Iodine-mediated 1,2-aryl migration of primary benzhydryl amines

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CONTENTS:

1. General Information. ^{1}H and ^{13}C NMR spectra were recorded on a 400 MHz (100 MHz for ^{13}C NMR) spectrometer. Chemical shift values are given in ppm (parts per million) with reference to tetramethylsilane (TMS) as an internal standard. The peak patterns are as follows: s, singlet; d, doublet; t, triplet; q, quartet; quint, quintet; sext, sextet; m, multiplet; dd, doublet of doublets; and dt, doublet of triplets; tt, triplet of triplets. The coupling constants (*J*) are reported in hertz (Hz). Melting points were determined on a micromelting point apparatus and are uncorrected. High-resolution mass spectra (HRMS) were obtained on a Q-TOF mass spectrometer equipped with an electrospray ion source (ESI), operated in the positive mode. Flash column chromatography was performed over 200−300 mesh silica gel. 1,2-Dichloromethane (DCE) and carbon tetrachloride (CCl_4) used in the synthesis of products **2** was analytical reagent grade and used without any pretreatment.

2. Preparation of Substrates 1. Substrate **1j** is commercially available and the other ones were prepared according to the following methods:

Method A.[1] A solution of 1,1-diarylethan-1-ol[2] (10 mmol) in anhydrous CH_2Cl_2 (30 mL) was treated with NaN_3 (1.43 g, 22 mmol) at room temperature, and then cooled to −5 °C. A mixture of TFA (6.2 mL, 84 mmol) and CH_2Cl_2 (12.4 mL) was added dropwise slowly to the above reaction mixture under a nitrogen atmosphere. It was stirred at −5 °C for 15 min, then at 0 °C for another 2−12 h. Upon the completion of the reaction (indicated by TLC), it was quenched with water (20 mL) dropwise slowly, followed by dropwise addition of 14% ammonia solution (20 mL). After vigorously stirred for 30 min, the resulting mixture was allowed to warm up slowly to room temperature, and extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and concentrated to provide the crude azide intermediate.

A solution of the above crude azide in Et_2O (5 mL) was added dropwise to a suspension of lithium aluminum hydride (569 mg, 15 mmol) in Et_2O (15 mL) at 0 °C under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 3 h, and then quenched with 1 N NaOH solution (pH > 10). The insoluble solid was filtered off and the filtrate was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated and purified through silica gel chromatography to yield substrates **1a**−**1b**, **1d**, **1f**, **1i**, **1k**−**1r**, **1t** and **1w**−**1aa**.

Method B.[3] A Grignard reagent (30 mmol, 1 M or 3 M in Et_2O) was added dropwise (within 15 min) to a vigorously stirred solution of the corresponding nitrile (10 mmol) in Et_2O (40 mL) at room temperature under a nitrogen atmosphere. After further stirred for 40 min, the resulting mixture was treated with Ti(*i*-PrO)$_4$ (3 mL, 10 mmol) and stirred for another 24 h. Upon the completion of the reaction (indicated by TLC), it was quenched with 10% NaOH solution (40 mL) and filtered. The solid was washed with EtOAc (30 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc (3 × 20 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated, and then purified through silica gel column chromatography to yield substrates **1c**, **1e**, **1g**−**1h**, **1s** and **1u**−**1v**.

1,1-Diphenylethan-1-amine (1a).[4] Method A; eluent: EtOAc/petroleum ether (PE)/Et_3N 16:83:1; yield: 1.03 g, 52%; yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37−7.35 (m, 4H), 7.30−7.26 (m, 4H, overlapped with the peak of chloroform), 7.21−7.18 (m, 2H), 1.86 (s, 2H), 1.84 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 128.2, 126.4, 126.2, 58.5, 31.9; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{14}H_{13}$

181.1012, found 181.1008.

1,1-Diphenylpropan-1-amine (1b).[3] Method A; eluent: EtOAc/PE/Et_3N 3:96:1; yield: 359 mg, 17%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37−7.34 (m, 4H), 7.30−7.26 (m, 4H), 7.18 (tt, J = 7.2, 1.2 Hz, 2H), 2.25 (q, J = 7.2 Hz, 2H), 1.83 (s, 2H), 0.81 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.7, 128.1, 126.7, 126.3, 61.3, 35.0, 8.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ calcd for $C_{15}H_{17}NNa$ 234.1253, found 234.1254.

1,1-Diphenylbutan-1-amine (1c).[5] Method B; eluent: EtOAc/PE/Et_3N 2:97:1; yield: 1.40 g, 62%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.36−7.33 (m, 4H), 7.30−7.25 (m, 4H), 7.19 (tt, J = 7.2, 1.6 Hz, 2H), 2.20−2.16 (m, 2H), 1.78 (s, 2H), 1.26−1.16 (m, 2H), 0.91 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.9, 128.0, 126.5, 126.2, 61.0, 44.9, 17.5, 14.6; HRMS (ESI-TOF) m/z: $[M - NH_2]^+$ calcd for $C_{16}H_{17}$ 209.1325, found 209.1326.

2-Methyl-1,1-diphenylpropan-1-amine (1d). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 879 mg, 39%; light yellow solid; mp 61−62 °C (lit.[3] mp 63−65 °C); ^1H NMR (400 MHz, $CDCl_3$) δ 7.50−7.48 (m, 4H), 7.28−7.24 (m, 4H, overlapped with the peak of chloroform), 7.14 (t, J = 7.6 Hz, 2H), 2.96−2.86 (m, 1H), 1.62 (s, 2H), 0.85 (d, J = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.9, 128.0, 126.5, 125.9, 63.7, 34.6, 17.6; HRMS (ESI-TOF) m/z: $[M - NH_2]^+$ calcd for $C_{16}H_{17}$ 209.1325, found 209.1323.

Cyclopropyldiphenylmethanamine (1e).[6] Method B; eluent: EtOAc/PE/Et_3N 2:97:1; yield: 1.65 g, 74%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.41−7.38 (m, 4H), 7.30−7.26 (m, 4H), 7.21 (tt, J = 7.2, 1.6 Hz, 2H), 1.64 (s, 2H), 1.59−1.54 (m, 1H), 0.58−0.53 (m, 2H), 0.35−0.31 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.9, 127.9, 127.2, 126.4, 60.5, 22.4, 1.7; HRMS (ESI-TOF) m/z: $[M - NH_2]^+$ calcd for $C_{16}H_{15}$

207.1168, found 207.1168.

Cyclobutyldiphenylmethanamine (1f). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 427 mg, 18%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31−7.22 (m, 8H, overlapped with the peak of chloroform), 7.19−7.14 (m, 2H), 3.40−3.32 (m, 1H), 1.98−1.80 (m, 7H), 1.70−1.65 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.1, 128.0, 126.9, 126.2, 62.0, 44.7, 23.6, 17.3; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{17}H_{19}NNa$ 260.1410, found 260.1406.

Cyclopentyldiphenylmethanamine (1g). Method B; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 1.76 g, 70%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45−7.43 (m, 4H), 7.27−7.23 (m, 4H, overlapped with the peak of chloroform), 7.14 (t, J = 7.6 Hz, 2H), 3.17−3.09 (m, 1H), 1.70 (s, 2H), 1.62−1.53 (m, 6H), 1.38−1.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.9, 127.9, 126.7, 125.9, 62.9, 47.7, 28.1, 26.3; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{18}H_{19}$ 235.1481, found 235.1482.

Cyclohexyldiphenylmethanamine (1h). Method B; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 1.78 g, 67%; white solid; mp 84−86 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47−7.45 (m, 4H), 7.26 (t, J = 7.6 Hz, 4H, overlapped with the peak of chloroform), 7.14 (t, J = 7.2 Hz, 2H), 2.45−2.39 (m, 1H), 1.76−1.58 (m, 7H), 1.39−1.26 (m, 2H), 1.16−0.93 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 128.0, 126.6, 125.9, 63.6, 45.9, 27.8, 26.9, 26.7; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{19}H_{21}$ 249.1638, found 249.1639.

2,2-Dimethyl-1,1-diphenylpropan-1-amine (1i). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 814 mg, 34%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41−7.38 (m, 4H), 7.25−7.20 (m, 4H, overlapped with the peak of chloroform), 7.19−7.15 (m, 2H), 1.82 (s, 2H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.6, 129.4, 127.0, 125.8, 67.4, 38.0, 28.1; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{17}H_{19}$

223.1481, found 223.1484.

Triphenylmethanamine (1j). White solid; mp 103−104 °C (lit.[3] mp 101−102 °C); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31−7.21 (m, 15H, overlapped with the peak of chloroform), 2.27 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.5, 128.1, 127.9, 126.6, 66.2; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{19}H_{17}NNa$ 282.1253, found 282.1251.

1,1-Di-*p*-tolylethan-1-amine (1k). Method A; eluent: PE/Et_3N 99:1; yield: 1.35 g, 60%; light yellow solid; mp 39−41 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, *J* = 8.0 Hz, 4H), 7.09 (d, *J* = 8.0 Hz, 4H), 2.31 (s, 6H), 1.82 (s, 2H), 1.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.2, 135.8, 128.8, 126.1, 58.0, 32.1, 21.0; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{16}H_{19}NNa$ 248.1410, found 248.1411.

1,1-Bis(4-methoxyphenyl)ethan-1-amine (1l).[5] Method A; eluent: EtOAc/PE/Et_3N 3:96:1; yield: 1.78 g, 69%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30−7.26 (m, 4H), 6.84−6.80 (m, 4H), 3.79 (s, 6H), 1.90 (s, 2H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.9, 142.3, 127.2, 113.3, 57.5, 55.3, 32.3; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{16}H_{19}NNaO_2$ 280.1308, found 280.1306.

1,1-Di([1,1'-biphenyl]-4-yl)ethan-1-amine (1m). Method A; eluent: EtOAc/PE/Et_3N 20:79:1; yield: 2.52 g, 72%; white solid; mp 158−160 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59−7.54 (m, 8H), 7.49 (d, *J* = 8.0 Hz, 4H), 7.42 (t, *J* = 7.6 Hz, 4H), 7.34−7.30 (m, 2H), 1.92 (s, 5H, overlapped with the peak of NH_2); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.8, 140.7, 139.2, 128.7, 127.2, 127.0, 126.9, 126.6, 58.1, 31.9; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{26}H_{21}$ 333.1638, found 333.1639.

1,1-Bis(4-fluorophenyl)ethan-1-amine (1n).[6] Method A; eluent: EtOAc/PE/Et_3N 3:96:1; yield: 1.10 g, 47%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35−7.30 (m, 4H), 7.00−6.94 (m, 4H), 1.86 (s, 2H), 1.82 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ

161.4 (d, J_{C-F} = 243.7 Hz), 145.4 (d, J_{C-F} = 3.3 Hz), 127.8 (d, J_{C-F} = 7.9 Hz), 114.9 (d, J_{C-F} = 20.9 Hz), 57.7, 32.3; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{14}H_{11}F_2$ 217.0823, found 217.0824.

1,1-Bis(4-chlorophenyl)ethan-1-amine (1o). Method A; eluent: EtOAc/PE/Et_3N 3:96:1; yield: 958 mg, 36%; light yellow solid; mp 77−80 °C (lit.[5] mp 73 °C); ^1H NMR (400 MHz, $CDCl_3$) δ 7.31−7.24 (m, 8H, overlapped with the peak of chloroform), 1.87 (s, 2H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.9, 132.4, 128.3, 127.6, 57.9, 31.9; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{14}H_{11}Cl_2$ 249.0232, found 249.0232.

1,1-Bis(4-(trifluoromethyl)phenyl)ethan-1-amine (1p). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 1.57 g, 47%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, J = 8.0 Hz, 4H), 7.50 (d, J = 8.4 Hz, 4H), 1.90 (s, 2H), 1.88 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.9, 129.0 (q, J_{C-F} = 32.3 Hz), 126.5, 125.3 (q, J_{C-F} = 3.9 Hz), 124.1 (q, J_{C-F} = 270.2 Hz), 58.4, 31.6; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{16}H_{11}F_6$ 317.0759, found 317.0755.

1,1-Di-*m*-tolylethan-1-amine (1q). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 1.62 g, 72%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.21−7.13 (m, 6H), 7.02 (d, J = 7.2 Hz, 2H), 2.32 (s, 6H), 1.90 (s, 2H), 1.82 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.8, 137.6, 128.0, 127.1, 126.8, 123.3, 58.3, 31.9, 21.7; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{16}H_{19}NNa$ 248.1410, found 248.1406.

1,1-Bis(3-chlorophenyl)ethan-1-amine (1r). Method A; eluent: EtOAc/PE/Et_3N 2:97:1; yield: 1.78 g, 67%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.41−7.40 (m, 2H), 7.25−7.18 (m, 6H, overlapped with the peak of chloroform), 1.81 (s, 3H), 1.79 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.3, 134.2, 129.6, 126.8, 126.3, 124.5, 58.2, 31.7; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{14}H_{11}Cl_2$ 249.0232, found

249.0229.

1,1-Di-*o*-tolylethan-1-amine (1s). Method B; eluent: EtOAc/PE/Et_3N 2:97:1; yield: 1.26 g, 56%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 7.6, 0.8 Hz, 2H), 7.26−7.22 (m, 2H, overlapped with the peak of chloroform), 7.15 (td, *J* = 7.6, 1.6 Hz, 2H), 7.01 (d, *J* = 7.6 Hz, 2H), 1.85 (s, 3H), 1.82 (s, 2H), 1.75 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.9, 135.3, 132.3, 126.6, 126.1, 125.3, 58.8, 31.3, 21.4; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{16}H_{17}$ 209.1325, found 209.1328.

1,1-Bis(3,4-dimethylphenyl)ethan-1-amine (1t). Method A; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 1.32 g, 52%; dark yellow solid; mp 52−54 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.17−7.16 (m, 2H), 7.09−7.03 (m, 4H), 2.23 (m, 12H), 1.81 (s, 5H, overlapped with the peak of NH_2); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.6, 136.2, 134.4, 129.3, 127.4, 123.6, 57.8, 32.2, 20.1, 19.4; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{18}H_{23}NNa$ 276.1723, found 276.1721.

1,1-Bis(3,4-dichlorophenyl)ethan-1-amine (1u). Method B; eluent: EtOAc/PE/Et_3N 10:89:1; yield: 1.78 g, 53%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 2.0 Hz, 2H), 7.36 (d, *J* = 8.4 Hz, 2H), 7.15 (dd, *J* = 8.8, 2.4 Hz, 2H), 1.80 (s, 5H, overlapped with the peak of NH_2); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.0, 132.4, 130.9, 130.3, 128.1, 125.7, 57.7, 31.6; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{14}H_9Cl_4$ 316.9453, found 316.9457.

1,1-Bis(3,5-dimethylphenyl)ethan-1-amine (1v). Method B; eluent: EtOAc/PE/Et_3N 5:94:1; yield: 811 mg, 32%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.98 (s, 4H), 6.85 (s, 2H), 2.28 (s, 12H), 1.79 (s, 5H, overlapped with the peak of NH_2); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 137.4, 127.9, 123.9, 58.1, 32.1, 21.5; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{18}H_{21}$ 237.1638, found 237.1639.

1,1-Di(naphthalen-2-yl)ethan-1-amine (1w). Method A; eluent: EtOAc/PE/Et_3N

10:89:1; yield: 1.43 g, 48%; white solid; mp 89−90 °C (lit.[5] mp 89 °C); ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.02 (s, 2H), 7.84 (d, *J* = 8.0 Hz, 2H), 7.78 (d, *J* = 8.8 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.50−7.43 (m, 4H), 7.33 (dd, *J* = 8.4, 1.6 Hz, 2H), 2.03 (s, 5H, overlapped with the peak of NH$_2$); ^{13}C NMR (100 MHz, CDCl$_3$) δ 146.8, 133.2, 132.2, 128.2, 128.0, 127.5, 126.2, 125.84, 125.78, 123.7, 58.8, 31.5; HRMS (ESI-TOF) *m/z*: [M + Na]$^+$ calcd for $C_{22}H_{19}NNa$ 320.1410, found 320.1409.

1-Phenyl-1-(*p*-tolyl)ethan-1-amine (1x).[7] Method A; eluent: EtOAc/PE/Et$_3$N 15:84:1; yield: 1.56 g, 74%; light yellow oil; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.37 (d, *J* = 8.0 Hz, 2H), 7.30−7.24 (m, 4H), 7.19 (t, *J* = 7.2 Hz, 1H), 7.10 (d, *J* = 8.0 Hz, 2H), 2.31 (s, 3H), 1.88 (s, 2H), 1.83 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 150.0, 147.0, 135.9, 128.8, 128.1, 126.3, 126.2, 126.1, 58.2, 32.0, 21.0; HRMS (ESI-TOF) *m/z*: [M − NH$_2$]$^+$ calcd for $C_{15}H_{15}$ 195.1168, found 195.1165.

1-(4-Chlorophenyl)-1-phenylethan-1-amine (1y).[8] Method A; eluent: EtOAc/PE/Et$_3$N 15:84:1; yield: 950 mg, 41%; light yellow oil; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.35−7.19 (m, 9H, overlapped with the peak of chloroform), 1.83 (s, 2H), 1.81(s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 149.4, 148.4, 132.1, 128.3, 128.2, 127.8, 126.6, 126.1, 58.2, 31.9; HRMS (ESI-TOF) *m/z*: [M − NH$_2$]$^+$ calcd for $C_{14}H_{12}Cl$ 215.0622, found 215.0619.

1-Phenyl-1-(4-(trifluoromethyl)phenyl)ethan-1-amine (1z). Method A; eluent: EtOAc/PE/Et$_3$N 5:94:1; yield: 1.06 g, 40%; colorless oil; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.56−7.50 (m, 4H), 7.37−7.29 (m, 4H), 7.25−7.21 (m, 1H, overlapped with the peak of chloroform), 1.86 (s, 5H, overlapped with the peak of NH$_2$); ^{13}C NMR (100 MHz, CDCl$_3$) δ 153.8 (q, J_{C-F} = 1.4 Hz), 149.0, 128.8, 128.4, 126.7, 126.6, 126.1, 125.1 (q, J_{C-F} = 3.9 Hz), 124.2 (q, J_{C-F} = 270.2 Hz), 58.4, 31.8; HRMS (ESI-TOF) *m/z*: [M − NH$_2$]$^+$ calcd for $C_{15}H_{12}F_3$ 249.0886, found 249.0889.

1-(4-Chlorophenyl)-1-(4-methoxyphenyl)ethan-1-amine (1aa).[9] Method A; eluent: EtOAc/PE/Et_3N 10:89:1; yield: 1.44 g, 55%; yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.33−7.30 (m, 2H), 7.28−7.22 (m, 4H, overlapped with the peak of chloroform), 6.84−6.81 (m, 2H), 3.79 (s, 3H), 1.82 (s, 2H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.1, 148.6, 141.6, 132.0, 128.1, 127.6, 127.2, 113.4, 57.7, 55.2, 32.1; HRMS (ESI-TOF) *m/z*: $[M - NH_2]^+$ calcd for $C_{15}H_{14}ClO$ 245.0728, found 245.0723.

3. General Procedure for the Synthesis of Products 2. A stirred solution of the substrate **1** (0.5 mmol) in DCE (6 mL) and CCl_4 (2 mL) was treated with iodine (317 mg, 1.25 mmol) and Cs_2CO_3 (814 mg, 2.5 mmol) in sequence, and then heated to reflux (the reaction temperature was −5 °C then rt for **1l**; 70 °C for **1aa**) until TLC indicating that the conversion was complete. After cooling to room temperature, the solvent was evaporated to dryness under reduced pressure. The resulting residue was dissolved in MeOH (8 mL), and then treated with $NaBH_4$ (95 mg, 2.5 mmol) at 0 °C. The reaction mixture was stirred at room temperature for 1 h. Upon completion of the reaction (indicated by TLC), it was quenched with 1 N NaOH (5 mL), and extracted with CH_2Cl_2 (3 × 15 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated and purified through silica gel chromatography to yield the product **2**.

***N*-(1-Phenylethyl)aniline (2a).**[10] 3 h; eluent: EtOAc/PE 1:99; yield: 89 mg, 91%; light yellow oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37−7.28 (m, 4H), 7.24−7.19 (m, 1H, overlapped with the peak of chloroform), 7.11−7.06 (m, 2H), 6.63 (tt, J = 7.6, 0.8 Hz, 1H), 6.51−6.48 (m, 2H), 4.47 (q, J = 6.8 Hz, 1H), 4.01 (s, 1H), 1.50 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.3, 145.3, 129.1, 128.7, 126.9, 125.9, 117.3, 113.3, 53.5, 25.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{14}H_{16}N$ 198.1277, found 198.1276.

***N*-(1-Phenylpropyl)aniline (2b).**[10] 2 h; eluent: EtOAc/PE 1:99; yield: 99 mg, 93%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35−7.28 (m, 4H), 7.23−7.19 (m, 1H, overlapped with the peak of chloroform), 7.09−7.05 (m, 2H), 6.62 (t, J = 7.2 Hz, 1H), 6.50 (d, J = 7.6 Hz, 2H), 4.22 (t, J = 6.8 Hz, 1H), 4.06 (s, 1H), 1.89−1.74 (m, 2H), 0.95 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.5, 144.0, 129.1, 128.5, 126.9, 126.5, 117.1, 113.2, 59.7, 31.7, 10.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{15}H_{18}N$ 212.1434, found 212.1433.

***N*-(1-Phenylbutyl)aniline (2c).**[11] 3 h; eluent: EtOAc/PE 1:99; yield: 34 mg, 30%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34−7.28 (m, 4H), 7.21 (t, J = 6.8 Hz, 1H), 7.09−7.05 (m, 2H), 6.64−6.60 (m, 1H), 6.51−6.49 (m, 2H), 4.30 (t, J = 6.8 Hz, 1H), 4.06 (s, 1H), 1.84−1.69 (m, 2H), 1.48−1.30 (m, 2H), 0.93 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.5, 144.3, 129.1, 128.5, 126.8, 126.4, 117.1, 113.2, 58.0, 41.2, 19.6, 14.0; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{20}N$ 226.1590, found 226.1594.

***N*-(2-Methyl-1-phenylpropyl)aniline (2d).**[11] 3 h; eluent: EtOAc/PE 1:99; yield: 67 mg, 59%; yellow solid; mp 49−50 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30−7.26 (m, 4H), 7.23−7.18 (m, 1H), 7.08−7.03 (m, 2H), 6.60 (t, J = 7.2 Hz, 1H), 6.50 (d, J = 7.6 Hz, 2H), 4.12 (d, J = 6.0 Hz, 2H, overlapped with the peak of NH_2), 2.09−1.97 (m, 1H), 0.98 (d, J = 6.8 Hz, 3H), 0.92 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 142.5, 129.0, 128.2, 127.1, 126.7, 116.9, 113.2, 63.7, 34.9, 19.7, 18.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{20}N$ 226.1590, found 226.1588.

***N*-(Cyclopropyl(phenyl)methyl)aniline (2e).**[12] 1.5 h; eluent: EtOAc/PE 1:99; yield: 109 mg, 98%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41−7.39 (m, 2H), 7.34−7.30 (m, 2H), 7.26−7.21 (m, 1H, overlapped with the peak of chloroform), 7.08−7.03 (m, 2H), 6.62 (t, *J* = 7.2 Hz, 1H), 6.46 (d, *J* = 7.6 Hz, 2H), 4.38 (s, 1H), 3.64 (d, *J* = 8.0 Hz, 1H), 1.22−1.13 (m, 1H), 0.65−0.34 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 147.6, 143.3, 129.1, 128.5, 127.0, 126.5, 117.2, 113.4, 63.0, 19.8, 4.2, 3.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{18}N$ 224.1434, found 224.1435.

***N*-(Cyclobutyl(phenyl)methyl)aniline (2f).**[13] 2 h; eluent: EtOAc/PE 1:99; yield: 81 mg, 68%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.33−7.26 (m, 4H), 7.21−7.18 (m, 1H), 7.07−7.03 (m, 2H), 6.61 (t, *J* = 7.6 Hz, 1H), 6.48 (d, *J* = 8.0 Hz, 2H), 4.15 (d, *J* = 9.2 Hz, 1H), 4.00 (s, 1H), 2.57−2.48 (m, 1H), 2.15−2.10 (m, 1H), 1.93−1.76 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 147.7, 142.6, 129.1, 128.4, 127.0, 126.6, 117.2, 113.4, 63.8, 42.6, 26.2, 25.6, 17.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{17}H_{20}N$ 238.1590, found 238.1592.

***N*-(Cyclopentyl(phenyl)methyl)aniline (2g).**[14] 2 h; eluent: EtOAc/PE 1:99; yield: 96 mg, 76%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.34−7.26 (m, 4H), 7.19 (tt, *J* = 7.2, 1.6 Hz, 1H), 7.07−7.02 (m, 2H), 6.59 (t, *J* = 7.2 Hz, 1H), 6.50−6.48 (m, 2H), 4.18 (s, 1H), 4.07 (d, *J* = 8.4 Hz, 1H), 2.20−2.10 (m, 1H), 1.92−1.84 (m, 1H), 1.69−1.23 (m, 7H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 147.6, 143.9, 129.0, 128.3, 126.9, 126.8, 116.9, 113.2, 63.0, 47.7, 30.1, 29.9, 25.20, 25.15; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{18}H_{22}N$ 252.1747, found 252.1749.

***N*-(Cyclohexyl(phenyl)methyl)aniline (2h).**[13] 1 h; eluent: EtOAc/PE 1:99; yield: 109 mg, 82%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.29−7.26 (m, 4H), 7.22−7.17 (m, 1H), 7.08−7.02 (m, 2H), 6.59 (tt, *J* = 7.2, 1.2 Hz, 1H), 6.50−6.47 (m, 2H), 4.14 (s, 1H), 4.11 (d, *J* = 6.4 Hz, 1H), 1.88 (d, *J* = 12.4 Hz, 1H), 1.77−1.60 (m, 4H), 1.53 (d, *J* = 12.8 Hz, 1H), 1.24−0.99 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 147.7, 142.6, 129.0, 128.1, 127.2, 126.7, 116.9, 113.1, 63.3, 44.9, 30.2, 29.4, 26.39, 26.36, 26.32; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{19}H_{24}N$ 266.1903, found 266.1907.

***N*-(2,2-Dimethyl-1-phenylpropyl)aniline (2i).**[13] 4.5 h; eluent: EtOAc/PE 1:99; yield: 22 mg, 18%; colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31−7.25 (m, 4H), 7.22−7.18 (m, 1H), 7.06−7.02 (m, 2H), 6.60−6.56 (m, 1H), 6.49−6.46 (m, 2H), 4.26 (s, 1H), 4.04 (s, 1H), 0.99 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 141.1, 129.0, 128.5, 127.7, 126.8, 116.8, 113.1, 67.1, 34.9, 27.0; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{17}H_{22}N$ 240.1747, found 240.1749.

***N*-Benzhydrylaniline (2j).**[10] eluent: EtOAc/PE 1:99; yield: 128 mg, 98% (0.5 mmol, 2 h); 1.49 g, 96% (6 mmol, 8 h); light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37−7.30 (m, 8H), 7.27−7.23 (m, 2H overlapped with the peak of chloroform), 7.14−7.09 (m, 2H), 6.69 (t, J = 7.2 Hz, 1H), 6.55−6.53 (m, 2H), 5.49 (s, 1H), 4.23 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.4, 143.0, 129.2, 128.8, 127.5, 127.4, 117.7, 113.5, 63.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{19}H_{18}N$ 260.1434, found 260.1438.

4-Methyl-*N*-(1-(*p*-tolyl)ethyl)aniline (2k).[15] 3 h; eluent: EtOAc/PE 1:99; yield: 88 mg, 78%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, J = 8.4 Hz, 2H, overlapped with the peak of chloroform), 7.11 (d, J = 7.6 Hz, 2H), 6.89 (d, J = 8.0 Hz, 2H), 6.43 (d, J = 8.4 Hz, 2H), 4.42 (q, J = 6.8 Hz, 1H), 3.77 (s, 1H), 2.31 (s, 3H), 2.18 (s, 3H), 1.48 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.1, 142.4, 136.3, 129.6, 129.3, 126.3, 125.8, 113.4, 53.4, 25.1, 21.1, 20.4; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{20}N$ 226.1590, found 226.1585.

4-Methoxy-*N*-(1-(4-methoxyphenyl)ethyl)aniline (2l).[16] According to the *General Procedure*, the first-step rearrangement reaction was performed at −5 °C for 12 h and then rt for 16 h; eluent: EtOAc/PE 3:97; yield: 116 mg, 90%; brown oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28−7.25 (m, 2H), 6.87−6.83 (m, 2H), 6.71−6.67 (m, 2H), 6.49−6.45 (m, 2H), 4.37 (q, J = 6.4 Hz, 1H), 3.78 (s, 3H), 3.69 (s, 3H), 1.47 (d, J =

6.8 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 158.4, 151.8, 141.6, 137.5, 126.9, 114.7, 114.6, 114.0, 55.8, 55.3, 53.6, 25.2; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ calcd for $C_{16}H_{20}NO_2$ 258.1489, found 258.1485.

***N*-(1-([1,1'-Biphenyl]-4-yl)ethyl)-[1,1'-biphenyl]-4-amine (2m).** 2 h; eluent: EtOAc/PE 2:98; yield: 147 mg, 84%; white solid, mp 123−125 °C; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.59−7.55 (m, 4H), 7.50−7.30 (m, 11H), 7.24−7.20 (m, 1H, overlapped with the peak of chloroform), 6.63−6.59 (m, 2H), 4.57 (q, *J* = 6.4 Hz, 1H), 4.18 (s, 1H), 1.57 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 146.6, 144.1, 141.2, 140.9, 139.8, 130.2, 128.7, 128.6, 127.8, 127.4, 127.1, 127.0, 126.3, 126.2, 126.0, 113.5, 53.2, 25.0; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ calcd for $C_{26}H_{24}N$ 350.1903, found 350.1906.

4-Fluoro-*N*-(1-(4-fluorophenyl)ethyl)aniline (2n).[17] 2 h; eluent: EtOAc/PE 1:99; yield: 52 mg, 45%; brown oil; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.32−7.28 (m, 2H), 7.02−6.96 (m, 2H), 6.82−6.76 (m, 2H), 6.42−6.37 (m, 2H), 4.38 (q, *J* = 6.8 Hz, 1H), 3.88 (s, 1H), 1.47 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 161.9, 159.5, 155.8, 153.5, 142.3, 139.6, 126.2 (d, J_{C-F} = 7.9 Hz), 114.6 (d, J_{C-F} = 5.6 Hz), 114.3 (d, J_{C-F} = 4.6 Hz), 113.0 (d, J_{C-F} = 7.3 Hz), 52.4, 24.2; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ calcd for $C_{14}H_{14}F_2N$ 234.1089, found 234.1091.

4-Chloro-*N*-(1-(4-chlorophenyl)ethyl)aniline (2o).[16] 2 h; eluent: EtOAc/PE 1:99; yield: 124 mg, 93%; yellow oil; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.29−7.25 (m, 4H, overlapped with the peak of chloroform), 7.04−7.00 (m, 2H), 6.40−6.36 (m, 2H), 4.39 (q, *J* = 6.8 Hz, 1H), 4.03 (s, 1H), 1.48 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 145.5, 143.3, 132.6, 129.0, 128.9, 127.2, 122.1, 114.4, 53.1, 25.1; HRMS (ESI-TOF) *m/z*: [M + H]$^+$ calcd for $C_{14}H_{14}Cl_2N$ 266.0498, found 266.0497.

4-(Trifluoromethyl)-*N*-(1-(4-(trifluoromethyl)phenyl)ethyl)aniline (2p). 6 h; eluent:

EtOAc/PE 1:99; yield: 135 mg, 81%; colorless solid; mp 80−81 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, J = 8.0 Hz, 2H), 7.45 (d, J = 8.4 Hz, 2H), 7.32 (d, J = 8.4 Hz, 2H), 6.47 (d, J = 8.4 Hz, 2H), 4.56 (q, J = 6.4 Hz, 1H), 4.38 (s, 1H), 1.55 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.2, 148.4, 129.5 (q, J_{C-F} = 32.2 Hz), 126.6 (q, J_{C-F} = 3.8 Hz), 126.1, 125.9 (q, J_{C-F} = 3.7 Hz), 124.8 (q, J_{C-F} = 268.7 Hz), 124.1 (J_{C-F} = 270.3 Hz), 119.3 (J_{C-F} = 32.4 Hz), 112.5, 53.0, 24.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{14}F_6N$ 334.1025, found 334.1022.

3-Methyl-*N*-(1-(*m*-tolyl)ethyl)aniline (2q). 5 h; eluent: EtOAc/PE 1:99; yield: 80 mg, 71%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22−7.15 (m, 3H), 7.04−7.02 (m, 1H), 6.97 (t, J = 8.0 Hz, 1H), 6.48−6.46 (m, 1H), 6.37 (s, 1H), 6.31 (dd, J = 8.0, 2.4 Hz, 1H), 4.43 (q, J = 6.8 Hz, 1H), 3.90 (s, 1H), 2.33 (s, 3H), 2.21 (s, 3H), 1.48 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.4, 145.3, 138.8, 138.1, 129.0, 128.5, 127.6, 126.5, 122.9, 118.1, 114.1, 110.2, 53.4, 24.9, 21.6, 21.5; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{20}N$ 226.1590, found 226.1587.

3-Chloro-*N*-(1-(3-chlorophenyl)ethyl)aniline (2r). 1.5 h; eluent: EtOAc/PE 1:99; yield: 98 mg, 74%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33−7.32 (m, 1H), 7.26−7.20 (m, 3H, overlapped with the peak of chloroform), 6.99 (t, J = 8.0 Hz, 1H), 6.64−6.61 (m, 1H), 6.46 (t, J = 2.0 Hz, 1H), 6.35−6.32 (m, 1H), 4.41 (q, J = 6.8 Hz, 1H), 4.09 (s, 1H), 1.49 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.9, 146.8, 134.8, 134.6, 130.12, 130.06, 127.3, 125.9, 123.9, 117.5, 113.0, 111.4, 53.1, 24.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{14}H_{14}Cl_2N$ 266.0498, found 266.0497.

2-Methyl-*N*-(1-(*o*-tolyl)ethyl)aniline (2s). 5 h; eluent: EtOAc/PE 1:99; yield: 45 mg, 40%; light yellow solid; mp 73−76 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39−7.37 (m, 1H), 7.18−7.12 (m, 3H), 7.04 (d, J = 7.2 Hz, 1H), 6.94 (t, J = 7.6 Hz, 1H), 6.58 (t, J =

7.2 Hz, 1H), 6.22 (d, *J* = 8.0 Hz, 1H), 4.70 (q, *J* = 6.8 Hz, 1H), 3.84 (s, 1H), 2.44 (s, 3H), 2.22 (s, 3H), 1.50 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.1, 142.8, 134.6, 130.6, 130.0, 127.1, 126.7, 126.6, 124.5, 121.5, 116.7, 110.6, 49.7, 23.3, 19.0, 17.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{16}H_{20}N$ 226.1590, found 226.1592.

***N*-(1-(3,4-Dimethylphenyl)ethyl)-3,4-dimethylaniline (2t).** 2.5 h; eluent: EtOAc/PE 1:99; yield: 70 mg, 55%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.12 (s, 1H), 7.10−7.04 (m, 2H), 6.83 (d, *J* = 8.0 Hz, 1H), 6.39−6.38 (m, 1H), 6.26 (dd, *J* = 8.0, 2.4 Hz, 1H), 4.38 (q, *J* = 6.8 Hz, 1H), 3.65 (s, 1H), 2.22 (d, *J* = 6.8 Hz, 6H), 2.11 (d, *J* = 13.6 Hz, 6H), 1.46 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.7, 143.1, 137.1, 136.7, 135.0, 130.2, 129.9, 127.2, 125.1, 123.3, 115.3, 110.6, 53.4, 25.1, 20.1, 20.0, 19.5, 18.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{18}H_{24}N$ 254.1903, found 254.1904.

3,4-Dichloro-*N*-(1-(3,4-dichlorophenyl)ethyl)aniline (2u). 3 h; eluent: EtOAc/PE 1:99; yield: 128 mg, 76%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41−7.39 (m, 2H), 7.17−7.10 (m, 2H), 6.53 (d, *J* = 2.8 Hz, 1H), 6.28 (dd, *J* = 8.8, 2.8 Hz, 1H), 4.36 (q, *J* = 6.8 Hz, 1H), 4.08 (s, 1H), 1.49 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.0, 144.6, 132.9, 132.7, 131.1, 130.8, 130.6, 127.7, 125.1, 120.4, 114.5, 112.8, 52.8, 24.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{14}H_{12}Cl_4N$ 333.9718, found 333.9722.

***N*-(1-(3,5-Dimethylphenyl)ethyl)-3,5-dimethylaniline (2v).** 3.5 h; eluent: EtOAc/PE 1:99; yield: 95 mg, 75%; light yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.98 (s, 2H), 6.86 (s, 1H), 6.32 (s, 1H), 6.19 (s, 2H), 4.39 (q, *J* = 6.8 Hz, 1H), 3.92 (s, 1H), 2.29 (s, 6H), 2.18 (s, 6H), 1.47 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.3, 145.3, 138.7, 138.0, 128.5, 123.7, 119.3, 111.3, 53.5, 24.7, 21.5, 21.4; HRMS

(ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{18}H_{24}N$ 254.1903, found 254.1907.

***N*-(1-(Naphthalen-2-yl)ethyl)naphthalen-2-amine (2w).**[18] 4 h; eluent: EtOAc/PE 1:99; yield: 121 mg, 81%; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.85−7.77 (m, 4H), 7.59 (t, *J* = 8.8 Hz, 2H), 7.53 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.46−7.39 (m, 3H), 7.27−7.22 (m, 1H, overlapped with the peak of chloroform), 7.14−7.10 (m, 1H), 6.92 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.67−6.66 (m, 1H), 4.76 (q, *J* = 6.8 Hz, 1H), 4.37 (s, 1H), 1.63 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 144.6, 142.3, 134.9, 133.5, 132.7, 128.8, 128.5, 127.8, 127.6, 127.5, 127.4, 126.1, 125.99, 125.97, 125.5, 124.4, 124.3, 122.0, 118.0, 105.9, 53.8, 24.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{22}H_{20}N$ 298.1590, found 298.1586.

4-Methyl-*N*-(1-phenylethyl)aniline (2x)[19] and ***N*-(1-(*p*-Tolyl)ethyl)aniline (2x').**[20] 4 h; eluent: EtOAc/PE 1:99; yield: 81 mg, 76% (**2x:2x'** = 1:1.71, determined by the ^{1}H NMR peaks of the $ArCH_3$ group); dark yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.37−7.35 (m, 3.5H), 7.32−7.28 (m, 3.5H), 7.26−7.19 (m, 3.8H, overlapped with the peak of chloroform), 7.13−7.06 (m, 3.9H), 6.91−6.88 (m, 3.4H), 6.65−6.61 (m, 1H), 6.52−6.49 (m, 1.9H), 6.44−6.41 (m, 3.4H), 4.47−4.42 (m, 2.7H), 3.91 (s, 2.5H), 2.31 (s, 3H), 2.18 (s, 5.1H), 1.50−1.48 (m, 8.1H); ^{13}C NMR (100 MHz, $CDCl_3$): **2x**: *δ* 147.4, 142.3, 136.4, 129.4, 129.2, 125.9, 117.2, 113.3, 53.2, 25.2, 21.2; **2x'**: *δ* 145.5, 145.1, 129.7, 128.7, 126.9, 126.4, 125.8, 113.5, 53.7, 25.1, 20.4; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{15}H_{18}N$ 212.1434, found 212.1430.

***N*-(1-(4-Chlorophenyl)ethyl)aniline (2y)**[21] **and 4-Chloro-*N*-(1-phenylethyl)aniline (2y').**[21] 4.5 h; eluent: EtOAc/PE 1:99; yield: 104 mg, 90% (**2y:2y'** = 1:1.45, determined by the ^{1}H NMR peaks of the only CH_3 group); dark yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.34−7.20 (m, 11.8H, overlapped with the peak of chloroform), 7.11−7.07 (m, 2H), 7.03−6.99 (m, 2.9H), 6.65 (t, *J* = 7.6 Hz, 1H), 6.47 (d, *J* = 7.6 Hz, 2H), 6.43−6.39 (m, 2.9H), 4.46−4.40 (m, 2.5H), 4.03 (s, 2.4H), 1.50 (d, J = 6.8 Hz, 4.4H), 1.48 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): **2y**: δ 147.0, 143.8, 132.4, 129.2, 128.9, 127.3, 117.5, 113.3, 53.0, 25.2; **2y'**: δ 145.8, 144.7, 128.82, 128.76, 127.1, 125.8, 121.8, 114.4, 53.6, 25.1; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{14}H_{15}ClN$ 232.0888, found 232.0884.

***N*-(1-(4-(Trifluoromethyl)phenyl)ethyl)aniline (2z)**[19] **and *N*-(1-Phenylethyl)-4-(trifluoromethyl)aniline (2z').**[22] 3 h; eluent: EtOAc/PE 1:99; yield: 102 mg, 77% (**2z:2z'** = 1:1.25, determined by the ^{1}H NMR peaks of the only CH_3 group); yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, J = 8.4 Hz, 2H), 7.48 (d, J = 8.0 Hz, 2H), 7.34−7.30 (m. 7.5H), 7.26−7.22 (m, 1.25H, overlapped with the peak of chloroform), 7.11−7.07 (m, 2H), 6.67 (t, J = 7.2 Hz, 1H), 6.51−6.45 (m, 4.5H), 4.55−4.49 (m, 2.3H), 4.33 (s, 2.3H), 1.54−1.51 (m, 6.8H); ^{13}C NMR (100 MHz, $CDCl_3$): **2z**: δ 149.4, 146.8, 129.2 (q, J_{C-F} = 32.0 Hz), 129.2, 126.2, 125.7 (q, J_{C-F} = 3.8Hz), 124.2 (q, J_{C-F} = 272.2Hz), 117.7, 113.3, 53.3, 25.1; **2z'**: δ 149.5, 144.2, 128.8, 127.2, 126.4 (q, J_{C-F} = 3.8 Hz), 125.8 (q, J_{C-F} = 268.6 Hz), 125.7, 118.7 (q, J_{C-F} = 32.4 Hz), 112.4, 53.2, 24.9; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{15}H_{15}F_3N$ 266.1151, found 266.1154.

4-Chloro-*N*-(1-(4-methoxyphenyl)ethyl)aniline (2aa).[23] According to the *General Procedure*, the first-step rearrangement reaction was performed at 70 °C for 3 h; eluent: EtOAc/PE 1:99; yield: 27 mg, 21%; dark yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26−7.22 (m, 2H, overlapped with the peak of chloroform), 7.04−7.00 (m, 2H), 6.87−6.83 (m, 2H), 6.44−6.40 (m, 2H), 4.39 (q, J = 6.8 Hz, 1H), 4.02 (s, 1H), 3.78 (s, 3H), 1.48 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.5, 145.8, 136.6, 128.9, 126.8, 121.7, 114.4, 114.0, 55.2, 52.9, 25.0; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{15}H_{17}ClNO$ 262.0993, found 262.0988.

***N*-(1-(4-Chlorophenyl)ethyl)-4-methoxyaniline (2aa').**[24] According to the *General Procedure*, the first-step rearrangement reaction was performed at 70 °C for 3 h; eluent: EtOAc/PE 1:99; yield: 85 mg, 65%; dark yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30−7.25 (m, 4H), 6.68 (d, J = 8.8 Hz, 2H), 6.43 (d, J = 8.8 Hz, 2H), 4.37 (q, J = 6.8 Hz, 1H), 3.68 (m, 4H), 1.46 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.1, 144.1, 141.2, 132.3, 128.8, 127.3, 114.8, 114.6, 55.7, 53.8, 25.2; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{15}H_{17}ClNO$ 262.0993, found 262.0988.

4. Synthesis of Compound 3. According to the *General Procedure for the Synthesis of Products **2***, upon the completion of the first-step rearrangement of substrate **1j** (130 mg, 0.5 mmol), the reaction mixture was allowed to cool to room temperature. It was quenched with 5% $Na_2S_2O_3$ (5 mL) and extracted with CH_2Cl_2 (3 × 15 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and concentrated to give the crude imine intermediate, which was re-dissolved in anhydrous THF (8 mL). The solution of the crude imine was cooled to −78 °C and treated with methyllithium (1.25 mL, 2 mmol, 1.6 M in Et_2O) under a nitrogen atmosphere. After stirred at the same temperature for 2 h, it was allowed to warm up to room temperature slowly and stirred for another 12 h. Upon completion of the reaction (indicated by TLC), it was quenched with water (5 mL) and extracted with CH_2Cl_2 (3 × 15 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated and purified through silica gel chromatography (EtOAc/PE 1:99) to yield *N*-(1,1-diphenylethyl)aniline (**3**)[25] as colorless oil (136 mg, 99% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47−7.44 (m, 4H), 7.33−7.29 (m, 4H), 7.25−7.21 (m, 2H, overlapped with the peak of chloroform), 7.04−6.99 (m, 2H), 6.65 (t, J = 7.2 Hz, 1H), 6.44−6.41 (m, 2H), 4.38 (s, 1H), 2.11 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1, 145.9, 128.7, 128.5, 126.9, 126.8, 117.5, 116.1, 62.4, 26.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{20}H_{20}N$ 274.1590, found 274.1591.

5. Synthesis of Compound 4. According to the procedure for the synthesis of **3**, the crude imine intermediate was obtained from substrate **1j** (130 mg, 0.5 mmol). It was re-dissolved in anhydrous THF (8 mL), cooled to 0 °C, and then treated with allyl magnesium bromide (1 mL, 1 mmol, 1 M in Et_2O) under a nitrogen atmosphere. After addition, the reaction mixture was allowed to warm up to room temperature and stirred for 12 h. Upon completion of the reaction (indicated by TLC), it was quenched with sat. NH_4Cl solution (5 mL) and extracted with EtOAc (3 × 15 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated and purified through silica gel chromatography (EtOAc/PE 1:99) to yield *N*-(1,1-diphenylbut-3-en-1-yl)aniline (**4**)[26] as yellow oil (124 mg, 83%). ^1H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.0 Hz, 4H), 7.30 (t, J = 7.2 Hz, 4H), 7.21 (t, J = 7.2 Hz, 2H), 6.96 (t, J = 7.6 Hz, 2H), 6.60 (t, J = 7.2 Hz, 1H), 6.34 (d, J = 8.0 Hz, 2H), 5.53−5.43 (m, 1H), 5.08−5.03 (m, 2H), 4.65 (s, 1H), 3.25 (d, J = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.9, 144.8, 133.6, 128.6, 128.4, 127.3, 126.7, 119.6, 117.5, 116.0, 64.5, 44.9; HRMS (ESI-TOF) *m/z*: $[M + Na]^+$ calcd for $C_{22}H_{21}NNa$ 322.1566, found 322.1565.

6. Synthesis of Compound 5. According to the procedure for the synthesis of **3**, the crude imine intermediate was obtained from substrate **1j** (130 mg, 0.5 mmol). It was re-dissolved in DMSO (5 mL), and then treated with phenylacetylene (77 mg, 0.75 mmol) and ^{t}BuOK (28 mg, 0.25 mmol). After stirred at 40 °C for 10 min, the reaction was quenched with 0.6 M K_2CO_3 solution (5 mL) and extracted with CH_2Cl_2 (3 × 15 mL). The combined organic layer was dried over anhydrous Na_2SO_4, concentrated and purified through silica gel chromatography (EtOAc/PE 1:99) to yield *N*-(1,1,3-triphenylprop-2-yn-1-yl)aniline (**5**) as a yellow solid (146 mg, 81% yield). mp 80−81 °C (lit.[27] mp 81 °C); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76−7.74 (m, 4H), 7.40−7.36 (m, 3H), 7.34−7.32 (m, 3H), 7.28−7.25 (m, 5H), 7.13−7.08 (m, 2H), 6.77−6.73 (m, 1H), 6.70−6.68 (m, 2H), 4.47 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.3, 144.3, 131.7, 128.6, 128.4, 128.28, 128.26, 127.6, 126.9, 123.0, 118.6, 116.6, 90.9, 87.0, 63.7; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ calcd for $C_{27}H_{22}N$ 360.1747, found 360.1749.

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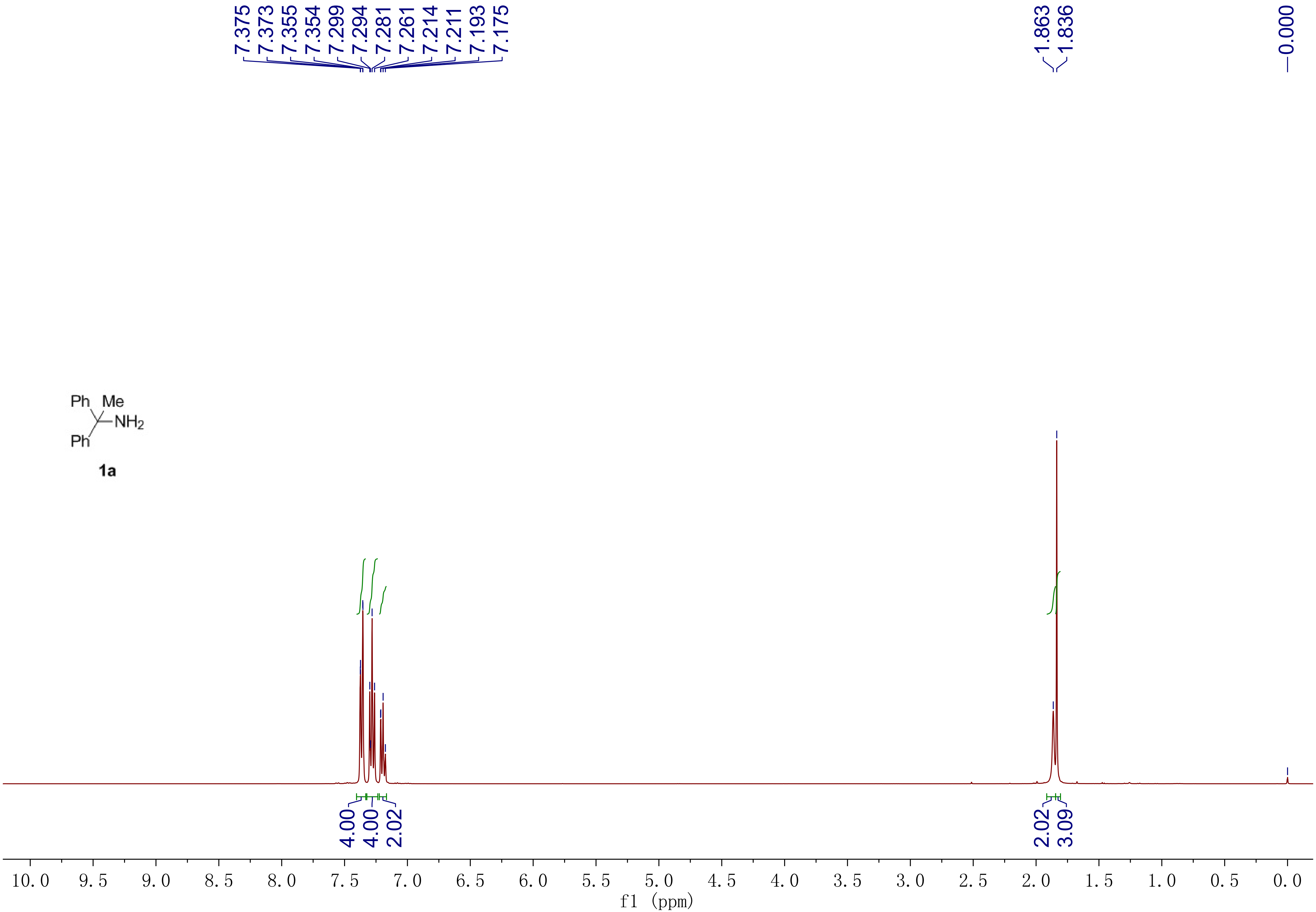
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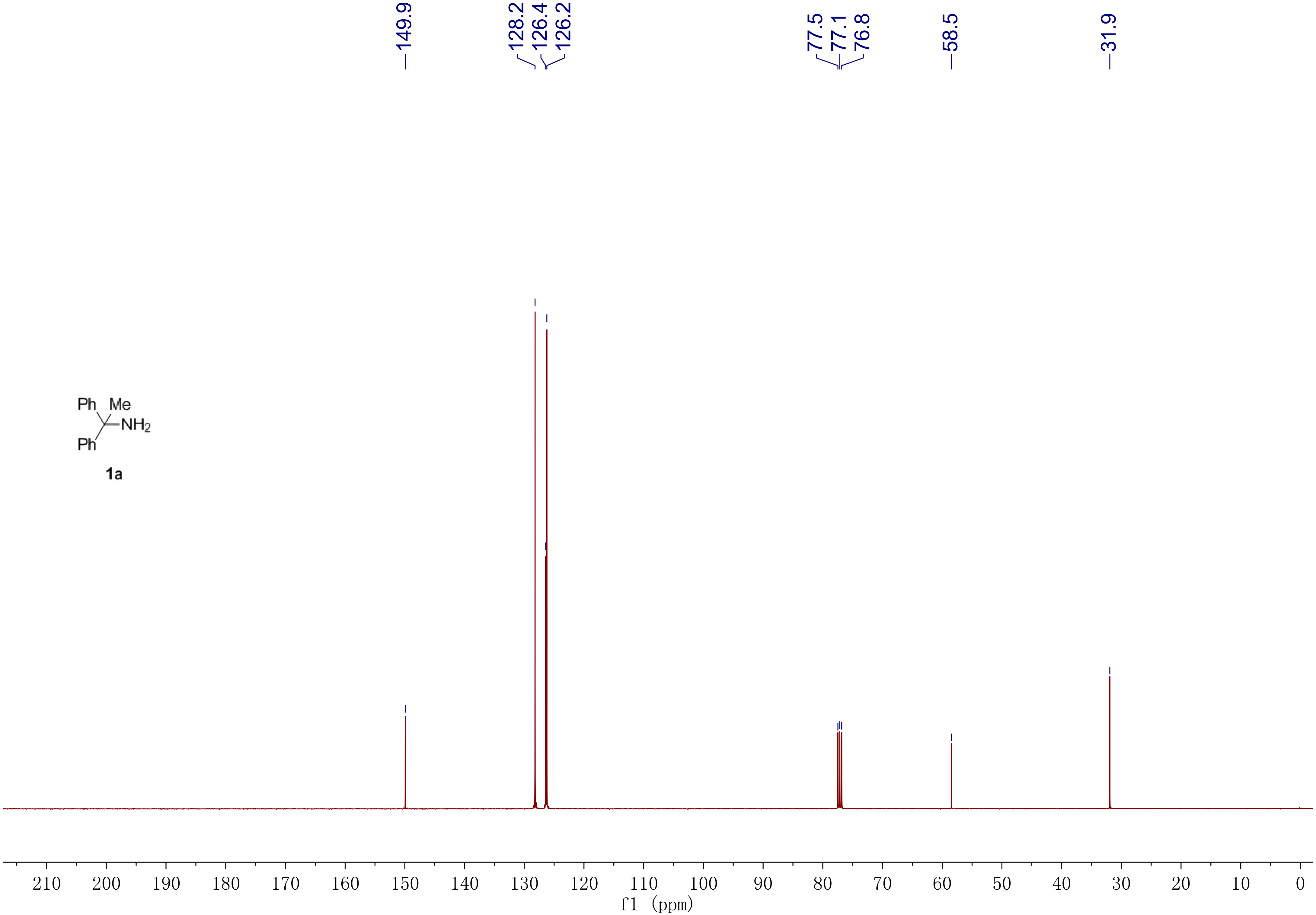
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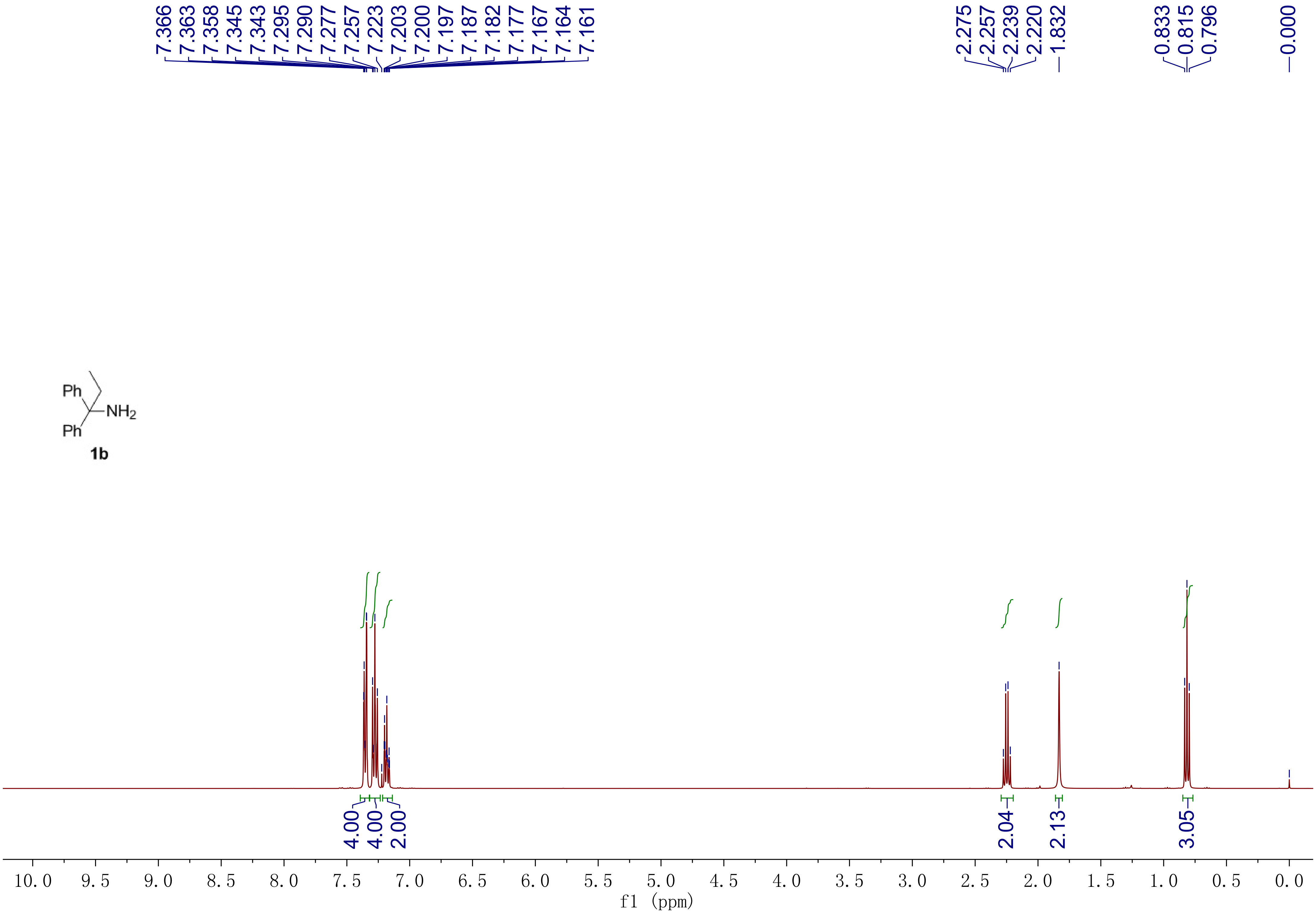
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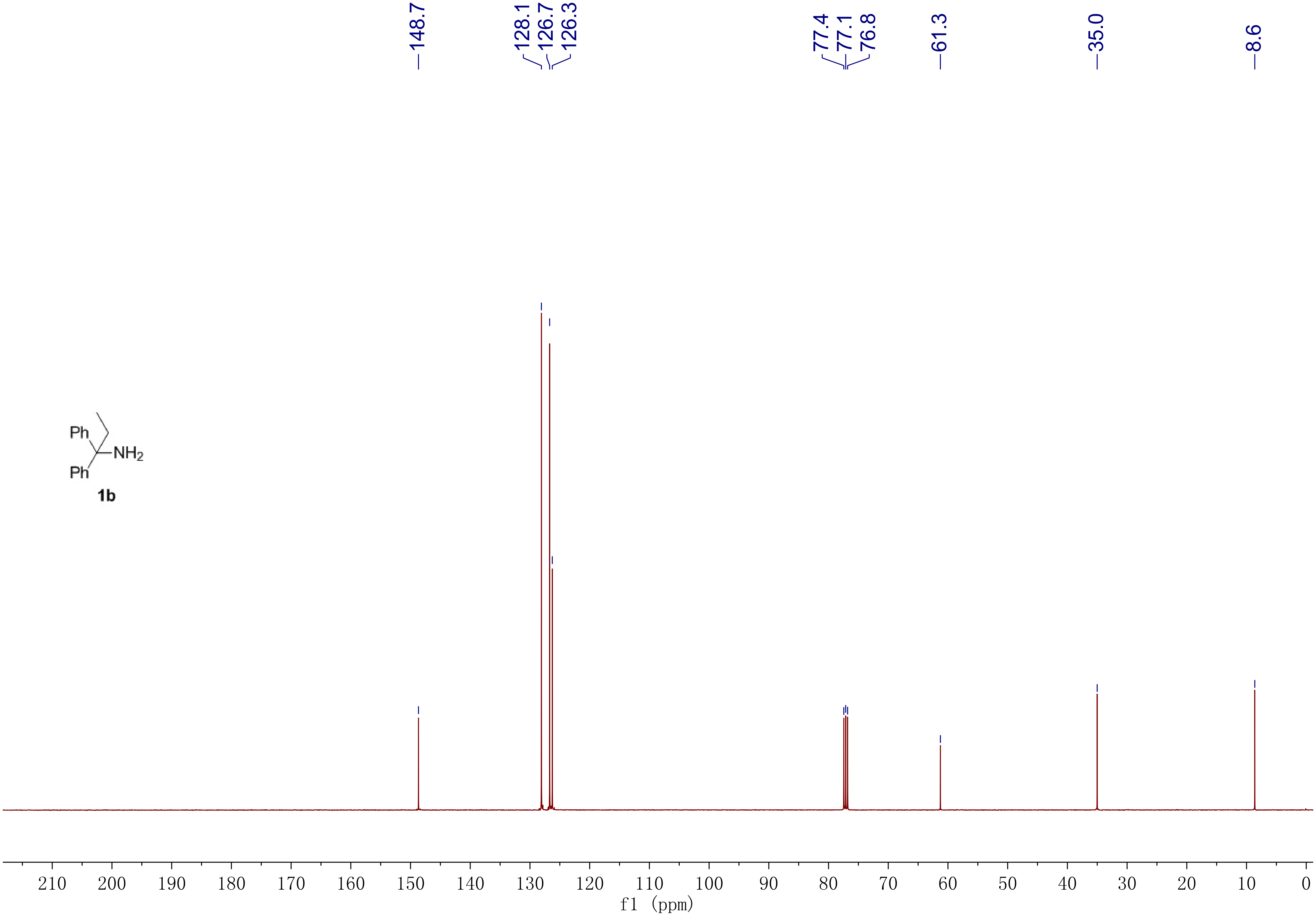
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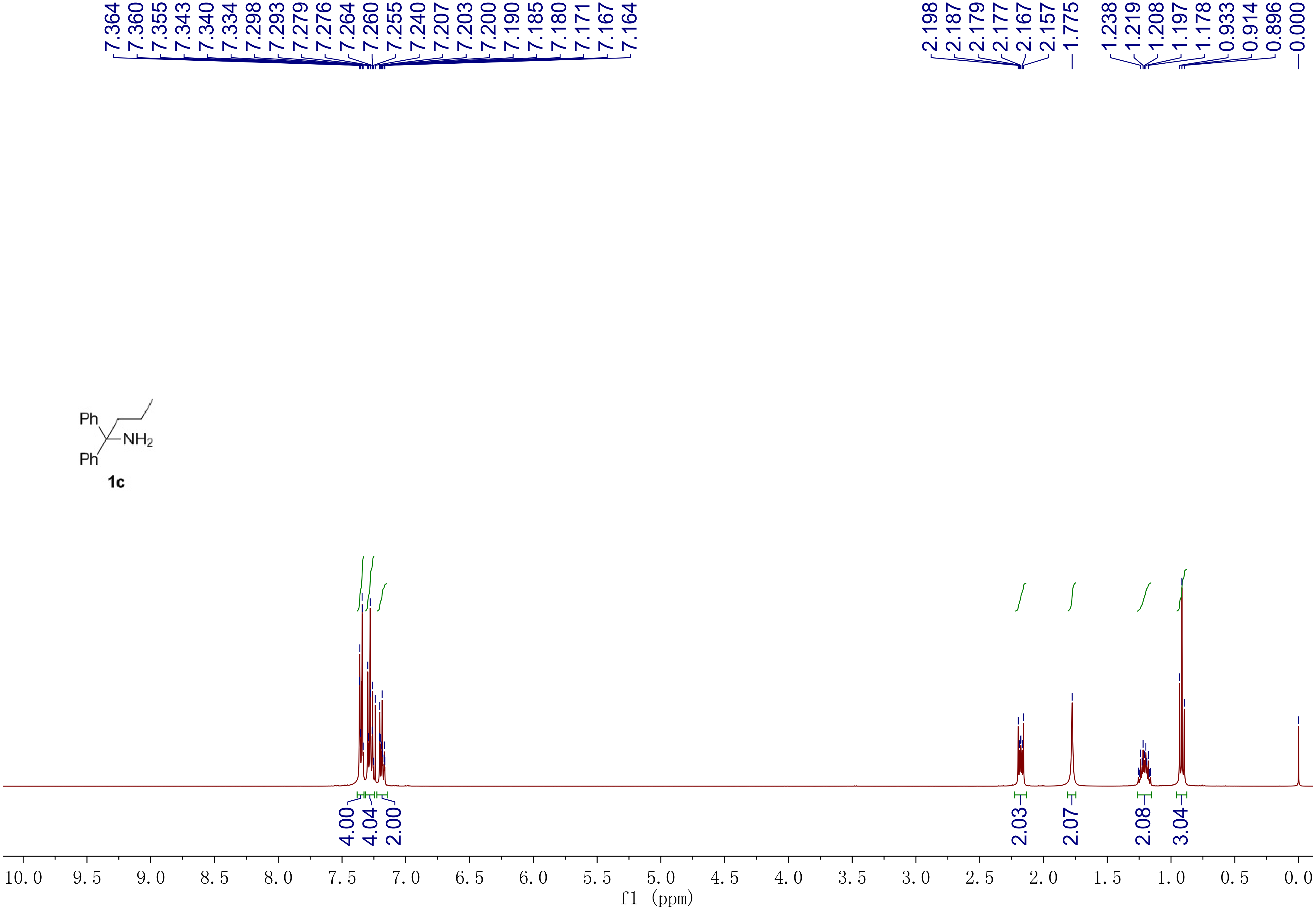
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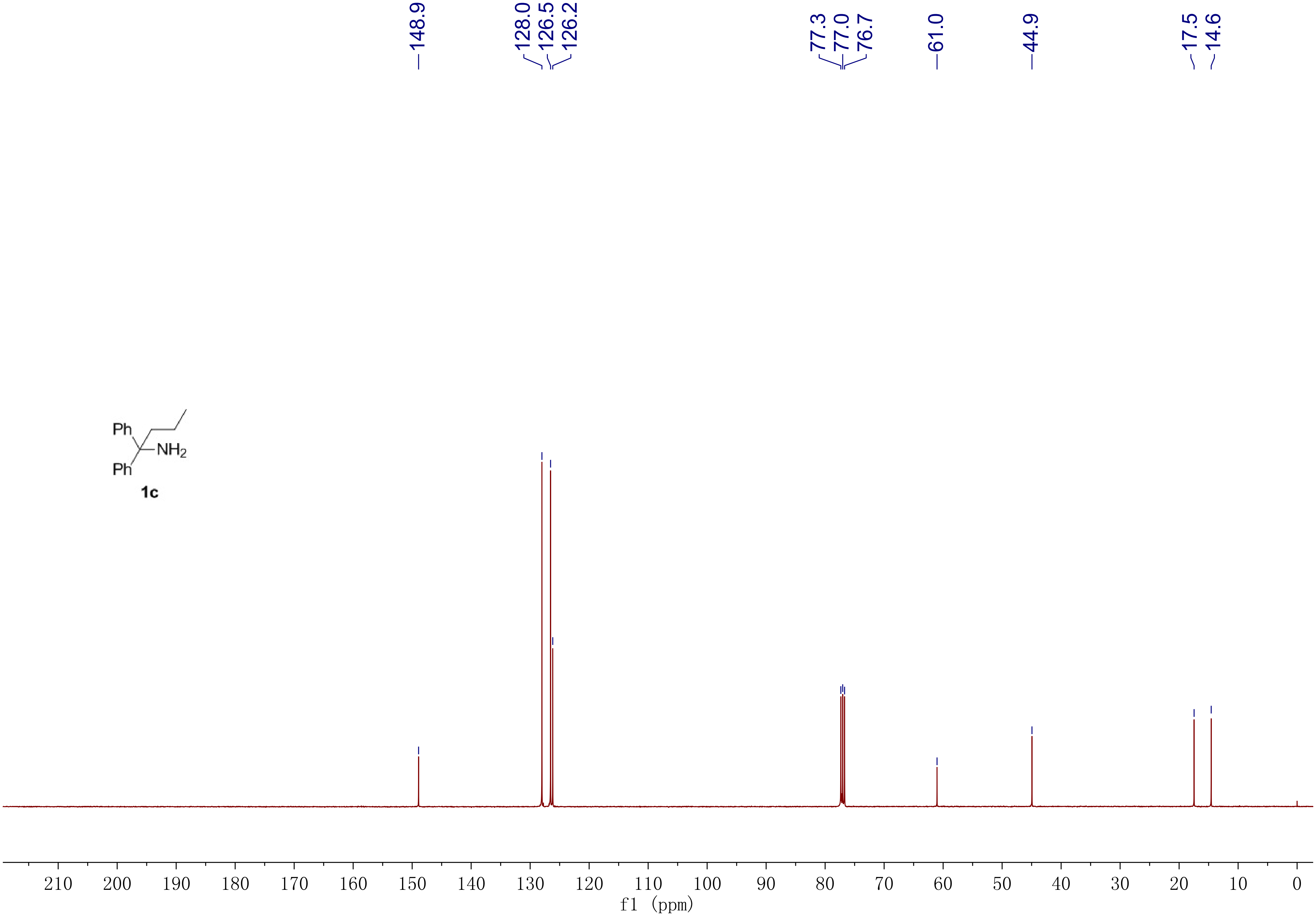
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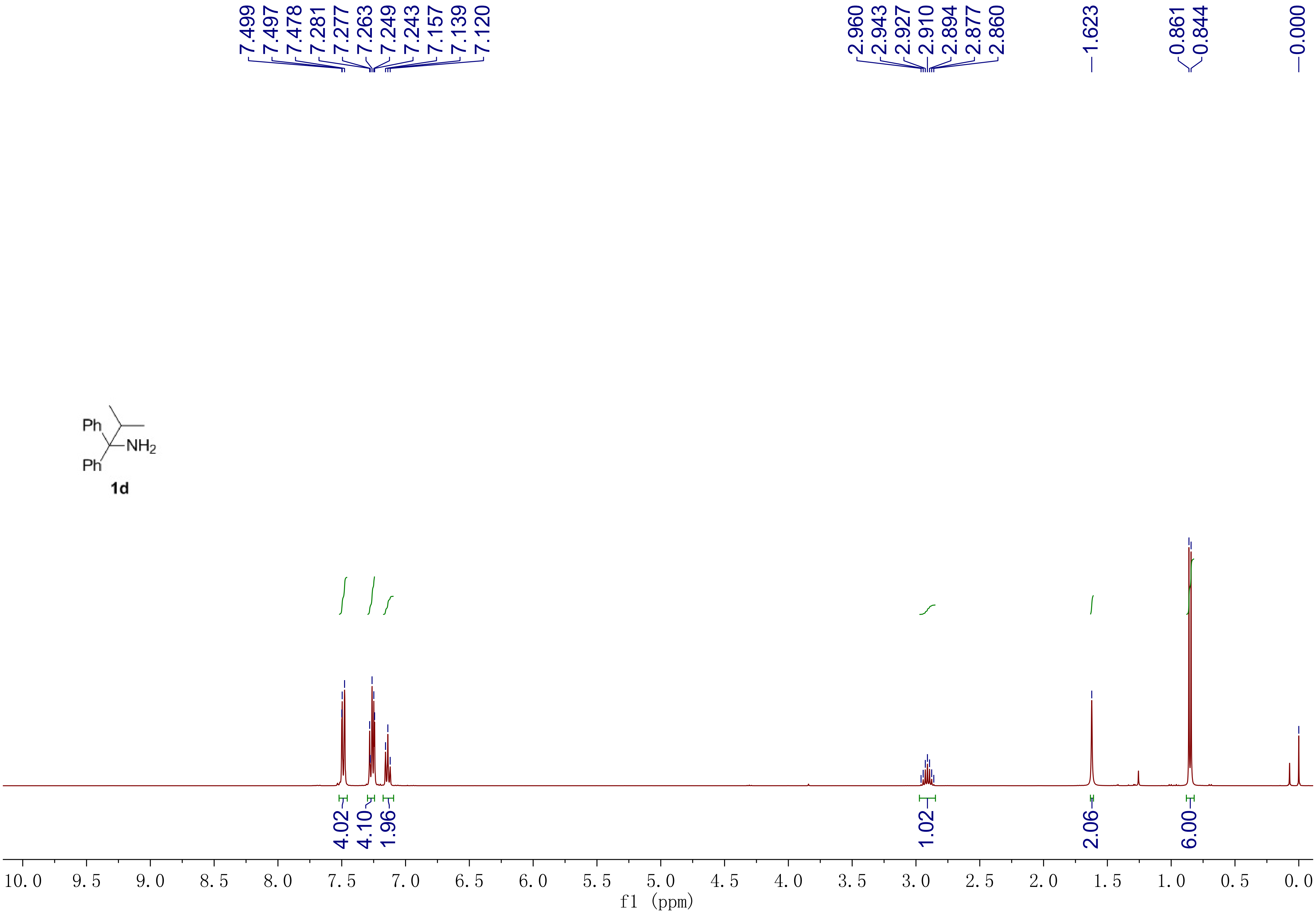
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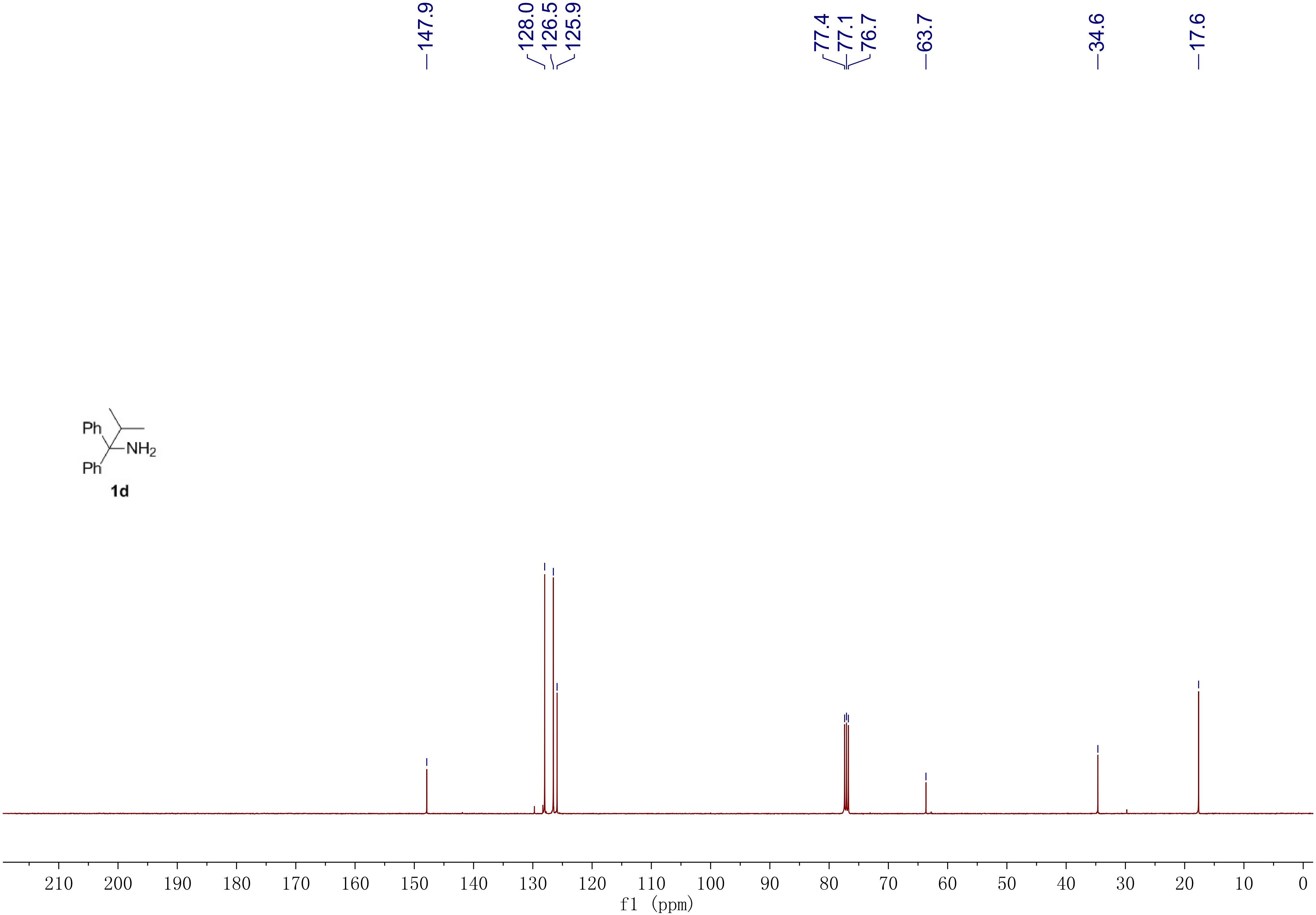
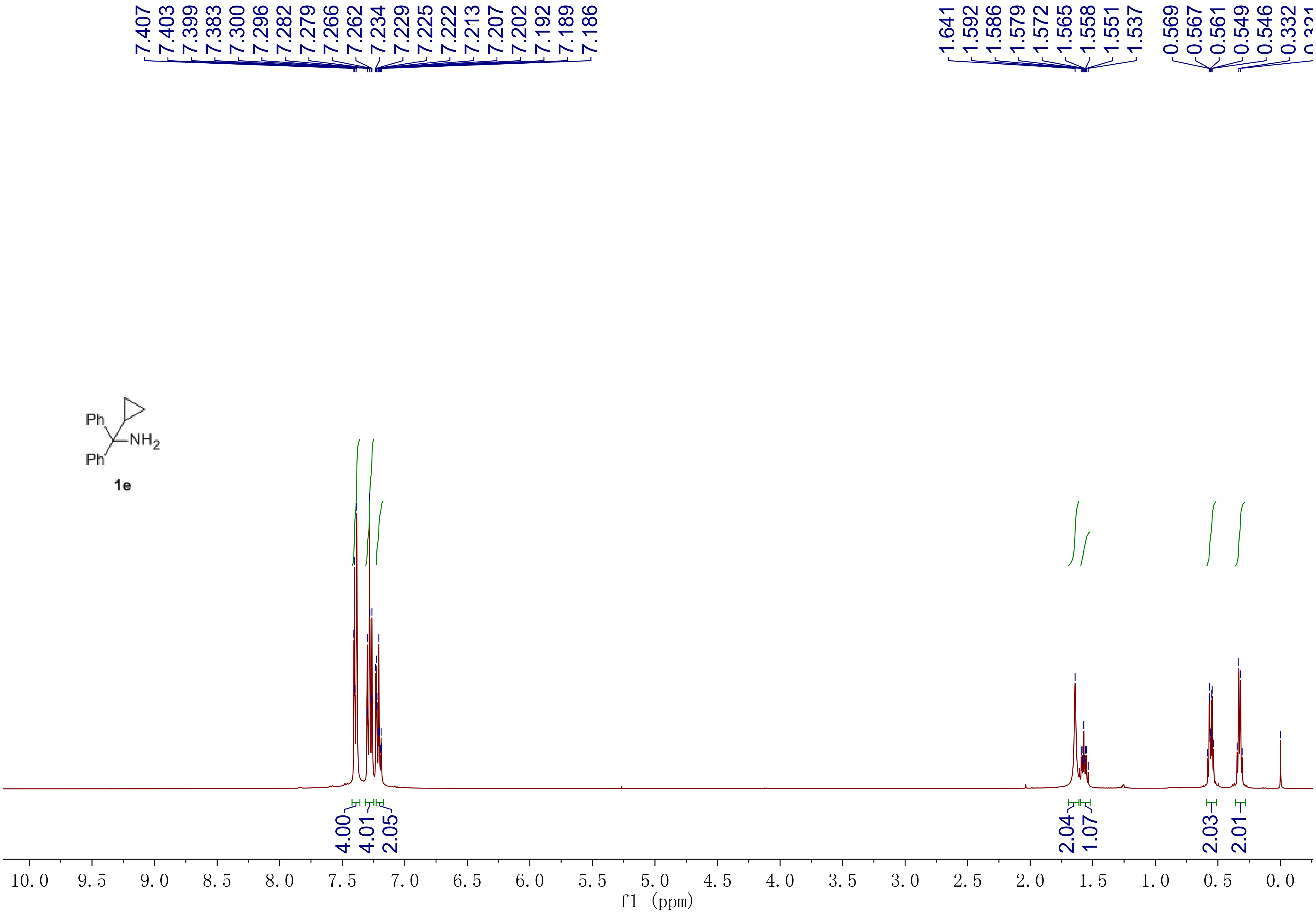
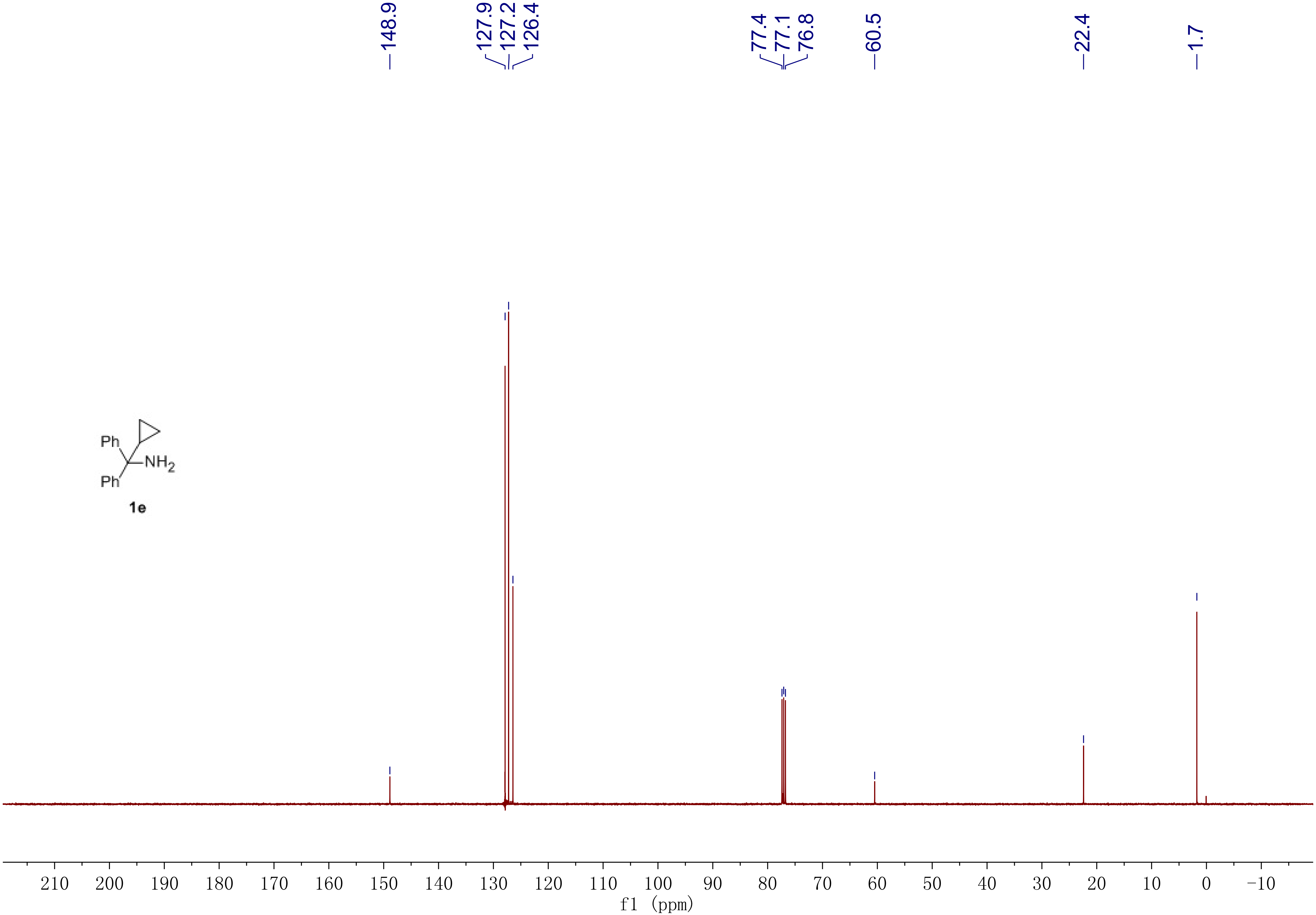
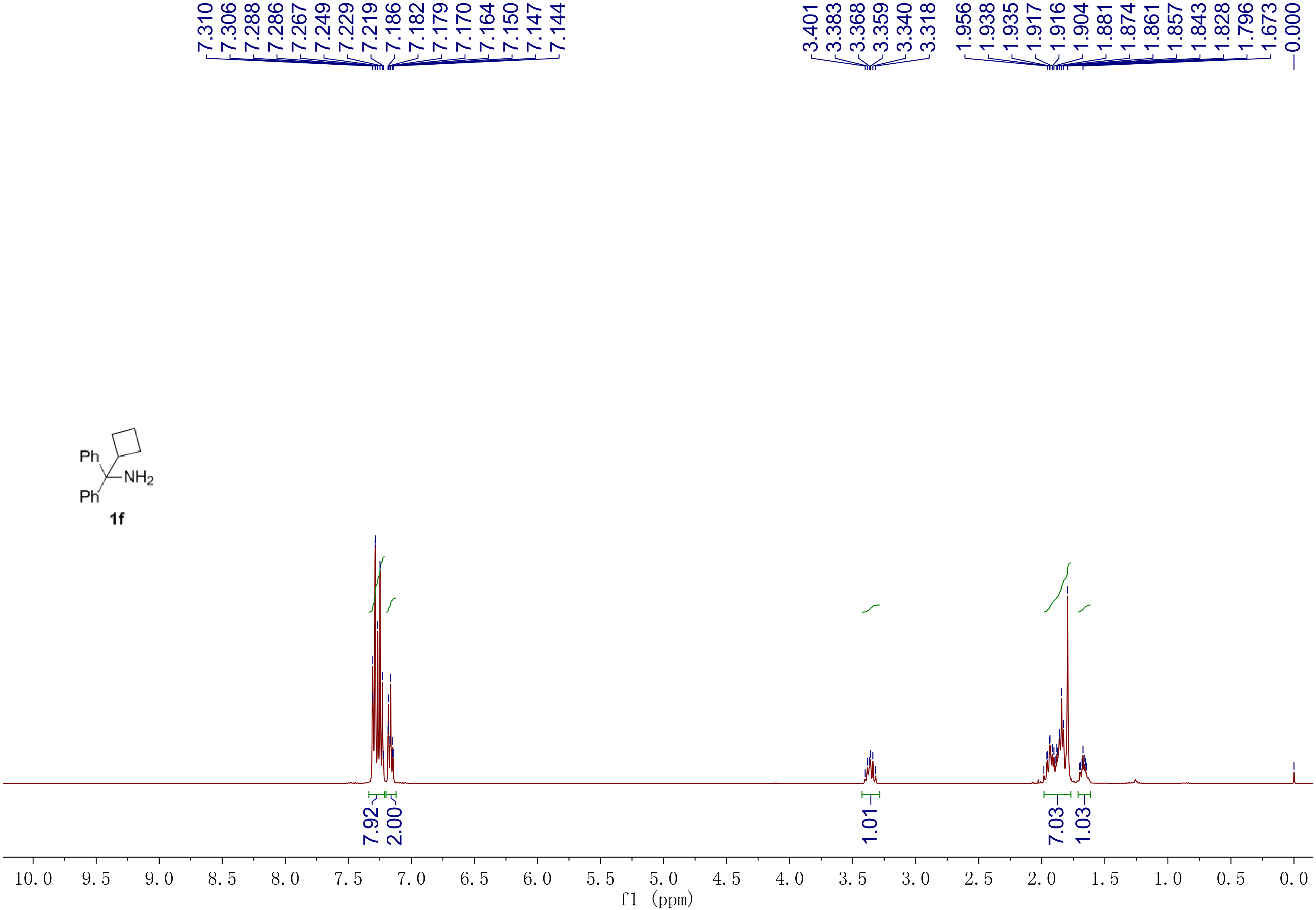
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

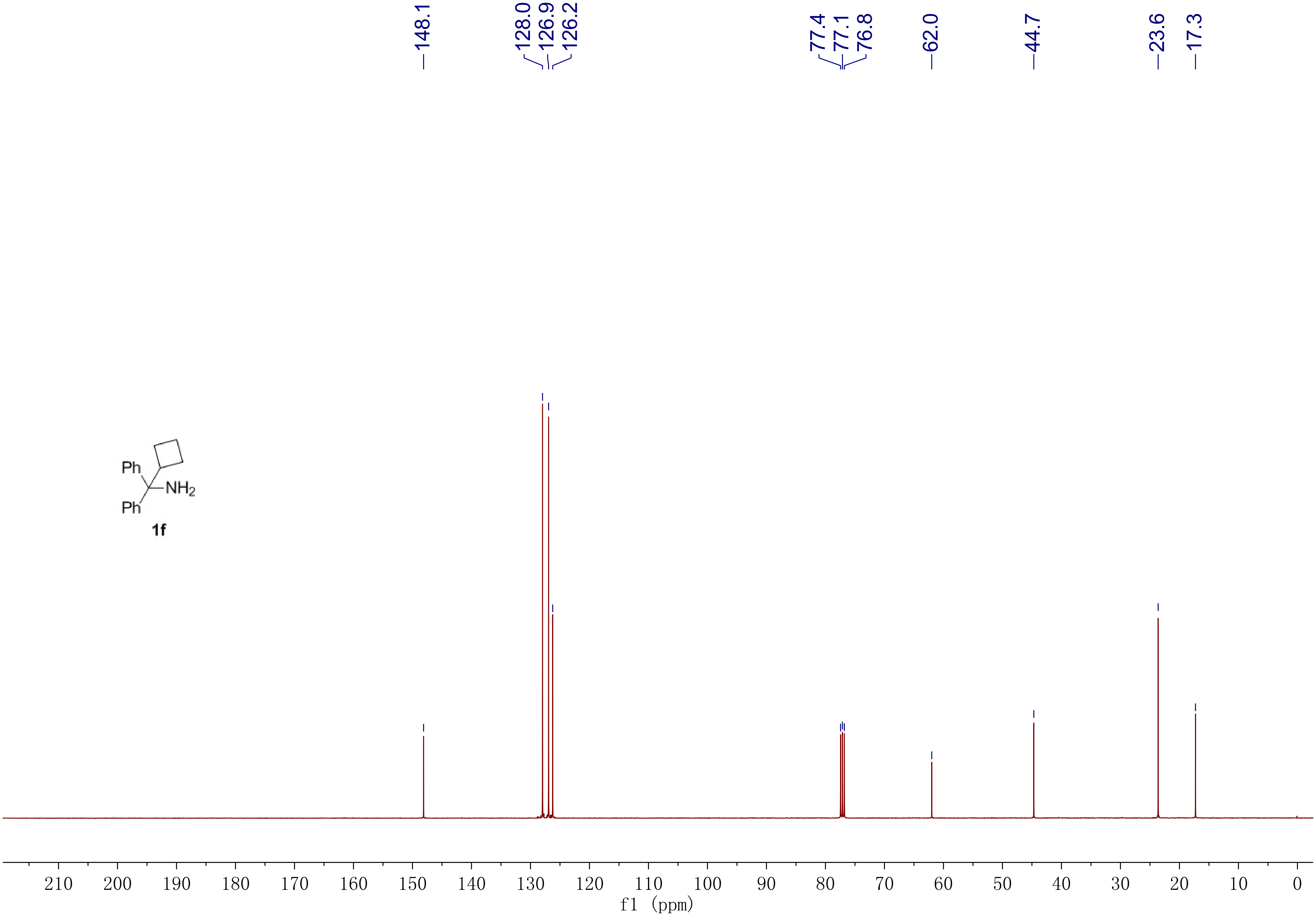

147.9
128.0
126.5
125.9
77.4
77.1
76.7
63.7
34.6
17.6
Ph
Ph
NH_2
1d
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

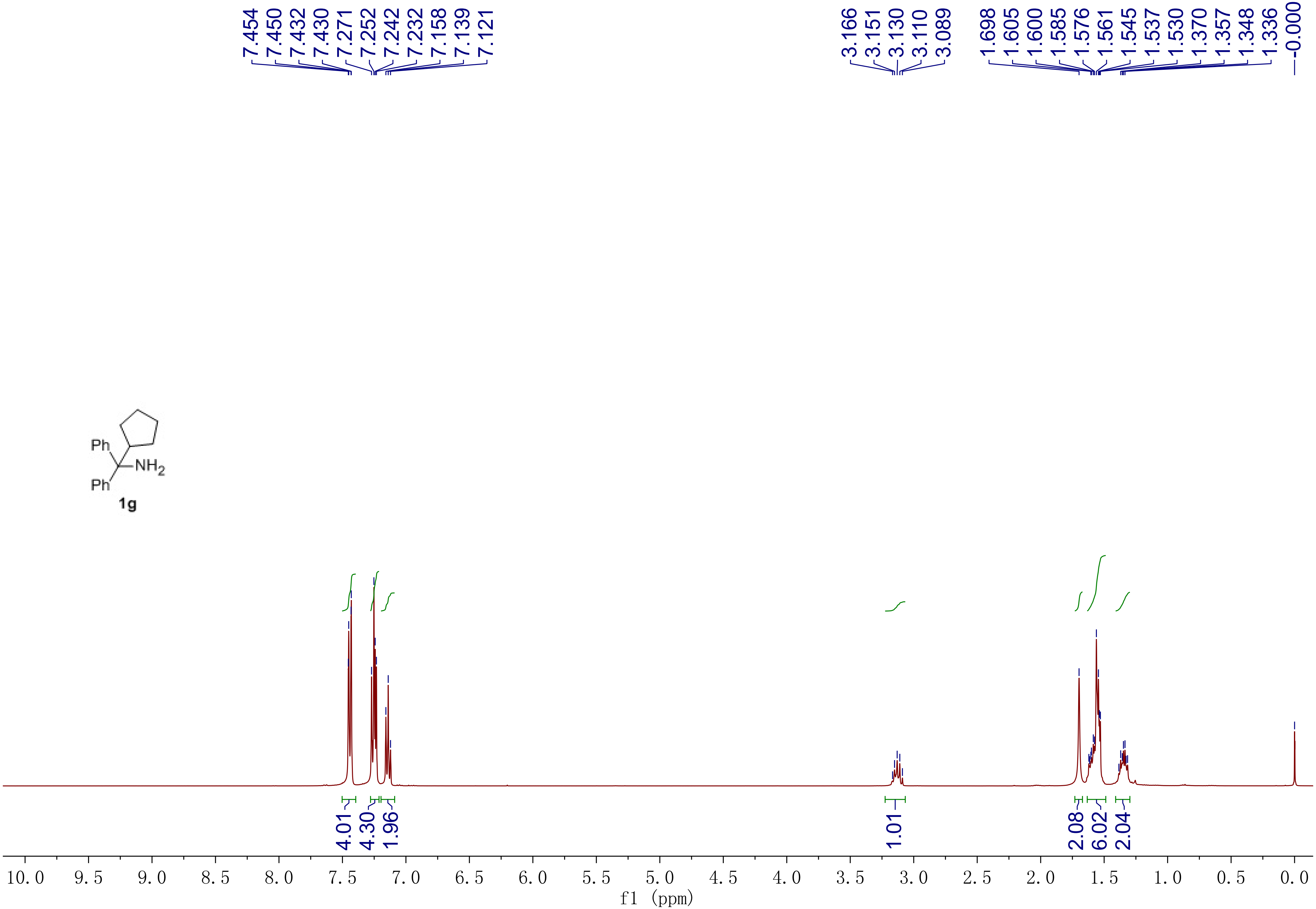

7.407
7.403
7.399
7.383
7.300
7.296
7.282
7.279
7.266
7.262
7.234
7.229
7.225
7.222
7.213
7.207
7.202
7.192
7.189
7.186
1.641
1.592
1.586
1.579
1.572
1.565
1.558
1.551
1.537
0.569
0.567
0.561
0.549
0.546
0.332
0.321
Ph
NH2
Ph
4.00
4.01
2.05
2.04
1.07
2.03
2.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

1e

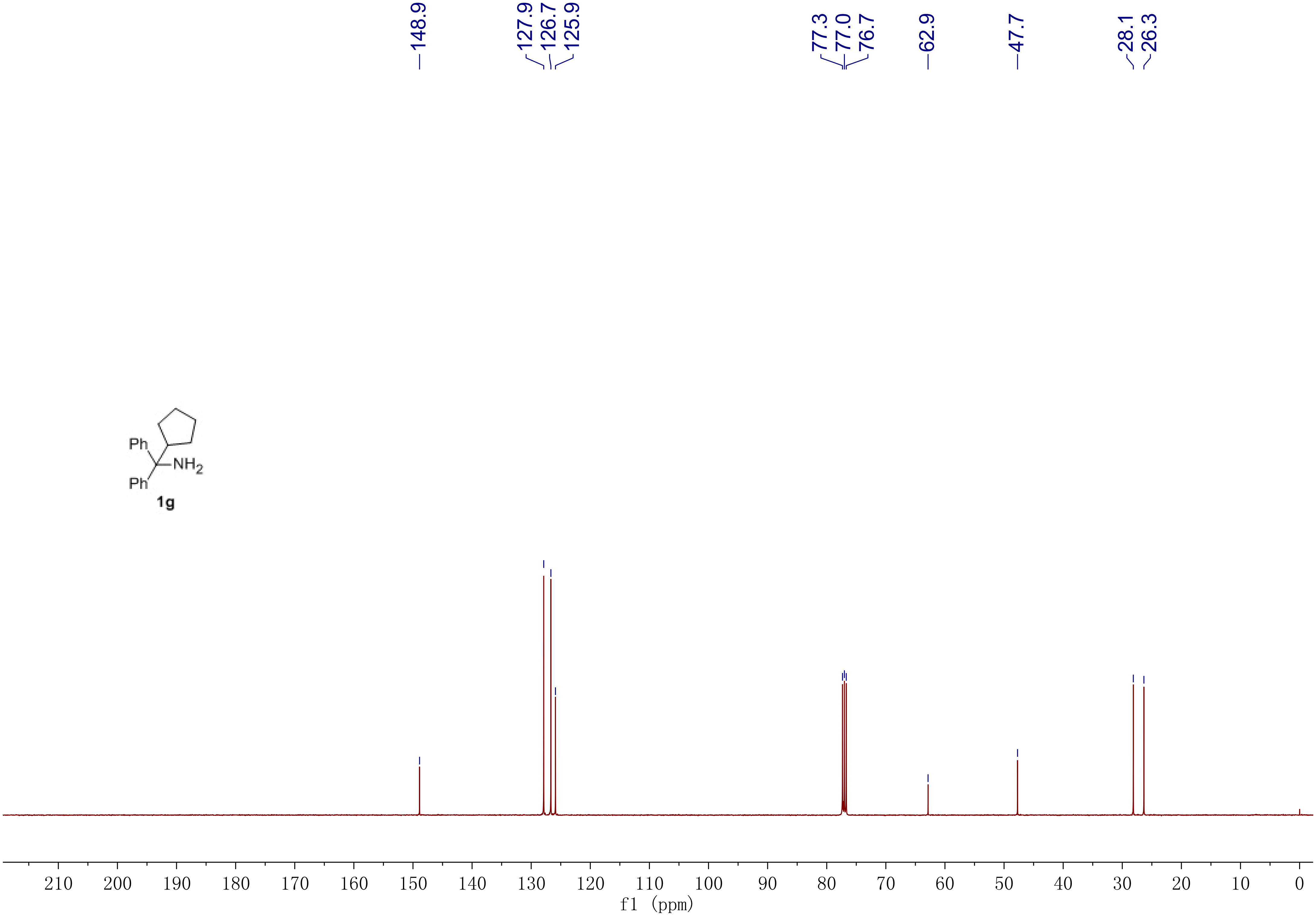

148.9
127.9
127.2
126.4
77.4
77.1
76.8
60.5
22.4
1.7
Ph
Ph
NH2
1e
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

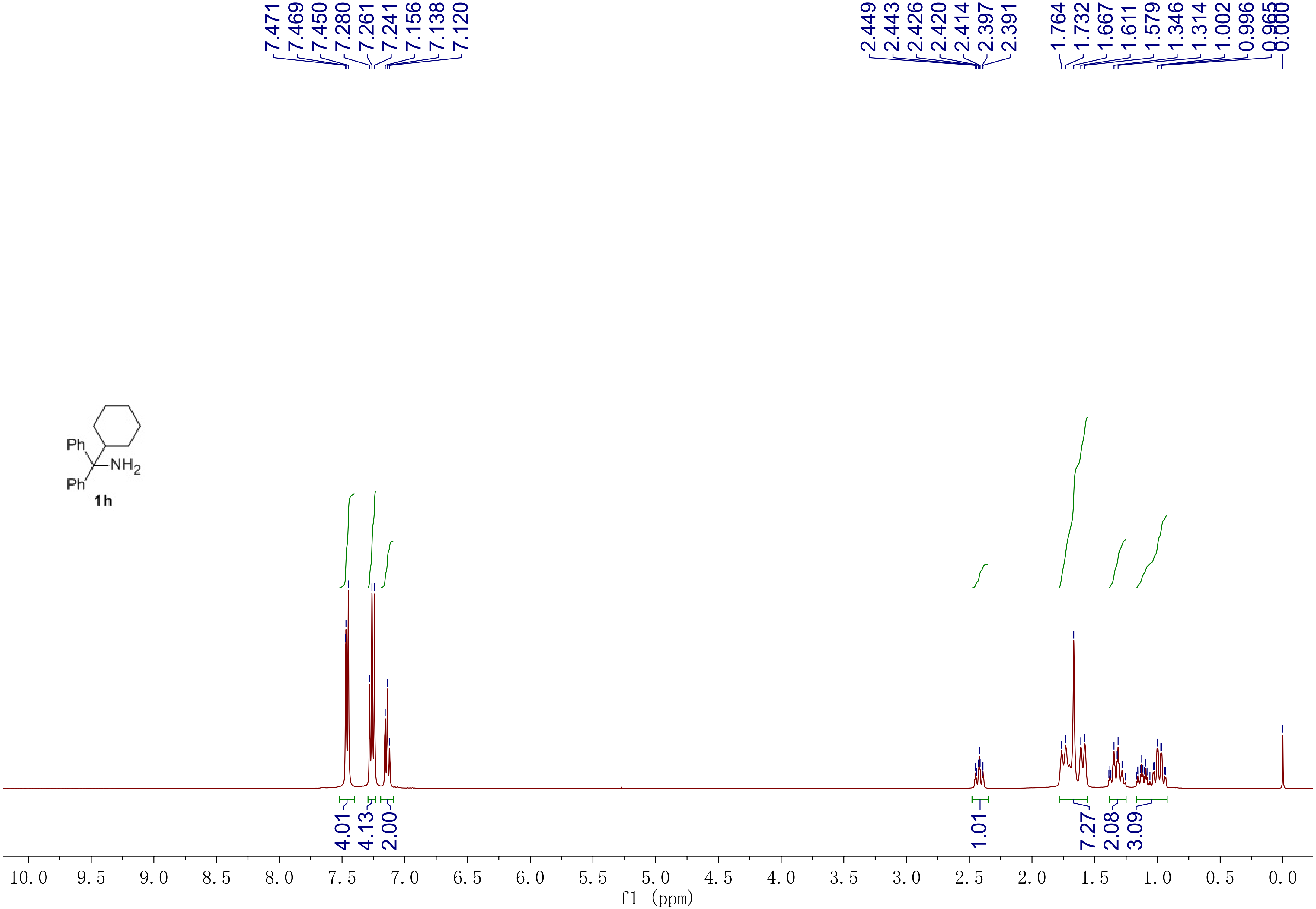

7.310
7.306
7.288
7.286
7.267
7.249
7.229
7.219
7.186
7.182
7.179
7.170
7.164
7.150
7.147
7.144
3.401
3.383
3.368
3.359
3.340
3.318
1.956
1.938
1.935
1.917
1.916
1.904
1.881
1.874
1.861
1.857
1.843
1.828
1.796
1.673
0.000
Ph
Ph
NH2
1f
7.92
2.00
1.01
7.03
1.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

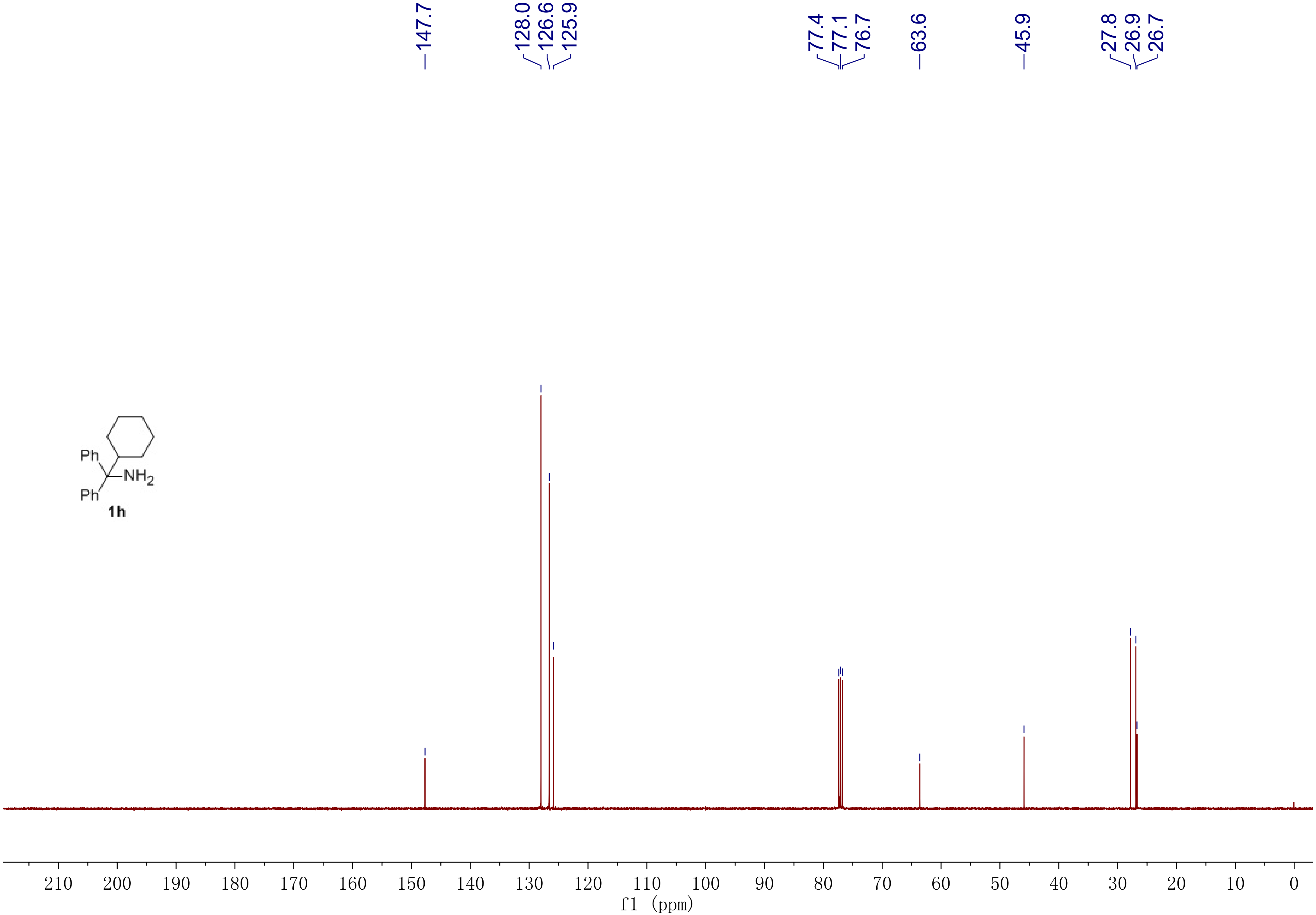

148.1
128.0
126.9
126.2
77.4
77.1
76.8
62.0
44.7
23.6
17.3
Ph
Ph
NH2
1f
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.454
7.450
7.432
7.430
7.271
7.252
7.242
7.232
7.158
7.139
7.121
3.166
3.151
3.130
3.110
3.089
1.698
1.605
1.600
1.585
1.576
1.561
1.545
1.537
1.530
1.370
1.357
1.348
1.336
-0.000
Ph
NH$_2$
Ph
4.01
4.30
1.96
1.01
2.08
6.02
2.04
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
f1 (ppm)

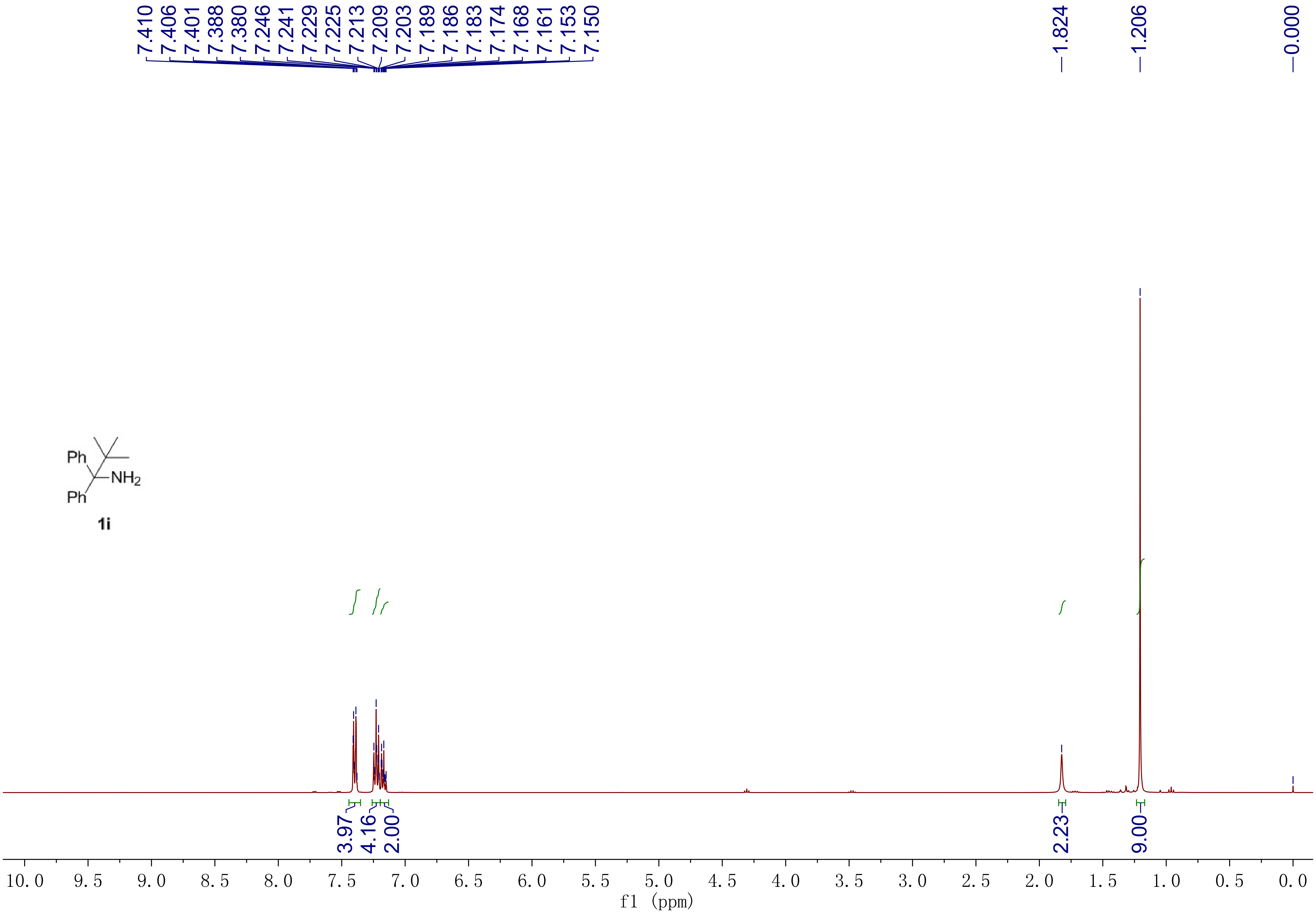
1g

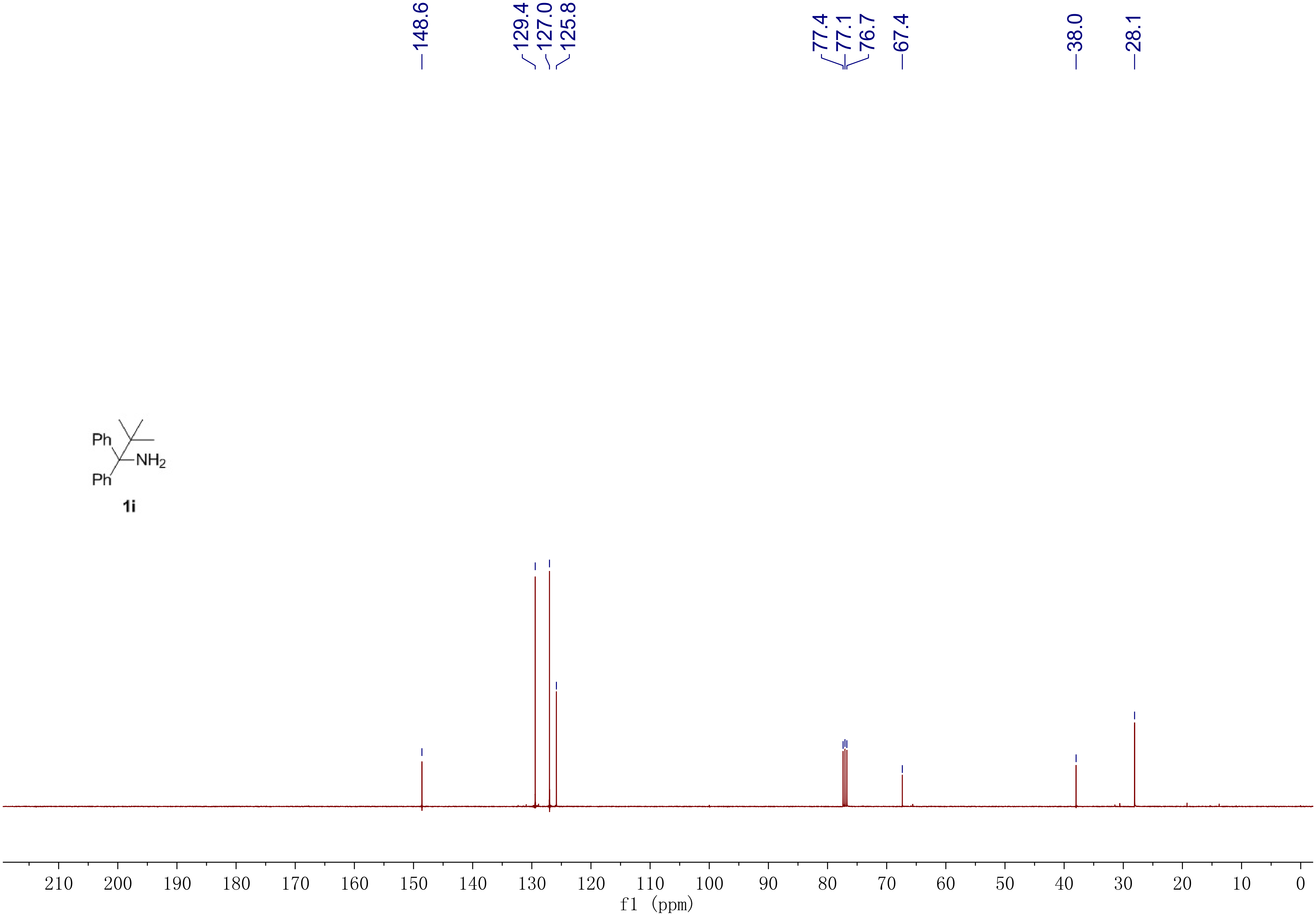

148.9
127.9
126.7
125.9
77.3
77.0
76.7
62.9
47.7
28.1
26.3
Ph
NH2
Ph
1g
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.471
7.469
7.450
7.280
7.261
7.241
7.156
7.138
7.120
2.449
2.443
2.426
2.420
2.414
2.397
2.391
1.764
1.732
1.667
1.611
1.579
1.346
1.314
1.002
0.996
0.965
0.000
Ph
NH$_2$
Ph
1h
4.01
4.13
2.00
1.01
7.27
2.08
3.09
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
f1 (ppm)

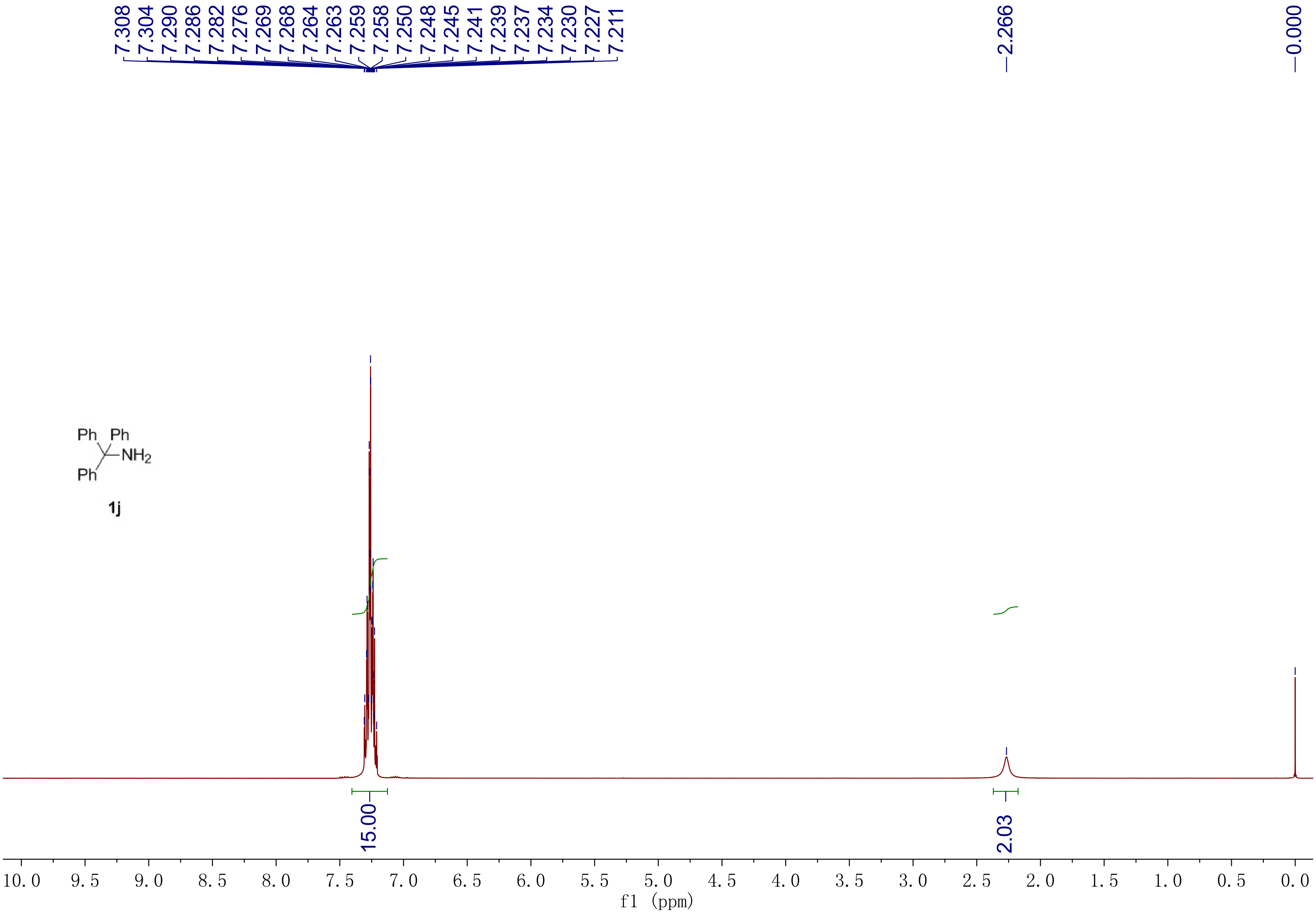

147.7
128.0
126.6
125.9
77.4
77.1
76.7
63.6
45.9
27.8
26.9
26.7
Ph
NH2
Ph
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

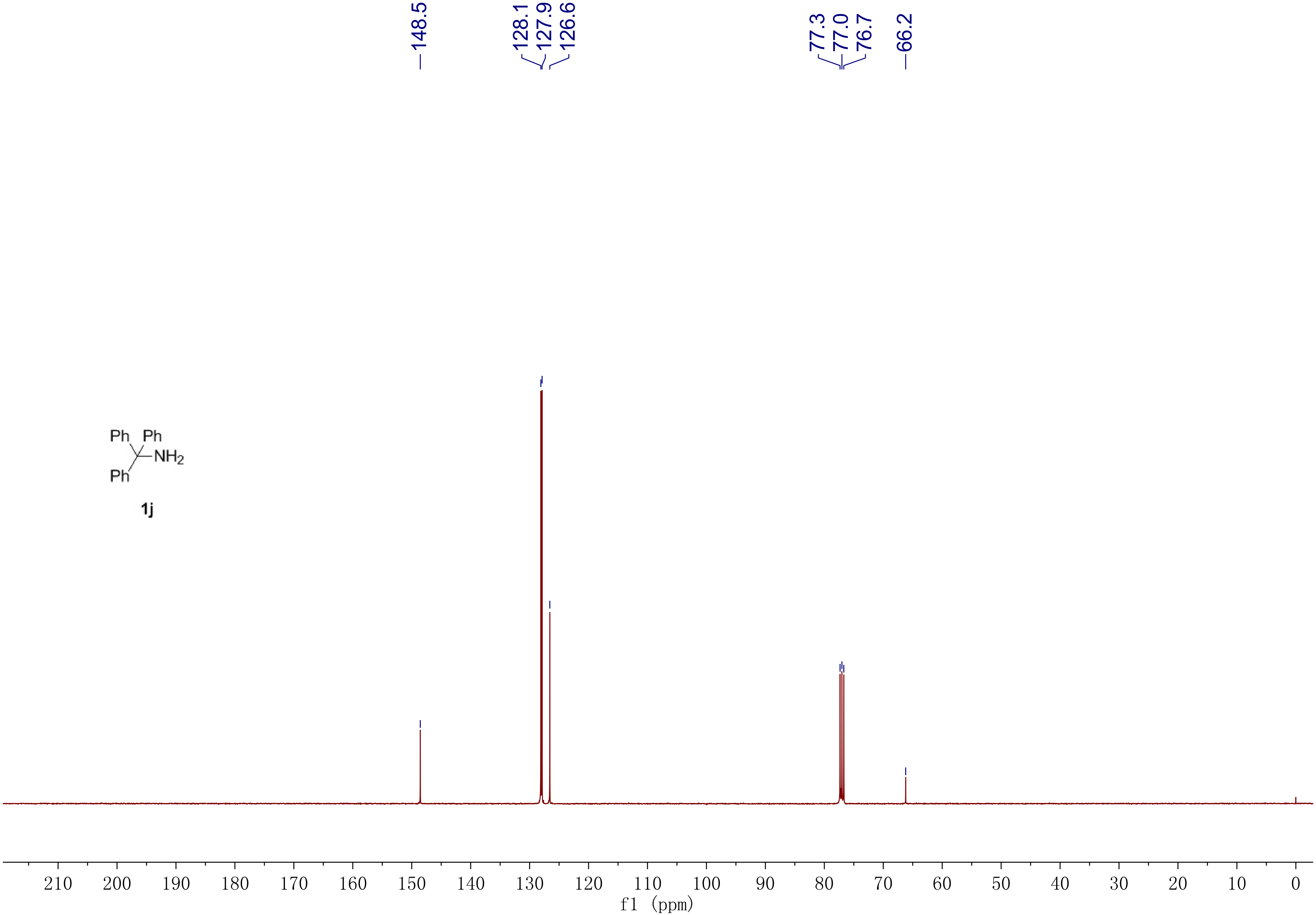
1h

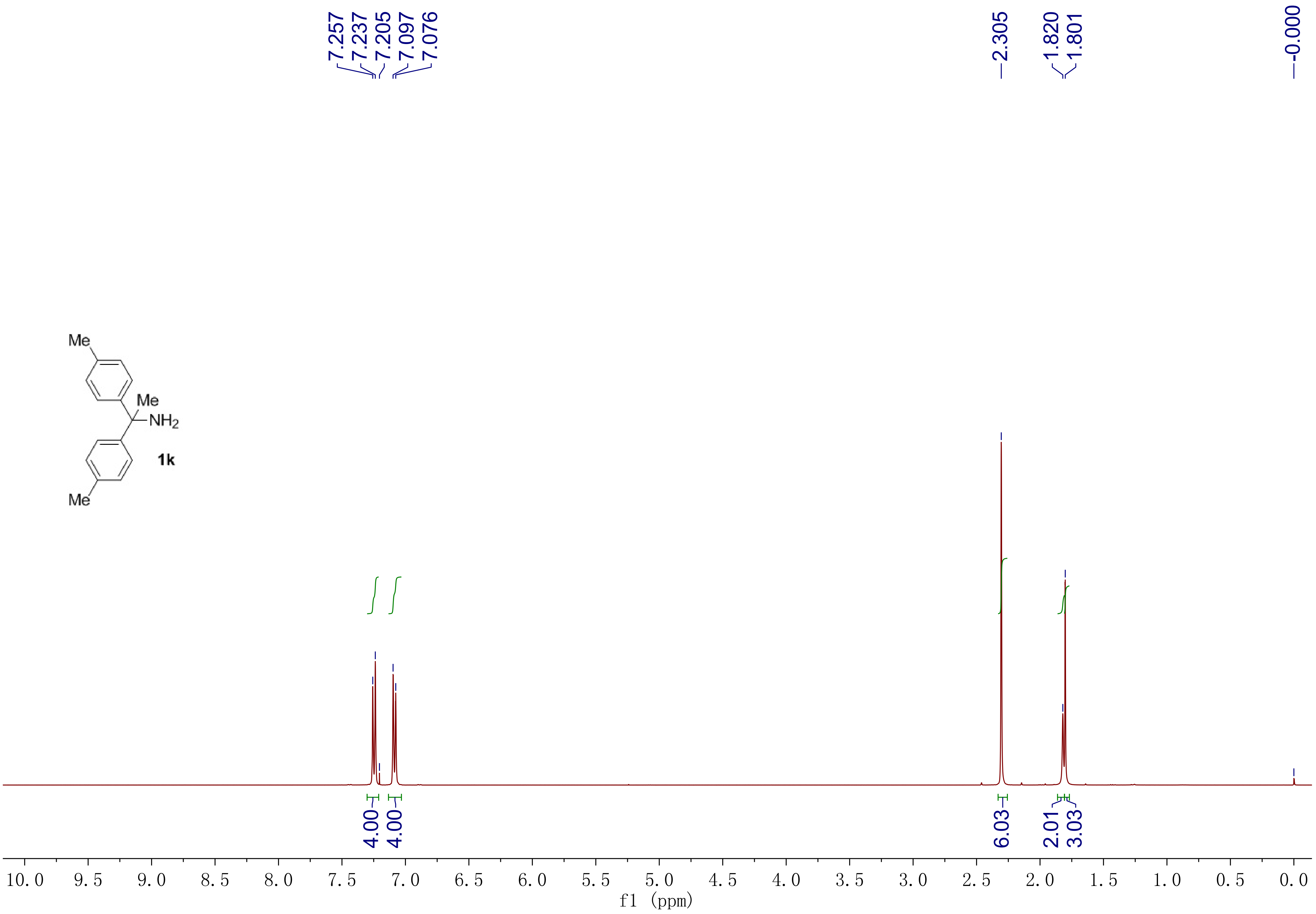

7.410
7.406
7.401
7.388
7.380
7.246
7.241
7.229
7.225
7.213
7.209
7.203
7.189
7.186
7.183
7.174
7.168
7.161
7.153
7.150
1.824
1.206
0.000
Ph
NH$_2$
Ph
1i
3.97
4.16
2.00
2.23
9.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

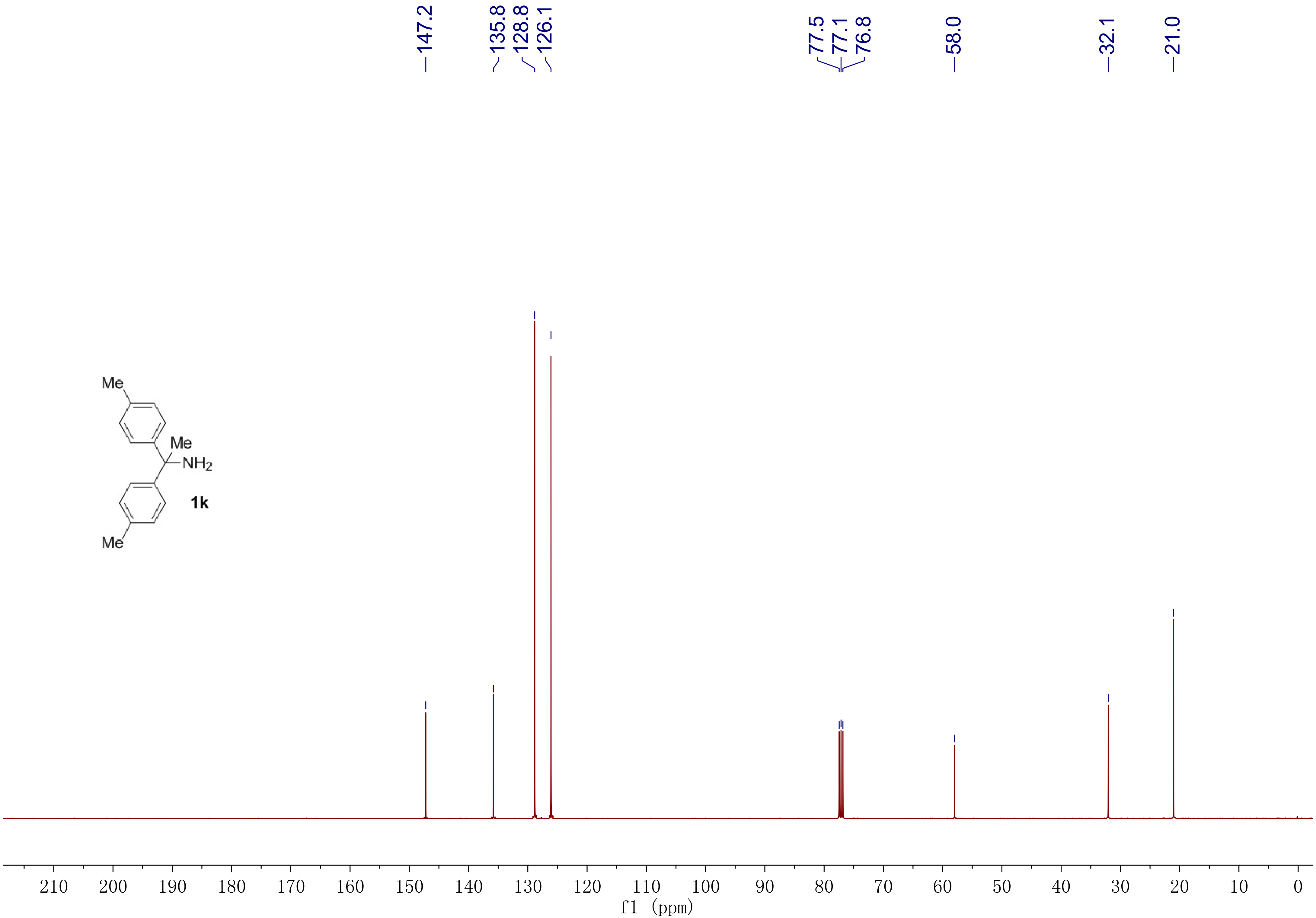

148.6
129.4
127.0
125.8
77.4
77.1
76.7
67.4
38.0
28.1
Ph
NH2
Ph
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

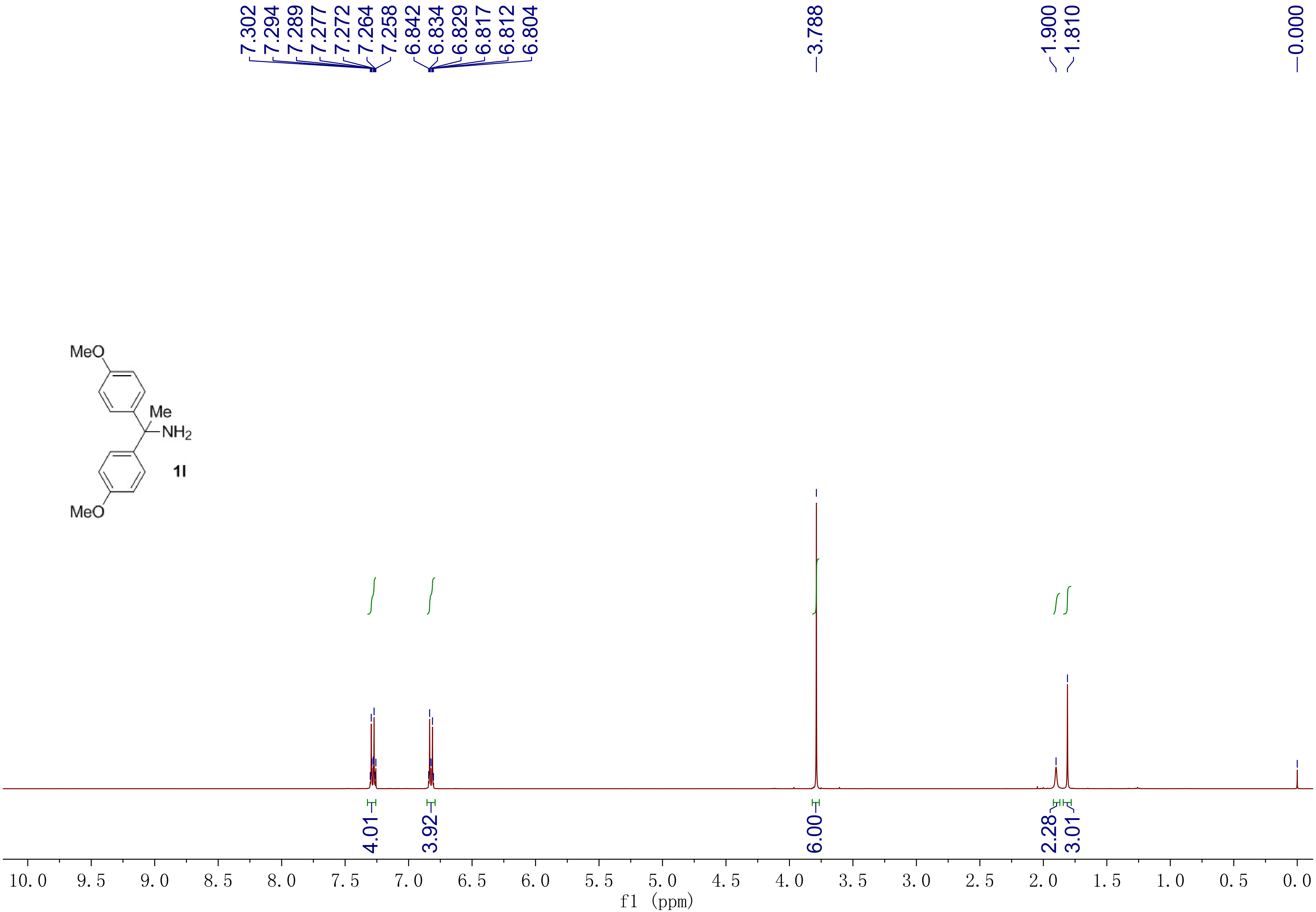
1i

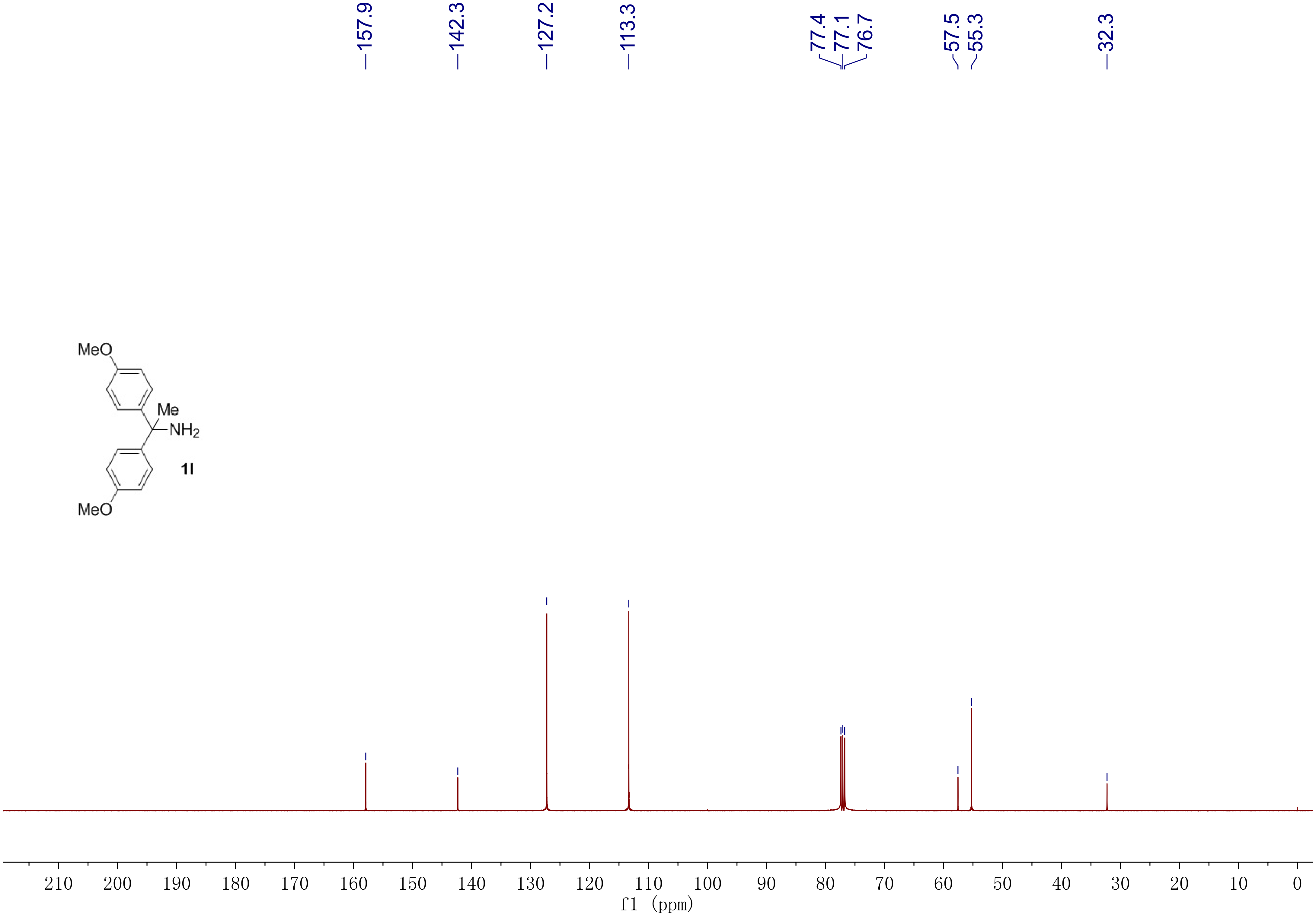

7.308
7.304
7.290
7.286
7.282
7.276
7.269
7.268
7.264
7.263
7.259
7.258
7.250
7.248
7.245
7.241
7.239
7.237
7.234
7.230
7.227
7.211
2.266
0.000
Ph
Ph
NH$_2$
Ph
1j
15.00
2.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


148.5
128.1
127.9
126.6
77.3
77.0
76.7
66.2
Ph
Ph
NH$_2$
Ph
1j
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

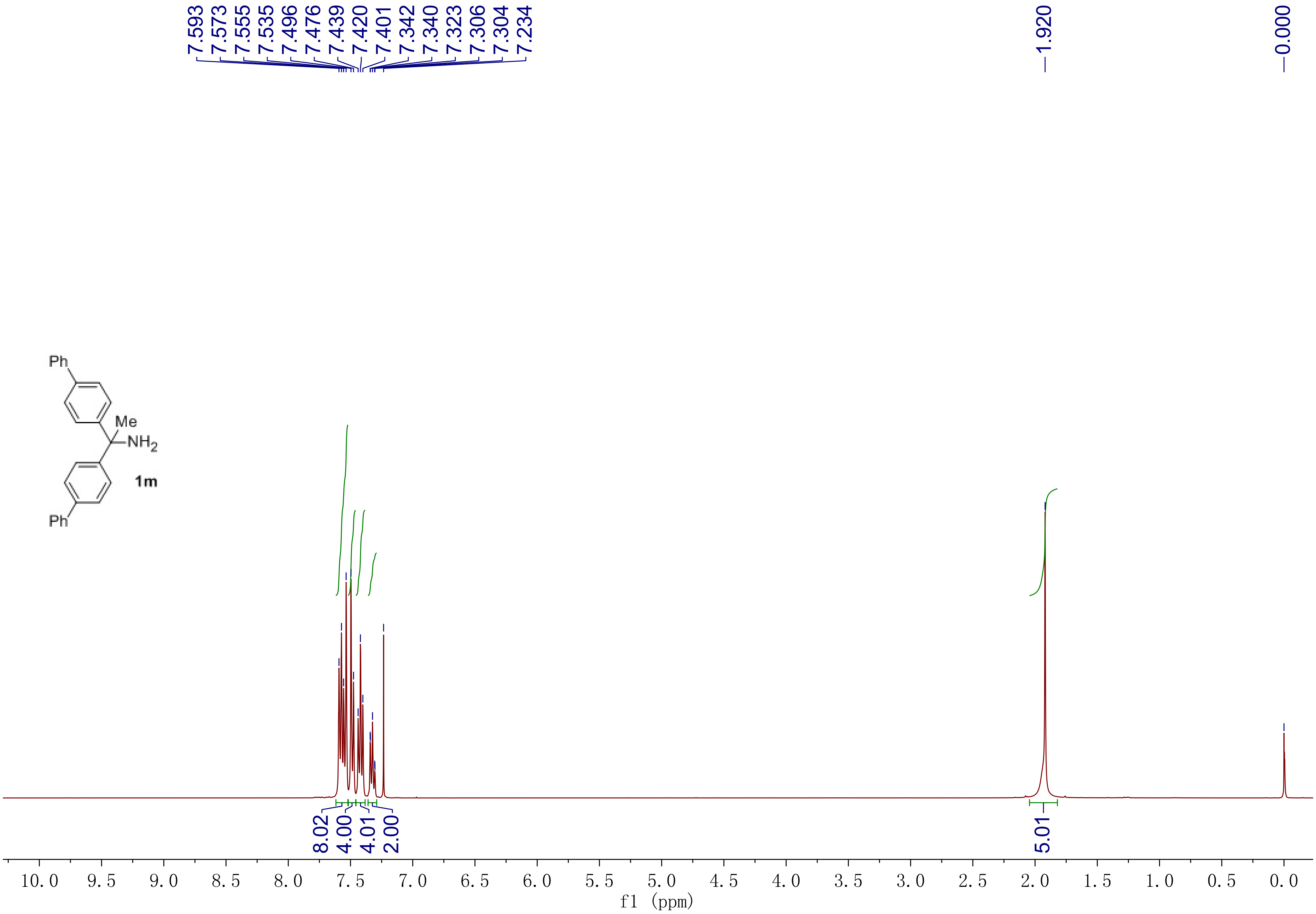

7.257
7.237
7.205
7.097
7.076
2.305
1.820
1.801
-0.000
Me
Me
NH2
Me
1k
4.00
4.00
6.03
2.01
3.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


147.2
135.8
128.8
126.1
77.5
77.1
76.8
58.0
32.1
21.0
Me
Me
NH2
Me
1k
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.302
7.294
7.289
7.277
7.272
7.264
7.258
6.842
6.834
6.829
6.817
6.812
6.804
3.788
1.900
1.810
0.000
MeO
Me
NH2
MeO
1l
4.01
3.92
6.00
2.28
3.01
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
f1 (ppm)


157.9
142.3
127.2
113.3
77.4
77.1
76.7
57.5
55.3
32.3
MeO
Me
NH$_2$
MeO
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

1l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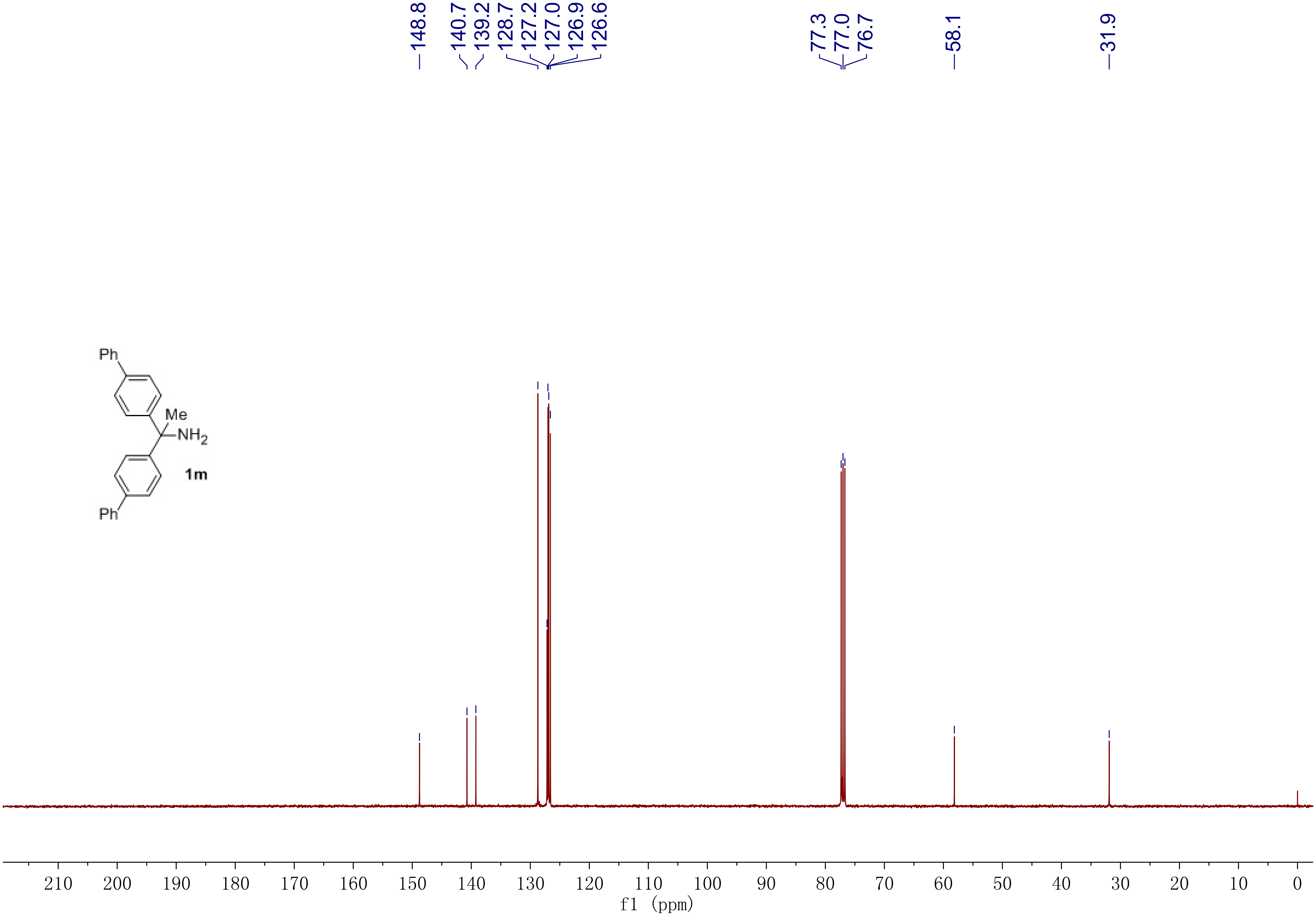
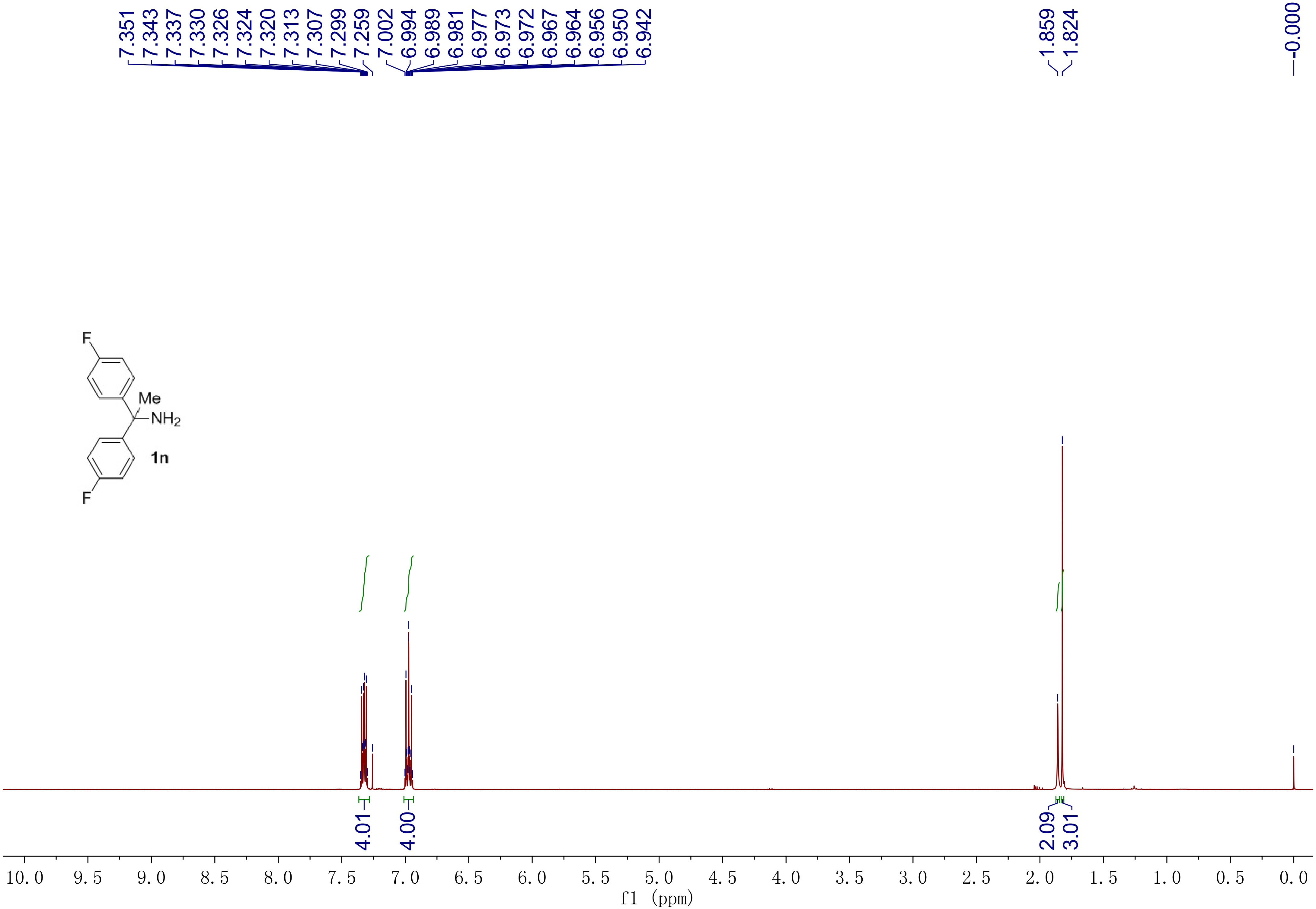
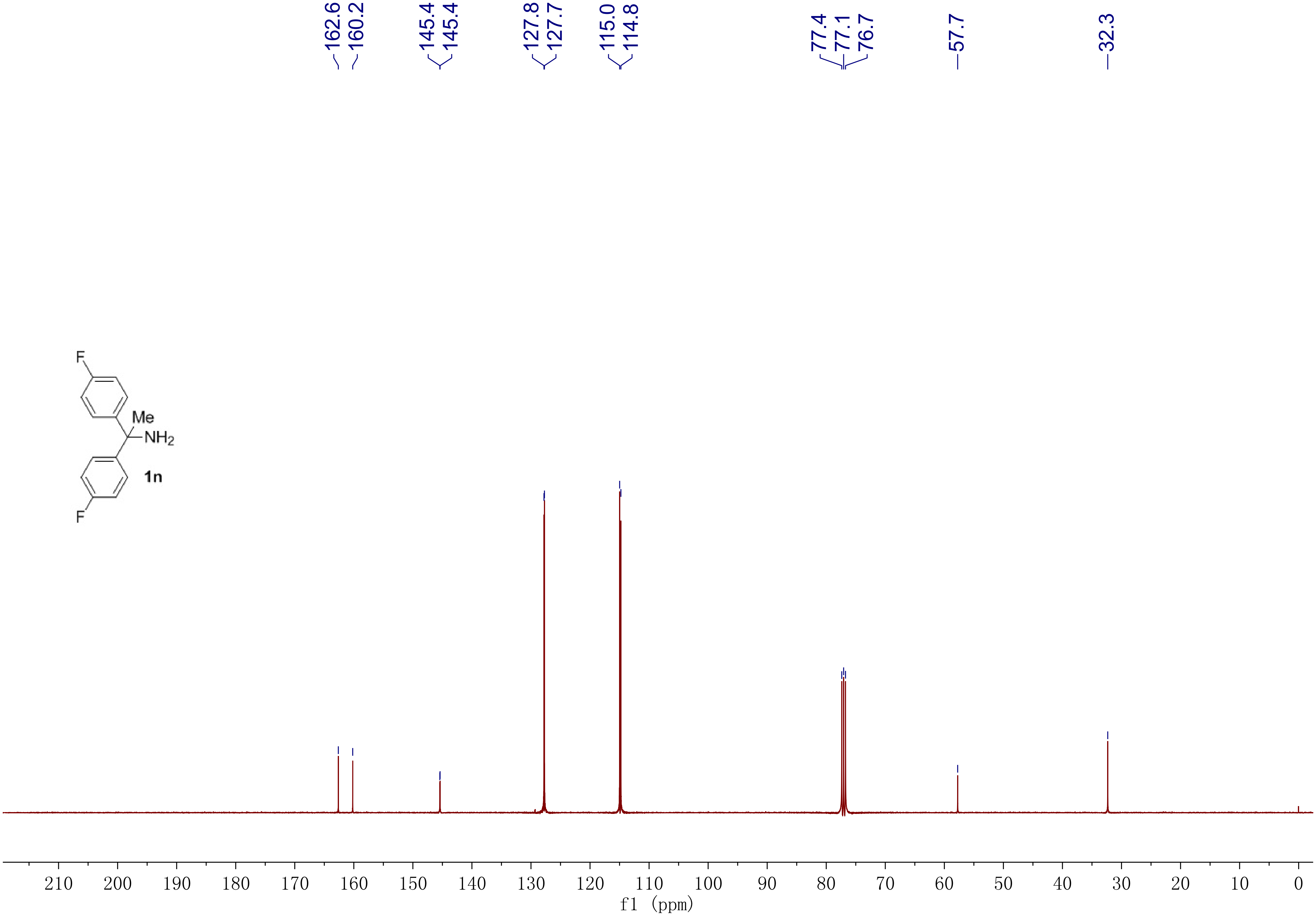
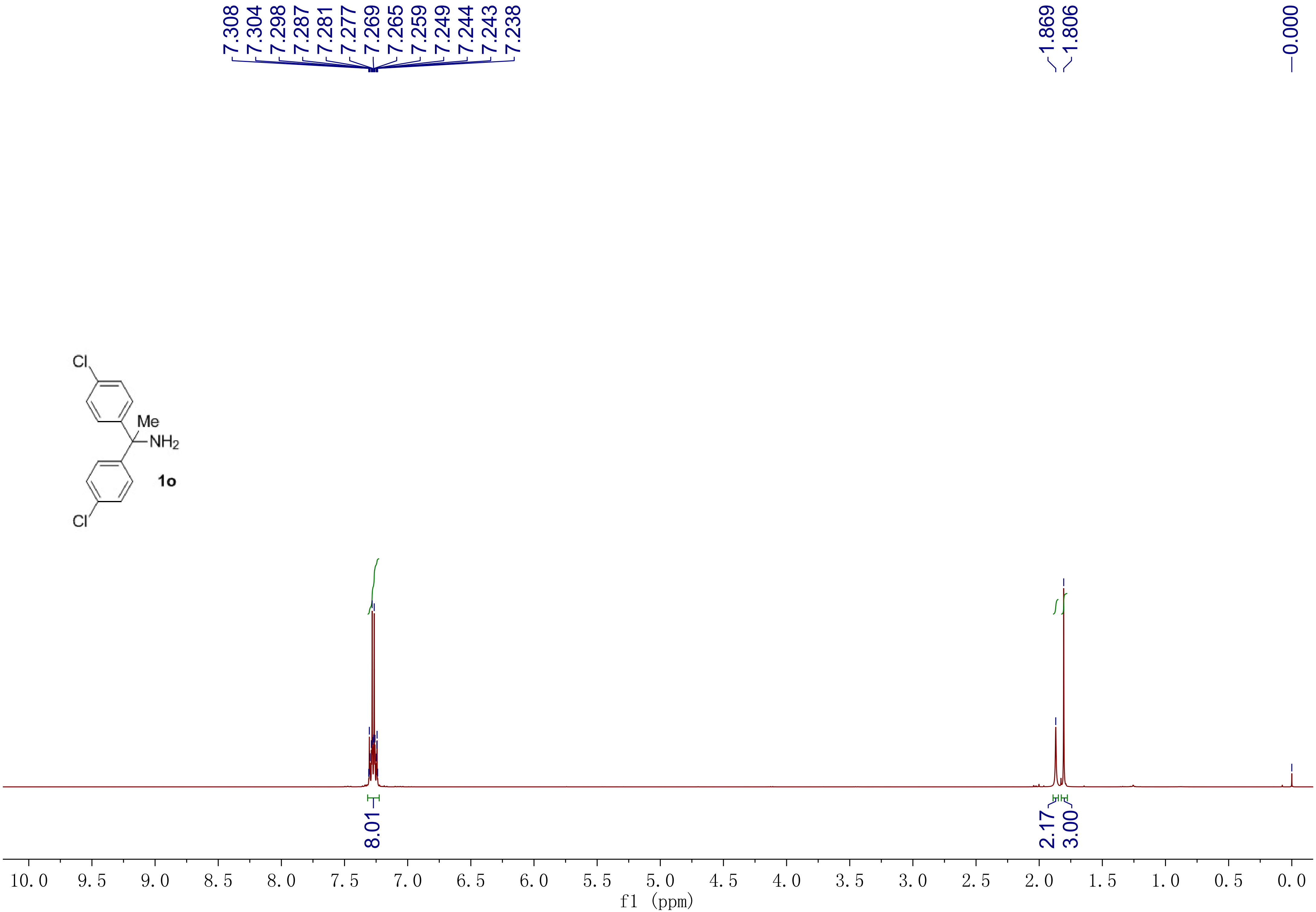
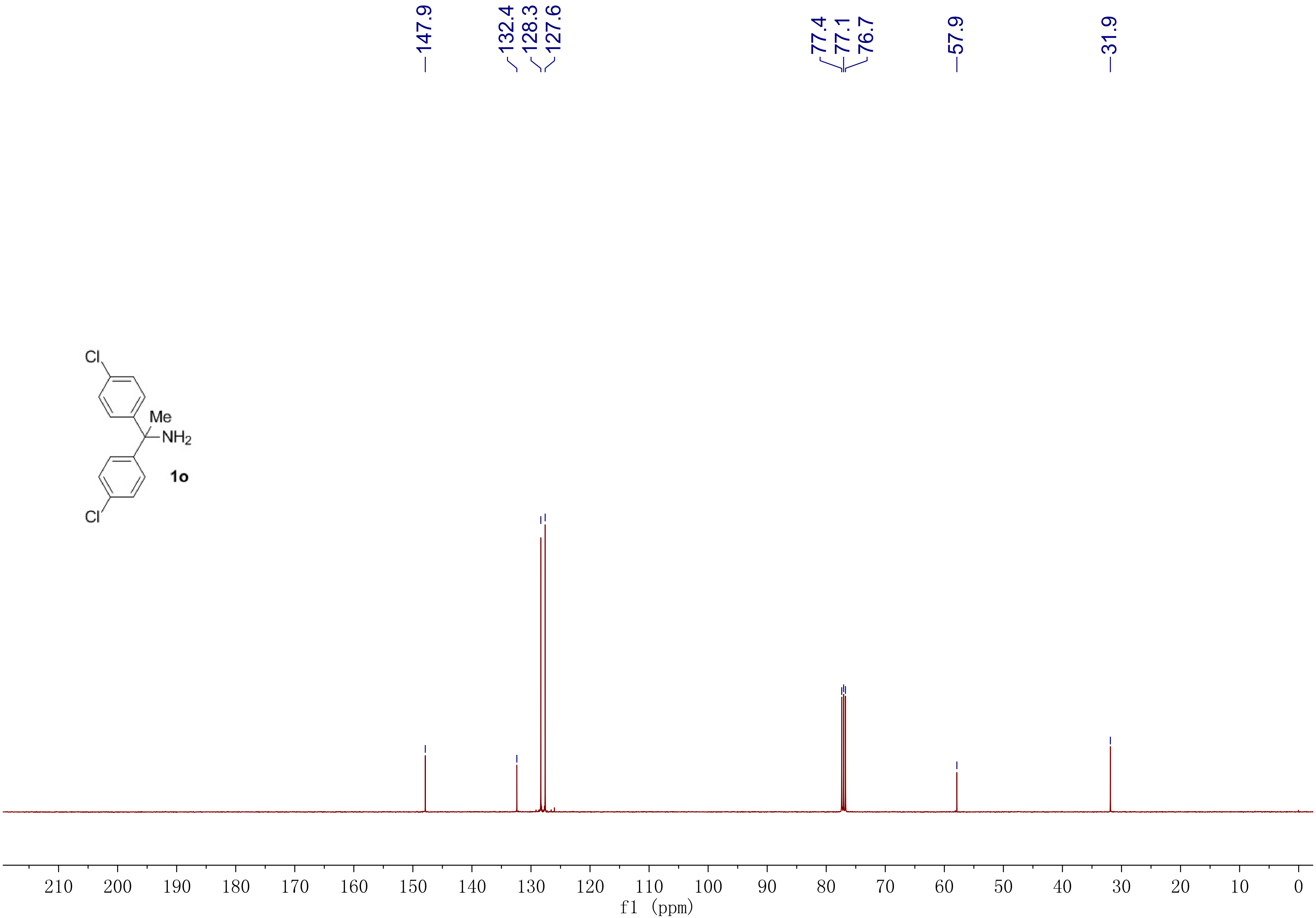
7.555
7.535
7.496
7.476
7.439
7.420
7.401
7.342
7.340
7.323
7.306
7.304
7.234
1.920
0.000
Ph
Me
NH2
1m
Ph
8.02
4.00
4.01
2.00
5.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

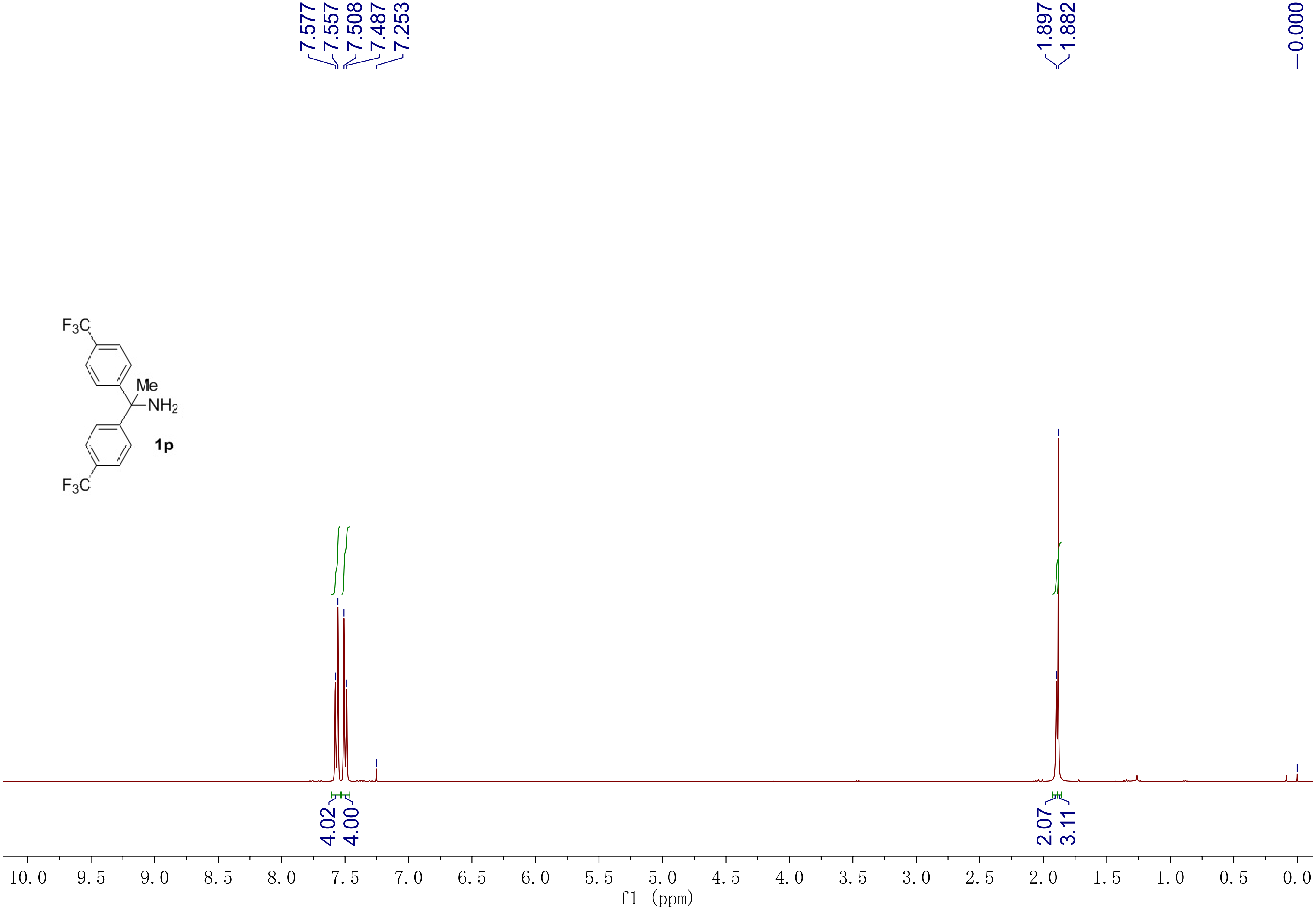

148.8
140.7
139.2
128.7
127.2
127.0
126.9
126.6
77.3
77.0
76.7
58.1
31.9
Ph
Me
NH2
Ph
1m
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

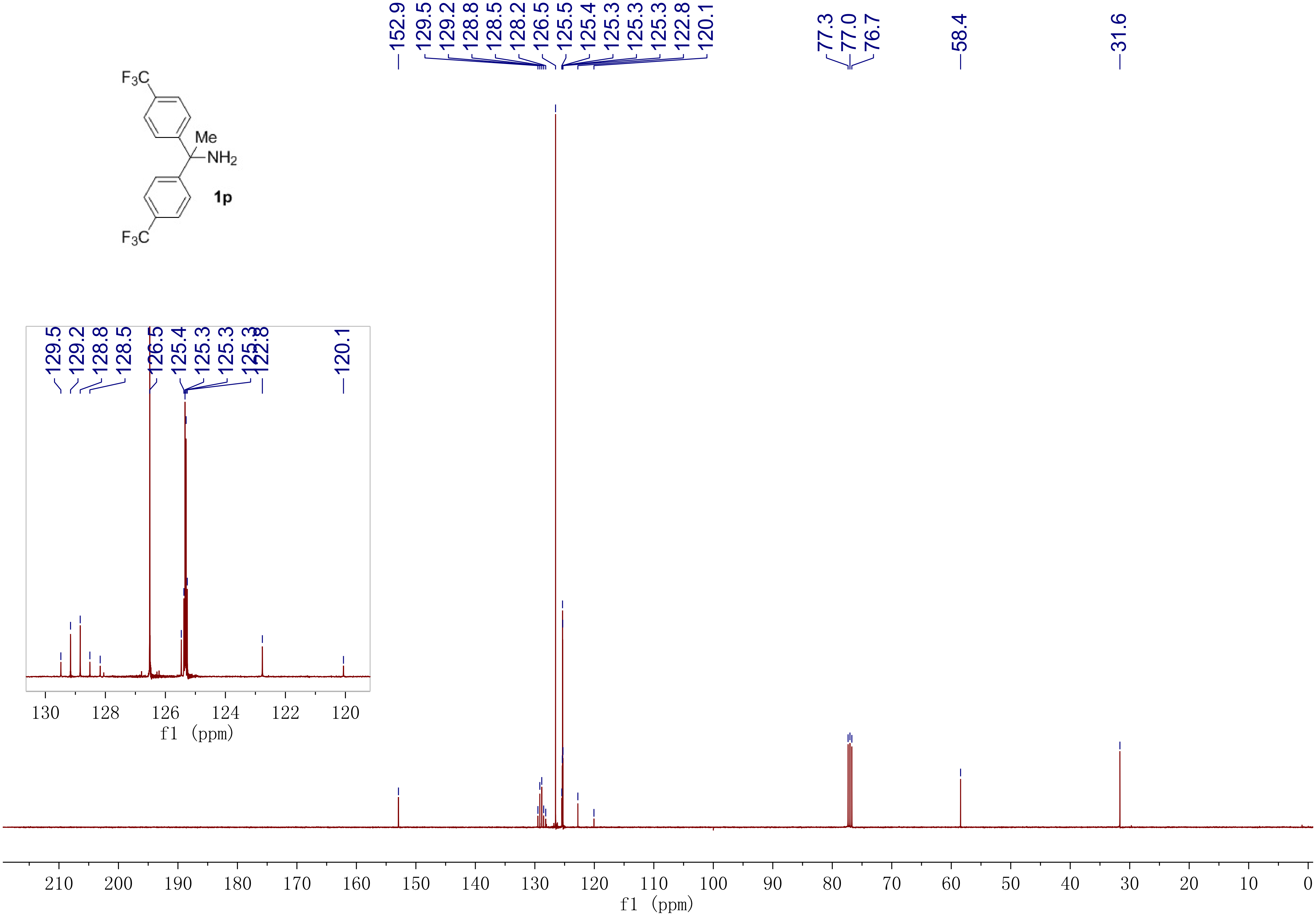

7.351
7.343
7.337
7.330
7.326
7.324
7.320
7.313
7.307
7.299
7.259
7.002
6.994
6.989
6.981
6.977
6.973
6.972
6.967
6.964
6.956
6.950
6.942
1.859
1.824
-0.000
F
Me
NH2
1n
F
4.01
4.00
2.09
3.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


162.6
160.2
145.4
145.4
127.8
127.7
115.0
114.8
77.4
77.1
76.7
57.7
32.3
F
Me
NH2
F
1n
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

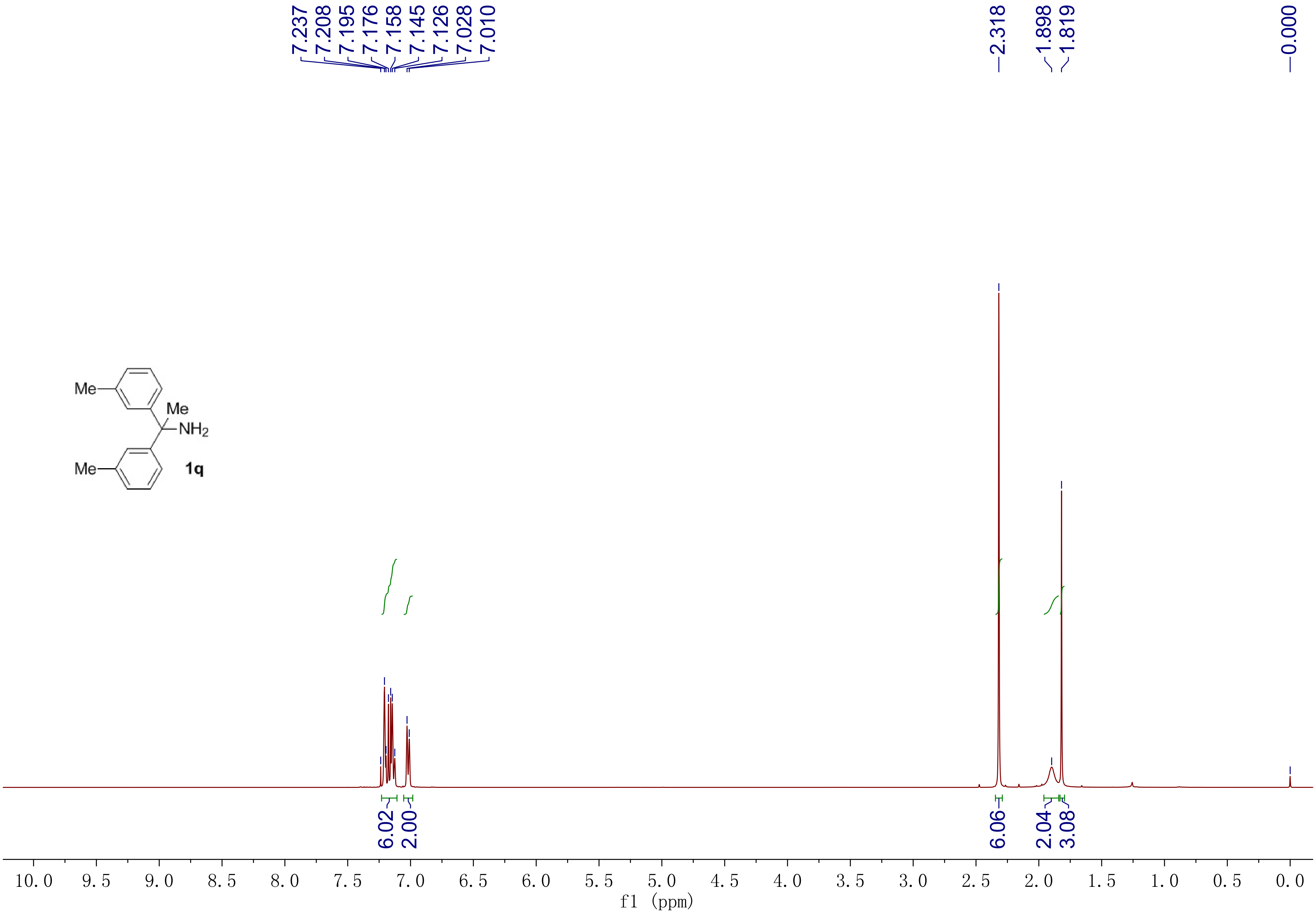

7.308
7.304
7.298
7.287
7.281
7.277
7.269
7.265
7.259
7.249
7.244
7.243
7.238
1.869
1.806
0.000
Cl
Me
NH2
Cl
1o
8.01
2.17
3.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

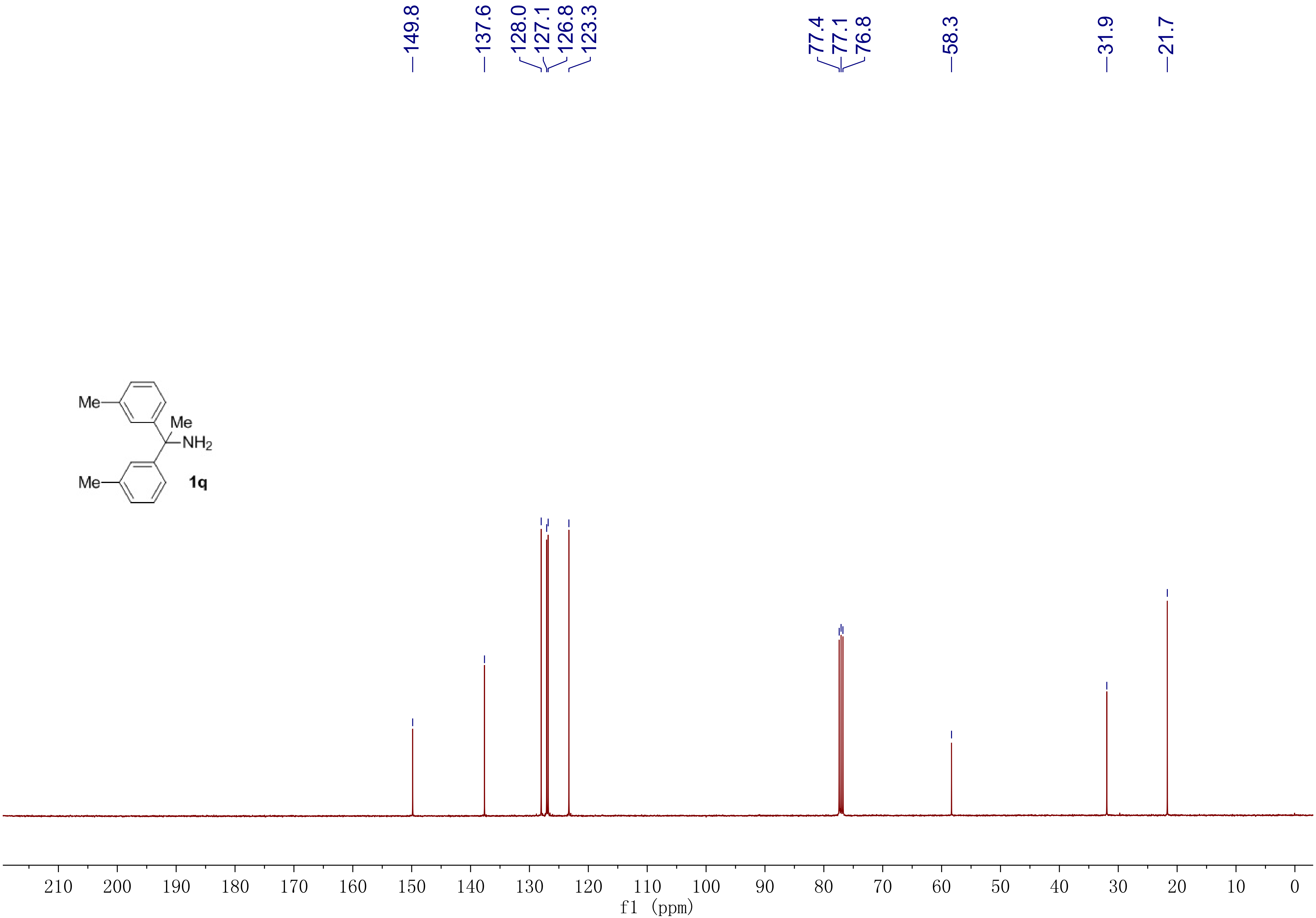

147.9
132.4
128.3
127.6
77.4
77.1
76.7
57.9
31.9
Cl
Me
NH2
Cl
1o
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

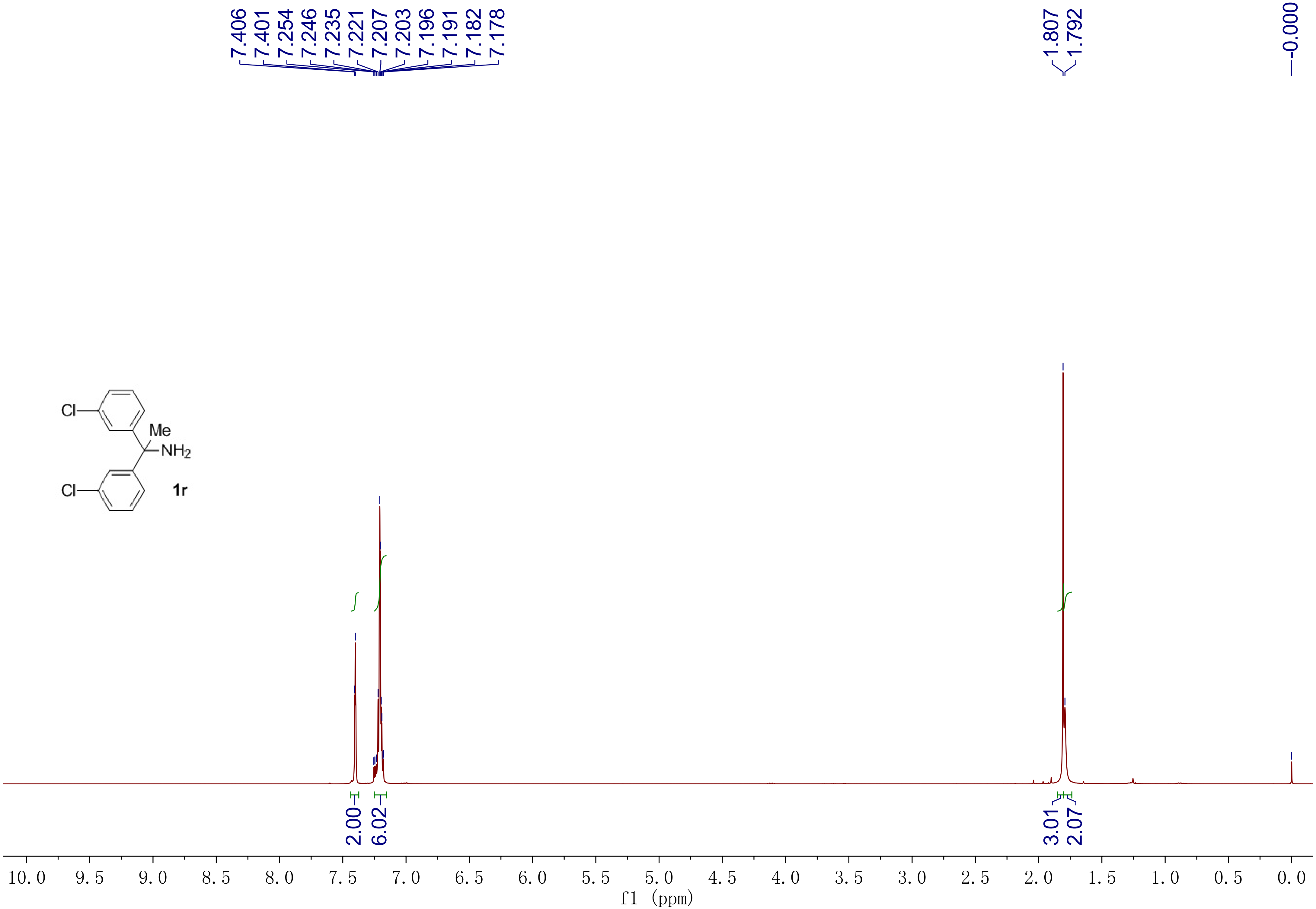

7.577
7.557
7.508
7.487
7.253
1.897
1.882
0.000
F3C
Me
NH2
1p
F3C
4.02
4.00
2.07
3.11
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


F3C
Me
NH2
F3C
152.9
129.5
129.2
128.8
128.5
128.2
126.5
125.5
125.4
125.3
125.3
125.3
122.8
120.1
77.3
77.0
76.7
58.4
31.6
130
128
126
124
122
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

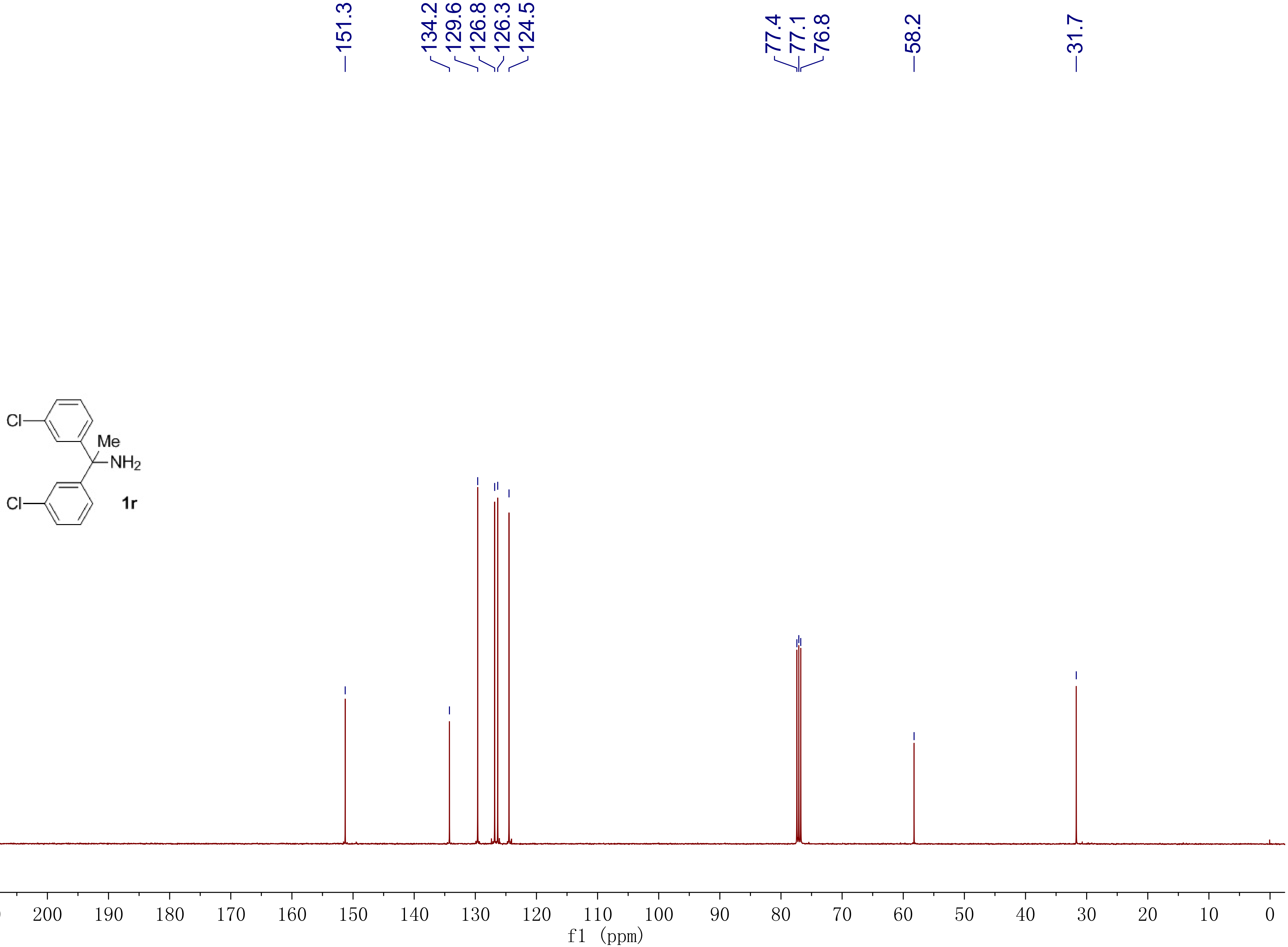
1p


7.237
7.208
7.195
7.176
7.158
7.145
7.126
7.028
7.010
2.318
1.898
1.819
0.000
Me
Me
NH2
Me
1q
6.02
2.00
6.06
2.04
3.08
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
f1 (ppm)

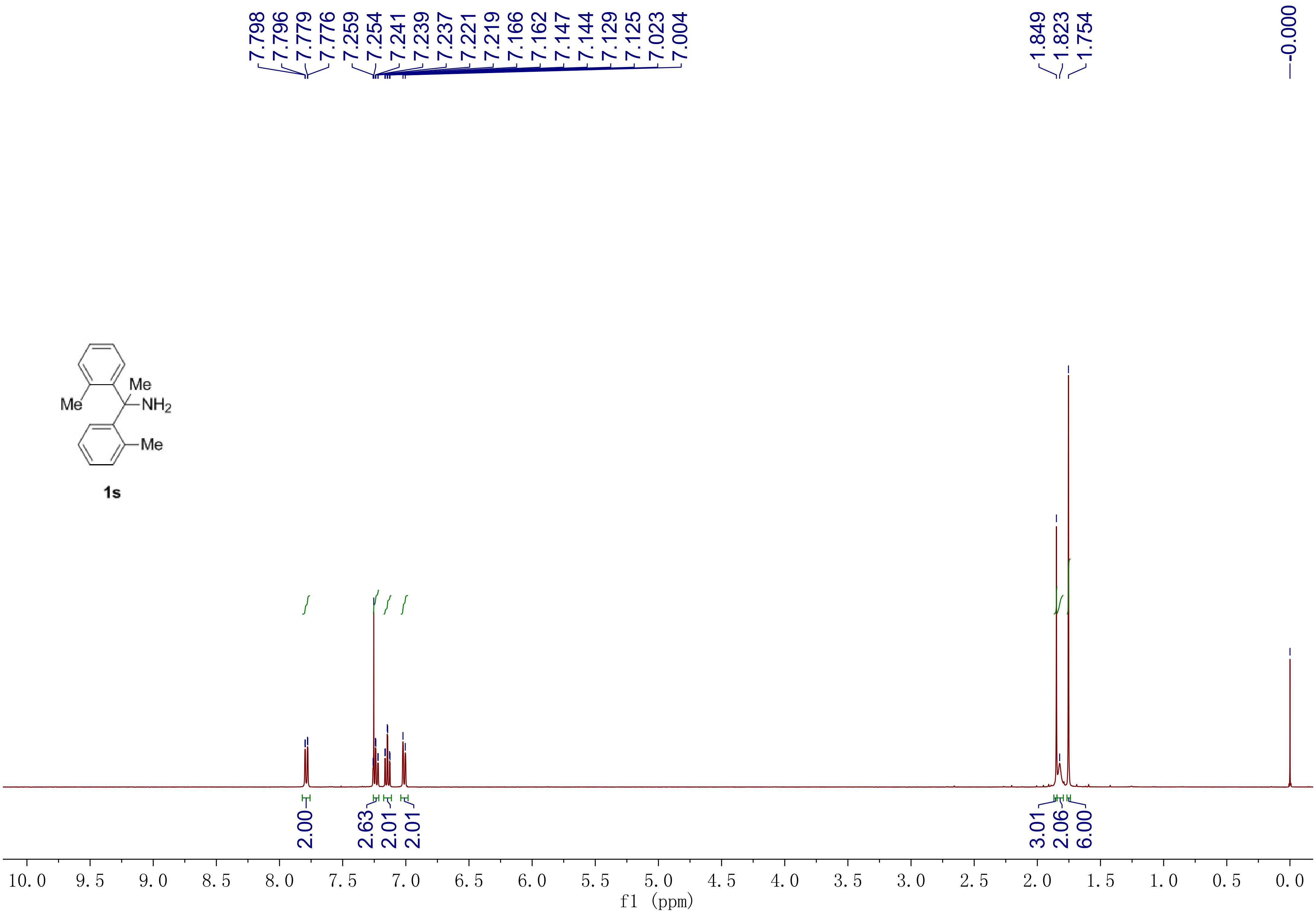

149.8
137.6
128.0
127.1
126.8
123.3
77.4
77.1
76.8
58.3
31.9
21.7
Me
Me
NH2
Me
1q
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.406
7.401
7.254
7.246
7.235
7.221
7.207
7.203
7.196
7.191
7.182
7.178
1.807
1.792
-0.000
Cl
Cl
Me
NH2
2.00
6.02
3.01
2.07
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
f1 (ppm)

1r



151.3
134.2
129.6
126.8
126.3
124.5
77.4
77.1
76.8
58.2
31.7
Cl
Me
NH2
Cl
1r
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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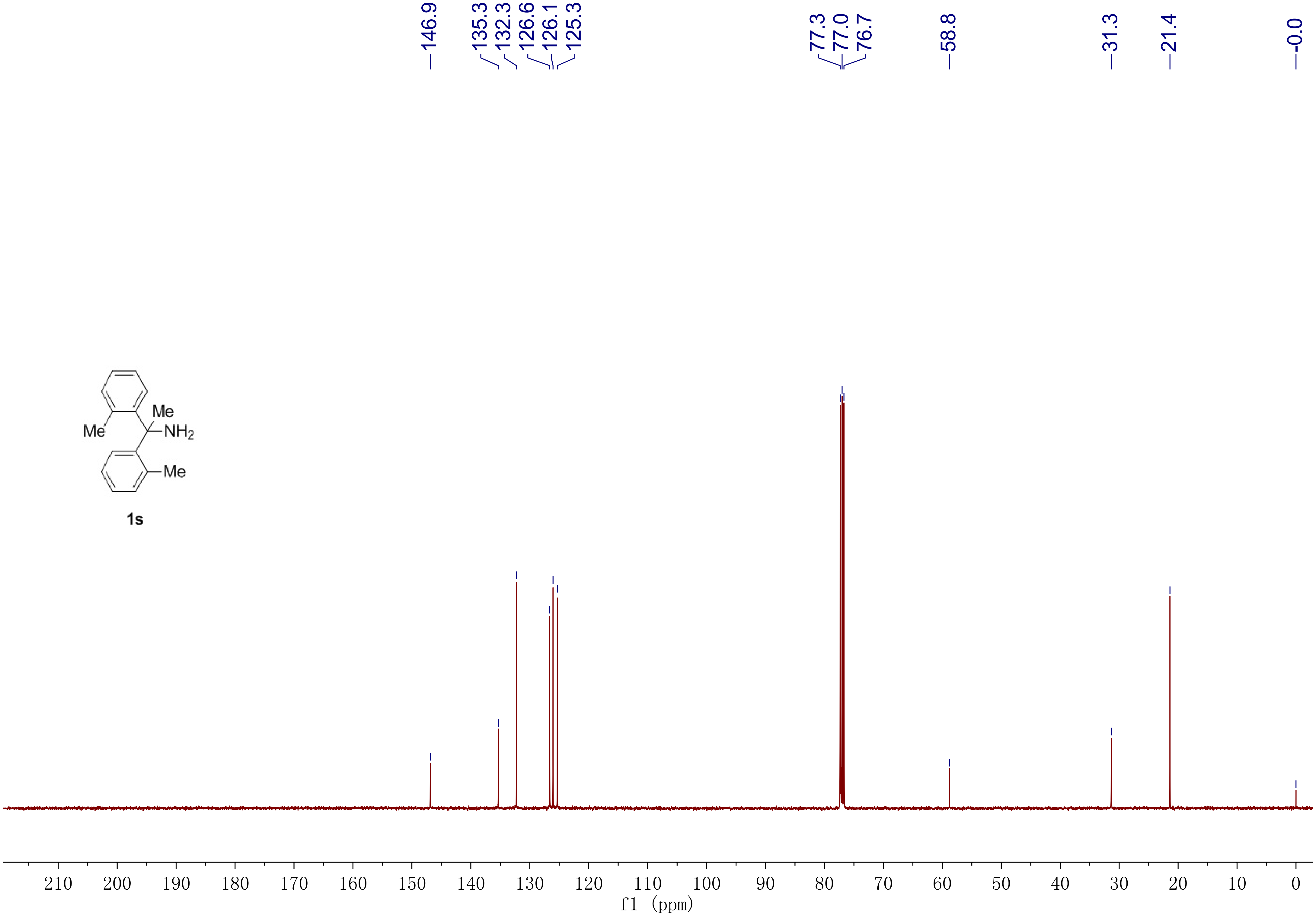
7.779
7.776
7.259
7.254
7.241
7.239
7.237
7.221
7.219
7.166
7.162
7.147
7.144
7.129
7.125
7.023
7.004
1.849
1.823
1.754
-0.000
Me
Me
NH2
Me
2.00
2.63
2.01
2.01
3.01
2.06
6.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

1s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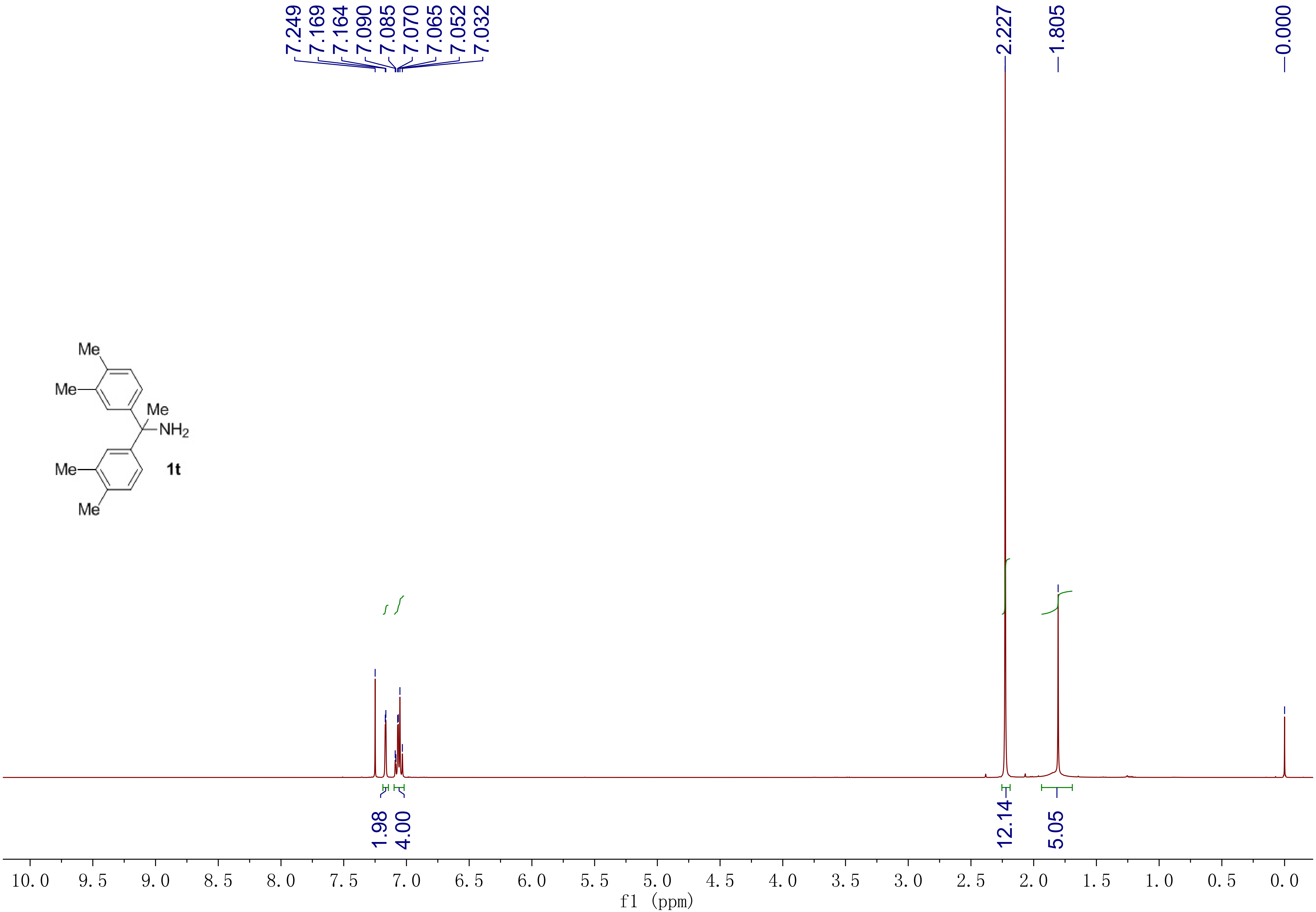
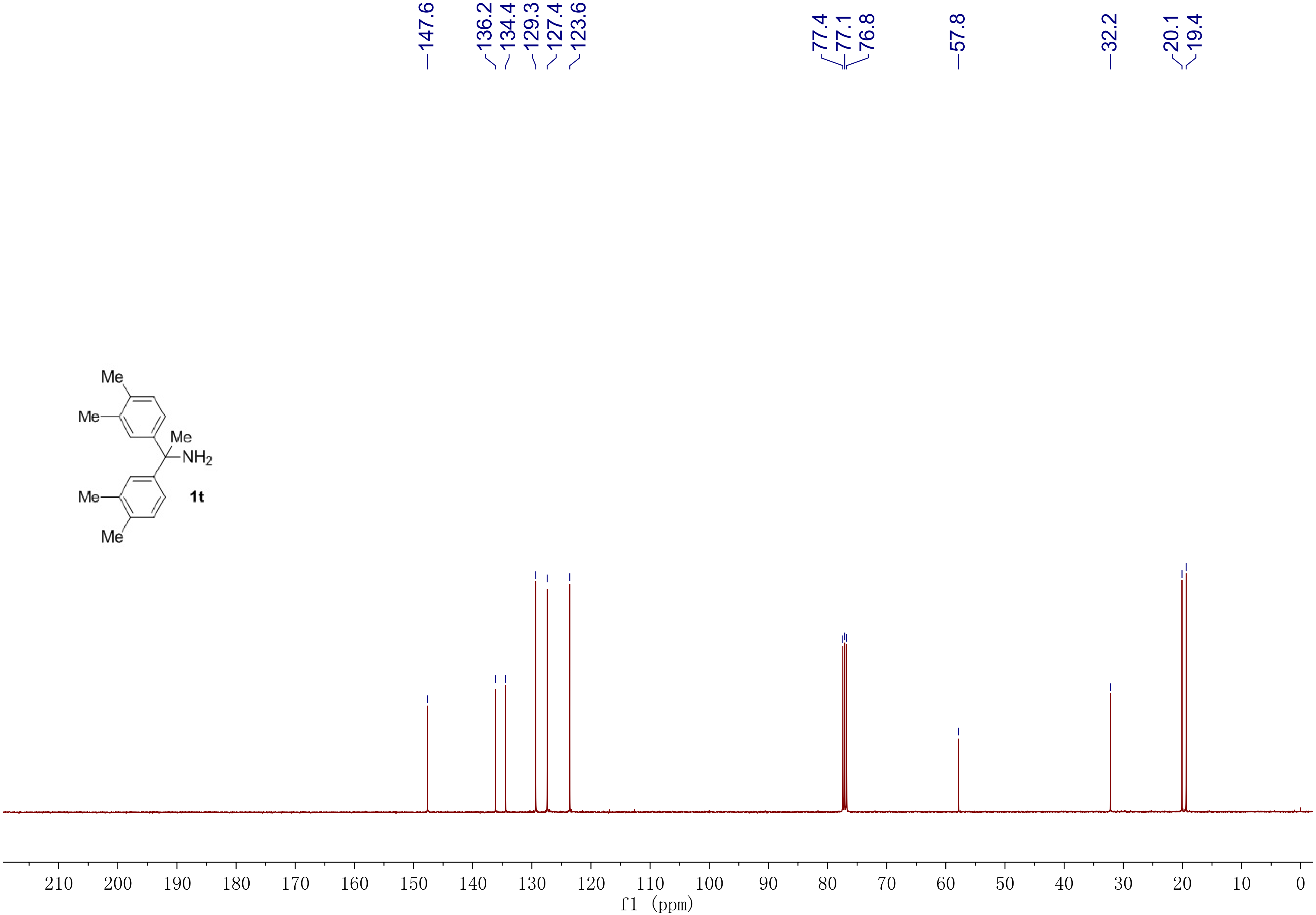
135.3
132.3
126.6
126.1
125.3
77.3
77.0
76.7
58.8
31.3
21.4
-0.0
Me
Me
NH$_2$
Me
1s
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.249
7.169
7.164
7.090
7.085
7.070
7.065
7.052
7.032
2.227
1.805
0.000
1.98
4.00
12.14
5.05
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
f1 (ppm)
Me
Me
Me
NH2
Me
Me
1t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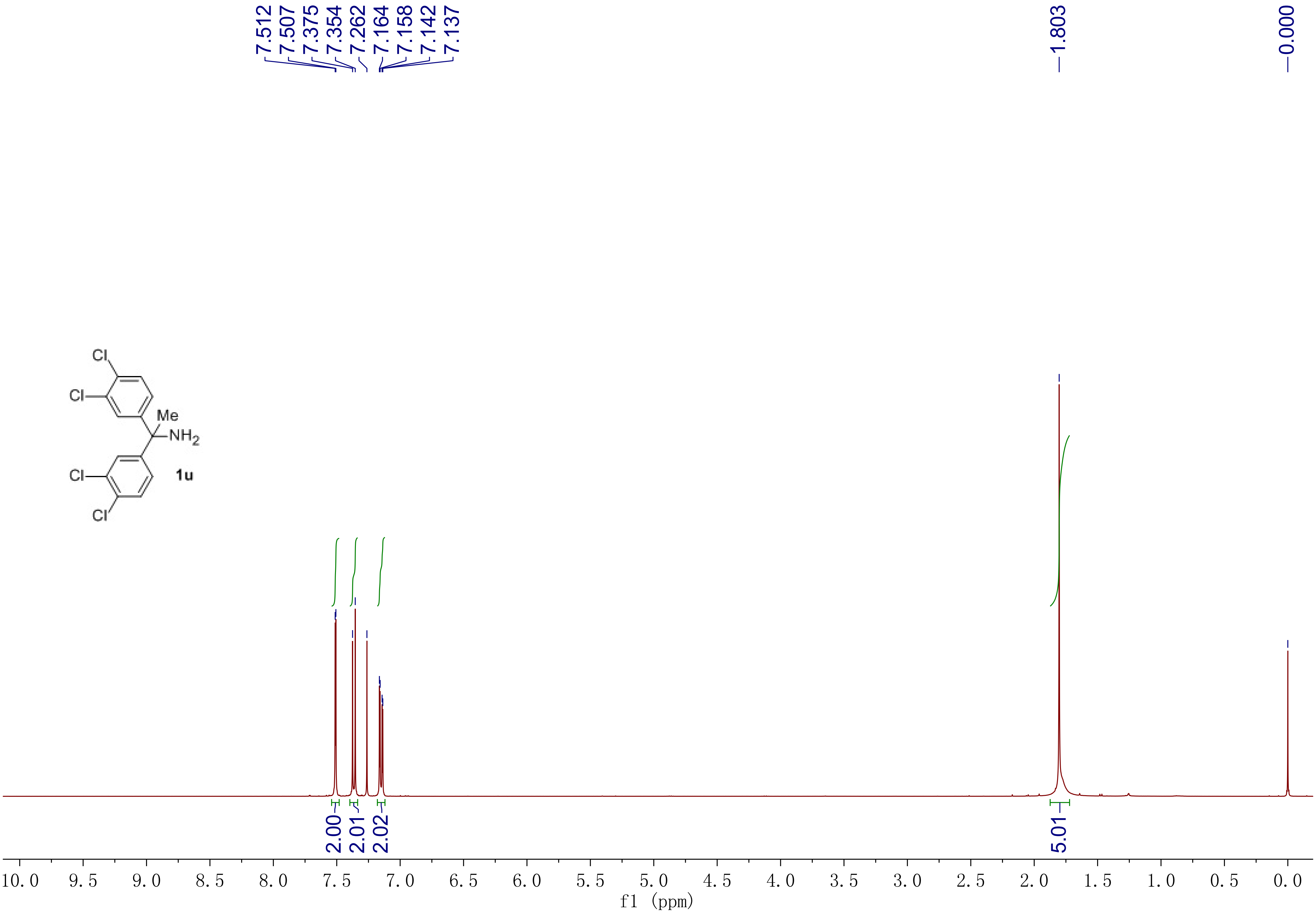
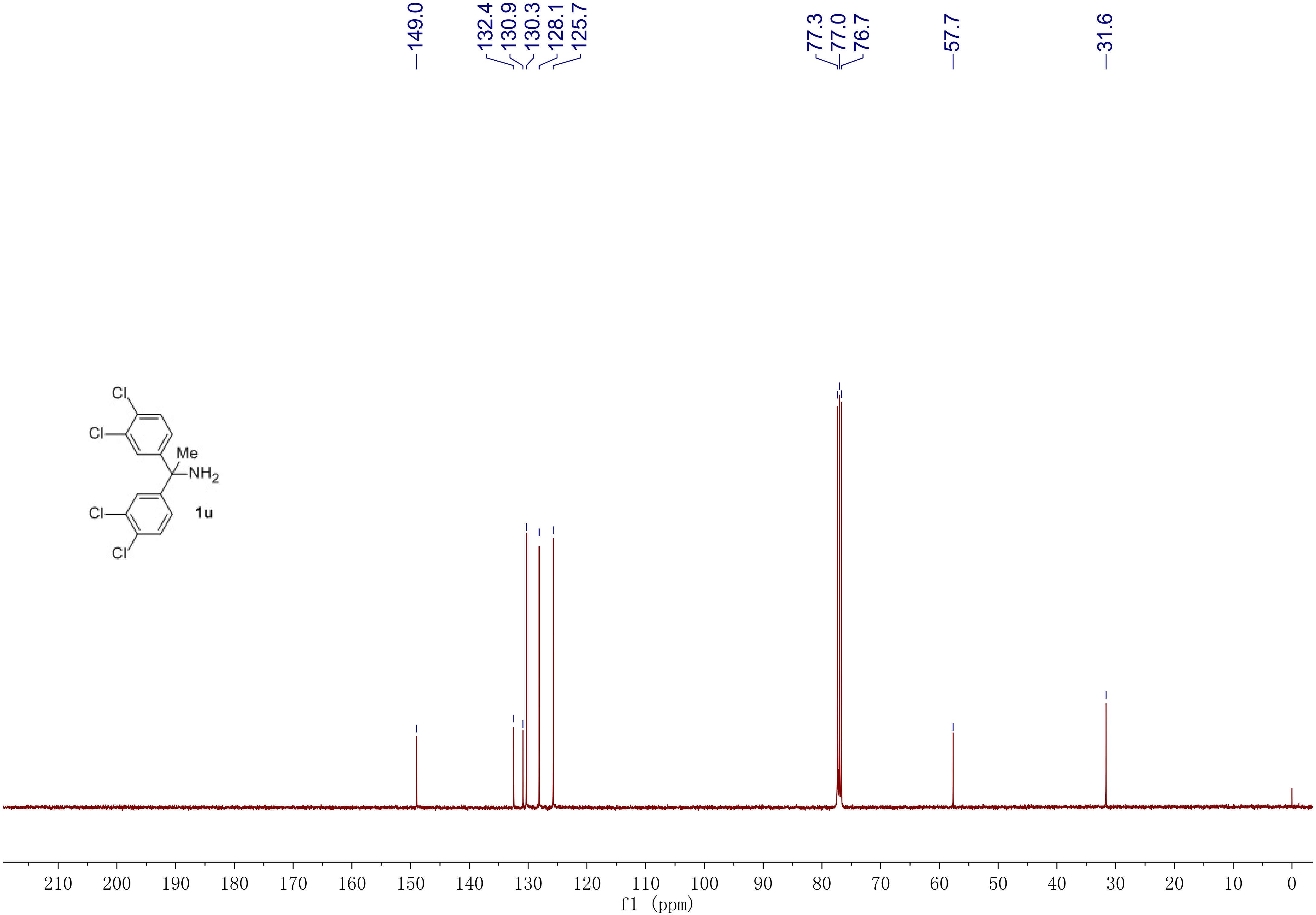
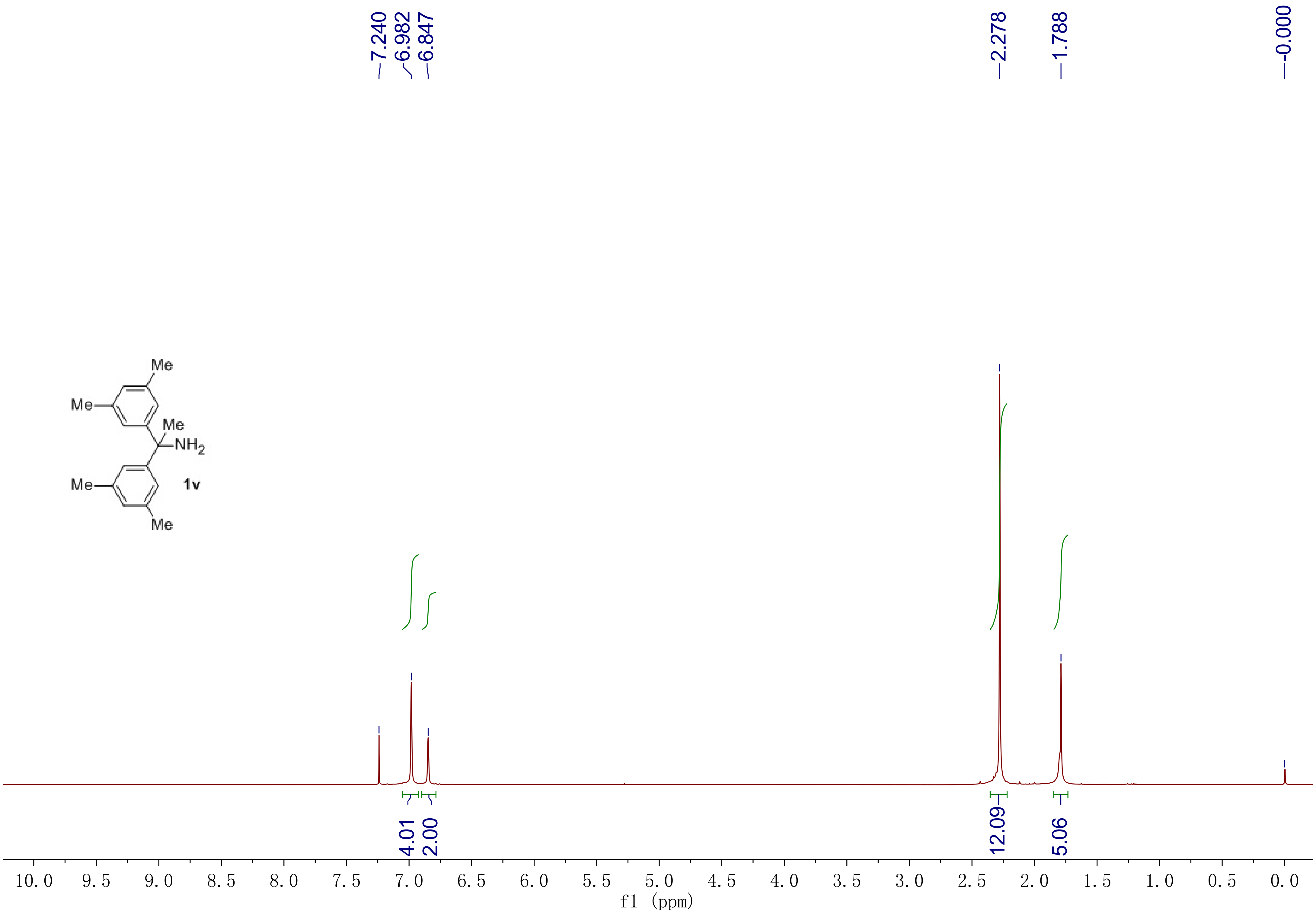
136.2
134.4
129.3
127.4
123.6
77.4
77.1
76.8
57.8
32.2
20.1
19.4
Me
Me
Me
NH2
Me
Me
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

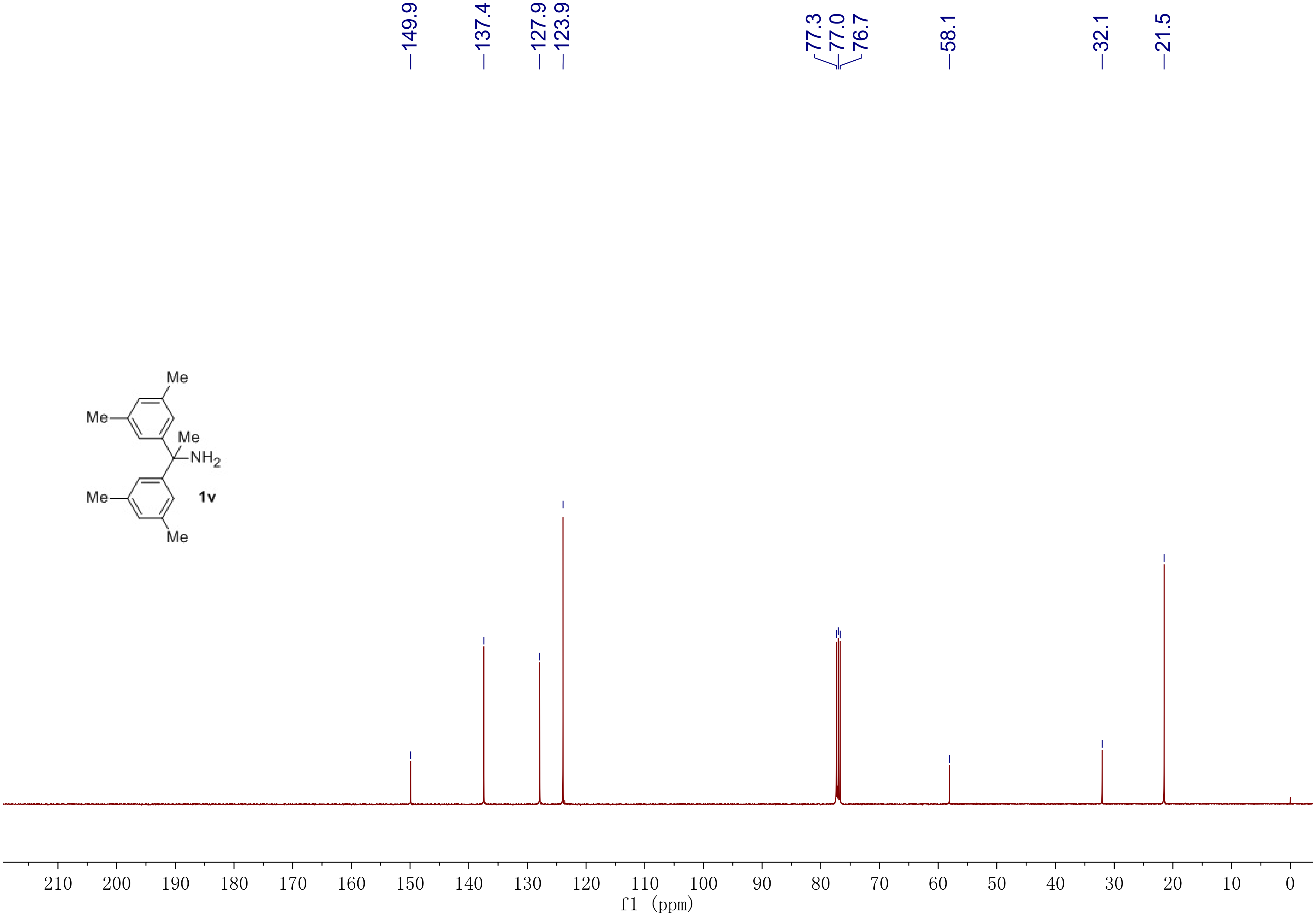
1t


7.512
7.507
7.375
7.354
7.262
7.164
7.158
7.142
7.137
1.803
0.000
Cl
Cl
Me
NH2
Cl
Cl
1u
2.00
2.01
2.02
5.01
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
f1 (ppm)

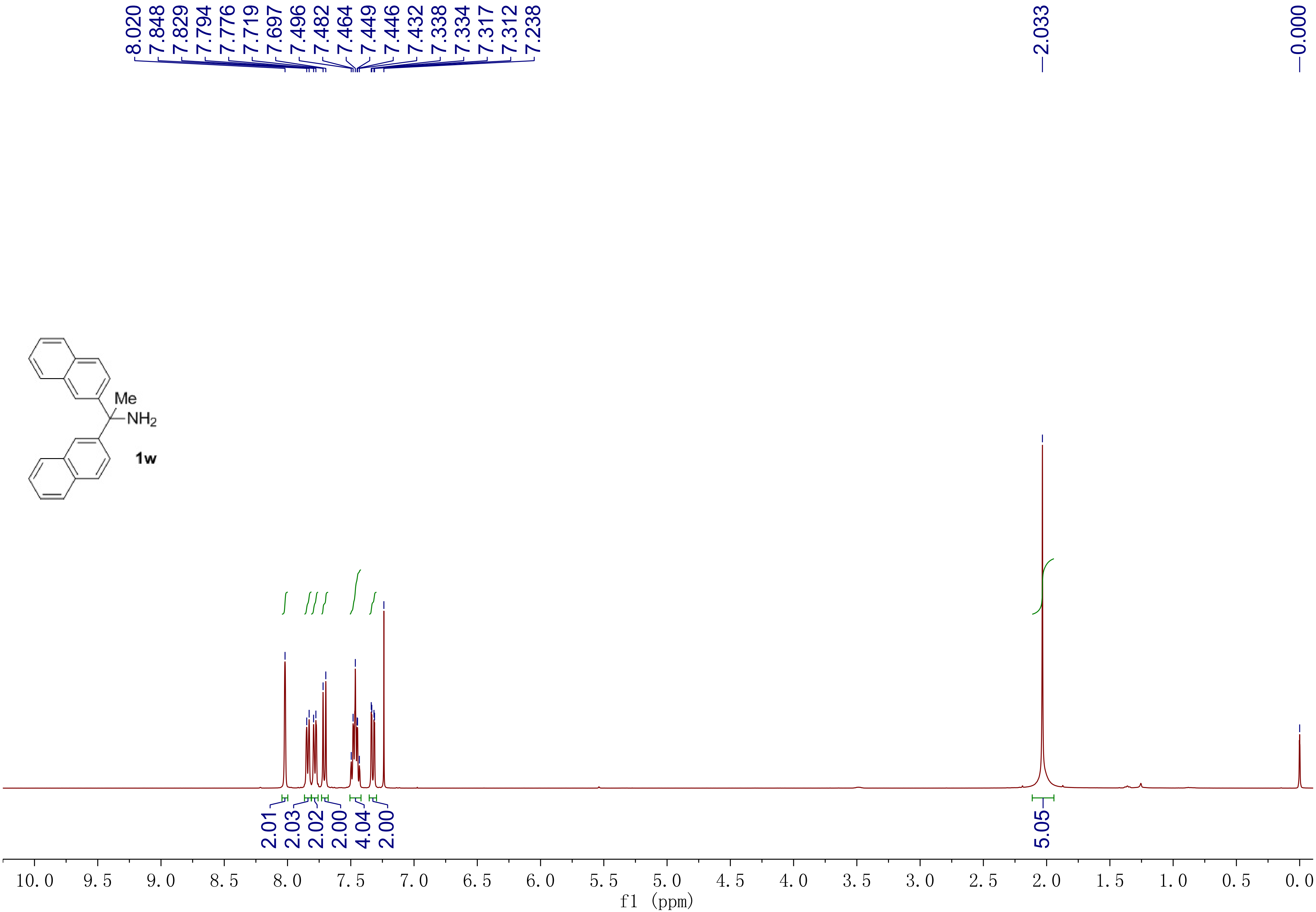

149.0
132.4
130.9
130.3
128.1
125.7
77.3
77.0
76.7
57.7
31.6
Cl
Cl
Me
NH2
Cl
Cl
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

1u


7.240
6.982
6.847
2.278
1.788
-0.000
Me
Me
Me
NH2
Me
Me
1v
4.01
2.00
12.09
5.06
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
f1 (ppm)



149.9
137.4
127.9
123.9
77.3
77.0
76.7
58.1
32.1
21.5
Me
Me
Me
NH2
Me
Me
1v
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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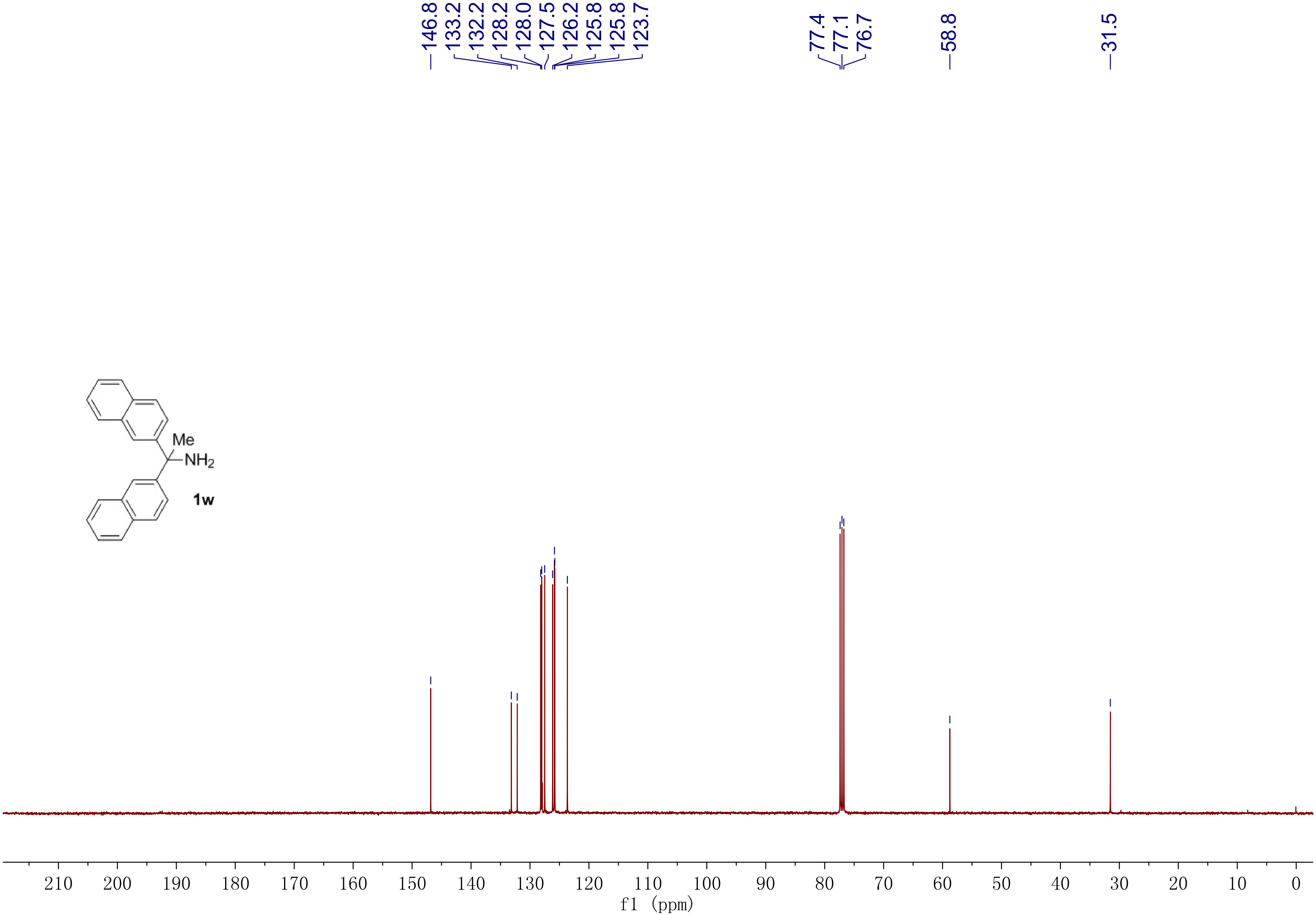
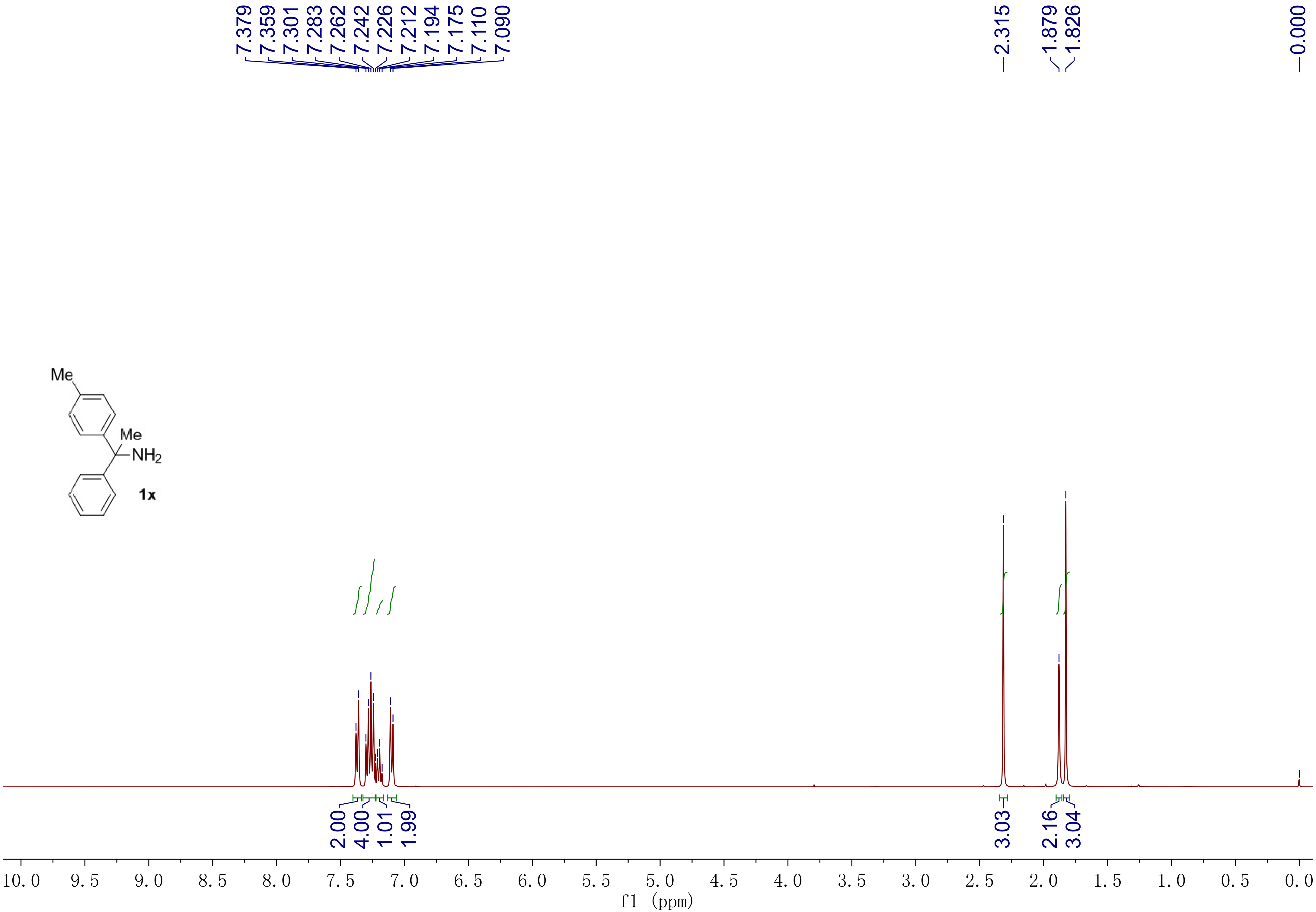
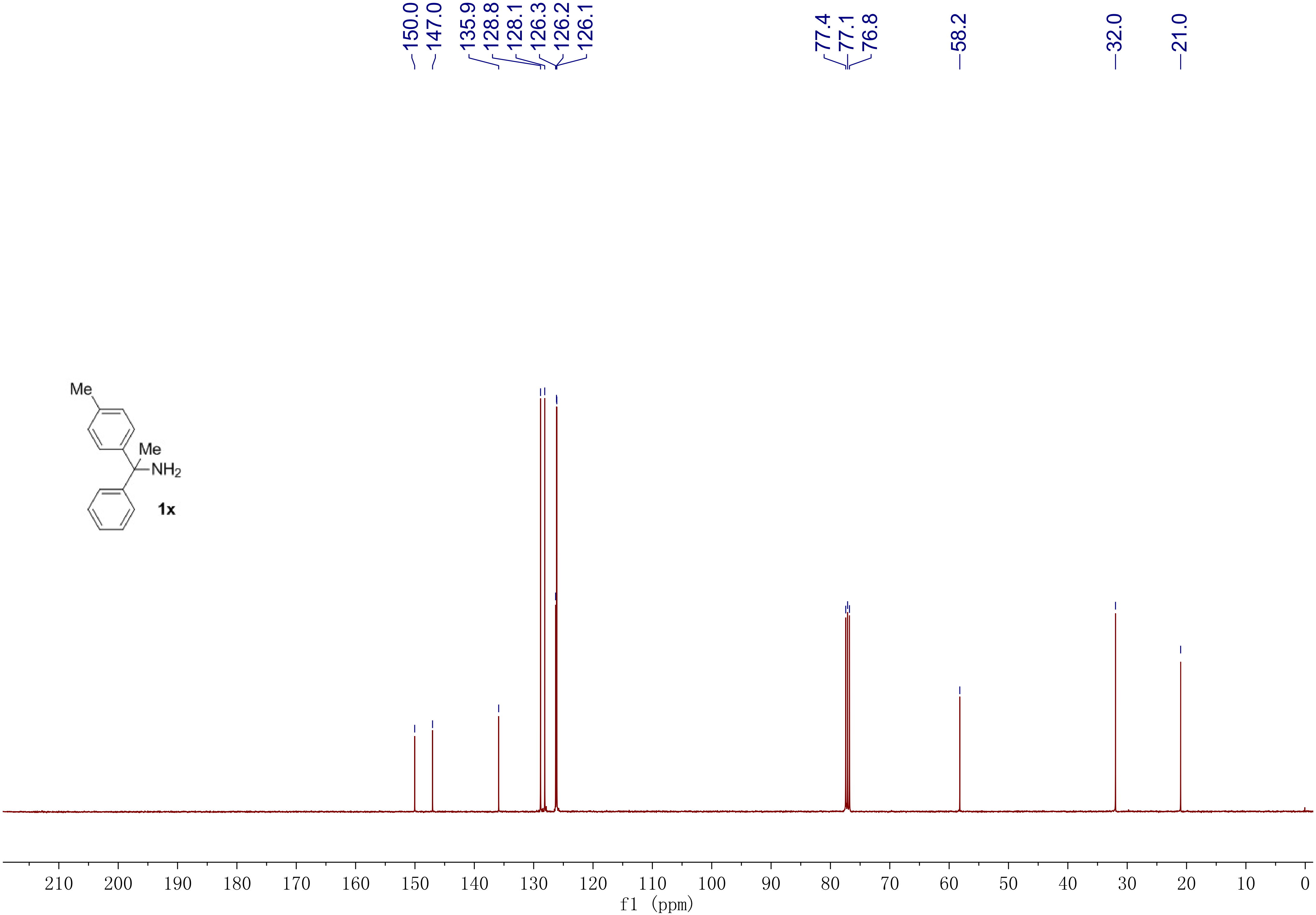
7.848
7.829
7.794
7.776
7.719
7.697
7.496
7.482
7.464
7.449
7.446
7.432
7.338
7.334
7.317
7.312
7.238
2.033
0.000
Me
NH2
2.01
2.03
2.02
2.00
4.04
2.00
5.05
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

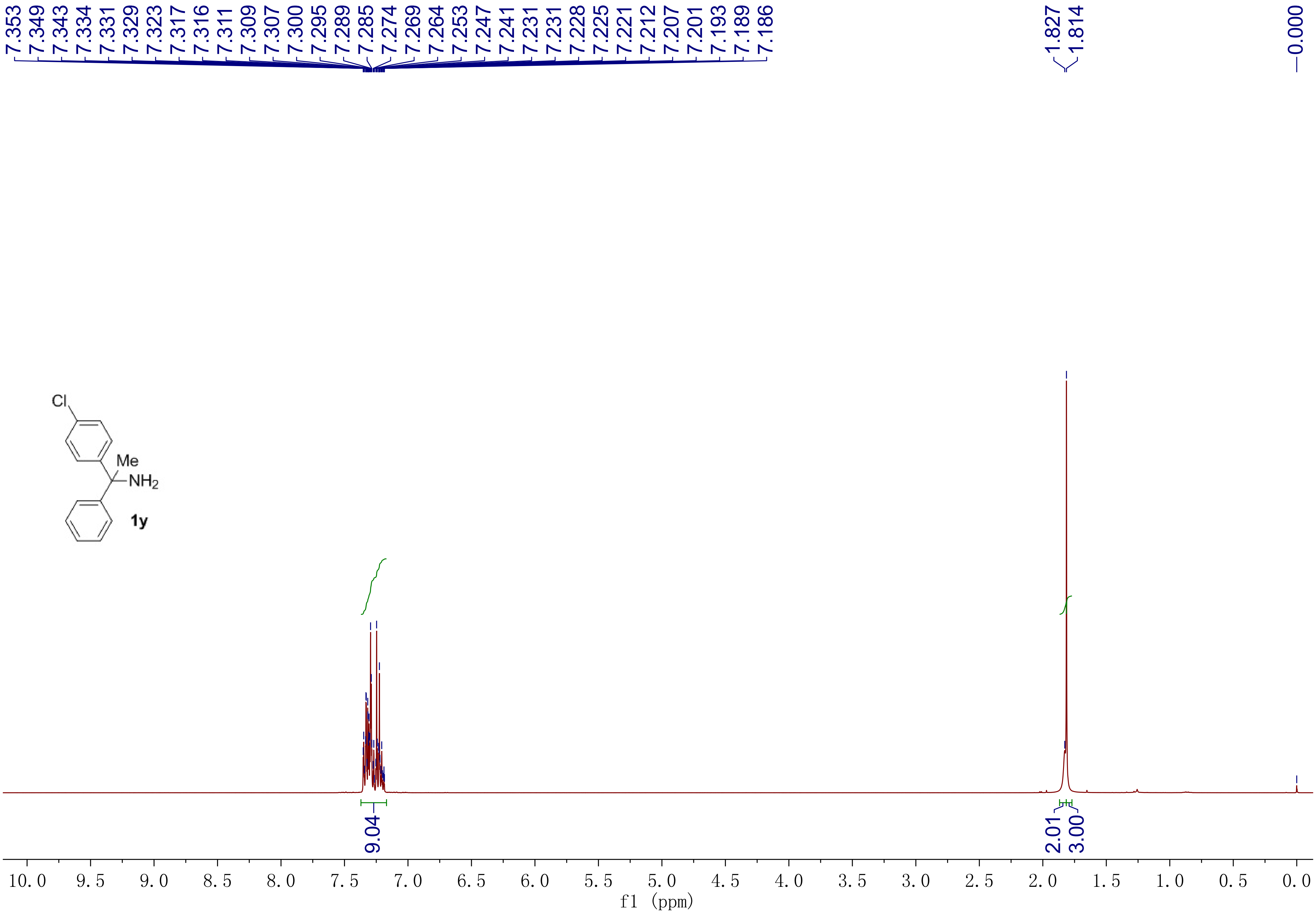
1w

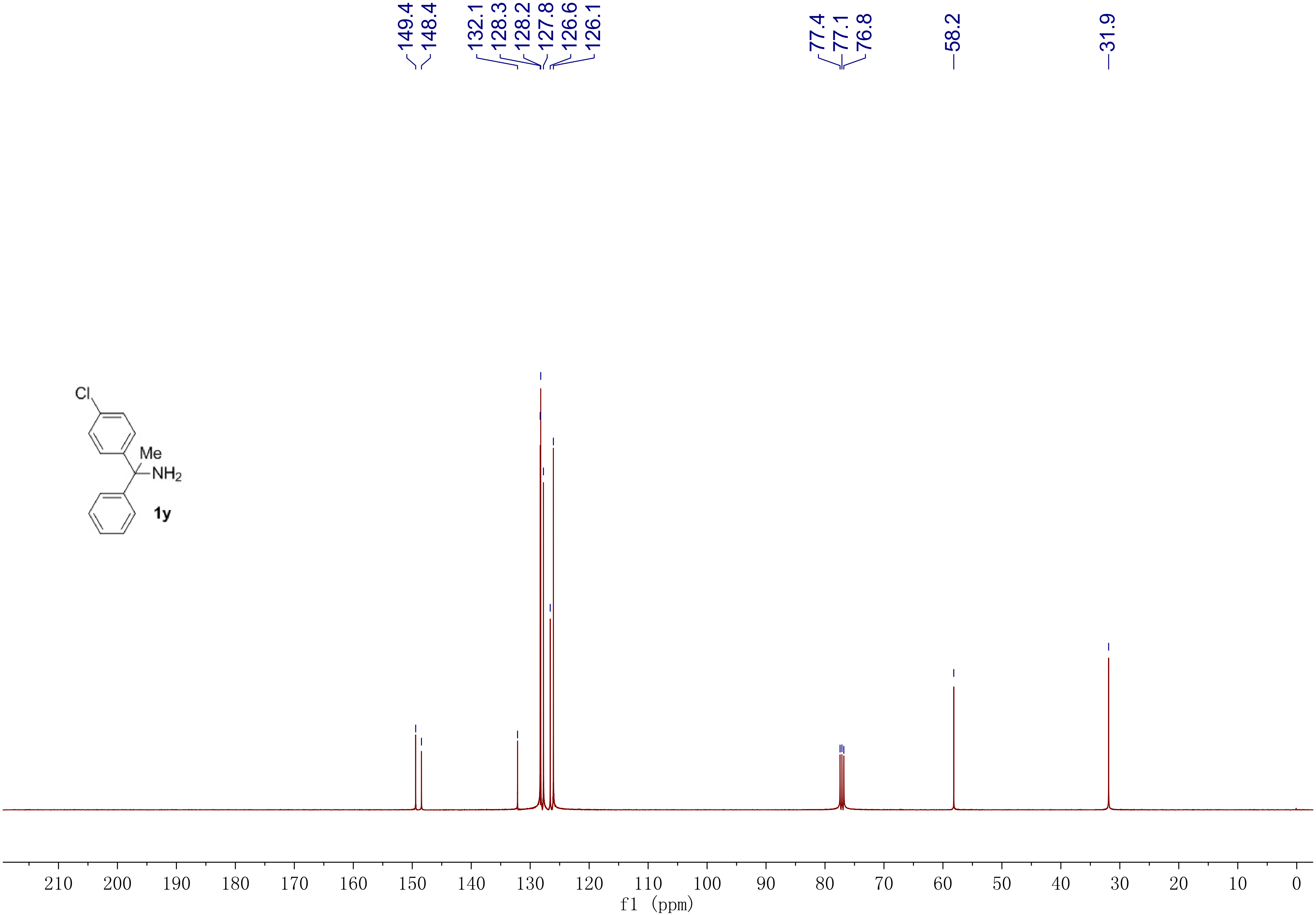

146.8
133.2
132.2
128.2
128.0
127.5
126.2
125.8
125.8
123.7
77.4
77.1
76.7
58.8
31.5
Me
NH2
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

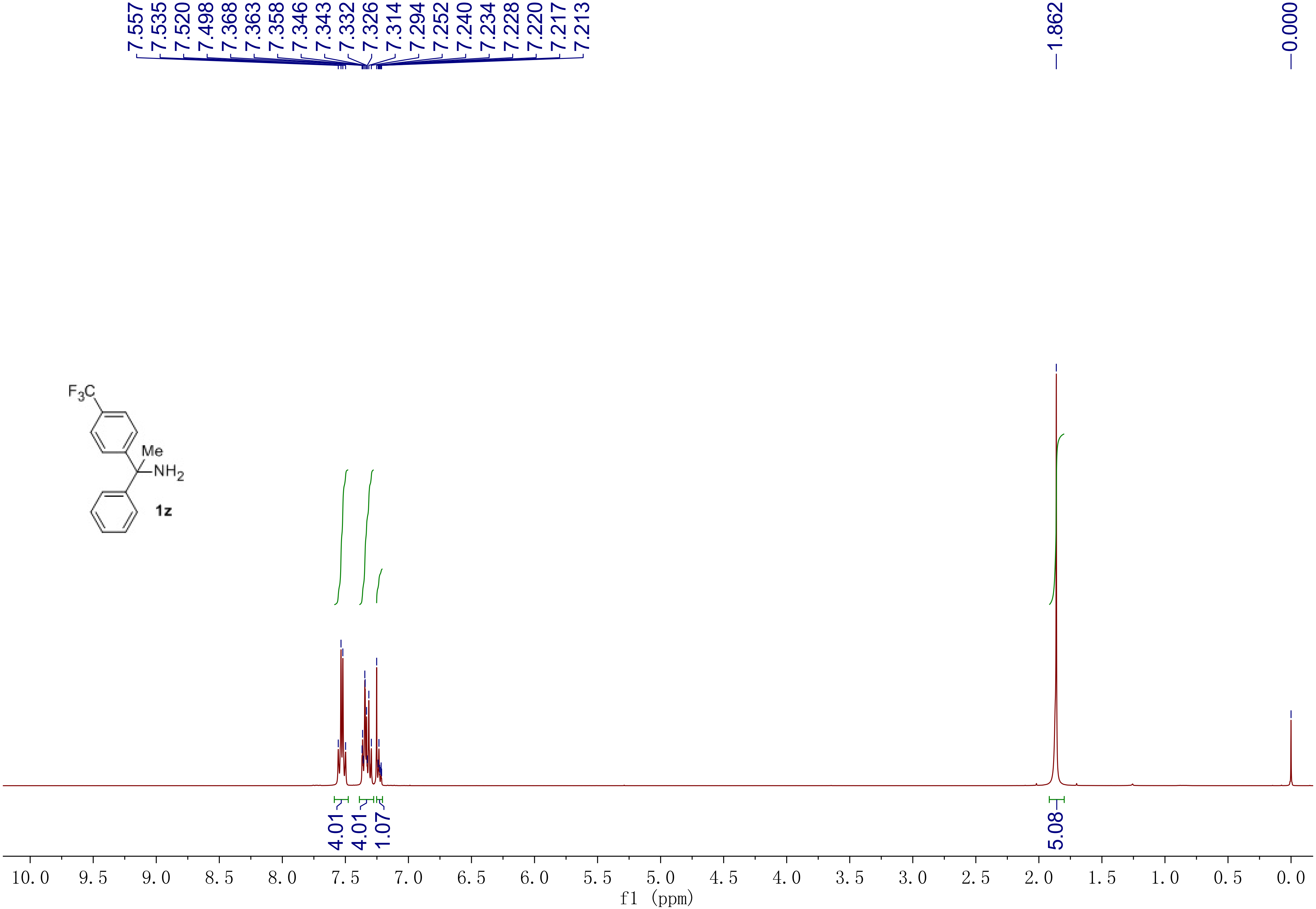
1w


7.379
7.359
7.301
7.283
7.262
7.242
7.226
7.212
7.194
7.175
7.110
7.090
2.315
1.879
1.826
0.000
Me
Me
NH2
1x
2.00
4.00
1.01
1.99
3.03
2.16
3.04
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
f1 (ppm)


150.0
147.0
135.9
128.8
128.1
126.3
126.2
126.1
77.4
77.1
76.8
58.2
32.0
21.0
Me
Me
NH2
1x
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.353
7.349
7.343
7.334
7.331
7.329
7.323
7.317
7.316
7.311
7.309
7.307
7.300
7.295
7.289
7.285
7.274
7.269
7.264
7.253
7.247
7.241
7.231
7.231
7.228
7.225
7.221
7.212
7.207
7.201
7.193
7.189
7.186
1.827
1.814
0.000
Cl
Me
NH2
1y
9.04
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
f1 (ppm)


149.4
148.4
132.1
128.3
128.2
127.8
126.6
126.1
77.4
77.1
76.8
58.2
31.9
Cl
Me
NH2
1y
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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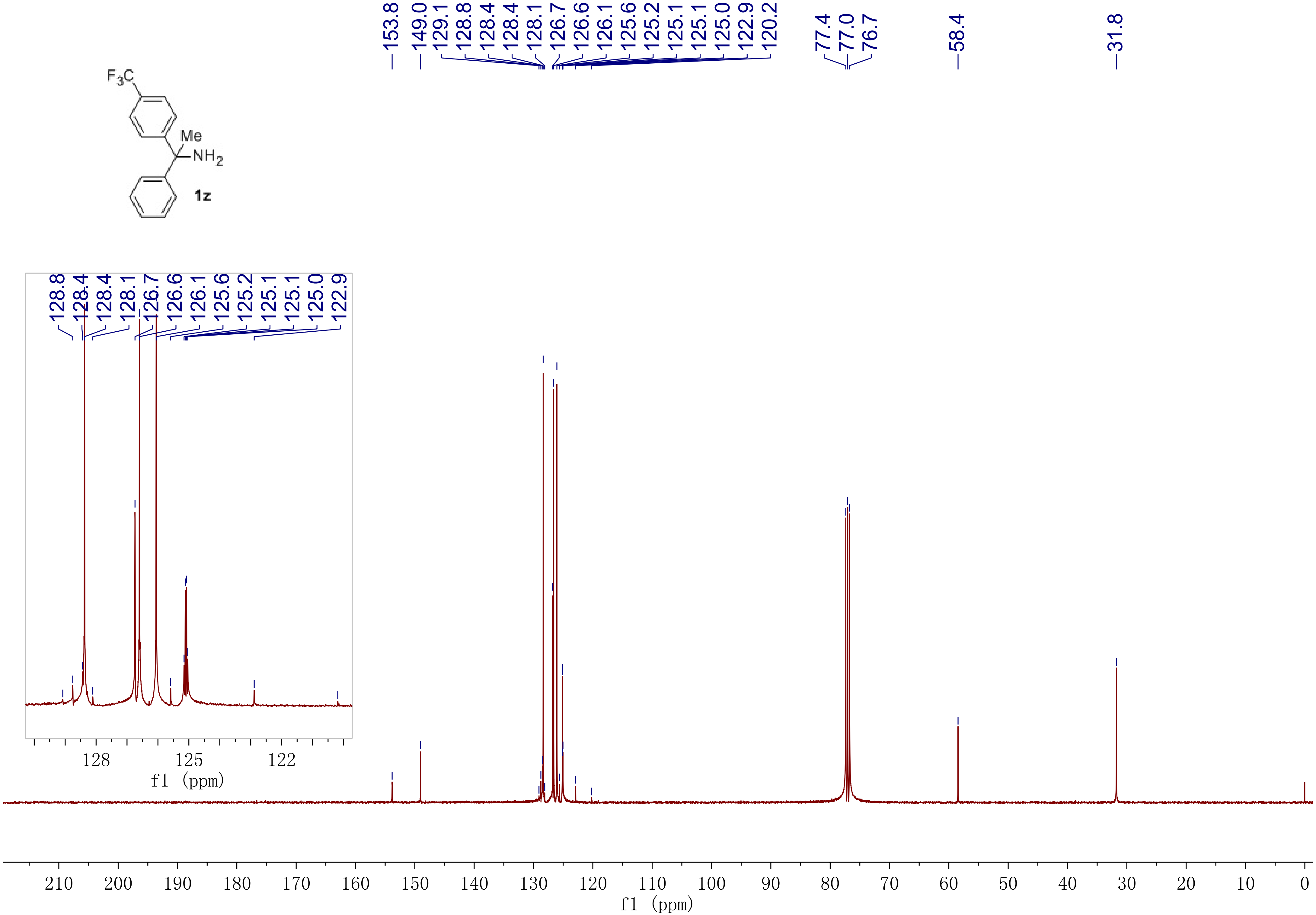
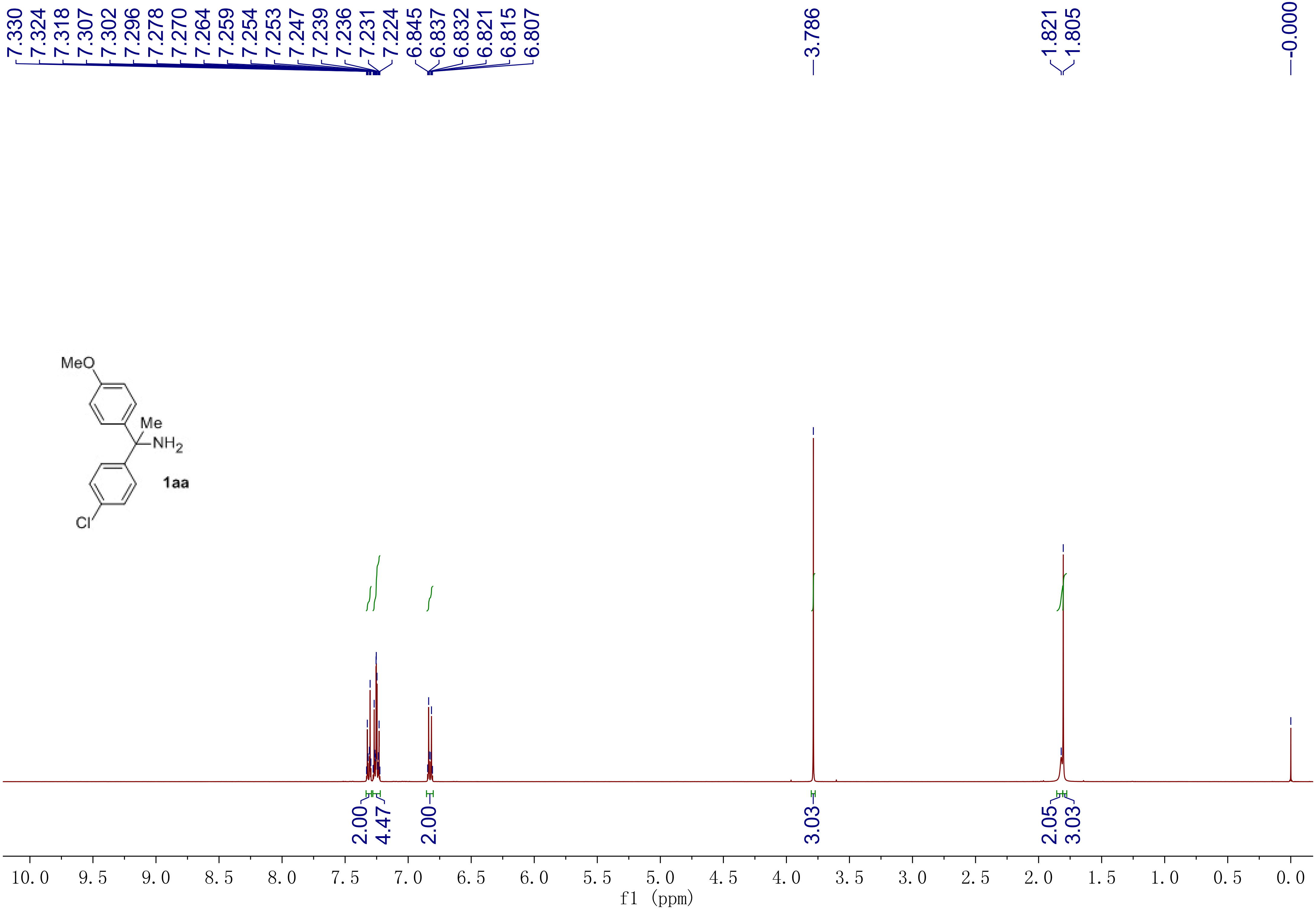
7.520
7.498
7.368
7.363
7.358
7.346
7.343
7.332
7.326
7.314
7.294
7.252
7.240
7.234
7.228
7.220
7.217
7.213
1.862
0.000
F3C
Me
NH2
1z
4.01
4.01
1.07
5.08
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


F$_3$C
Me
NH$_2$
1z
153.8
149.0
129.1
128.8
128.4
128.4
128.1
126.7
126.6
126.1
125.6
125.2
125.1
125.1
125.0
122.9
120.2
77.4
77.0
76.7
58.4
31.8
128.8
128.4
128.4
128.1
126.7
126.6
126.1
125.6
125.2
125.1
125.1
125.0
122.9
128
125
122
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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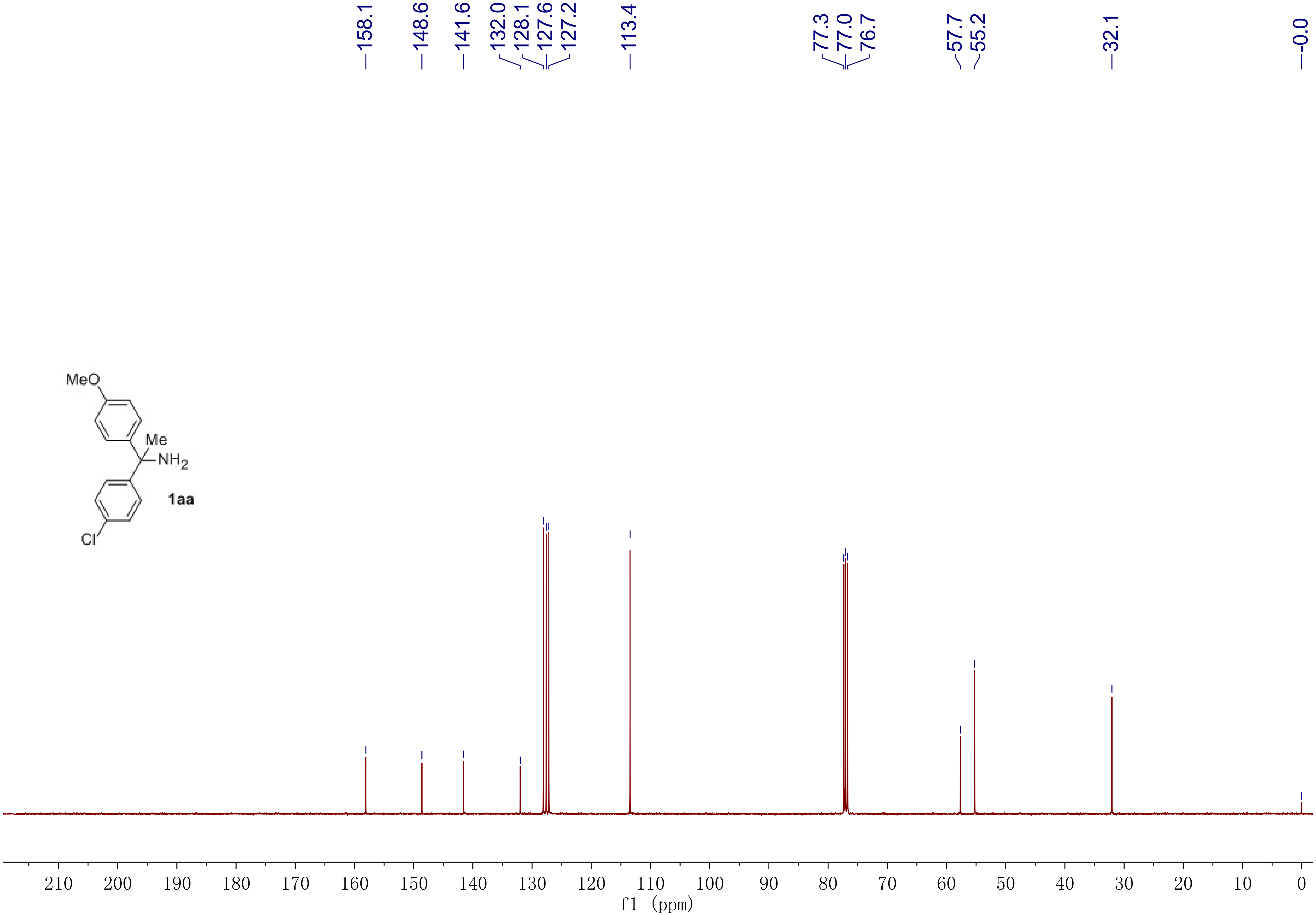
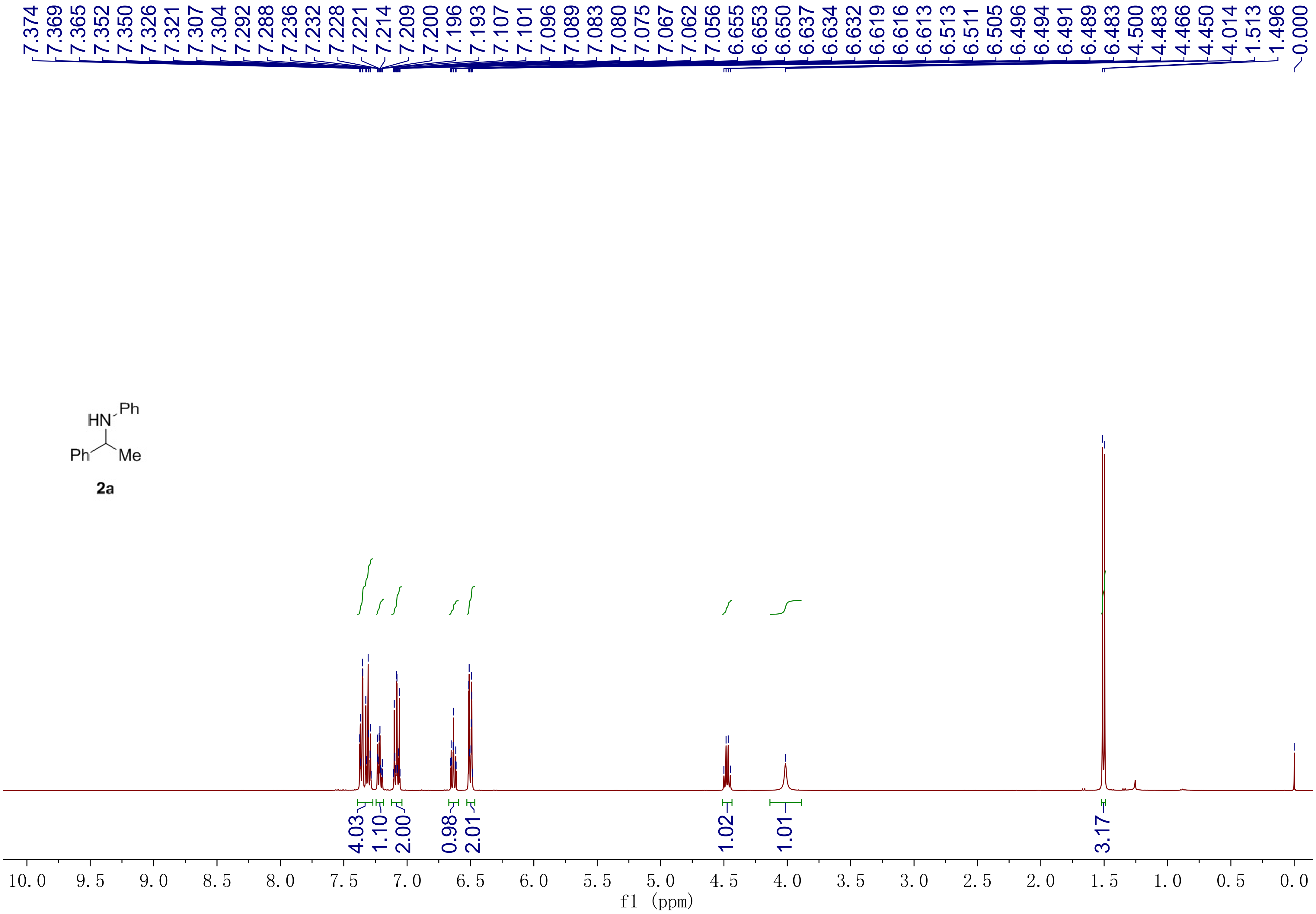
7.318
7.307
7.302
7.296
7.278
7.270
7.264
7.259
7.254
7.253
7.247
7.239
7.236
7.231
7.224
6.845
6.837
6.832
6.821
6.815
6.807
3.786
1.821
1.805
-0.000
MeO
Me
NH2
Cl
1aa
2.00
4.47
2.00
3.03
2.05
3.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

158.1
148.6
141.6
132.0
128.1
127.6
127.2
113.4
77.3
77.0
76.7
57.7
55.2
32.1
-0.0
MeO
Me
NH2
Cl
1aa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.374
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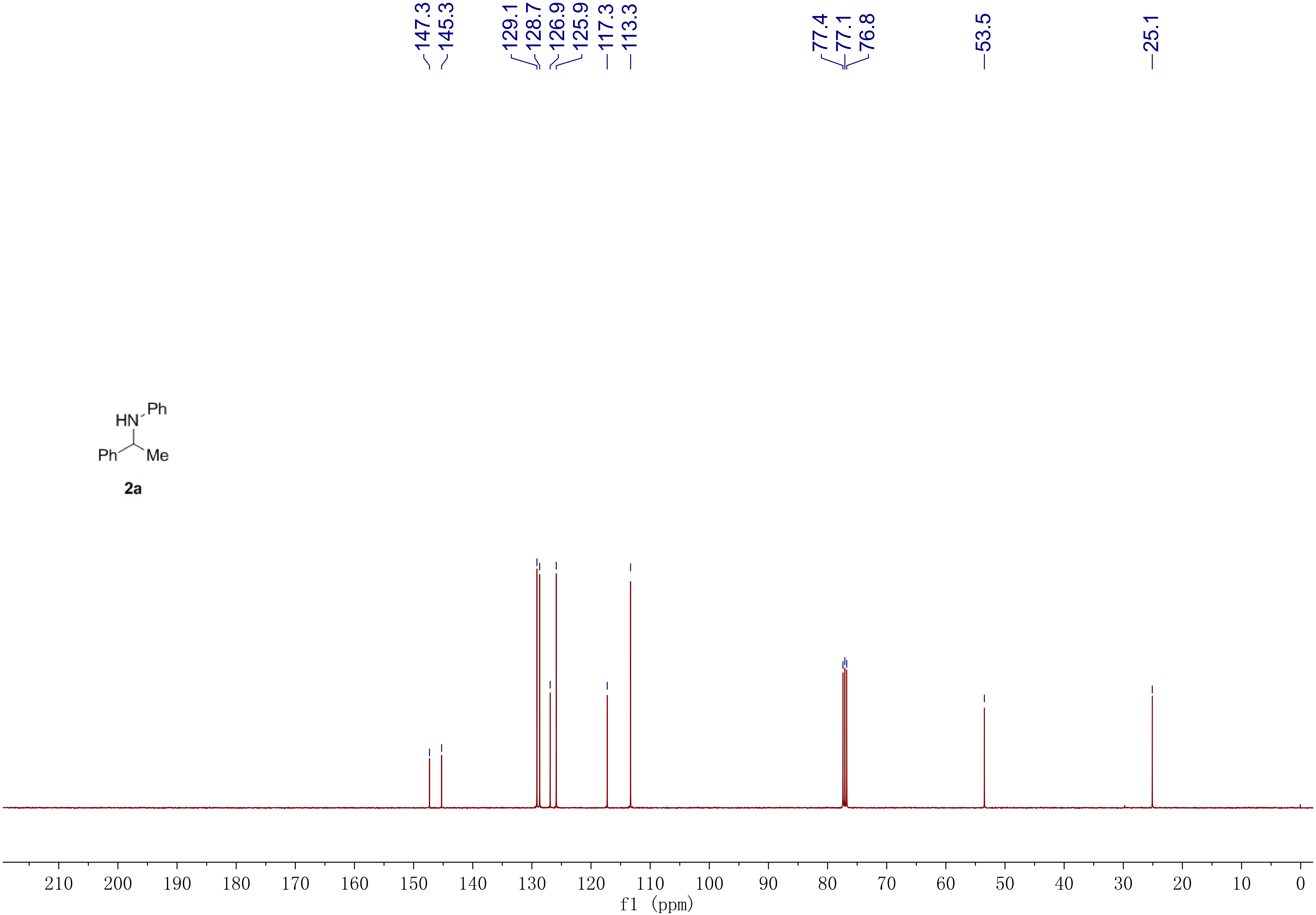
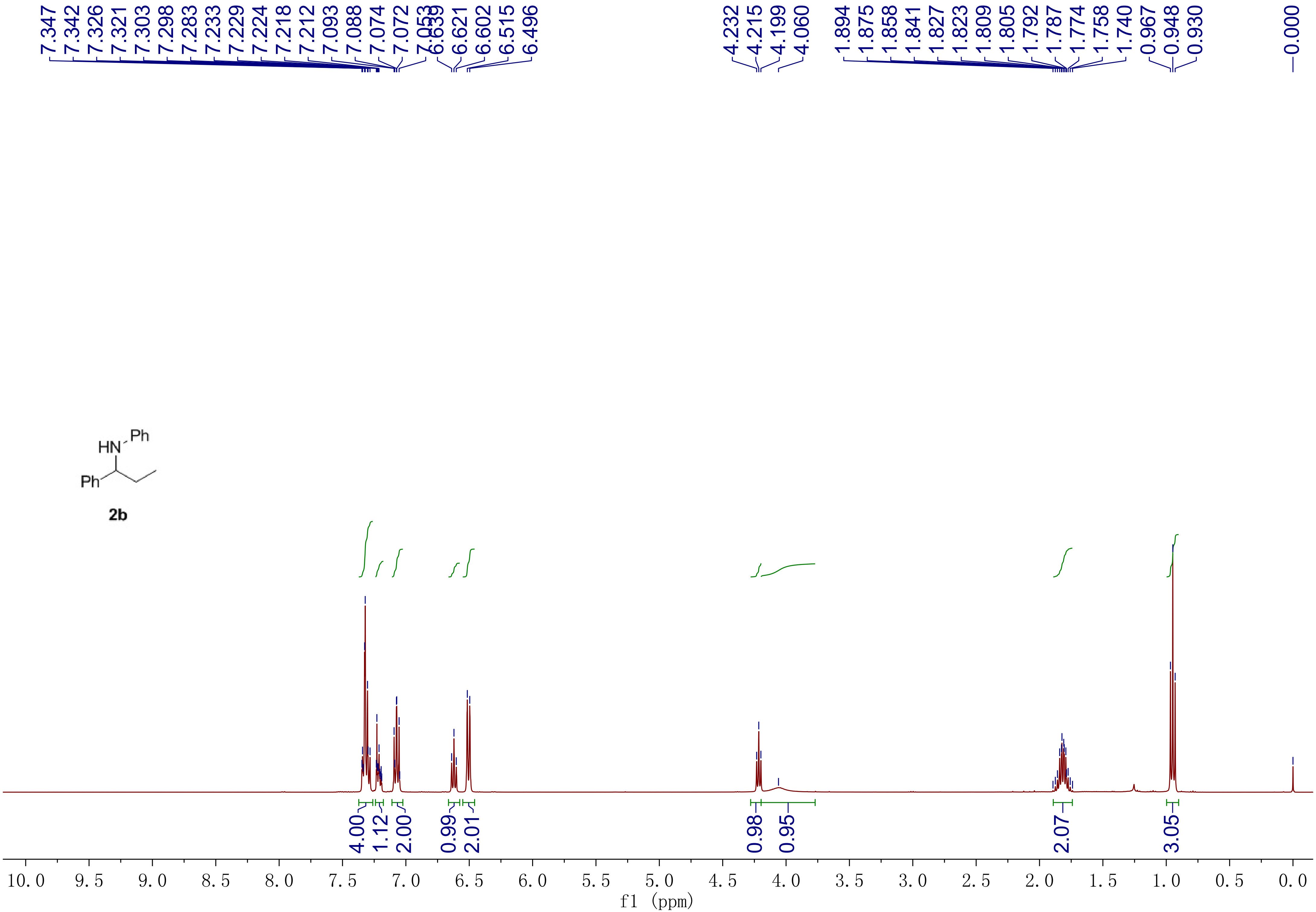
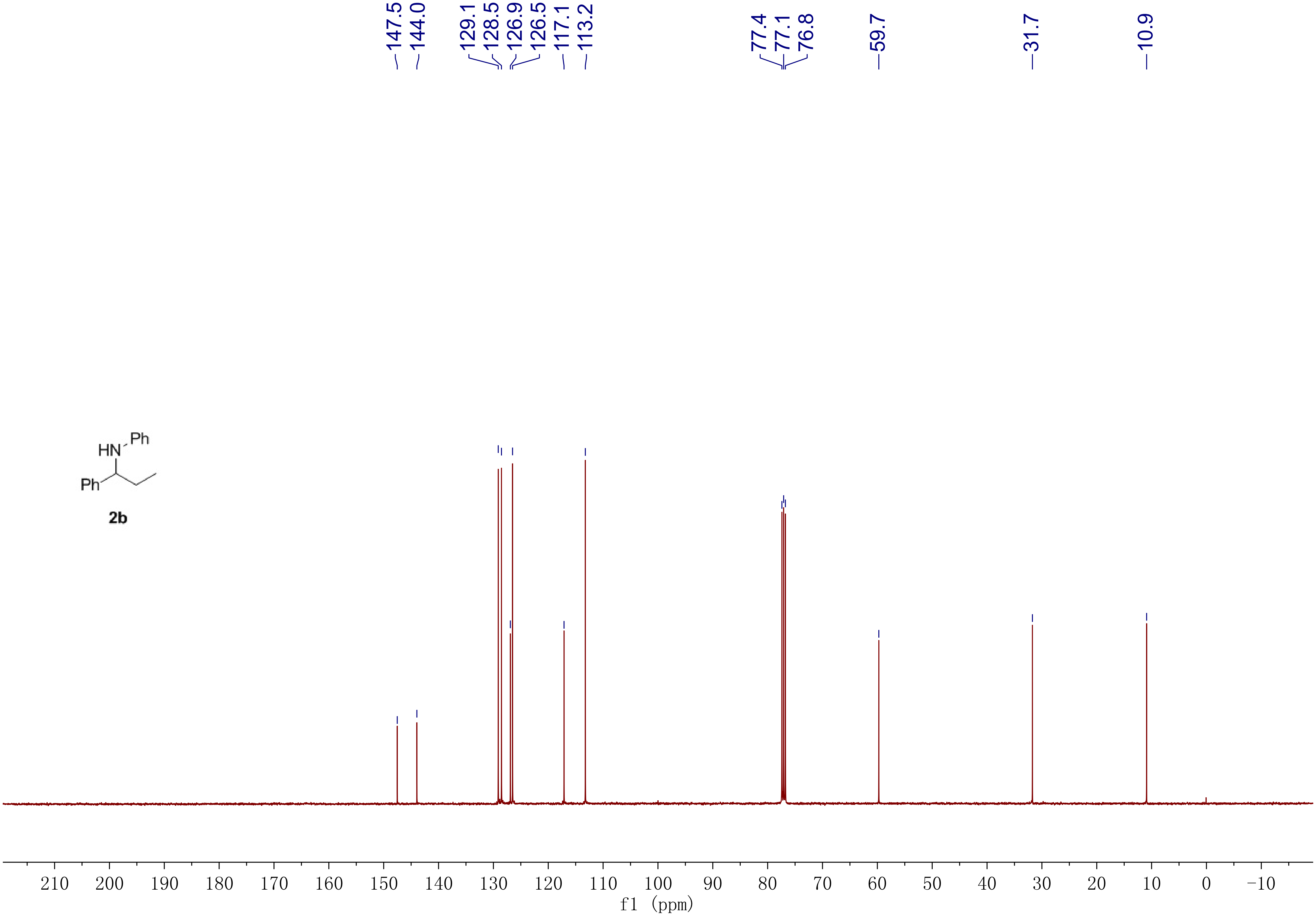
7.365
7.352
7.350
7.326
7.321
7.307
7.304
7.292
7.288
7.236
7.232
7.228
7.221
7.214
7.209
7.200
7.196
7.193
7.107
7.101
7.096
7.089
7.083
7.080
7.075
7.067
7.062
7.056
6.655
6.653
6.650
6.637
6.634
6.632
6.619
6.616
6.613
6.513
6.511
6.505
6.496
6.494
6.491
6.489
6.483
4.500
4.483
4.466
4.450
4.014
1.513
1.496
0.000
HN
Ph
Ph
Me
4.03
1.10
2.00
0.98
2.01
1.02
1.01
3.17
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
f1 (ppm)

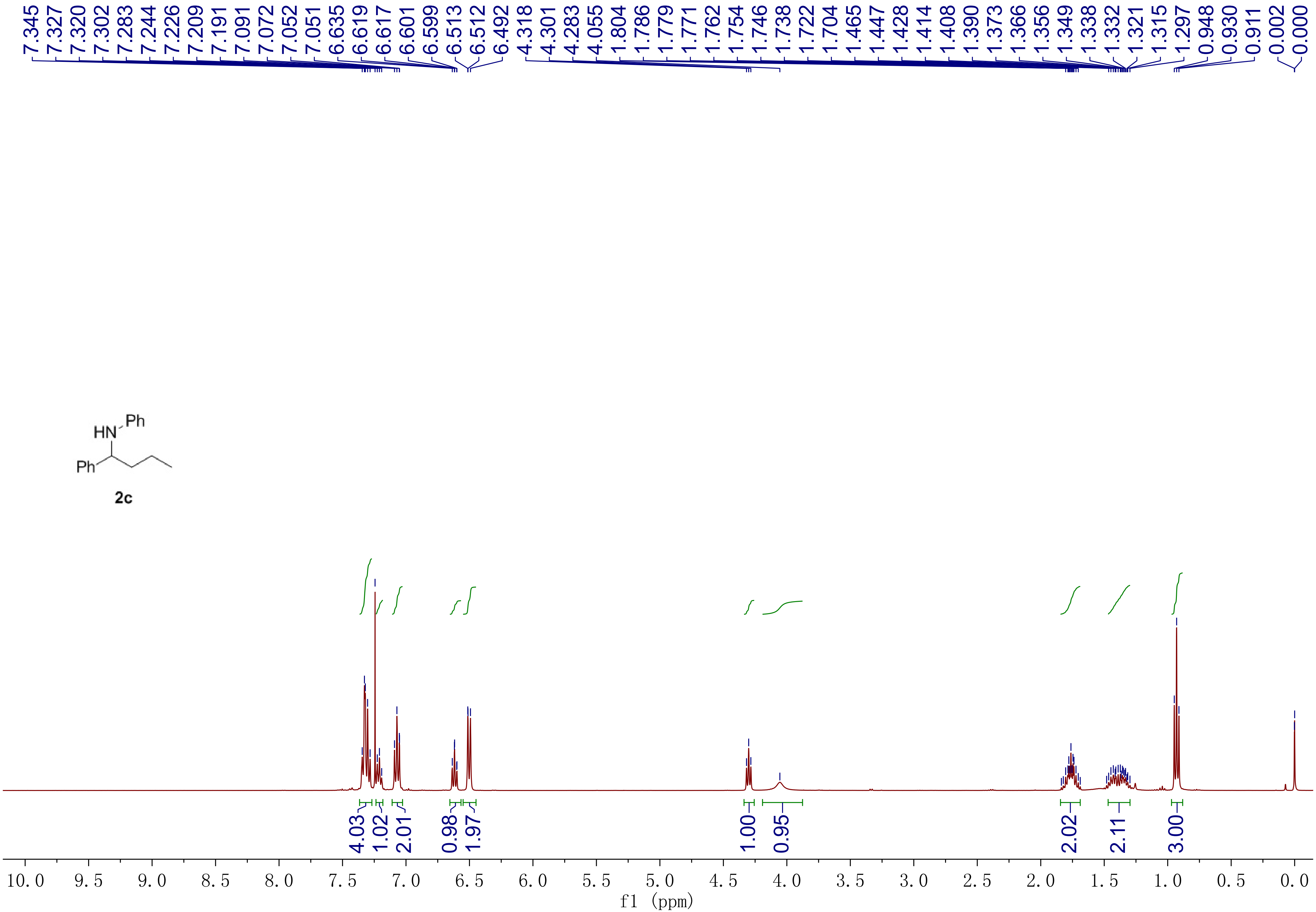
2a


147.3
145.3
129.1
128.7
126.9
125.9
117.3
113.3
77.4
77.1
76.8
53.5
25.1
HN
Ph
Ph
Me
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

2a


7.347
7.342
7.326
7.321
7.303
7.298
7.283
7.233
7.229
7.224
7.218
7.212
7.093
7.088
7.074
7.072
7.053
6.639
6.621
6.602
6.515
6.496
4.232
4.215
4.199
4.060
1.894
1.875
1.858
1.841
1.827
1.823
1.809
1.805
1.792
1.787
1.774
1.758
1.740
0.967
0.948
0.930
0.000
HN
Ph
Ph
2b
4.00
1.12
2.00
0.99
2.01
0.98
0.95
2.07
3.05
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
f1 (ppm)


147.5
144.0
129.1
128.5
126.9
126.5
117.1
113.2
77.4
77.1
76.8
59.7
31.7
10.9
HN
Ph
Ph
2b
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)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7.051
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6.619
6.617
6.601
6.599
6.513
6.512
6.492
4.318
4.301
4.283
4.055
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1.786
1.779
1.771
1.762
1.754
1.746
1.738
1.722
1.704
1.465
1.447
1.428
1.414
1.408
1.390
1.373
1.366
1.356
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1.338
1.332
1.321
1.315
1.297
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0.930
0.911
0.002
0.000
HN
Ph
Ph
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2.01
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1.97
1.00
0.95
2.02
2.11
3.00
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9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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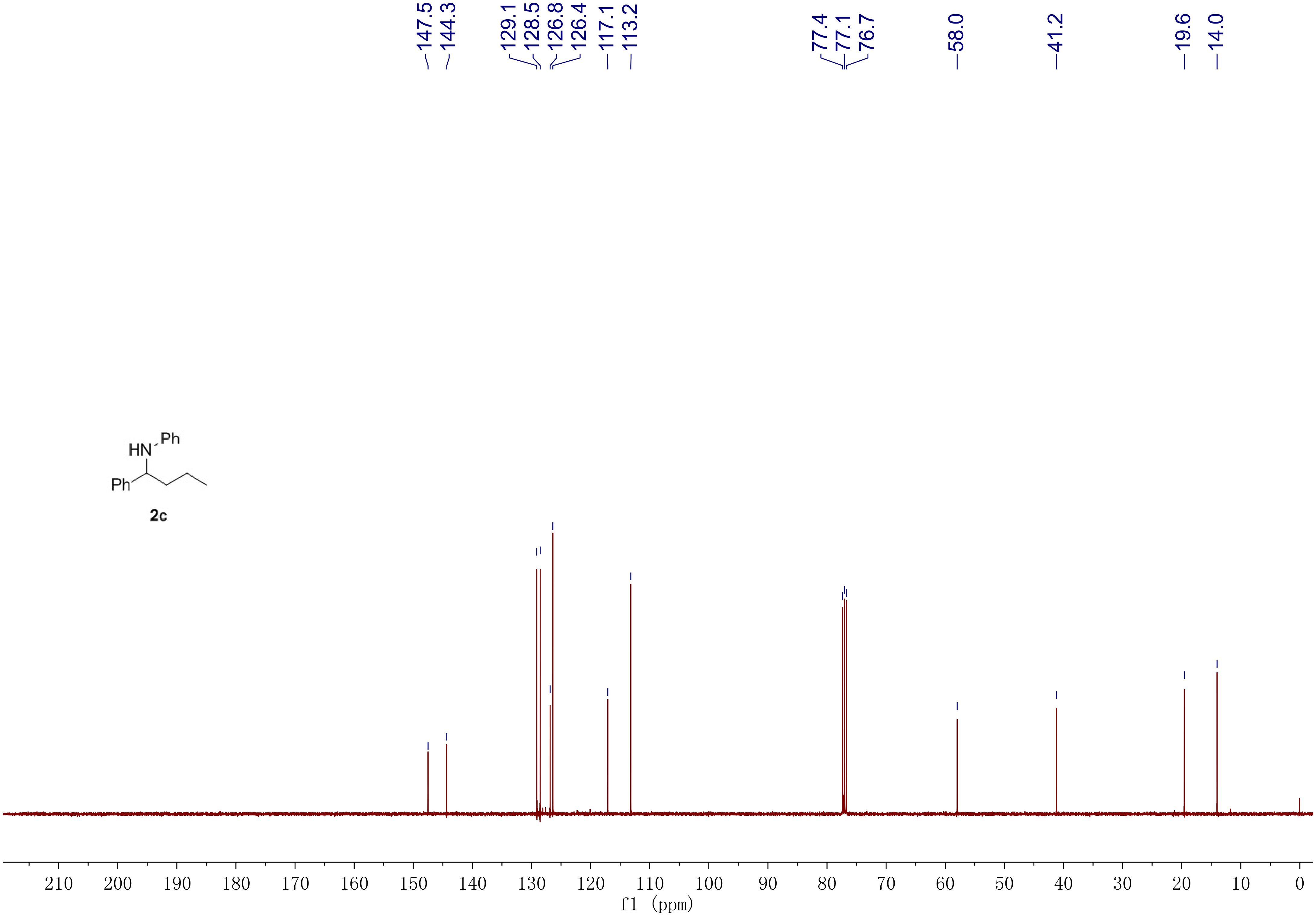
f1 (ppm)

2c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14.0
HN
Ph
Ph
2c
210
200
190
180
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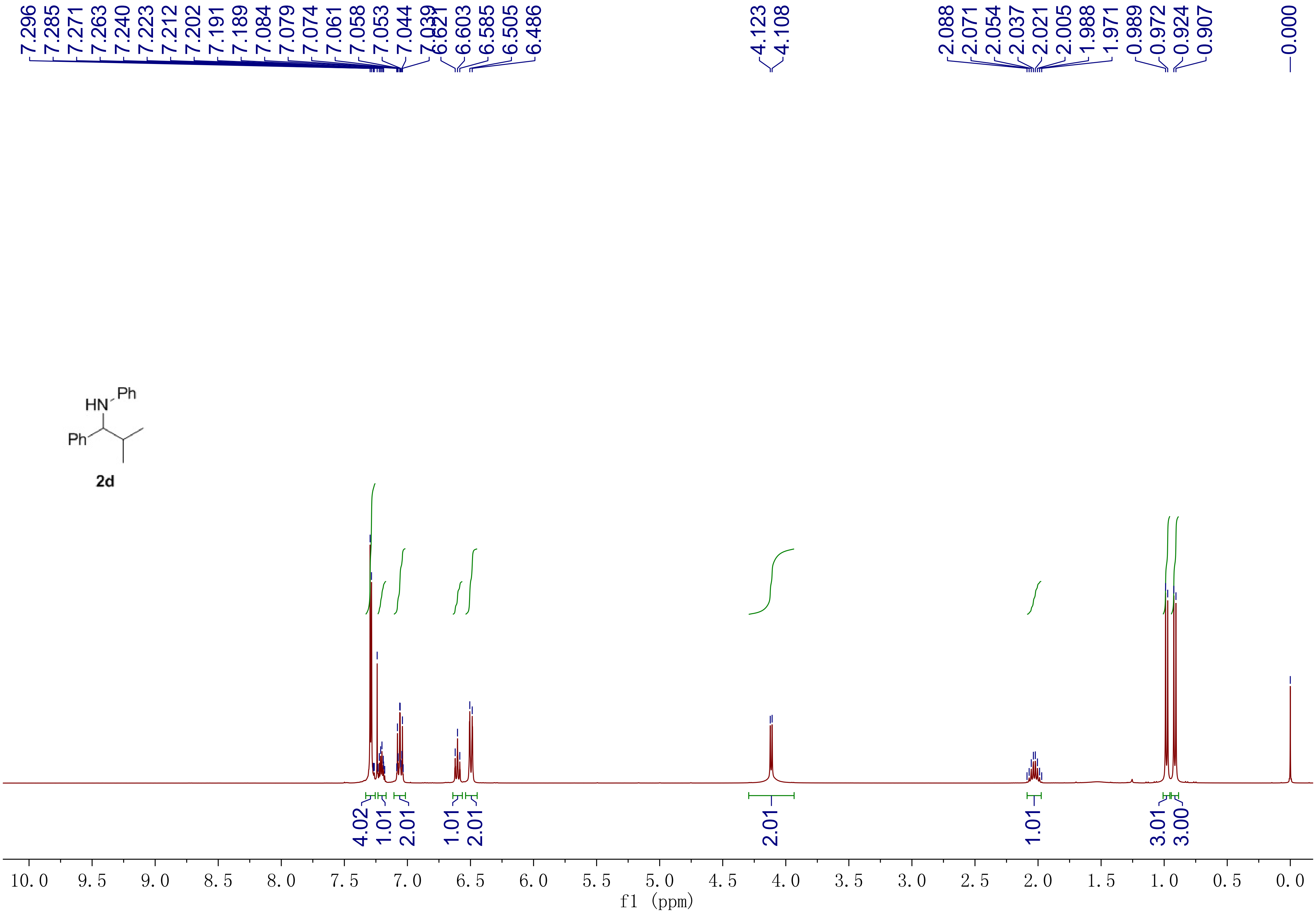
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7.189
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7.079
7.074
7.061
7.058
7.053
7.044
7.039
6.621
6.603
6.585
6.505
6.486
4.123
4.108
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2.071
2.054
2.037
2.021
2.005
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1.971
0.989
0.972
0.924
0.907
0.000
HN
Ph
Ph
2d
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1.01
2.01
1.01
2.01
2.01
1.01
3.01
3.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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2.5
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1.0
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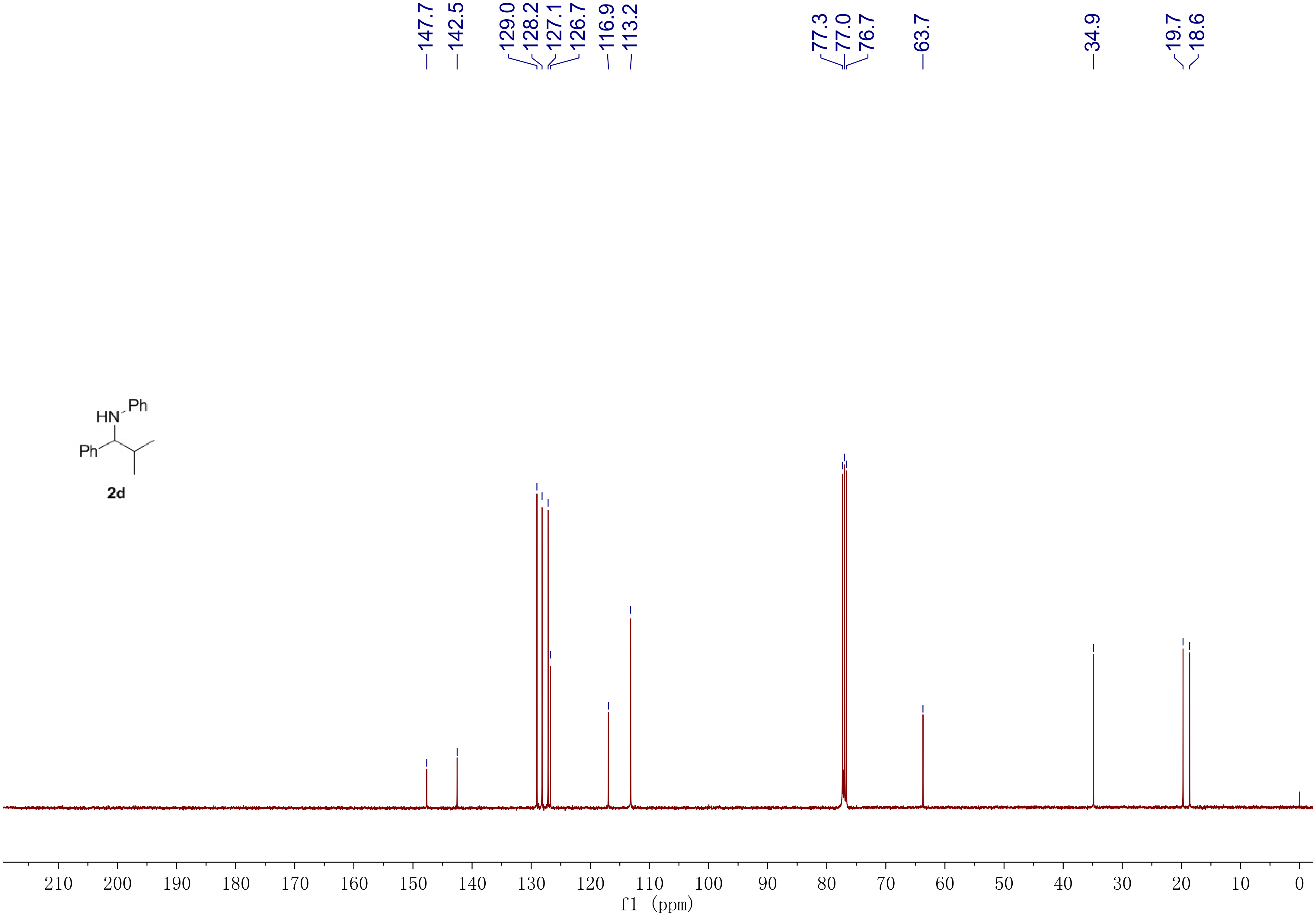
f1 (ppm)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76.7
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19.7
18.6
HN
Ph
Ph
2d
210
200
190
180
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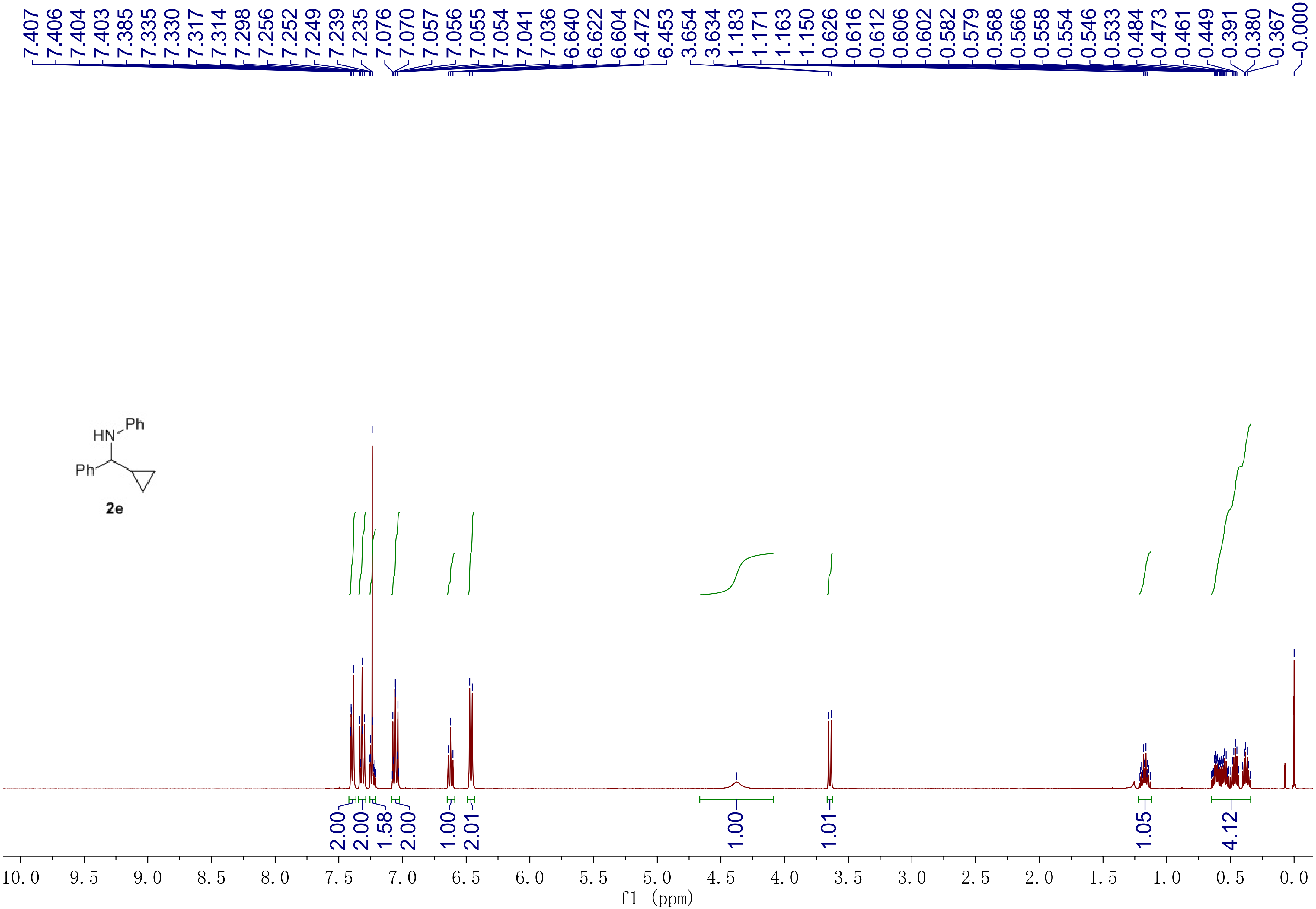
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7.249
7.239
7.235
7.076
7.070
7.057
7.056
7.055
7.054
7.041
7.036
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6.622
6.604
6.472
6.453
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3.634
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1.171
1.163
1.150
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0.612
0.606
0.602
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0.579
0.568
0.566
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0.554
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0.484
0.473
0.461
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0.391
0.380
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Ph
Ph
2e
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2.00
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2.01
1.00
1.01
1.05
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7.5
7.0
6.5
6.0
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3.0
2.5
2.0
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1.0
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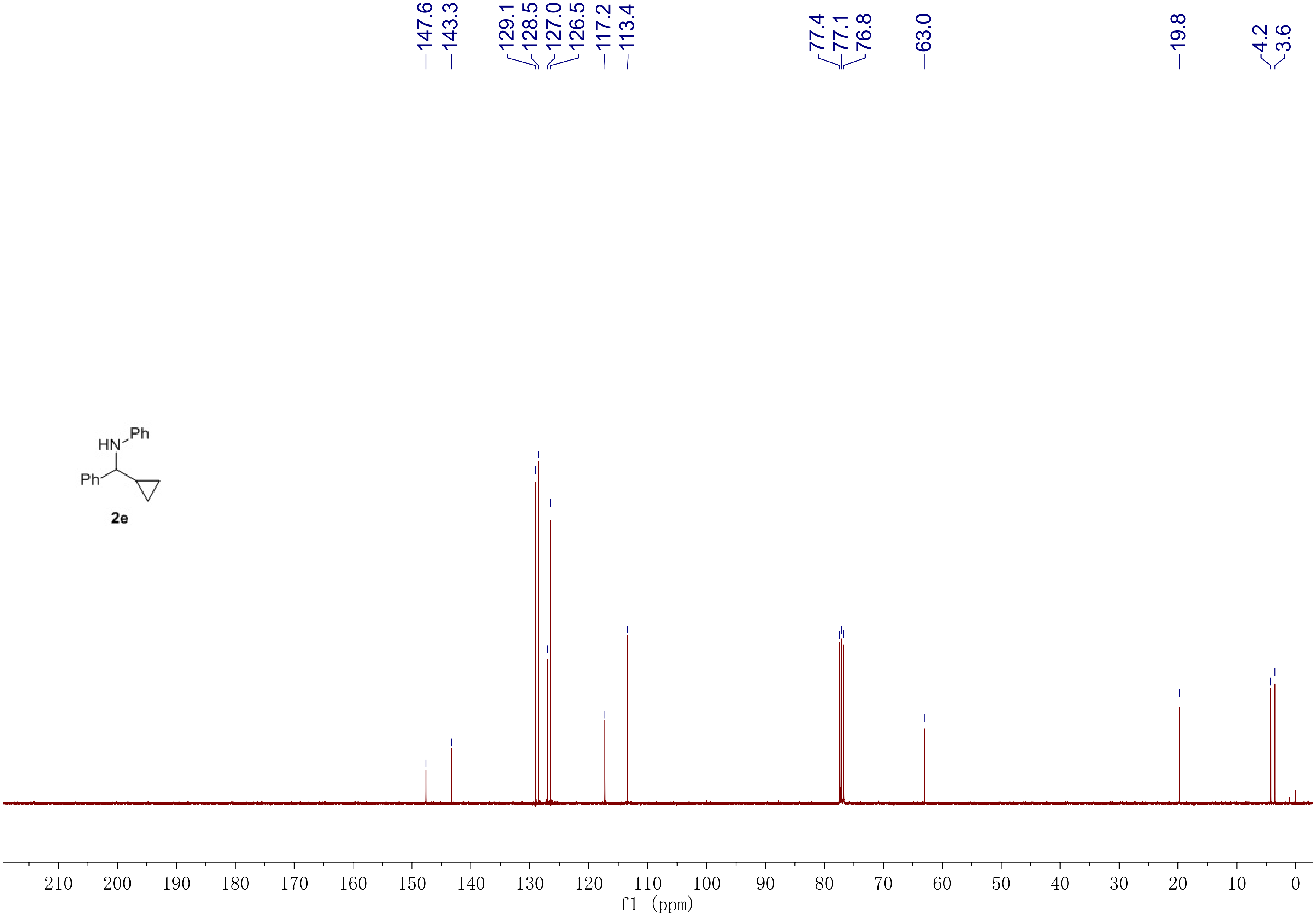
0.0
f1 (ppm)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77.1
76.8
63.0
19.8
4.2
3.6
HN
Ph
Ph
2e
210
200
190
180
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150
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130
120
110
100
90
80
70
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50
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30
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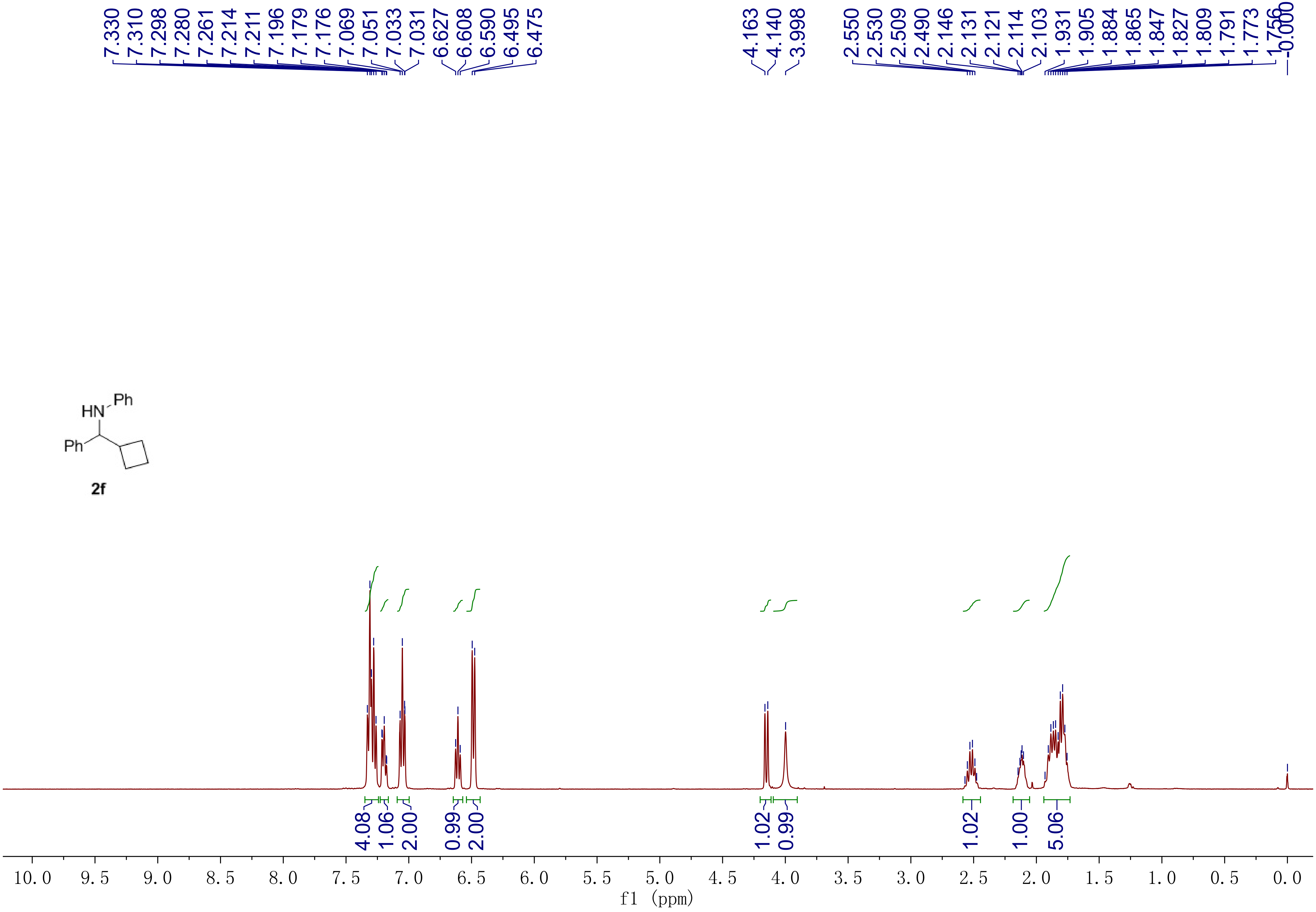
10
0
f1 (ppm)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7.033
7.031
6.627
6.608
6.590
6.495
6.475
4.163
4.140
3.998
2.550
2.530
2.509
2.490
2.146
2.131
2.121
2.114
2.103
1.931
1.905
1.884
1.865
1.847
1.827
1.809
1.791
1.773
1.756
-0.000
HN
Ph
Ph
2f
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1.06
2.00
0.99
2.00
1.02
0.99
1.02
1.00
5.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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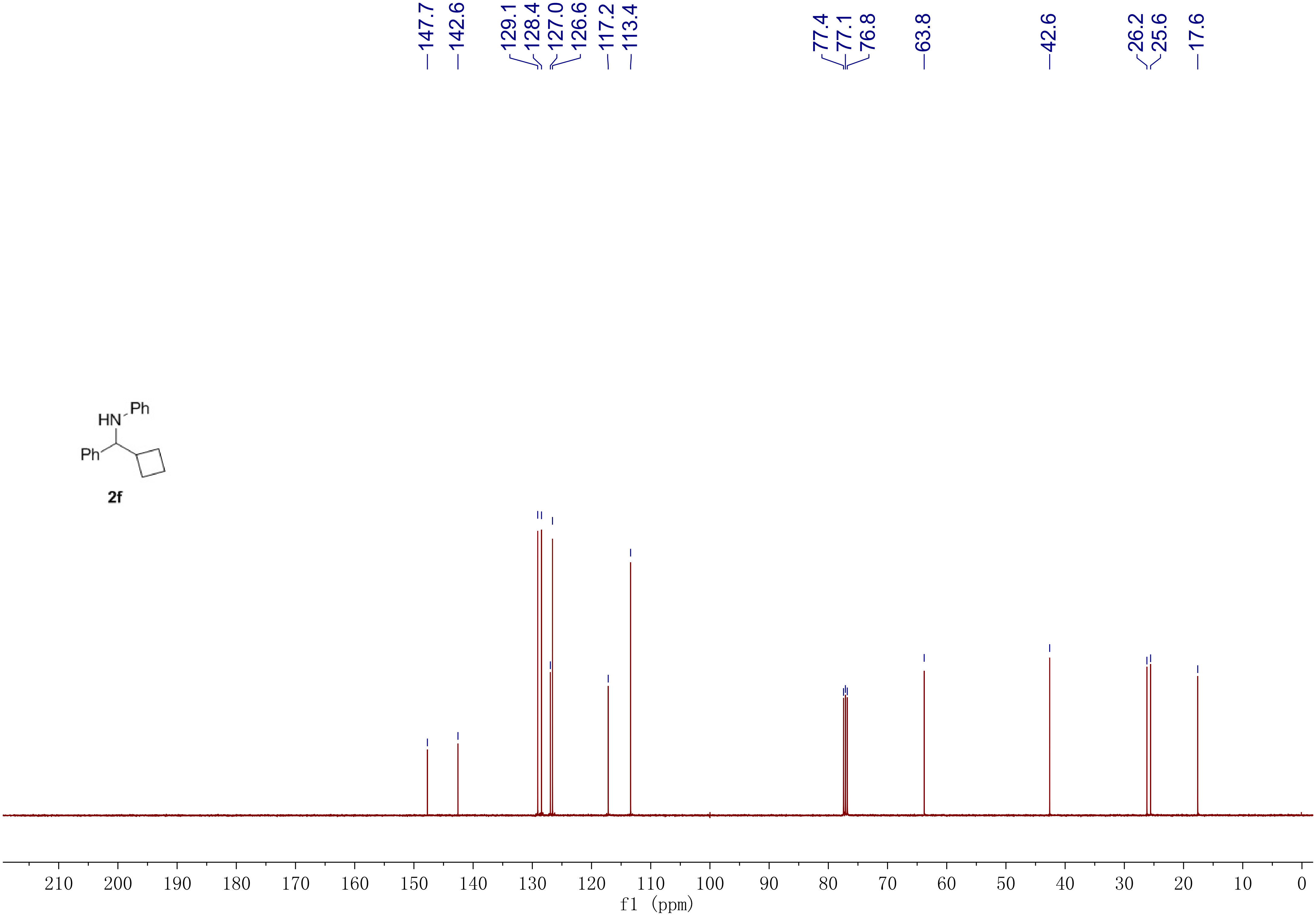
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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77.1
76.8
63.8
42.6
26.2
25.6
17.6
HN
Ph
Ph
2f
210
200
190
180
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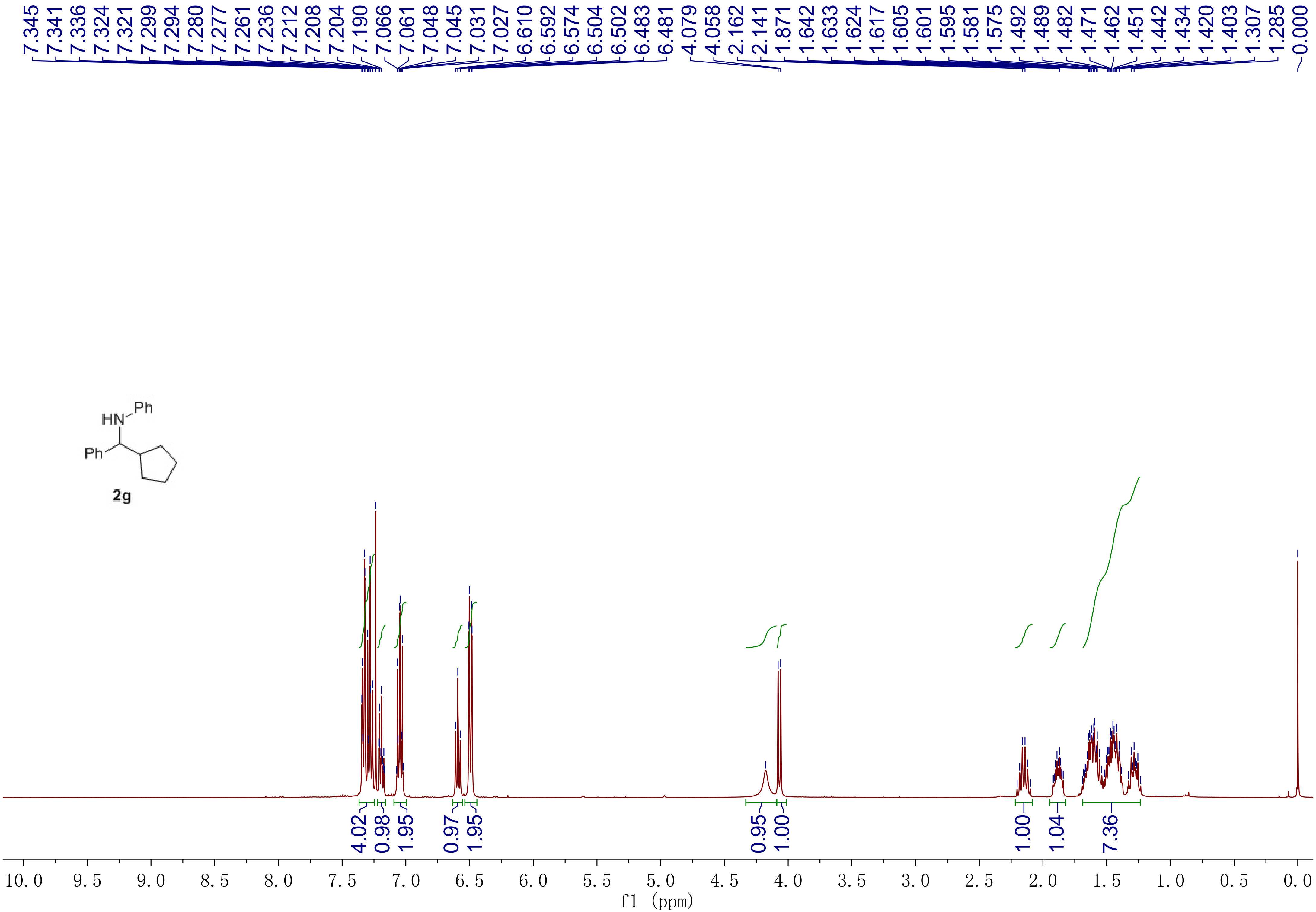
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.236
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7.208
7.204
7.190
7.066
7.061
7.048
7.045
7.031
7.027
6.610
6.592
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6.504
6.502
6.483
6.481
4.079
4.058
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1.642
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1.617
1.605
1.601
1.595
1.581
1.575
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1.482
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1.462
1.451
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1.434
1.420
1.403
1.307
1.285
0.000
HN
Ph
Ph
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0.97
1.95
0.95
1.00
1.00
1.04
7.36
10.0
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7.0
6.5
6.0
5.5
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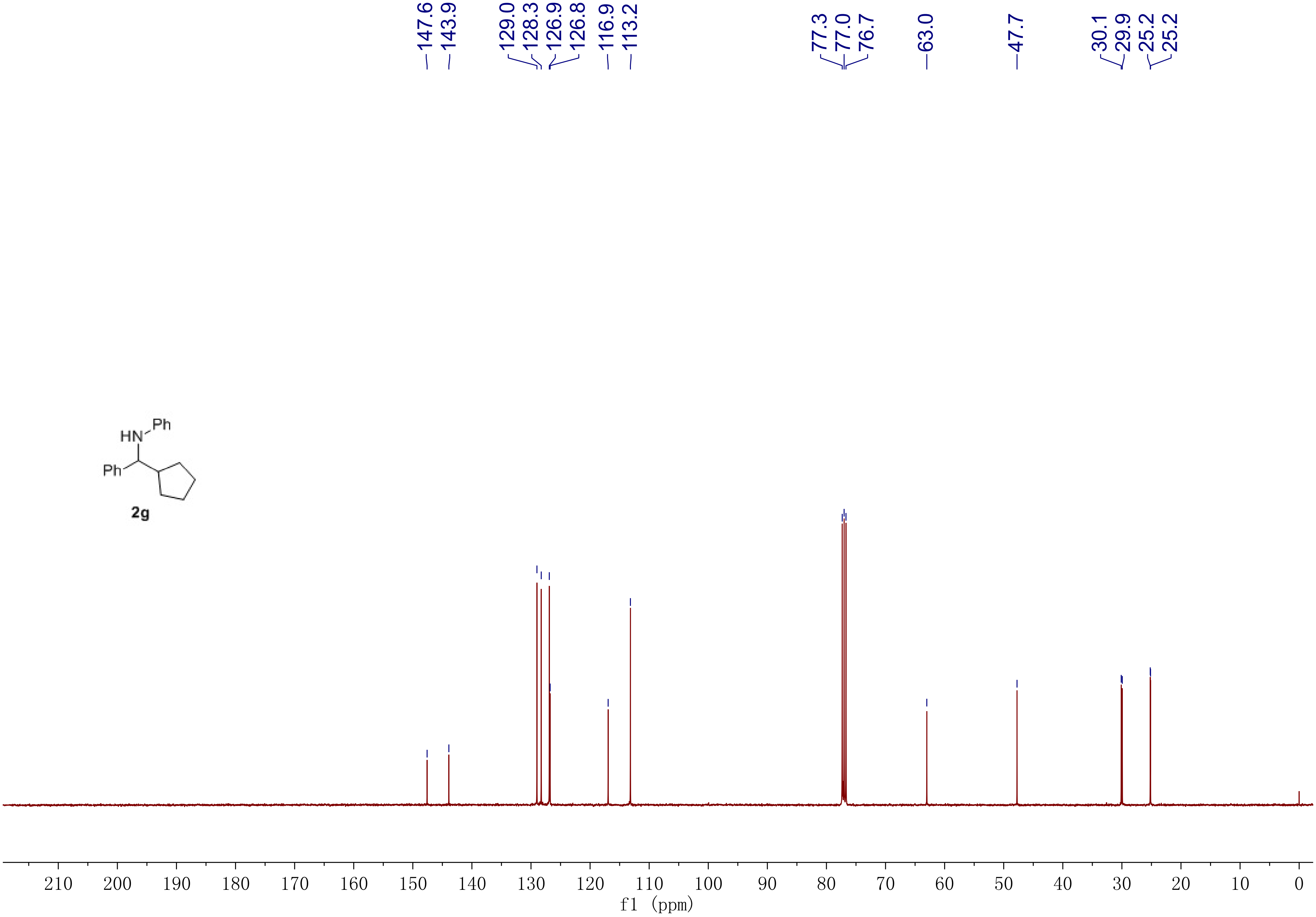
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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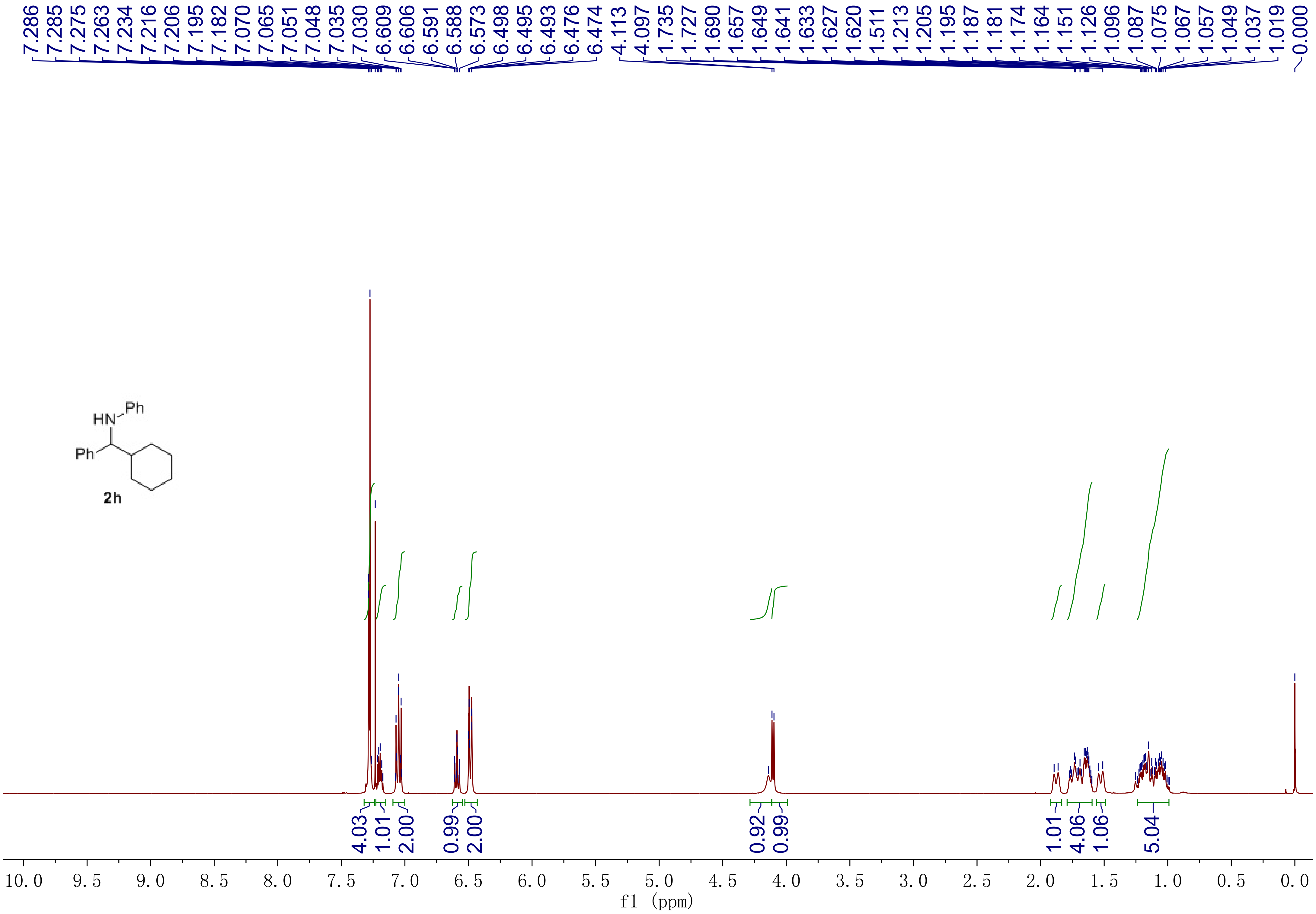
30.1
29.9
25.2
25.2
HN
Ph
Ph
2g
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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6.606
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1.181
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1.067
1.057
1.049
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1.019
0.000
HN
Ph
Ph
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2.00
0.99
2.00
0.92
0.99
1.01
4.06
1.06
5.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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4.0
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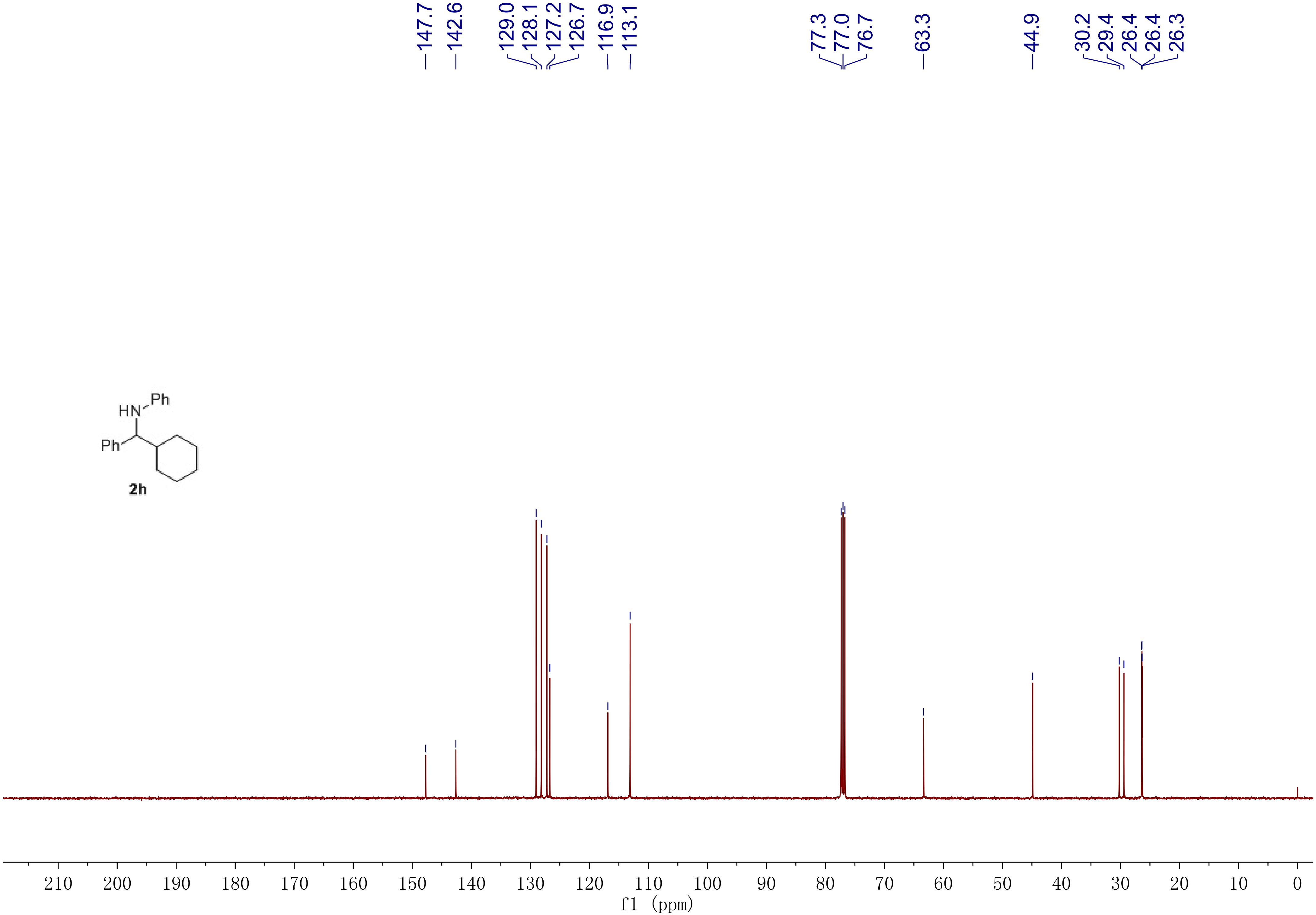
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

2h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76.7
63.3
44.9
30.2
29.4
26.4
26.4
26.3
HN
Ph
Ph
2h
210
200
190
180
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150
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130
120
110
100
90
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70
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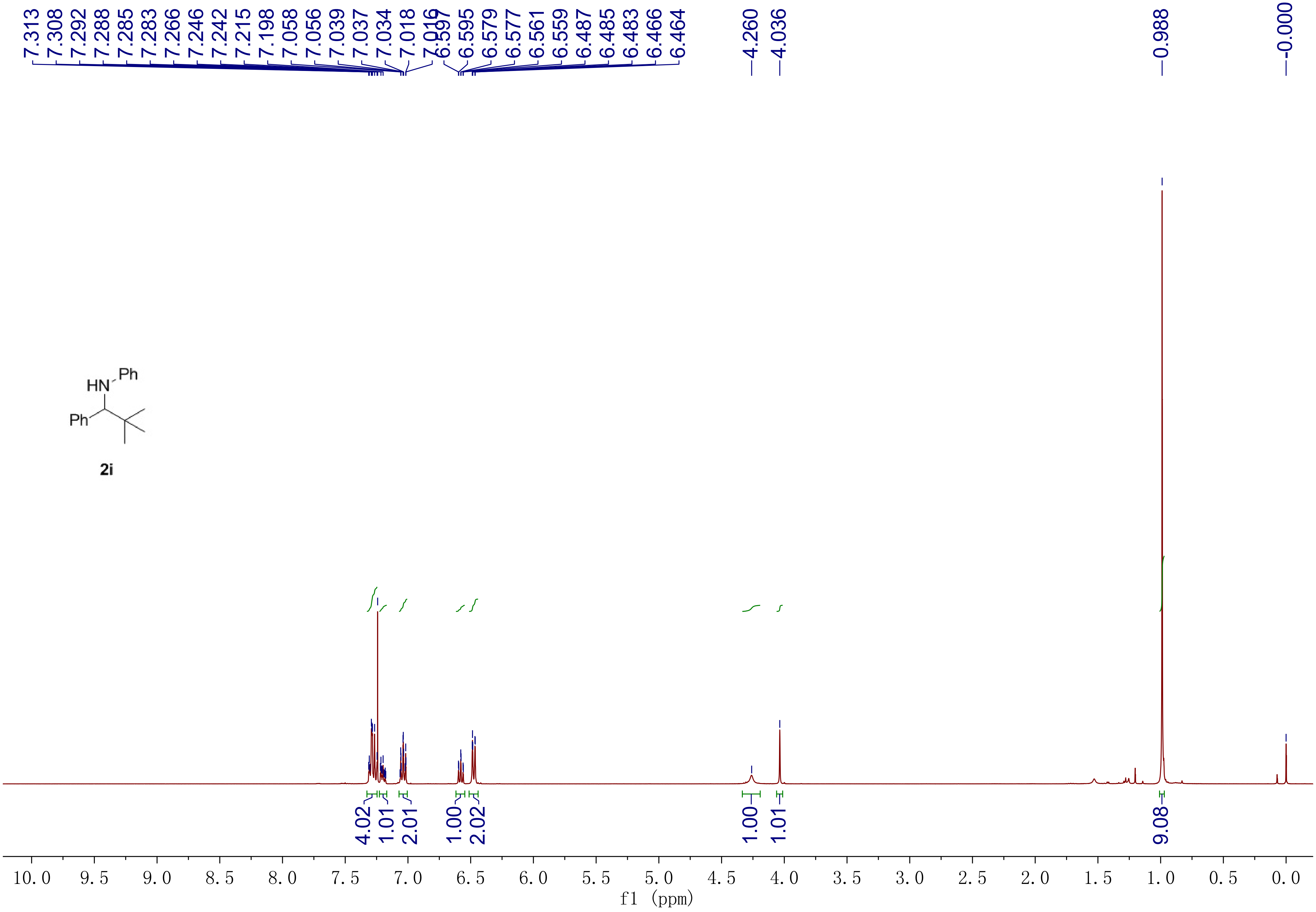
50
40
30
20
10
0
f1 (ppm)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7.016
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6.579
6.577
6.561
6.559
6.487
6.485
6.483
6.466
6.464
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4.036
0.988
-0.000
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Ph
Ph
2i
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2.01
1.00
2.02
1.00
1.01
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6.0
5.5
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3.0
2.5
2.0
1.5
1.0
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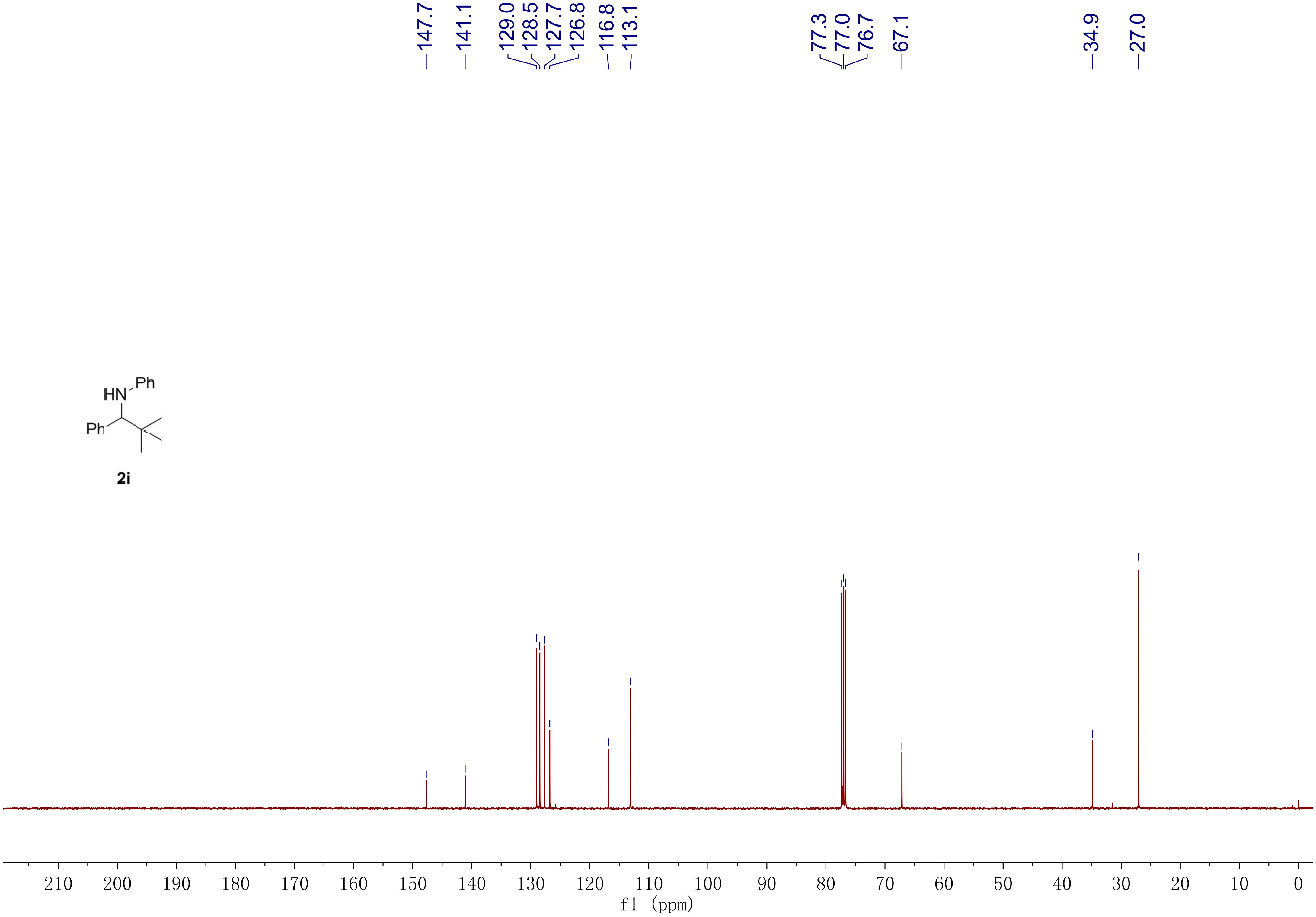
f1 (ppm)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77.0
76.7
67.1
34.9
27.0
HN
Ph
Ph
2i
210
200
190
180
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130
120
110
100
90
80
70
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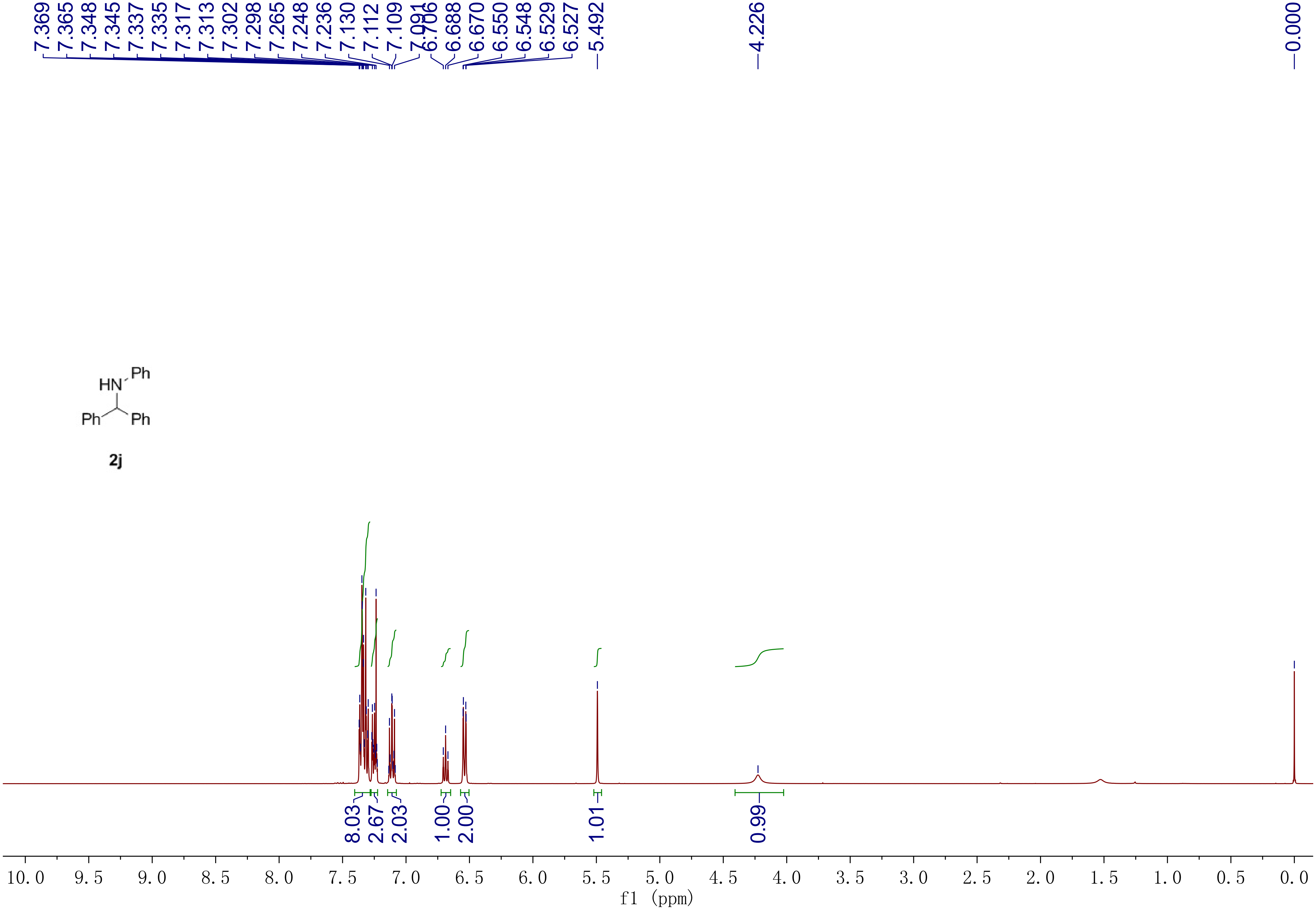
50
40
30
20
10
0
f1 (ppm)



2j

HN
Ph
Ph
Ph
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7.248
7.236
7.130
7.112
7.109
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6.527
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2.00
1.01
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2.5
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1.5
1.0
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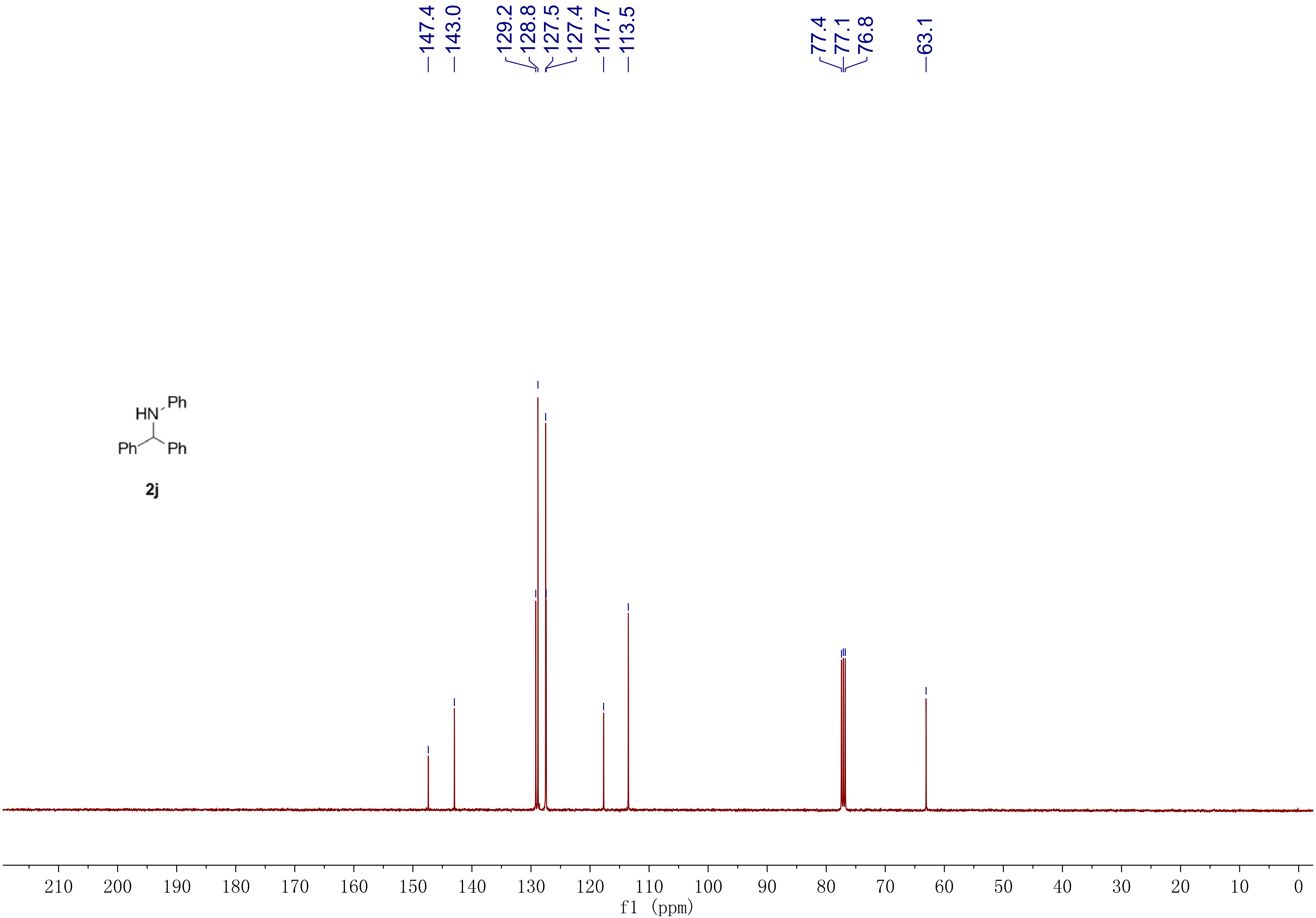
0.0
f1 (ppm)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77.4
77.1
76.8
63.1
HN
Ph
Ph
Ph
2j
210
200
190
180
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150
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130
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110
100
90
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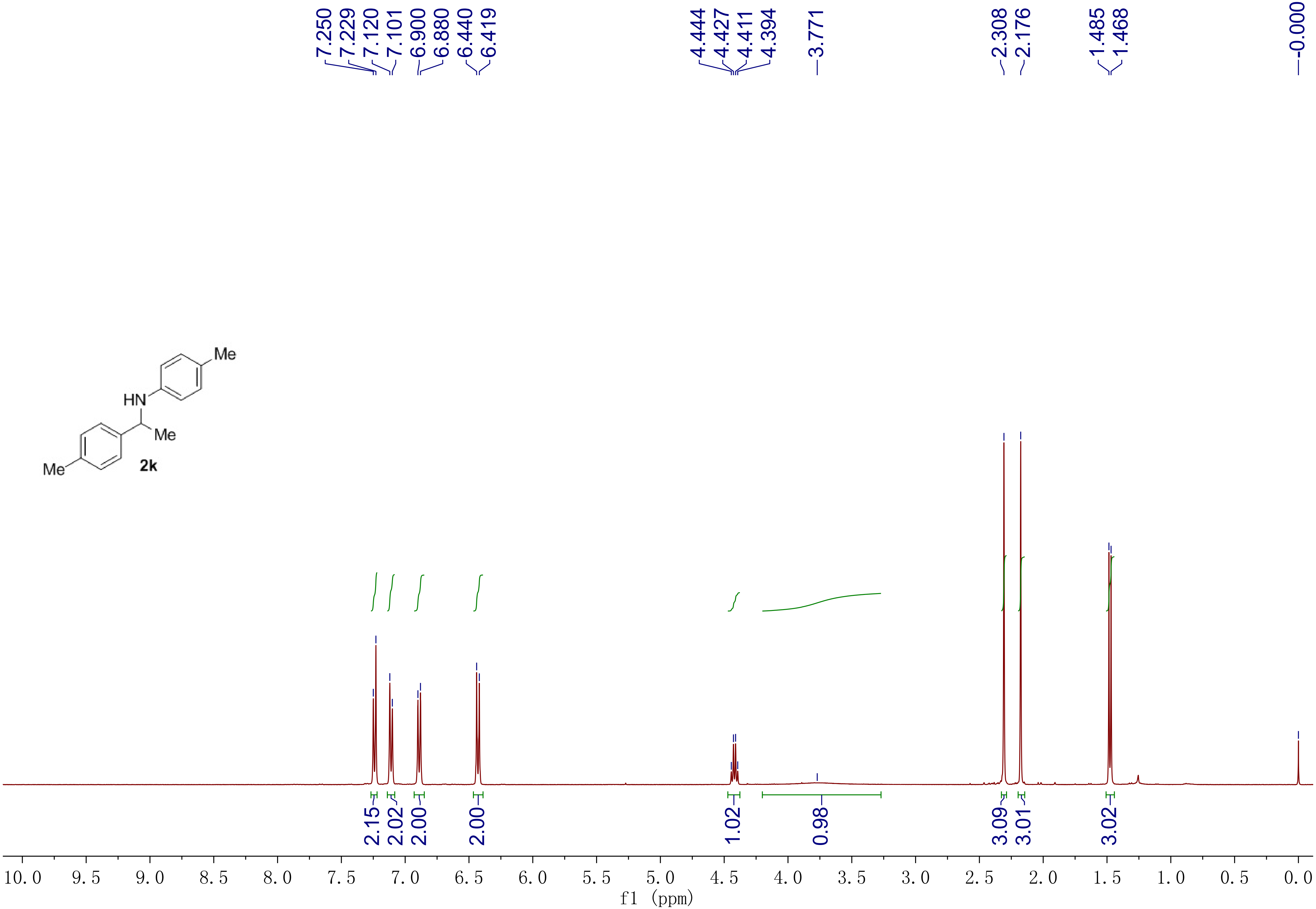
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1.468
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Me
Me
Me
2k
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2.00
1.02
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3.01
3.02
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9.0
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7.5
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6.0
5.5
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2.0
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1.0
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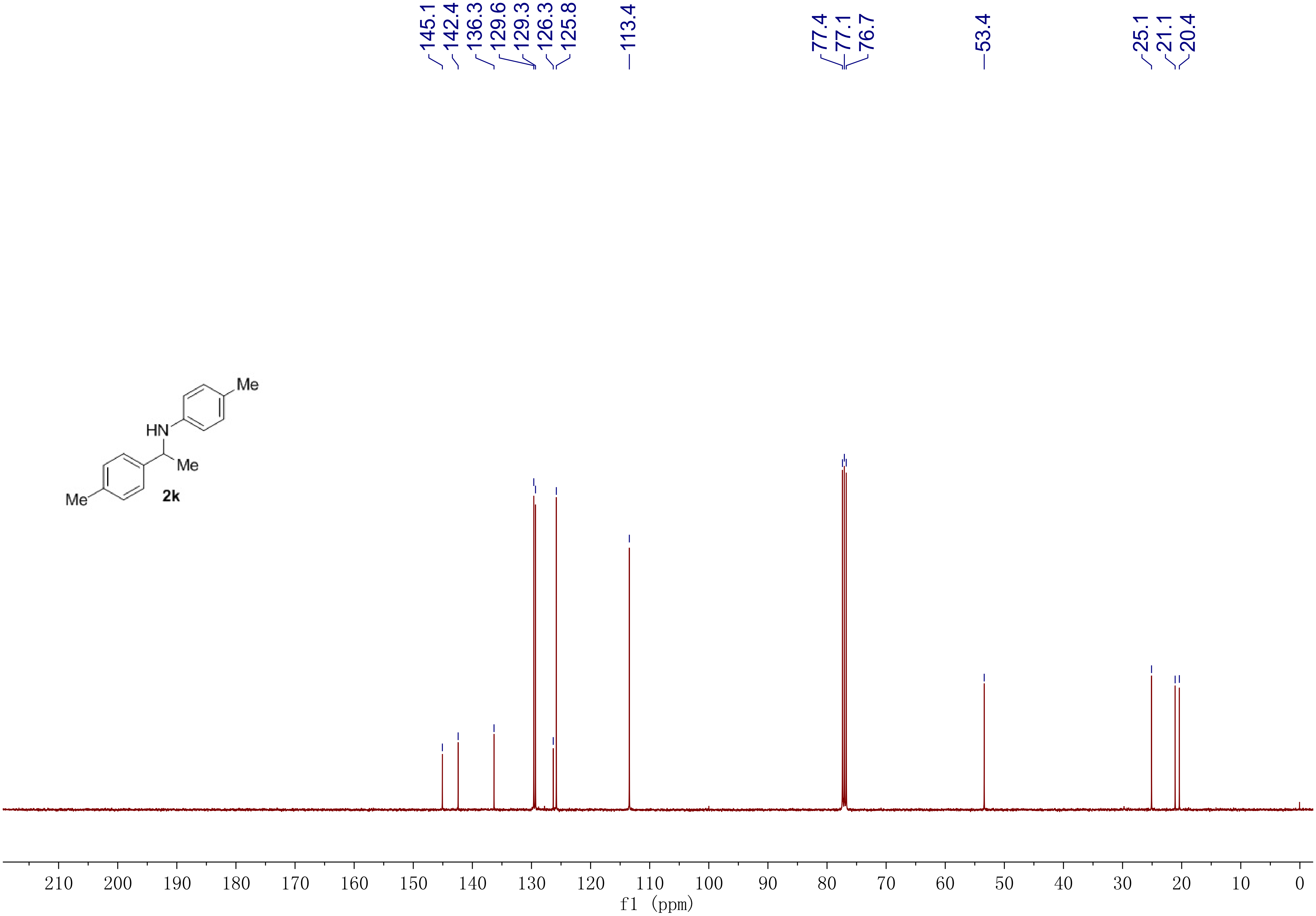
f1 (ppm)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113.4
77.4
77.1
76.7
53.4
25.1
21.1
20.4
Me
HN
Me
Me
2k
210
200
190
180
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120
110
100
90
80
70
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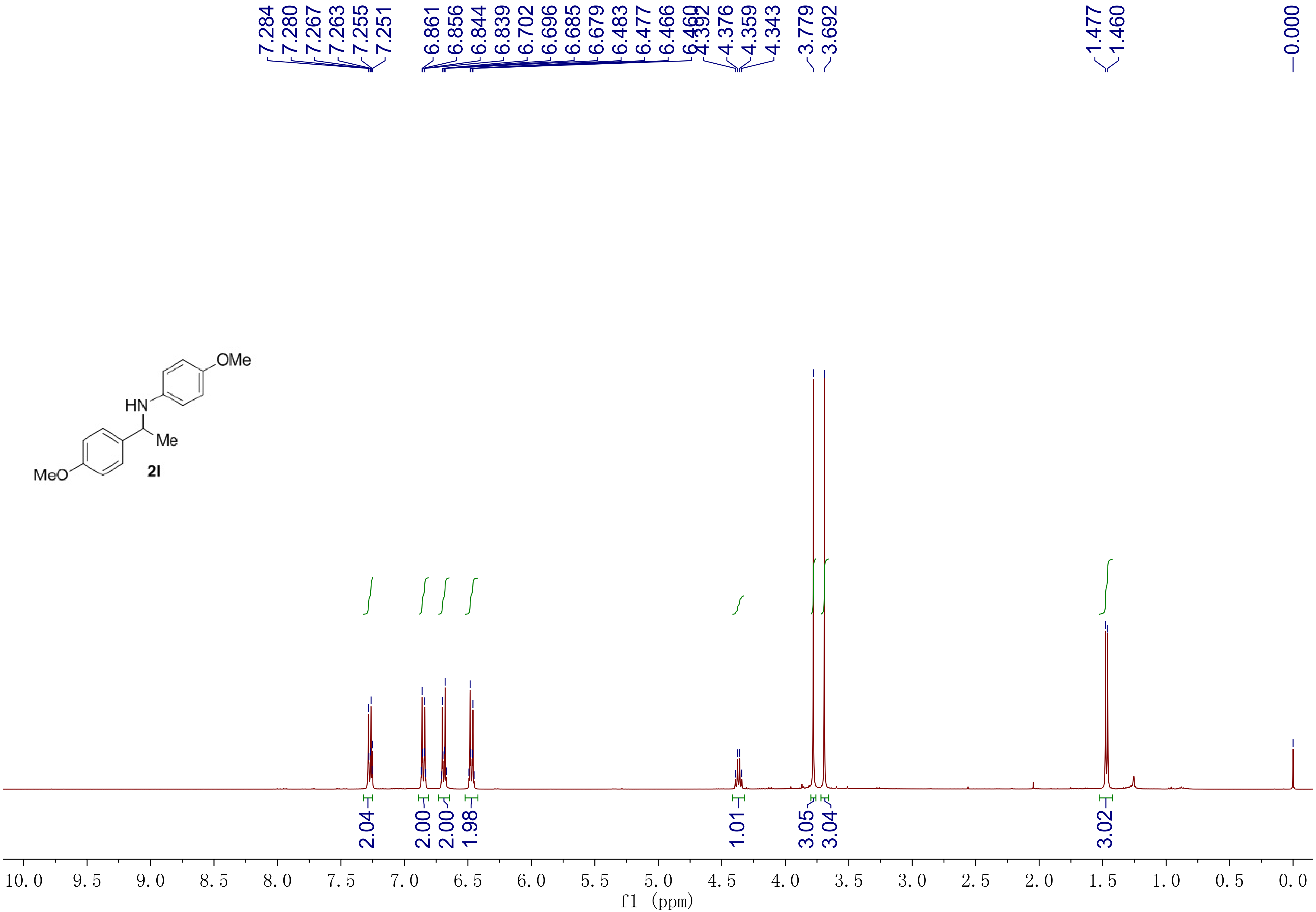
50
40
30
20
10
0
f1 (ppm)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HN
Me
MeO
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2.00
2.00
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1.01
3.05
3.04
3.02
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9.0
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8.0
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6.0
5.5
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1.0
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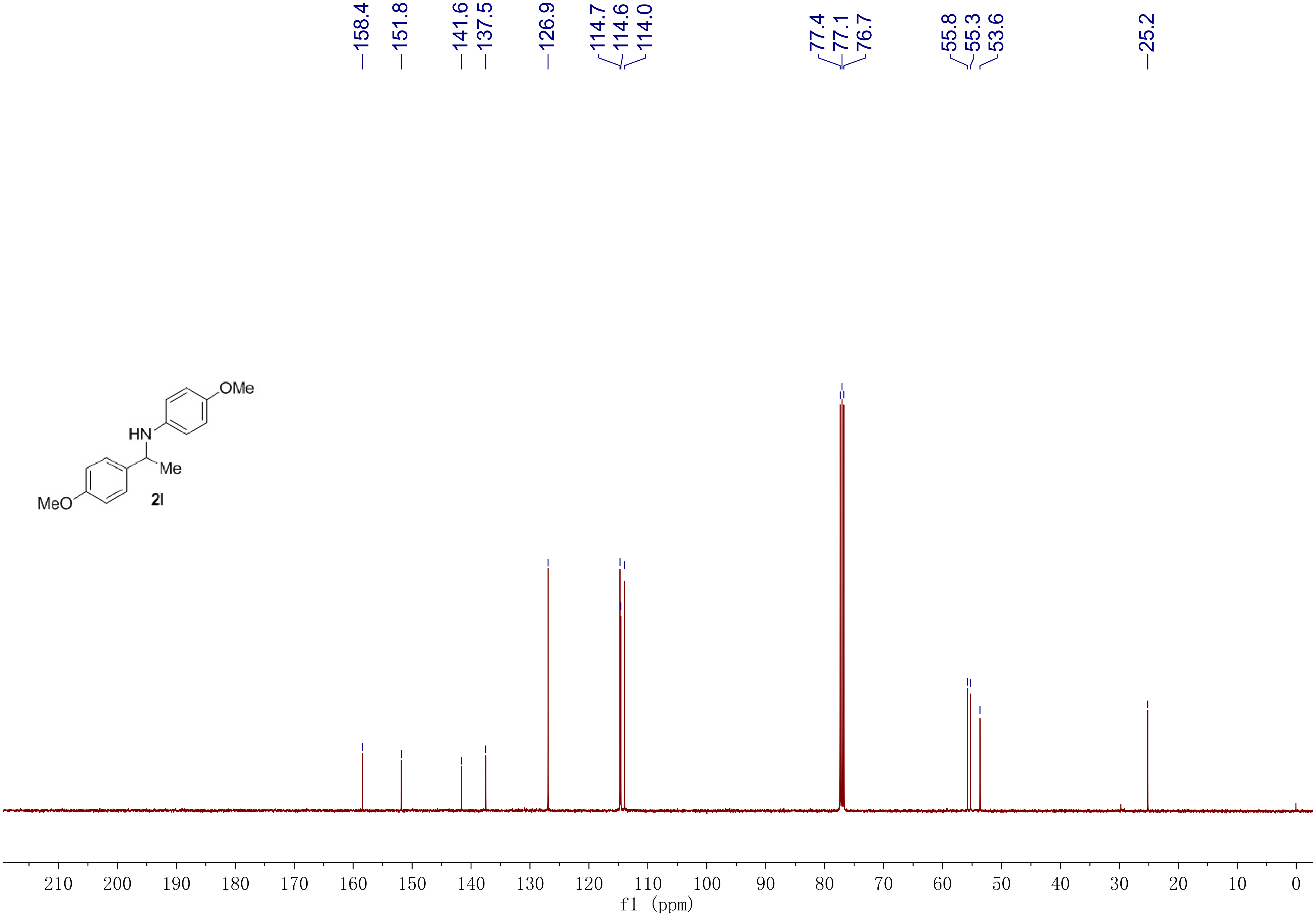
f1 (ppm)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77.1
76.7
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55.3
53.6
25.2
OMe
HN
Me
MeO
2l
210
200
190
180
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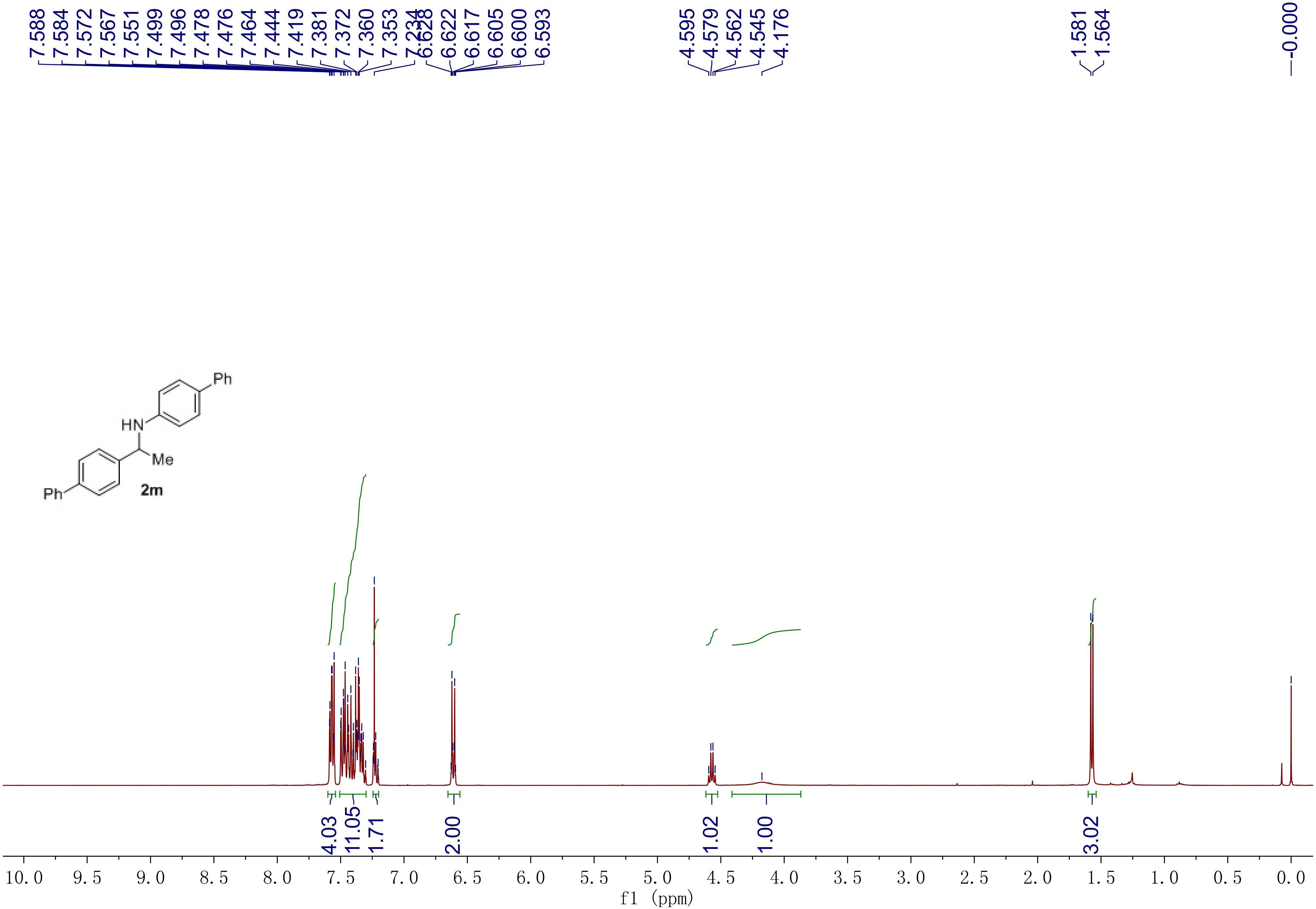
f1 (ppm)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7.372
7.360
7.353
7.234
6.628
6.622
6.617
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6.600
6.593
4.595
4.579
4.562
4.545
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1.564
-0.000
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HN
Me
Ph
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11.05
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3.02
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5.5
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1.0
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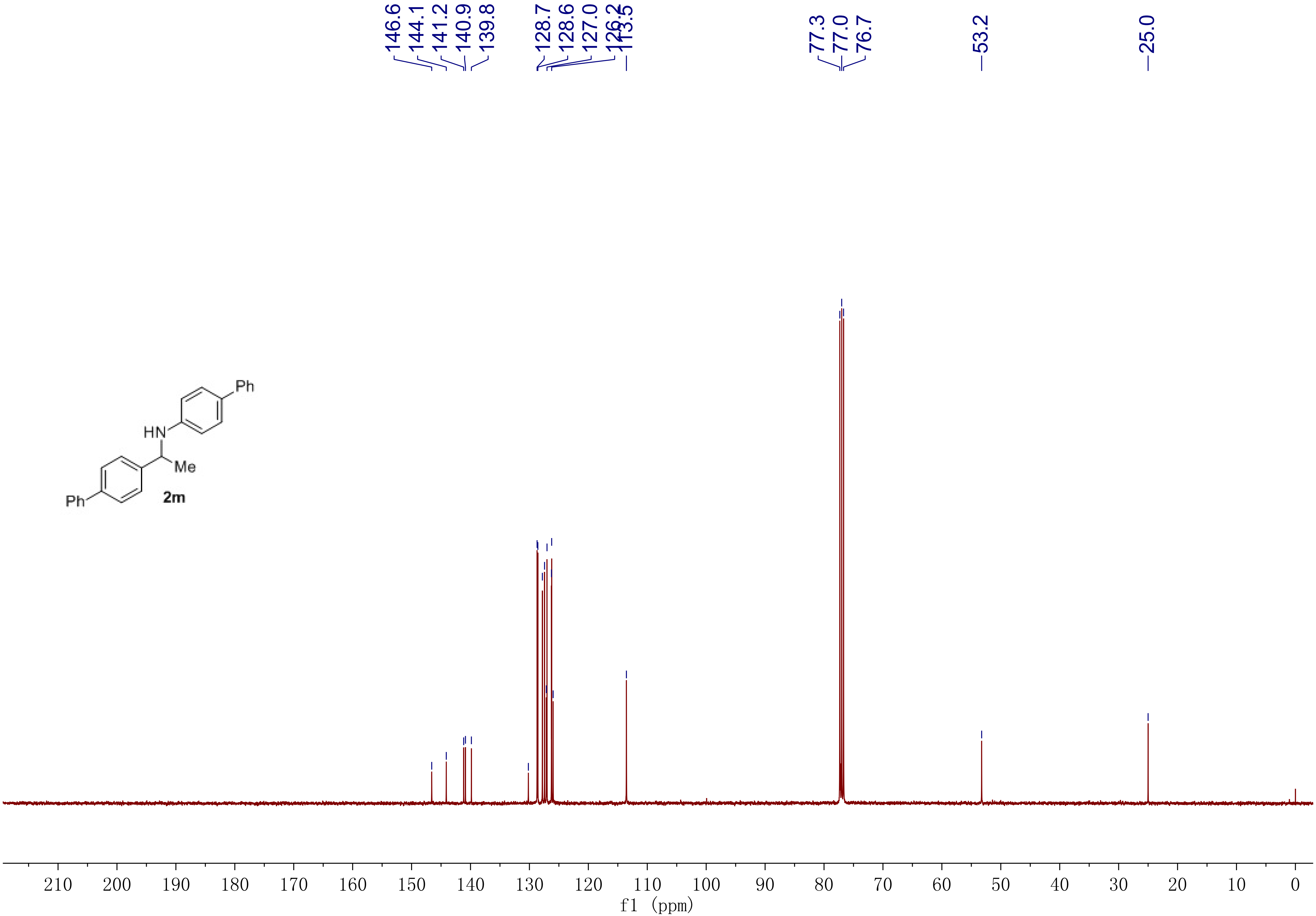
0.0
f1 (ppm)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53.2
25.0
Ph
HN
Me
Ph
2m
210
200
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170
160
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130
120
110
100
90
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40
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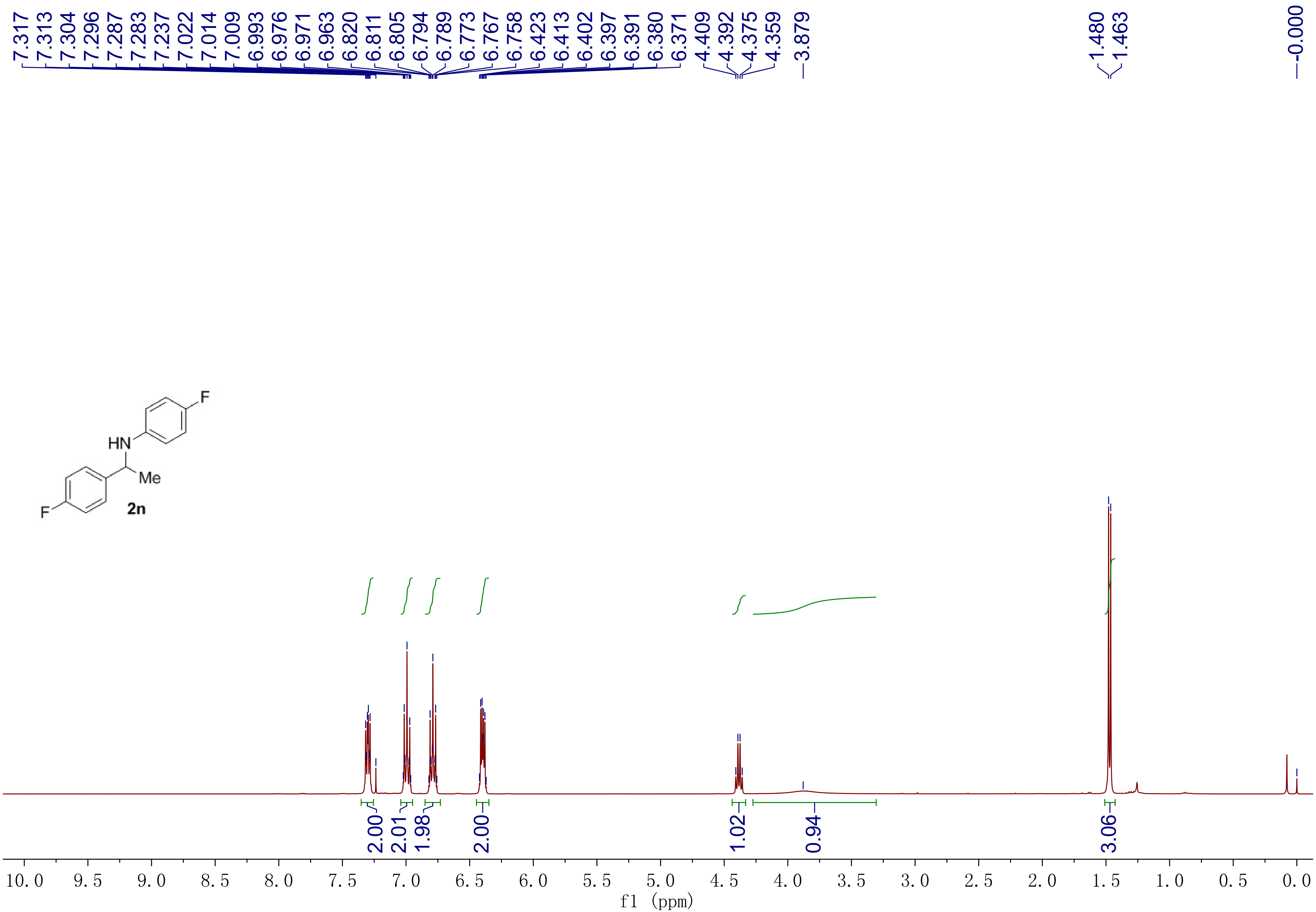
f1 (ppm)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7.283
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7.009
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6.976
6.971
6.963
6.820
6.811
6.805
6.794
6.789
6.773
6.767
6.758
6.423
6.413
6.402
6.397
6.391
6.380
6.371
4.409
4.392
4.375
4.359
3.879
1.480
1.463
-0.000
F
HN
Me
F
2n
2.00
2.01
1.98
2.00
1.02
0.94
3.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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4.0
3.5
3.0
2.5
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1.5
1.0
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0.0
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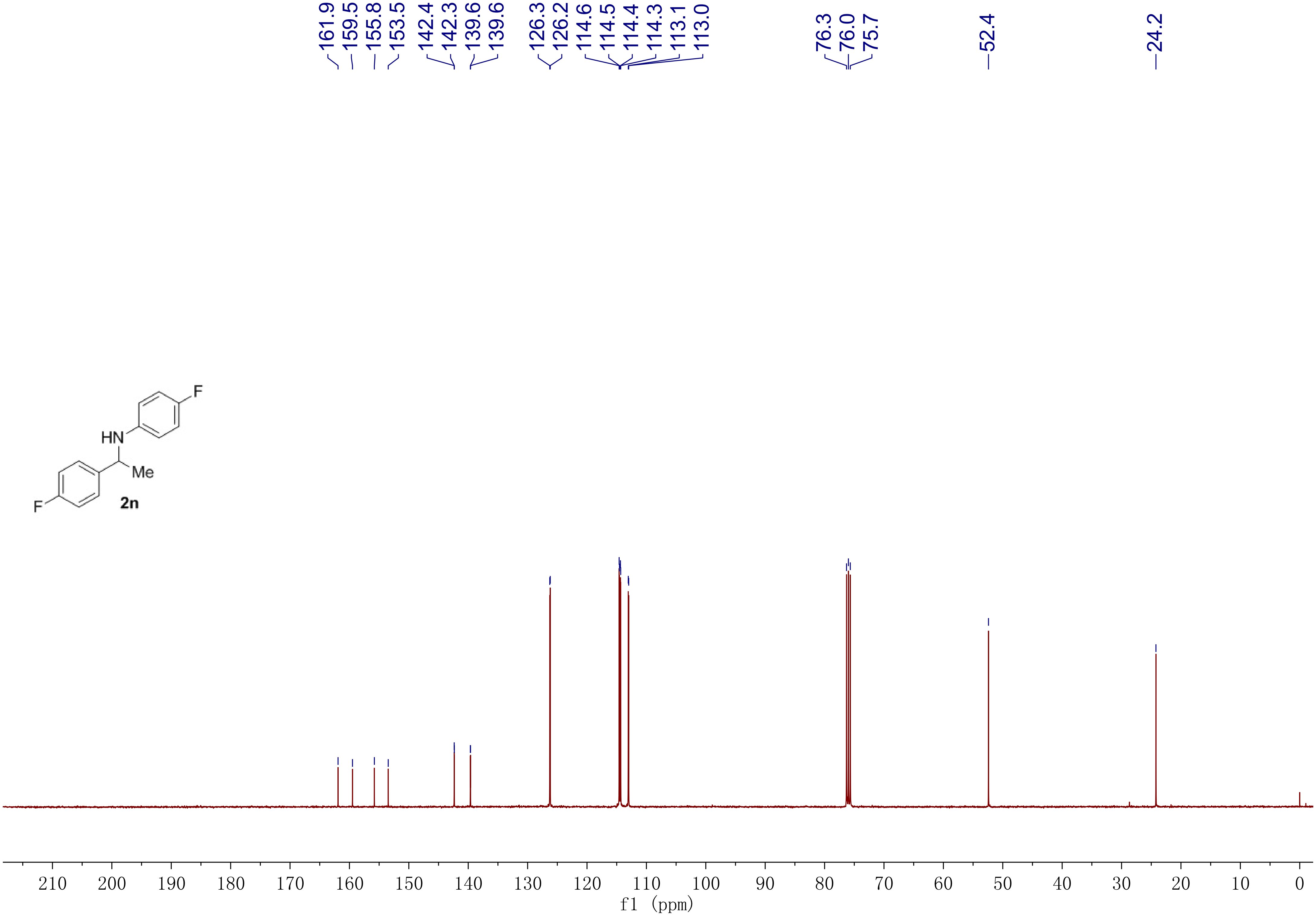
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153.5
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142.3
139.6
139.6
126.3
126.2
114.6
114.5
114.4
114.3
113.1
113.0
76.3
76.0
75.7
52.4
24.2
F
HN
Me
F
2n
210
200
190
180
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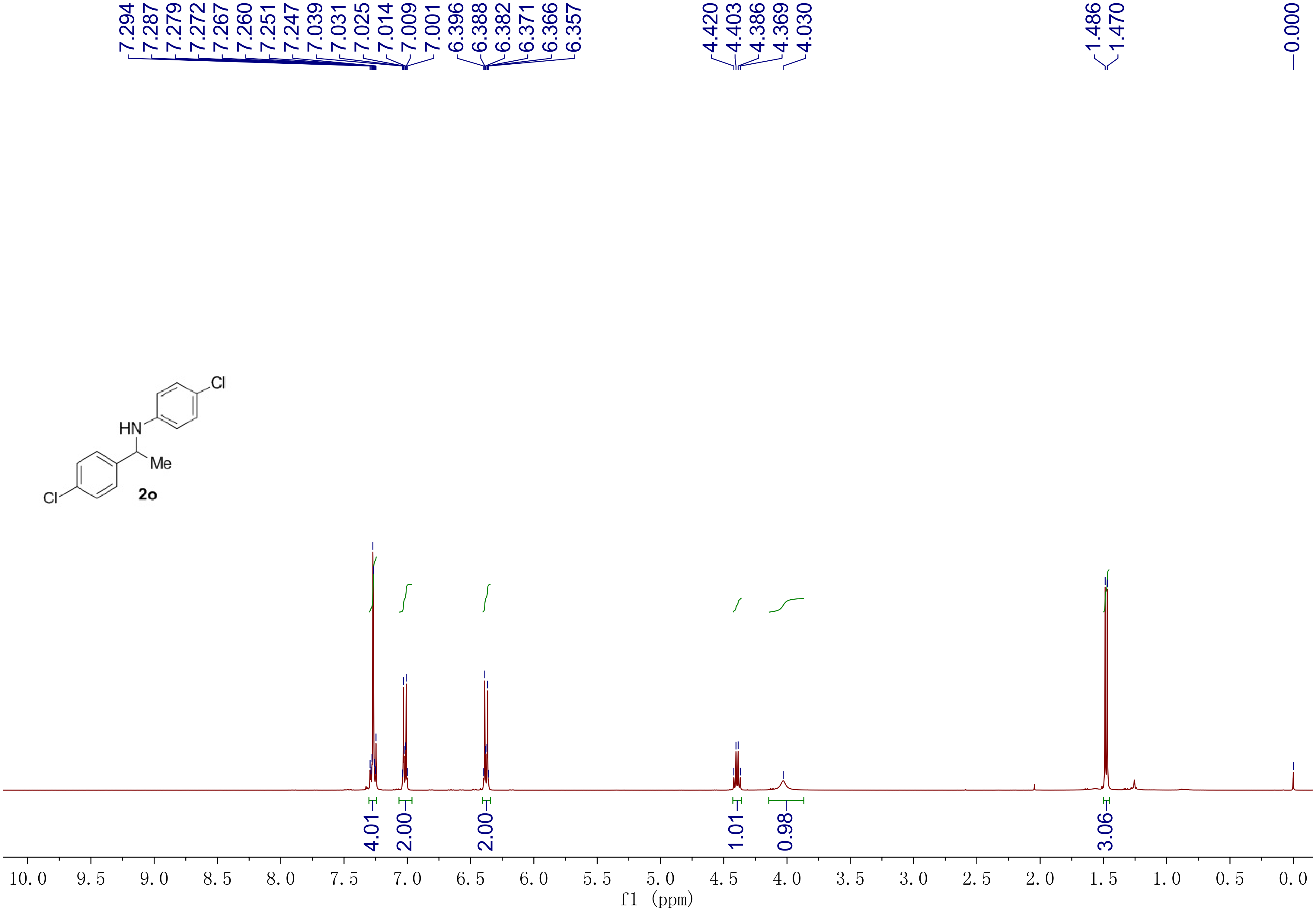
10
0
f1 (ppm)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7.247
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7.031
7.025
7.014
7.009
7.001
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6.388
6.382
6.371
6.366
6.357
4.420
4.403
4.386
4.369
4.030
1.486
1.470
0.000
HN
Cl
Me
Cl
2o
4.01
2.00
2.00
1.01
0.98
3.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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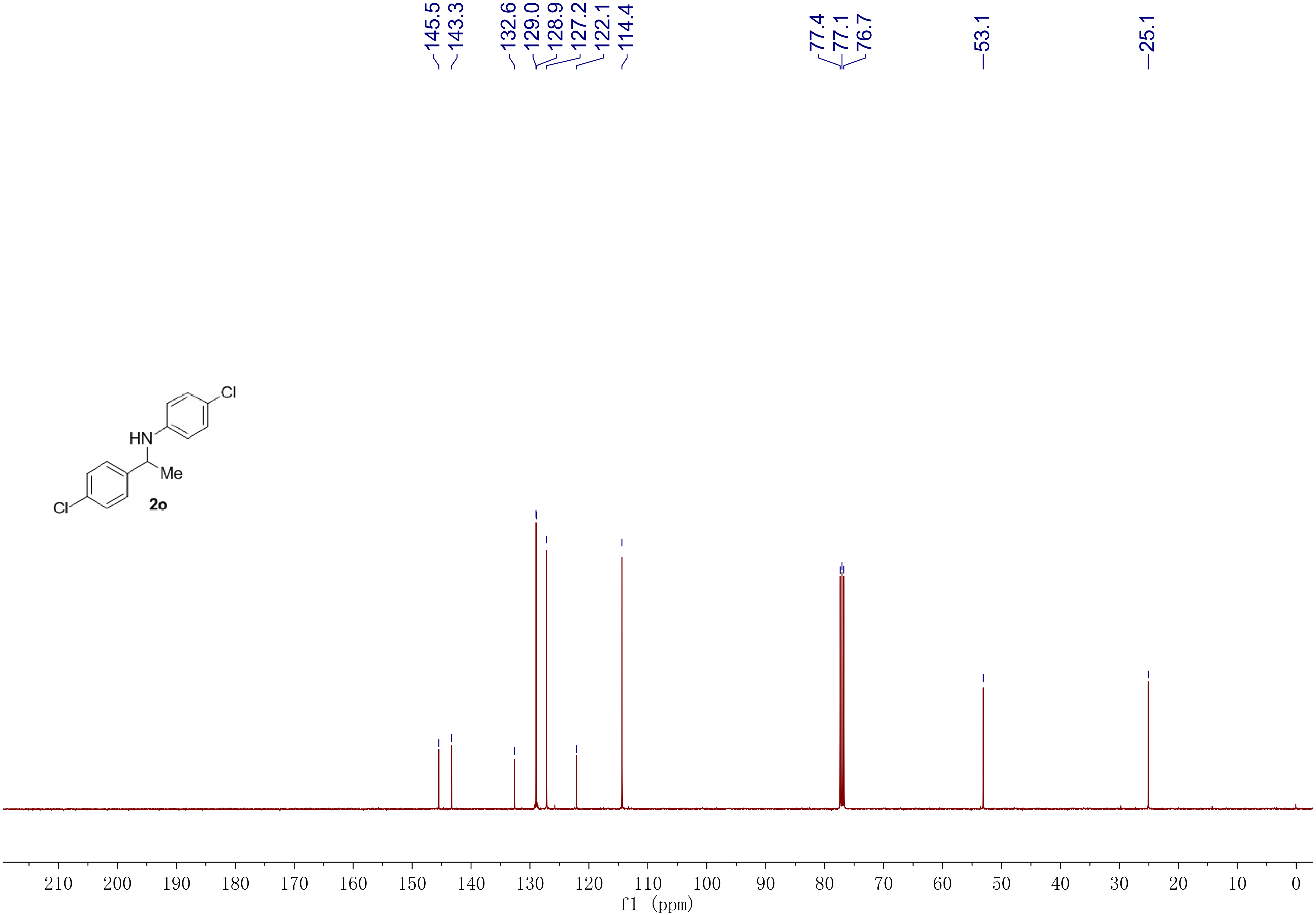
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127.2
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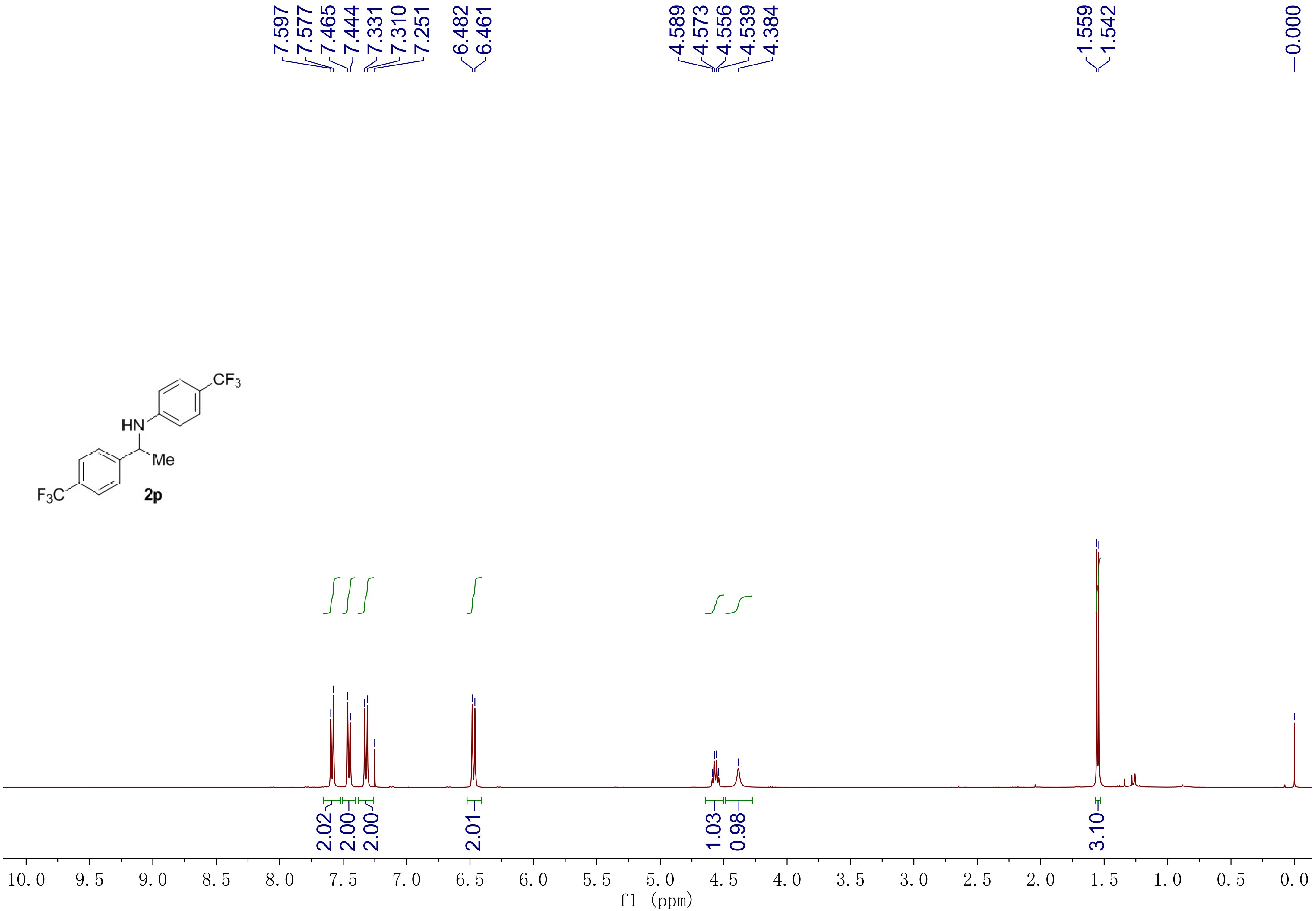
114.4
77.4
77.1
76.7
53.1
25.1
Cl
HN
Me
Cl
2o
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.331
7.310
7.251
6.482
6.461
4.589
4.573
4.556
4.539
4.384
1.559
1.542
0.000
CF3
HN
Me
F3C
2p
2.02
2.00
2.00
2.01
1.03
0.98
3.10
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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3.5
3.0
2.5
2.0
1.5
1.0
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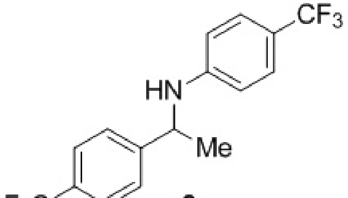
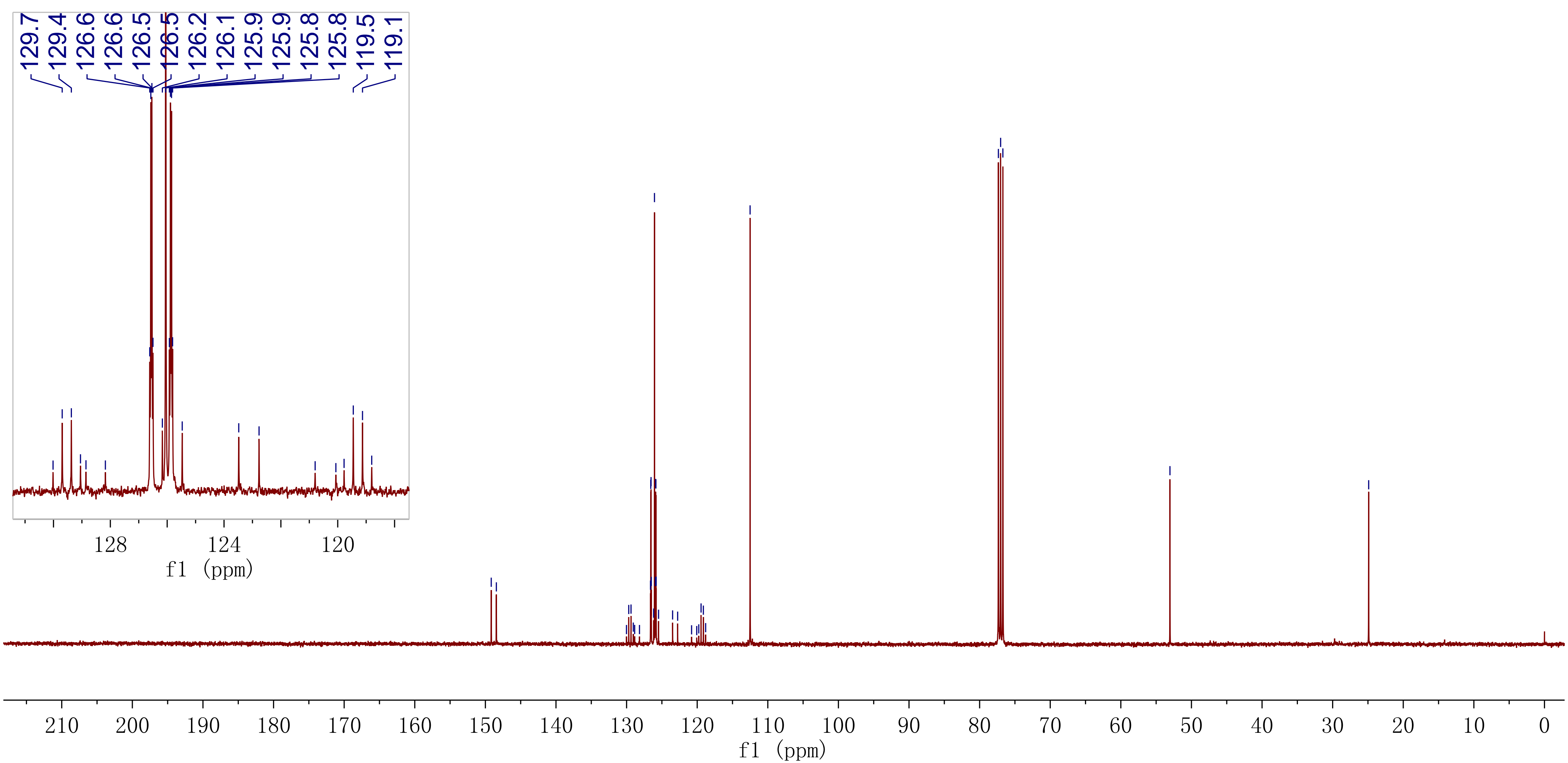
0.0
f1 (ppm)


CF3
HN
Me
F3C

2p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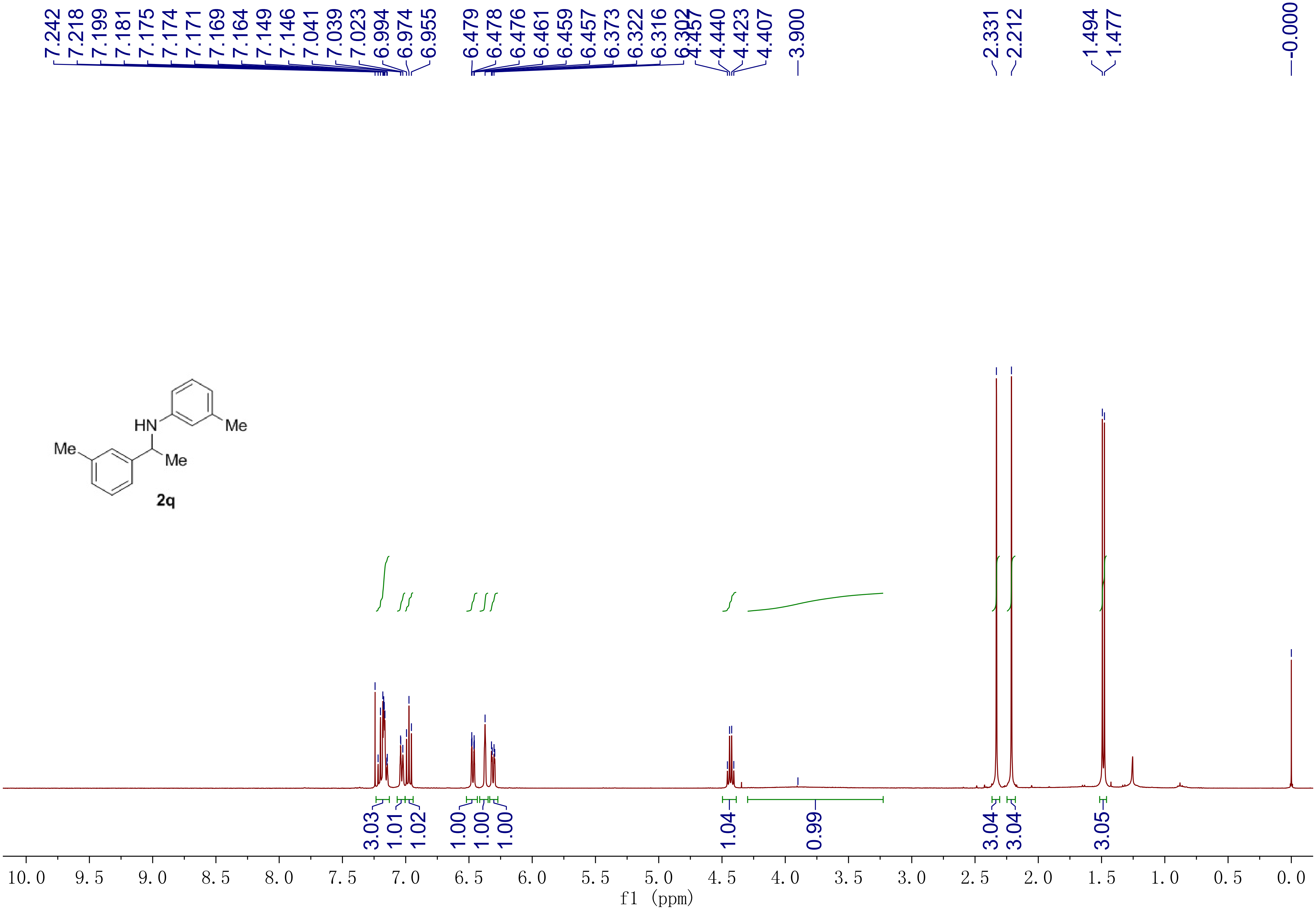
126.6
126.5
126.5
126.2
126.1
125.9
125.9
125.8
125.8
119.5
119.1
112.5
77.3
77.0
76.7
53.0
24.9
129.7
129.4
126.6
126.6
126.5
126.5
126.2
126.1
125.9
125.9
125.8
125.8
119.5
119.1
128
124
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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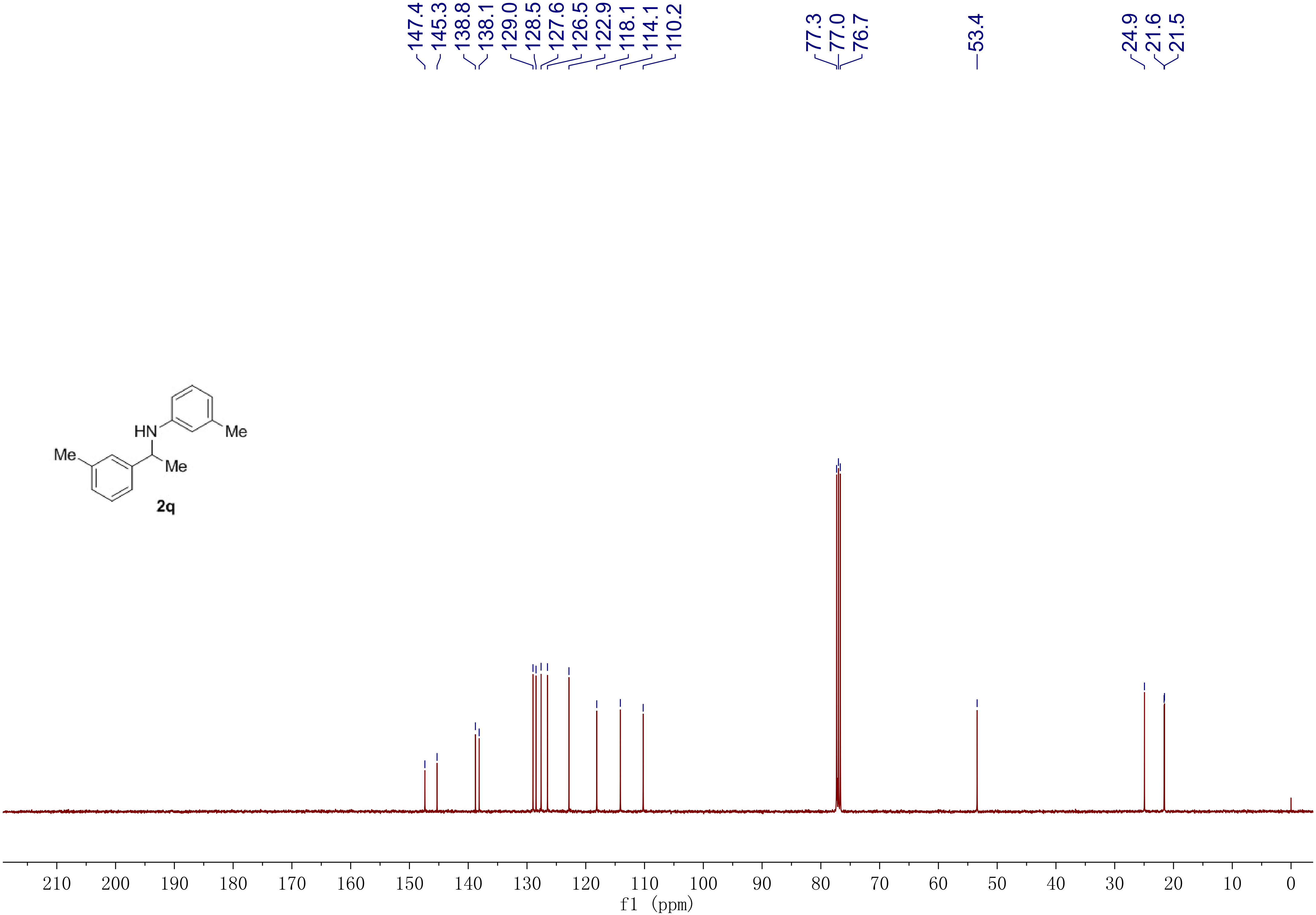
7.174
7.171
7.169
7.164
7.149
7.146
7.041
7.039
7.023
6.994
6.974
6.955
6.479
6.478
6.476
6.461
6.459
6.457
6.373
6.322
6.316
6.302
4.457
4.440
4.423
4.407
3.900
2.331
2.212
1.494
1.477
-0.000
HN
Me
Me
Me
2q
3.03
1.01
1.02
1.00
1.00
1.00
1.04
0.99
3.04
3.04
3.05
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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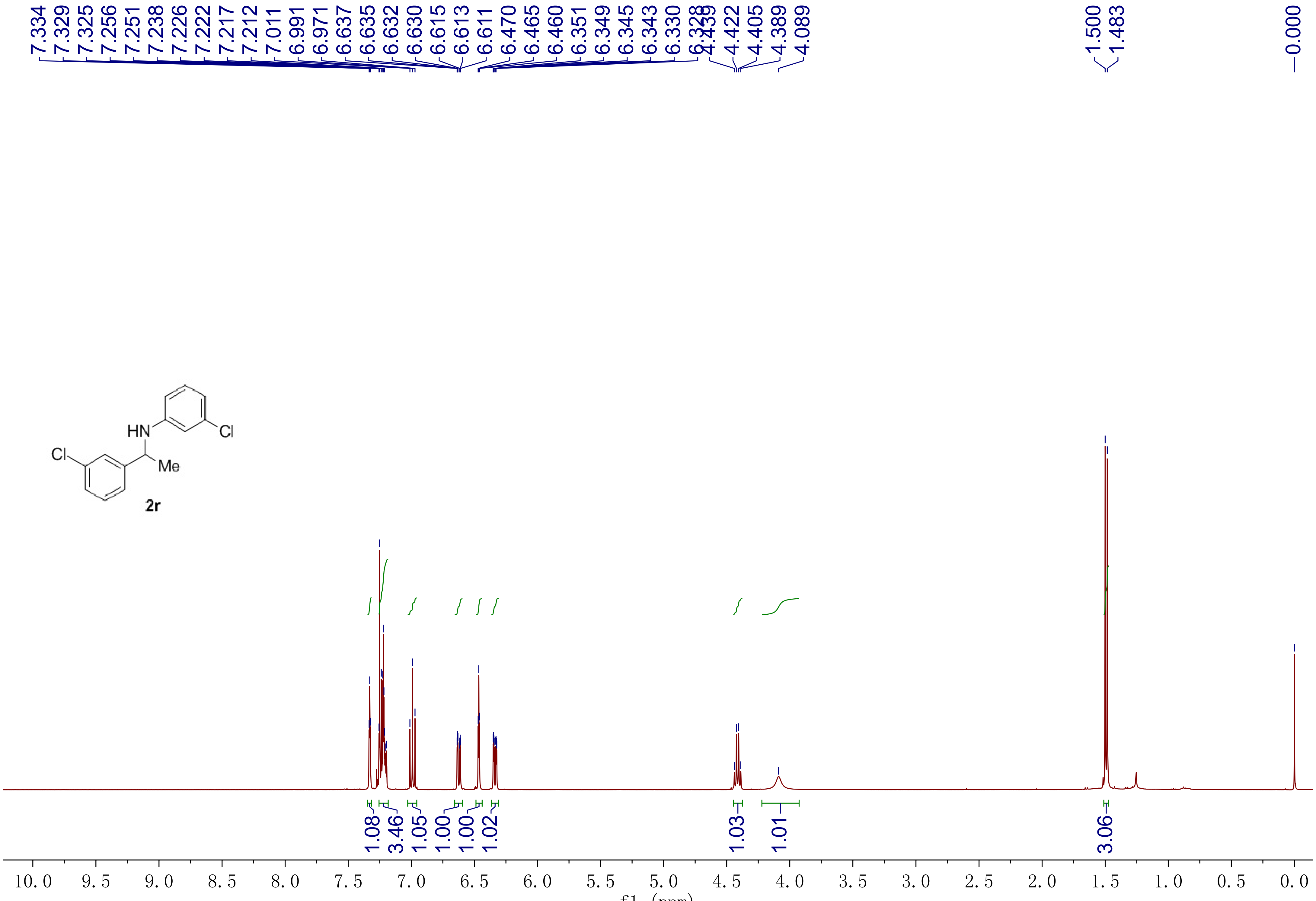
138.8
138.1
129.0
128.5
127.6
126.5
122.9
118.1
114.1
110.2
77.3
77.0
76.7
53.4
24.9
21.6
21.5
HN
Me
Me
Me
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

2q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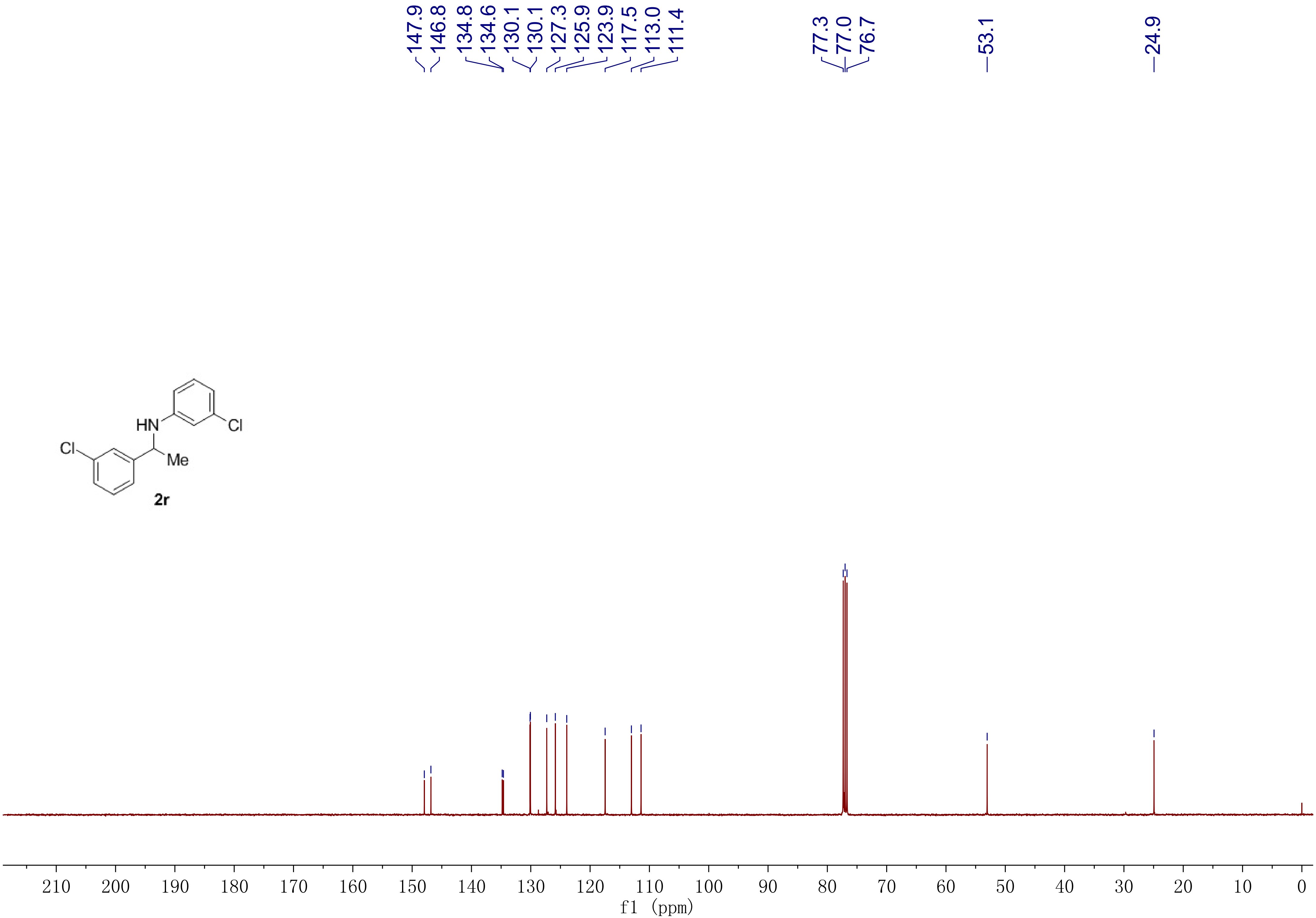
7.325
7.256
7.251
7.238
7.226
7.222
7.217
7.212
7.011
6.991
6.971
6.637
6.635
6.632
6.630
6.615
6.613
6.611
6.470
6.465
6.460
6.351
6.349
6.345
6.343
6.330
6.328
4.439
4.422
4.405
4.389
4.089
1.500
1.483
0.000
HN
Cl
Cl
Me
2r
1.08
3.46
1.05
1.00
1.00
1.02
1.03
1.01
3.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
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
f1 (ppm)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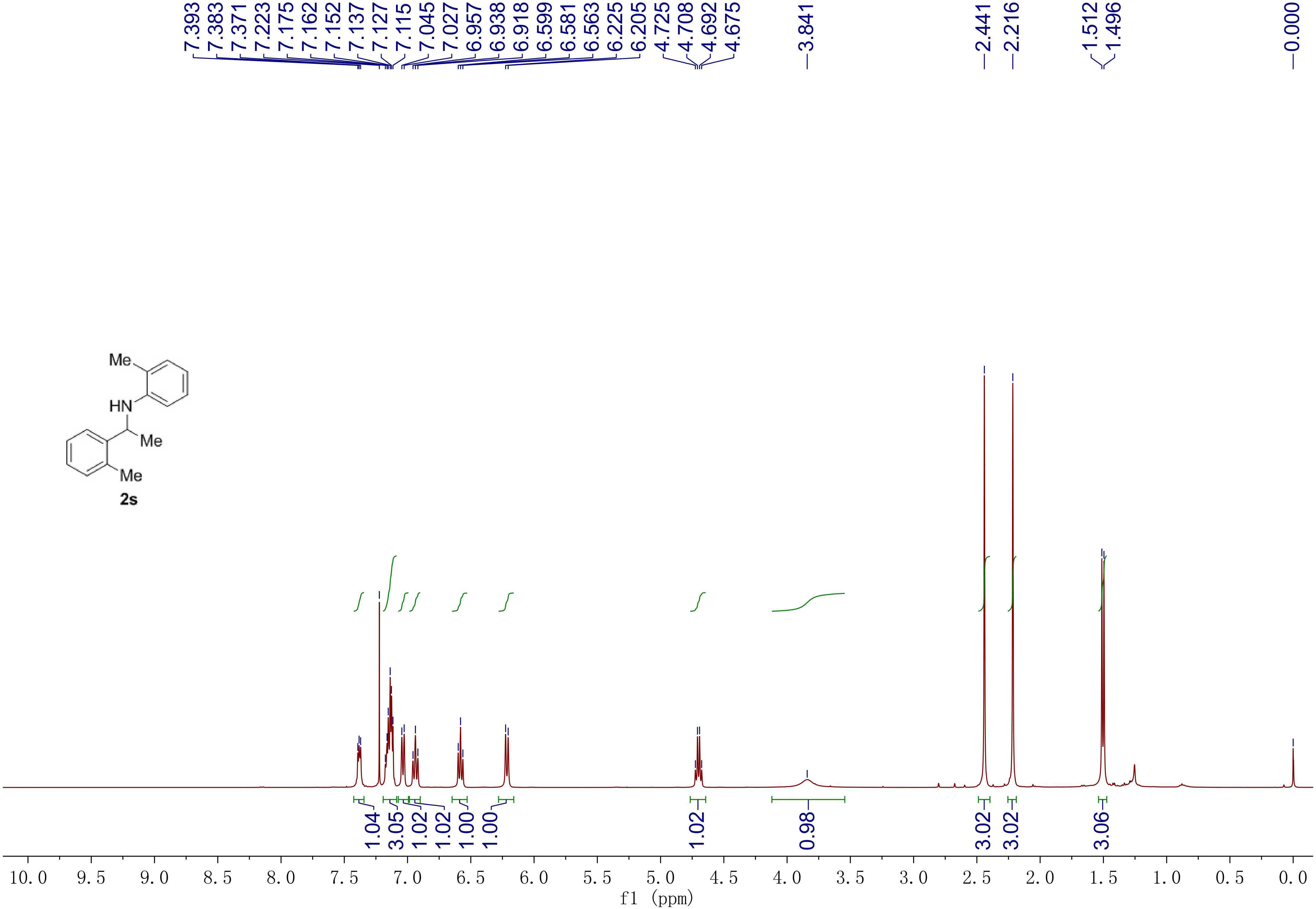
134.8
134.6
130.1
130.1
127.3
125.9
123.9
117.5
113.0
111.4
77.3
77.0
76.7
53.1
24.9
HN
Cl
Cl
Me
2r
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.223
7.175
7.162
7.152
7.137
7.127
7.115
7.045
7.027
6.957
6.938
6.918
6.599
6.581
6.563
6.225
6.205
4.725
4.708
4.692
4.675
3.841
2.441
2.216
1.512
1.496
0.000
Me
HN
Me
Me
2s
1.04
3.05
1.02
1.02
1.00
1.00
1.02
0.98
3.02
3.02
3.06
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
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3.0
2.5
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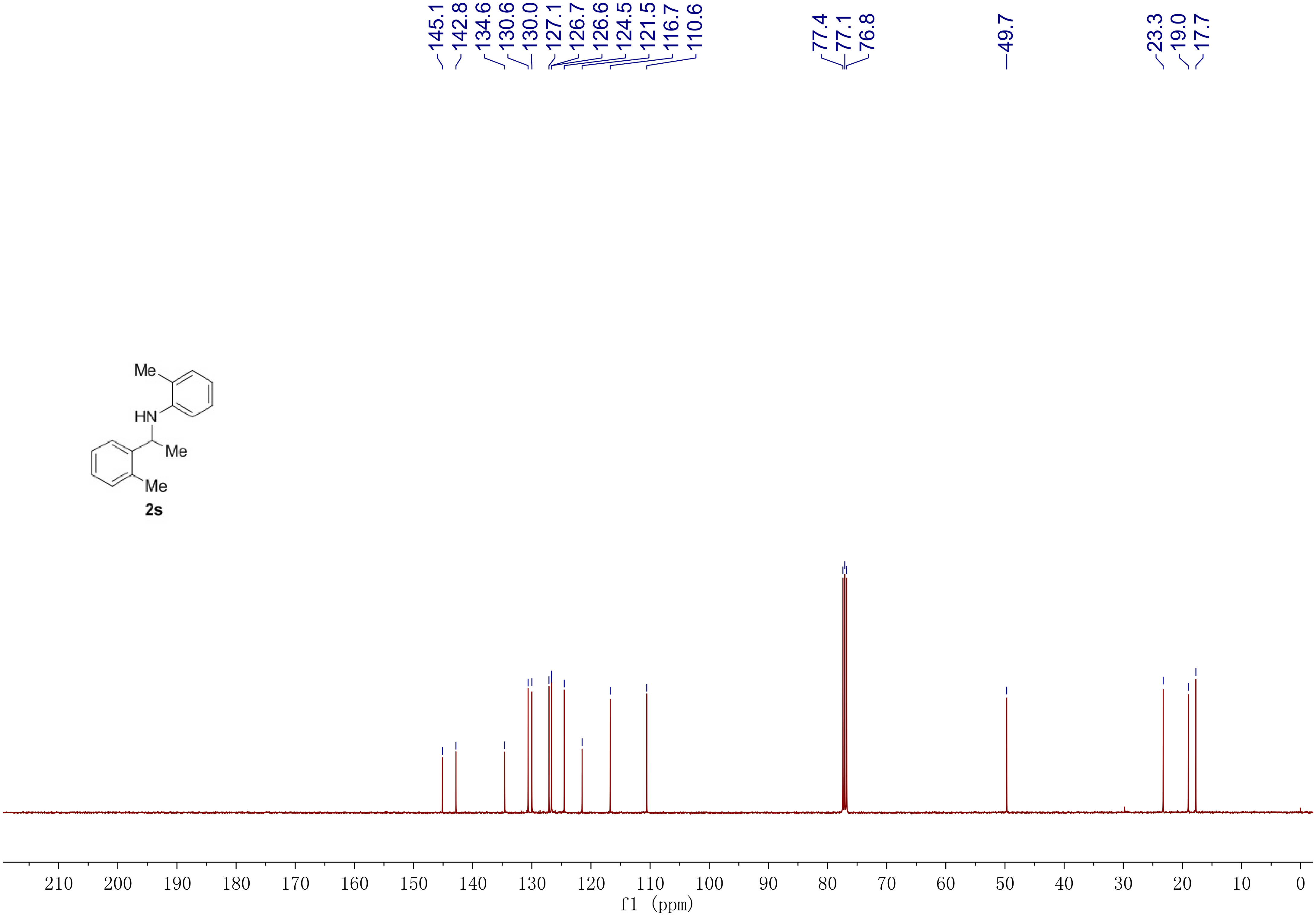
f1 (ppm)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130.6
130.0
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126.7
126.6
124.5
121.5
116.7
110.6
77.4
77.1
76.8
49.7
23.3
19.0
17.7
Me
HN
Me
Me
2s
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
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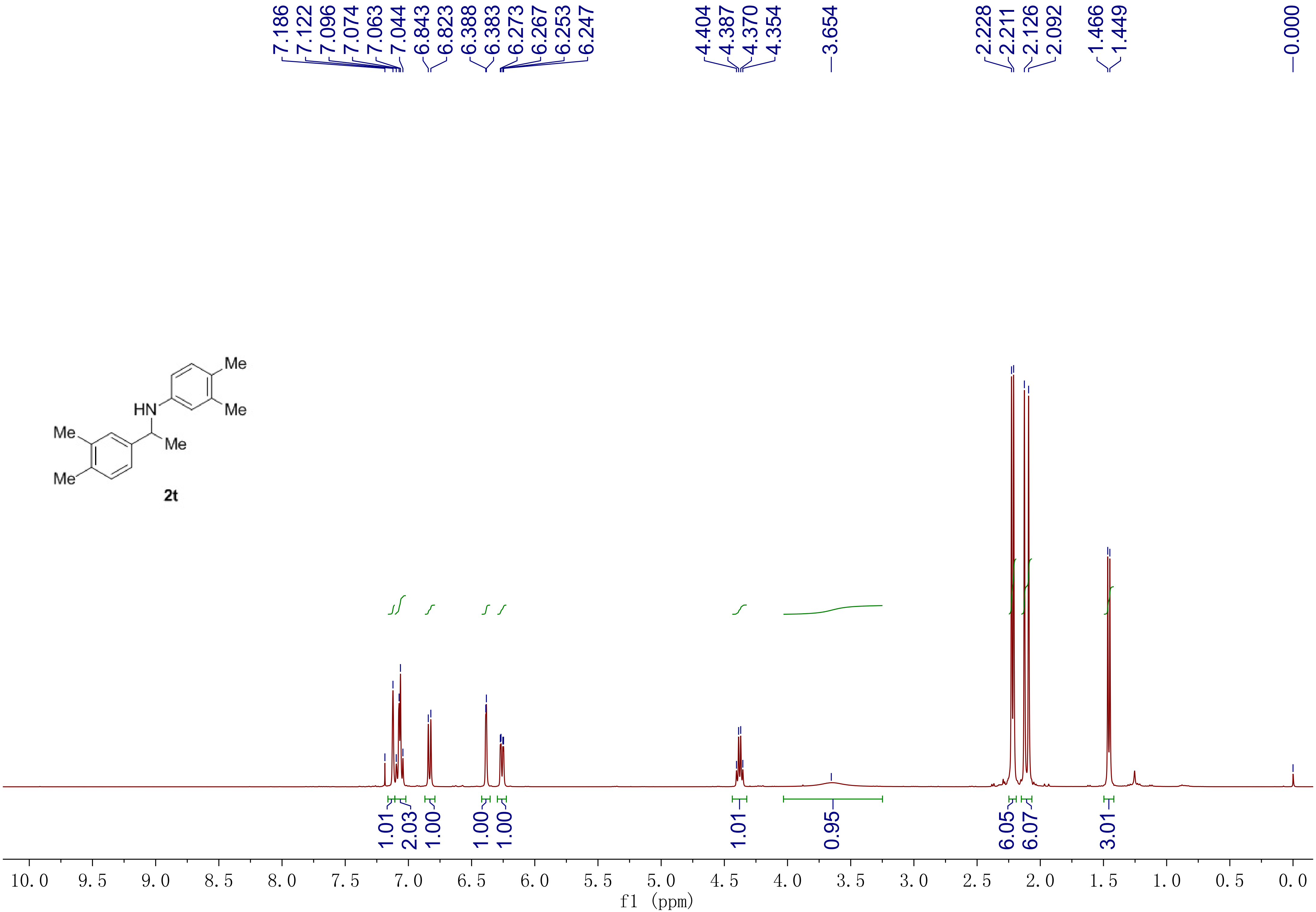
20
10
0
f1 (ppm)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7.044
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6.823
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6.383
6.273
6.267
6.253
6.247
4.404
4.387
4.370
4.354
3.654
2.228
2.211
2.126
2.092
1.466
1.449
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Me
HN
Me
Me
Me
Me
2t
1.01
2.03
1.00
1.00
1.00
1.01
0.95
6.05
6.07
3.01
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8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.5
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2.0
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1.0
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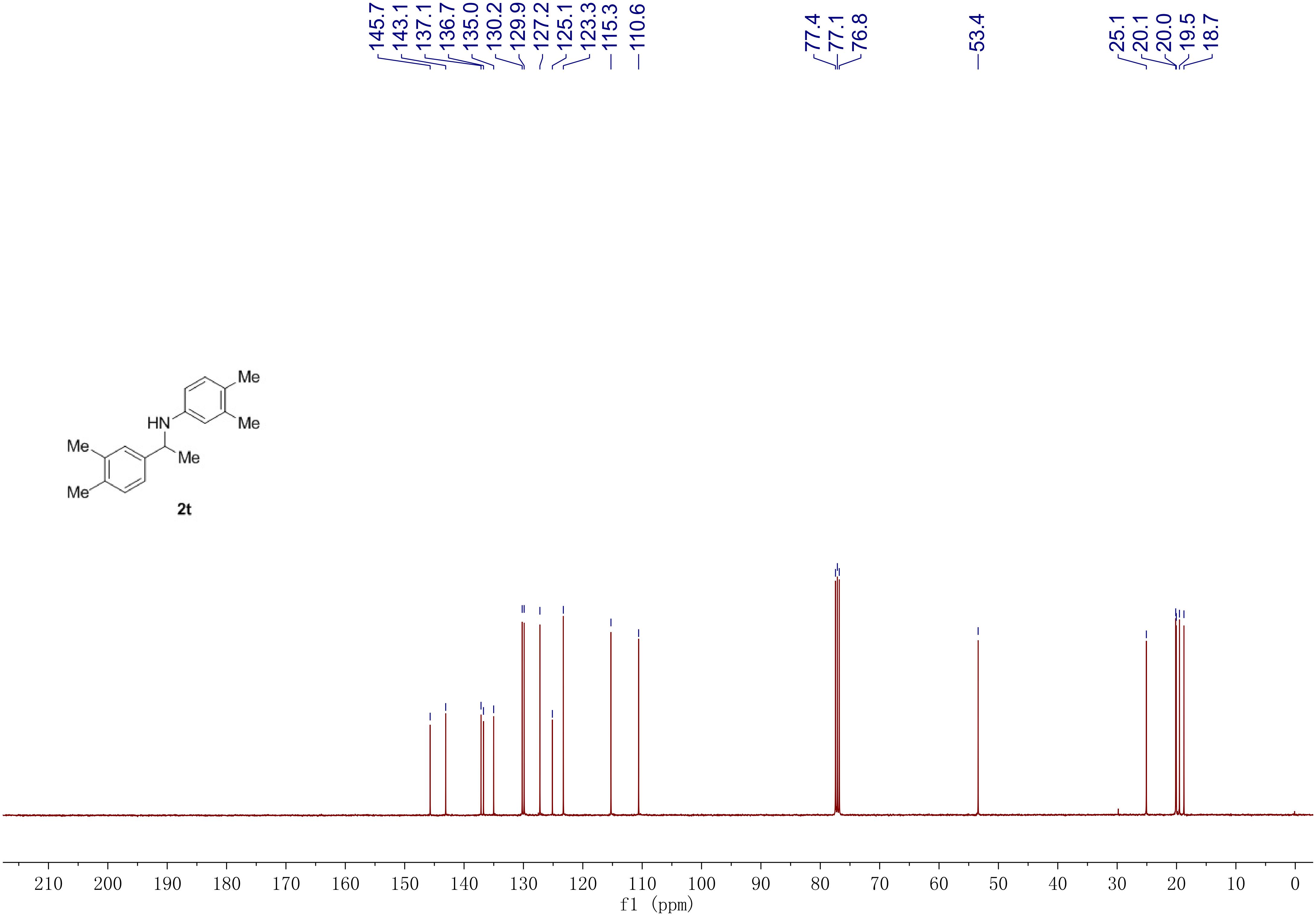
0.0
f1 (ppm)



2t

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137.1
136.7
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127.2
125.1
123.3
115.3
110.6
77.4
77.1
76.8
53.4
25.1
20.1
20.0
19.5
18.7
HN
Me
Me
Me
Me
Me
210
200
190
180
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130
120
110
100
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70
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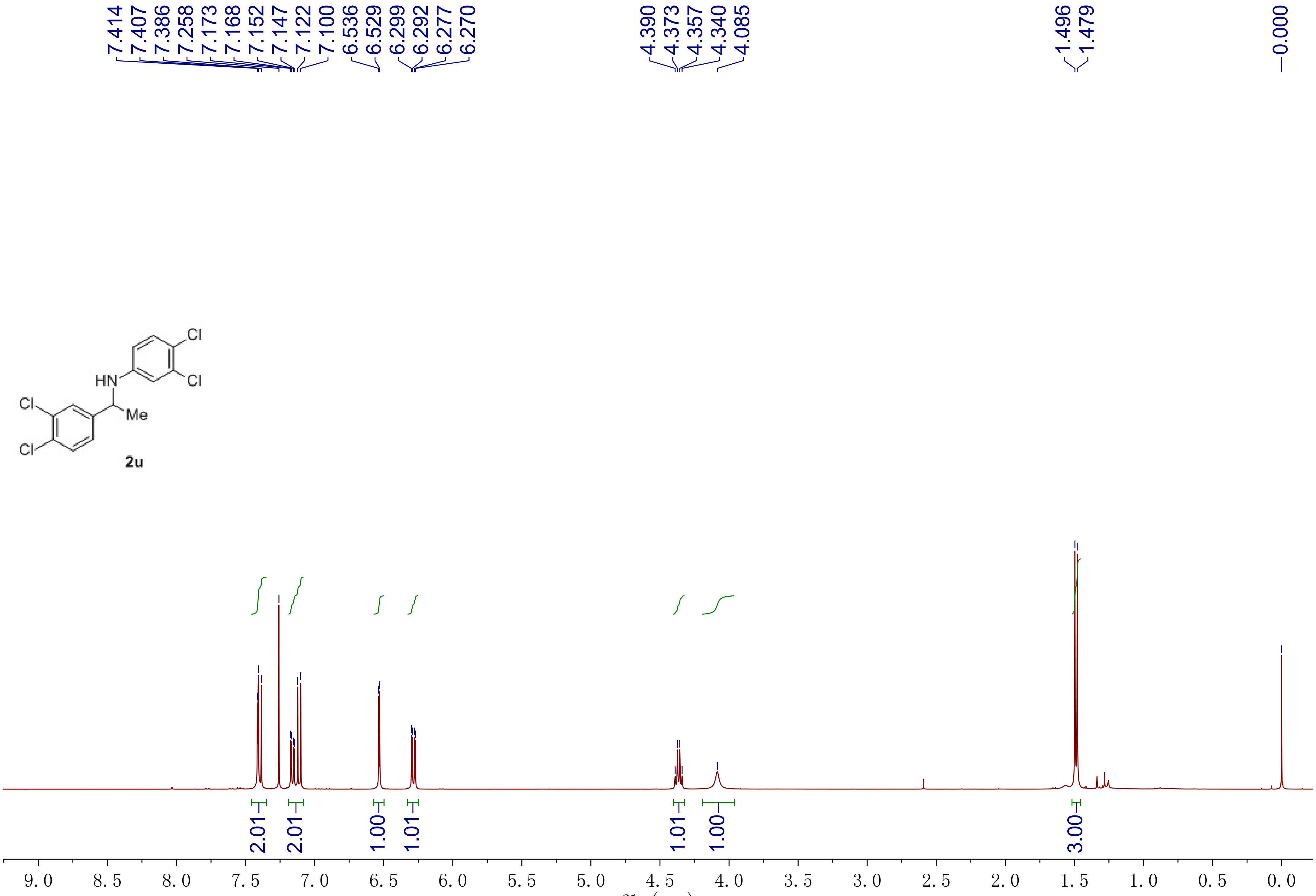
40
30
20
10
0
f1 (ppm)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7.147
7.122
7.100
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6.529
6.299
6.292
6.277
6.270
4.390
4.373
4.357
4.340
4.085
1.496
1.479
0.000
HN
Cl
Cl
Cl
Cl
Me
2.01
2.01
1.00
1.01
1.01
1.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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2.0
1.5
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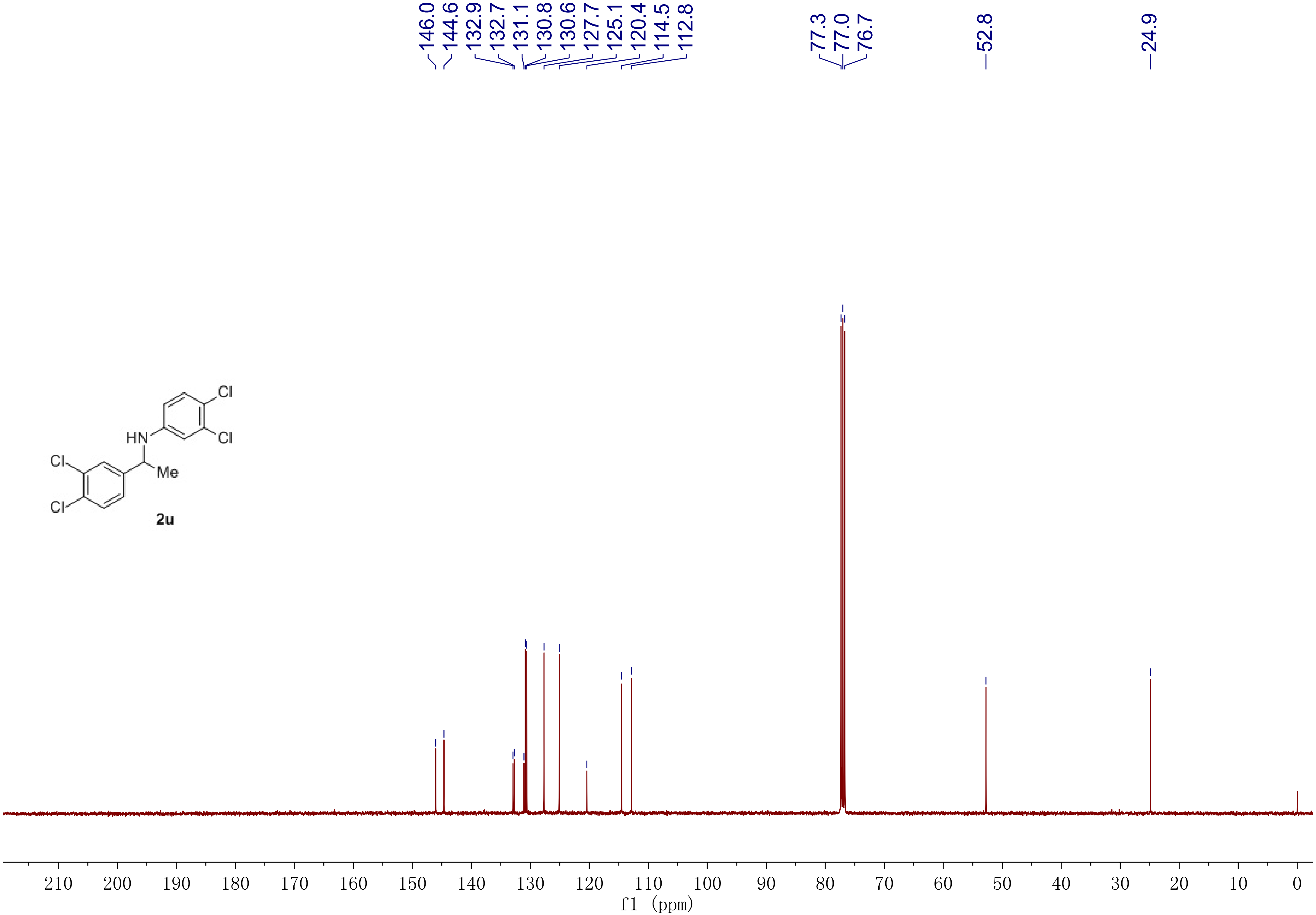
0.0
f1 (ppm)

2u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130.8
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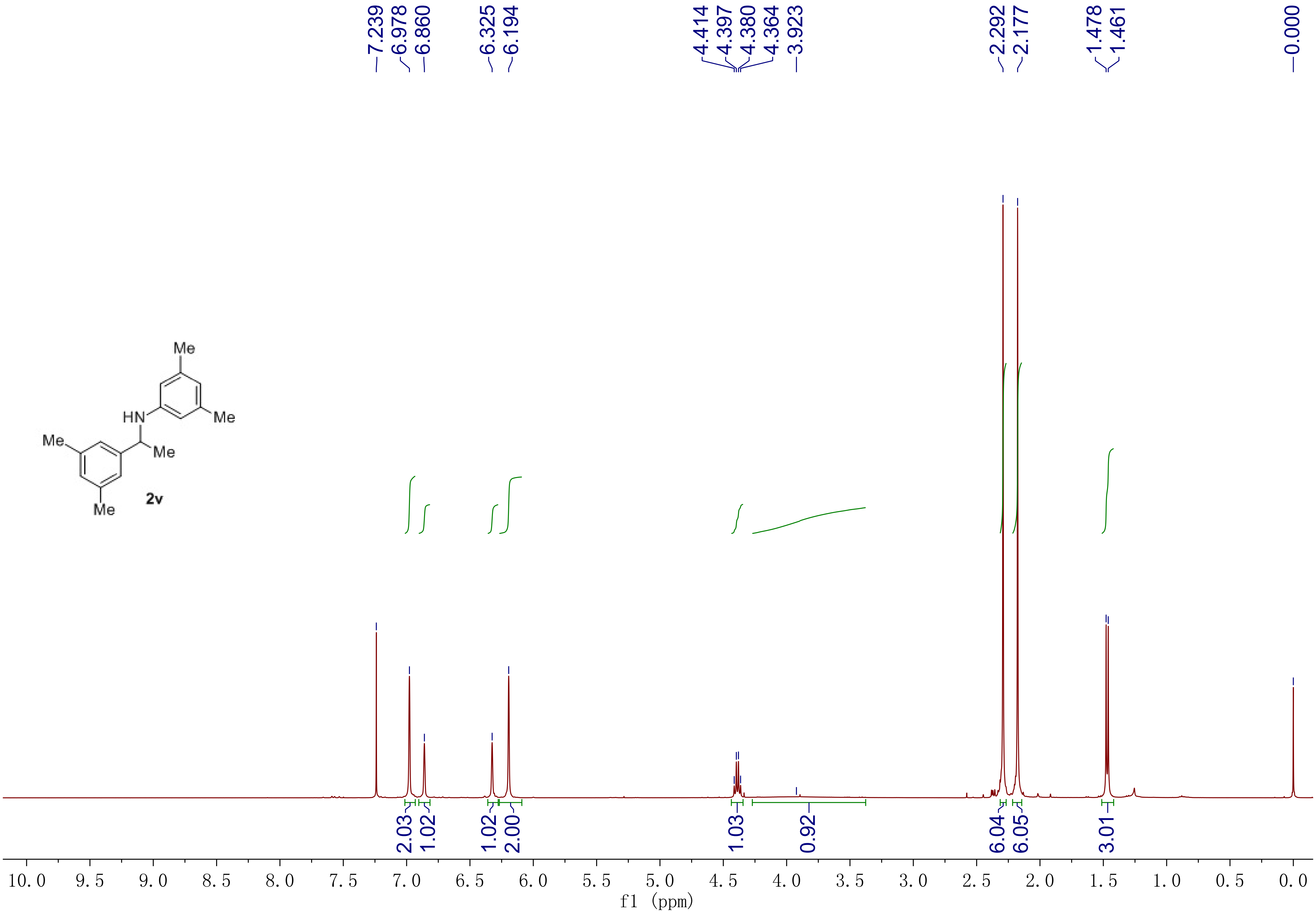
127.7
125.1
120.4
114.5
112.8
77.3
77.0
76.7
52.8
24.9
Cl
Cl
HN
Cl
Cl
Me
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

2u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3.923
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1.478
1.461
0.000
Me
Me
HN
Me
Me
Me
2v
2.03
1.02
1.02
2.00
1.03
0.92
6.04
6.05
3.01
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9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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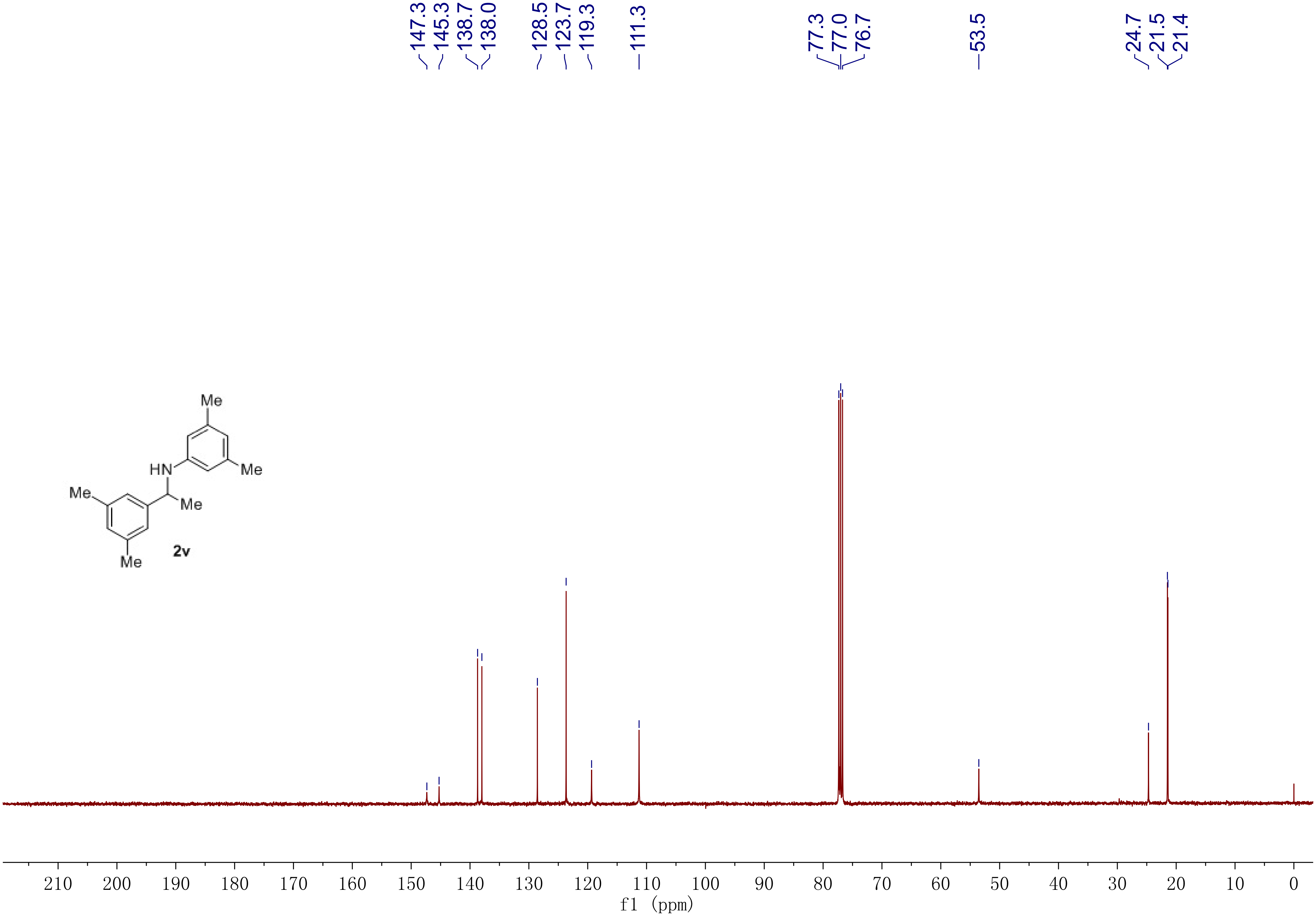
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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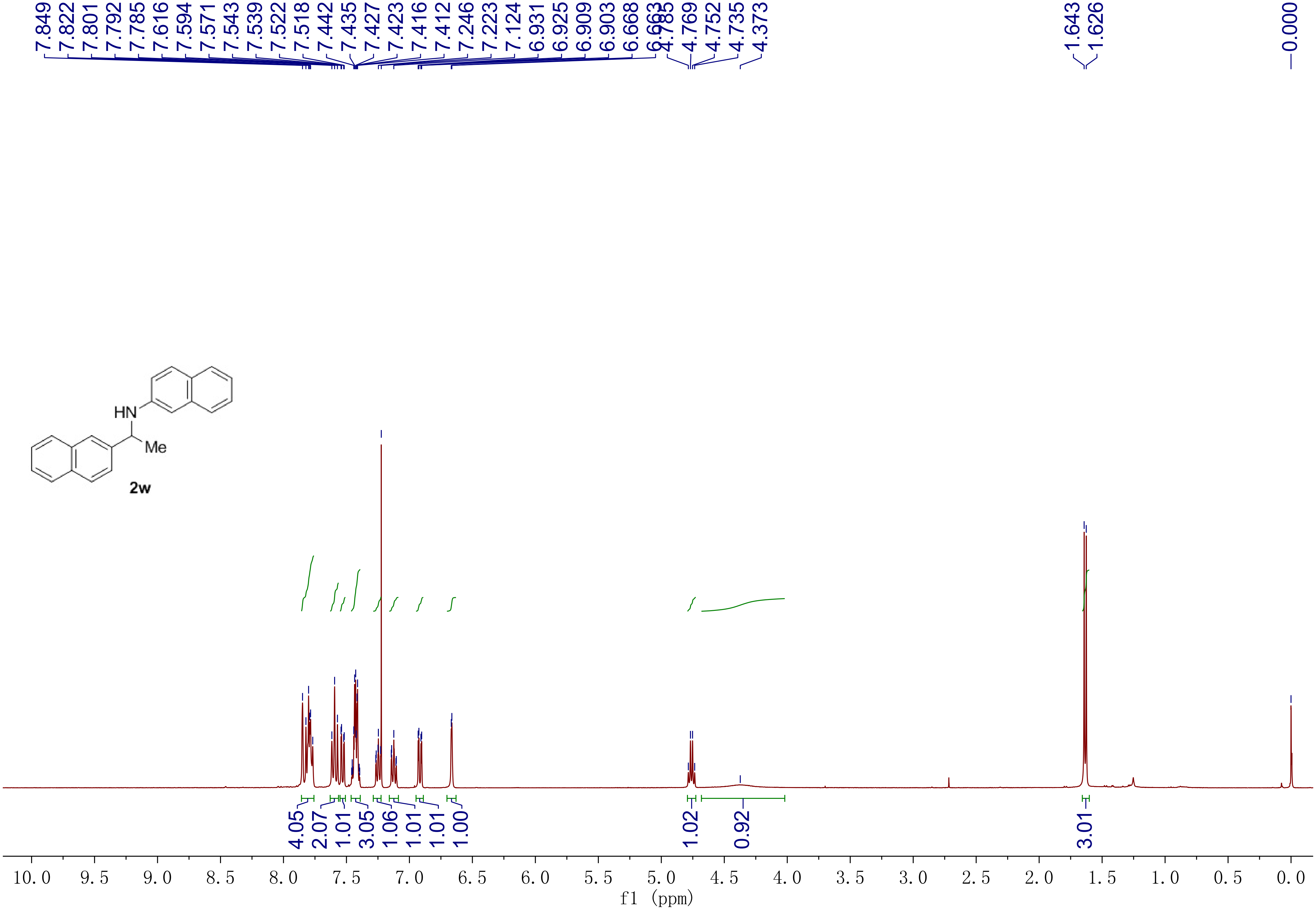
111.3
77.3
77.0
76.7
53.5
24.7
21.5
21.4
Me
HN
Me
Me
Me
Me
2v
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.571
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7.539
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7.518
7.442
7.435
7.427
7.423
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7.412
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7.223
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6.925
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6.663
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4.769
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4.373
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1.626
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HN
Me
2w
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2.07
1.01
3.05
1.06
1.01
1.01
1.00
1.02
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3.01
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8.0
7.5
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6.0
5.5
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3.0
2.5
2.0
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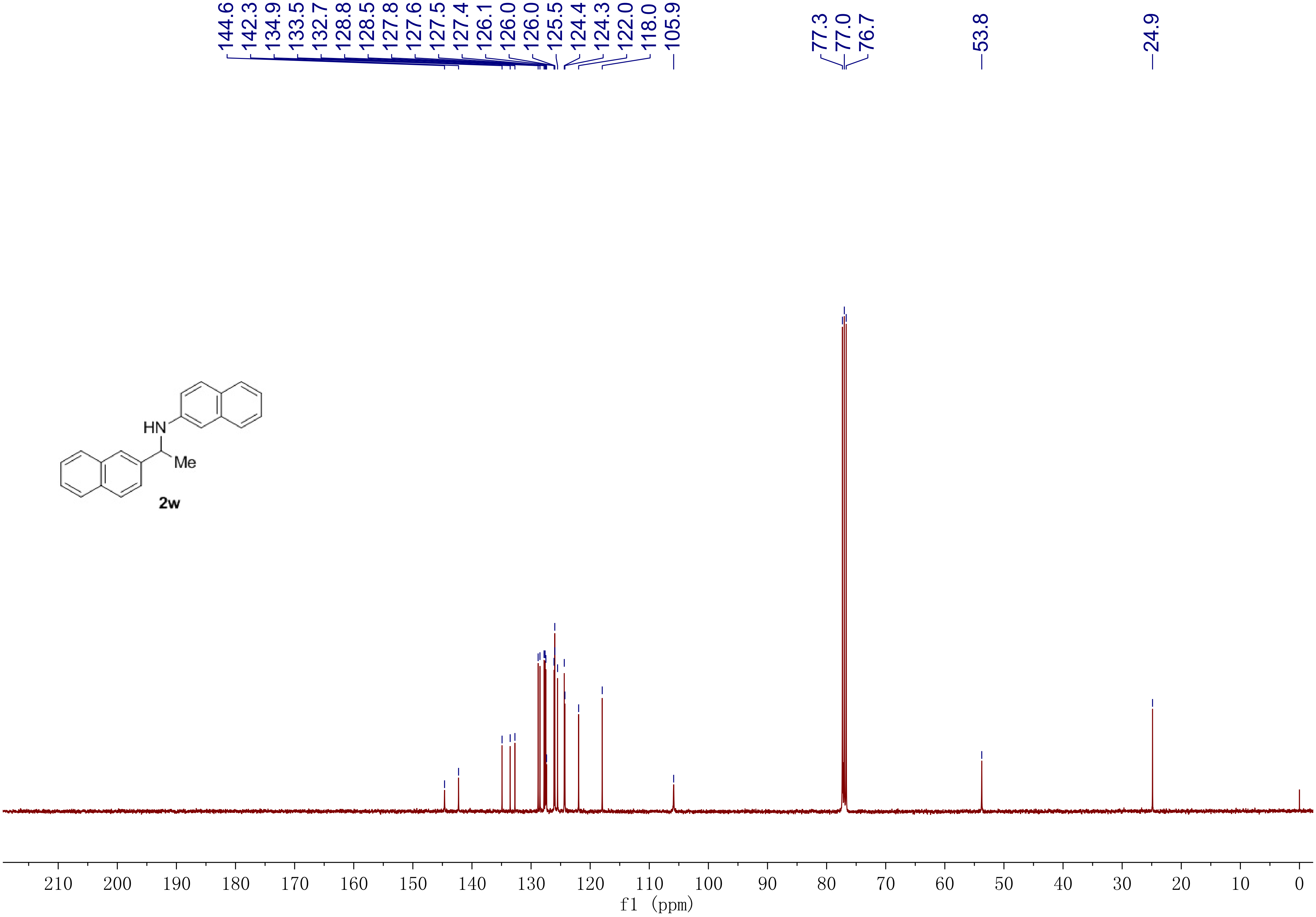
1.0
0.5
0.0
f1 (ppm)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133.5
132.7
128.8
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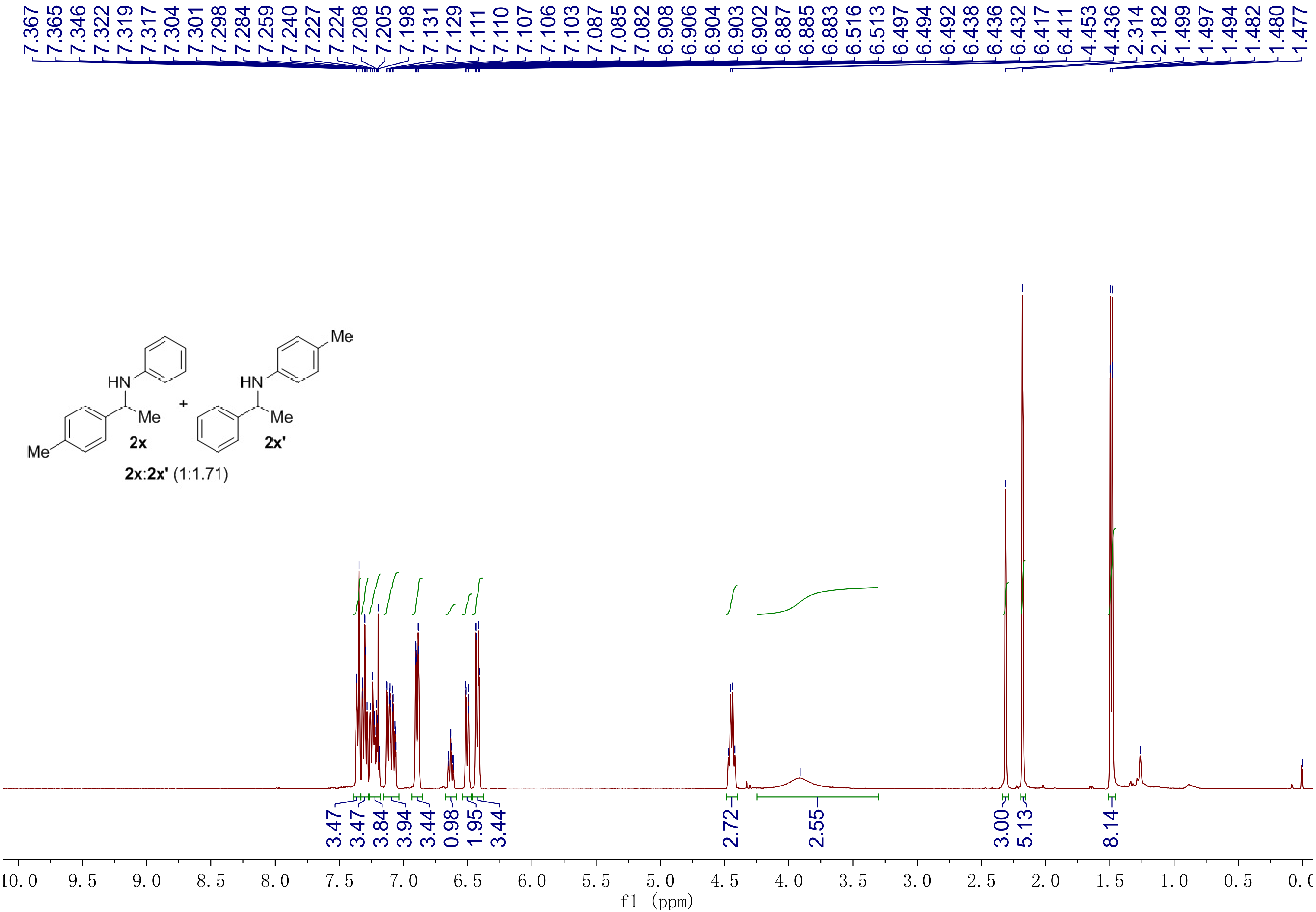
127.8
127.6
127.5
127.4
126.1
126.0
126.0
125.5
124.4
124.3
122.0
118.0
105.9
77.3
77.0
76.7
53.8
24.9
HN
Me
2w
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.106
7.103
7.087
7.085
7.082
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6.906
6.904
6.903
6.902
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6.883
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6.513
6.497
6.494
6.492
6.438
6.436
6.432
6.417
6.411
4.453
4.436
2.314
2.182
1.499
1.497
1.494
1.482
1.480
1.477
HN
Me
Me
2x
+
HN
Me
Me
2x'
2x:2x' (1:1.71)
3.47
3.47
3.84
3.94
3.44
0.98
1.95
3.44
2.72
2.55
3.00
5.13
8.14
10.0
9.5
9.0
8.5
8.0
7.5
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6.5
6.0
5.5
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2.5
2.0
1.5
1.0
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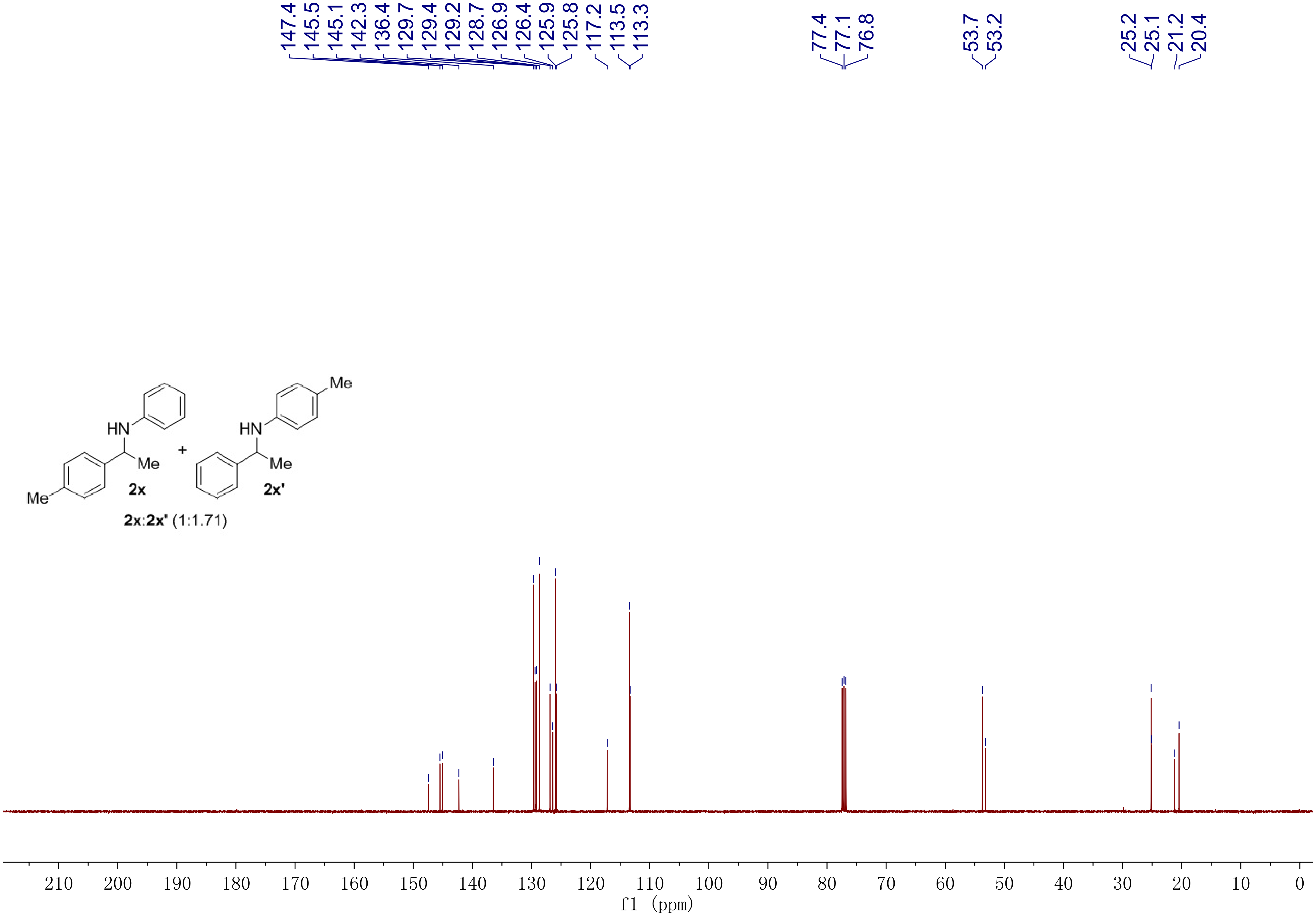
0.0
f1 (ppm)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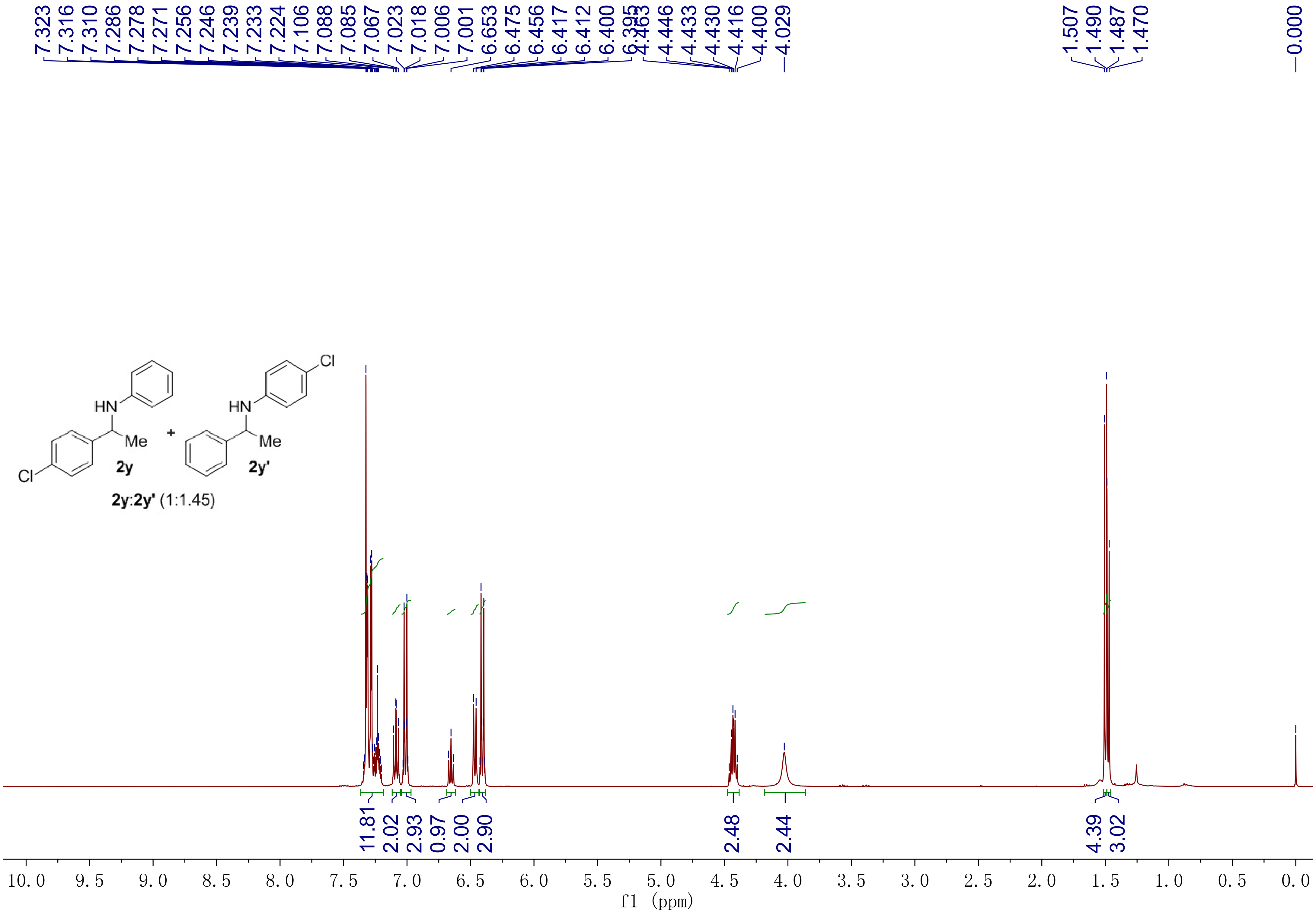
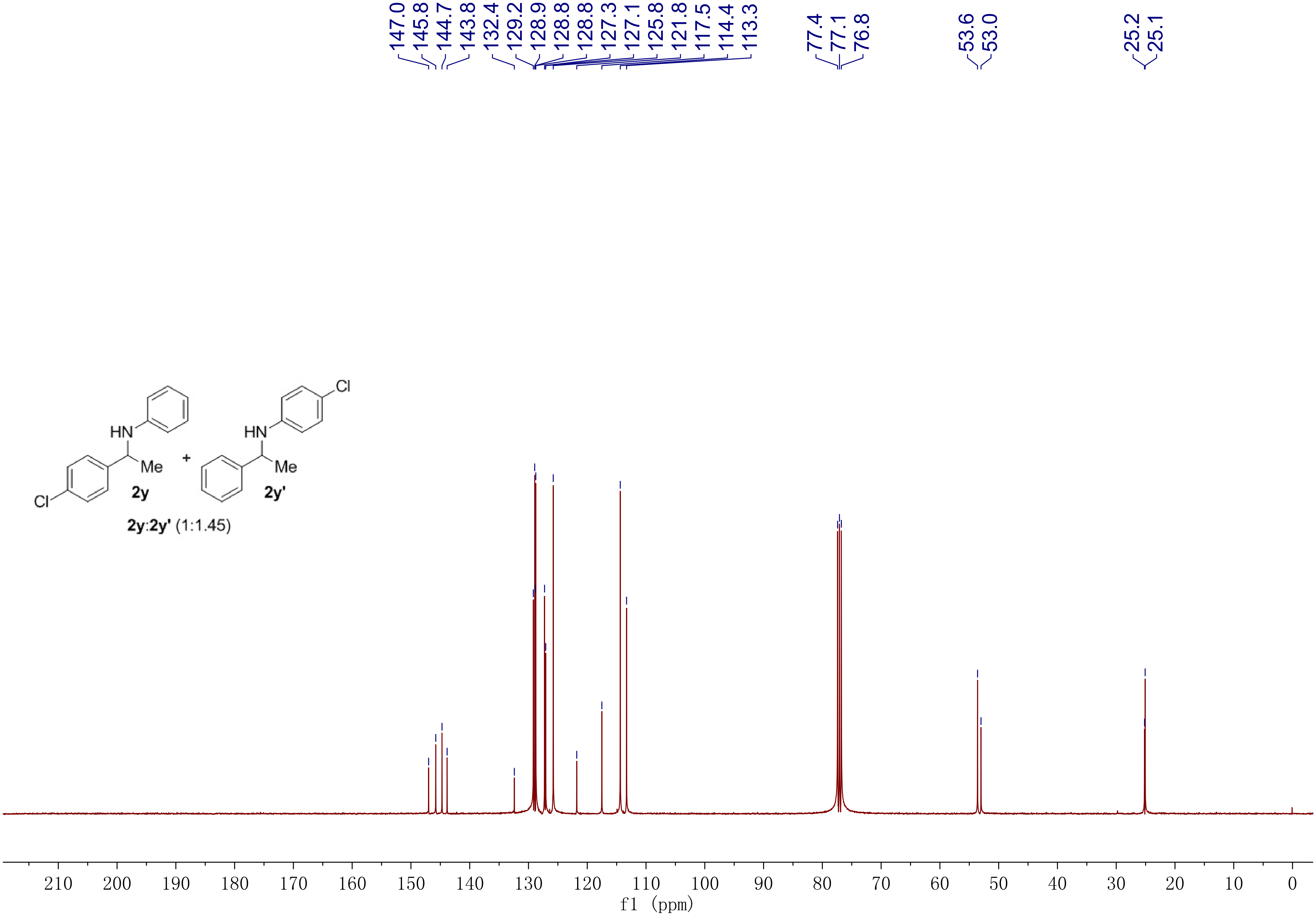
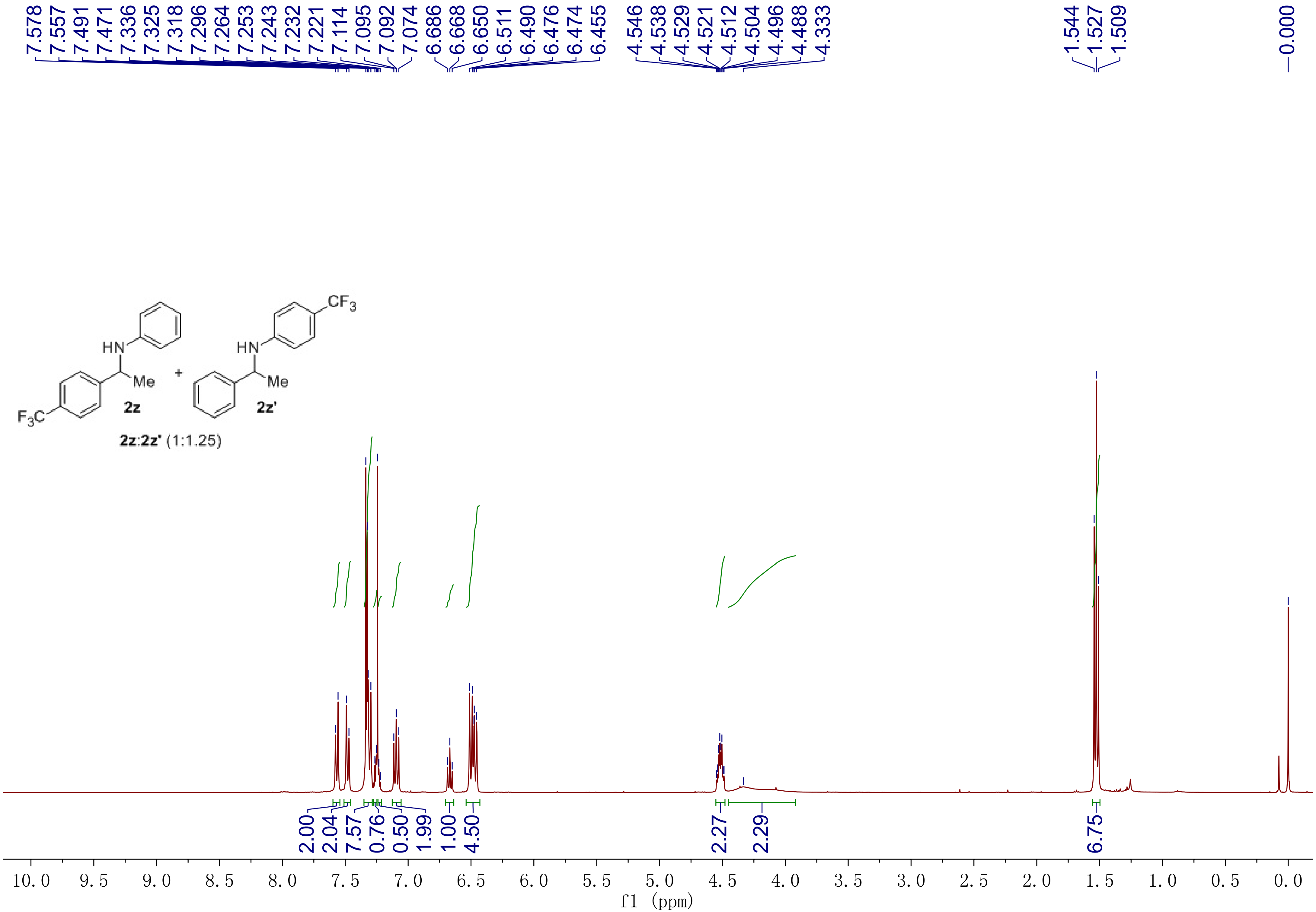
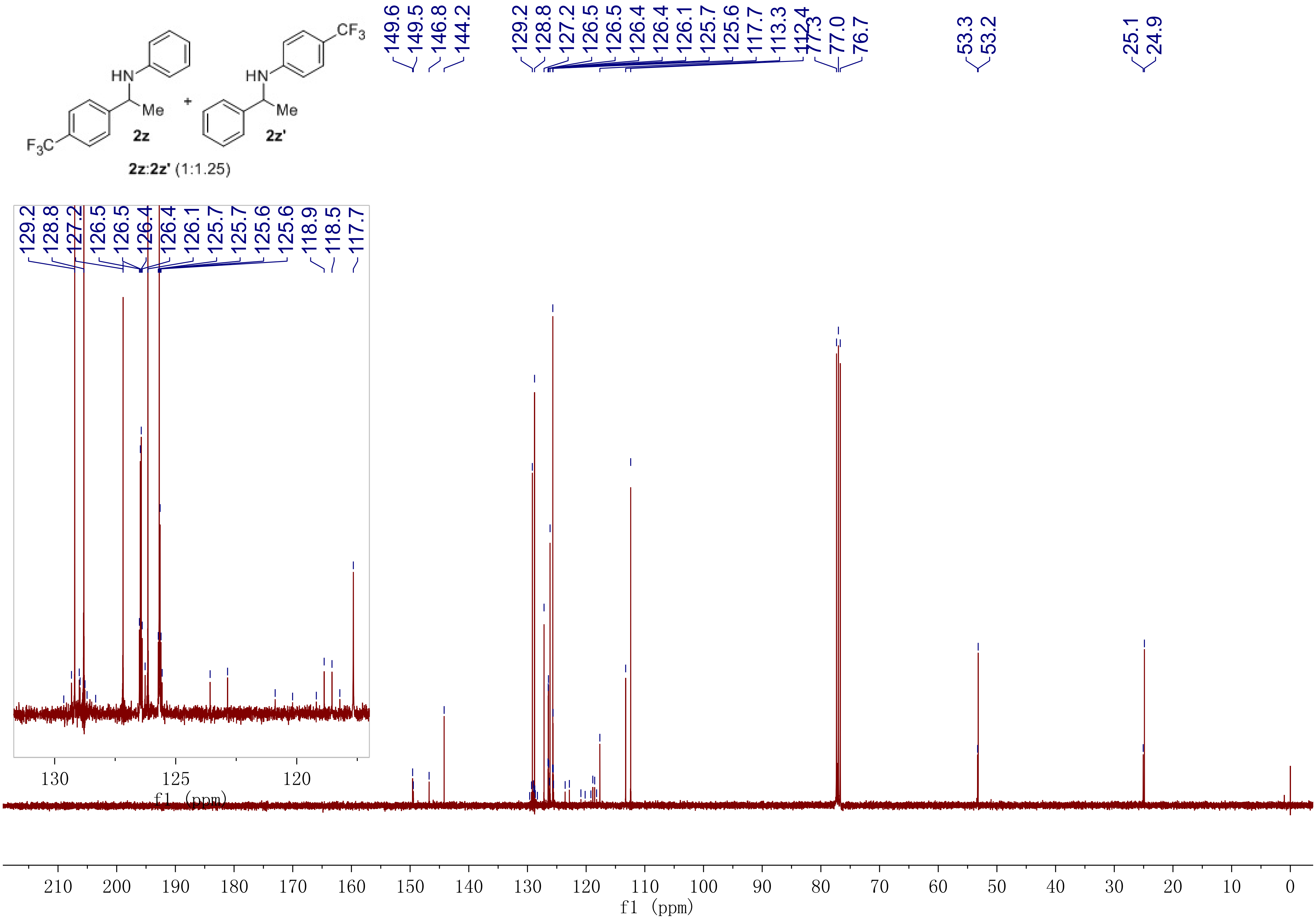
129.4
129.2
128.7
126.9
126.4
125.9
125.8
117.2
113.5
113.3
77.4
77.1
76.8
53.7
53.2
25.2
25.1
21.2
20.4
HN
Me
Me
2x
+
HN
Me
Me
2x'
2x:2x' (1:1.71)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

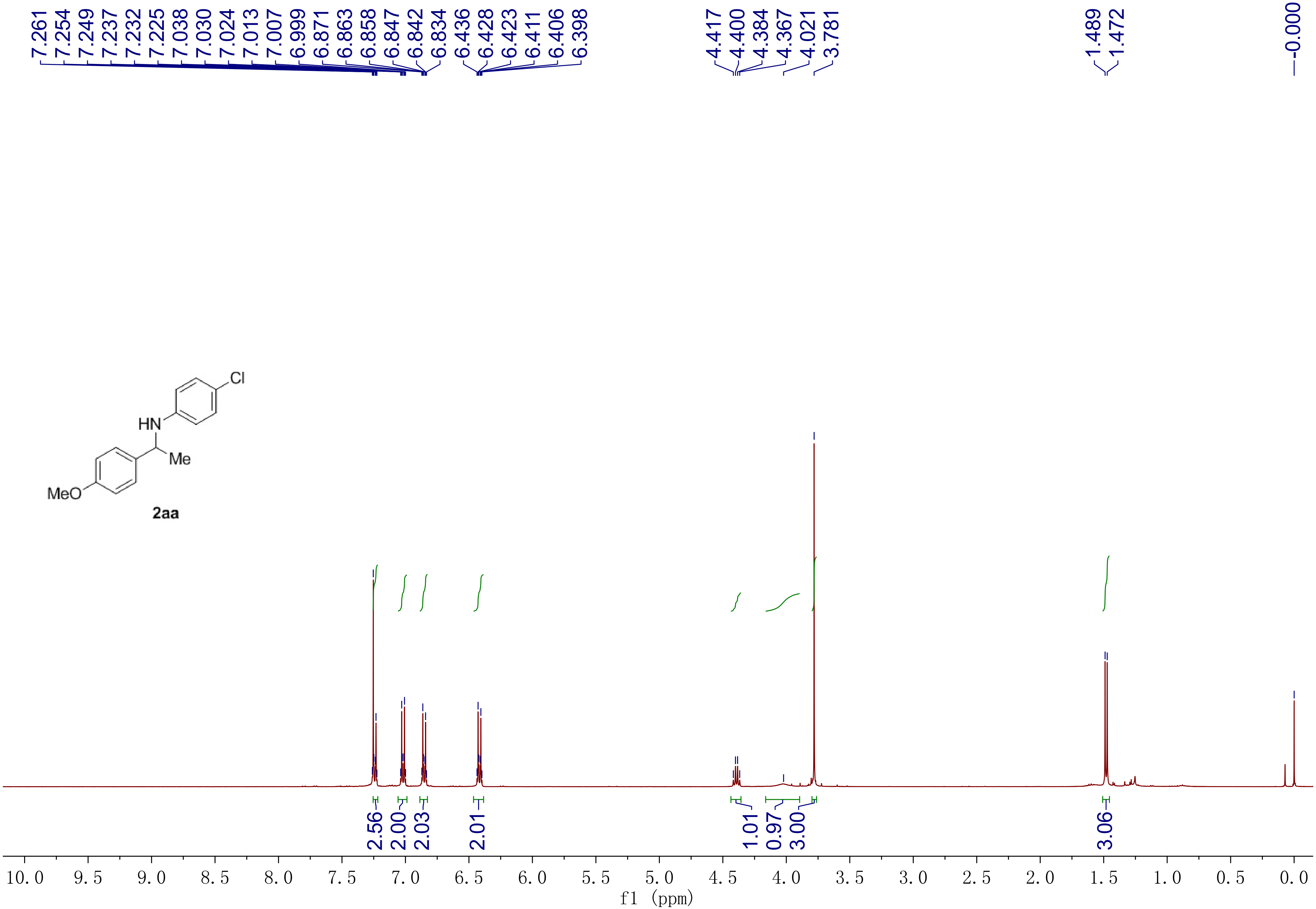

7.323
7.316
7.310
7.286
7.278
7.271
7.256
7.246
7.239
7.233
7.224
7.106
7.088
7.085
7.067
7.023
7.018
7.006
7.001
6.653
6.475
6.456
6.417
6.412
6.400
6.395
4.463
4.446
4.433
4.430
4.416
4.400
4.029
1.507
1.490
1.487
1.470
0.000
HN
Me
Cl
2y
+
HN
Cl
Me
2y'
2y:2y' (1:1.45)
11.81
2.02
2.93
0.97
2.00
2.90
2.48
2.44
4.39
3.02
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
f1 (ppm)

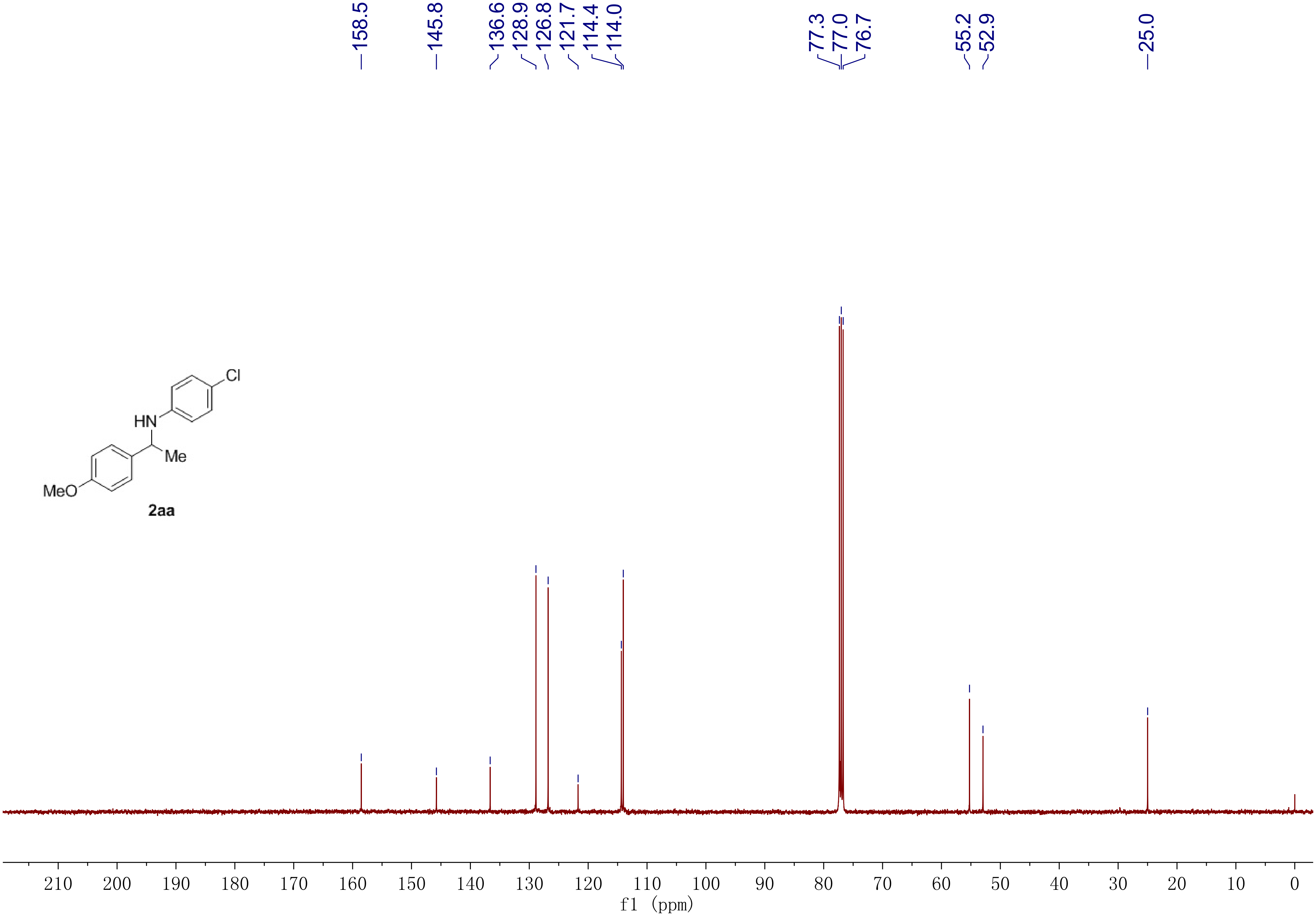

147.0
145.8
144.7
143.8
132.4
129.2
128.9
128.8
128.8
127.3
127.1
125.8
121.8
117.5
114.4
113.3
77.4
77.1
76.8
53.6
53.0
25.2
25.1
HN
Me
Cl
2y
+
HN
Cl
Me
2y'
2y:2y' (1:1.45)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.578
7.557
7.491
7.471
7.336
7.325
7.318
7.296
7.264
7.253
7.243
7.232
7.221
7.114
7.095
7.092
7.074
6.686
6.668
6.650
6.511
6.490
6.476
6.474
6.455
4.546
4.538
4.529
4.521
4.512
4.504
4.496
4.488
4.333
1.544
1.527
1.509
0.000
HN
Me
F_3C
2z
+
CF_3
HN
Me
2z'
2z:2z' (1:1.25)
2.00
2.04
7.57
0.76
0.50
1.99
1.00
4.50
2.27
2.29
6.75
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
f1 (ppm)

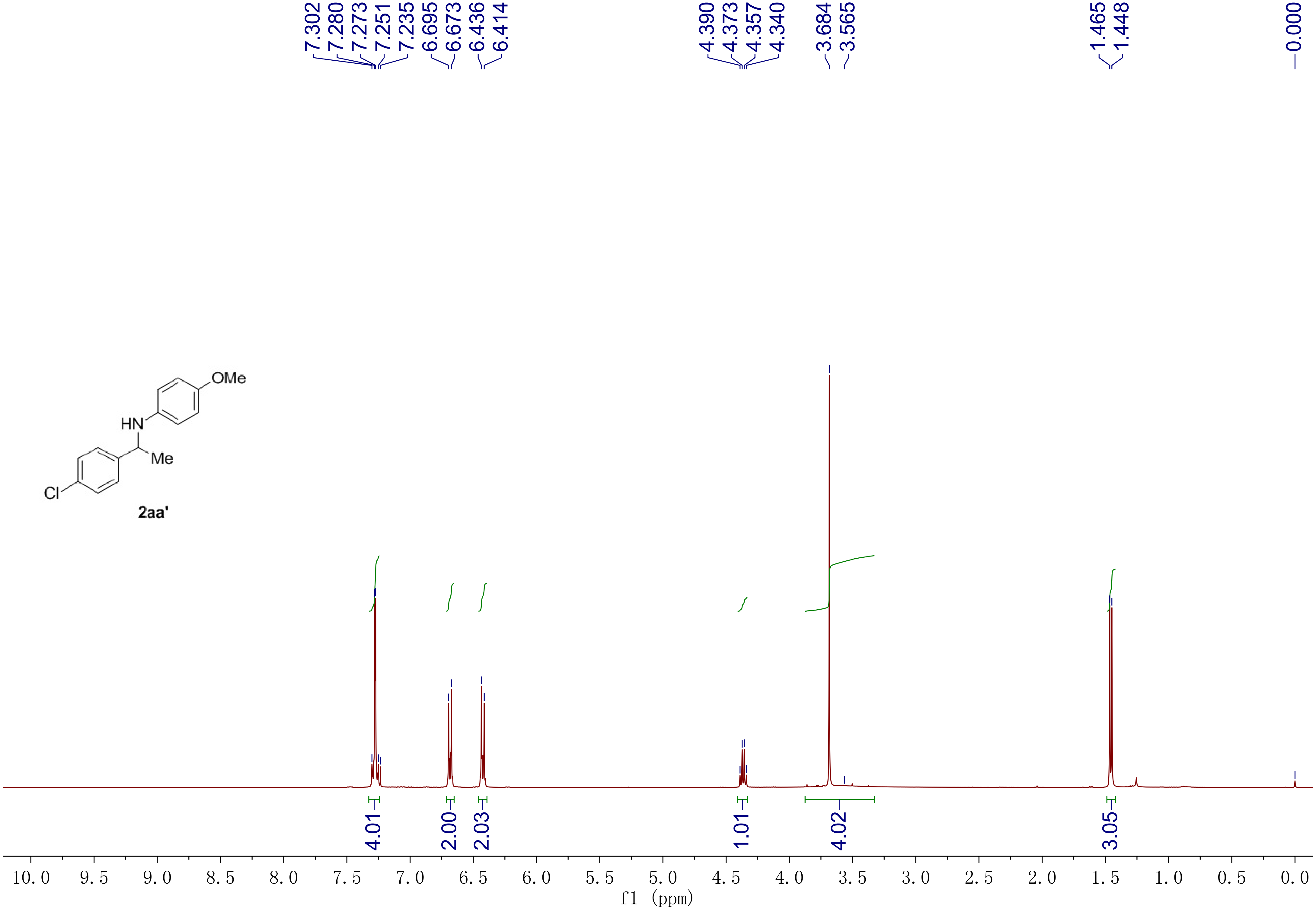


HN
Me
F3C
2z
+
HN
CF3
Me
2z'
2z:2z' (1:1.25)
149.6
149.5
146.8
144.2
129.2
128.8
127.2
126.5
126.5
126.4
126.1
125.7
125.6
117.7
113.3
112.4
77.3
77.0
76.7
53.3
53.2
25.1
24.9
129.2
128.8
127.2
126.5
126.5
126.4
126.4
126.1
125.7
125.7
125.6
125.6
118.9
118.5
117.7
130
125
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

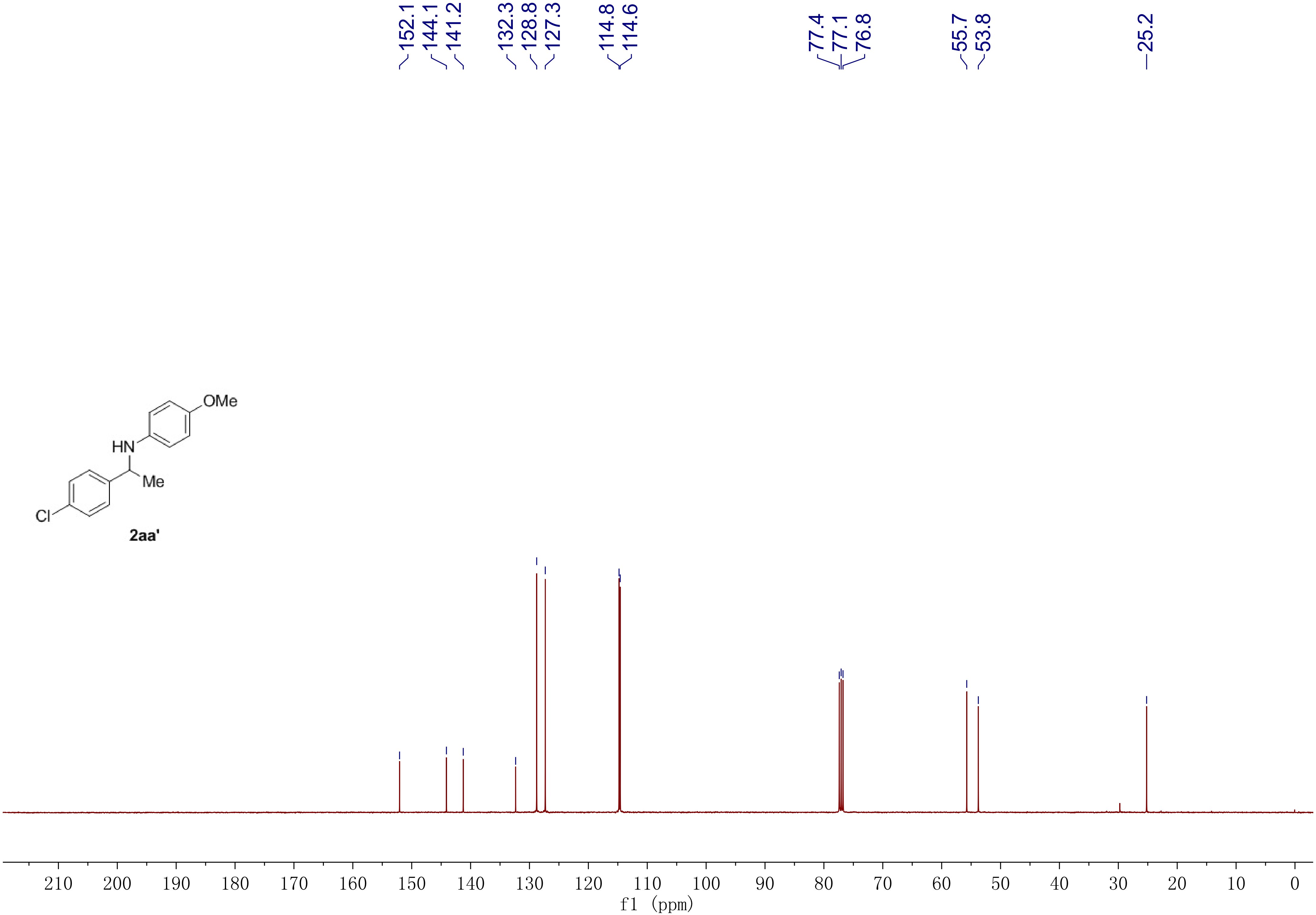

7.261
7.254
7.249
7.237
7.232
7.225
7.038
7.030
7.024
7.013
7.007
6.999
6.871
6.863
6.858
6.847
6.842
6.834
6.436
6.428
6.423
6.411
6.406
6.398
4.417
4.400
4.384
4.367
4.021
3.781
1.489
1.472
-0.000
Cl
HN
Me
MeO
2aa
2.56
2.00
2.03
2.01
1.01
0.97
3.00
3.06
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


158.5
145.8
136.6
128.9
126.8
121.7
114.4
114.0
77.3
77.0
76.7
55.2
52.9
25.0
Cl
HN
Me
MeO
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

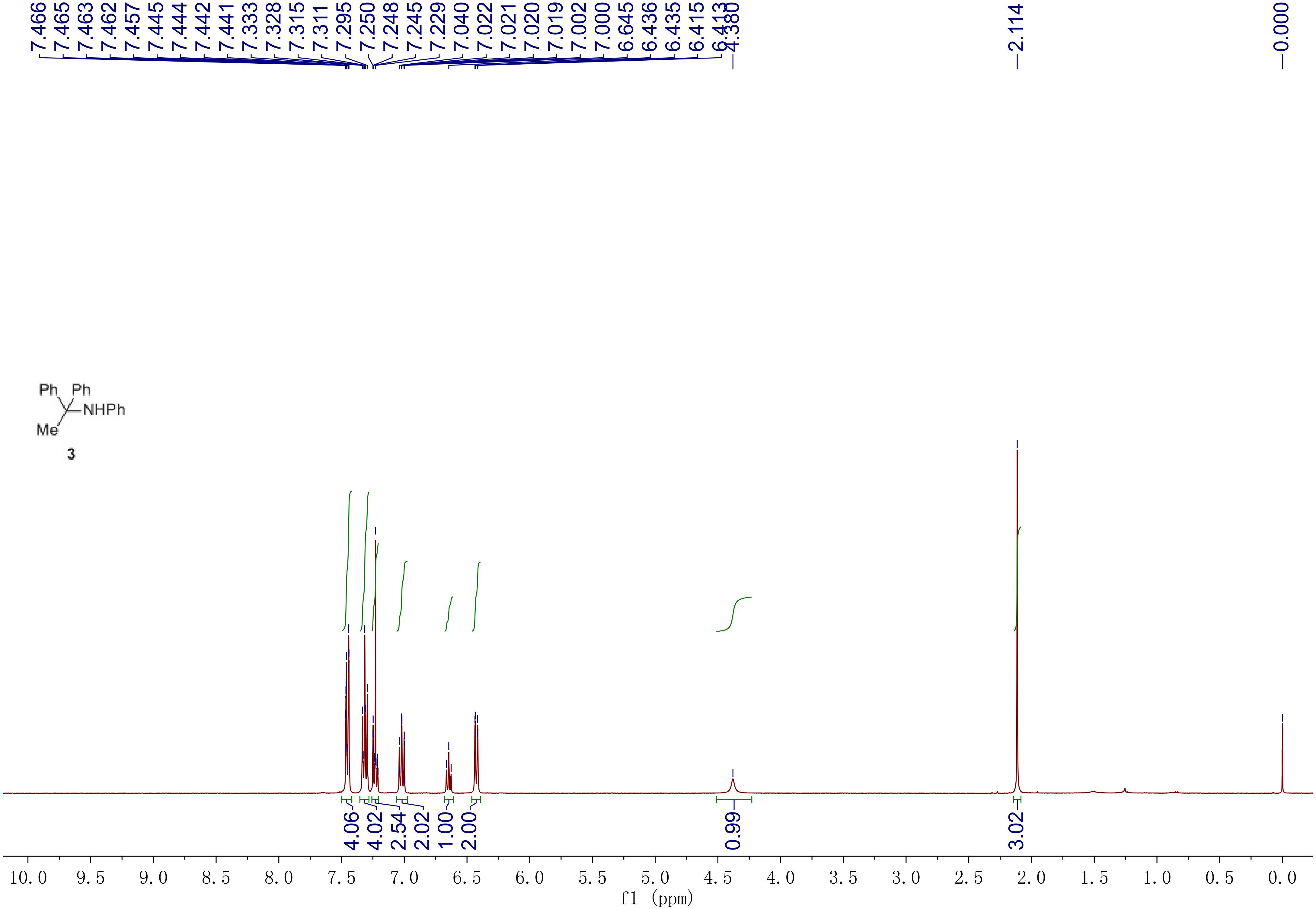
2aa

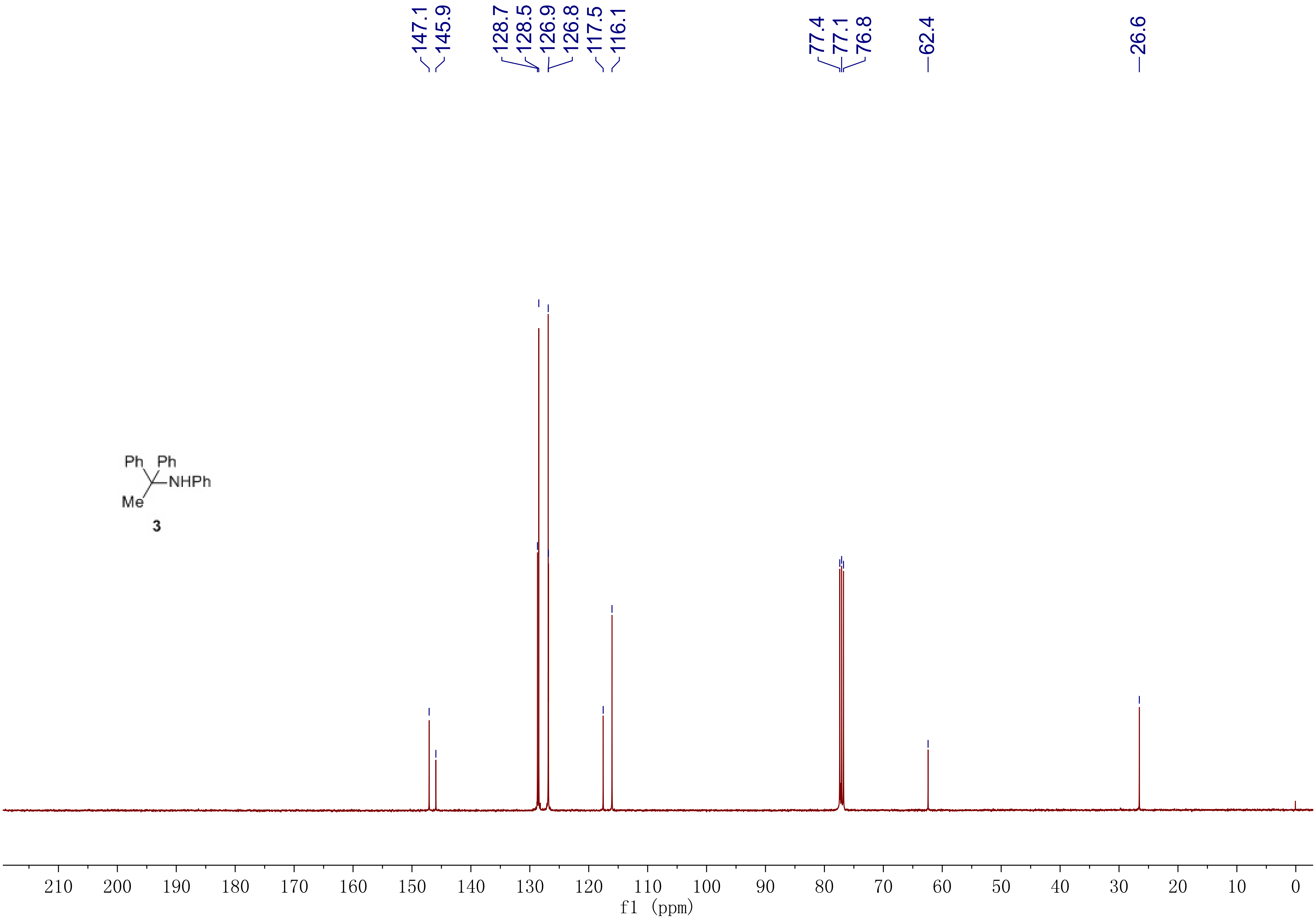

7.302
7.280
7.273
7.251
7.235
6.695
6.673
6.436
6.414
4.390
4.373
4.357
4.340
3.684
3.565
1.465
1.448
0.000
OMe
HN
Me
Cl
4.01
2.00
2.03
1.01
4.02
3.05
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

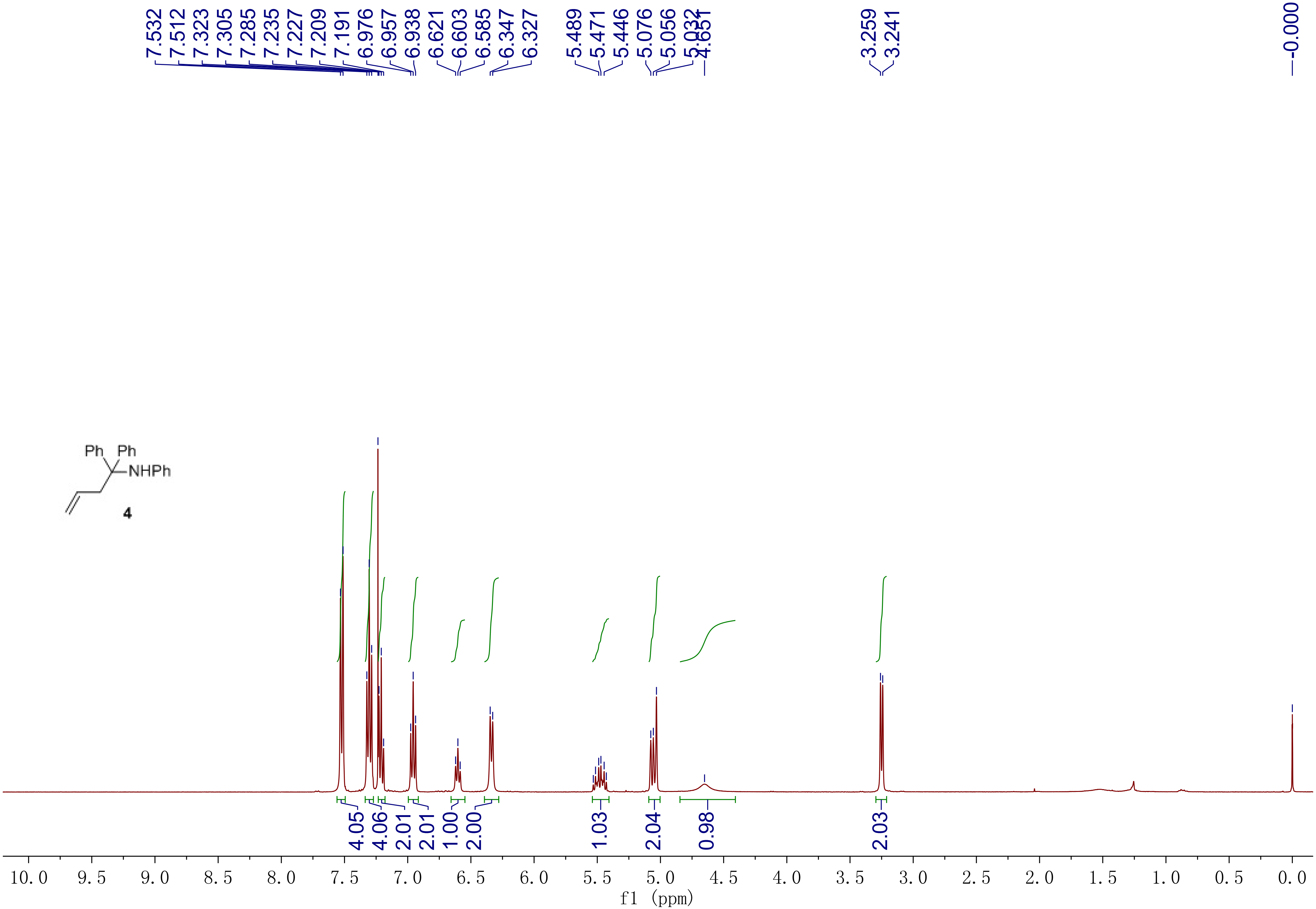
2aa'

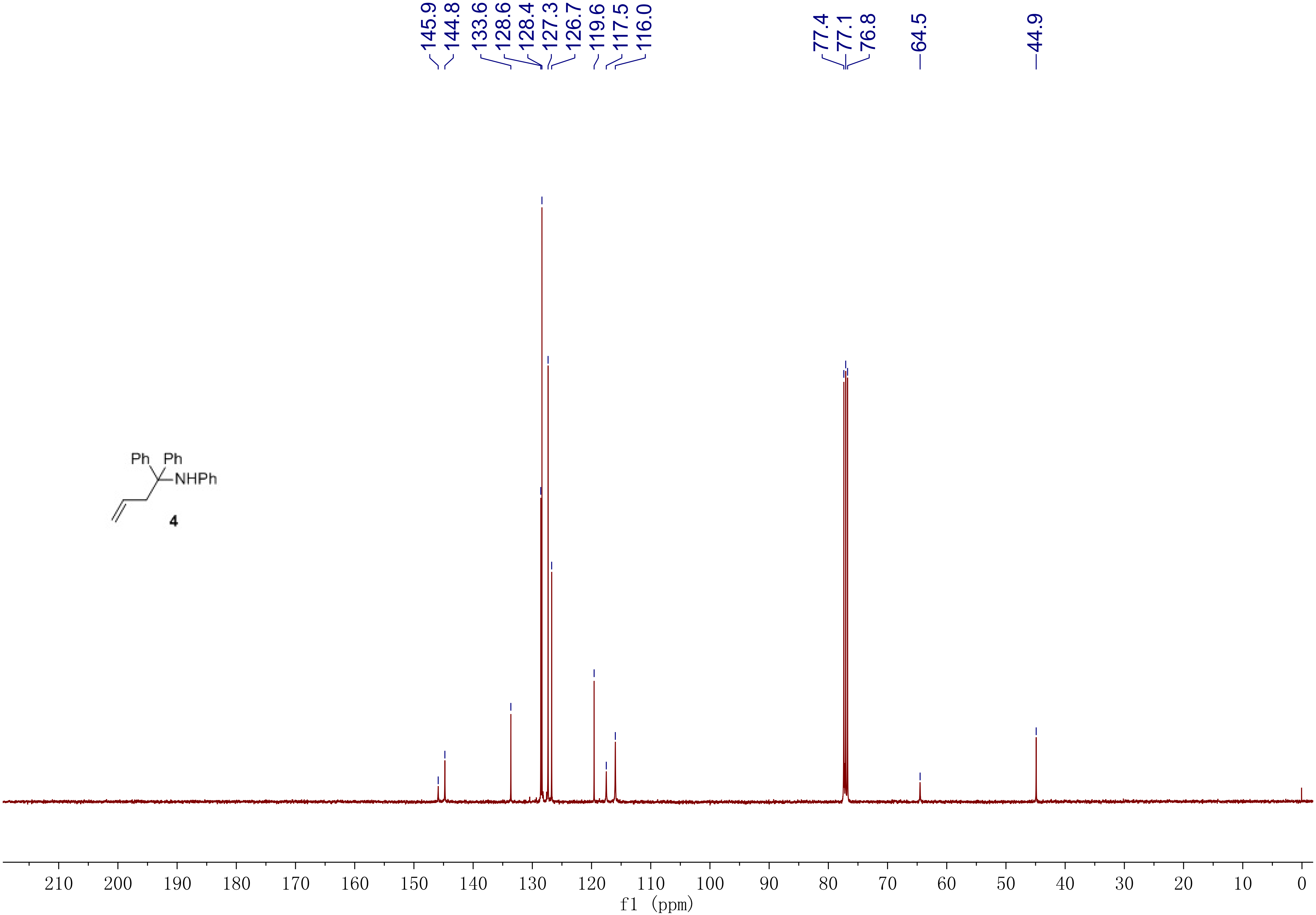

152.1
144.1
141.2
132.3
128.8
127.3
114.8
114.6
77.4
77.1
76.8
55.7
53.8
25.2
OMe
HN
Me
Cl
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

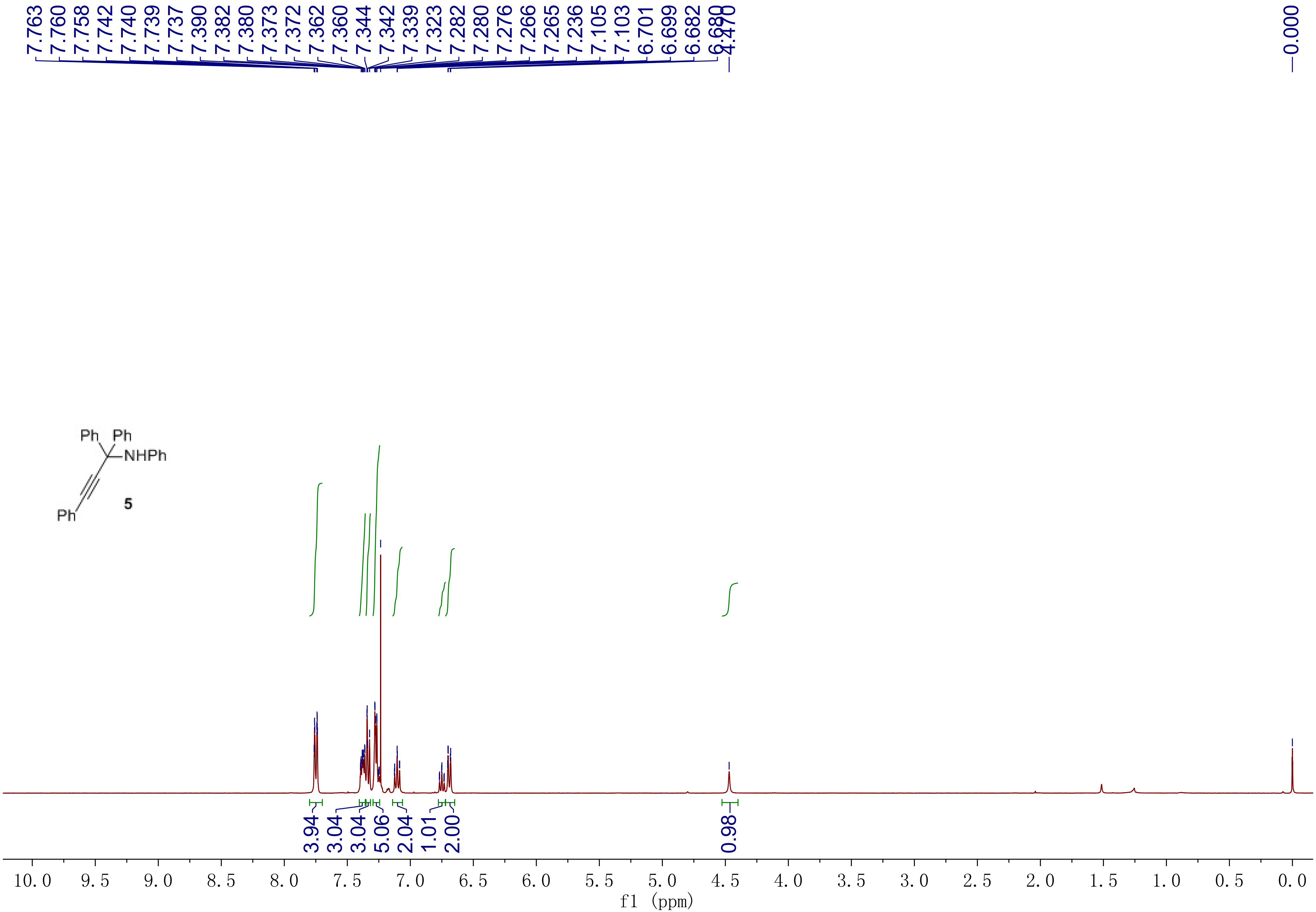
2aa'

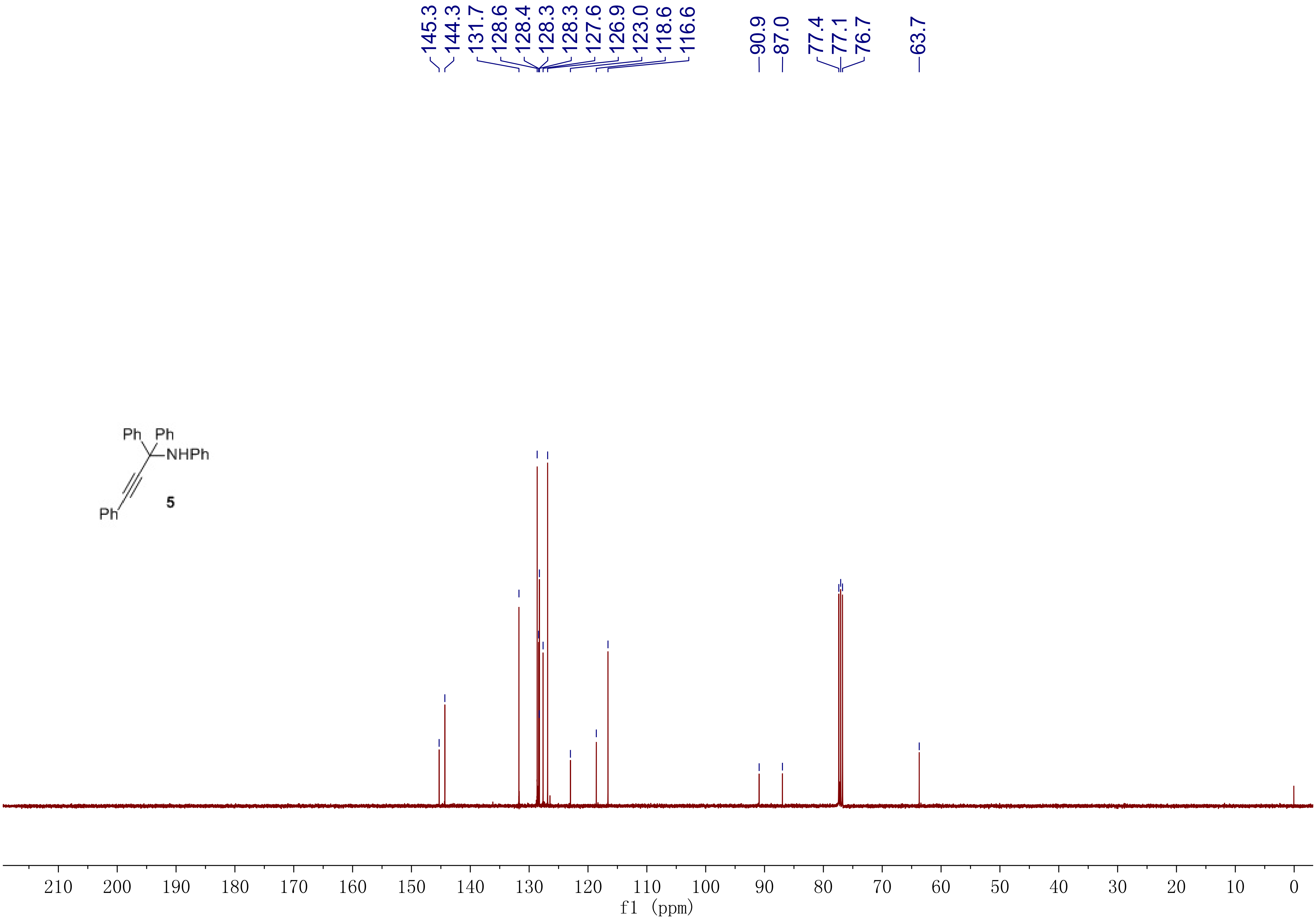

7.466
7.465
7.463
7.462
7.457
7.445
7.444
7.442
7.441
7.333
7.328
7.315
7.311
7.295
7.250
7.248
7.245
7.229
7.040
7.022
7.021
7.020
7.019
7.002
7.000
6.645
6.436
6.435
6.415
6.413
4.380
2.114
0.000
Ph
Ph
NHPh
Me
3
4.06
4.02
2.54
2.02
1.00
2.00
0.99
3.02
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


147.1
145.9
128.7
128.5
126.9
126.8
117.5
116.1
77.4
77.1
76.8
62.4
26.6
Ph
Ph
NHPh
Me
3
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.532
7.512
7.323
7.305
7.285
7.235
7.227
7.209
7.191
6.976
6.957
6.938
6.621
6.603
6.585
6.347
6.327
5.489
5.471
5.446
5.076
5.056
5.032
4.651
3.259
3.241
-0.000
Ph
Ph
NHPh
4
4.05
4.06
2.01
2.01
1.00
2.00
1.03
2.04
0.98
2.03
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
f1 (ppm)


145.9
144.8
133.6
128.6
128.4
127.3
126.7
119.6
117.5
116.0
77.4
77.1
76.8
64.5
44.9
Ph
Ph
NHPh
4
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.763
7.760
7.758
7.742
7.740
7.739
7.737
7.390
7.382
7.380
7.373
7.372
7.362
7.360
7.344
7.342
7.339
7.323
7.282
7.280
7.276
7.266
7.265
7.236
7.105
7.103
6.701
6.699
6.682
6.680
4.470
0.000
Ph
Ph
NHPh
Ph
5
3.94
3.04
3.04
5.06
2.04
1.01
2.00
0.98
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
f1 (ppm)


145.3
144.3
131.7
128.6
128.4
128.3
128.3
127.6
126.9
123.0
118.6
116.6
90.9
87.0
77.4
77.1
76.7
63.7
Ph
Ph
NHPh
Ph
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5