Supporting Information

Non-Deprotonative Primary and Secondary Amination of (Hetero)Arylmetals

Zhe Zhou, Zhiwei Ma, Nicole Erin Behnke, Hongyin Gao and László Kürti*

Department of Chemistry, Rice University, BioScience Research Collaborative, 6500 Main Street, Rm 380, Houston, TX 77030 (USA)

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General Remarks

Solvents were dried by passage through an activated alumina column under argon. All reactions were carried out in flame-dried glassware under an atmosphere of argon with magnetic stirring. All reactions were monitored by thin-layer chromatography (TLC) with E. Merck silica gel 60 F254 pre-coated plates (0.25 mm). Flash chromatography was carried out using a Biotage Isolera One system with 25g KP-Sil cartridges.

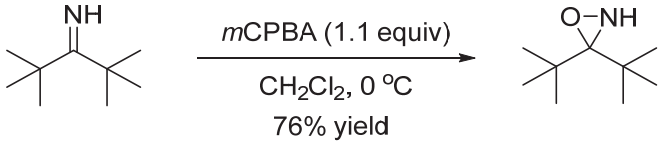
Proton (^{1}H) and carbon (^{13}C) NMR spectra were recorded on a Bruker DRX-600 spectrometer operating at 600 MHz for proton and 151 MHz for carbon nuclei using $CDCl_3$ or DMSO-d_6 as solvent, respectively. Chemical shifts are expressed as parts per million (δ, ppm) and are referenced to 7.26 ($CDCl_3$) for ^{1}H NMR and 77.16 ($CDCl_3$) for ^{13}C NMR. Proton signal data uses the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad and *J* = coupling constant. High Resolution Mass Spectrometry was performed on an Agilent 1290/6230 LCMS- TOF under the conditions of electrospray ionization (ESI) in both positive and negative mode.

General Procedure for Amination Reactions

1. Preparation of oxaziridine reagents

Oxaziridines **3-5** were prepared according to the optimized procedures our group recently published.[1] The detailed procedure for the preparation of oxaziridine **5** is described below.

Synthesis of Di-*t*-Butyl Oxaziridine 5



To a solution of 2,2,4,4-tetramethylpentan-3-imine (5 g, 35 mmol) in 20 mL of CH_2Cl_2 was added dropwise a solution of *m*-CPBA (7.1 g, 39 mmol, 1.1 equiv) in 80 mL of CH_2Cl_2 at 0 °C. The reaction mixture was stirred at 0 °C for 3 hours, and then concentrated in *vacuo* to remove half of the solvent and filtered the *m*-chlorobenzoic acid by-product from the mixture. Hexanes (50 mL) was added and the solution again concentrated in *vacuo* until approximately 25% of the original volume remained. This process was repeated once more and finally hexanes (50 mL) was added to the mixture. The precipitated *m*-chlorobenzoic acid was removed by filtration, and the rest of this by-product washed out of the resulting solution with aqueous sodium hydroxide (1.0 M, 3 x 50 mL). The organic solution was dried (Na_2SO_4) and the solvent was removed in *vacuo* to give the crude oxaziridine, which can be further purified by column chromatography (Hexanes:EtOAc = 40:1) over silica gel to give di-*t*-butyl oxaziridine **5** as a colorless oil (4.2 g, 76%). ^{1}H NMR (600 MHz, $CDC1_3$): δ 3.78 (br s, 1H), 1.13 (s, 9H), 1.09 (s, 9H); ^{13}C NMR (151 MHz, $CDC1_3$): δ 85.2, 37.5, 28.1, 27.9.

2. Preparation of arylmetal reagents

Organozinc reagents were either purchased from Rieke Metals, Inc. or, in the case of **21**, prepared according to Knochel's procedure.[2] Immediately before using, these reagents were titrated using Iodine following a procedure developed by Knochel et. al.

Organolithium reagents were prepared via lithium exchange: 1 mmol corresponding aryl halide was dissolved in 5 mL anhydrous THF and the solution was cooled to -78ºC. To this solution was added a solution of 1.1 mmol n-BuLi in hexanes at -78ºC and the reaction was stirred for 30 min at -78ºC before used in the next step.

Grignard reagents were prepared using one of the following methods:

a. Aryl halide and freshly activated Mg turnings was mixed in anhydrous THF. The reaction was activated with small amount of 1,2-dibromoethane and the resulting Grignard reagent was titrated before using.

b. Br-Mg exchange using *i*-PrMgCl·LiCl as described by Knochel et. al.[3]

c. Direct magnesiation of arenes using TMPMgCl·LiCl as described by Knochel et. al.[4]

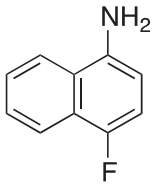
3. Primary Amination

To a flame-dried flask was added a solution of arylmetal reagent (1 mmol in THF) under argon. The aryl metal solution was cooled to -78ºC and a solution of CuCN·2LiCl (or CuCl·2LiCl) (1 M in THF, 1.1 mL, 1,1 mmol, 1.1 eq.) was added. After 30min at -78ºC, a solution of oxaziridine **5** (1.2 mmol, 1.2 eq.) in 2 mL THF was added to the reaction mixture. After 10 min at -78ºC, the reaction was quenched at -78ºC with the addition of 3 mL sat. aq. NH_4Cl and 5 mL sat. aq. $Na_2S_2O_3$. After allowing the reaction mixture to reach room temperature, it was diluted with 20 mL EtOAc and transferred to a separatory funnel. The organic layer was separated and the aqueous layer was extracted with EtOAc (2 x 20 mL). The combined organic layer was dried over Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified using flash chromatography on a Biotage Isolera system to give the corresponding aniline. Traditional manual flash chromatography gave virtually the same yield.

4. Secondary Amination

To a flame-dried flask was added a solution of organozinc reagent (1 mmol in THF) under argon and a solution of CuCN·2LiCl (or CuCl·2LiCl) (1 M in THF, 1.1 mL, 1,1 mmol, 1.1 eq.) was added at room temperature. After 30 min at rt, the reaction mixture was cooled to 0ºC and a solution of hydroxylamine **25** (1.2 mmol, 1.2 eq.) in 2 mL THF was added to the reaction mixture. After 2 h at 0ºC, the reaction was quenched at -78ºC with the addition of 3 mL sat. aq. NH_4Cl and 5 mL sat. aq. $Na_2S_2O_3$. After allowing the reaction mixture to reach room temperature, it was diluted with 20 mL EtOAc and transferred to a separatory funnel. The organic layer was separated and the aqueous layer was extracted with EtOAc (2 x 20 mL). The combined organic layer was dried over Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified using flash chromatography on a Biotage Isolera system to give the corresponding aniline. Traditional manual flash chromatography gave virtually the same yield.

Analytical data for products



4-fluoronaphthalen-1-amine (6)

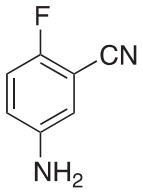
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08 (d, *J* = 8.3 Hz, 1H), 7.82 (d, *J* = 8.1 Hz, 1H), 7.53 (p, *J* = 6.8 Hz, 2H), 6.98 (dd, *J* = 10.3, 8.1 Hz, 1H), 6.66 (dd, *J* = 8.1, 4.4 Hz, 1H), 3.99 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.6, 152.0, 138.3, 138.2, 126.2, 125.9, 124.7, 124.7, 124.3, 124.2, 121.3, 121.2, 109.6, 109.5, 108.8, 108.8.

^{19}F (470 MHz, $CDCl_3$) δ -120.17.

Yield: 53%. Purple waxy solid.

HRMS (ESI) m/z calcd for $[C_{10}H_9FN]^+$ $[M+H]^+$: 162.0719, found 162.0722.



5-amino-2-fluorobenzonitrile (7)

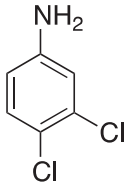
^{1}H NMR (600 MHz, $CDCl_3$) δ 6.96 (t, *J* = 8.7 Hz, 1H), 6.87 – 6.82 (m, 1H), 6.82 – 6.78 (m, 1H), 3.83 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 157.3, 155.7, 143.4, 143.3, 121.3, 121.2, 117.6, 117.1, 117.0, 114.5, 101.2, 101.1.

^{19}F (470 MHz, $CDCl_3$) δ -133.66.

Yield: 86%. White solid, **MP:** 97.2°C

HRMS (ESI) m/z calcd for $[C_7H_6FN_2]^+$ $[M+H]^+$: 137.0515, found 137.0506.



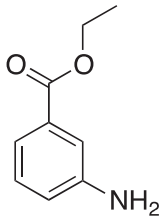
3,4-dichloroaniline (8)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.17 (d, *J* = 8.6 Hz, 1H), 6.76 (s, 1H), 6.50 (d, *J* = 8.4 Hz, 1H), 3.71 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 146.1, 132.8, 130.8, 121.2, 116.5, 114.7.

Yield: 65%. Tan solid. **MP:** 72°C (lit.[5])

HRMS (ESI) m/z calcd for $[C_6H_6Cl_2N]^+$ $[M+H]^+$: 161.9877, found 161.9878.



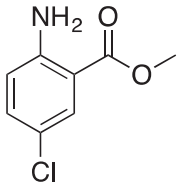
ethyl 3-aminobenzoate (2)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.44 (d, *J* = 7.6 Hz, 1H), 7.37 (s, 1H), 7.21 (t, *J* = 7.8 Hz, 1H), 6.87 (d, *J* = 8.1 Hz, 1H), 4.35 (q, *J* = 7.1 Hz, 2H), 3.69 (s, 2H), 1.38 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.9, 146.1, 131.6, 129.4, 120.1, 119.7, 116.1, 77.4, 77.2, 76.9, 61.0, 14.4.

Yield: 90%. Colorless oil.

HRMS (ESI) m/z calcd for $[C_9H_{12}NO_2]^+$ $[M+H]^+$: 166.0868, found 166.0880.



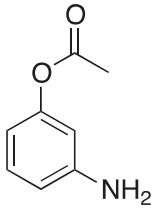
methyl 2-amino-5-chlorobenzoate (9)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.82 (d, *J* = 2.5 Hz, 1H), 7.20 (dd, *J* = 8.8, 2.6 Hz, 1H), 6.60 (d, *J* = 8.8 Hz, 1H), 5.73 (s, 2H), 3.87 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.7, 149.1, 134.2, 130.5, 120.8, 118.1, 111.6, 51.9.

Yield: 88%. White solid. **MP:** 69-70°C (lit.[6])

HRMS (ESI) m/z calcd for $[C_8H_9ClNO_2]^+$ $[M+H]^+$: 186.0322, found 186.0349.



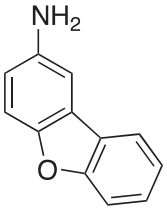
3-aminophenyl acetate (10)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.12 (t, *J* = 8.0 Hz, 1H), 6.52 (dd, *J* = 8.1, 2.2 Hz, 1H), 6.46 (dd, *J* = 8.1, 2.1 Hz, 1H), 6.39 (t, *J* = 2.3 Hz, 1H), 3.73 (s, 2H), 2.26 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 169.6, 151.7, 147.8, 130.1, 112.7, 111.3, 108.3, 21.2.

Yield: 62%. Orange waxy solid.

HRMS (ESI) m/z calcd for $[C_8H_{10}NO_2]^+$ $[M+H]^+$: 152.0712, found 152.0716.



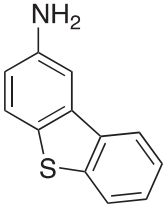
dibenzo[*b*,*d*]furan-2-amine (11)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.6 Hz, 1H), 7.53 (d, *J* = 8.2 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 1H), 7.37 (d, *J* = 8.6 Hz, 1H), 7.30 (t, *J* = 7.5 Hz, 1H), 7.22 (d, *J* = 2.4 Hz, 1H), 6.82 (dd, *J* = 8.6, 2.5 Hz, 1H), 3.58 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.4, 142.2, 127.0, 125.0, 124.4, 122.3, 120.6, 115.9, 112.0, 111.7, 106.1.

Yield: 78%. Off-white solid. **MP:** 114.5-121.4°C

HRMS (ESI) m/z calcd for $[C_{12}H_{10}NO]^+$ $[M+H]^+$: 184.0762, found 184.0761.



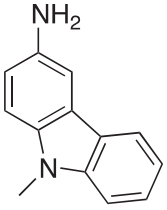
dibenzo[*b*,*d*]thiophen-2-amine (12)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (dd, *J* = 6.1, 2.8 Hz, 1H), 7.82 (dd, *J* = 6.2, 2.6 Hz, 1H), 7.61 (d, *J* = 8.4 Hz, 1H), 7.44 (d, *J* = 2.3 Hz, 1H), 7.41 (td, *J* = 7.6, 6.9, 3.9 Hz, 2H), 6.87 (dd, *J* = 8.4, 2.3 Hz, 1H), 3.79 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 144.0, 140.6, 136.8, 135.4, 129.4, 126.6, 124.1, 123.4, 123.0, 121.6, 116.5, 107.2.

Yield: 71%. Off-white solid. **MP:** 132-133°C (lit.[7])

HRMS (ESI) m/z calcd for $[C_{12}H_{10}NS]^+$ $[M+H]^+$: 200.0534, found 200.0564.



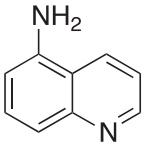
9-methyl-9*H*-carbazol-3-amine (13)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.8 Hz, 1H), 7.47 – 7.41 (m, 2H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.22 (d, *J* = 8.5 Hz, 1H), 7.17 (t, *J* = 7.4 Hz, 1H), 6.93 (dd, *J* = 8.4, 2.3 Hz, 1H), 3.79 (s, 3H), 3.29 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 141.6, 139.1, 135.8, 125.6, 123.6, 122.4, 120.4, 118.2, 115.7, 109.1, 108.5, 106.4, 29.2.

Yield: 61%. Brown solid. **MP:** 168°C (decomp.)

HRMS (ESI) m/z calcd for $[C_{13}H_{13}N_2]^+$ $[M+H]^+$: 197.1079, found 197.1105.



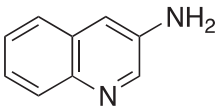
quinolin-5-amine (14)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.88 (d, *J* = 3.7 Hz, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 7.57 (d, *J* = 8.4 Hz, 1H), 7.54 – 7.47 (m, 1H), 7.33 (dd, *J* = 8.5, 4.2 Hz, 1H), 6.81 (d, *J* = 7.3 Hz, 1H), 4.22 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 150.4, 149.3, 142.4, 130.1, 129.6, 120.3, 119.7, 118.8, 110.1.

Yield: 67%. Yellow solid. **MP:** 108.4-110.1°C

HRMS (ESI) m/z calcd for $[C_9H_9N_2]^+$ $[M+H]^+$: 145.0766, found 145.0756.



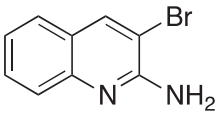
quinolin-3-amine (15)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.50 (d, *J* = 2.8 Hz, 1H), 7.96 (d, *J* = 7.9 Hz, 1H), 7.58 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.47 – 7.39 (m, 2H), 7.22 (d, *J* = 2.7 Hz, 1H), 3.94 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 143.2, 142.9, 139.8, 129.3, 129.2, 127.1, 126.0, 125.7, 115.1.

Yield: 42%. Brown solid. **MP:** 78.9-82.1°C

HRMS (ESI) m/z calcd for $[C_9H_9N_2]^+$ $[M+H]^+$: 145.0766, found 145.0761.



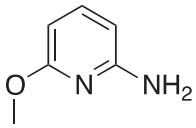
3-bromoquinolin-2-amine (16)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.16 (s, 1H), 7.65 (d, *J* = 8.3 Hz, 1H), 7.60 – 7.54 (m, 2H), 7.28 (d, *J* = 7.6 Hz, 1H), 5.34 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 153.7, 146.7, 139.8, 130.2, 126.8, 126.1, 125.0, 123.4, 106.9.

Yield: 73%. White solid. **MP:** 151.4-155.0°C

HRMS (ESI) m/z calcd for $[C_9H_8BrN_2]^+$ $[M+H]^+$: 222.9871 found 222.9868.



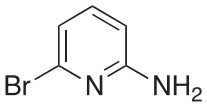
6-methoxypyridin-2-amine (17)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.8 Hz, 1H), 6.08 (d, *J* = 7.9 Hz, 1H), 6.05 (d, *J* = 7.7 Hz, 1H), 4.32 (s, 2H), 3.83 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 163.9, 157.3, 140.4, 99.8, 98.6, 53.4.

Yield: 58%. Orange oil.

HRMS (ESI) m/z calcd for $[C_6H_9N_2O]^+$ $[M+H]^+$: 125.0715, found 125.0724.



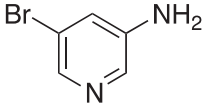
6-bromopyridin-2-amine (18)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.27 – 7.22 (m, 1H), 6.79 (d, *J* = 7.5 Hz, 1H), 6.40 (d, *J* = 8.1 Hz, 1H), 4.66 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 158.7, 140.1, 139.9, 117.1, 106.9.

Yield: 56%. Brown solid. **MP:** 87-88°C (lit.[8])

HRMS (ESI) m/z calcd for $[C_5H_6BrN_2]^+$ $[M+H]^+$: 172.9714, found 172.0707.



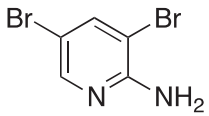
5-bromopyridin-3-amine (19)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.96 (d, *J* = 2.5 Hz, 1H), 7.10 (t, *J* = 2.1 Hz, 1H), 3.88 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 143.7, 140.4, 135.6, 123.7, 120.9.

Yield: 77%. White solid. **MP:** 64.3-66.5°C

HRMS (ESI) m/z calcd for $[C_5H_6BrN_2]^+$ $[M+H]^+$: 172.9714, found 172.9707.



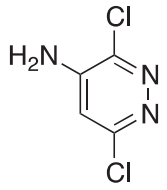
3,5-dibromopyridin-2-amine (20)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (d, *J* = 2.2 Hz, 1H), 7.77 (d, *J* = 2.1 Hz, 1H), 5.03 (s, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 154.4, 147.4, 142.2, 107.3, 104.8.

Yield: 45%. White solid. **MP:** 104-105°C (lit.[9])

HRMS (ESI) m/z calcd for $[C_5H_5Br_2N_2]^+$ $[M+H]^+$: 250.8819, found 250.8818



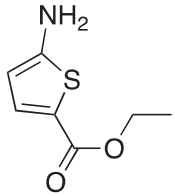
3,6-dichloropyridazin-4-amine (21)

^{1}H NMR (600 MHz, DMSO-d_6) δ 7.30 – 6.97 (m, 2H), 6.82 (s, 1H).

^{13}C NMR (151 MHz, DMSO-d_6) δ 154.1, 145.8, 143.3, 108.0.

Yield: 33%. White Solid. **MP:** 201.9°C (decomp.)

HRMS (ESI) m/z calcd for $[C_4H_4Cl_2N_3]^+$ $[M+H]^+$: 163.9782, found 163.9790.



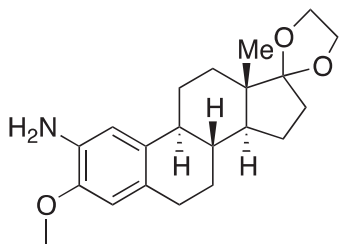
ethyl 5-aminothiophene-2-carboxylate (22)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.44 (d, *J* = 4.0 Hz, 1H), 6.08 (d, *J* = 4.0 Hz, 1H), 4.32 (s, 2H), 4.27 (q, *J* = 7.1 Hz, 2H), 1.33 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 162.8, 158.8, 134.8, 118.3, 108.0, 60.6, 14.6.

Yield: 83%. Tan oil.

HRMS (ESI) m/z calcd for $[C_7H_{10}NO_2S]^+$ $[M+H]^+$: 172.0432, found 172.0460.



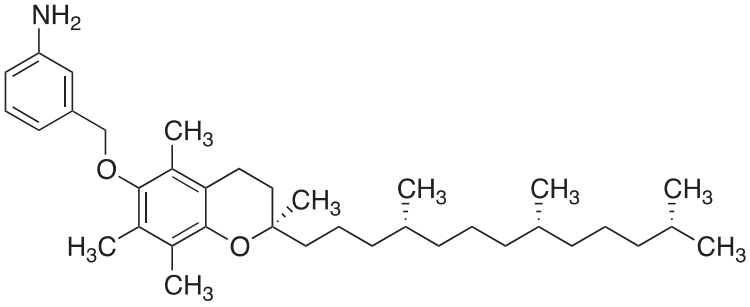
(8*R*,9*S*,13*S*,14*S*)-3-methoxy-13-methyl-6,7,8,9,11,12,13,14,15,16-decahydrospiro[cyclopenta[*a*]phenanthrene-17,2'-[1,3]dioxolan]-2-amine (23)

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.69 (s, 1H), 6.51 (s, 1H), 3.98 – 3.87 (m, 4H), 3.82 (s, 3H), 3.65 (s, 2H), 2.85 – 2.72 (m, 2H), 2.28 – 2.17 (m, 2H), 2.03 (ddd, *J* = 14.3, 11.7, 2.6 Hz, 1H), 1.91 – 1.81 (m, 2H), 1.81 – 1.72 (m, 2H), 1.63 (td, *J* = 11.5, 7.1 Hz, 1H), 1.53 (dt, *J* = 12.5, 3.3 Hz, 1H), 1.49 – 1.29 (m, 4H), 0.89 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 145.7, 133.8, 132.7, 126.7, 119.6, 112.5, 111.1, 65.3, 64.7, 55.6, 49.5, 46.3, 43.8, 39.3, 34.4, 30.9, 29.4, 27.4, 26.4, 22.5, 14.5.

Yield: 58%. Yellow solid. **MP:** 177.8-179.7°C

HRMS (ESI) m/z calcd for $[C_{21}H_{30}NO_3]^+$ $[M+H]^+$: 344.2226, found 344.2221.



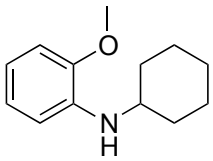
3-((((*R*)-2,5,7,8-tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl)oxy)methyl)aniline (24)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.20 (t, *J* = 7.7 Hz, 1H), 6.91 – 6.87 (m, 2H), 6.67 (d, *J* = 7.5 Hz, 1H), 4.64 (s, 2H), 3.72 (s, 2H), 2.62 (t, *J* = 6.8 Hz, 2H), 2.25 (s, 3H), 2.20 (s, 3H), 2.14 (s, 3H), 1.83 (ddt, *J* = 37.7, 13.3, 6.8 Hz, 2H), 1.66 – 1.06 (m, 26H), 0.93 – 0.85 (m, 12H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 148.3, 148.0, 146.7, 139.4, 129.5, 128.1, 126.1, 123.0, 117.8, 117.7, 114.6, 114.3, 74.9, 74.8, 40.2, 39.5, 37.6, 37.6, 37.6, 37.4, 32.9, 32.8, 31.5, 28.1, 24.9, 24.6, 24.0, 22.9, 22.8, 21.2, 20.8, 19.9, 19.8, 13.0, 12.1, 12.0.

Yield: 55%. Light yellow oil.

HRMS (ESI) m/z calcd for $[C_{36}H_{58}NO_2]^+$ $[M+H]^+$: 536.4468, found 536.4446.



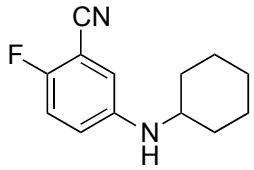
***N*-cyclohexyl-2-methoxyaniline (26)**

^{1}H NMR (600 MHz, $CDCl_3$) δ 6.89 (t, *J* = 7.4 Hz, 1H), 6.80 (d, *J* = 7.5 Hz, 1H), 6.67 (t, *J* = 7.1 Hz, 2H), 4.04 (s, 1H), 3.87 (s, 3H), 3.30 (tt, *J* = 10.1, 3.8 Hz, 1H), 2.12 (dd, *J* = 12.9, 4.0 Hz, 2H), 1.82 (dt, *J* = 13.4, 4.0 Hz, 2H), 1.70 (dt, *J* = 12.9, 3.9 Hz, 1H), 1.43 (qt, *J* = 12.0, 3.5 Hz, 2H), 1.35 – 1.20 (m, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 146.8, 137.3, 121.3, 115.9, 110.3, 109.6, 55.4, 51.4, 33.5, 26.1, 25.2.

Yield: 71%. Light yellow oil.

HRMS (ESI) m/z calcd for $[C_{13}H_{20}NO]^+$ $[M+H]^+$: 206.1545, found 206.1551.



5-(cyclohexylamino)-2-fluorobenzonitrile (27)

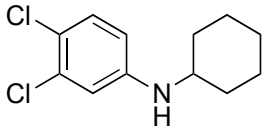
^{1}H NMR (600 MHz, $CDCl_3$) δ 6.96 (t, *J* = 8.8 Hz, 1H), 6.71 (dd, *J* = 9.0, 3.9 Hz, 1H), 6.69 – 6.63 (m, 1H), 3.64 (s, 1H), 3.19 – 3.11 (m, 1H), 2.04 – 1.96 (m, 2H), 1.77 (dt, *J* = 13.6, 4.1 Hz, 2H), 1.66 (dt, *J* = 13.0, 4.0 Hz, 1H), 1.42 – 1.31 (m, 2H), 1.27 – 1.09 (m, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 155.54 (d, *J* = 247.6 Hz), 144.10 (d, *J* = 1.8 Hz), 119.4, 117.09 (dd, *J* = 20.7, 4.1 Hz), 114.86 (d, *J* = 13.3 Hz), 101.3, 52.2, 33.2, 25.9, 25.0.

^{19}F (470 MHz, $CDCl_3$) δ -122.60.

Yield: 57%. White solid. **MP:** 59.7-60.7°C

HRMS (ESI) m/z calcd for $[C_{13}H_{16}FN_2]^+$ $[M+H]^+$: 219.1298, found 219.1287.



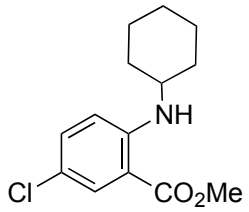
3,4-dichloro-*N*-cyclohexylaniline (28)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.14 (d, *J* = 8.7 Hz, 1H), 6.63 (d, *J* = 2.7 Hz, 1H), 6.39 (dd, *J* = 8.8, 2.8 Hz, 1H), 3.48 (s, 1H), 3.18 (ddd, *J* = 14.0, 10.2, 3.8 Hz, 1H), 2.06 – 1.96 (m, 2H), 1.76 (dt, *J* = 13.6, 4.0 Hz, 2H), 1.66 (dt, *J* = 12.9, 4.0 Hz, 1H), 1.42 – 1.30 (m, 2H), 1.29 – 1.18 (m, 1H), 1.17 – 1.08 (m, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 147.0, 132.9, 130.7, 119.1, 114.0, 112.9, 51.9, 33.3, 25.9, 25.0.

Yield: 76%. Brown solid. **MP:** 56.1-56.8°C

HRMS (ESI) m/z calcd for $[C_{12}H_{16}Cl_2N]^+$ $[M+H]^+$: 244.0660, found 244.0658.



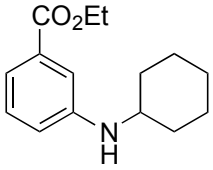
methyl 5-chloro-2-(cyclohexylamino)benzoate (29)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (d, *J* = 2.7 Hz, 1H), 7.74 (d, *J* = 7.6 Hz, 1H), 7.24 (dd, *J* = 9.1, 2.7 Hz, 1H), 6.63 (d, *J* = 9.1 Hz, 1H), 3.85 (s, 3H), 3.36 (qd, *J* = 9.2, 7.6, 3.9 Hz, 1H), 2.02 – 1.96 (m, 2H), 1.76 (dt, *J* = 13.4, 4.3 Hz, 2H), 1.62 (dt, *J* = 13.2, 4.1 Hz, 1H), 1.39 (dtt, *J* = 13.2, 10.4, 3.2 Hz, 3H), 1.36 – 1.28 (m, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 168.3, 149.1, 134.5, 131.2, 131.1, 118.5, 113.3, 113.2, 110.4, 51.8, 51.7, 50.8, 32.9, 26.0, 24.7, 24.7.

Yield: 61%. Yellow oil.

HRMS (ESI) m/z calcd for $[C_{14}H_{19}ClNO_2]^+$ $[M+H]^+$: 268.1104, found 268.1117.



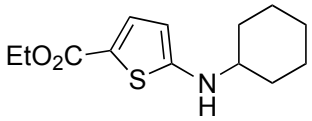
ethyl 3-(cyclohexylamino)benzoate (30)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.32 (d, *J* = 7.6 Hz, 1H), 7.25 (t, *J* = 2.1 Hz, 1H), 7.19 (t, *J* = 7.8 Hz, 1H), 6.74 (dd, *J* = 8.1, 2.4 Hz, 1H), 4.35 (q, *J* = 7.1 Hz, 2H), 3.65 (s, 1H), 3.31 (td, *J* = 9.8, 4.8 Hz, 1H), 2.05 (dd, *J* = 13.0, 4.0 Hz, 2H), 1.76 (dt, *J* = 13.6, 4.0 Hz, 2H), 1.66 (dt, *J* = 12.9, 3.9 Hz, 1H), 1.42 – 1.34 (m, 5H), 1.28 – 1.10 (m, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.3, 147.5, 131.5, 129.3, 118.0, 117.5, 113.9, 60.9, 51.7, 33.5, 26.0, 25.1, 14.5.

Yield: 65%. Brown oil.

HRMS (ESI) m/z calcd for $[C_{15}H_{22}NO_2]^+$ $[M+H]^+$: 248.1651, found 248.1642.



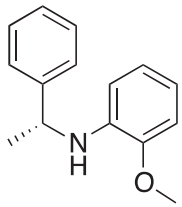
ethyl 5-(cyclohexylamino)thiophene-2-carboxylate (31)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.48 (d, *J* = 4.2 Hz, 1H), 5.90 (d, *J* = 4.2 Hz, 1H), 4.34 (d, *J* = 7.9 Hz, 1H), 4.27 (q, *J* = 7.1 Hz, 2H), 3.17 (tdt, *J* = 10.6, 7.7, 3.8 Hz, 1H), 2.16 – 2.05 (m, 2H), 1.76 (dt, *J* = 13.5, 4.1 Hz, 2H), 1.65 (dt, *J* = 13.0, 4.0 Hz, 1H), 1.41 – 1.30 (m, 5H), 1.22 (dddt, *J* = 18.5, 11.4, 6.6, 3.4 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 163.0, 161.4, 135.2, 114.9, 103.7, 60.4, 56.3, 33.1, 25.7, 24.9, 14.7.

Yield: 49%. Brown oil.

HRMS (ESI) m/z calcd for $[C_{13}H_{20}NO_2S]^+$ $[M+H]^+$: 254.1215, found 254.1200.



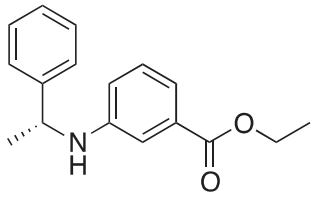
(*R*)-2-methoxy-*N*-(1-phenylethyl)aniline (32)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 – 7.37 (m, 2H), 7.33 (t, *J* = 7.6 Hz, 2H), 7.26 – 7.22 (m, 1H), 6.79 (dd, *J* = 7.9, 1.4 Hz, 1H), 6.72 (td, *J* = 7.7, 1.4 Hz, 1H), 6.63 (td, *J* = 7.7, 1.6 Hz, 1H), 6.37 (dd, *J* = 7.9, 1.5 Hz, 1H), 4.66 (s, 1H), 4.50 (q, *J* = 6.7 Hz, 1H), 3.91 (s, 3H), 1.58 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 146.7, 145.6, 137.3, 128.7, 126.9, 126.0, 121.3, 116.4, 111.1, 109.4, 55.6, 53.4, 25.3.

Yield: 83%. Brown solid. **MP:** 78.1-82.3°C

HRMS (ESI) m/z calcd for $[C_{15}H_{18}NO]^+$ $[M+H]^+$: 228.1388, found 228.1384.



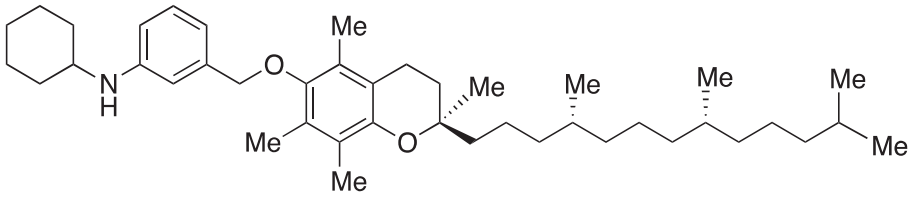
(*R*)-ethyl 3-((1-phenylethyl)amino)benzoate (33)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38 (d, *J* = 7.3 Hz, 2H), 7.37 – 7.32 (m, 3H), 7.30 (t, *J* = 2.1 Hz, 1H), 7.25 (t, *J* = 7.3 Hz, 1H), 7.14 (t, *J* = 7.9 Hz, 1H), 6.66 (dd, *J* = 8.1, 2.4 Hz, 1H), 4.55 (q, *J* = 6.8 Hz, 1H), 4.34 (q, *J* = 7.1 Hz, 2H), 4.25 (s, 1H), 1.55 (d, *J* = 6.7 Hz, 3H), 1.37 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.0, 147.3, 144.8, 131.3, 129.1, 128.8, 127.1, 125.9, 118.4, 117.3, 114.5, 60.8, 53.5, 24.9, 14.4.

Yield: 88%. Light yellow solid. **MP:** 62.6-67.4°C

HRMS (ESI) m/z calcd for $[C_{17}H_{20}NO_2]^+$ $[M+H]^+$: 270.1494, found 270.1500.



***N*-cyclohexyl-3-((((*R*)-2,5,7,8-tetramethyl-2-((4*R*,8*R*)-4,8,12-trimethyltridecyl)chroman-6-yl)oxy)methyl)aniline (34)**

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.19 (t, *J* = 7.9 Hz, 1H), 6.78 (d, *J* = 6.7 Hz, 2H), 6.58 (d, *J* = 8.0 Hz, 1H), 4.63 (s, 2H), 3.30 (td, *J* = 9.9, 4.9 Hz, 1H), 2.60 (t, *J* = 6.8 Hz, 2H), 2.23 (s, 3H), 2.18 (s, 3H), 2.12 (s, 3H), 2.11 – 2.06 (m, 2H), 1.81 (ddt, *J* = 37.4, 13.0, 6.9 Hz, 4H), 1.67 (dt, *J* = 12.9, 4.0 Hz, 1H), 1.56 (ddt, *J* = 19.7, 13.3, 5.9 Hz, 3H), 1.51 – 1.04 (m, 27H), 0.88 (dd, *J* = 12.7, 6.7 Hz, 12H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 148.3, 148.0, 147.6, 139.3, 129.5, 128.1, 126.1, 123.0, 117.7, 116.3, 112.6, 112.5, 75.1, 74.9, 51.9, 40.2, 39.5, 37.6, 37.6, 37.6, 37.4, 33.6, 32.9, 32.9, 31.5, 28.1, 26.1, 25.1, 25.0, 24.6, 24.0, 22.9, 22.8, 21.2, 20.8, 19.9, 19.9, 19.8, 13.0, 12.2, 12.0.

Yield: 60%. Brown oil.

HRMS (ESI) m/z calcd for $[C_{42}H_{68}NO_2]^+$ $[M+H]^+$: 618.5250, found 618.5243.

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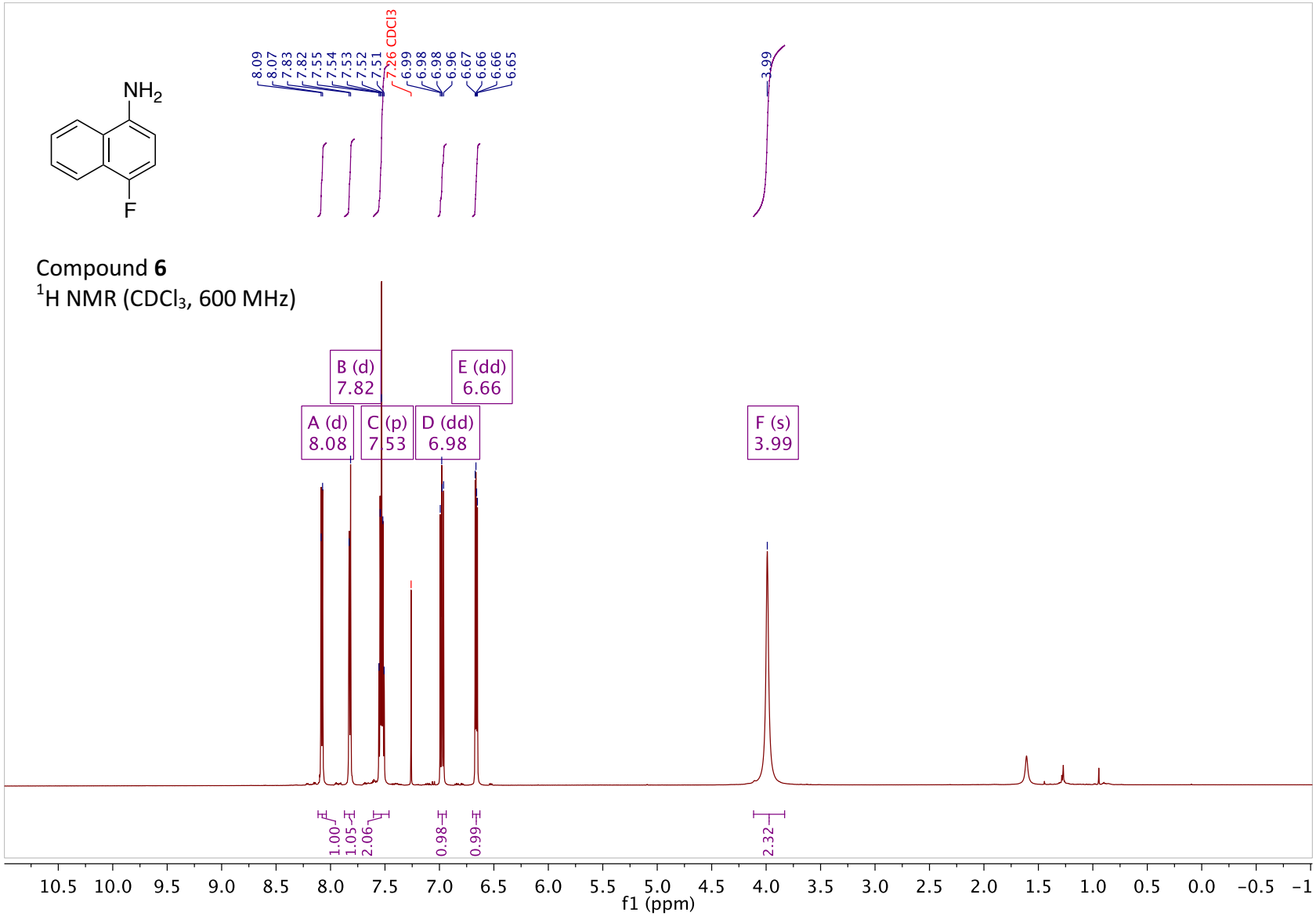
Spectral Data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8.07
7.83
7.82
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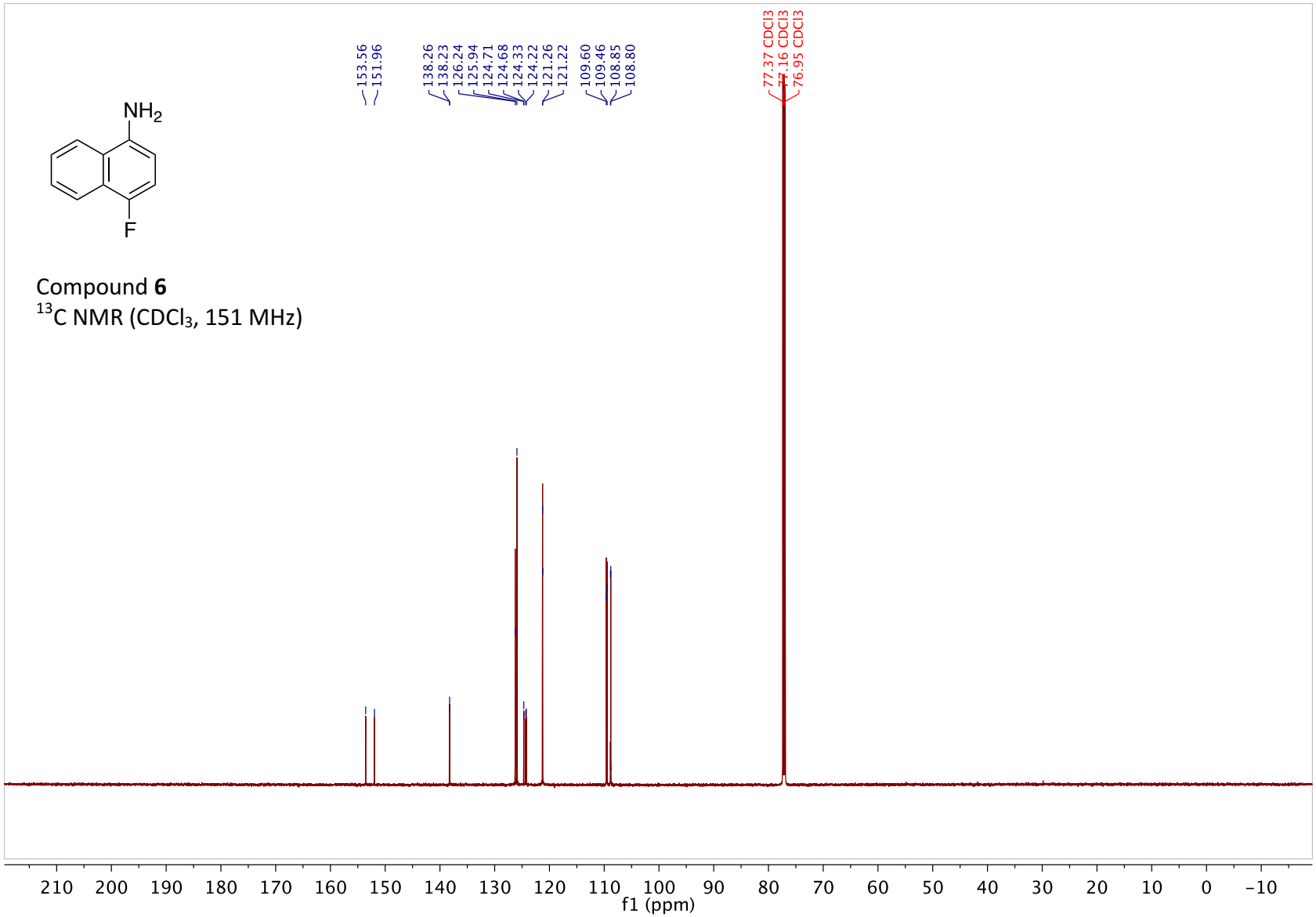
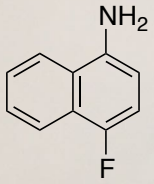
7.52
7.51
7.26 CDCl3
6.99
6.98
6.98
6.96
6.67
6.66
6.66
6.65
3.99
Compound 6
1H NMR (CDCl3, 600 MHz)
B (d)
7.82
E (dd)
6.66
A (d)
8.08
C (p)
7.53
D (dd)
6.98
F (s)
3.99
1.00
1.05
2.06
0.98
0.99
2.32
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)



Compound **6**

^{13}C NMR ($CDCl_3$, 151 MHz)

NB_88. In CDCl3
Fluorine sample 6 (1-amino-4-fluoronaphthalene).
3J(HF) and two different 4J(HF) are all evident.
Chemical shifts relative to external CFCl3 defined as 0 ppm (sr = -442.57)



Compound **6**

^{19}F NMR ($CDCl_3$, 470 MHz)

BRUKER

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Current Data Parameters
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PROCNO                          1

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DE                         6.50 usec
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D1                     5.00000000 sec

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F2 - Processing parameters
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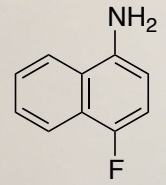
NB_88. In CDCl3
Fluorine sample 6 (1-amino-4-fluoronaphthalene).
3J(HF) and two different 4J(HF) are all evident.
Chemical shifts relative to external CFCl3 defined as 0 ppm (sr = -442.57)



Compound **6**
^{19}F NMR ($CDCl_3$, 470 MHz)

BRUKER

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NS                             16
DS                              0
SWH                     9398.496 Hz
FIDRES                  0.071705 Hz
AQ                      6.9730806 sec
RG                           40.3
DW                         53.200 usec
DE                          6.50 usec
TE                         293.8 K
D1                     5.00000000 sec

======== CHANNEL f1 ========
NUC1                          19F
P1                         11.30 usec
PLW1                21.79999924 W
SFO1                470.6234000 MHz

F2 - Processing parameters
SI                         4194304
SF                  470.6860284 MHz
WDW                            no
SSB                 0
LB                  0 Hz
GB                  0
PC                           1.00
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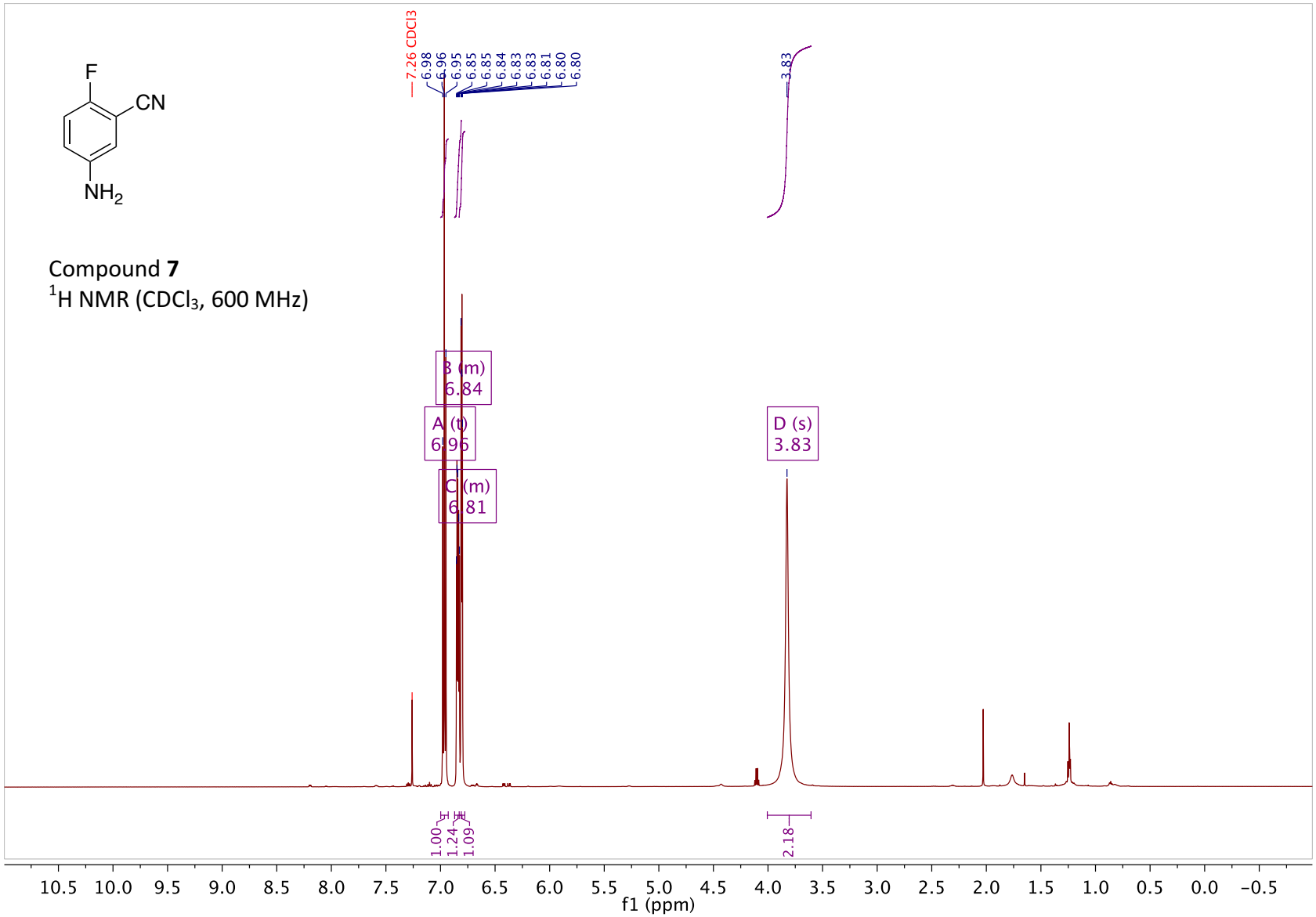
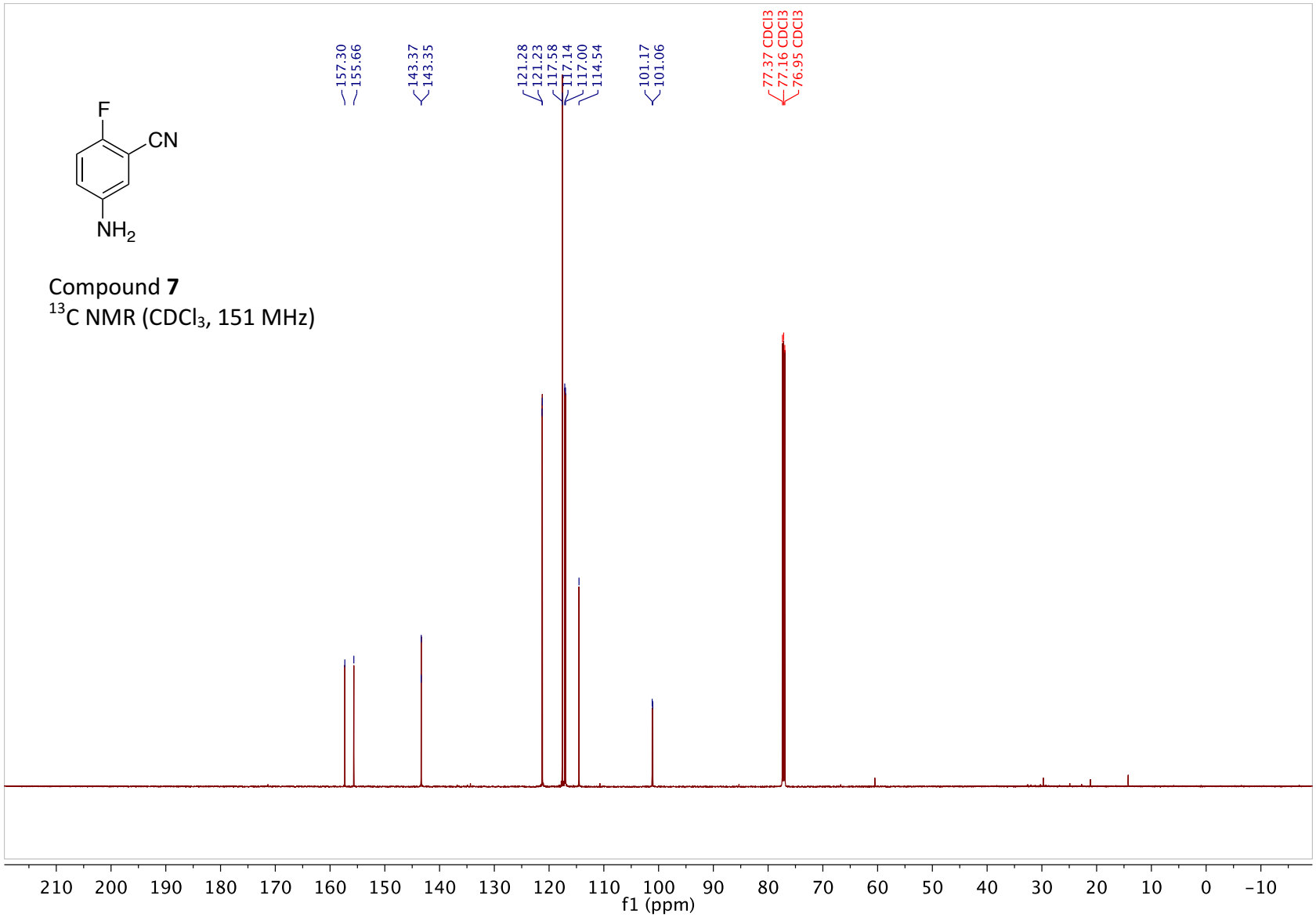
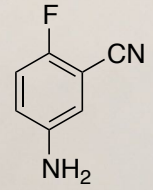

F
CN
NH2
Compound 7
1H NMR (CDCl3, 600 MHz)
7.26 CDCl3
6.98
6.96
6.95
6.85
6.85
6.84
6.83
6.83
6.81
6.80
6.80
3.83
B (m)
6.84
A (t)
6.96
C (m)
6.81
D (s)
3.83
1.00
1.24
1.09
2.18
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)



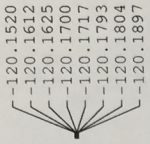
Compound **7**

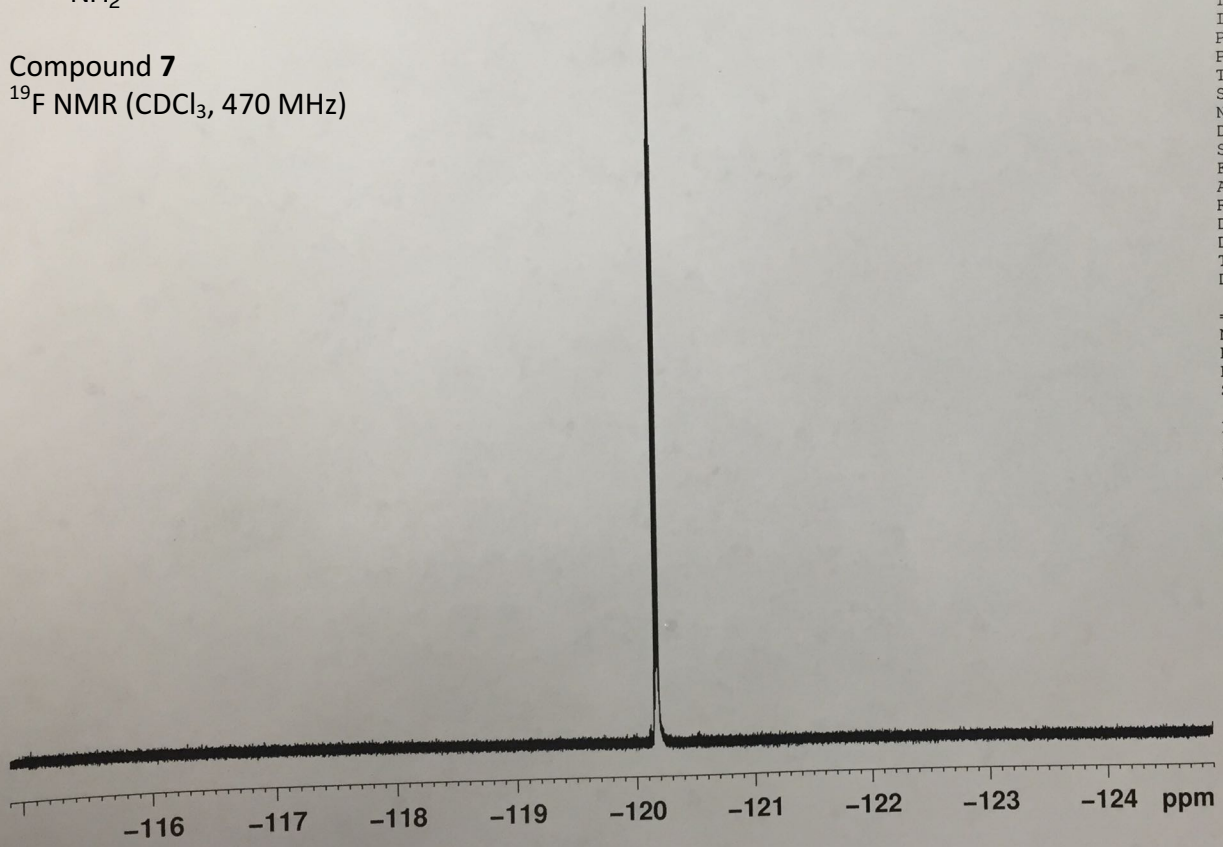
^{13}C NMR ($CDCl_3$, 151 MHz)

ZZ_2_139. In CDCl3
Fluorine sample 7 (3-cyano-4-fluoroaniline).
3J(HF) and two 4J(HF) are all evident.
Chemical shifts relative to external CFCl3 defined as 0 ppm (sr = -442.57)



Compound **7**
^{19}F NMR ($CDCl_3$, 470 MHz)





BRUKER

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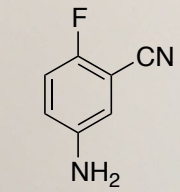
Current Data Parameters
NAME                 ZZ_2_139_F
EXPNO                         1
PROCNO                        1

F2 - Acquisition Parameters
Date_                 20161220
Time                     10.17
INSTRUM                  spect
PROBHD    5 mm PABBO BB-
PULPROG                     zg
TD                      131072
SOLVENT                  CDCl3
NS                          16
DS                           0
SWH                   4708.098 Hz
FIDRES                0.035920 Hz
AQ                   13.9198961 sec
RG                         40.3
DW                      106.200 usec
DE                        6.50 usec
TE                       293.8 K
D1                   5.00000000 sec

======== CHANNEL f1 ========
NUC1                        19F
P1                        11.30 usec
PLW1                 21.79999924 W
SFO1                470.6295930 MHz

F2 - Processing parameters
SI                       2097152
SF                  470.6860284 MHz
WDW                           no
SSB          0
LB           0 Hz
GB           0
PC                        1.00
```

ZZ_2_139. In CDCl3
Fluorine sample 7 (3-cyano-4-fluoroaniline).
3J(HF) and two 4J(HF) are all evident.
Chemical shifts relative to external CFCl3 defined as 0 ppm (sr = -442.57)



Compound **7**
^{19}F NMR ($CDCl_3$, 470 MHz)

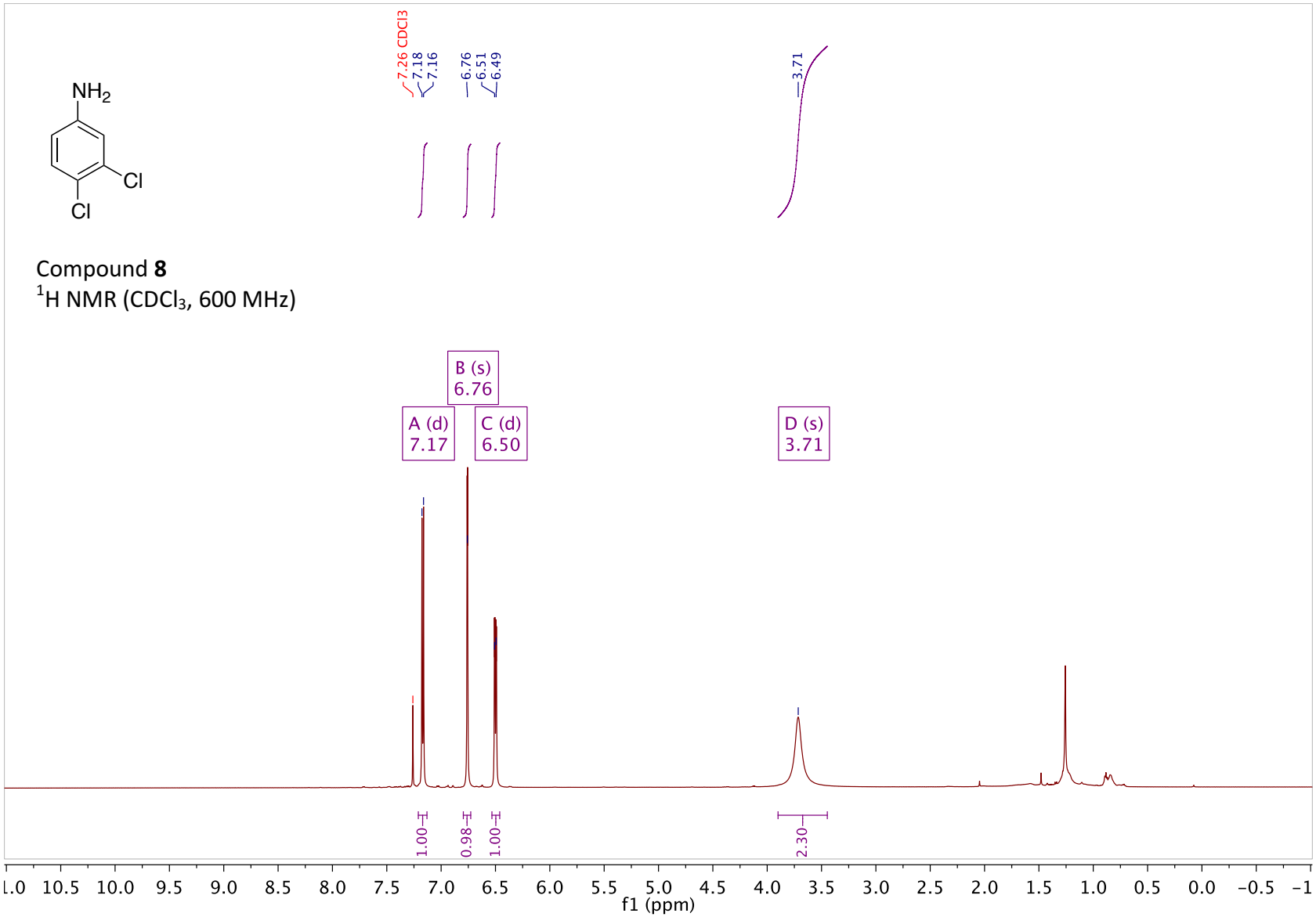
BRUKER

Current Data Parameters
NAME ZZ_2_139_F
EXPNO 1
PROCNO 1

F2 - Acquisition Parameters
Date_ 20161220
Time 10.17
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg
TD 131072
SOLVENT CDCl3
NS 16
DS 0
SWH 4708.098 Hz
FIDRES 0.035920 Hz
AQ 13.9198961 sec
RG 40.3
DW 106.200 usec
DE 6.50 usec
TE 293.8 K
D1 5.00000000 sec

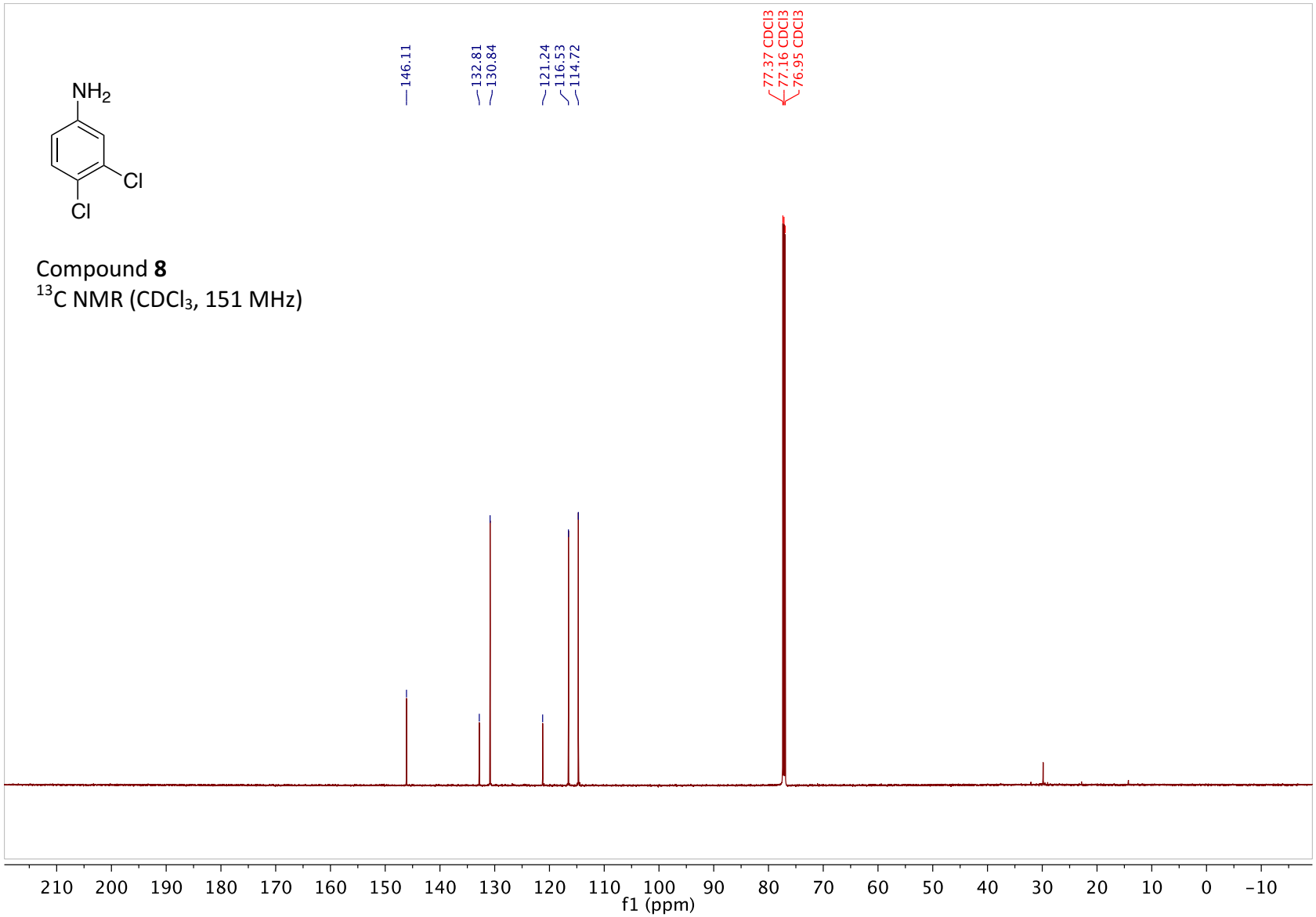
======== CHANNEL f1 ========
NUC1 19F
P1 11.30 usec
PLW1 21.79999924 W
SFO1 470.6295930 MHz

F2 - Processing parameters
SI 2097152
SF 470.6860284 MHz
WDW no
SSB 0
LB 0 Hz
GB 0
PC 1.00



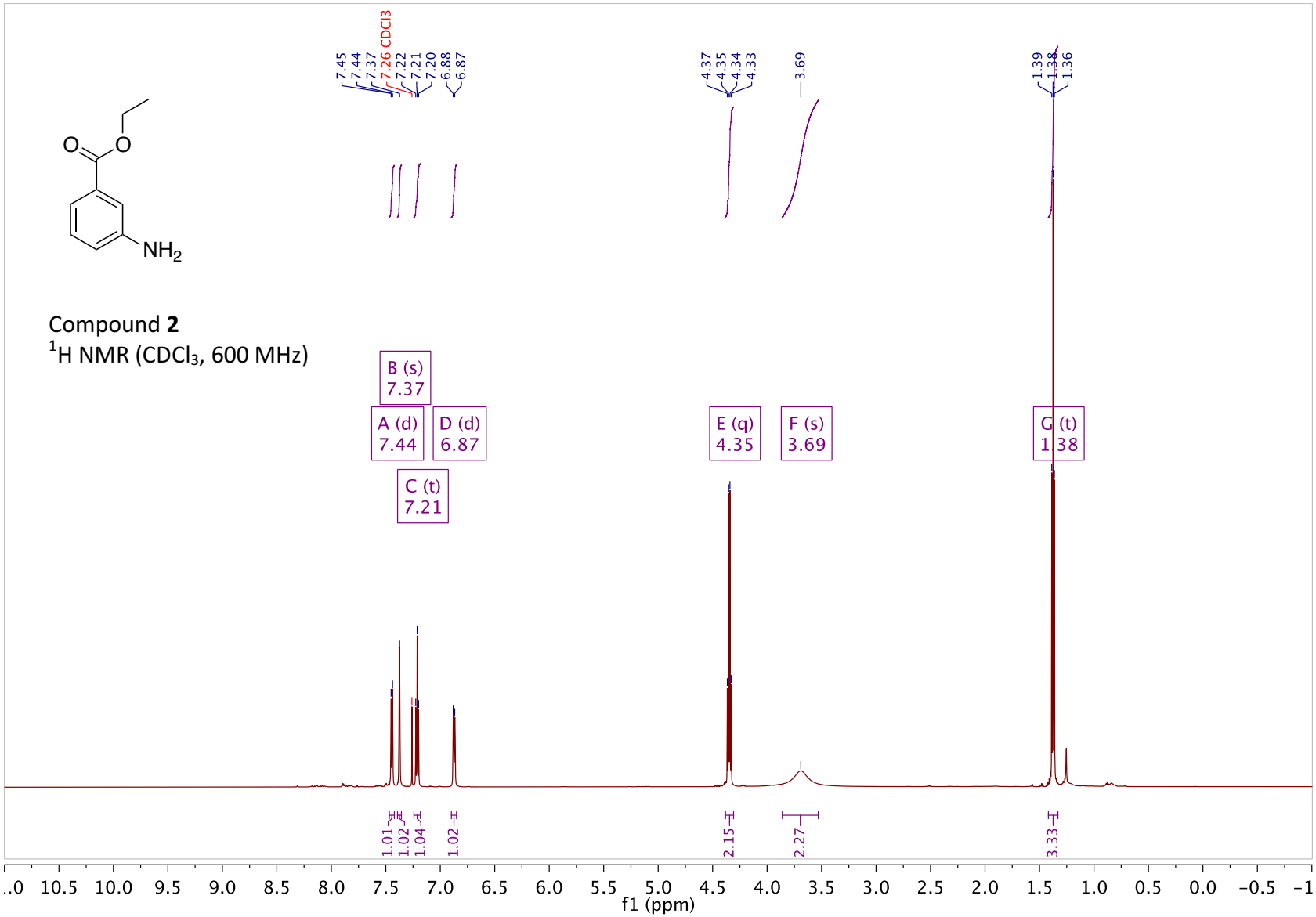
Compound **8**

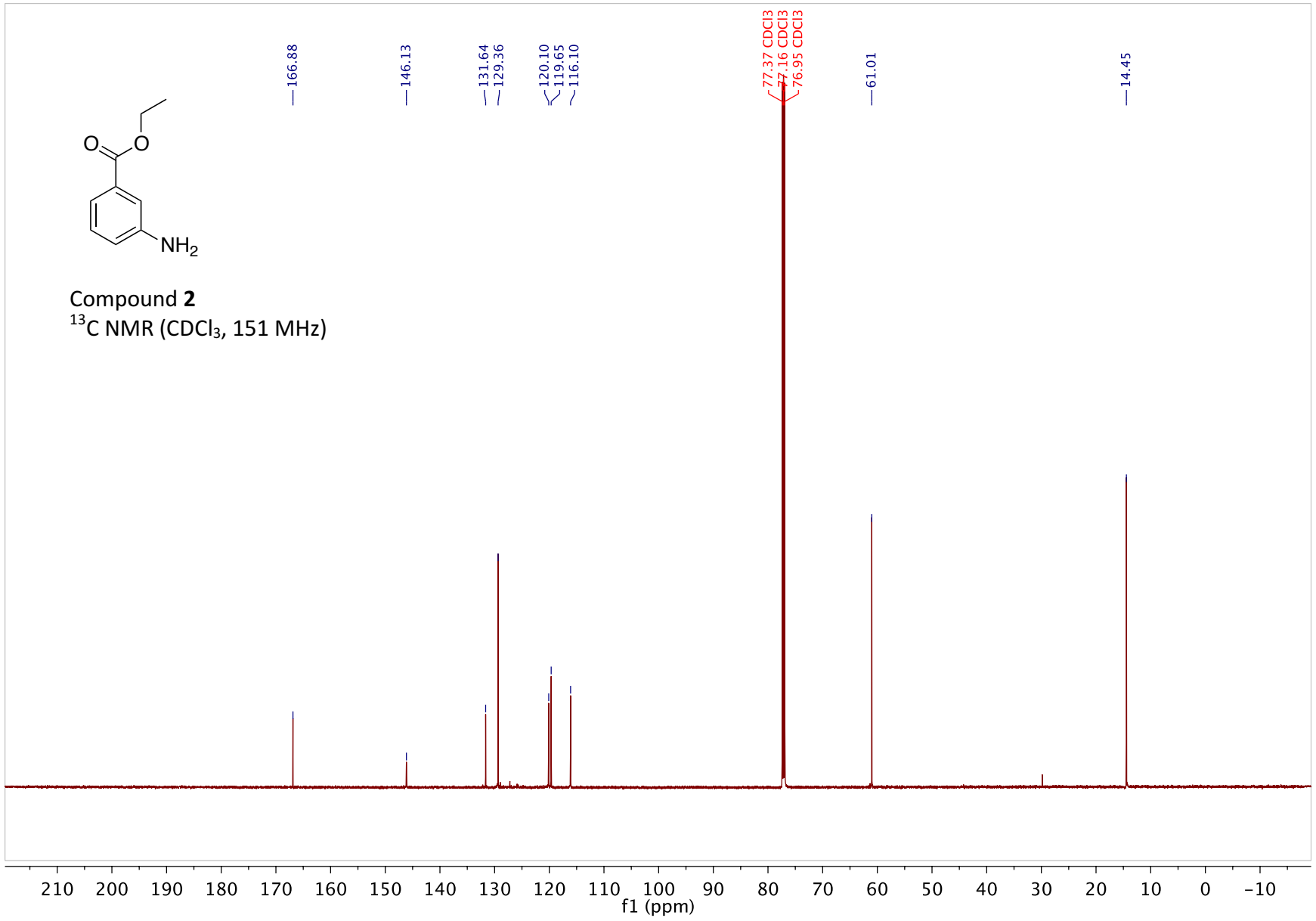
^{1}H NMR ($CDCl_3$, 600 MHz)

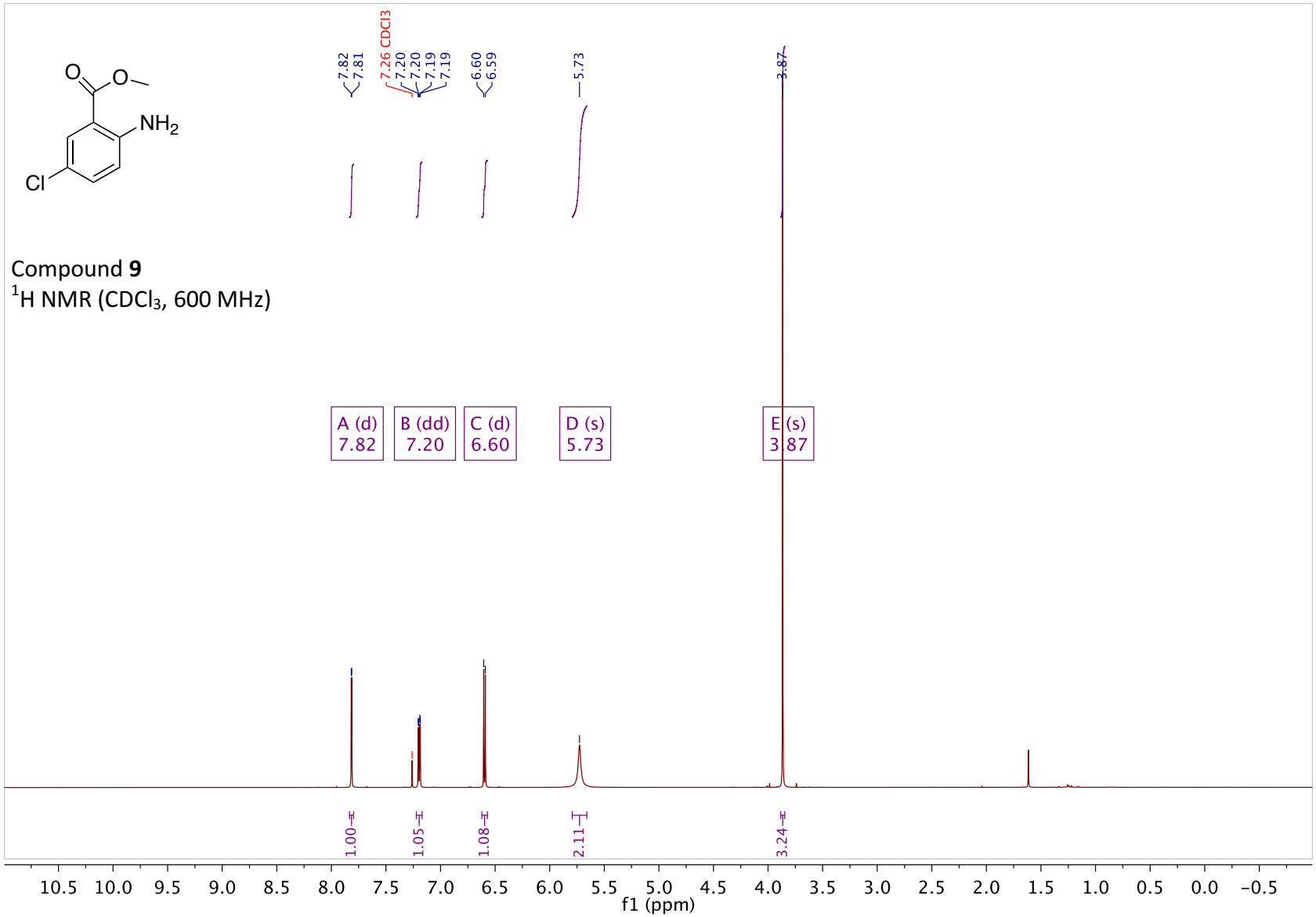


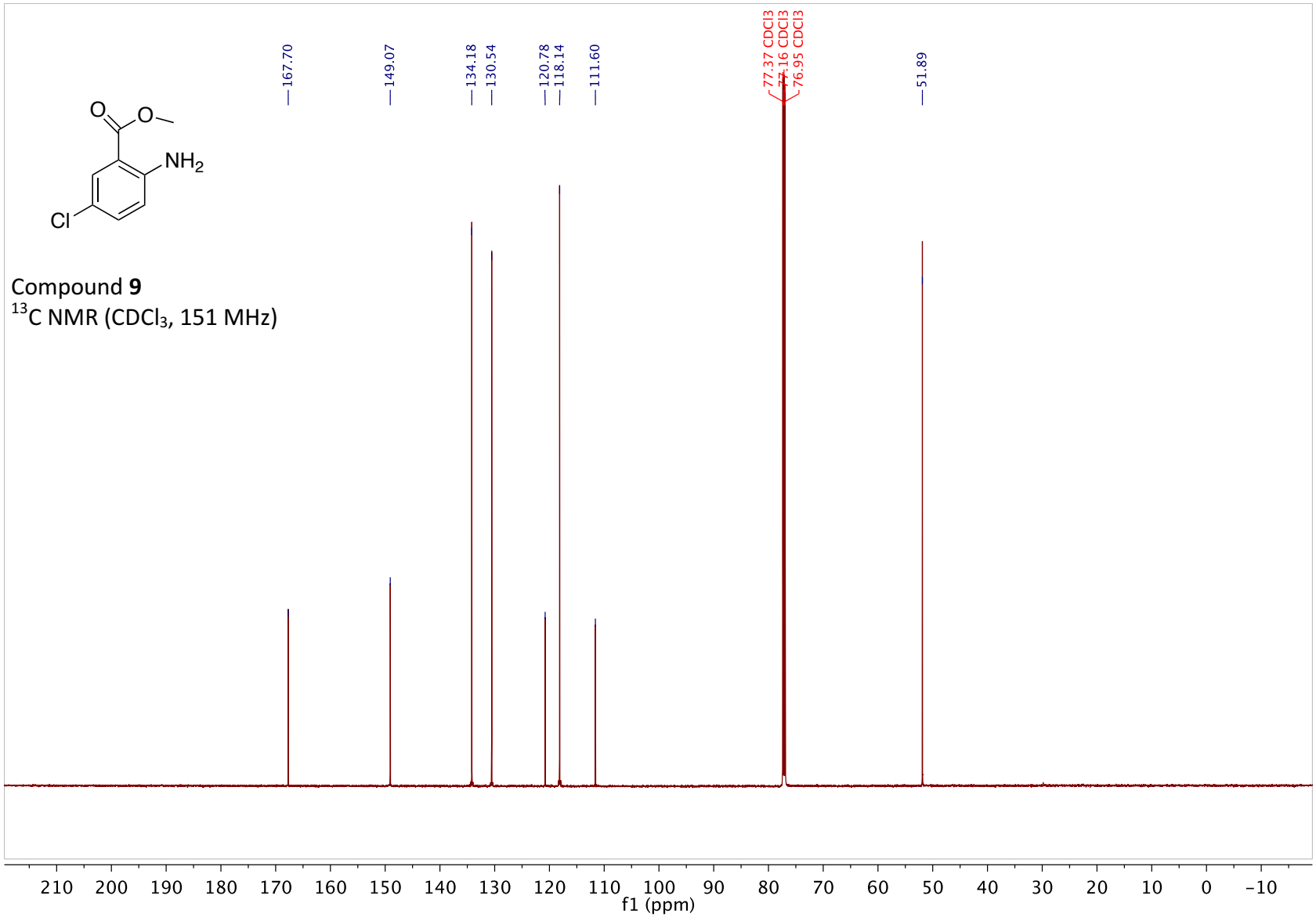
Compound **8**

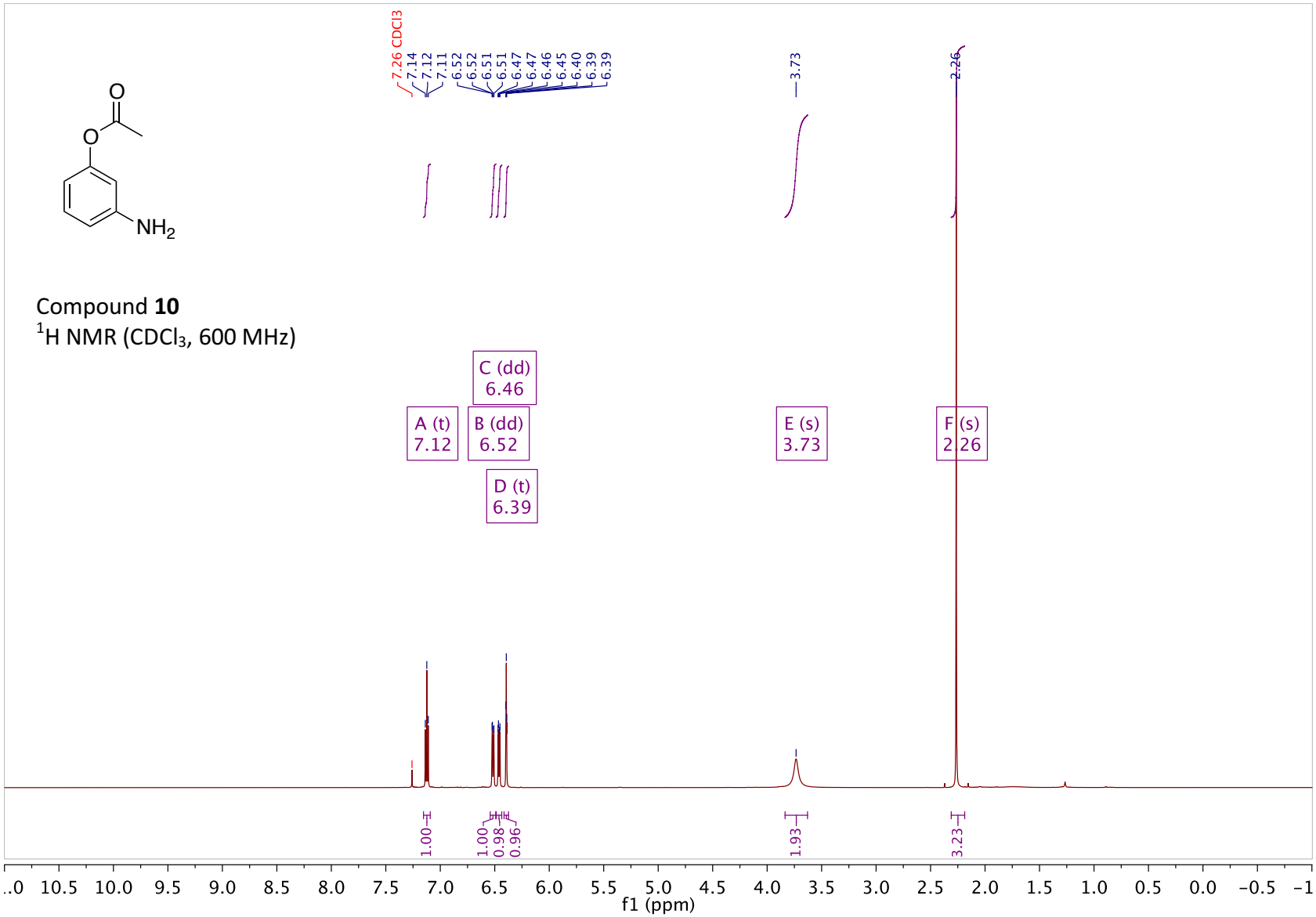
^{13}C NMR ($CDCl_3$, 151 MHz)

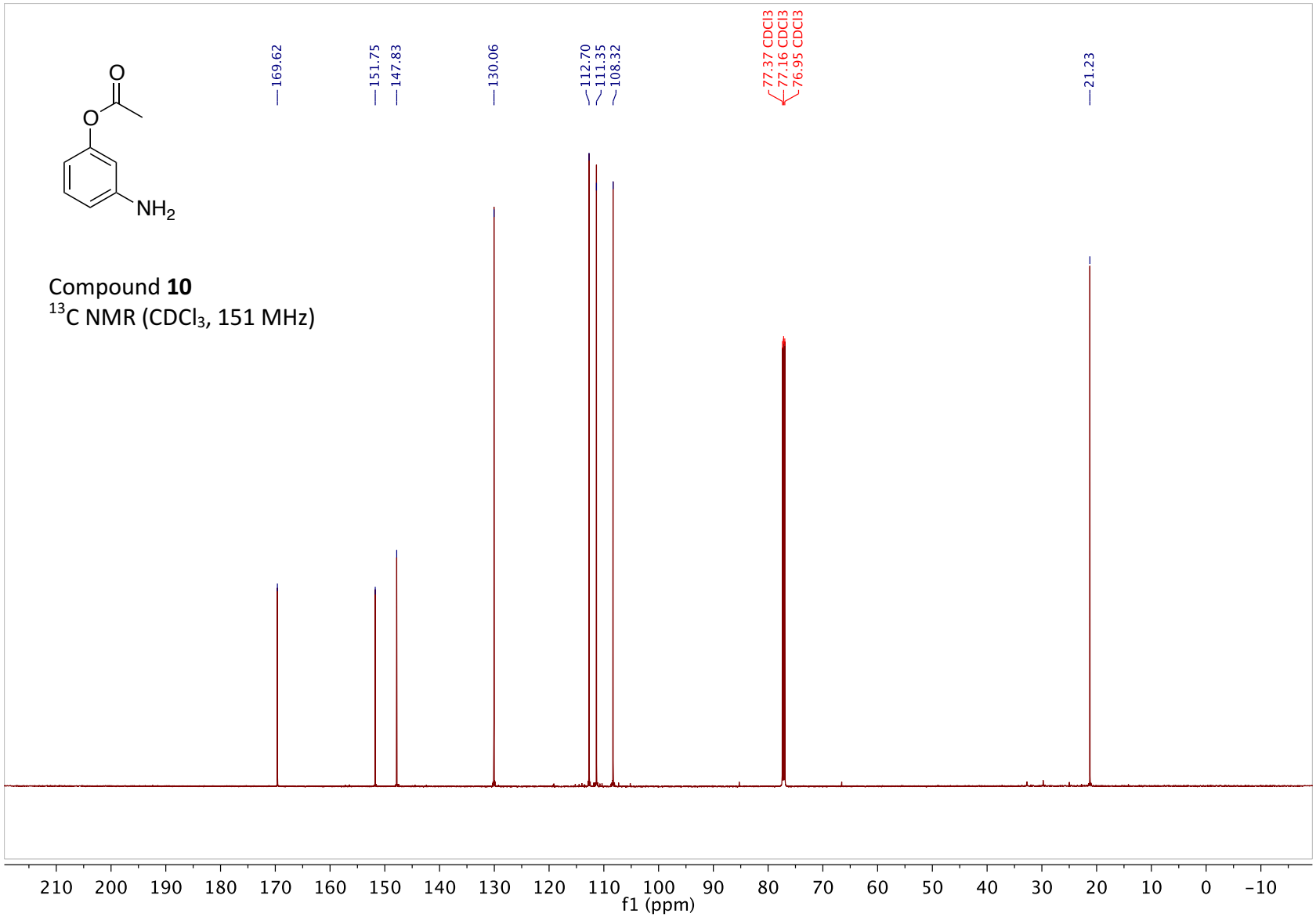

7.45
7.44
7.37
7.26 CDCl3
7.22
7.21
7.20
6.88
6.87
4.37
4.35
4.34
4.33
3.69
1.39
1.38
1.36
O
O
NH2
Compound 2
1H NMR (CDCl3, 600 MHz)
B (s)
7.37
A (d)
7.44
D (d)
6.87
C (t)
7.21
E (q)
4.35
F (s)
3.69
G (t)
1.38
1.01
1.02
1.04
1.02
2.15
2.27
3.33
f1 (ppm)

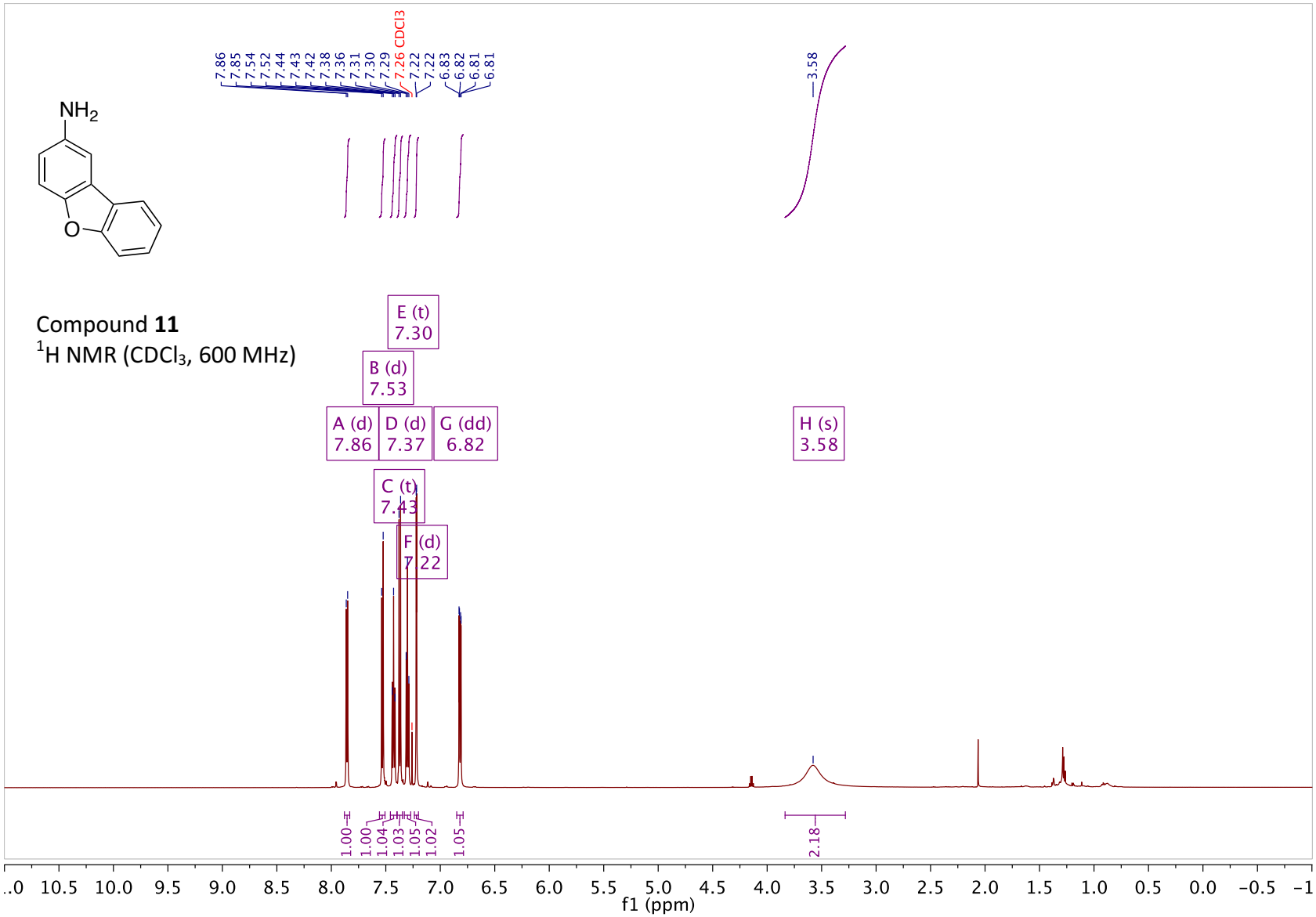

166.88
146.13
131.64
129.36
120.10
119.65
116.10
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
61.01
14.45
O
O
NH2
Compound 2
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

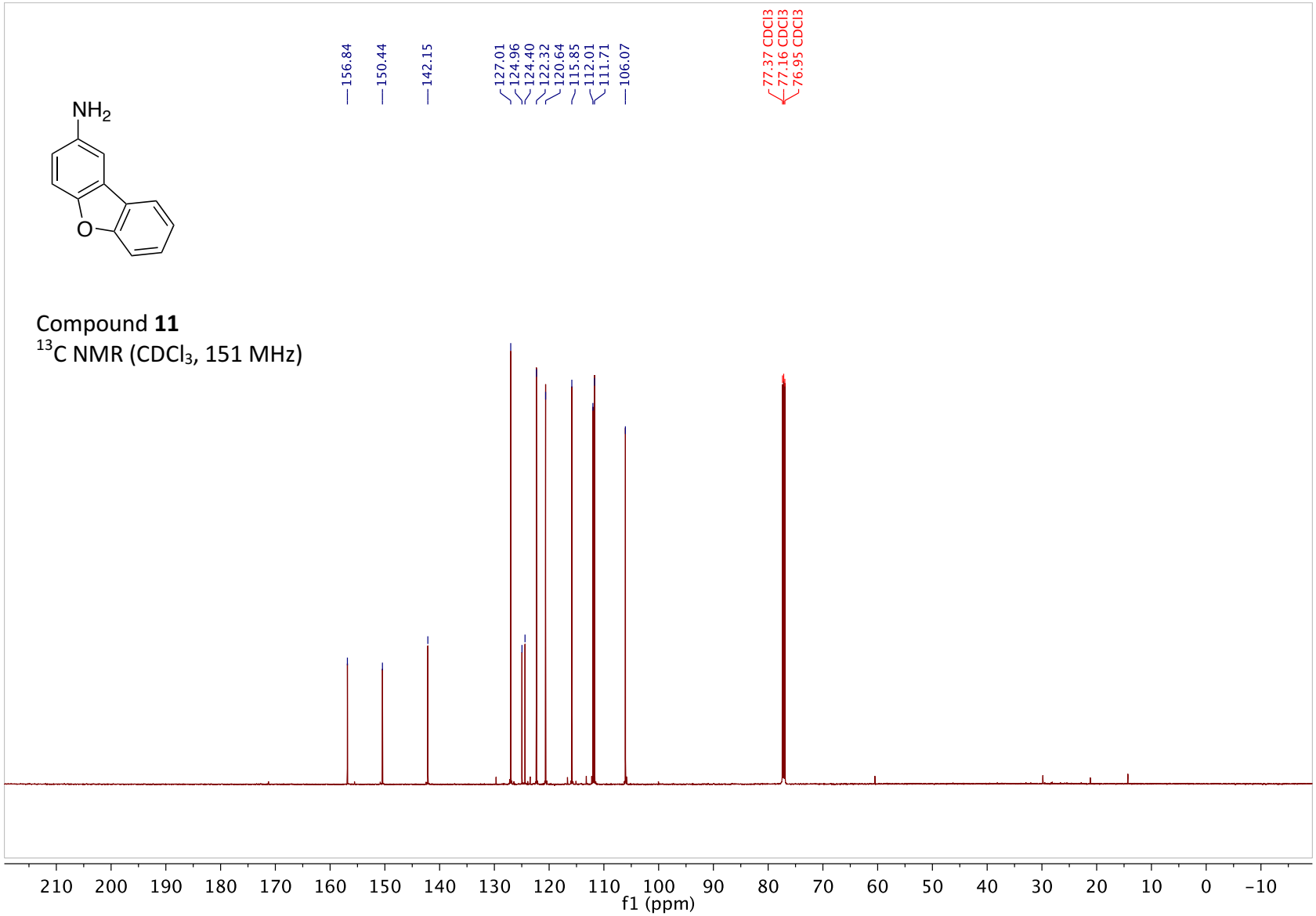

Compound 9
1H NMR (CDCl3, 600 MHz)
7.82
7.81
7.26 CDCl3
7.20
7.20
7.19
7.19
6.60
6.59
5.73
3.87
A (d) 7.82
B (dd) 7.20
C (d) 6.60
D (s) 5.73
E (s) 3.87
1.00
1.05
1.08
2.11
3.24
f1 (ppm)

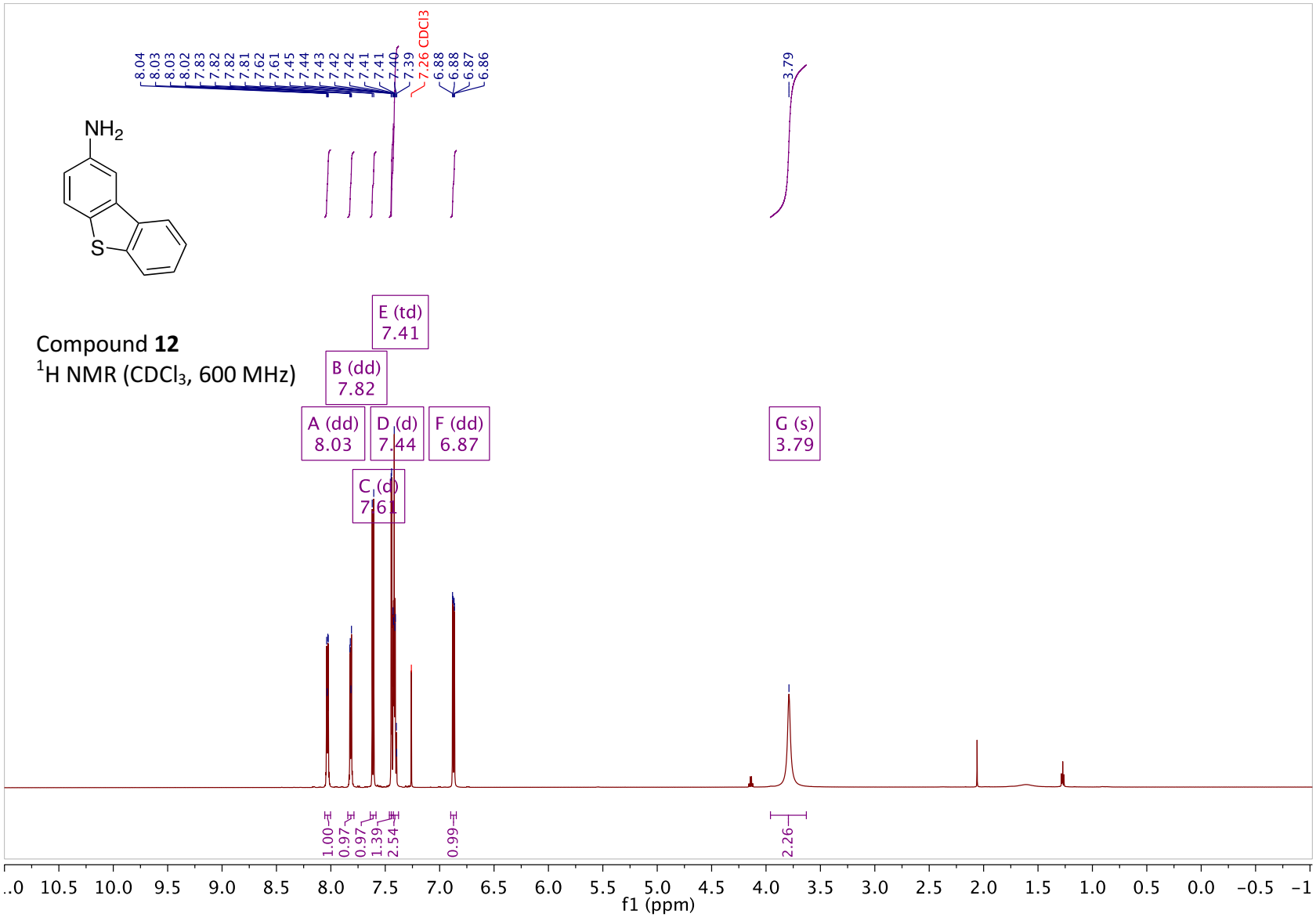

167.70
149.07
134.18
130.54
120.78
118.14
111.60
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
51.89
O
O
NH2
Cl
Compound 9
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

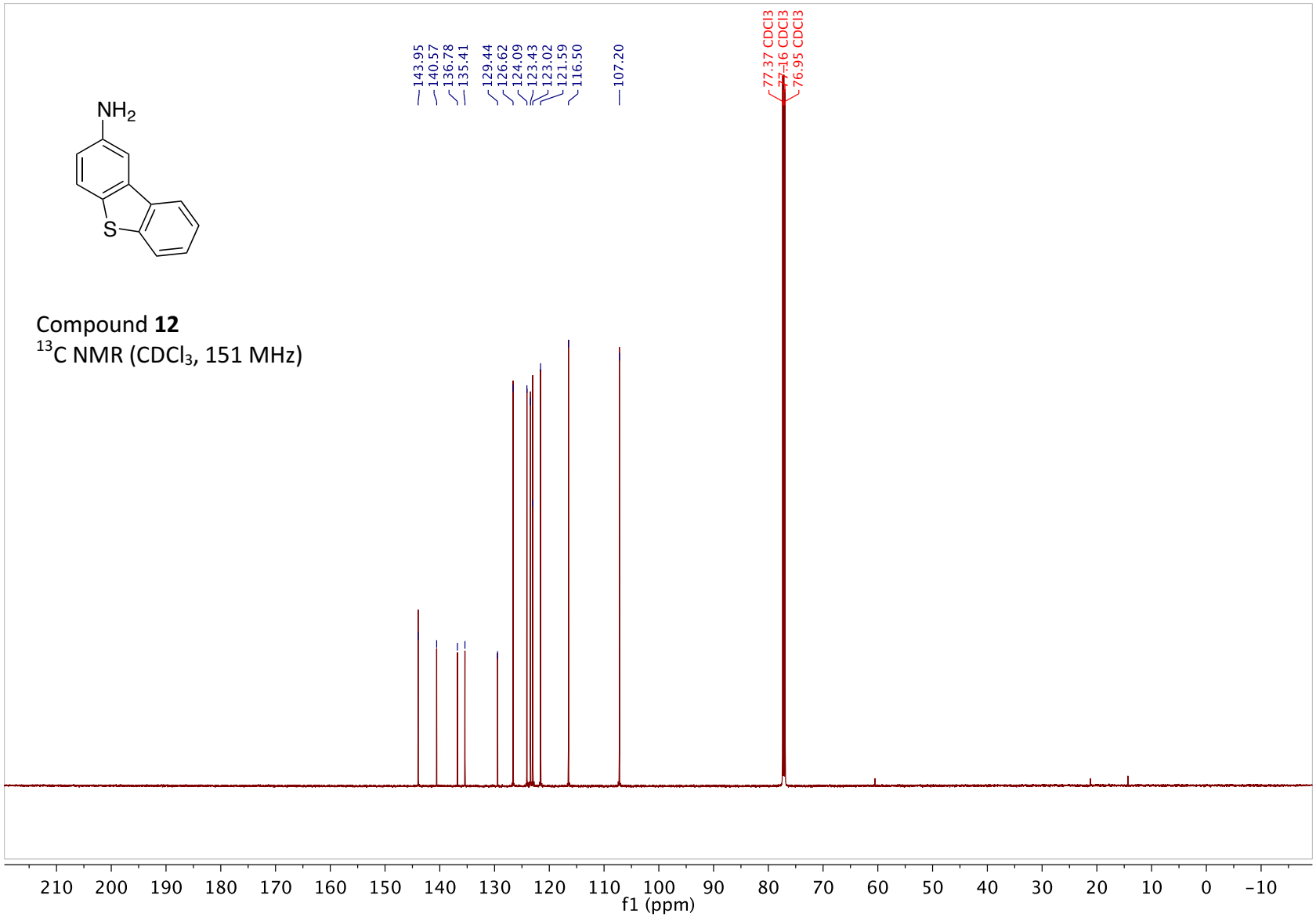

7.26 CDCl3
7.14
7.12
7.11
6.52
6.52
6.51
6.51
6.47
6.47
6.46
6.45
6.40
6.39
6.39
3.73
2.26
O
O
NH2
Compound 10
1H NMR (CDCl3, 600 MHz)
C (dd)
6.46
A (t)
7.12
B (dd)
6.52
D (t)
6.39
E (s)
3.73
F (s)
2.26
1.00
1.00
0.98
0.96
1.93
3.23
f1 (ppm)

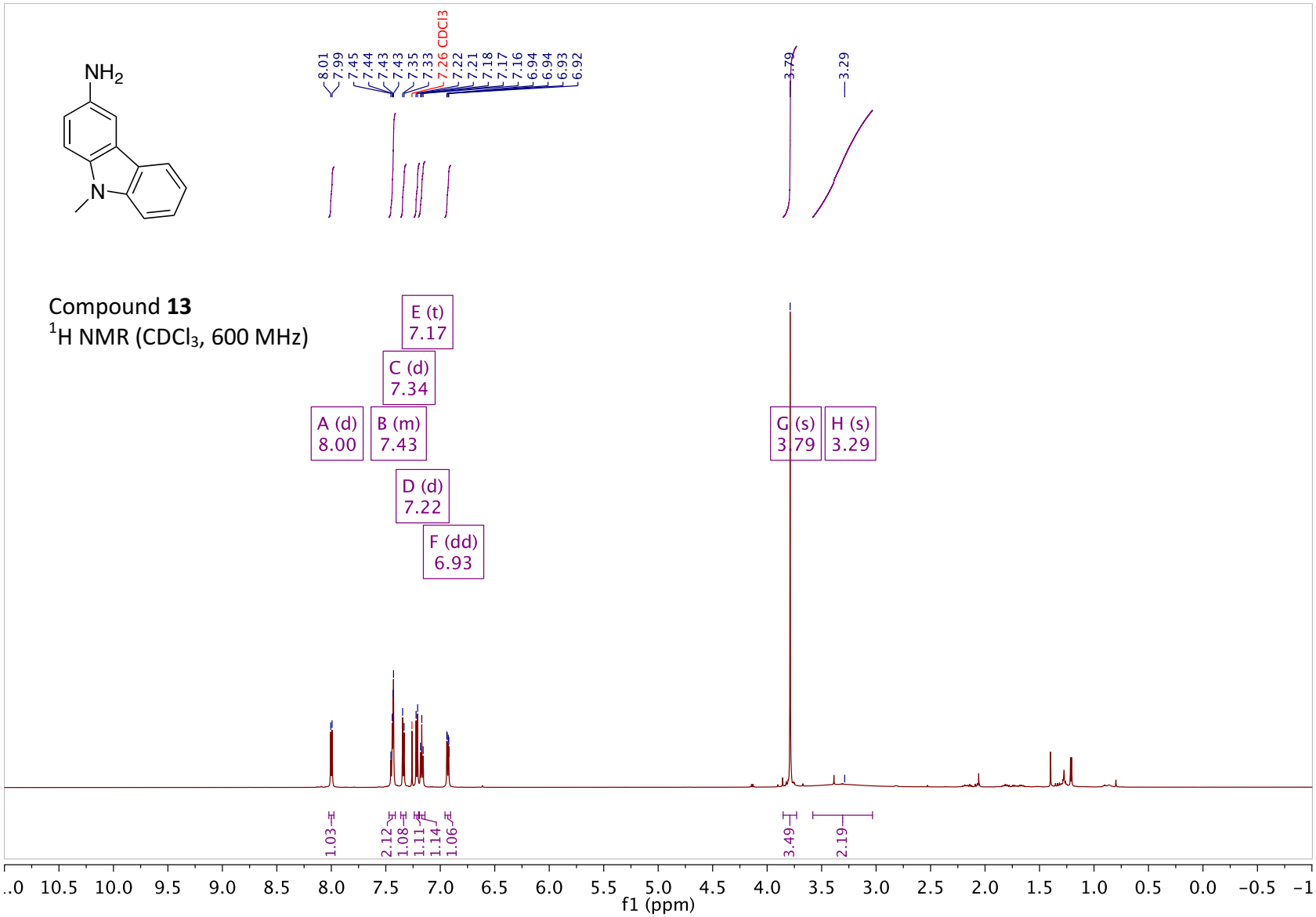

O
O
NH2
169.62
151.75
147.83
130.06
112.70
111.35
108.32
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
21.23
Compound 10
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

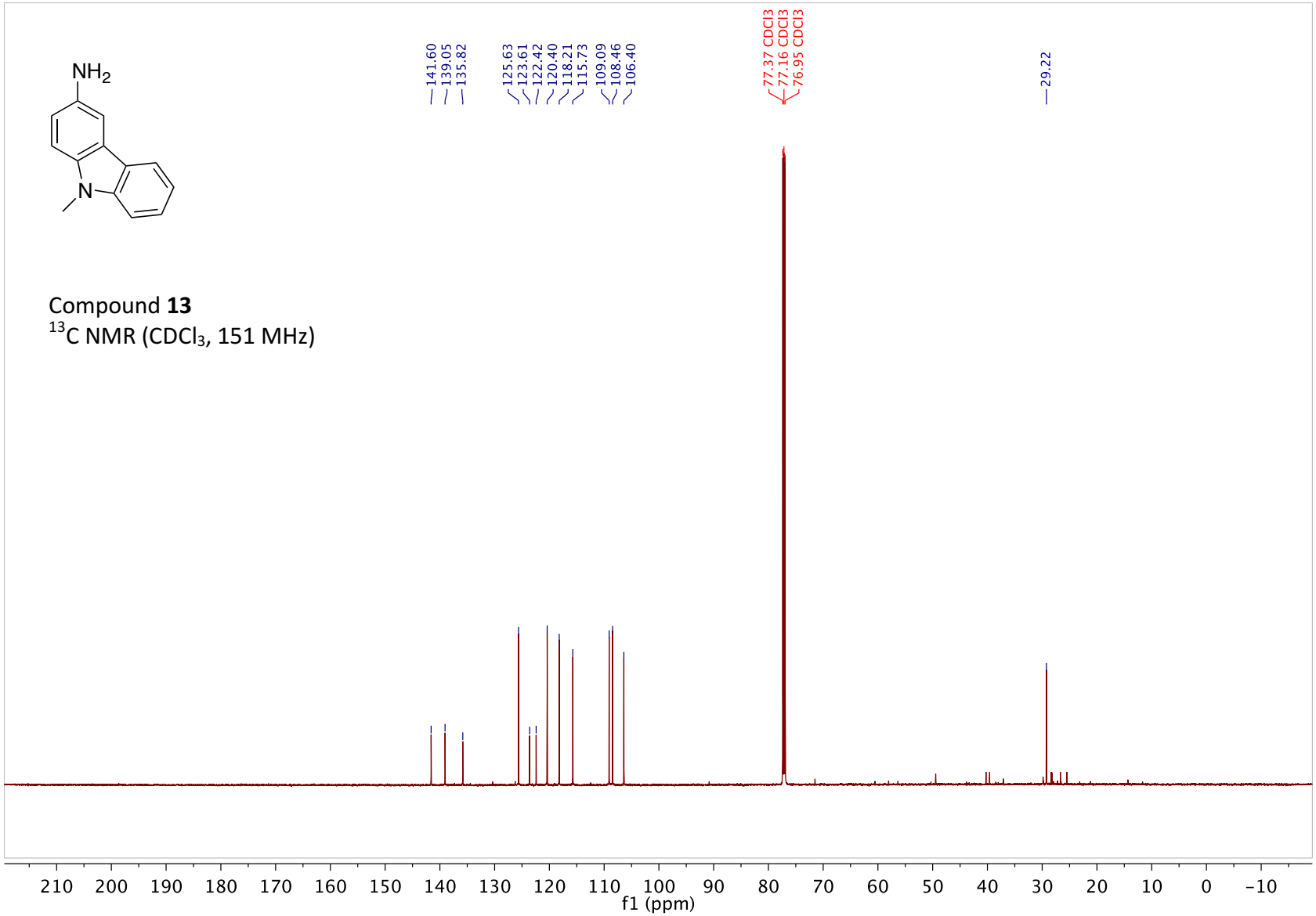

NH2
O
7.86
7.85
7.54
7.52
7.44
7.43
7.42
7.38
7.36
7.31
7.30
7.29
7.26 CDCl3
7.22
7.22
6.83
6.82
6.81
6.81
3.58
Compound 11
1H NMR (CDCl3, 600 MHz)
E (t)
7.30
B (d)
7.53
A (d)
7.86
D (d)
7.37
G (dd)
6.82
H (s)
3.58
C (t)
7.43
F (d)
7.22
1.00
1.00
1.04
1.03
1.05
1.02
1.05
2.18
f1 (ppm)


156.84
150.44
142.15
127.01
124.96
124.40
122.32
120.64
115.85
112.01
111.71
106.07
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
NH2
O
Compound 11
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.04
8.03
8.03
8.02
7.83
7.82
7.82
7.81
7.62
7.61
7.45
7.44
7.43
7.42
7.42
7.41
7.41
7.40
7.39
7.26 CDCl3
6.88
6.88
6.87
6.86
3.79
NH2
S
Compound 12
1H NMR (CDCl3, 600 MHz)
E (td)
7.41
B (dd)
7.82
A (dd)
8.03
D (d)
7.44
F (dd)
6.87
G (s)
3.79
C (d)
7.61
1.00
0.97
0.97
1.39
2.54
0.99
2.26
f1 (ppm)

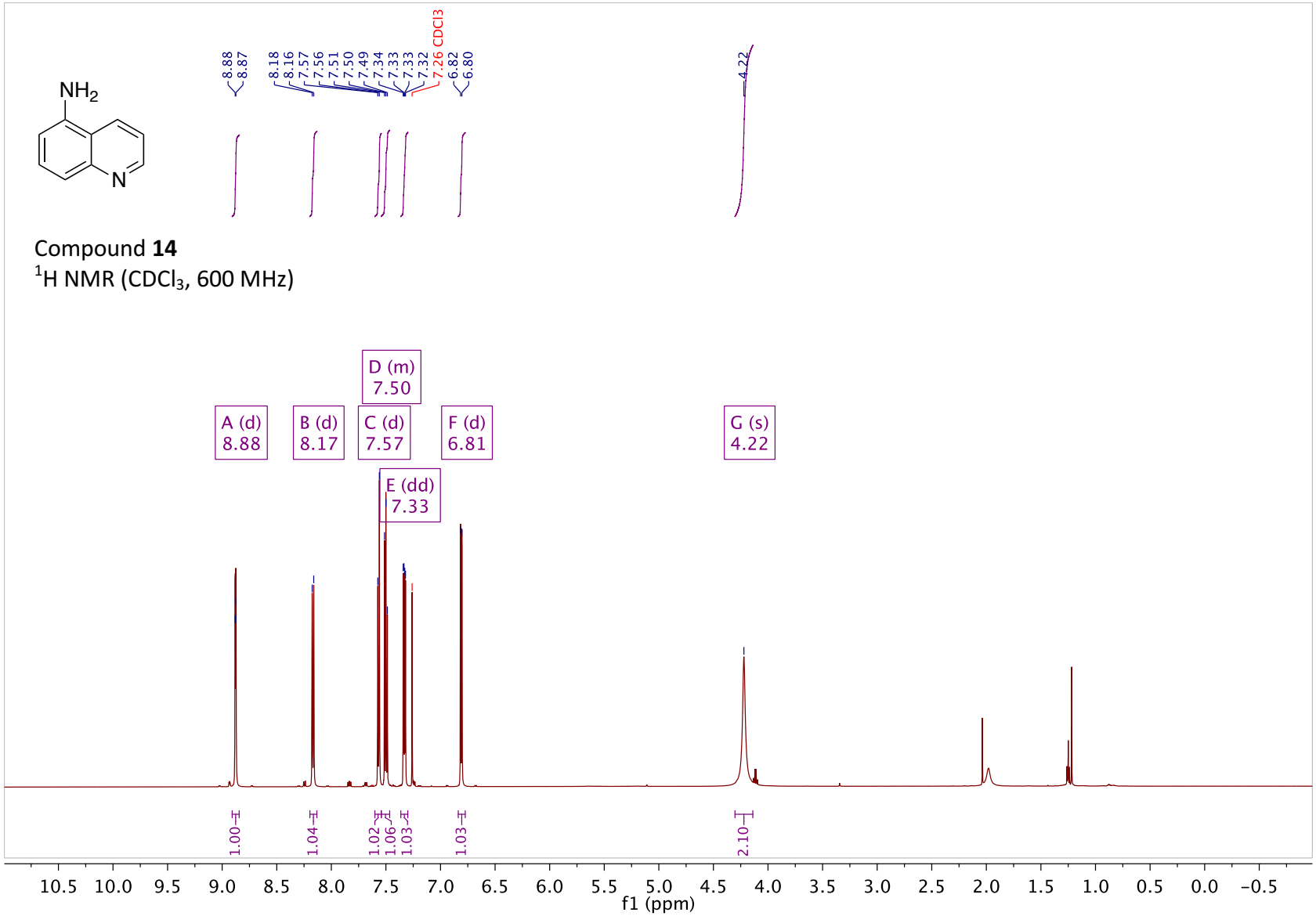

NH2
S
Compound 12
13C NMR (CDCl3, 151 MHz)
143.95
140.57
136.78
135.41
129.44
126.62
124.09
123.43
123.02
121.59
116.50
107.20
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

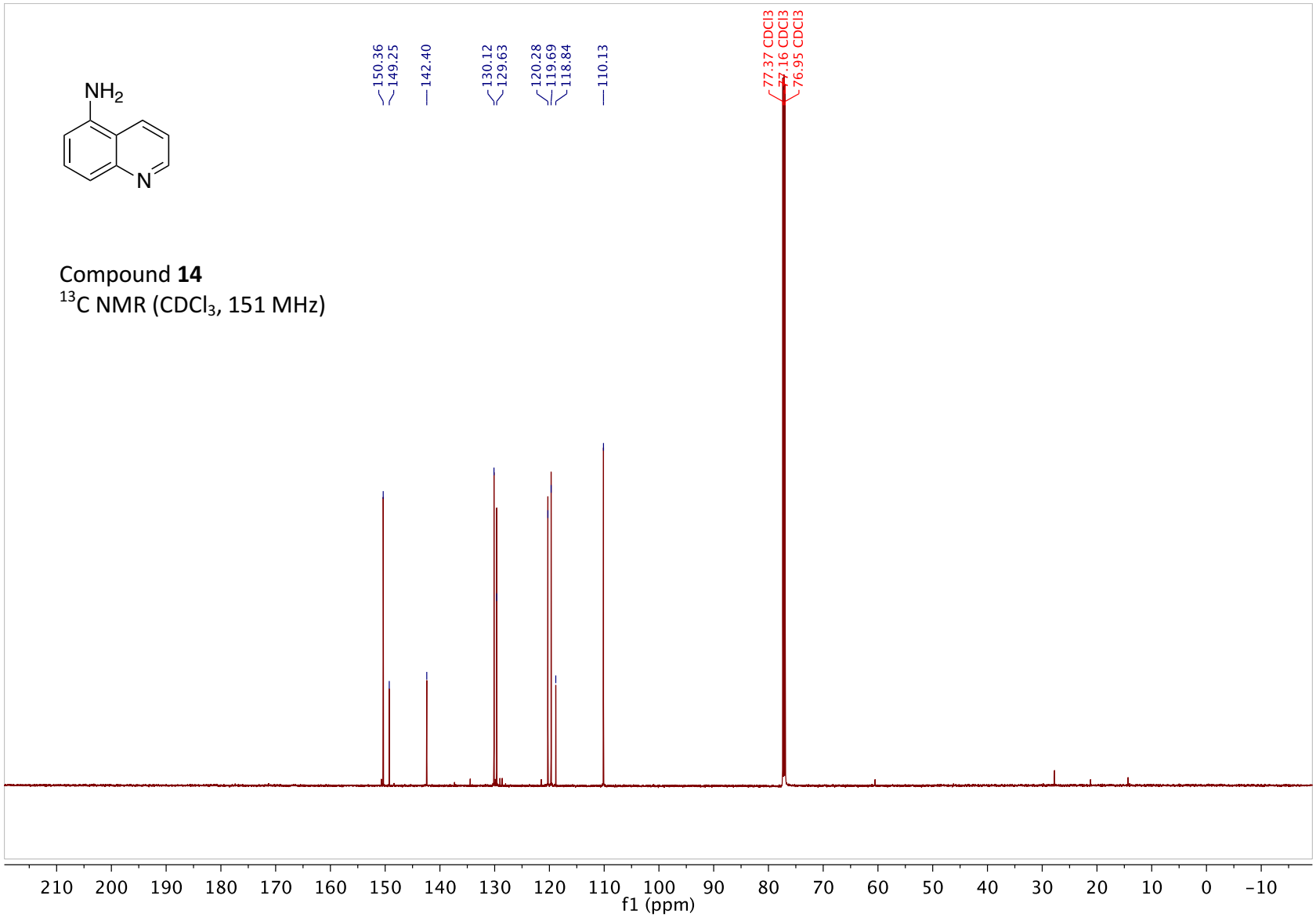

NH2
N
8.01
7.99
7.45
7.44
7.43
7.43
7.35
7.33
7.26 CDCl3
7.22
7.21
7.18
7.17
7.16
6.94
6.94
6.93
6.92
3.79
3.29
Compound 13
1H NMR (CDCl3, 600 MHz)
E (t)
7.17
C (d)
7.34
A (d)
8.00
B (m)
7.43
G (s)
3.79
H (s)
3.29
D (d)
7.22
F (dd)
6.93
1.03
2.12
1.08
1.11
1.14
1.06
3.49
2.19
f1 (ppm)



Compound **13**

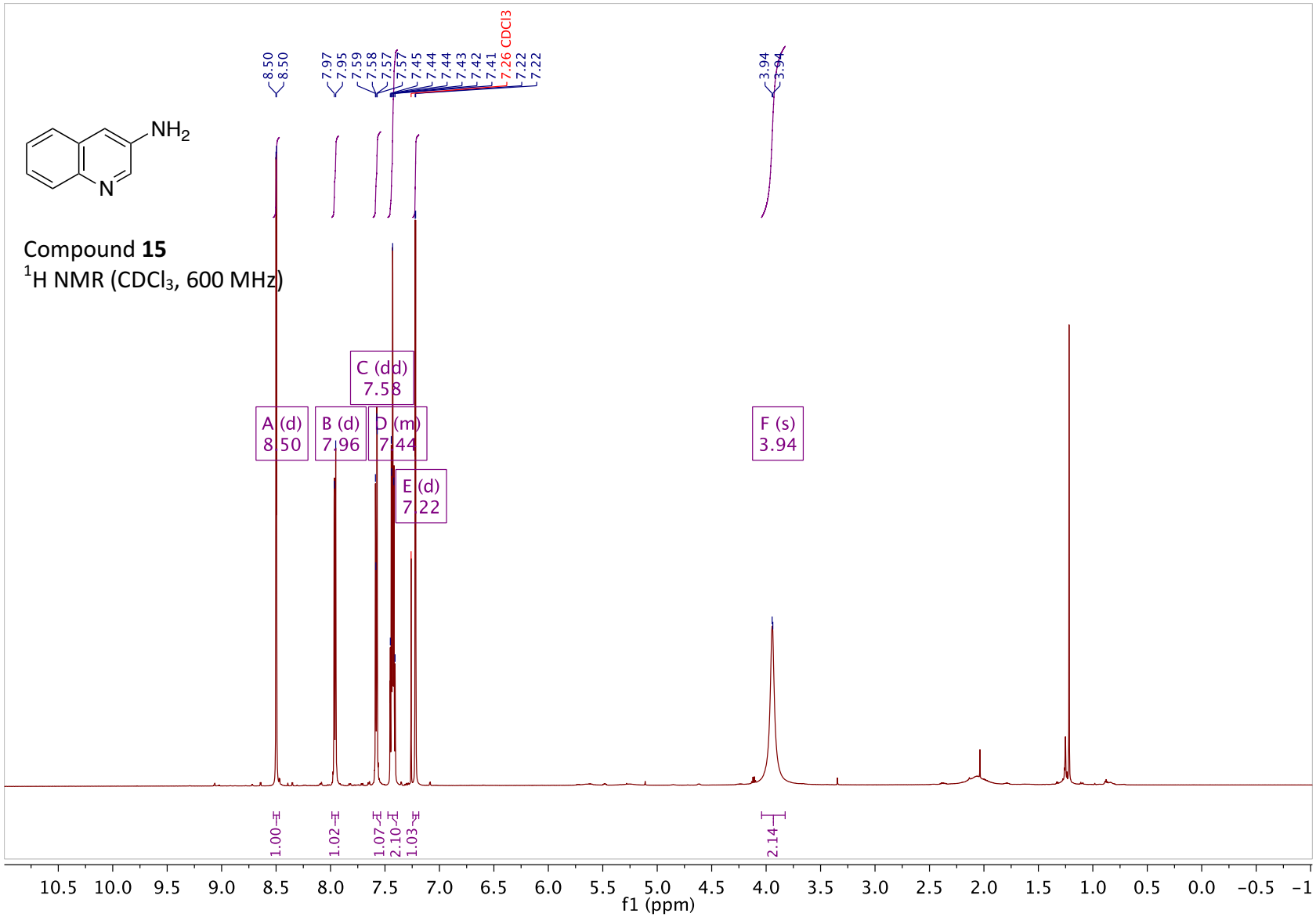
^{13}C NMR ($CDCl_3$, 151 MHz)

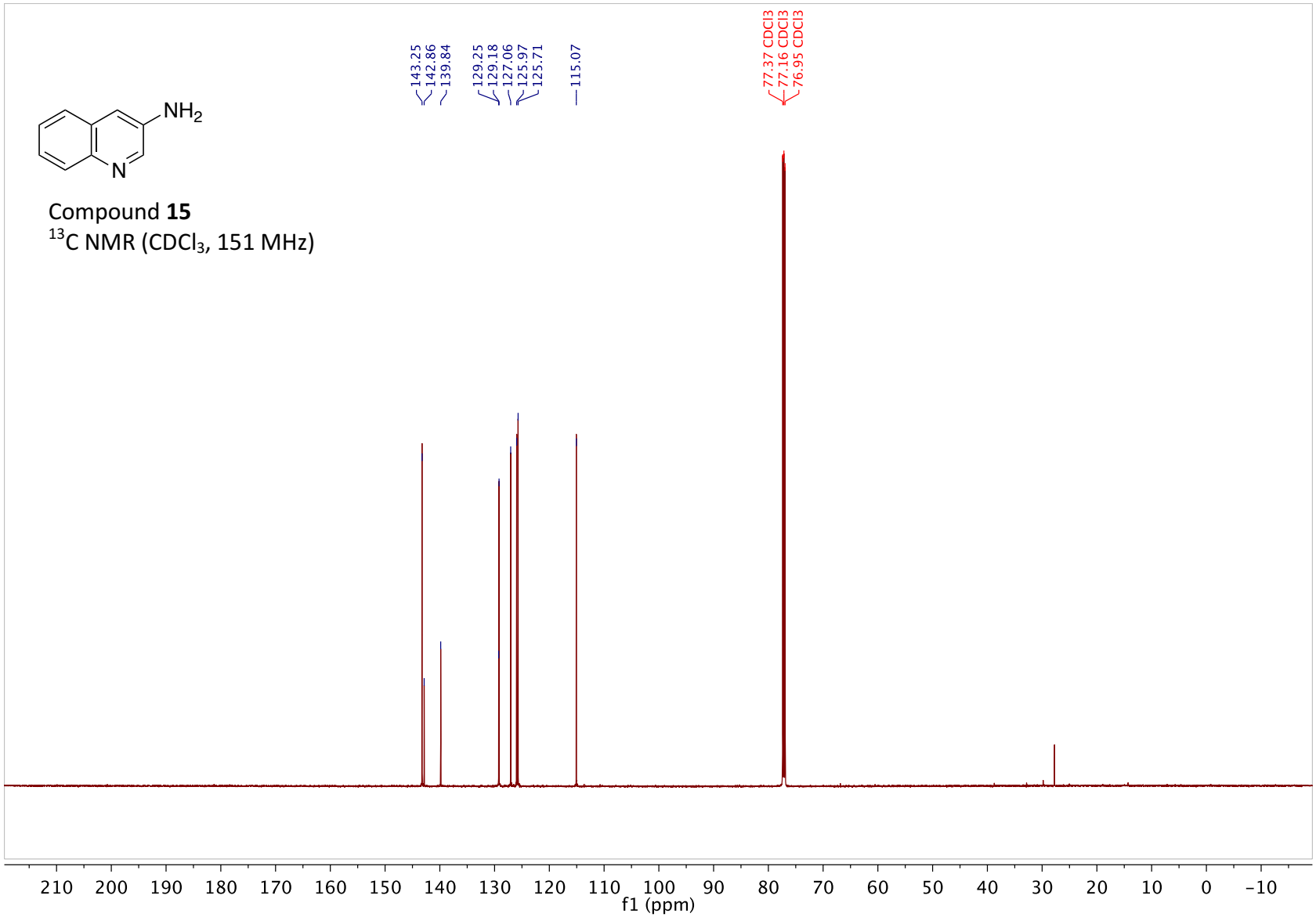

NH2
N
8.88
8.87
8.18
8.16
7.57
7.56
7.51
7.50
7.49
7.34
7.33
7.33
7.32
7.26 CDCl3
6.82
6.80
4.22
Compound 14
1H NMR (CDCl3, 600 MHz)
A (d) 8.88
B (d) 8.17
D (m) 7.50
C (d) 7.57
E (dd) 7.33
F (d) 6.81
G (s) 4.22
1.00
1.04
1.02
1.06
1.03
1.03
2.10
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)



Compound **14**

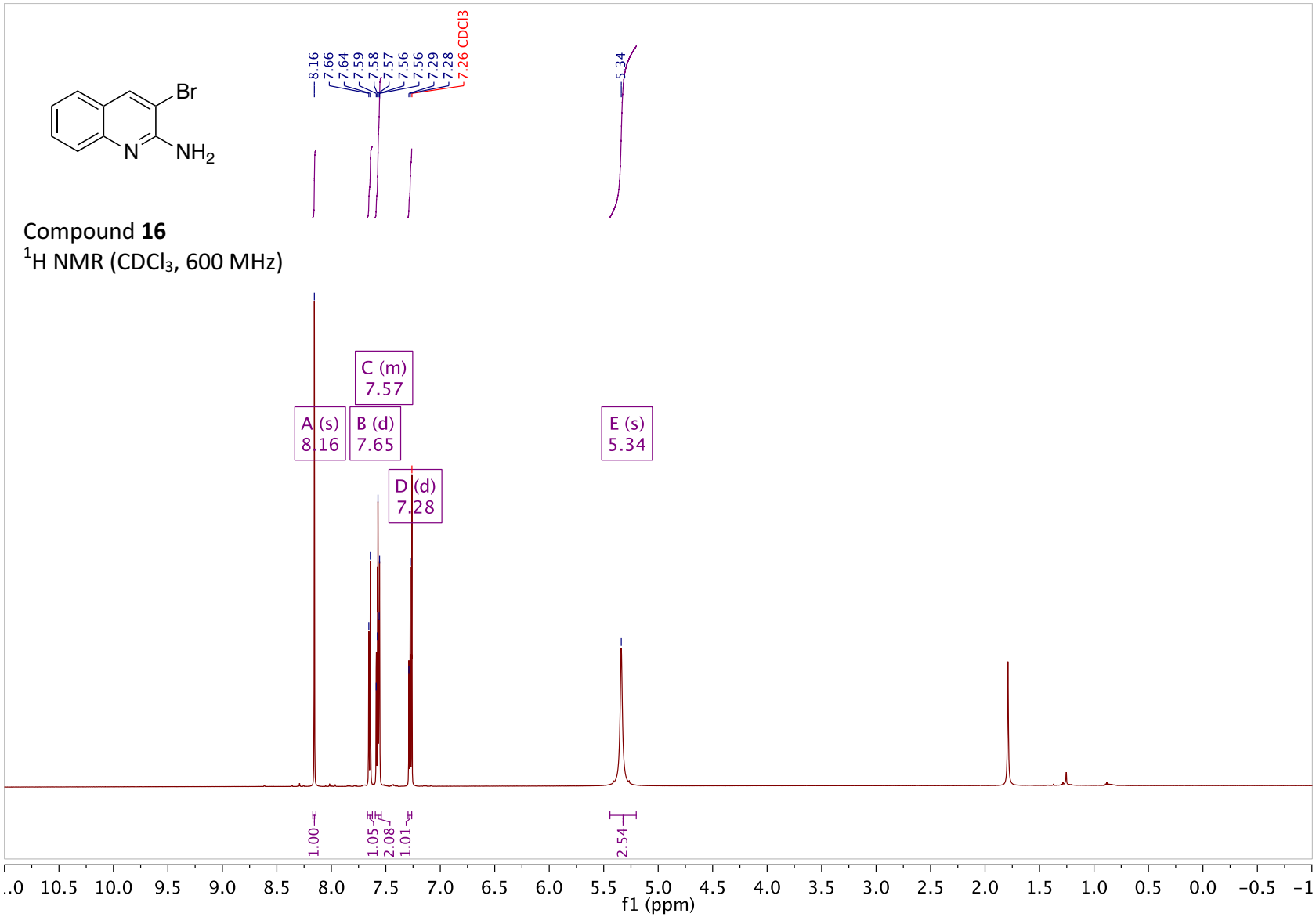
^{13}C NMR ($CDCl_3$, 151 MHz)

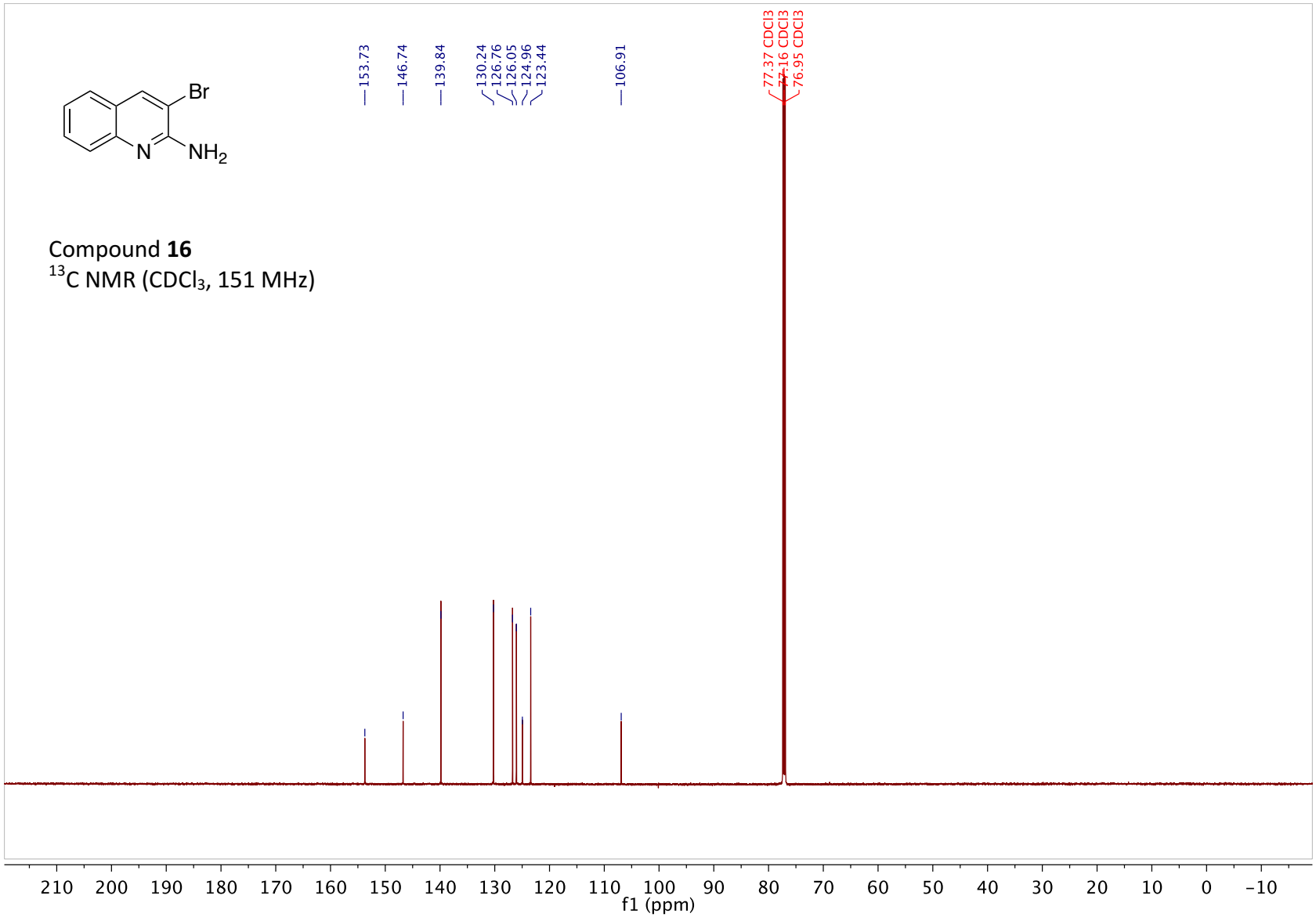

Compound **15**
^{1}H NMR ($CDCl_3$, 600 MHz)
NH2
N
8.50
8.50
7.97
7.95
7.59
7.58
7.57
7.57
7.45
7.44
7.44
7.43
7.42
7.41
7.26 CDCl3
7.22
7.22
3.94
3.94
A (d) 8.50
B (d) 7.96
C (dd) 7.58
D (m) 7.44
E (d) 7.22
F (s) 3.94
1.00
1.02
1.07
2.10
1.03
2.14
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)



Compound **15**

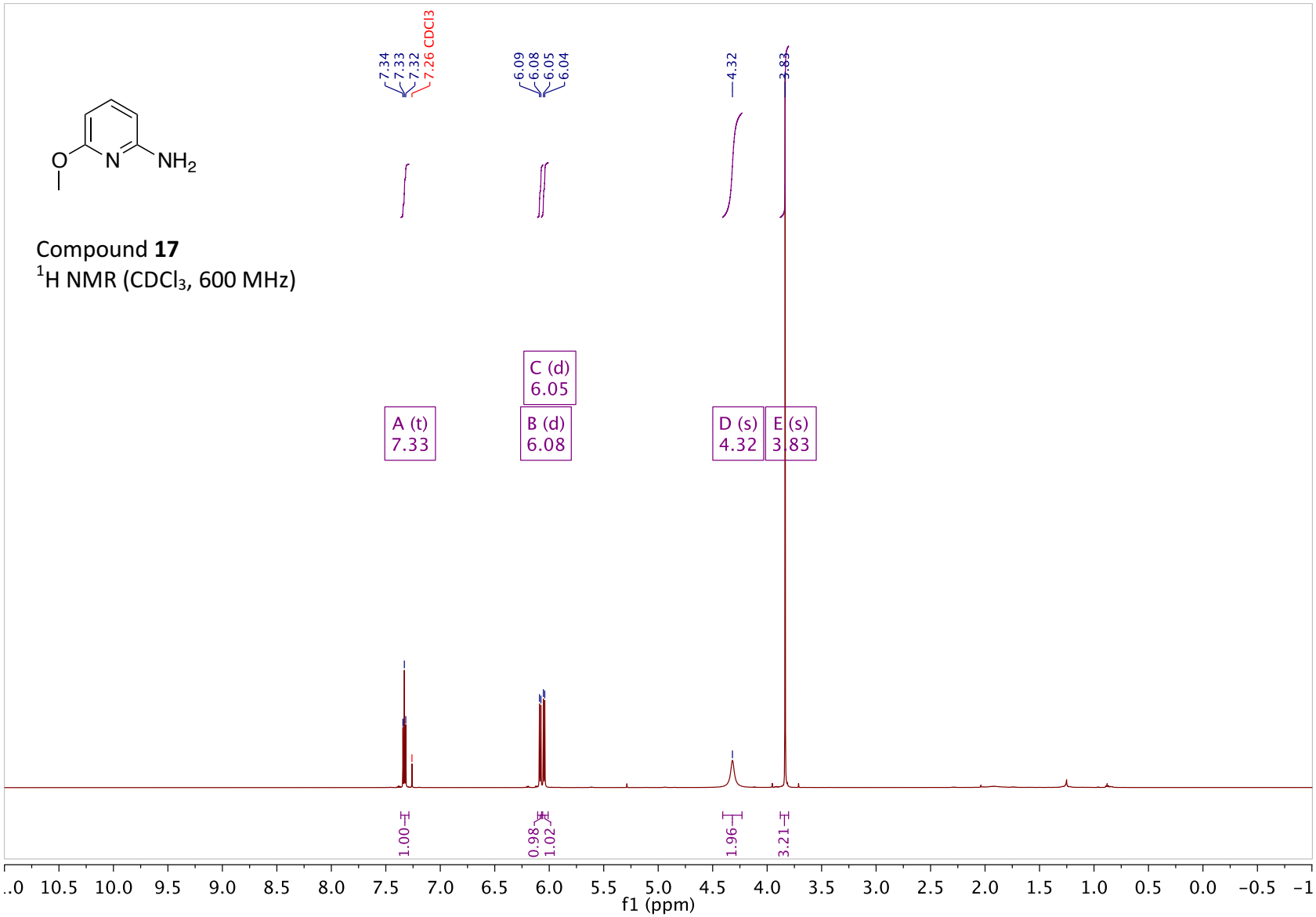
^{13}C NMR ($CDCl_3$, 151 MHz)

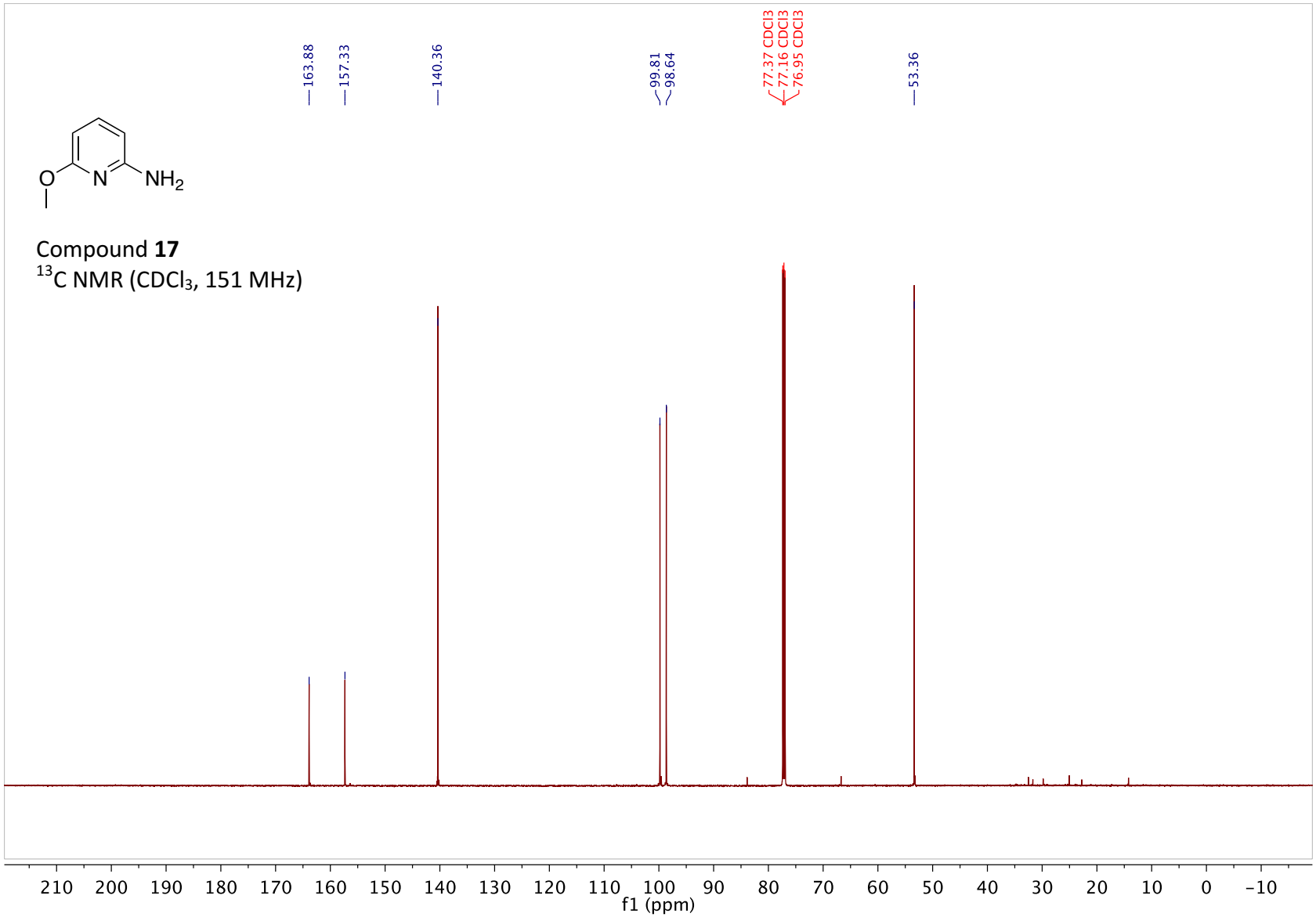

Br
N
NH2
8.16
7.66
7.64
7.59
7.58
7.57
7.56
7.56
7.29
7.28
7.26 CDCl3
5.34
Compound 16
1H NMR (CDCl3, 600 MHz)
C (m)
7.57
A (s)
8.16
B (d)
7.65
D (d)
7.28
E (s)
5.34
1.00
1.05
2.08
1.01
2.54
f1 (ppm)

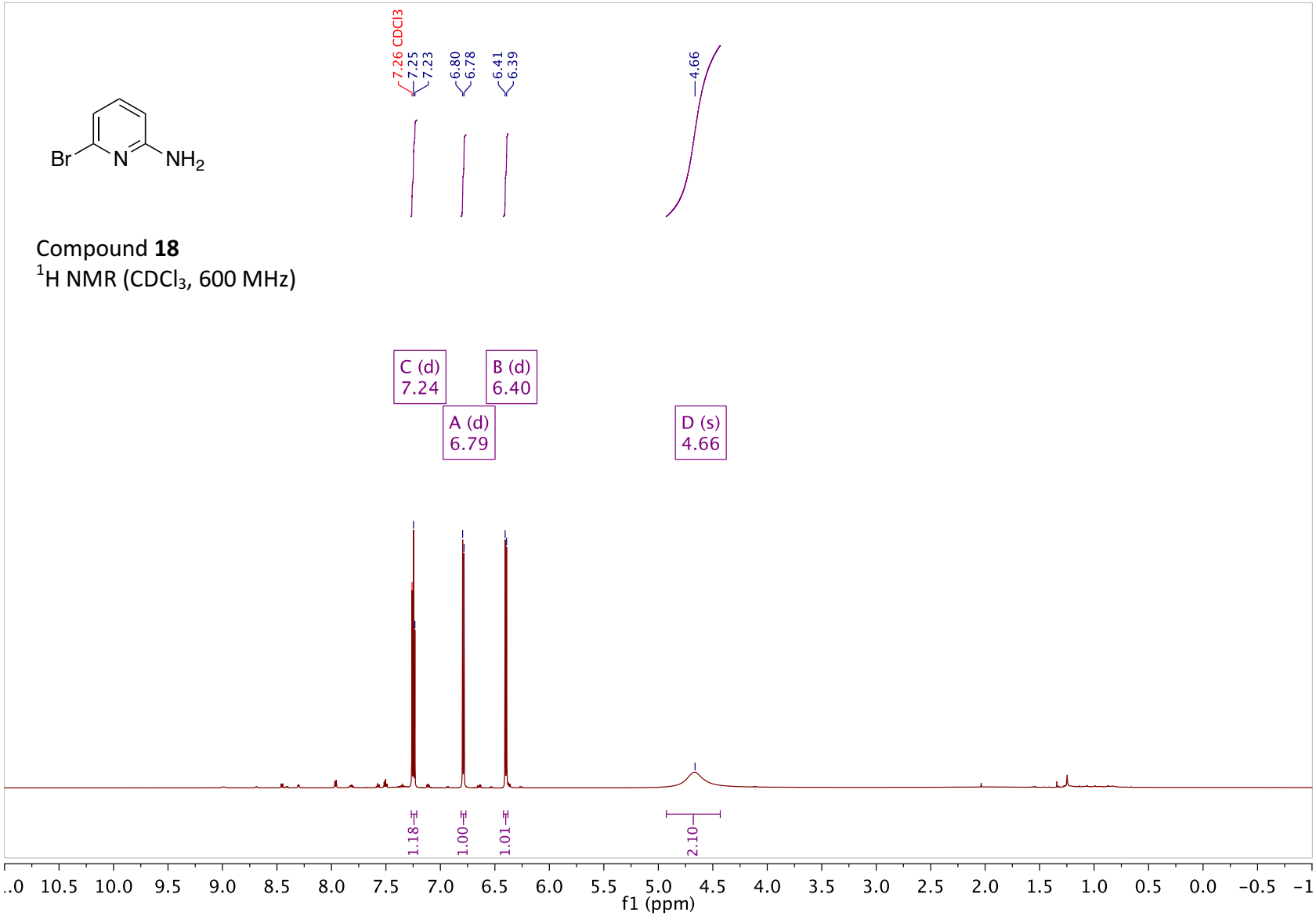


Compound **16**

^{13}C NMR ($CDCl_3$, 151 MHz)

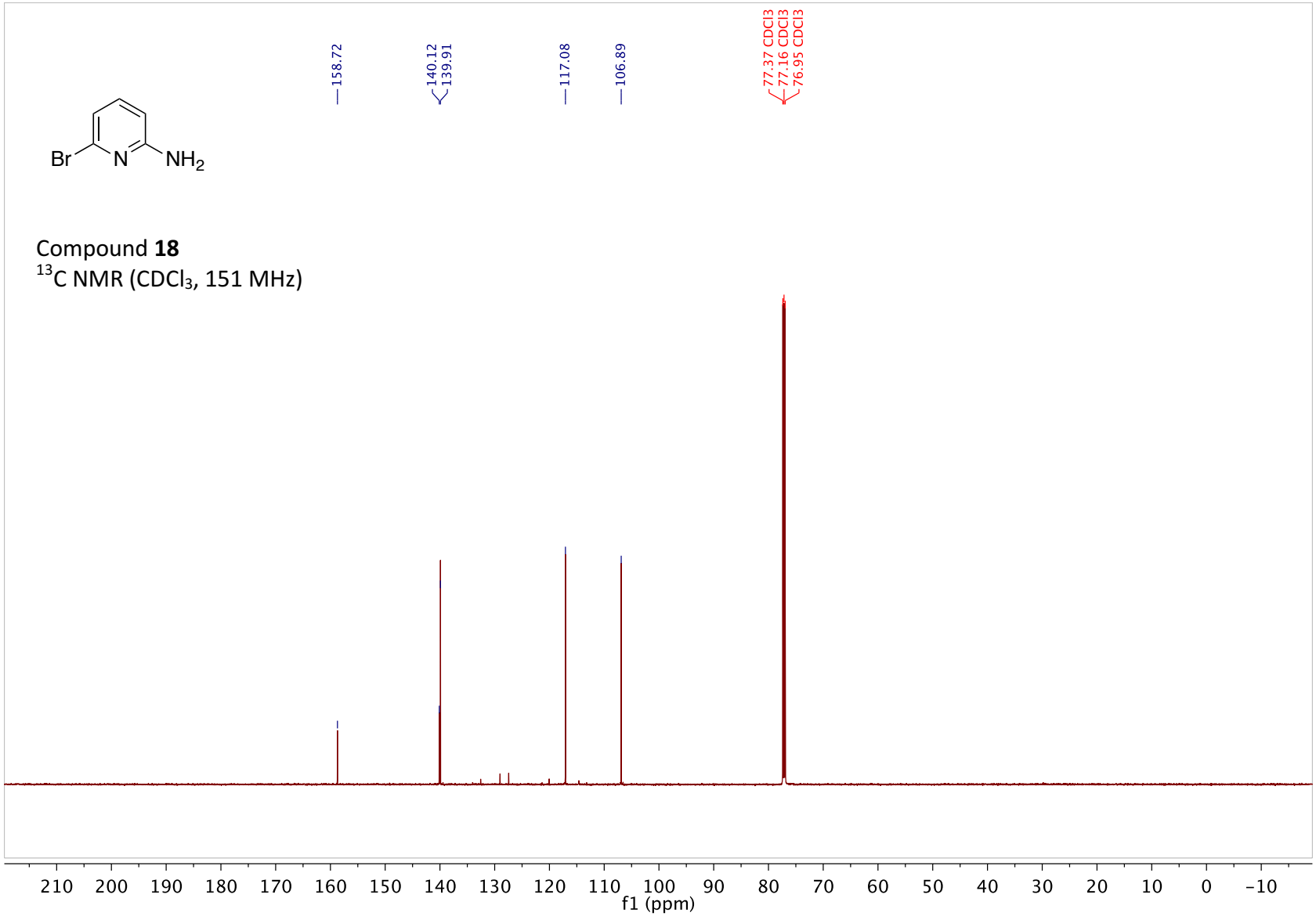

Compound **17**
^{1}H NMR ($CDCl_3$, 600 MHz)
7.34
7.33
7.32
7.26 CDCl3
6.09
6.08
6.05
6.04
4.32
3.83
A (t)
7.33
B (d)
6.08
C (d)
6.05
D (s)
4.32
E (s)
3.83
1.00
0.98
1.02
1.96
3.21
f1 (ppm)

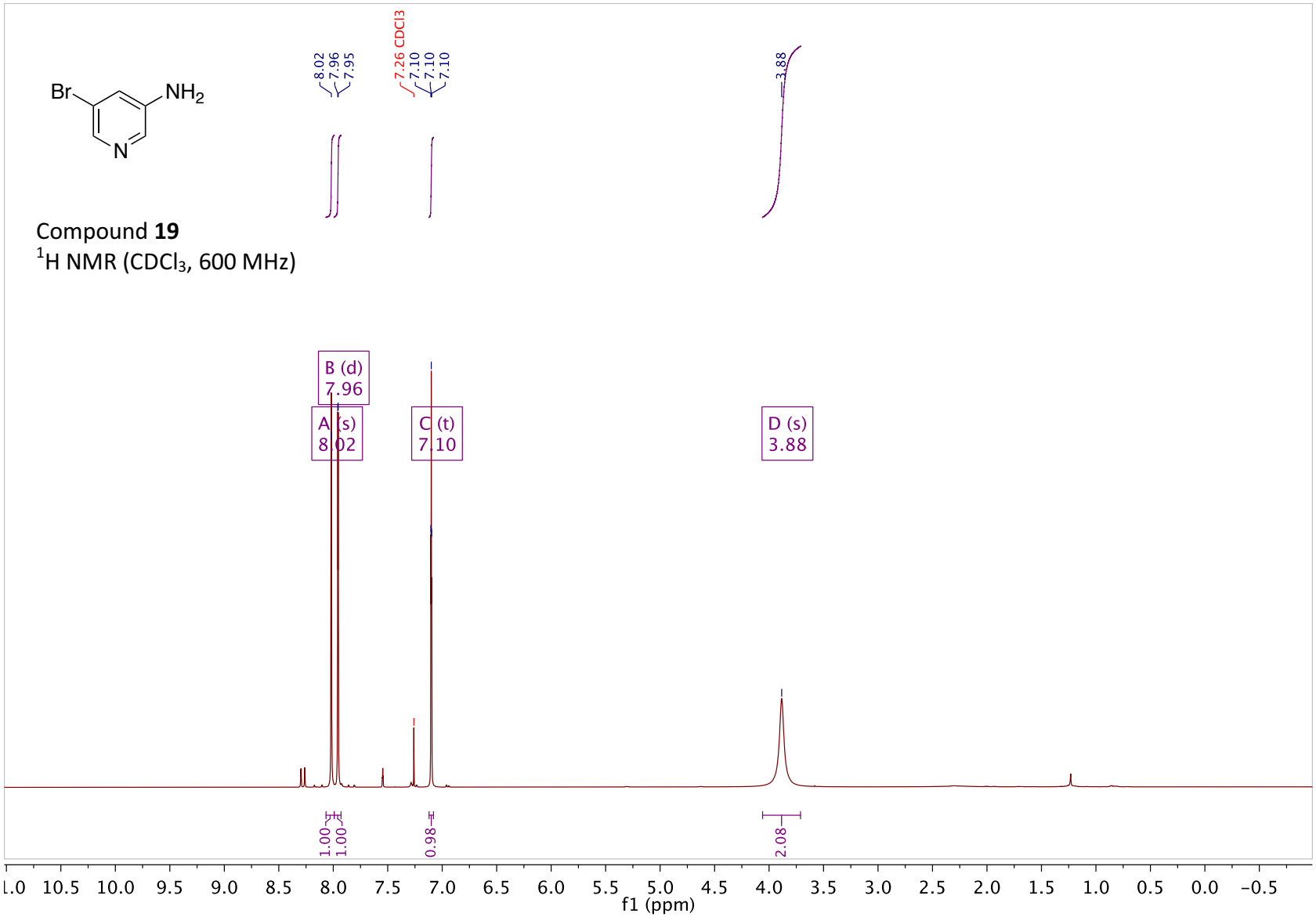

163.88
157.33
140.36
99.81
98.64
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
53.36
O
N
NH2
Compound 17
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



Compound **18**

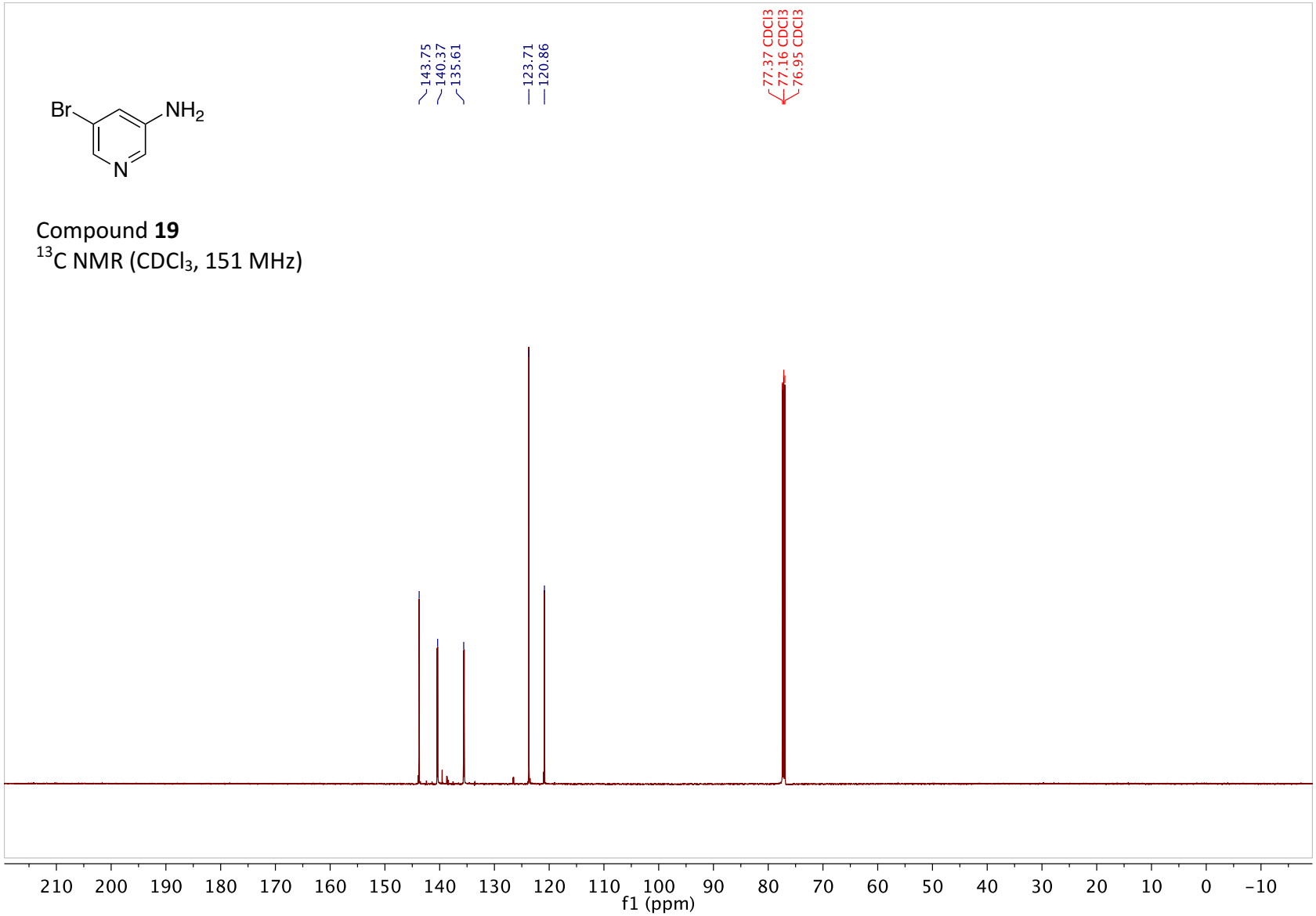
^{1}H NMR ($CDCl_3$, 600 MHz)


158.72
140.12
139.91
117.08
106.89
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
Br
N
NH2
Compound 18
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



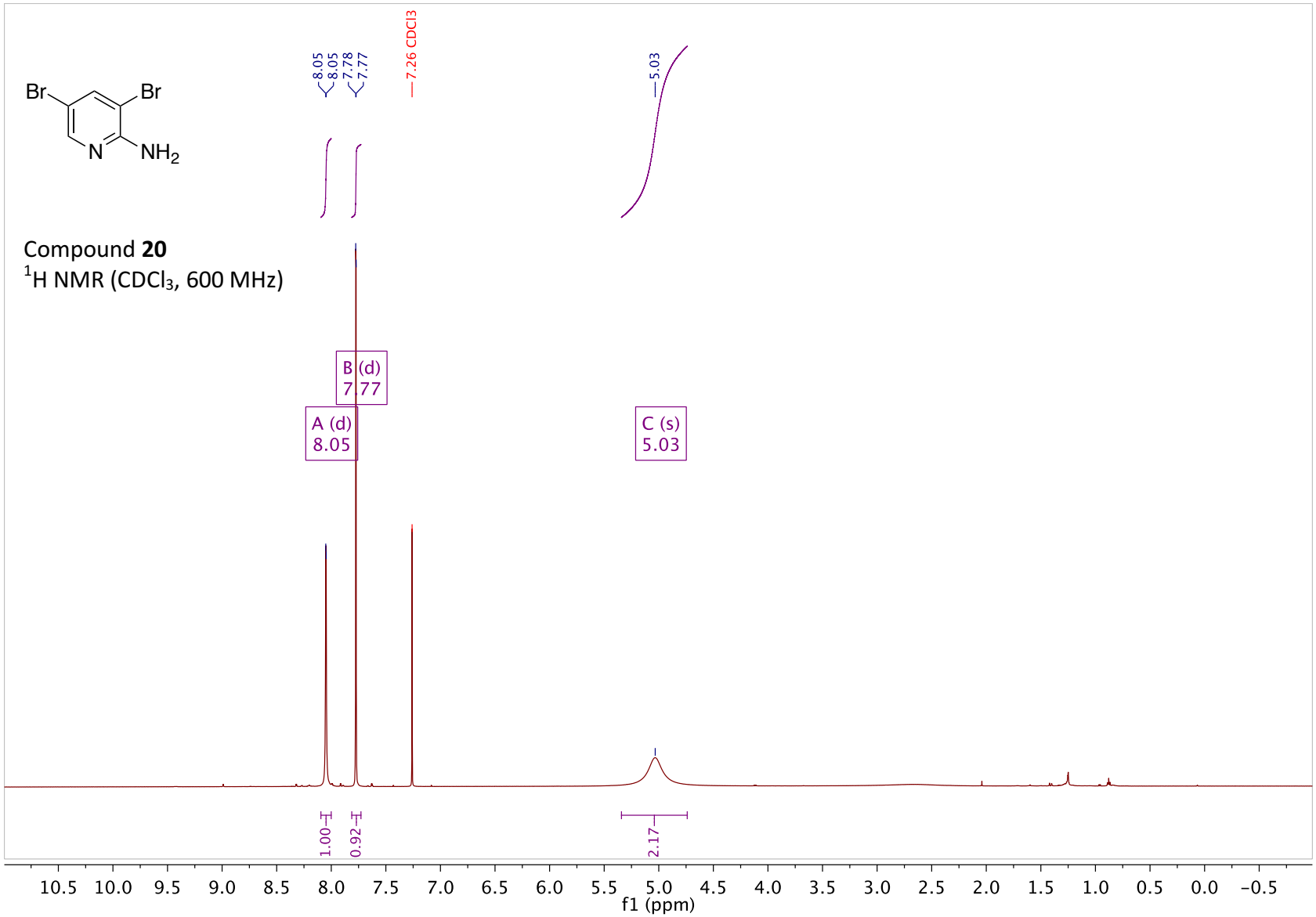
Compound **19**

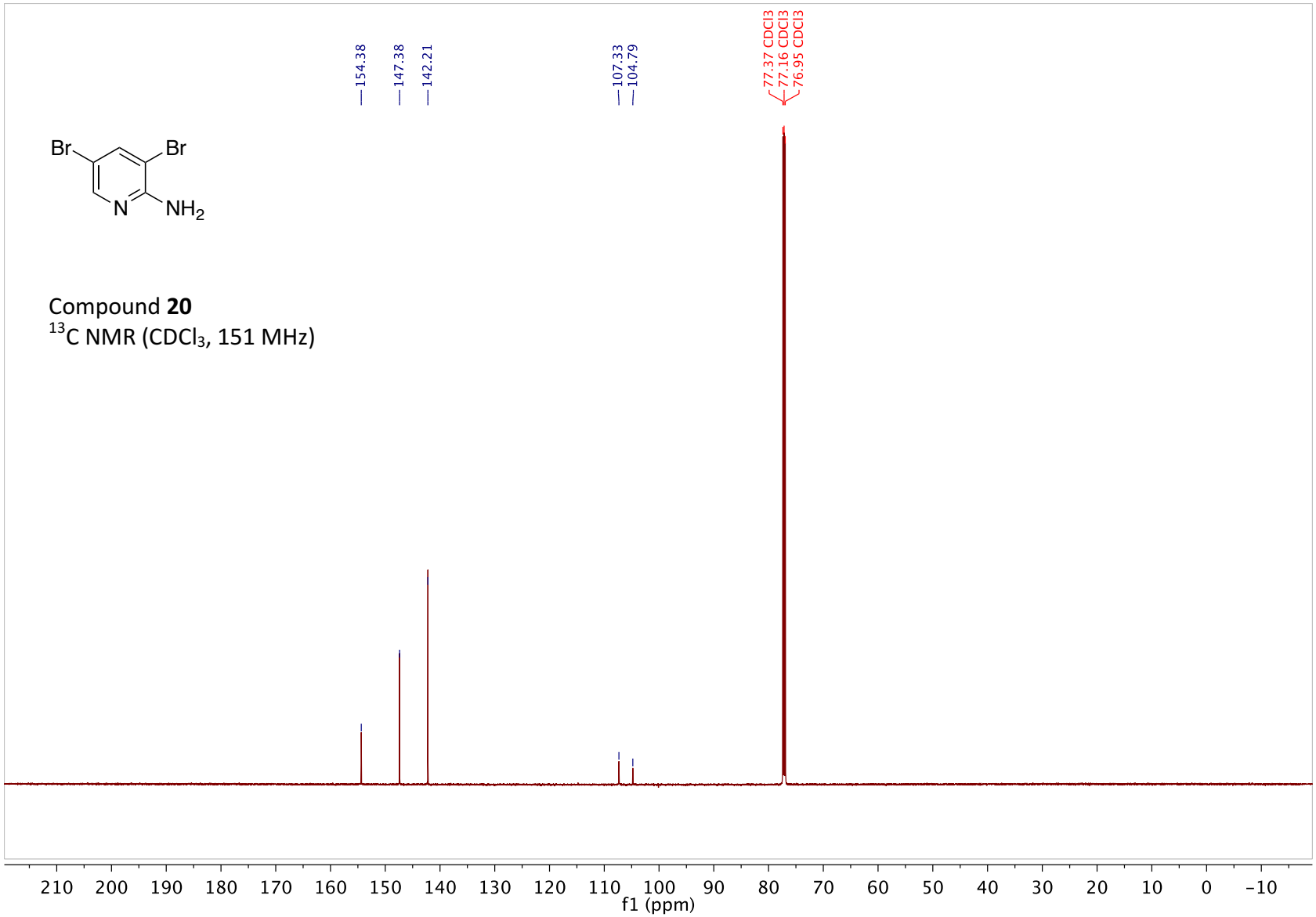
^{1}H NMR ($CDCl_3$, 600 MHz)

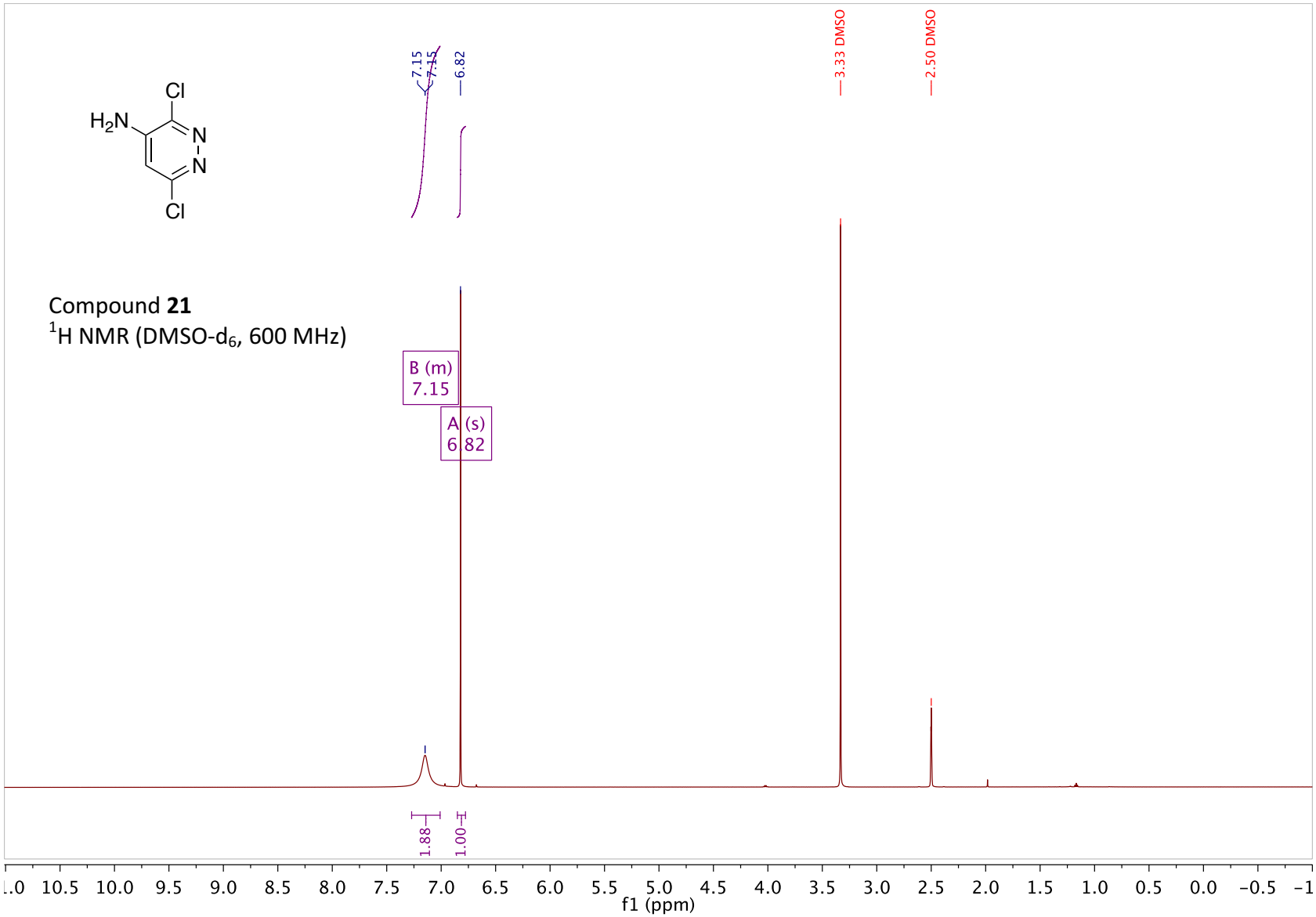


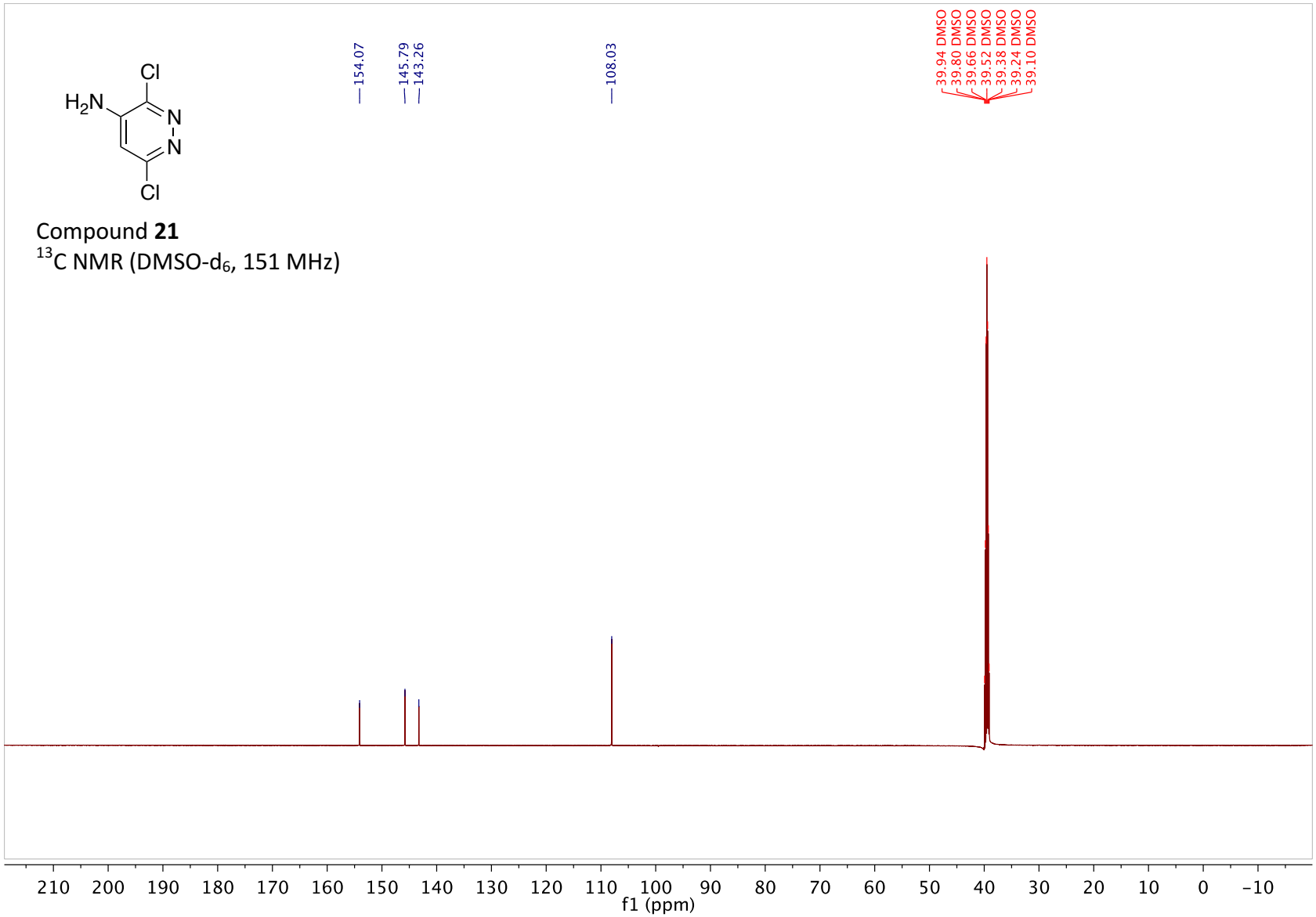
Compound **19**

^{13}C NMR ($CDCl_3$, 151 MHz)


Br
Br
N
NH2
8.05
8.05
7.78
7.77
7.26 CDCl3
5.03
Compound 20
1H NMR (CDCl3, 600 MHz)
B (d)
7.77
A (d)
8.05
C (s)
5.03
1.00
0.92
2.17
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

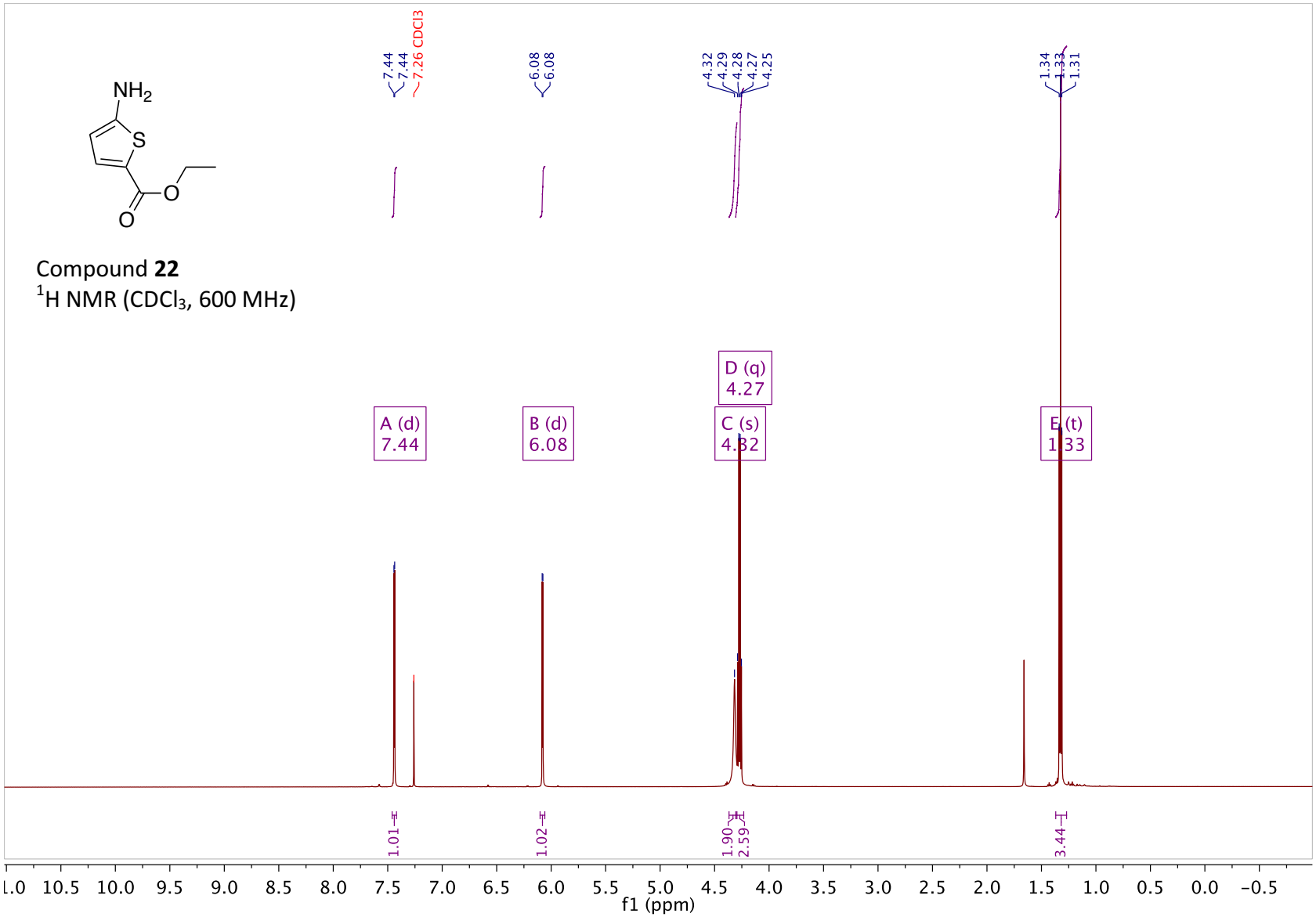

154.38
147.38
142.21
107.33
104.79
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
Br
Br
N
NH2
Compound 20
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Cl
H2N
N
N
Cl
7.15
7.15
6.82
3.33 DMSO
2.50 DMSO
Compound 21
1H NMR (DMSO-d6, 600 MHz)
B (m)
7.15
A (s)
6.82
1.88
1.00
f1 (ppm)



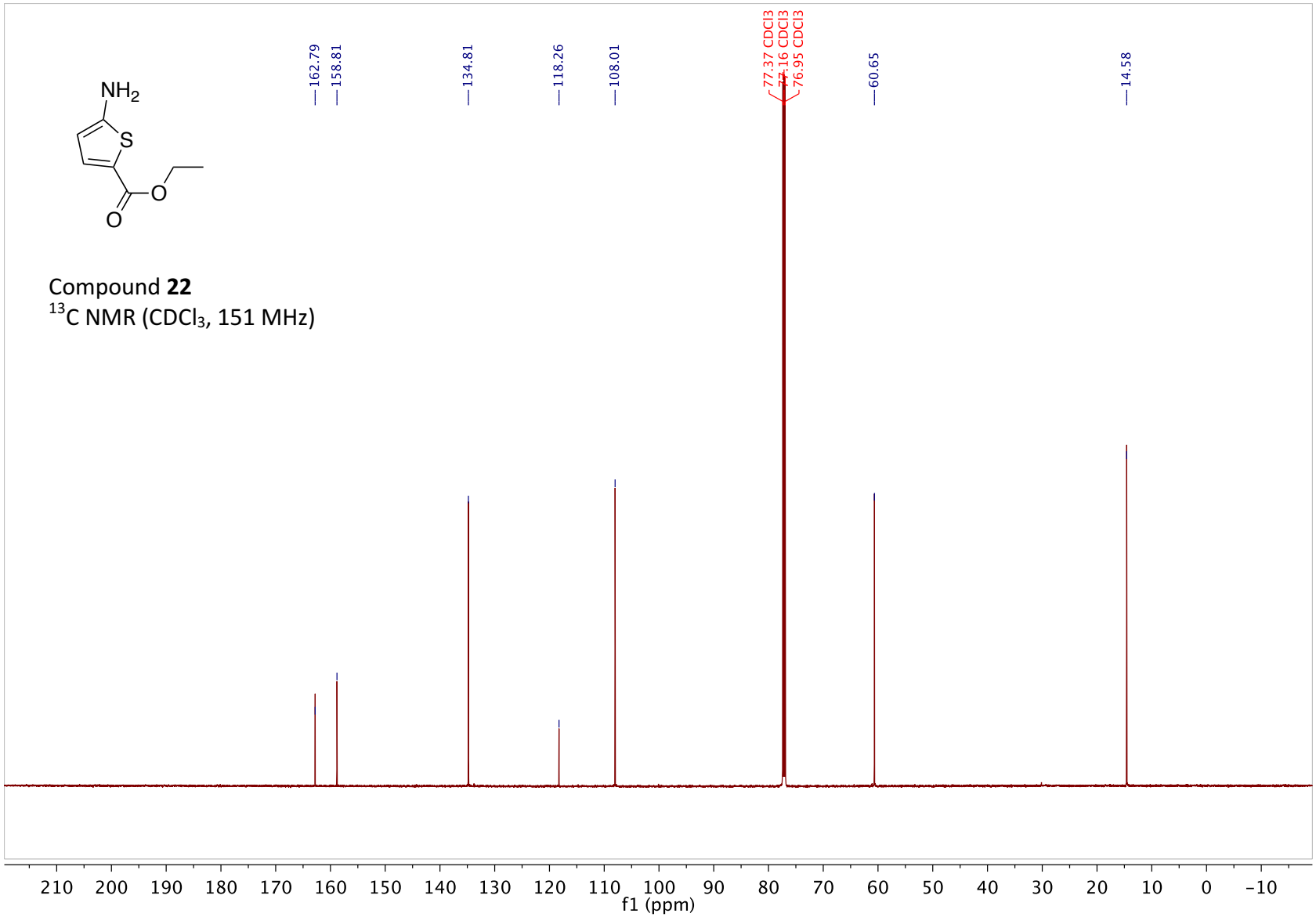
Compound **21**

^{13}C NMR (DMSO-d_6, 151 MHz)



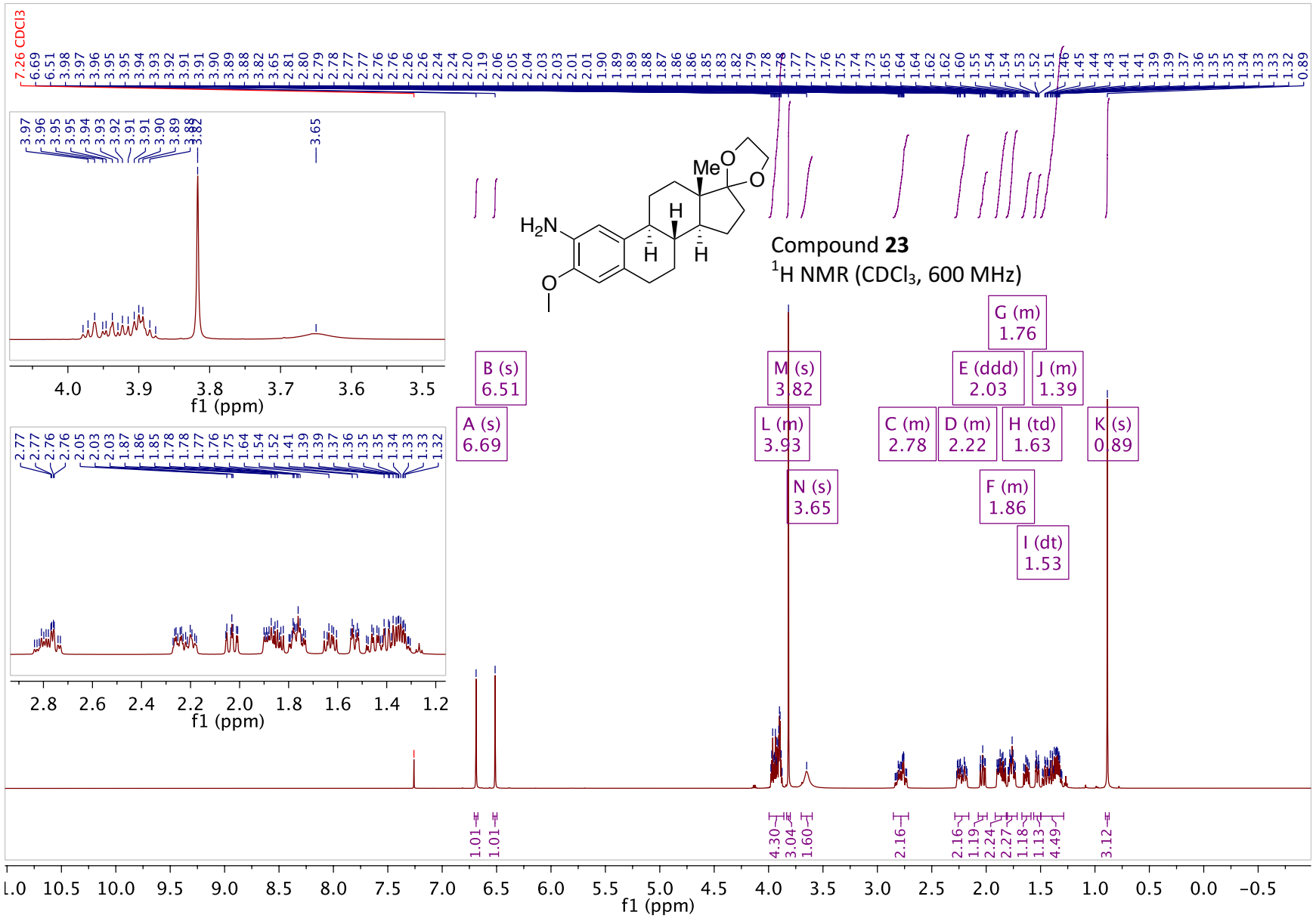
Compound **22**

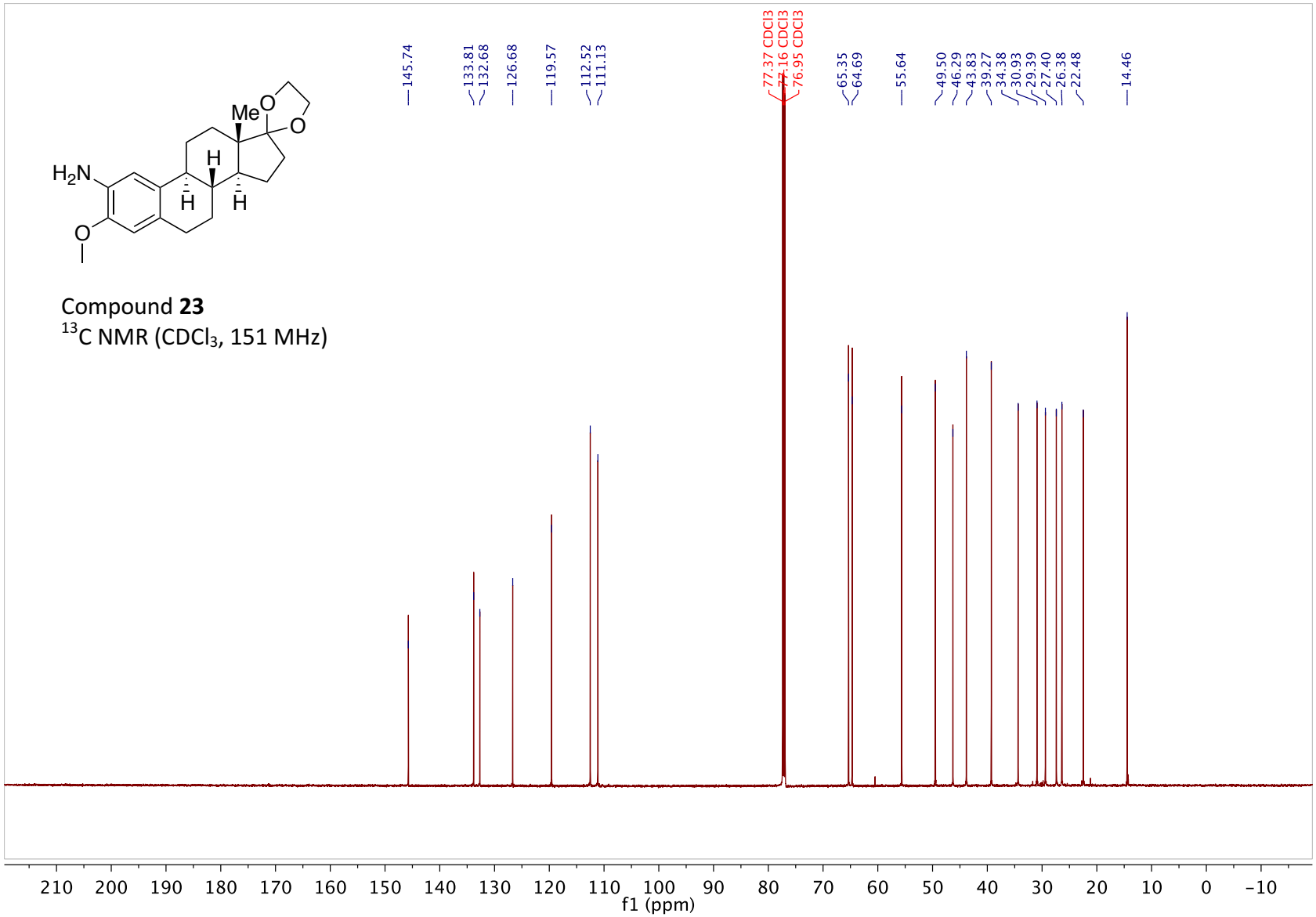
^{1}H NMR ($CDCl_3$, 600 MHz)



Compound **22**

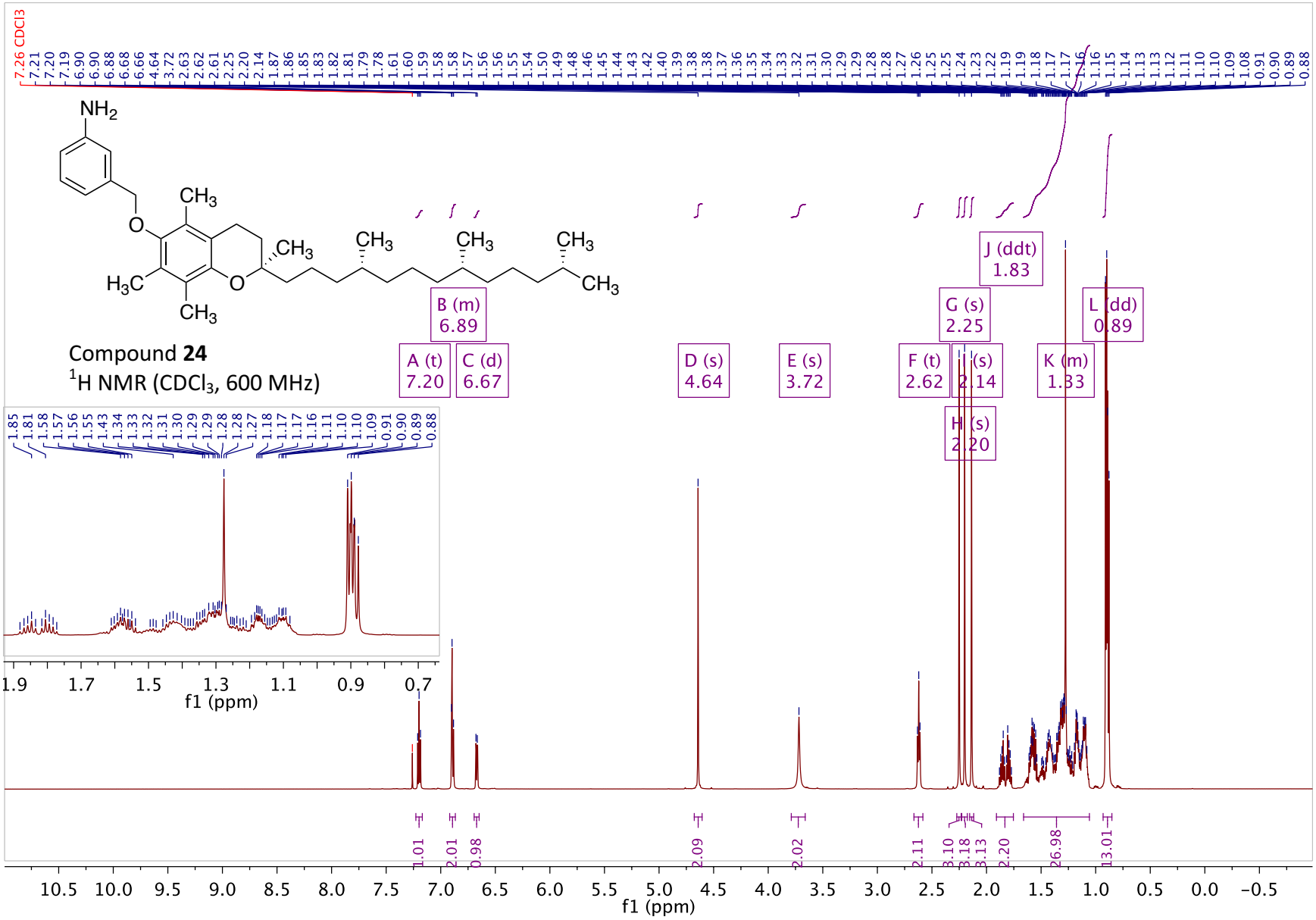
^{13}C NMR ($CDCl_3$, 151 MHz)

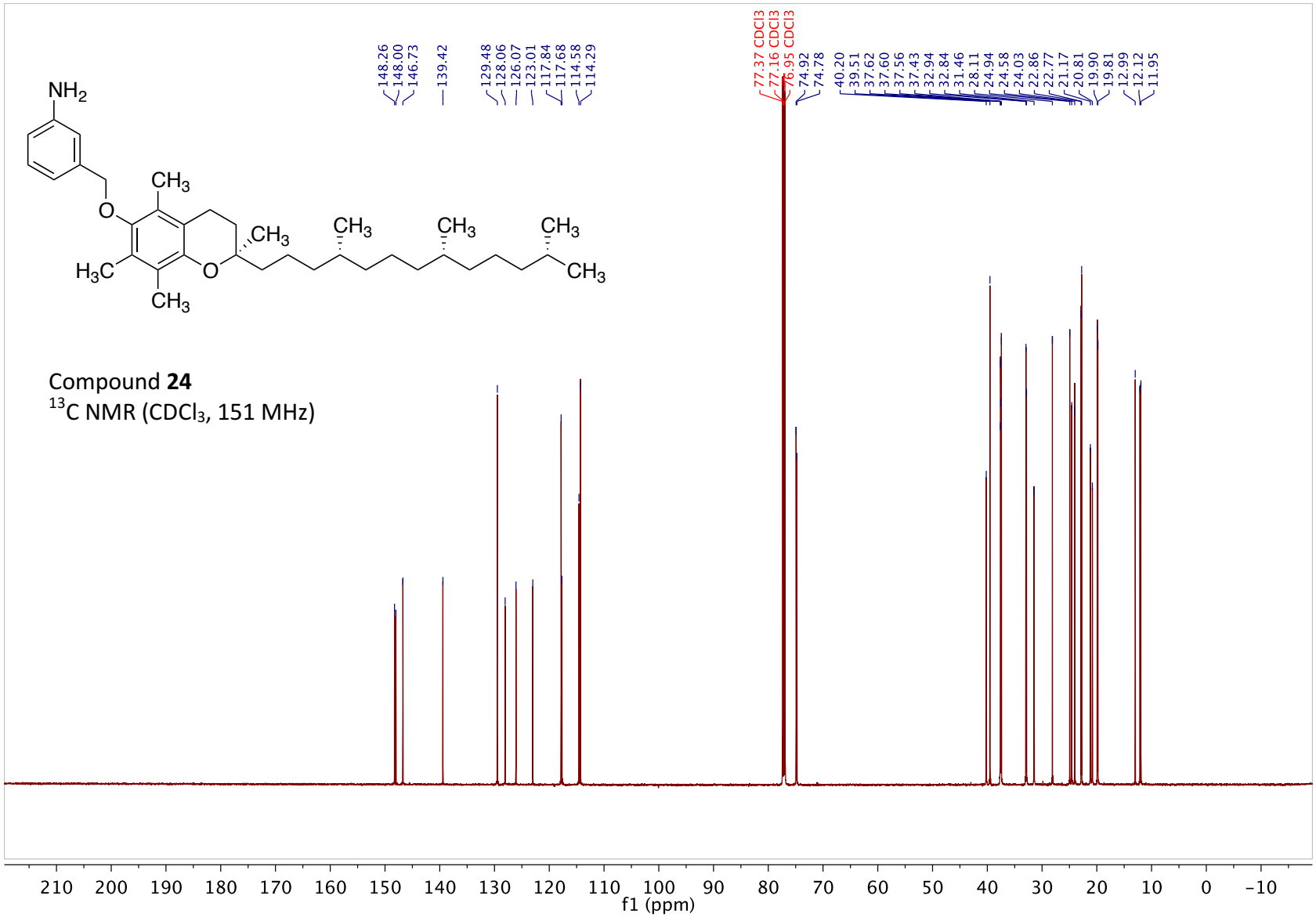

Compound 23
1H NMR (CDCl3, 600 MHz)
B (s) 6.51
A (s) 6.69
M (s) 3.82
L (m) 3.93
N (s) 3.65
G (m) 1.76
E (ddd) 2.03
J (m) 1.39
C (m) 2.78
D (m) 2.22
H (td) 1.63
K (s) 0.89
F (m) 1.86
I (dt) 1.53
f1 (ppm)

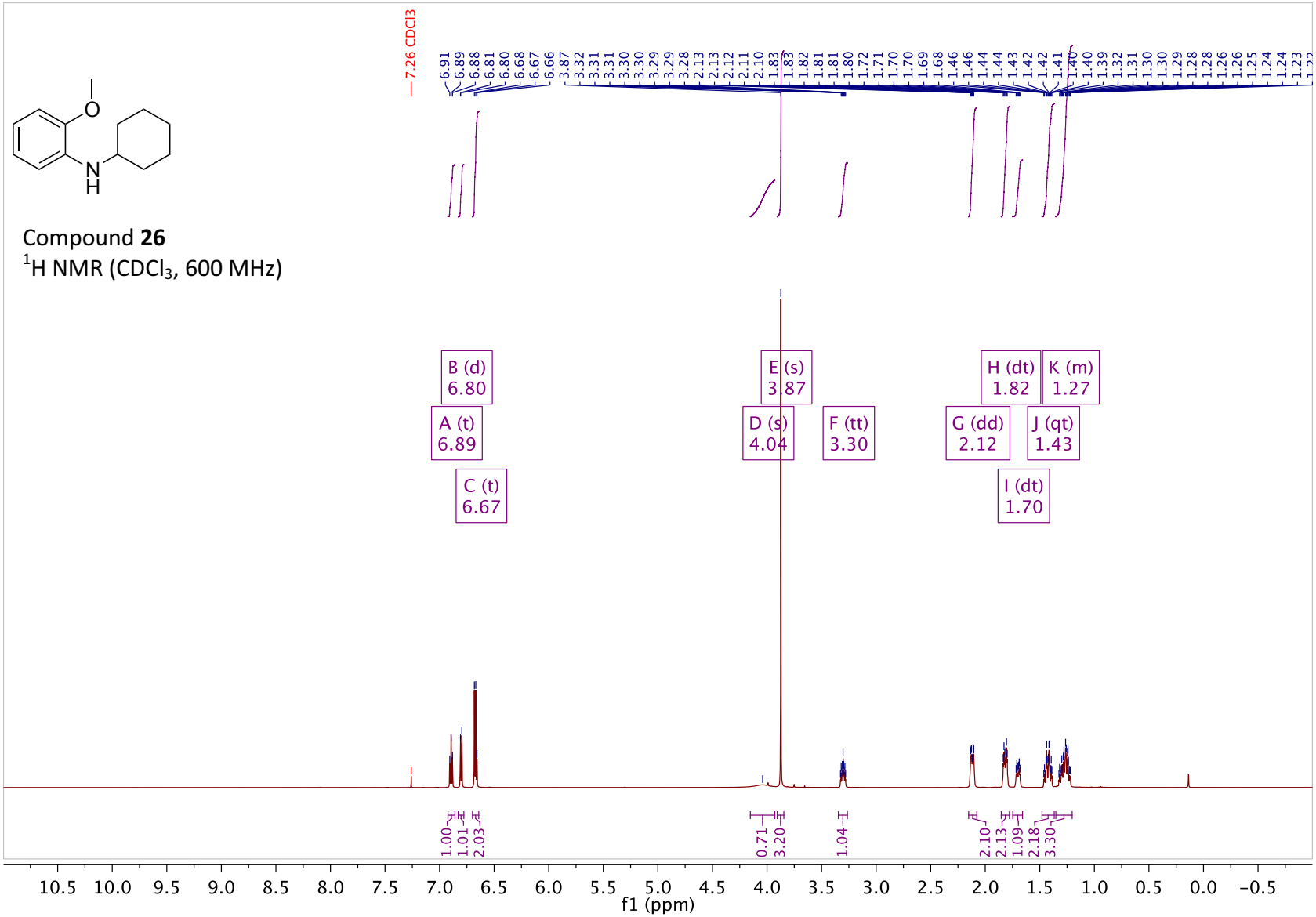


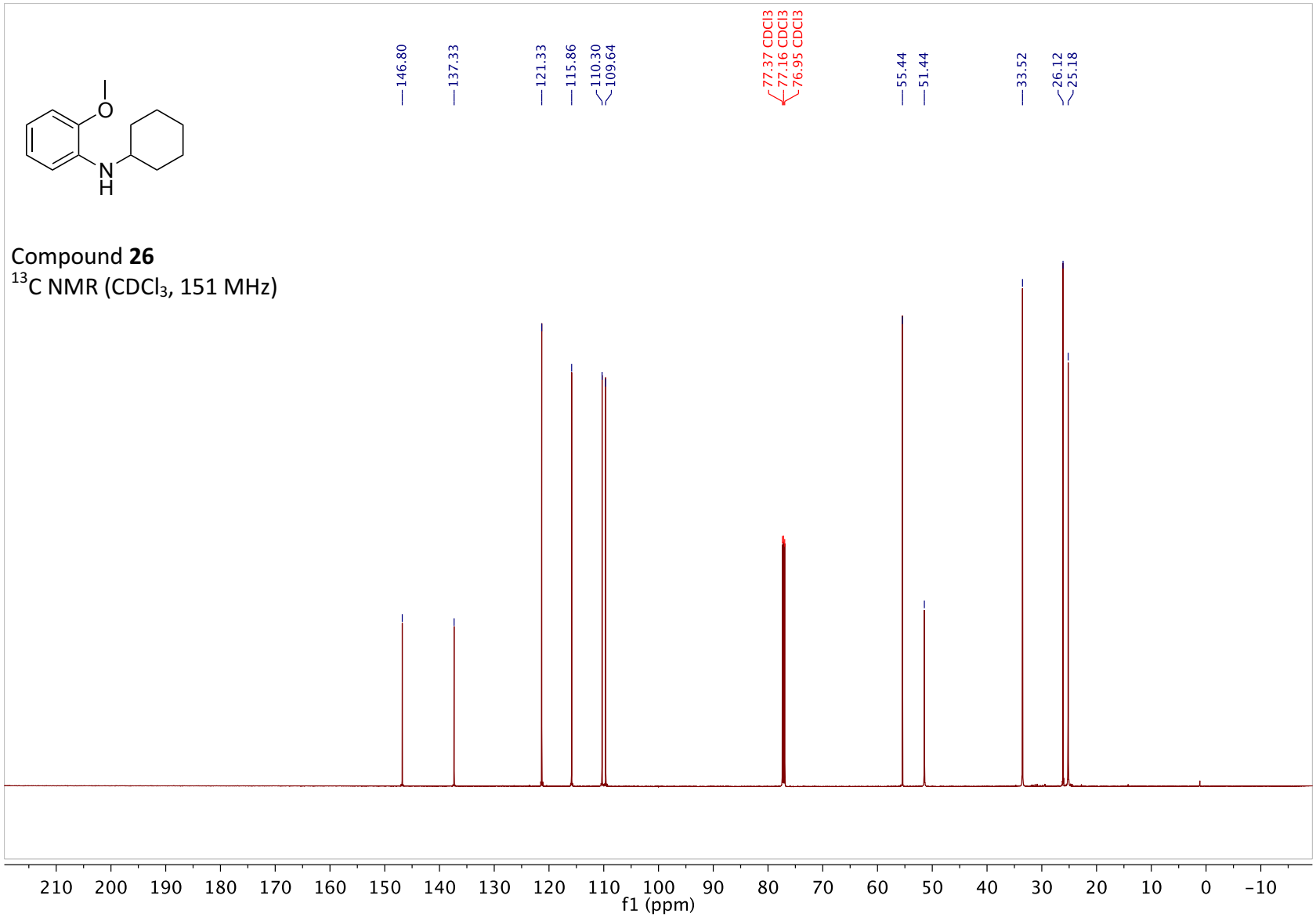
Compound **23**

^{13}C NMR ($CDCl_3$, 151 MHz)


Compound **24**
^{1}H NMR ($CDCl_3$, 600 MHz)
A (t) 7.20
B (m) 6.89
C (d) 6.67
D (s) 4.64
E (s) 3.72
F (t) 2.62
G (s) 2.25
H (s) 2.20
I (s) 2.14
J (ddt) 1.83
K (m) 1.33
L (dd) 0.89
f1 (ppm)

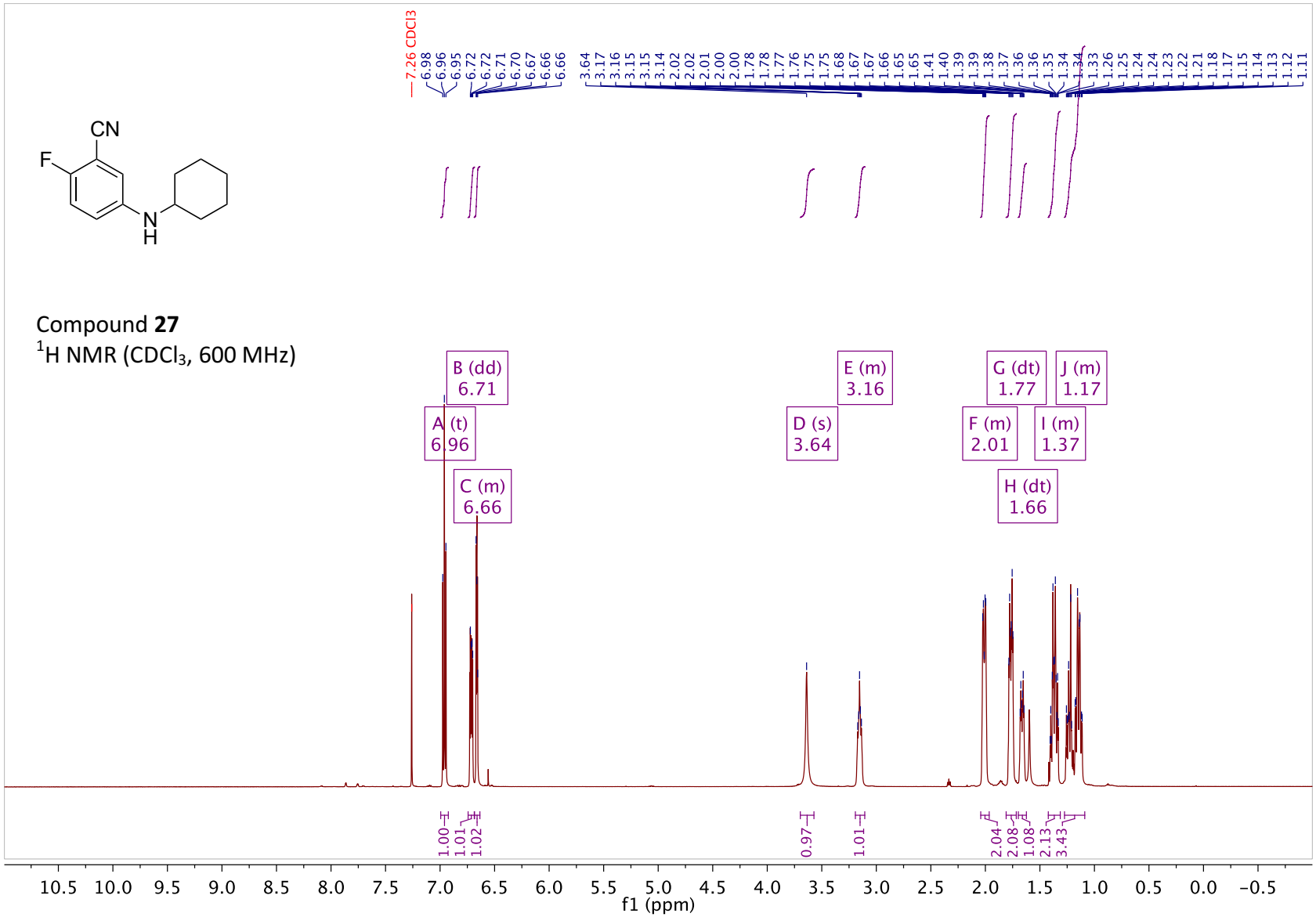

148.26
148.00
146.73
139.42
129.48
128.06
126.07
123.01
117.84
117.68
114.58
114.29
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
74.92
74.78
40.20
39.51
37.62
37.60
37.56
37.43
32.94
32.84
31.46
28.11
24.94
24.58
24.03
22.86
22.77
21.17
20.81
19.90
19.81
12.99
12.12
11.95
NH2
CH3
O
CH3
CH3
CH3
CH3
H3C
O
CH3
CH3
Compound 24
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

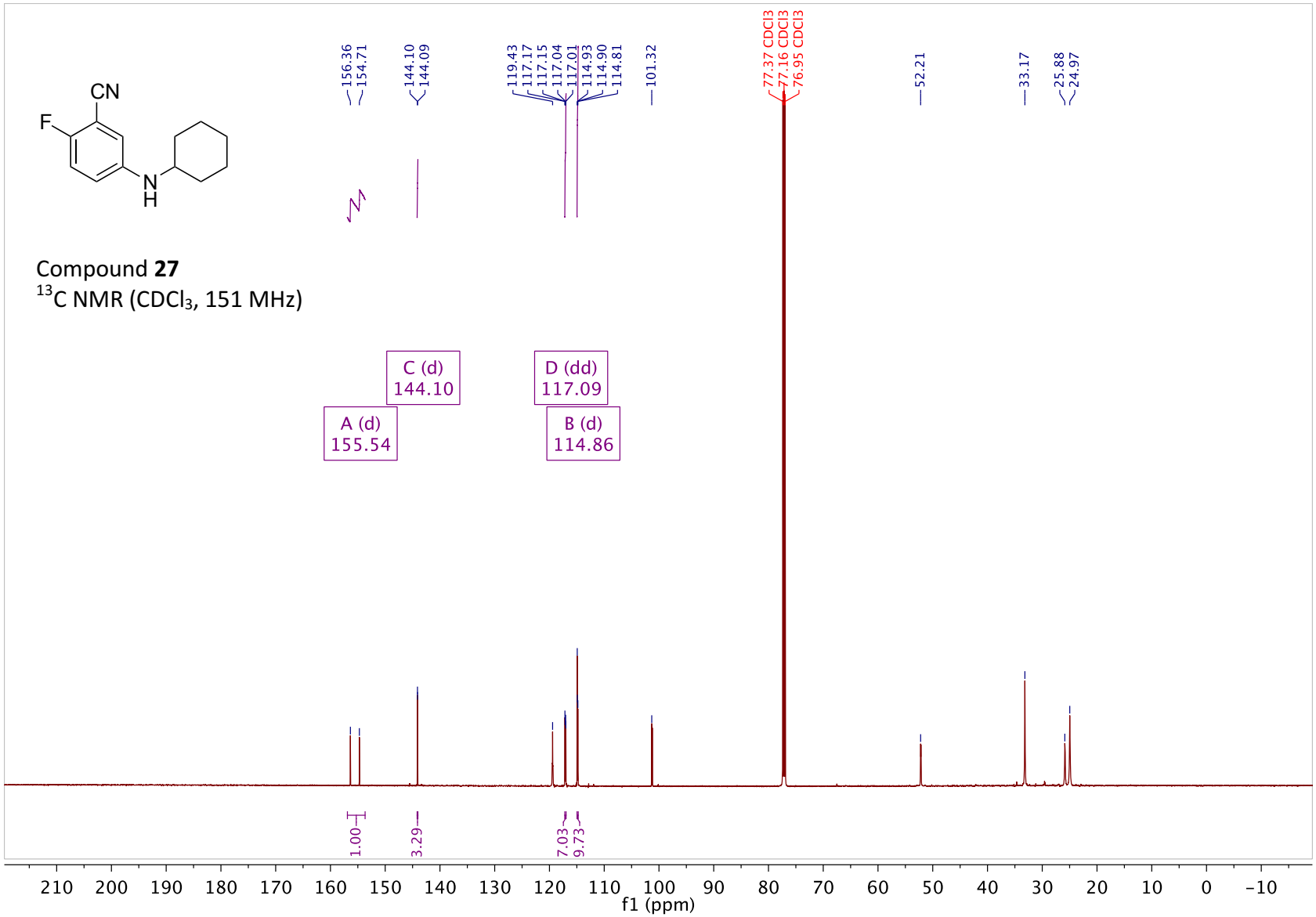

Compound **26**
^{1}H NMR ($CDCl_3$, 600 MHz)
7.26 CDCl3
B (d) 6.80
A (t) 6.89
C (t) 6.67
E (s) 3.87
D (s) 4.04
F (tt) 3.30
H (dt) 1.82
K (m) 1.27
G (dd) 2.12
J (qt) 1.43
I (dt) 1.70
1.00
1.01
2.03
0.71
3.20
1.04
2.10
2.13
1.09
2.18
3.30
f1 (ppm)



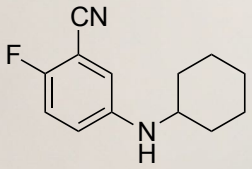
Compound **26**

^{13}C NMR ($CDCl_3$, 151 MHz)


CN
F
N
H
Compound **27**
^{1}H NMR ($CDCl_3$, 600 MHz)
7.26 CDCl3
B (dd) 6.71
A (t) 6.96
C (m) 6.66
E (m) 3.16
D (s) 3.64
G (dt) 1.77
J (m) 1.17
F (m) 2.01
I (m) 1.37
H (dt) 1.66
1.00
1.01
1.02
0.97
1.01
2.04
2.08
1.08
2.13
3.43
f1 (ppm)


CN
F
N
H
156.36
154.71
144.10
144.09
119.43
117.17
117.15
117.04
117.01
114.93
114.90
114.81
101.32
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
52.21
33.17
25.88
24.97
Compound 27
13C NMR (CDCl3, 151 MHz)
C (d)
144.10
D (dd)
117.09
A (d)
155.54
B (d)
114.86
1.00
3.29
7.03
9.73
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)

ZM_3_206. In CDCl3
Fluorine sample 27 (cyclohexy)(3-cyano-4-fluorophenyl)amine.
Observe only a broadened signal that cannot be sharpened by shimming z
(half-height linewidth = 21 Hz).
Chemical shifts relative to external CFCl3 defined as 0 ppm (sr = -442.57)



Compound **27**
^{19}F NMR ($CDCl_3$, 470 MHz)

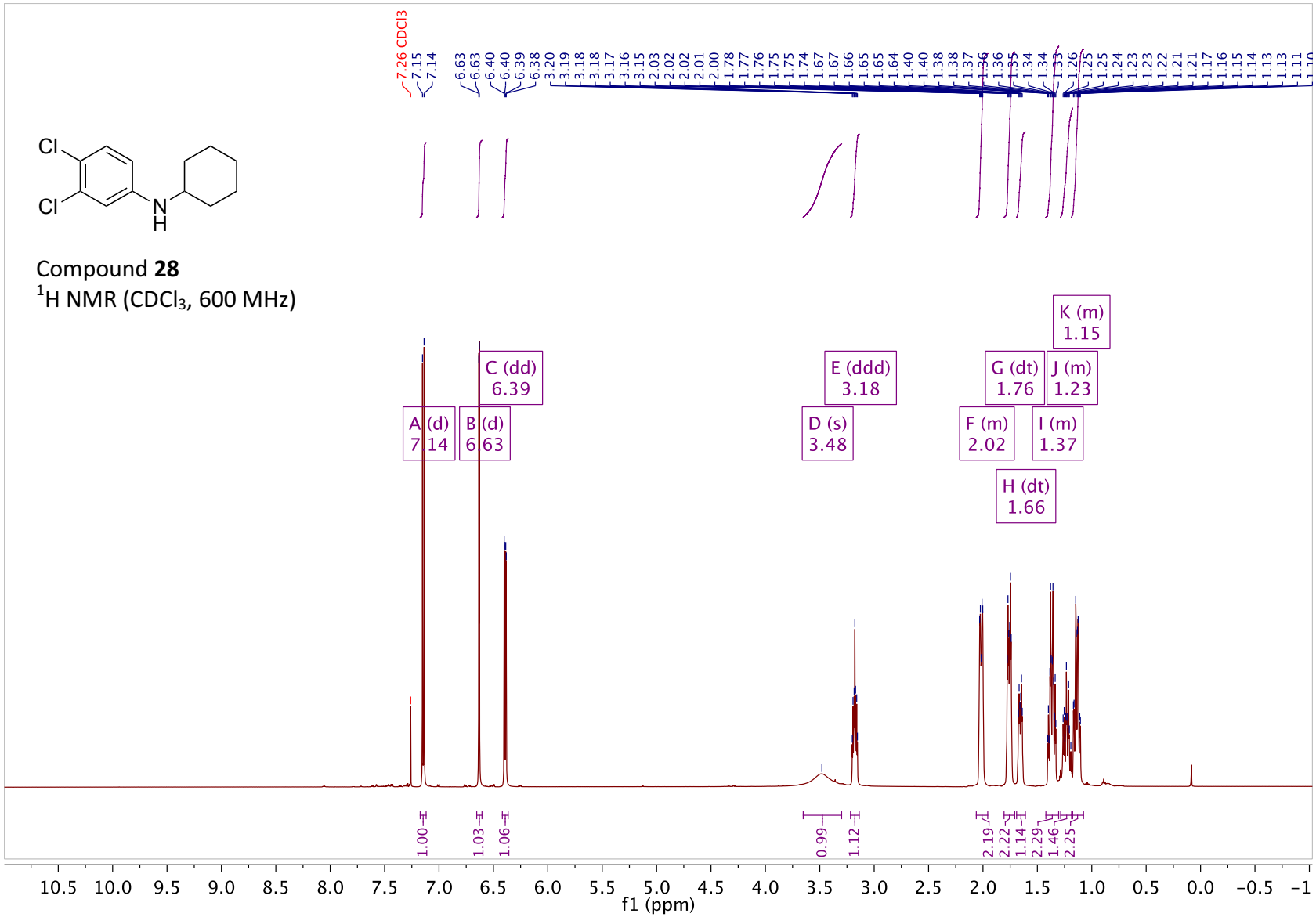
BRUKER

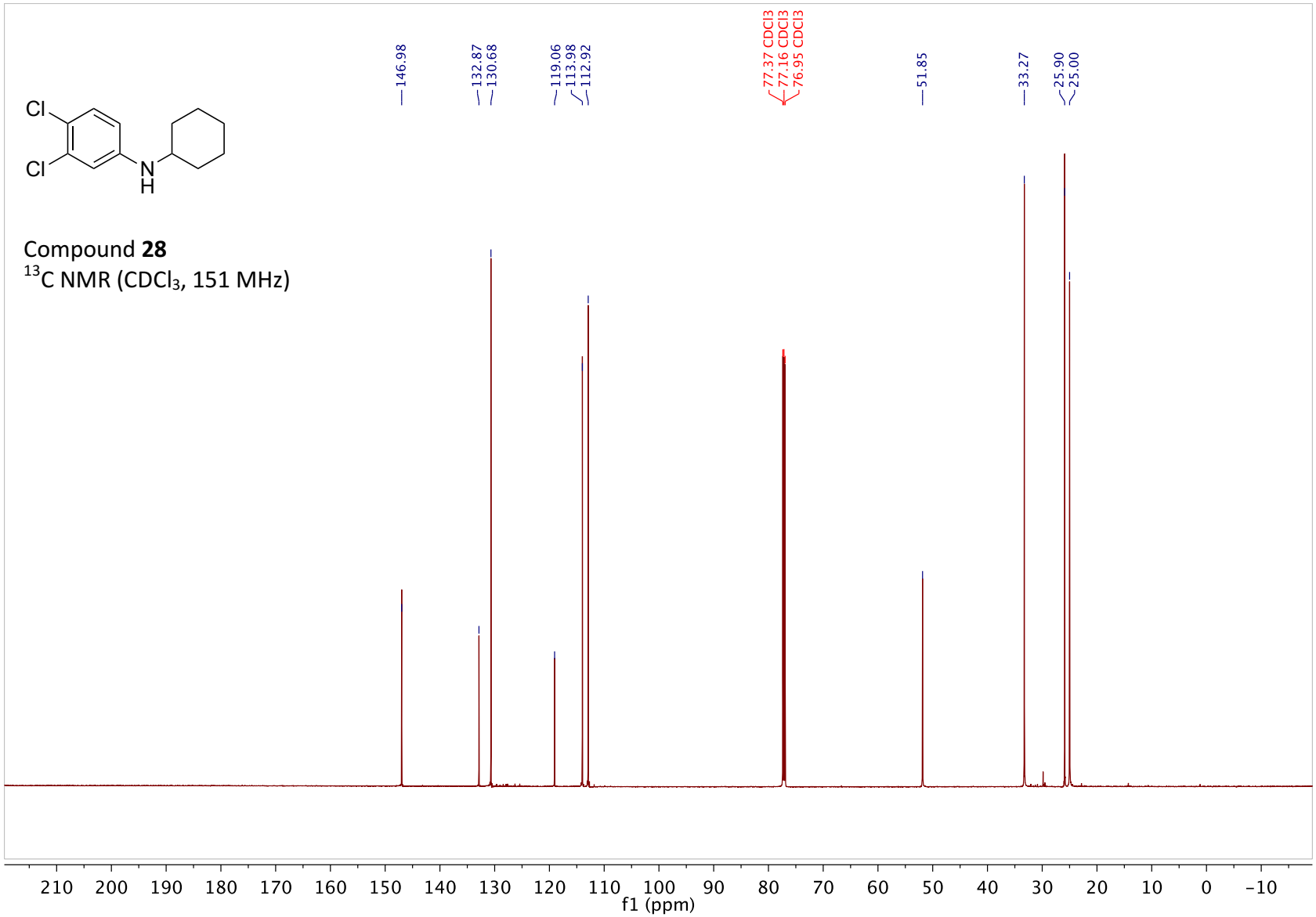
```
Current Data Parameters
NAME          ZM_3_206_F
EXPNO                  1
PROCNO                 1

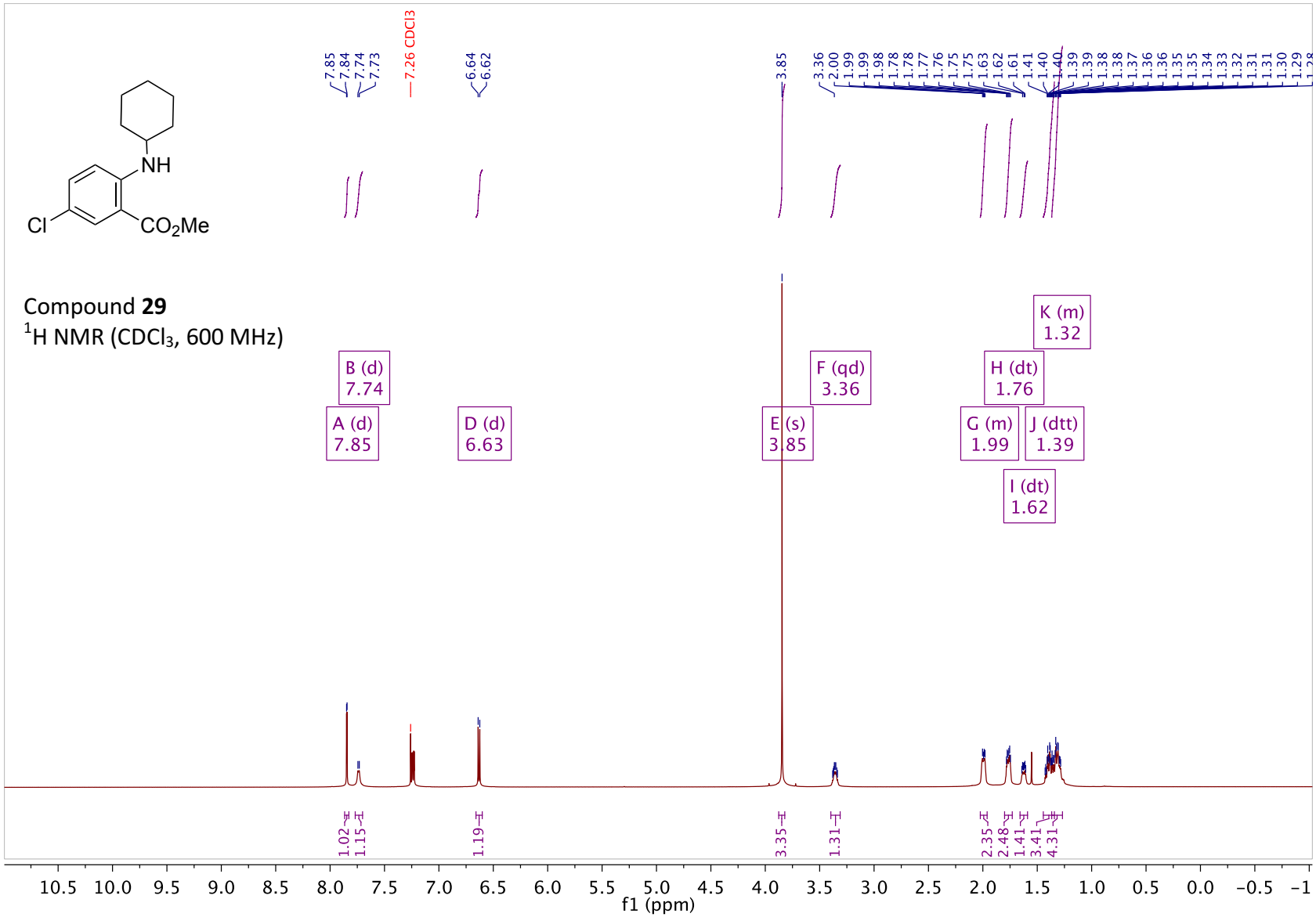
F2 - Acquisition Parameters
Date_           20161220
Time               10.44
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG               zg
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             4708.098 Hz
FIDRES          0.071840 Hz
AQ              6.9599733 sec
RG                  40.3
DW                106.200 usec
DE                  6.50 usec
TE                 293.9 K
D1             5.00000000 sec

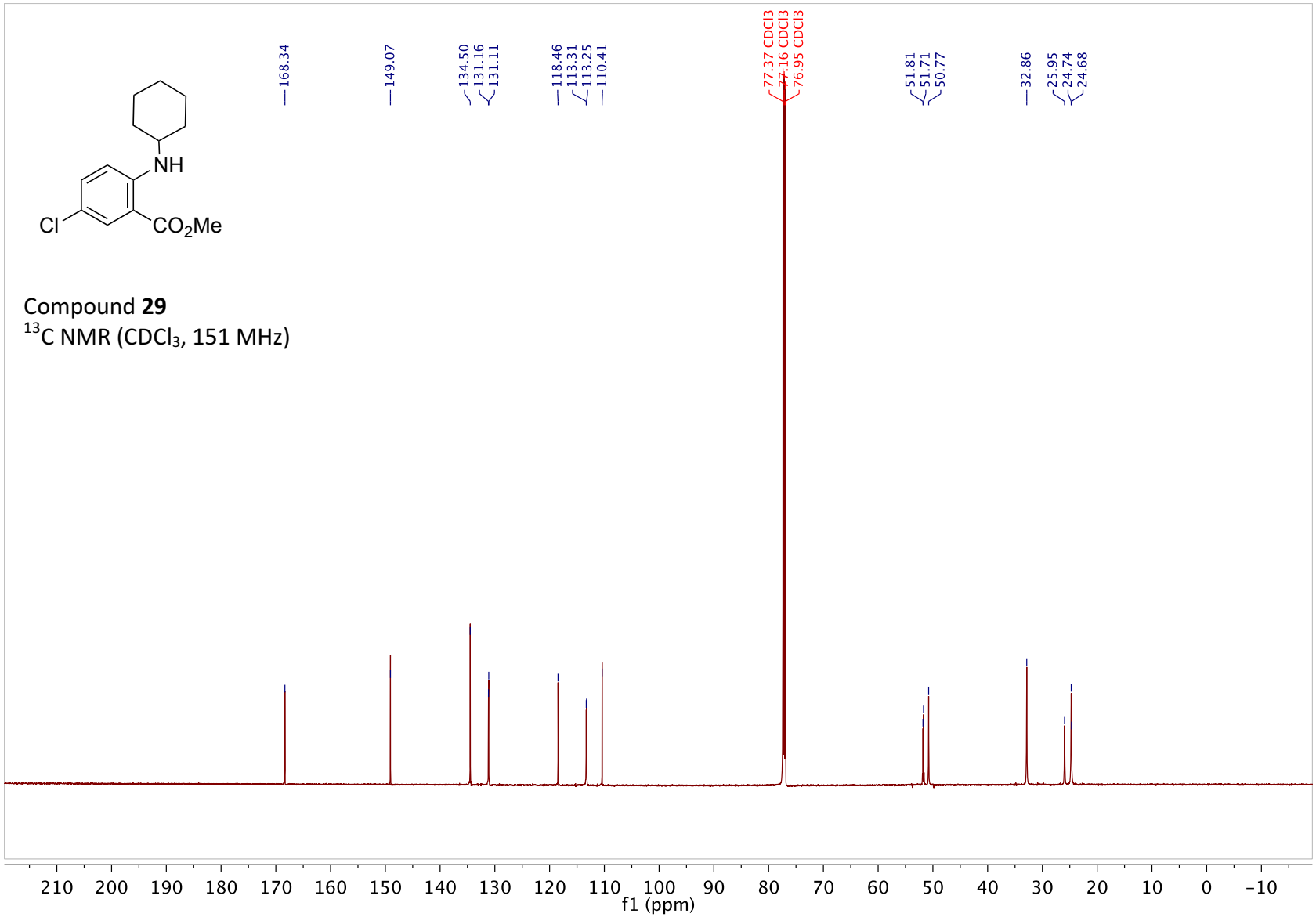
======== CHANNEL f1 ========
NUC1                  19F
P1                 11.30 usec
PLW1         21.79999924 W
SFO1         470.6285500 MHz

F2 - Processing parameters
SI                 2097152
SF           470.6860284 MHz
WDW                   no
SSB       0
LB        0 Hz
GB        0
PC                  1.00
```


Cl
Cl
N
H
Compound **28**
^{1}H NMR ($CDCl_3$, 600 MHz)
7.26 CDCl3
A (d) 7.14
B (d) 6.63
C (dd) 6.39
D (s) 3.48
E (ddd) 3.18
F (m) 2.02
G (dt) 1.76
H (dt) 1.66
I (m) 1.37
J (m) 1.23
K (m) 1.15
1.00
1.03
1.06
0.99
1.12
2.19
2.22
1.14
2.29
1.46
2.25
f1 (ppm)

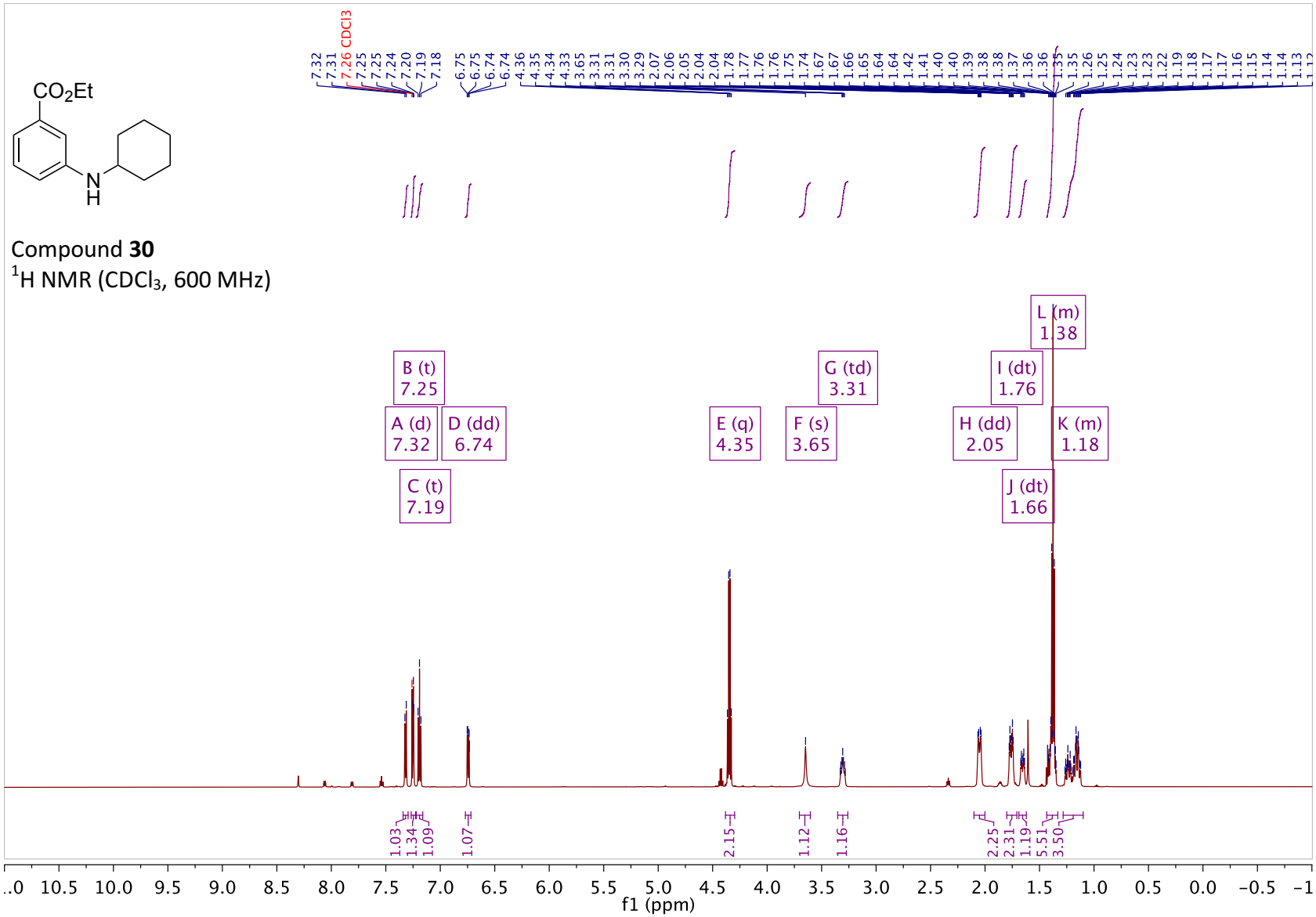

Cl
Cl
N
H
Compound **28**
^{13}C NMR ($CDCl_3$, 151 MHz)
146.98
132.87
130.68
119.06
113.98
112.92
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
51.85
33.27
25.90
25.00
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

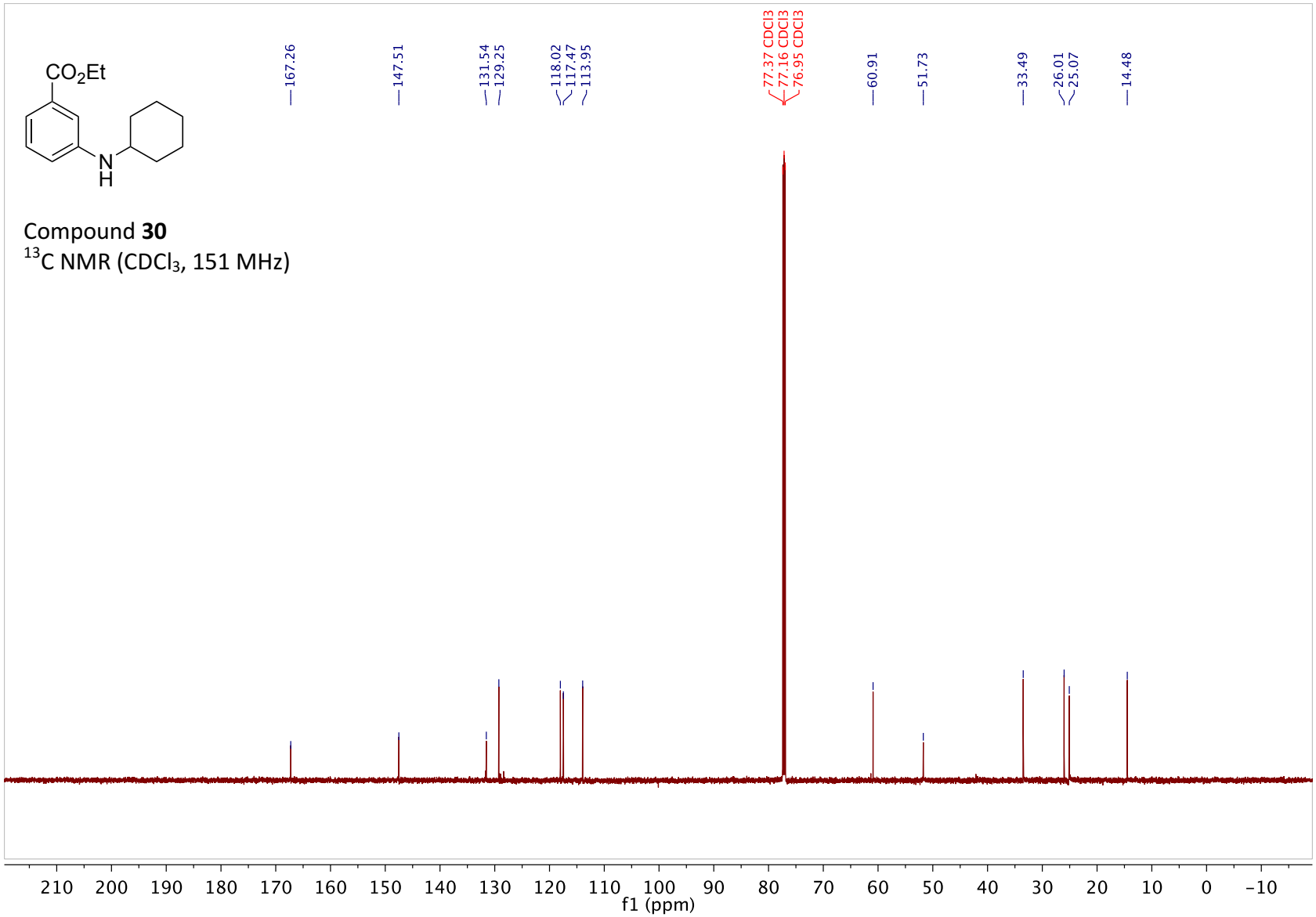

NH
Cl
CO2Me
Compound 29
1H NMR (CDCl3, 600 MHz)
7.26 CDCl3
B (d) 7.74
A (d) 7.85
D (d) 6.63
E (s) 3.85
F (qd) 3.36
K (m) 1.32
H (dt) 1.76
G (m) 1.99
J (dtt) 1.39
I (dt) 1.62
f1 (ppm)



Compound **29**

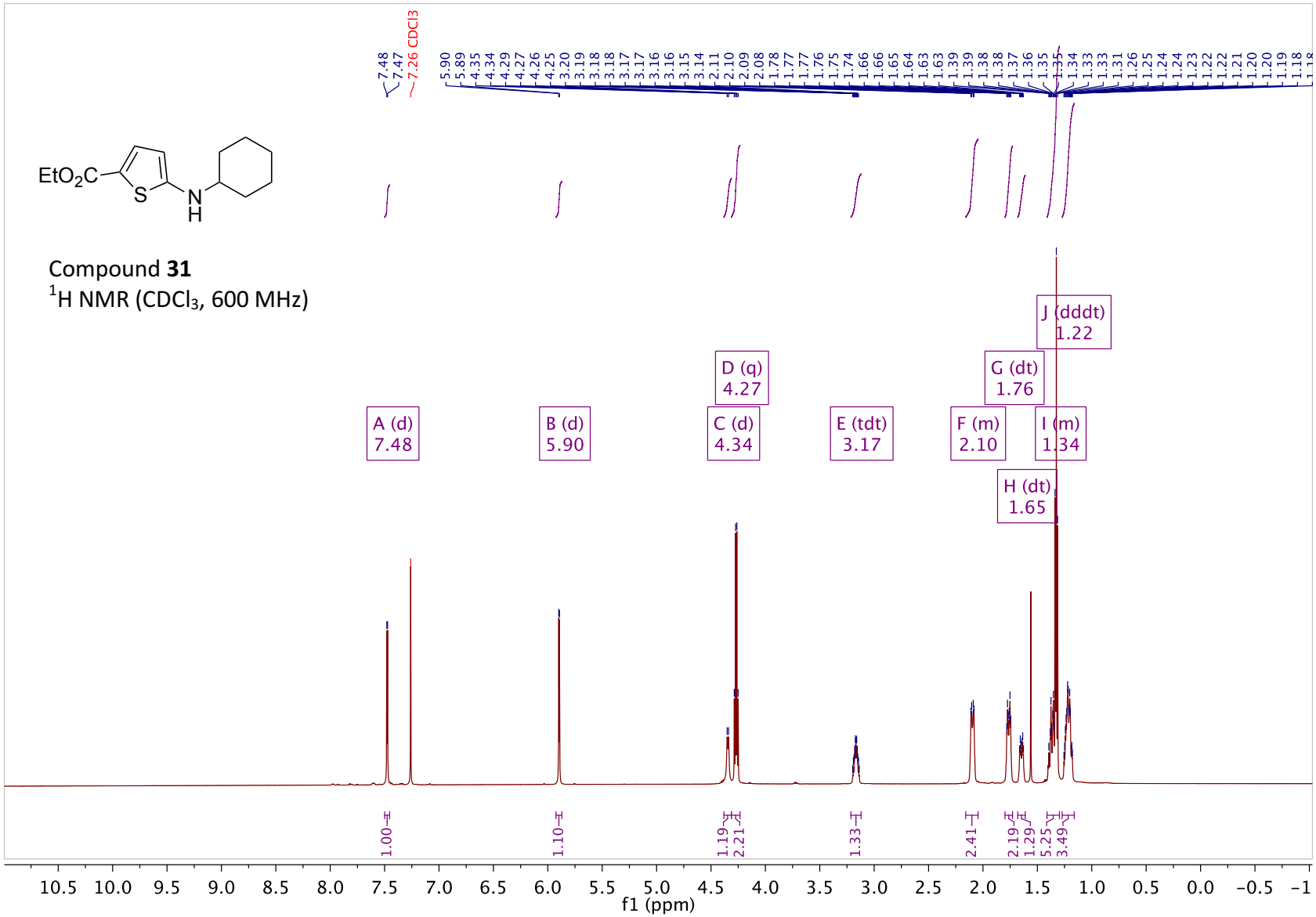
^{13}C NMR ($CDCl_3$, 151 MHz)

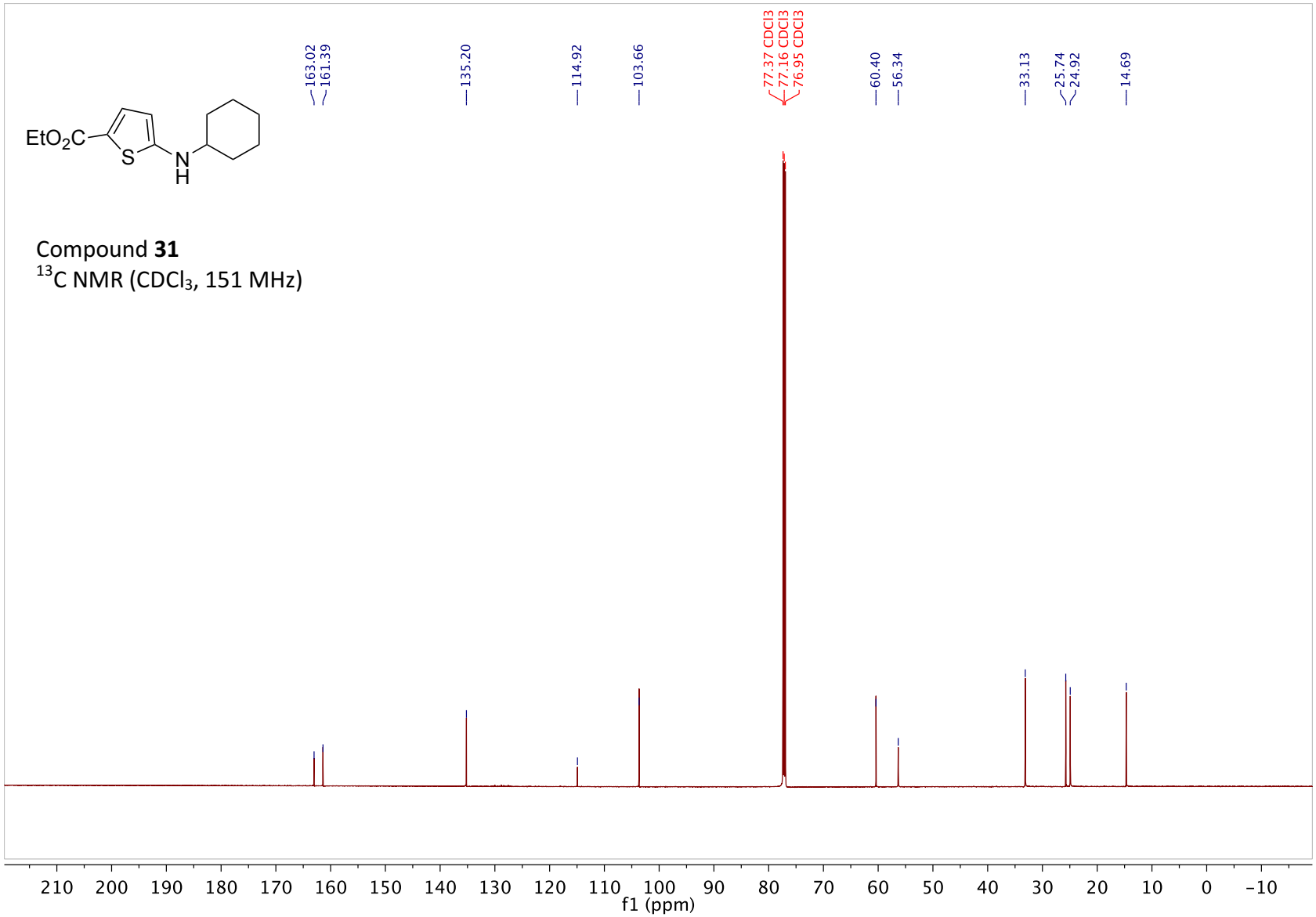

CO2Et
N
H
Compound 30
1H NMR (CDCl3, 600 MHz)
7.32
7.31
7.26 CDCl3
7.25
7.25
7.24
7.20
7.19
7.18
6.75
6.75
6.74
6.74
4.36
4.35
4.34
4.33
3.65
3.31
3.31
3.30
3.29
2.07
2.06
2.05
2.04
2.04
1.78
1.77
1.76
1.76
1.75
1.74
1.67
1.67
1.66
1.65
1.64
1.64
1.42
1.41
1.40
1.40
1.39
1.38
1.38
1.37
1.36
1.36
1.35
1.35
1.26
1.25
1.24
1.23
1.23
1.22
1.19
1.18
1.17
1.17
1.16
1.15
1.14
1.14
1.13
B (t)
7.25
A (d)
7.32
D (dd)
6.74
C (t)
7.19
E (q)
4.35
G (td)
3.31
F (s)
3.65
I (dt)
1.76
H (dd)
2.05
L (m)
1.38
K (m)
1.18
J (dt)
1.66
1.03
1.34
1.09
1.07
2.15
1.12
1.16
2.25
2.31
1.19
5.51
3.50
..0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)



Compound **30**

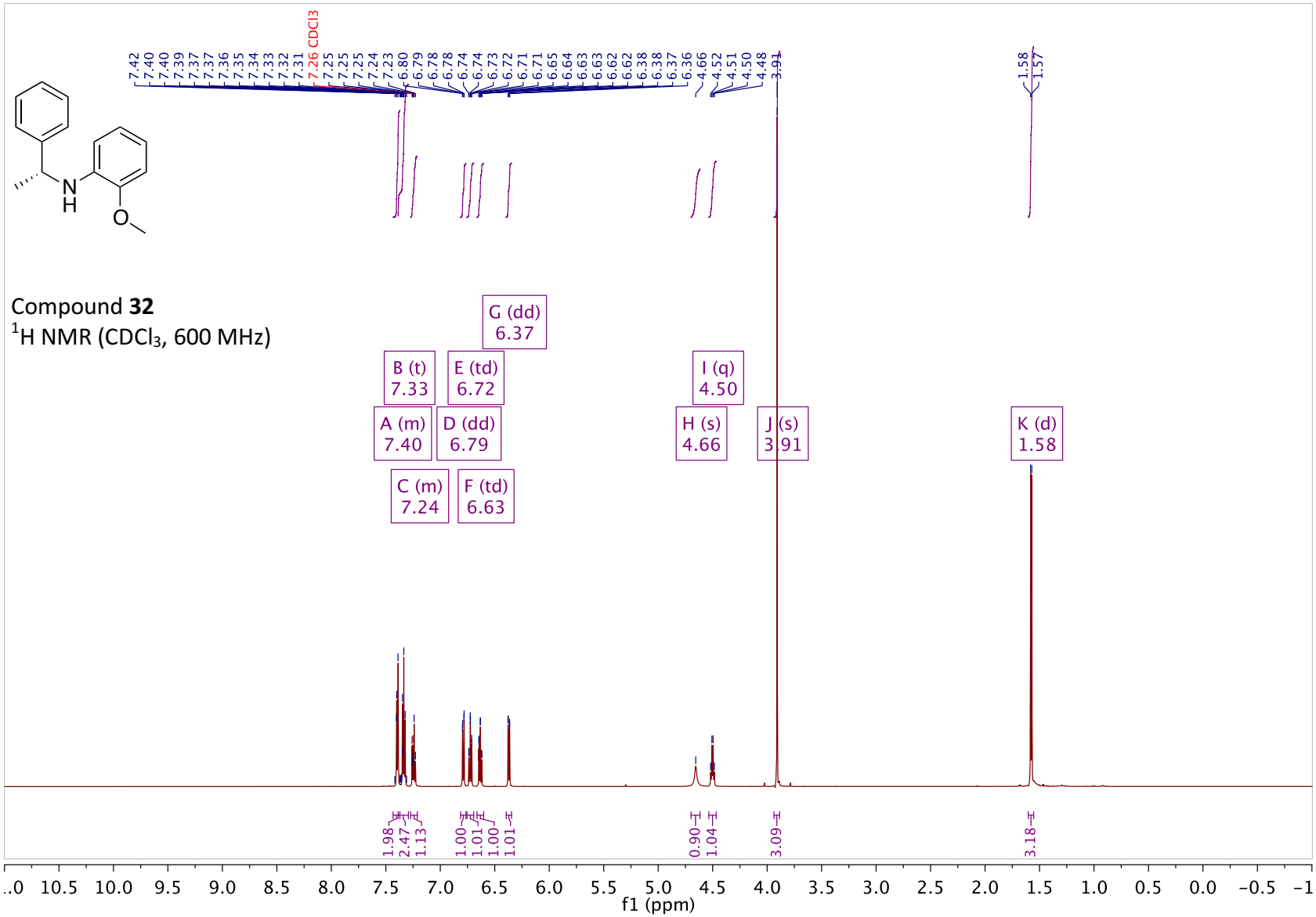
^{13}C NMR ($CDCl_3$, 151 MHz)

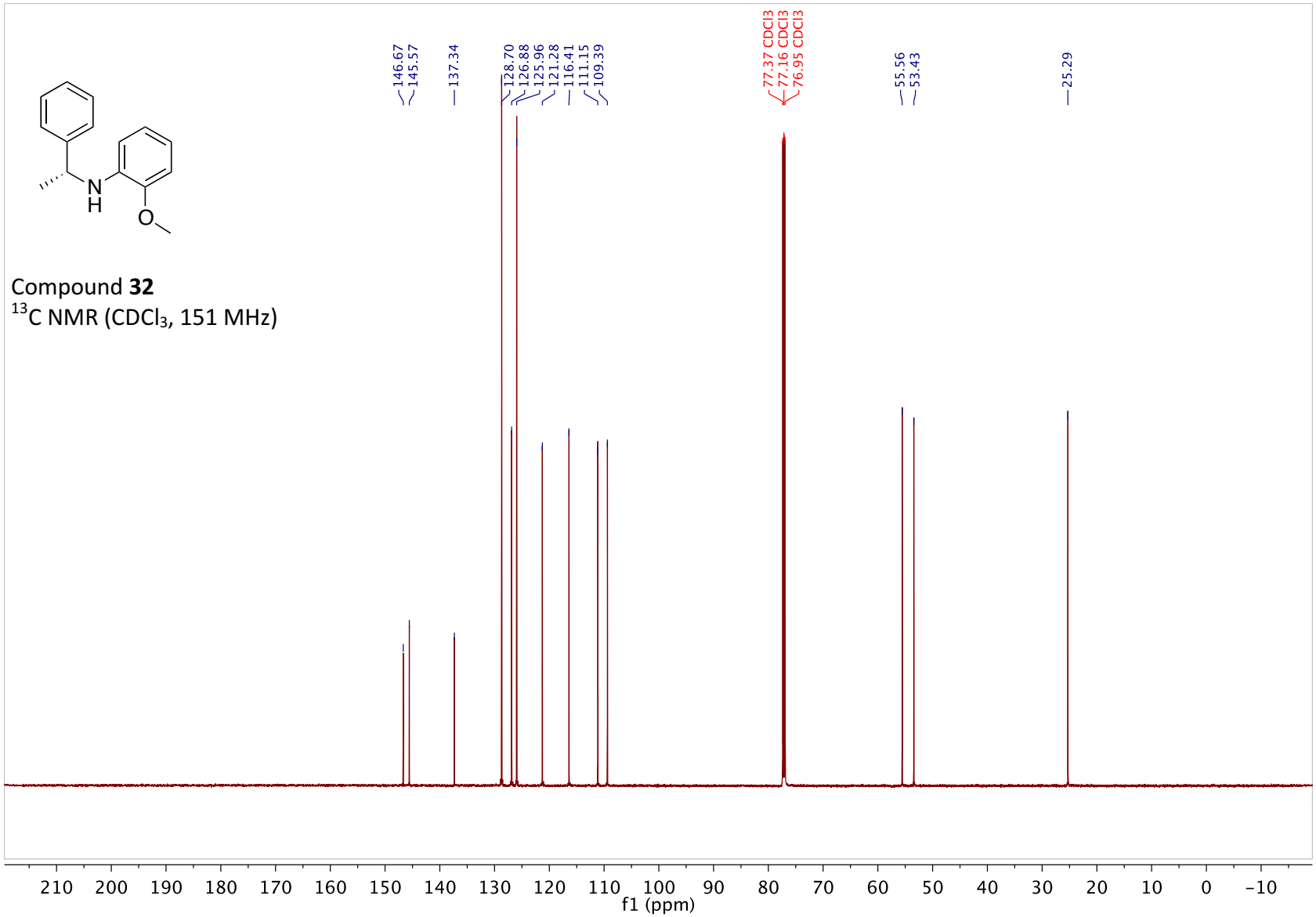

EtO2C
S
N
H
Compound 31
1H NMR (CDCl3, 600 MHz)
7.48
7.47
7.26 CDCl3
A (d)
7.48
B (d)
5.90
D (q)
4.27
C (d)
4.34
E (tdt)
3.17
F (m)
2.10
G (dt)
1.76
H (dt)
1.65
I (m)
1.34
J (dddt)
1.22
1.00
1.10
1.19
2.21
1.33
2.41
2.19
1.29
5.25
3.49
f1 (ppm)

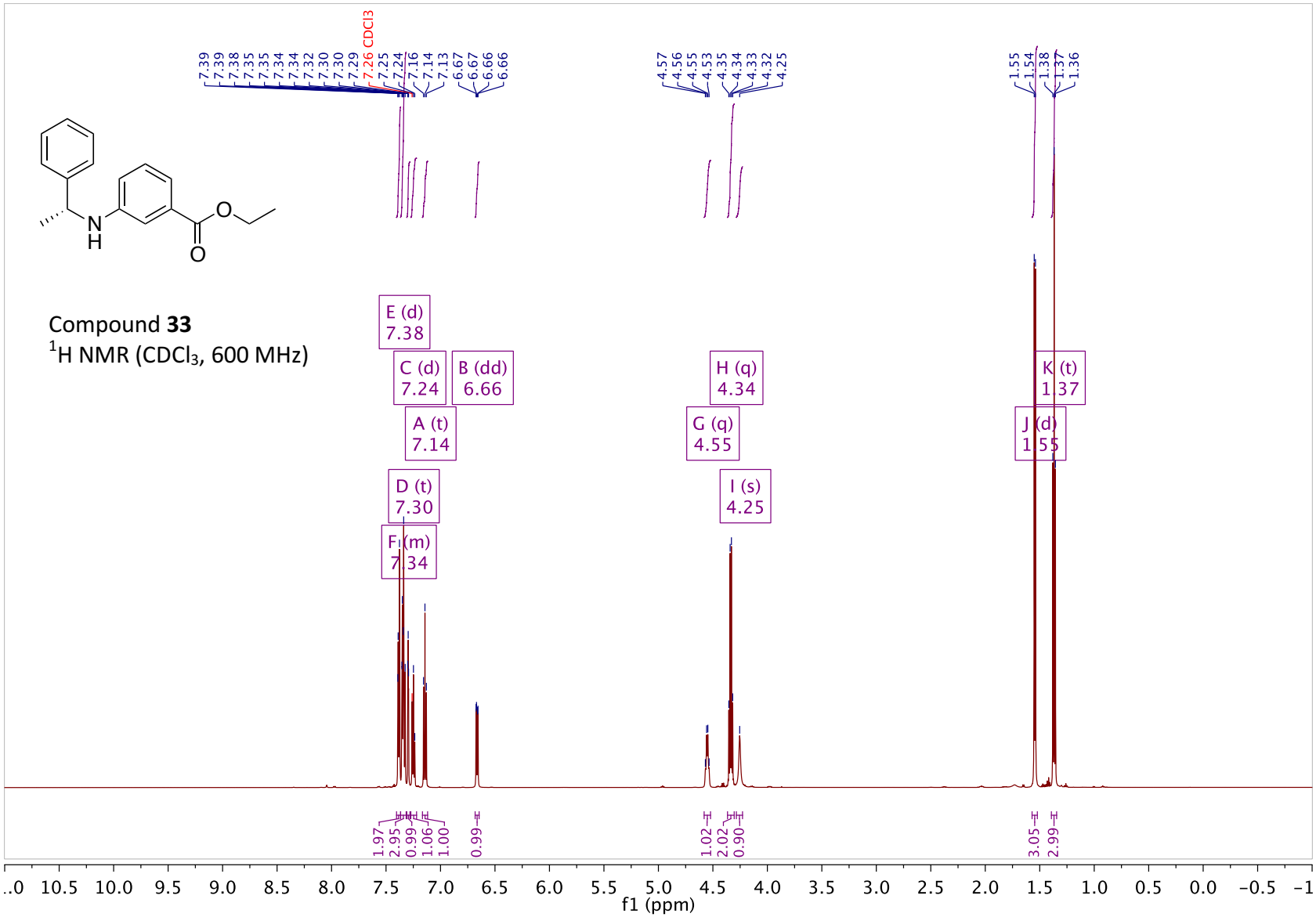


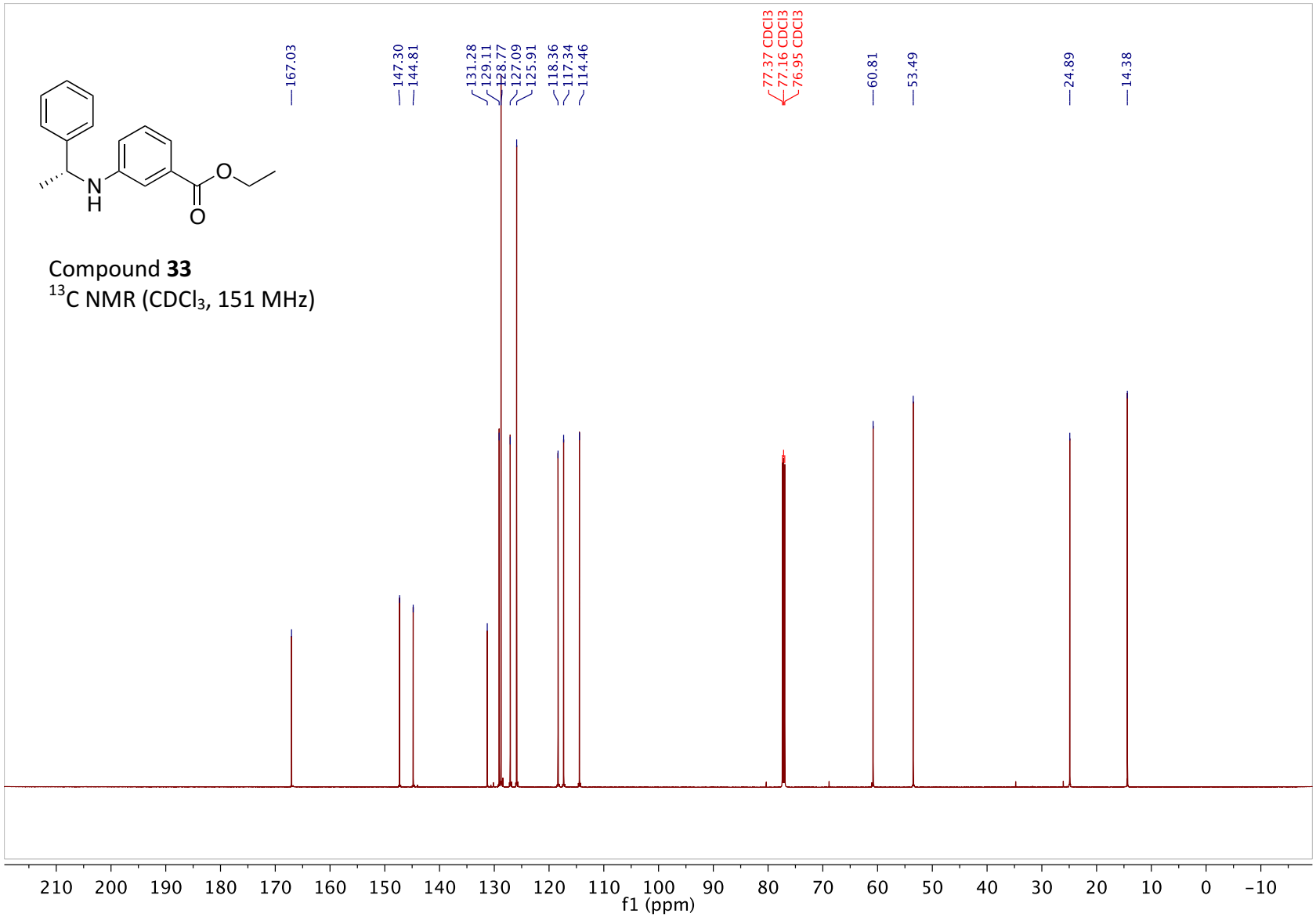
Compound **31**

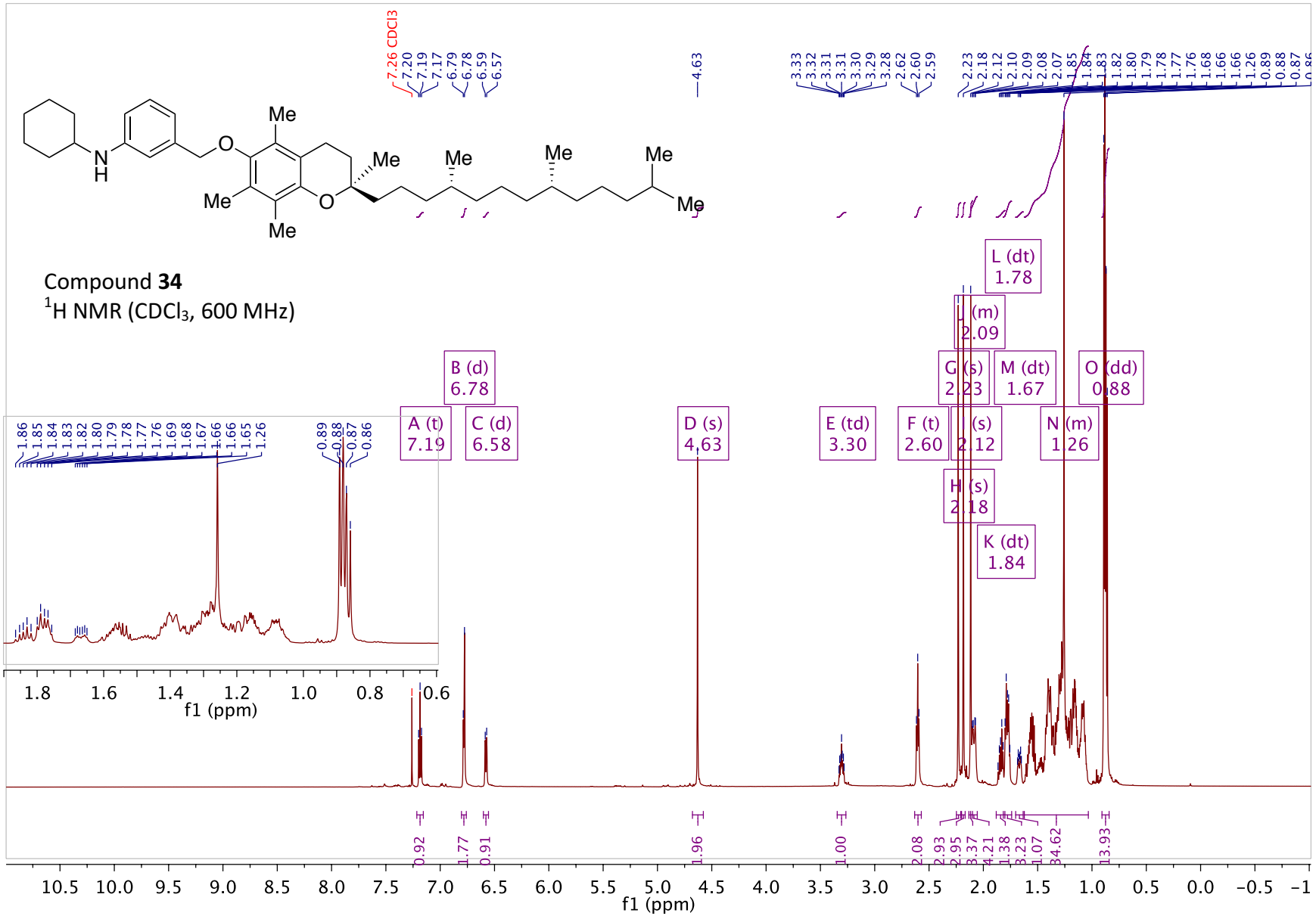
^{13}C NMR ($CDCl_3$, 151 MHz)

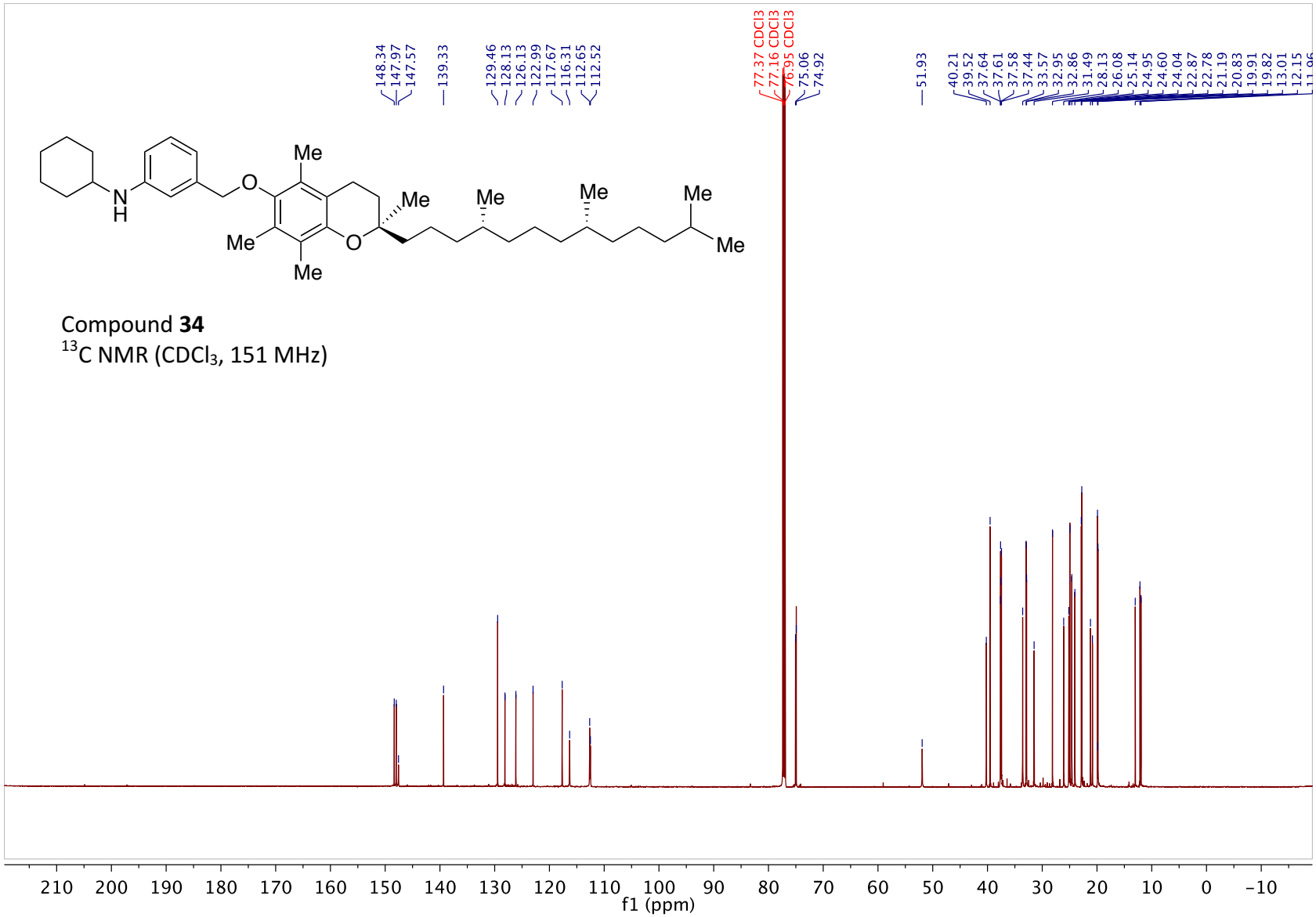

Compound **32**
^{1}H NMR ($CDCl_3$, 600 MHz)
G (dd) 6.37
B (t) 7.33
E (td) 6.72
I (q) 4.50
A (m) 7.40
D (dd) 6.79
H (s) 4.66
J (s) 3.91
K (d) 1.58
C (m) 7.24
F (td) 6.63
f1 (ppm)


146.67
145.57
137.34
128.70
126.88
125.96
121.28
116.41
111.15
109.39
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
55.56
53.43
25.29
N
H
O
Compound 32
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Compound **33**
^{1}H NMR ($CDCl_3$, 600 MHz)
E (d) 7.38
C (d) 7.24
B (dd) 6.66
A (t) 7.14
D (t) 7.30
F (m) 7.34
H (q) 4.34
G (q) 4.55
I (s) 4.25
K (t) 1.37
J (d) 1.55
f1 (ppm)


167.03
147.30
144.81
131.28
129.11
128.77
127.09
125.91
118.36
117.34
114.46
77.37 CDCl3
77.16 CDCl3
76.95 CDCl3
60.81
53.49
24.89
14.38
N
H
O
O
Compound 33
13C NMR (CDCl3, 151 MHz)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Compound **34**
^{1}H NMR ($CDCl_3$, 600 MHz)
A (t) 7.19
B (d) 6.78
C (d) 6.58
D (s) 4.63
E (td) 3.30
F (t) 2.60
G (s) 2.23
H (s) 2.18
I (s) 2.12
J (m) 2.09
K (dt) 1.84
L (dt) 1.78
M (dt) 1.67
N (m) 1.26
O (dd) 0.88
f1 (ppm)



Compound **34**

^{13}C NMR ($CDCl_3$, 151 MHz)