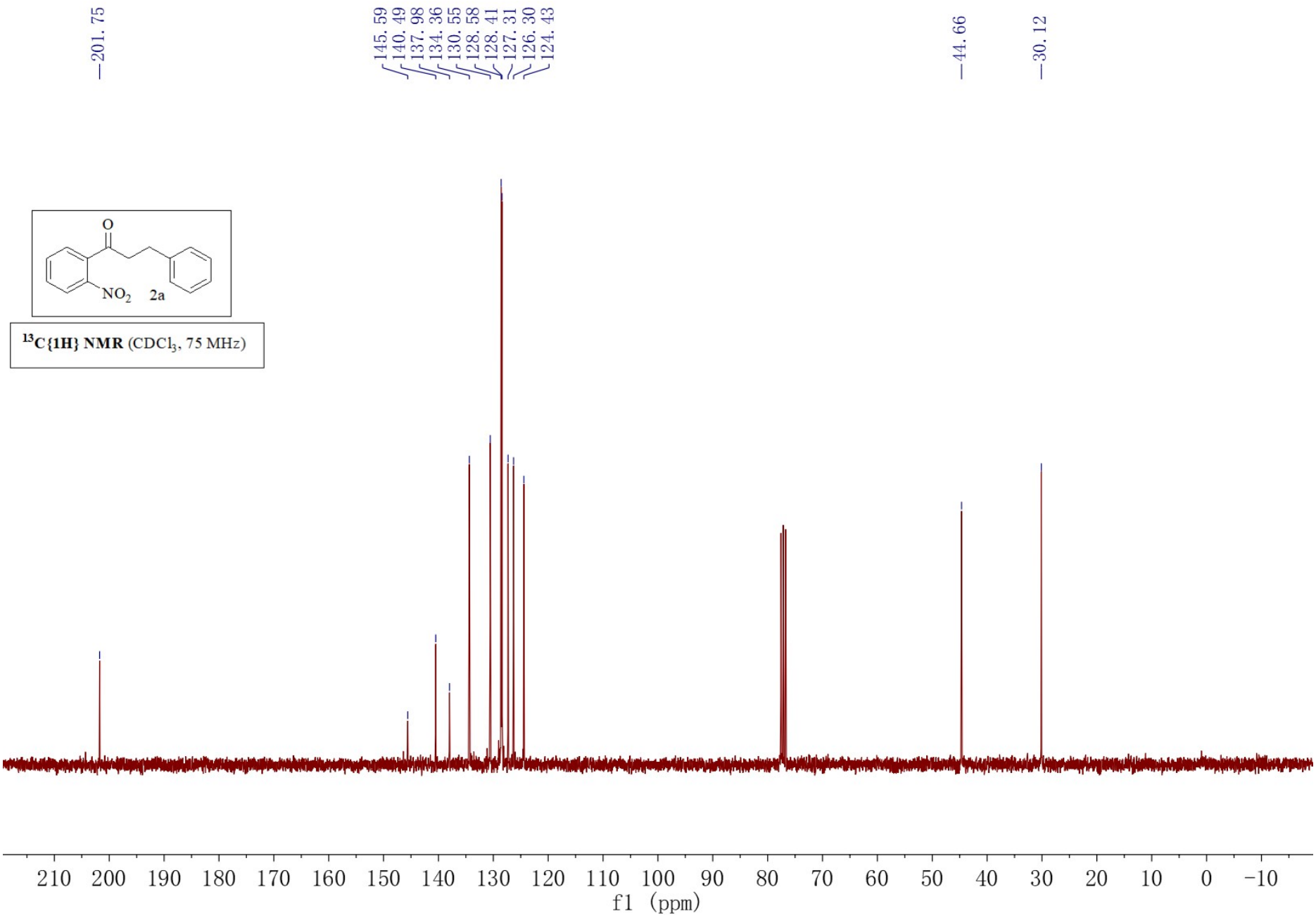
f1 (ppm)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124.43
44.66
30.12
O
NO2
2a
13C{1H} NMR (CDCl3, 75 MHz)
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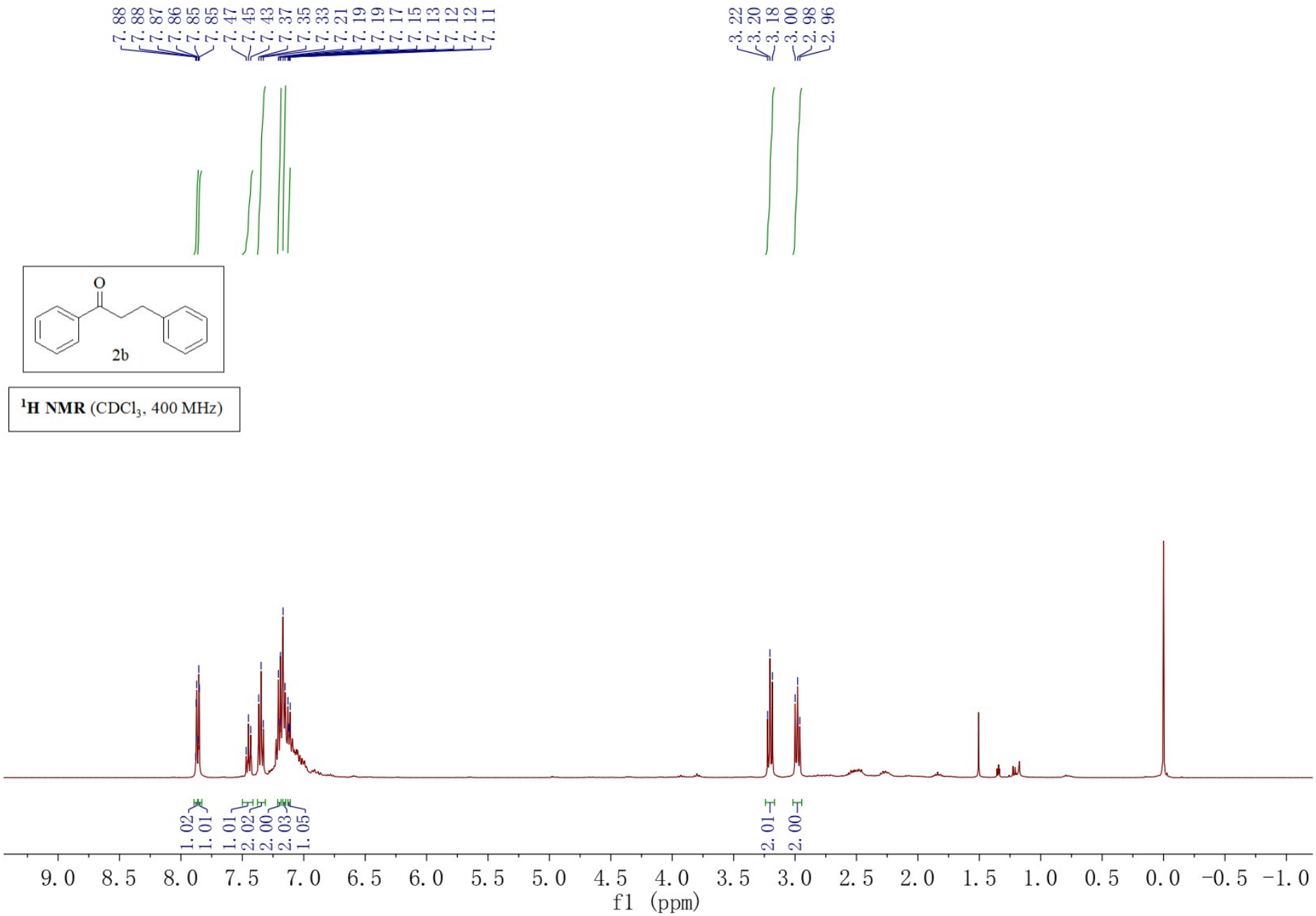
f1 (ppm)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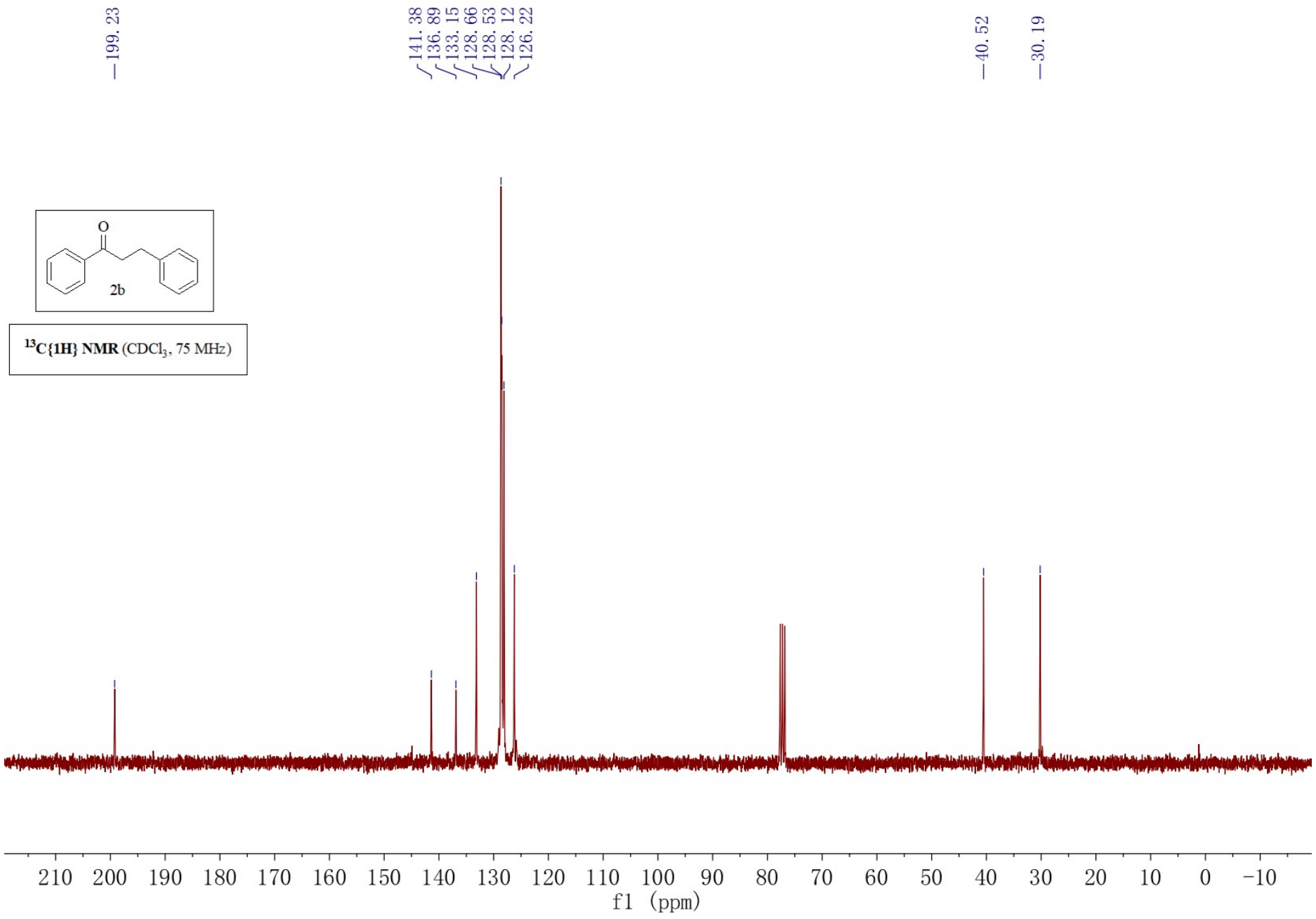
7.21
7.19
7.19
7.17
7.15
7.13
7.12
7.12
7.11
3.22
3.20
3.18
3.00
2.98
2.96
O
2b
1H NMR (CDCl3, 400 MHz)
1.02
1.01
1.01
2.02
2.00
2.03
1.05
2.01
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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128.53
128.12
126.22
40.52
30.19
O
2b
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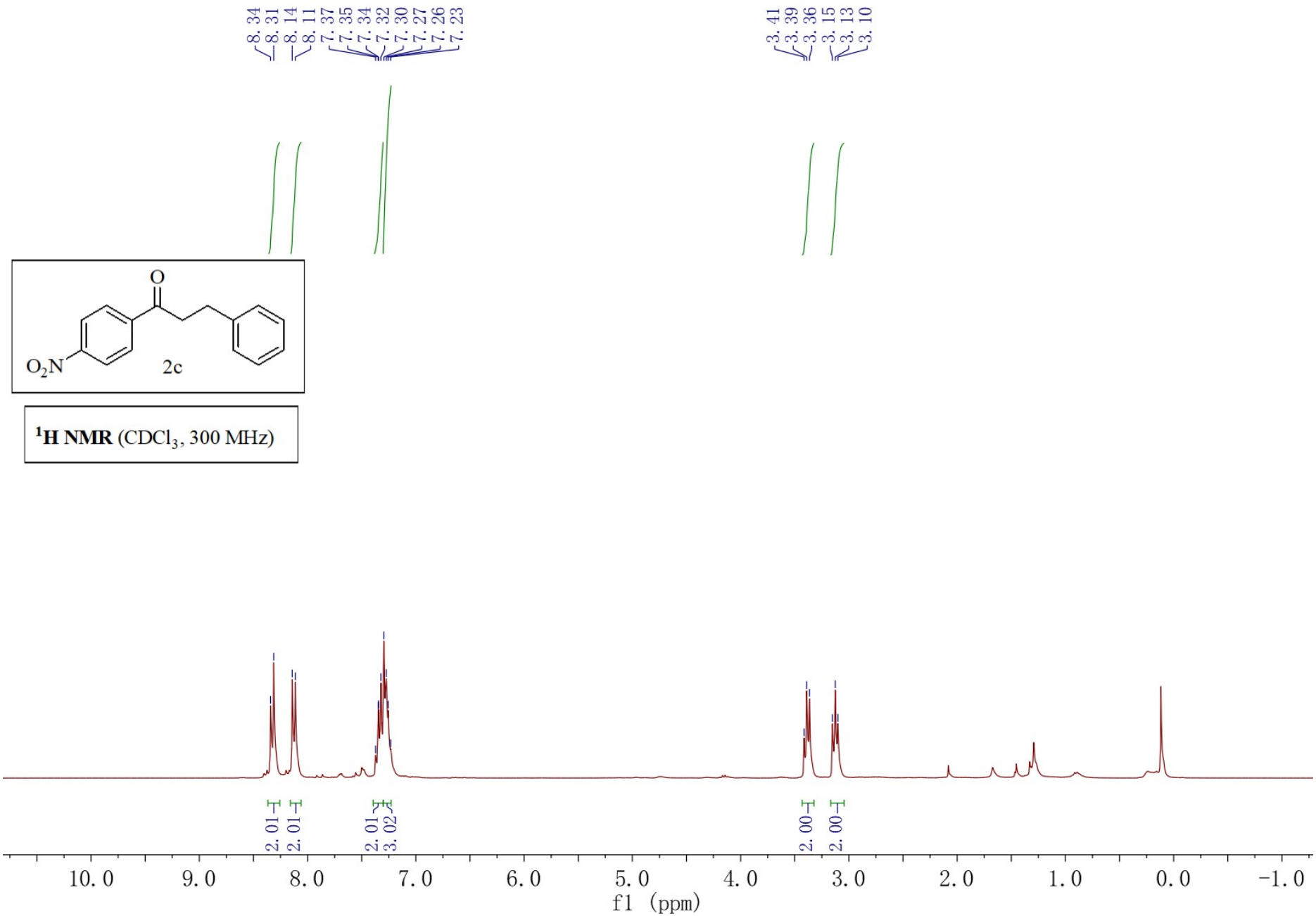
f1 (ppm)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7.34
7.32
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7.27
7.26
7.23
3.41
3.39
3.36
3.15
3.13
3.10
O
O2N
2c
1H NMR (CDCl3, 300 MHz)
2.01
2.01
2.01
3.02
2.00
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
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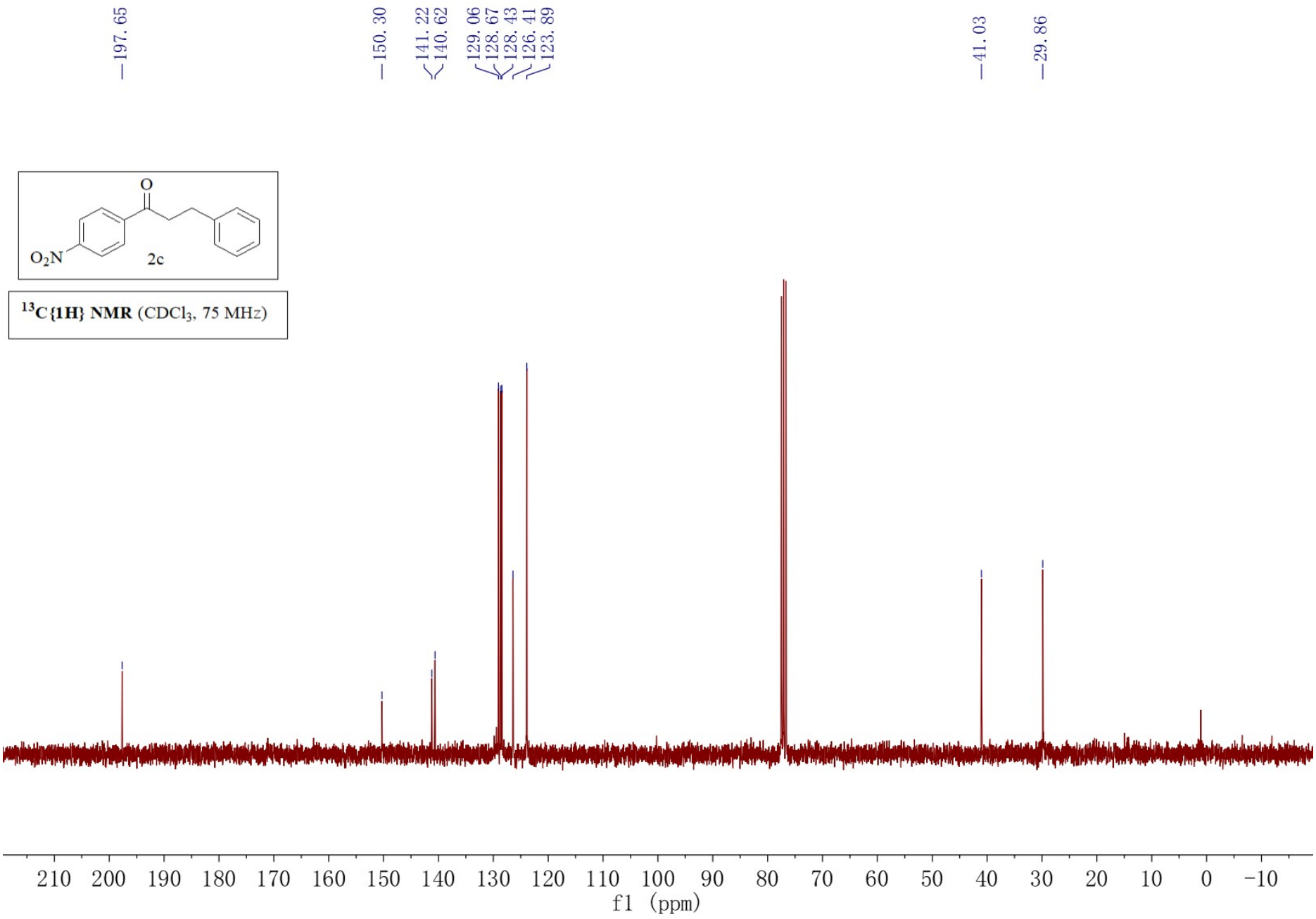
-1.0
f1 (ppm)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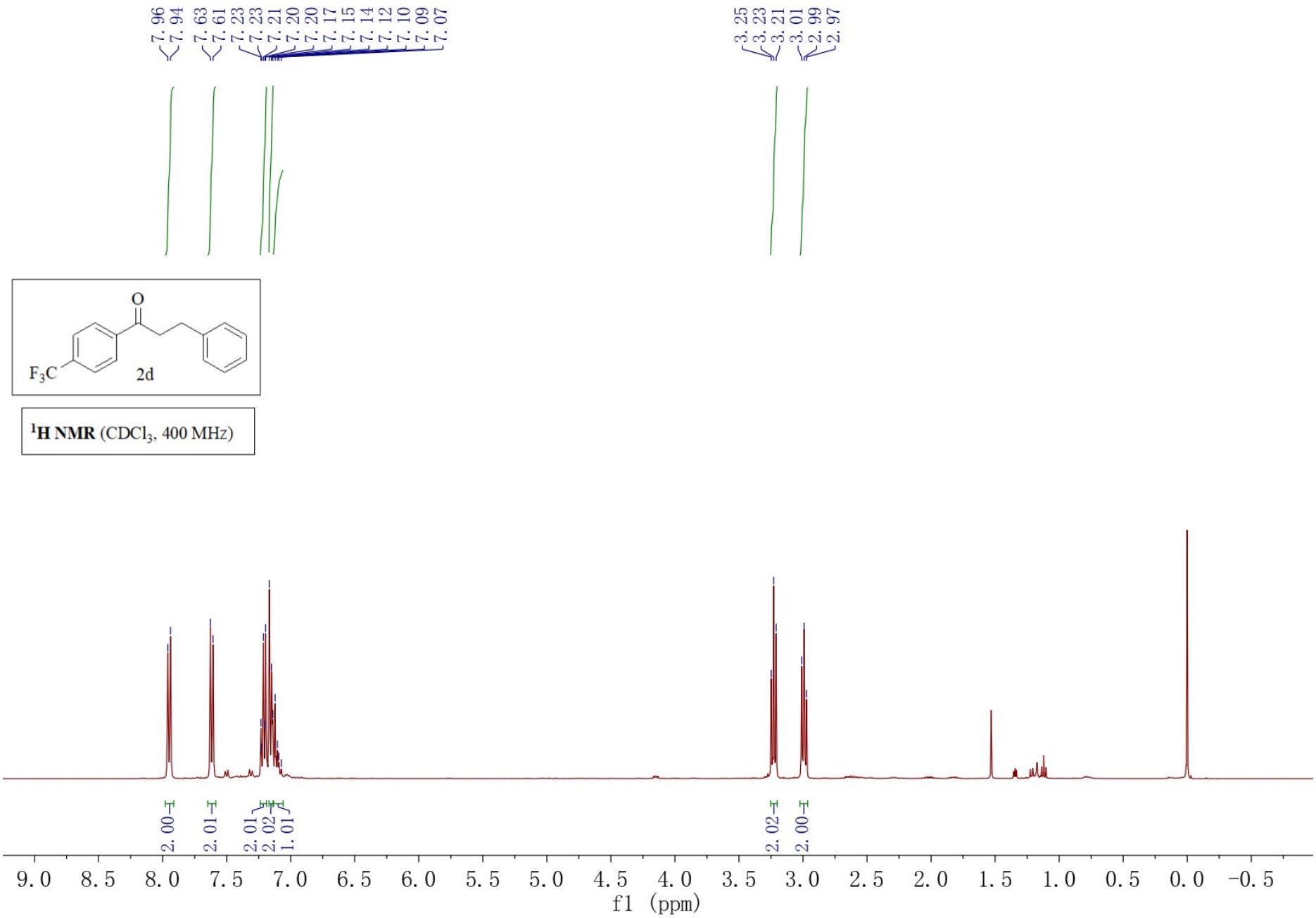
f1 (ppm)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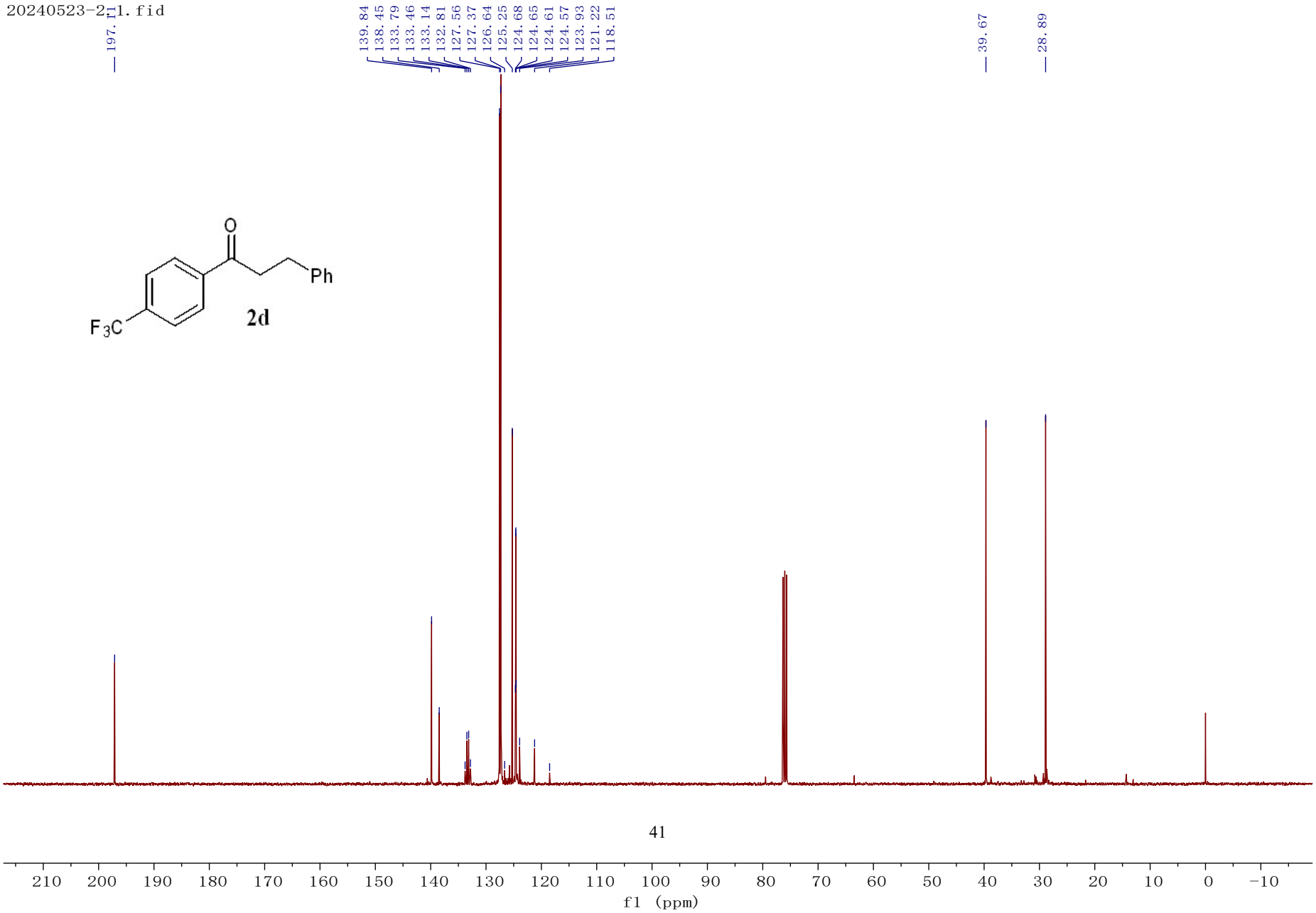
7.12
7.10
7.09
7.07
3.25
3.23
3.21
3.01
2.99
2.97
O
F3C
2d
1H NMR (CDCl3, 400 MHz)
2.00
2.01
2.01
2.02
1.01
2.02
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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127.37
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125.25
124.68
124.65
124.61
124.57
123.93
121.22
118.51
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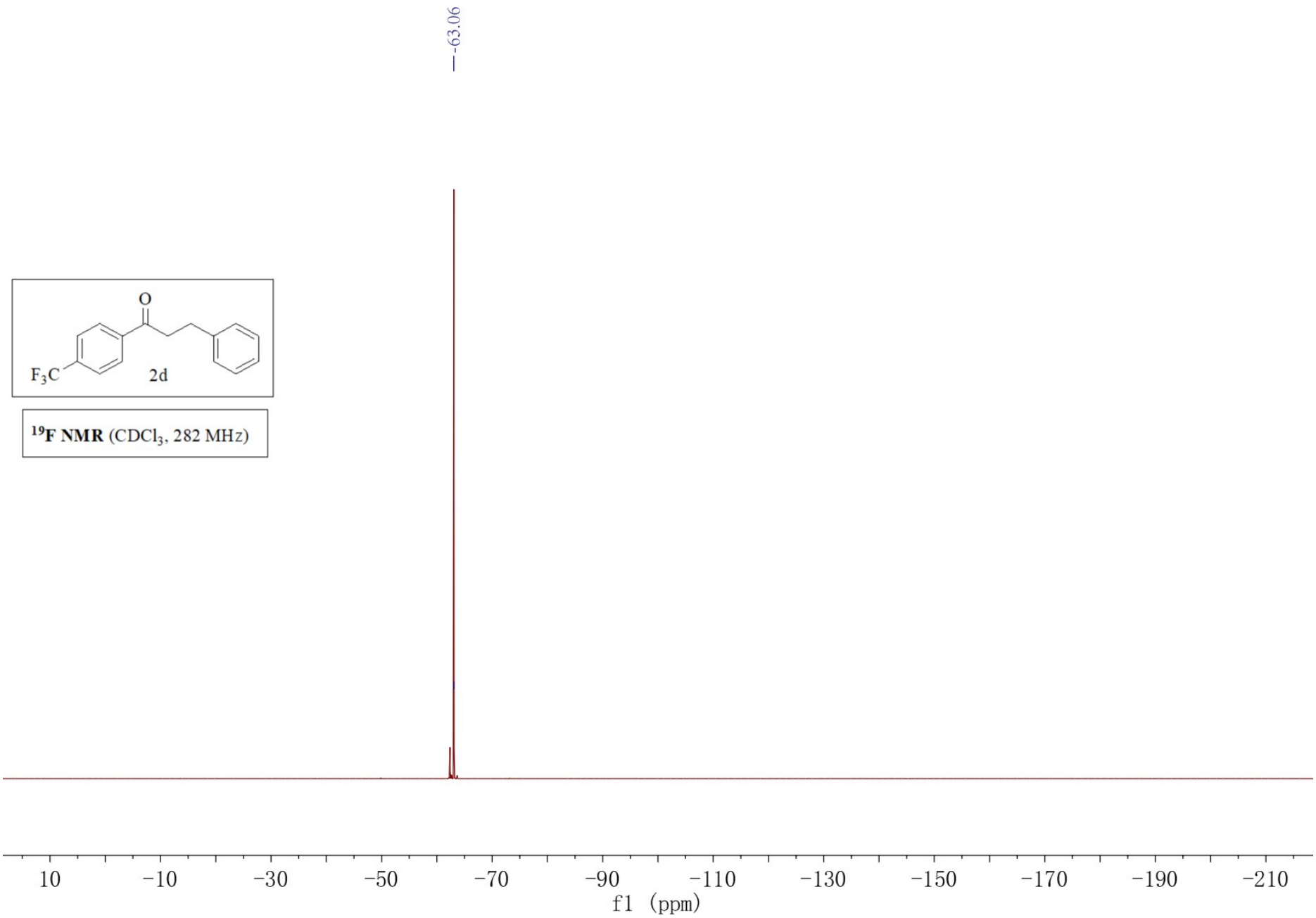
28.89
O
Ph
F3C
2d
41
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)


-63.06
O
F3C
2d
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-150
-170
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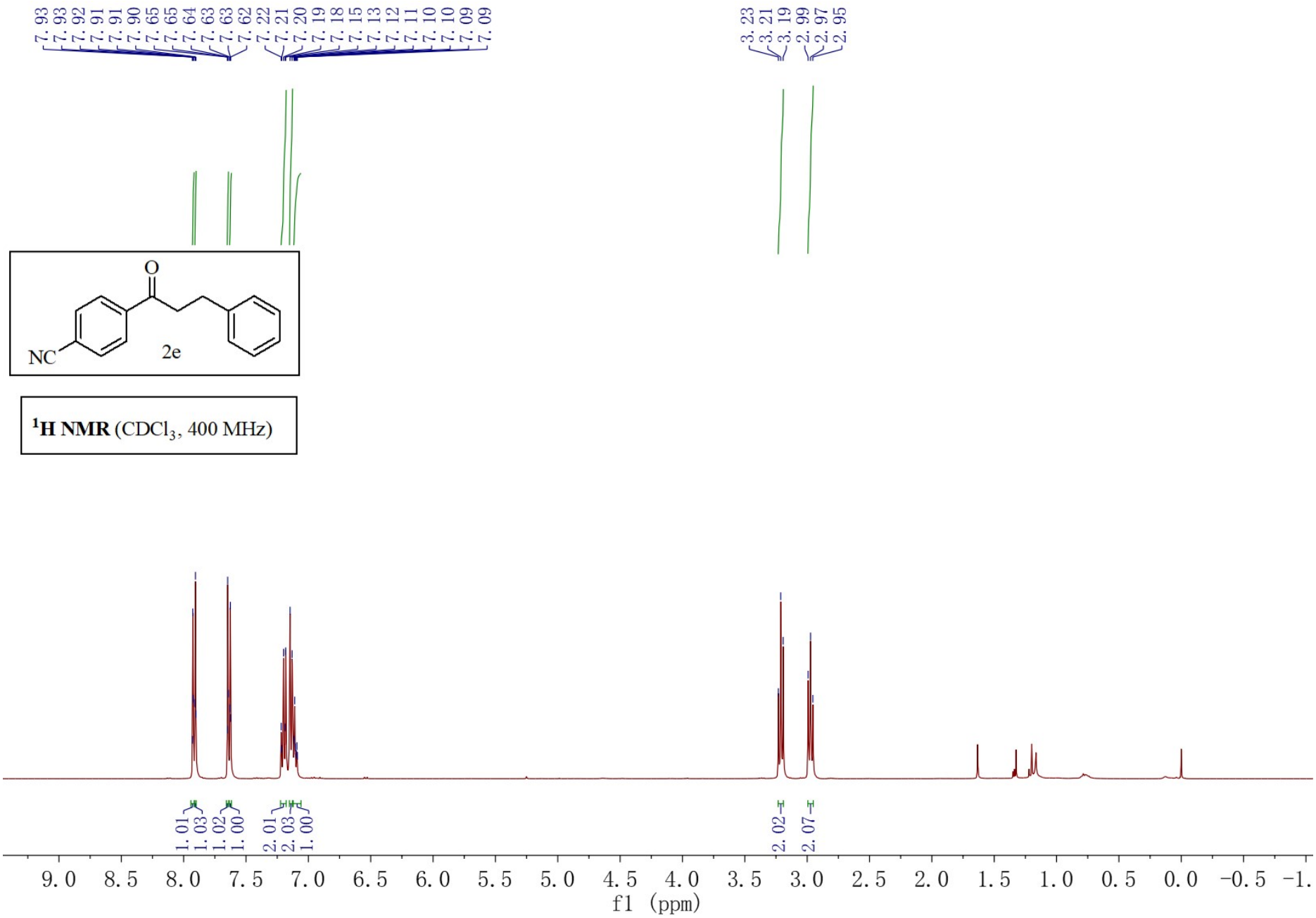
-210
f1 (ppm)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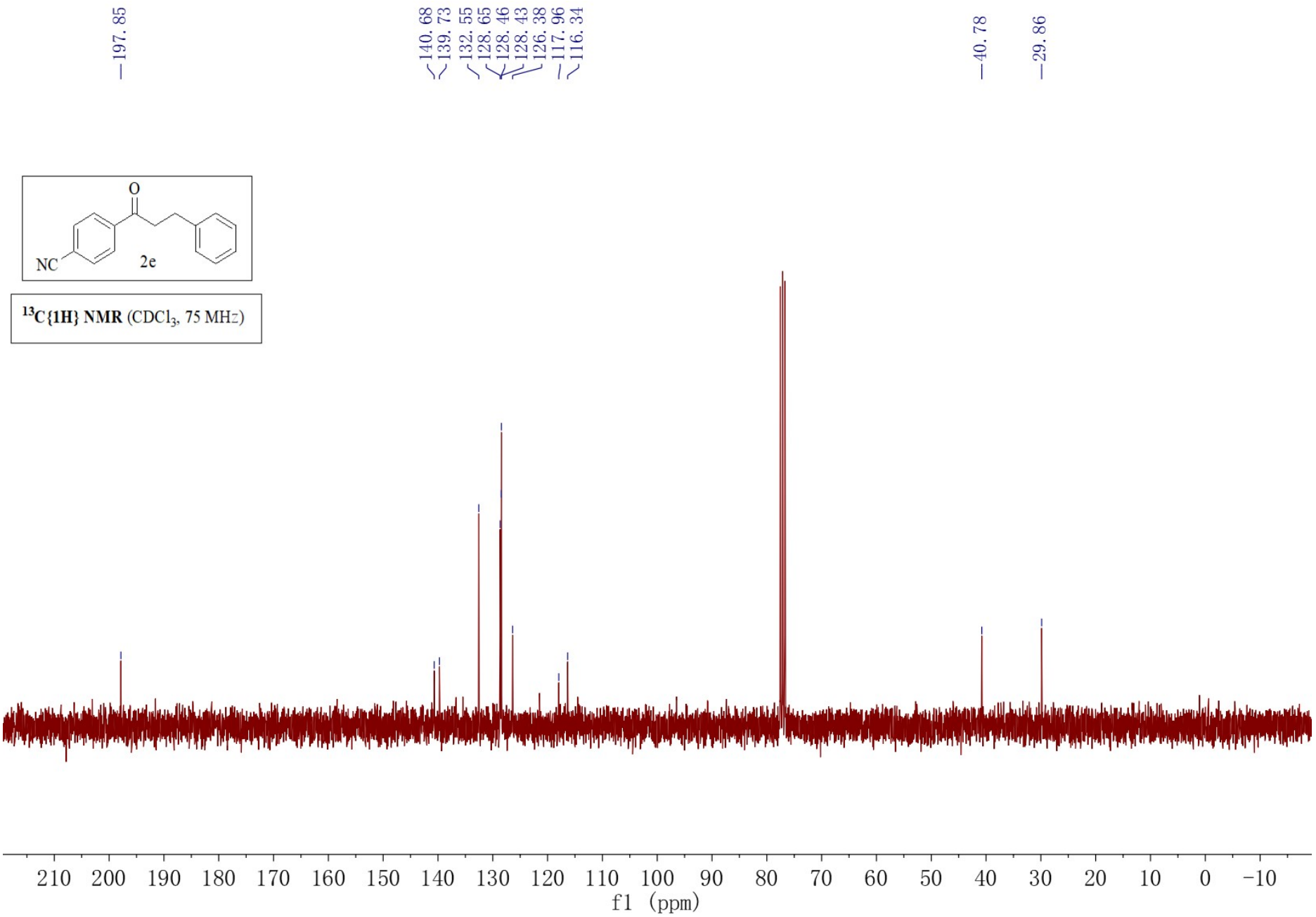
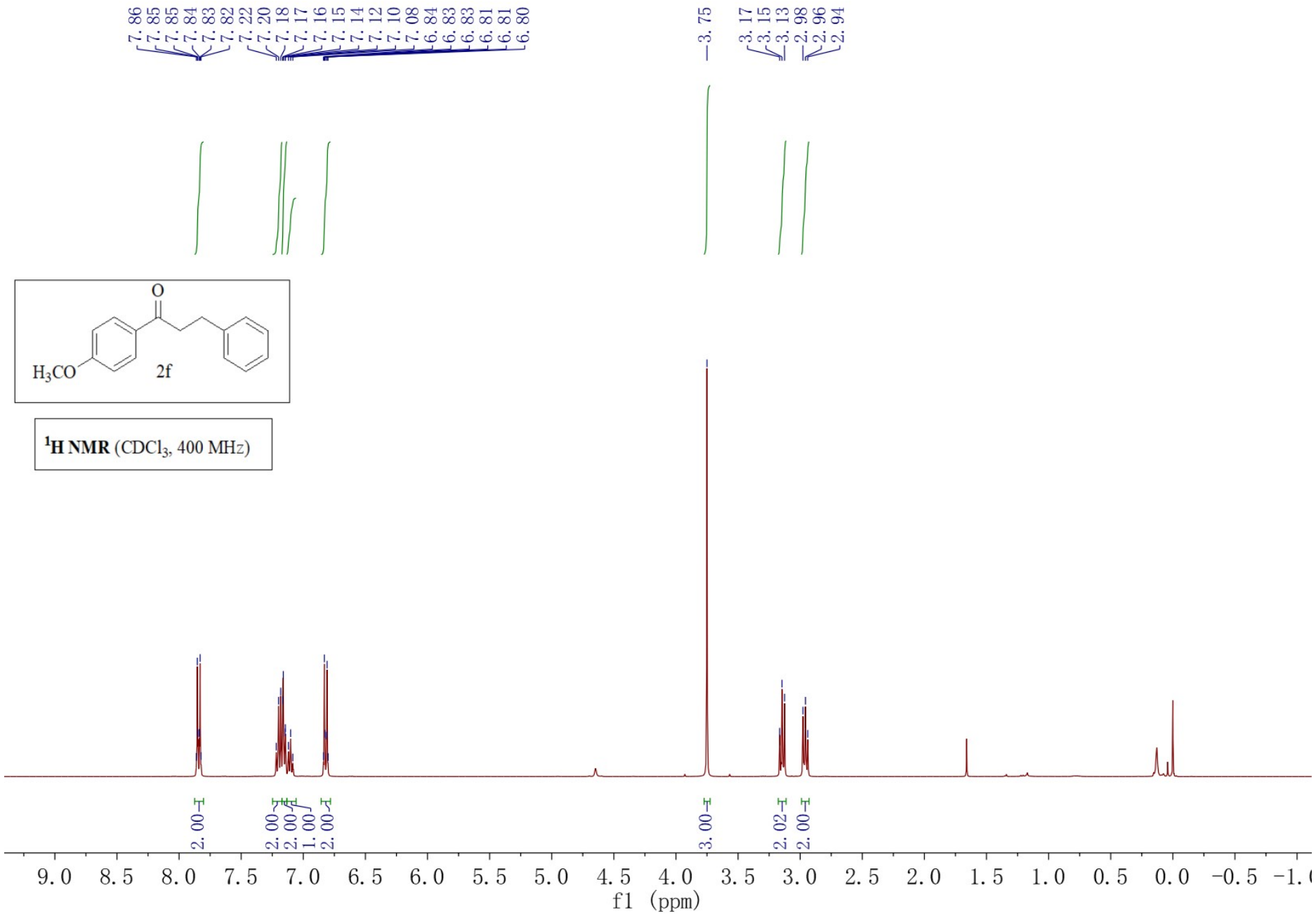
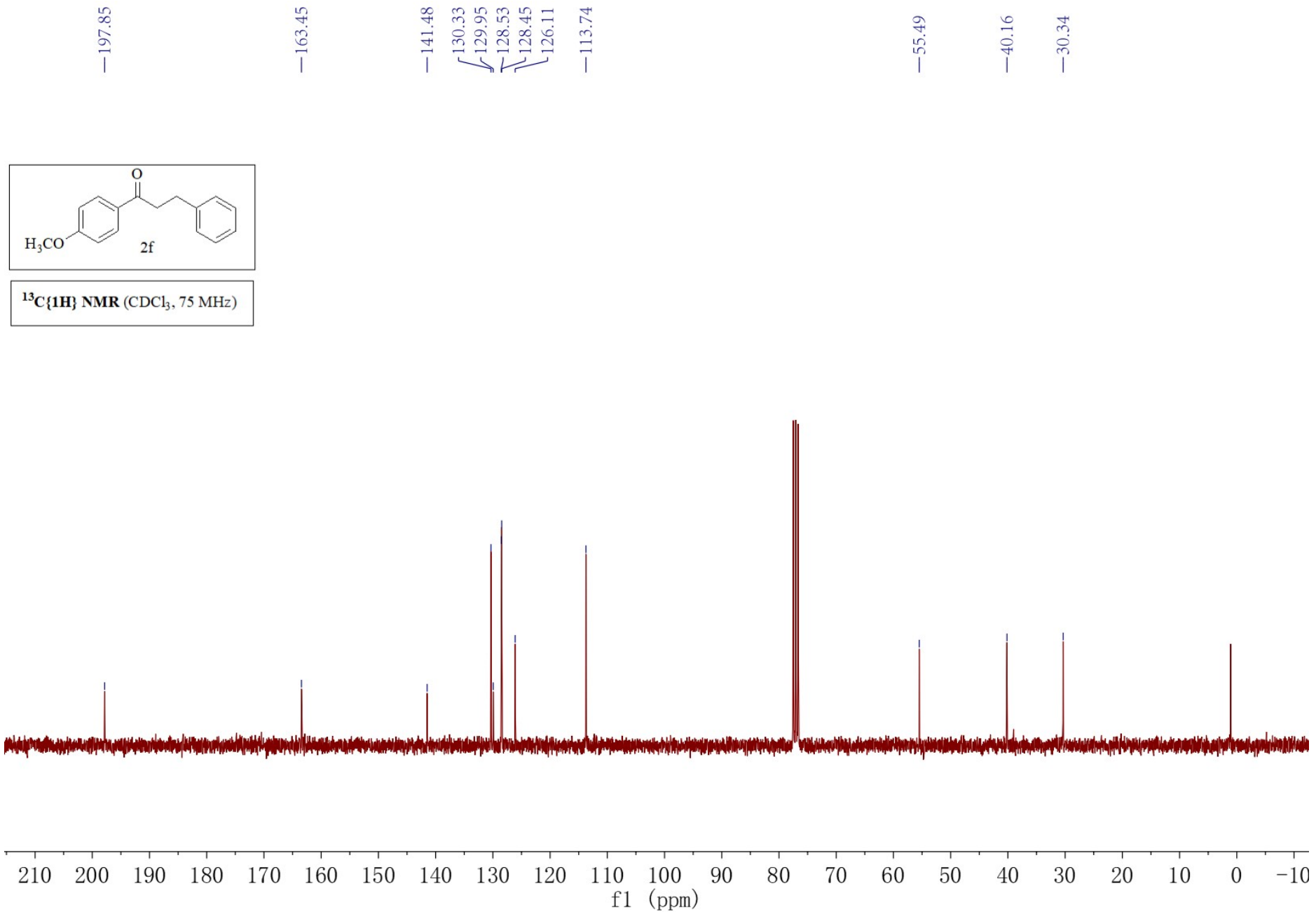
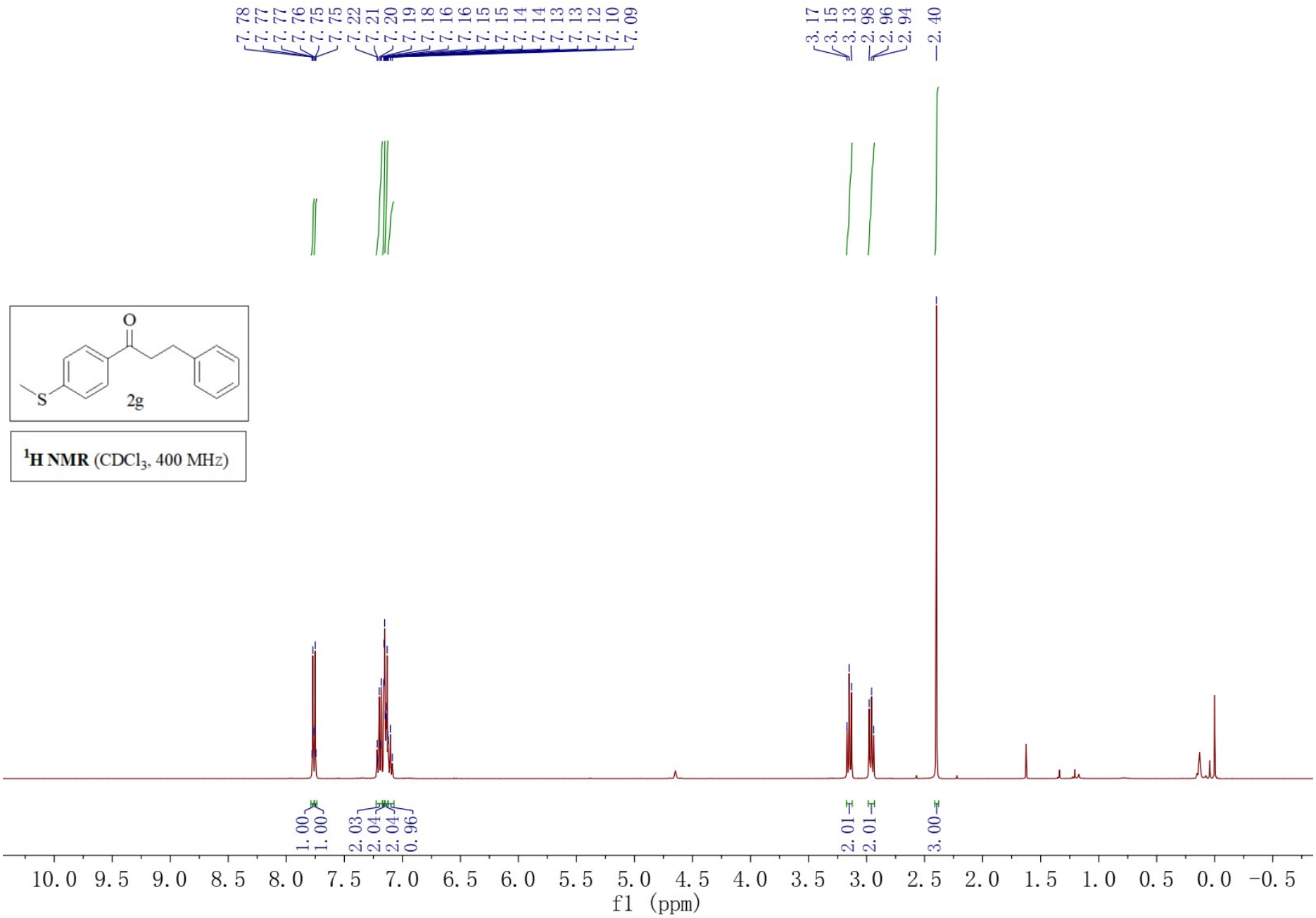
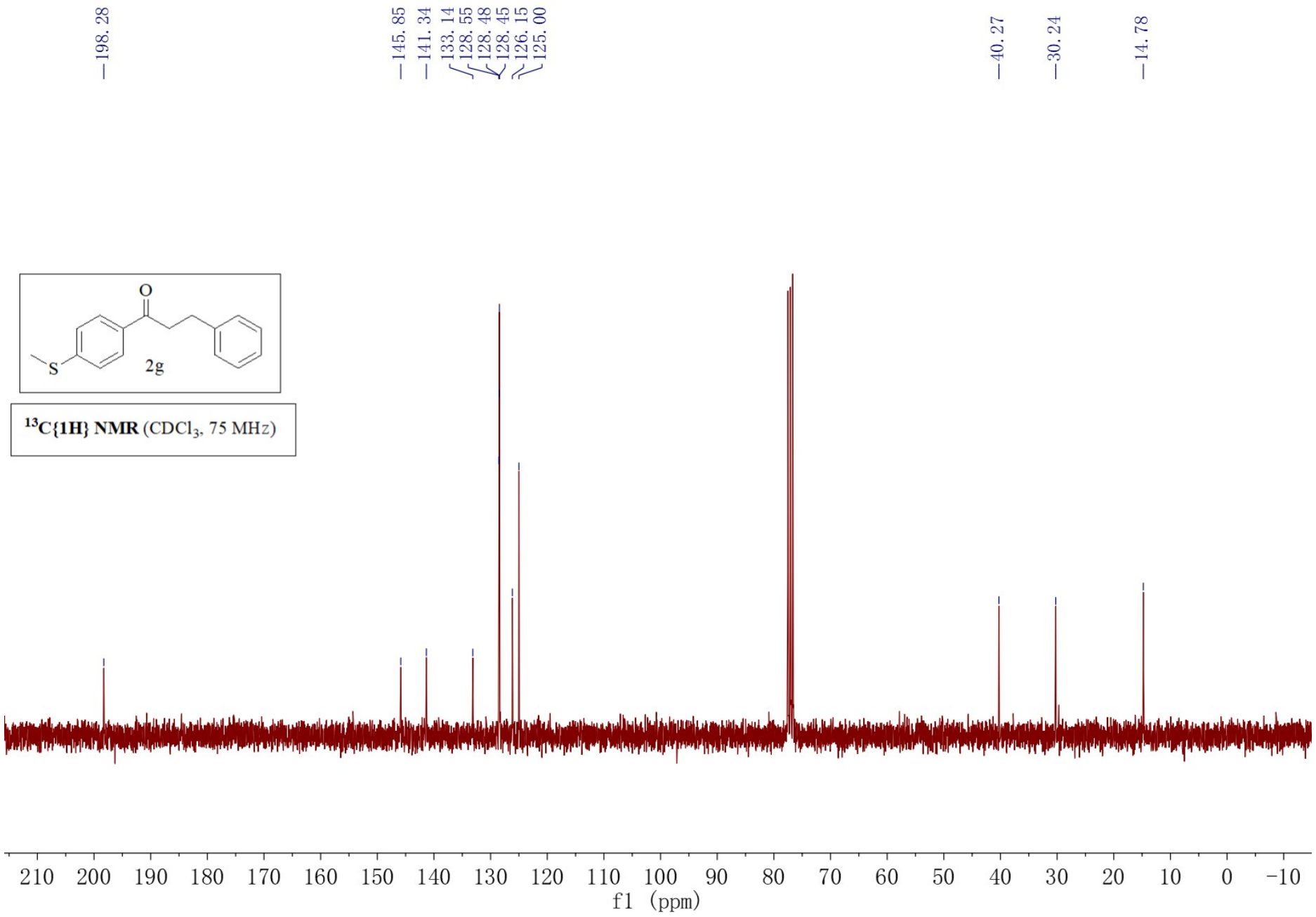
7.93
7.92
7.91
7.91
7.90
7.65
7.65
7.64
7.63
7.63
7.62
7.22
7.21
7.20
7.19
7.18
7.15
7.13
7.12
7.11
7.10
7.10
7.09
7.09
3.23
3.21
3.19
2.99
2.97
2.95
O
NC
2e
1H NMR (CDCl3, 400 MHz)
1.01
1.03
1.02
1.00
2.01
2.03
1.00
2.02
2.07
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.
f1 (ppm)

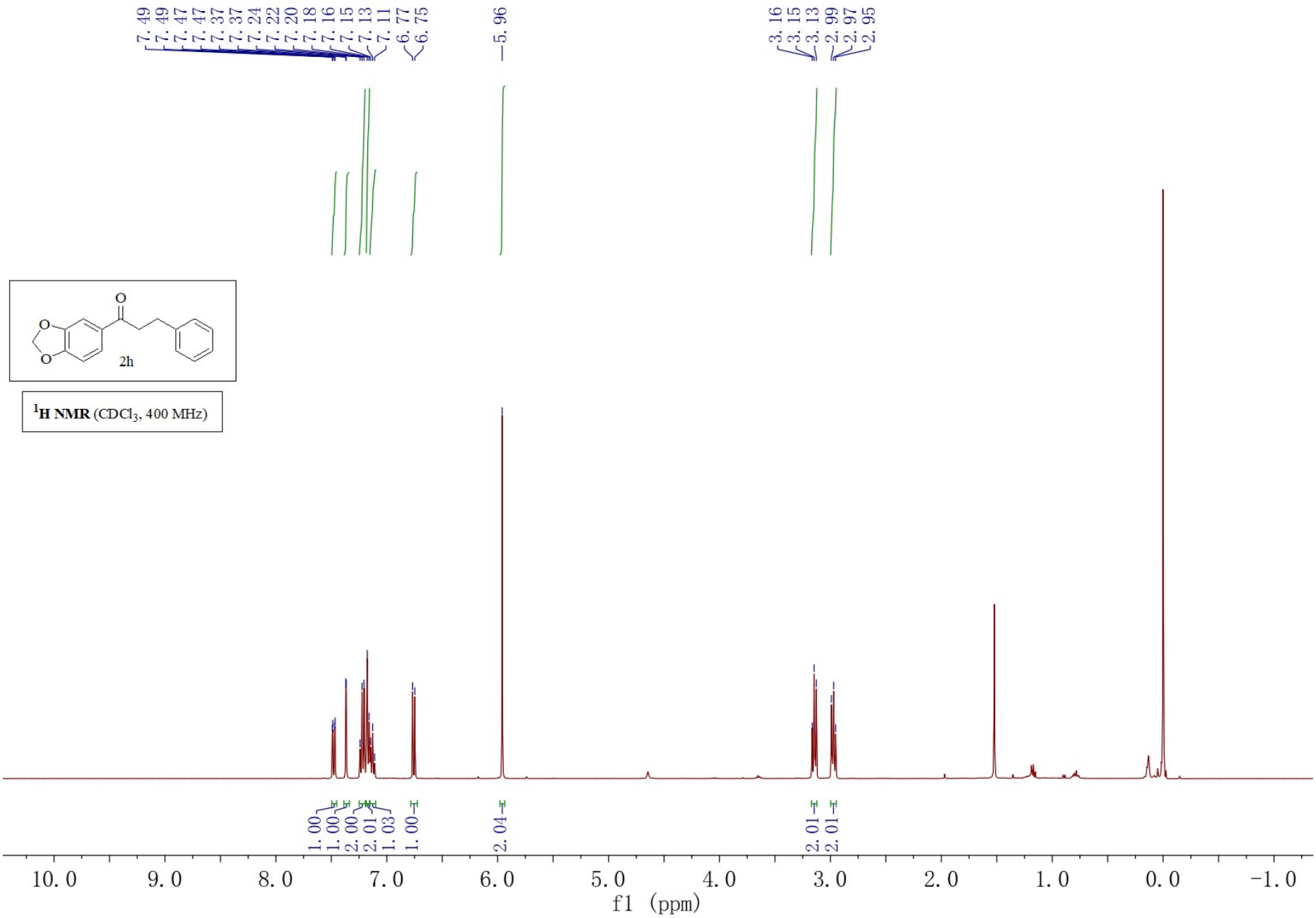

197.85
140.68
139.73
132.55
128.65
128.46
128.43
126.38
117.96
116.34
40.78
29.86
O
NC
2e
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

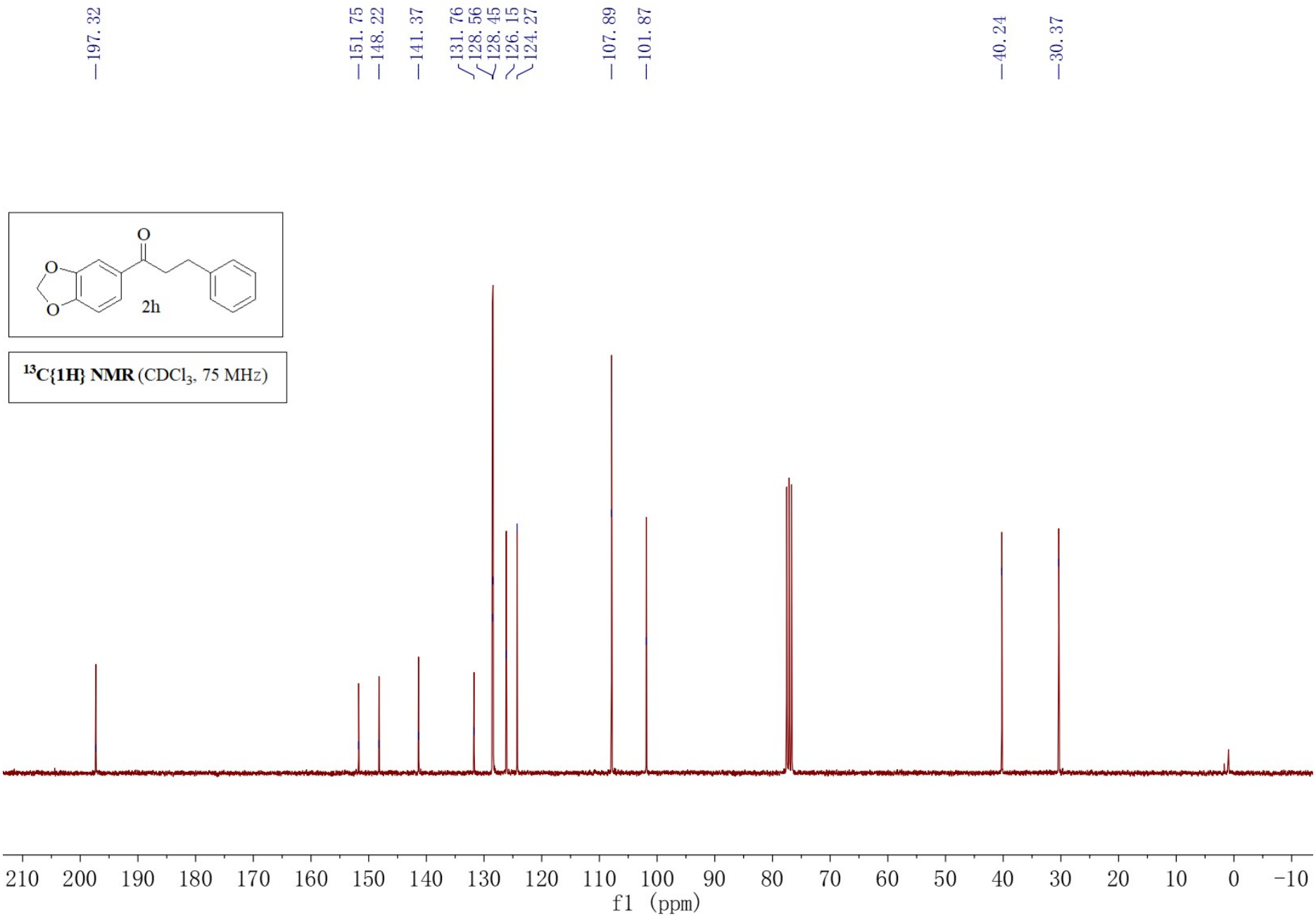

7.86
7.85
7.85
7.84
7.83
7.82
7.22
7.20
7.18
7.17
7.16
7.15
7.14
7.12
7.10
7.08
6.84
6.83
6.83
6.81
6.81
6.80
3.75
3.17
3.15
3.13
2.98
2.96
2.94
O
H3CO
2f
1H NMR (CDCl3, 400 MHz)
2.00
2.00
2.00
1.00
2.00
3.00
2.02
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

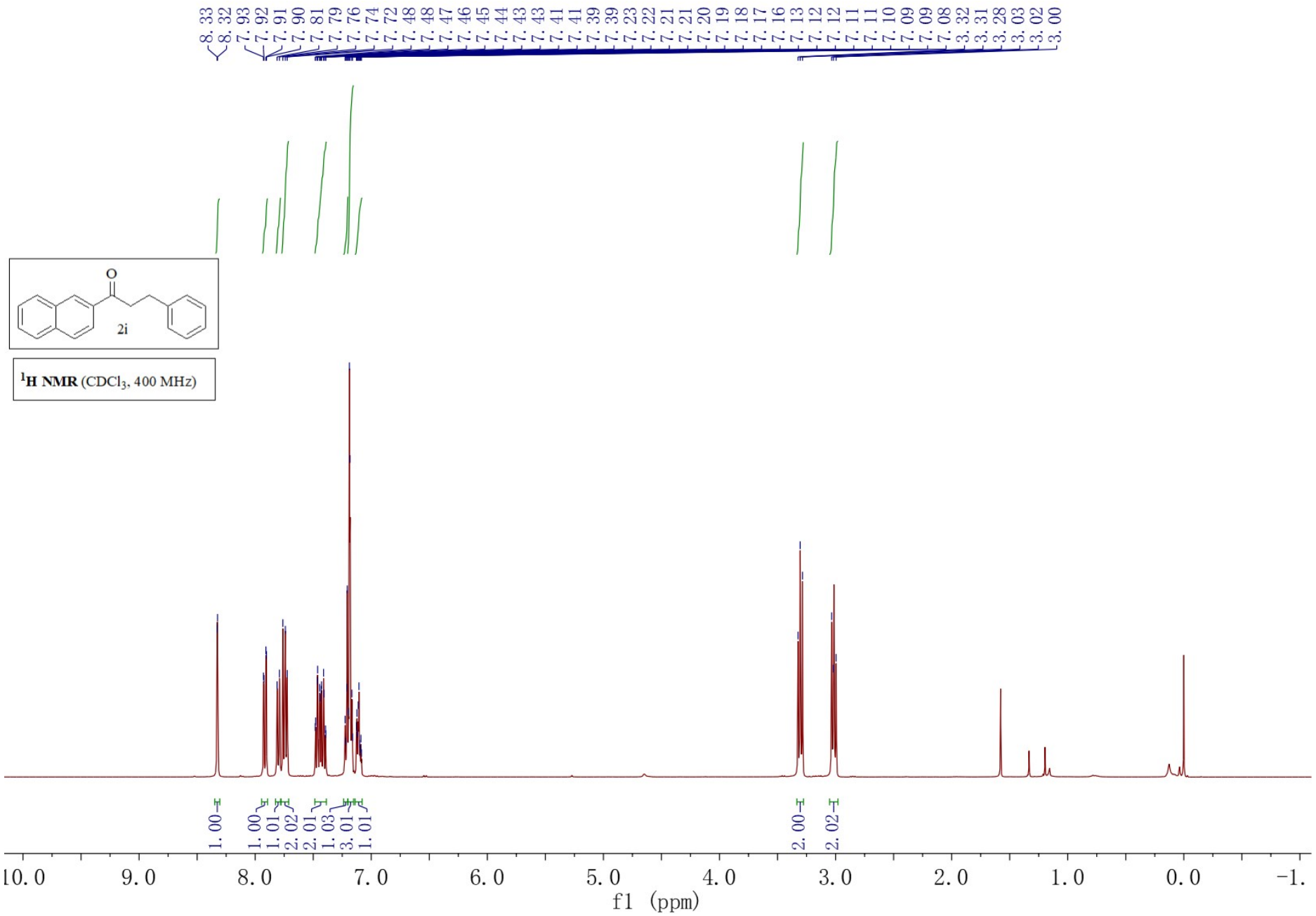

197.85
163.45
141.48
130.33
129.95
128.53
128.45
126.11
113.74
55.49
40.16
30.34
O
H3CO
2f
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

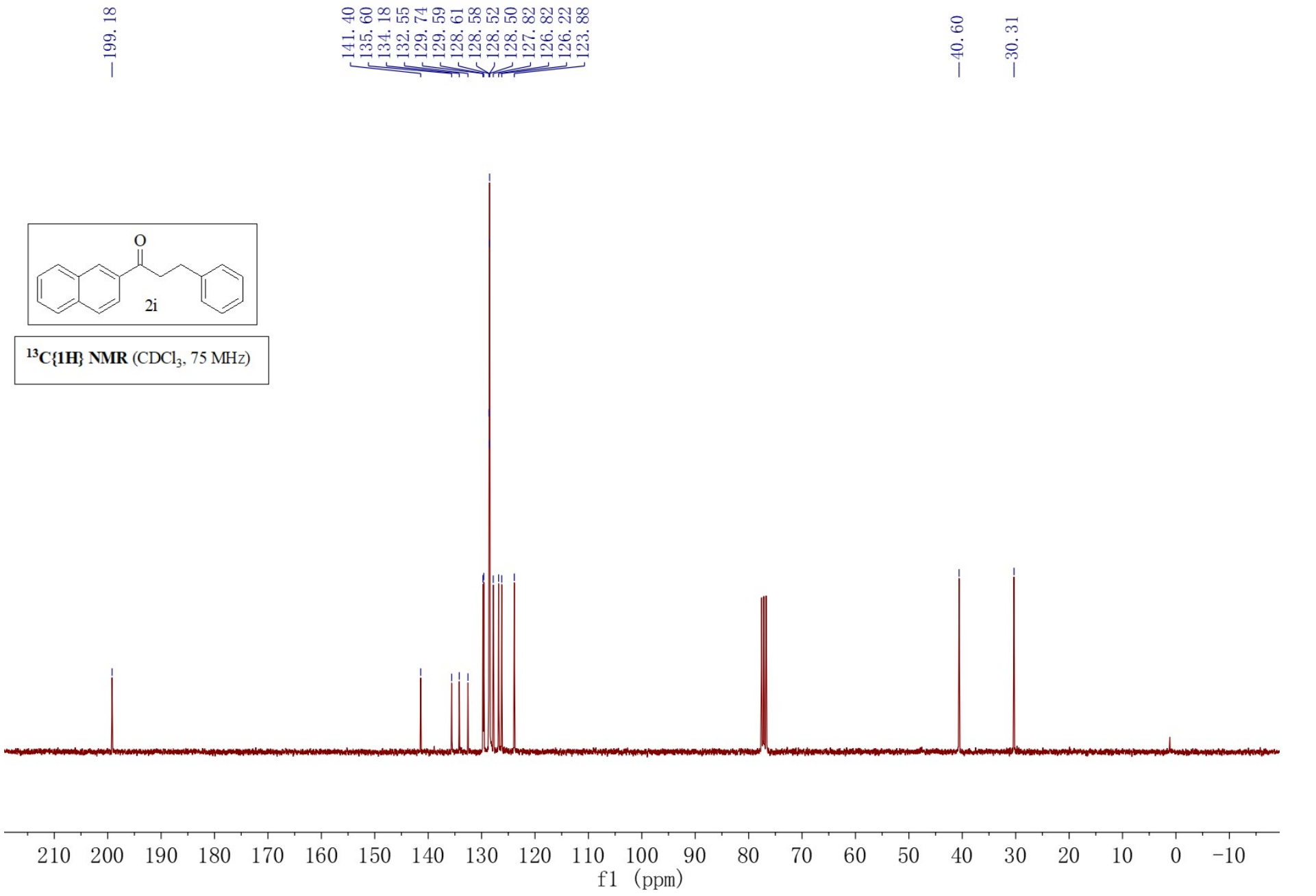

7.78
7.77
7.77
7.76
7.75
7.75
7.22
7.21
7.20
7.19
7.18
7.16
7.16
7.15
7.15
7.14
7.14
7.13
7.13
7.12
7.10
7.09
3.17
3.15
3.13
2.98
2.96
2.94
2.40
O
S
2g
1H NMR (CDCl3, 400 MHz)
1.00
1.00
2.03
2.04
2.04
0.96
2.01
2.01
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

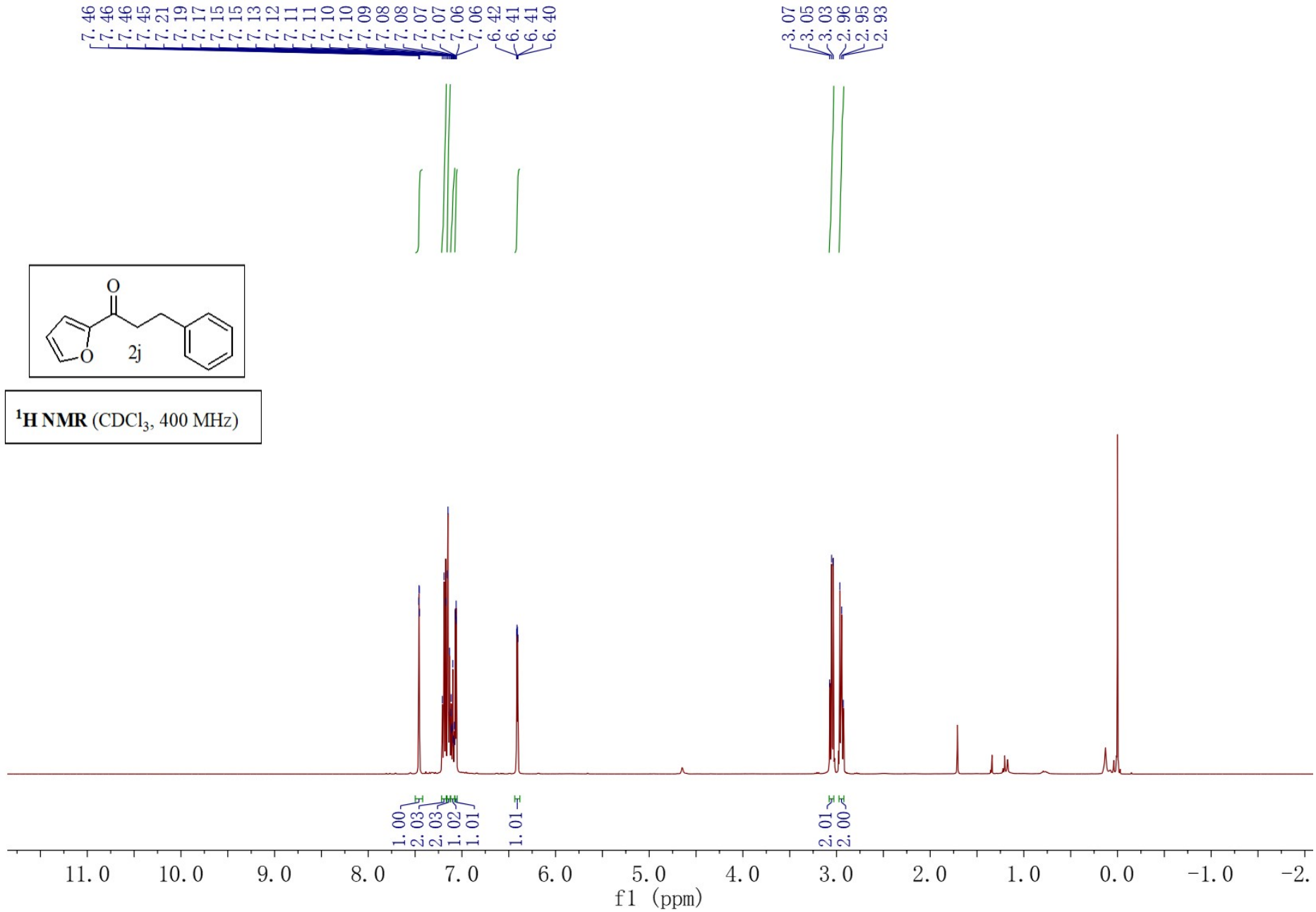

198.28
145.85
141.34
133.14
128.55
128.48
128.45
126.15
125.00
40.27
30.24
14.78
O
S
2g
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

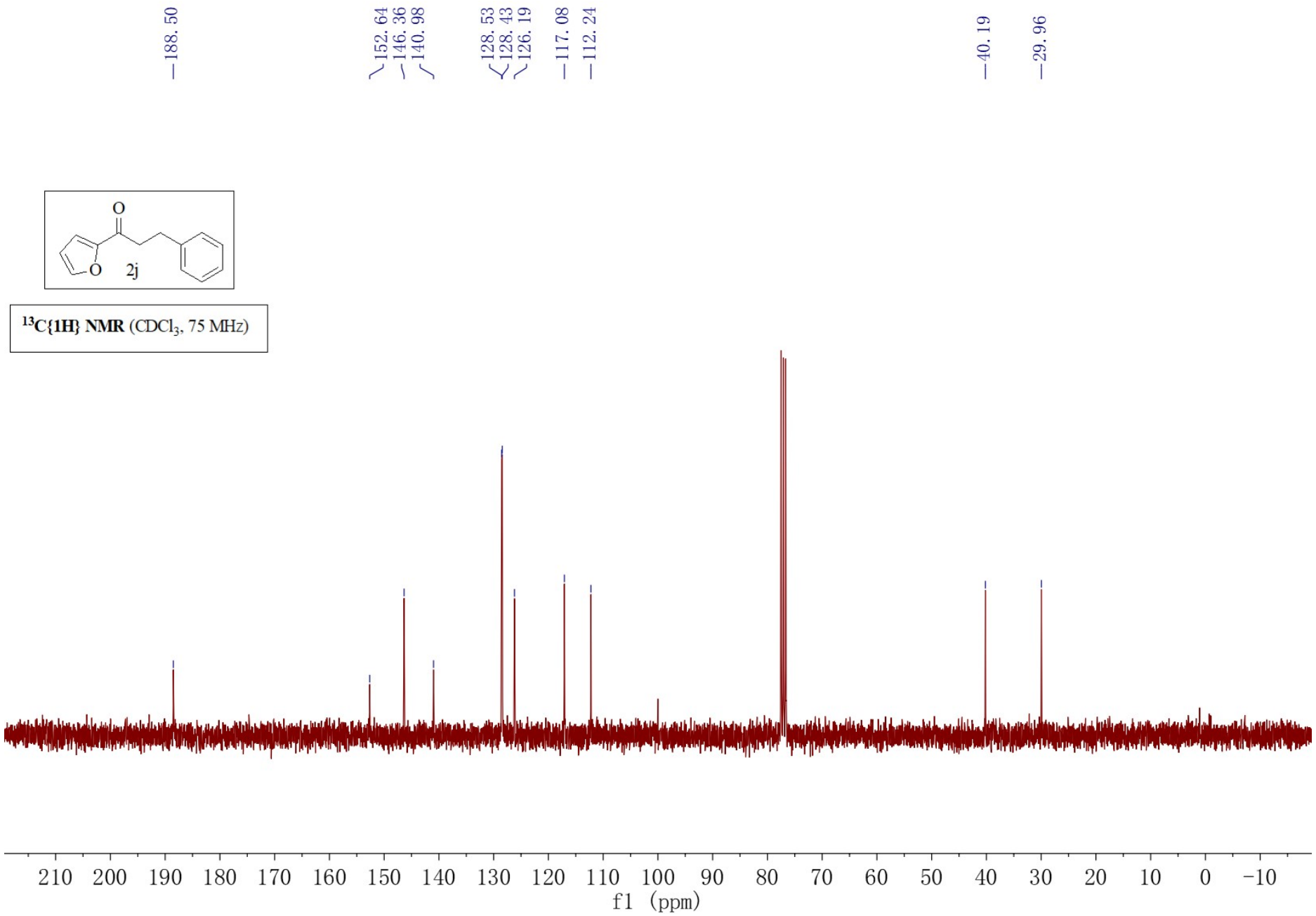

7.49
7.49
7.47
7.47
7.37
7.37
7.24
7.22
7.20
7.18
7.16
7.15
7.13
7.11
6.77
6.75
5.96
3.16
3.15
3.13
2.99
2.97
2.95
O
O
O
2h
1H NMR (CDCl3, 400 MHz)
1.00
1.00
2.00
2.01
1.03
1.00
2.04
2.01
2.01
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

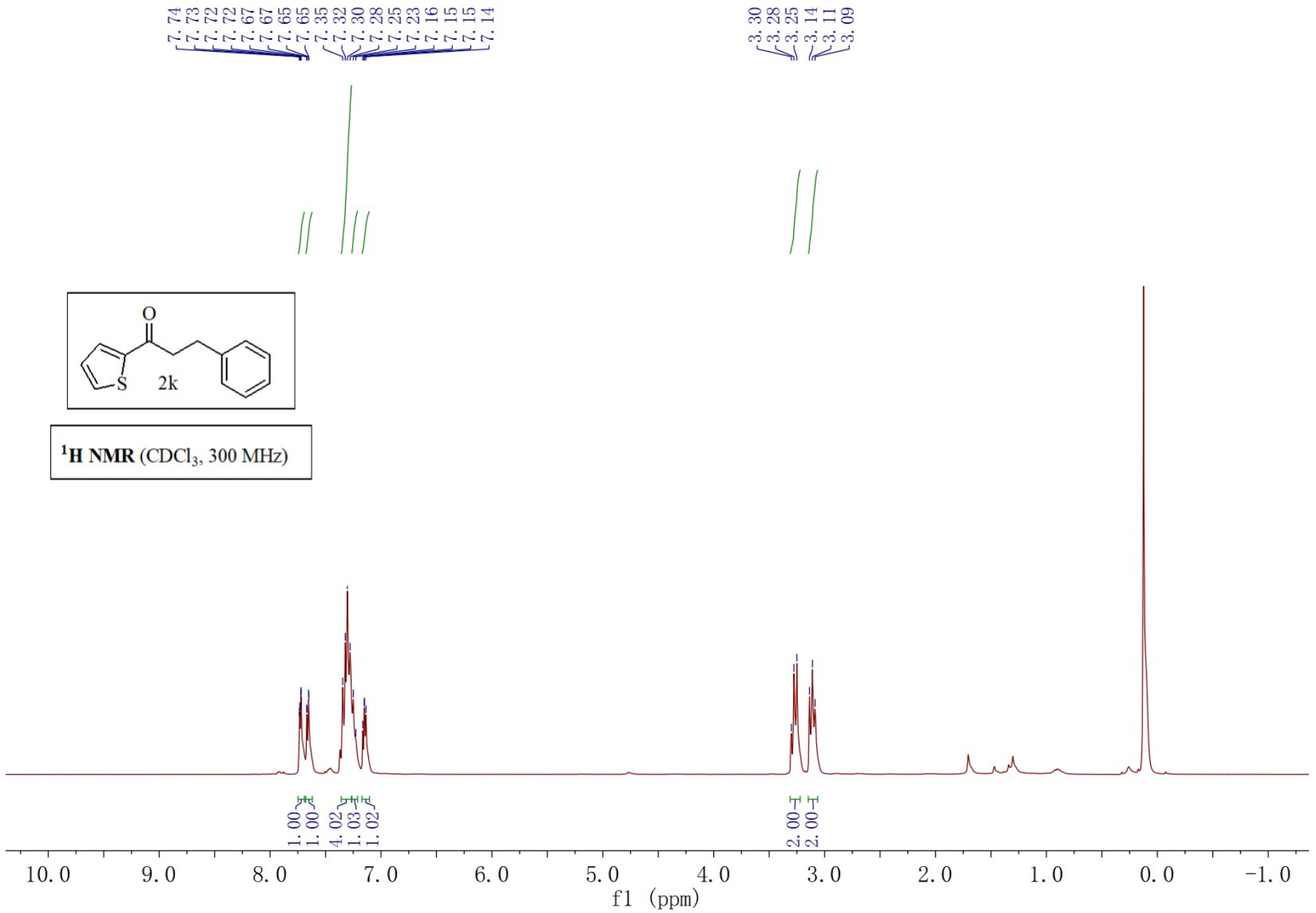

197.32
151.75
148.22
141.37
131.76
128.56
128.45
126.15
124.27
107.89
101.87
40.24
30.37
O
O
O
2h
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

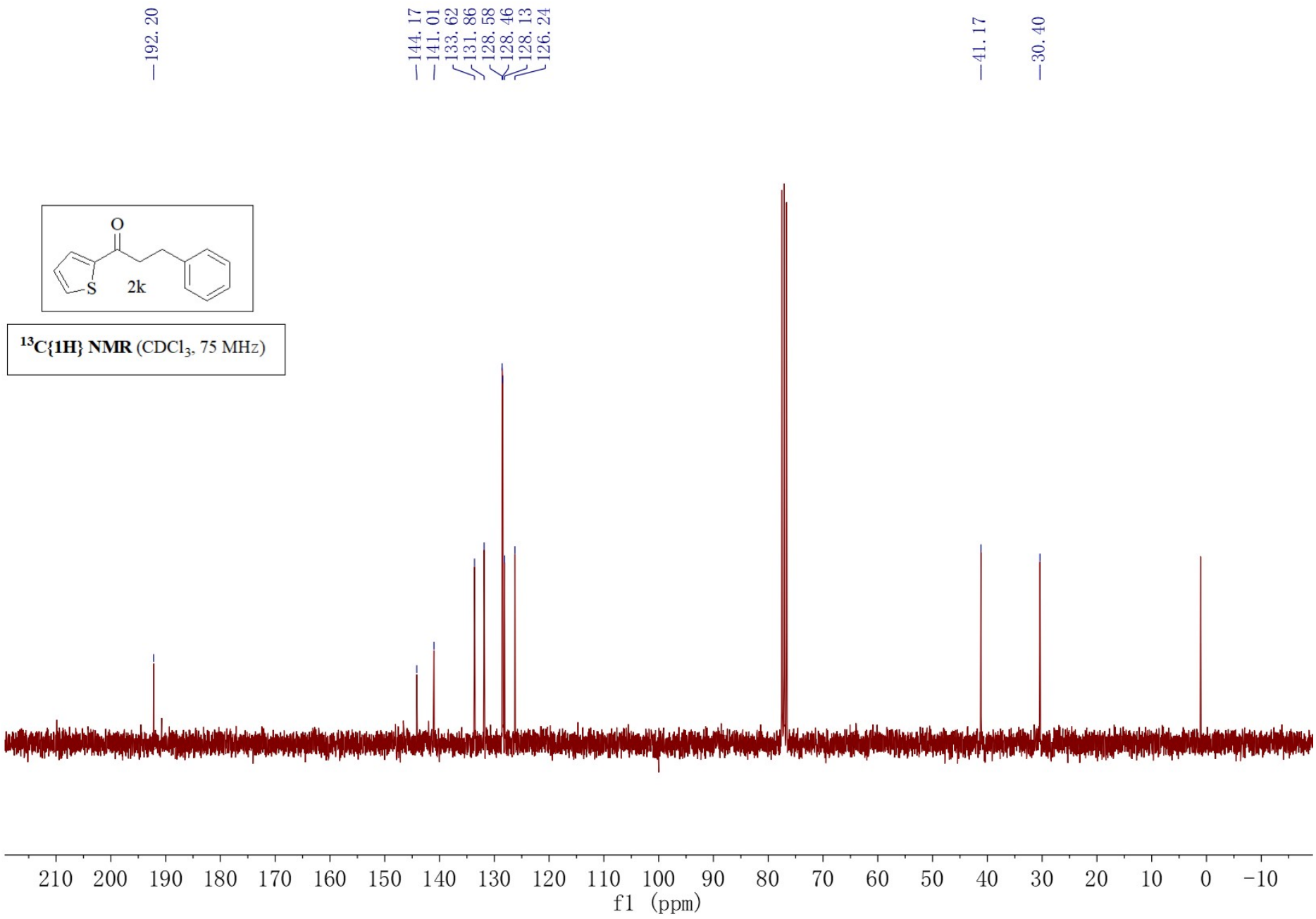

8.33
8.32
7.93
7.92
7.91
7.90
7.81
7.79
7.76
7.74
7.72
7.48
7.48
7.47
7.46
7.45
7.44
7.43
7.43
7.41
7.41
7.39
7.39
7.23
7.22
7.21
7.21
7.20
7.19
7.18
7.17
7.16
7.13
7.12
7.12
7.11
7.11
7.10
7.09
7.09
7.08
3.32
3.31
3.28
3.03
3.02
3.00
O
2i
1H NMR (CDCl3, 400 MHz)
1.00
1.00
1.01
2.02
2.01
1.03
3.01
1.01
2.00
2.02
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
f1 (ppm)

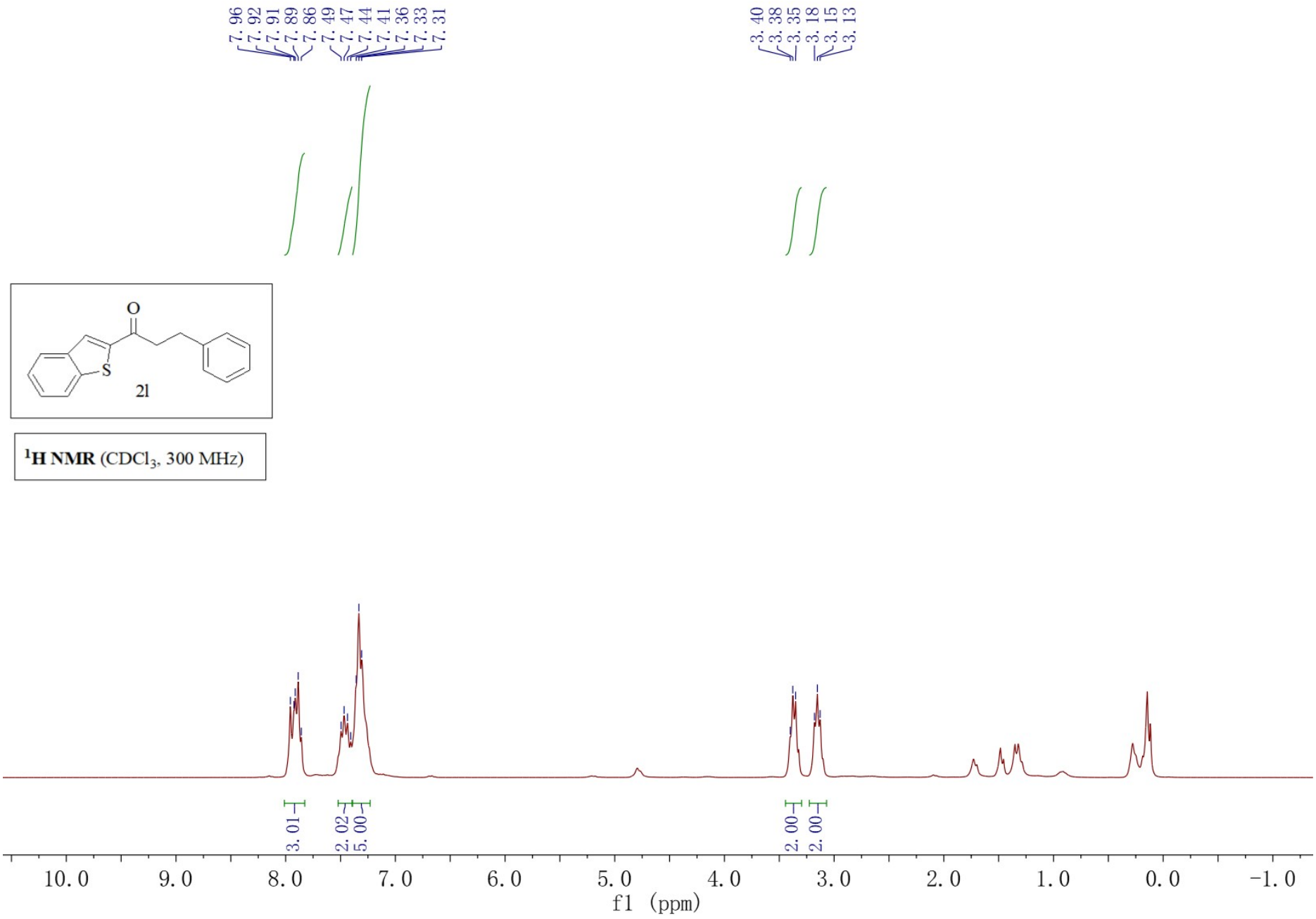

199.18
141.40
135.60
134.18
132.55
129.74
129.59
128.61
128.58
128.52
128.50
127.82
126.82
126.22
123.88
40.60
30.31
O
2i
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

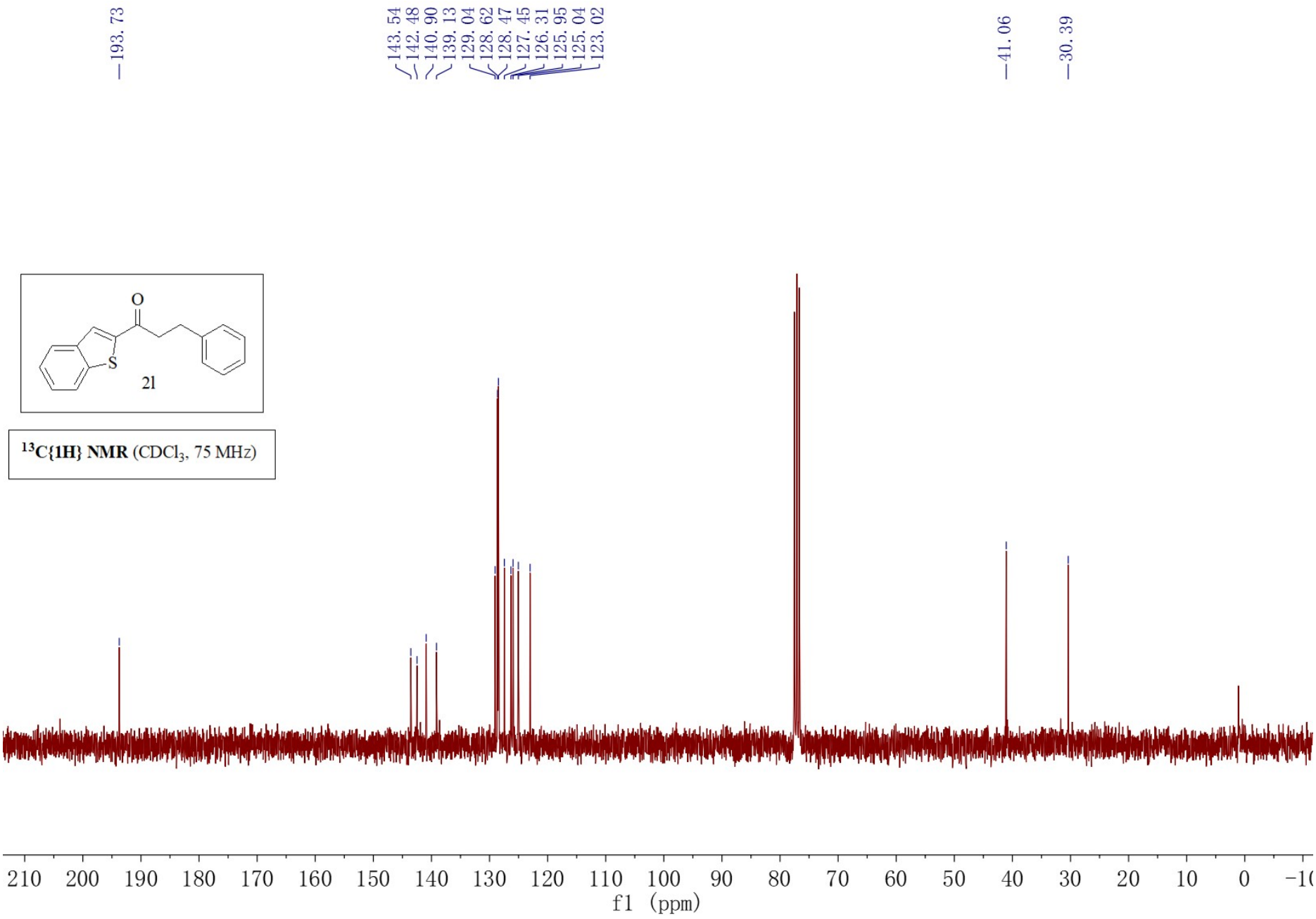

7.46
7.46
7.46
7.45
7.21
7.19
7.17
7.15
7.15
7.13
7.12
7.11
7.11
7.10
7.10
7.09
7.08
7.08
7.07
7.07
7.06
7.06
6.42
6.41
6.41
6.40
3.07
3.05
3.03
2.96
2.95
2.93
O
O
2j
1H NMR (CDCl3, 400 MHz)
1.00
2.03
2.03
1.02
1.01
1.01
2.01
2.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.
f1 (ppm)

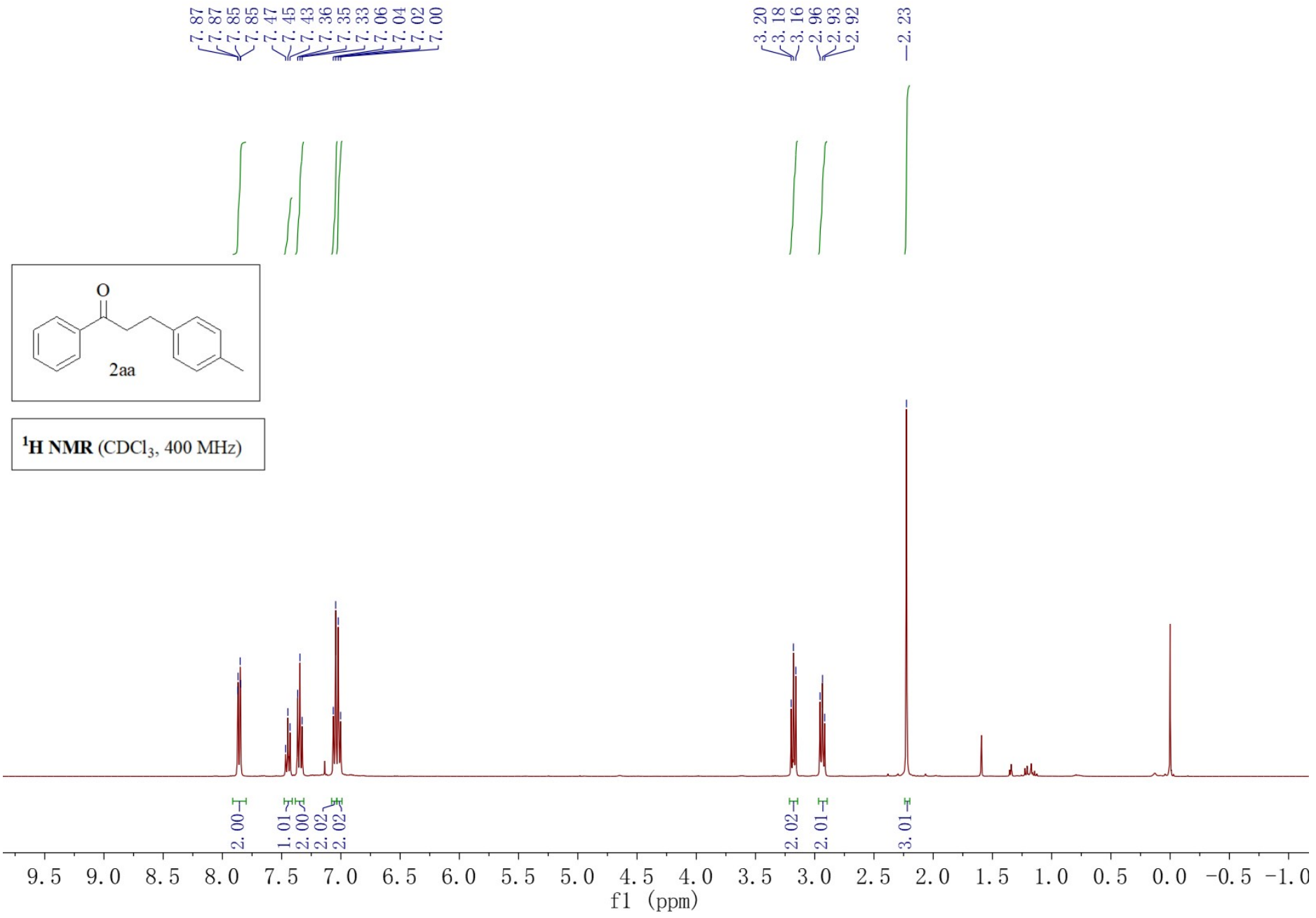

188.50
152.64
146.36
140.98
128.53
128.43
126.19
117.08
112.24
40.19
29.96
O
O
2j
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

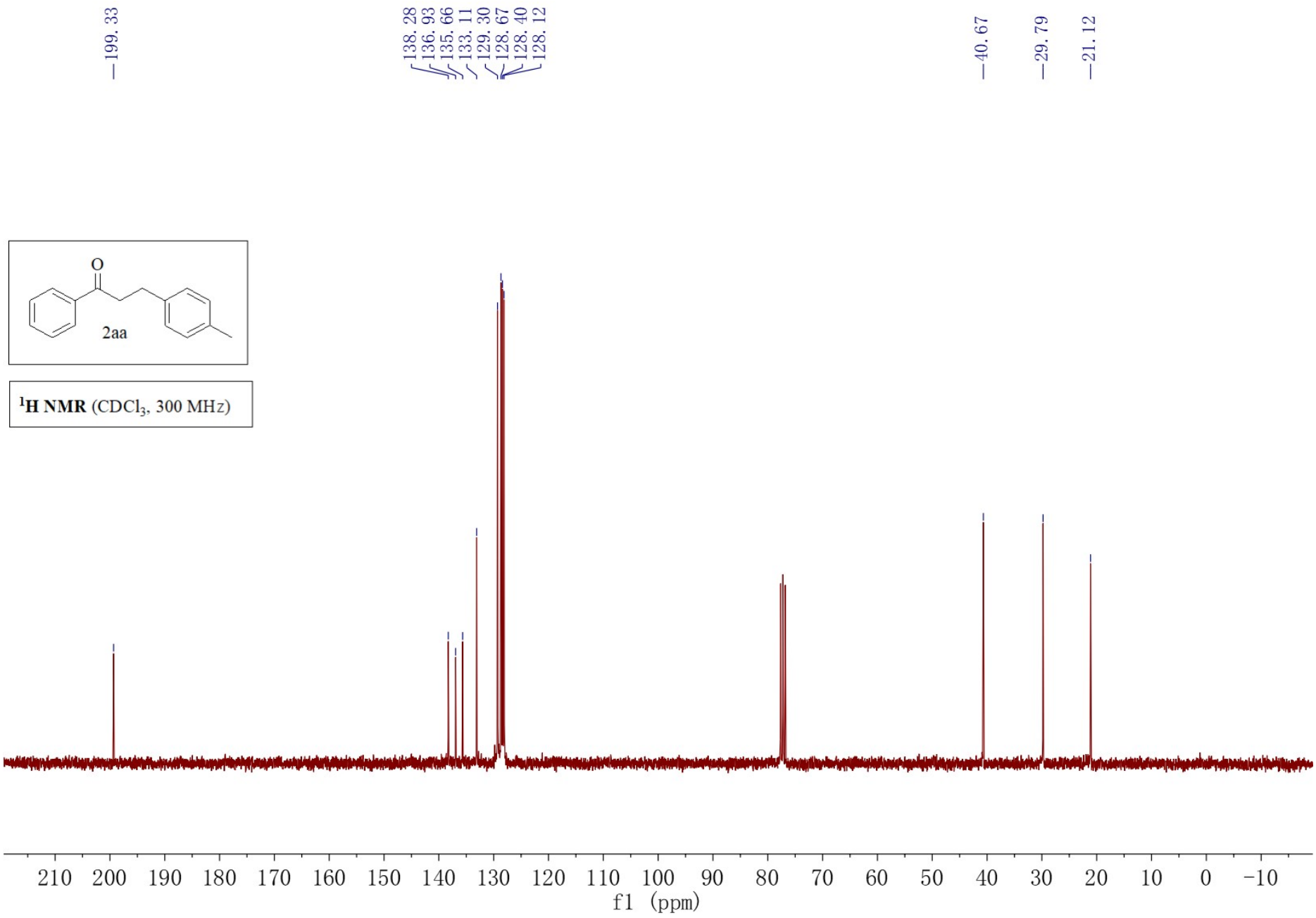

7.74
7.73
7.72
7.72
7.67
7.67
7.65
7.65
7.35
7.32
7.30
7.28
7.25
7.23
7.16
7.15
7.15
7.14
3.30
3.28
3.25
3.14
3.11
3.09
O
S
2k
1H NMR (CDCl3, 300 MHz)
1.00
1.00
4.02
1.03
1.02
2.00
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

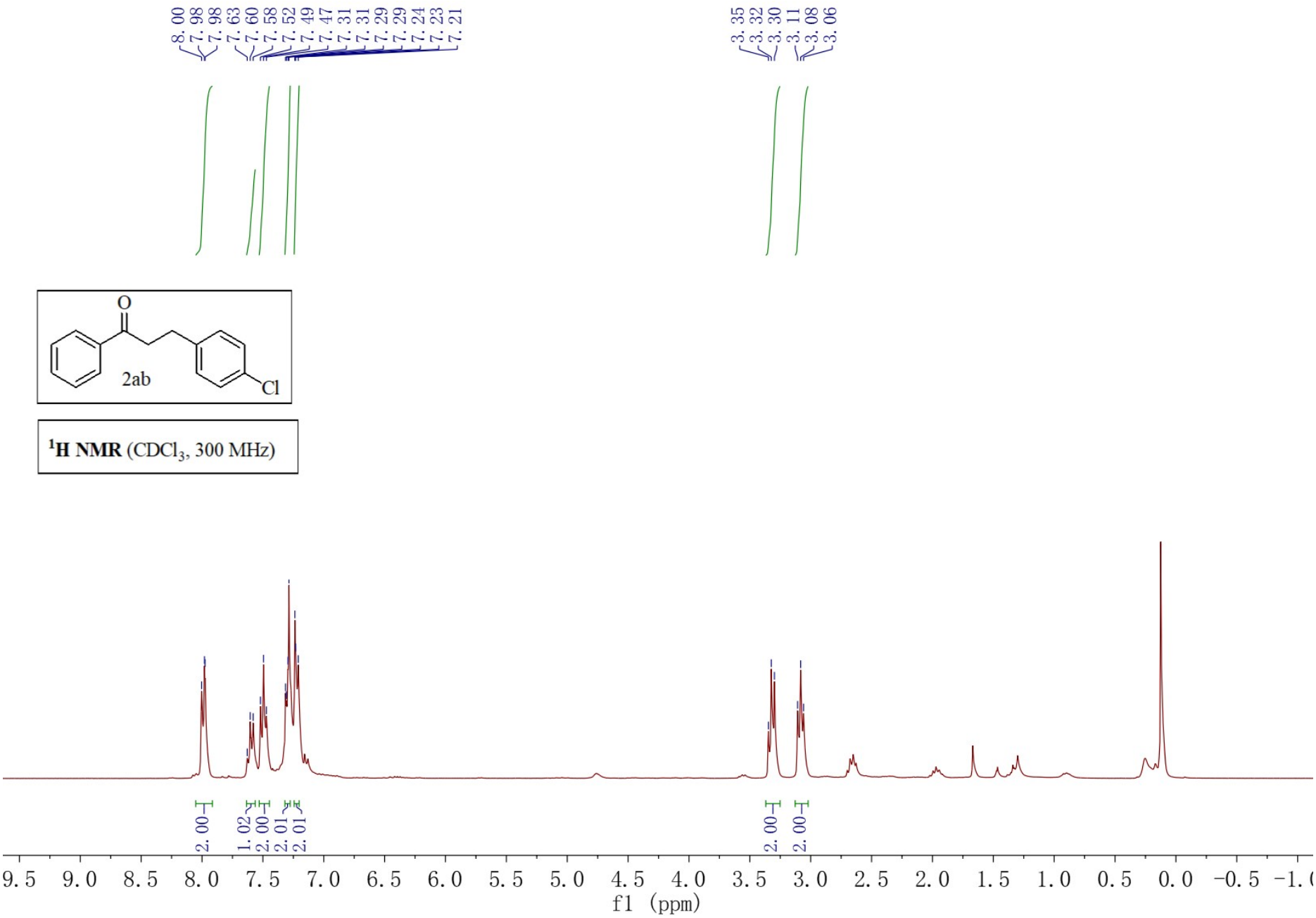

192.20
144.17
141.01
133.62
131.86
128.58
128.46
128.13
126.24
41.17
30.40
O
S
2k
^{13}C{1H} NMR (CDCl$_3$, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

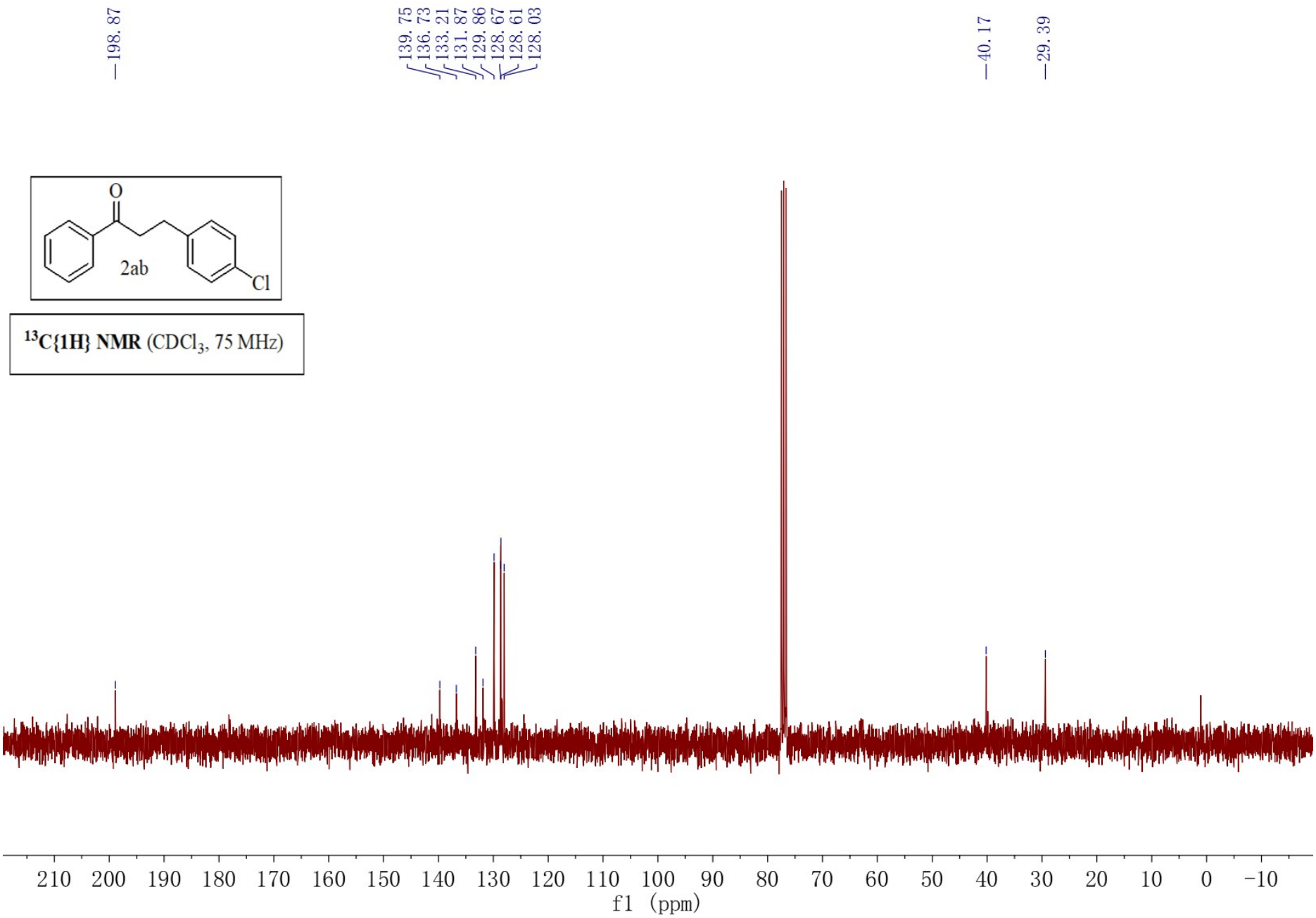

7.96
7.92
7.91
7.89
7.86
7.49
7.47
7.44
7.41
7.36
7.33
7.31
3.40
3.38
3.35
3.18
3.15
3.13
O
S
2l
1H NMR (CDCl3, 300 MHz)
3.01
2.02
5.00
2.00
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

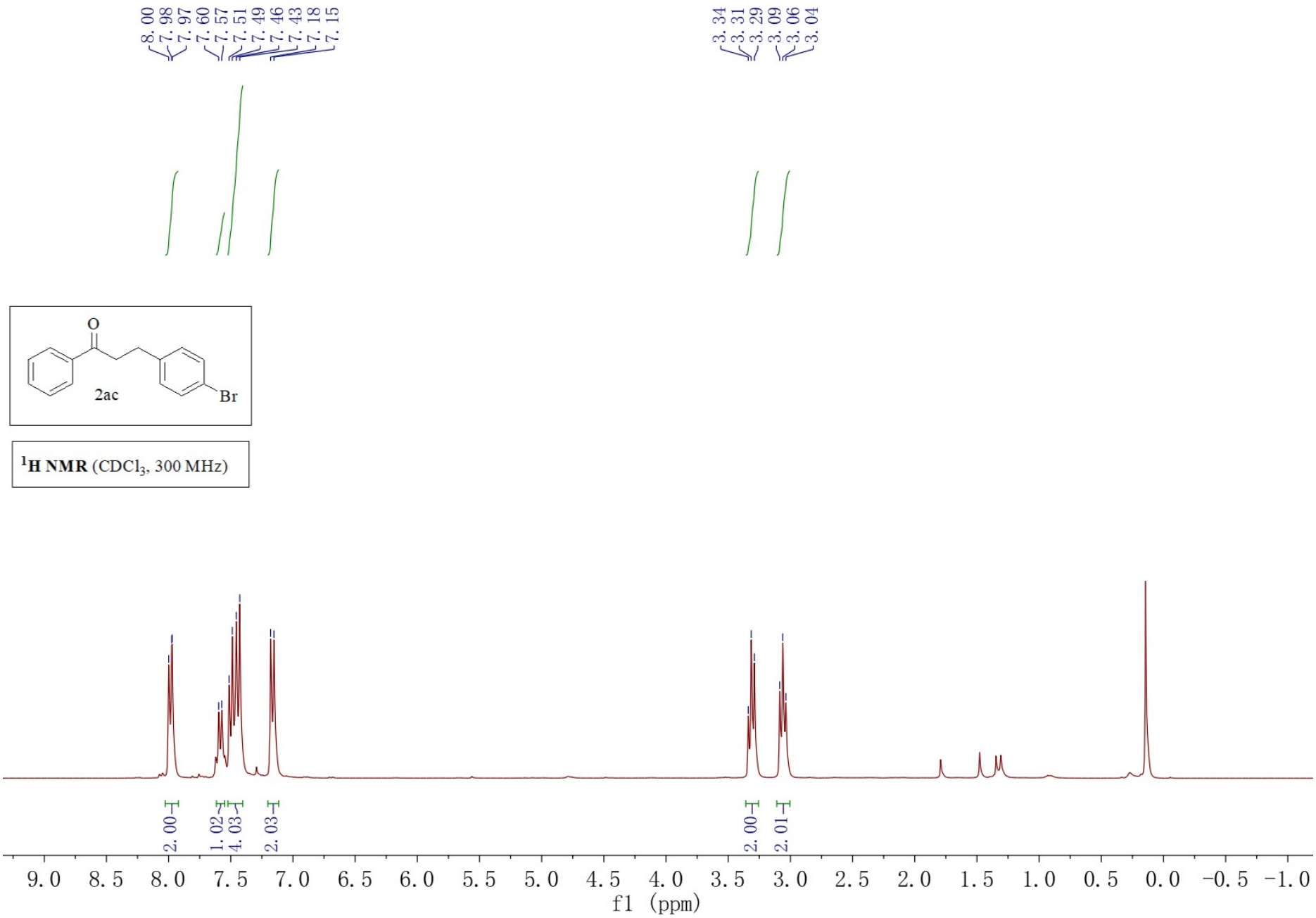

193.73
143.54
142.48
140.90
139.13
129.04
128.62
128.47
127.45
126.31
125.95
125.04
123.02
41.06
30.39
O
S
21
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

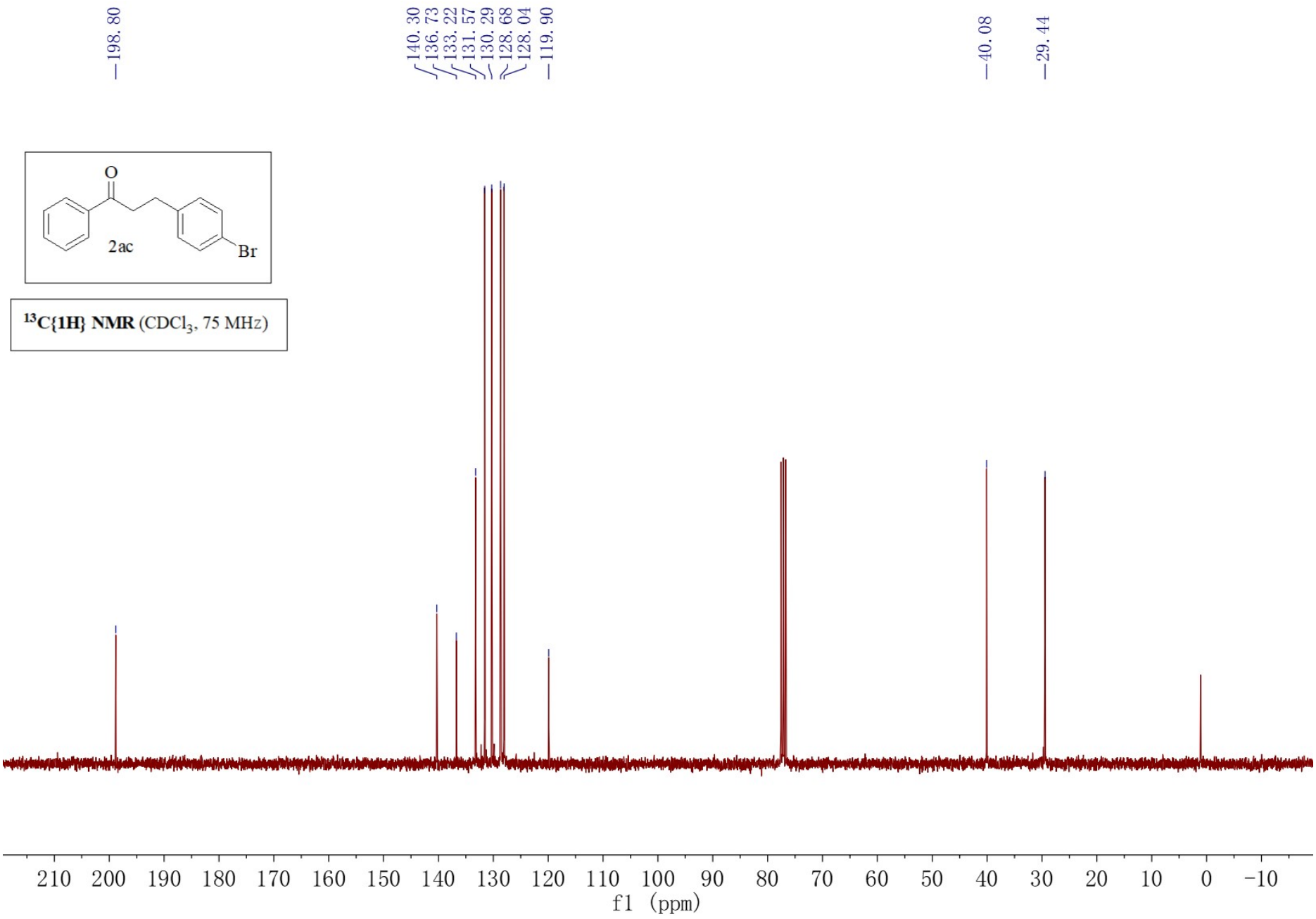

7.87
7.87
7.85
7.85
7.47
7.45
7.43
7.36
7.35
7.33
7.06
7.04
7.02
7.00
3.20
3.18
3.16
2.96
2.93
2.92
2.23
O
2aa
¹H NMR (CDCl₃, 400 MHz)
2.00
1.01
2.00
2.02
2.02
2.02
2.01
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

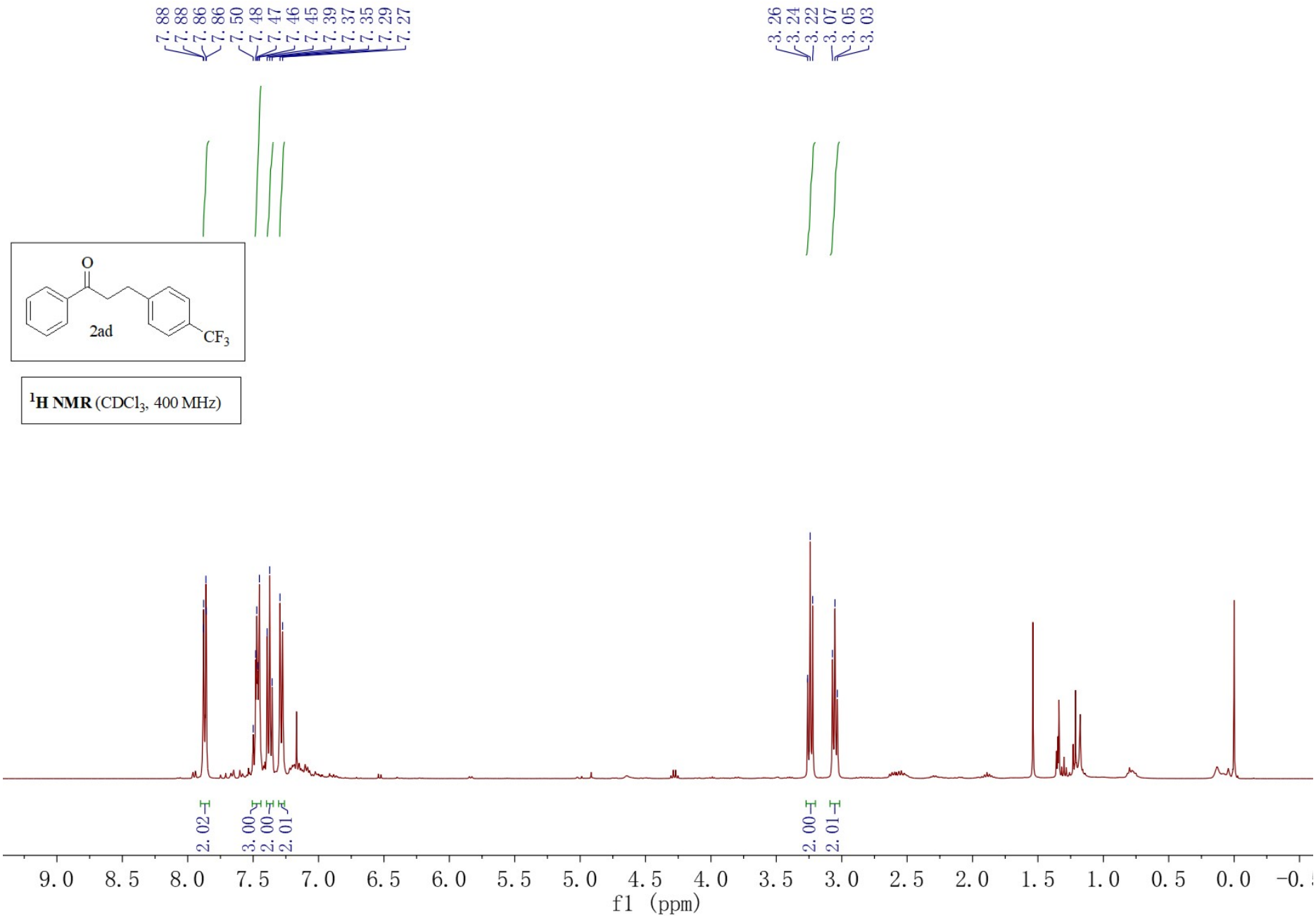

199.33
138.28
136.93
135.66
133.11
129.30
128.67
128.40
128.12
40.67
29.79
21.12
O
2aa
^{1}H NMR (CDCl$_3$, 300 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

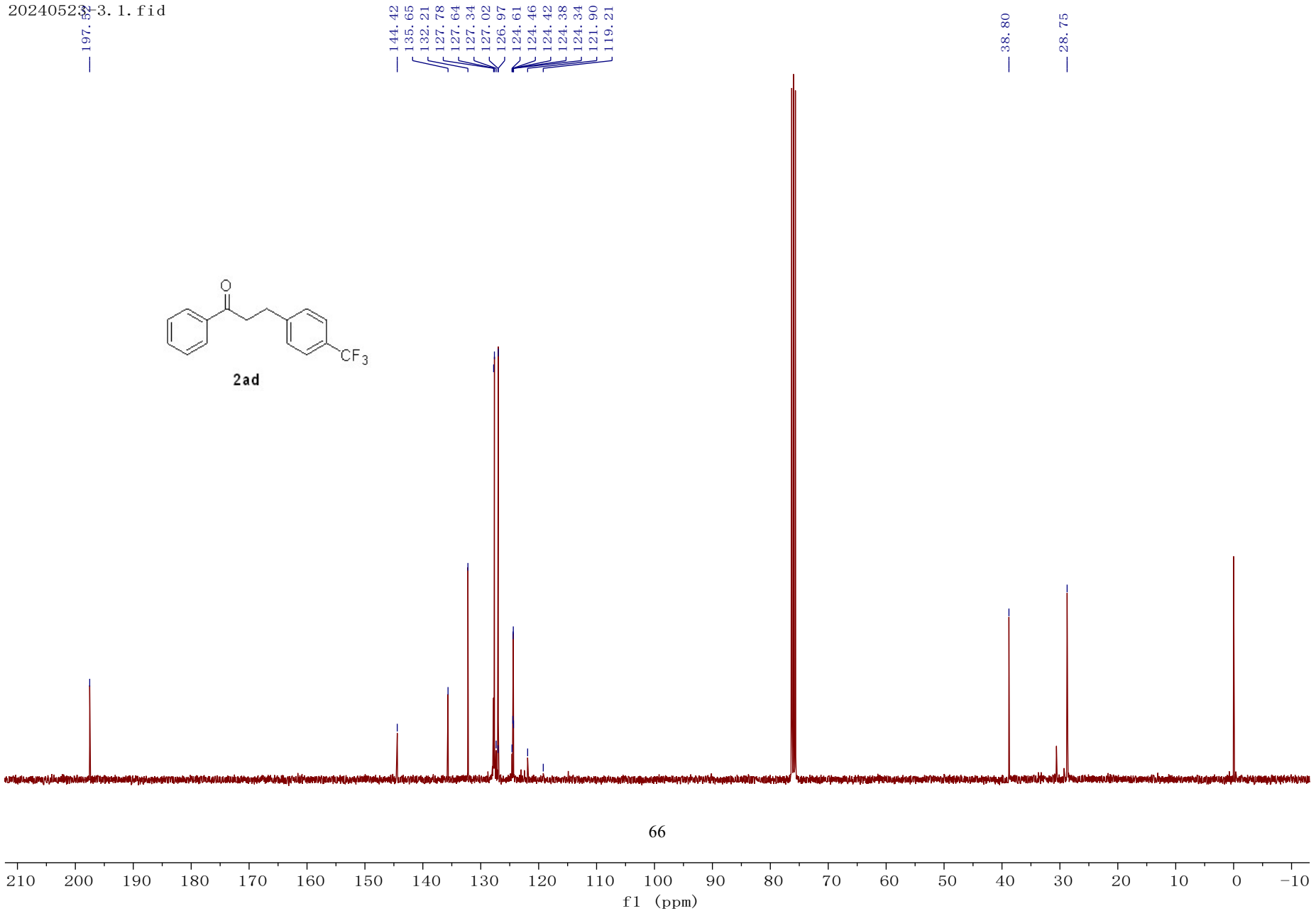

8.00
7.98
7.98
7.63
7.60
7.58
7.52
7.49
7.47
7.31
7.31
7.29
7.29
7.24
7.23
7.21
3.35
3.32
3.30
3.11
3.08
3.06
O
2ab
Cl
¹H NMR (CDCl₃, 300 MHz)
2.00
1.02
2.00
2.01
2.01
2.00
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

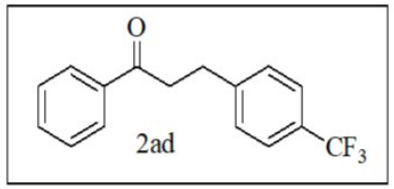

198.87
139.75
136.73
133.21
131.87
129.86
128.67
128.61
128.03
40.17
29.39
O
2ab
Cl
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.00
7.98
7.97
7.60
7.57
7.51
7.49
7.46
7.43
7.18
7.15
3.34
3.31
3.29
3.09
3.06
3.04
O
2ac
Br
1H NMR (CDCl3, 300 MHz)
2.00
1.02
4.03
2.03
2.00
2.01
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
-1.0
f1 (ppm)

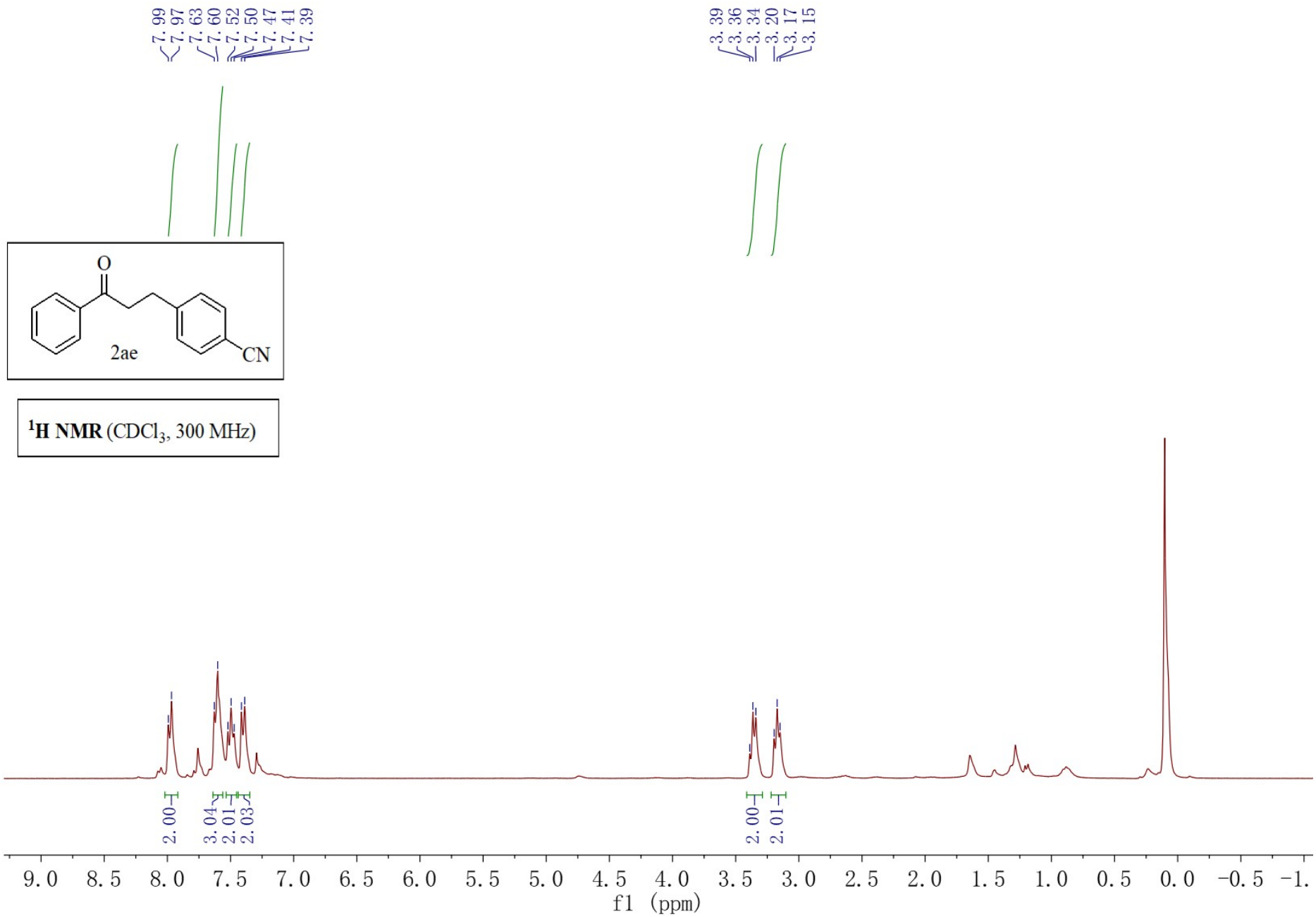

198.80
140.30
136.73
133.22
131.57
130.29
128.68
128.04
119.90
40.08
29.44
O
2ac
Br
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

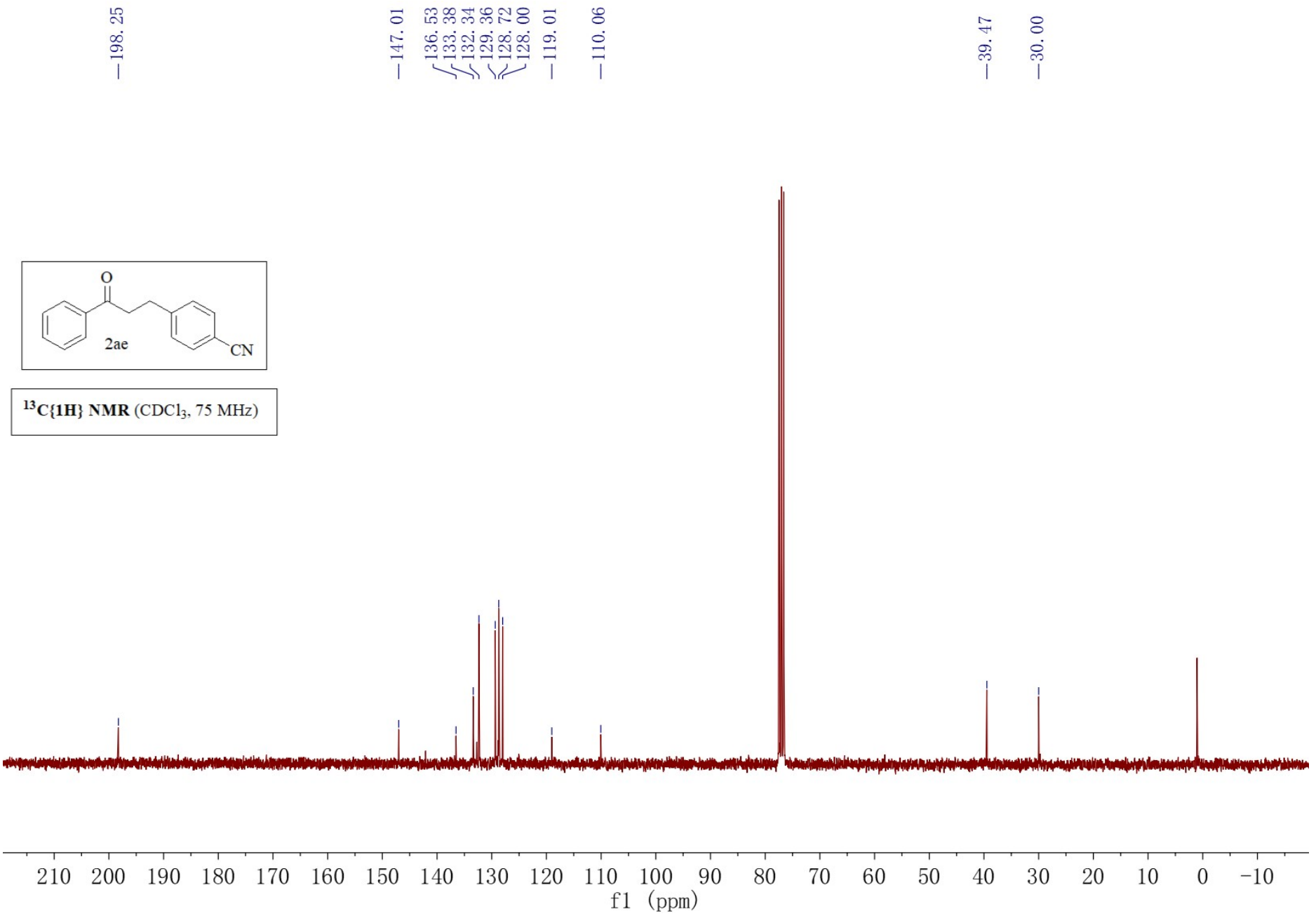

7.88
7.88
7.86
7.86
7.50
7.48
7.47
7.46
7.45
7.39
7.37
7.35
7.29
7.27
3.26
3.24
3.22
3.07
3.05
3.03
O
2ad
CF3
1H NMR (CDCl3, 400 MHz)
2.02
3.00
2.00
2.01
2.00
2.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

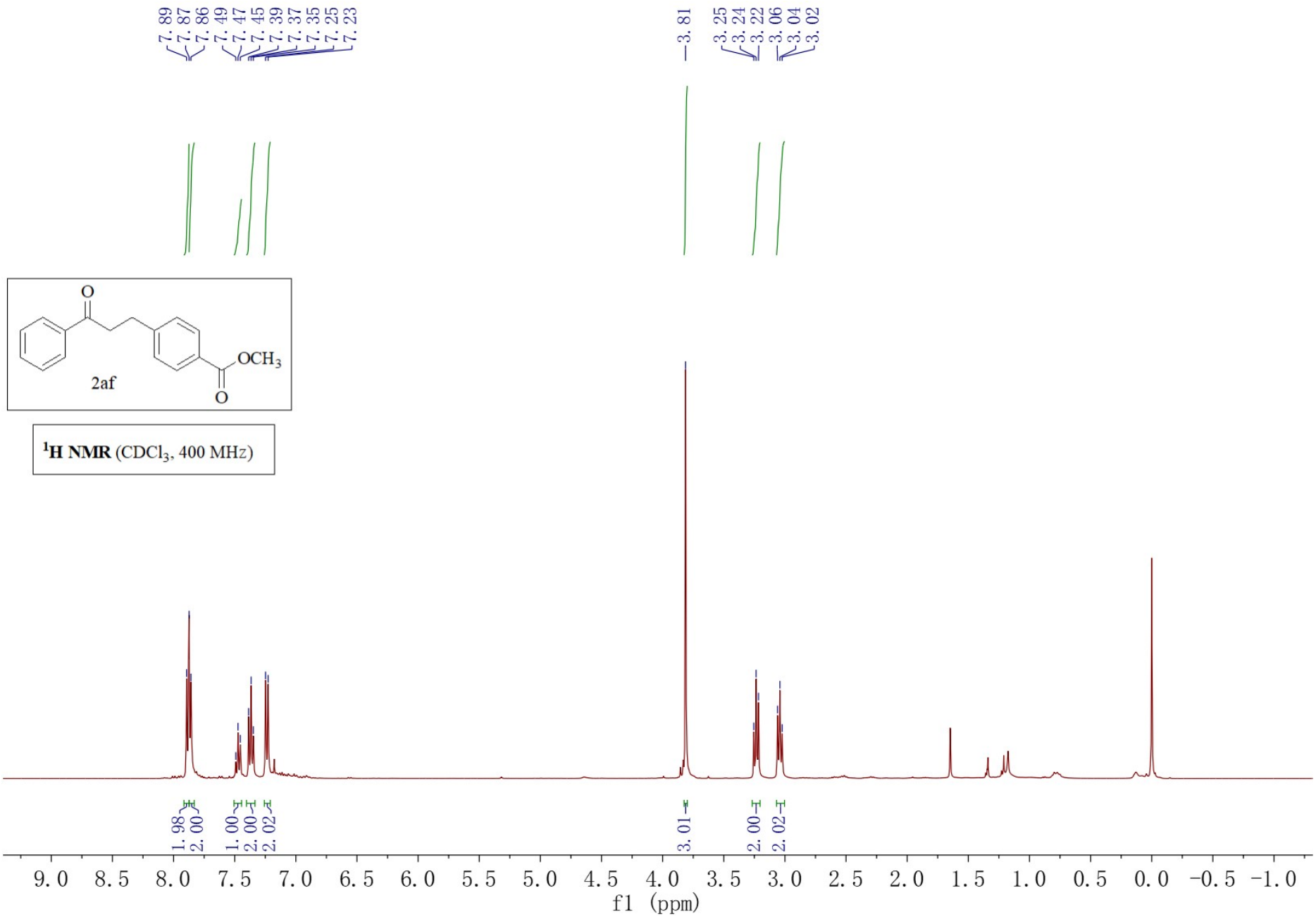

20240523-3.1.fid
197.52
144.42
135.65
132.21
127.78
127.64
127.34
127.02
126.97
124.61
124.46
124.42
124.38
124.34
121.90
119.21
38.80
28.75
O
CF3
2ad
66
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

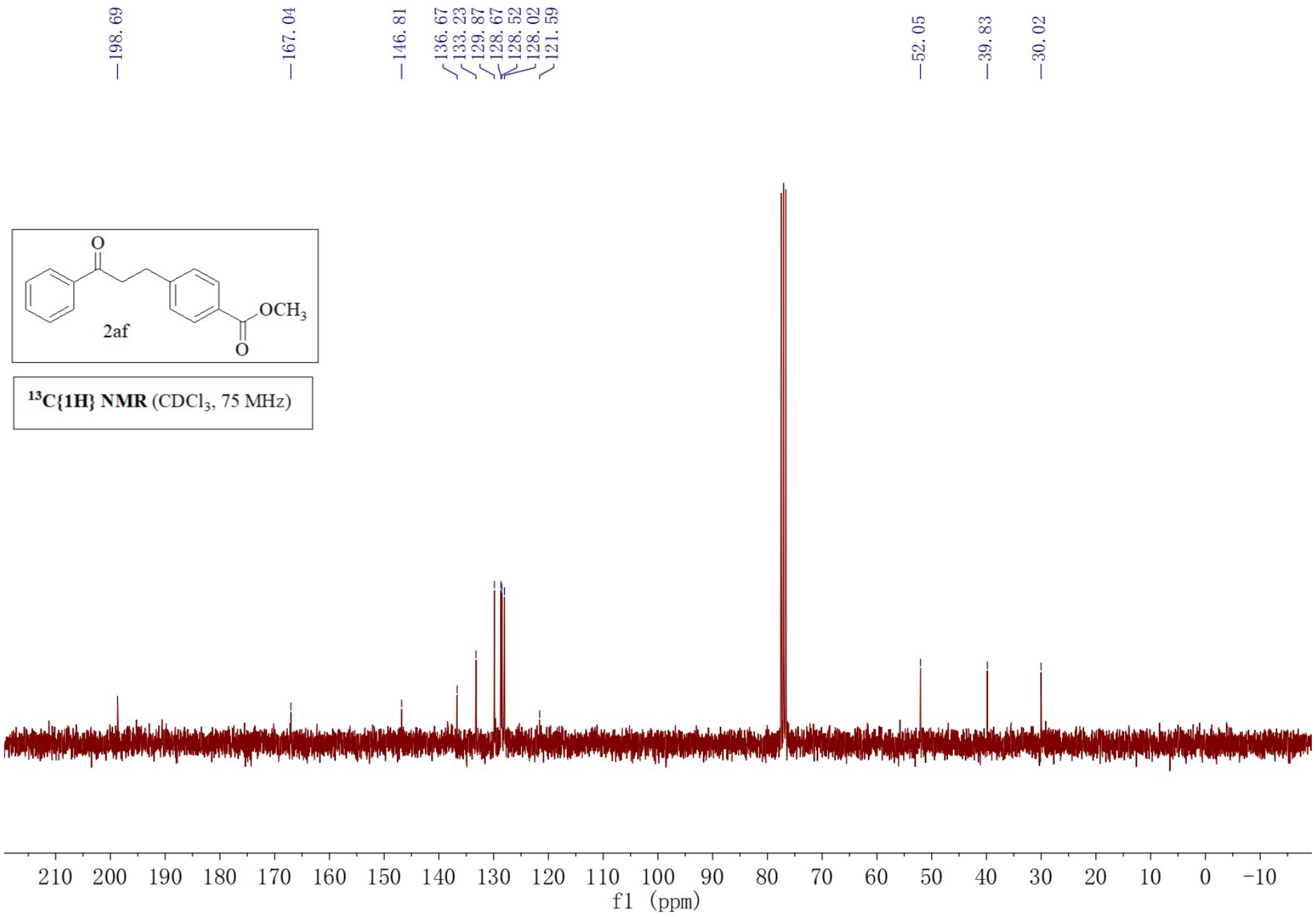


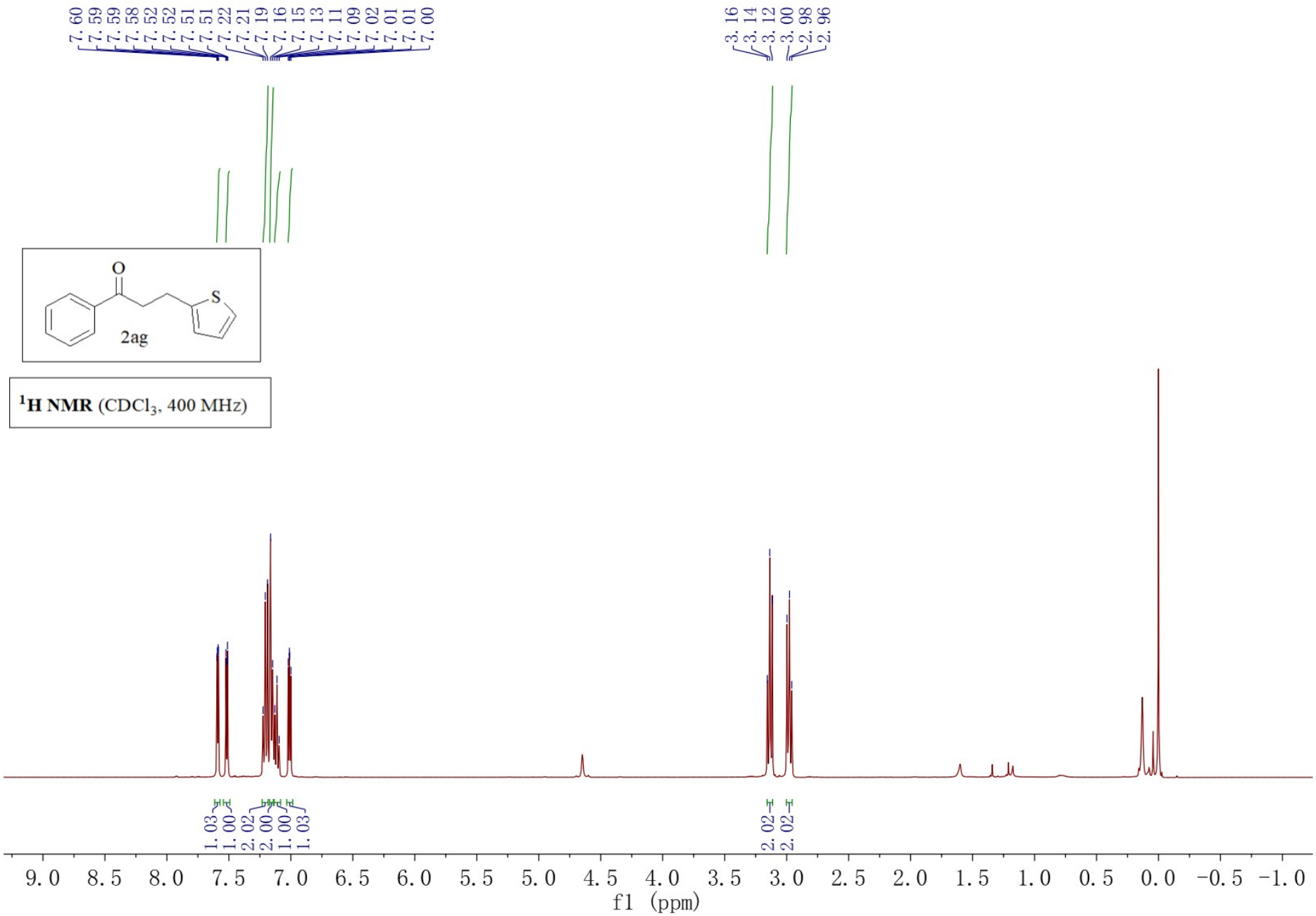
^{19}F NMR ($CDCl_3$, 282 MHz)

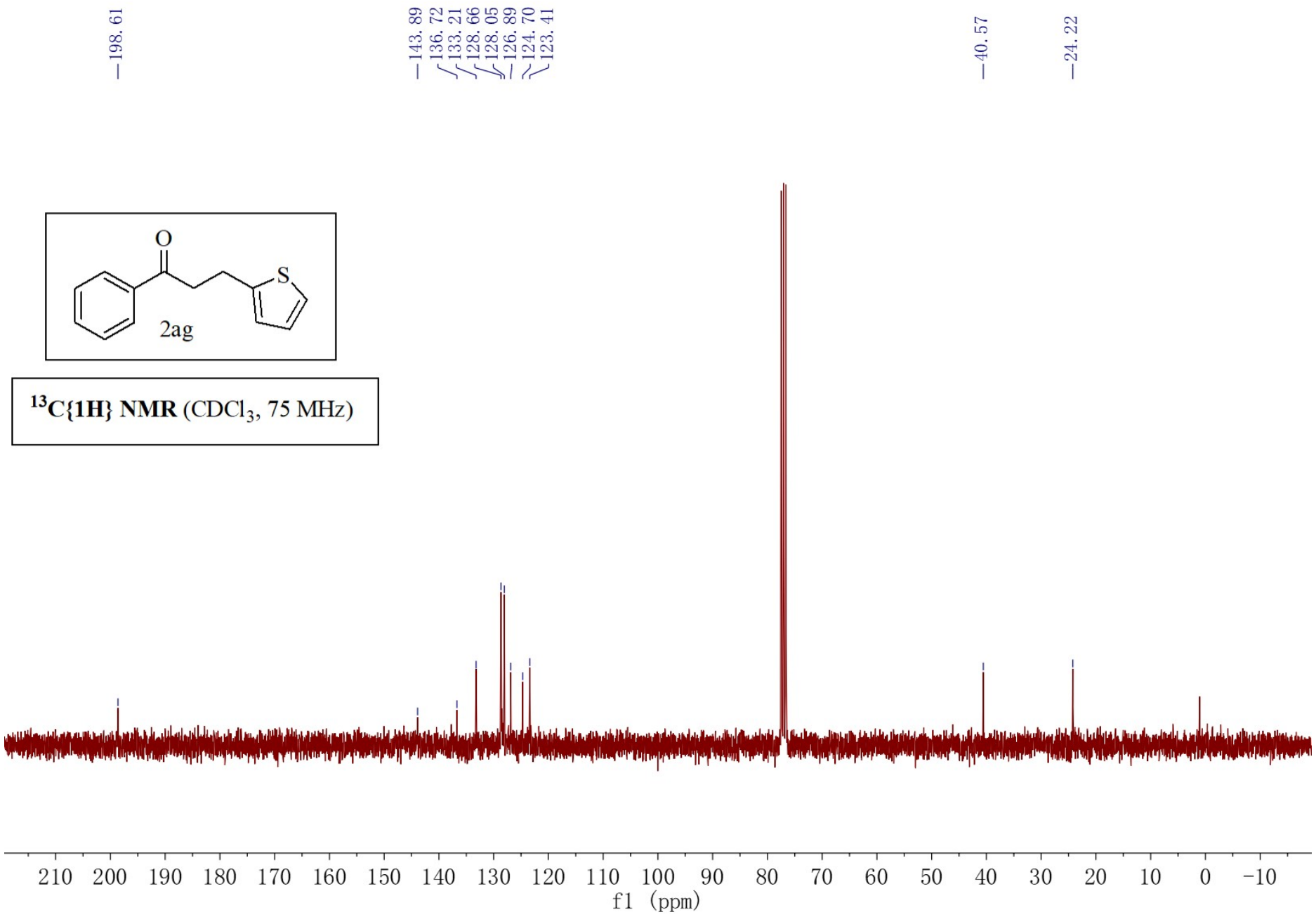

7.99
7.97
7.63
7.60
7.52
7.50
7.47
7.41
7.39
3.39
3.36
3.34
3.20
3.17
3.15
O
2ae
CN
1H NMR (CDCl3, 300 MHz)
2.00
3.04
2.01
2.03
2.00
2.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)

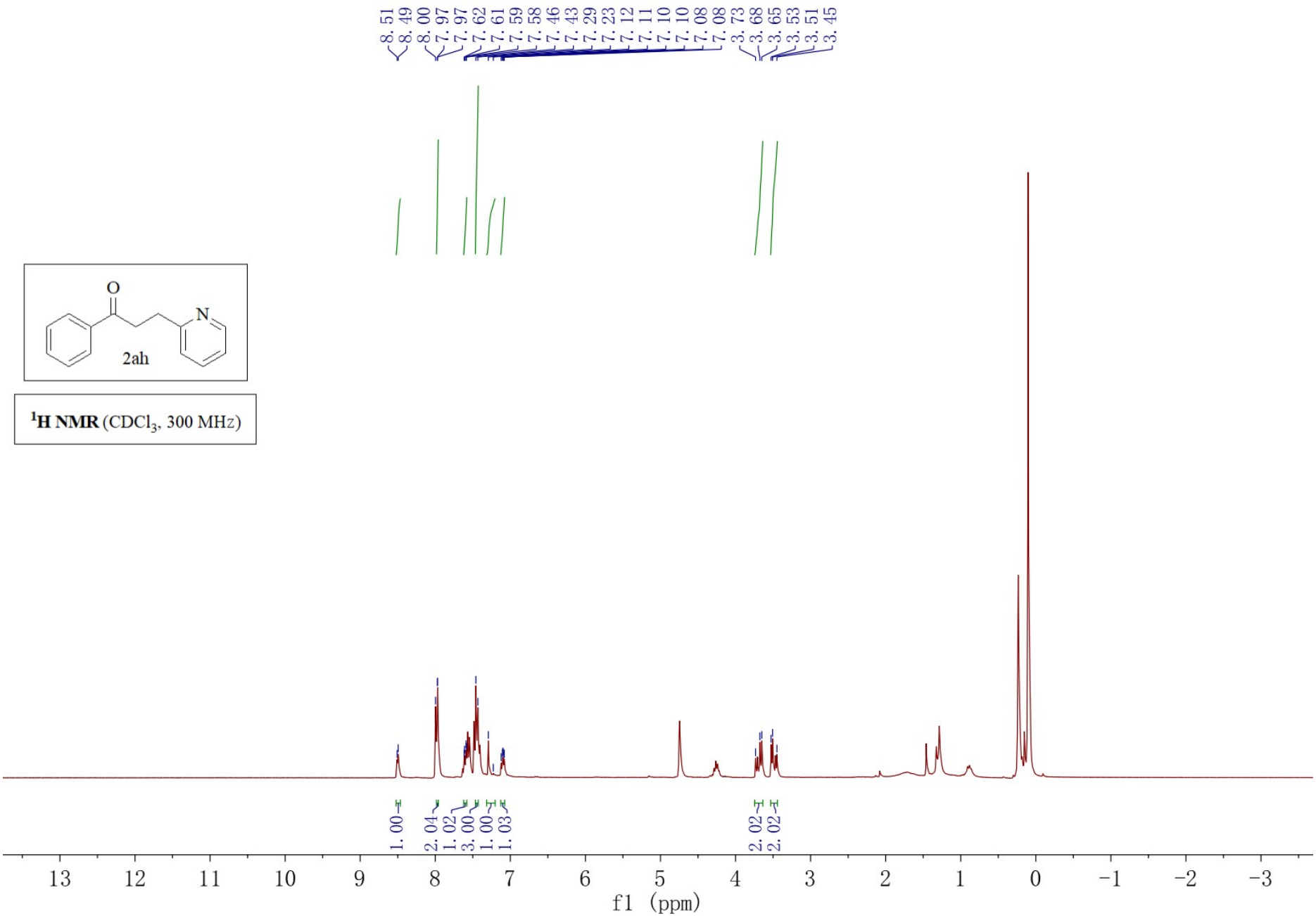

198.25
147.01
136.53
133.38
132.34
129.36
128.72
128.00
119.01
110.06
39.47
30.00
O
2ae
CN
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

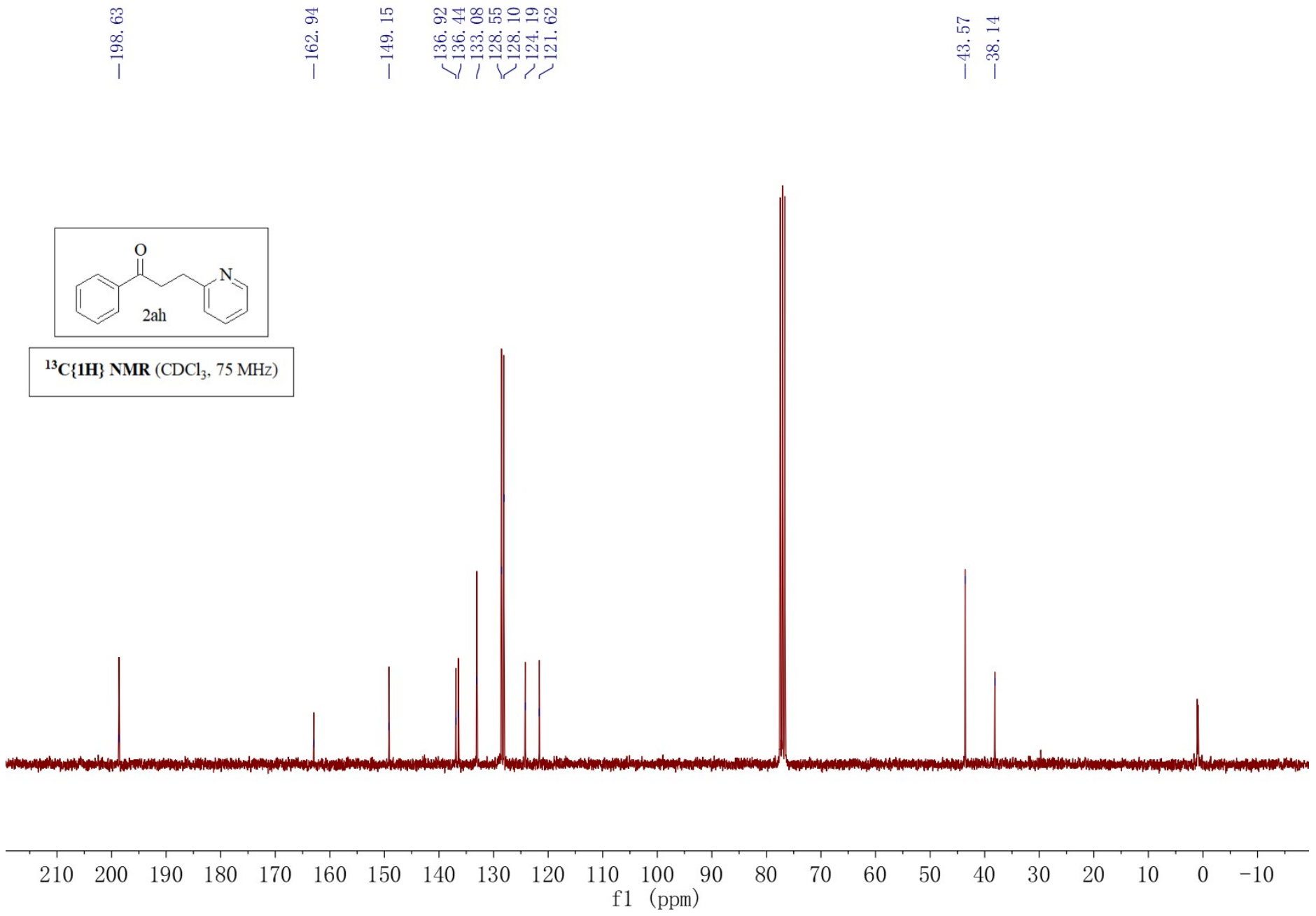

7.89
7.87
7.86
7.49
7.47
7.45
7.39
7.37
7.35
7.25
7.23
3.81
3.25
3.24
3.22
3.06
3.04
3.02
O
OCH3
O
2af
1H NMR (CDCl3, 400 MHz)
1.98
2.00
1.00
2.00
2.02
3.01
2.00
2.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

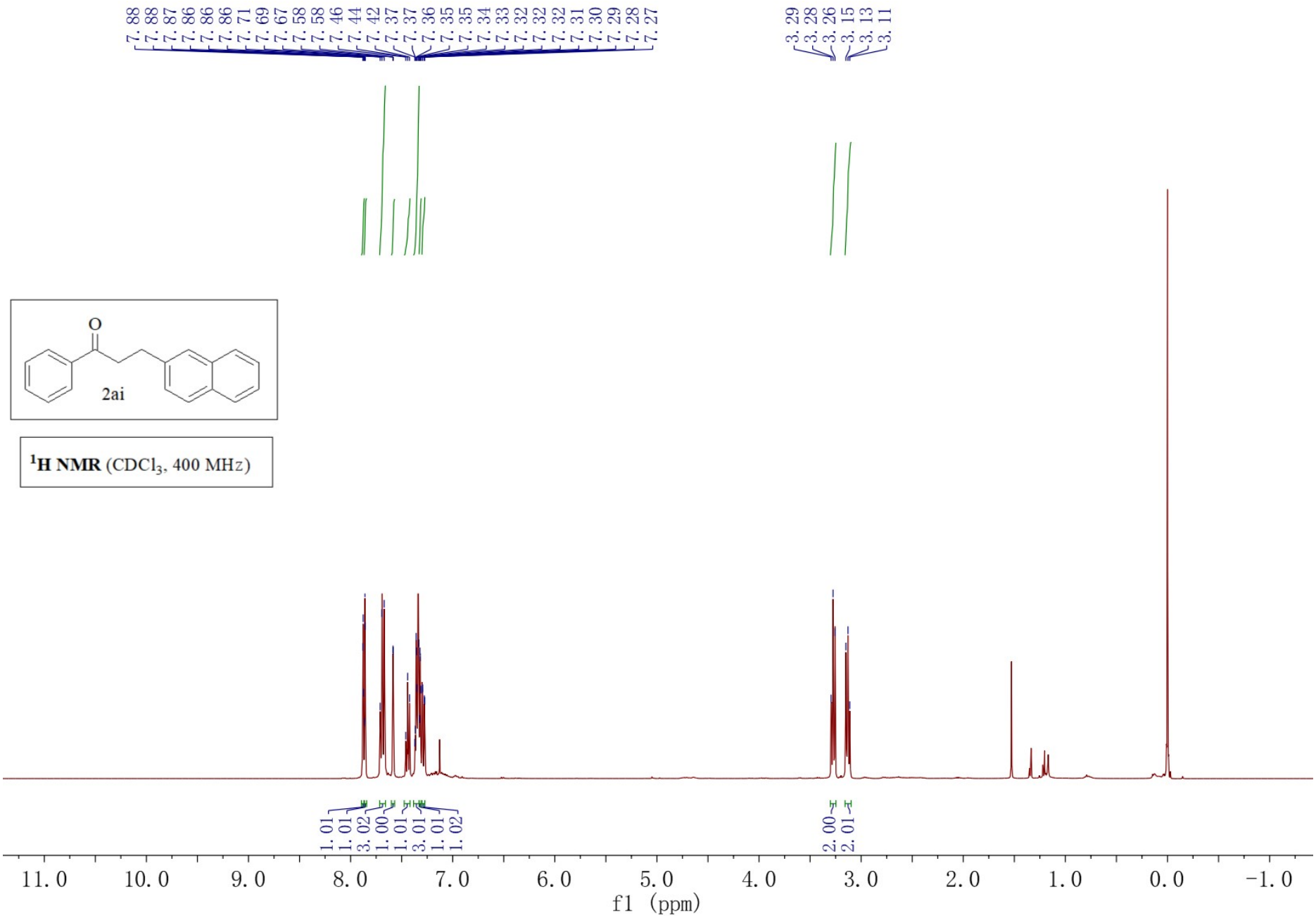

198.69
167.04
146.81
136.67
133.23
129.87
128.67
128.52
128.02
121.59
52.05
39.83
30.02
O
OCH3
O
2af
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

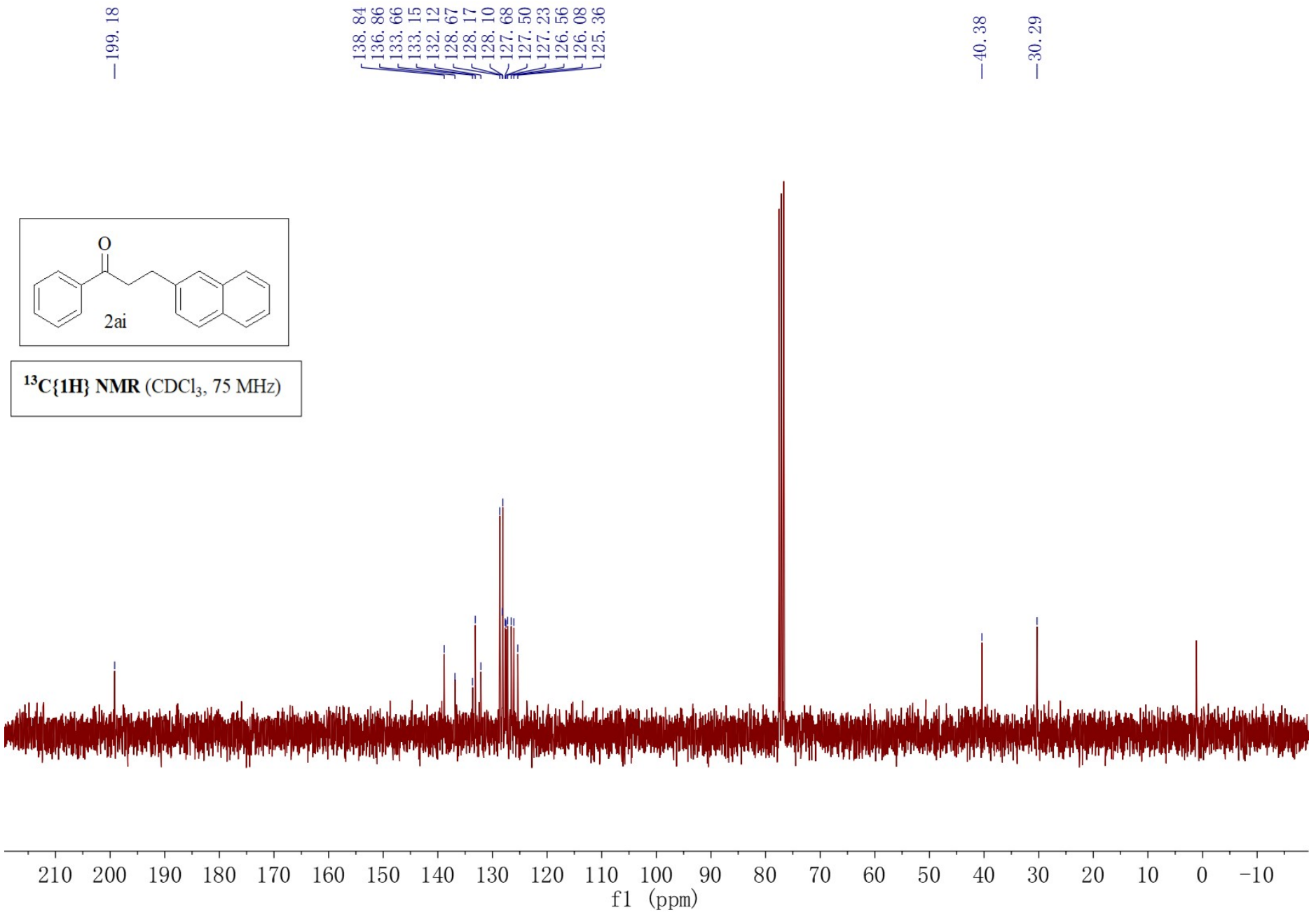

7.60
7.59
7.59
7.58
7.52
7.52
7.51
7.51
7.22
7.21
7.19
7.16
7.15
7.13
7.11
7.09
7.02
7.01
7.01
7.00
3.16
3.14
3.12
3.00
2.98
2.96
O
S
2ag
1H NMR (CDCl3, 400 MHz)
1.03
1.00
2.02
2.00
1.00
1.03
2.02
2.02
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

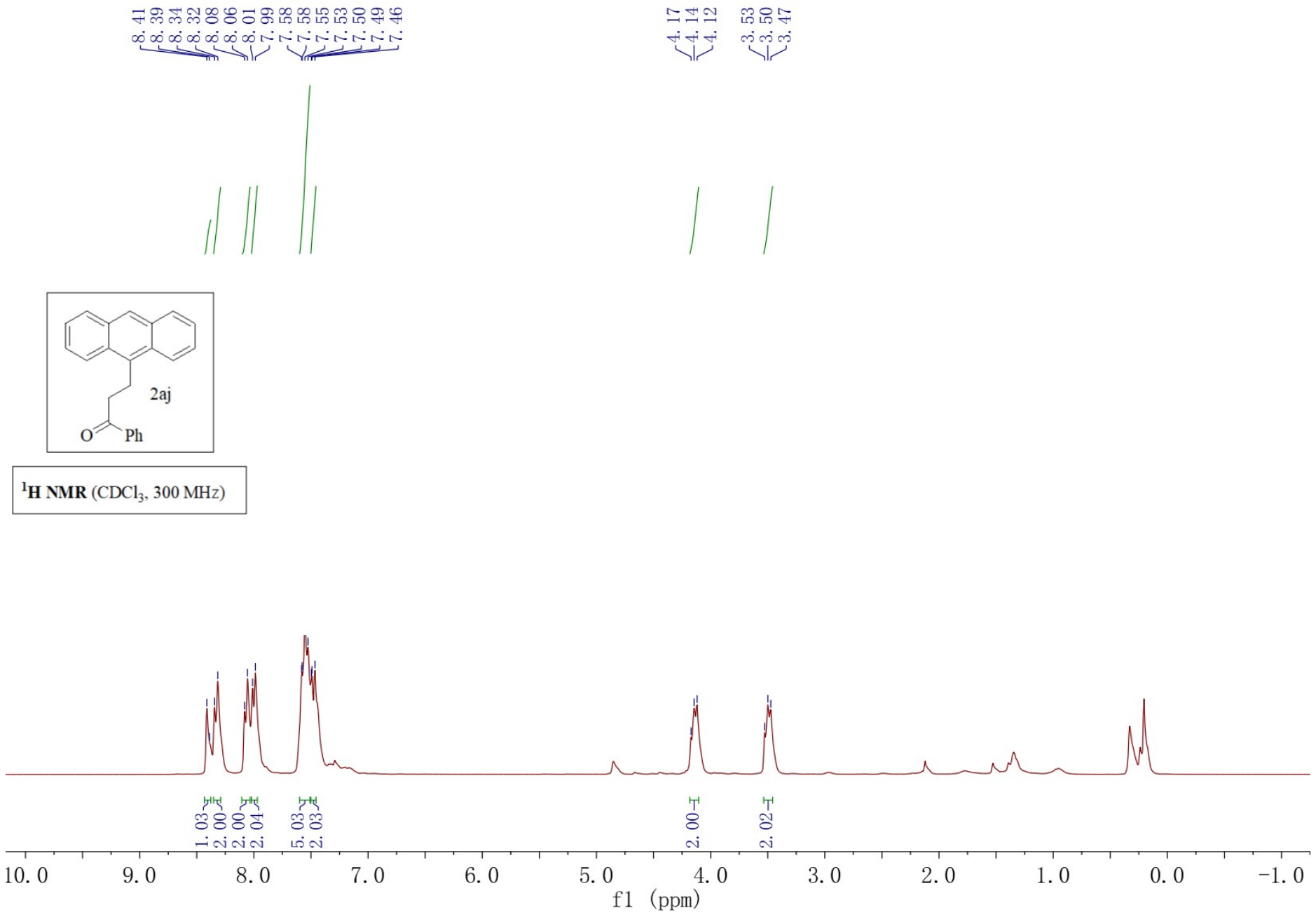

198.61
143.89
136.72
133.21
128.66
128.05
126.89
124.70
123.41
40.57
24.22
O
S
2ag
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.51
8.49
8.00
7.97
7.97
7.62
7.61
7.59
7.58
7.46
7.43
7.29
7.23
7.12
7.11
7.10
7.10
7.08
7.08
3.73
3.68
3.65
3.53
3.51
3.45
O
N
2ah
1H NMR (CDCl3, 300 MHz)
1.00
2.04
1.02
3.00
1.00
1.03
2.02
2.02
13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
−3
f1 (ppm)

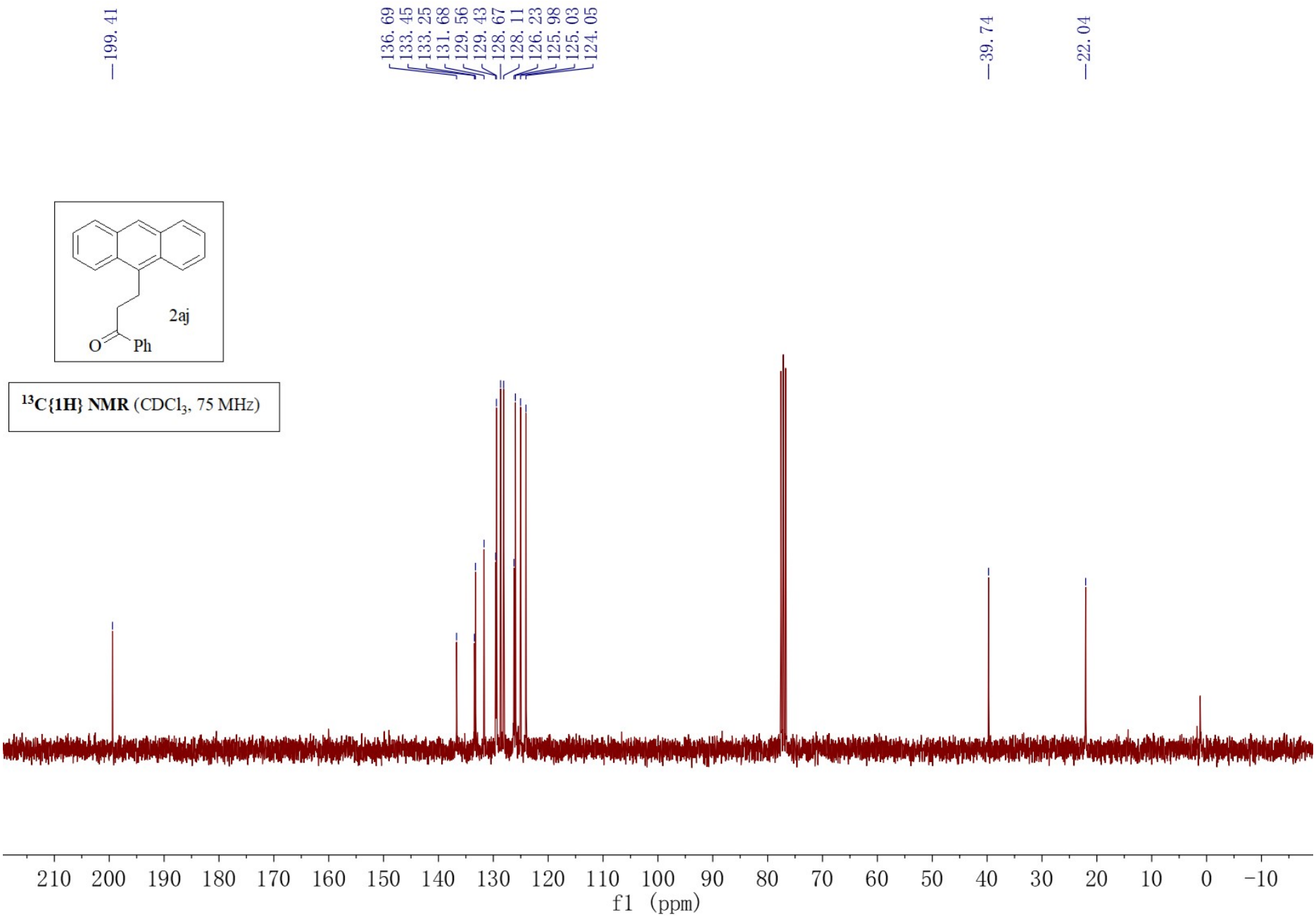

198.63
162.94
149.15
136.92
136.44
133.08
128.55
128.10
124.19
121.62
43.57
38.14
O
N
2ah
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

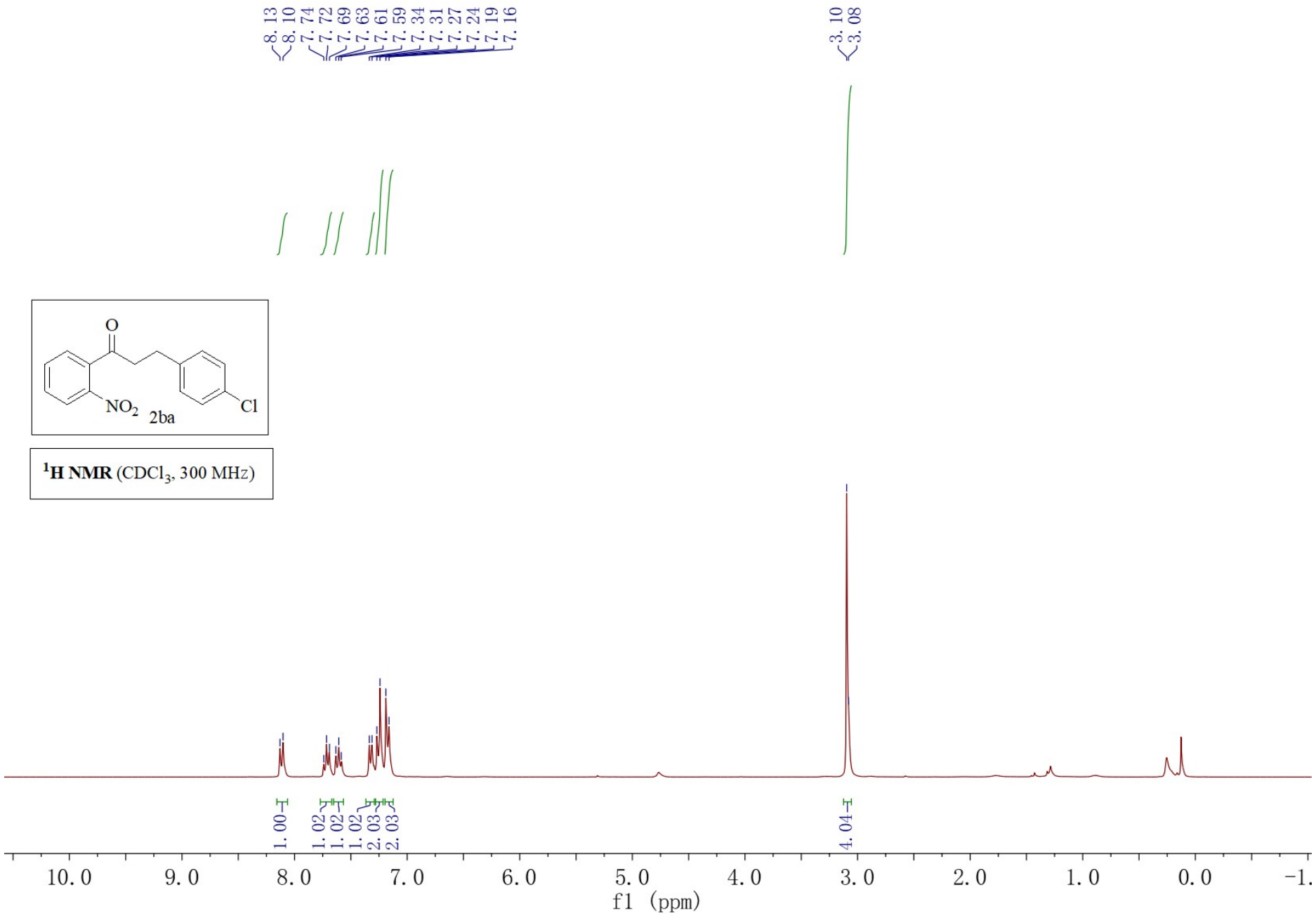

7.88
7.88
7.87
7.86
7.86
7.86
7.71
7.69
7.67
7.58
7.58
7.46
7.44
7.42
7.37
7.37
7.36
7.35
7.35
7.34
7.33
7.32
7.32
7.32
7.31
7.30
7.29
7.28
7.27
3.29
3.28
3.26
3.15
3.13
3.11
O
2ai
1H NMR (CDCl3, 400 MHz)
1.01
1.01
3.02
1.00
1.01
3.01
1.01
1.02
2.00
2.01
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

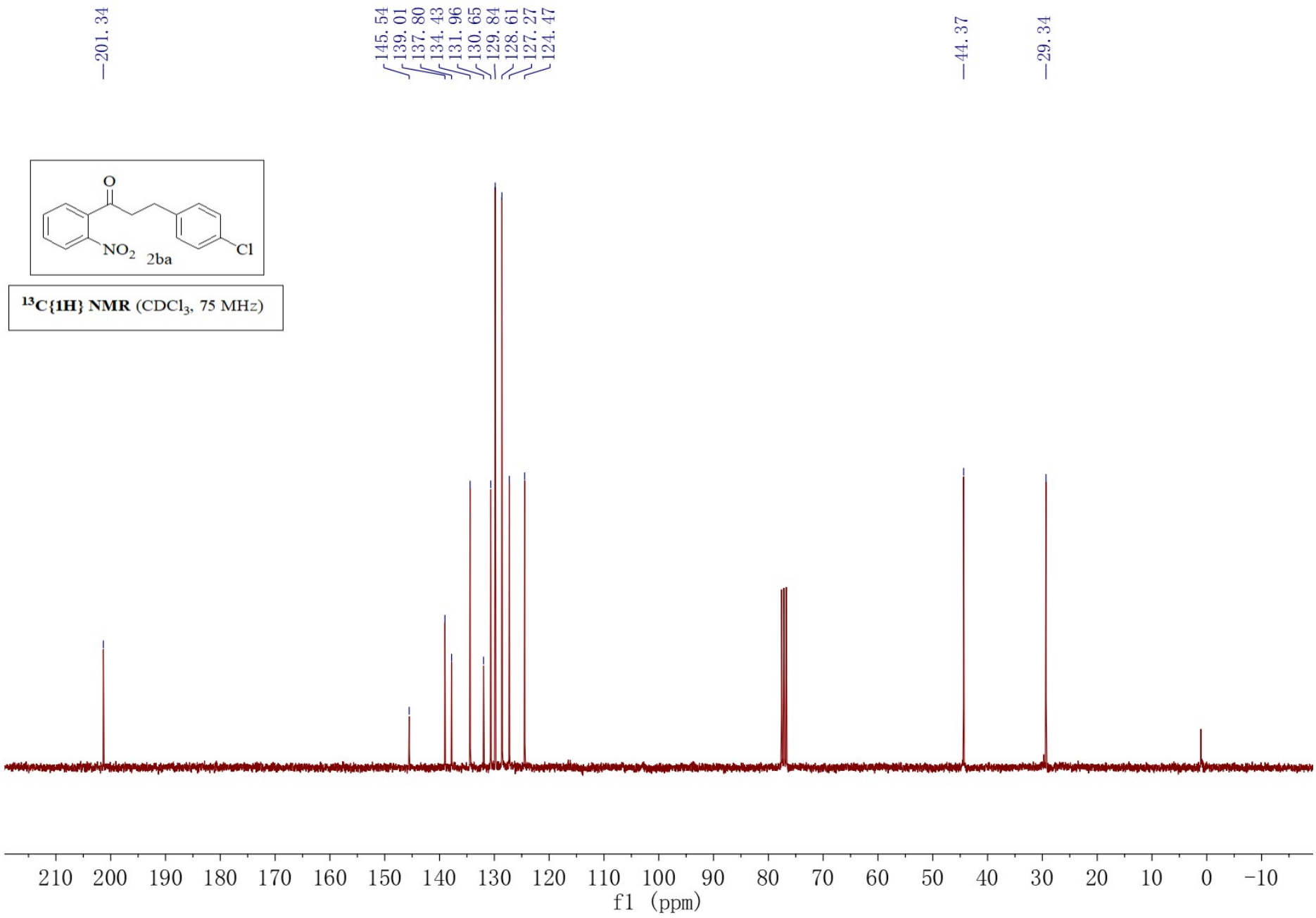

199.18
138.84
136.86
133.66
133.15
132.12
128.67
128.17
128.10
127.68
127.50
127.23
126.56
126.08
125.36
40.38
30.29
O
2ai
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

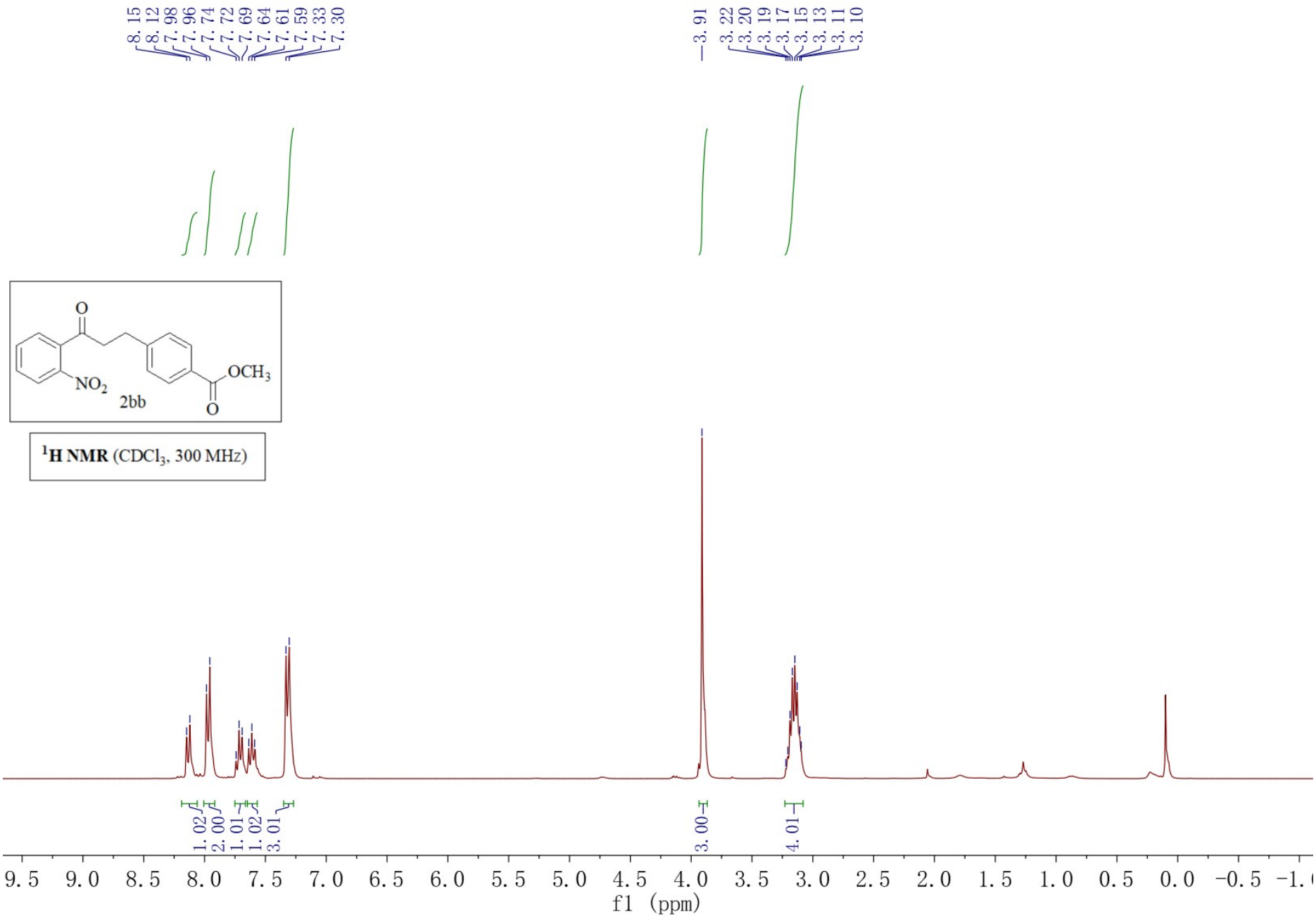


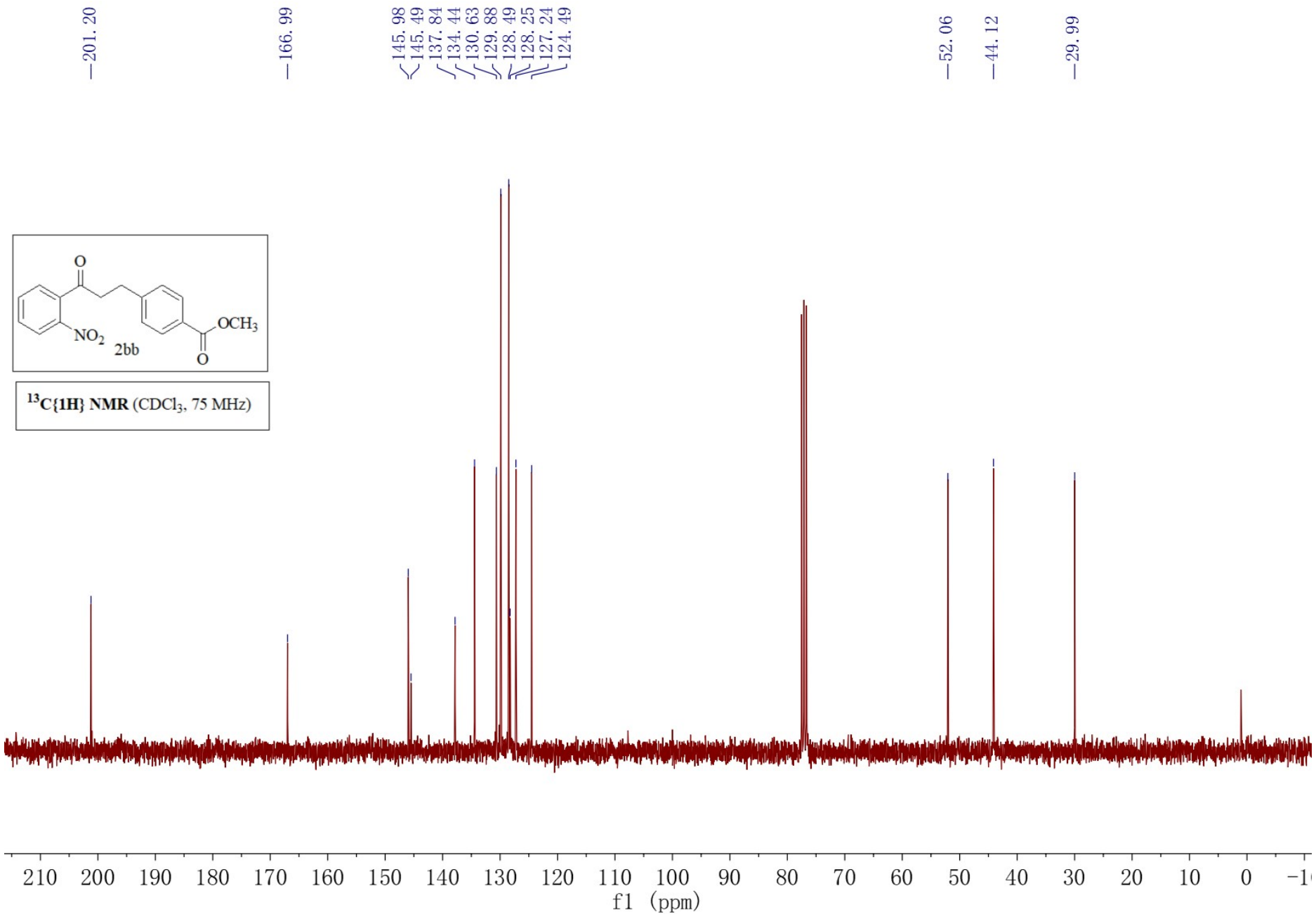
^{1}H NMR ($CDCl_3$, 300 MHz)

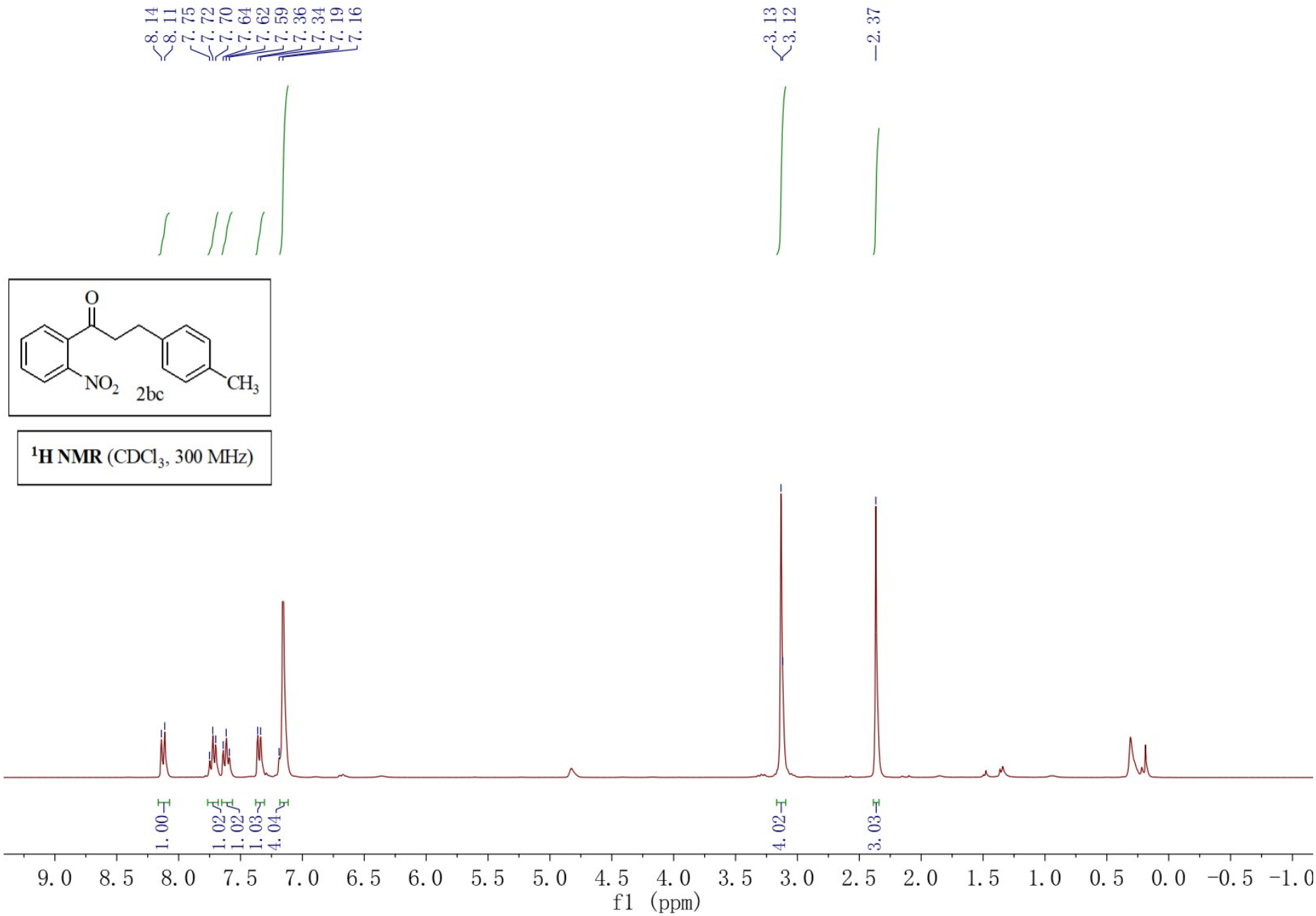

199.41
136.69
133.45
133.25
131.68
129.56
129.43
128.67
128.11
126.23
125.98
125.03
124.05
39.74
22.04
2aj
O
Ph
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

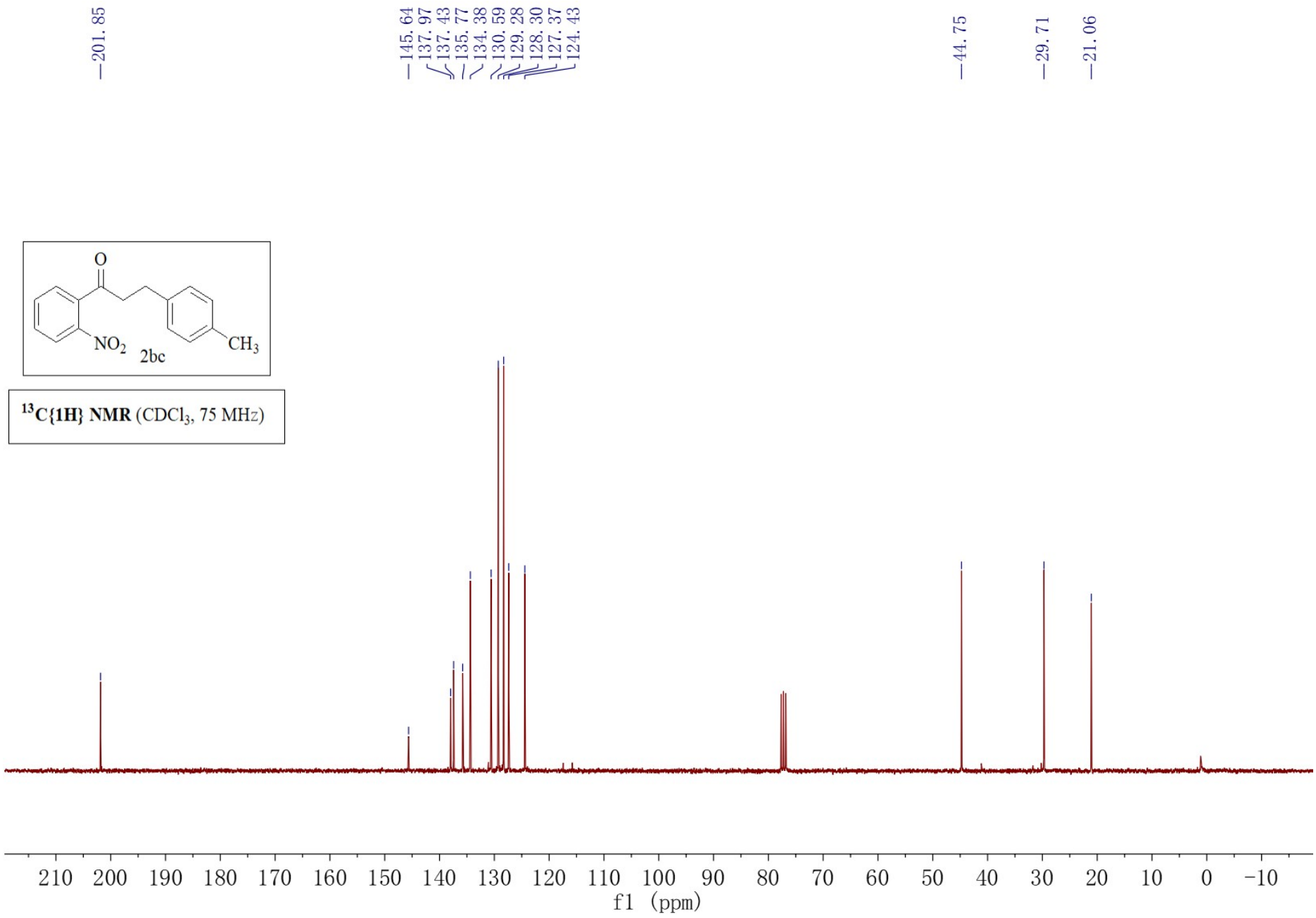

8.13
8.10
7.74
7.72
7.69
7.63
7.61
7.59
7.34
7.31
7.27
7.24
7.19
7.16
3.10
3.08
O
NO2
Cl
2ba
1H NMR (CDCl3, 300 MHz)
1.00
1.02
1.02
1.02
2.03
2.03
4.04
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
f1 (ppm)

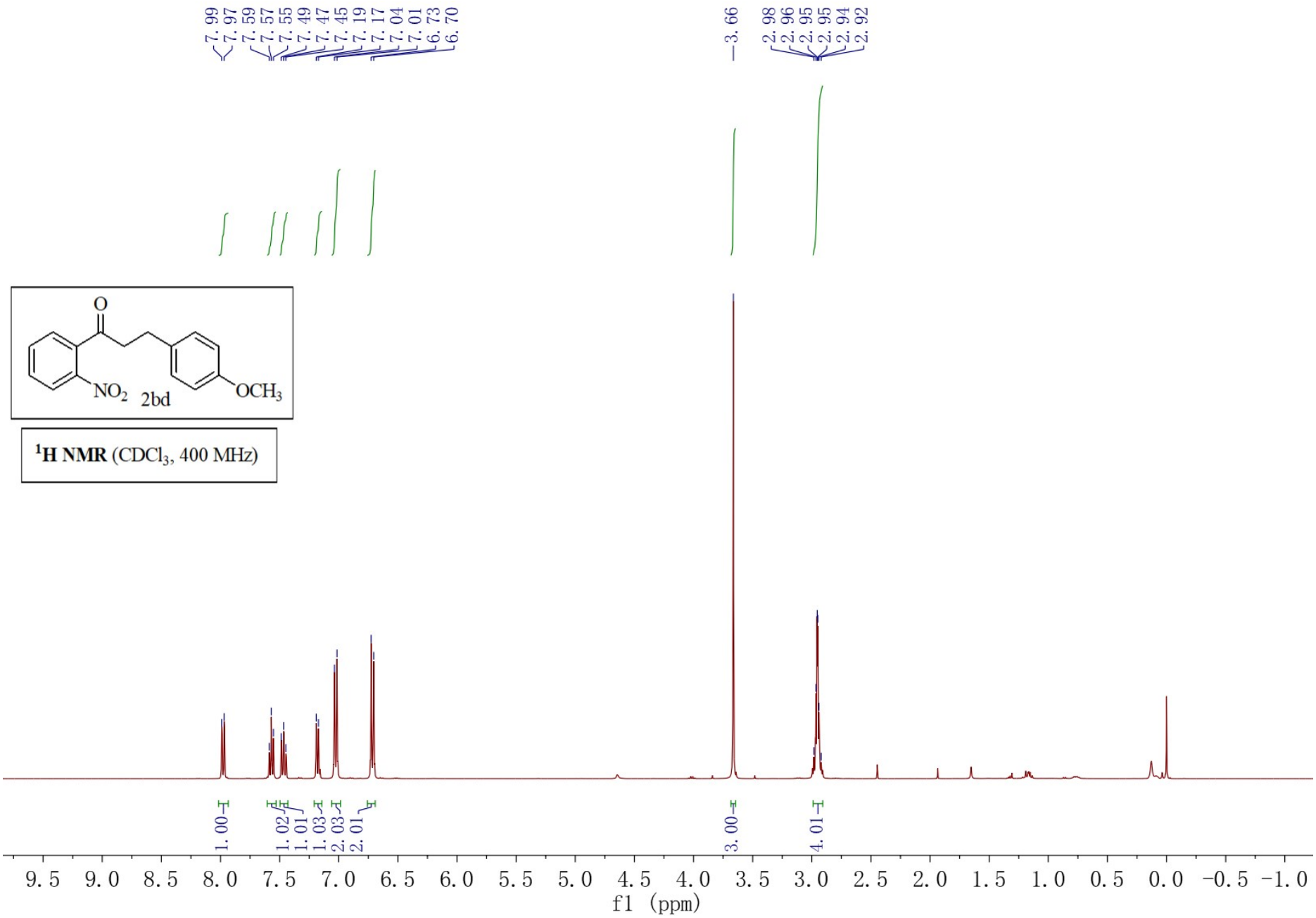

201.34
145.54
139.01
137.80
134.43
131.96
130.65
129.84
128.61
127.27
124.47
44.37
29.34
O
NO2
Cl
2ba
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

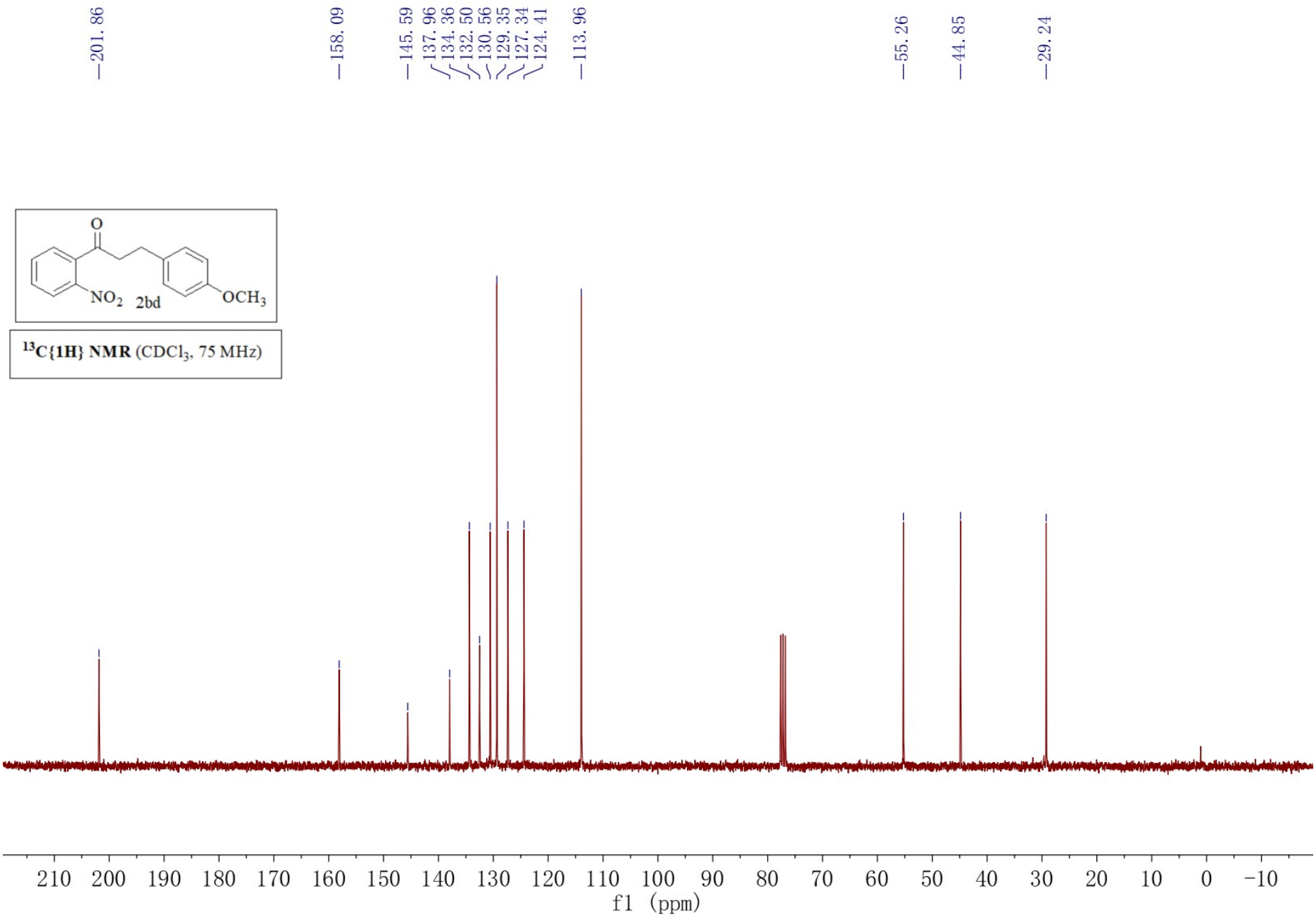

8.15
8.12
7.98
7.96
7.74
7.72
7.69
7.64
7.61
7.59
7.33
7.30
3.91
3.22
3.20
3.19
3.17
3.15
3.13
3.11
3.10
O
NO2
OCH3
O
2bb
1H NMR (CDCl3, 300 MHz)
1.02
2.00
1.01
1.02
3.01
3.00
4.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

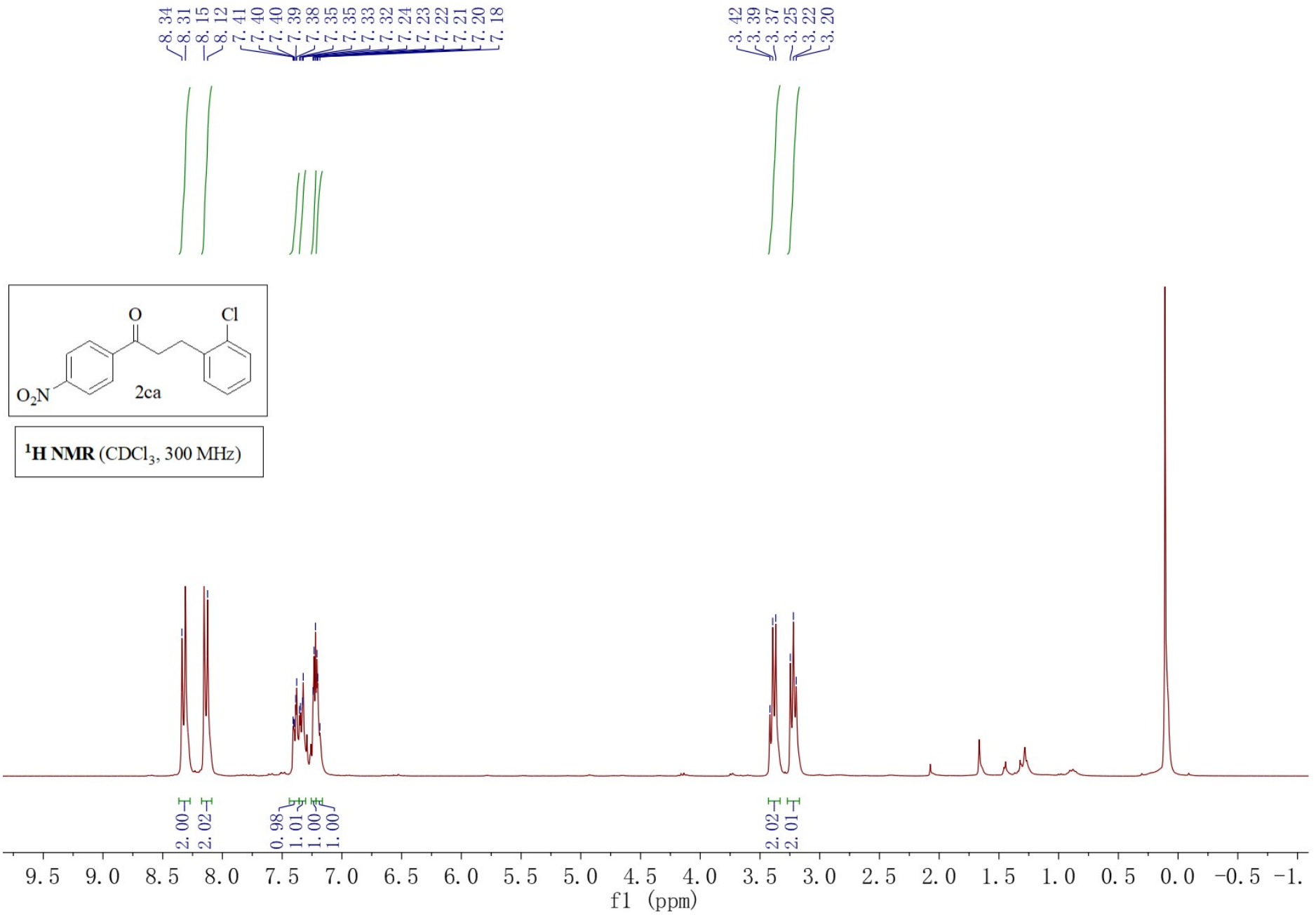

201.20
166.99
145.98
145.49
137.84
134.44
130.63
129.88
128.49
128.25
127.24
124.49
52.06
44.12
29.99
O
NO2
OCH3
O
2bb
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

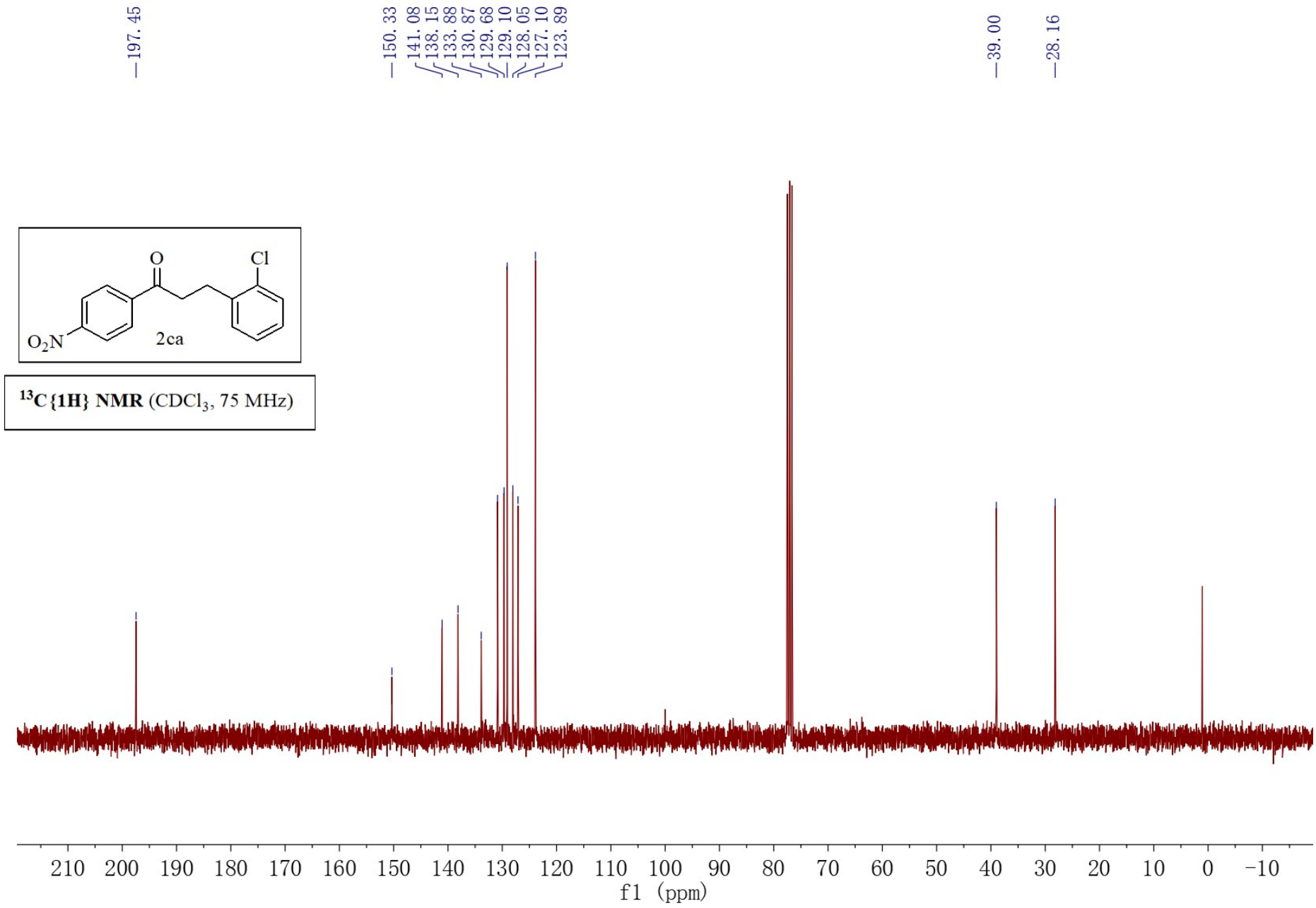

8.14
8.11
7.75
7.72
7.70
7.64
7.62
7.59
7.36
7.34
7.19
7.16
3.13
3.12
2.37
O
NO2
CH3
2bc
1H NMR (CDCl3, 300 MHz)
1.00
1.02
1.02
1.03
4.04
4.02
3.03
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

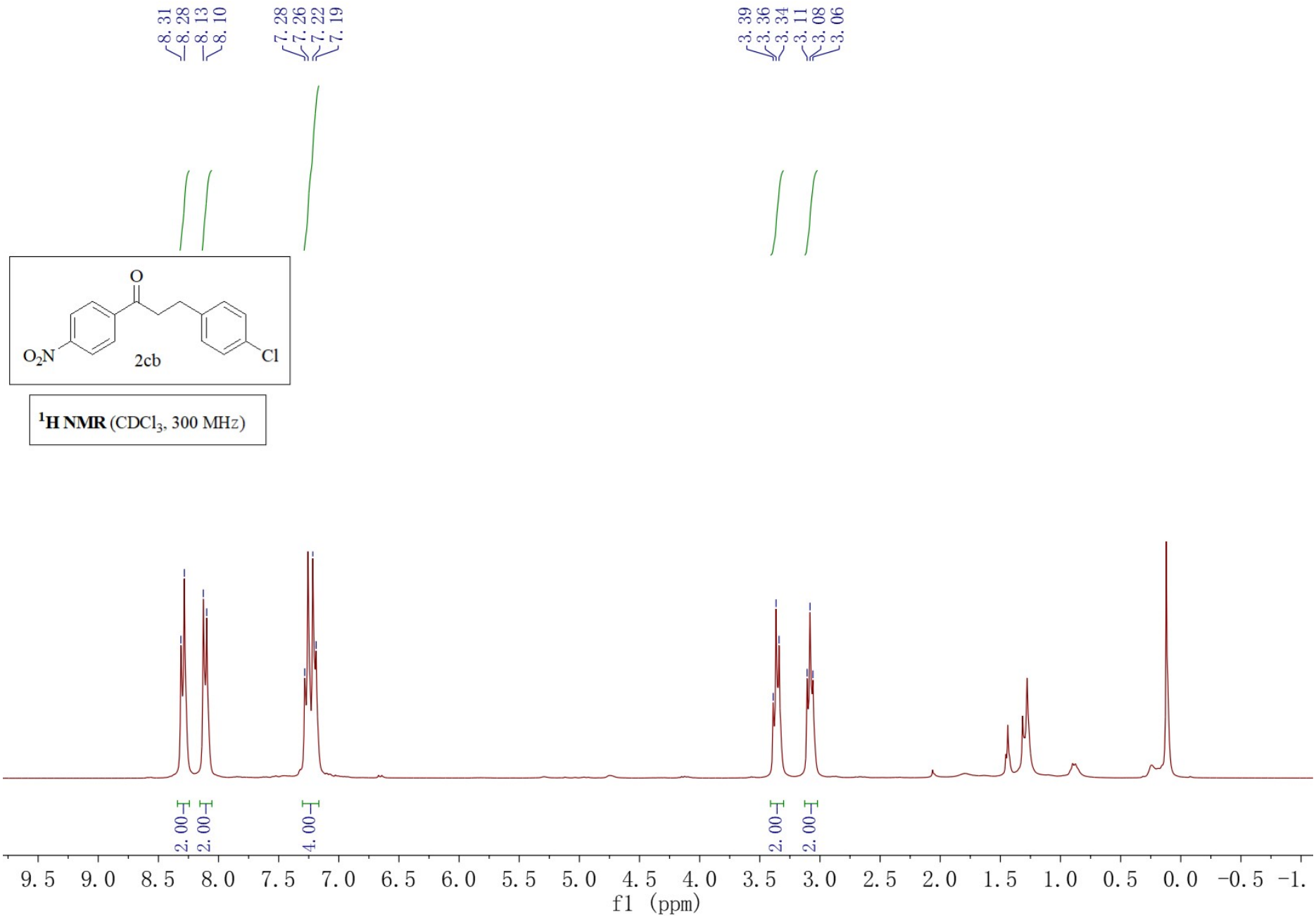

201.85
145.64
137.97
137.43
135.77
134.38
130.59
129.28
128.30
127.37
124.43
44.75
29.71
21.06
O
NO2
CH3
2bc
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

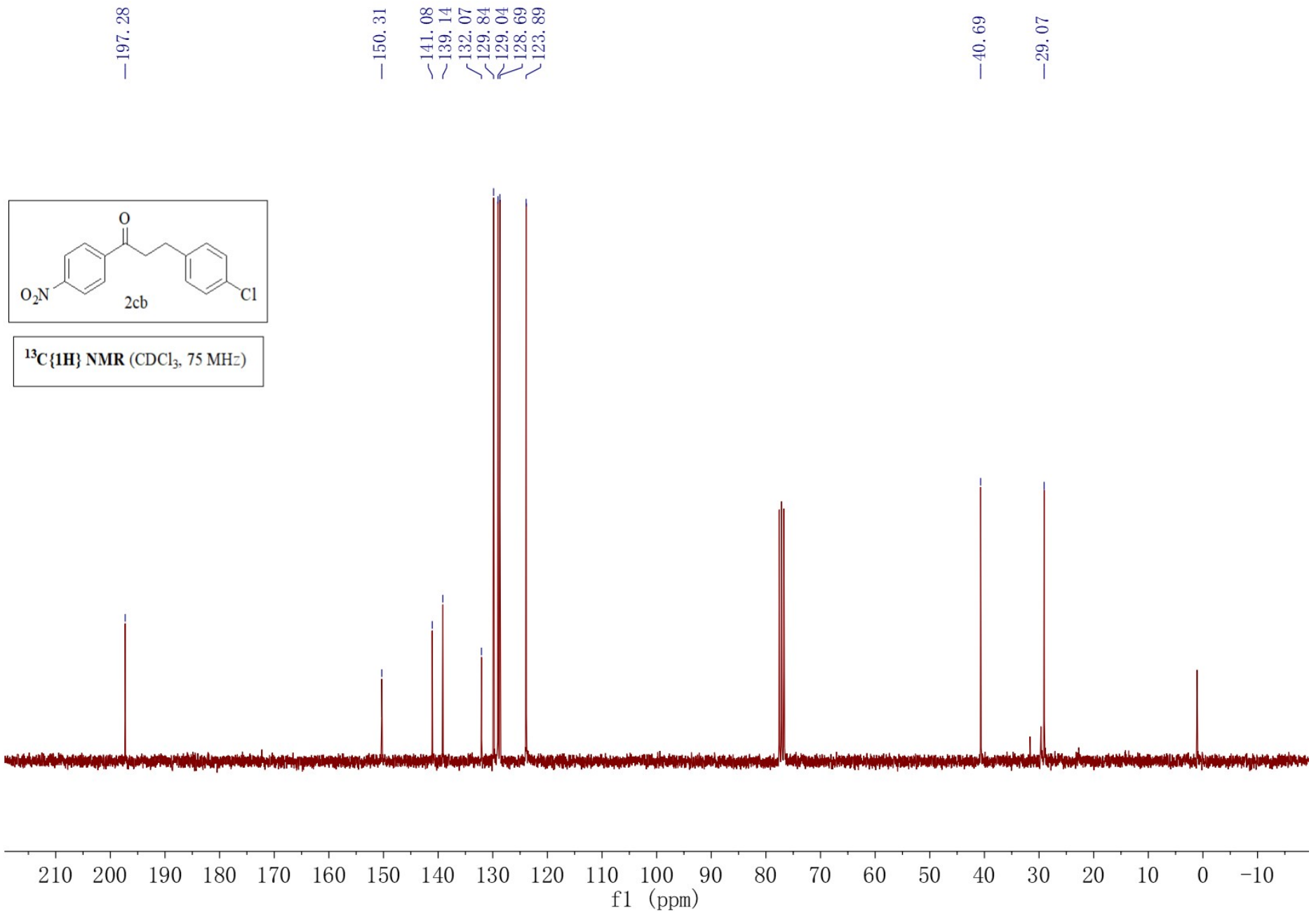

7.99
7.97
7.59
7.57
7.55
7.49
7.47
7.45
7.19
7.17
7.04
7.01
6.73
6.70
3.66
2.98
2.96
2.95
2.95
2.94
2.92
O
NO2
2bd
OCH3
1H NMR (CDCl3, 400 MHz)
1.00
1.02
1.01
1.03
2.03
2.01
3.00
4.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

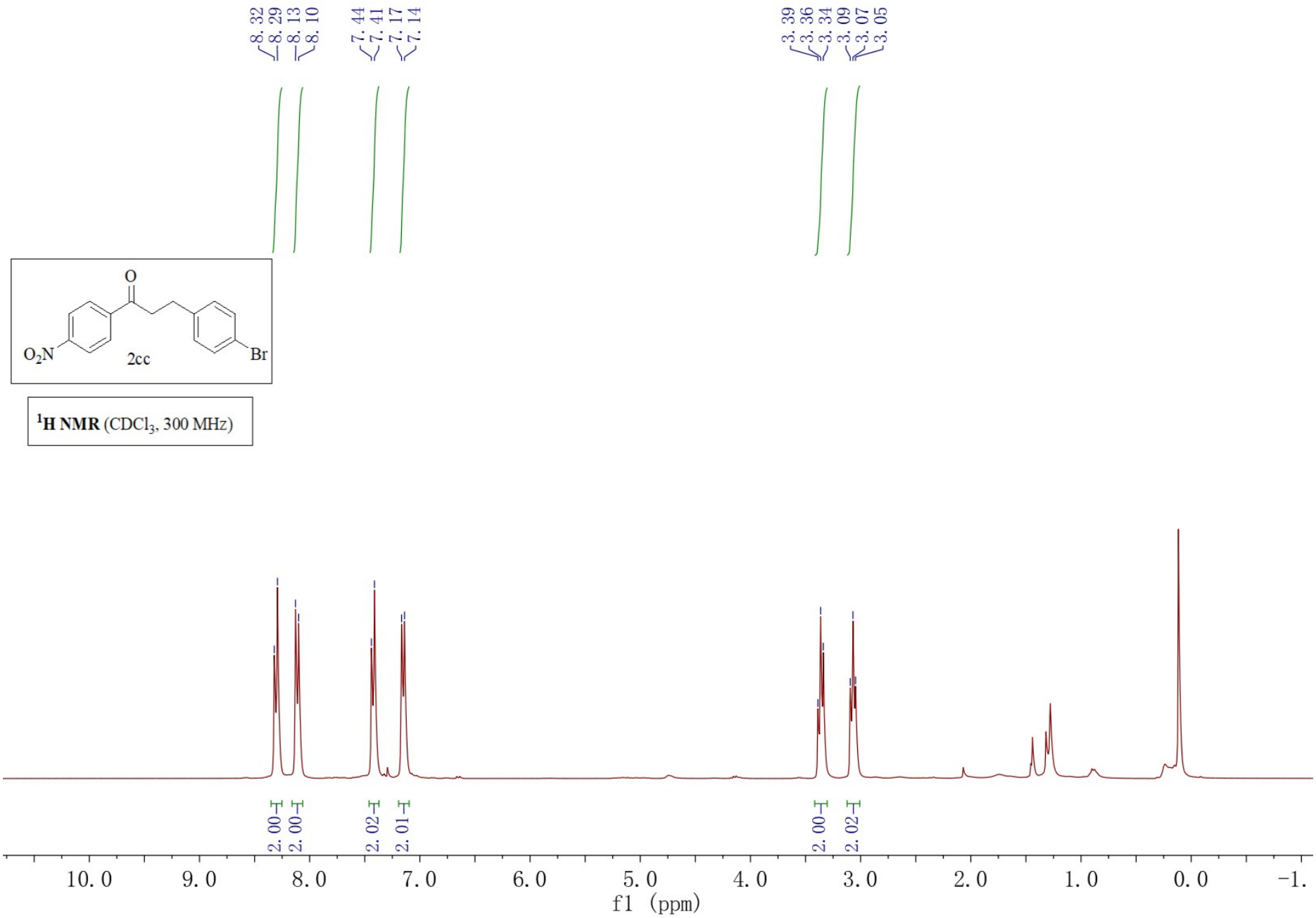

201.86
158.09
145.59
137.96
134.36
132.50
130.56
129.35
127.34
124.41
113.96
55.26
44.85
29.24
O
NO2
2bd
OCH3
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

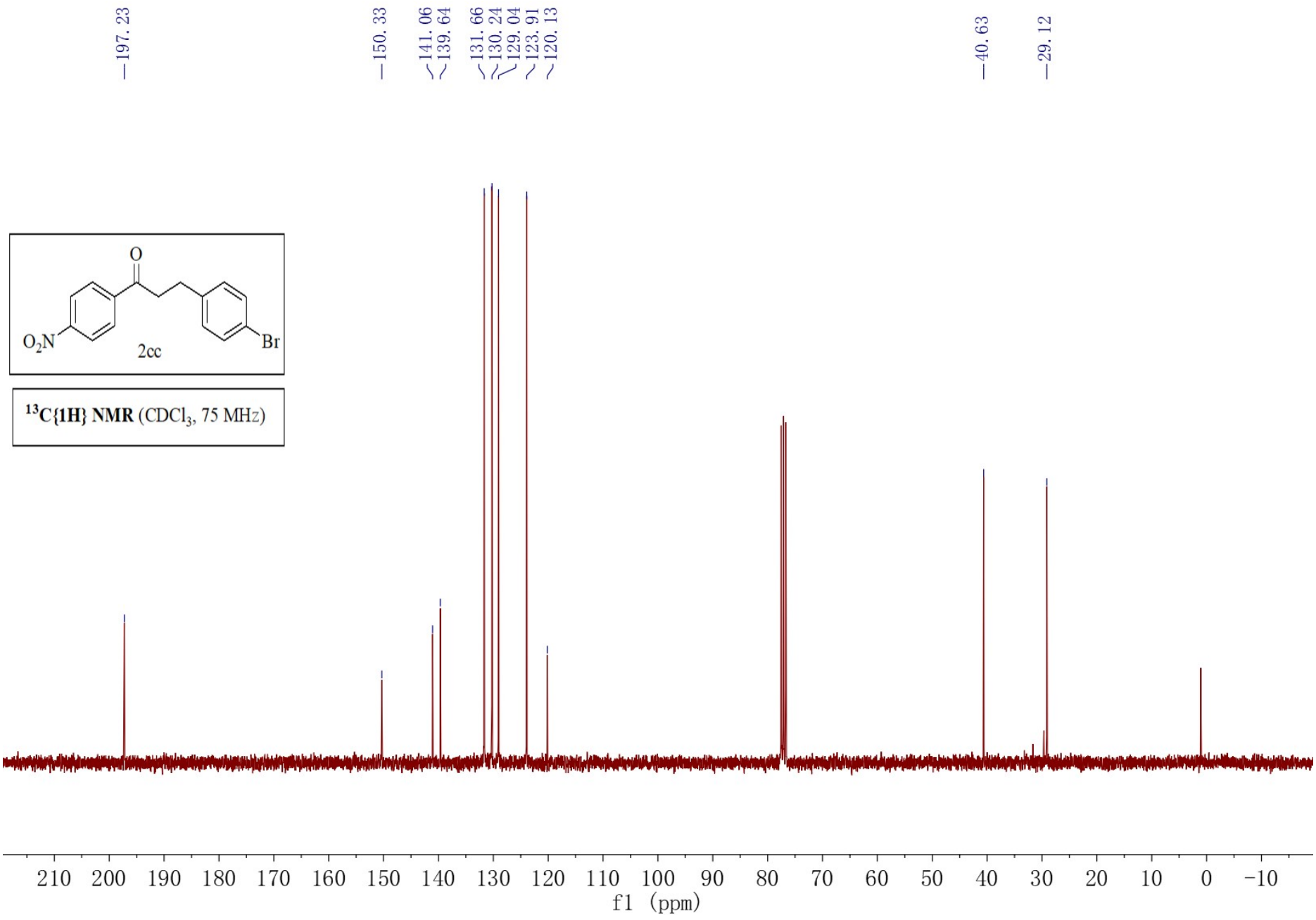

8.34
8.31
8.15
8.12
7.41
7.40
7.40
7.39
7.38
7.35
7.35
7.33
7.32
7.24
7.23
7.22
7.21
7.20
7.18
3.42
3.39
3.37
3.25
3.22
3.20
O
Cl
O2N
2ca
1H NMR (CDCl3, 300 MHz)
2.00
2.02
0.98
1.01
1.00
1.00
2.02
2.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)

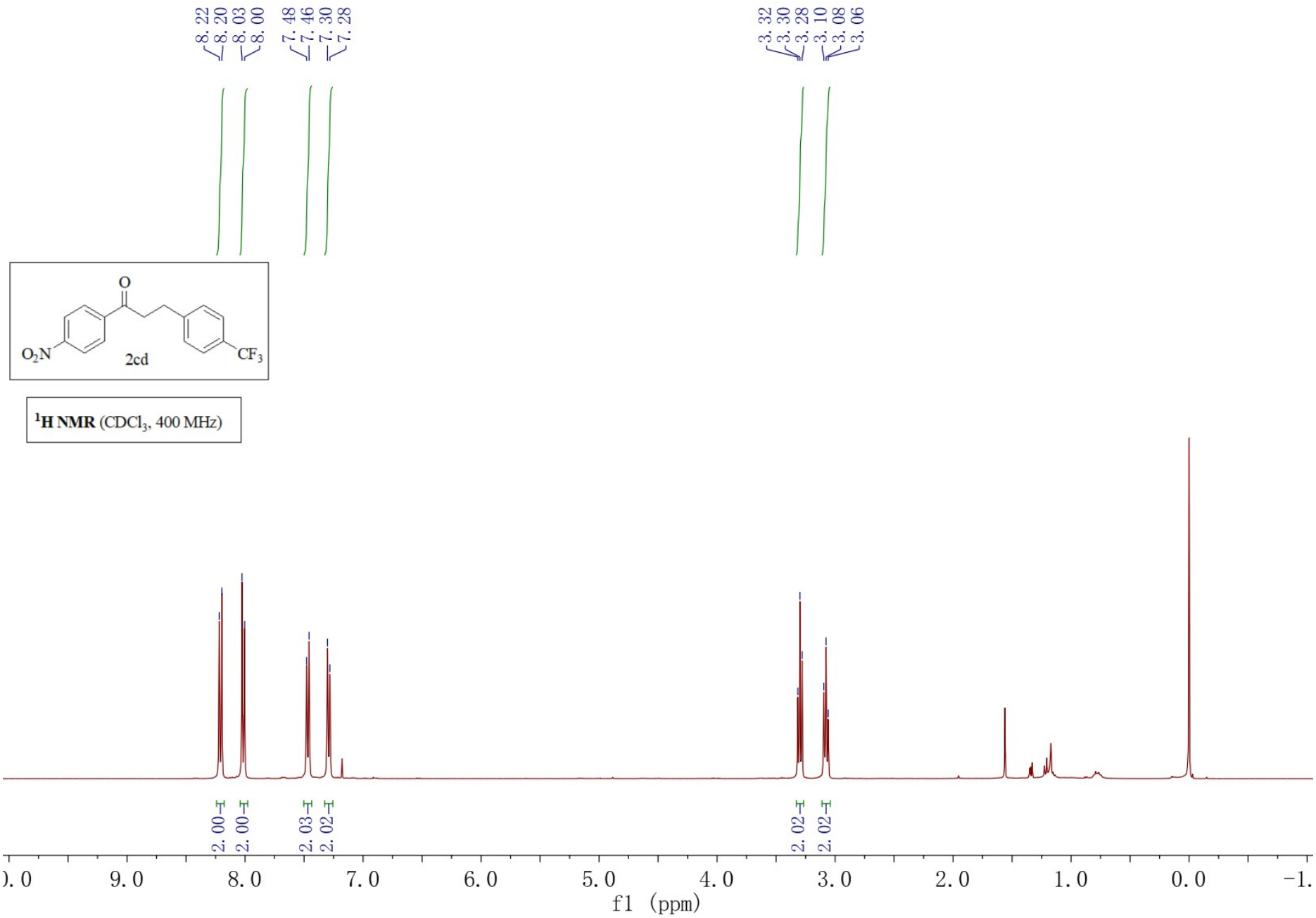

197.45
150.33
141.08
138.15
133.88
130.87
129.68
129.10
128.05
127.10
123.89
39.00
28.16
O
Cl
O2N
2ca
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

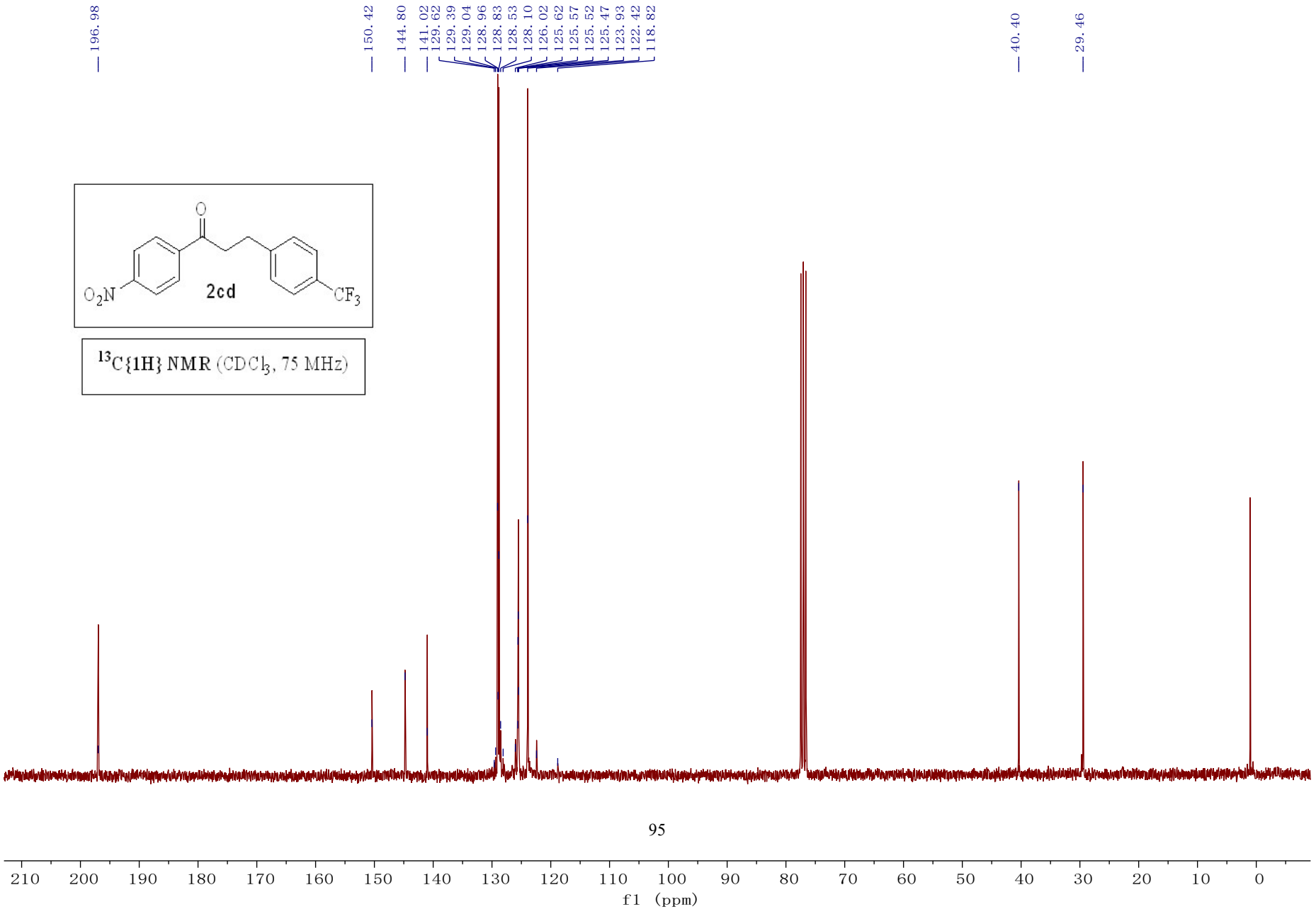

8.31
8.28
8.13
8.10
7.28
7.26
7.22
7.19
3.39
3.36
3.34
3.11
3.08
3.06
O
O2N
Cl
2cb
1H NMR (CDCl3, 300 MHz)
2.00
2.00
4.00
2.00
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)

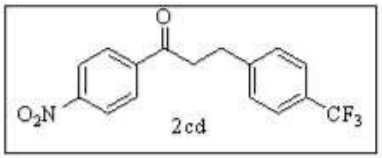

197.28
150.31
141.08
139.14
132.07
129.84
129.04
128.69
123.89
40.69
29.07
O
O2N
Cl
2cb
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.32
8.29
8.13
8.10
7.44
7.41
7.17
7.14
3.39
3.36
3.34
3.09
3.07
3.05
O
O2N
Br
2cc
1H NMR (CDCl3, 300 MHz)
2.00
2.00
2.02
2.01
2.00
2.02
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
f1 (ppm)


197.23
150.33
141.06
139.64
131.66
130.24
129.04
123.91
120.13
40.63
29.12
O
O2N
Br
2cc
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

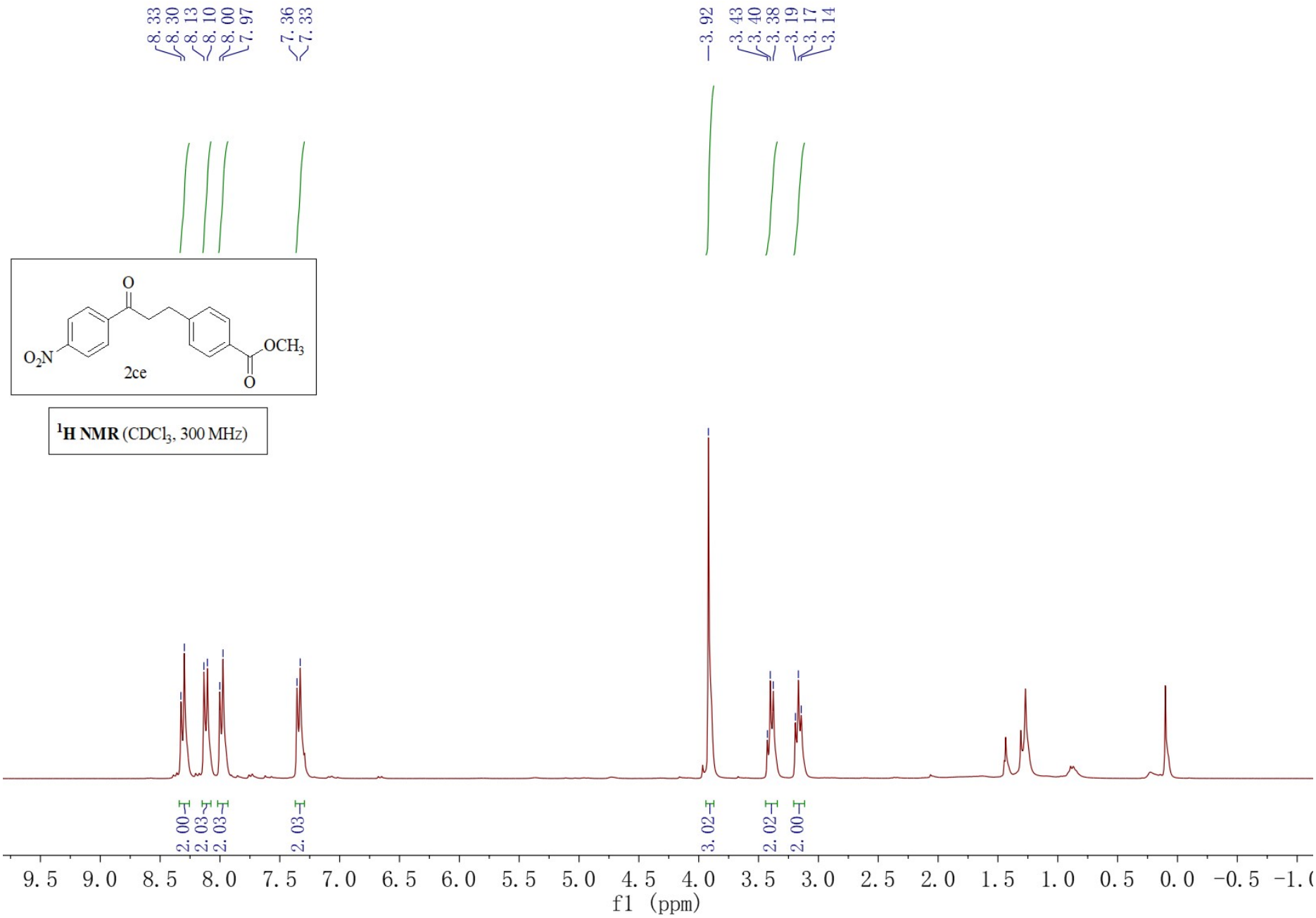

8.22
8.20
8.03
8.00
7.48
7.46
7.30
7.28
3.32
3.30
3.28
3.10
3.08
3.06
O
O2N
CF3
2cd
1H NMR (CDCl3, 400 MHz)
2.00
2.00
2.03
2.02
2.02
2.02
f1 (ppm)

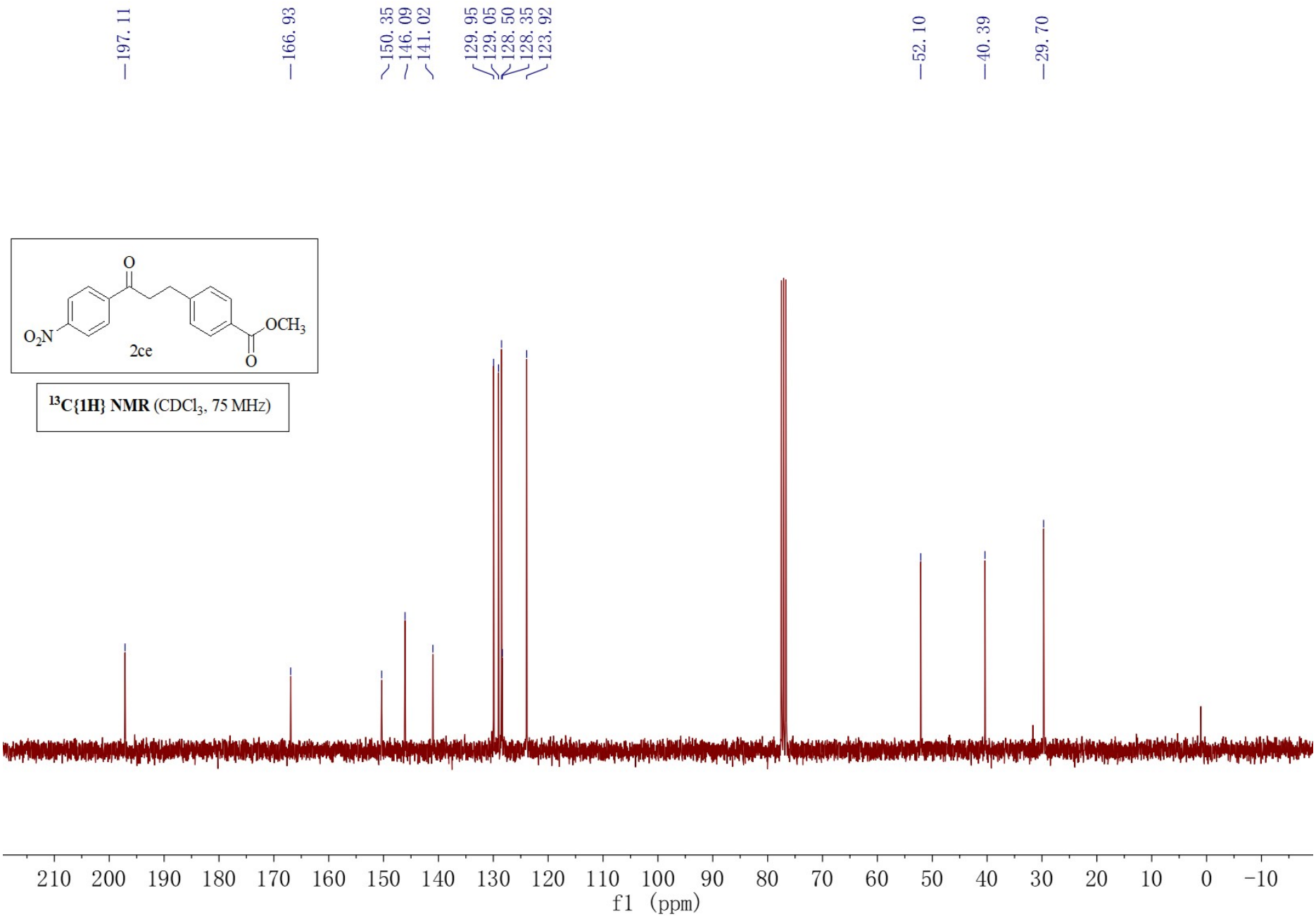

196.98
150.42
144.80
141.02
129.62
129.39
129.04
128.96
128.83
128.53
128.10
126.02
125.62
125.57
125.52
125.47
123.93
122.42
118.82
40.40
29.46
O
O2N
CF3
2cd
13C{1H} NMR (CDCl3, 75 MHz)
95
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

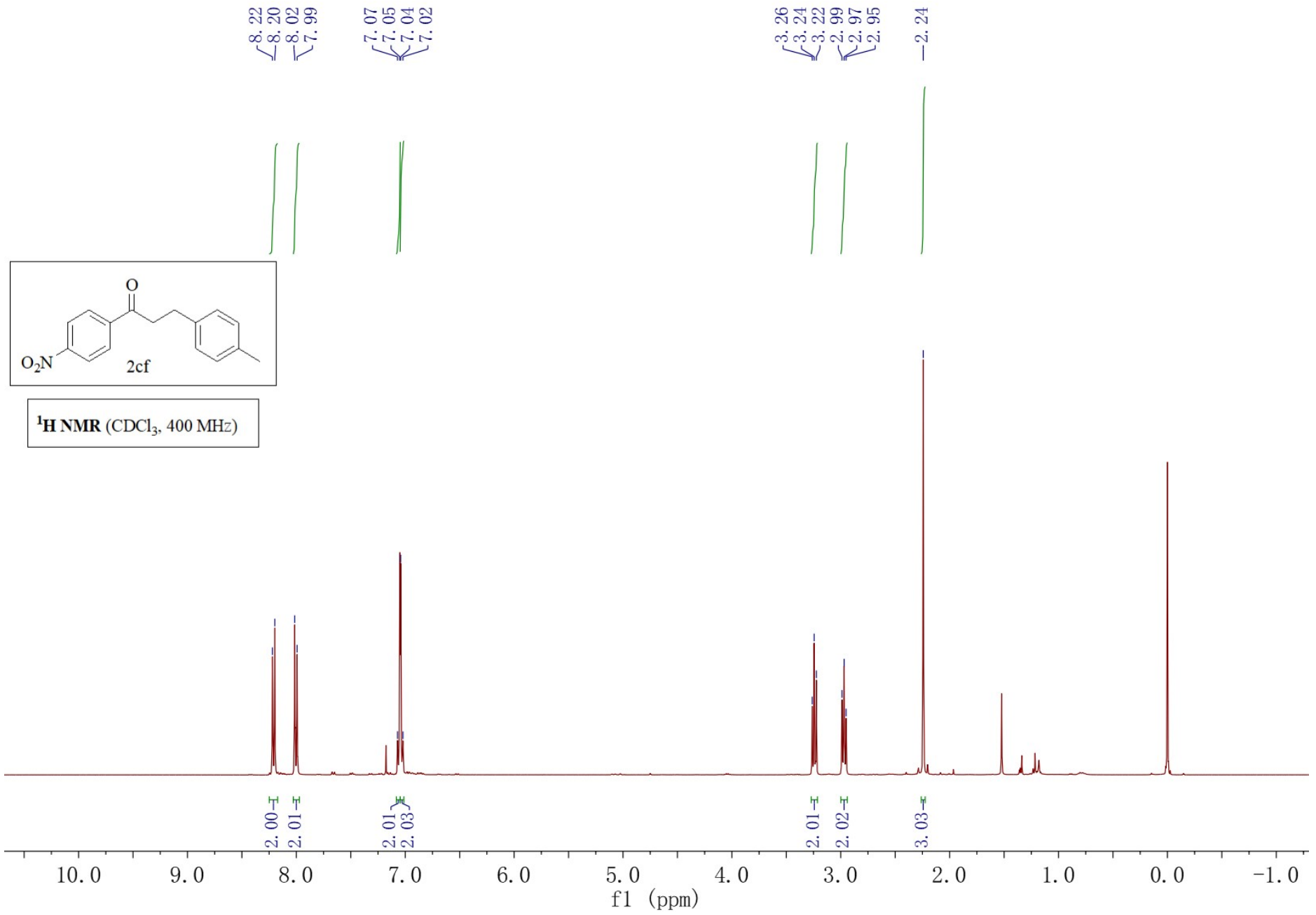


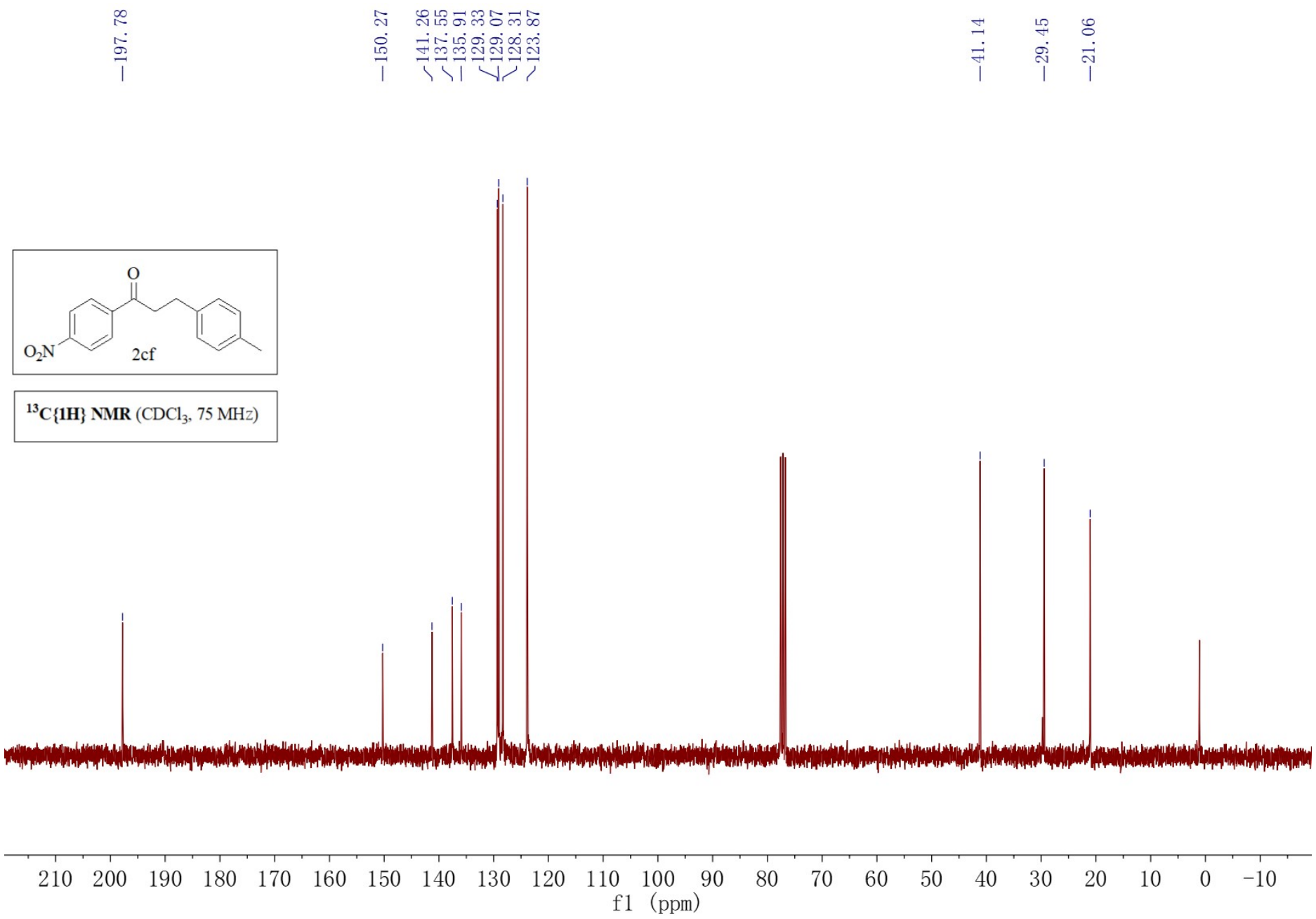
2cd

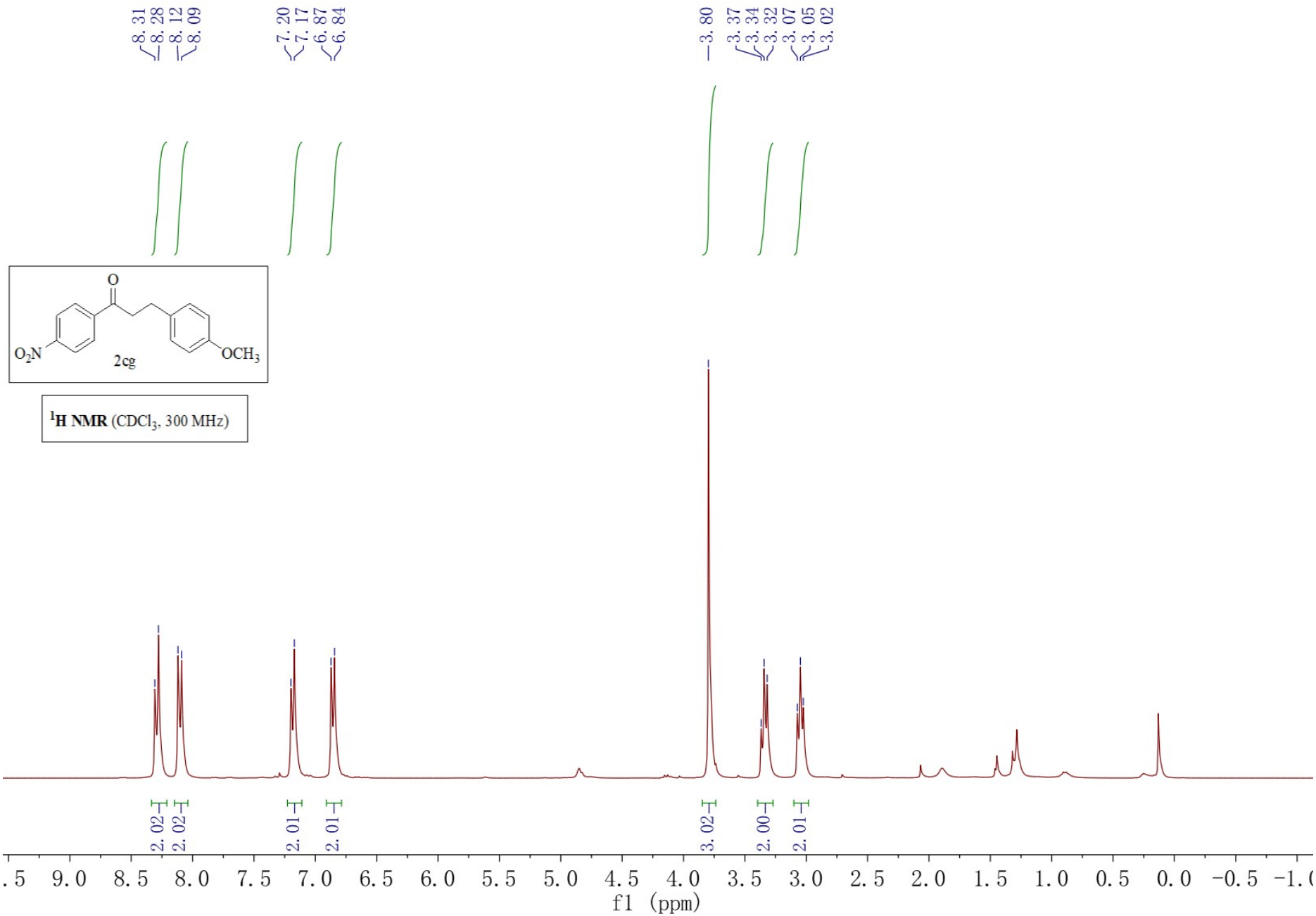
^{19}F NMR ($CDCl_3$, 282 MHz)

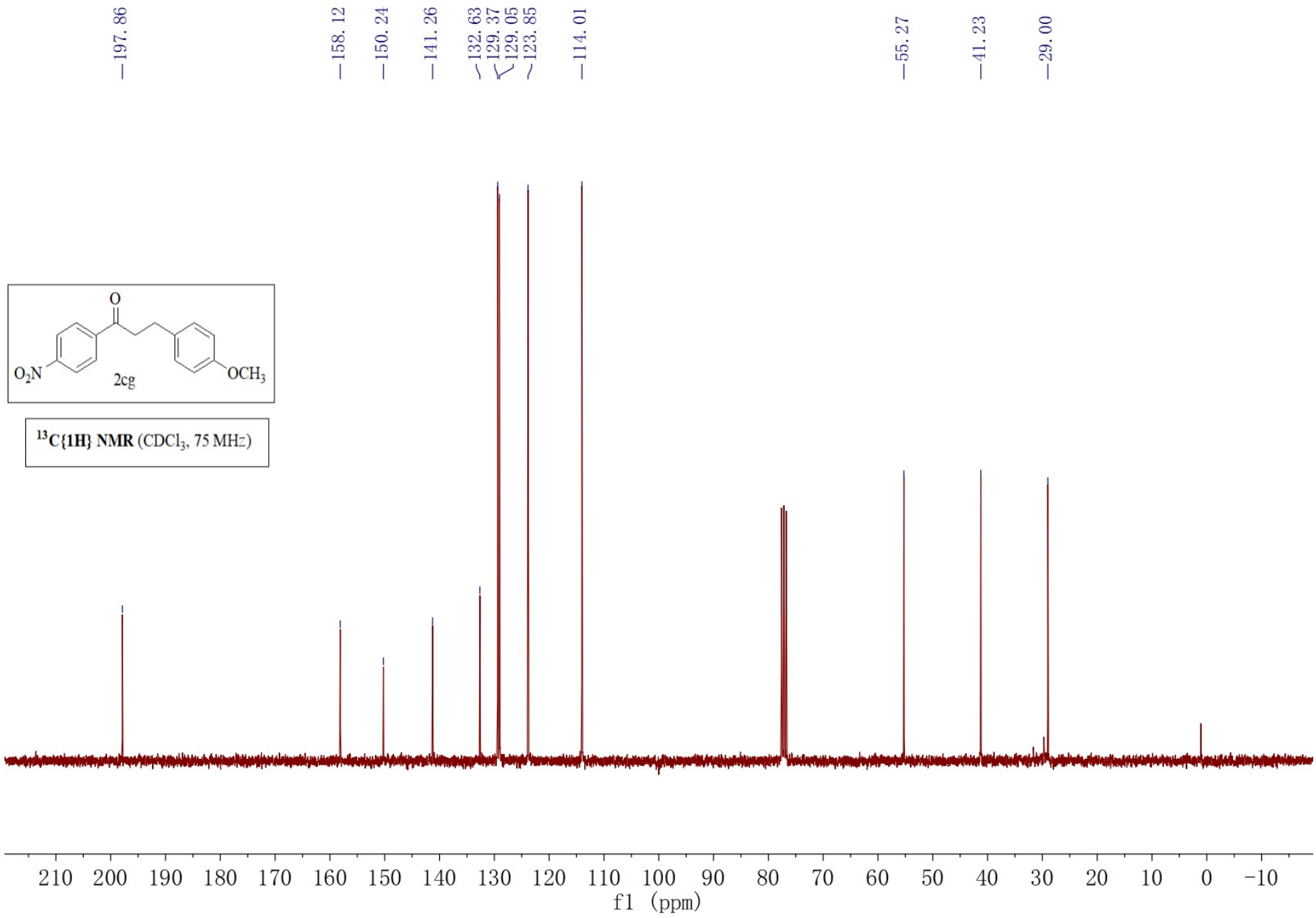

8.33
8.30
8.13
8.10
8.00
7.97
7.36
7.33
3.92
3.43
3.40
3.38
3.19
3.17
3.14
O
O2N
OCH3
O
2ce
1H NMR (CDCl3, 300 MHz)
2.00
2.03
2.03
2.03
3.02
2.02
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

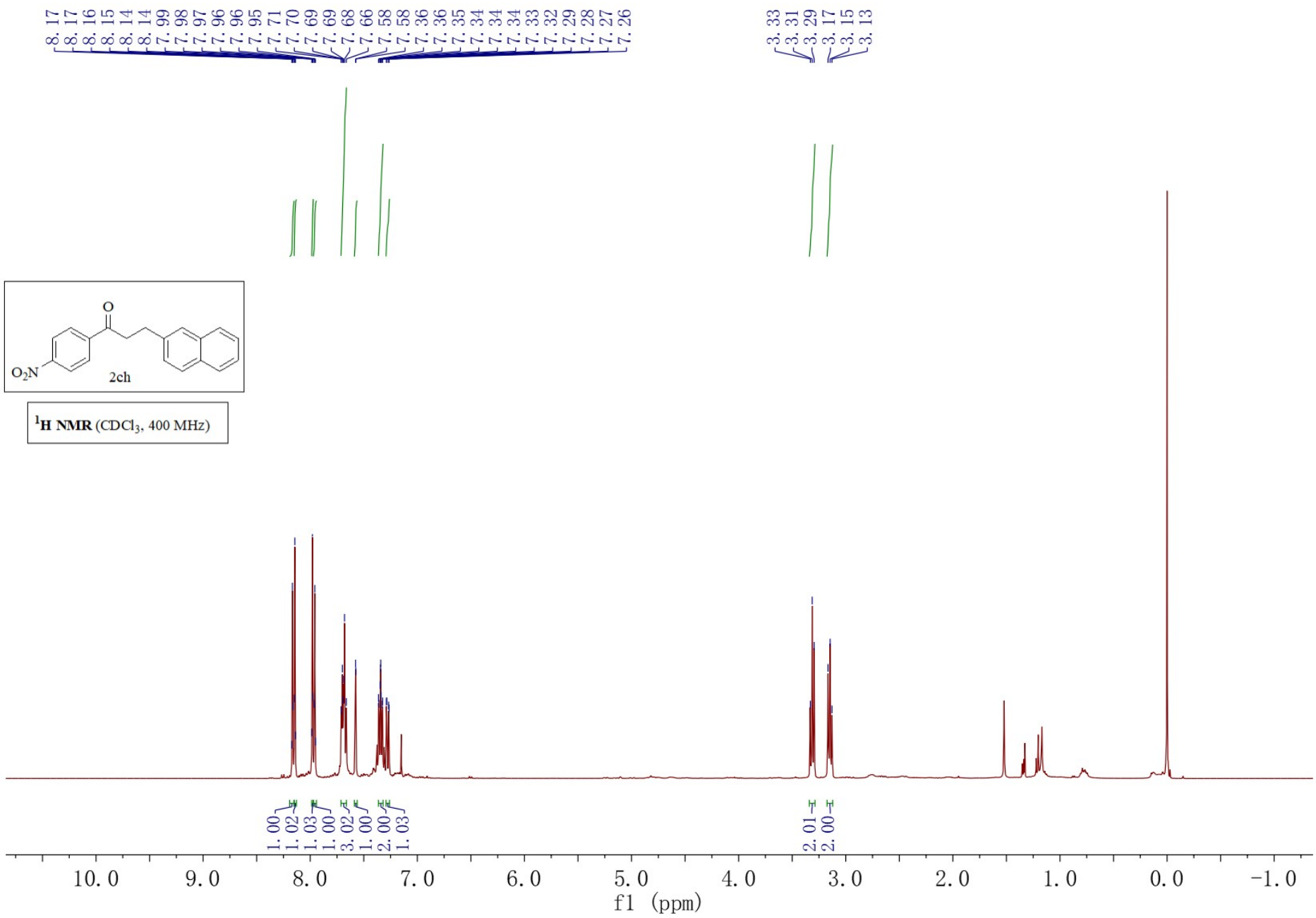

197.11
166.93
150.35
146.09
141.02
129.95
129.05
128.50
128.35
123.92
52.10
40.39
29.70
O
O2N
OCH3
O
2ce
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

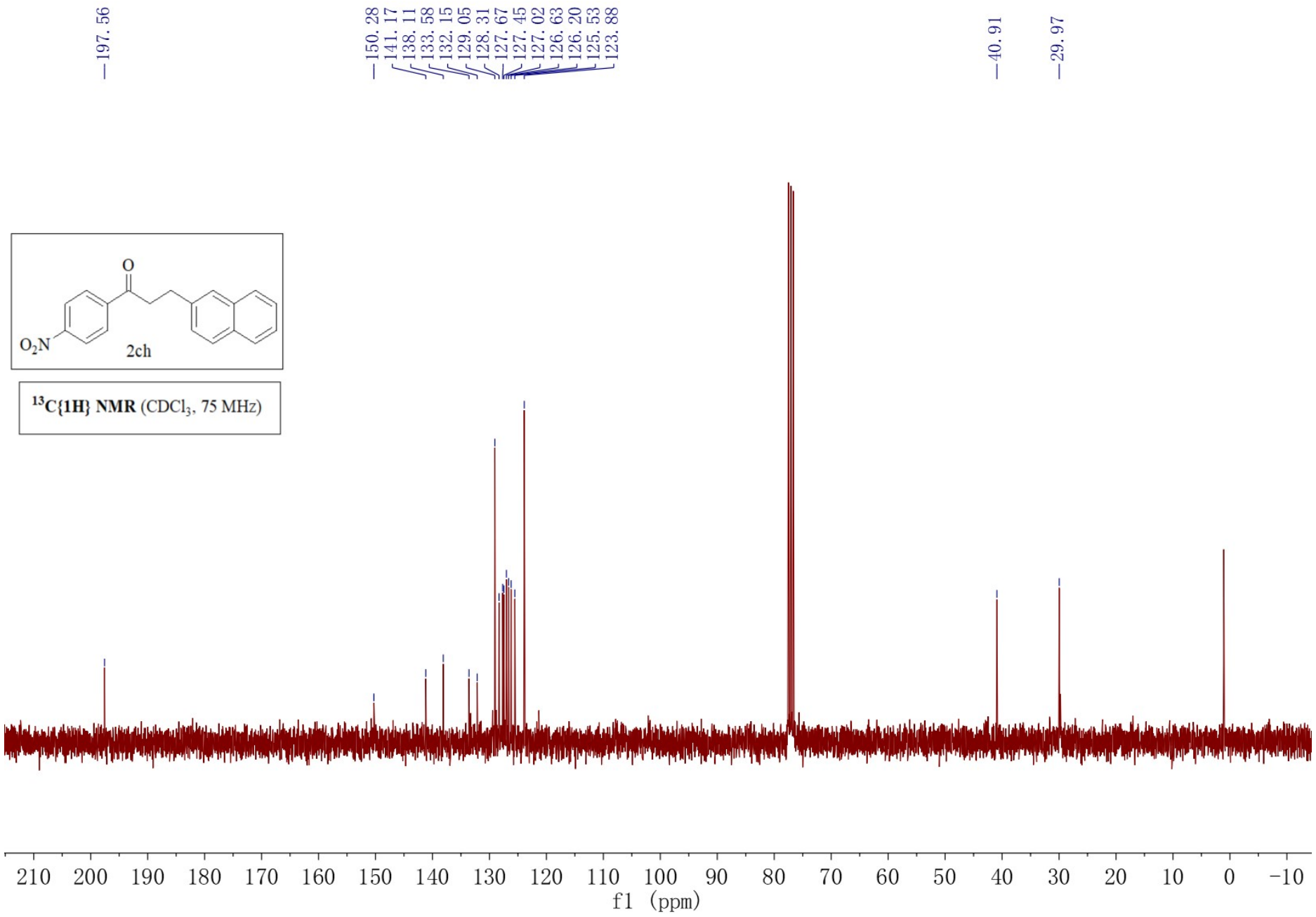

8.22
8.20
8.02
7.99
7.07
7.05
7.04
7.02
3.26
3.24
3.22
2.99
2.97
2.95
2.24
O
O2N
2cf
1H NMR (CDCl3, 400 MHz)
2.00
2.01
2.01
2.03
2.01
2.02
3.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

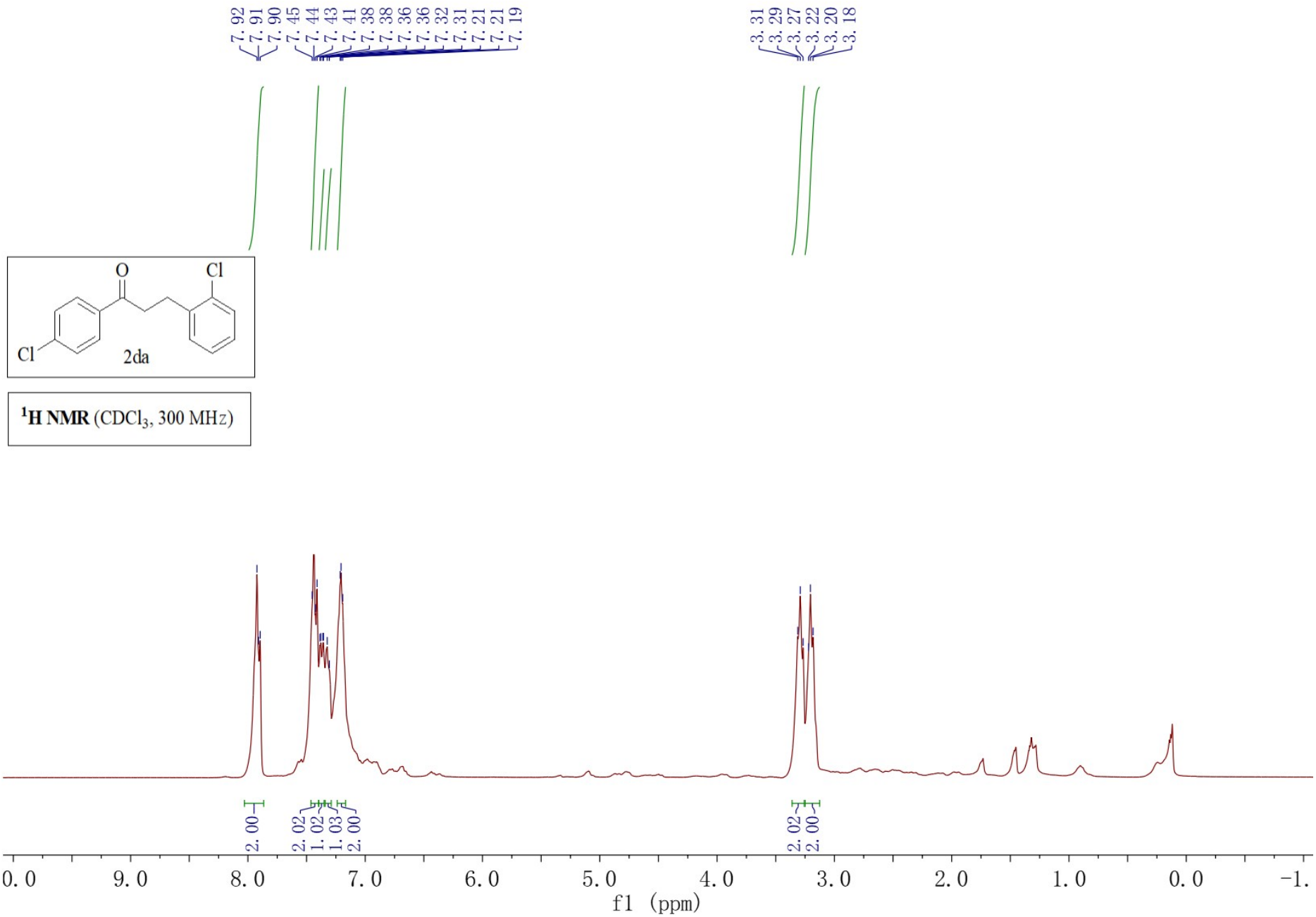

197.78
150.27
141.26
137.55
135.91
129.33
129.07
128.31
123.87
41.14
29.45
21.06
O
O2N
2cf
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

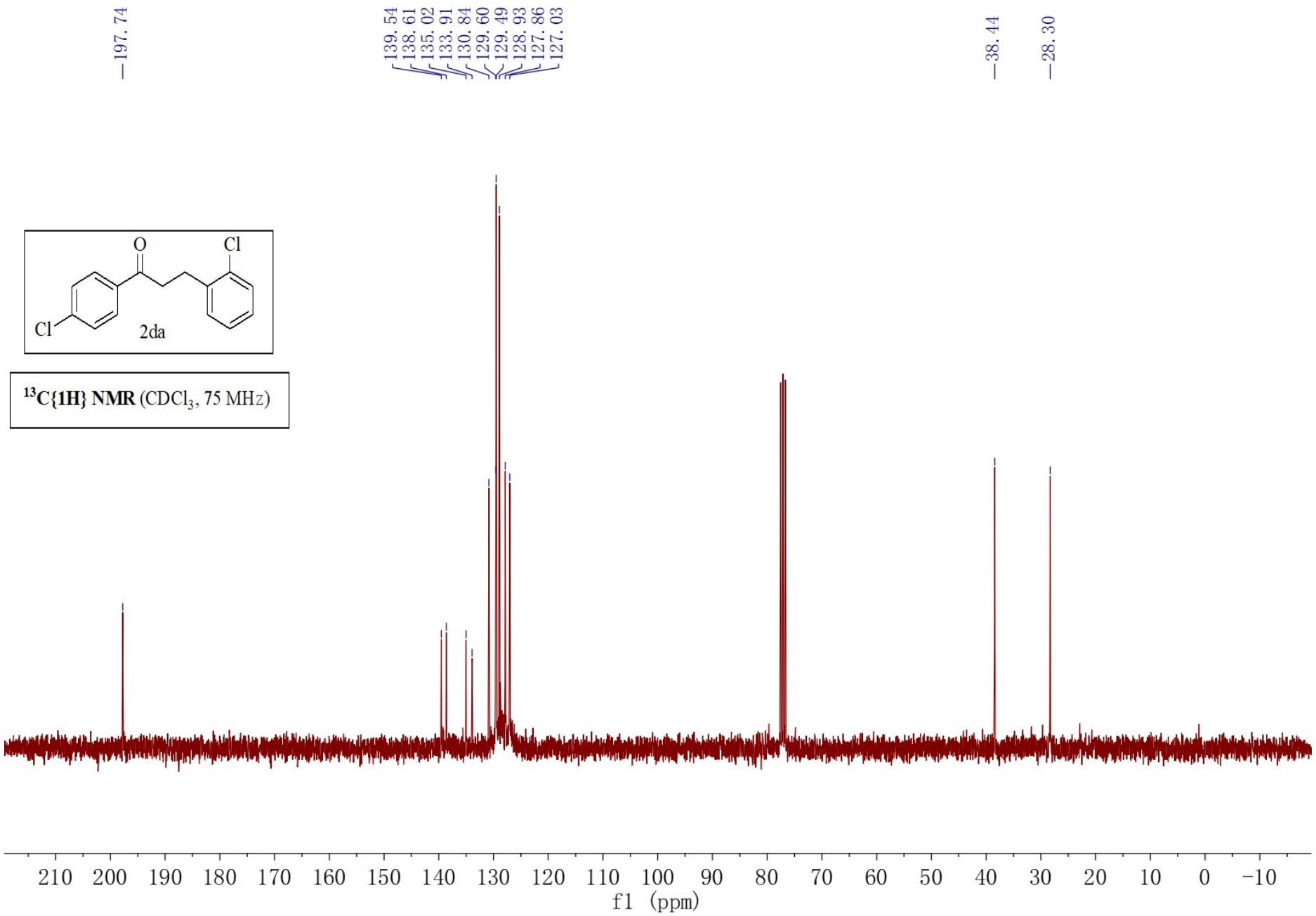

8.31
8.28
8.12
8.09
7.20
7.17
6.87
6.84
3.80
3.37
3.34
3.32
3.07
3.05
3.02
O
O2N
OCH3
2cg
1H NMR (CDCl3, 300 MHz)
2.02
2.02
2.01
2.01
3.02
2.00
2.01
f1 (ppm)

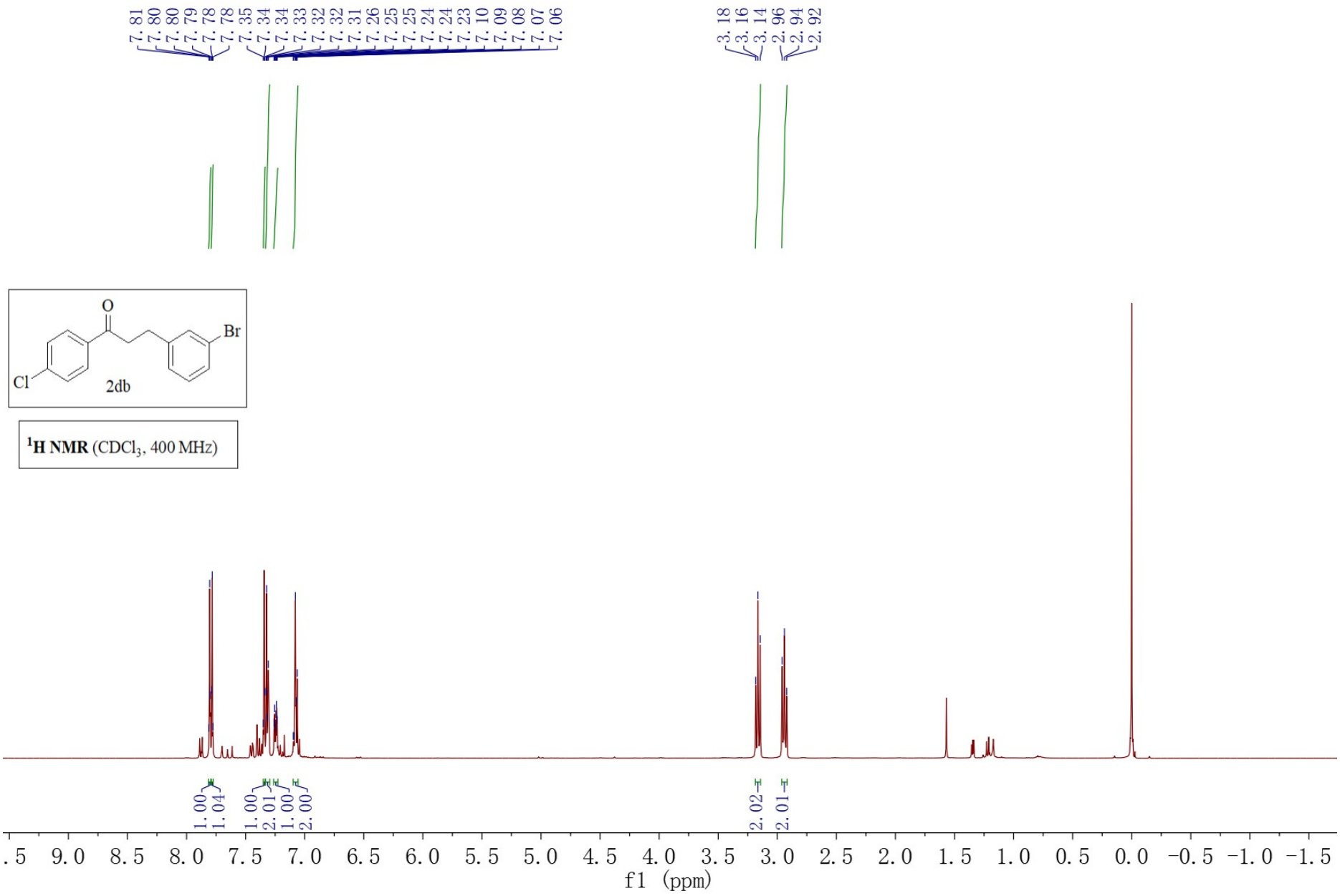

197.86
158.12
150.24
141.26
132.63
129.37
129.05
123.85
114.01
55.27
41.23
29.00
O
O2N
OCH3
2cg
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

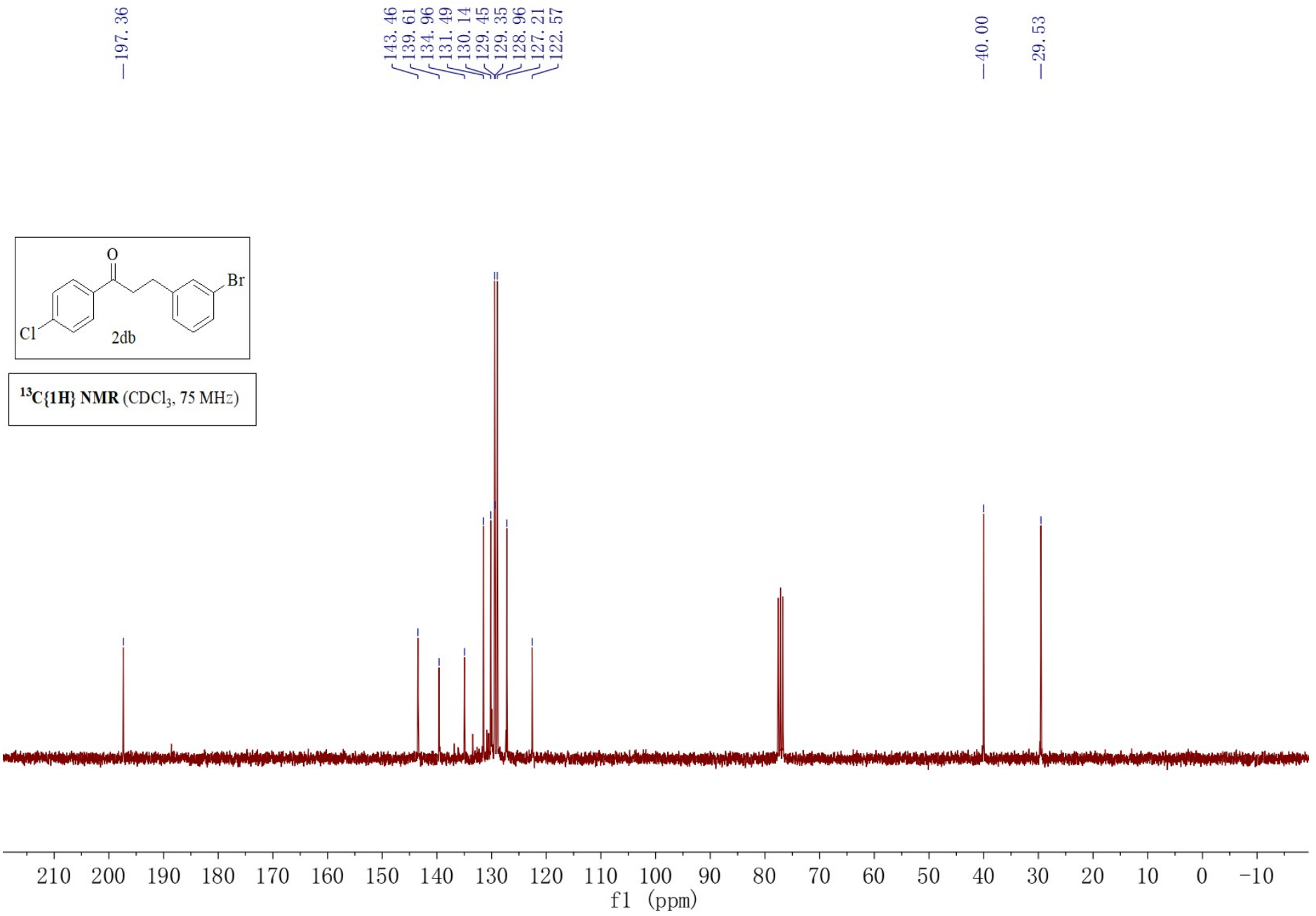

8.17
8.17
8.16
8.15
8.14
8.14
7.99
7.98
7.97
7.96
7.96
7.95
7.71
7.70
7.69
7.69
7.68
7.66
7.58
7.58
7.36
7.35
7.34
7.34
7.34
7.33
7.32
7.29
7.28
7.27
7.26
3.33
3.31
3.29
3.17
3.15
3.13
O
O2N
2ch
1H NMR (CDCl3, 400 MHz)
1.00
1.02
1.03
1.00
3.02
1.00
2.00
1.03
2.01
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

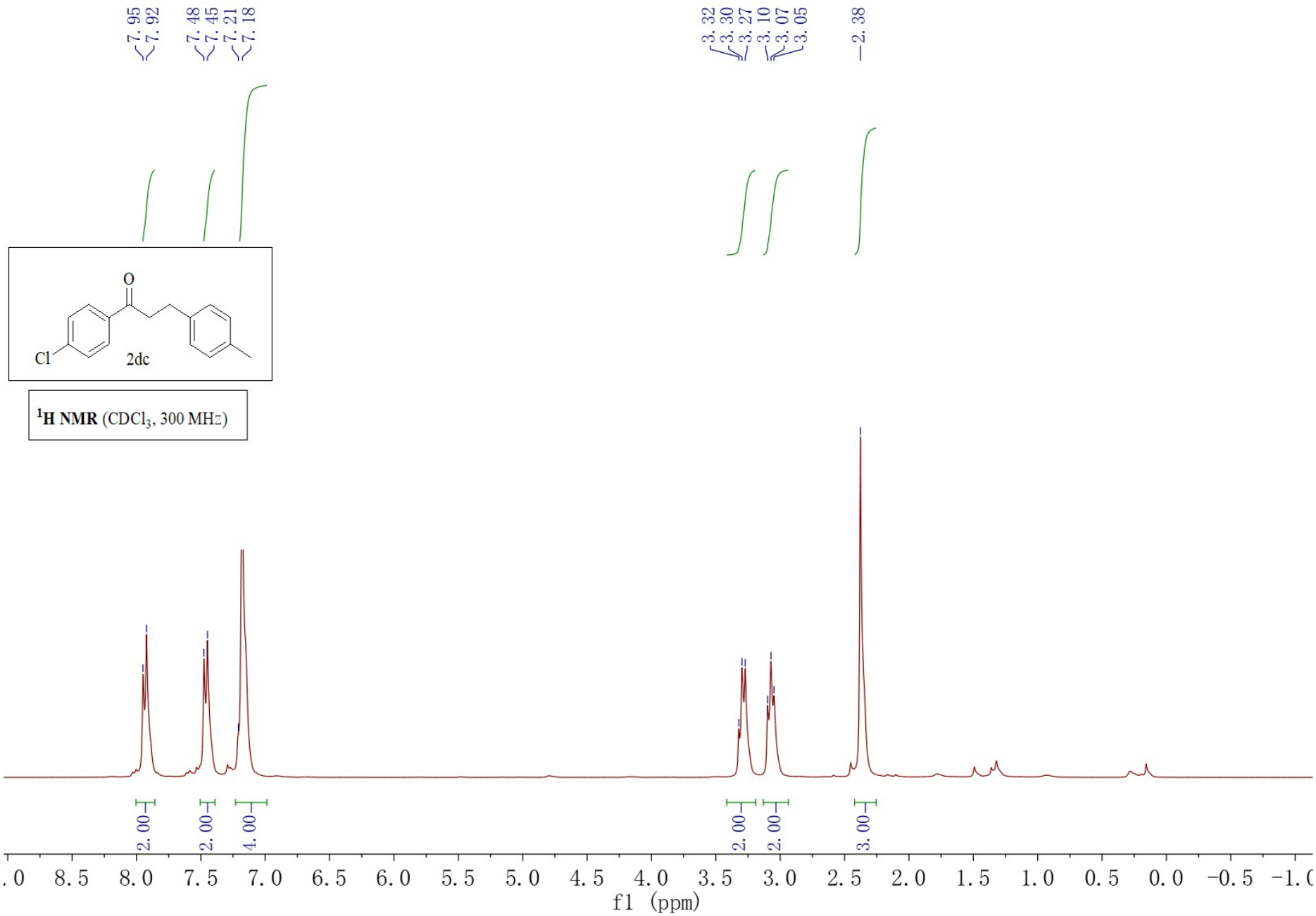

197.56
150.28
141.17
138.11
133.58
132.15
129.05
128.31
127.67
127.45
127.02
126.63
126.20
125.53
123.88
40.91
29.97
O
O2N
2ch
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

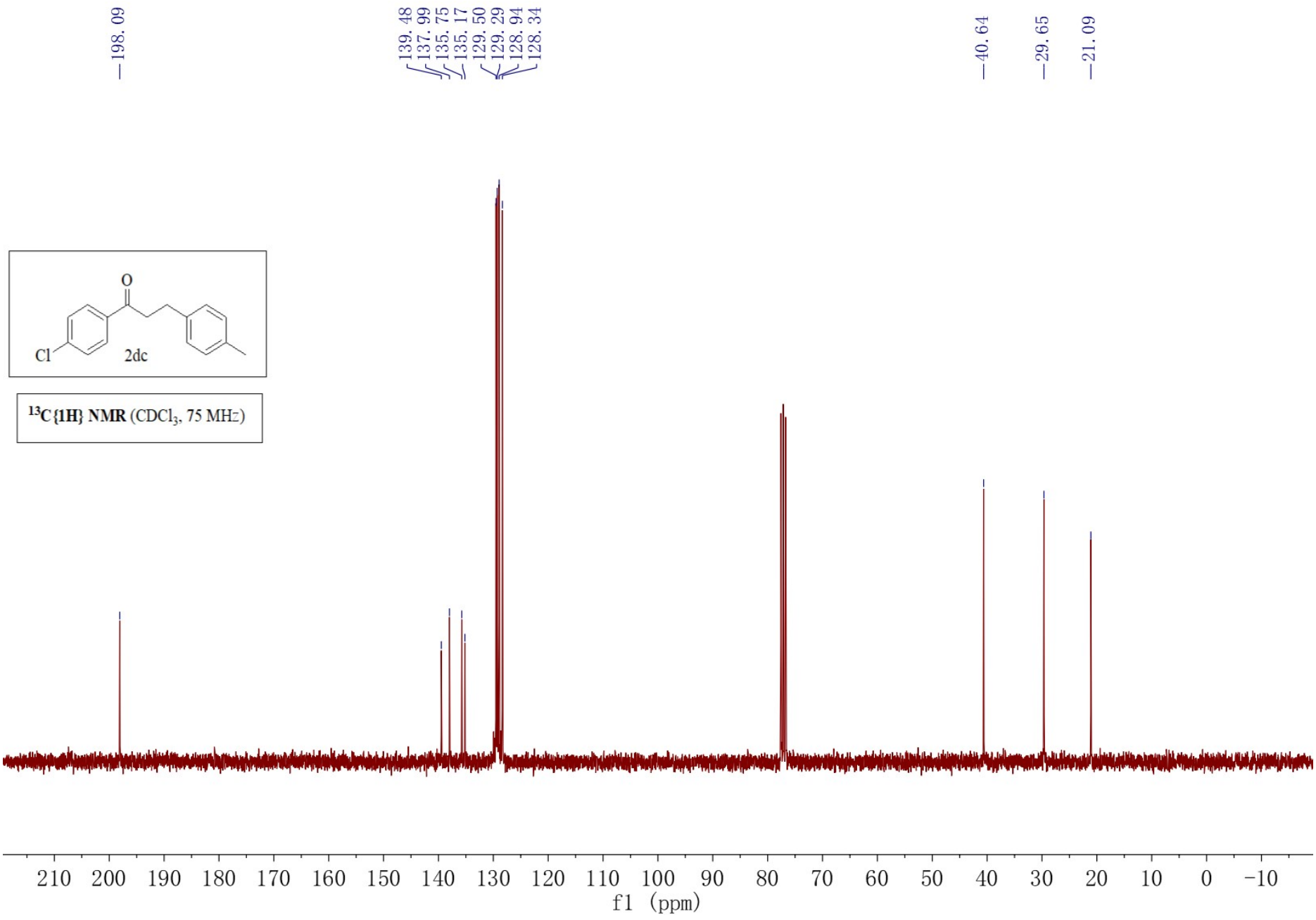

7.92
7.91
7.90
7.45
7.44
7.43
7.41
7.38
7.38
7.36
7.36
7.32
7.31
7.21
7.21
7.19
3.31
3.29
3.27
3.22
3.20
3.18
O
Cl
Cl
2da
¹H NMR (CDCl₃, 300 MHz)
2.00
2.02
1.02
1.03
2.00
2.02
2.00
0.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
f1 (ppm)

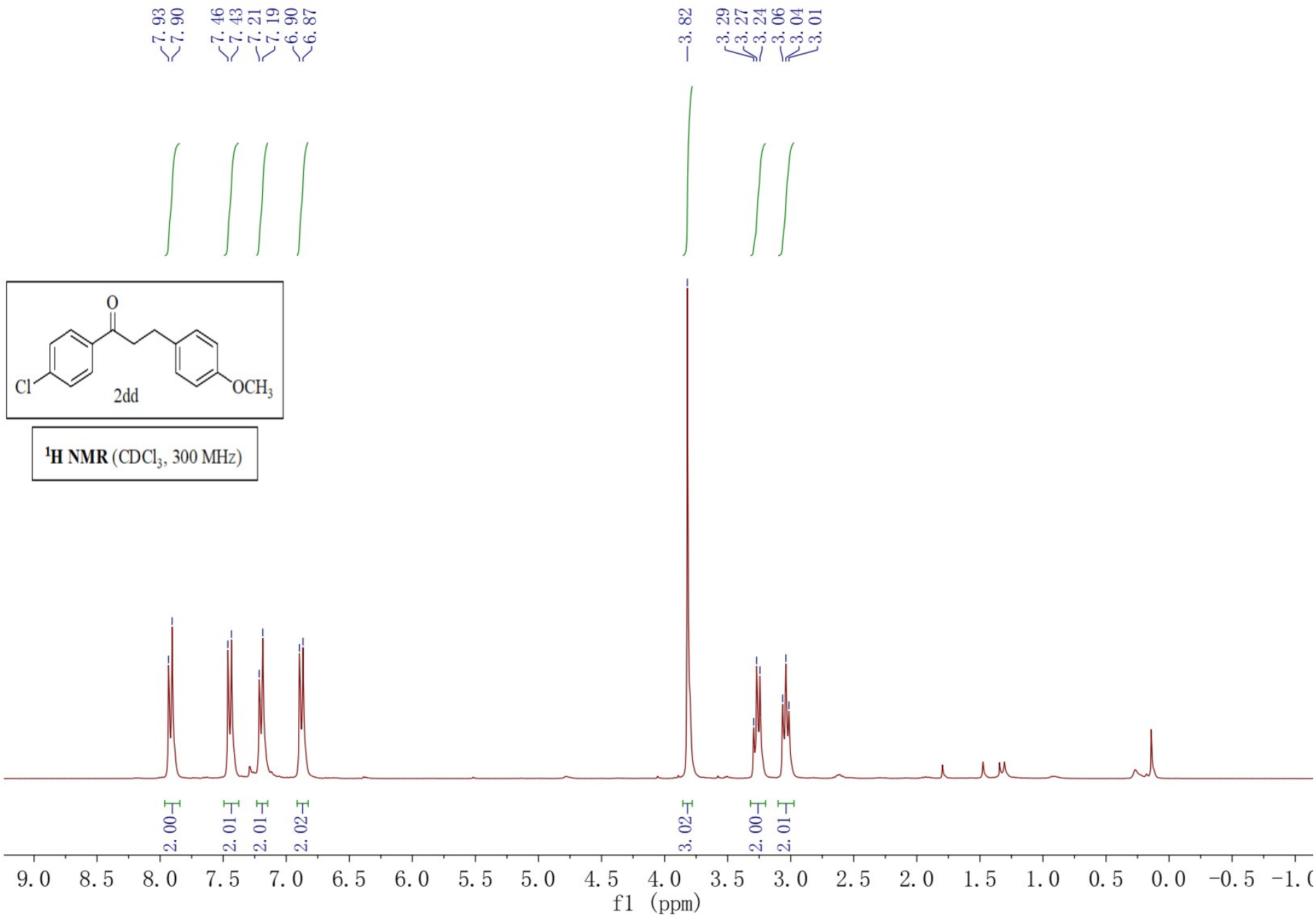

197.74
139.54
138.61
135.02
133.91
130.84
129.60
129.49
128.93
127.86
127.03
38.44
28.30
O
Cl
Cl
2da
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

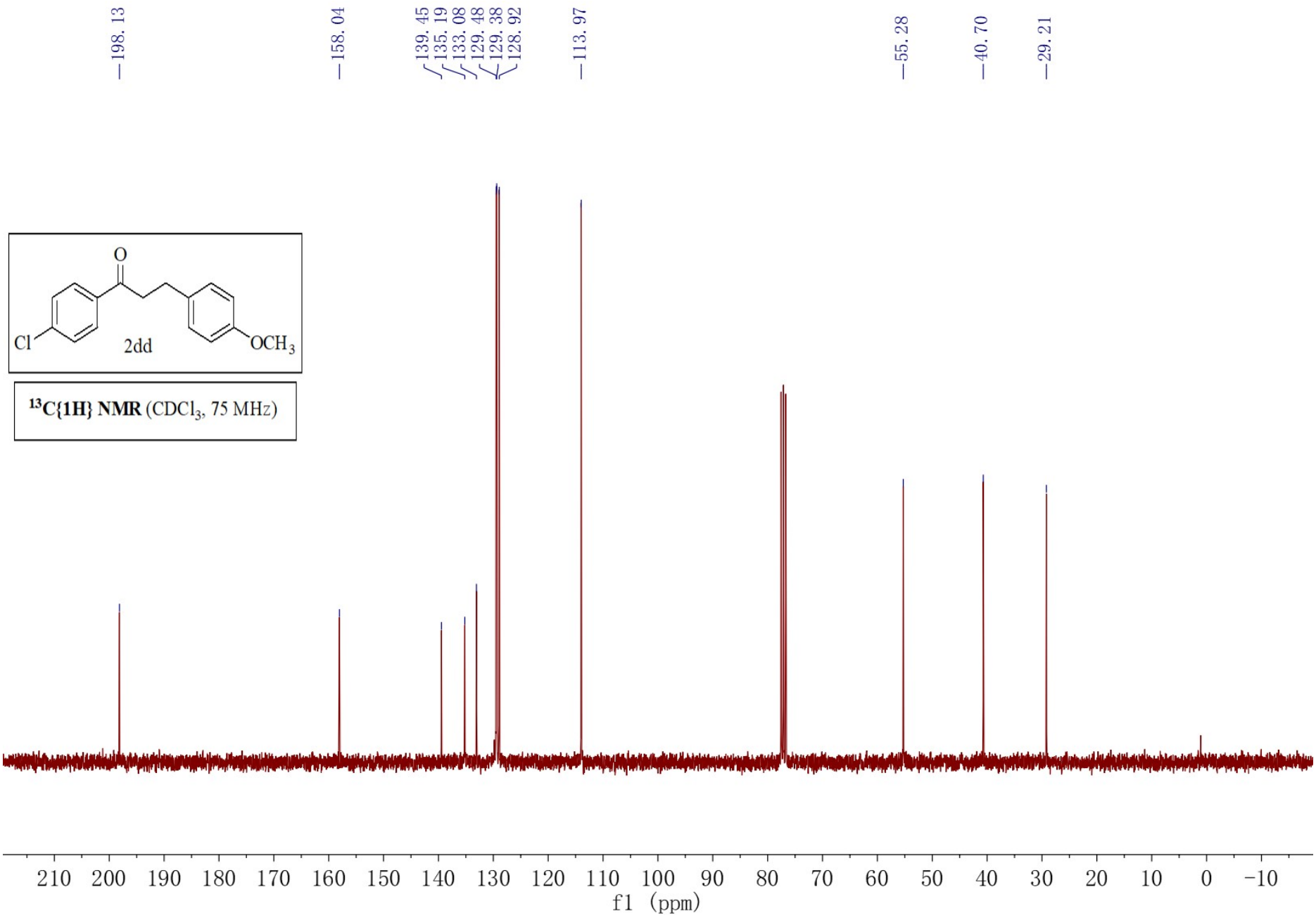

7.81
7.80
7.80
7.79
7.78
7.78
7.35
7.34
7.34
7.33
7.32
7.32
7.31
7.26
7.25
7.25
7.24
7.24
7.23
7.10
7.09
7.08
7.07
7.06
3.18
3.16
3.14
2.96
2.94
2.92
O
Br
Cl
2db
1H NMR (CDCl3, 400 MHz)
1.00
1.04
1.00
2.01
1.00
2.00
2.02
2.01
f1 (ppm)

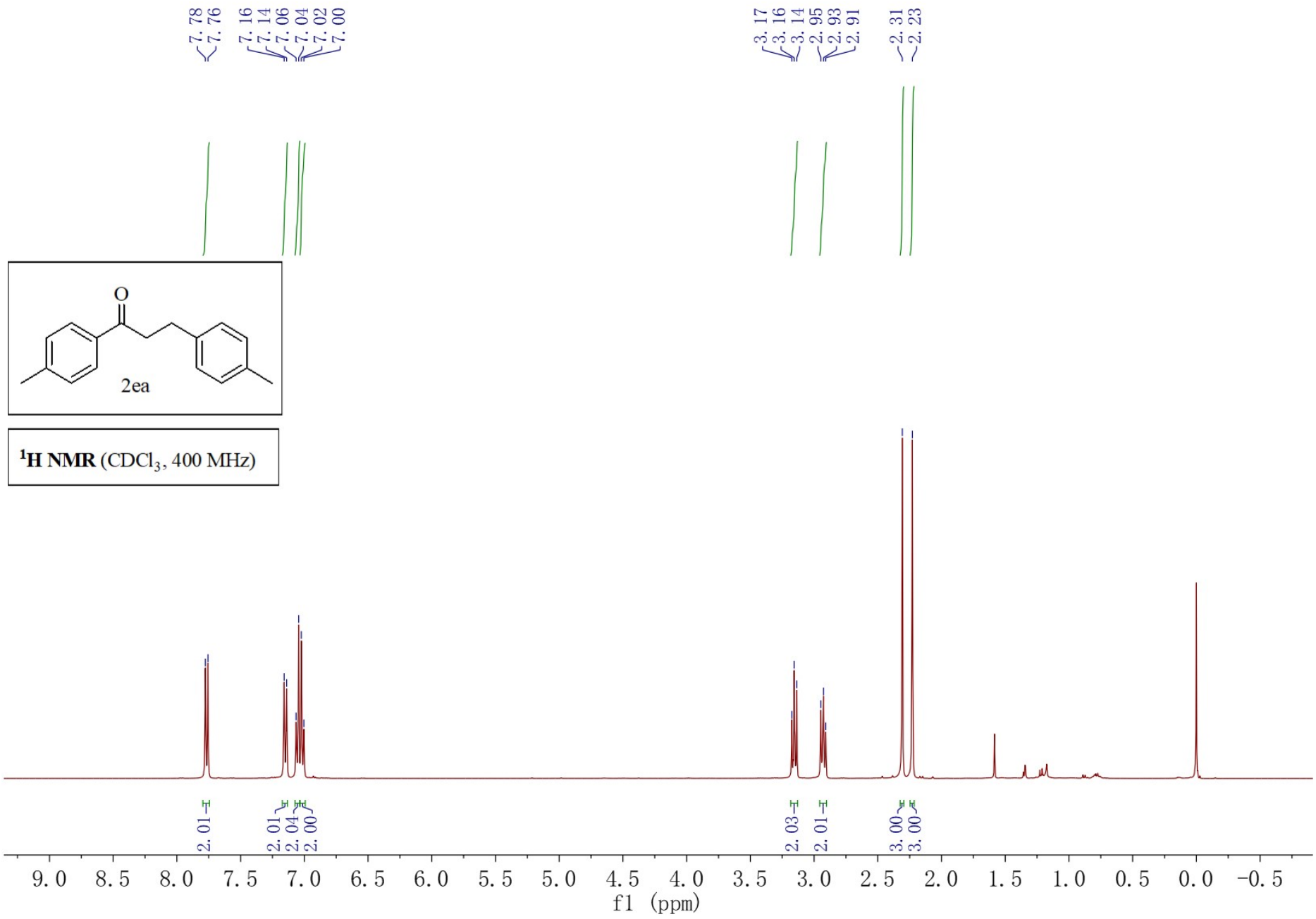

197.36
143.46
139.61
134.96
131.49
130.14
129.45
129.35
128.96
127.21
122.57
40.00
29.53
O
Br
Cl
2db
^{13}C{1H} NMR (CDCl$_3$, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

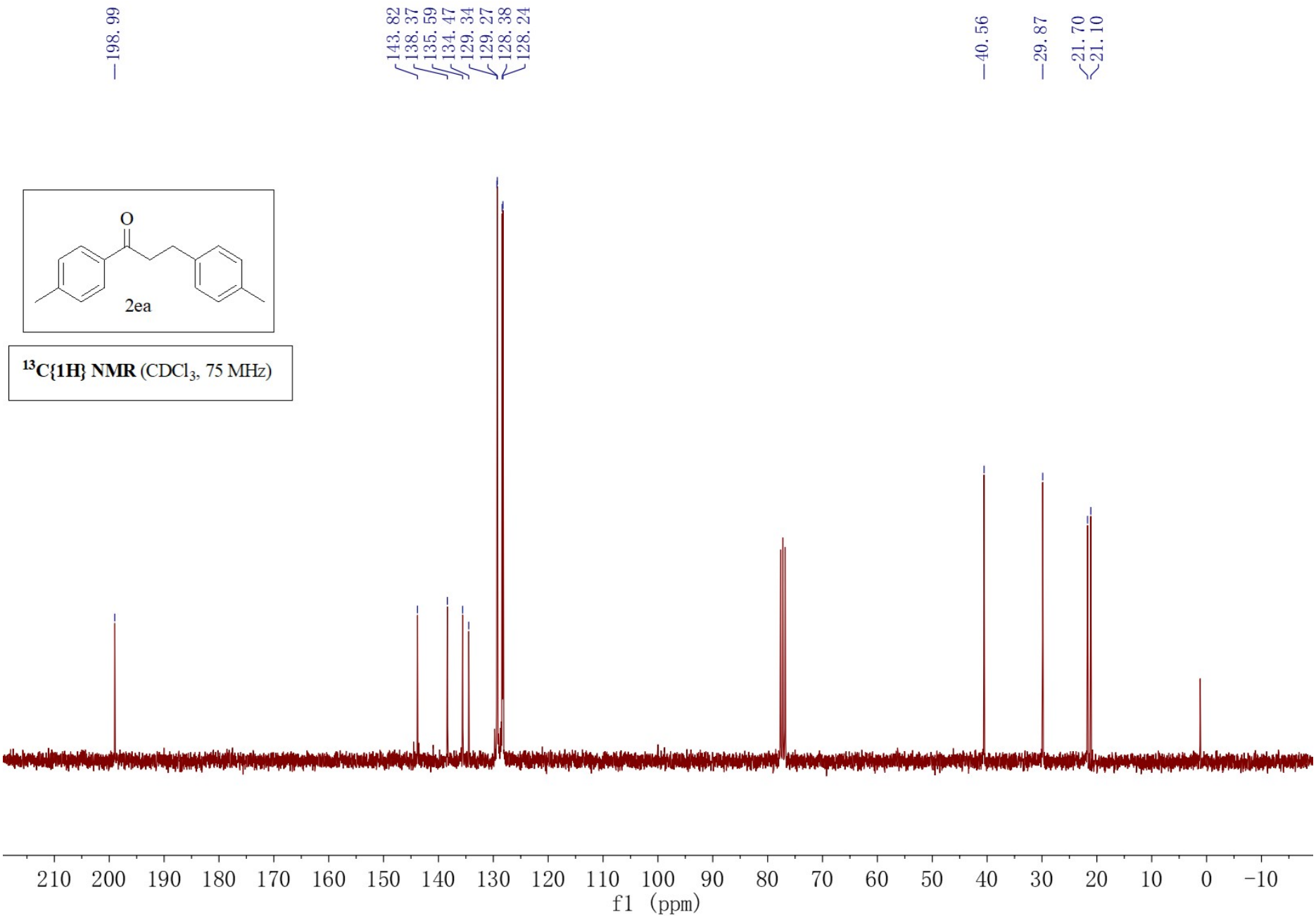

7.95
7.92
7.48
7.45
7.21
7.18
3.32
3.30
3.27
3.10
3.07
3.05
2.38
O
Cl
2dc
¹H NMR (CDCl₃, 300 MHz)
2.00
2.00
4.00
2.00
2.00
3.00
f1 (ppm)

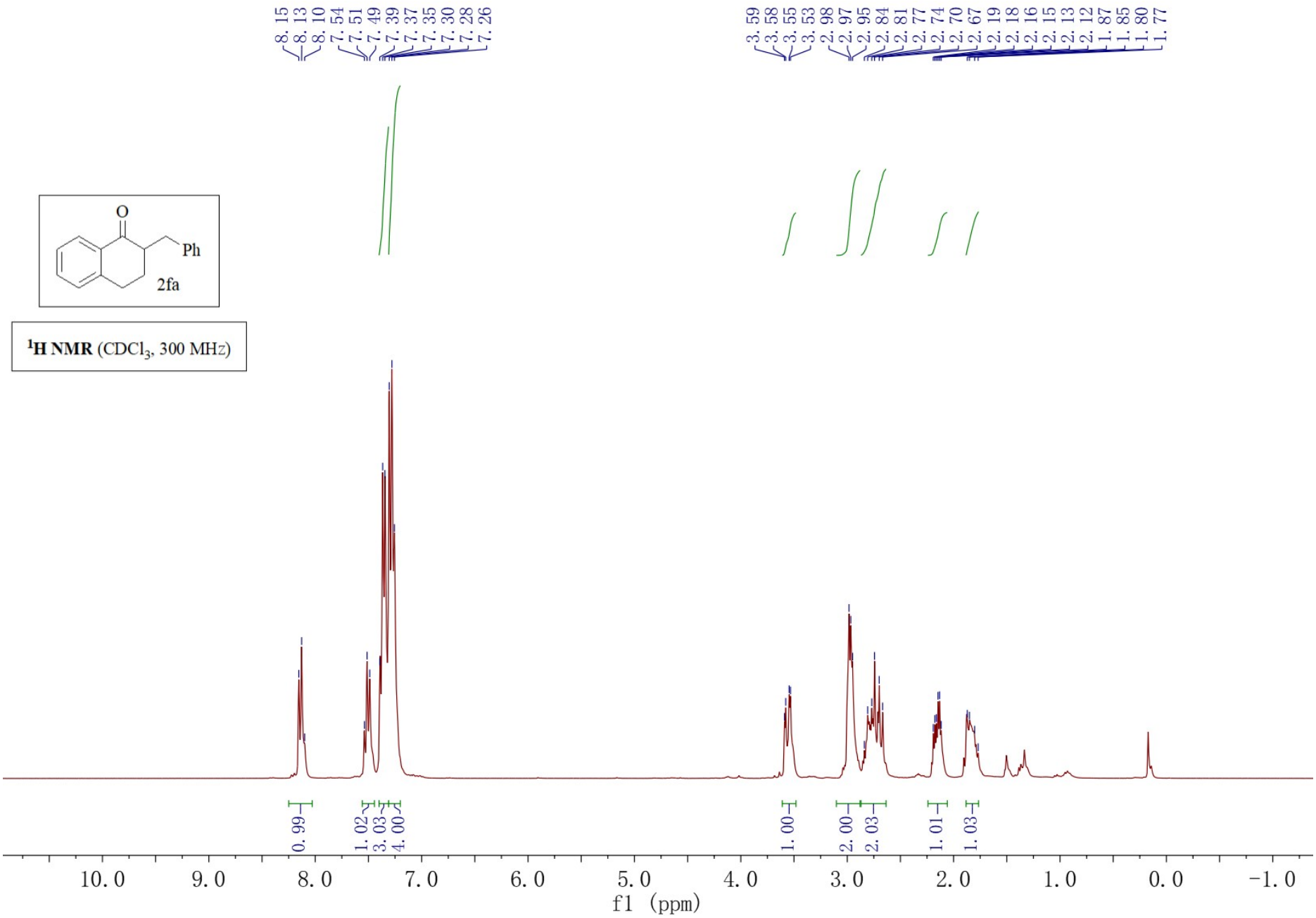

198.09
139.48
137.99
135.75
135.17
129.50
129.29
128.94
128.34
40.64
29.65
21.09
O
Cl
2dc
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

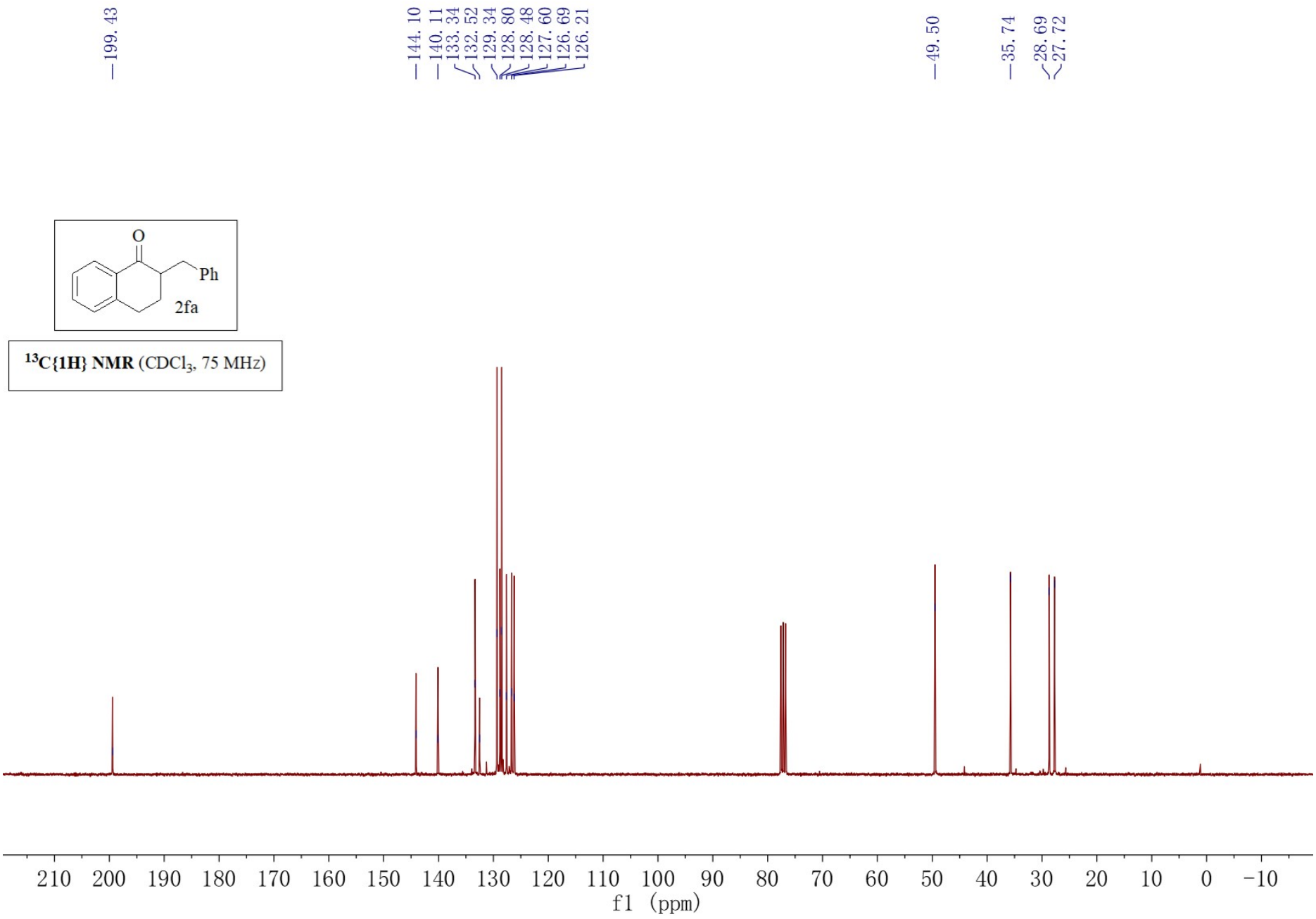

7.93
7.90
7.46
7.43
7.21
7.19
6.90
6.87
3.82
3.29
3.27
3.24
3.06
3.04
3.01
O
Cl
OCH3
2dd
1H NMR (CDCl3, 300 MHz)
2.00
2.01
2.01
2.02
3.02
2.00
2.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

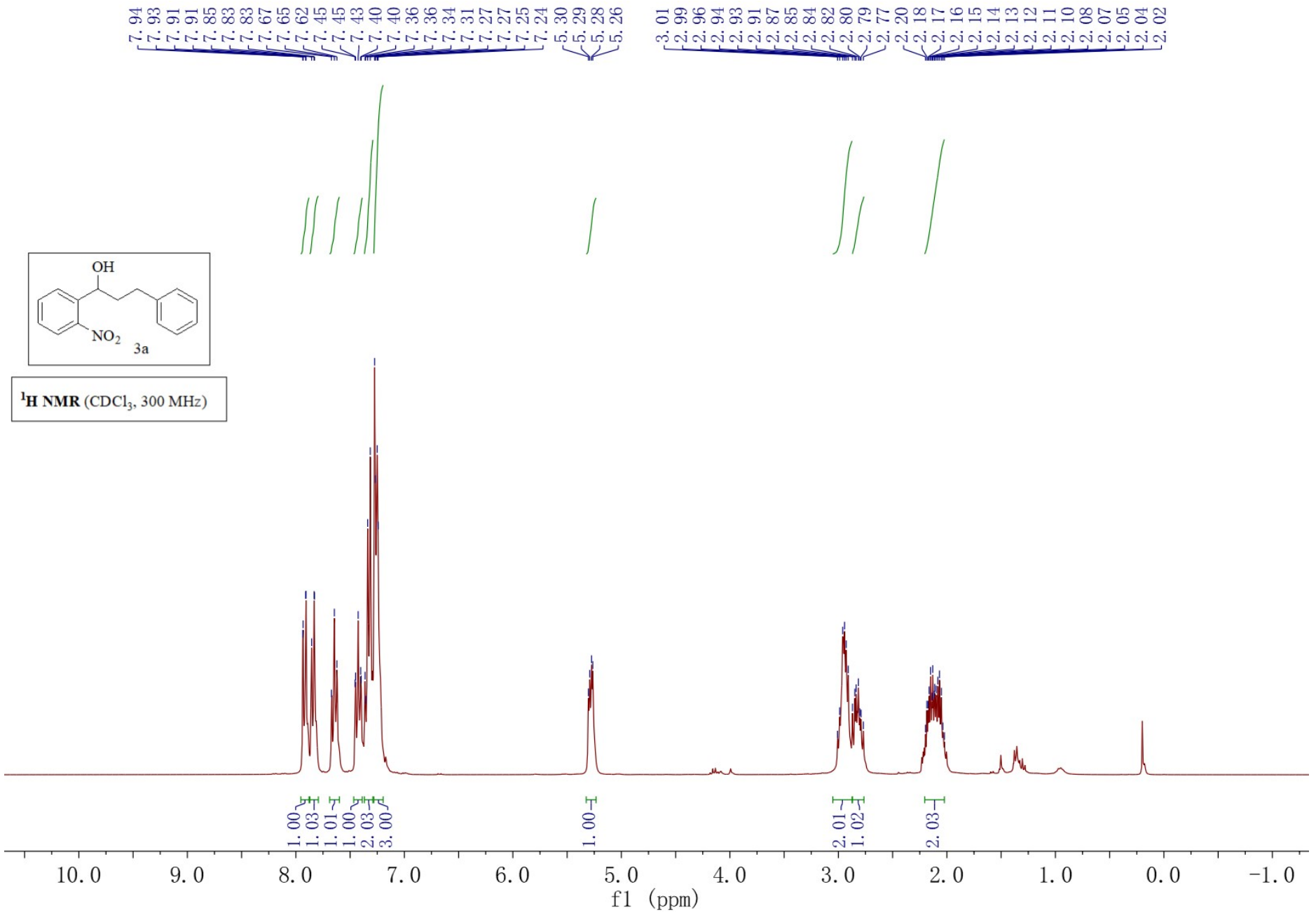

198.13
158.04
139.45
135.19
133.08
129.48
129.38
128.92
113.97
55.28
40.70
29.21
O
Cl
OCH3
2dd
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

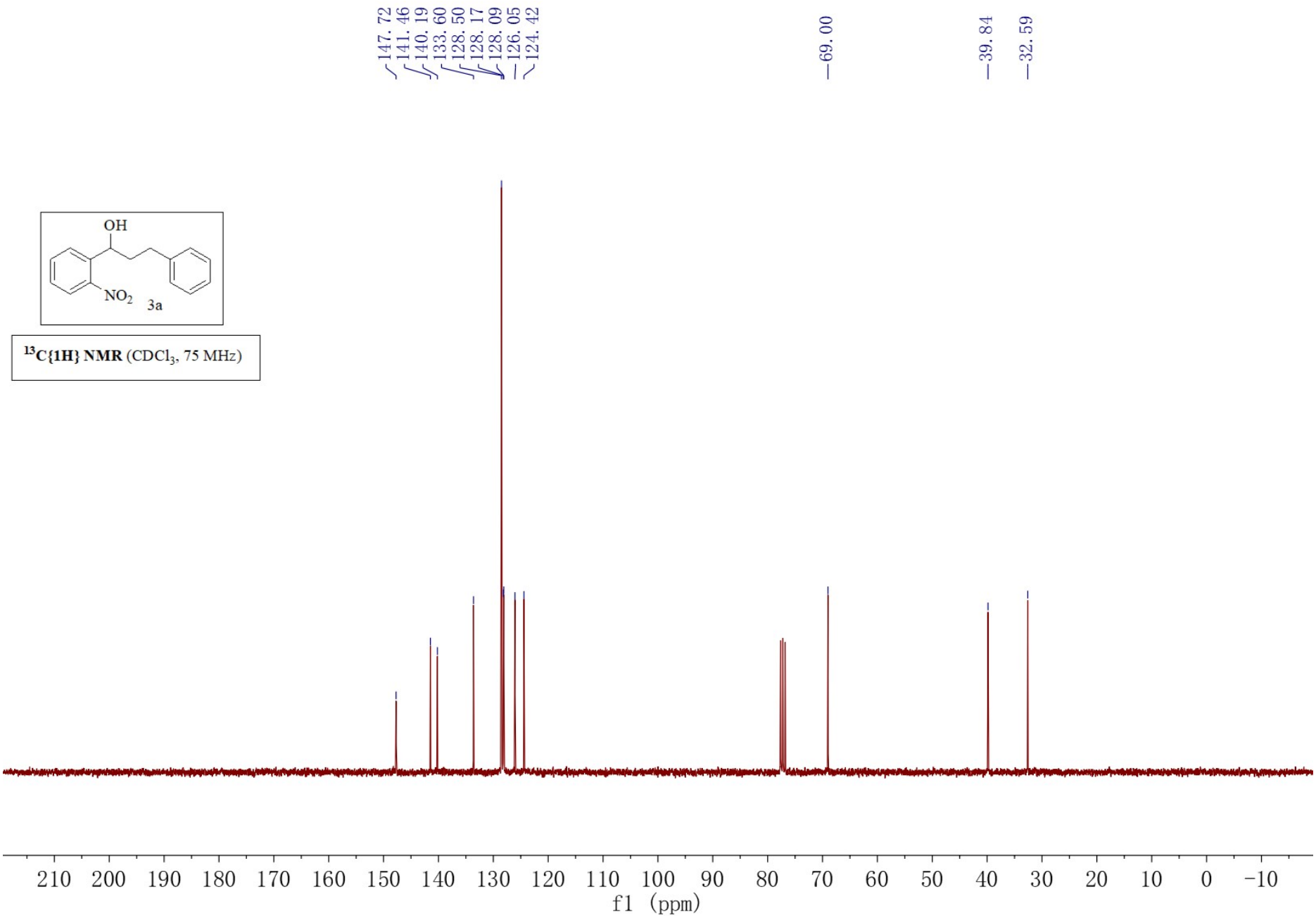

7.78
7.76
7.16
7.14
7.06
7.04
7.02
7.00
3.17
3.16
3.14
2.95
2.93
2.91
2.31
2.23
O
2ea
1H NMR (CDCl3, 400 MHz)
2.01
2.01
2.04
2.00
2.03
2.01
3.00
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

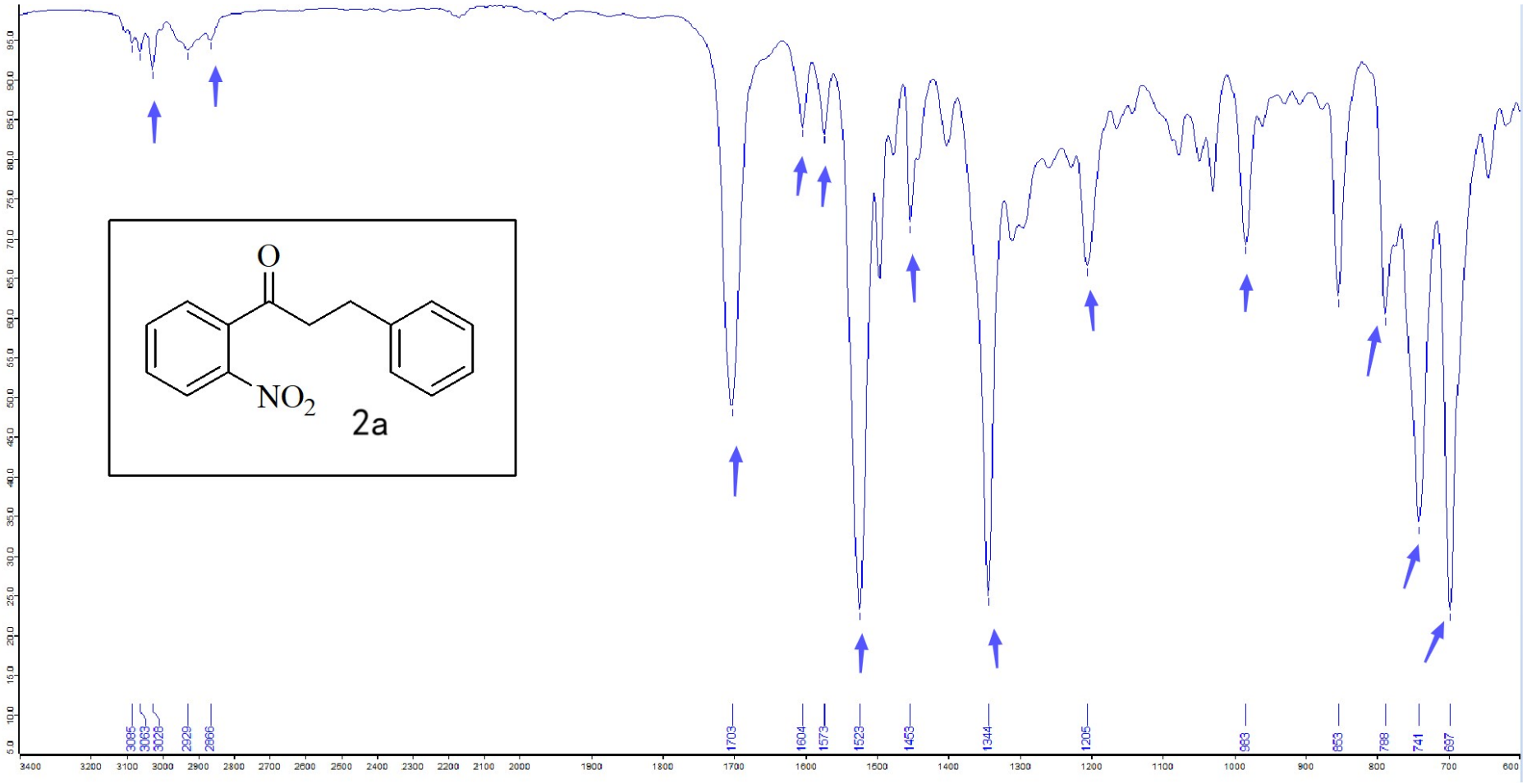

198.99
143.82
138.37
135.59
134.47
129.34
129.27
128.38
128.24
40.56
29.87
21.70
21.10
O
2ea
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

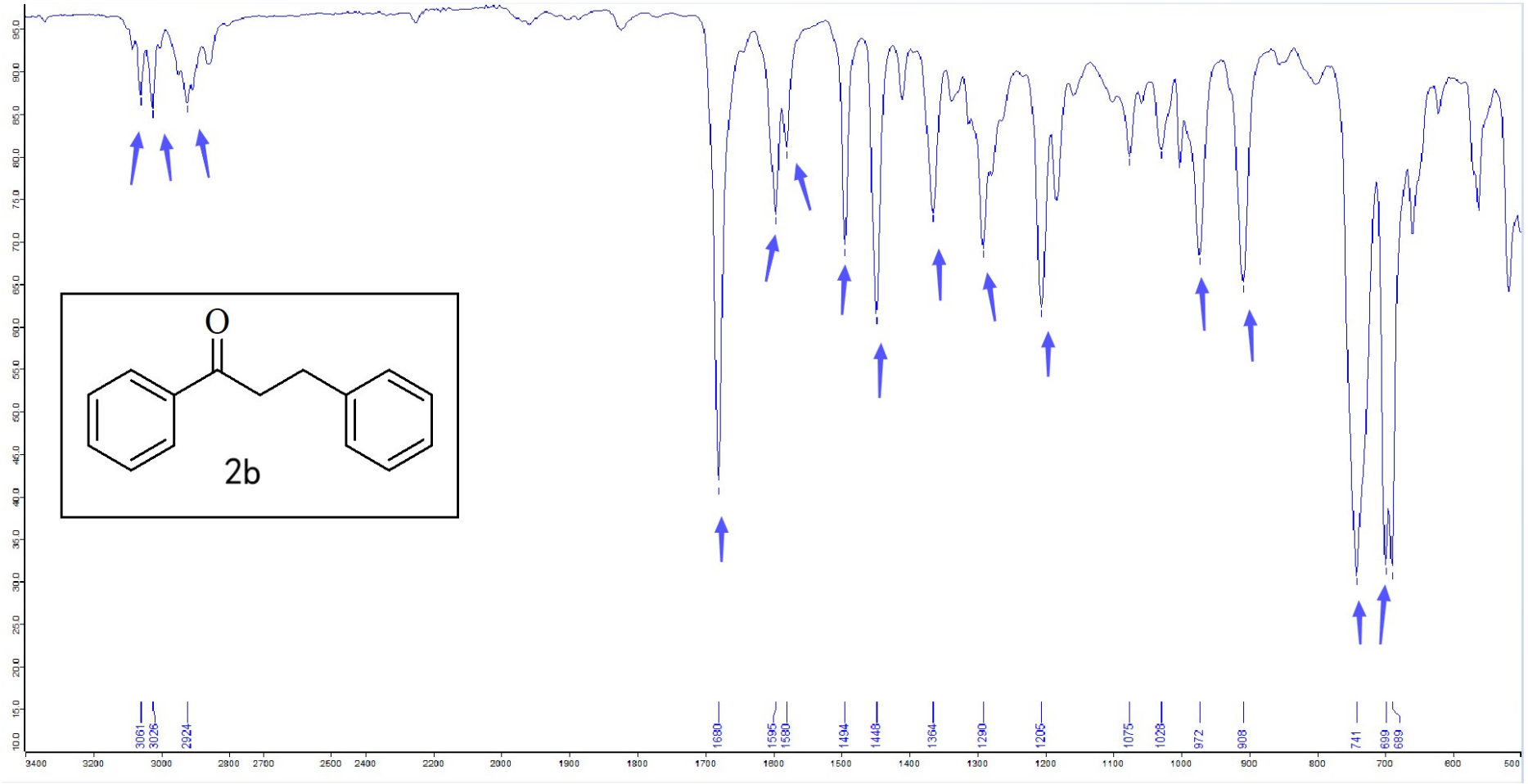

8.15
8.13
8.10
7.54
7.51
7.49
7.39
7.37
7.35
7.30
7.28
7.26
3.59
3.58
3.55
3.53
2.98
2.97
2.95
2.84
2.81
2.77
2.74
2.70
2.67
2.19
2.18
2.16
2.15
2.13
2.12
1.87
1.85
1.80
1.77
O
Ph
2fa
¹H NMR (CDCl₃, 300 MHz)
0.99
1.02
3.03
4.00
1.00
2.00
2.03
1.01
1.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

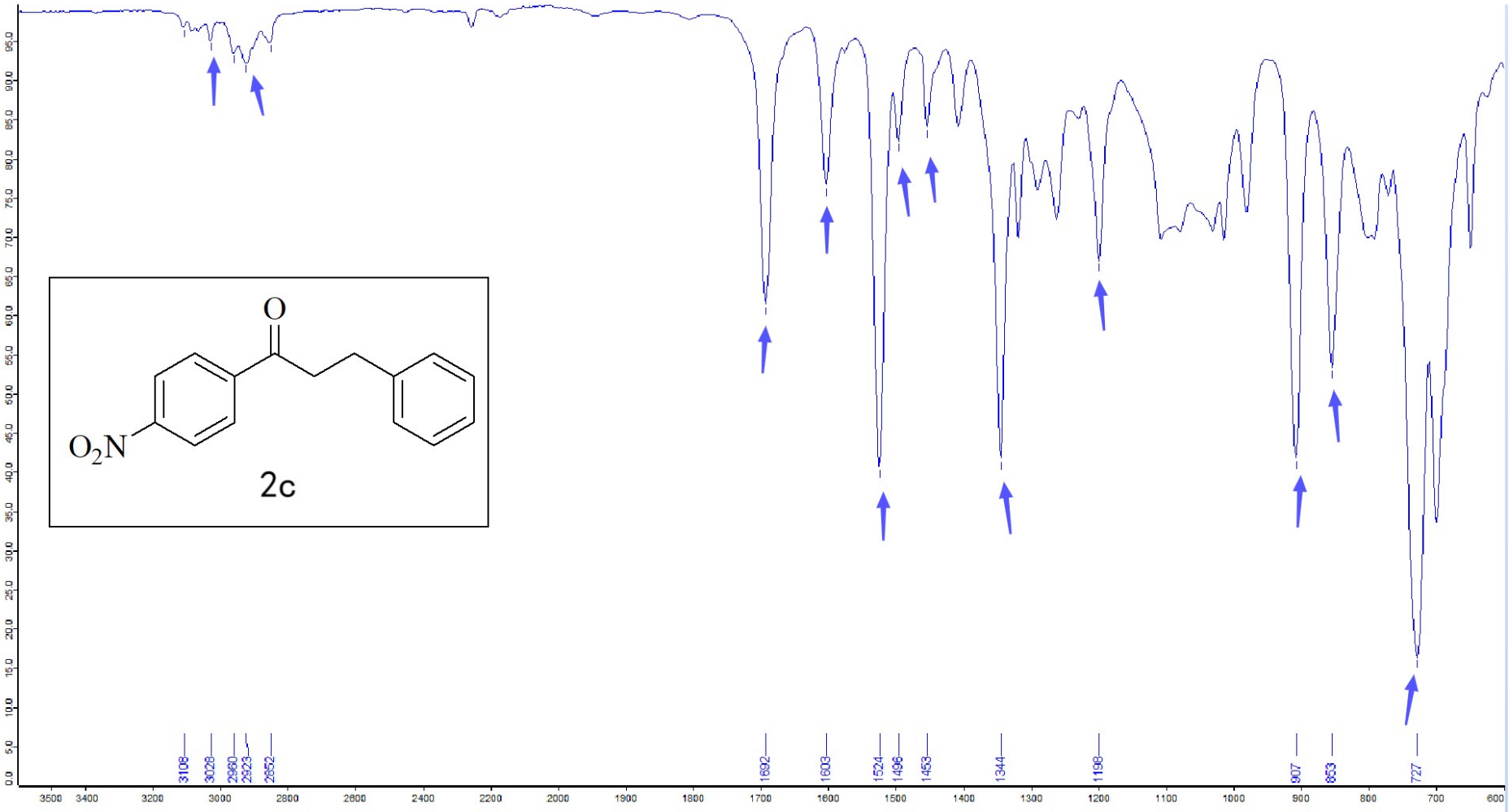

199.43
144.10
140.11
133.34
132.52
129.34
128.80
128.48
127.60
126.69
126.21
49.50
35.74
28.69
27.72
O
Ph
2fa
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.94
7.93
7.91
7.91
7.85
7.83
7.83
7.67
7.65
7.62
7.45
7.45
7.43
7.40
7.40
7.36
7.36
7.34
7.31
7.27
7.27
7.25
7.24
5.30
5.29
5.28
5.26
3.01
2.99
2.96
2.94
2.93
2.91
2.87
2.85
2.84
2.82
2.80
2.79
2.77
2.20
2.18
2.17
2.16
2.15
2.14
2.13
2.12
2.11
2.10
2.08
2.07
2.05
2.04
2.02
OH
NO2
3a
1H NMR (CDCl3, 300 MHz)
1.00
1.03
1.01
1.00
2.03
3.00
1.00
2.01
1.02
2.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)


147.72
141.46
140.19
133.60
128.50
128.17
128.09
126.05
124.42
69.00
39.84
32.59
OH
NO2
3a
13C{1H} NMR (CDCl3, 75 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O
NO2
2a
3085
3063
3028
2929
2866
1703
1604
1573
1523
1453
1344
1205
983
853
788
741
697


O
2b
3061
3026
2924
1680
1595
1580
1494
1448
1364
1290
1205
1075
1028
972
908
741
699
689


O
O_2N
2c
3108
3028
2960
2923
2852
1692
1603
1524
1496
1453
1344
1198
907
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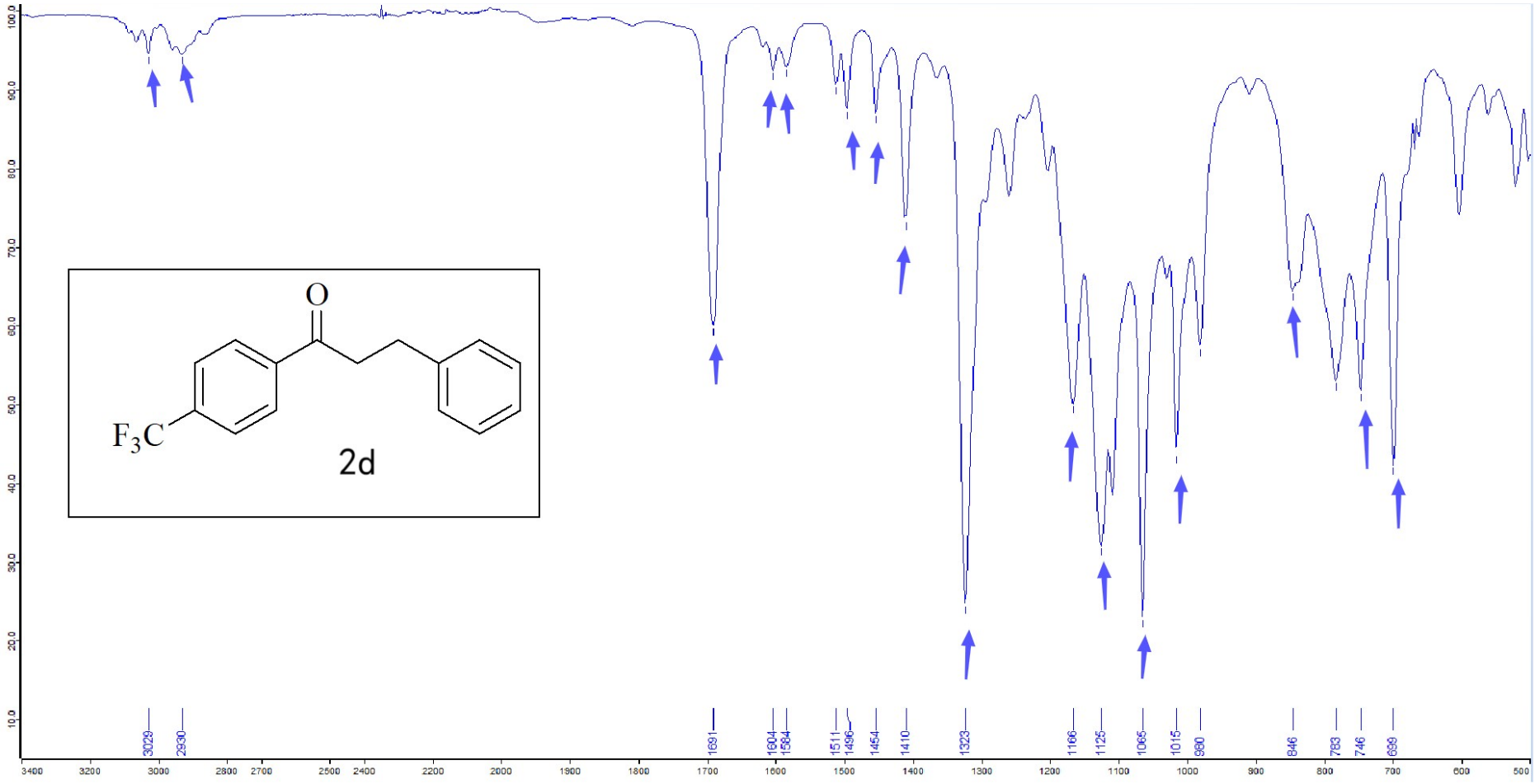
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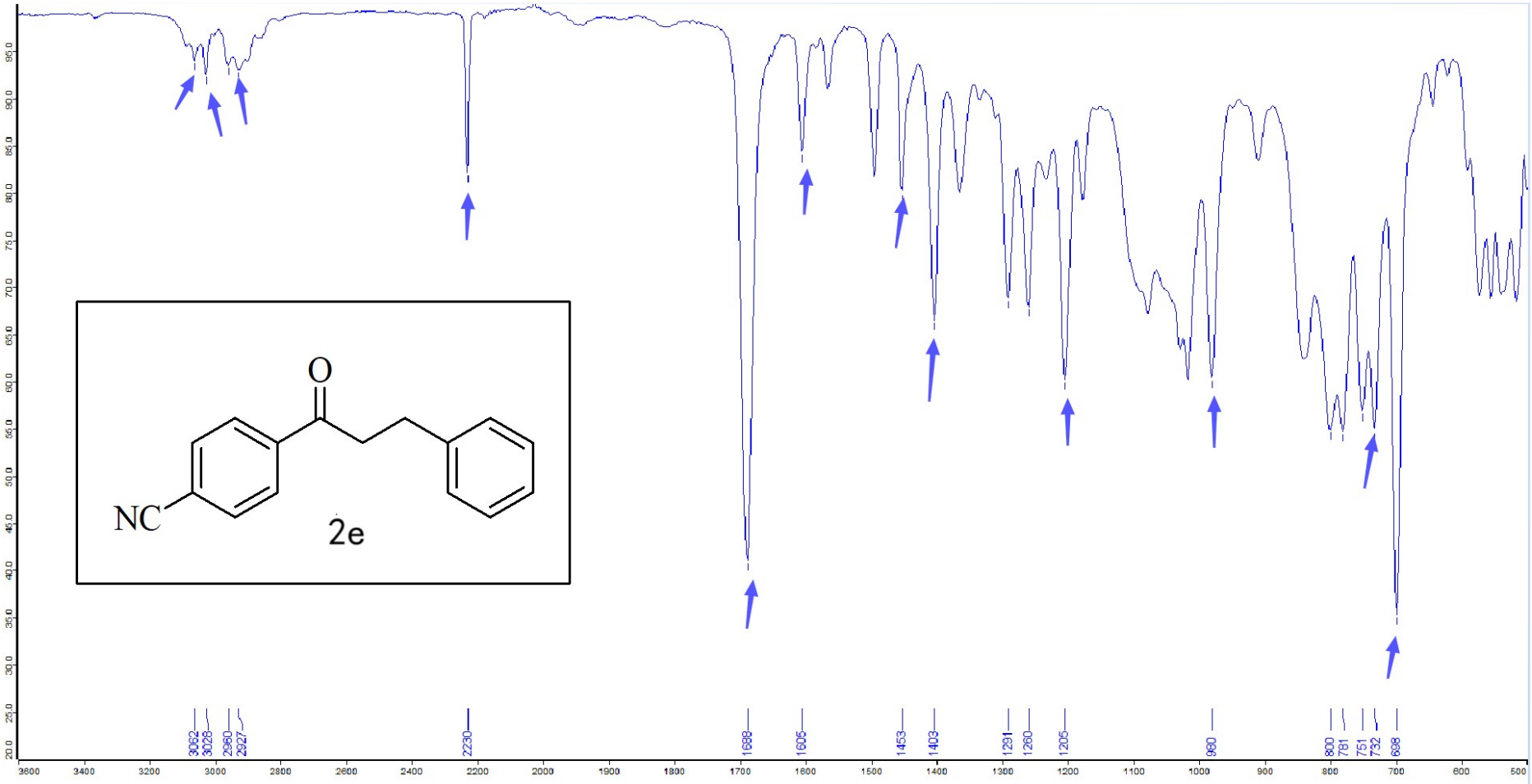
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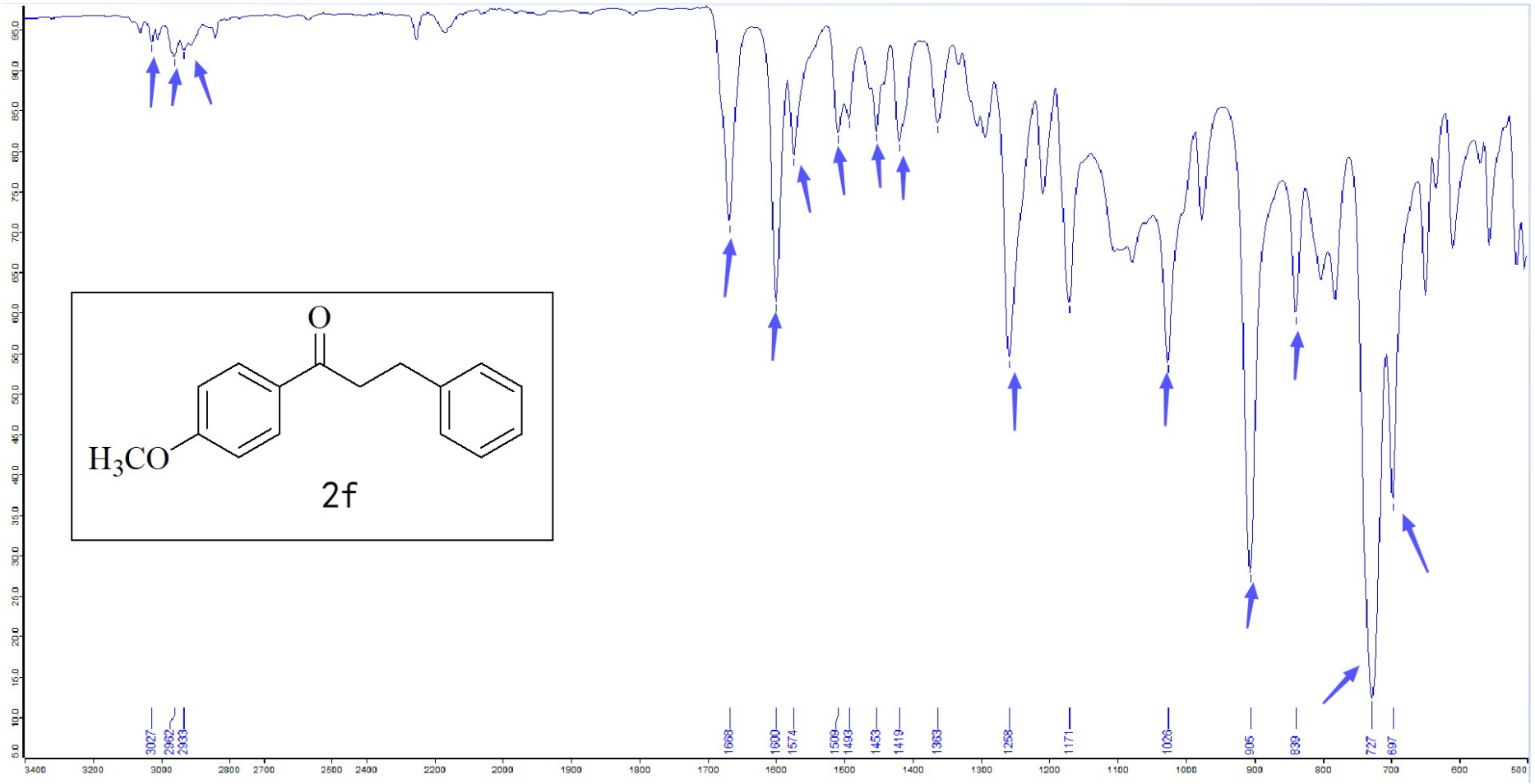
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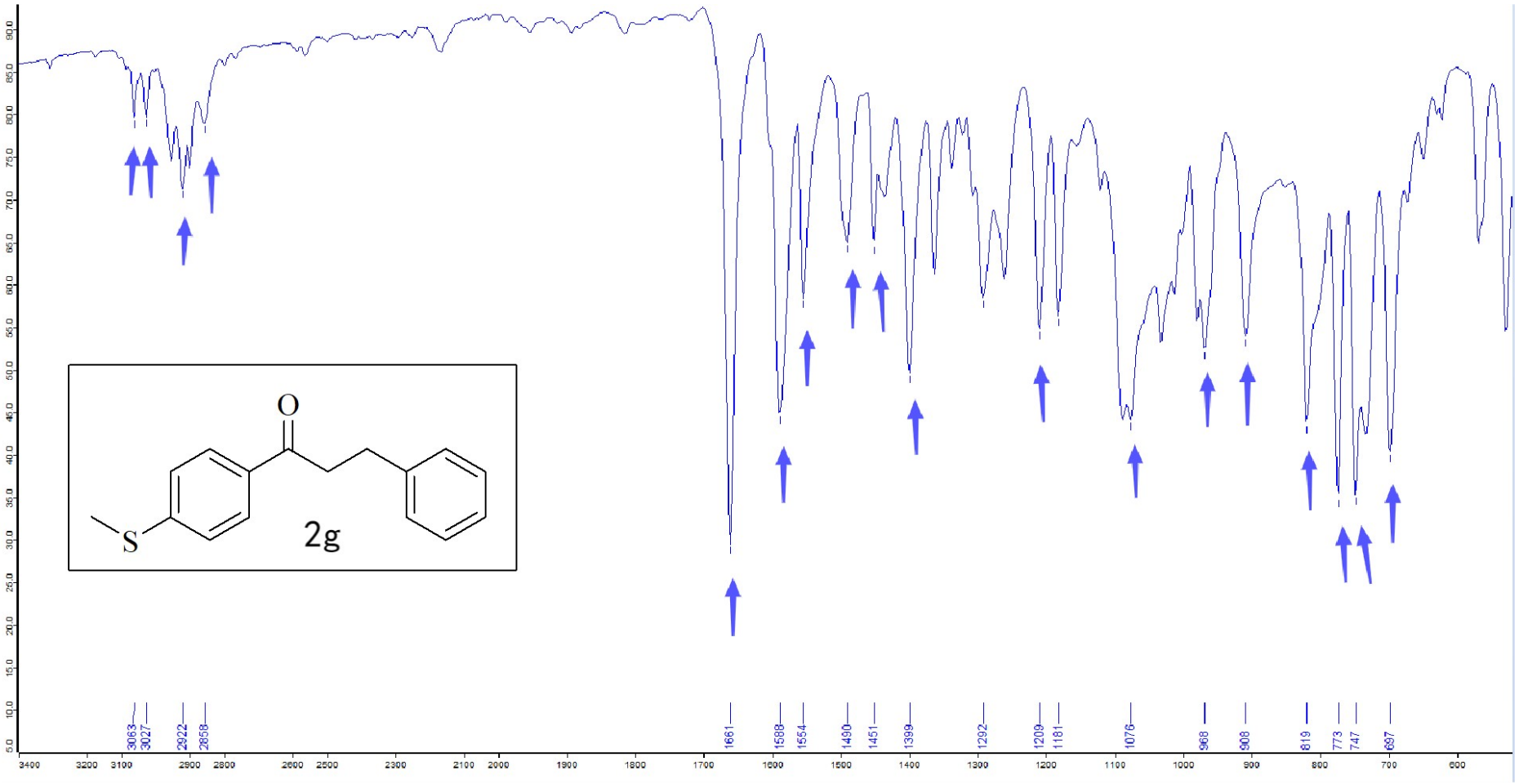
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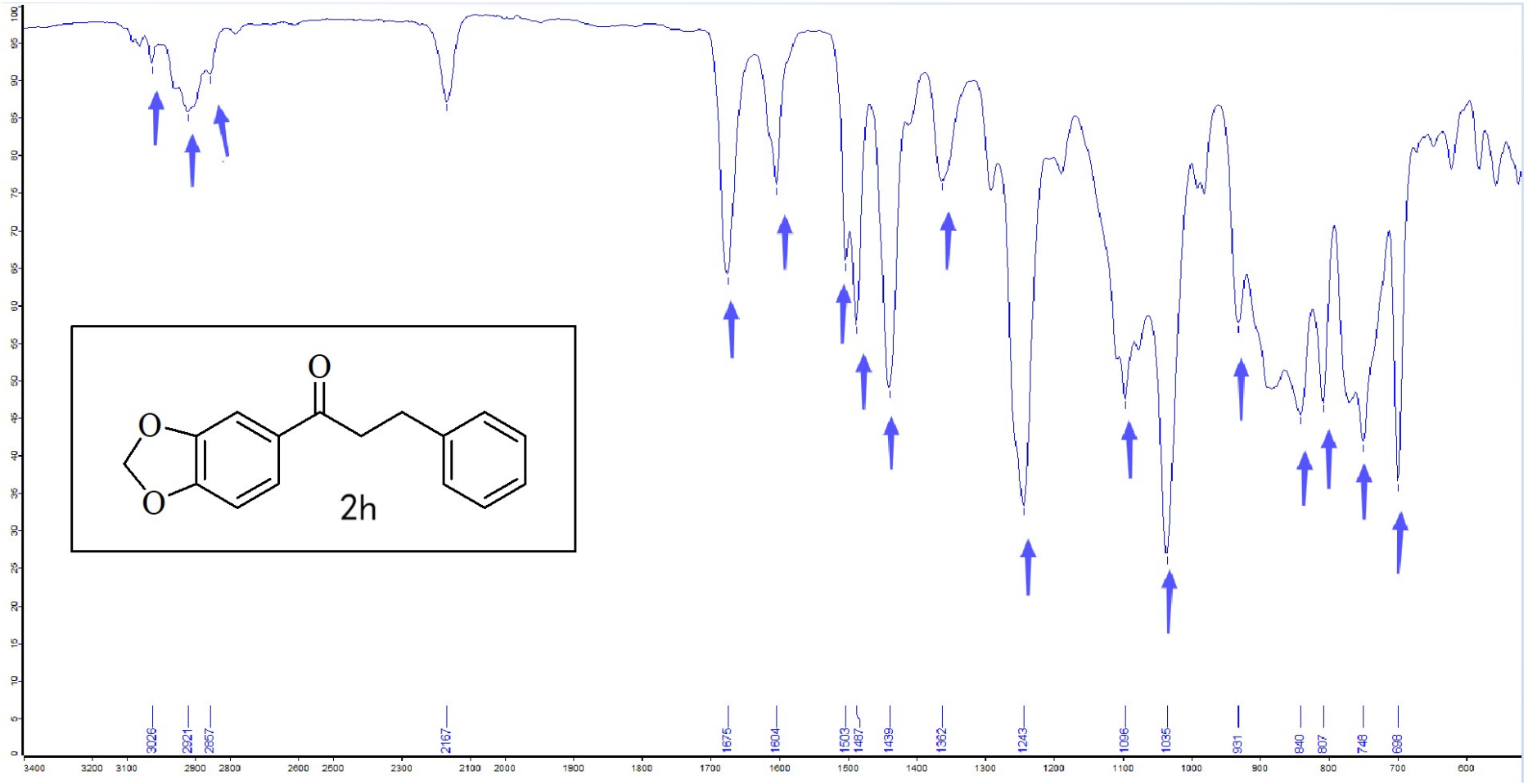
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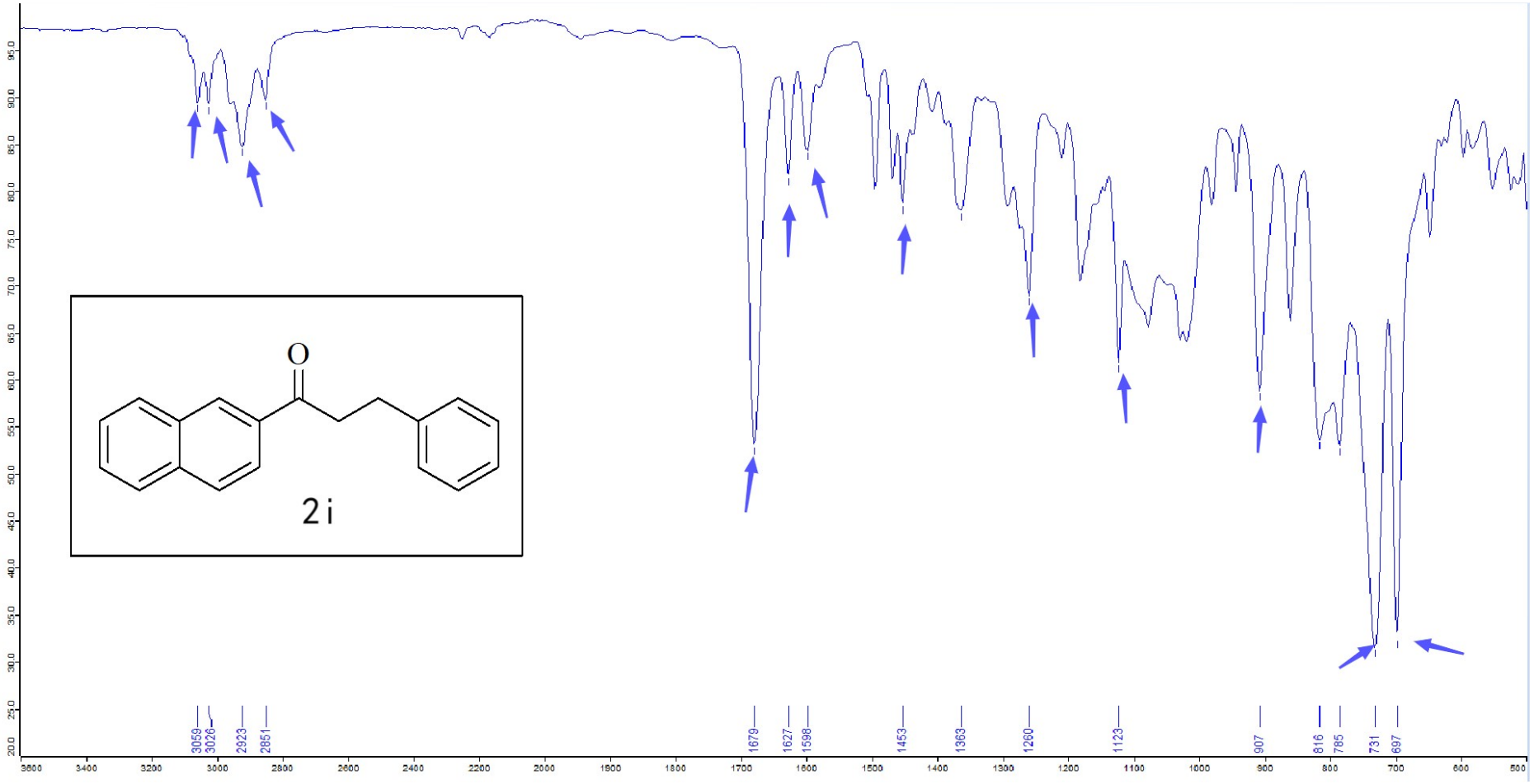
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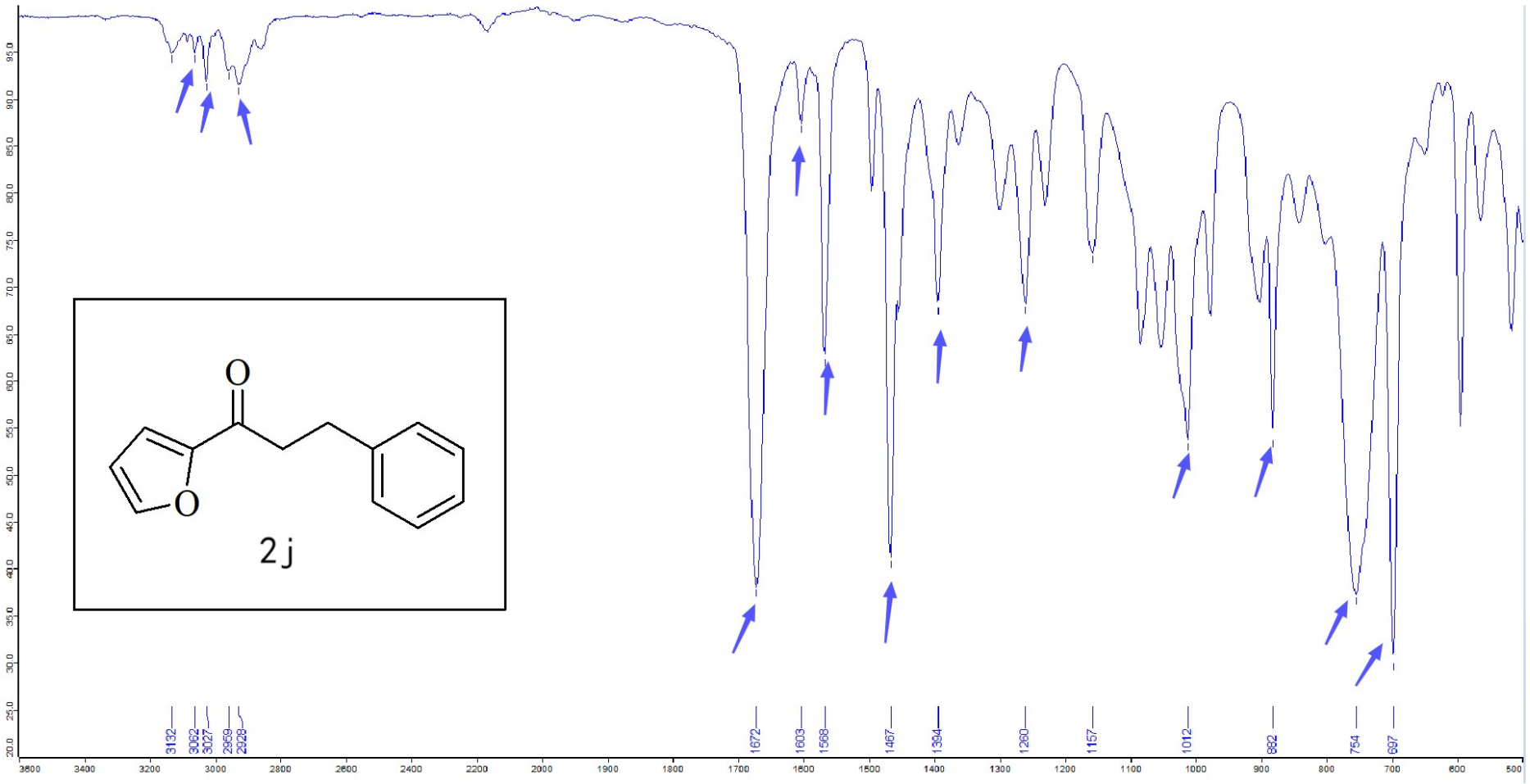
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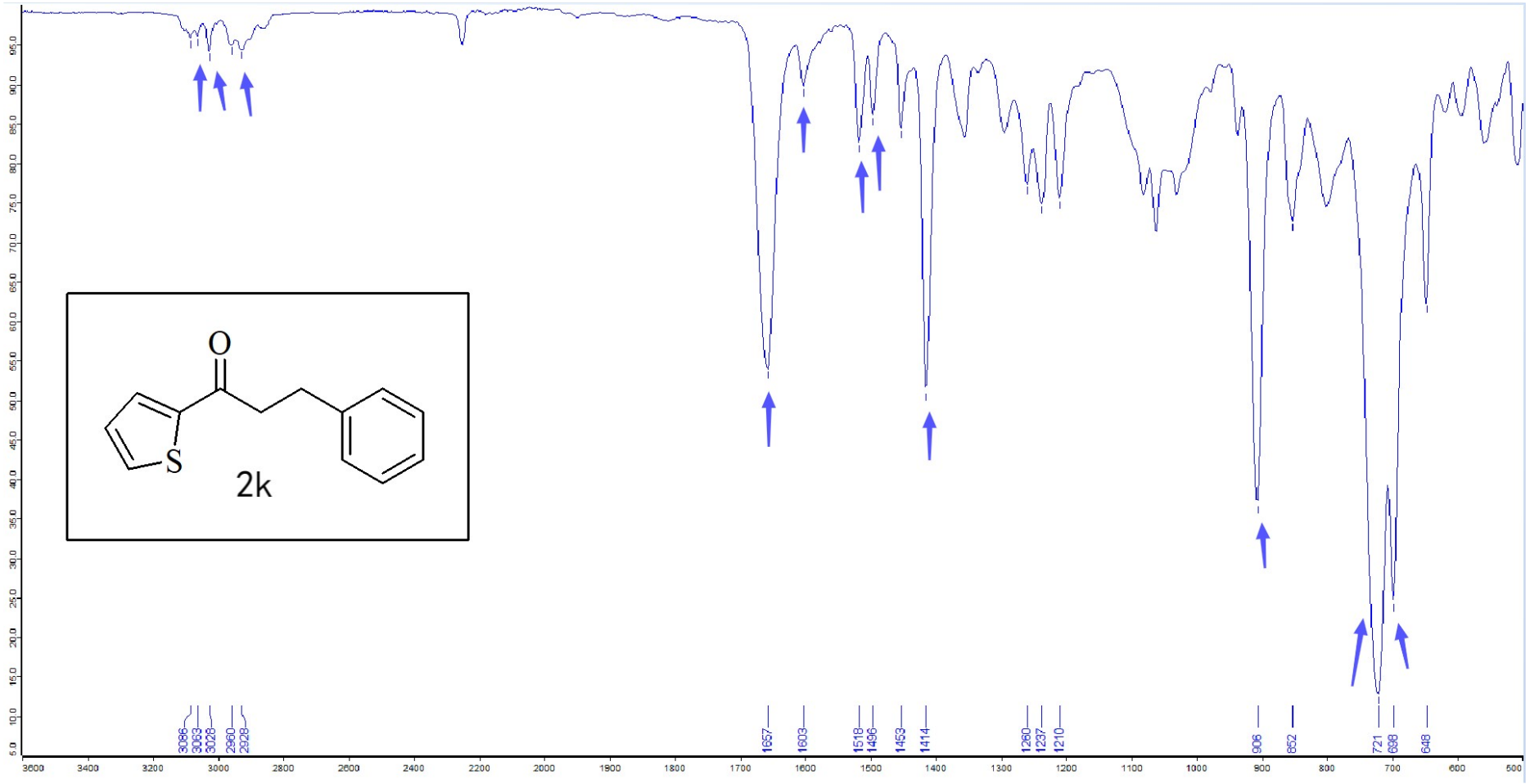
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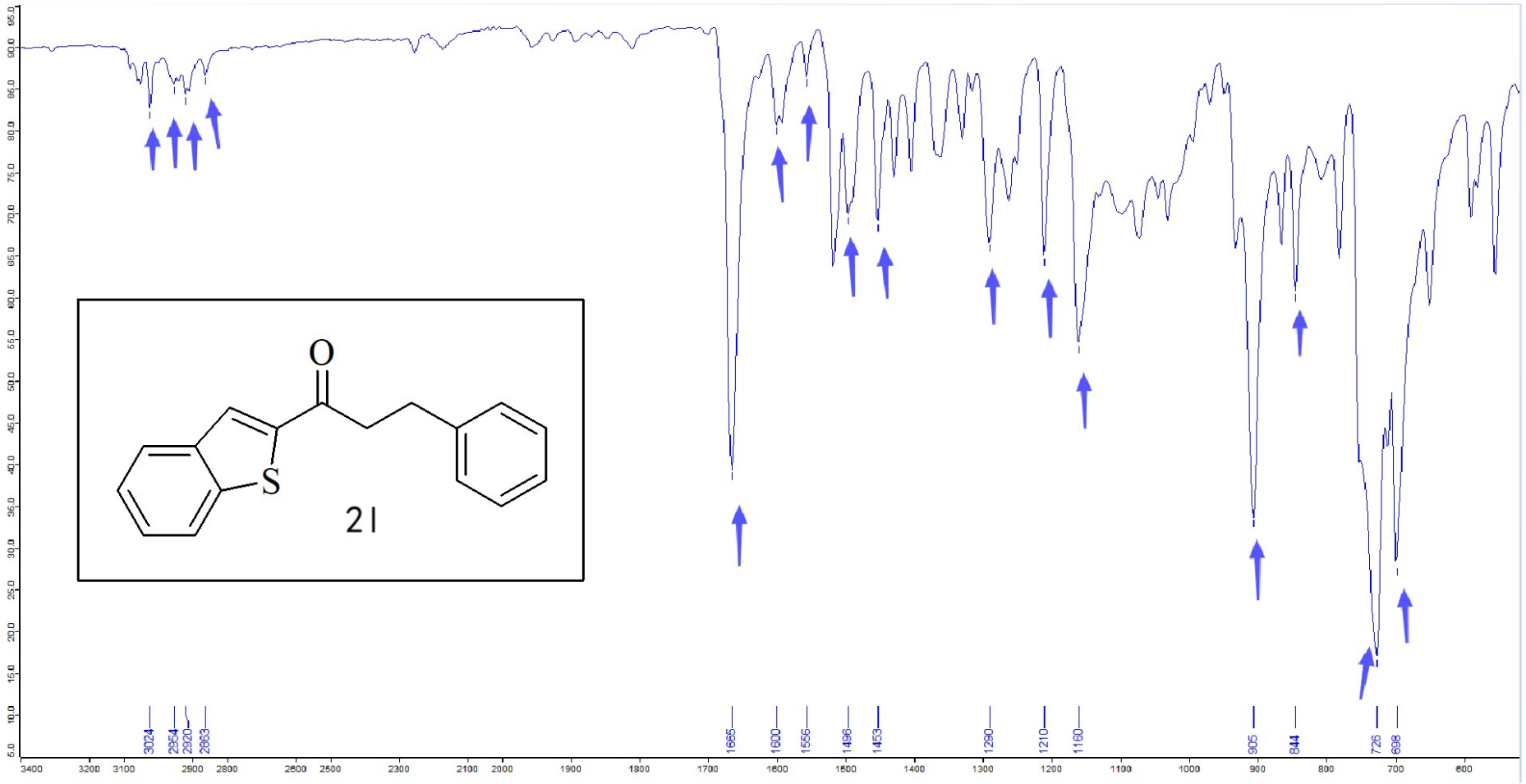
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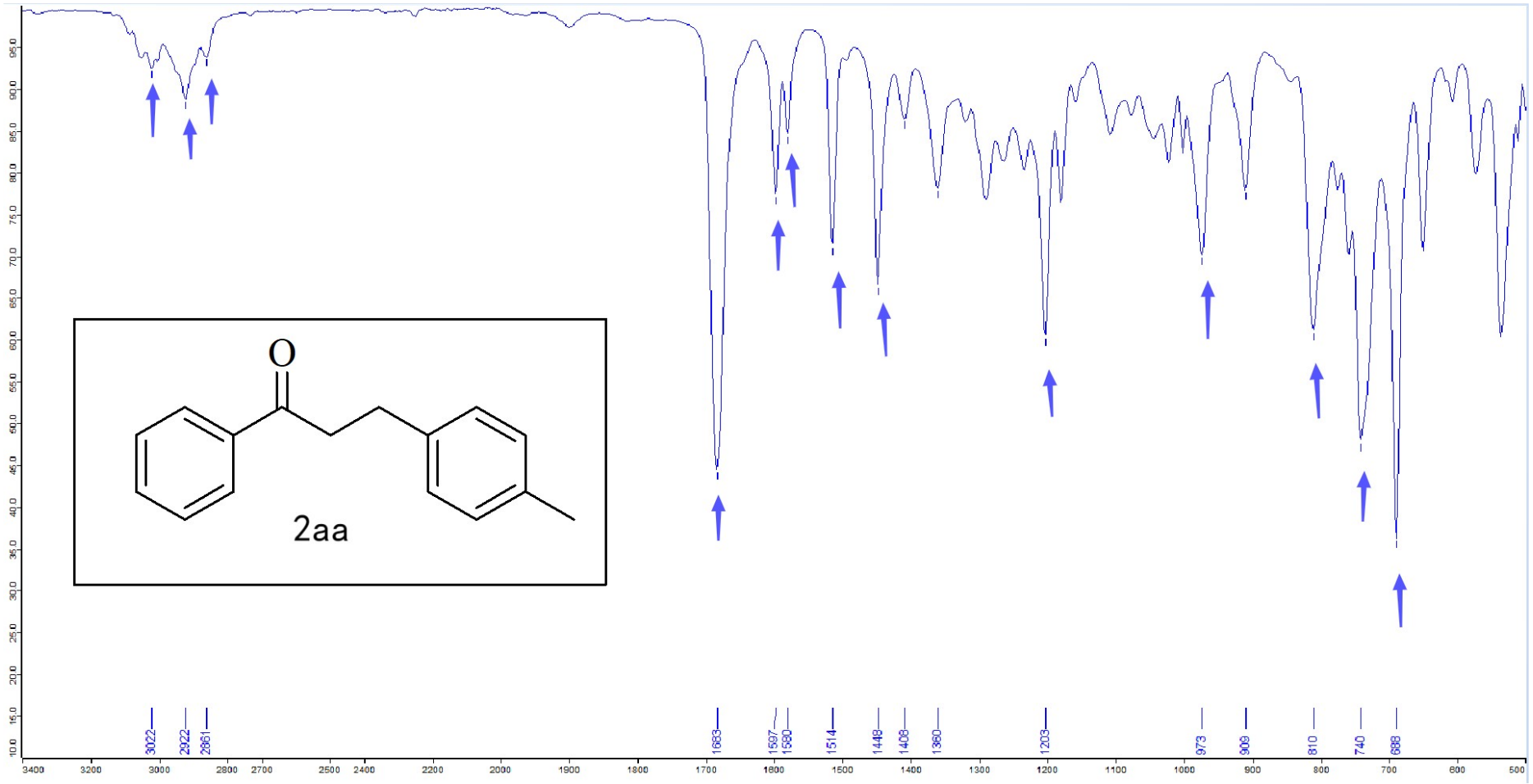
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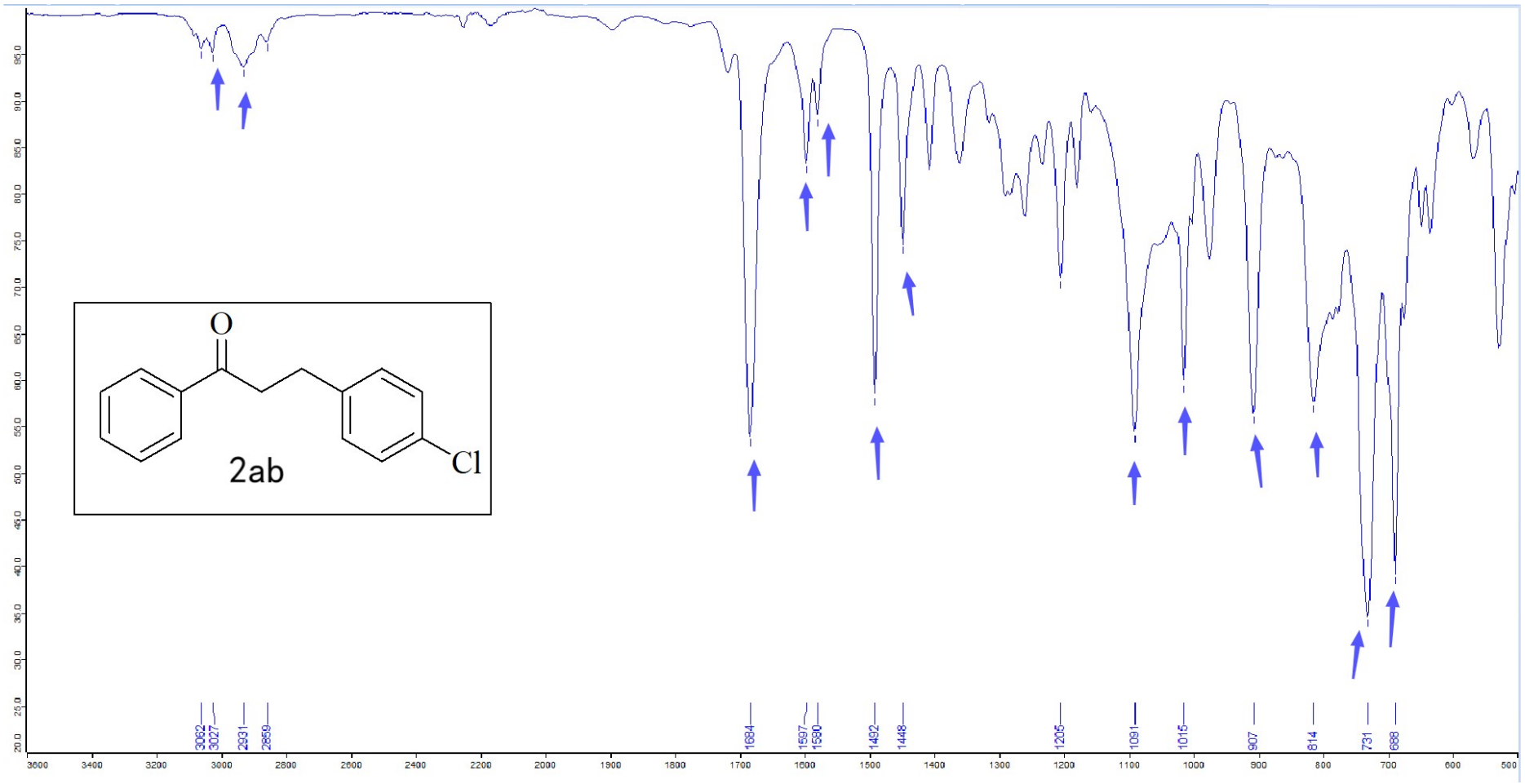
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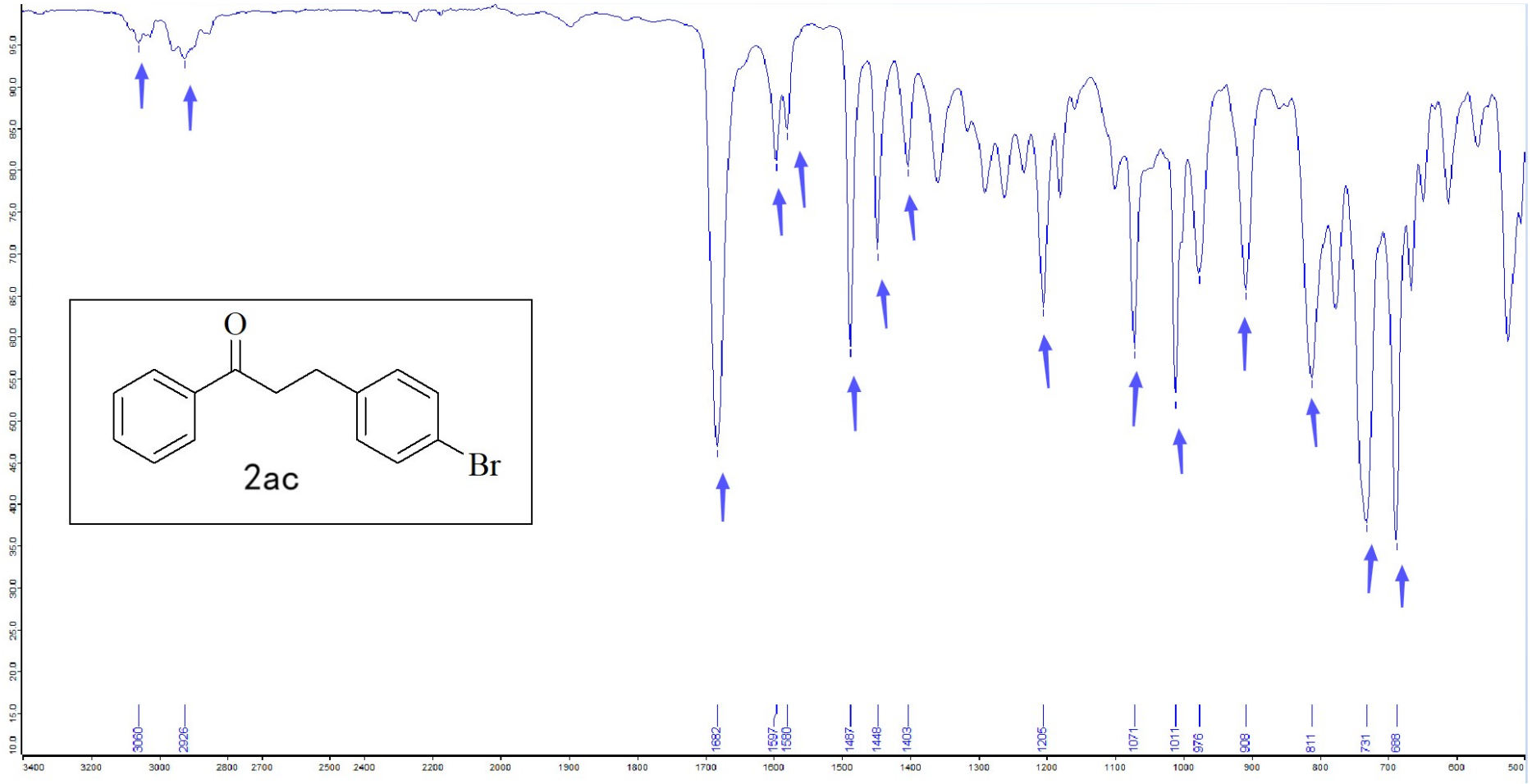
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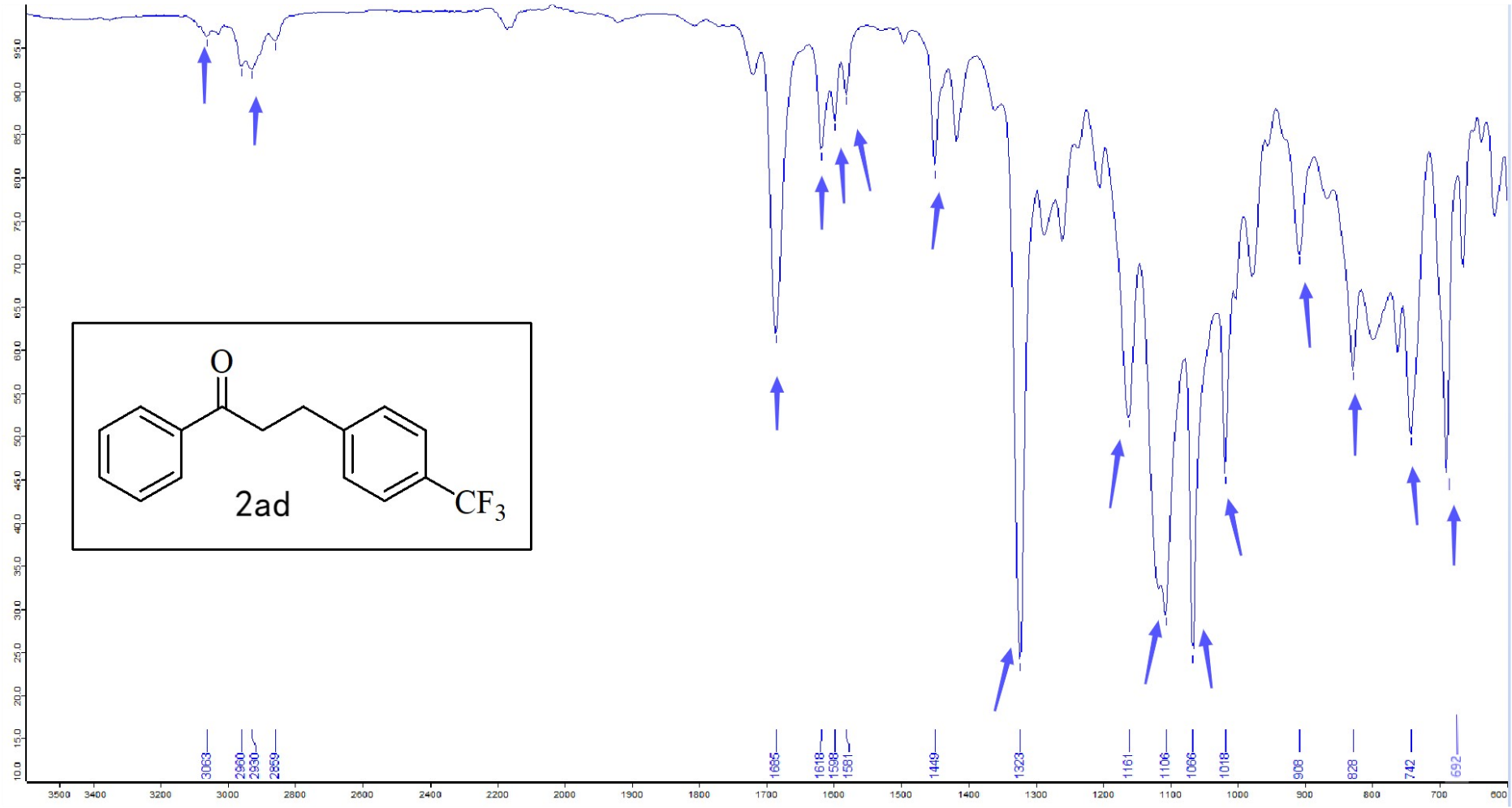
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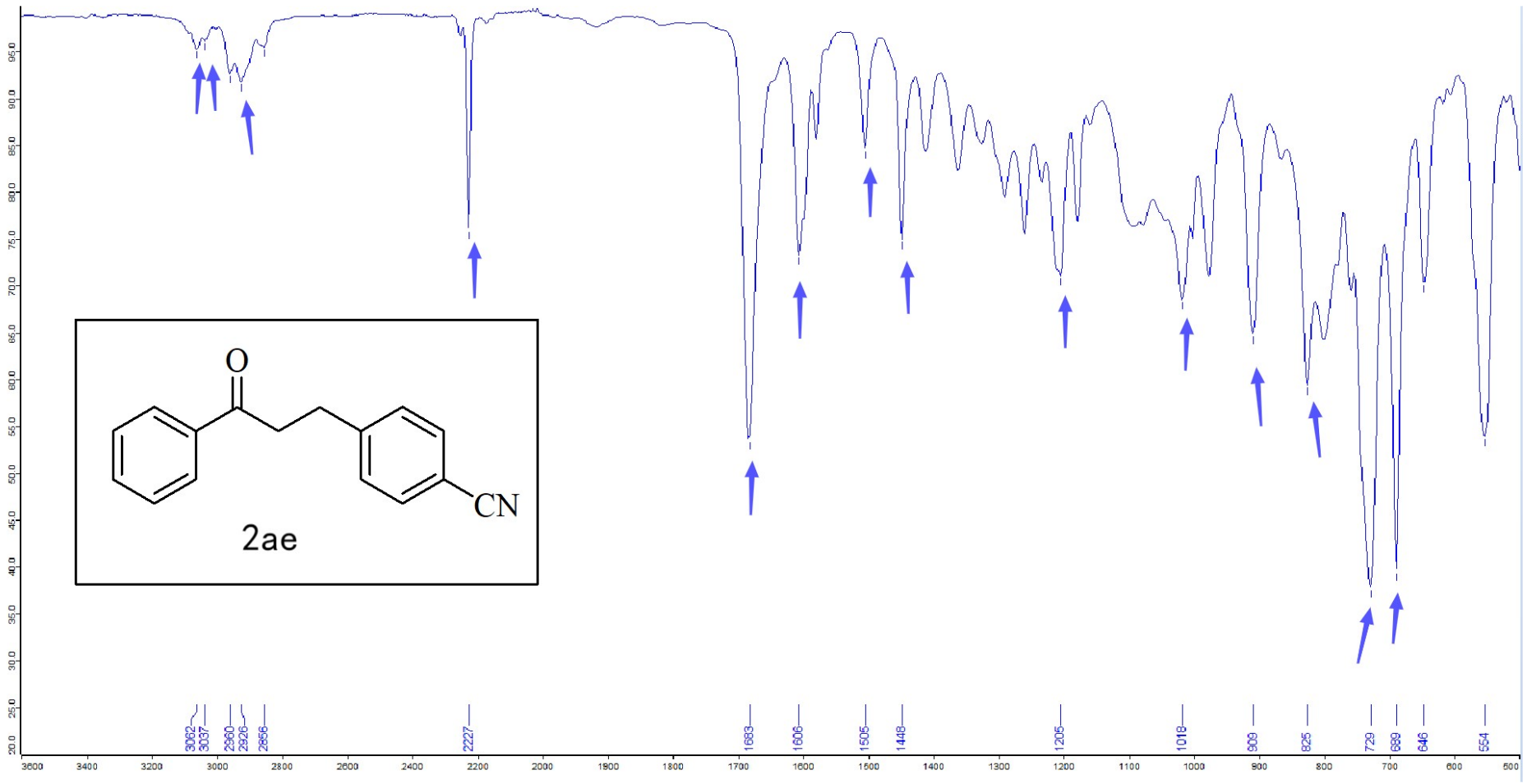
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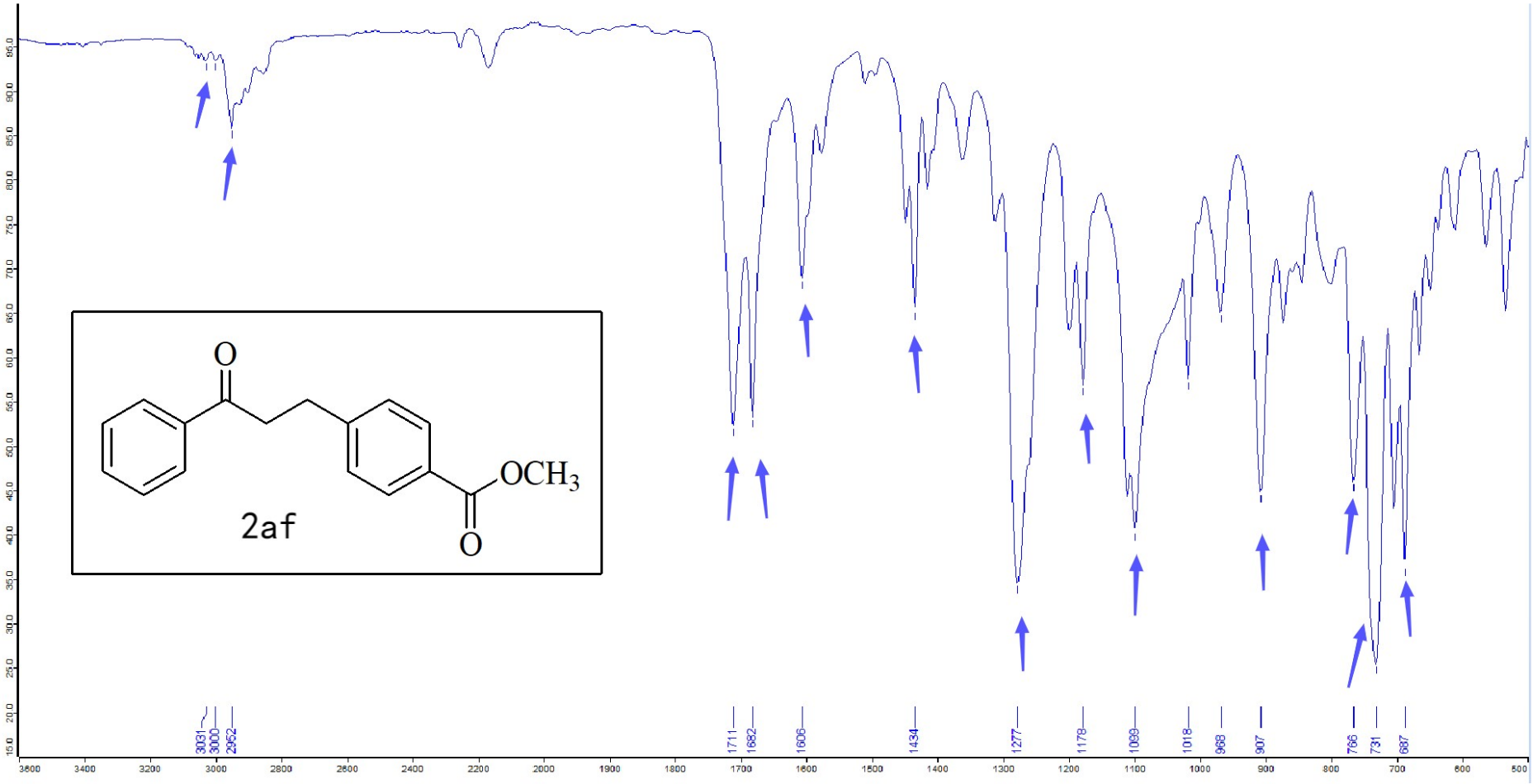
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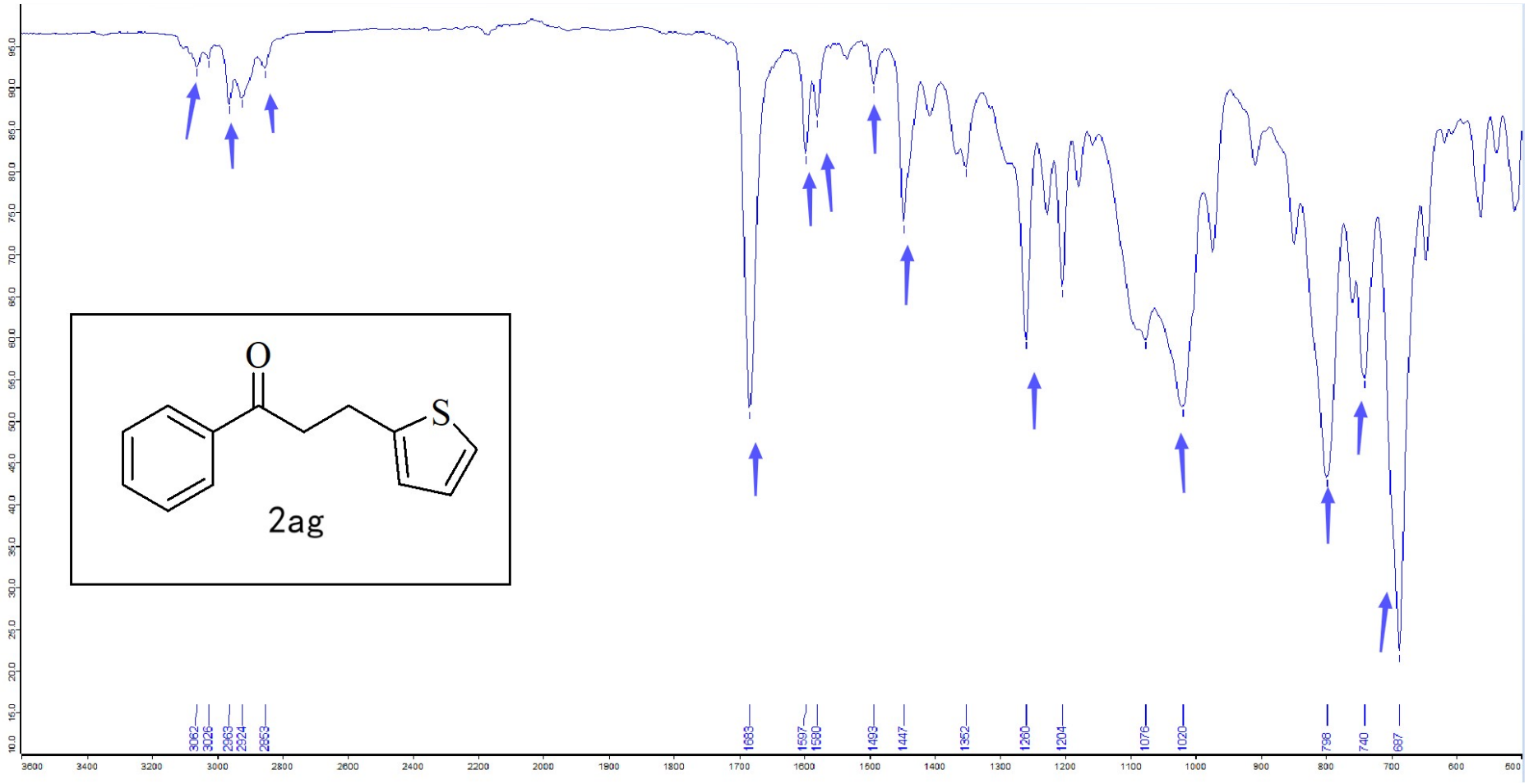
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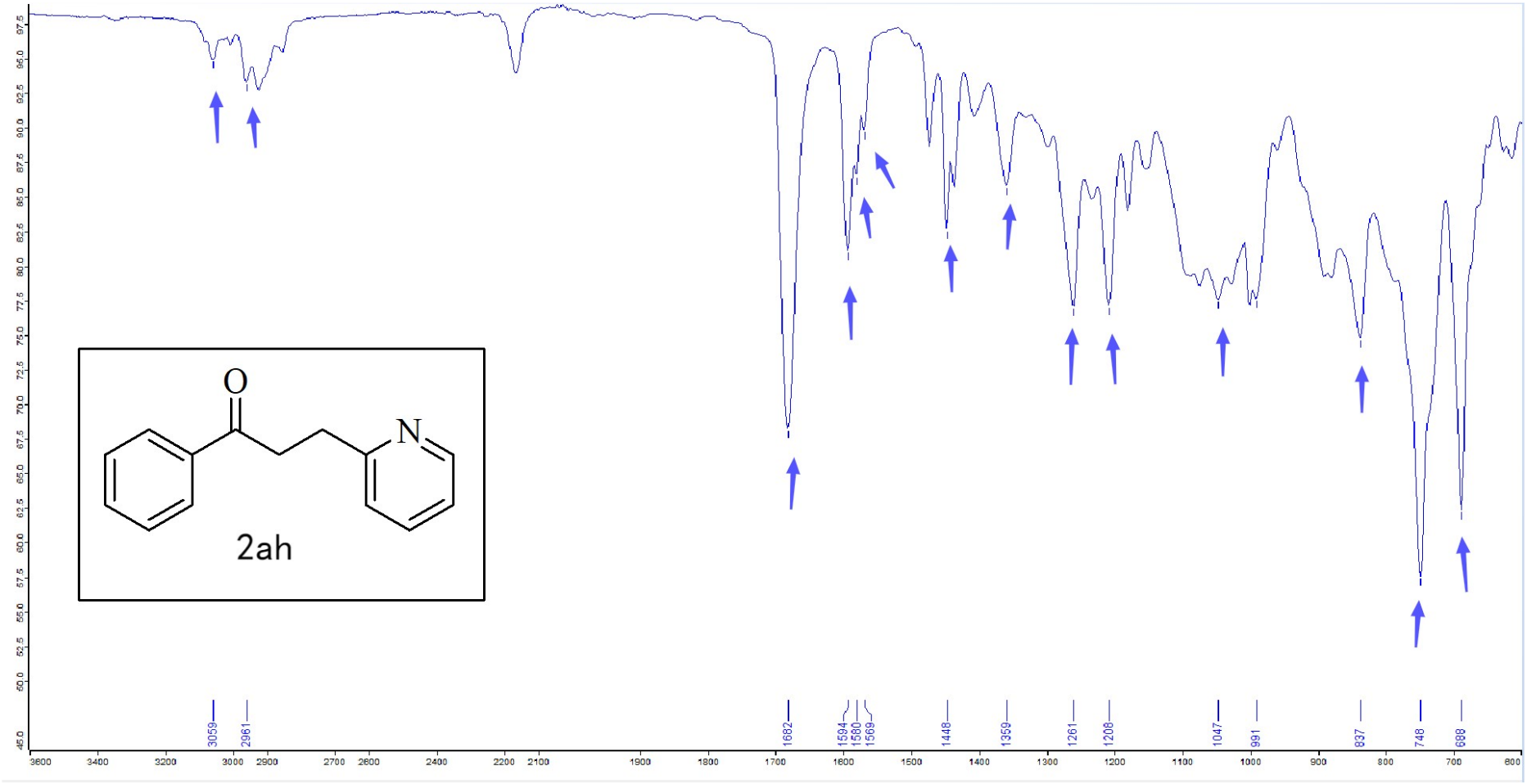
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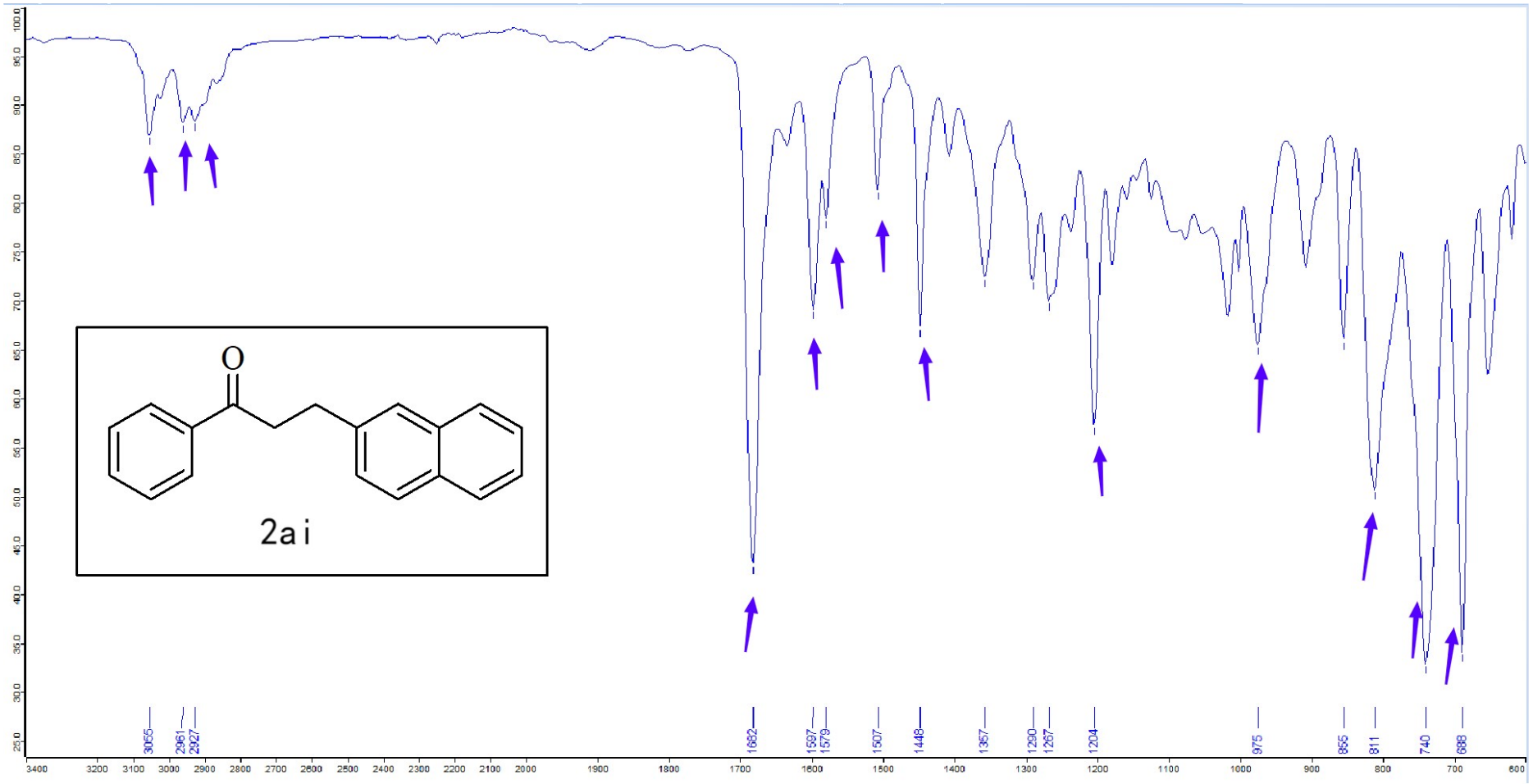
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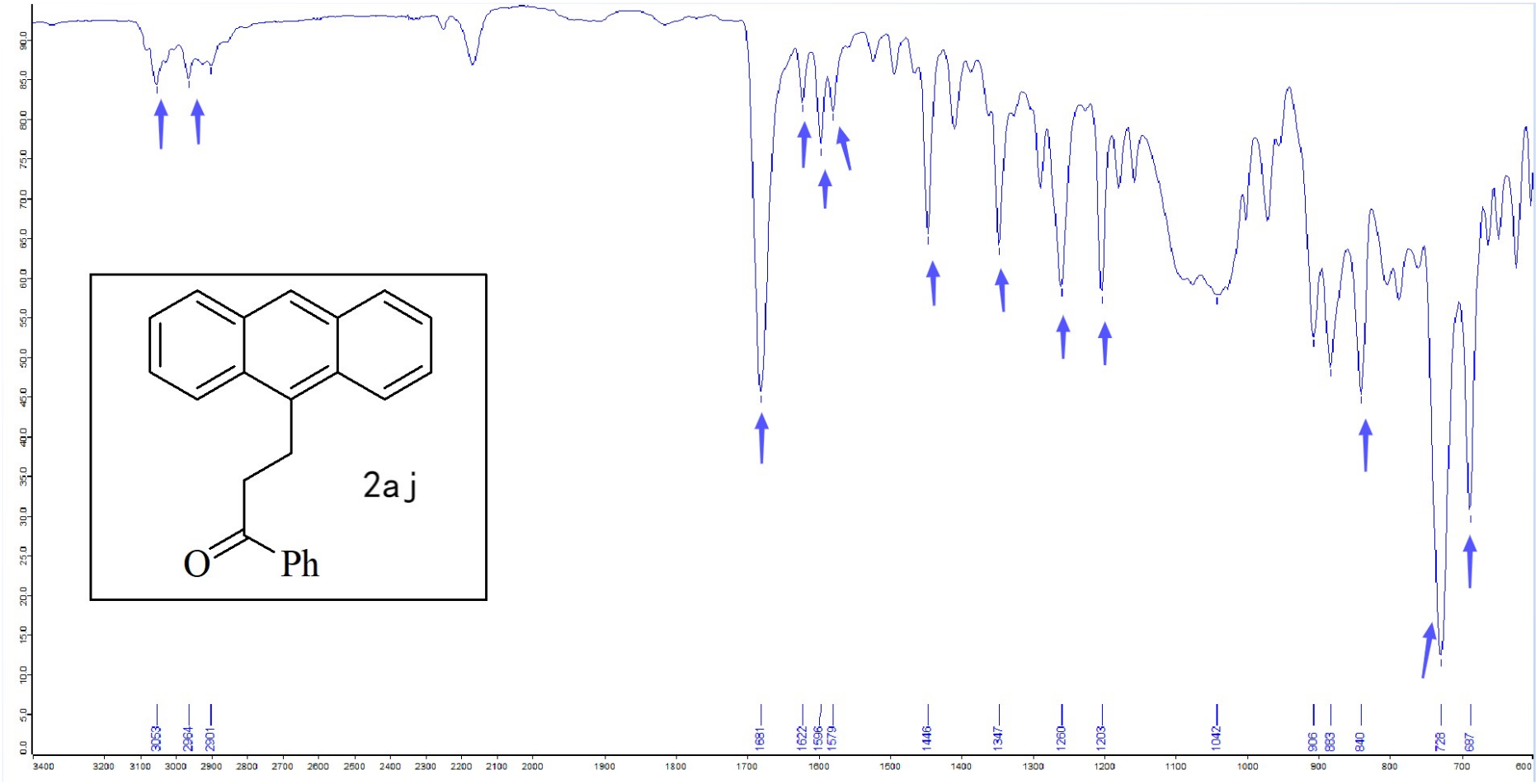
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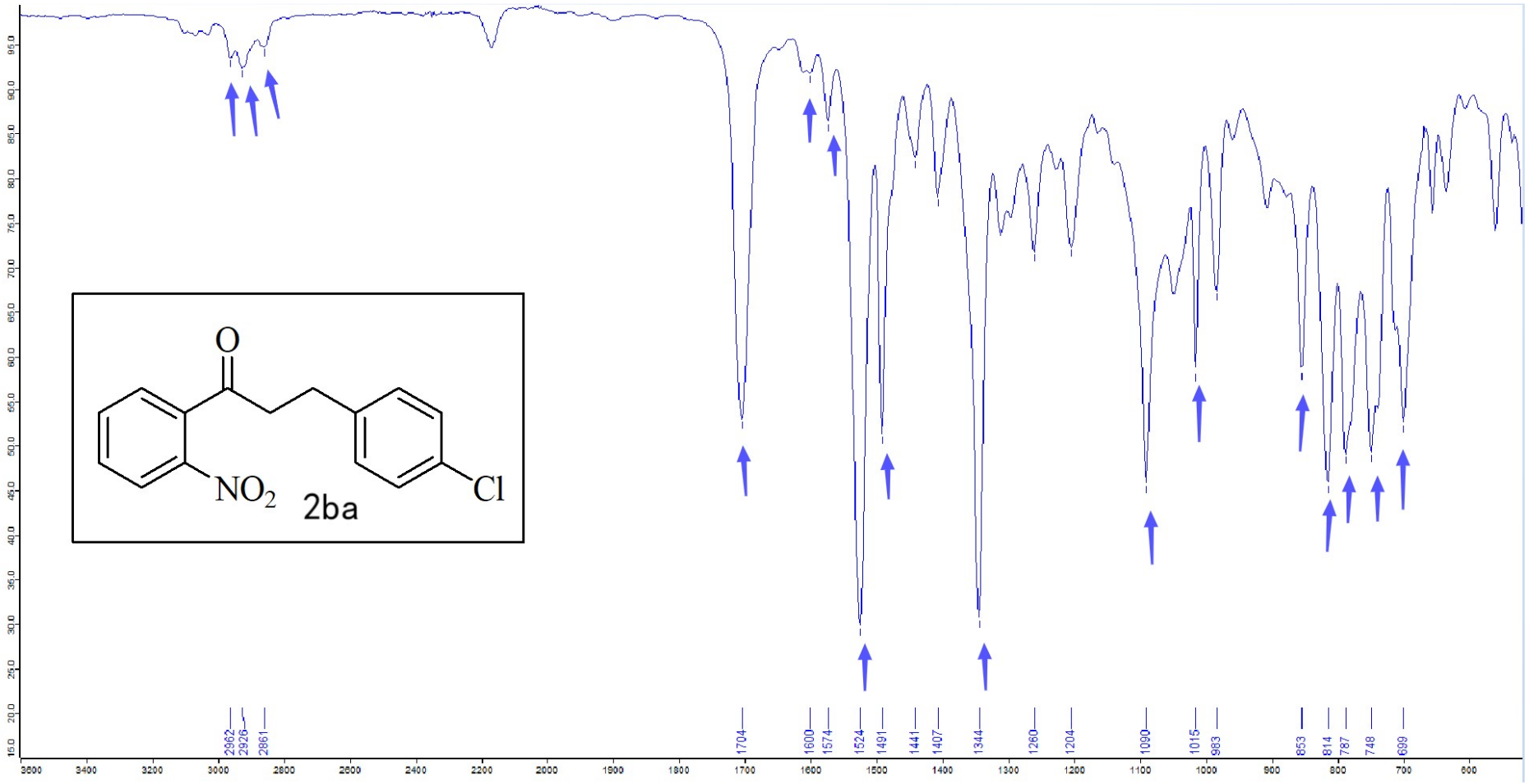
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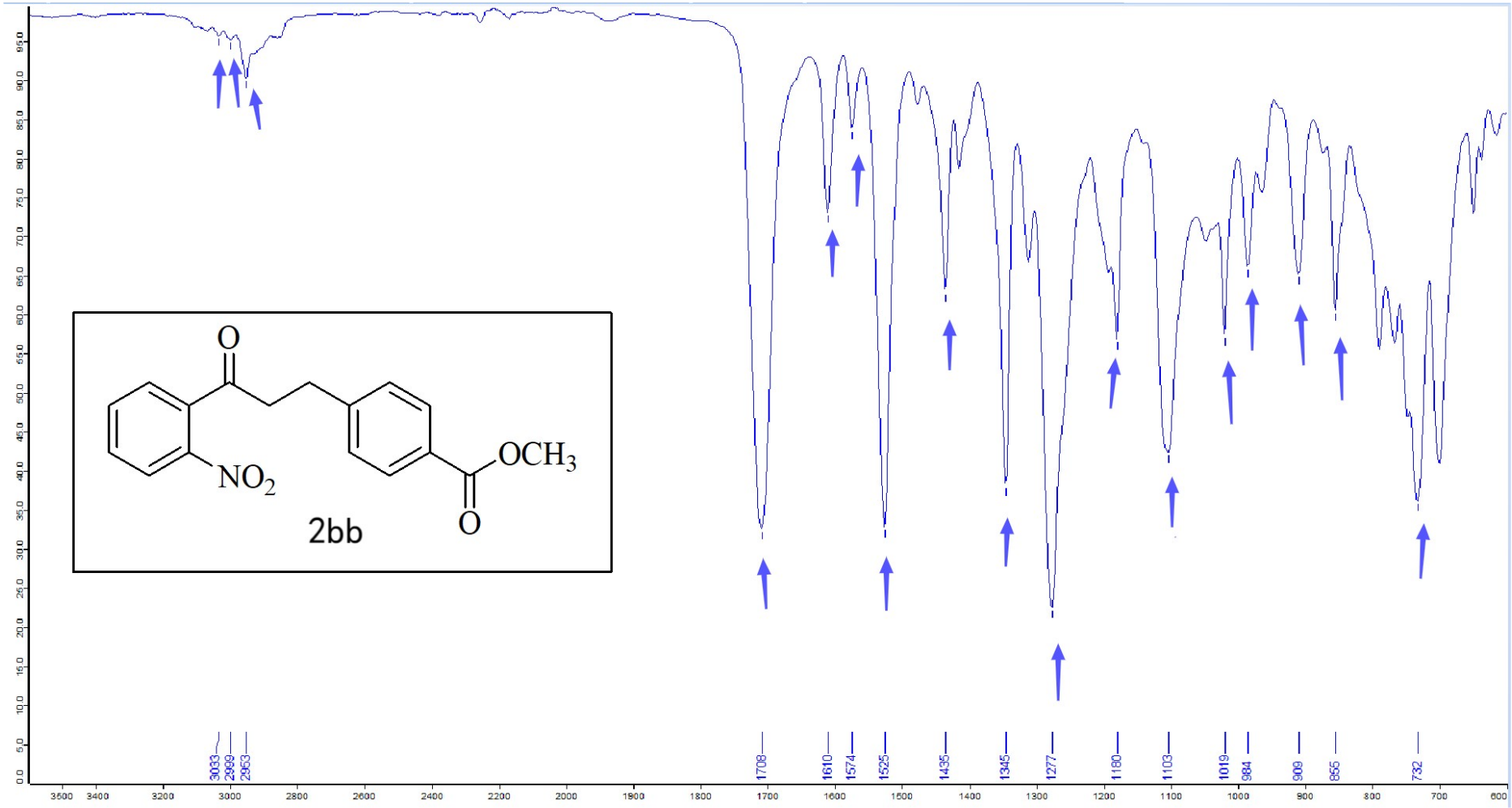
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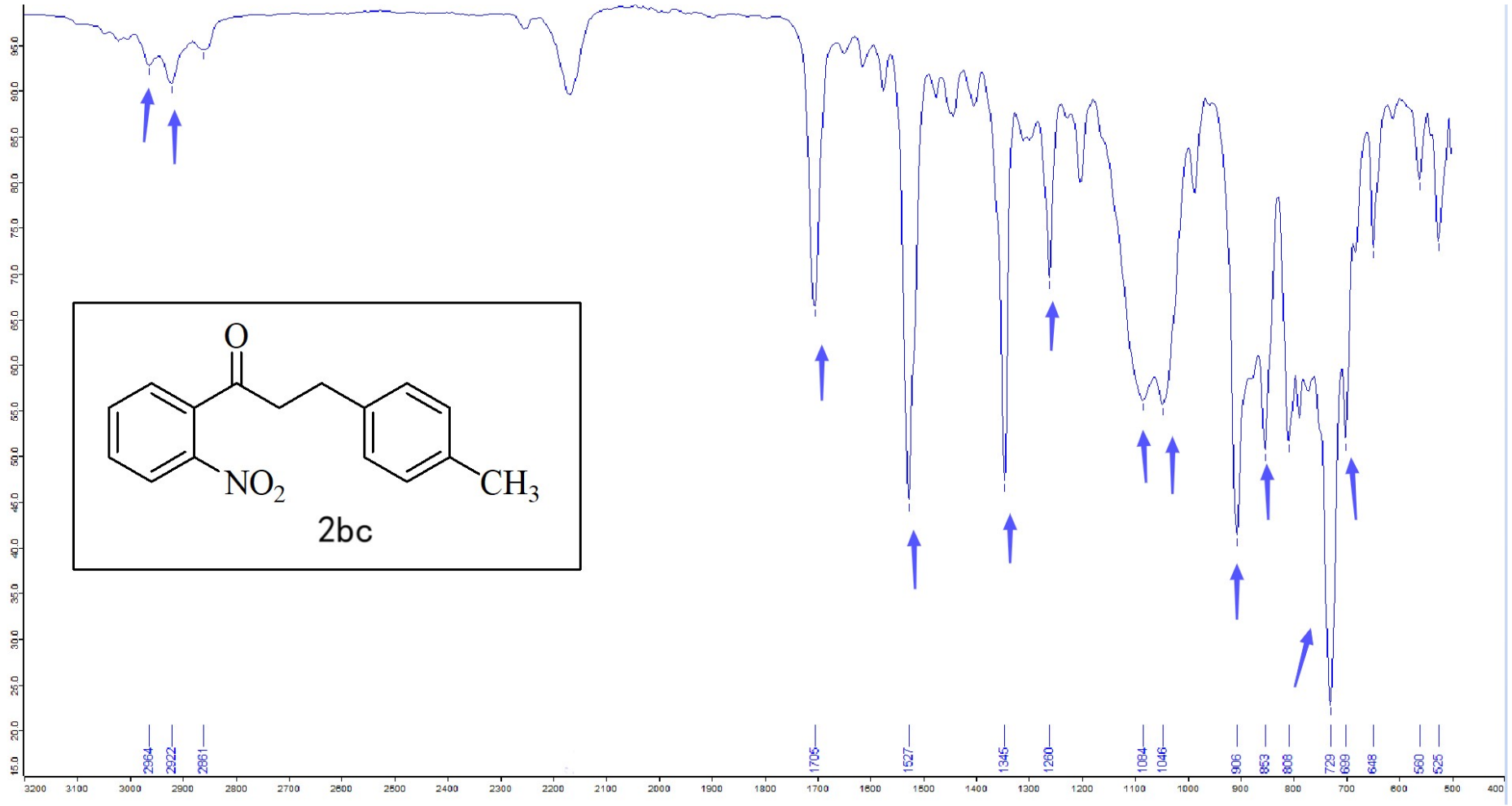
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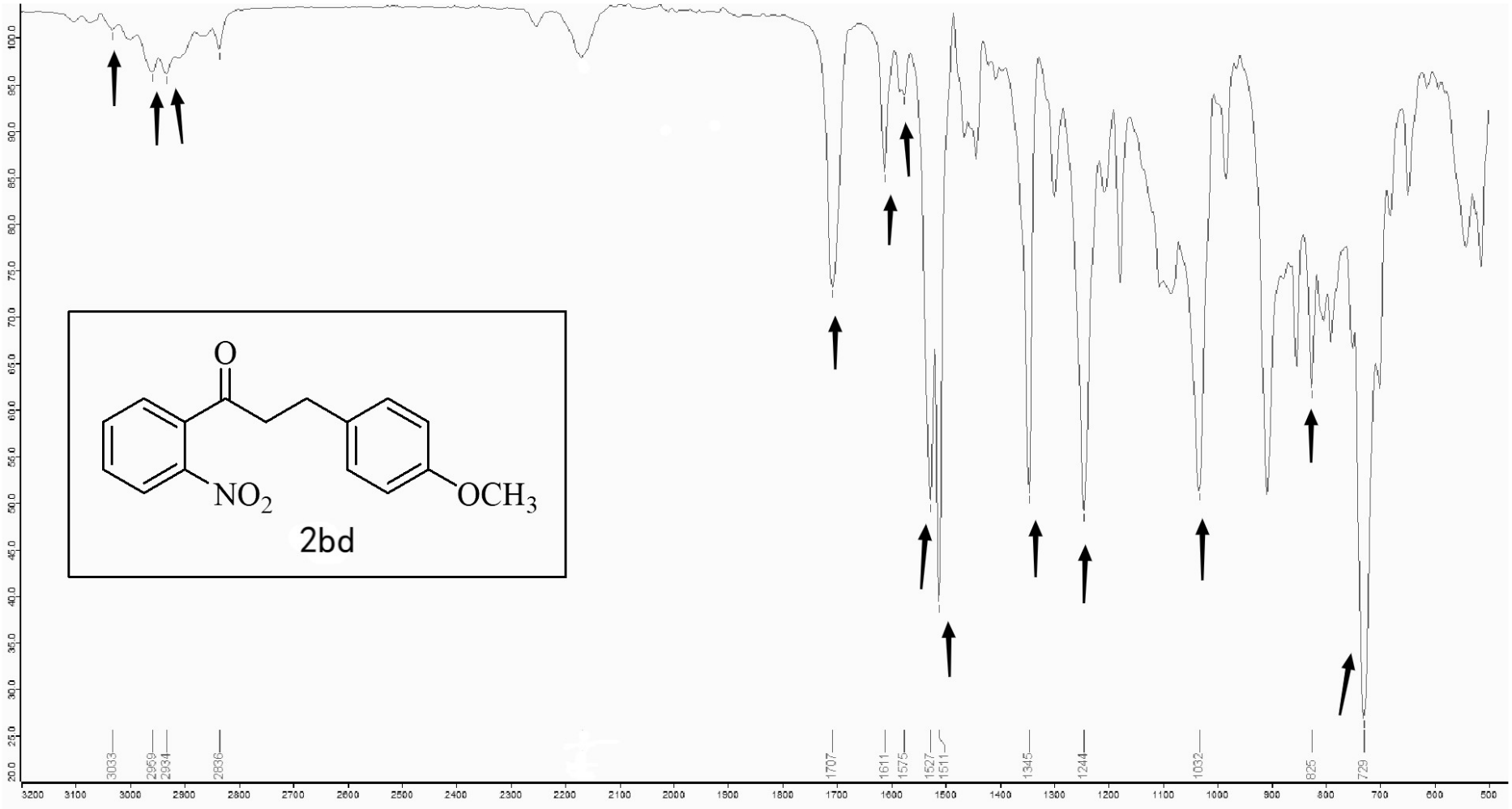
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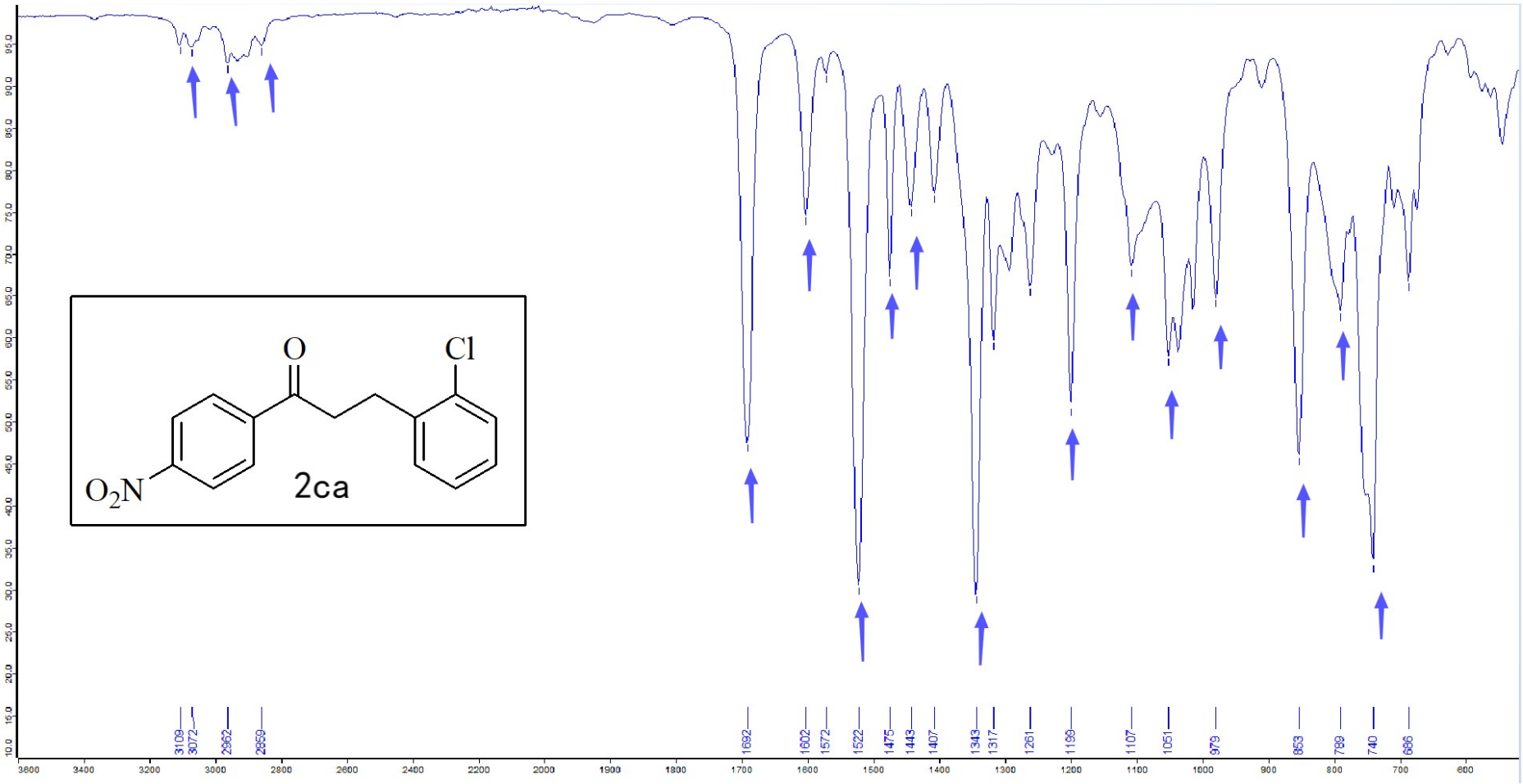
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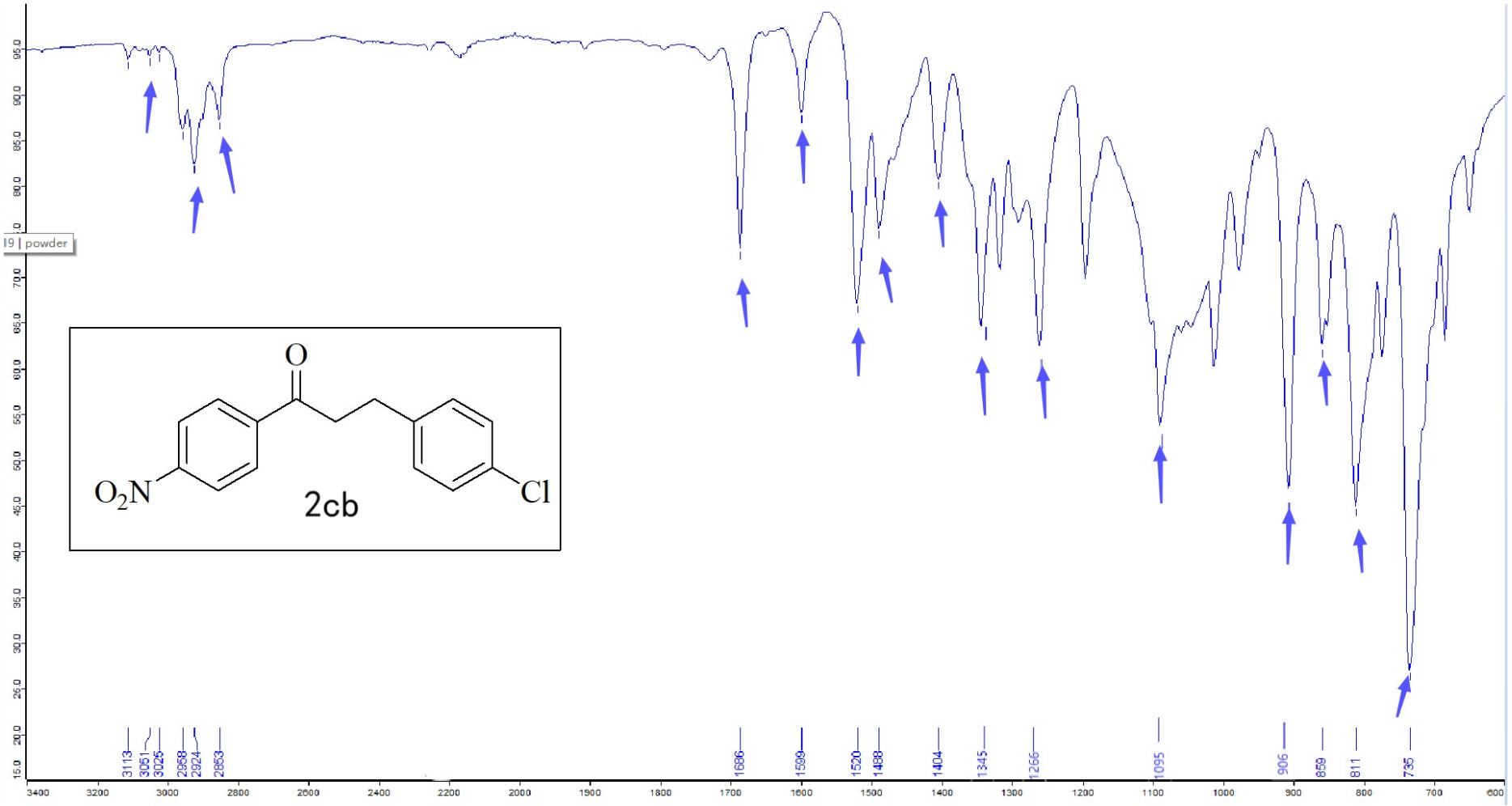
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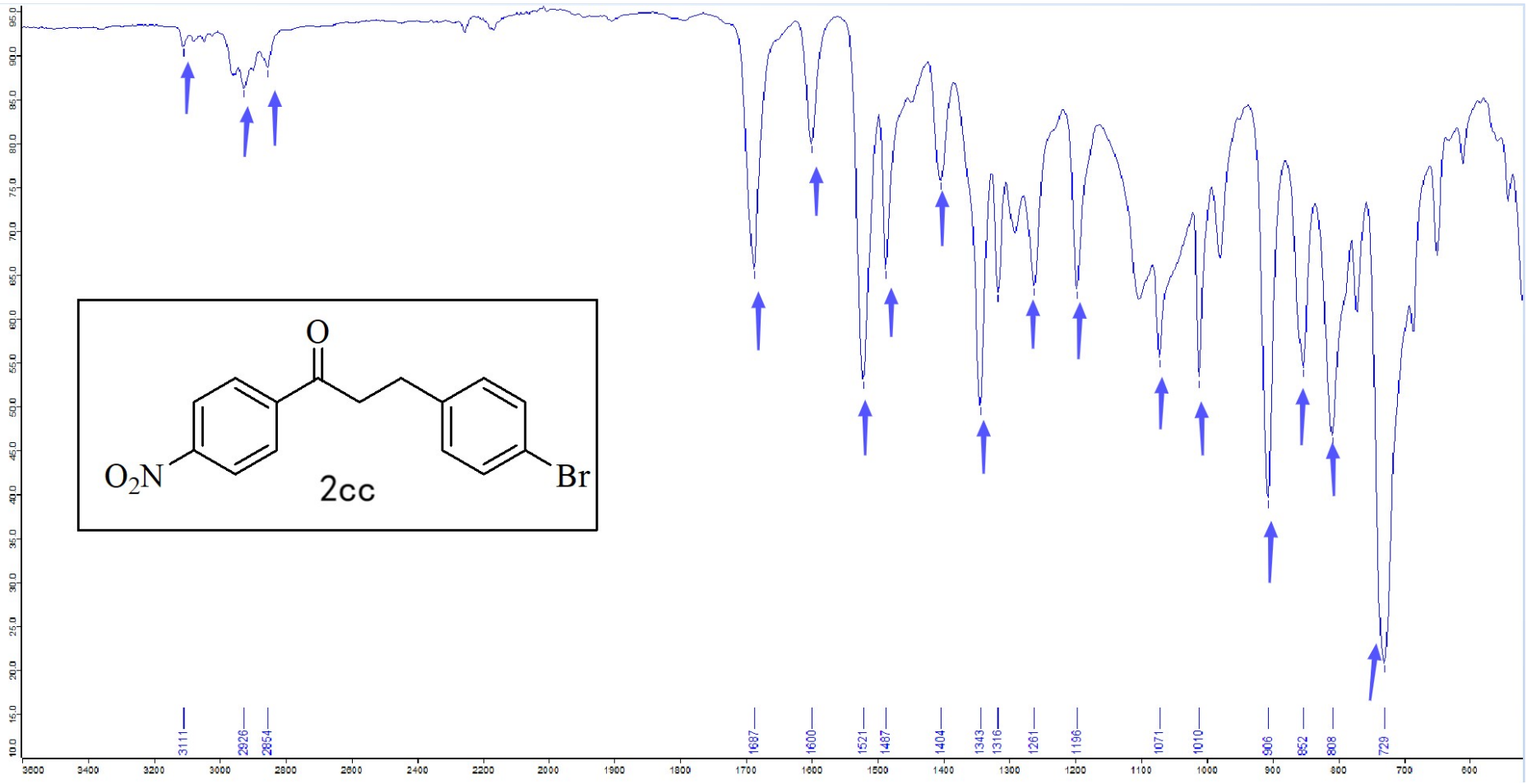
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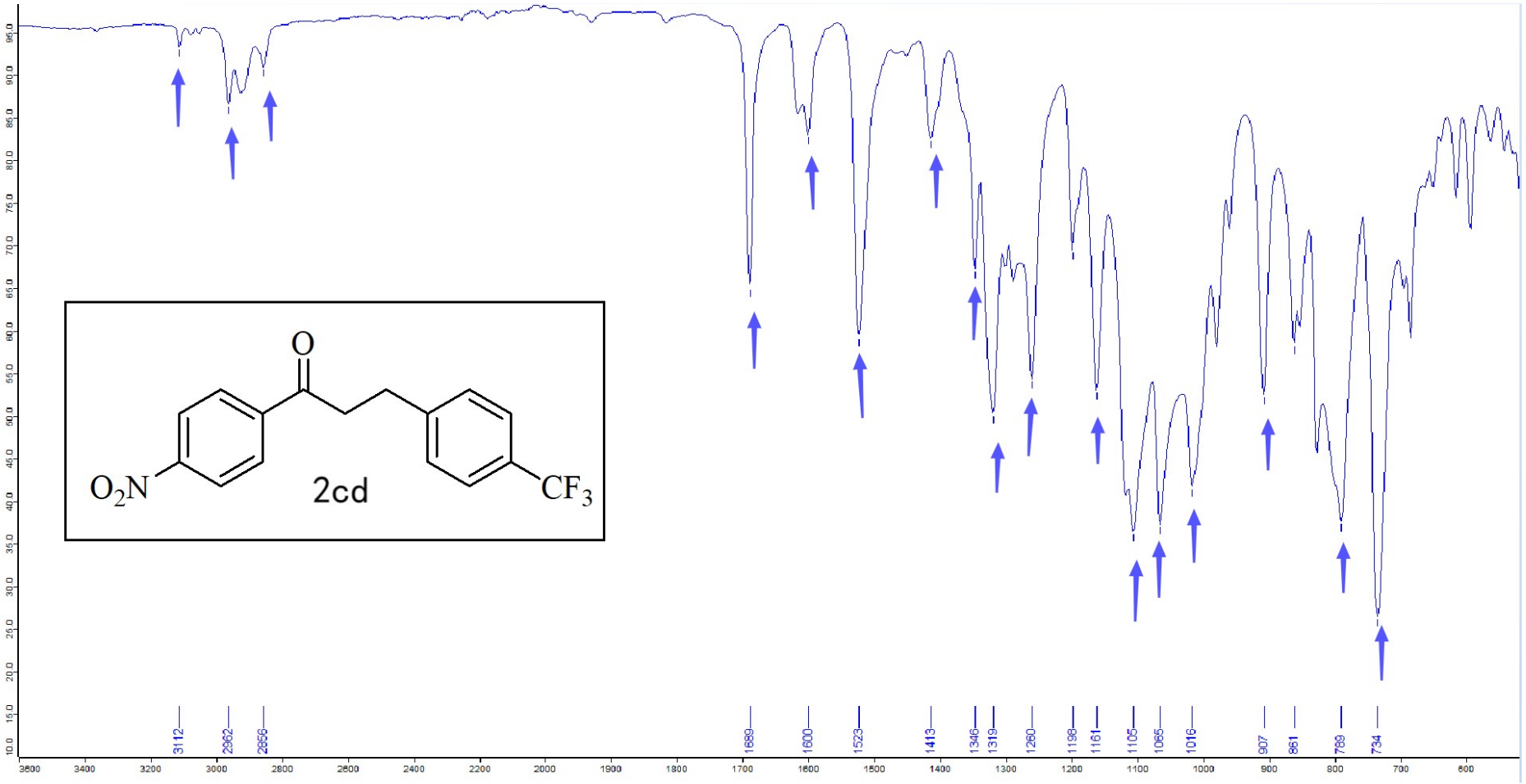
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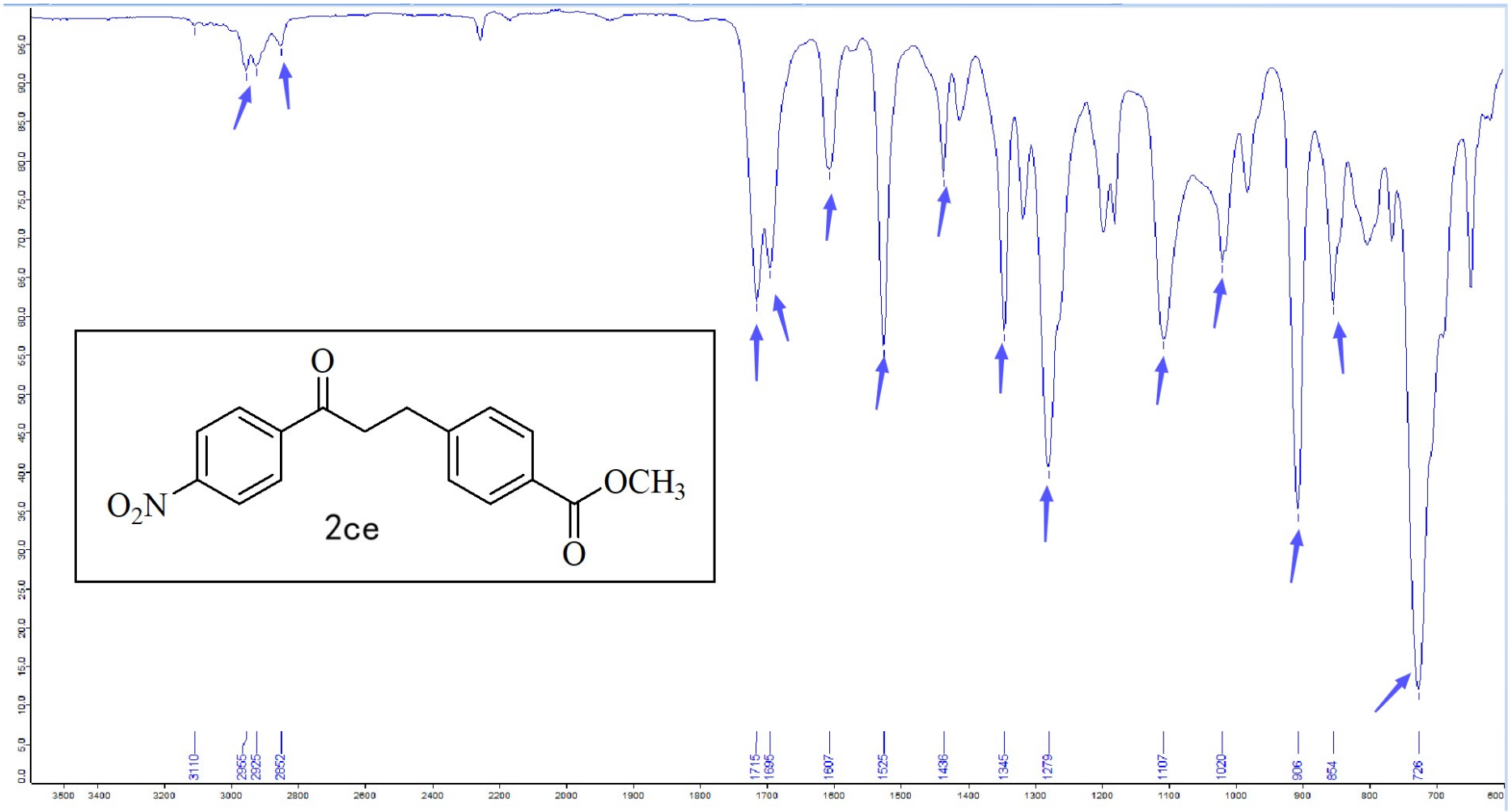
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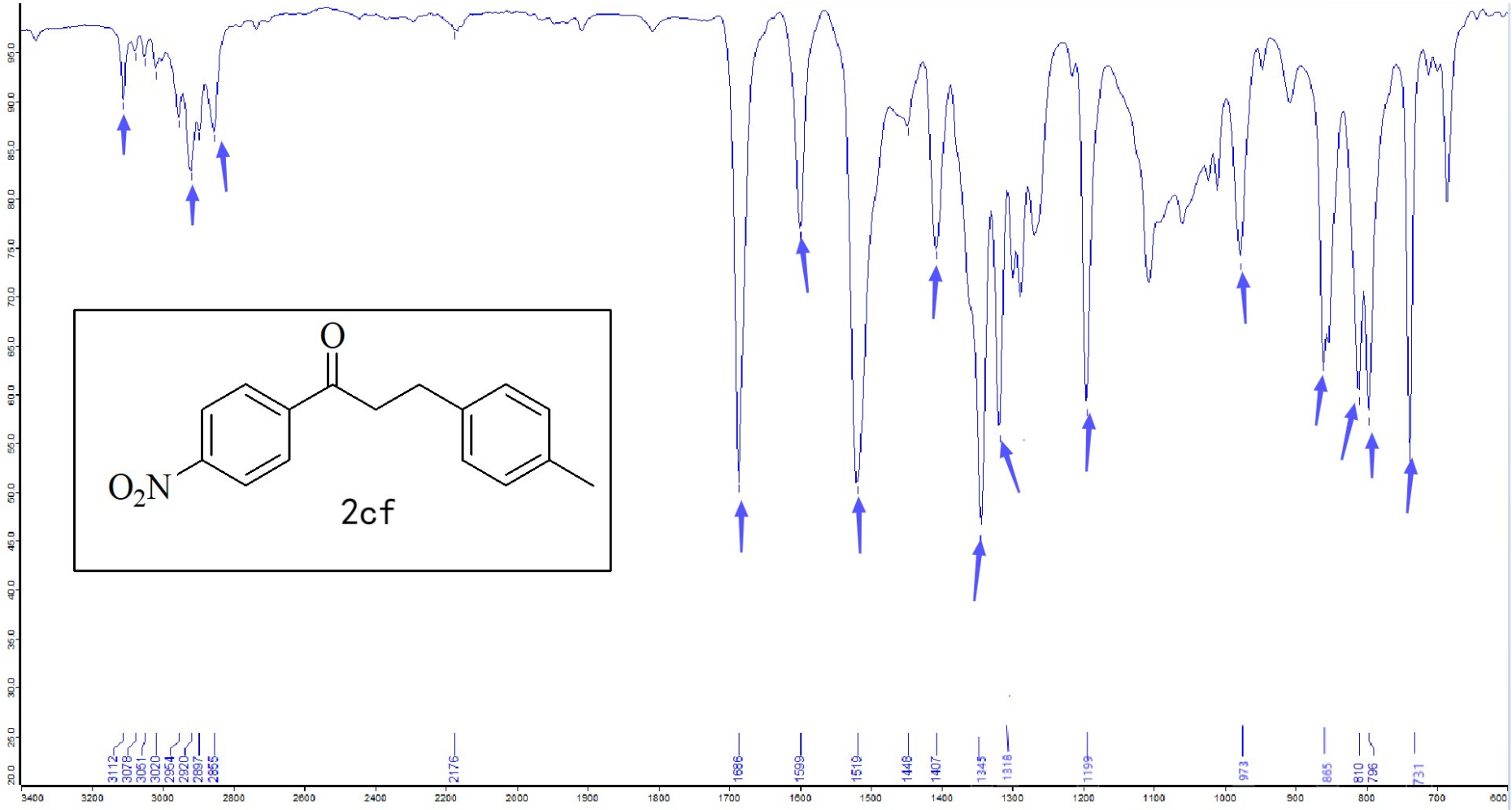
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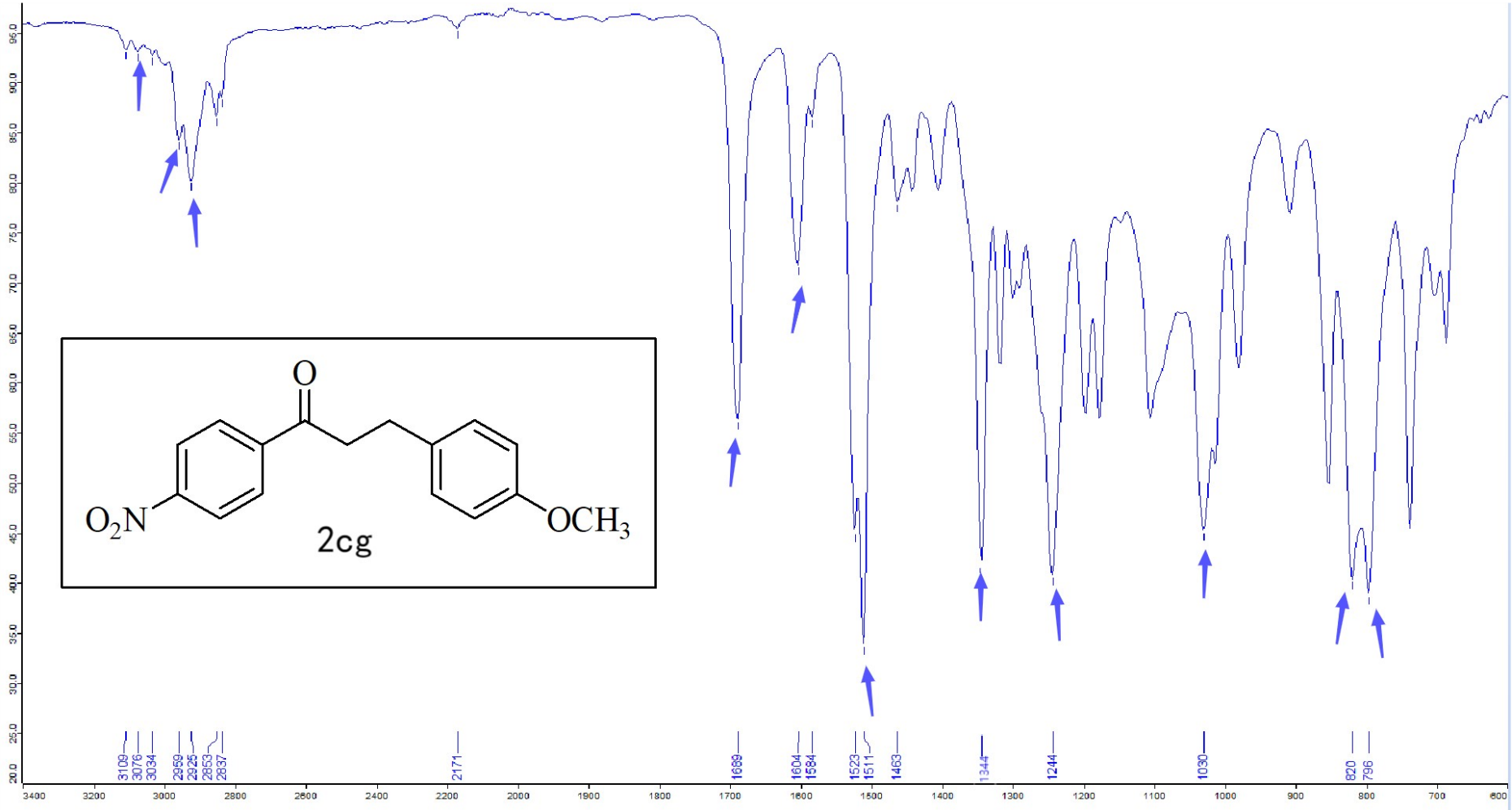
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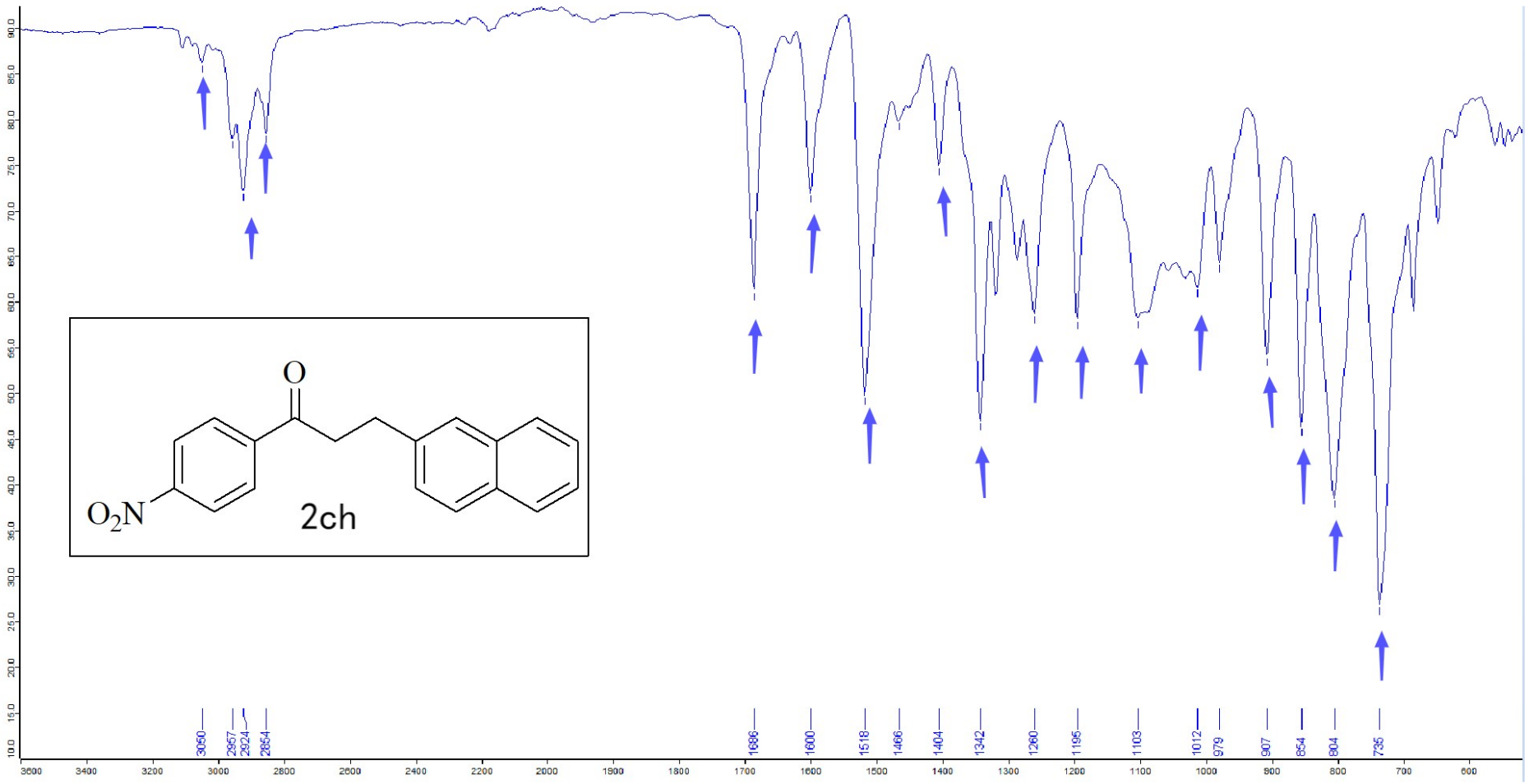
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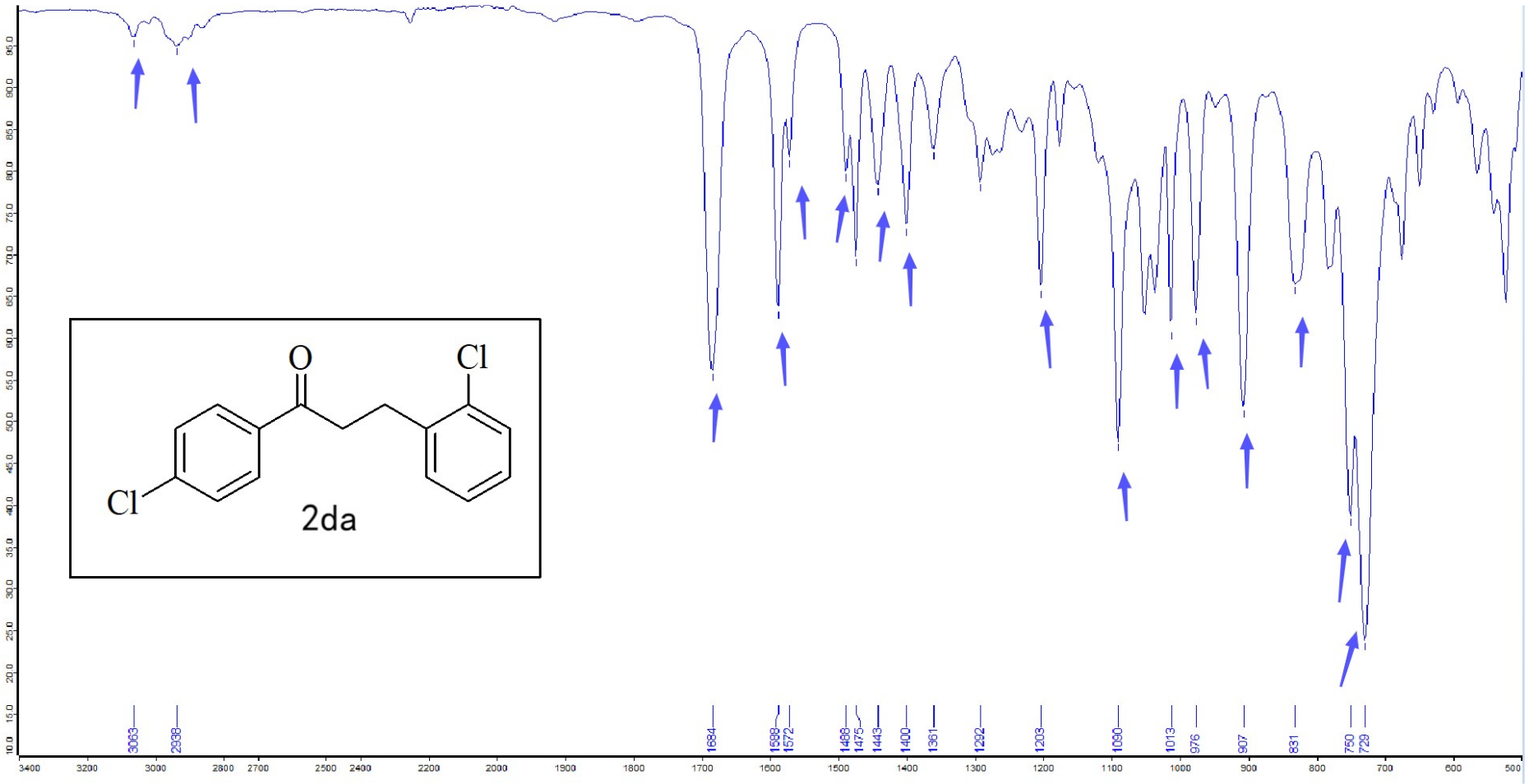
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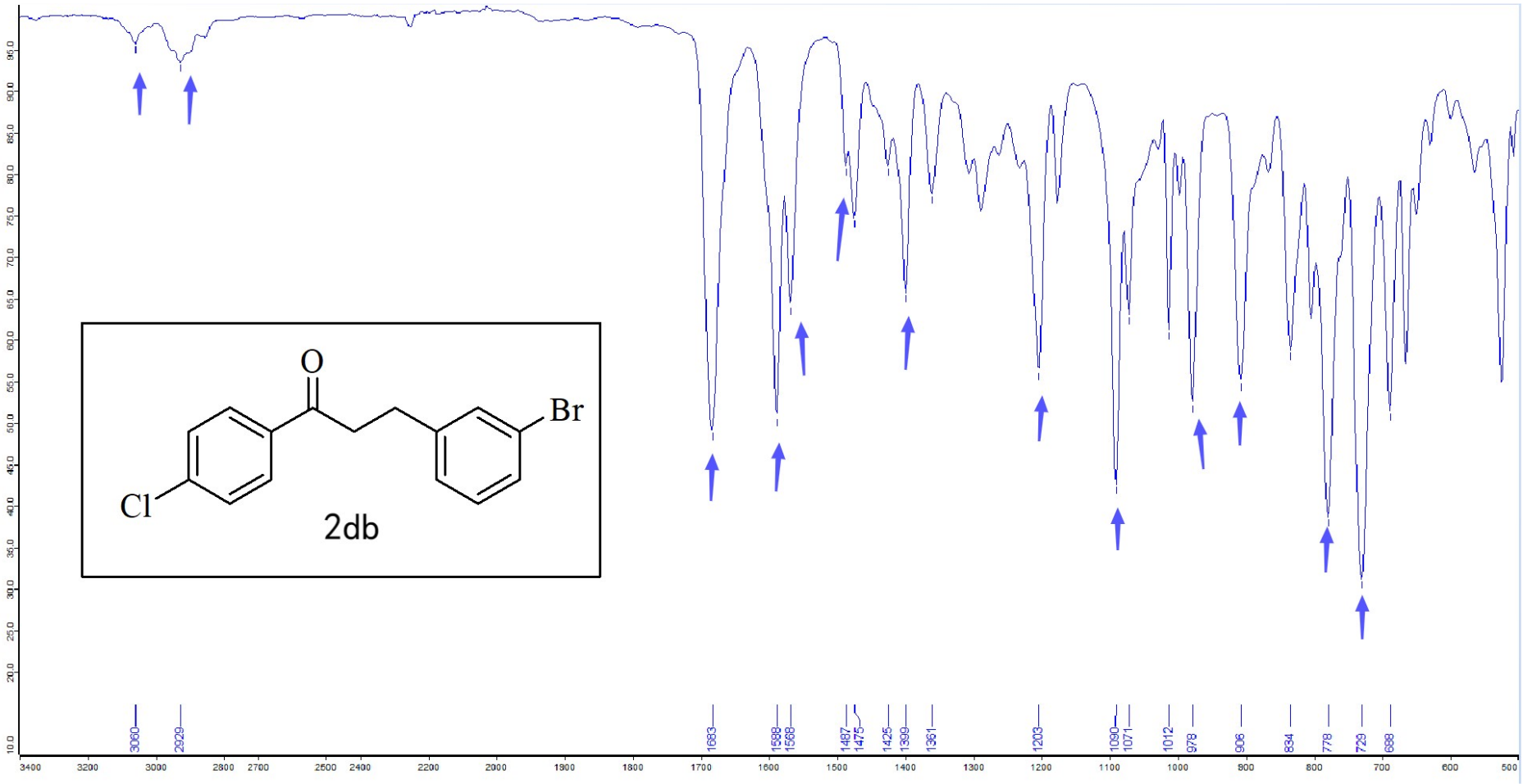
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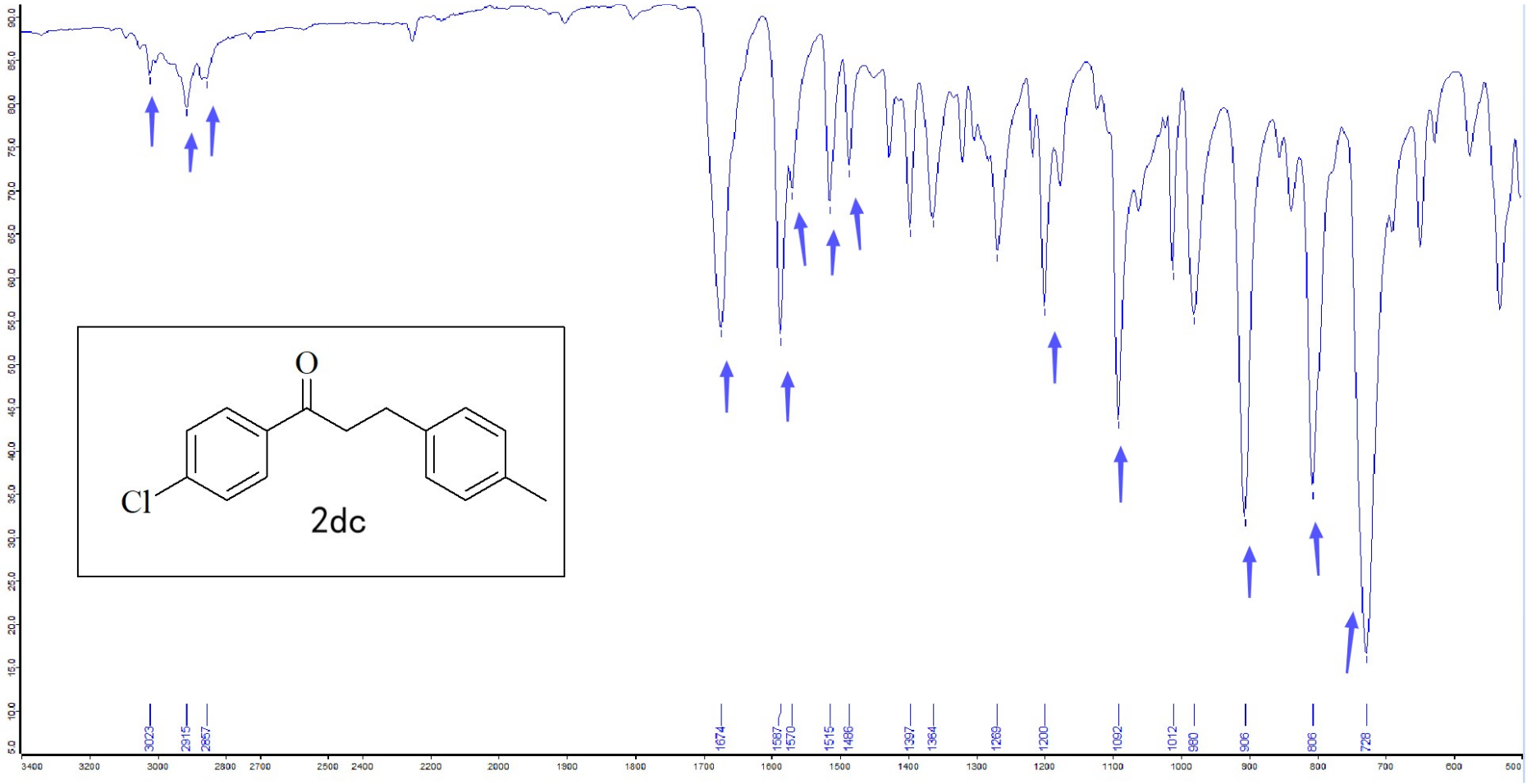
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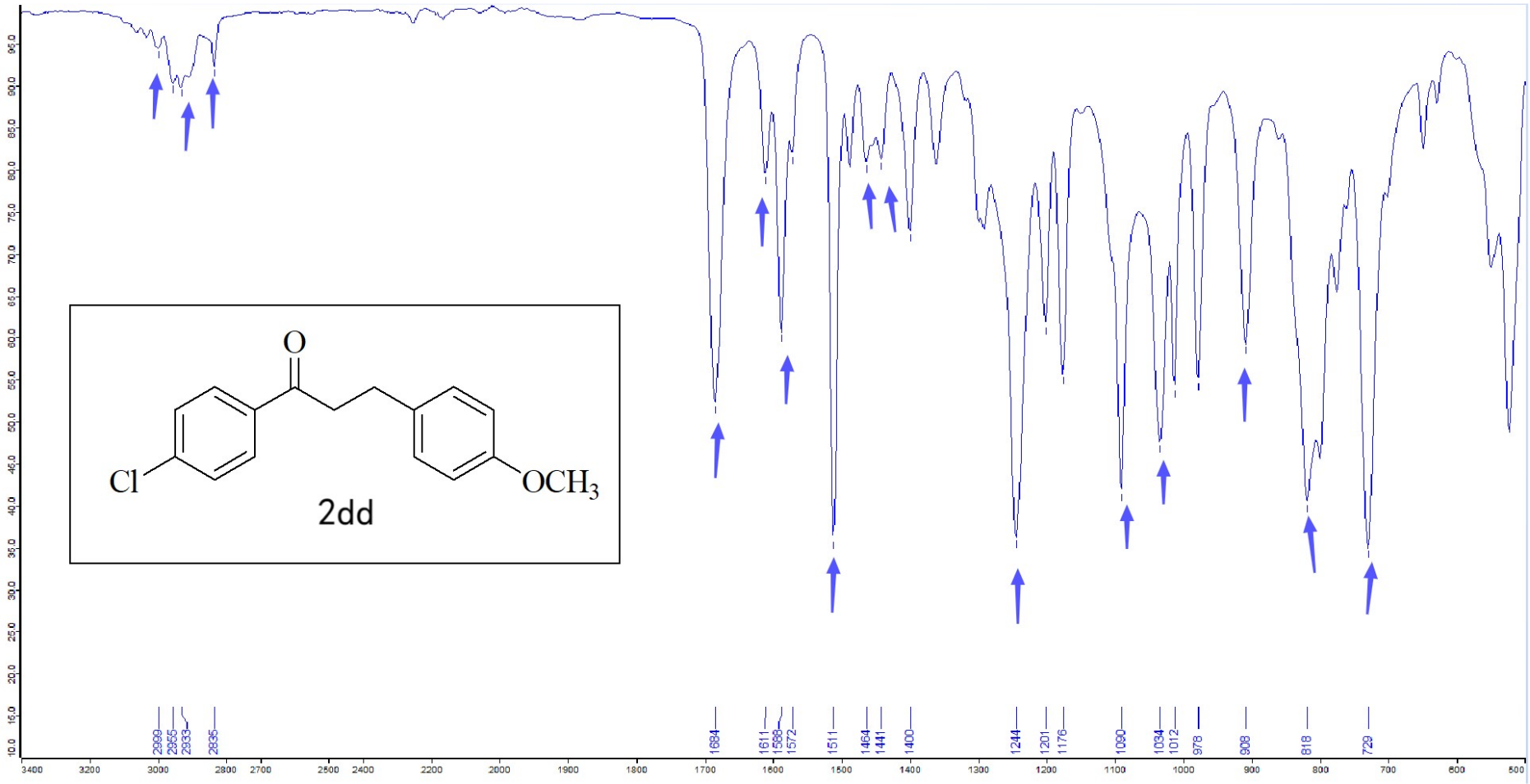
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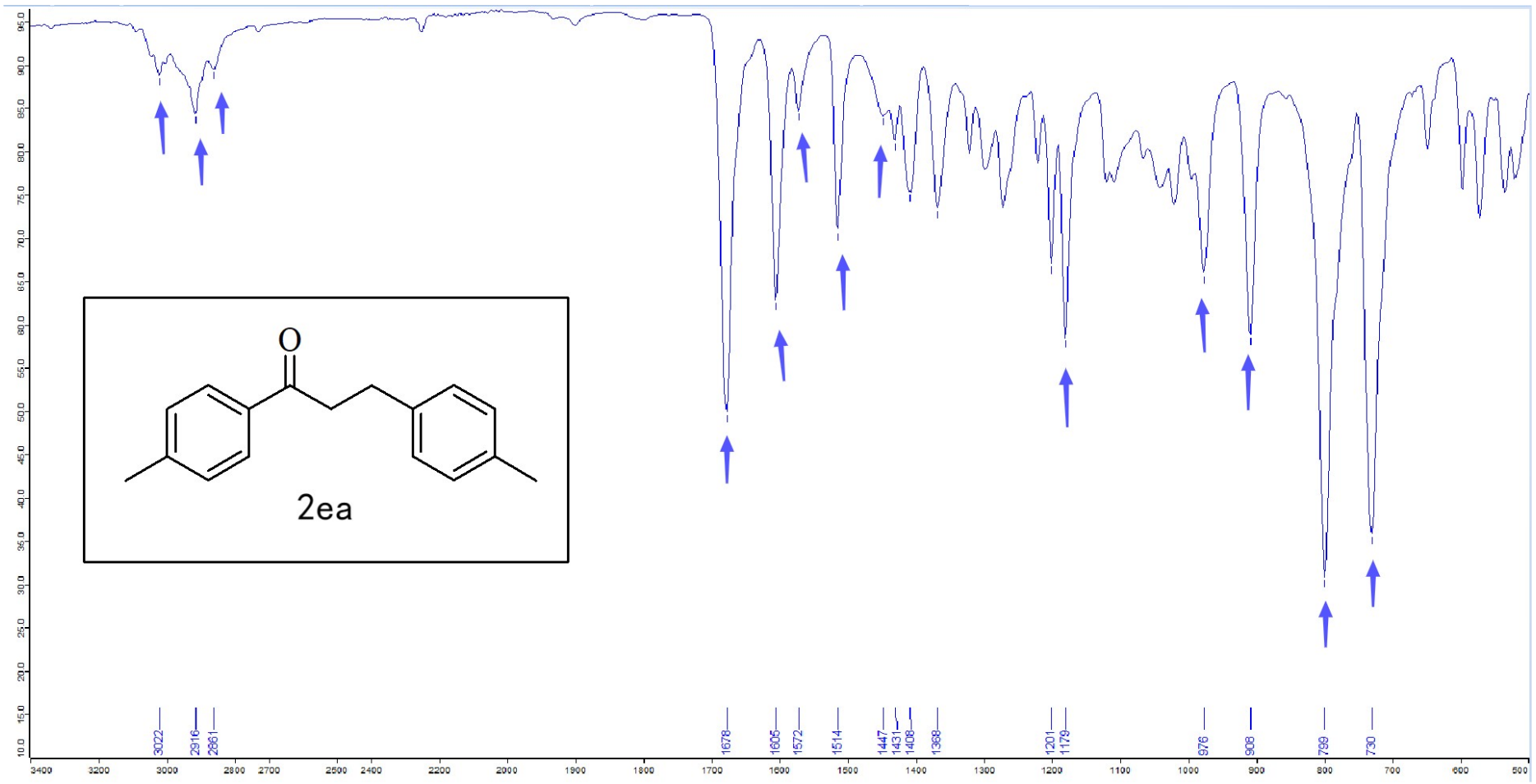
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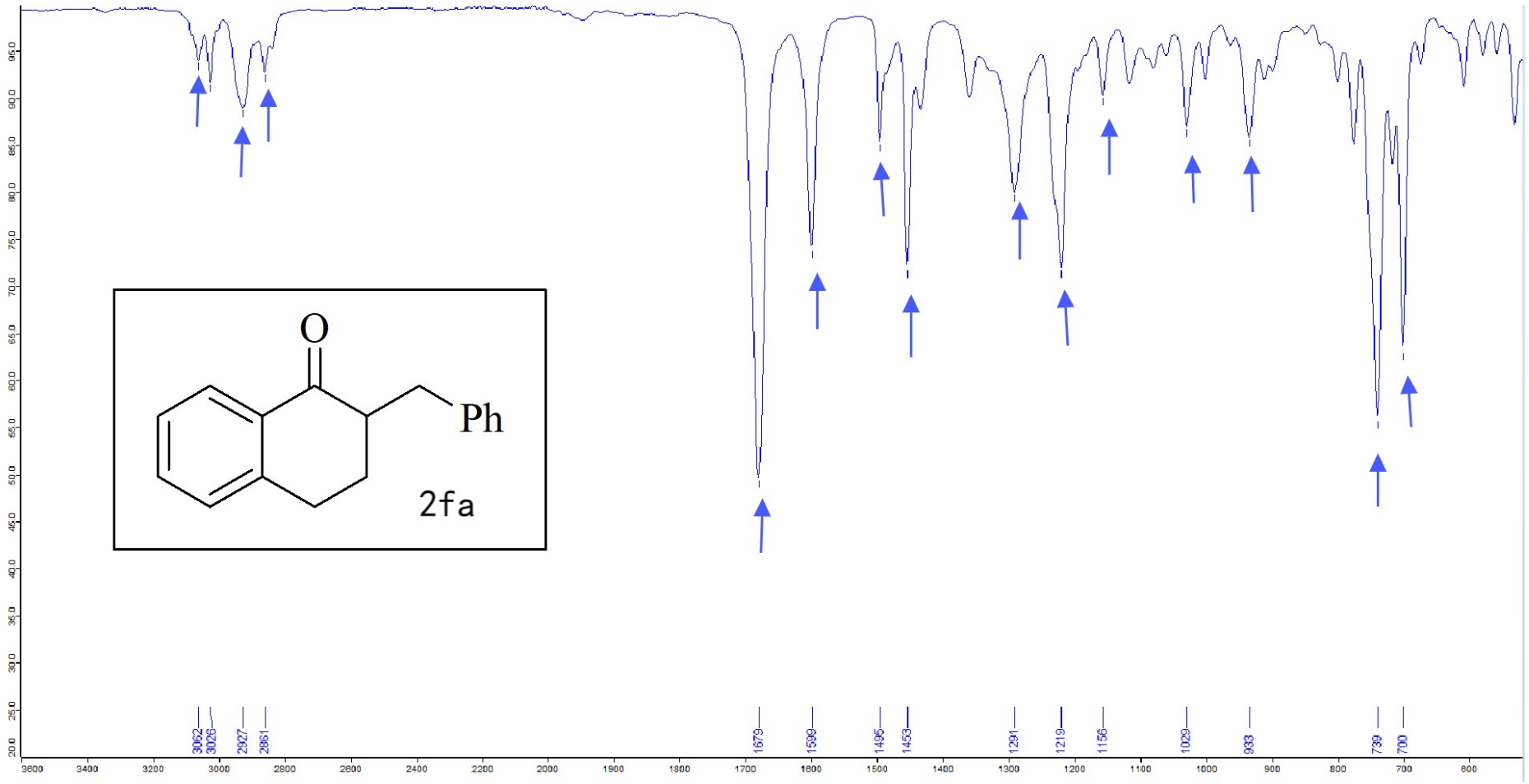
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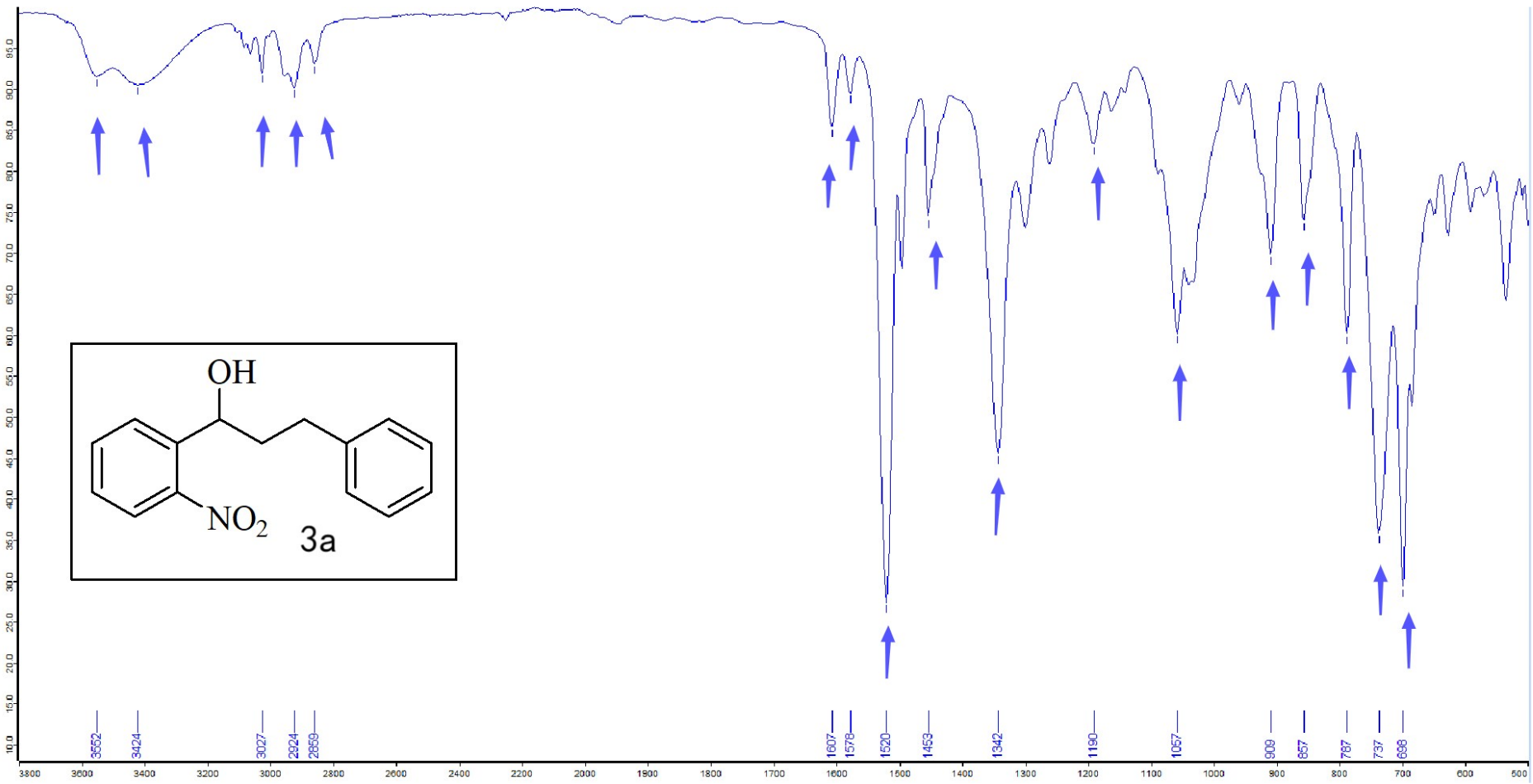
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