**Supporting Information**

# Silver-Catalyzed Ring-Opening Trifluoromethylthiolation/ Difluoromethylthiolation of Cycloalkanols with $PhSO_2SCF_2H$ or $PhSO_2SCF_3$

*Bin Xu,[a] Decai Wang,[a] Yonghong Hu*[a] and Qilong Shen*[b]*

*[a]Biotechnology and Pharmaceutical Engineering, Nanjing Tech University, Nanjing, Jiangsu Province, 210009, P. R. China*
*[b]Key Laboratory of Organofluorine Chemistry, Center for Excellence in Molecular Synthesis, Shanghai Institute of Organic Chemistry, University of Chinese Academy Sciences, Chinese Academy of Sciences, 345 Lingling Road, Shanghai 200032, P. R. China*

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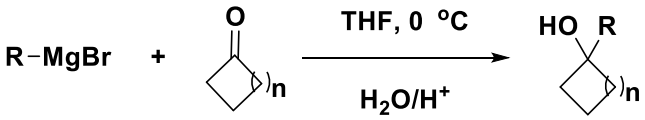
**General information**. All reactions were maintained under an argon atmosphere unless otherwise stated. All solvents were purified by standard method. $^{1}H$, $^{13}C$ and $^{19}F$ NMR spectra were acquired on 400 MHz, 125 MHz, 100 MHz, 375 MHz spectrometer (400 MHz for $^{1}H$ ; 100 MHz or 125 MHz for $^{13}C$; 375 MHz for $^{19}F$). $^{1}H$ NMR and $^{13}C$ NMR chemical shifts were determined relative to internal standard TMS at δ 0.0 ppm and $^{19}F$ NMR chemical shifts were determined relative to $CFCl_3$ as inter standard. Chemical shifts (δ) are reported in ppm, and coupling constants (*J*) are in hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad. All reactions were monitored by TLC or $^{19}F$ NMR. Flash column chromatograph was carried out using 300-400 mesh silica gel at medium pressure.

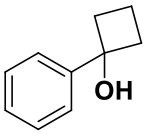
**Materials**. Cyclic alcohols (**3a**, **3c**, **3f**) were received from commercial sources. Solvents were freshly dried and degassed according to the purification handbook *Purification of Laboratory Chemicals* before using.

**General procedure A for the preparation of cycloalkanols**



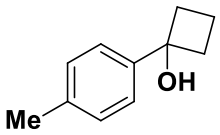

Aryl magnesium bromide (2.0 equiv., 1.0 M in $Et_2O$) in diethyl ether was added drop wise over 30 min at 0 $^oC$ to a solution of cyclic ketones (10 mmol, 1.0 equiv) in THF. The mixture was warmed to room temperature and was stirred overnight. Then the mixture was quenched with acidic water solution. The precipitate was removed by filtration. The filtrate was extracted with diethyl ether (30.0 mL × 3), washed with water and dried over anhydrous $Na_2SO_4$, filtered and concentrated. The residue was then purified by column chromatography (eluent: petroleum ether: ethyl acetate = 10:1) to afford the cycloalkanols **1a-e, 3j, 3l, 3n, 3o and 3p**.

**1-Phenylcyclobutanol 1a**[1]




The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-phenylcyclobutanol **1a** (1.1 g, 80%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.46 (m, 2 H), 7.45 – 7.35 (m, 2 H), 7.30 (m, 1 H), 2.69 – 2.46 (m, 2 H), 2.46 – 2.29 (m, 2 H), 2.14 – 1.93 (m, 1 H), 1.79 – 1.60 (m, 1 H); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 146.34, 128.46, 127.24, 125.05, 77.01, 36.84, 13.07 ppm.

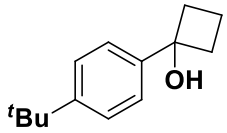
**1-(*p*-Tolyl)cyclobutanol 1b**




The general procedure **A** conducted with *p*-tolylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(*p*-tolyl)cyclobutanol **1b** (1.2 g, 72%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.35 (m, 2 H), 7.30 – 7.13

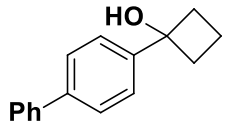
(m, 2 H), 2.81 – 2.47 (m, 2 H), 2.46 – 2.23 (m, 5 H), 2.14 – 1.84 (m, 1 H), 1.83 – 1.54 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 143.39, 136.85, 129.13, 125.13, 76.87, 36.83, 21.13, 13.06 ppm.

**1-(4-(*tert*-Butyl)phenyl)cyclobutanol 1c**



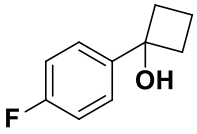

The general procedure **A** conducted with (4-(*tert*-butyl)phenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(4-(*tert*-butyl)phenyl)cyclobutanol **1c** (1.4 g, 70%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.29 (m, 4 H), 2.78 – 2.46 (m, 2 H), 2.48 – 2.26 (m, 2 H), 2.21 – 1.83 (m, 2 H), 1.89 – 1.45 (m, 1 H), 1.32 (d, *J* = 15.8 Hz, 9 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 150.20, 143.28, 125.37, 124.75, 76.87, 36.79, 34.51, 31.38, 13.02 ppm.

**1-([1,1'-Biphenyl]-4-yl)cyclobutanol 1d**



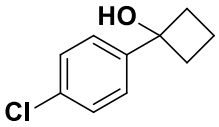

The general procedure **A** conducted with [1,1'-biphenyl]-4-ylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-([1,1'-biphenyl]-4-yl)cyclobutanol **1d** (1.5 g, 67%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.53 (m, 6 H), 7.52 – 7.42 (m, 2 H), 7.42 – 7.32 (m, 1 H), 2.72 – 2.53 (m, 2 H), 2.54 – 2.33 (m, 2 H), 2.15 (d, *J* = 1.9 Hz, 1 H), 2.12 – 1.98 (m, 1 H), 1.86 – 1.66 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 145.32, 140.84, 140.21, 128.82, 127.34, 127.23, 127.14, 125.50, 76.92, 36.99, 13.07 ppm.

**1-(4-Fluorophenyl)cyclobutanol 1e**



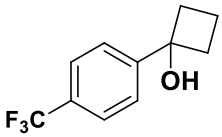
The general procedure **A** conducted with (4-fluorophenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(4-fluorophenyl)cyclobutanol **1e** (0.9 g, 56%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.34 (m, 2 H), 7.03 (m, 2 H), 2.64 – 2.46 (m, 2 H), 2.42 – 2.25 (m, 2 H), 2.17 – 1.80 (m, 1 H), 1.80 – 1.39 (m, 1 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -115.68 – -115.76 (m, 1 F); $^{13}$C NMR (101 MHz, $CDCl_3$) δ δ 161.98 (d, $J$ = 245.5 Hz), 142.10 (d, $J$ = 3.1 Hz), 126.84 (d, $J$ = 8.1 Hz), 115.12 (d, $J$ = 21.2 Hz), 76.61, 37.00, 12.91 ppm.

**1-(4-Chlorophenyl)cyclobutanol 1f**




The general procedure **A** conducted with (4-chlorophenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(4-chlorophenyl)cyclobutanol **1f** (0.9 g, 50%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.37 (m, 2 H), 7.35 – 7.27 (m, 2 H), 2.63 (s, 1 H), 2.56 – 2.42 (m, 2 H), 2.39 – 2.26 (m, 2 H), 2.11 – 1.89 (m, 1 H), 1.76 – 1.59 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 144.71, 132.99, 128.51, 126.56, 76.62, 36.95, 12.95 ppm.

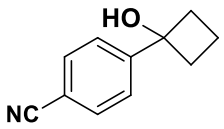
**1-(4-(Trifluoromethyl)phenyl)cyclobutanol 1g**




The general procedure **A** conducted with (4-(trifluoromethyl)phenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(4-(trifluoromethyl)phenyl)cyclobutanol **1g** (1.3 g, 62%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.09 – 7.18 (m, 4 H), 2.73 – 2.46 (m, 2 H), 2.46 – 2.28 (m, 2 H), 2.19 – 1.88 (m, 1 H), 1.86 – 1.62 (m, 1 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -62.51 (s); $^{13}$C NMR (101 MHz,

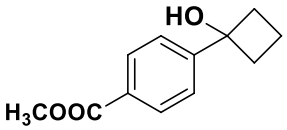
$CDCl_3$) δ 150.20, 129.40 (q, *J* = 33.3 Hz), 125.38 (q, *J* = 4.0 Hz), 125.31, 124.21 (q, *J* = 272.7 Hz), 76.70, 37.13, 12.97 ppm.

**4-(1-Hydroxycyclobutyl)benzonitrile 1h**



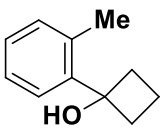

The general procedure **A** conducted with (4-cyanophenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 4-(1-hydroxycyclobutyl)benzonitrile **1h** (1.0 g, 60%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.57-7.60 (m, 4 H), 2.64 – 2.39 (m, 2 H), 2.36 (dt, *J* = 9.1, 8.2 Hz, 2 H), 2.20 – 1.88 (m, 1 H), 1.88 – 1.60 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 151.94, 132.24, 125.75, 118.93, 110.53, 76.50, 37.23, 13.02 ppm.

**Methyl 4-(1-hydroxycyclobutyl)benzoate 1i**




The general procedure **A** conducted with (4-(methoxycarbonyl)phenyl)magnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave methyl 4-(1-hydroxycyclobutyl)benzoate **1i** (1.7 g, 82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.0 Hz, 2 H), 7.54 (d, *J* = 8.3 Hz, 2 H), 3.89 (s, 3 H), 2.70 (s, 1 H), 2.49 – 2.56 (m, 2 H), 2.47 – 2.29 (m, 2 H), 2.26 – 1.93 (m, 1 H), 1.84 – 1.62 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 167.05, 151.51, 129.76, 128.81, 124.93, 76.77, 52.13, 37.09, 13.05 ppm.

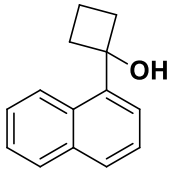
**1-(*o*-Tolyl)cyclobutanol 1j**




The general procedure **A** conducted with *o*-tolylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave

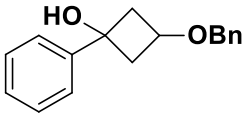
1-(*o*-tolyl)cyclobutanol **1j** (0.9 g, 55%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.27 (m, 1 H), 7.23 – 7.11 (m, 3 H), 2.96 – 2.59 (m, 2 H), 2.51 – 2.31 (m, 5 H), 2.30 – 2.05 (m, 1 H), 1.93 (s, 1 H), 1.84 – 1.47 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 142.97, 137.11, 131.76, 127.74, 125.52, 125.15, 79.08, 36.02, 20.20, 14.73.

**1-(Naphthalen-1-yl)cyclobutanol 1k**



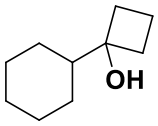

The general procedure **A** conducted with naphthalen-1-ylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-(naphthalen-1-yl)cyclobutanol **1k** (0.8 g, 41%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.38 – 8.25 (m, 1 H), 8.00 – 7.84 (m, 1 H), 7.81 (d, $J$ = 8.2 Hz, 1 H), 7.62 – 7.37 (m, 4 H), 2.97 – 2.82 (m, 2 H), 2.73 – 2.54 (m, 2 H), 2.32 (s, 1 H), 2.16 (m, 1 H), 1.83 – 1.53 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 140.40, 134.78, 130.82, 128.96, 128.75, 126.28, 125.76, 125.65, 124.84, 122.91, 78.53, 36.78, 14.54 ppm.

**3-(Benzyloxy)-1-phenylcyclobutanol 1l**



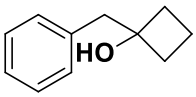

The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), 3-(benzyloxy)cyclobutanone (1.76g, 10.0 mmol) in THF (20.0 mL) gave 3-(benzyloxy)-1-phenylcyclobutanol **1l** (1.0 g, 40%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.43 (m, 2 H), 7.42 – 7.33 (m, 5 H), 7.34 – 7.26 (m, 2 H), 4.47 (s, 2 H), 3.86 (quint, $J$ = 6.7 Hz, 1H), 2.92-2.98 (m, 2 H), 2.45-2.51 (m, 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 145.47, 138.05, 128.59, 128.50, 127.94, 127.80, 127.46, 127.30, 125.24, 124.84, 70.56, 70.24, 65.39, 45.37 ppm.

**1-Cyclohexylcyclobutanol 1m**



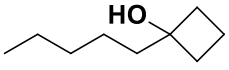

The general procedure **A** conducted with cyclohexylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-cyclohexylcyclobutanol **1m** (1.3 g, 85%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1).$^{1}$H NMR (400 MHz, $CDCl_3$) δ 2.21 – 2.06 (m, 2 H), 1.97 – 1.62 (m, 8 H), 1.57 – 1.43 (m, 1 H), 1.31-1.38 (m, 1 H), 1.29 – 0.95 (m, 5 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 78.03, 45.55, 33.82, 26.50, 26.47, 25.62, 12.40 ppm.

**1-Benzylcyclobutanol 1n**



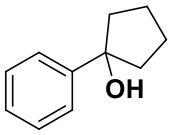

The general procedure **A** conducted with benzylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-benzylcyclobutanol **1n** (1.1 g, 70%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.06 (m, 5 H), 2.92 (s, 2 H), 2.36 – 2.08 (m, 2 H), 1.98-2.06 (m, 2 H), 1.93 – 1.71 (m, 1 H), 1.72 – 1.49 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 137.64, 130.15, 128.36, 126.57, 75.07, 45.55, 35.41, 12.24 ppm.

**1-Pentylcyclobutanol 1o**



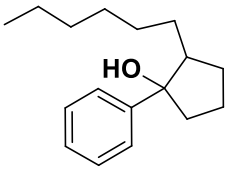

The general procedure **A** conducted with pentylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclobutanone (0.700 g, 10.0 mmol) in THF (20.0 mL) gave 1-pentylcyclobutanol **1o** (0.9 g, 63%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 2.12 – 1.88 (m, 5 H), 1.81 – 1.64 (m, 1 H), 1.63 – 1.46 (m, 2 H), 1.40 – 1.21 (m, 6 H), 0.87 (t, $J$ = 6.8 Hz, 3H).$^{13}$C NMR (101 MHz, $CDCl_3$) δ 75.40, 39.54, 35.88, 32.26, 23.08, 22.70, 14.05, 12.14 ppm.

**1-Phenylcyclopentanol 3j**[2]



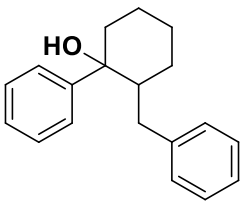

The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cyclopentanone (0.840 g, 10.0 mmol) in THF (20.0 mL) gave 1-phenylcyclopentanol **3j** (0.6 g, 40%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 30:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.42 (m, 2 H), 7.39 – 7.30 (m, 2 H), 7.22-7.26 (m, 1 H), 2.14 – 1.89 (m, 6 H), 1.80-1.85 (m, 2 H), 1.64 (s, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 147.08, 128.24, 126.83, 125.11, 83.51, 41.86, 23.88 ppm.

**2-Hexyl-1-phenylcyclopentanol 3l**




The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), 2-hexylcyclopentanone (1.68 g, 10.0 mmol) in THF (20.0 mL) gave 2-hexyl-1-phenylcyclopentanol **3l** (1.8 g, 75%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 40:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.51 – 7.39 (m, 2 H), 7.33 (t, *J* = 7.6 Hz, 2 H), 7.27 – 7.15 (m, 1 H), 2.17 – 1.99 (m, 2 H), 2.00 – 1.84 (m, 2 H), 1.85 – 1.69 (m, 1 H), 1.67 – 1.50 (m, 1 H), 1.41 – 1.06 (m, 10 H), 0.92 – 0.73 (m, 4 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 146.23, 128.09, 126.39, 125.03, 84.20, 50.94, 43.68, 31.81, 29.77, 29.59, 28.63, 28.06, 22.65, 21.76, 14.11 ppm. MS (EI): m/z (%) 133 (100). HRMS (EI) for $C_{17}H_{26}O$ Calcd: 246.1984; Found: 246.1992. IR (KBr): $\nu_{max}$ = 2950, 2856, 1718, 1445 cm$^{-1}$.

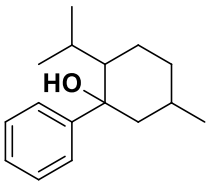
**2-Benzyl-1-phenylcyclohexanol 3n**




The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0

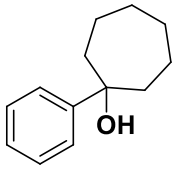
mmol, 1.00 N), 2-benzylcyclohexanone (1.88 g, 10.0 mmol) in THF (20.0 mL) gave 2-benzyl-1-phenylcyclohexanol **3n** (2.0 g, 78%) as a white solid (M.P.: 93.2-94.9 ℃) (eluent: petroleum ether: ethyl acetate = 40:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.7 Hz, 2 H), 7.40 (t, *J* = 7.8 Hz, 2 H), 7.33 – 7.23 (m, 1 H), 7.23 – 7.16 (m, 2 H), 7.16 – 7.09 (m, 1 H), 6.95 (d, *J* = 7.1 Hz, 2 H), 2.42-2.46 (m, 1 H), 2.11-2.17 (m, 1 H), 2.08 – 1.93 (m, 1 H), 1.90 – 1.69 (m, 4 H), 1.68 – 1.56 (m, 2 H), 1.48 – 1.34 (m, 1 H), 1.22-1.30 (m, 1 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 148.24, 141.43, 129.08, 128.33, 128.11, 126.50, 125.64, 124.74, 76.41, 47.79, 41.76, 36.51, 26.74, 25.94, 22.12 ppm. MS (EI): m/z (%) 120 (100). HRMS (EI) for $C_{19}H_{22}O$ Calcd: 266.1671; Found: 266.1669. IR (KBr): $\nu_{max}$ = 2931, 2854, 1493, 1444 cm$^{-1}$.

**2-Isopropyl-5-methyl-1-phenylcyclohexanol 3o**




The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), 2-isopropyl-5-methylcyclohexanone (1.54 g, 10.0 mmol) in THF (20.0 mL) gave 2-isopropyl-5-methyl-1-phenylcyclohexanol **3o** (1.3 g, 56%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.43-7.51 (m, 2 H), 7.33-7.37 (m, 2 H), 7.29 – 7.17 (m, 1 H), 1.81-1.90 (m, 2 H), 1.75 – 1.58 (m, 5 H), 1.56 – 1.37 (m, 2 H), 1.17 – 0.95 (m, 1 H), 0.97 – 0.87 (m, 3 H), 0.88 – 0.79 (m, 3 H), 0.79 – 0.69 (m, 3 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 148.68, 128.13, 126.16, 124.66, 78.45, 51.67, 49.98, 35.25, 28.56, 26.75, 23.78, 22.28, 21.37, 18.44 ppm.

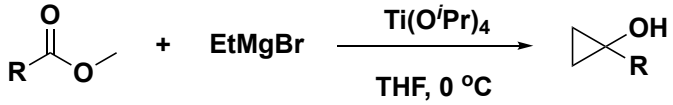
**1-Phenylcycloheptanol 3p**[3]




The general procedure **A** conducted with phenylmagnesium bromide (20.0 mL, 20.0 mmol, 1.00 N), cycloheptanone (1.12 g, 10.0 mmol) in THF (20.0 mL) gave

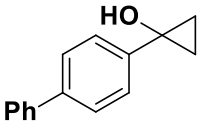
1-phenylcycloheptanol **3p** (1.3 g, 67%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (300 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.2 Hz, 2 H), 7.33 (t, *J* = 7.4 Hz, 2 H), 7.31 – 6.93 (m, 1 H), 2.41 – 1.31 (m, 12 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 150.78, 128.19, 126.54, 124.50, 76.86, 43.25, 29.16, 22.60 ppm.

**General procedure B for the preparation of cyclopropanols**



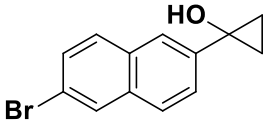

Ethyl magnesium bromide (10.0 mL, 2.0 equiv., 1.0 M in $Et_2O$) in THF was added dropwise over 30 min at 0 °C to a solution of ester (5.0 mmol, 1.0 equiv.) and titanium isopropoxide (1.6 g, 1.1 equiv.) in THF (20.0 mL). The mixture was warmed to room temperature and was stirred overnight. The mixture was then quenched with water. The precipitate was removed by filtration (30.0 mL × 3), washed with water and dried over anhydrous $Na_2SO_4$, filtered and concentrated. The residue was then purified by column chromatography to afford the cyclopropanols **3b, 3d, 3g, 3h and 3i** (eluent: petroleum ether: ethyl acetate = 10:1).

**1-([1,1'-Biphenyl]-4-yl)cyclopropanol 3b**




The general procedure **B** conducted with ethylmagnesium bromide (10 ml, 10.0 mmol, 1.00 N), titanium isopropoxide (1.6 g, 5.5 mmol) and methyl [1,1'-biphenyl]-4-carboxylate (1.1 g, 5.0 mmol) in THF (20.0 mL) gave 1-([1,1'-biphenyl]-4-yl)cyclopropanol **3b** (0.6 g, 54%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.55-7.60 (m, 4 H) , 7.51 – 7.39 (m, 2 H), 7.40 – 7.30 (m, 3 H), 2.52 (s, 1 H), 1.29-1.32 (m, 2 H), 1.19 – 1.01 (m, 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 143.46, 140.84, 139.37, 128.81, 127.24, 127.12, 127.04, 124.87, 56.54, 18.06 ppm.

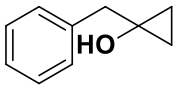
**1-(6-Bromonaphthalen-2-yl)cyclopropanol 3d**




The general procedure **B** conducted with ethylmagnesium bromide (10 ml, 10.0 mmol, 1.00 N), titanium isopropoxide (1.6 g, 5.5 mmol) and methyl methyl 6-bromo-2-naphthoate (1.3 g, 5.0 mmol) in THF (20.0 mL) gave

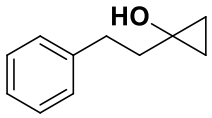
1-(6-bromonaphthalen-2-yl)cyclopropanol **3d** (0.7 g, 48%) as a white solid (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1 H), 7.78 (s, 1 H), 7.73 – 7.57 (m, 2 H), 7.56 – 7.45 (m, 1 H), 7.24-7.27 (m, 1 H), 2.60 (s, 1 H), 1.33 (q, *J* = 5.3 Hz, 2 H), 1.13 (q, *J* = 5.2 Hz, 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 142.31, 133.19, 131.68, 129.61, 129.59, 129.43, 127.29, 123.87, 122.88, 119.41, 56.74, 18.06 ppm.

**1-Benzylcyclopropanol 3g**[4]



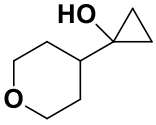

The general procedure **B** conducted with ethylmagnesium bromide (10 ml, 10.0 mmol, 1.00 N), titanium isopropoxide (1.6 g, 5.5 mmol) and methyl methyl 2-phenylacetate (0.8 g, 5.0 mmol) in THF (20.0 mL) gave 1-benzylcyclopropanol **3g** (0.5 g, 72%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.10 (m, 5 H), 2.87 (s, 2 H), 1.96 (s, 1 H), 0.80 (q, *J* = 5.2 Hz, 2 H), 0.63 (q, *J* = 5.0 Hz, 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 138.70, 129.51, 128.54, 126.65, 56.12, 44.13, 13.24 ppm.

**1-Phenethylcyclopropanol 3h**[5]



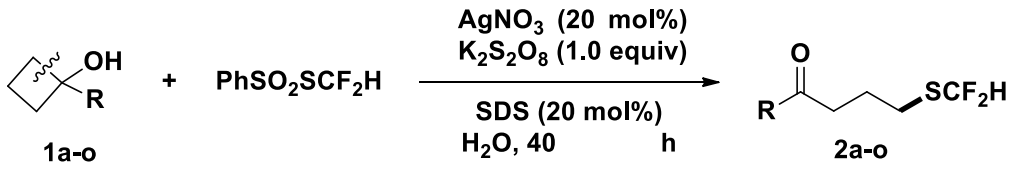

The general procedure **B** conducted with ethylmagnesium bromide (10 ml, 10.0 mmol, 1.00 N), titanium isopropoxide (1.6 g, 5.5 mmol) and methyl methyl 3-phenylpropanoate (0.8 g, 5.0 mmol) in THF (20.0 mL) gave 1-phenethylcyclopropanol **3h** (0.6 g, 75%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 20:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.84 – 6.99 (m, 5 H), 2.86-2.93 (m, 2 H), 1.87-1.93 (m, 2 H), 0.78-0.82 (m, 2 H), 0.47-0.50 (m 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 142.41, 142.38, 128.51, 125.91, 55.66, 40.53, 32.58, 13.59 ppm.

**1-(Tetrahydro-2 H-pyran-4-yl)cyclopropanol 3i**[6]



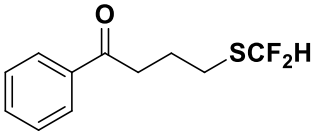
The general procedure **B** conducted with ethylmagnesium bromide (10 ml, 10.0 mmol, 1.00 N), titanium isopropoxide (1.6 g, 5.5 mmol) and methyl methyl tetrahydro-2 H-pyran-4-carboxylate (0.8 g, 5.0 mmol) in THF (20.0 mL) gave 1-(tetrahydro-2 H-pyran-4-yl)cyclopropanol **3i** (0.5 g, 70%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 30:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 4.75 (s, 1 H), 4.27 – 3.73 (m, 2 H), 3.25-3.32 (m, 2 H), 1.99 – 1.33 (m, 4 H), 1.37 – 0.96 (m, 1 H), 0.91 – 0.48 (m, 2 H), 0.52 – 0.14 (m, 2 H); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 68.02, 58.19, 42.07, 28.68, 12.06 ppm.

**General procedure for sliver-catalyzed ring-opening difluoromethylation of cyclobutanol**



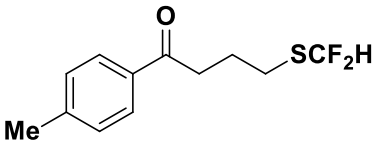

Cyclobutanol (0.300 mmol), $AgNO_3$ (10.2 mg, $6.00\times10^{-2}$ mmol), sodium dodecyl sulfate (SDS) (18.0 mg, $6.00\times10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol), $H_2O$ (0.5 mL) were placed into an oven-dried Schlenk tube that was equipped with a stirring bar under an atmosphere of argon. S-(Difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol) was added. The tube was quickly sealed with a rubber stopper. The reaction was stirred at 40 $^{o}$C for 12 h and was then allowed to cool to room temperature. The mixture was extracted with diethyl ether (20 ml × 3), The organic layer was combined , dried over anhydrous $Na_2SO_4$ and concentrated under vacuum. The residue was purified by flash column chromatography (eluent: petroleum ether: ethyl acetate = 100:1). The yields of the products were calculated based on cyclobutanol.

**4-((Difluoromethyl)thio)-1-phenylbutan-1-one 2a**



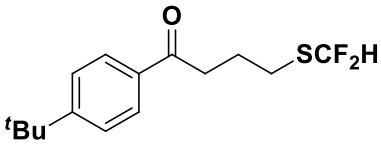

The general procedure conducted with 1-phenylcyclobutanol (44.5 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-phenylbutan-1-one **2a** (57 mg, 82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.8 Hz, 2 H), 7.57 (t, *J* = 7.2 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 2 H), δ 6.83 (t, *J* = 56.3 Hz, 1H) , 3.14 (t, *J* = 7.0 Hz, 2 H), 2.93 (t, *J* = 7.1 Hz, 2 H), 2.14 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.50 (d, *J* = 56.3 Hz).; $^{13}$C NMR (101 MHz, $CDCl_3$) δ 198.91, 136.74, 133.16, 128.62, 127.96, 120.64 (t, *J* = 272.7 Hz), 36.63, 26.82, 24.38 ppm. MS (EI): m/z (%) 120 (100). HRMS (EI) for $C_{11}H_{12}F_2OS$ Calcd: 230.0577; Found: 230.0582. IR (KBr): $\nu_{max}$= 1685, 1597 cm$^{-1}$.

**4-((Difluoromethyl)thio)-1-(*p*-tolyl)butan-1-one 2b**




The general procedure conducted with 1-(p-tolyl)cyclobutanol (48.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-(p-tolyl)butan-1-one **2b** (56.4 mg, 77%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.1 Hz, 2 H), 7.24 (d, *J* = 8.0 Hz, 2 H), 6.80 (t, *J* = 56.3 Hz, 1H), 3.09 (t, *J* = 7.0 Hz, 2 H), 2.91 (t, *J* = 7.1 Hz, 2 H), 2.39 (s, 3H), 2.10 (quint, *J* = 7.1 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.50 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 198.56, 143.97, 134.29, 129.29, 128.09, 120.67 (t, *J* = 272.6 Hz), 36.52, 26.88 (t, *J* = 3.1 Hz), 24.48, 21.59 ppm. MS (EI): m/z (%) 119 (100). HRMS (EI) for $C_{12}H_{14}F_2OS$ Calcd: 244.0733; Found: 244.0731. IR (KBr): $\nu_{max}$= 1682, 1573 $cm^{-1}$.

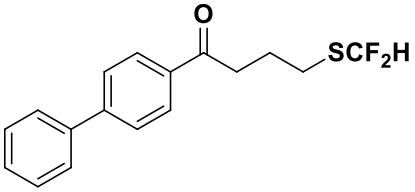
**1-(4-(*tert*-Butyl)phenyl)-4-((difluoromethyl)thio)butan-1-one 2c**




The general procedure conducted with 1-(4-(*tert*-butyl)phenyl)cyclobutanol (61.3 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-(*tert*-butyl)phenyl)-4-((difluoromethyl)thio)butan-1-one **2c** (54 mg, 63%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.4 Hz, 2 H), 7.50 (d, *J* = 8.4 Hz, 2 H), 6.84 (t, *J* = 56.3 Hz, 1H), 3.14 (t, *J* = 7.0 Hz, 2 H), 2.95 (t, *J* = 7.1 Hz, 2 H), 2.15 (quint, *J* = 7.0 Hz, 2 H), 1.36 (s, 9H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.48 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 198.58, 156.93, 134.19, 127.95, 125.56, 120.67 (t, *J* = 272.7 Hz), 36.53,

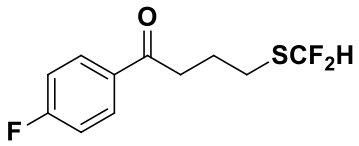
35.09, 31.04, 26.89, 24.48 ppm. MS (EI): m/z (%) 161 (100). HRMS (EI) for $C_{15}H_{20}F_2OS$ Calcd: 286.1203; Found: 286.1198. IR (KBr): $\nu_{max}$= 1682, 1605 $cm^{-1}$.

**1-([1,1'-Biphenyl]-4-yl)-4-((difluoromethyl)thio)butan-1-one 2d**




The general procedure conducted with 1-([1,1'-biphenyl]-4-yl)cyclobutanol (67.3 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-([1,1'-biphenyl]-4-yl)-4-((difluoromethyl)thio)butan-1-one **2d** (62.5 mg, 68%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 8.2 Hz, 2 H), 7.68 (d, *J* = 8.2 Hz, 2 H), 7.62 (d, *J* = 7.4 Hz, 2 H), 7.46 (t, *J* = 7.4 Hz, 2 H), 7.39 (t, *J* = 7.2 Hz, 1 H), 6.82 (t, *J* = 56.3 Hz, 1 H), 3.15 (t, *J* = 6.9 Hz, 2 H), 2.94 (t, *J* = 7.1 Hz, 2 H), 2.15 (quint, *J* = 7.0 Hz, 2 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -92.45 (d, *J* = 56.3 Hz); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 198.53 , 145.85, 139.78, 135.39, 128.94, 128.58, 128.25, 127.26, 127.24, 120.66 (t, *J* = 272.7 Hz), 36.68, 26.85, 24.44 ppm. MS (EI): m/z (%) 196 (100). HRMS (EI) for $C_{17}H_{16}F_2OS$ Calcd: 306.0890; Found: 306.0887. IR (KBr): $\nu_{max}$= 1677, 1603 $cm^{-1}$.

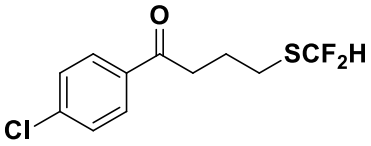
**4-((Difluoromethyl)thio)-1-(4-fluorophenyl)butan-1-one 2e**




The general procedure conducted with 1-(4-fluorophenyl)cyclobutanol (49.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-(4-fluorophenyl)butan-1-one **2e** (60 mg, 80%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.99 (dd, *J* = 8.6, 5.5 Hz, 2 H), 7.13 (t, *J* = 8.5 Hz, 2 H), 6.82 (t, *J* = 56.2 Hz,

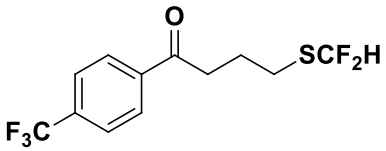
1H), 3.10 (t, *J* = 7.0 Hz, 2 H), 2.92 (t, *J* = 7.1 Hz, 2 H), 2.12 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz,$CDCl_3$) δ -92.50 (d, *J* = 56.2 Hz), -105.10 (tt, *J* = 8.4, 5.4 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.28, 165.77 (d, *J* = 254.9 Hz), 133.17 (d, *J* = 3.0 Hz), 130.59 (d, *J* = 9.3 Hz), 120.61 (t, *J* = 272.7 Hz), 115.70 (d, *J* = 21.9 Hz), 36.50, 26.74 (t, *J* = 3.1 Hz), 24.32 ppm. MS (EI): m/z (%) 138 (100). HRMS (EI) for $C_{11}H_{11}F_3OS$ Calcd: 248.0483; Found: 248.0487. IR (KBr): $\nu_{max}$= 1685, 1598 cm$^{-1}$.

**1-(4-Chlorophenyl)-4-((difluoromethyl)thio)butan-1-one 2f**




The general procedure conducted with 1-(4-chlorophenyl)cyclobutanol (54.8 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-chlorophenyl)-4-((difluoromethyl)thio)butan-1-one **2f** (44.5 mg, 56%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.6 Hz, 2 H), 7.43 (d, *J* = 8.6 Hz, 2 H), 6.82 (t, *J* = 56.2 Hz, 1H), 3.10 (t, *J* = 7.0 Hz, 2 H), 2.92 (t, *J* = 7.1 Hz, 2 H), 2.12 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.48 (d, *J* = 56.2 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.65, 139.61, 135.03, 129.38, 128.93, 120.58 (t, *J* = 272.8 Hz), 36.56, 26.70 (t, *J* = 3.2 Hz), 24.27 ppm. MS (EI): m/z (%) 154 (100). HRMS (EI) for $C_{11}H_{11}ClF_2OS$ Calcd: 264.0187; Found: 264.0181. IR (KBr): $\nu_{max}$= 1685, 1590 cm$^{-1}$.

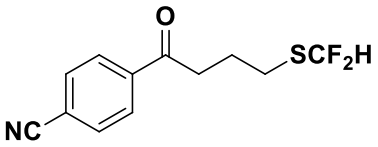
**4-((Difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)butan-1-one 2g**




The general procedure conducted with 1-(4-(trifluoromethyl)phenyl)cyclobutanol (64.8 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave

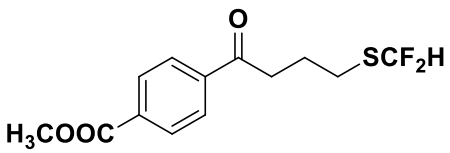
4-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)butan-1-one **2g** (53.7 mg, 60%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.1 Hz, 2 H), 7.73 (d, *J* = 8.2 Hz, 2 H), 6.82 (t, *J* = 56.2 Hz, 1H), 3.16 (t, *J* = 6.9 Hz, 2 H), 2.94 (t, *J* = 7.1 Hz, 2 H), 2.15 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -63.21 (s), -92.53 (d, *J* = 56.2 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.97, 139.38, 134.53 (q, *J* = 32.3 Hz), 128.34, 125.75 (q, *J* = 3.7 Hz), 123.59 (q, *J* = 274.7 Hz), 120.58 (t, *J* = 273.7 Hz), 36.91, 26.64 (t, *J* = 3.2 Hz), 24.19 ppm. MS (EI): m/z (%) 188 (100). HRMS (EI) for $C_{12}H_{11}F_5OS$ Calcd: 298.0451; Found: 298.0457. IR (KBr): $\nu_{max}$= 1693, 1582 cm$^{-1}$.

**4-(4-((Difluoromethyl)thio)butanoyl)benzonitrile 2h**



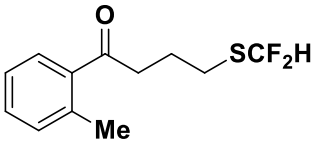

The general procedure conducted with 4-(1-hydroxycyclobutyl)benzonitrile (52 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-(4-((difluoromethyl)thio)butanoyl)benzonitrile **2h** (62.8 mg, 82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.7 Hz, 2 H), 7.76 (d, *J* = 8.7 Hz, 2 H), 6.81 (t, *J* = 56.2 Hz, 1H), 3.14 (t, *J* = 6.9 Hz, 2 H), 2.93 (t, *J* = 7.0 Hz, 2 H), 2.13 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.49 (d, *J* = 56.2 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.62, 139.64, 132.59, 128.43, 119.89 (dd, *J* = 406.5, 139.4 Hz), 117.90, 116.51, 36.92, 26.56 (t, *J* = 3.1 Hz), 24.10 ppm. MS (EI): m/z (%) 145 (100). HRMS (EI) for $C_{12\,H11}F_2NOS$ Calcd: 255.0529; Found: 255.0534. IR (KBr): $\nu_{max}$= 2232, 1689 cm$^{-1}$.

**Methyl 4-(4-((difluoromethyl)thio)butanoyl)benzoate 2i**



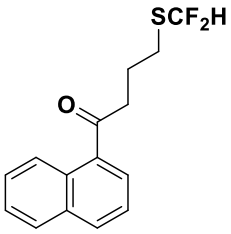
The general procedure conducted with methyl 4-(1-hydroxycyclobutyl)benzoate (62 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave methyl 4-(4-((difluoromethyl)thio)butanoyl)benzoate **2i** (77.8 mg, 90%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 40:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.1 Hz, 2 H), 7.97 (d, *J* = 8.0 Hz, 2 H), 6.80 (t, *J* = 56.2 Hz, 1H), 3.91 (s, 3H), 3.13 (t, *J* = 6.9 Hz, 2 H), 2.91 (t, *J* = 7.0 Hz, 2 H), 2.30 – 1.93 (m, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.53 (d, *J* = 56.2 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 198.41, 166.13, 139.83, 133.92, 129.83, 127.85, 120.56 (t, *J* = 272.8 Hz), 52.43, 36.96 (s), 26.63 (t, *J* = 3.1 Hz), 24.19 ppm. MS (EI): m/z (%) 178 (100). HRMS (EI) for $C_{13}H_{14}F_2O_3S$ Calcd: 288.0632; Found: 288.0634. IR (KBr): $\nu_{max}$ = 1724, 1689 cm$^{-1}$.

**4-((Difluoromethyl)thio)-1-(*o*-tolyl)butan-1-one 2j**



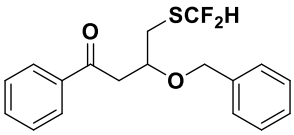

The general procedure conducted with 1-(o-tolyl)cyclobutanol (48.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-(o-tolyl)butan-1-one **2j** (63 mg, 86%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 7.7 Hz, 1 H), 7.36 (t, *J* = 7.5 Hz, 1 H), 7.25 (t, *J* = 8.4 Hz, 2 H), 6.80 (t, *J* = 56.3 Hz, 1 H), 3.04 (t, *J* = 7.0 Hz, 2 H), 2.90 (t, *J* = 7.1 Hz, 2 H), 2.48 (s, 3 H), 2.09 (quint, *J* = 7.1 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.57 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 202.91, 138.10, 137.66, 132.01, 131.37, 128.39, 125.71, 120.60 (t, *J* = 272.7 Hz), 39.51, 26.76, 24.52, 21.28 ppm. MS (EI): m/z (%) 119 (100). HRMS (EI) for $C_{12}H_{14}F_2OS$ Calcd: 244.0733; Found: 244.0743. IR (KBr): $\nu_{max}$ = 2923,1684, 1601, 1570 cm$^{-1}$.

**4-((Difluoromethyl)thio)-1-(naphthalen-1-yl)butan-1-one 2k**




The general procedure conducted with 1-(naphthalen-1-yl)cyclobutan-1-ol (59.5 mg, 0.300 mmol,), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-(naphthalen-1-yl)butan-1-one **2k** (79.0 mg, 95%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 8.60 (d, *J* = 8.5 Hz, 1 H), 7.99 (d, *J* = 8.2 Hz, 1 H), 7.88 (d, *J* = 7.4 Hz, 2 H), 7.70 – 7.39 (m, 3 H), 6.83 (t, *J* = 56.3 Hz, 1 H), 3.21 (t, *J* = 7.0 Hz, 2 H), 2.97 (t, *J* = 7.1 Hz, 2 H), 2.19 (quint, *J* = 7.1 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.50 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 203.16, 135.71, 134.02, 132.82, 130.14, 128.50, 128.04, 127.61, 126.54, 125.73, 124.40, 120.69 (t, *J* = 272.7 Hz), 40.14, 26.86, 24.85 ppm. MS (EI): m/z (%) 127 (100). HRMS (EI) for $C_{15}H_{14}F_2OS$ Calcd: 280.0733; Found: 280.0731. IR (KBr): $\nu_{max}$ = 1678, 1593 cm$^{-1}$.

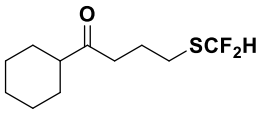
**3-(Benzyloxy)-4-((difluoromethyl)thio)-1-phenylbutan-1-one 2l**




The general procedure conducted with 3-(benzyloxy)-1-phenylcyclobutan-1-ol (76.3 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 3-(benzyloxy)-4-((difluoromethyl)thio)-1-phenylbutan-1-one **2l** (50.5 mg, 50%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 40:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.5 Hz, 2 H), 7.57 (t, *J* = 7.2 Hz, 1 H), 7.46 (t, *J* = 7.4 Hz, 2 H), 7.27 (m, 5 H), 6.89 (t, *J* = 57.0 Hz, 1 H), 4.61 (m, 2 H), 4.44 – 4.30 (m, 1 H), 3.22 (m, 4 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.68 (d, *J* = 56.9 Hz); $^{13}$C NMR (101 MHz,

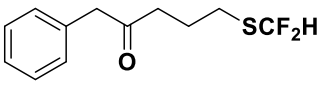
$CDCl_3$) δ 198.07, 137.98, 137.13, 133.67, 128.95, 128.71, 128.42, 128.20, 128.16, 120.80 (t, *J* = 272.9 Hz), 75.14, 72.67, 42.67, 31.86 ppm. MS (DART): m/z (%) 337 (100). HRMS (DART) for $C_{18}H_{19}F_2O_2S^+[M+H]^+$ Calcd: 337.1068; Found: 337.1068. IR (KBr): $\nu_{max}$ = 1678, 1593 $cm^{-1}$.

**1-Cyclohexyl-4-((difluoromethyl)thio)butan-1-one 2m**




The general procedure conducted with 1-cyclohexylcyclobutan-1-ol (46.3 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × $10^{-2}$ mmol), SDS (18.0 mg, 6.00 × $10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-cyclohexyl-4-((difluoromethyl)thio)butan-1-one **2m** (65.2 mg, 92%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 6.79 (t, *J* = 56.3 Hz, 1 H), 2.81 (t, *J* = 7.1 Hz, 2 H), 2.58 (t, *J* = 6.9 Hz, 2 H), 2.32 (m, 1 H), 1.92 (quint, *J* = 6.9 Hz, 2 H), 1.80 (m, 4 H), 1.74 – 1.58 (m, 1 H), 1.46 – 1.08 (m, 5 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.63 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 212.87, 120.60 (t, *J* = 272.6 Hz), 50.86, 38.47, 28.44, 26.72 (t, *J* = 3.1 Hz), 25.78, 25.60, 23.82 ppm. MS (EI): m/z (%) 83 (100). HRMS (EI) for $C_{11}H_{18}F_2OS$ Calcd: 236.1046; Found: 236.1051. IR (KBr): $\nu_{max}$ = 1705 $cm^{-1}$.

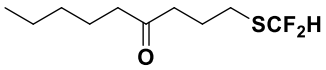
**5-((Difluoromethyl)thio)-1-phenylpentan-2-one 2n**




The general procedure conducted with 3-(benzyloxy)-1-phenylcyclobutan-1-ol (48.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × $10^{-2}$ mmol), SDS (18.0 mg, 6.00 × $10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 5-((difluoromethyl)thio)-1-phenylpentan-2-one **2n** (62.3 mg, 85%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 50:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.3 Hz, 2 H), 7.29 – 7.24 (m, 1 H), 7.19 (d, *J* = 6.9 Hz, 2 H), 6.74 (t, *J* = 56.3 Hz, 1 H), 3.68 (s, 2 H), 2.75 (t, *J* = 7.2 Hz, 2 H), 2.59 (t, *J* = 6.9 Hz, 2 H), 1.90 (quint, *J* =

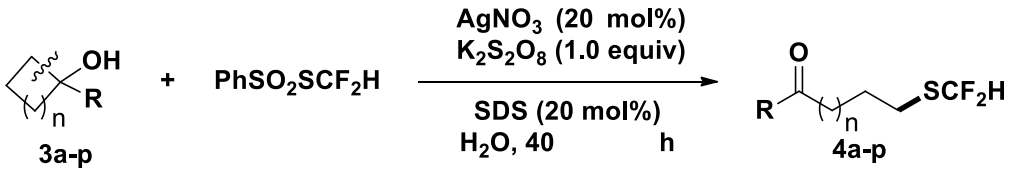
7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.56 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 207.13, 133.98, 129.35, 128.77, 127.10, 120.59 (t, *J* = 272.7 Hz), 50.21, 39.87, 26.52 (t, *J* = 3.2 Hz), 23.93 ppm. MS (EI): m/z (%) 89 (100). HRMS (EI) for $C_{12\ H14}F_2OS$ Calcd: 244.0733; Found: 244.0723. IR (KBr): $\nu_{max}$ = 1713 cm$^{-1}$.

**1-((Difluoromethyl)thio)nonan-4-one 2o**



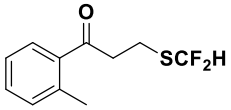

The general procedure conducted with 1-pentylcyclobutan-1-ol (42.7 mg,0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-((difluoromethyl)thio)nonan-4-one **2o** (61.2 mg, 91%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 6.77 (t, *J* = 56.3 Hz, 1 H), 2.80 (t, *J* = 7.2 Hz, 2 H), 2.53 (t, *J* = 7.0 Hz, 2 H), 2.37 (t, *J* = 7.5 Hz, 2 H), 1.91 (quint, *J* = 7.1 Hz, 2 H), 1.60 – 1.46 (m, 2 H), 1.45 – 1.11 (m, 4 H), 0.86 (t, *J* = 7.0 Hz, 3 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.65 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 210.03, 120.57 (t, *J* = 272.6 Hz), 42.87, 40.59, 31.34, 26.64 (t, *J* = 3.1 Hz), 23.91, 23.48, 22.39, 13.85 ppm. MS (EI): m/z (%) 43 (100). HRMS (EI) for $C_{10}H_{18}F_2OS$ Calcd: 224.1046; Found: 224.1039. IR (KBr): $\nu_{max}$ = 1695 cm$^{-1}$.

**General procedure for sliver-catalyzed ring-opening difluoromethylation of cycloalkanol.**



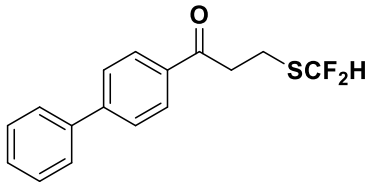

Cycloalkanol (0.300 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), sodium dodecyl sulfate (SDS) (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol), $H_2O$ (0.5 mL) were placed into an oven-dried Schlenk tube that was equipped with a stirring bar under an atmosphere of argon. S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol) was added. The tube was quickly sealed with a rubber stopper. The reaction was stirred at 40 $^{o}$C for 12 h and was then allowed to cool to room temperature. The mixture was extracted with diethyl ether (20 ml × 3), The organic layer was combined, dried over anhydrous $Na_2SO_4$ and concentrated under vacuum. The residue was purified by flash column chromatography (eluent: petroleum ether: ethyl acetate = 100:1). The yields of the products were calculated based on cyclic-alcohols.

**3-((Difluoromethyl)thio)-1-(*o*-tolyl)propan-1-one 4a**



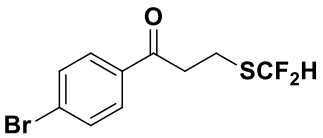

The general procedure conducted with 1-(o-tolyl)cyclopropanol (44.5 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 3-((difluoromethyl)thio)-1-(o-tolyl)propan-1-one **4a** (48.4 mg, 70%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, $J$ = 9.6 Hz, 2 H), 7.38 (m, 2 H), 6.87 (t, $J$ = 56.2 Hz, 1H), 3.40 (t, $J$ = 6.9 Hz, 2 H), 3.19 (t, $J$ = 6.8 Hz, 2 H), 2.42 (s, 3 H);$^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.77 (d, $J$ = 56.1 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.66, 138.53, 136.33, 134.22, 128.56, 128.49, 125.20, 120.80 (t, $J$ = 272.8 Hz), 39.79, 21.32, 21.25 (t, $J$ = 3.5 Hz) ppm. MS (EI): m/z (%) 119 (100). HRMS (EI) for $C_{11}H_{12}F_2OS$ Calcd: 230.0577; Found: 230.0584. IR (KBr): $\nu_{max}$ =1682, 1604, 1586 cm$^{-1}$.

**1-([1,1'-Biphenyl]-4-yl)-3-((difluoromethyl)thio)propan-1-one 4b**




The general procedure conducted with 1-([1,1'-biphenyl]-4-yl)cyclopropanol (63.0 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-([1,1'-biphenyl]-4-yl)-3-((difluoromethyl)thio)propan-1-one **4b** (70.1 mg, 80%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.5 Hz, 2 H), 7.70 (d, *J* = 8.6 Hz, 2 H), 7.64 (d, *J* = 8.7 Hz, 2 H), 7.48 (t, *J* = 7.9 Hz, 2 H), 7.42 (t, *J* = 7.3 Hz, 1 H), 6.89 (t, *J* = 56.1 Hz, 1 H), 3.45 (t, *J* = 6.8 Hz, 2 H), 3.22 (t, *J* = 6.8 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.69 (d, *J* = 56.1 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.06, 146.13, 139.69, 134.99, 128.97, 128.60, 128.33, 127.32, 127.25, 120.83 (t, *J* = 272.8 Hz), 39.79, 21.27 (t, *J* = 3.6 Hz) ppm. MS (EI): m/z (%) 181 (100). HRMS (EI) for $C_{16}H_{14}F_2OS$ Calcd: 292.0733; Found: 292.0724. IR (KBr): $\nu_{max}$ = 1677, 1603 cm$^{-1}$.

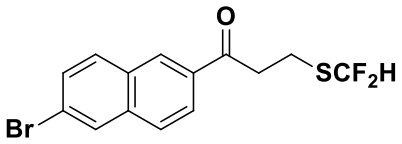
**1-(4-Bromophenyl)-3-((difluoromethyl)thio)propan-1-one 4c**




The general procedure conducted with 1-(4-bromophenyl)cyclopropanol (0.3 mmol, 63.9 mg), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-bromophenyl)-3-((difluoromethyl)thio)propan-1-one **4c** (51.3 mg, 58%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 10.6 Hz, 2 H), 7.60 (d, *J* = 8.6 Hz, 2 H), 6.84 (t, *J* = 56.0 Hz, 1H), 3.36 (t, *J* = 6.8 Hz, 2 H), 3.16 (t, *J* = 6.8 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ

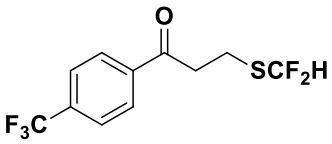
-92.77 (d, $J$ = 56.0 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 196.47, 135.00, 132.03, 129.48, 128.71, 120.70 (t, $J$ = 273.0 Hz), 39.77, 21.02 (t, $J$ = 3.6 Hz) ppm. MS (EI): m/z (%) 183 (100). HRMS (EI) for $C_{10}H_9BrF_2OS$ Calcd: 293.9526; Found: 293.9527. IR (KBr): $\nu_{max}$ = 1685, 1587 cm$^{-1}$.

**1-(6-Bromonaphthalen-2-yl)-3-((difluoromethyl)thio)propan-1-one 4d**




The general procedure conducted with 1-(6-bromonaphthalen-2-yl)cyclopropanol (78.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave (6-bromonaphthalen-2-yl)-3-((difluoromethyl)thio)propan-1-one **4d** (41.4 mg, 40%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 8.38 (s, 1H), 8.09 – 7.92 (m, 2 H), 7.78 (t, $J$ = 8.5 Hz, 2 H), 7.60 (dd, $J$ = 8.7, 1.8 Hz, 1 H), 6.88 (t, $J$ = 56.1 Hz, 1 H), 3.50 (t, $J$ = 6.9 Hz, 2 H), 3.23 (t, $J$ = 6.8 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.66 (d, $J$ = 56.0 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.04, 136.55, 133.91, 131.04, 130.85, 130.42, 129.94, 129.56, 127.66, 124.71, 123.08, 120.80 (t, $J$ = 273.7 Hz), 39.88, 21.24 (t, $J$ = 3.6 Hz) ppm. MS (EI): m/z (%) 126 (100). HRMS (EI) for $C_{14}H_{11}BrF_2OS$ Calcd: 343.9682; Found: 343.9678. IR (KBr): $\nu_{max}$ = 1682, 1618 cm$^{-1}$.

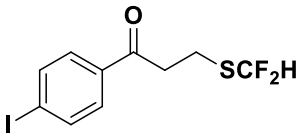
**3-((Difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)propan-1-one 4e**




The general procedure conducted with 1-(4-(trifluoromethyl)phenyl)cyclopropanol (60.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 3-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)propan-1-one **4e** (69.9 mg,

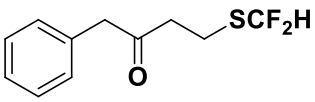
82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.2 Hz, 2 H), 7.74 (d, *J* = 8.2 Hz, 2 H), 6.87 (t, *J* = 56.0 Hz, 1H), 3.44 (t, *J* = 6.8 Hz, 2 H), 3.20 (t, *J* = 6.7 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -63.26 (s, 3 F), -92.81 (d, *J* = 56.0 Hz, 2 F); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 196.56, 138.89, 134.72 (q, *J* = 32.7 Hz), 128.32, 123.47 (q, *J* = 273.7 Hz), 125.78 (q, *J* = 3.7 Hz), 120.68 (t, *J* = 273.7 Hz), 40.14, 20.88 (t, *J* = 3.7 Hz) ppm. MS (EI): m/z (%) 173 (100). HRMS (EI) for $C_{11}H_9F_5OS$ Calcd:284.0294; Found: 284.0289. IR (KBr): $\nu_{max}$ = 1693 cm$^{-1}$.

**3-((Difluoromethyl)thio)-1-(4-iodophenyl)propan-1-one 4f**




The general procedure conducted with 1-(4-iodophenyl)cyclopropanol (78.0 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 3-((difluoromethyl)thio)-1-(4-iodophenyl)propan-1-one **4f** (67.7 mg, 66%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.5 Hz, 2 H), 7.64 (d, *J* = 8.6 Hz, 2 H), 6.84 (t, *J* = 56.0 Hz, 1H), 3.35 (t, *J* = 6.8 Hz,2 H), 3.16 (t, *J* = 6.8 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.76 (d, *J* = 56.0 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 196.79, 138.03, 135.52, 129.33, 120.70 (t, *J* = 273.0 Hz), 101.53, 39.70, 21.01 ppm. MS (EI): m/z (%) 231 (100). HRMS (EI) for $C_{10}H_9F_2IOS$ Calcd: 341.9387; Found: 341.9389. IR (KBr): $\nu_{max}$ = 1682, 1578 cm$^{-1}$.

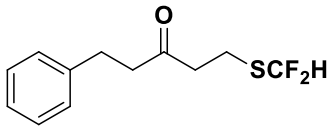
**4-((Difluoromethyl)thio)-1-phenylbutan-2-one 4g**




The general procedure conducted with 1-benzylcyclopropanol (44.5 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol)

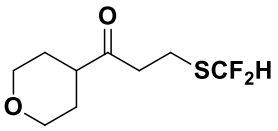
in $H_2O$ (0.5 mL) gave 4-((difluoromethyl)thio)-1-phenylbutan-2-one **4g** (49.1 mg, 71%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.34 (t, *J* = 7.2 Hz, 2 H), 7.28 (dd, *J* = 9.4, 6.5 Hz, 1 H), 7.23 – 7.16 (m, 2 H), 6.78 (t, *J* = 56.2 Hz, 1H), 3.71 (s, 2 H), 2.97 (t, *J* = 6.7 Hz, 2 H), 2.87 (t, *J* = 6.5 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.84 (d, *J* = 56.2 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 205.73, 133.52, 129.37, 128.82, 127.23, 120.67 (t, *J* = 272.8 Hz), 50.21, 42.67, 20.79 (d, *J* = 3.5 Hz) ppm. MS (EI): m/z (%) 91 (100). HRMS (EI) for $C_{11}H_{12}F_2OS$ Calcd: 230.0577; Found: 230.0585. IR (KBr): $\nu_{max}$ = 1716 cm$^{-1}$.

**1-((Difluoromethyl)thio)-5-phenylpentan-3-one 4h**




The general procedure conducted with 1-phenethylcyclopropanol (48.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-((difluoromethyl)thio)-5-phenylpentan-3-one **4h** (60.0 mg, 82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.29 (m, 2 H), 7.23 (m, 3 H), 6.84 (t, *J* = 56.1 Hz, 1 H), 3.03 (t, *J* = 6.8 Hz, 2 H), 2.96 (t, *J* = 7.6 Hz, 2 H), 2.85 (t, *J* = 6.8 Hz, 2 H), 2.80 (t, *J* = 7.5 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.84 (d, *J* = 56.1 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 209.96, 143.35, 131.22, 130.96, 128.90, 123.42 (t, *J* = 272.8 Hz), 47.12, 46.34, 32.27, 23.44 (t, *J* = 3.5 Hz) ppm. MS (EI): m/z (%) 91 (100). HRMS (EI) for $C_{12}H_{14}F_2OS$ Calcd: 244.0733; Found: 244.0730. IR (KBr): $\nu_{max}$ = 1715, 1603 cm$^{-1}$.

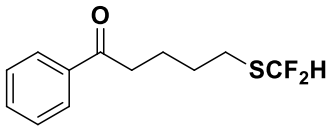
**3-((Difluoromethyl)thio)-1-(tetrahydro-2 H-pyran-4-yl)propan-1-one 4i**




The general procedure conducted with 1-(tetrahydro-2 H-pyran-4-yl)cyclopropanol (42.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol),

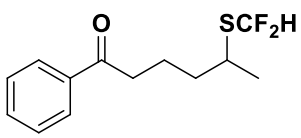
$K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 3-((difluoromethyl)thio)-1-(tetrahydro-2*H*-pyran-4-yl)propan-1-one **4i** (43.0 mg, 64%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 6.82 (t, *J* = 56.1 Hz, 1H), 4.25 – 3.88 (m, 2 H), 3.43 (td, *J* = 11.4, 2.5 Hz, 2 H), 3.02 (t, *J* = 6.6 Hz, 2 H), 2.89 (t, *J* = 6.6 Hz, 2 H), 2.76 – 2.39 (m, 1 H), 1.99 – 1.49 (m, 4 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.67 (d, *J* = 56.1 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 209.30, 120.73 (t, *J* = 272.8 Hz), 67.10, 47.55, 41.21, 27.87, 20.75 (t, *J* = 3.5 Hz) ppm. MS (EI): m/z (%) 91 (100). HRMS (EI) for $C_9H_{14}F_2O_2S$ Calcd: 224.0683; Found: 224.0688. IR (KBr): $\nu_{max}$ = 1717 cm$^{-1}$.

**5-((Difluoromethyl)thio)-1-phenylpentan-1-one 4j**




The general procedure conducted with 1-phenylcyclopentanol (48.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 5-((difluoromethyl)thio)-1-phenylpentan-1-one **4j** (49.1 mg, 67%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 8.02 – 7.88 (m, 2 H), 7.62 – 7.49 (m, 1 H), 7.44 (dd, *J* = 10.4, 4.7 Hz, 2 H), 6.79 (t, *J* = 56.3 Hz, 1 H), 2.99 (t, *J* = 7.0 Hz, 2 H), 2.83 (t, *J* = 7.2 Hz, 2 H), 1.94 – 1.80 (m, 2 H), 1.74 (ddt, *J* = 8.7, 6.9, 4.3 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.76 (d, *J* = 56.3 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 199.55, 136.82, 133.04, 128.58, 127.96, 120.65 (t, *J* = 272.5 Hz), 37.73, 29.76, 26.96 (t, *J* = 3.2 Hz), 23.11 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{12}H_{14}F_2OS$ Calcd: 244.0733; Found: 244.0736. IR (KBr): $\nu_{max}$ = 1685, 1597 cm$^{-1}$.

**5-((Difluoromethyl)thio)-1-phenylhexan-1-one 4k**



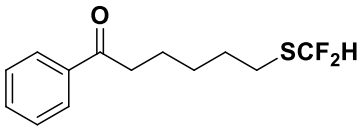
The general procedure conducted with 2-methyl-1-phenylcyclopentanol (52.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 5-((difluoromethyl)thio)-1-phenylhexan-1-one **4k** (54.2 mg, 70%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.94 (dd, *J* = 8.3, 1.2 Hz, 2 H), 7.66 – 7.48 (m, 1 H), 7.44 (dd, *J* = 10.5, 4.7 Hz, 2 H), 6.84 (t, *J* = 56.5 Hz, 1 H), 3.29 (hept, *J* = 6.8 Hz, 1 H), 3.12 – 2.80 (m, 2 H), 2.09 – 1.78 (m, 2 H), 1.69 (dt, *J* = 10.3, 6.3 Hz, 2 H), 1.41 (d, *J* = 6.9 Hz, 3 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -85.74 – -97.61 (m); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 199.63, 136.85, 133.03, 128.58, 127.96, 120.89 (t, *J* = 271.9 Hz), 38.49, 37.90, 36.93, 22.75, 21.31 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{13}H_{16}F_2OS$ Calcd: 258.0890; Found: 258.0885. IR (KBr): $\nu_{max}$ = 1685, 1597 cm$^{-1}$.

**5-((Difluoromethyl)thio)-1-phenylundecan-1-one 4l**


The general procedure conducted with 2-hexyl-1-phenylcyclopentanol (73.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 5-((difluoromethyl)thio)-1-phenylundecan-1-one **4l** (59.1 mg, 60%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.3 Hz, 2 H), 7.55 (t, *J* = 7.4 Hz, 1 H), 7.45 (t, *J* = 7.5 Hz, 2 H), 6.83 (t, *J* = 56.6 Hz, 1 H), 3.23 – 3.06 (m, 1 H), 2.98 (t, *J* = 7.2 Hz, 2 H), 1.88 (m, 2 H), 1.80 – 1.52 (m, 4 H), 1.51 – 1.34 (m, 2 H), 1.27 (m, 6H), 0.86 (t, *J* = 6.5 Hz, 3 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -91.00 (dd, *J* = 56.6, 5.5 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 199.75, 136.88, 133.00, 128.57, 127.97, 120.95 (t, *J* = 271.9 Hz), 43.93, 38.03, 35.55, 35.21, 31.65, 28.99, 26.47, 22.56, 21.09, 14.03 ppm. MS (EI): m/z (%) 105 (100). HRMS

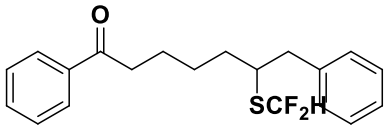
(EI) for $C_{18}H_{26}F_2OS$ Calcd: 328.1672; Found: 328.1680. IR (KBr): $\nu_{max}$ = 1686, 1597 $cm^{-1}$.

**6-((Difluoromethyl)thio)-1-phenylhexan-1-one 4m**




The general procedure conducted with 1-phenylcyclohexanol (52.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 6-((difluoromethyl)thio)-1-phenylhexan-1-one **4m** (54.2 mg, 70%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.6 Hz, 2 H), 7.56 (t, *J* = 7.4 Hz, 1 H), 7.46 (t, *J* = 7.6 Hz, 2 H), 6.80 (t, *J* = 56.4 Hz, 1 H), 2.98 (t, *J* = 7.3 Hz, 2 H), 2.81 (t, *J* = 7.4 Hz, 2 H), 2.01 – 1.62 (m, 4 H), 1.60 – 1.30 (m, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.72 (d, *J* = 56.4 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 199.97, 136.97, 132.95, 128.56, 127.98, 120.71 (t, *J* = 272.4 Hz), 38.20, 29.98, 28.28, 26.99 (t, *J* = 3.0 Hz), 23.56 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{13}H_{16}F_2OS$ Calcd: 258.0890; Found: 258.0898. IR (KBr): $\nu_{max}$ = 1685, 1597 $cm^{-1}$.

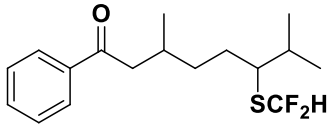
**6-((Difluoromethyl)thio)-1,7-diphenylheptan-1-one 4n**




The general procedure conducted with 2-benzyl-1-phenylcyclohexanol (79.9 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 6-((difluoromethyl)thio)-1,7-diphenylheptan-1-one **4n** (63.8 mg, 61%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 8.01 – 7.89 (m, 2 H), 7.55 (t, *J* = 7.4 Hz, 1 H), 7.46 (d, *J* = 7.8 Hz, 2 H), 7.30 (t, *J* = 7.2 Hz, 2 H), 7.26 – 7.14 (m, 3 H), 6.63 (t, *J* = 56.8 Hz, 1 H), 3.44 – 3.26 (m, 1 H), 3.02 (dd, *J*

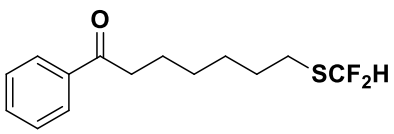
= 13.9, 6.7 Hz, 2 H), 2.93 (t, *J* = 7.2 Hz, 2 H), 1.87 – 1.43 (m, 6 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -91.46 (qd, *J* = 244.7, 56.8 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 200.01, 138.47, 136.94, 132.94, 129.36, 128.55, 128.42, 127.99, 126.69, 123.96 – 117.46 (m), 45.10, 43.03, 38.20, 34.14, 26.17, 23.67 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{20}H_{21}FOS[M\text{-}HF]^+$ Calcd: 328.1297; Found: 328.1298. IR (KBr): $\nu_{max}$ = 1686, 1597 cm$^{-1}$.

**6-((Difluoromethyl)thio)-3,7-dimethyl-1-phenyloctan-1-one 4o**




The general procedure conducted with 2-isopropyl-5-methyl-1-phenylcyclohexanol (69.7 mg, 0.300 mmol), S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, 6.00 × 10$^{-2}$ mmol), SDS (18.0 mg, 6.00 × 10$^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 6-((difluoromethyl)thio)-3,7-dimethyl-1-phenyloctan-1-one **4o** (1:1 d.r., 64.1 mg, 68%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.4 Hz, 2 H), 7.77 – 7.50 (m, 1 H), 7.44 (dd, *J* = 11.2, 4.0 Hz, 2 H), 6.79 (td, *J* = 56.8, 5.1 Hz, 1 H), 3.10 – 2.85 (m, 2 H), 2.79 (dd, *J* = 16.1, 7.8 Hz, 1H), 2.17 (td, *J* = 13.2, 6.5 Hz, 1 H), 1.96 (d, *J* = 5.6 Hz, 1 H), 1.81 – 1.39 (m, 4 H), 1.11 – 0.81 (m, 9 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -82.32 – -96.21 (m); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 200.22, 136.98, 132.90, 128.53, 127.98, 120.73 (tt, *J* = 272.2 Hz, 272.2 Hz), 50.59 (d, *J* = 4.9 Hz), 45.46, 45.23, 34.07, 31.20 (dd, *J* = 135.0, 42.2 Hz), 24.26 (dd, *J* = 943.7, 14.2 Hz), 19.30 (d, *J* = 4.0 Hz), 17.89, 17.62 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{17}H_{24}F_2OS$ Calcd: 314.1516; Found: 314.1519. IR (KBr): $\nu_{max}$ = 1677 cm$^{-1}$.

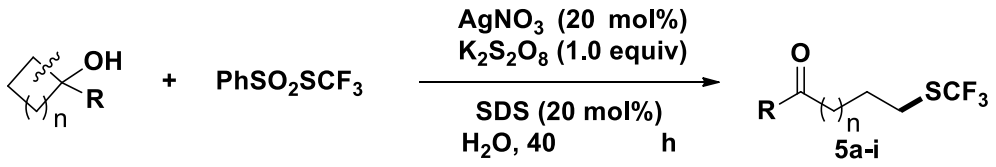
**7-((Difluoromethyl)thio)-1-phenylheptan-1-one 4p**




The general procedure conducted with 1-phenylcycloheptanol (57.1 mg, 0.300 mmol),

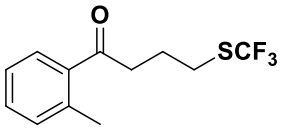
S-(difluoromethyl)benzenesulfonothionate (134 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 7-((difluoromethyl)thio)-1-phenylheptan-1-one **4p** (44.1 mg, 54%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.2 Hz, 2 H), 7.56 (dd, *J* = 10.6, 4.1 Hz, 1 H), 7.45 (t, *J* = 7.5 Hz, 2 H), 6.79 (t, *J* = 56.4 Hz, 1 H), 2.97 (t, *J* = 7.3 Hz, 2 H), 2.79 (t, *J* = 7.4 Hz, 2 H), 1.90 – 1.56 (m, 4 H), 1.55 – 1.24 (m, 4 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -92.75 (d, *J* = 56.4 Hz); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 200.22, 136.98, 132.90, 128.53, 127.98, 120.73 (t, *J* = 272.2 Hz), 38.34, 29.90, 28.68, 28.47, 27.09, 24.01 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{14}H_{18}F_2OS$ Calcd: 272.1046; Found: 272.1052. IR (KBr): $\nu_{max}$ = 1685,1597 $cm^{-1}$.

**General procedure for sliver-catalyzed ring-opening trifluoromethylation of cycloalkanol**



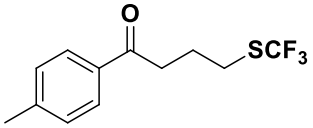

Cycloalkanol (0.300 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), sodium dodecyl sulfate (SDS) (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol), $H_2O$ (0.5 mL) were placed into an oven-dried Schlenk tube that was equipped with a stirring bar under an atmosphere of argon. S-(Trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol) was added. The tube was quickly sealed with a rubber stopper. The reaction was stirred at 40 $^{o}$C for 12 h and was then allowed to cool to room temperature. The mixture was extracted with diethyl ether (20 ml × 3), The organic layer was combined, dried over anhydrous $Na_2SO_4$ and concentrated under vacuum. The residue was purified by flash column chromatography (eluent: petroleum ether: ethyl acetate = 100:1). The yields of the products were calculated based on cyclobutanol.

**1-(*o*-Tolyl)-4-((trifluoromethyl)thio)butan-1-one 5a**



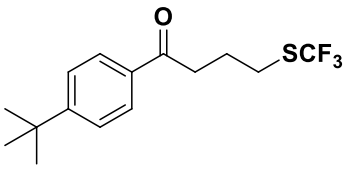

The general procedure conducted with 1-(*o*-tolyl)cyclobutanol (48.7 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(*o*-tolyl)-4-((trifluoromethyl)thio)butan-1-one **5a** (70.8 mg, 90%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, $J$ = 7.7 Hz, 1 H), 7.37 (t, $J$ = 7.5 Hz, 1 H), 7.32 – 7.18 (m, 2 H), 3.02 (m, 4 H), 2.48 (s, 3 H), 2.11 (quint, $J$ = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -41.01 (s); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 202.48, 138.20, 137.42, 132.06, 131.49, 130.99 (q, $J$ = 307.0 Hz), 128.41, 125.74, 39.16, 29.37 (d, $J$ = 1.9 Hz), 23.86, 21.34 ppm. MS (EI): m/z (%) 119 (100). HRMS (EI) for $C_{12}H_{13}F_3OS$ Calcd: 262.0639; Found: 262.0640. IR (KBr): $\nu_{max}$ = 1685, 1601 cm$^{-1}$.

**1-(*p*-Tolyl)-4-((trifluoromethyl)thio)butan-1-one 5b**




The general procedure conducted with 1-(*p*-tolyl)cyclobutanol (48.7 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(*p*-tolyl)-4-((trifluoromethyl)thio)butan-1-one **5b** (64.5 mg, 82%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 80:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.1 Hz, 2 H), 7.25 (d, *J* = 7.8 Hz, 2 H), 3.10 (t, *J* = 6.9 Hz, 2 H), 3.00 (t, *J* = 7.2 Hz, 2 H), 2.40 (s, 3 H), 2.13 (quint, *J* = 7.0 Hz, 2 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -40.99 (s); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 197.75, 143.61, 133.70, 130.54 (q, *J* = 307.0 Hz), 128.84, 127.58, 35.75, 28.96 (d, *J* = 2.0 Hz), 23.32, 21.11 ppm. MS (EI): m/z (%) 119 (100). HRMS (EI) for $C_{12}H_{13}F_3OS$ Calcd: 262.0639; Found: 262.0638. IR (KBr): $\nu_{max}$= 1677, 1605 cm$^{-1}$.

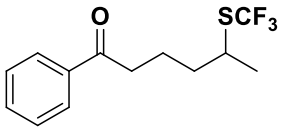
**1-(4-(*tert*-Butyl)phenyl)-4-((trifluoromethyl)thio)butan-1-one 5c**




The general procedure conducted with 1-(4-(*tert*-butyl)phenyl)cyclobutanol (61.3 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-(*tert*-Butyl)phenyl)-4-((trifluoromethyl)thio)butan-1-one **5c** (80.4 mg, 88%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1).$^1$H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.3 Hz, 2 H), 7.47 (d, *J* = 8.3 Hz, 2 H), 3.11 (t, *J* = 6.9 Hz, 2 H), 3.00 (t, *J* = 7.2 Hz, 2 H), 2.14 (quint, *J* = 7.0 Hz, 2 H), 1.33 (s, 9H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -40.97 (s); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 198.23, 157.04, 134.06, 131.02 (q, *J* = 308.0 Hz), 127.92, 125.58, 36.23, 35.10, 31.03, 29.44 (d, *J* = 1.9 Hz), 23.79 ppm. MS (EI): m/z (%) 161 (100). HRMS (EI) for $C_{15}H_{19}F_3OS$ Calcd: 304.1109;

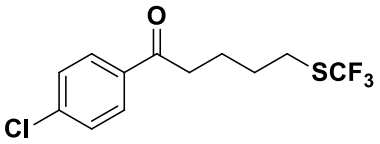
Found: 304.1102. IR (KBr): $\nu_{max}$ = 1683, 1605 $cm^{-1}$.

**1-Phenyl-5-((trifluoromethyl)thio)hexan-1-one 5d**




The general procedure conducted with 2-methyl-1-phenylcyclopentanol (52.9 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-phenyl-5-((trifluoromethyl)thio)hexan-1-one **5d** (64.7 mg, 78%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.93 (dd, *J* = 5.2, 3.3 Hz, 2 H), 7.69 – 7.47 (m, 1 H), 7.50 – 7.38 (m, 2 H), 3.63 – 3.16 (m, 1 H), 2.99 (dd, *J* = 10.8, 3.8 Hz, 2 H), 2.01 – 1.78 (m, 2 H), 1.79 – 1.62 (m, 2 H), 1.43 (dd, *J* = 6.4, 5.9 Hz, 3 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -39.14 (s); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 199.43, 136.80, 133.08, 131.14 (q, *J* = 308.0 Hz), 128.60, 127.95, 41.04, 37.80, 36.33, 22.18, 21.15 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{13}H_{15}F_3OS$ Calcd: 276.0796; Found: 276.0806. IR (KBr): $\nu_{max}$ = 1686, 1597 $cm^{-1}$.

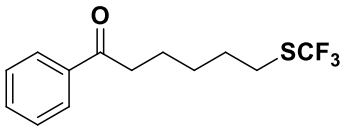
**1-(4-Chlorophenyl)-5-((trifluoromethyl)thio)pentan-1-one 5e**




The general procedure conducted with 1-(4-chlorophenyl)cyclopentanol (59.0 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-chlorophenyl)-5-((trifluoromethyl)thio)pentan-1-one **5e** (55.2 mg, 62%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1).$^1H$ NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.5 Hz, 2 H), 7.42 (d, *J* = 8.5 Hz, 2 H), 2.94 (m, 4 H), 2.15 – 1.62 (m, 4 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -41.16 (s); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 197.57, 139.08, 134.61, 130.59 (q, *J* = 307.0 Hz), 128.88, 128.45, 37.13, 29.18 (d, *J*

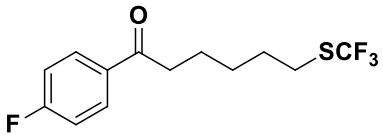
= 1.9 Hz), 28.57, 22.31 ppm. MS (EI): m/z (%) 139 (100). HRMS (EI) for $C_{12}H_{12}ClF_3OS$ Calcd: 296.0249; Found: 296.0252. IR (KBr): $\nu_{max}$=1686,1590 $cm^{-1}$.

**1-Phenyl-6-((trifluoromethyl)thio)hexan-1-one 5f**




The general procedure conducted with 1-phenylcyclohexanol (52.9 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-phenyl-6-((trifluoromethyl)thio)hexan-1-one **5f** (73.8 mg, 89%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.3 Hz, 2 H), 7.54 (t, *J* = 7.4 Hz, 1 H), 7.44 (t, *J* = 7.6 Hz, 2 H), 2.97 (t, *J* = 7.2 Hz, 2 H), 2.88 (t, *J* = 7.4 Hz, 2 H), 1.88 – 1.65 (m, 4 H), 1.55 – 1.33 (m, 2 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -41.19 (s); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 199.84, 136.90, 132.98, 131.13 (q, *J* = 308.0 Hz), 128.56, 127.96, 38.12, 29.65 (d, *J* = 1.9 Hz), 29.31, 28.10, 23.45 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{13}H_{15}F_3OS$ Calcd: 276.0796; Found: 276.0794. IR (KBr): $\nu_{max}$ = 1686, 1597 $cm^{-1}$.

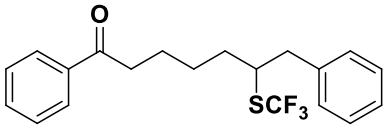
**1-(4-Fluorophenyl)-6-((trifluoromethyl)thio)hexan-1-one 5g**




The general procedure conducted with 1-(4-fluorophenyl)cyclohexanol (58.3 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-(4-fluorophenyl)-6-((trifluoromethyl)thio)hexan-1-one **5g** (69.7 mg, 79%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1H$ NMR (400 MHz, $CDCl_3$) δ 7.95 (dd, *J* = 8.4, 5.7 Hz, 2 H), 7.10 (t, *J* = 8.6 Hz, 2 H), 2.93 (t, *J* = 7.2 Hz, 2 H), 2.87 (t, *J* = 7.4 Hz, 2 H), 1.73 (m, 4 H), 1.57 – 1.29 (m, 2 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -41.21, -105.46 (tt, *J* = 8.4, 5.5 Hz); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ

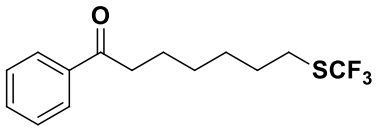
198.16, 166.92, 164.39, 133.31 (d, $J$ = 3.1 Hz), 131.11 (q, $J$ = 307.0 Hz), 123.09 (dd, $J$ = 9.3 Hz, 21.9 Hz), 38.03, 29.62 (d, $J$ = 1.9 Hz), 29.29, 28.04, 23.39 ppm. MS (EI): m/z (%) 123 (100). HRMS (EI) for $C_{13}H_{14}F_4OS$ Calcd: 294.0701; Found: 294.0695. IR (KBr): $\nu_{max}$ = 1686, 1599 $cm^{-1}$.

**1,7-Diphenyl-6-((trifluoromethyl)thio)heptan-1-one 5h**




The general procedure conducted with 2-benzyl-1-phenylcyclohexanol (79.9 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1,7-diphenyl-6-((trifluoromethyl)thio)heptan-1-one **5h** (61.6 mg, 56%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1$H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, $J$ = 7.9 Hz, 2 H), 7.55 (t, $J$ = 7.4 Hz, 1 H), 7.44 (t, $J$ = 7.6 Hz, 2 H), 7.29 (t, $J$ = 7.2 Hz, 2 H), 7.26 – 7.20 (m, 1 H), 7.17 (d, $J$ = 7.7 Hz, 2 H), 3.50 – 3.30 (m, 1 H), 3.09 (dd, $J$ = 14.0, 5.7 Hz, 1 H), 2.99 – 2.84 (m, 2 H), 1.59 (m, 7 H); $^{19}$F NMR (376 MHz, $CDCl_3$) δ -39.02 (s); $^{13}$C NMR (101 MHz, $CDCl_3$) δ 199.90, 137.85, 136.90, 132.96, 131.18 (q, $J$ = 308.0 Hz), 129.30, 128.55, 128.48, 127.97, 126.81, 47.38, 42.17, 38.11, 33.31, 25.97, 23.57 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{20}H_{21}F_3OS$ Calcd: 366.1265; Found: 366.1271. IR (KBr): $\nu_{max}$ = 1686,1597 $cm^{-1}$.

**1-Phenyl-7-((trifluoromethyl)thio)heptan-1-one 5i**




The general procedure conducted with 1-phenylcycloheptanol (57.1 mg, 0.300 mmol), S-(trifluoromethyl)benzenesulfonothionate (145 mg, 0.600 mmol), $AgNO_3$ (10.2 mg, $6.00 \times 10^{-2}$ mmol), SDS (18.0 mg, $6.00 \times 10^{-2}$ mmol), $K_2S_2O_8$ (81.0 mg, 0.300 mmol) in $H_2O$ (0.5 mL) gave 1-phenyl-7-((trifluoromethyl)thio)heptan-1-one **5i** (65.3 mg, 75%) as a colorless oil (eluent: petroleum ether: ethyl acetate = 100:1). $^1$H NMR (400

MHz, $CDCl_3$) δ 8.06 – 7.84 (m, 2 H), 7.54 (t, *J* = 7.4 Hz, 1 H), 7.44 (t, *J* = 7.6 Hz, 2 H), 2.96 (t, *J* = 7.3 Hz, 2 H), 2.86 (t, *J* = 7.4 Hz, 2 H), 1.72 (m, 4 H), 1.57 – 1.28 (m, 4 H); $^{19}F$ NMR (376 MHz, $CDCl_3$) δ -41.22 (s); $^{13}C$ NMR (101 MHz, $CDCl_3$) δ 199.66, 136.52, 132.43, 130.68 (q, *J* = 306.0 Hz), 128.07, 127.50, 37.81, 29.27 (d, *J* = 1.9 Hz), 28.74, 28.14, 27.83, 23.48 ppm. MS (EI): m/z (%) 105 (100). HRMS (EI) for $C_{14}H_{17}F_3OS$ Calcd: 290.0952; Found: 290.0956. IR (KBr): $\nu_{max}$ = 2859, 1686 $cm^{-1}$.

**References**

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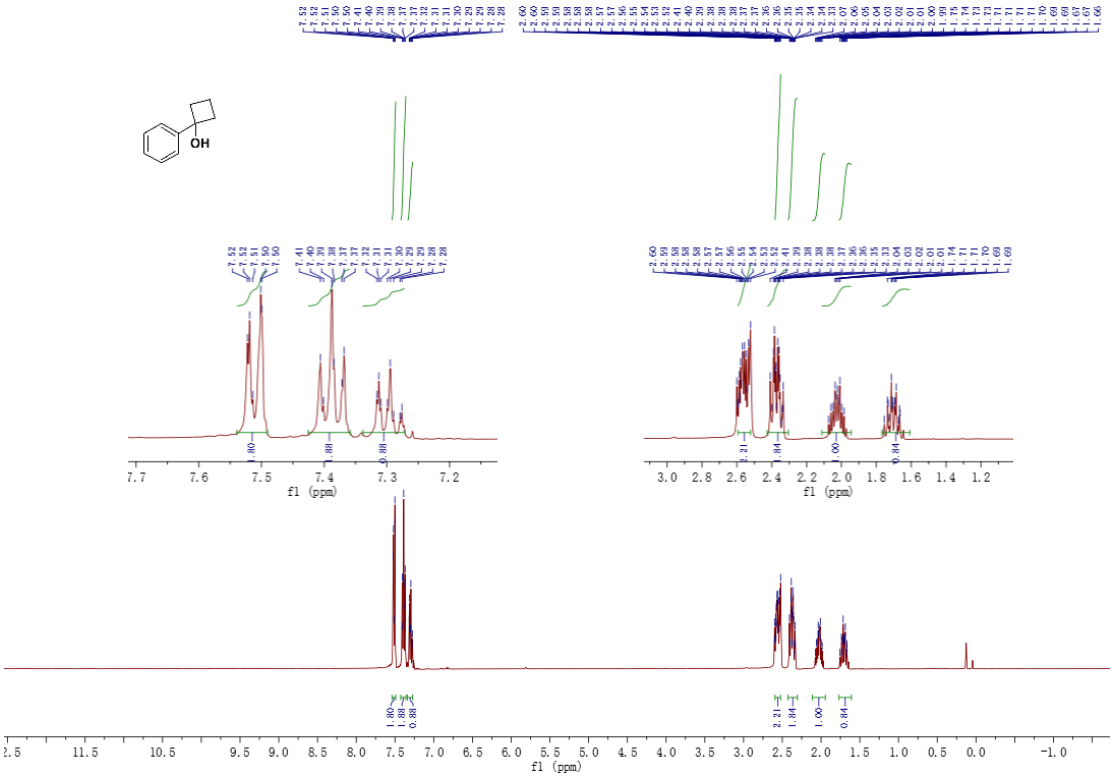
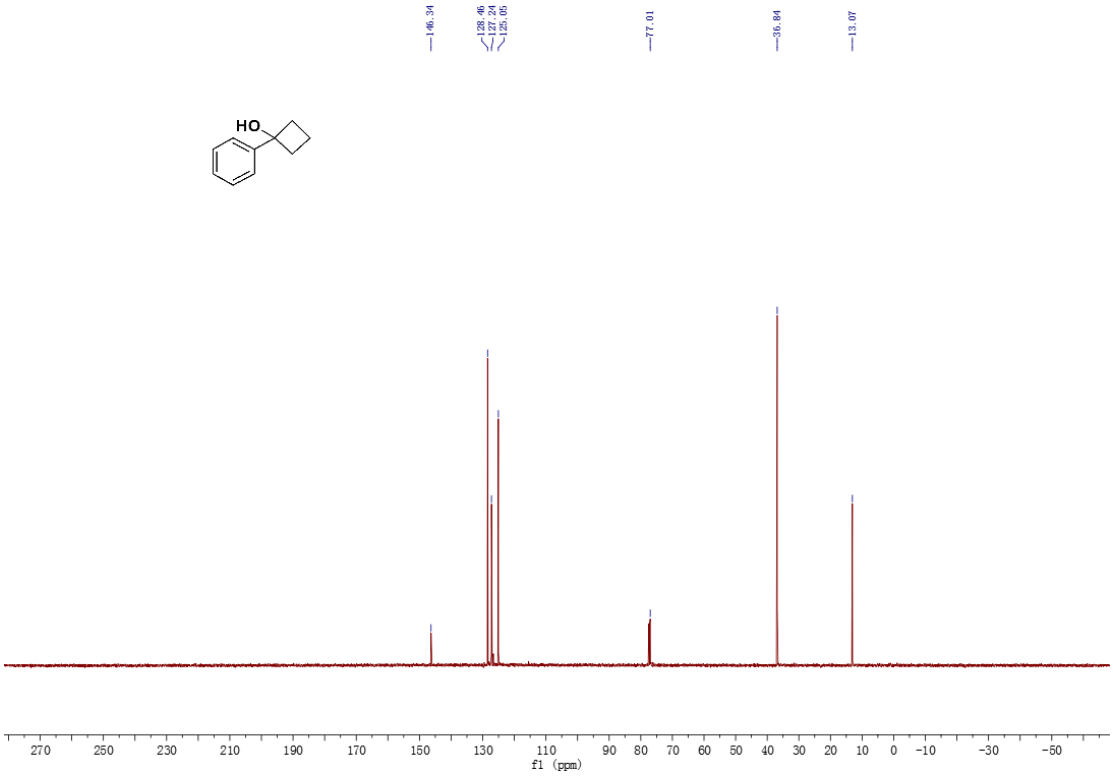
[6] G. Z. Elek, V. Borovkov, M. Lopp, D. G. Kananovich. *Org. Lett*. **2017**, *19*, 3544.

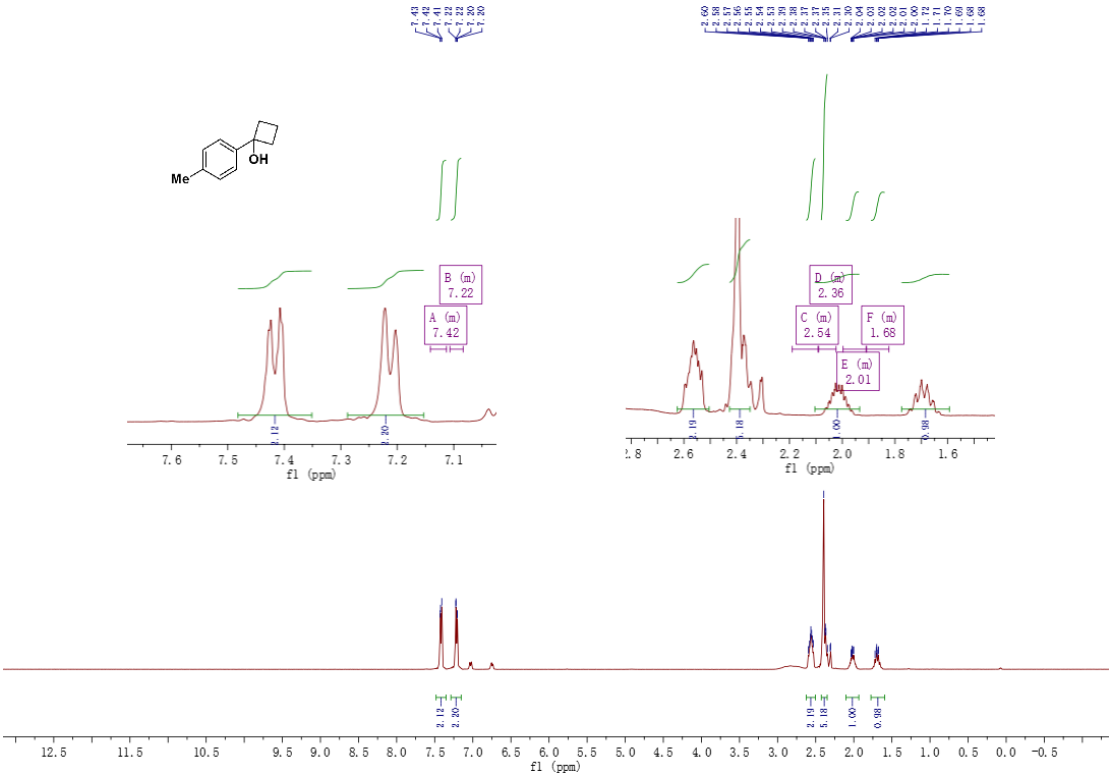
## $^{1}$H NMR spectrum of 1-phenylcyclobutanol 1a



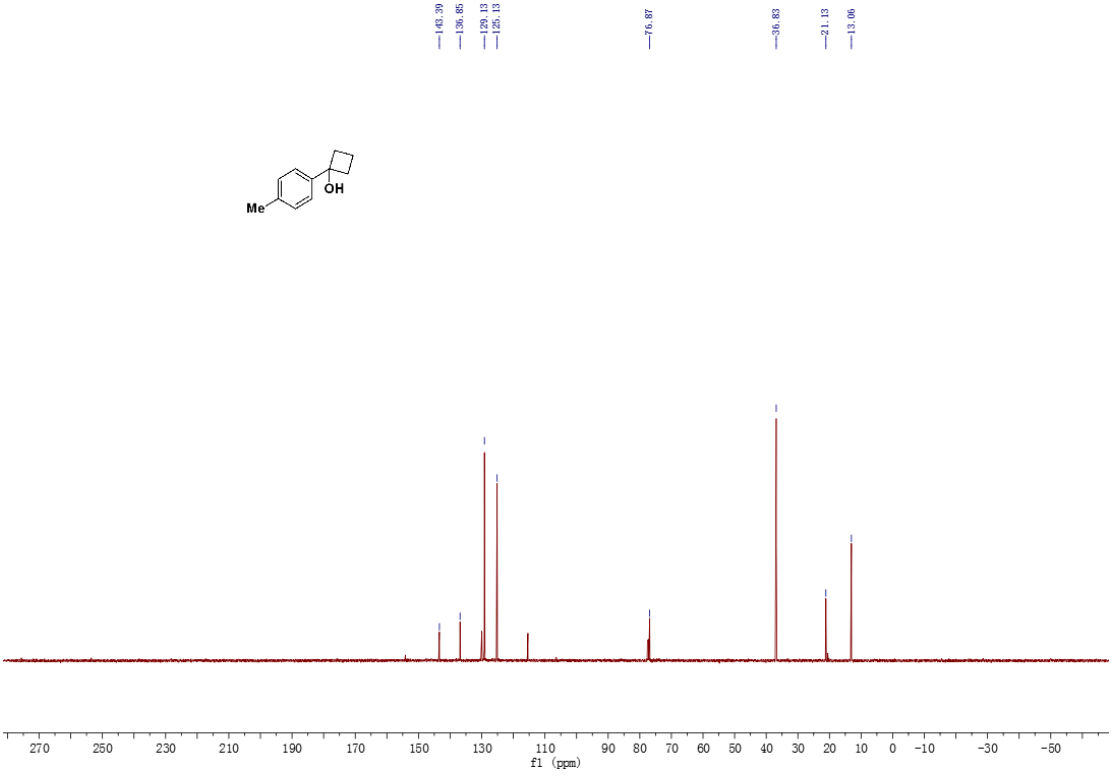

## $^{13}$C NMR spectrum of 1-phenylcyclobutanol 1a



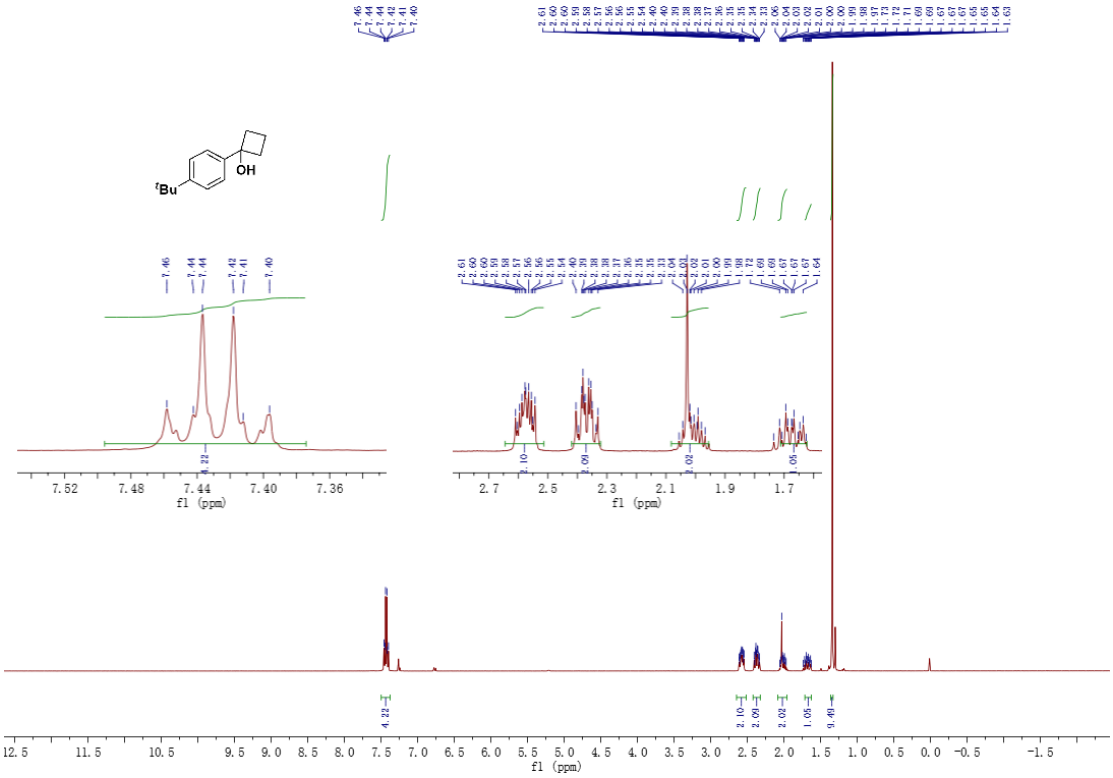
## $^{1}$H NMR spectrum of 1-(*p*-tolyl)cyclobutan-1-ol 1b



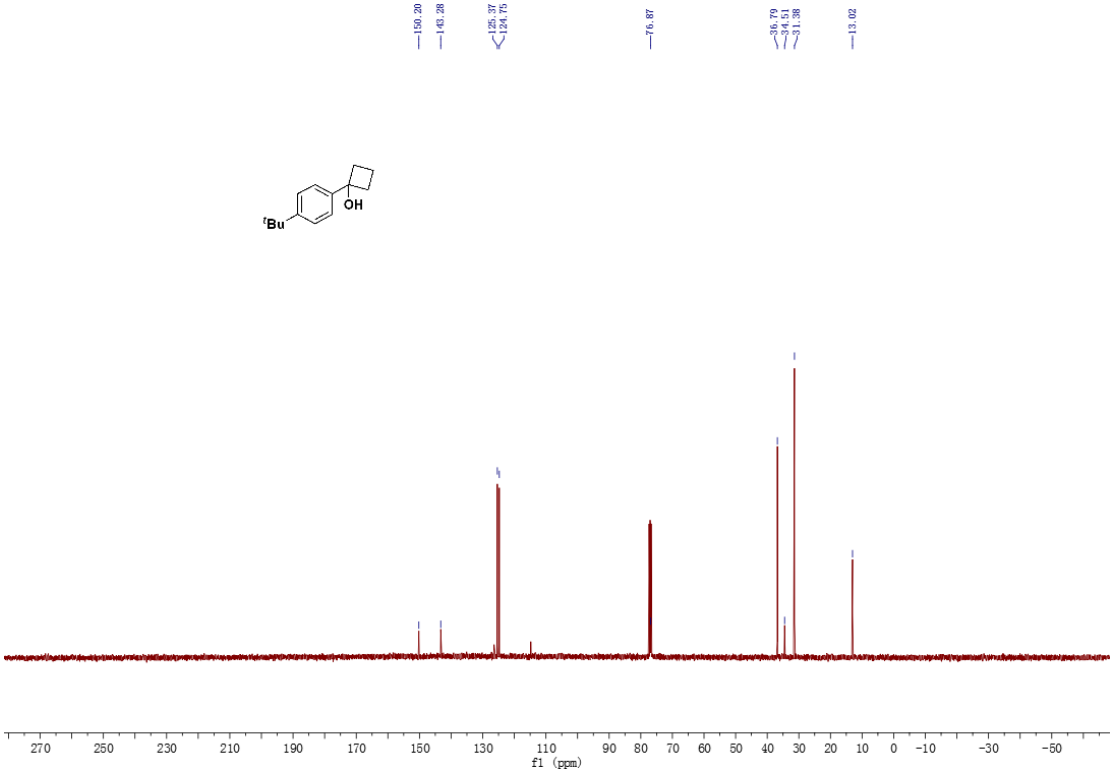

## $^{13}$C NMR spectrum of 1-(*p*-tolyl)cyclobutan-1-ol 1b



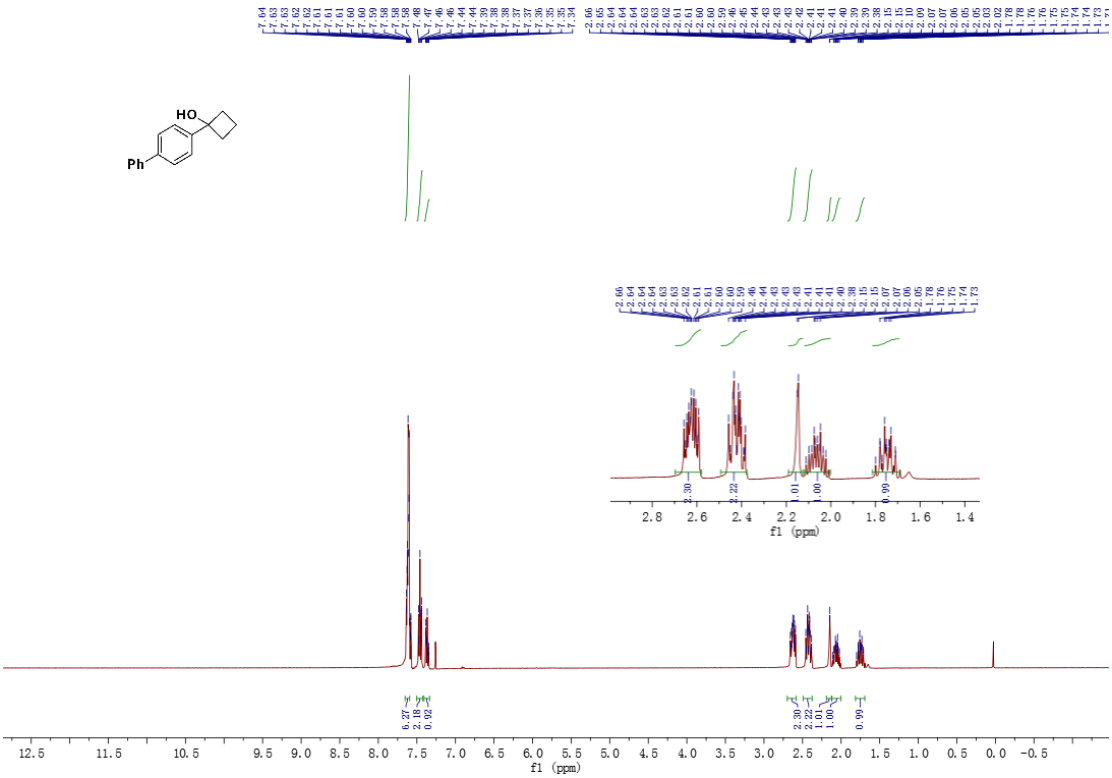
## $^{1}$H NMR spectrum of 1-(4-(*tert*-butyl)phenyl)cyclobutan-1-ol 1c



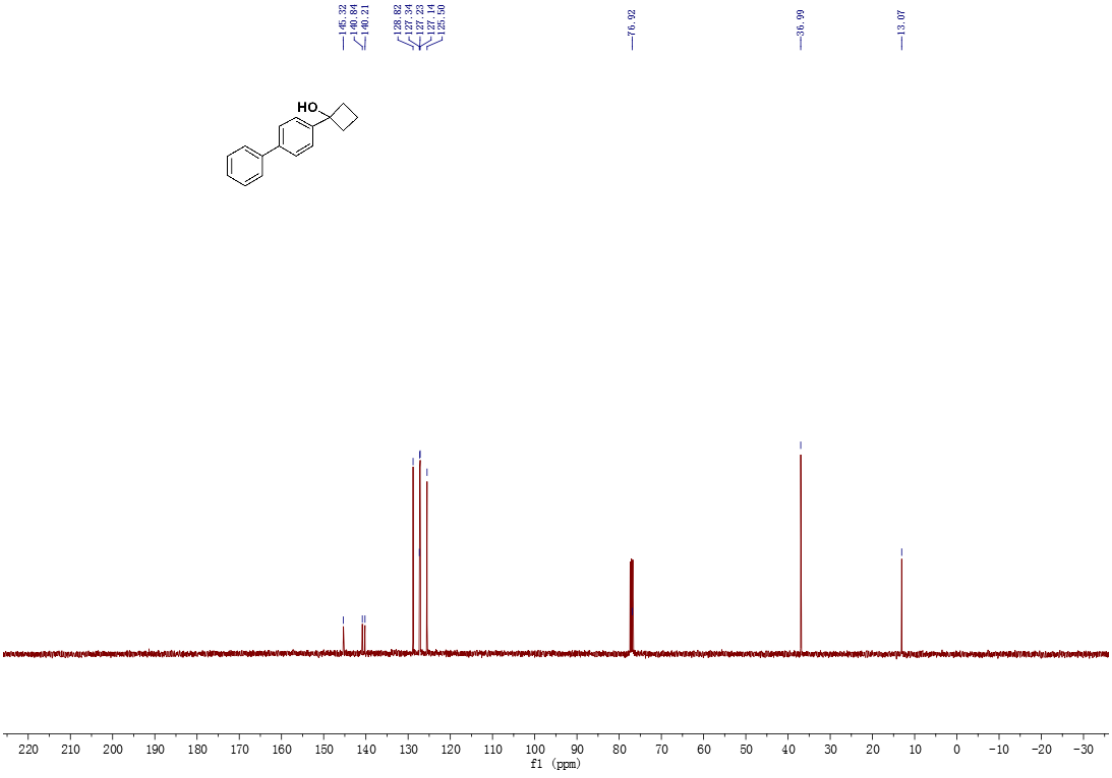

## $^{13}$C NMR spectrum of 1-(4-(*tert*-butyl)phenyl)cyclobutan-1-ol 1c



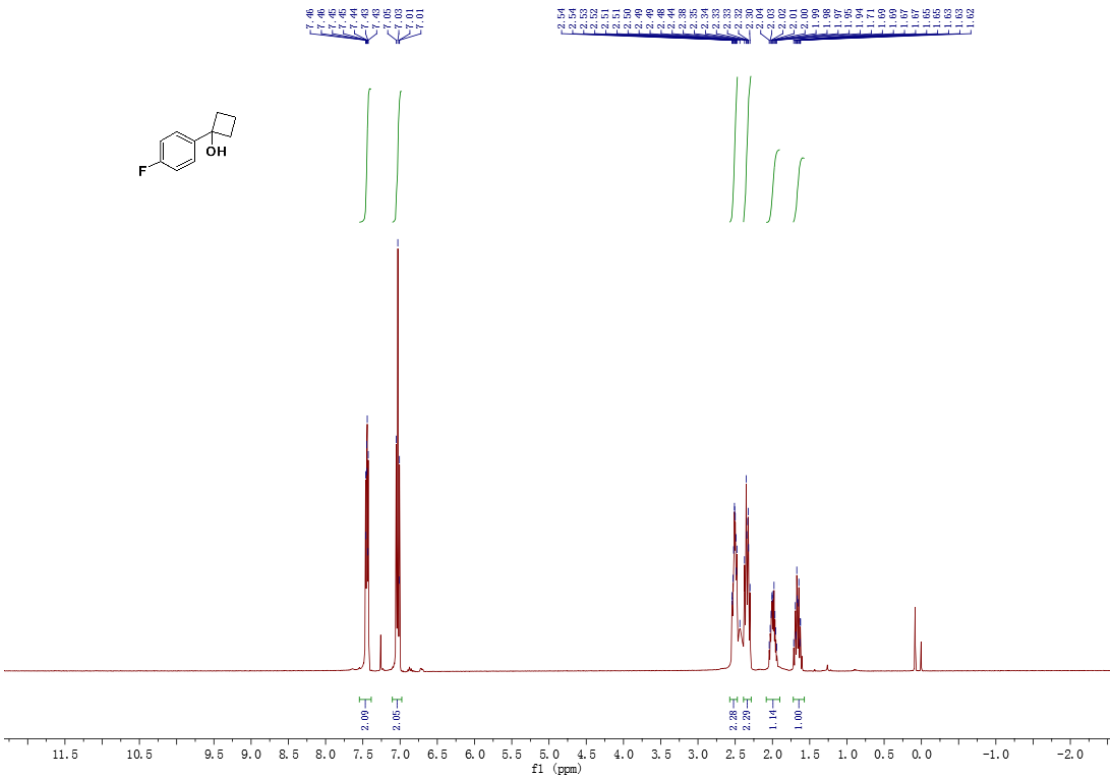
## $^{1}$H NMR spectrum of 1-([1,1'-biphenyl]-4-yl)cyclobutan-1-ol 1d



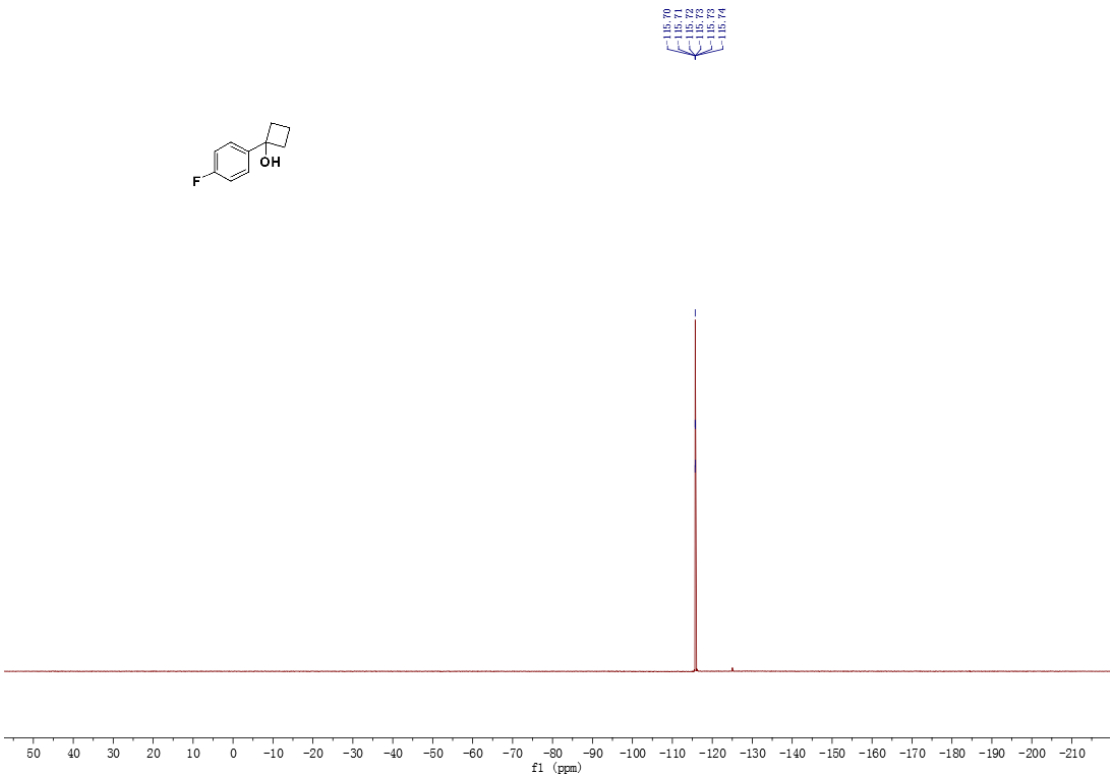

## $^{13}$C NMR spectrum of 1-([1,1'-biphenyl]-4-yl)cyclobutan-1-ol 1d



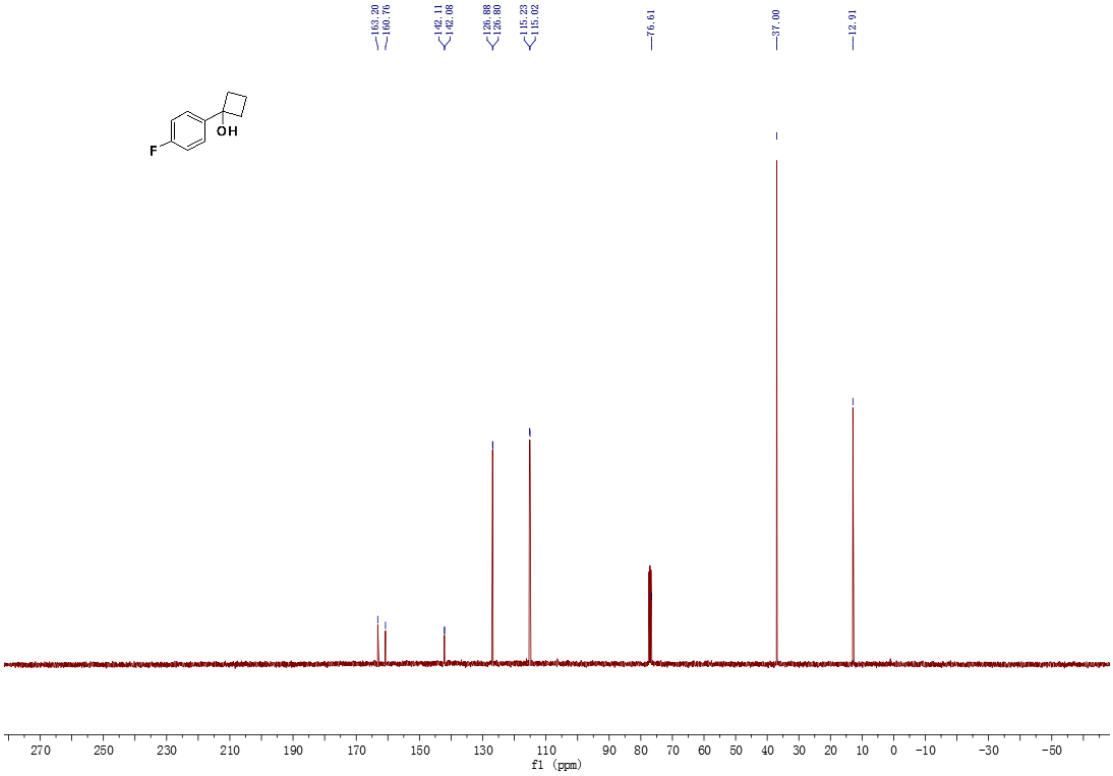
## $^{1}$H NMR spectrum of 1-(4-fluorophenyl)cyclobutanol 1e



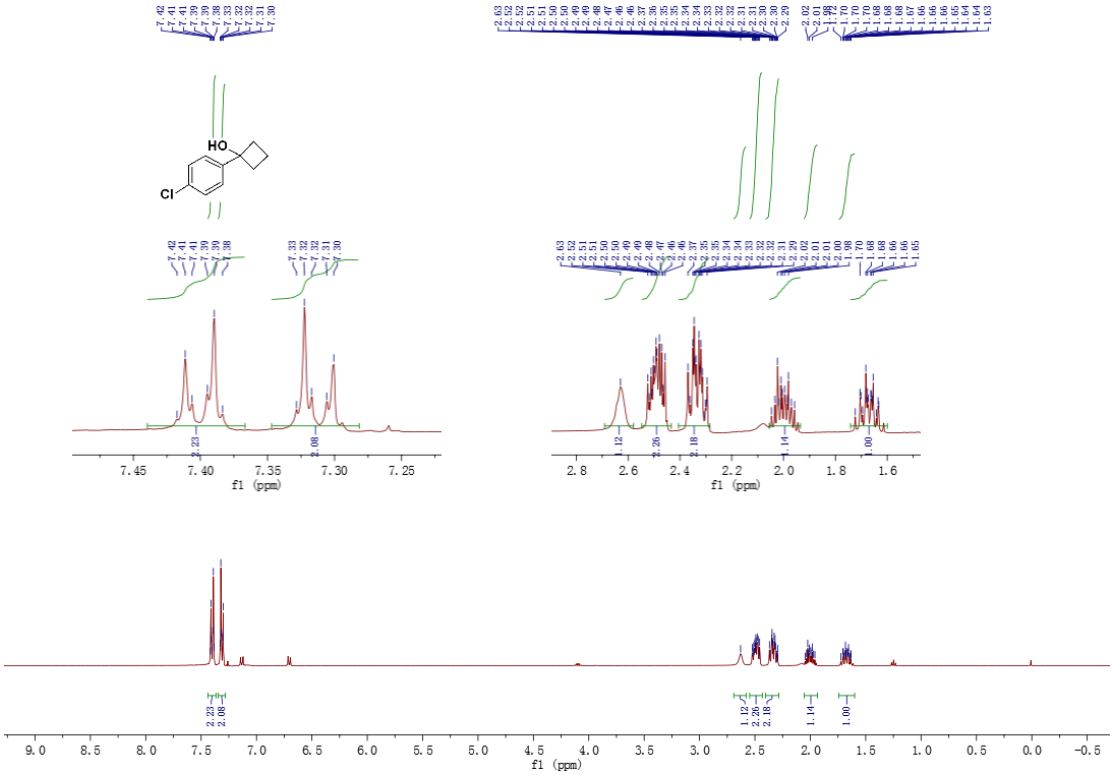

## $^{19}$F NMR spectrum of 1-(4-fluorophenyl)cyclobutanol 1e



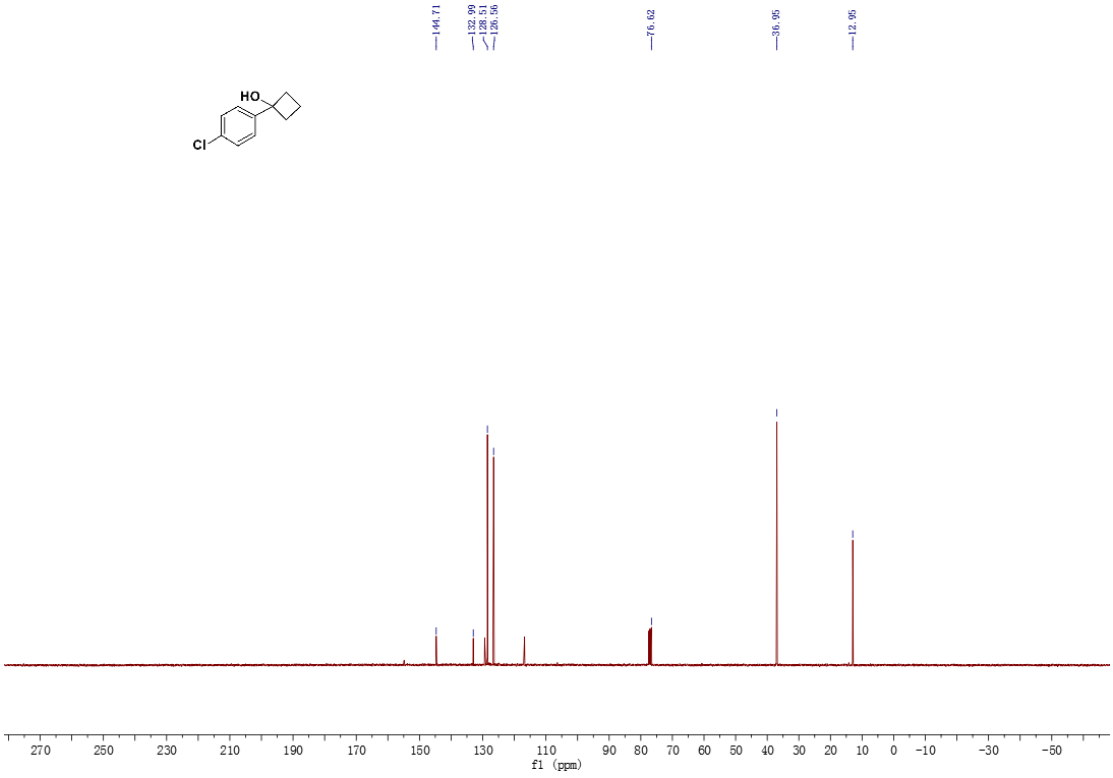
## $^{13}$C NMR spectrum of 1-(4-fluorophenyl)cyclobutanol 1e



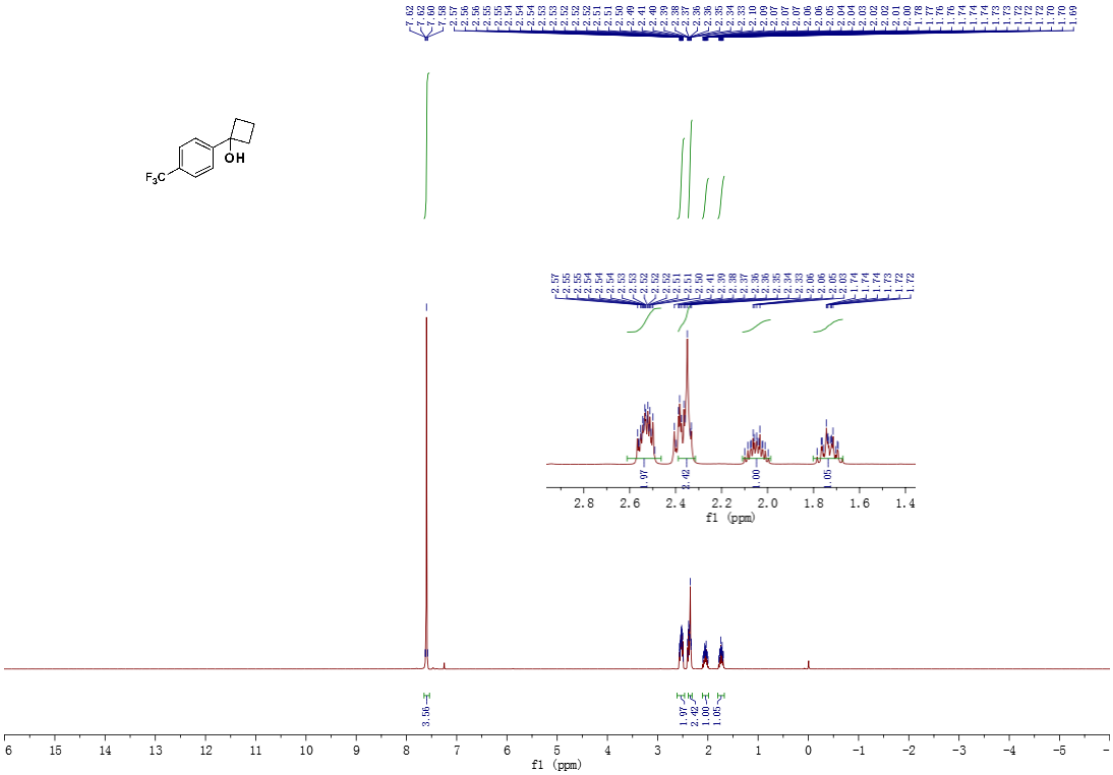

## $^{1}$H NMR spectrum of 1-(4-chlorophenyl)cyclobutanol 1f



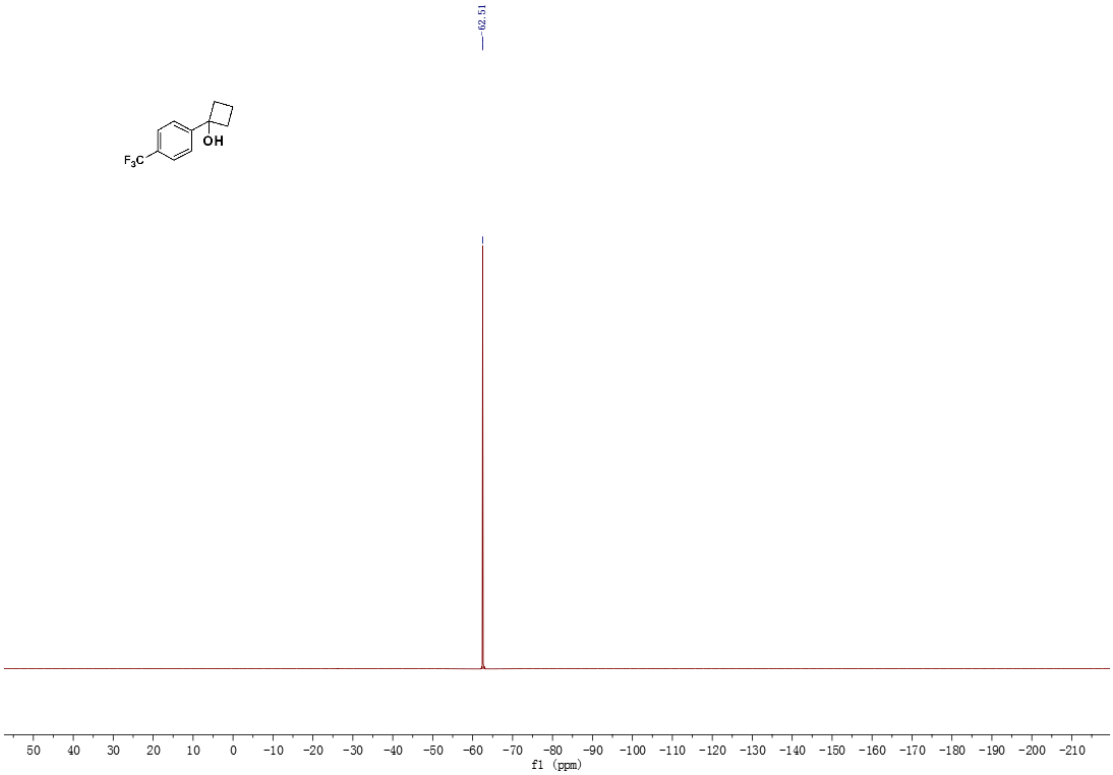
## $^{13}$C NMR spectrum of 1-(4-chlorophenyl)cyclobutanol 1f



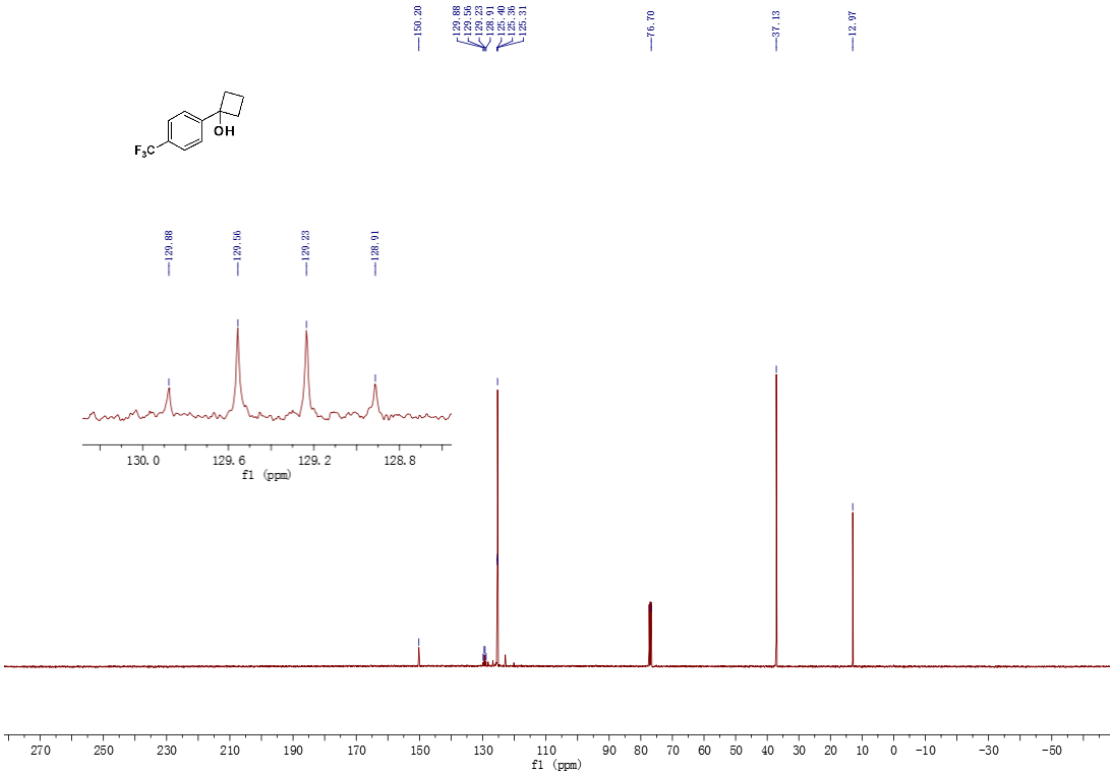

## $^{1}$H NMR spectrum of 1-(4-(trifluoromethyl)phenyl)cyclobutanol 1g



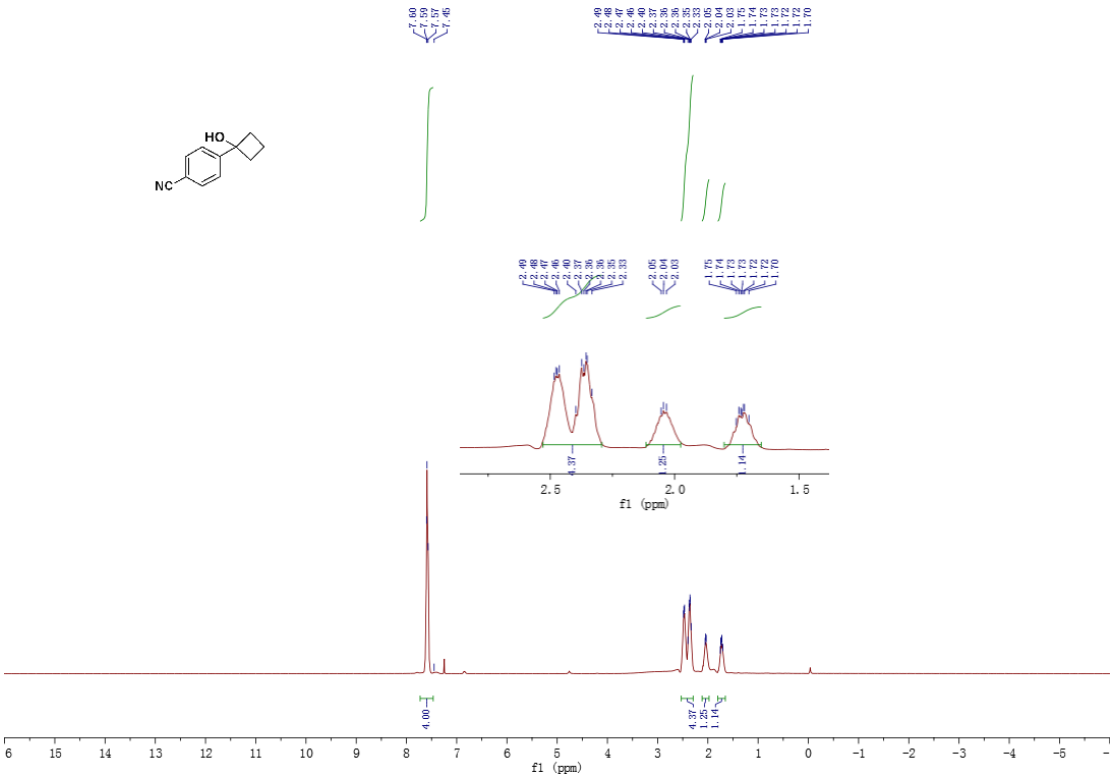
## $^{19}$F NMR spectrum of 1-(4-(trifluoromethyl)phenyl)cyclobutanol 1g



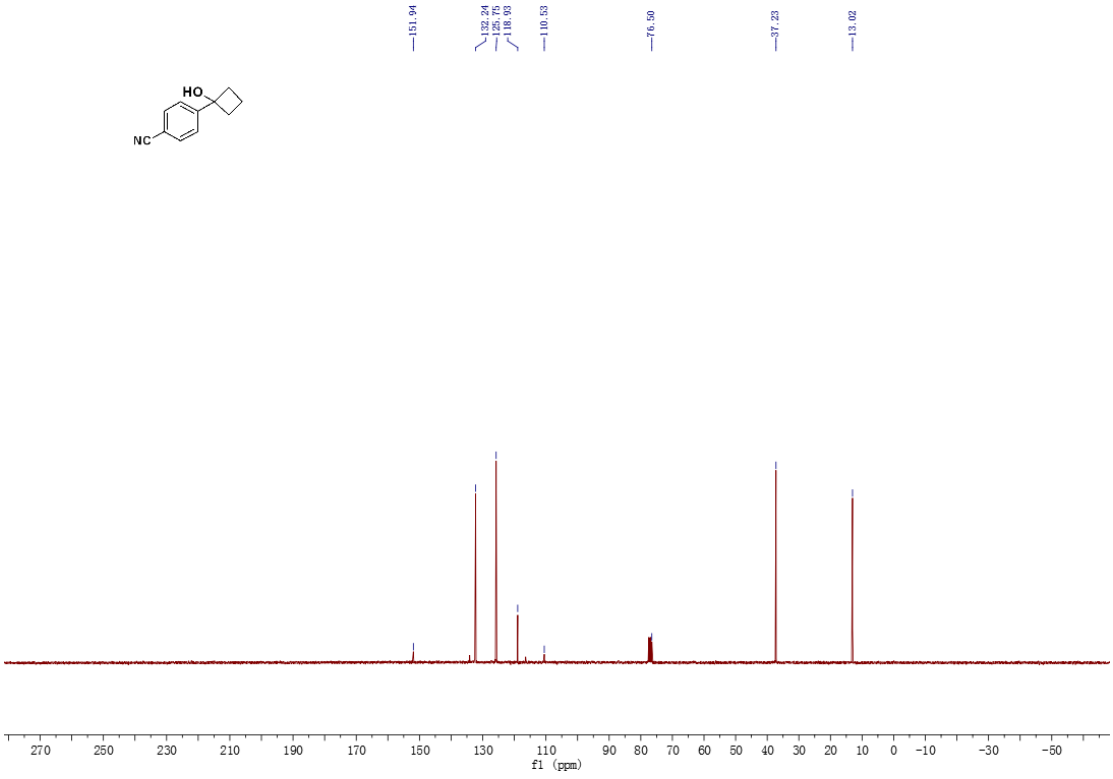

## $^{13}$C NMR spectrum of 1-(4-(trifluoromethyl)phenyl)cyclobutanol 1g



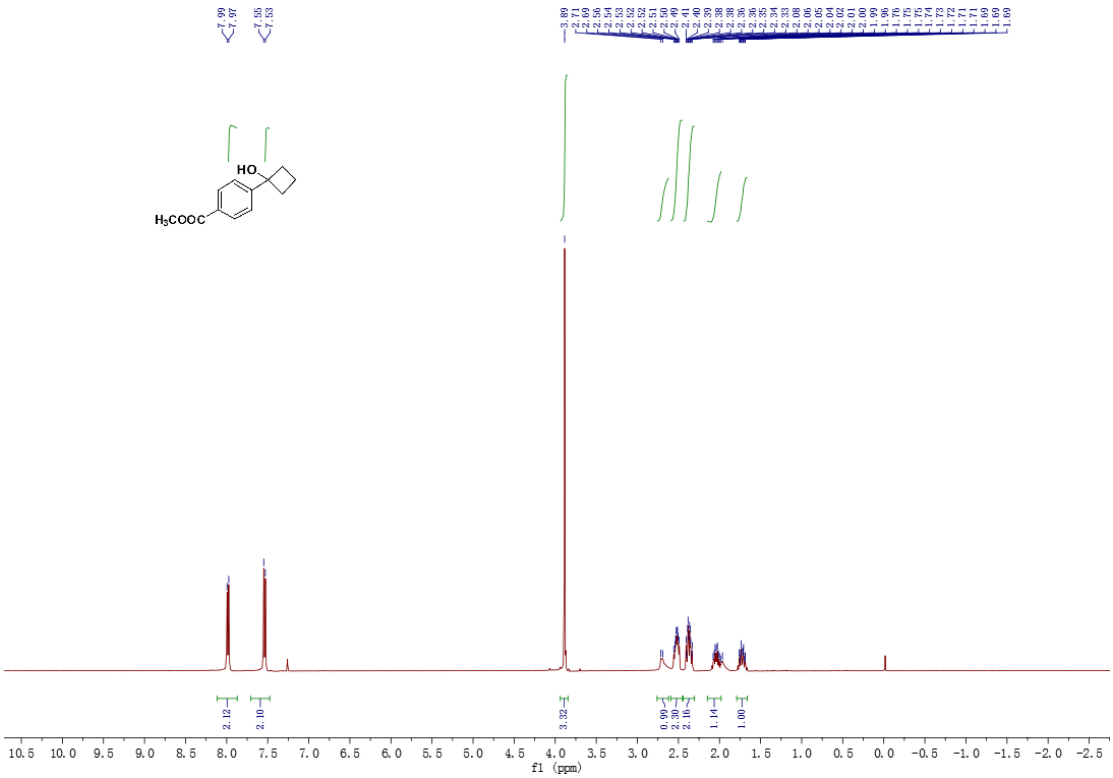
## $^{1}$H NMR spectrum of 4-(1-hydroxycyclobutyl)benzonitrile 1h



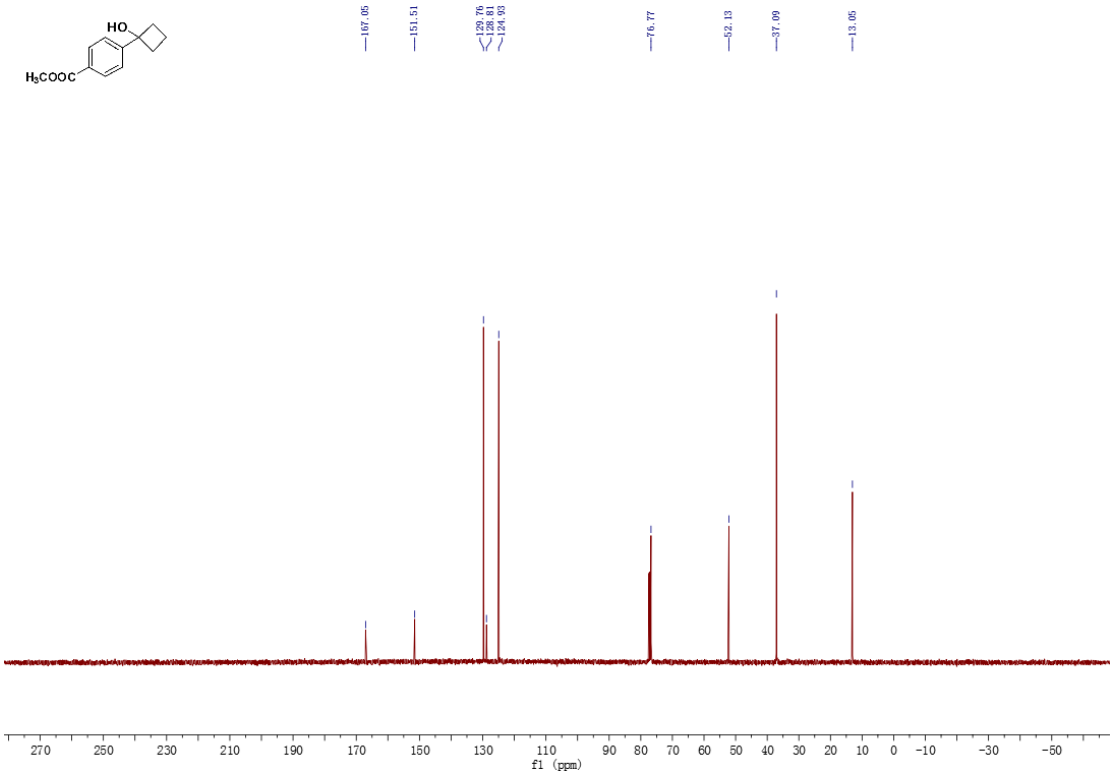

## $^{13}$C NMR spectrum of 4-(1-hydroxycyclobutyl)benzonitrile 1h



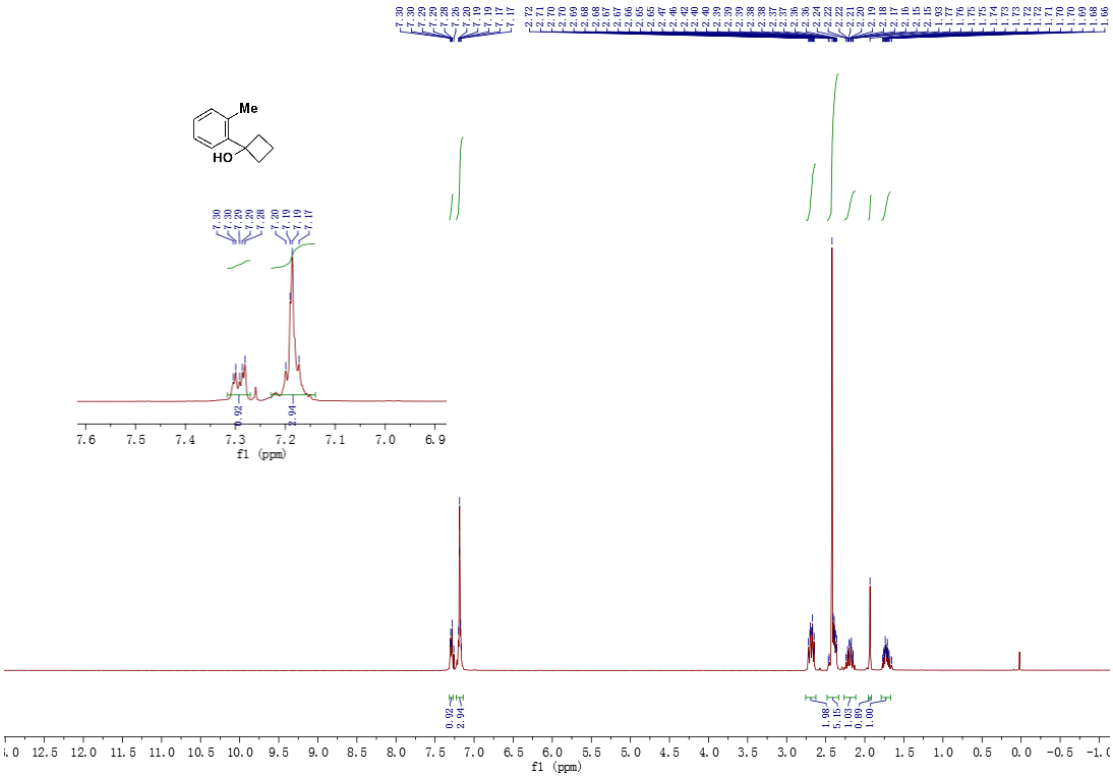
## $^{1}$H NMR spectrum of methyl 4-(1-hydroxycyclobutyl)benzoate 1i



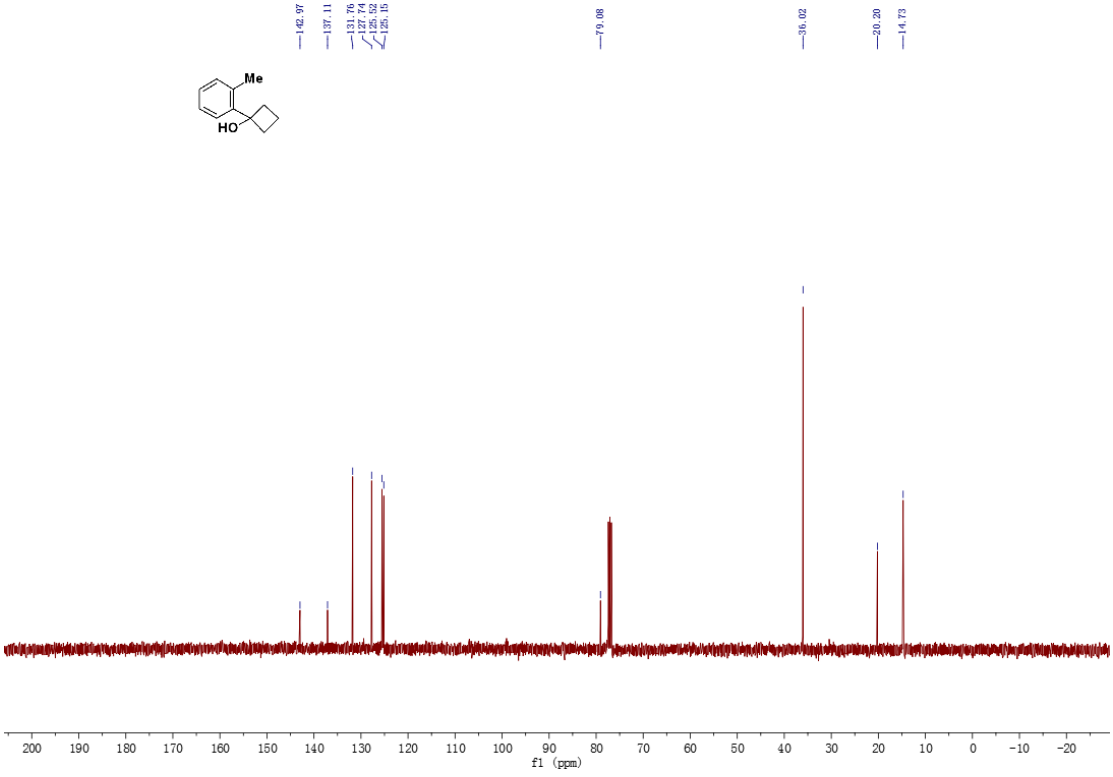

## $^{13}$C NMR spectrum of methyl 4-(1-hydroxycyclobutyl)benzoate 1i



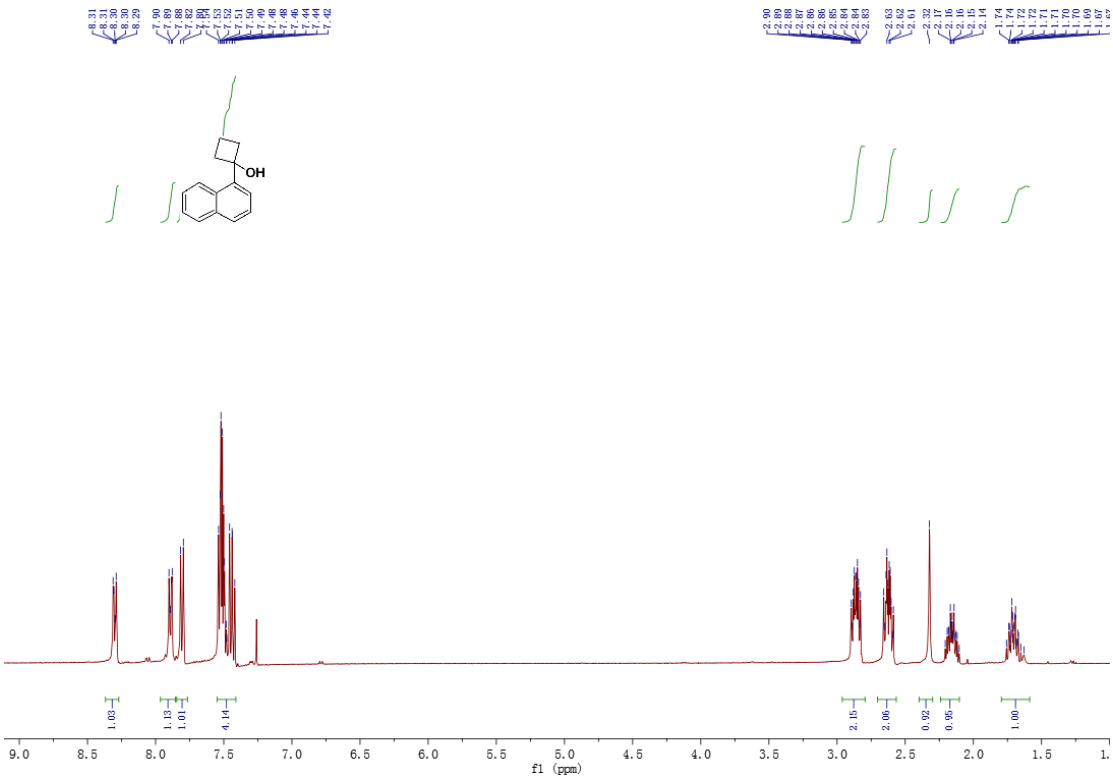
## $^{1}$H NMR spectrum of 1-(*o*-tolyl)cyclobutanol 1j



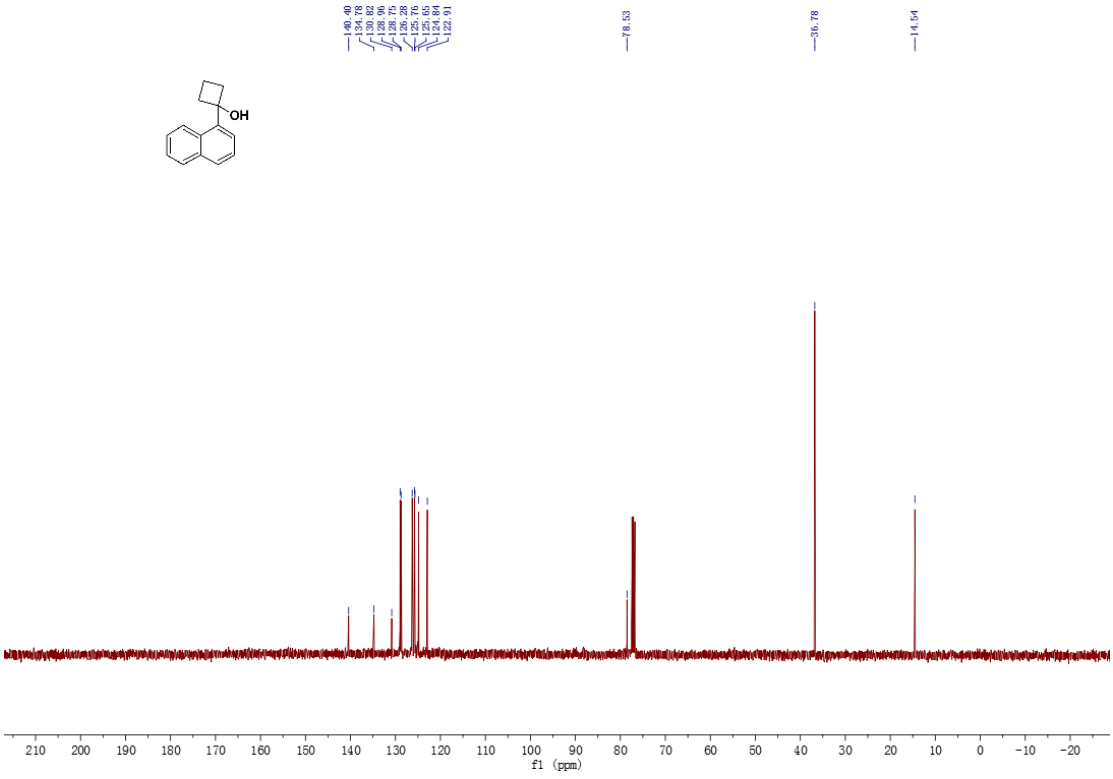

## $^{13}$C NMR spectrum of 1-(*o*-tolyl)cyclobutanol 1j



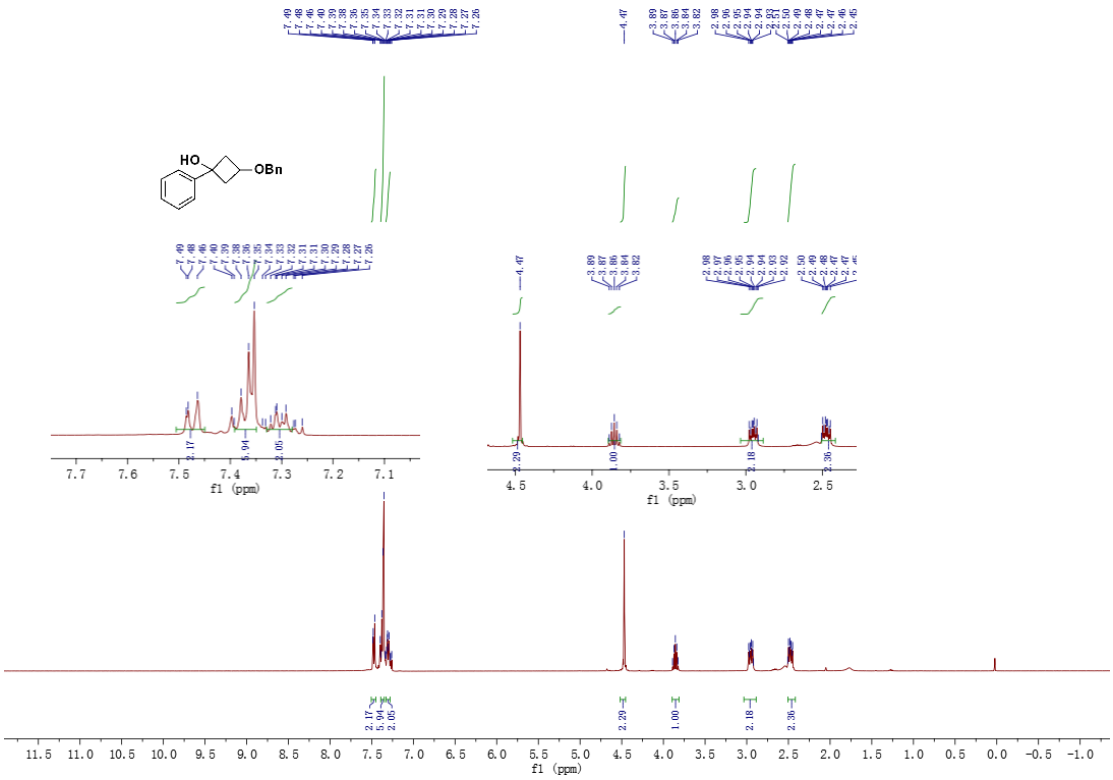
## $^{1}$H NMR spectrum of 1-(naphthalen-1-yl)cyclobutanol 1k



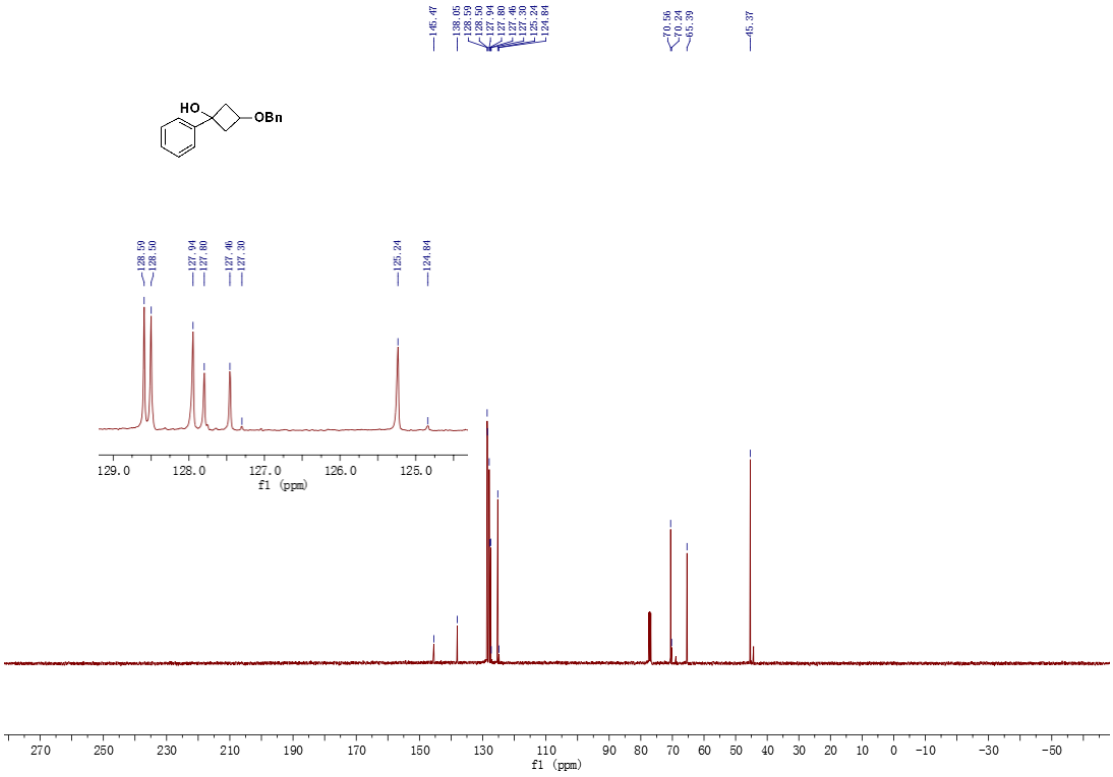

## $^{13}$C NMR spectrum of 1-(naphthalen-1-yl)cyclobutanol 1k



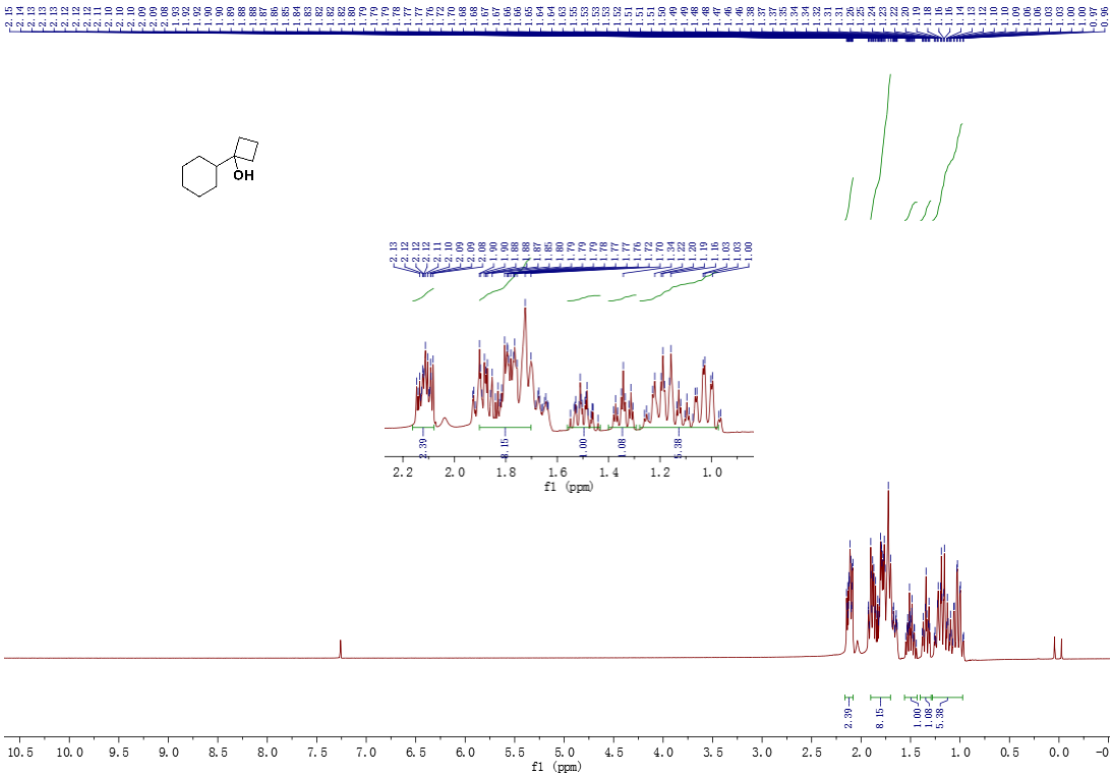
## $^{1}$H NMR spectrum of 3-(benzyloxy)-1-phenylcyclobutanol 1l



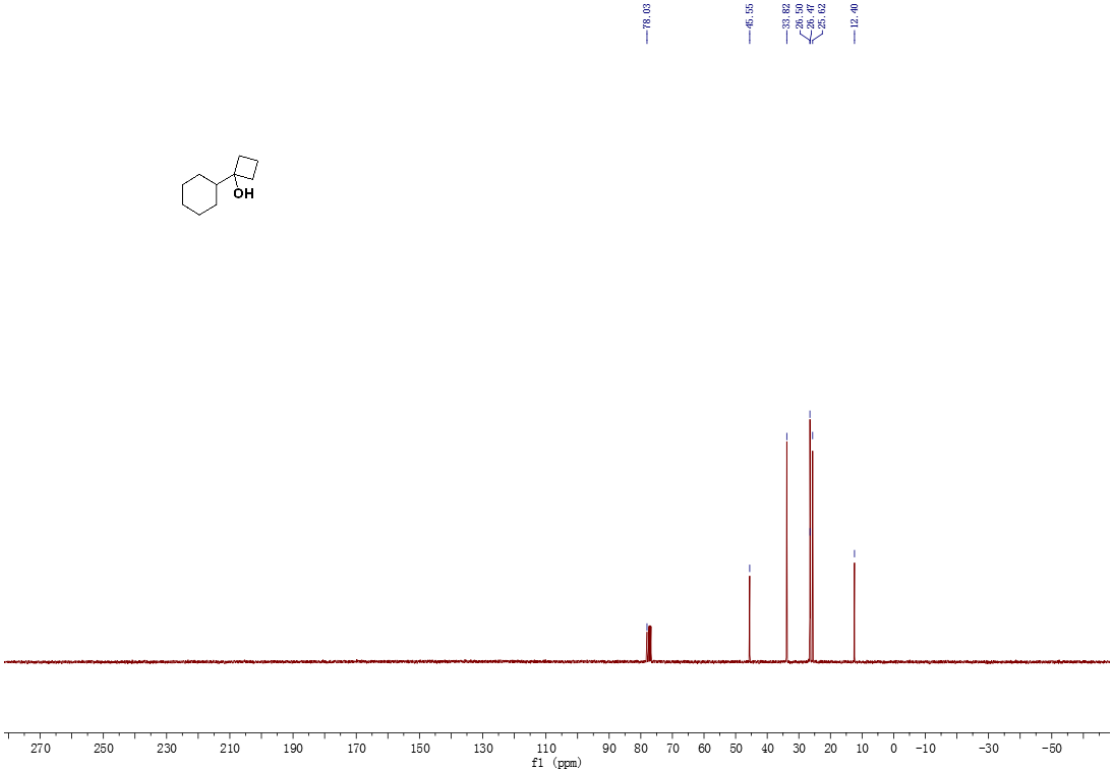

## $^{13}$C NMR spectrum of 3-(benzyloxy)-1-phenylcyclobutanol 1l



## $^{1}$H NMR spectrum of 1-cyclohexylcyclobutanol 1m




## $^{13}$C NMR spectrum of 1-cyclohexylcyclobutanol 1m



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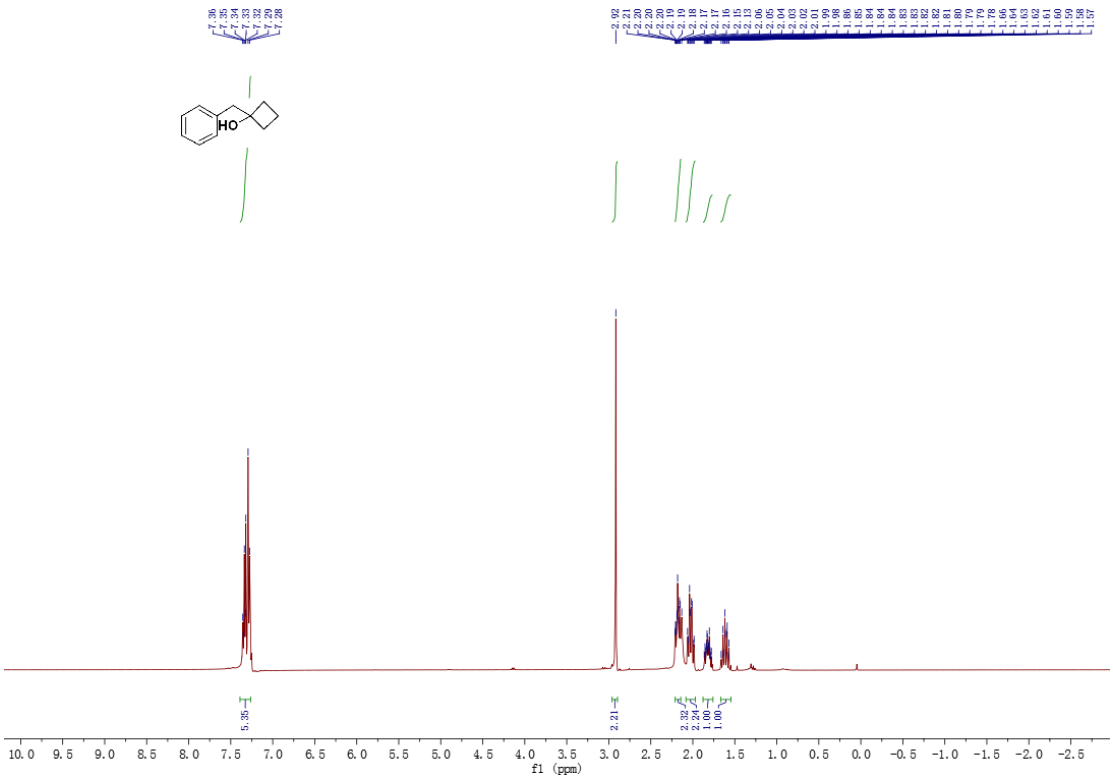
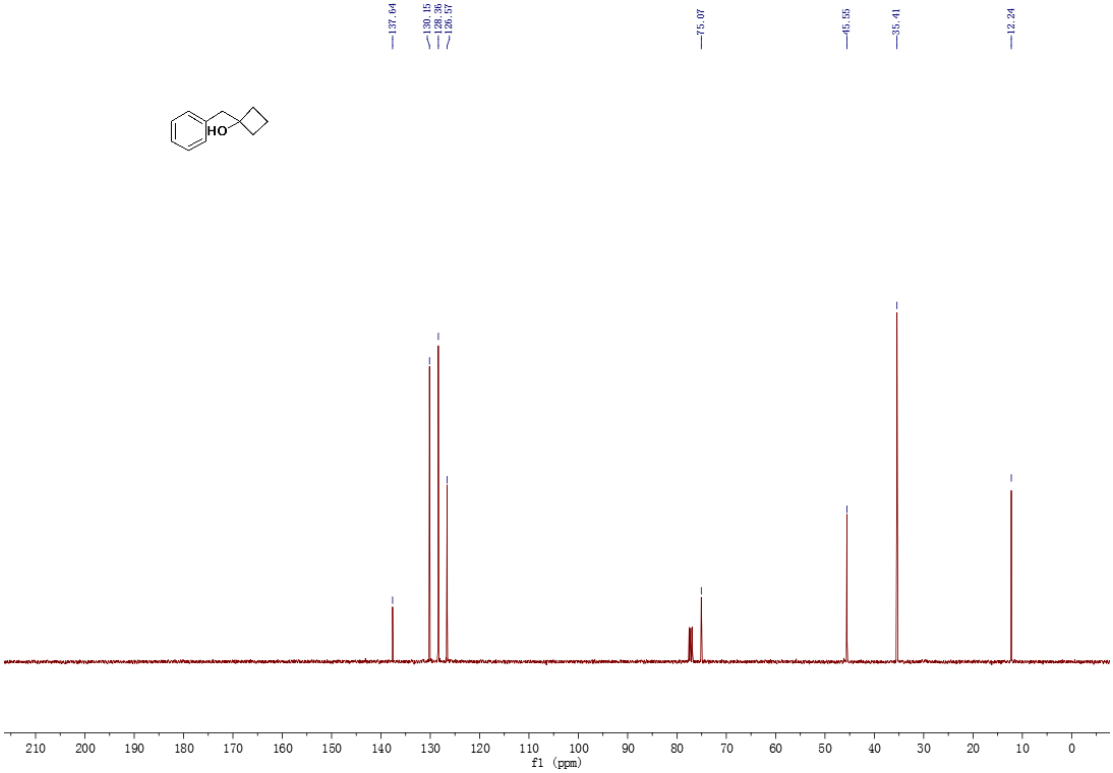
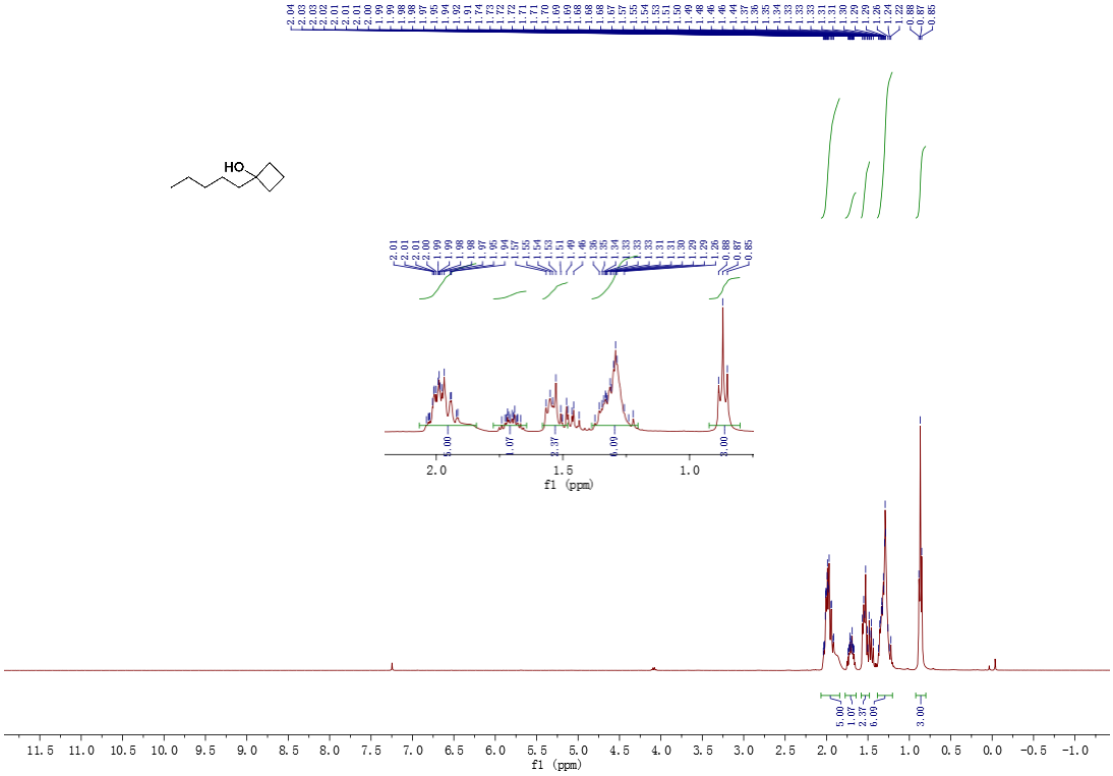


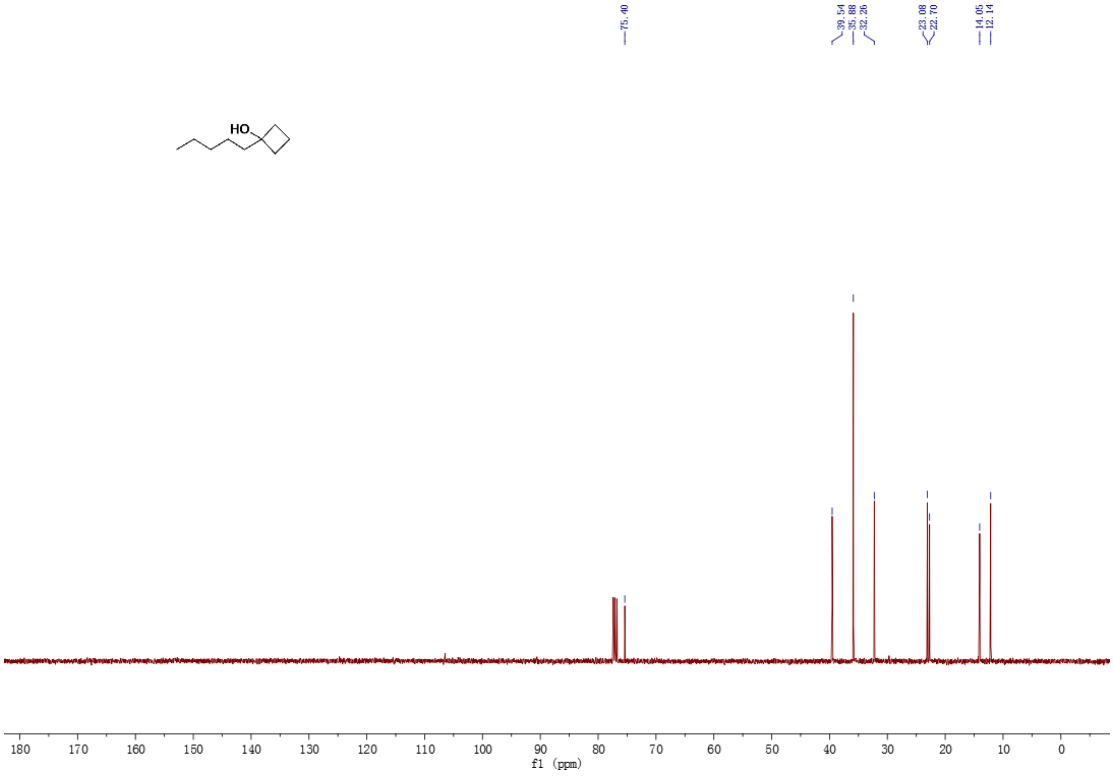

## $^{13}$C NMR spectrum of 1-benzylcyclobutanol 1n



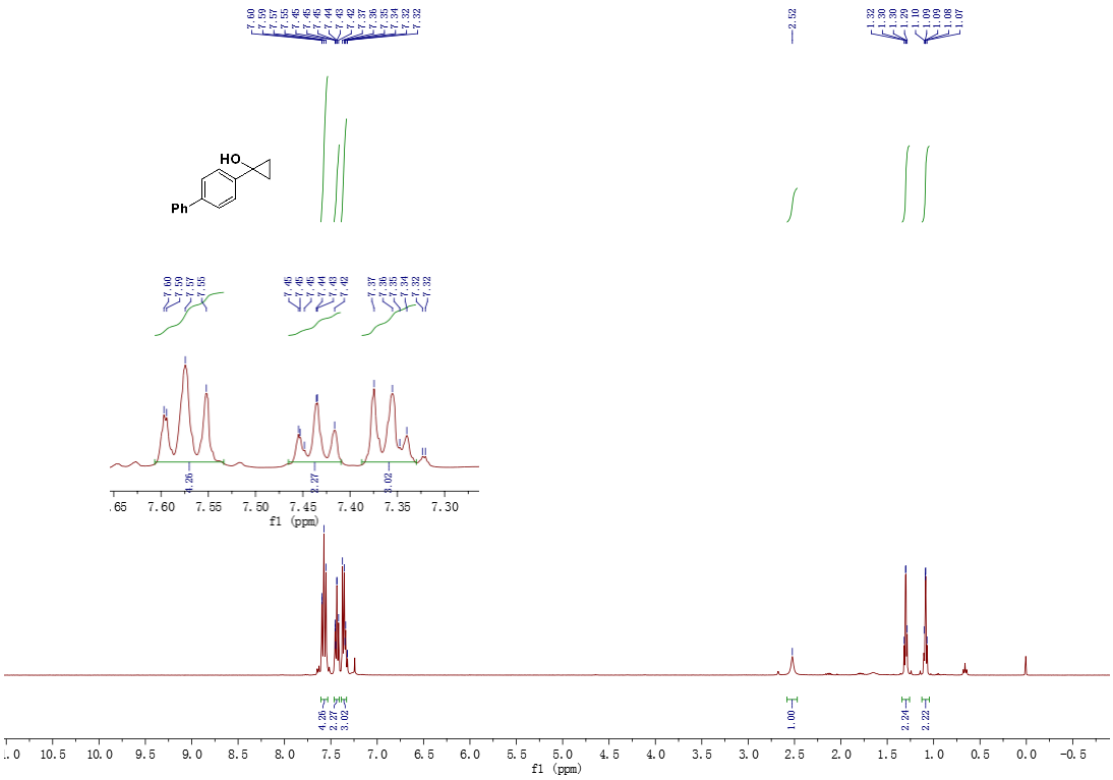
## $^{1}$H NMR spectrum of 1-pentylcyclobutanol 1o



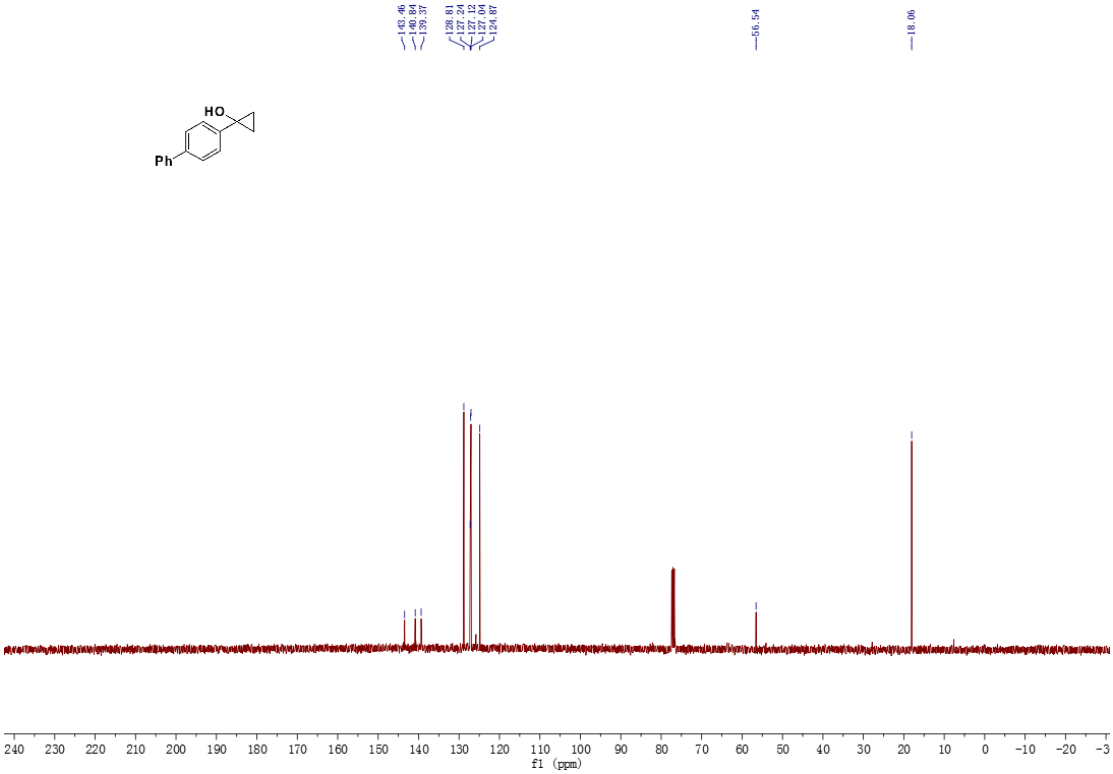

## $^{13}$C NMR spectrum of 1-pentylcyclobutanol 1o



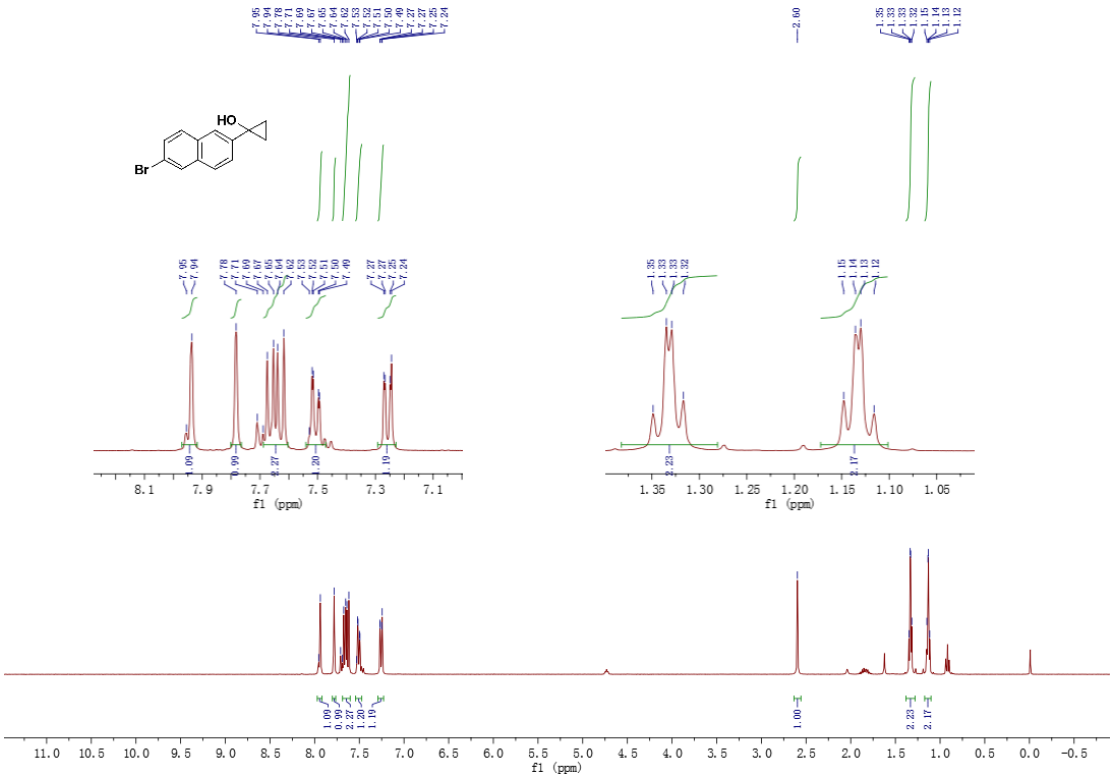
## $^{1}$H NMR spectrum of 1-([1,1'-biphenyl]-4-yl)cyclopropanol 3b



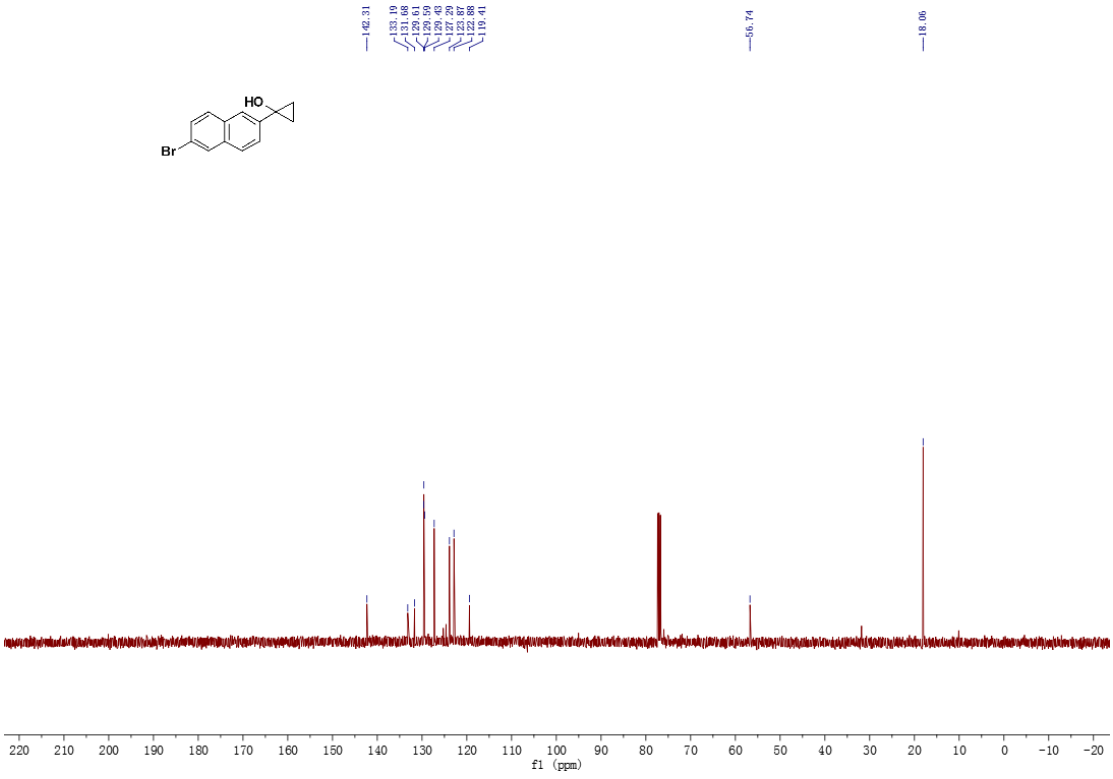

## $^{13}$C NMR spectrum of 1-([1,1'-biphenyl]-4-yl)cyclopropanol 3b



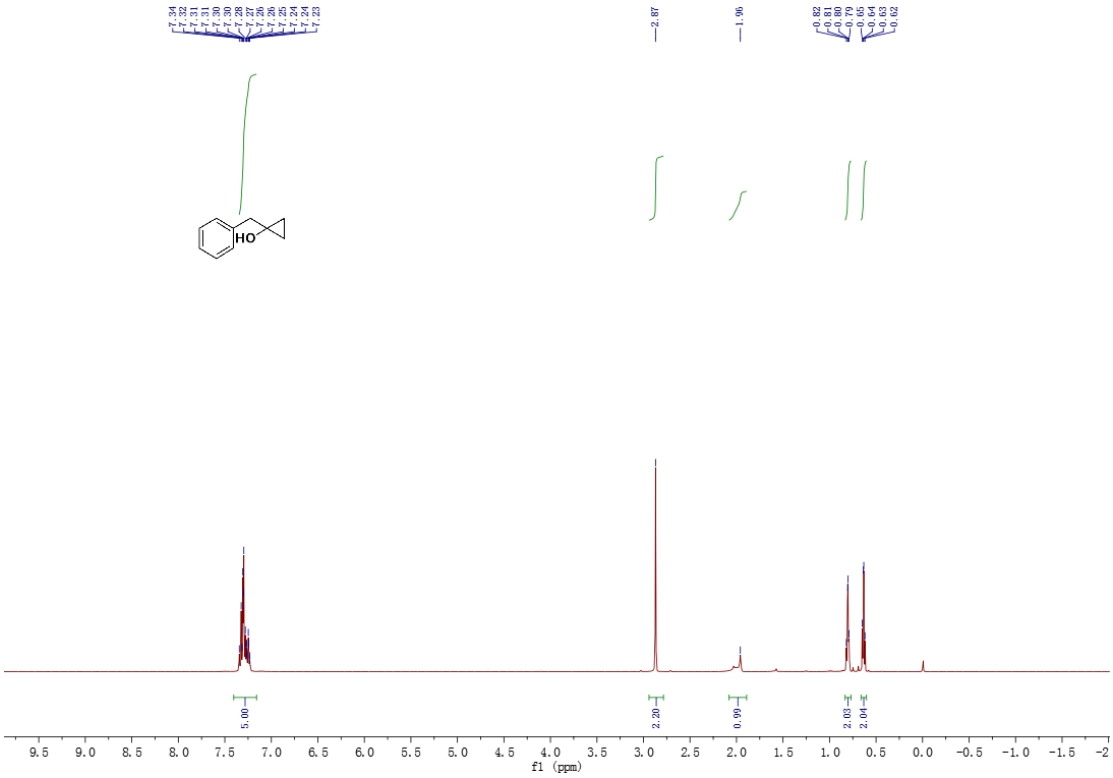
## $^{1}$H NMR spectrum of 1-(6-bromonaphthalen-2-yl)cyclopropanol 3d



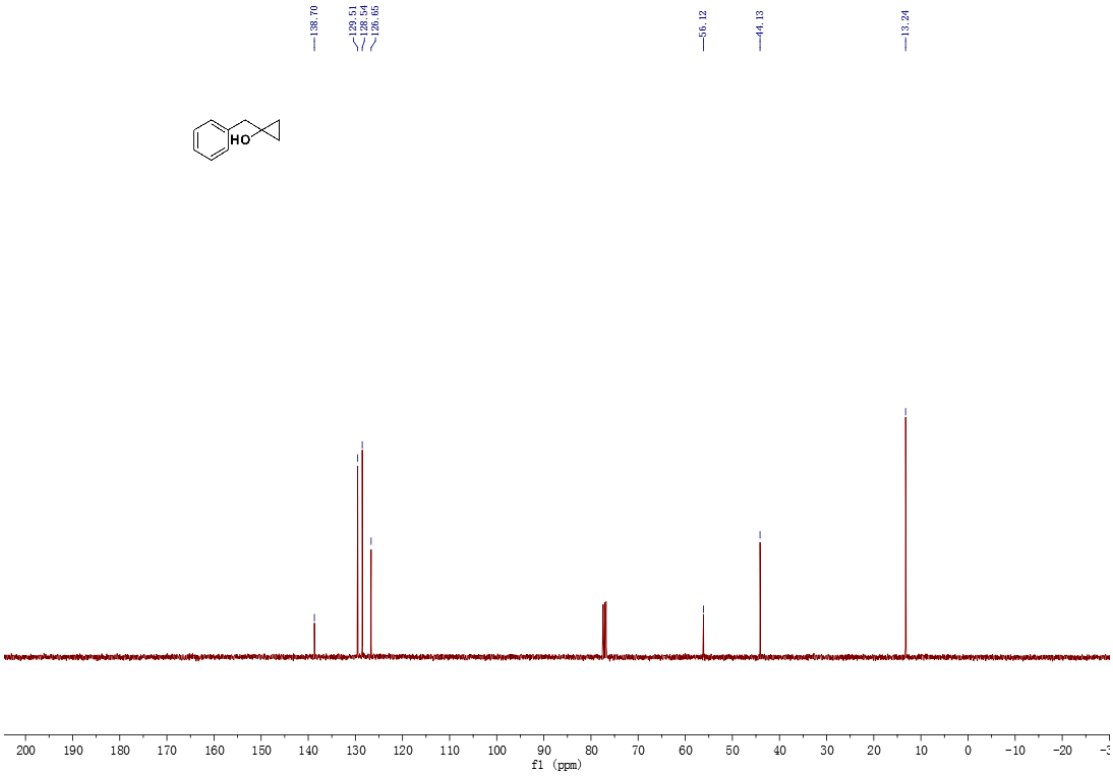

## $^{13}$C NMR spectrum of 1-(6-bromonaphthalen-2-yl)cyclopropanol 3d



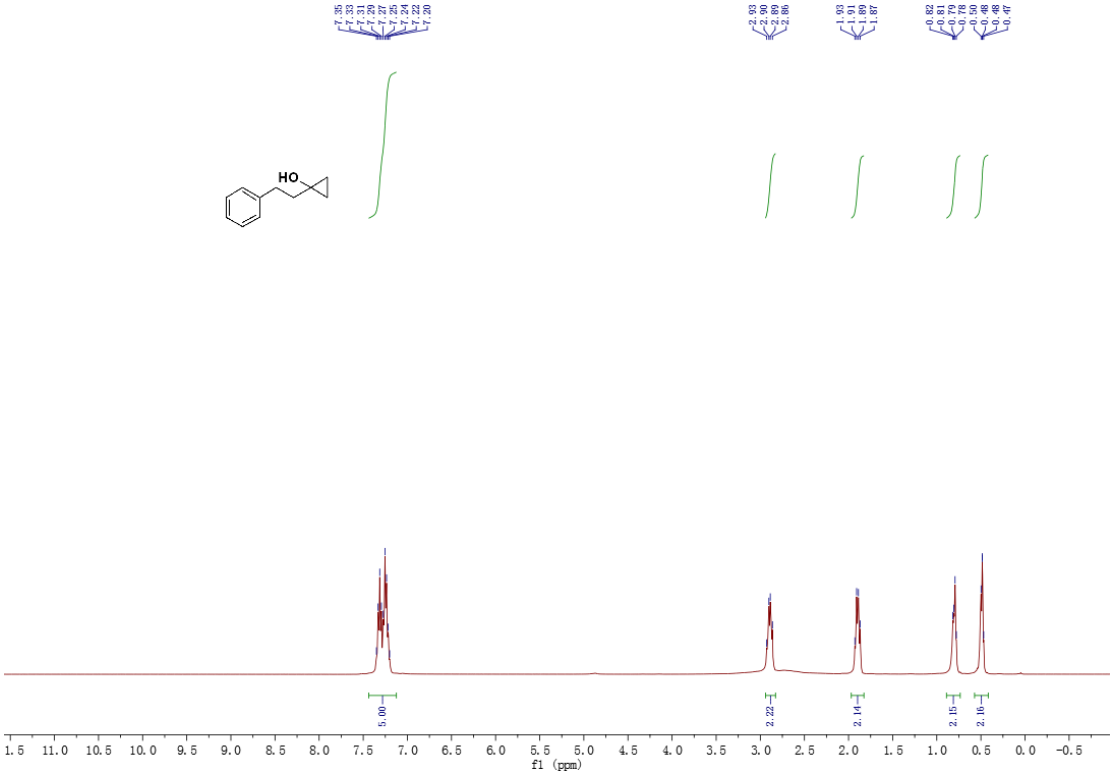
## $^{1}$H NMR spectrum of 1-benzylcyclopropanol 3g



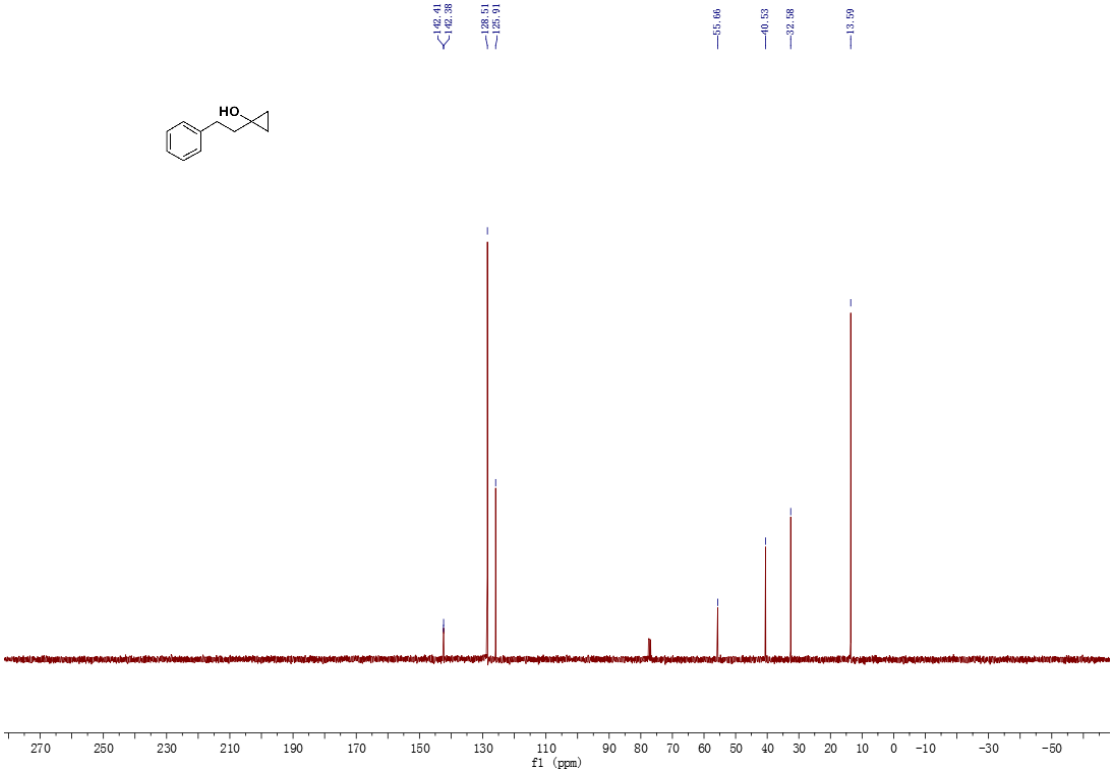

## $^{13}$C NMR spectrum of 1-benzylcyclopropanol 3g



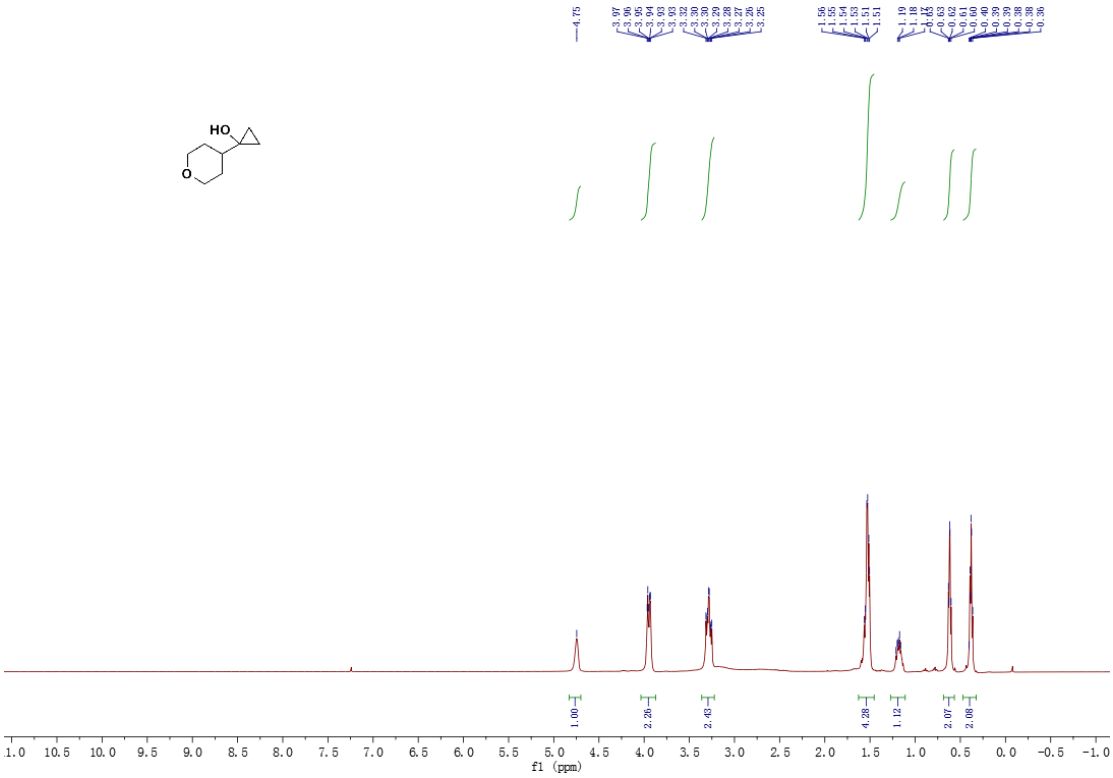
## $^{1}$H NMR spectrum of 1-phenethylcyclopropanol 3h



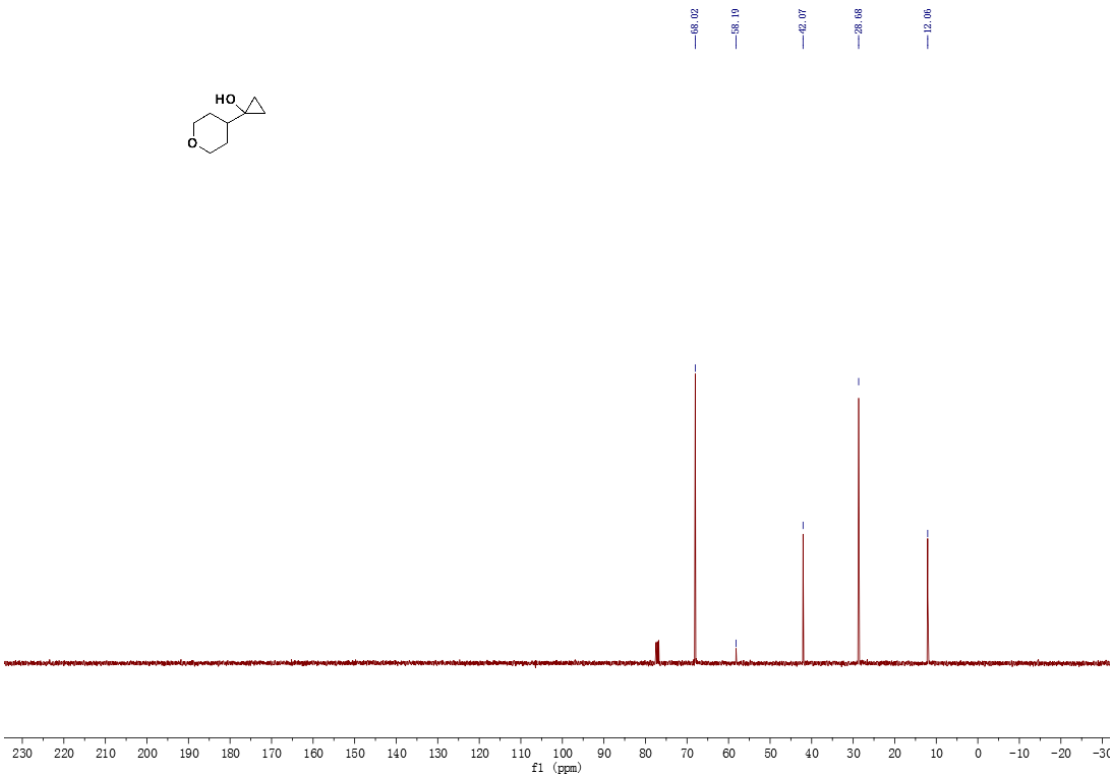

## $^{13}$C NMR spectrum of 1-phenethylcyclopropanol 3h



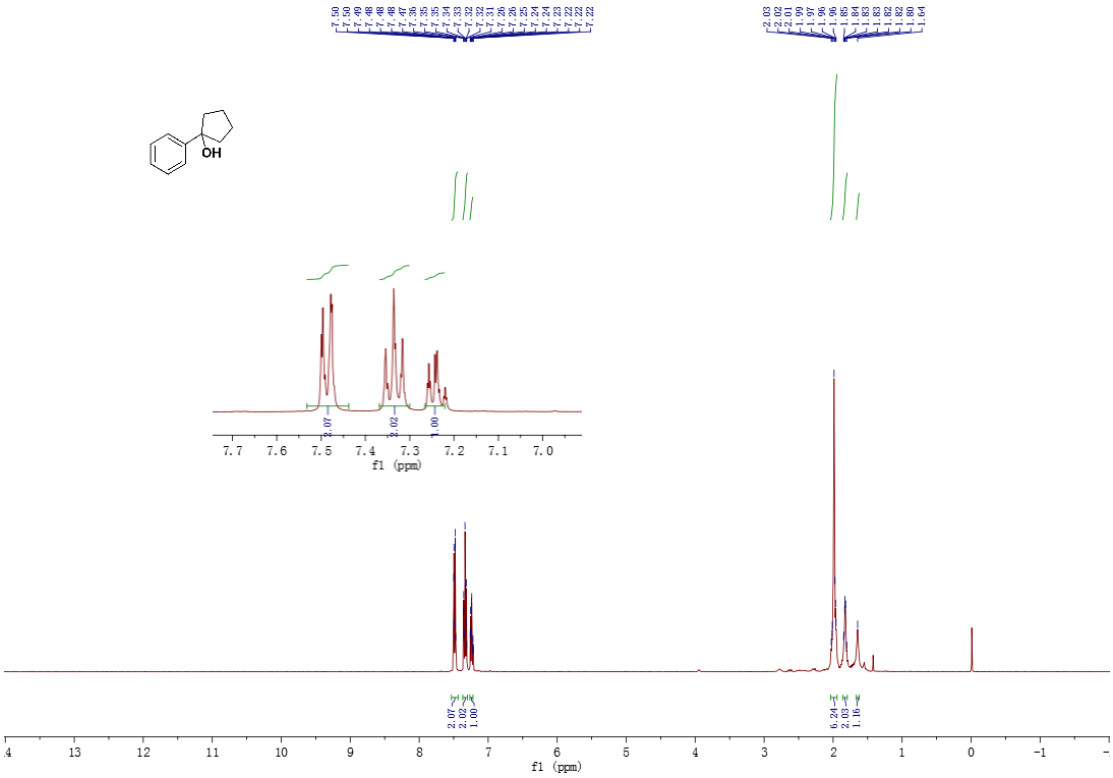
## $^{1}$H NMR spectrum of 1-phenethylcyclopropanol 3h



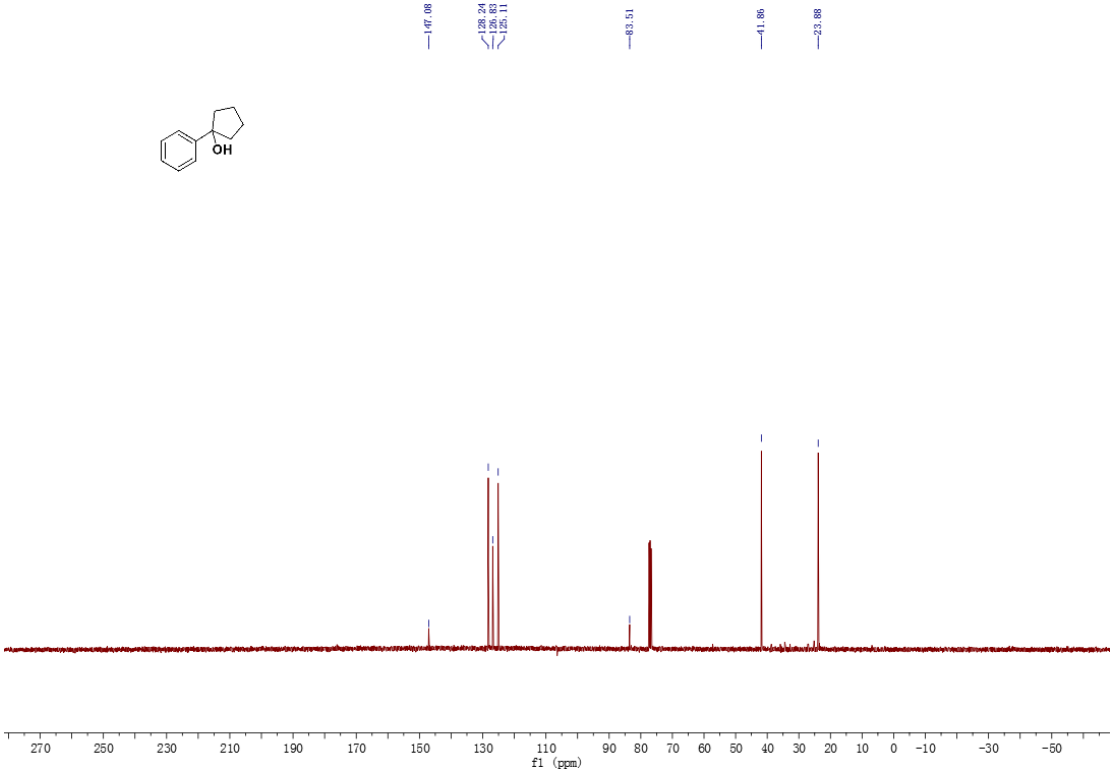

## $^{13}$C NMR spectrum of 1-(tetrahydro-2*H*-pyran-4-yl)cyclopropanol 3i



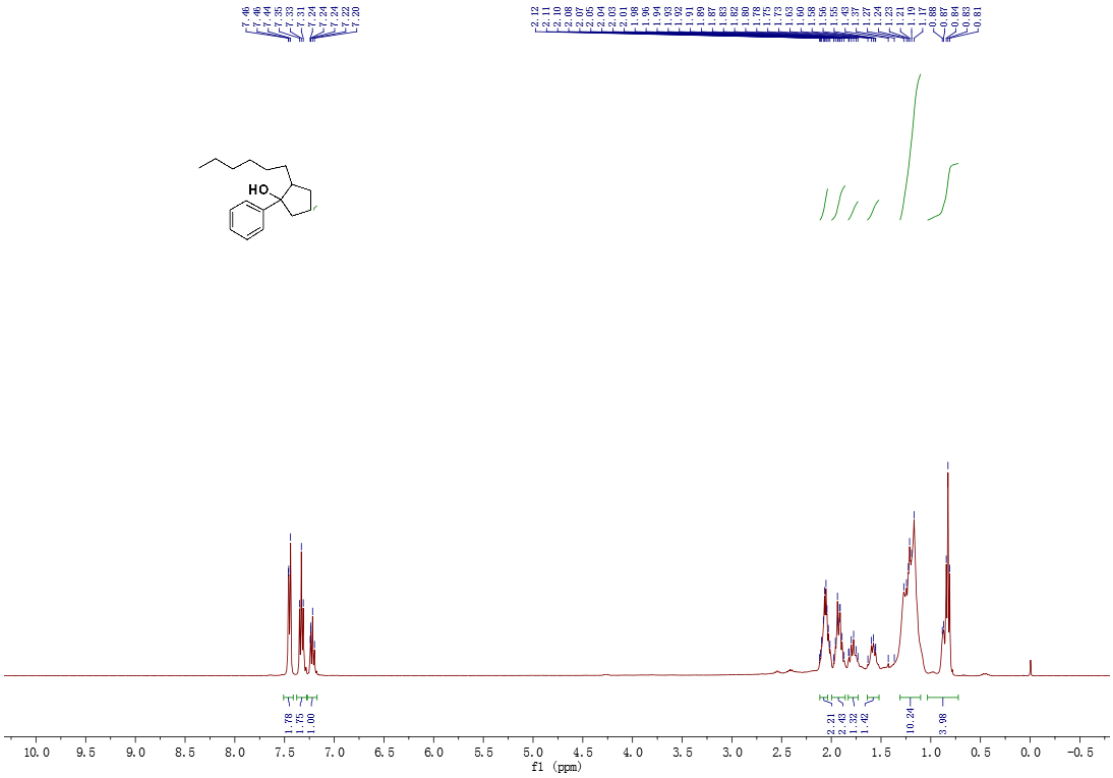
## $^{1}$H NMR spectrum of 1-phenylcyclopentanol 3j



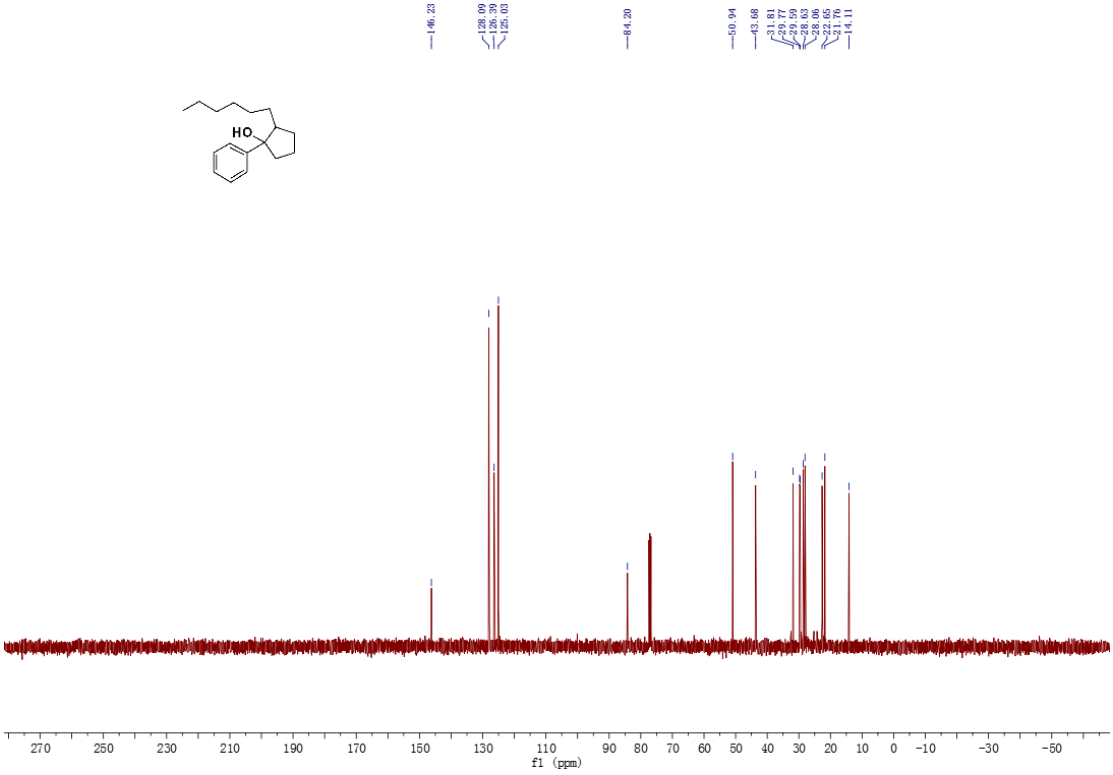

## $^{13}$C NMR spectrum of 1-phenylcyclopentanol 3j



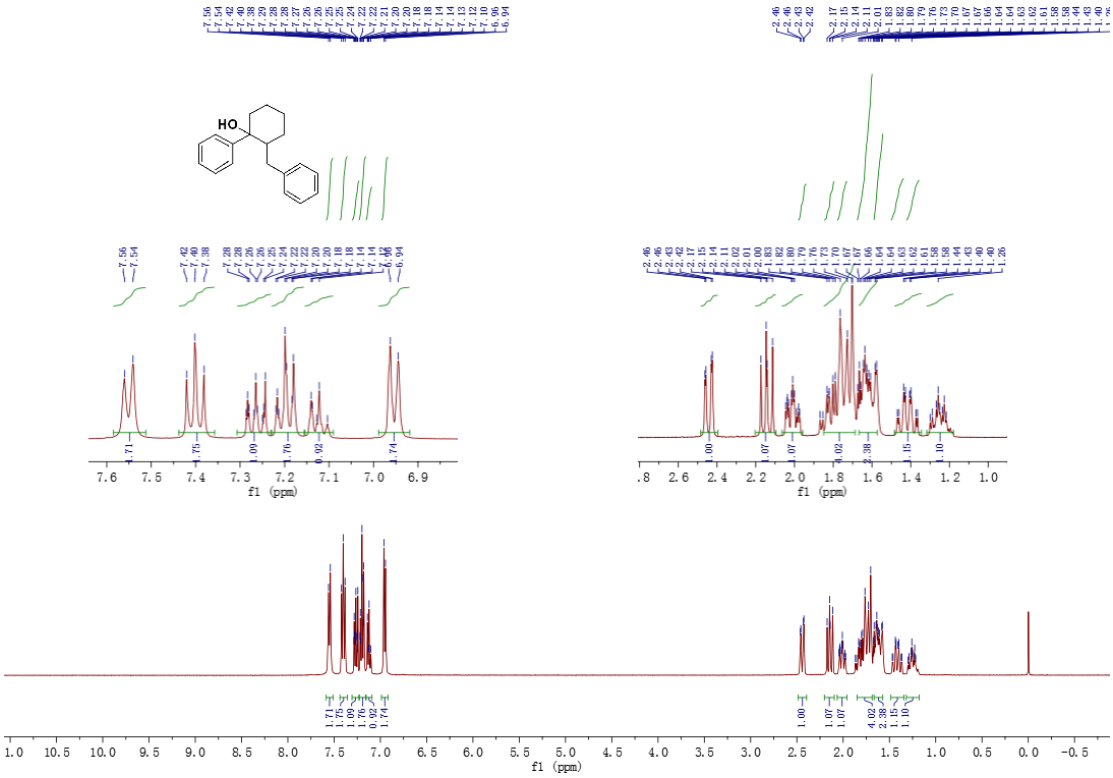
## $^{1}$H NMR spectrum of 2-hexyl-1-phenylcyclopentanol 3l



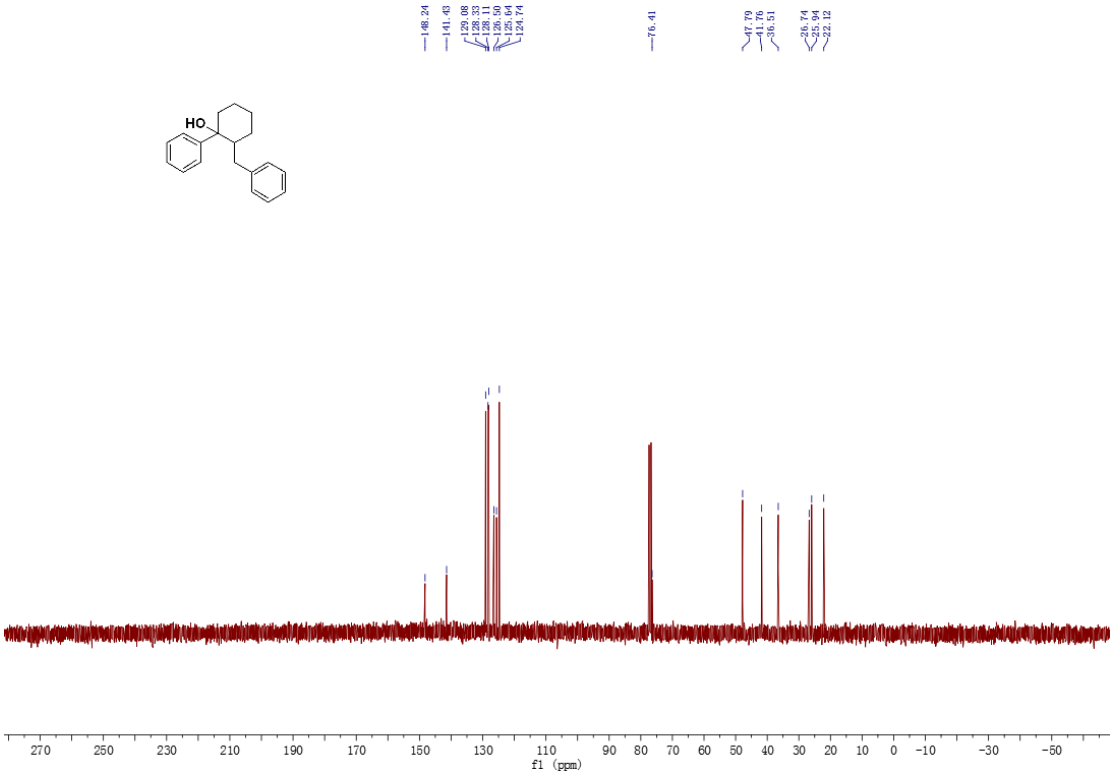

## $^{13}$C NMR spectrum of 2-hexyl-1-phenylcyclopentanol 3l



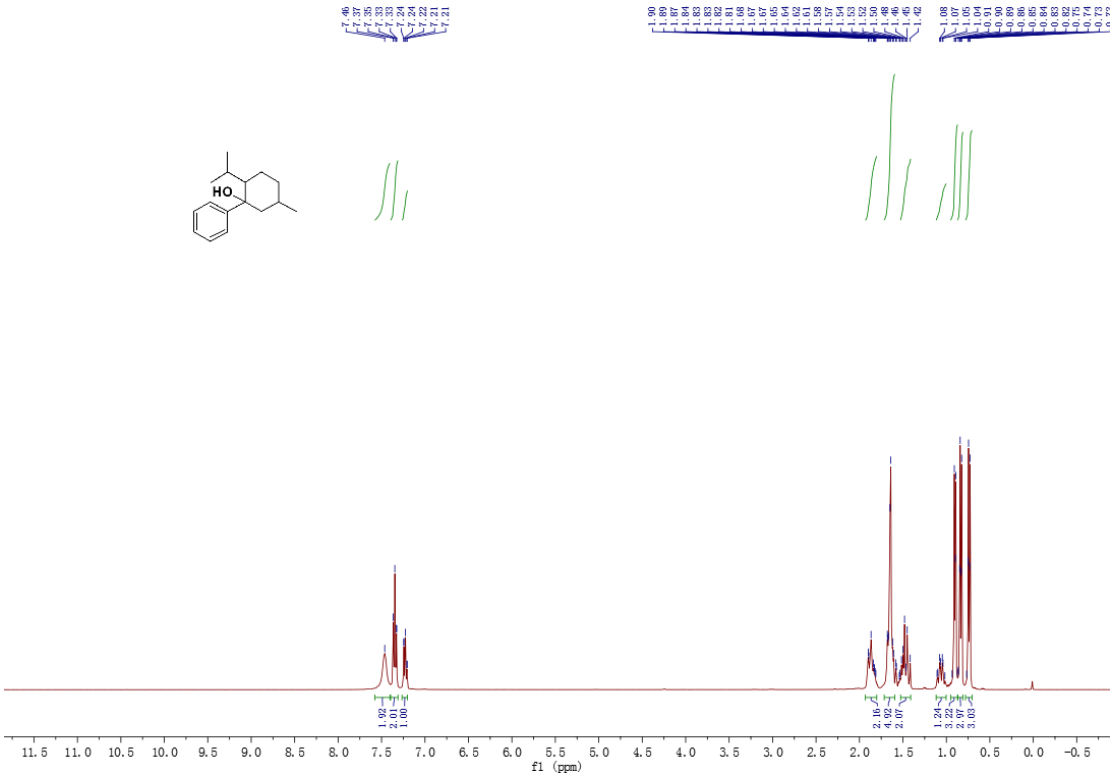
## $^{1}$H NMR spectrum of 2-benzyl-1-phenylcyclohexanol 3n



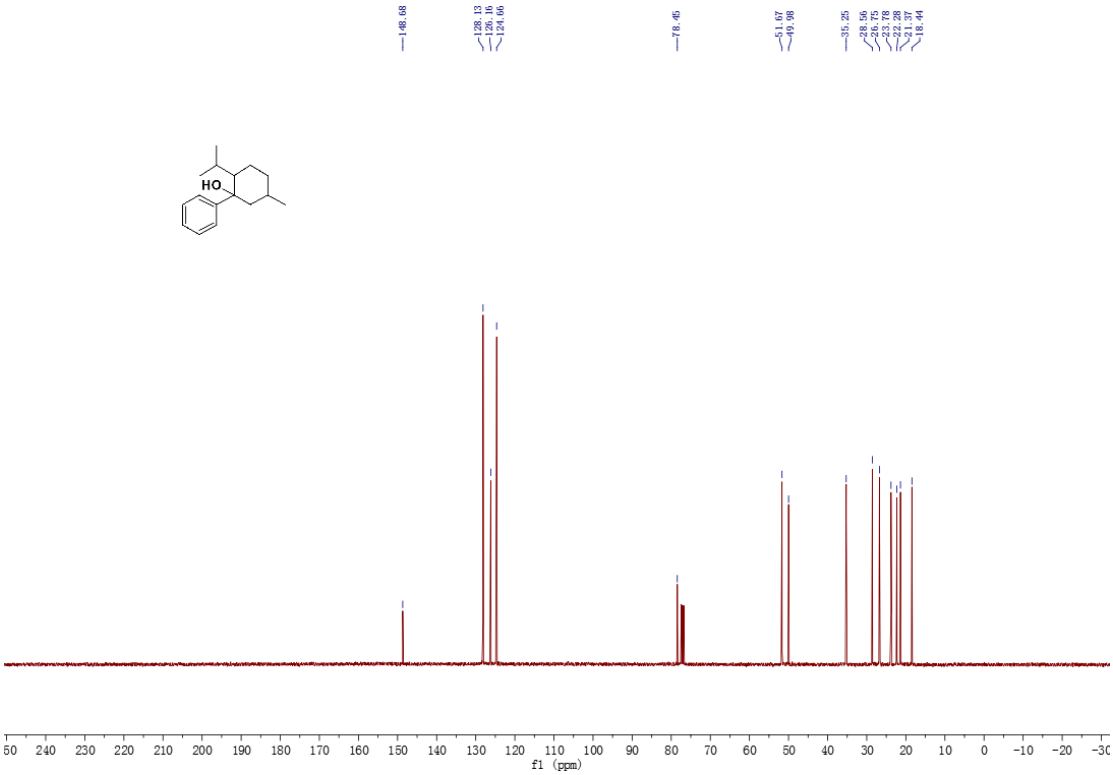

## $^{13}$C NMR spectrum of 2-benzyl-1-phenylcyclohexanol 3n



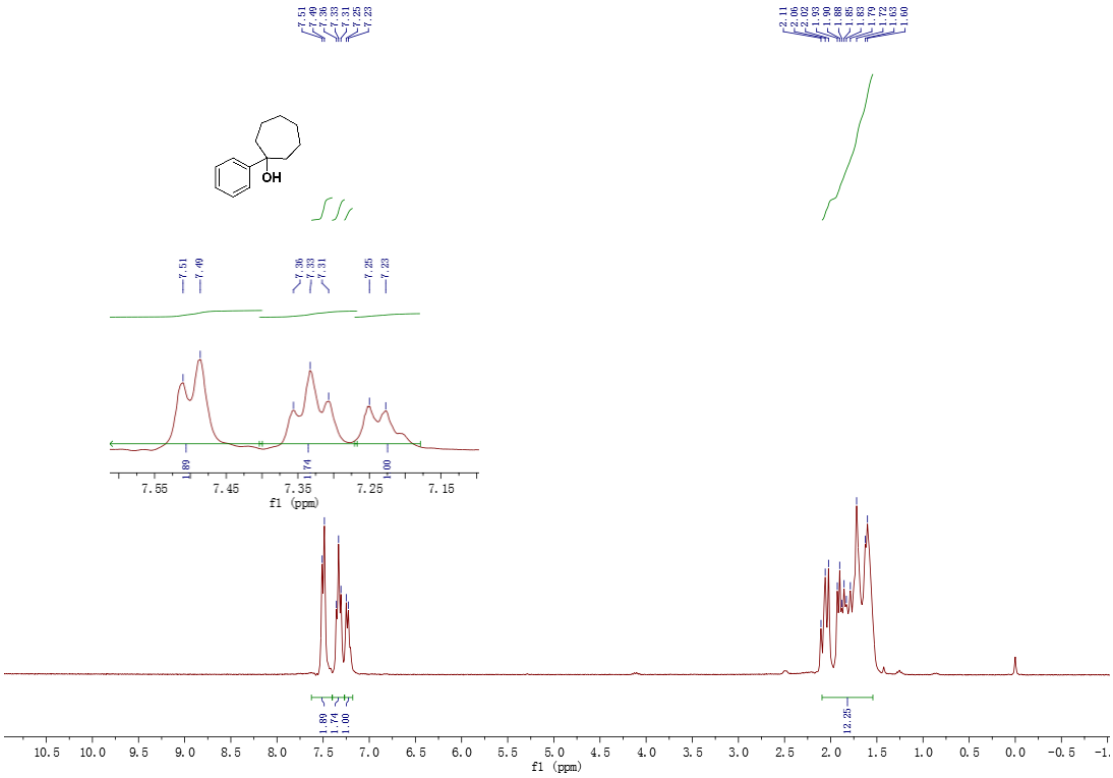
## $^{1}$H NMR spectrum of 2-isopropyl-5-methyl-1-phenylcyclohexanol 3o



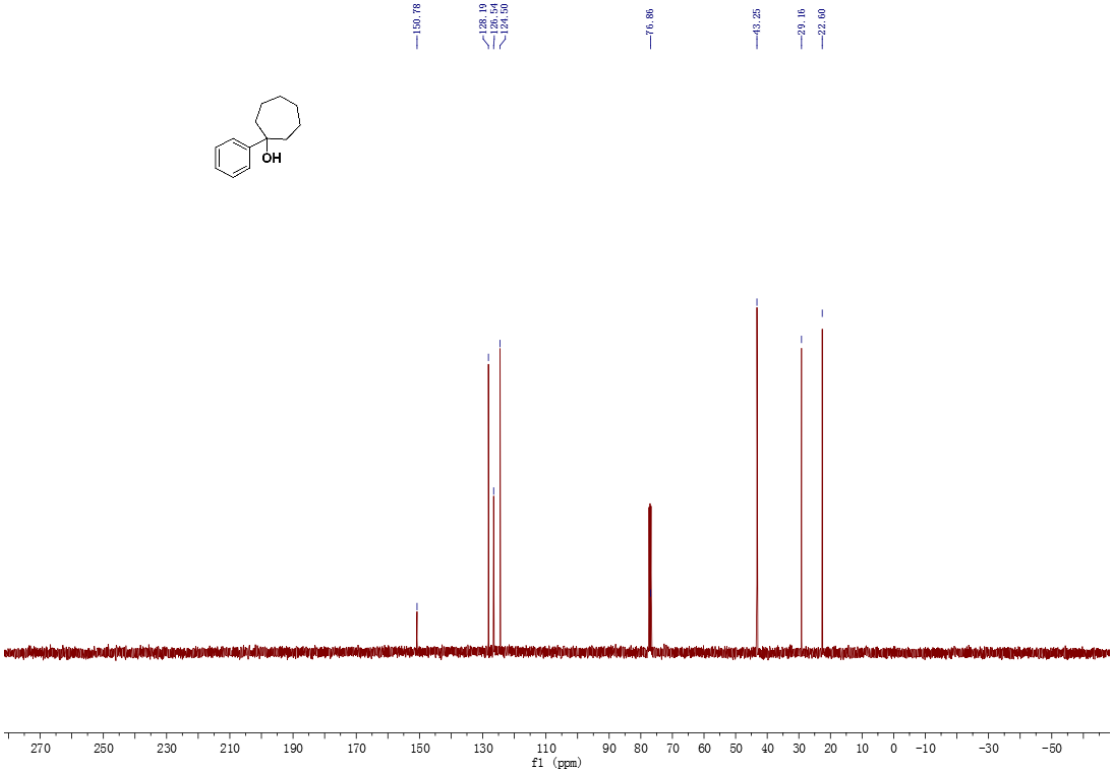

## $^{13}$C NMR spectrum of 2-isopropyl-5-methyl-1-phenylcyclohexanol 3o



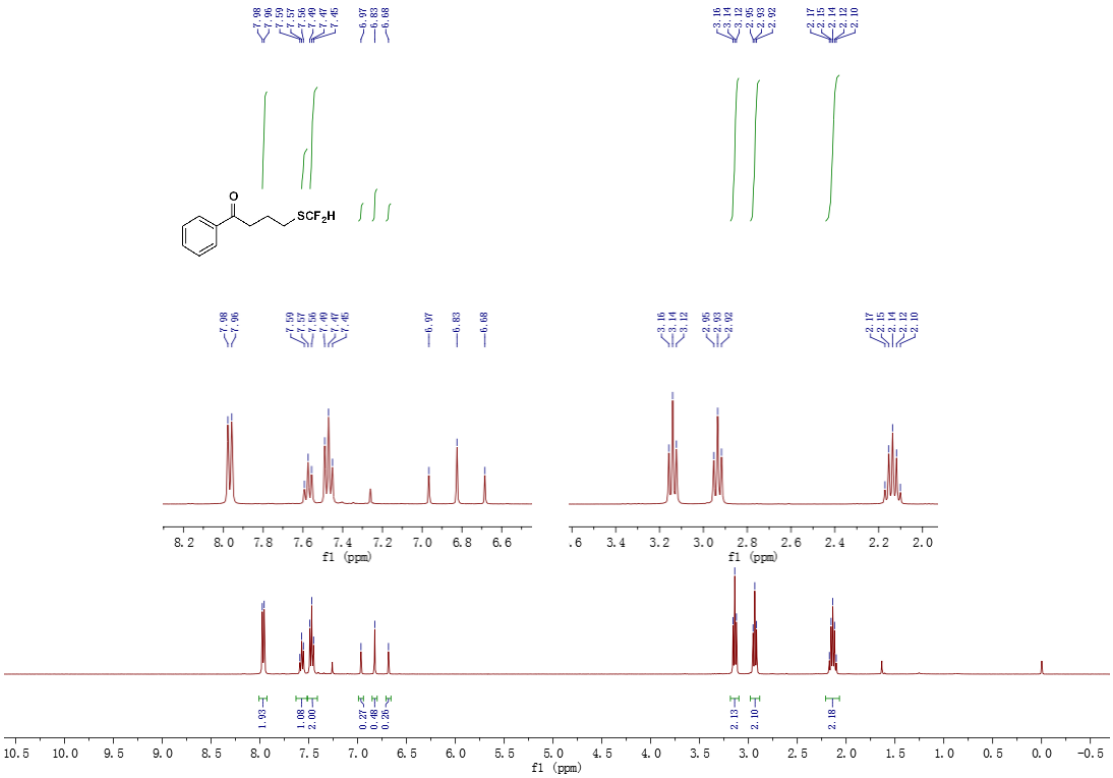
## $^{1}$H NMR spectrum of 1-phenylcycloheptanol 3p



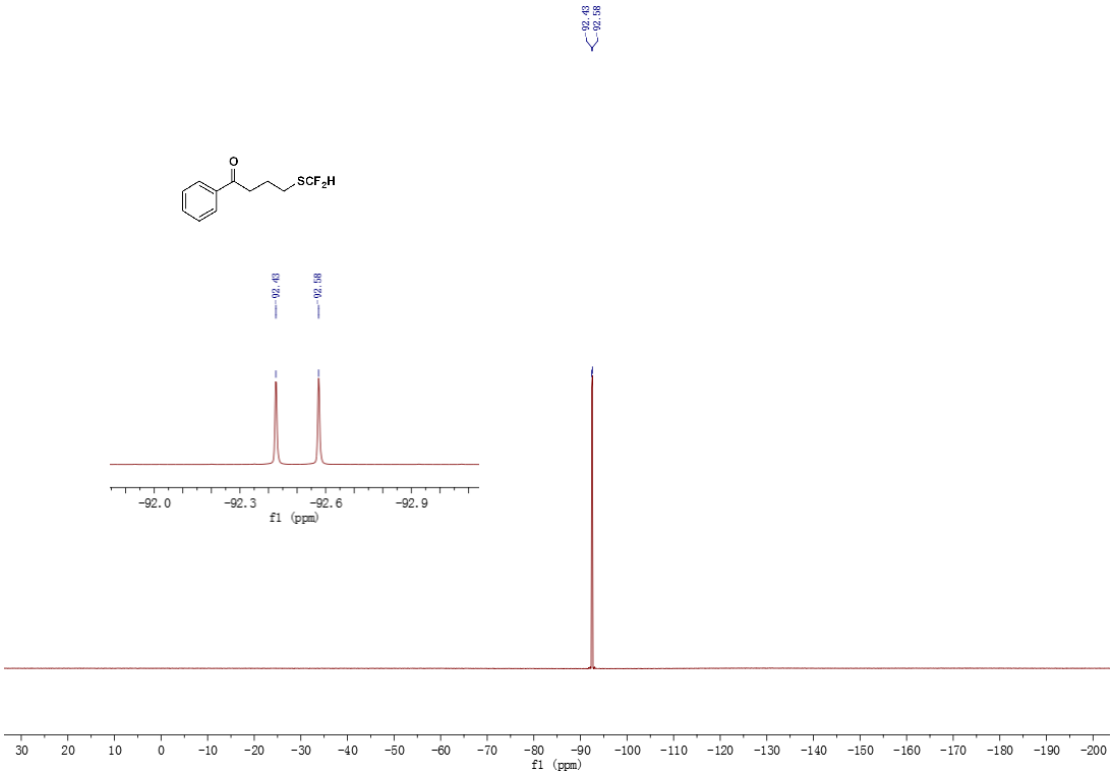

## $^{13}$C NMR spectrum of 1-phenylcycloheptanol 3p



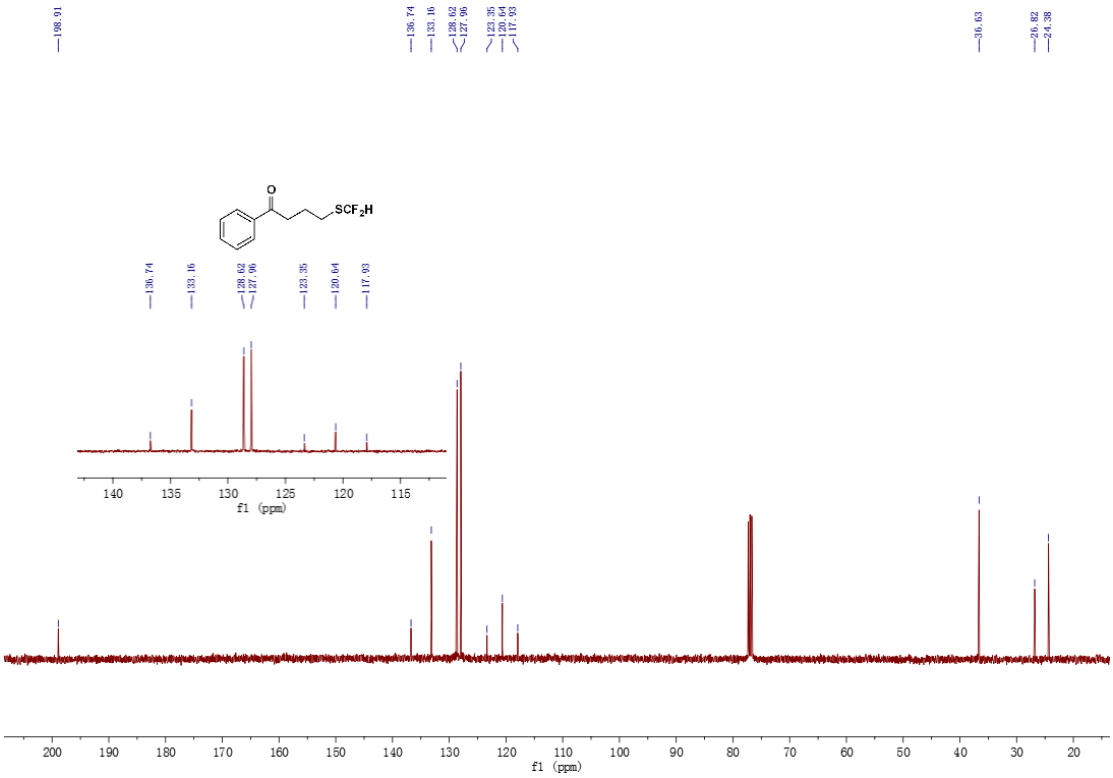
## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-1-one 2a



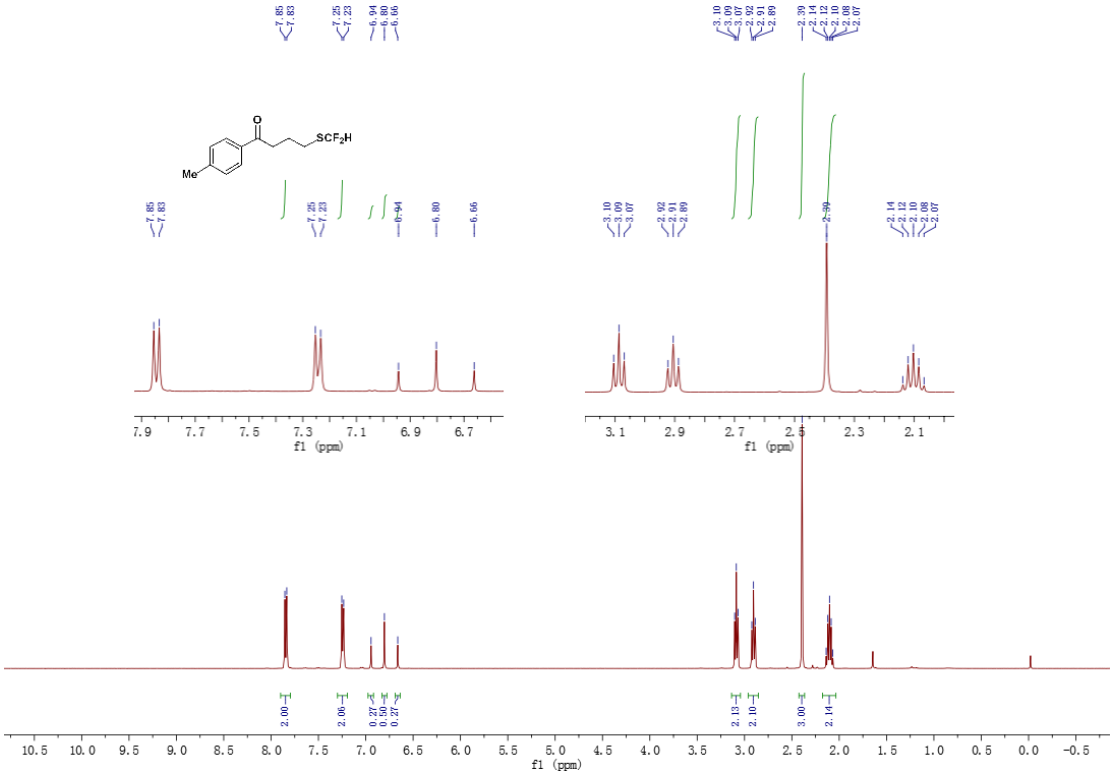

## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-1-one 2a



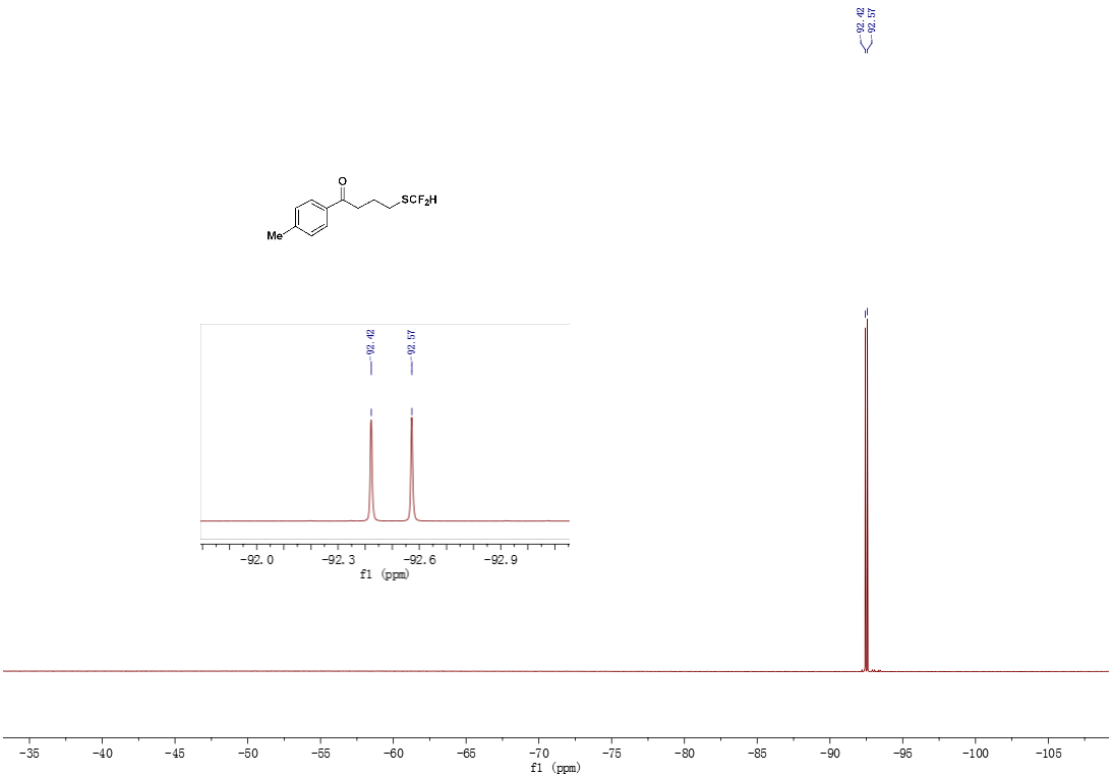
## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-1-one 2a



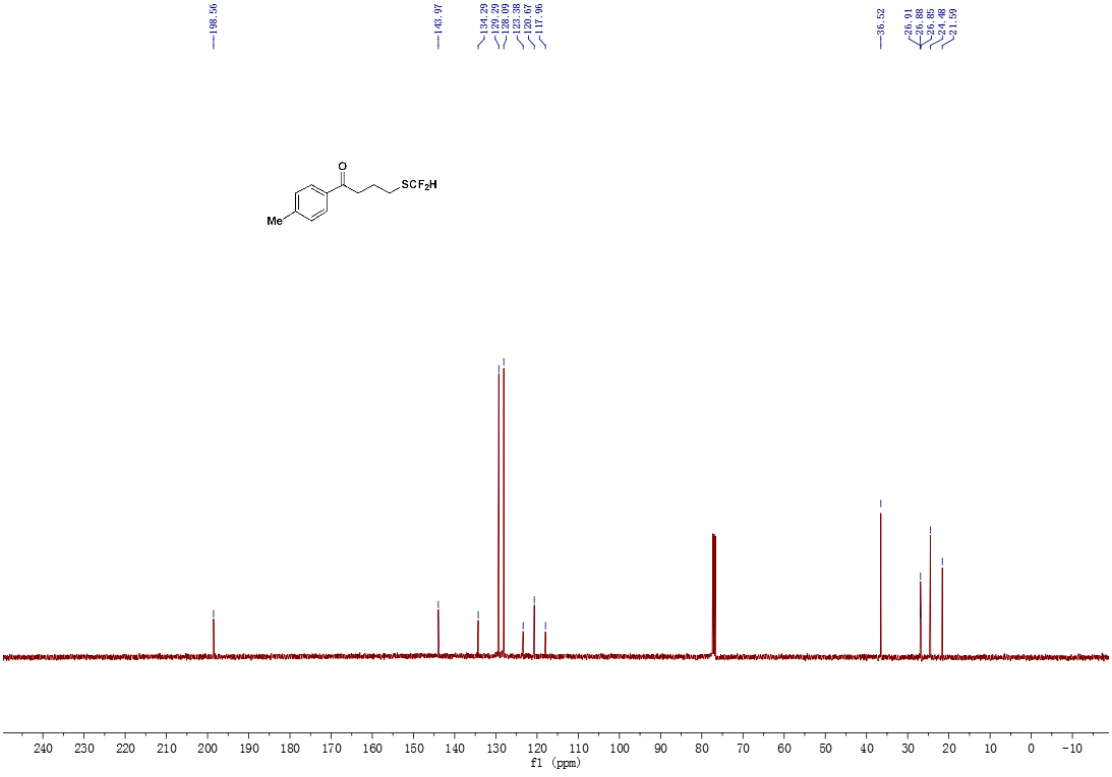

## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-(*p*-tolyl)butan-1-one 2b



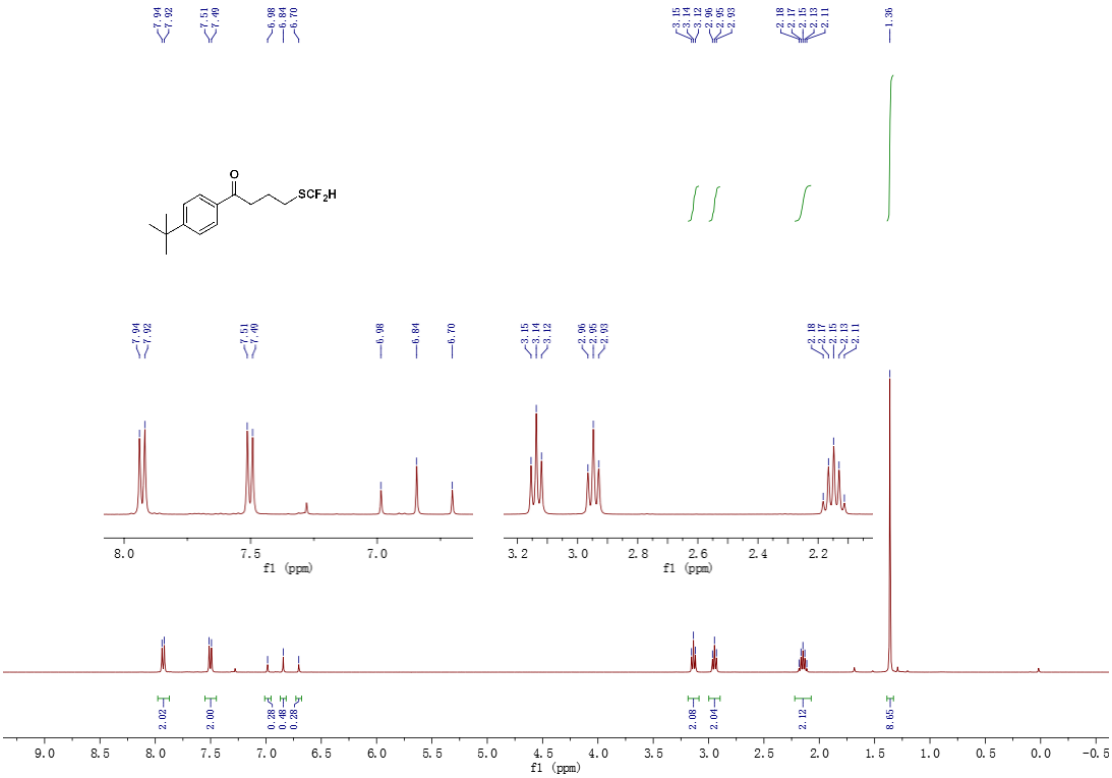
## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-(*p*-tolyl)butan-1-one 2b



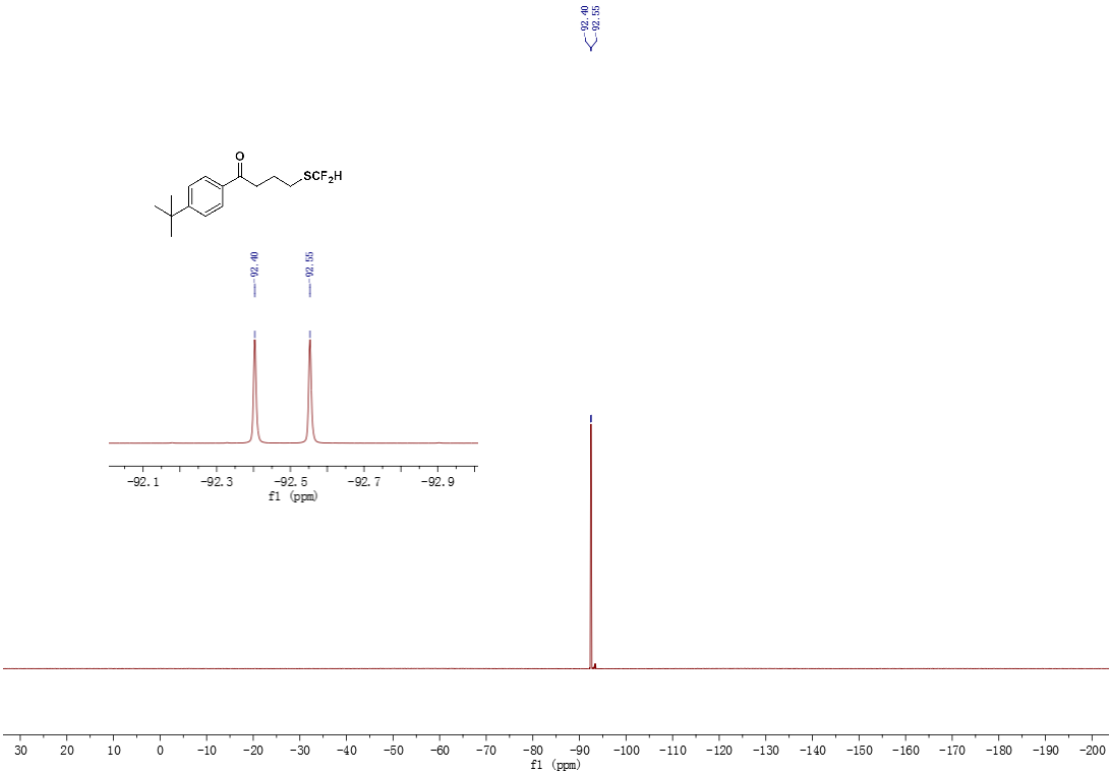

## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-(*p*-tolyl)butan-1-one 2b



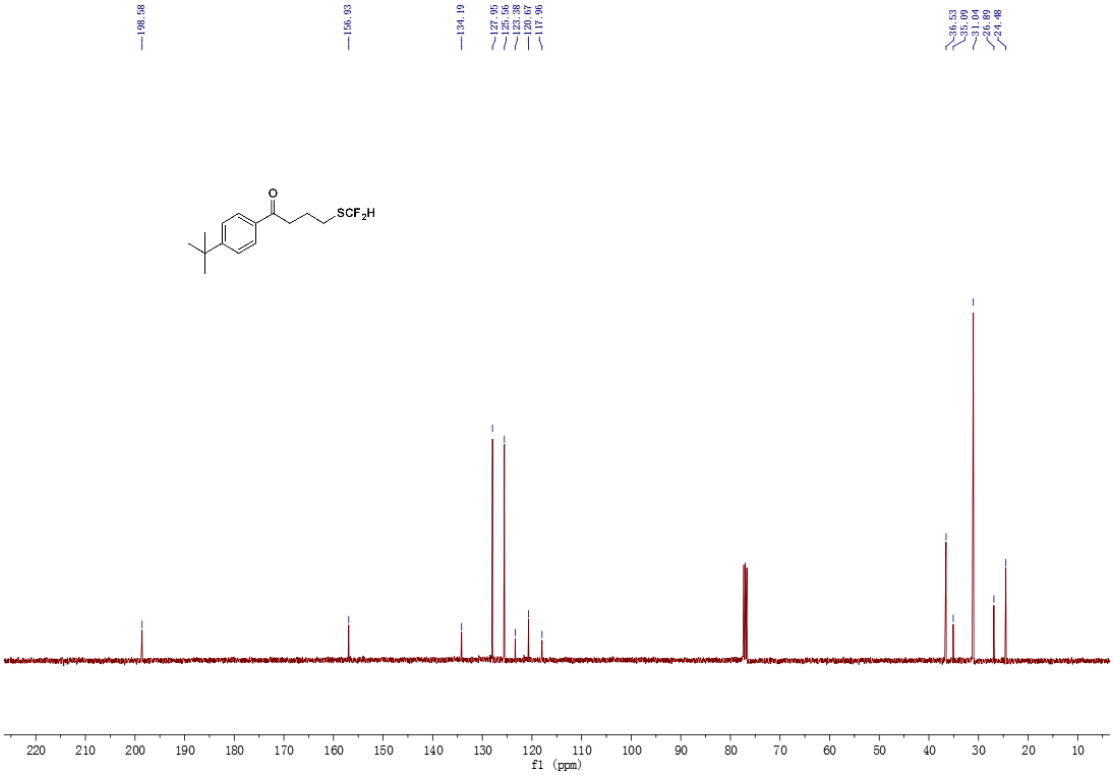
## $^{1}$H NMR spectrum of 1-(4-(*tert*-butyl)phenyl)-4-((difluoromethyl)thio)butan-1-one 2c



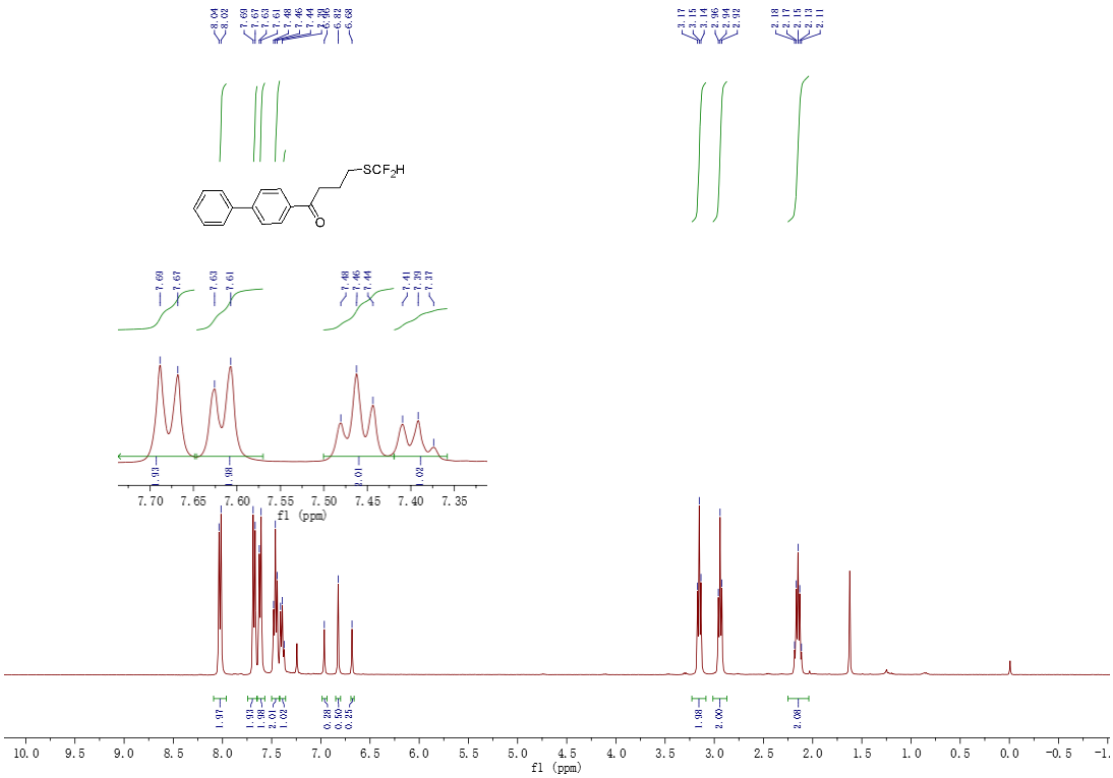

## $^{19}$F NMR spectrum of 1-(4-(*tert*-butyl)phenyl)-4-((difluoromethyl)thio)butan-1-one 2c



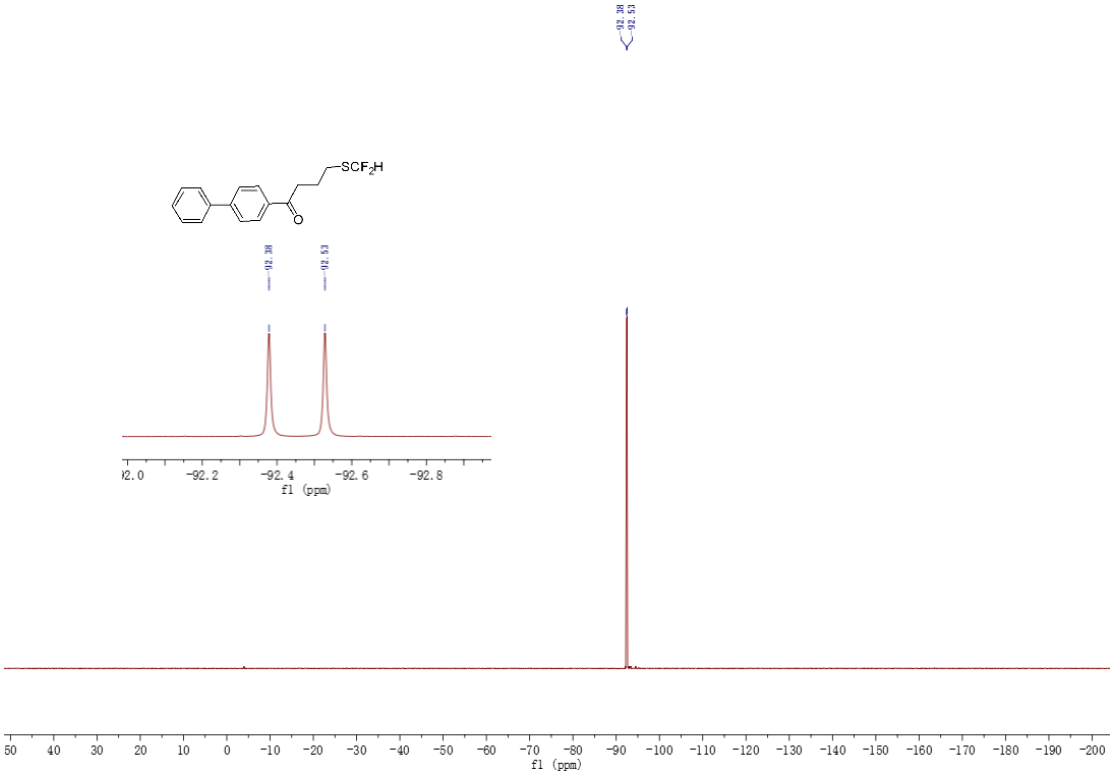
**$^{13}$C NMR spectrum of**
**1-(4-(*tert*-butyl)phenyl)-4-((difluoromethyl)thio)butan-1-one 2c**



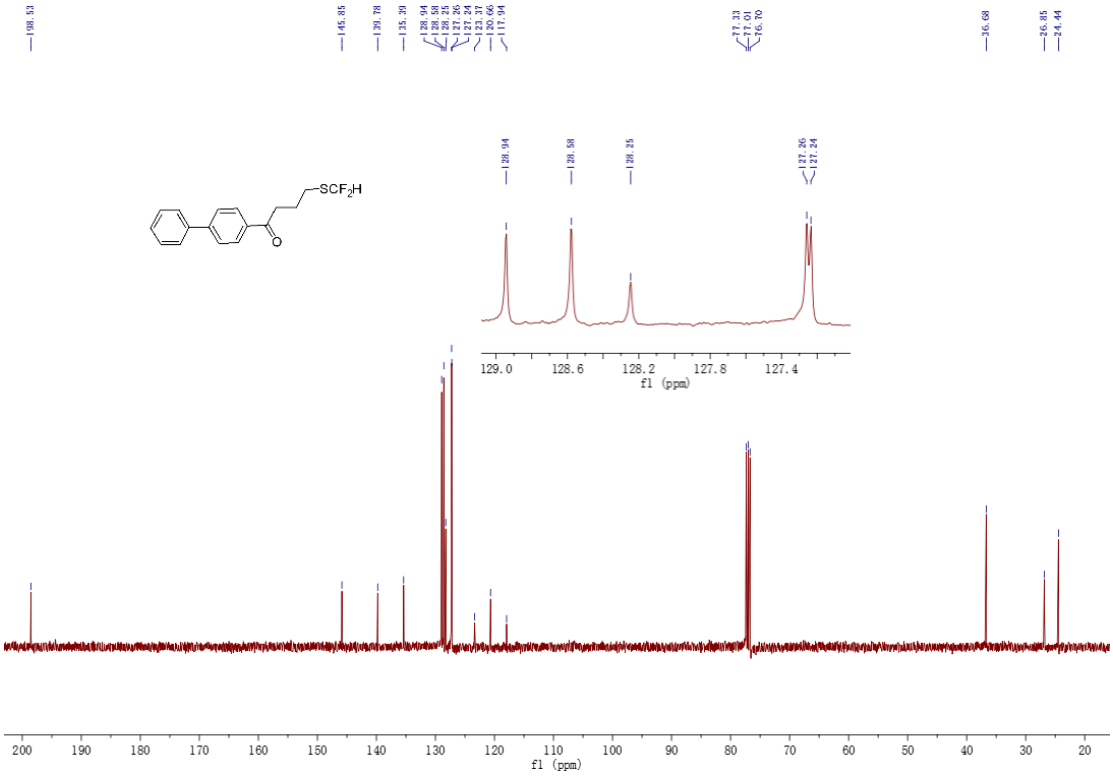

**$^{1}$H NMR spectrum of**
**1-([1,1'-biphenyl]-4-yl)-4-((difluoromethyl)thio)butan-1-one 2d**



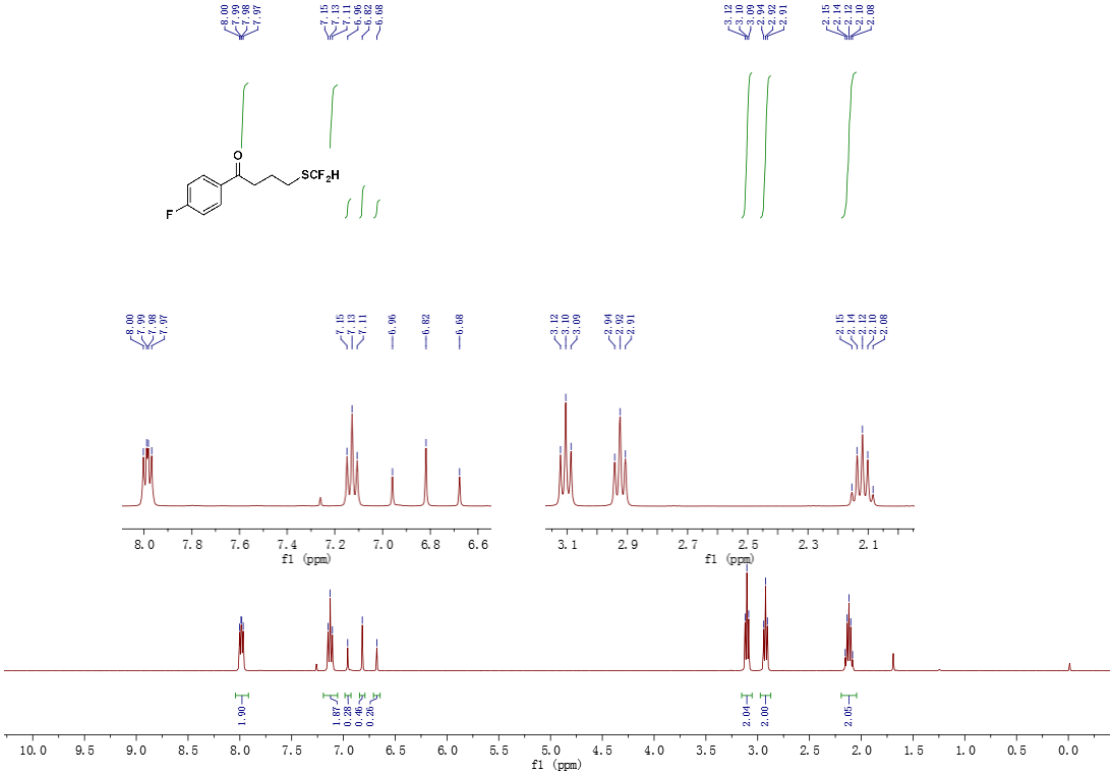
## $^{19}$F NMR spectrum of 1-([1,1'-biphenyl]-4-yl)-4-((difluoromethyl)thio)butan-1-one 2d



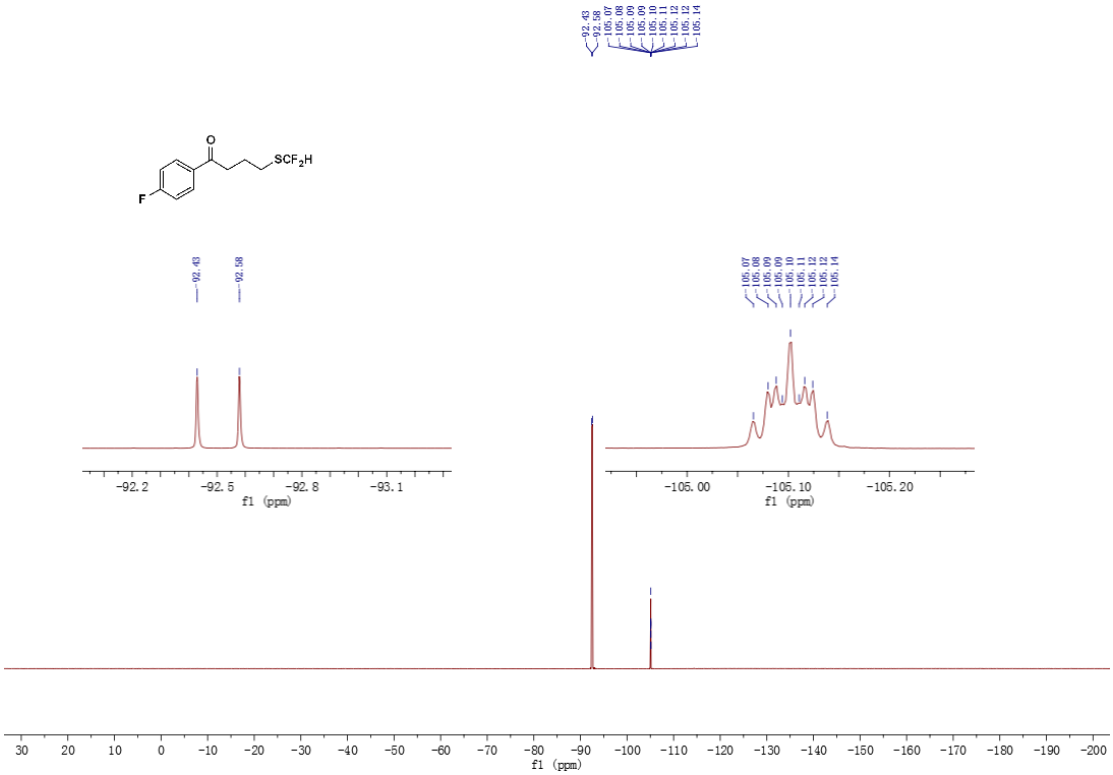

## $^{13}$C NMR spectrum of 1-([1,1'-biphenyl]-4-yl)-4-((difluoromethyl)thio)butan-1-one 2d



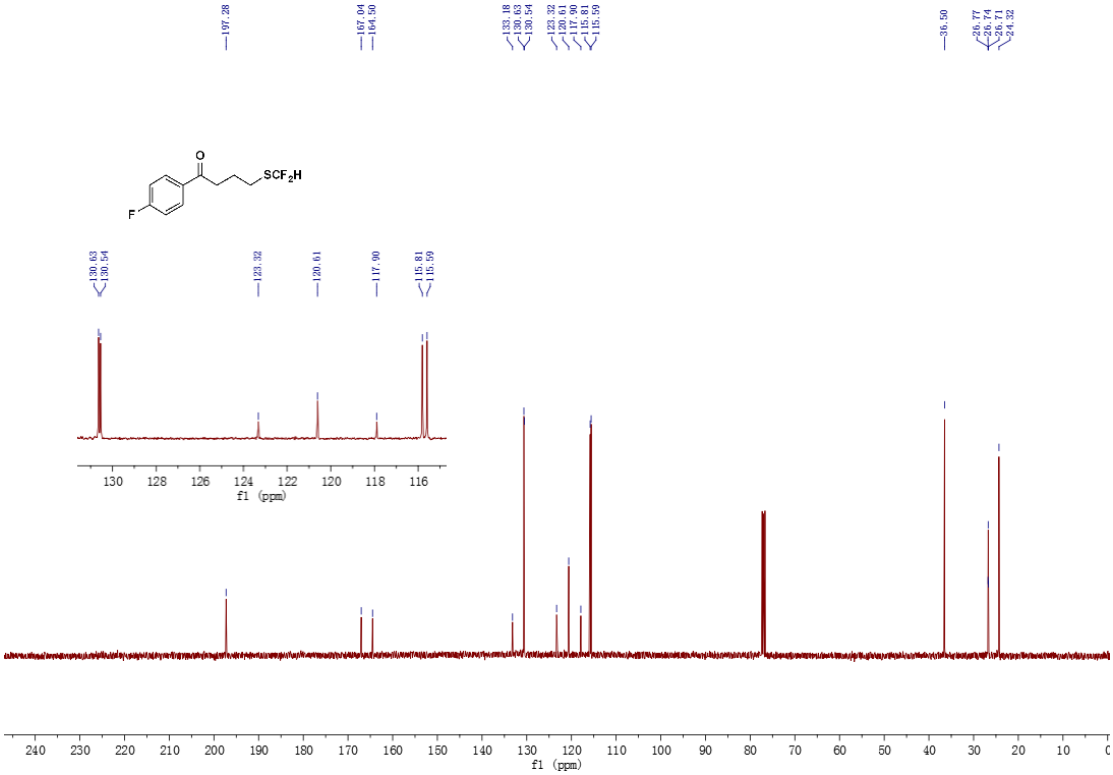
## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-(4-fluorophenyl)butan-1-one 2e



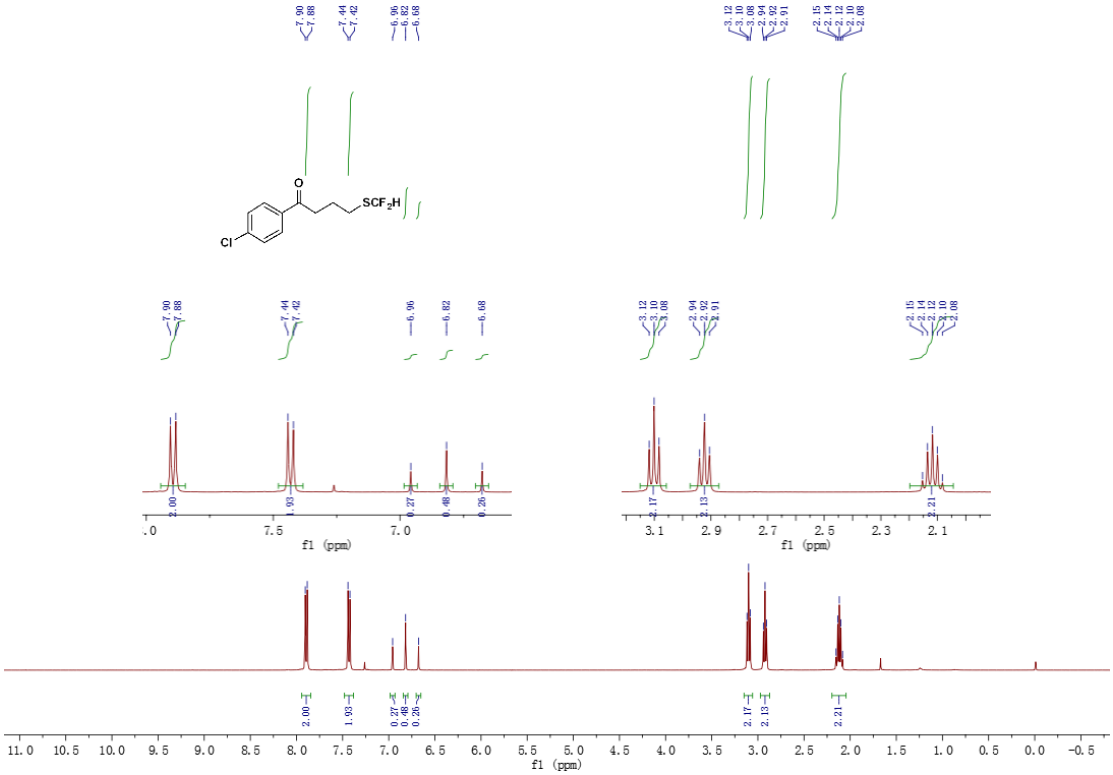

## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-(4-fluorophenyl)butan-1-one 2e



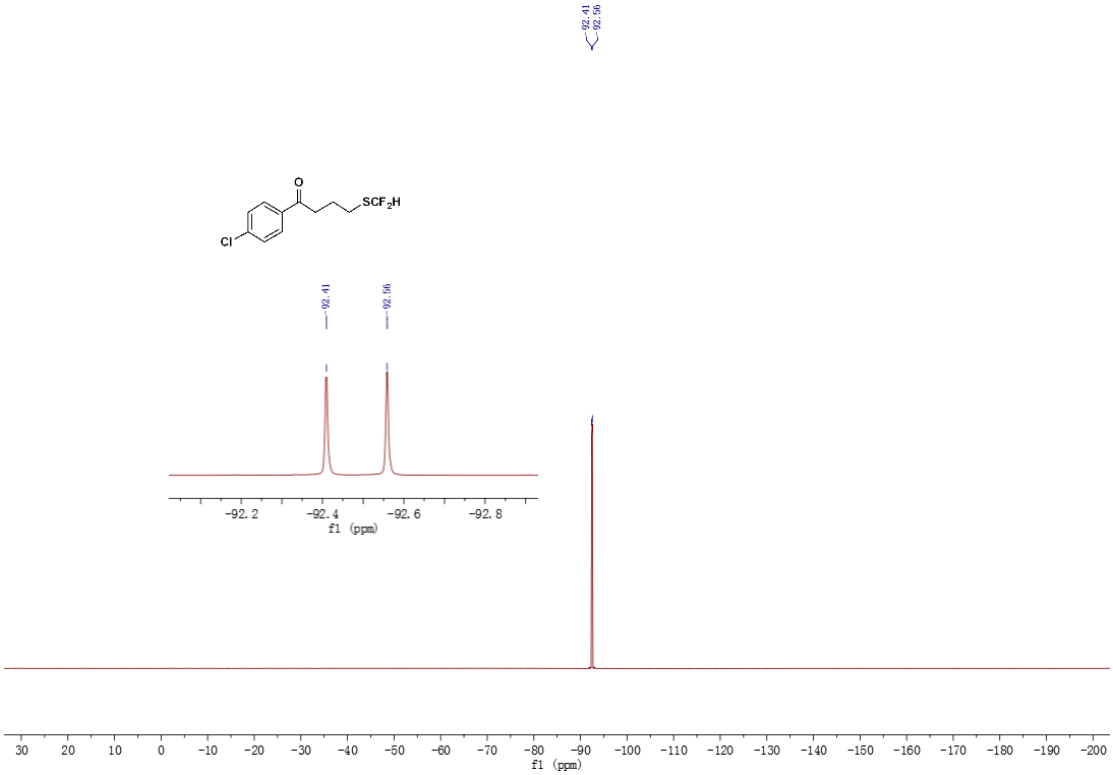
## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-(4-fluorophenyl)butan-1-one 2e



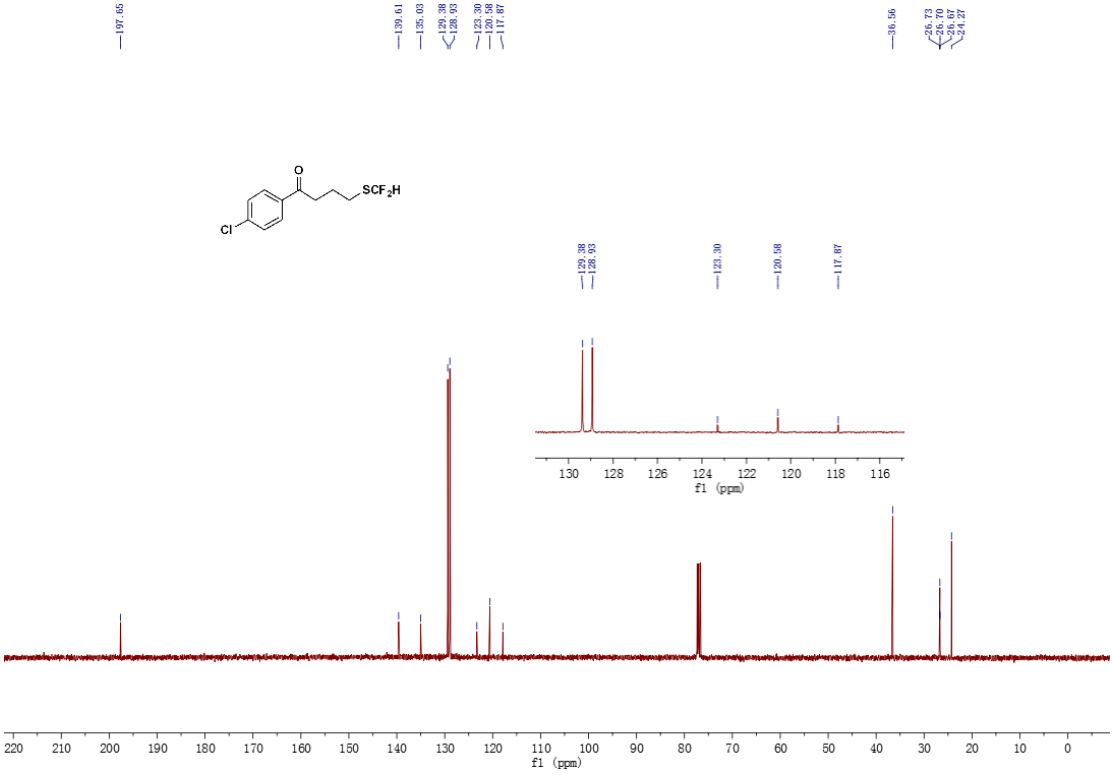

## $^{1}$H NMR spectrum of 1-(4-chlorophenyl)-4-((difluoromethyl)thio)butan-1-one 2f



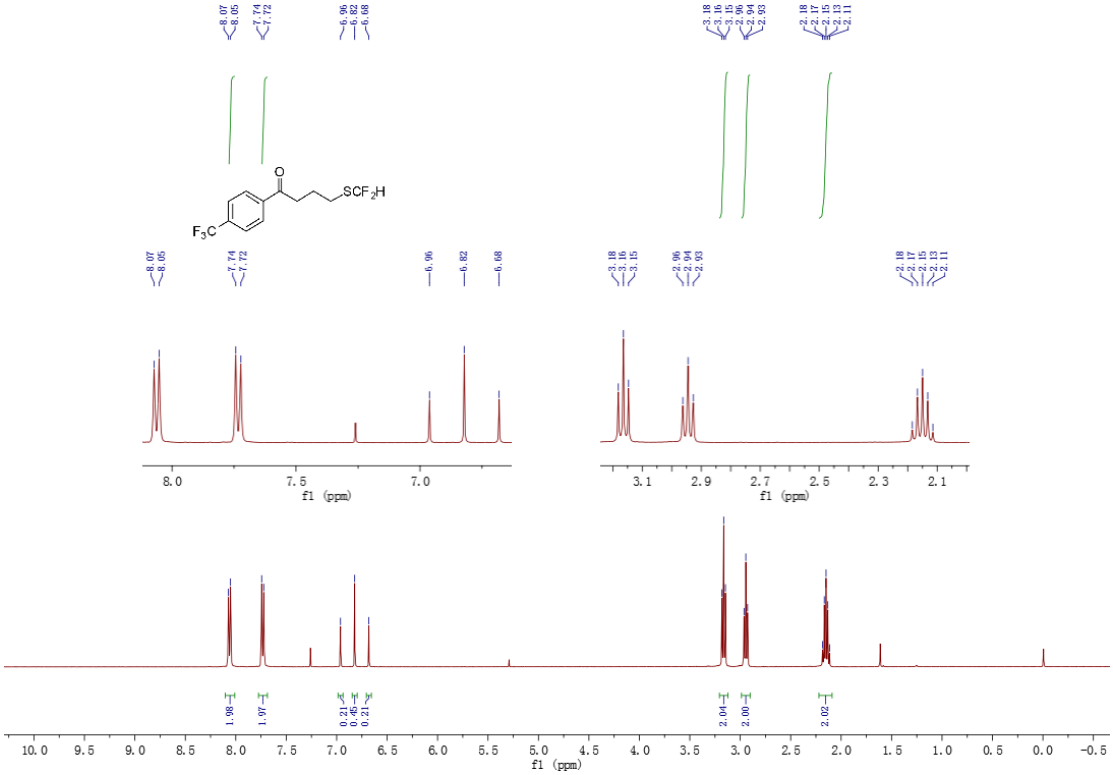
## $^{19}$F NMR spectrum of 1-(4-chlorophenyl)-4-((difluoromethyl)thio)butan-1-one 2f



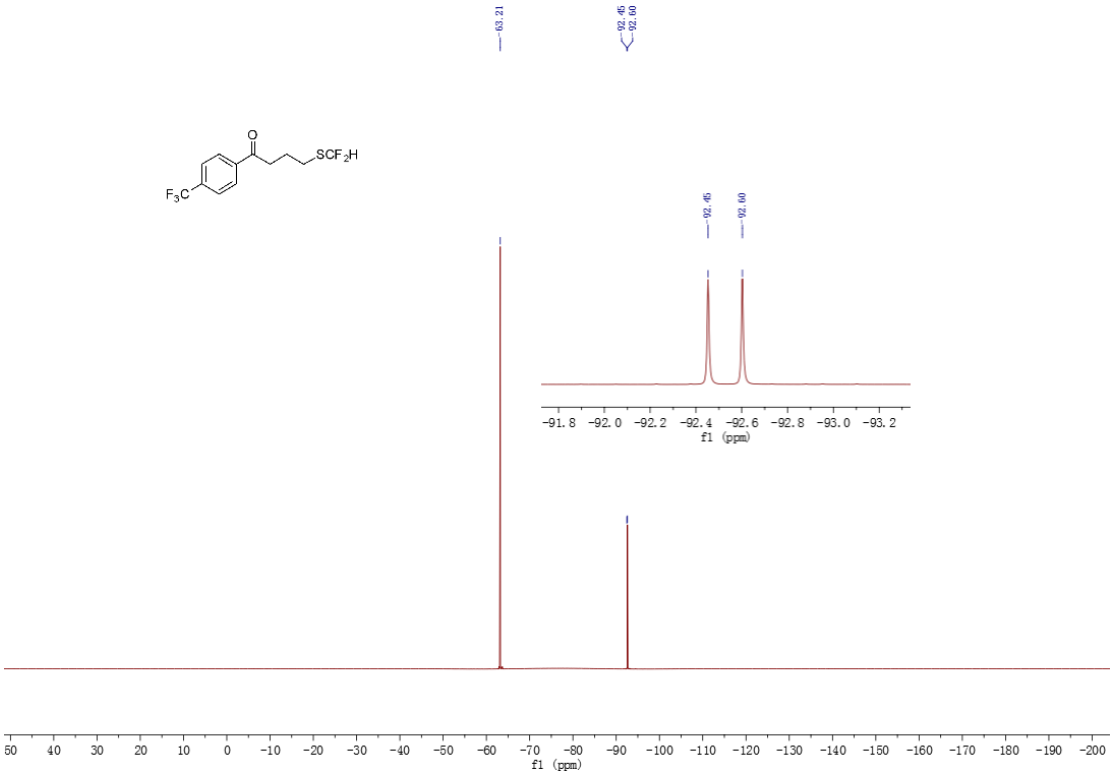

## $^{13}$C NMR spectrum of 1-(4-chlorophenyl)-4-((difluoromethyl)thio)butan-1-one 2f



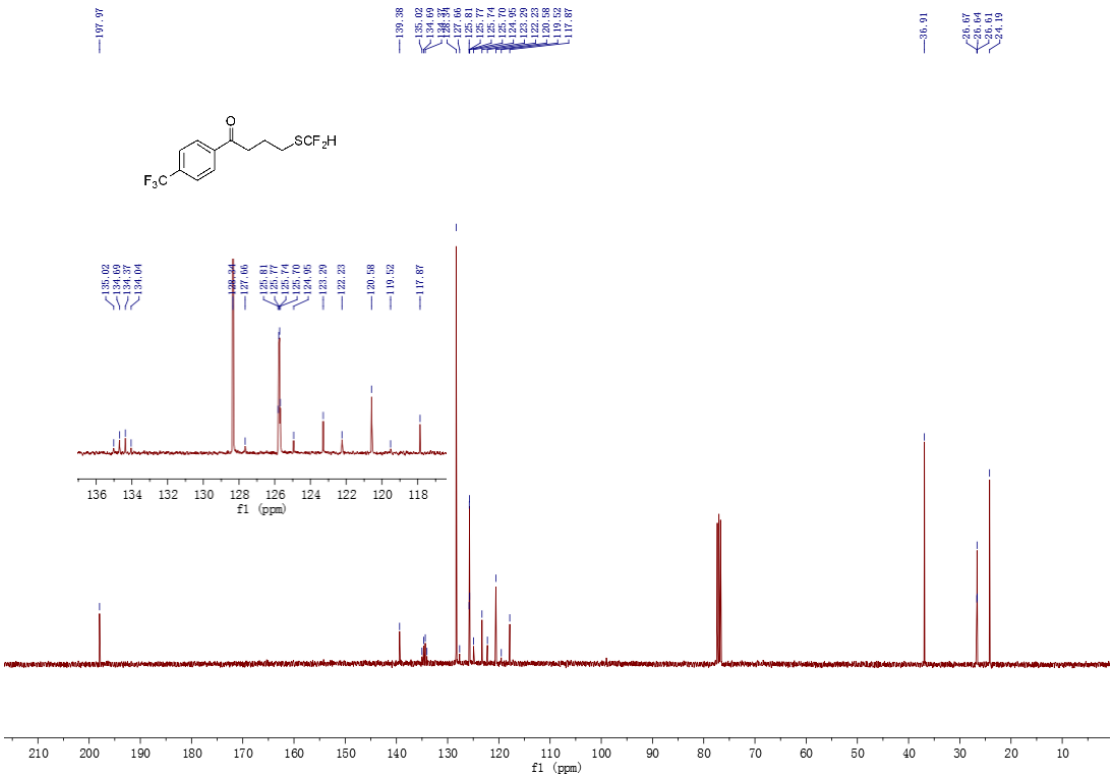
## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)butan-1-one 2g



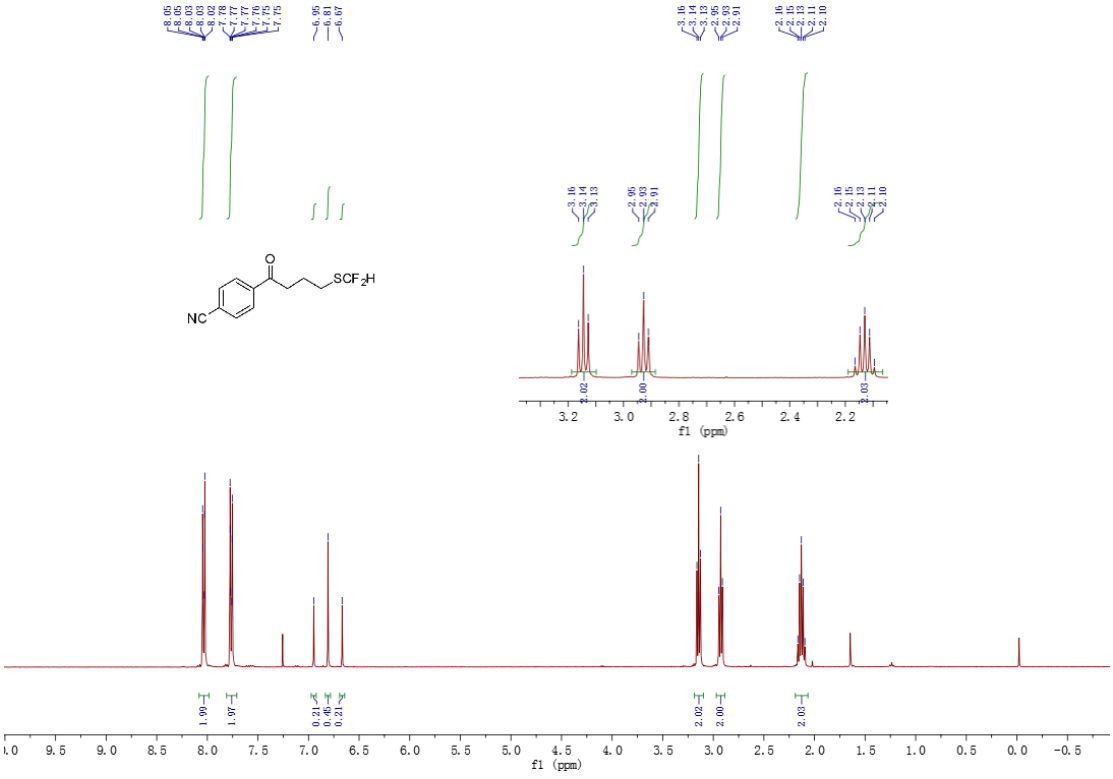

## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)butan-1-one 2g



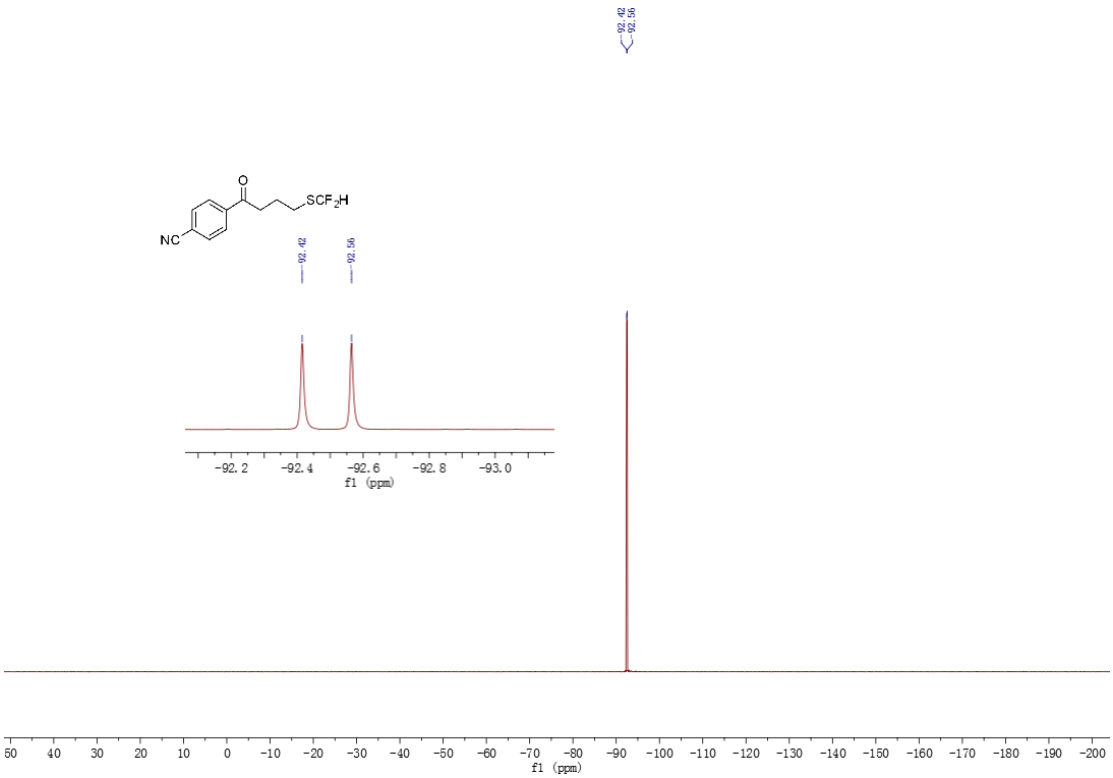
## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)butan-1-one 2g



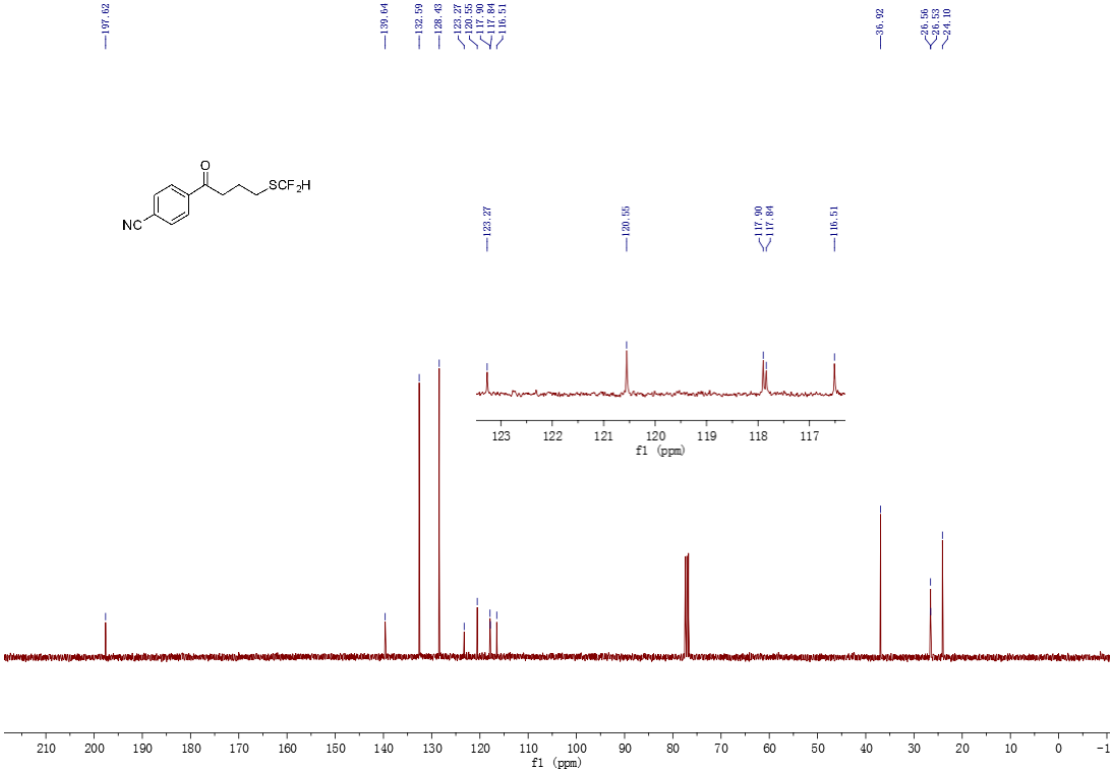

## $^{1}$H NMR spectrum of 4-(4-((difluoromethyl)thio)butanoyl)benzonitrile 2h



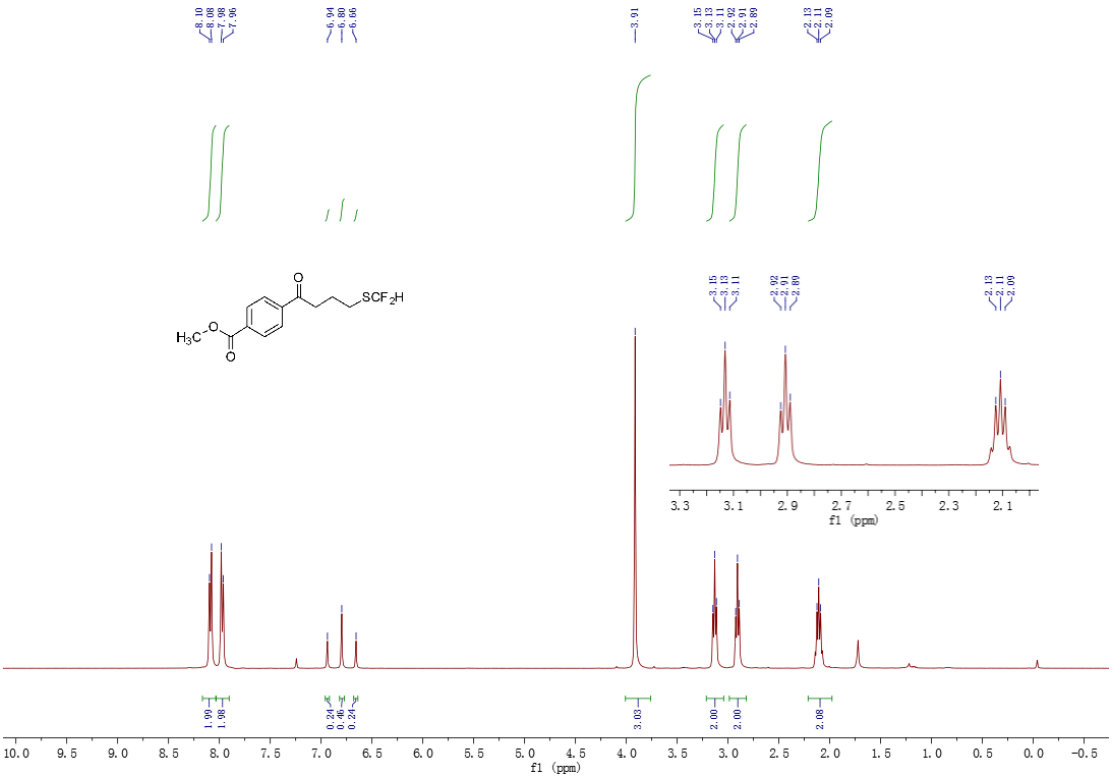
## $^{19}$F NMR spectrum of 4-(4-((difluoromethyl)thio)butanoyl)benzonitrile 2h



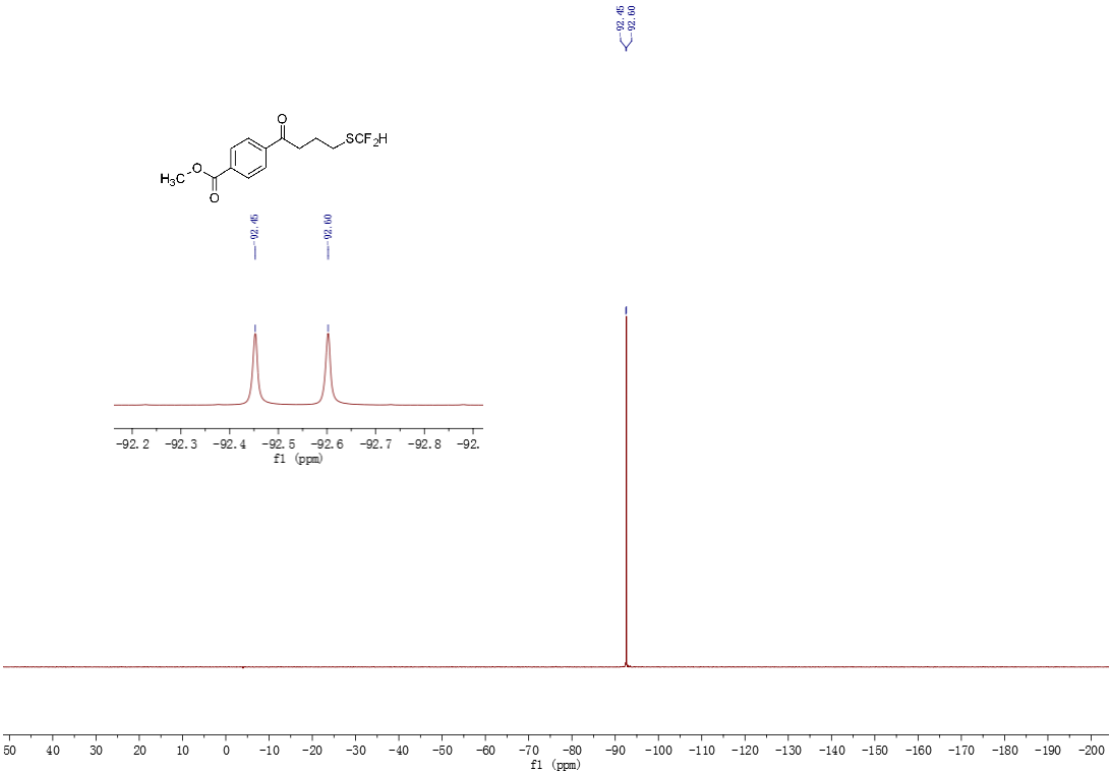

## $^{13}$C NMR spectrum of 4-(4-((difluoromethyl)thio)butanoyl)benzonitrile 2h



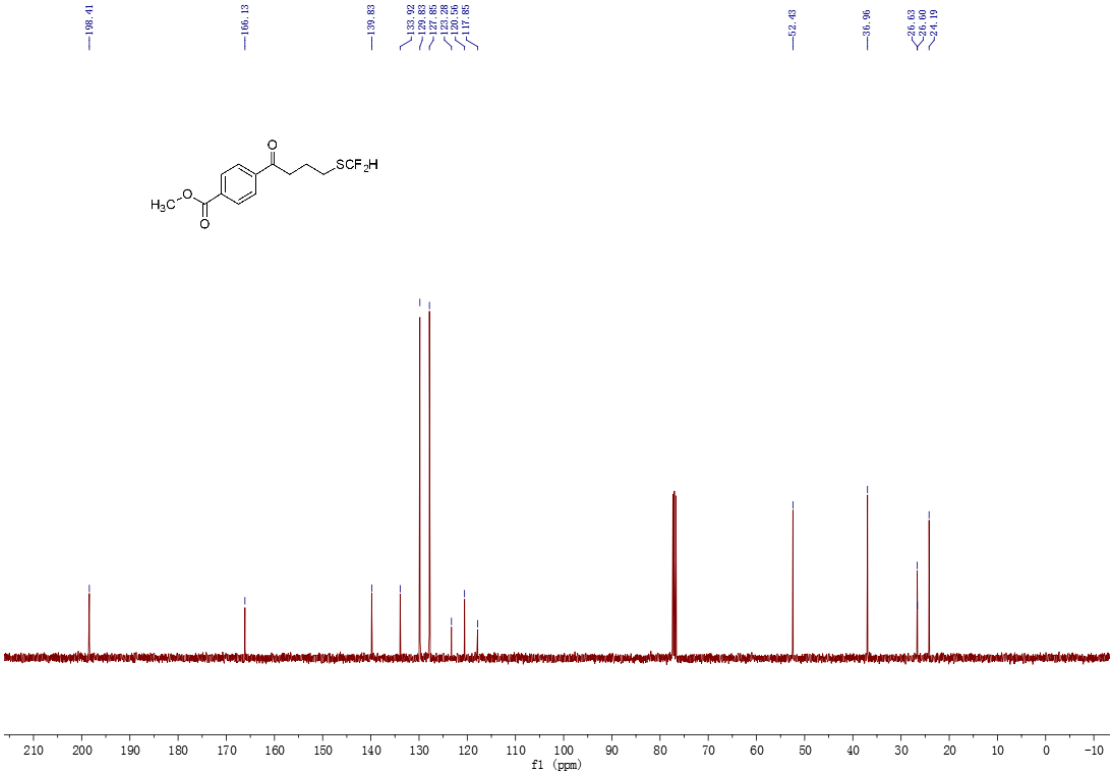
## $^{1}$H NMR spectrum of methyl 4-(4-((difluoromethyl)thio)butanoyl)benzoate 2i



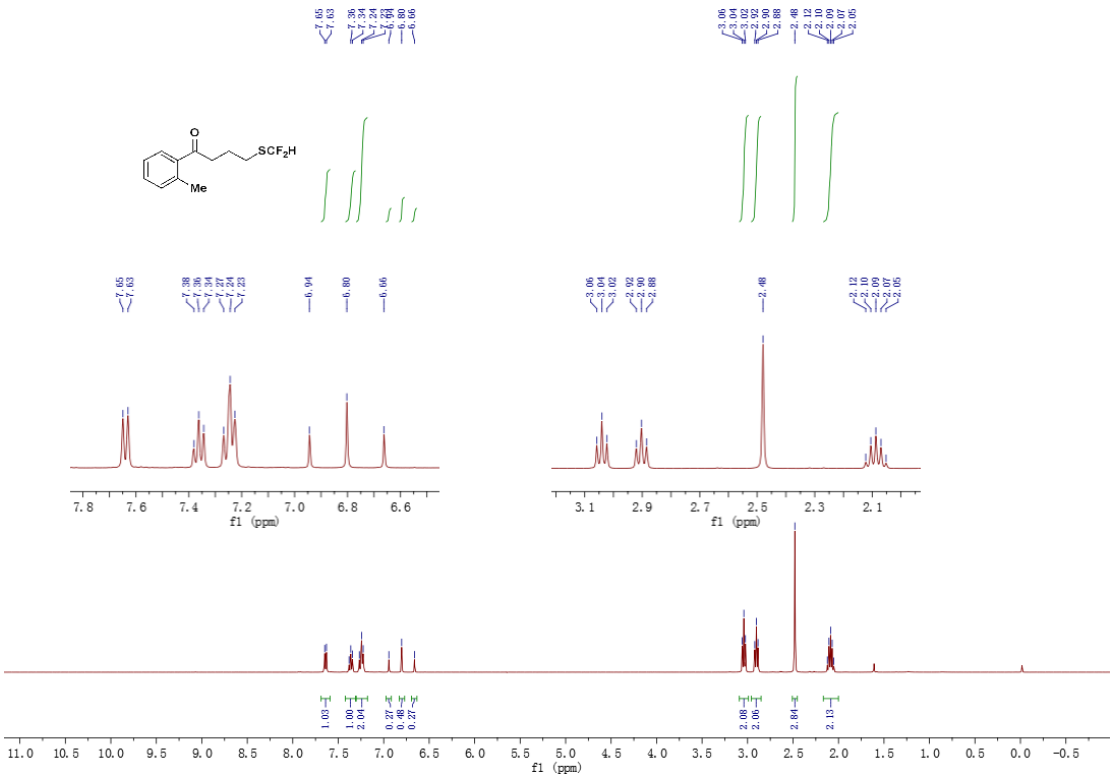

## $^{19}$F NMR spectrum of methyl 4-(4-((difluoromethyl)thio)butanoyl)benzoate 2i



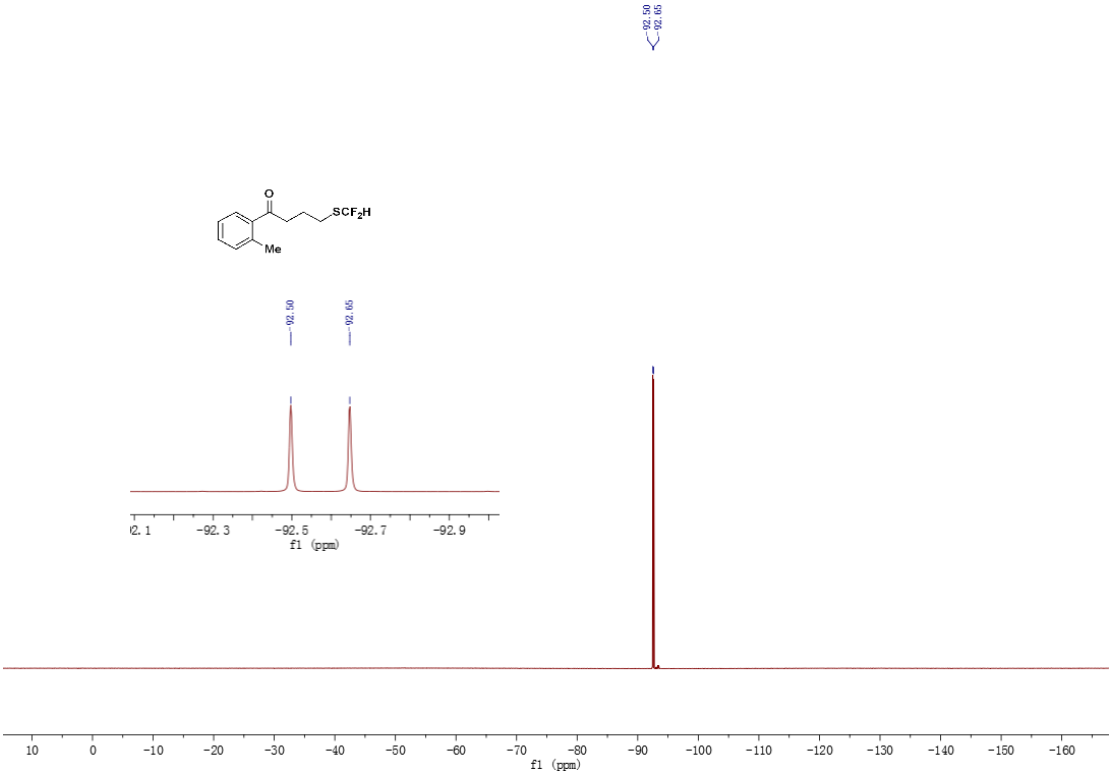
## $^{13}$C NMR spectrum of methyl 4-(4-((difluoromethyl)thio)butanoyl)benzoate 2i



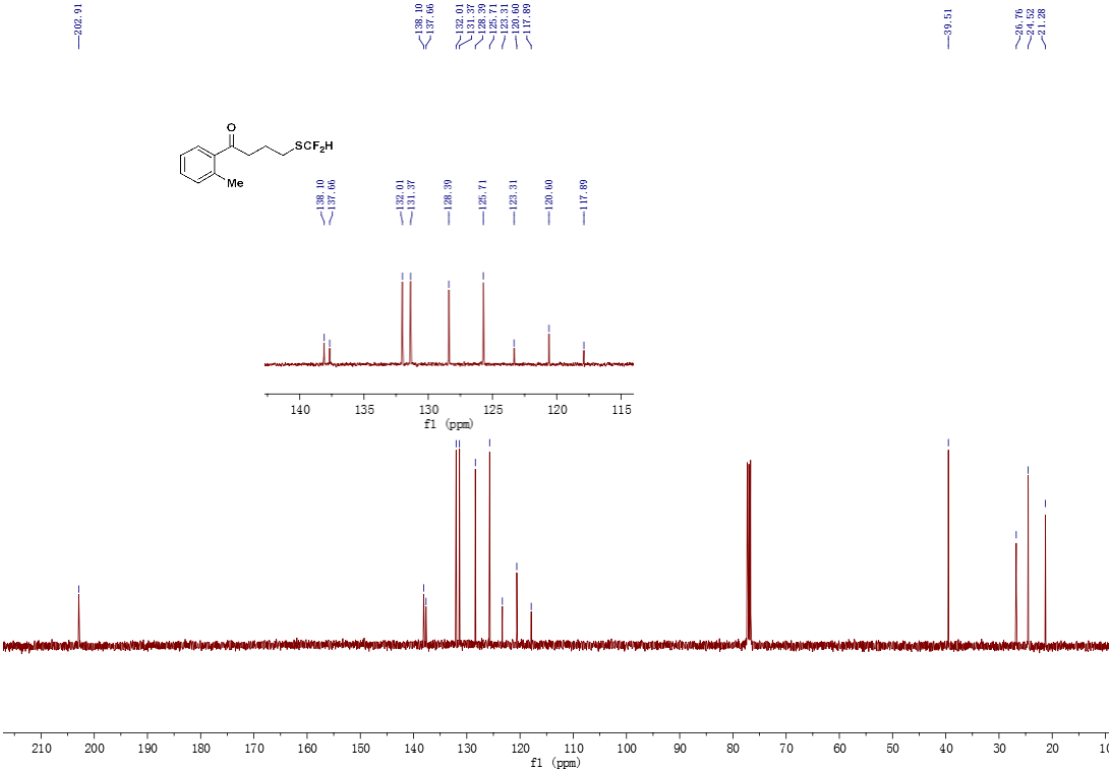

## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-(*o*-tolyl)butan-1-one 2j



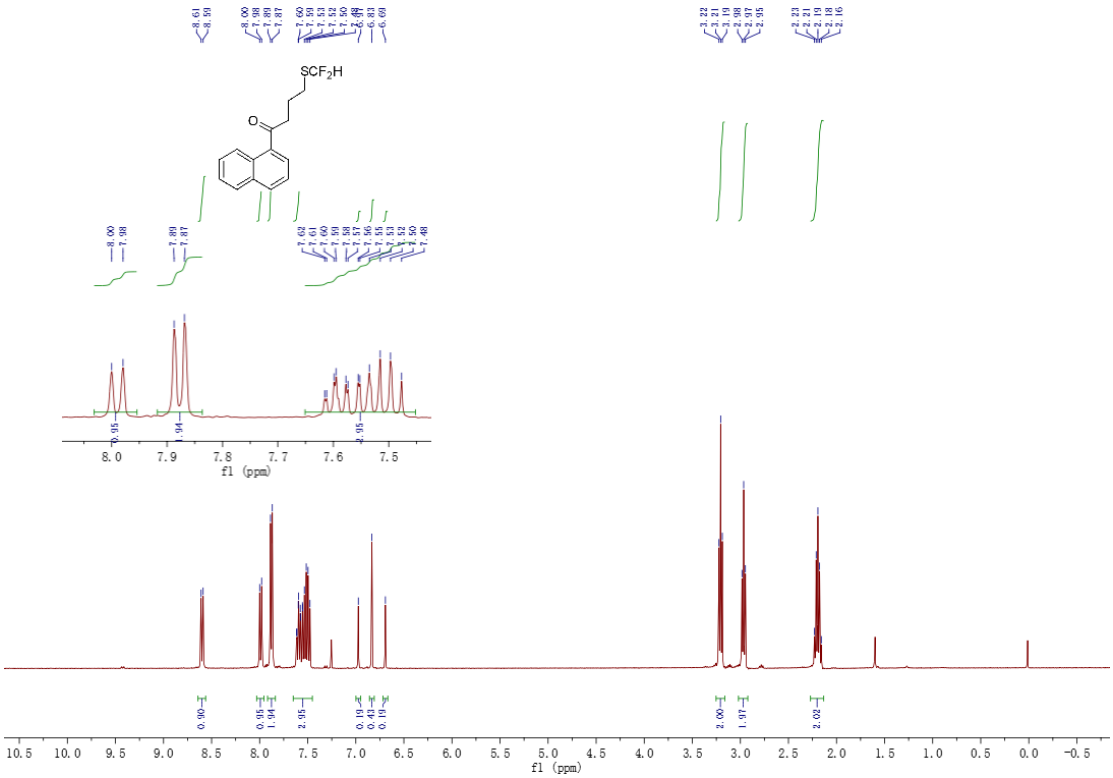
## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-(*o*-tolyl)butan-1-one 2j



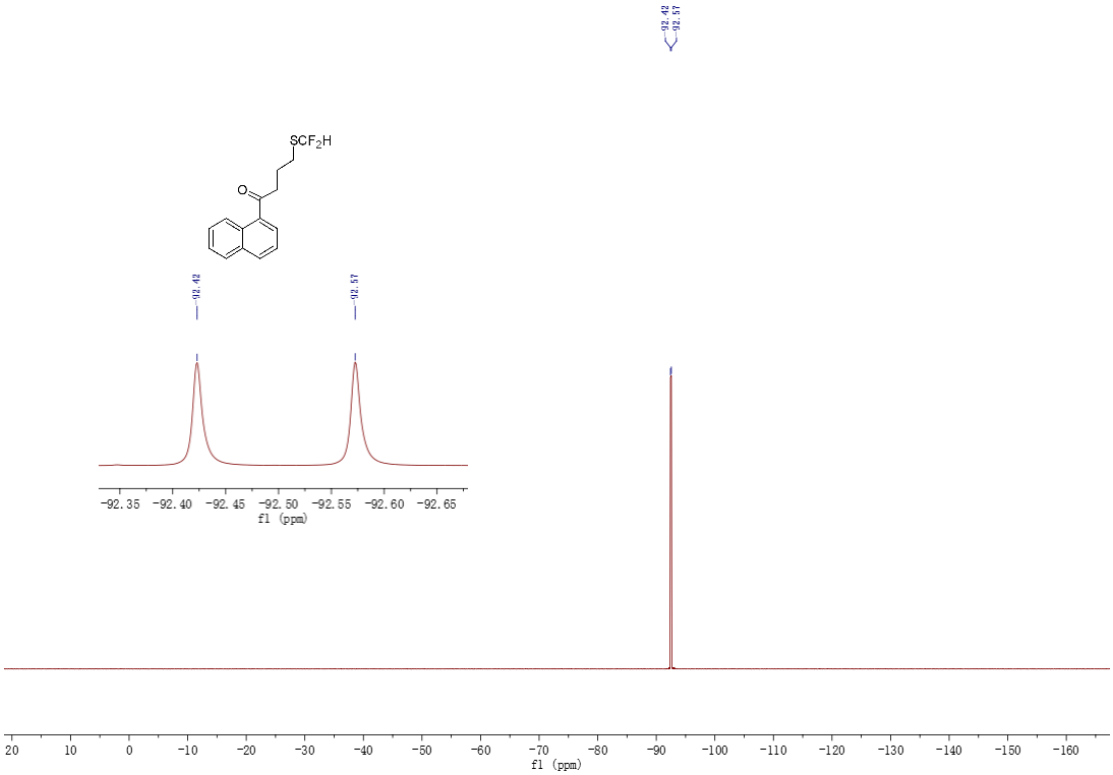

## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-(*o*-tolyl)butan-1-one 2j



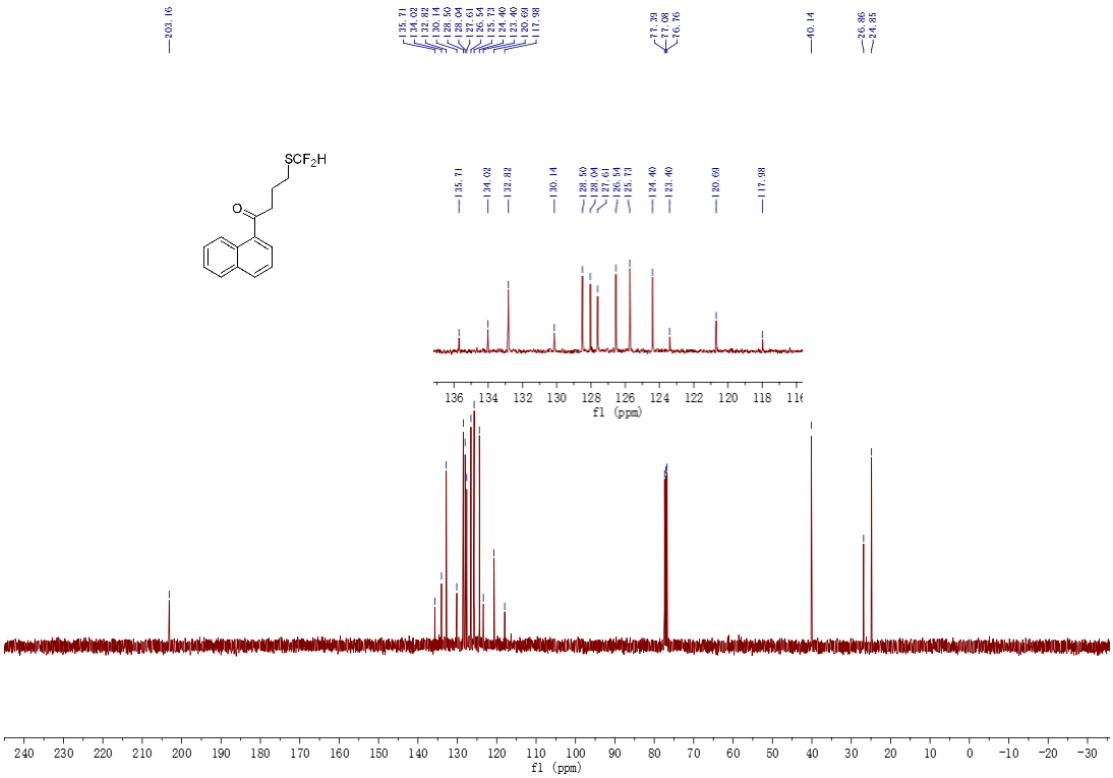
**$^{1}$H NMR spectrum of**
**4-((difluoromethyl)thio)-1-(naphthalen-1-yl)butan-1-one 2k**



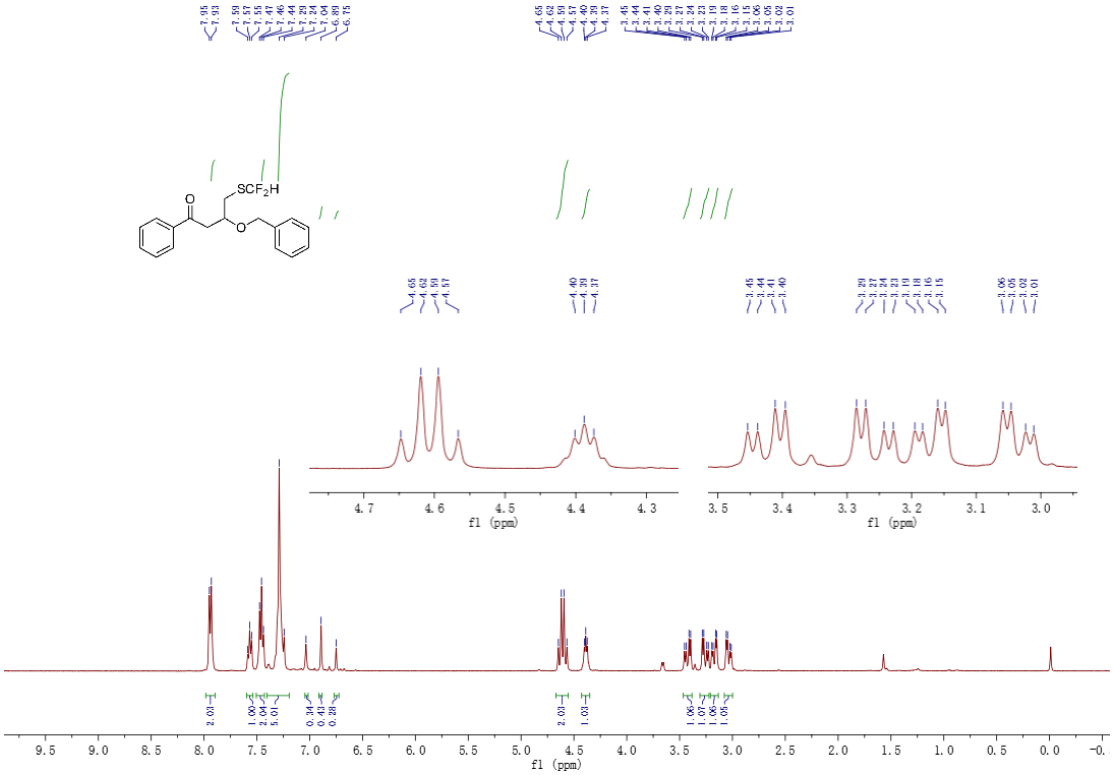

**$^{19}$F NMR spectrum of**
**4-((difluoromethyl)thio)-1-(naphthalen-1-yl)butan-1-one 2k**



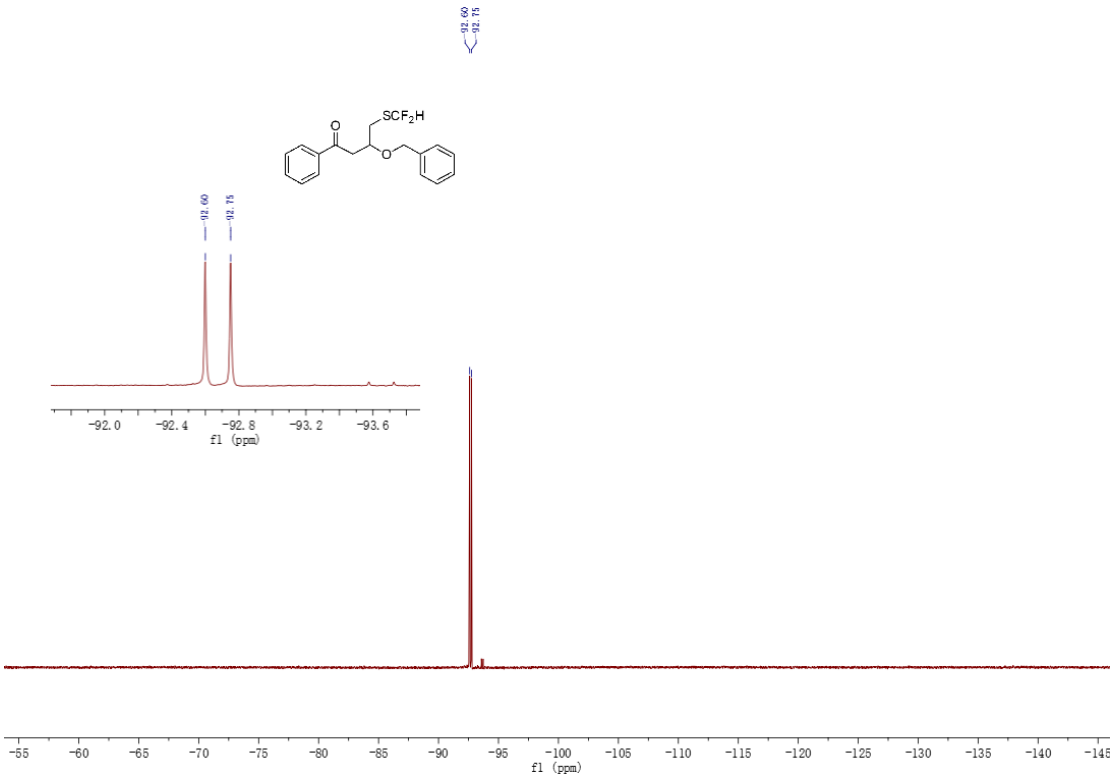
## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-(naphthalen-1-yl)butan-1-one 2k



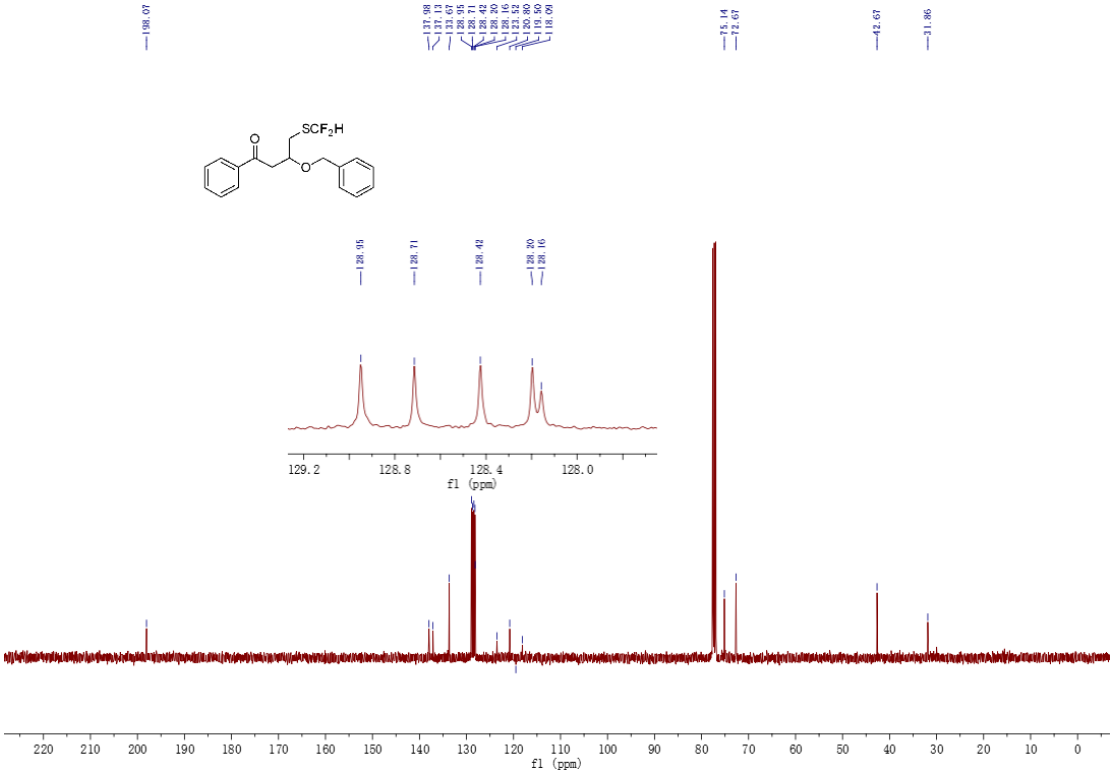

## $^{1}$H NMR spectrum of 3-(benzyloxy)-4-((difluoromethyl)thio)-1-phenylbutan-1-one 2l



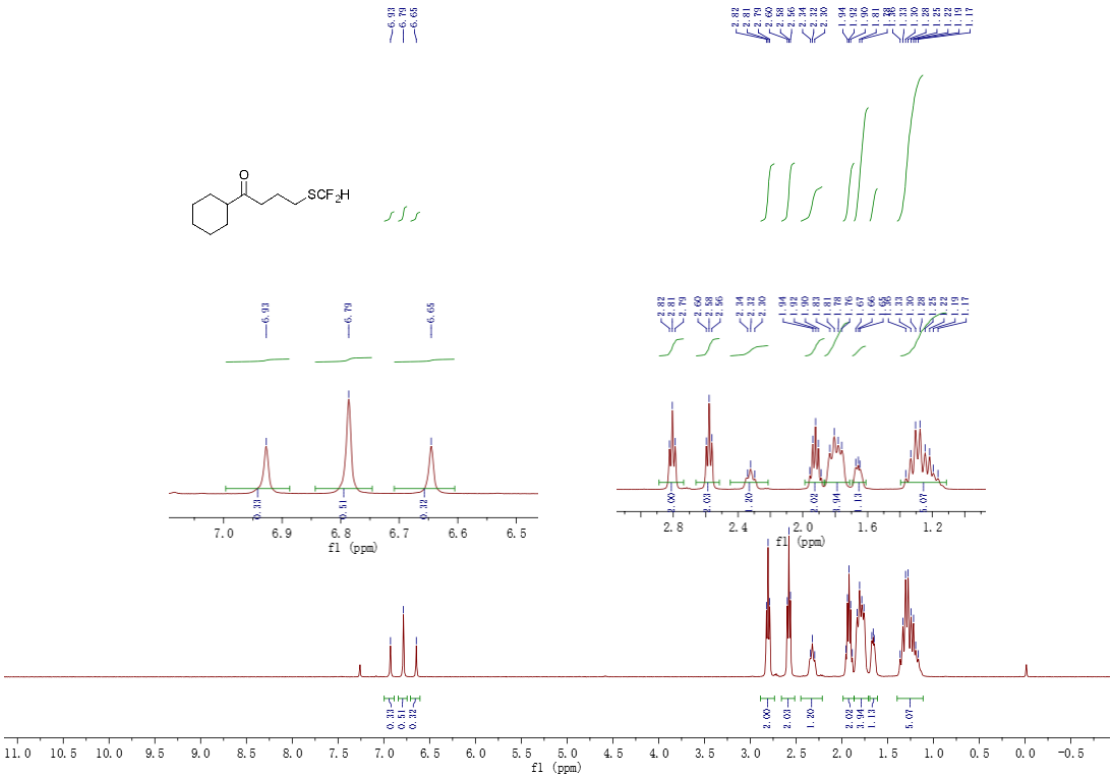
**$^{19}$F NMR spectrum of**
**3-(benzyloxy)-4-((difluoromethyl)thio)-1-phenylbutan-1-one 2l**



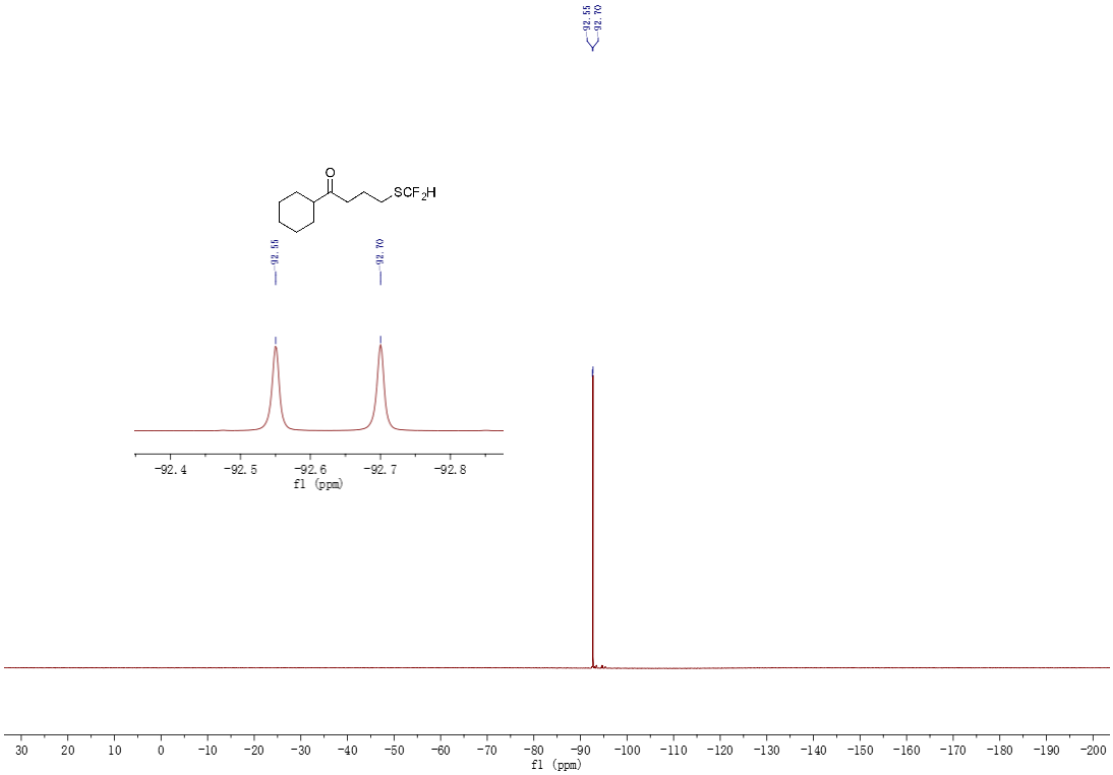

**$^{13}$C NMR spectrum of**
**3-(benzyloxy)-4-((difluoromethyl)thio)-1-phenylbutan-1-one 2l**



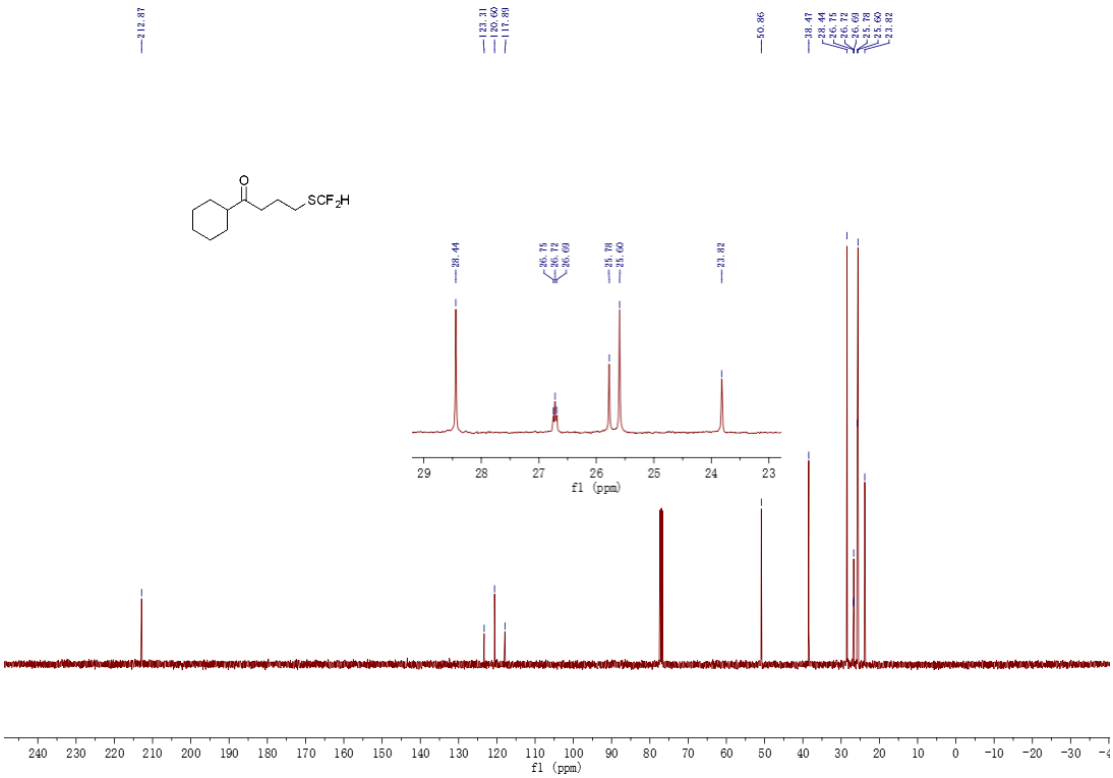
**$^{1}$H NMR spectrum of**
**1-cyclohexyl-4-((difluoromethyl)thio)butan-1-one 2m**



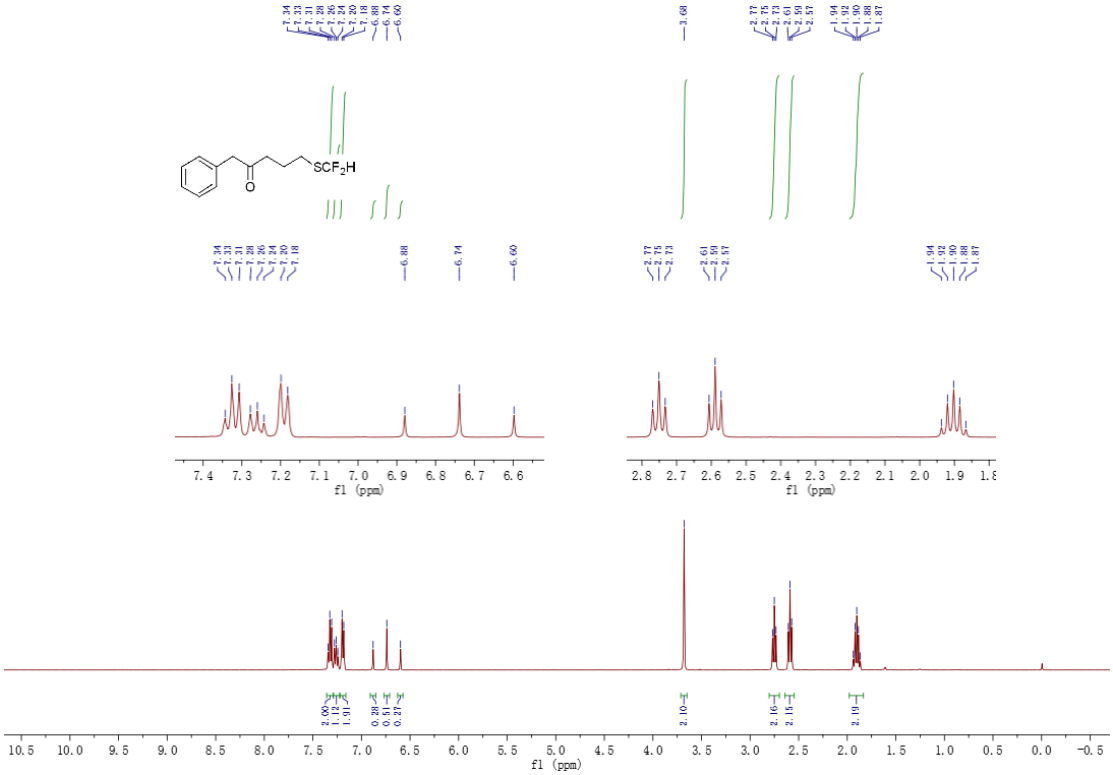

**$^{19}$F NMR spectrum of**
**1-cyclohexyl-4-((difluoromethyl)thio)butan-1-one 2m**



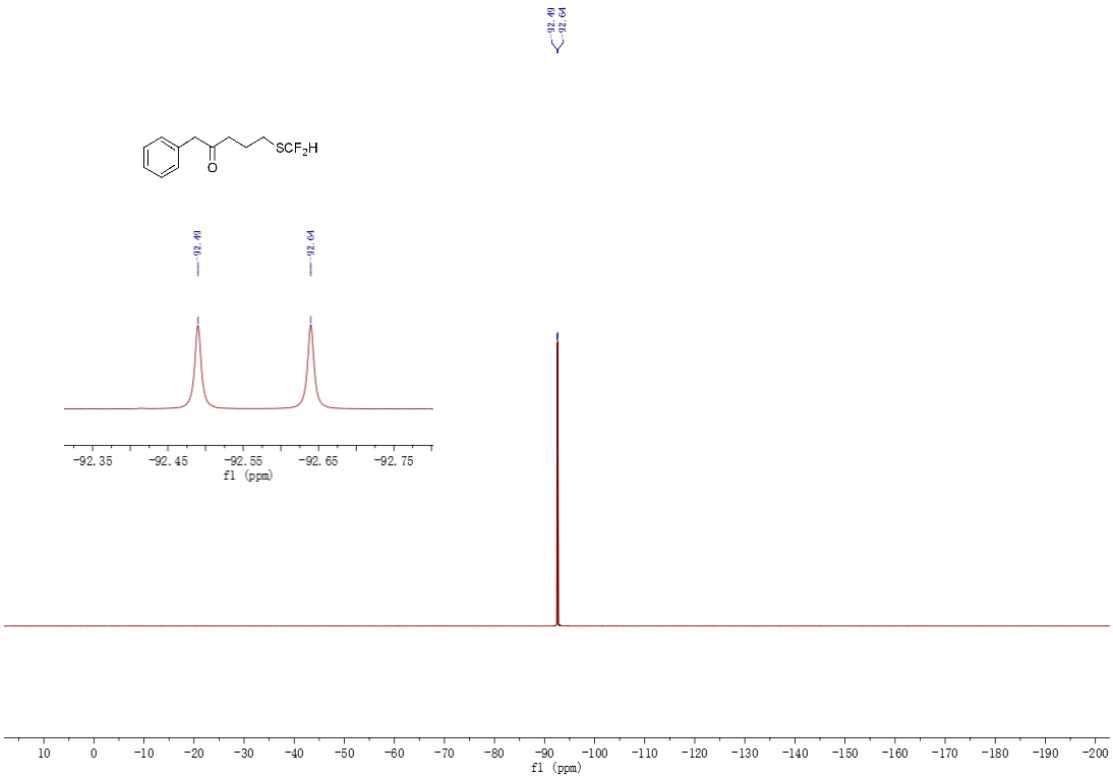
## $^{13}$C NMR spectrum of 1-cyclohexyl-4-((difluoromethyl)thio)butan-1-one 2m



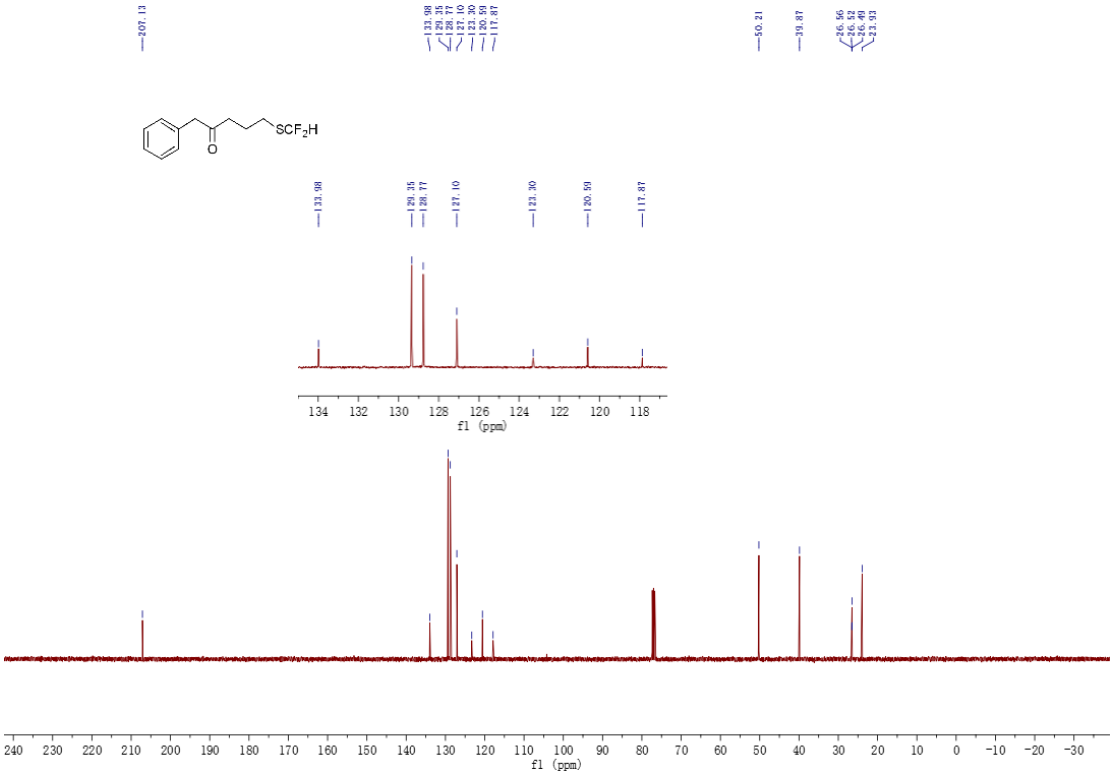

## $^{1}$H NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-2-one 2n



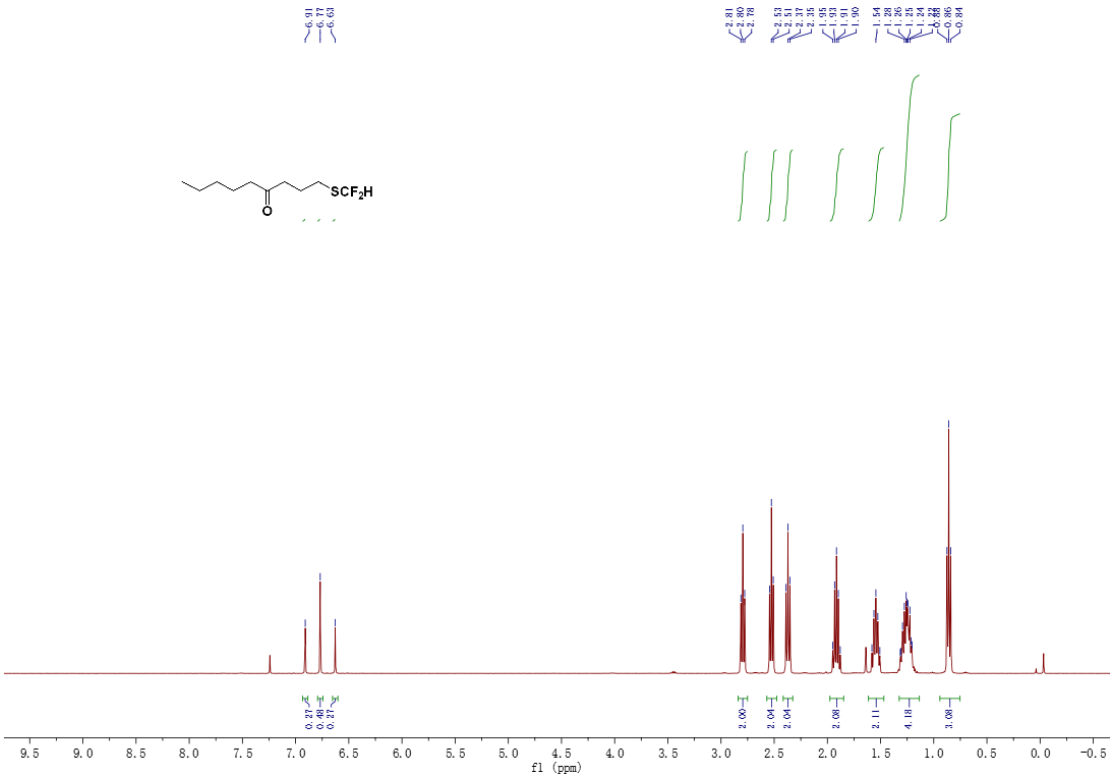
## $^{19}$F NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-2-one 2n



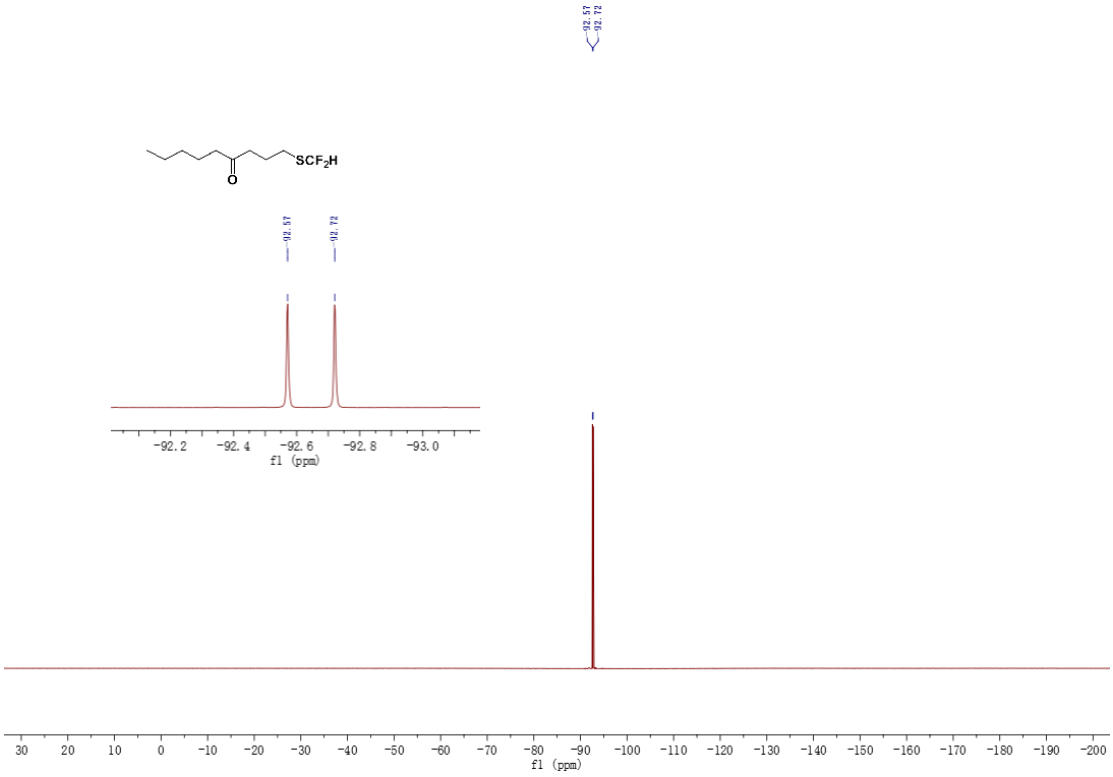

## $^{13}$C NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-2-one 2n



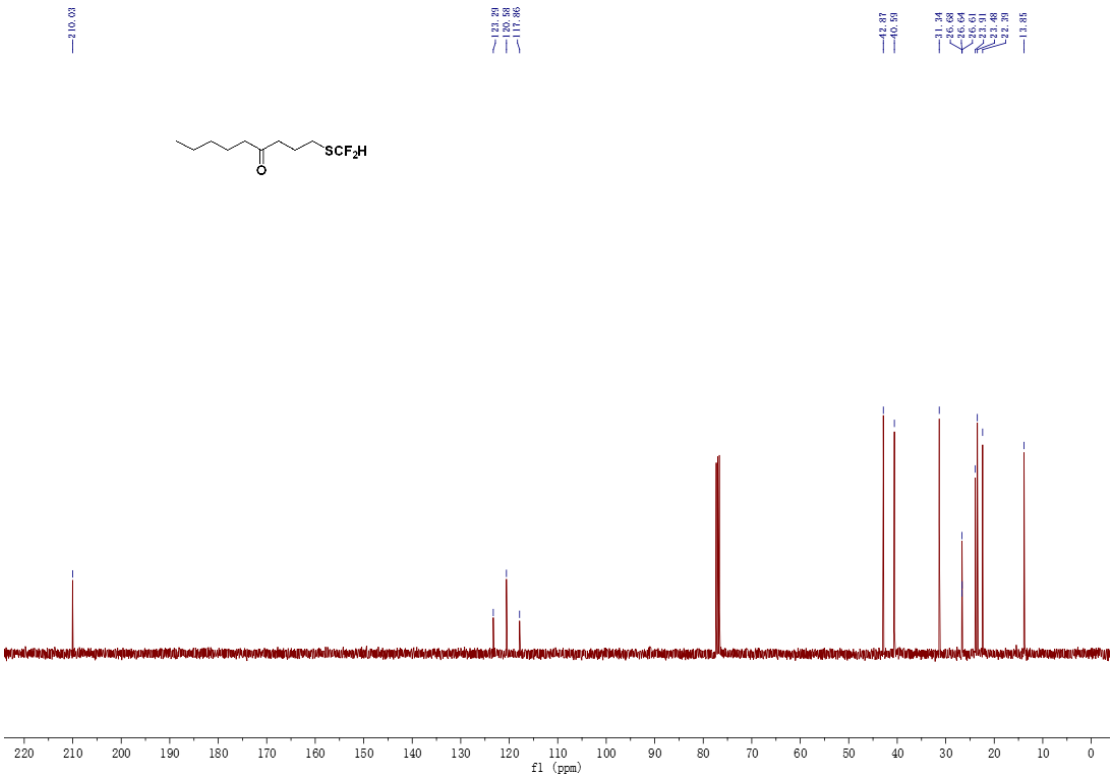
## $^{1}$H NMR spectrum of 1-((difluoromethyl)thio)nonan-4-one 2o



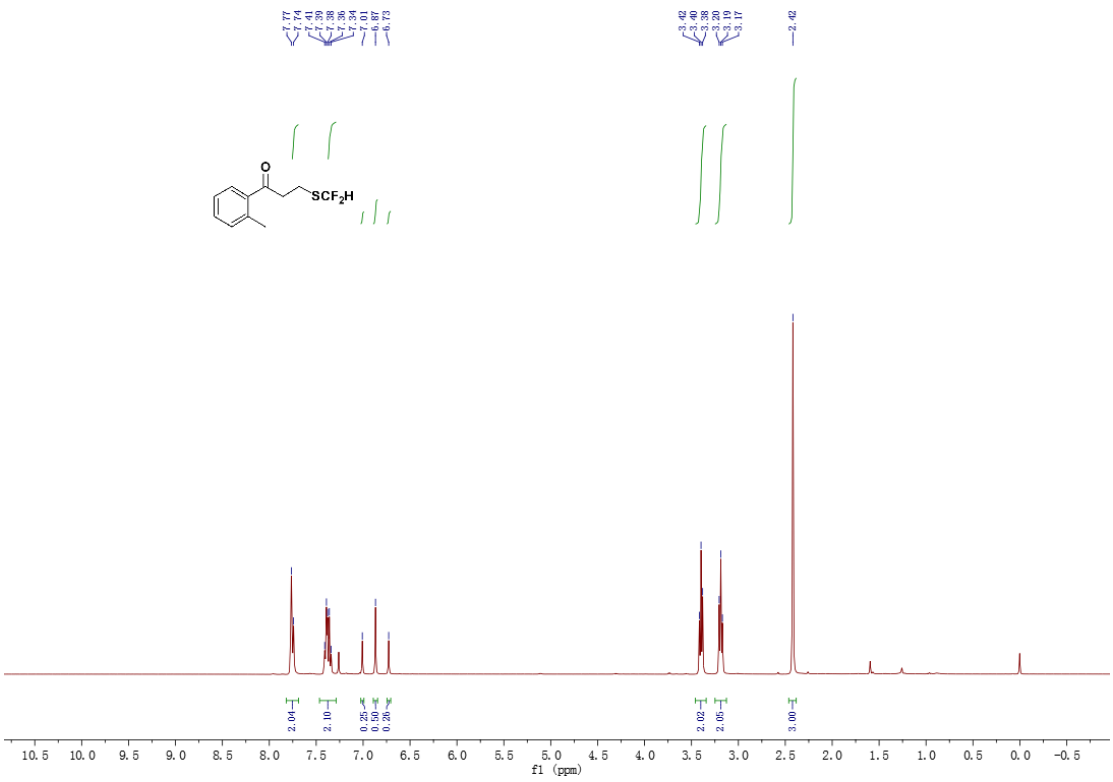

## $^{19}$F NMR spectrum of 1-((difluoromethyl)thio)nonan-4-one 2o



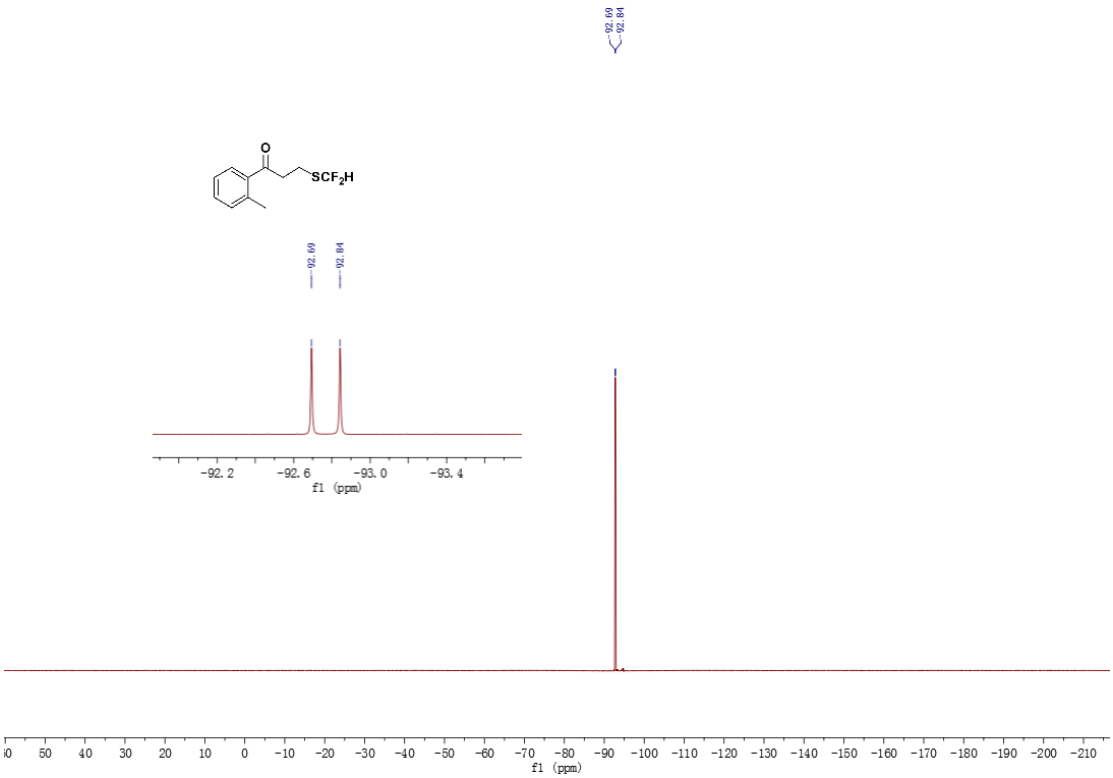
## $^{13}$C NMR spectrum of 1-((difluoromethyl)thio)nonan-4-one 2o



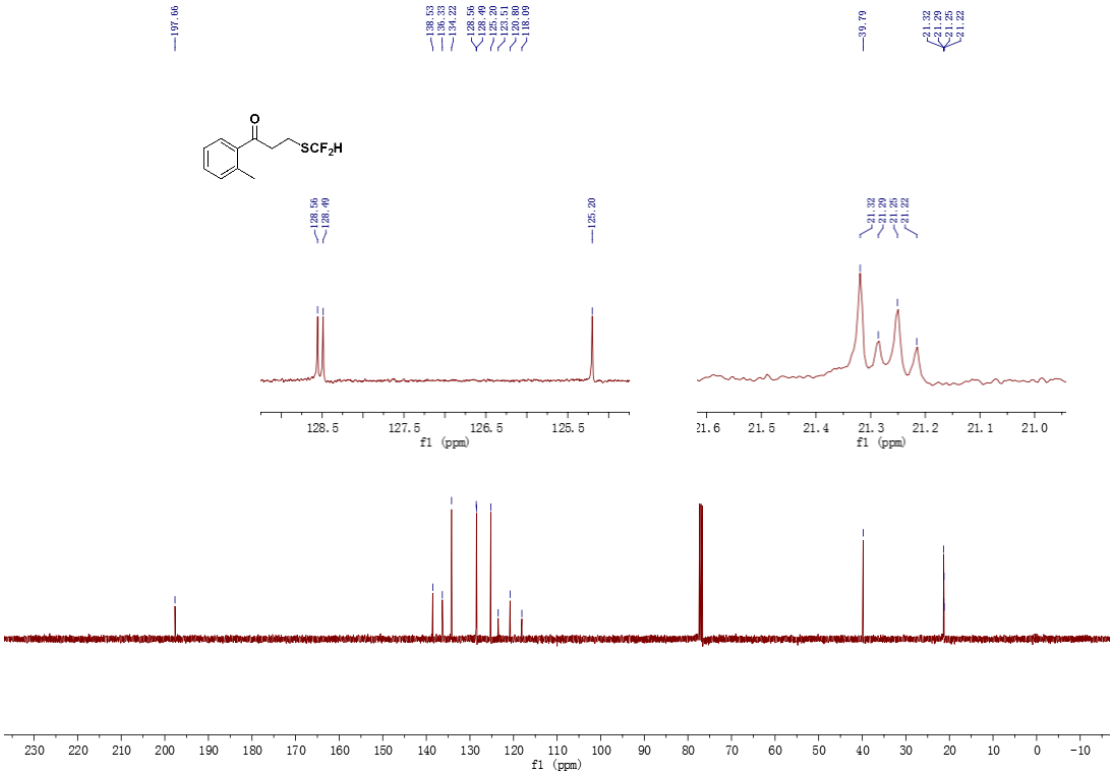

## $^{1}$H NMR spectrum of 3-((difluoromethyl)thio)-1-(*o*-tolyl)propan-1-one 4a



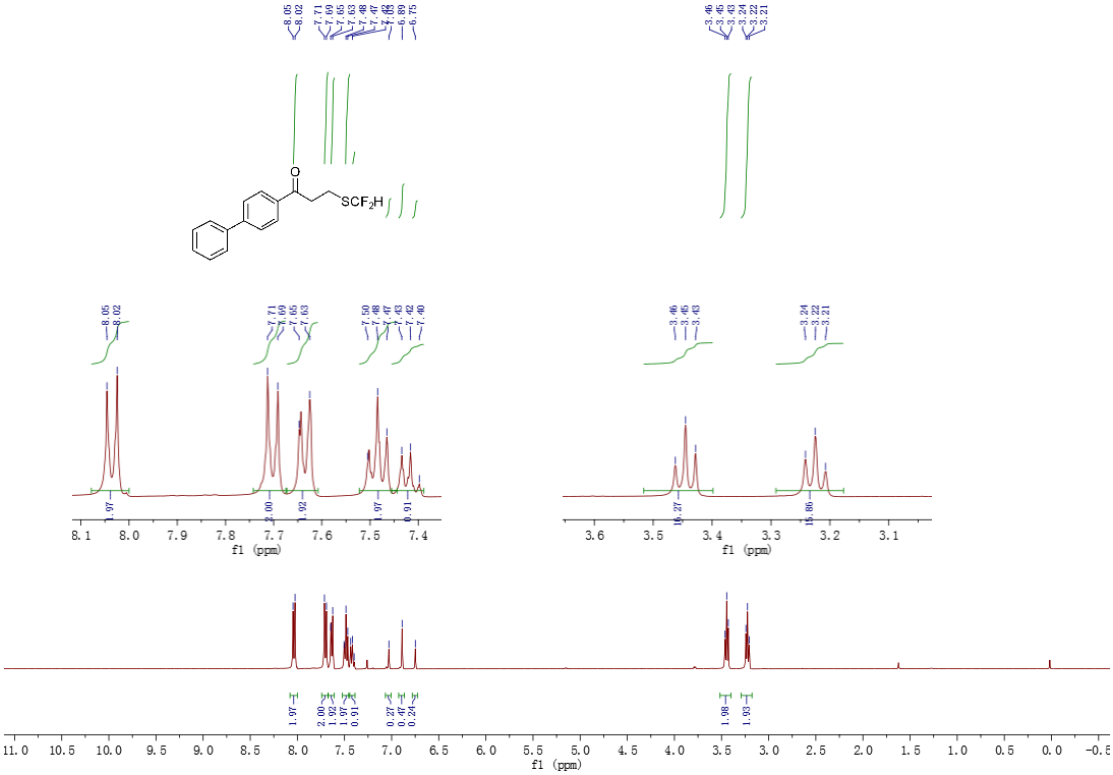
## $^{19}$F NMR spectrum of 3-((difluoromethyl)thio)-1-(*o*-tolyl)propan-1-one 4a



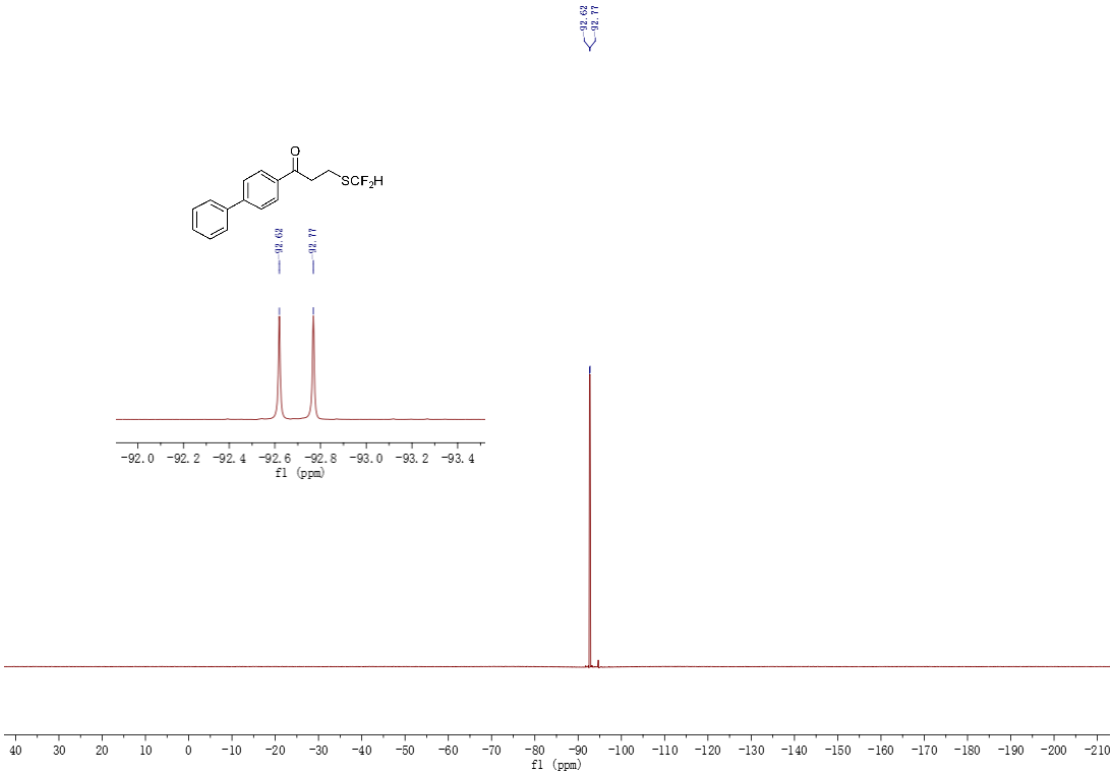

## $^{13}$C NMR spectrum of 3-((difluoromethyl)thio)-1-(*o*-tolyl)propan-1-one 4a



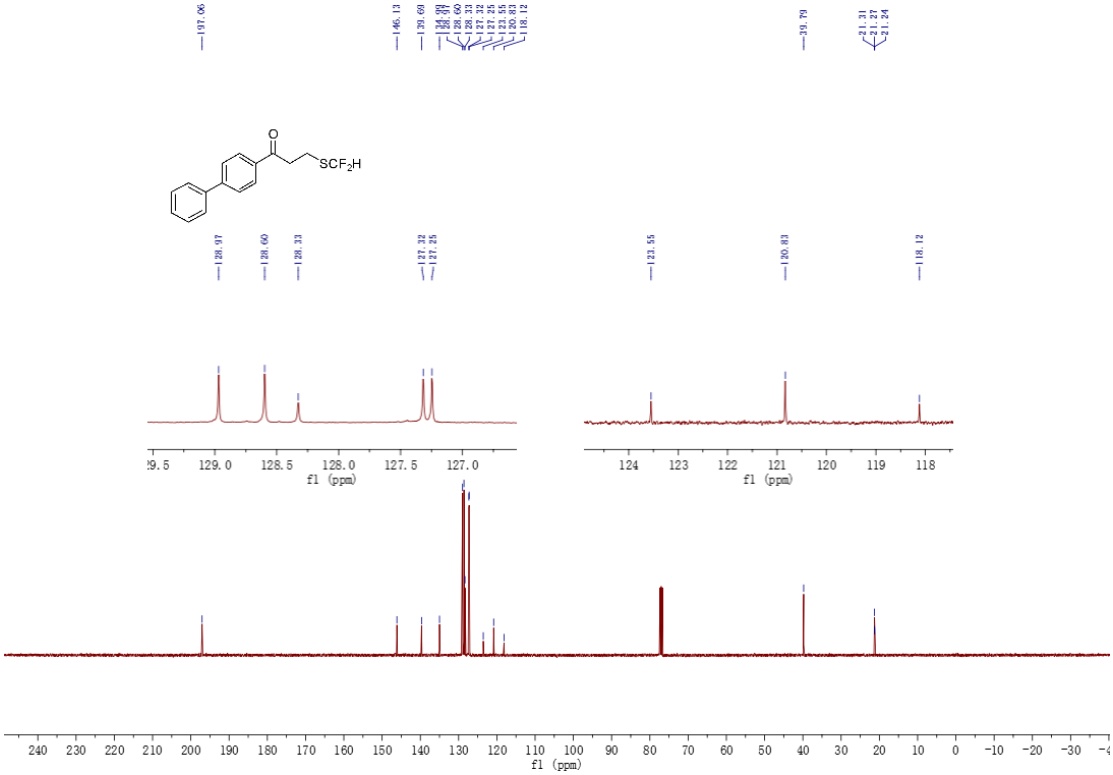
## $^{1}$H NMR spectrum of 1-([1,1'-biphenyl]-4-yl)-3-((difluoromethyl)thio)propan-1-one 4b



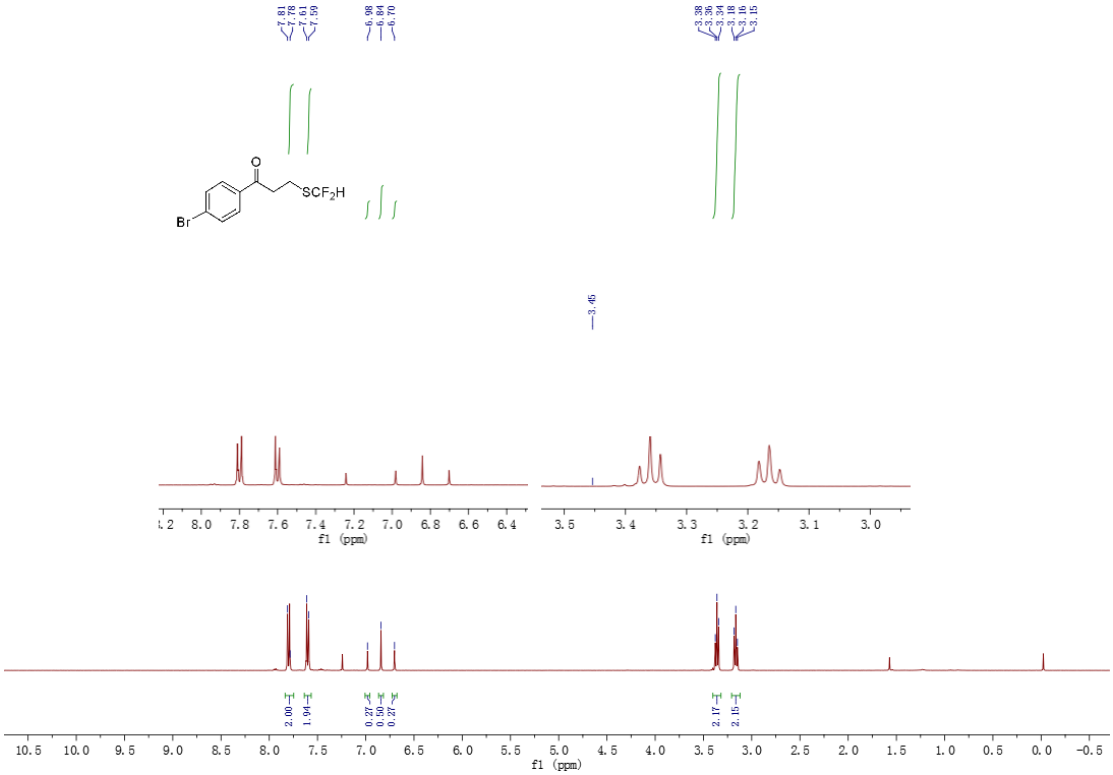

## $^{19}$F NMR spectrum of 1-([1,1'-biphenyl]-4-yl)-3-((difluoromethyl)thio)propan-1-one 4b



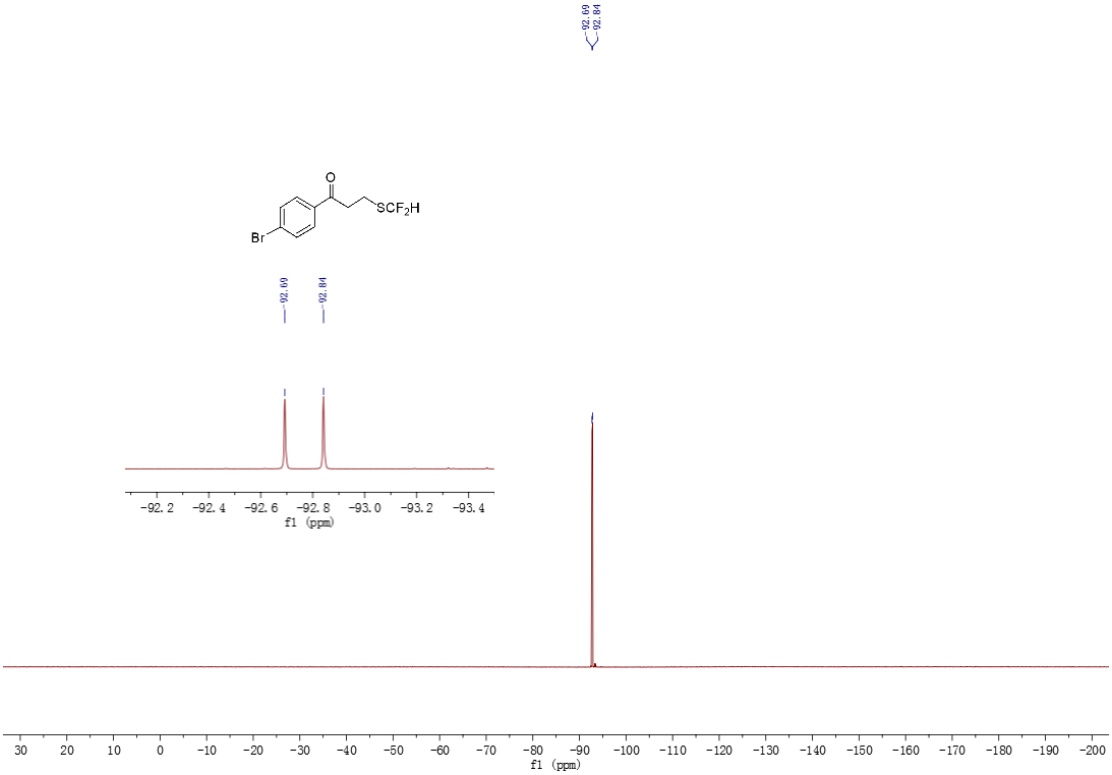
## $^{13}$C NMR spectrum of 1-([1,1'-biphenyl]-4-yl)-3-((difluoromethyl)thio)propan-1-one 4b



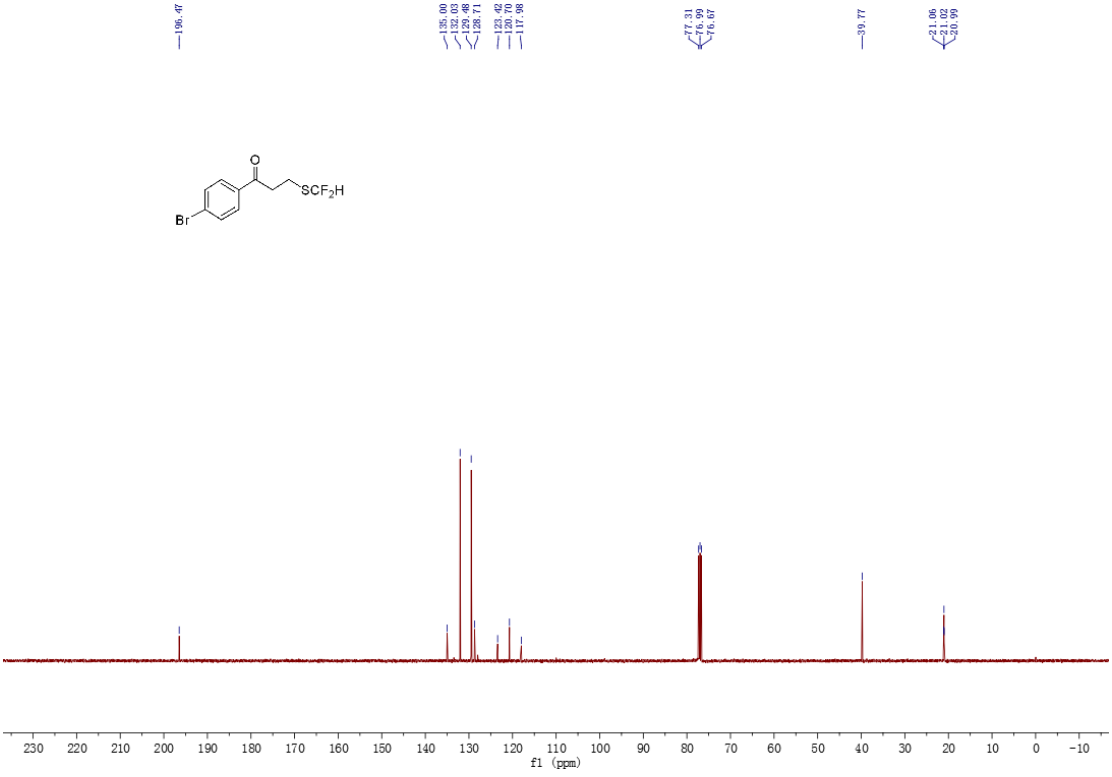

## $^{1}$H NMR spectrum of 1-(4-bromophenyl)-3-((difluoromethyl)thio)propan-1-one 4c



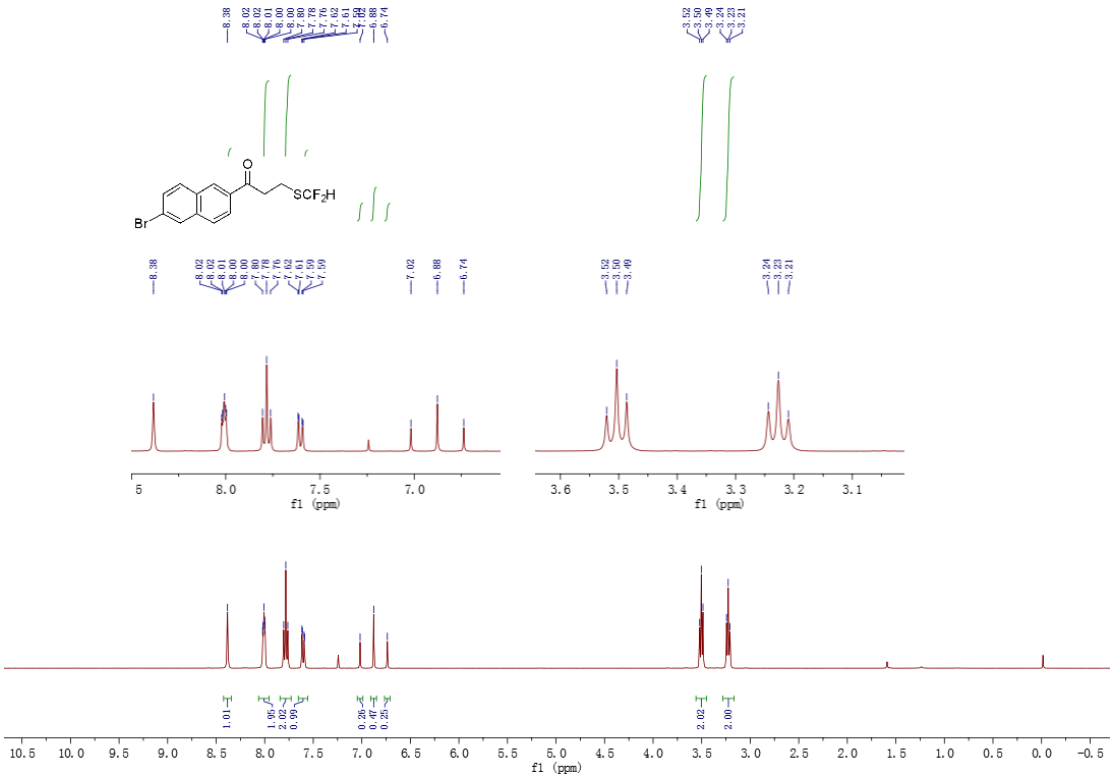
## $^{19}$F NMR spectrum of 1-(4-bromophenyl)-3-((difluoromethyl)thio)propan-1-one 4c



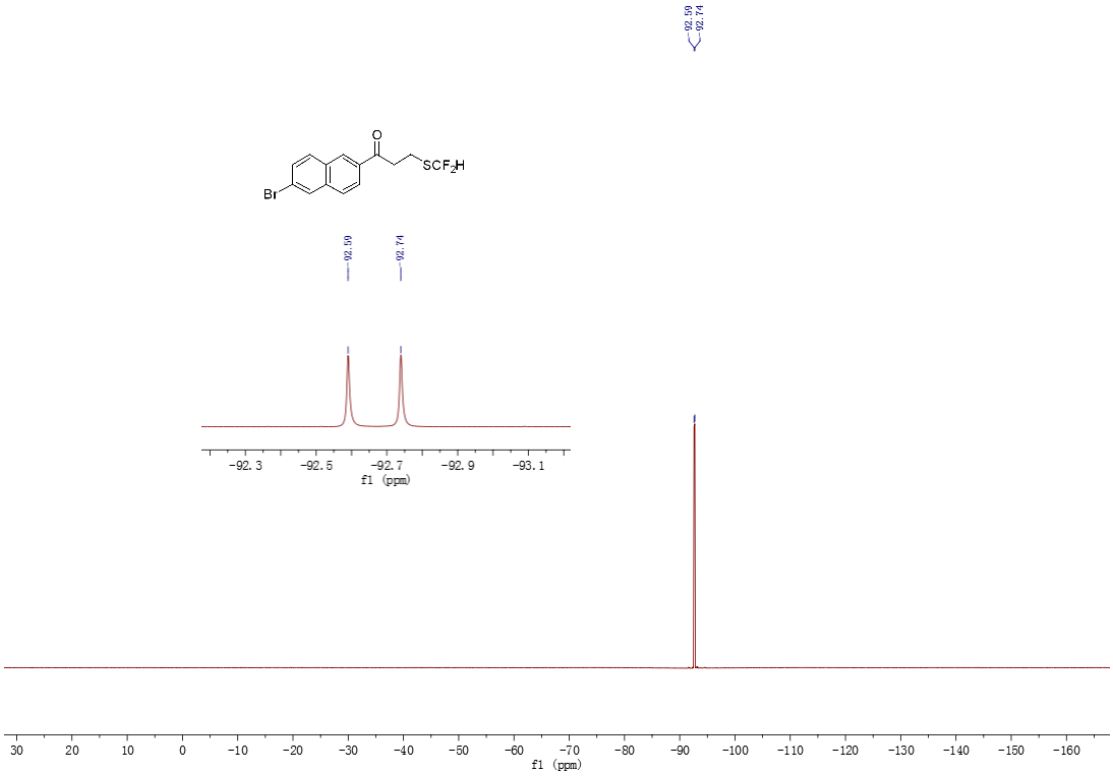

## $^{13}$C NMR spectrum of 1-(4-bromophenyl)-3-((difluoromethyl)thio)propan-1-one 4c



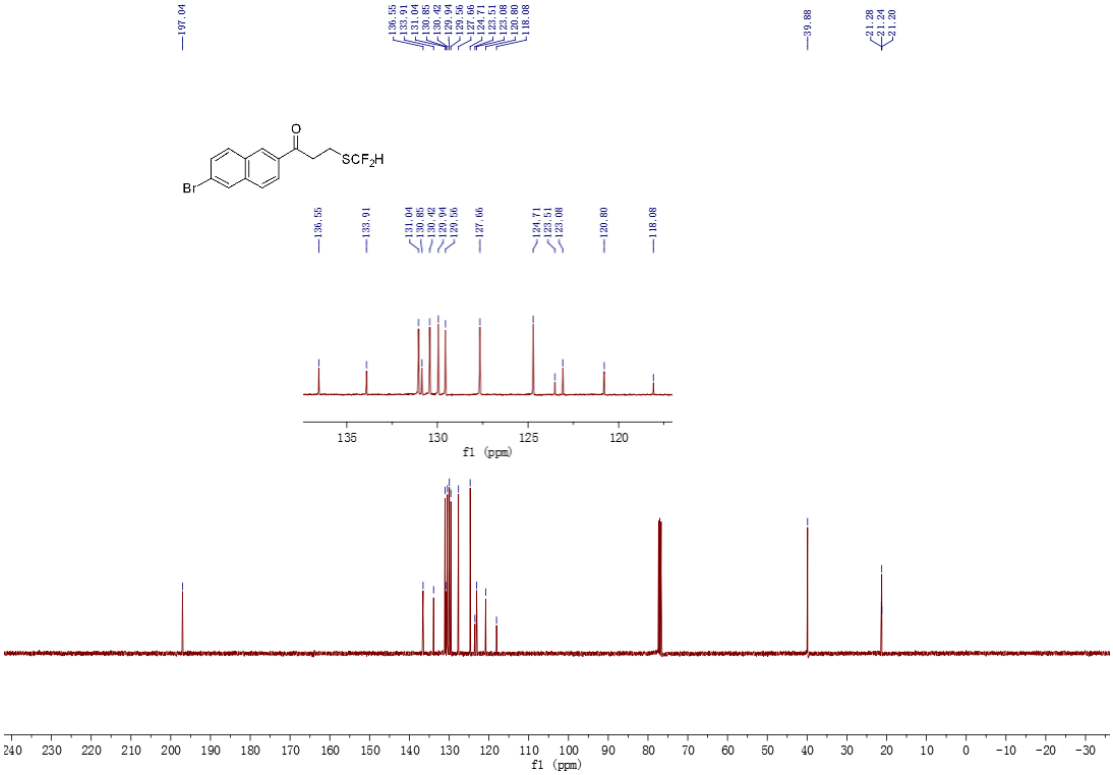
## $^{1}$H NMR spectrum of 1-(6-bromonaphthalen-2-yl)-3-((difluoromethyl)thio)propan-1-one 4d



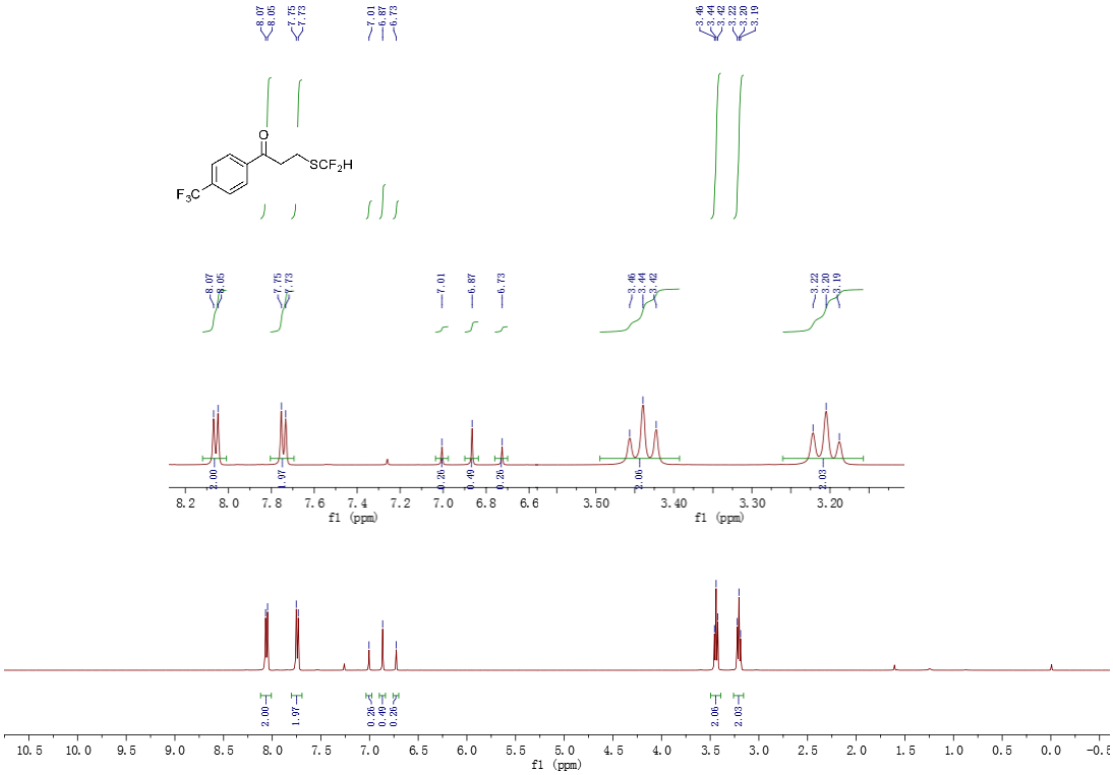

## $^{19}$F NMR spectrum of 1-(6-bromonaphthalen-2-yl)-3-((difluoromethyl)thio)propan-1-one 4d



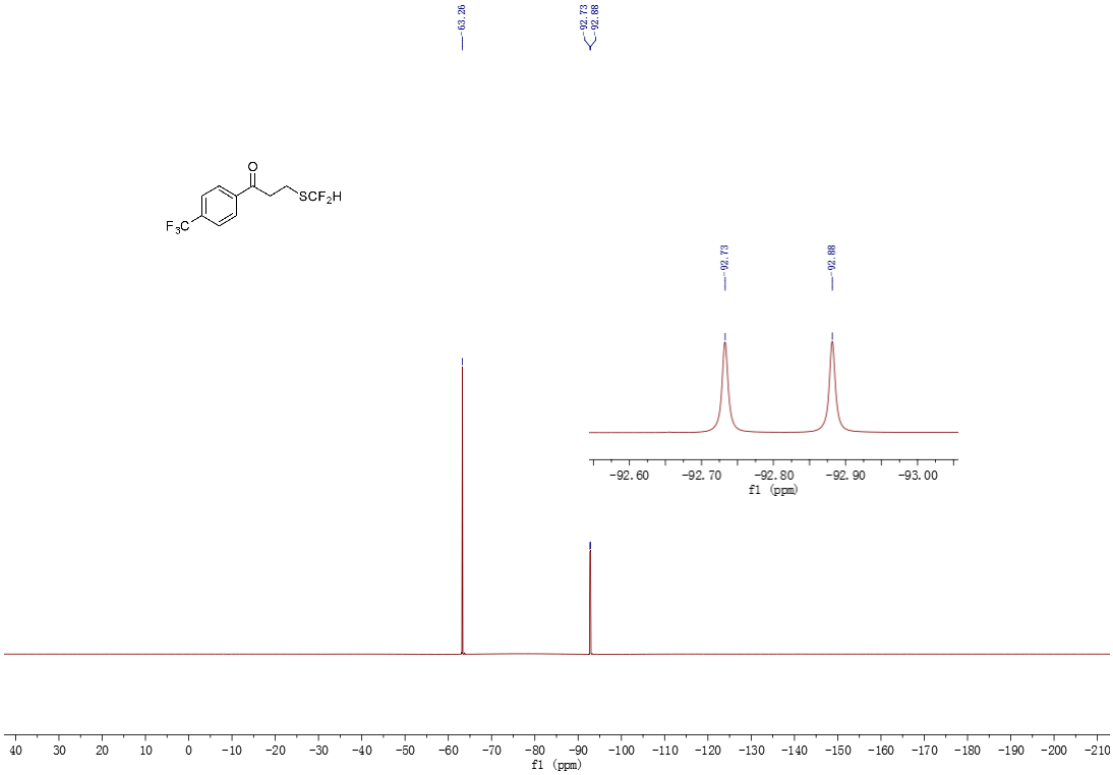
## $^{13}$C NMR spectrum of 1-(6-bromonaphthalen-2-yl)-3-((difluoromethyl)thio)propan-1-one 4d



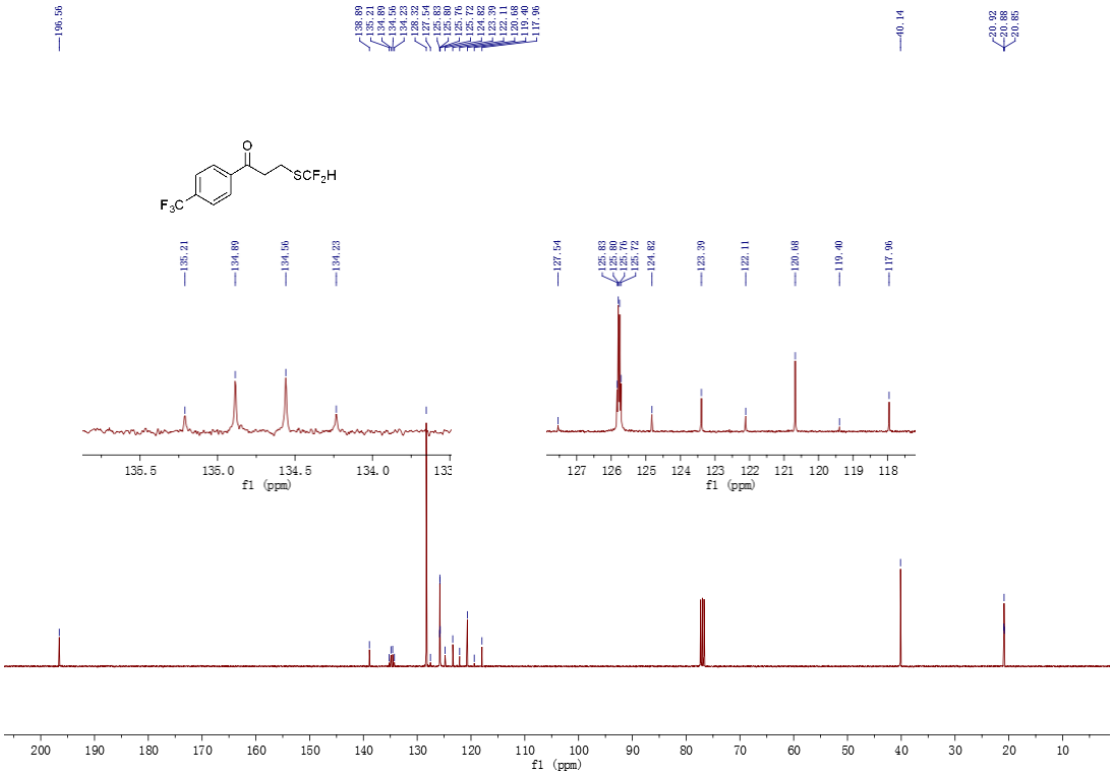

## $^{1}$H NMR spectrum of 3-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)propan-1-one 4e



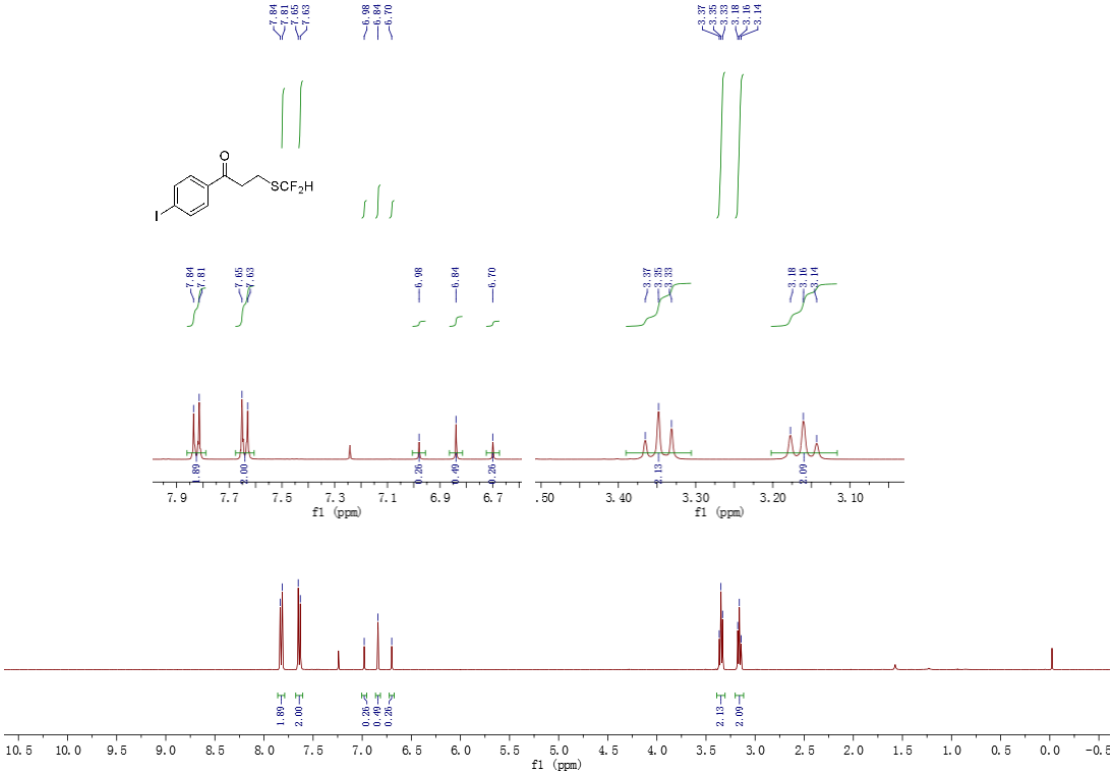
## $^{19}$F NMR spectrum of 3-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)propan-1-one 4e



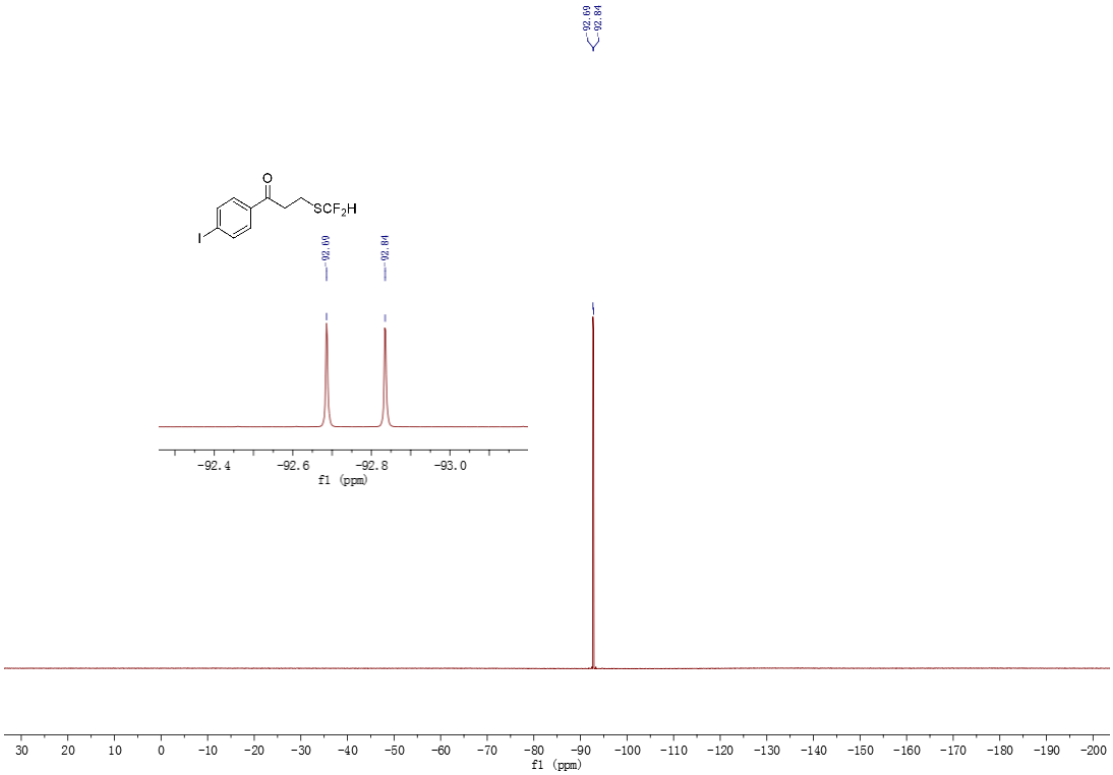

## $^{13}$C NMR spectrum of 3-((difluoromethyl)thio)-1-(4-(trifluoromethyl)phenyl)propan-1-one 4e



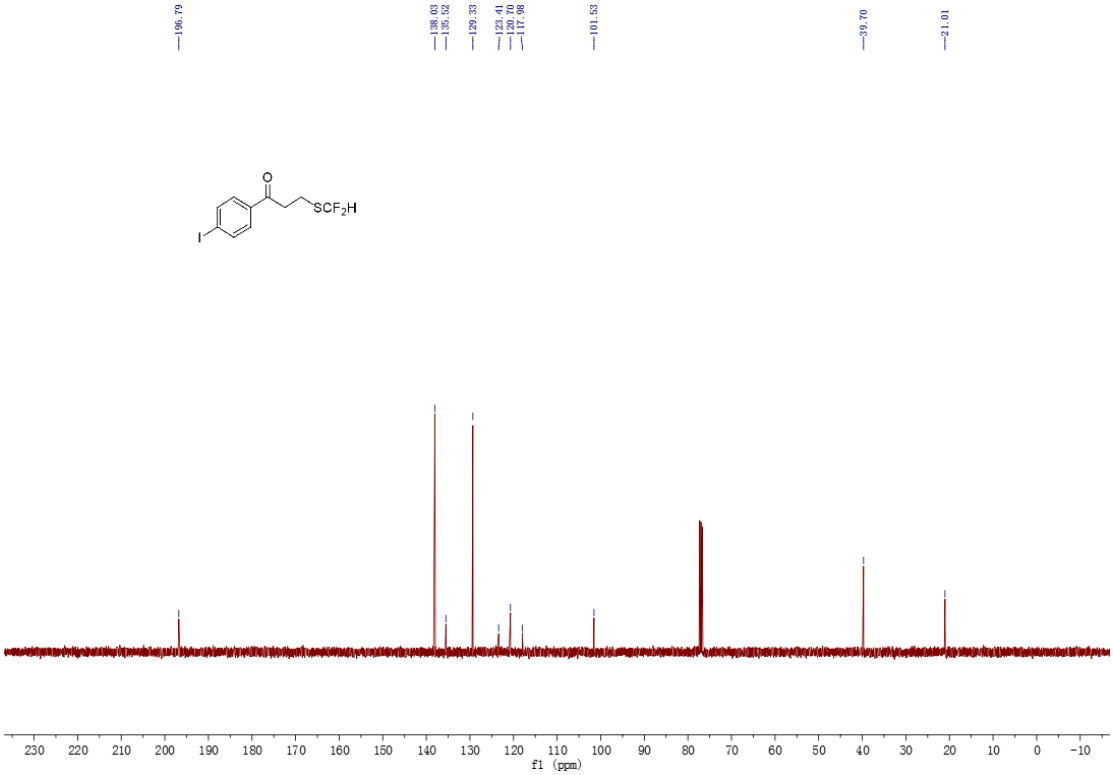
## $^{1}$H NMR spectrum of 3-((difluoromethyl)thio)-1-(4-iodophenyl)propan-1-one 4f



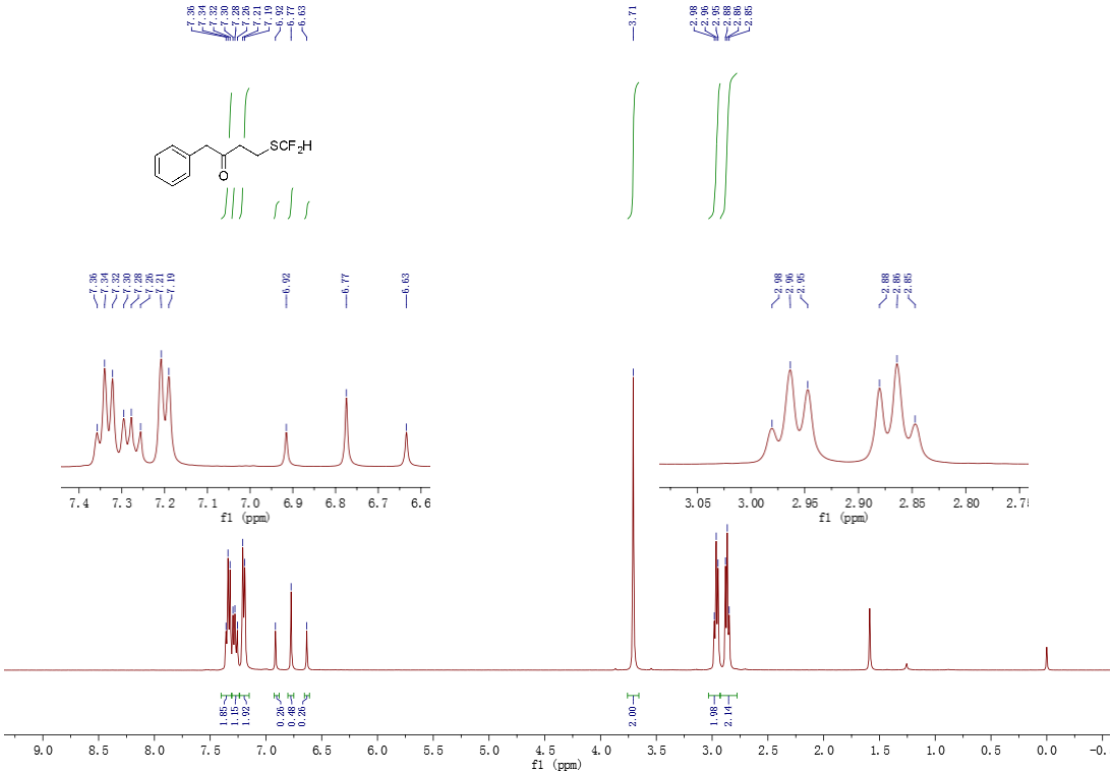

## $^{19}$F NMR spectrum of 3-((difluoromethyl)thio)-1-(4-iodophenyl)propan-1-one 4f



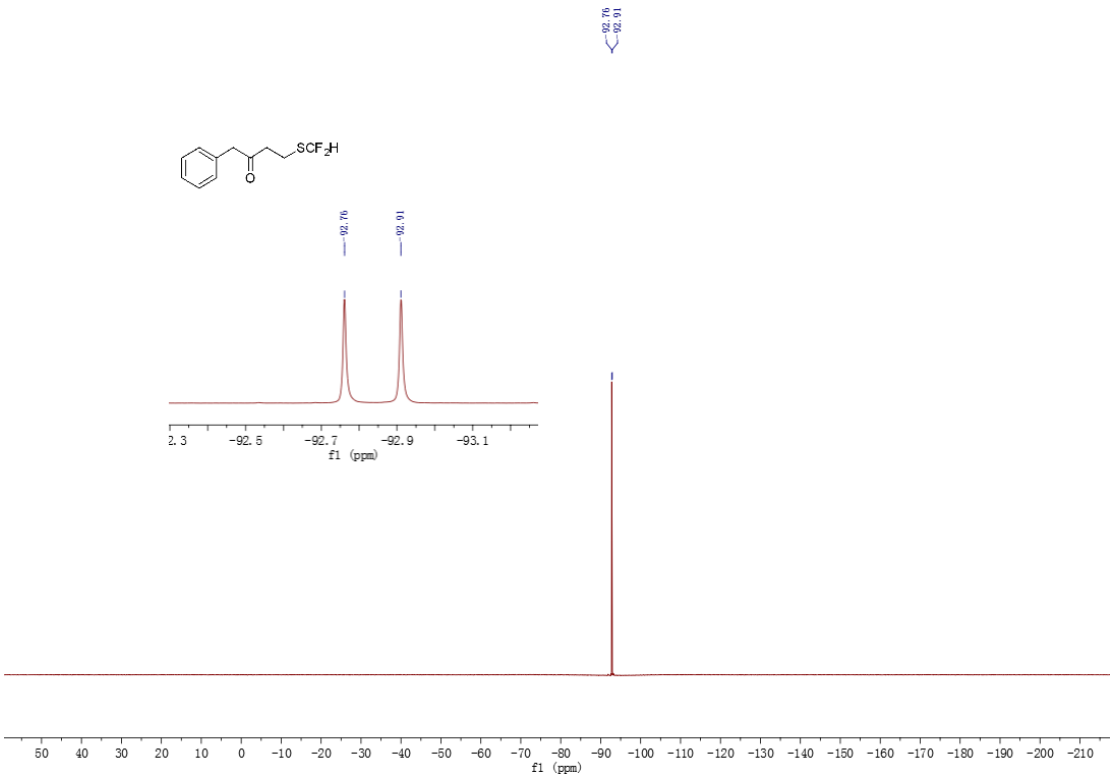
## $^{13}$C NMR spectrum of 3-((difluoromethyl)thio)-1-(4-iodophenyl)propan-1-one 4f



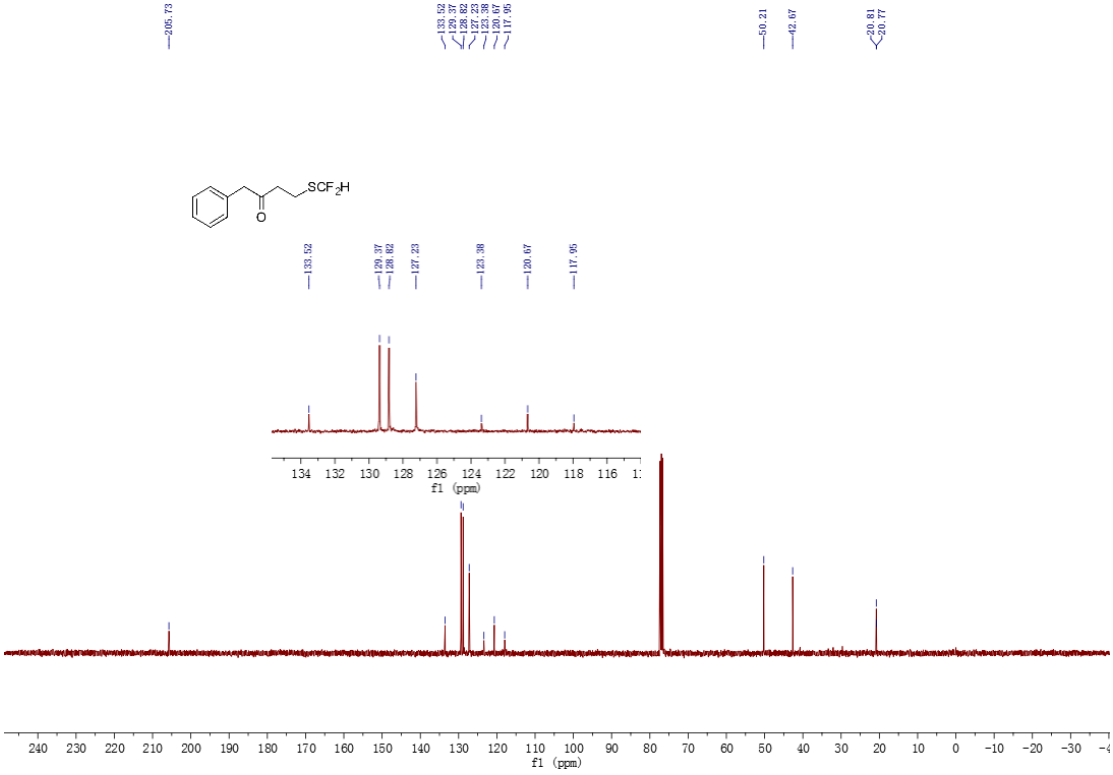

## $^{1}$H NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-2-one 4g



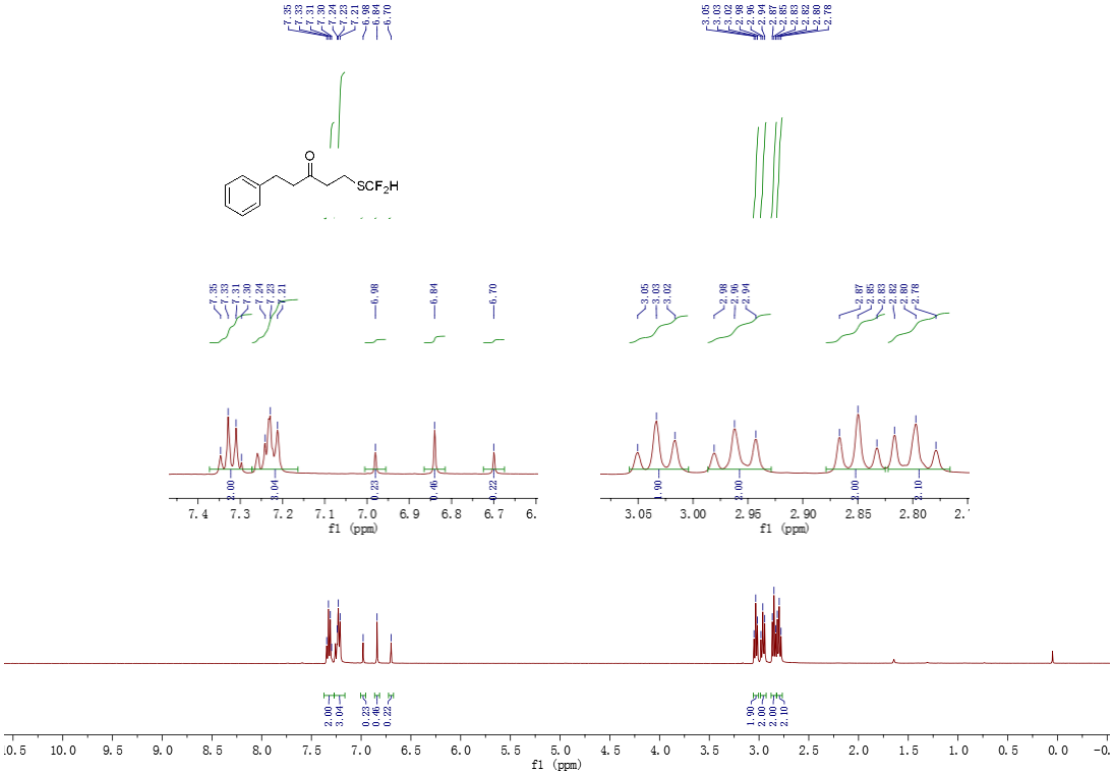
## $^{19}$F NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-2-one 4g



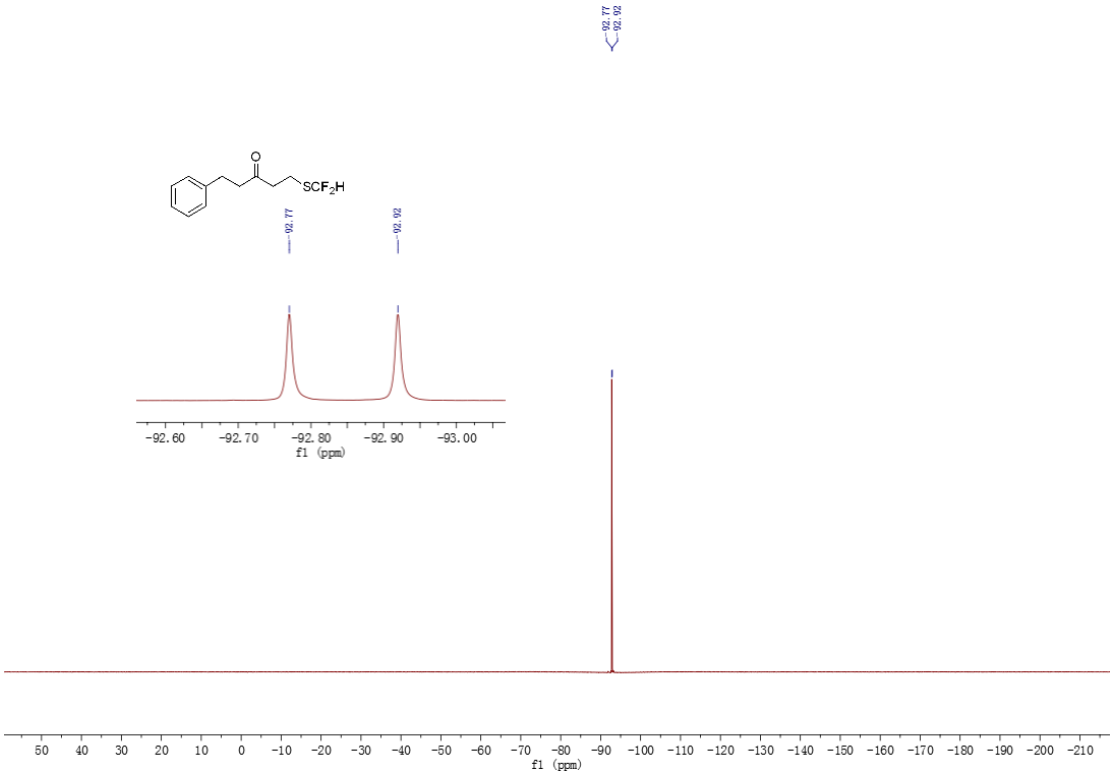

## $^{13}$C NMR spectrum of 4-((difluoromethyl)thio)-1-phenylbutan-2-one 4g



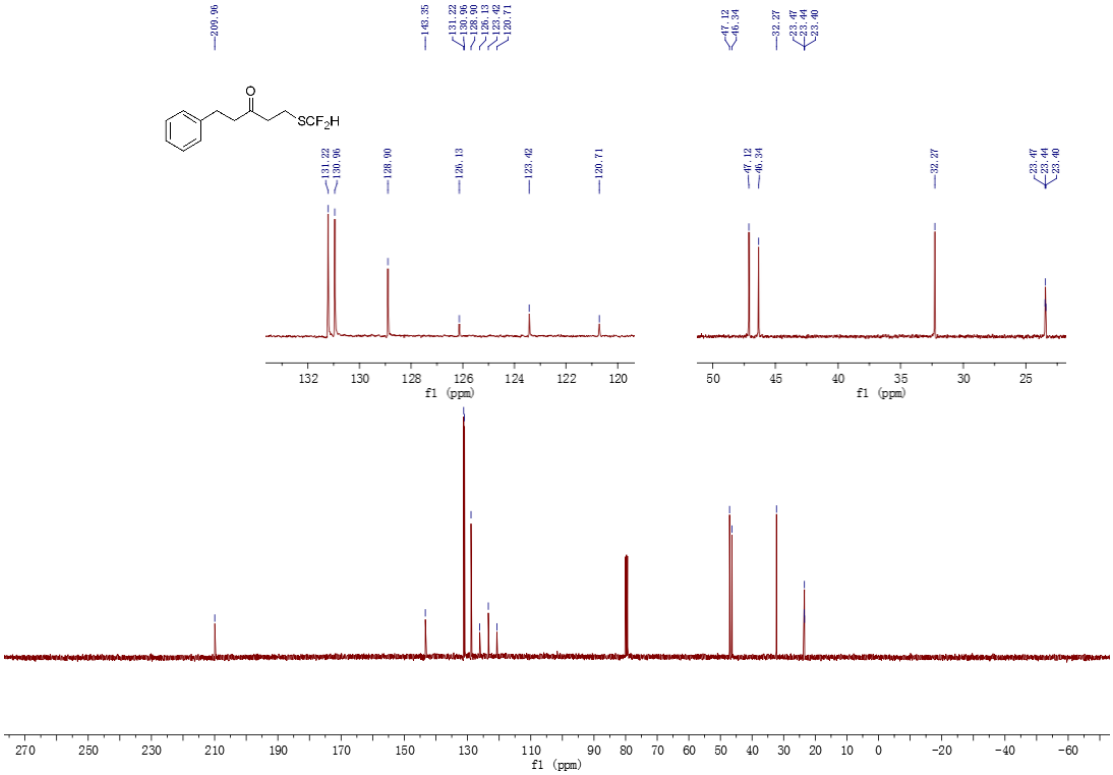
## $^{1}$H NMR spectrum of 1-((difluoromethyl)thio)-5-phenylpentan-3-one 4h



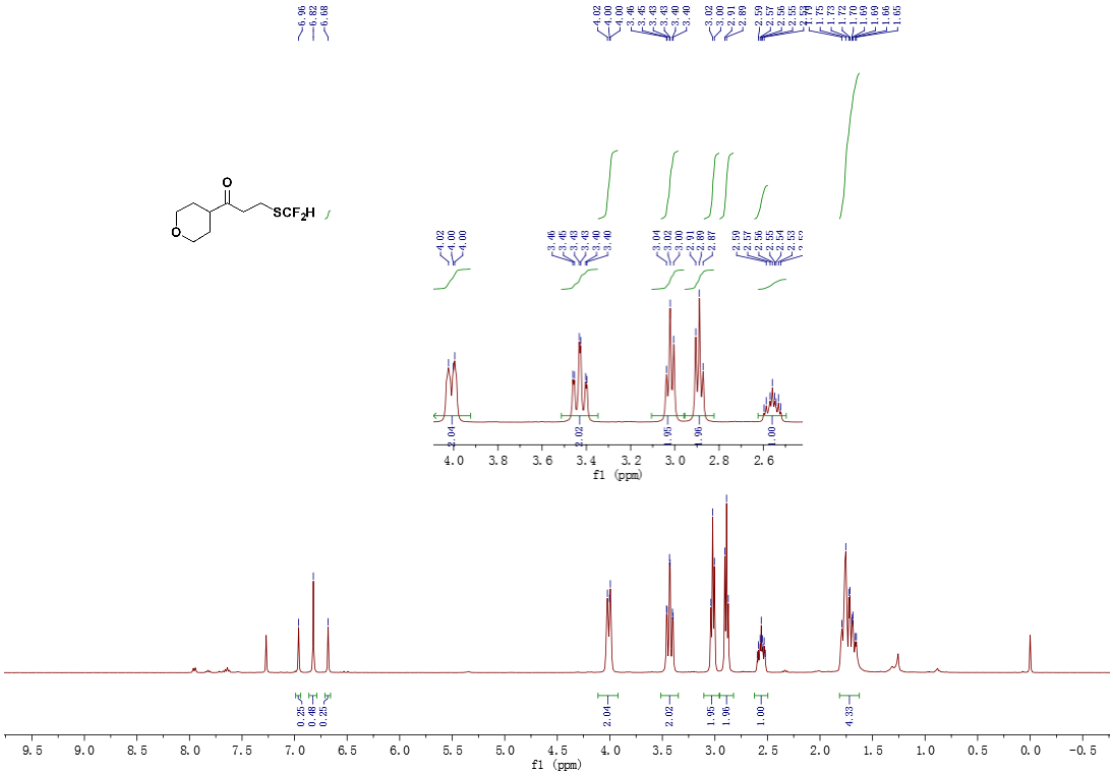

## $^{19}$F NMR spectrum of 1-((difluoromethyl)thio)-5-phenylpentan-3-one 4h



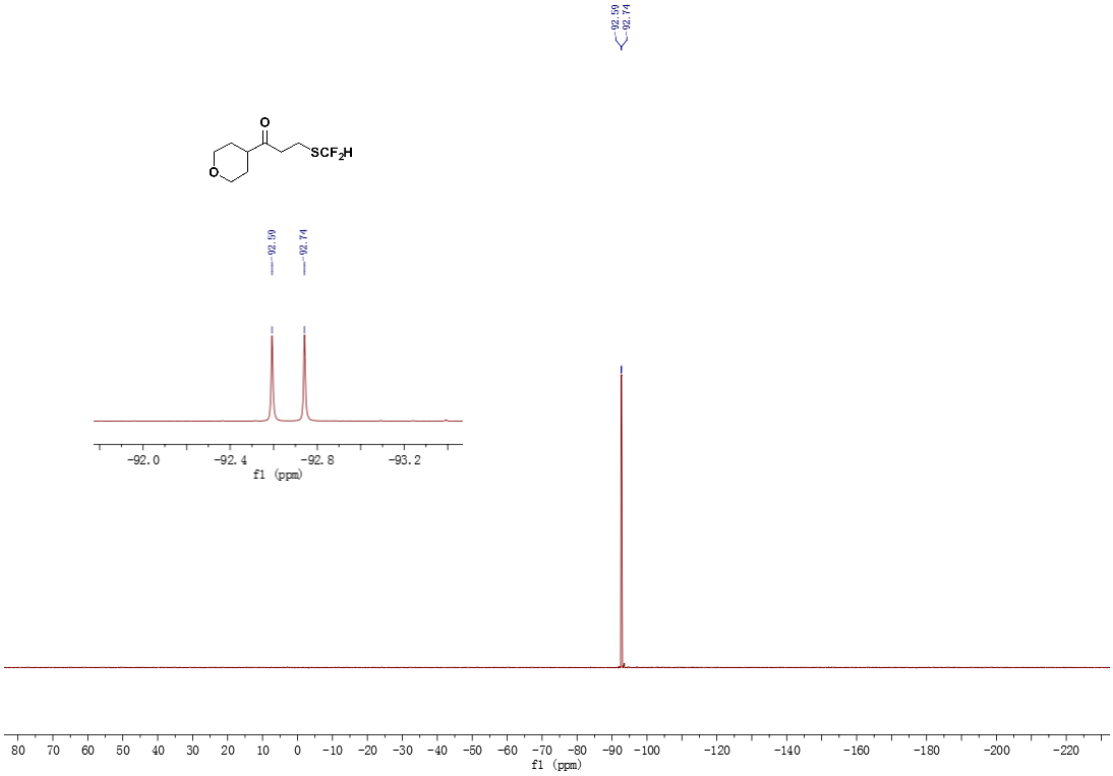
**$^{13}$C NMR spectrum of**
**1-((difluoromethyl)thio)-5-phenylpentan-3-one 4h**



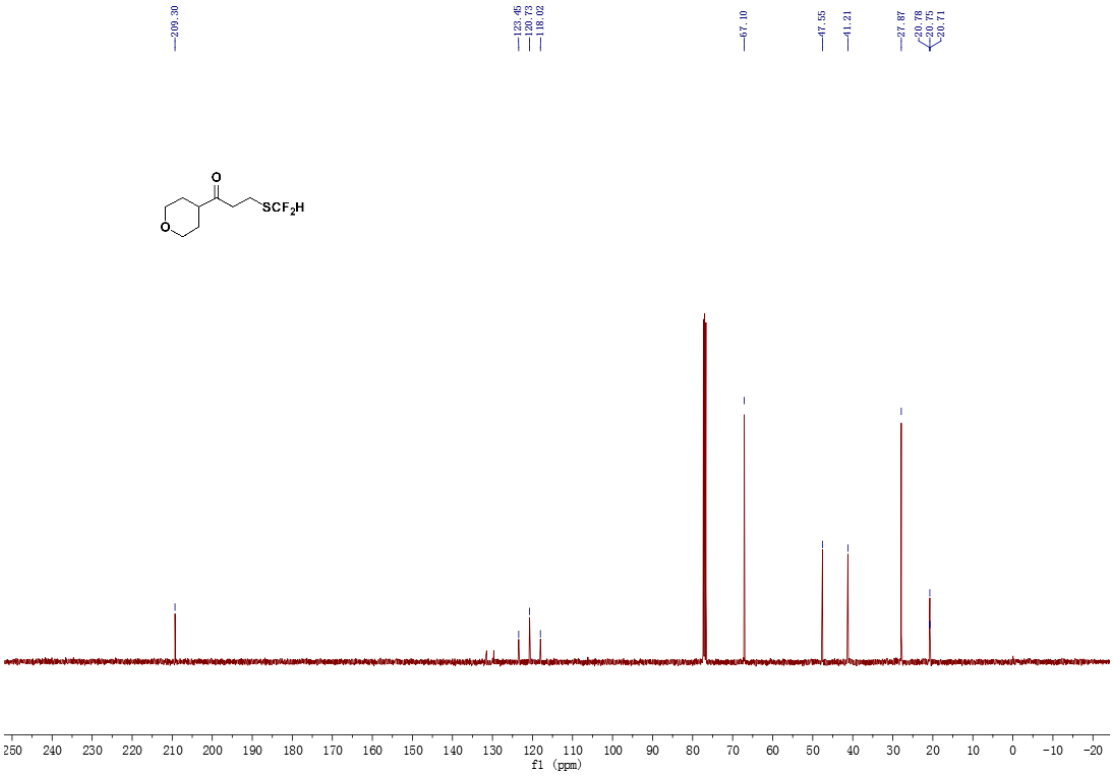

**$^{1}$H NMR spectrum of**
**3-((difluoromethyl)thio)-1-(tetrahydro-2 H-pyran-4-yl)propan-1-one 4i**



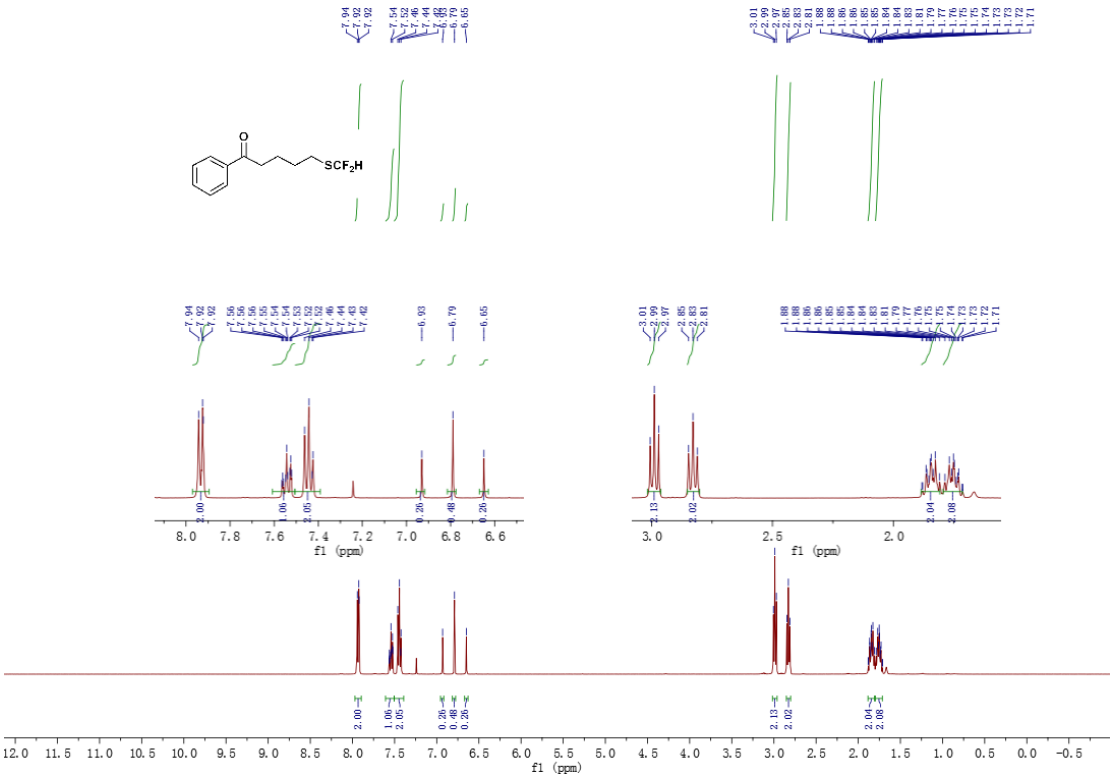
## $^{19}$F NMR spectrum of 3-((difluoromethyl)thio)-1-(tetrahydro-2 H-pyran-4-yl)propan-1-one 4i



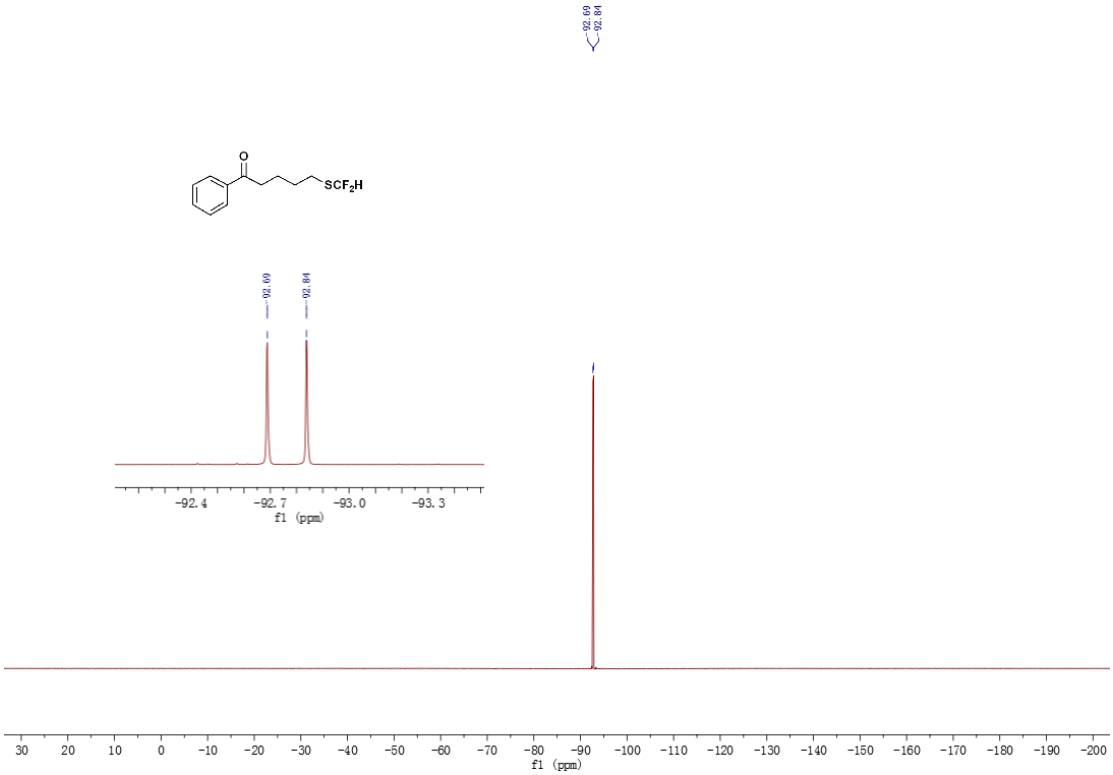

## $^{13}$C NMR spectrum of 3-((difluoromethyl)thio)-1-(tetrahydro-2 H-pyran-4-yl)propan-1-one 4i



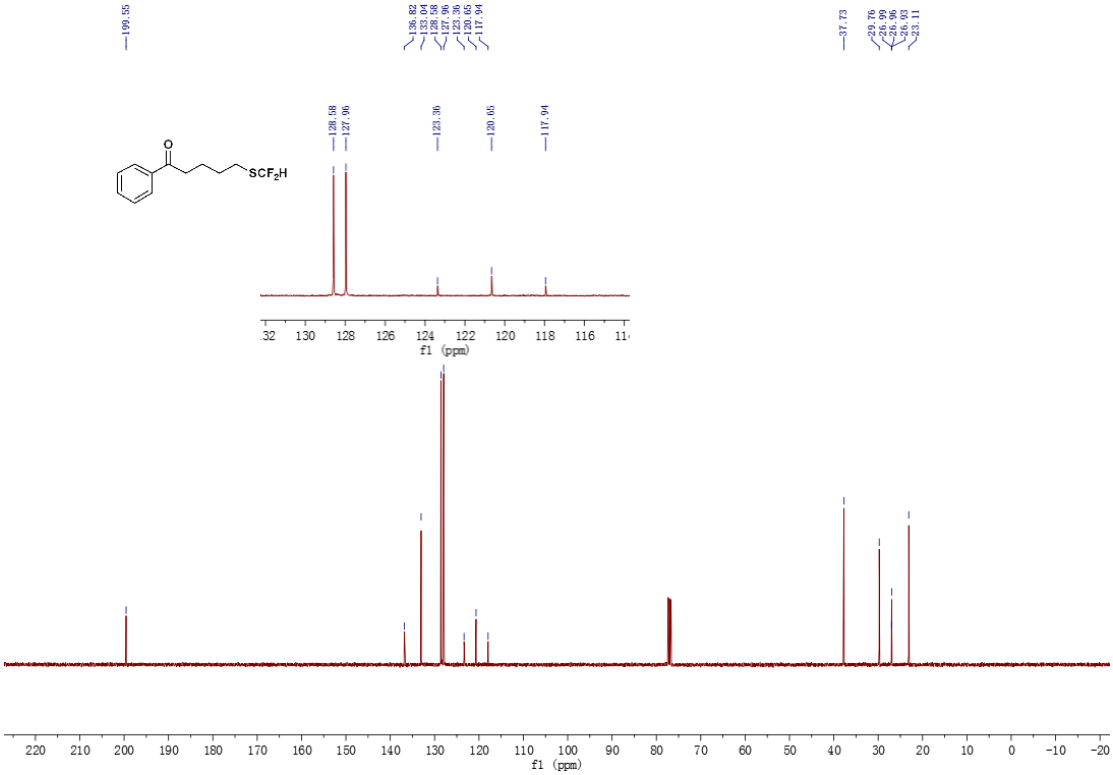
## $^{1}$H NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-1-one 4j



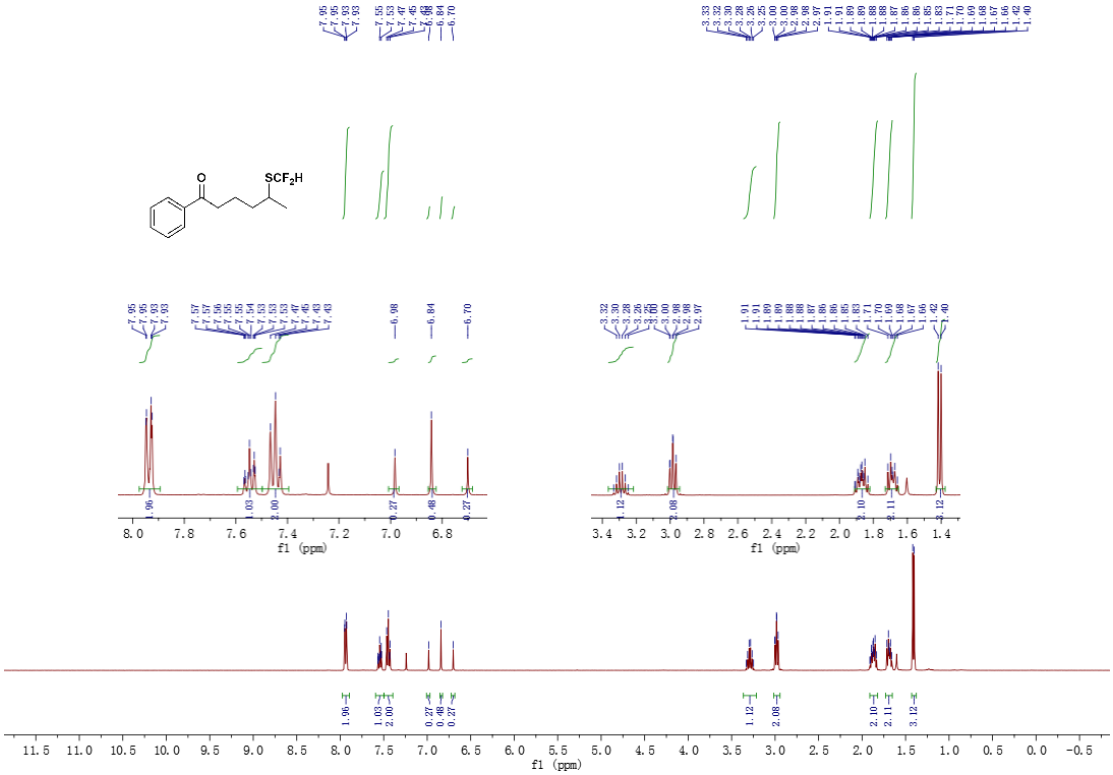

## $^{19}$F NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-1-one 4j



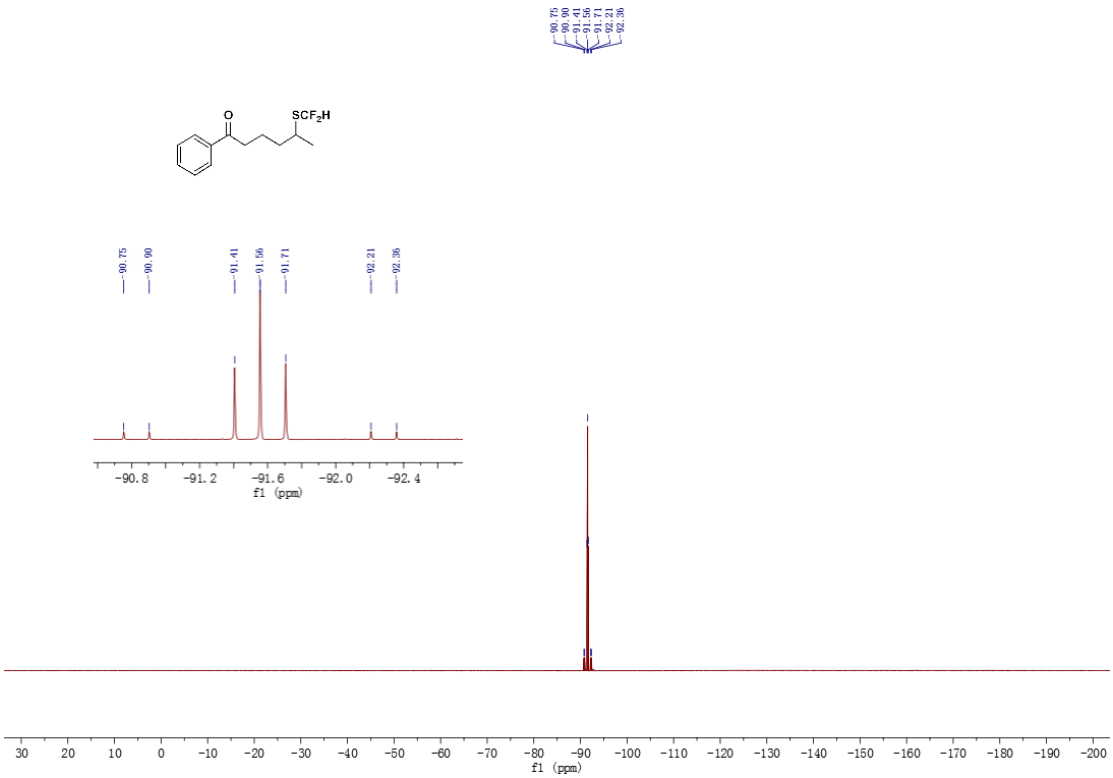
## $^{13}$C NMR spectrum of 5-((difluoromethyl)thio)-1-phenylpentan-1-one 4j



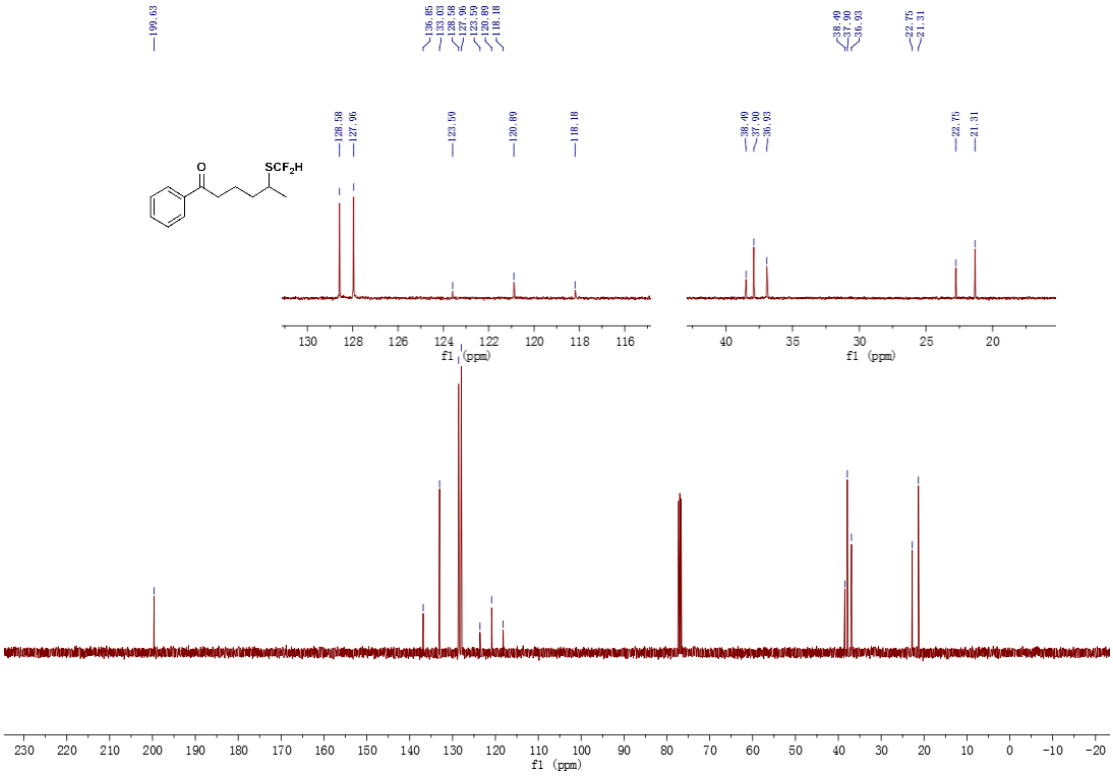

## $^{1}$H NMR spectrum of 5-((difluoromethyl)thio)-1-phenylhexan-1-one 4k



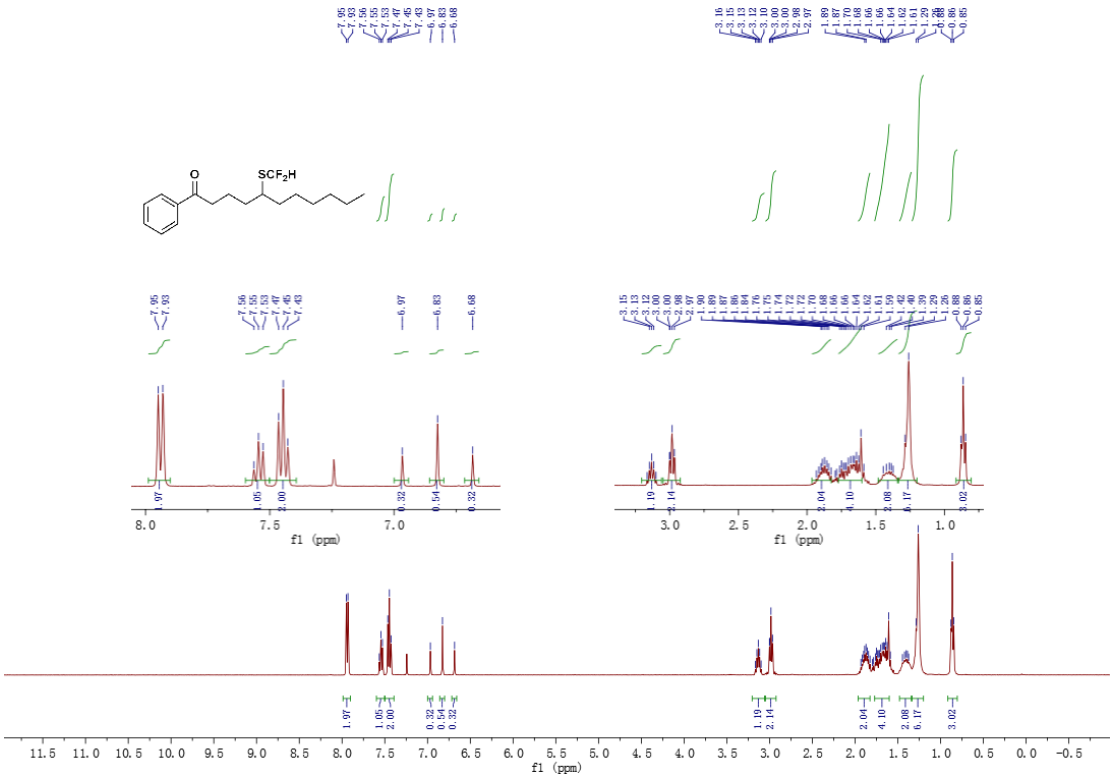
## $^{19}$F NMR spectrum of 5-((difluoromethyl)thio)-1-phenylhexan-1-one 4k



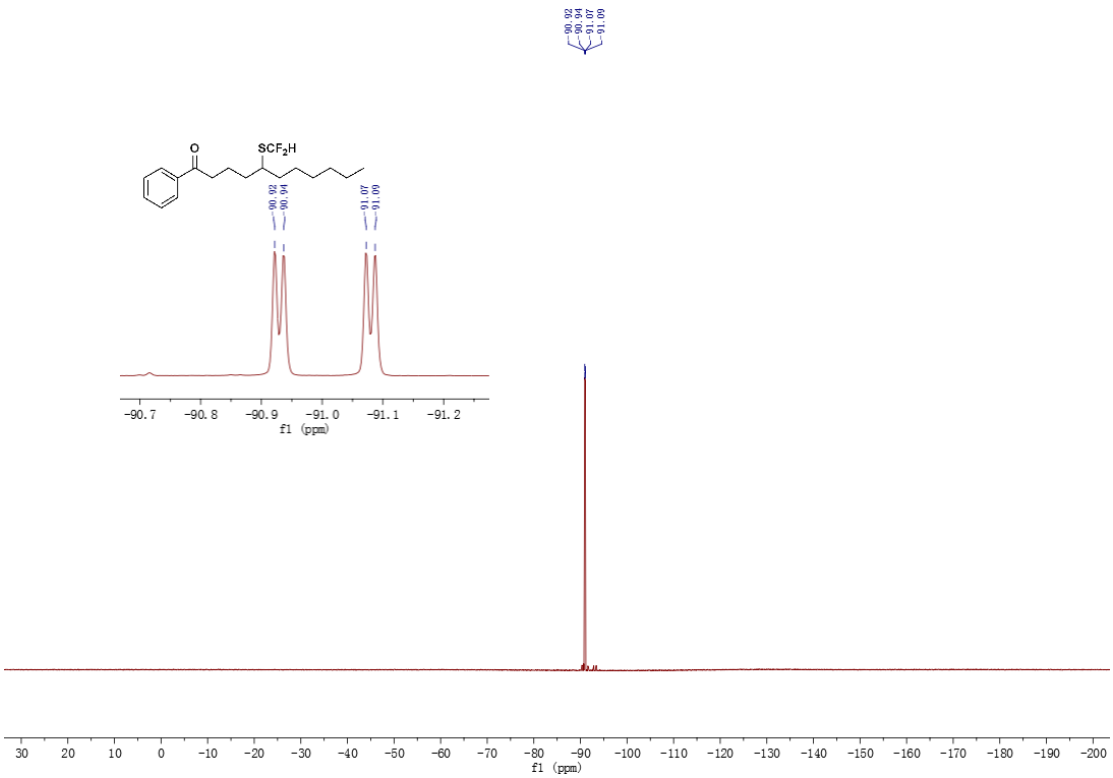

## $^{13}$C NMR spectrum of 5-((difluoromethyl)thio)-1-phenylhexan-1-one 4k



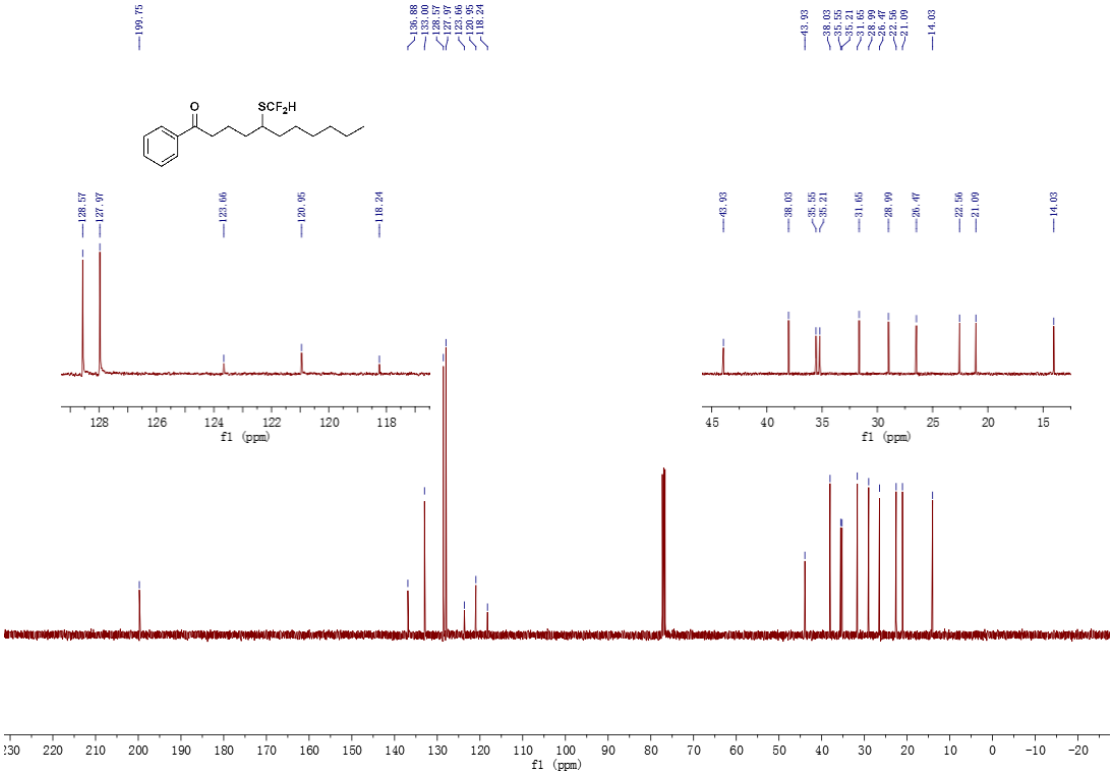
## $^{1}$H NMR spectrum of 5-((difluoromethyl)thio)-1-phenylundecan-1-one 4l



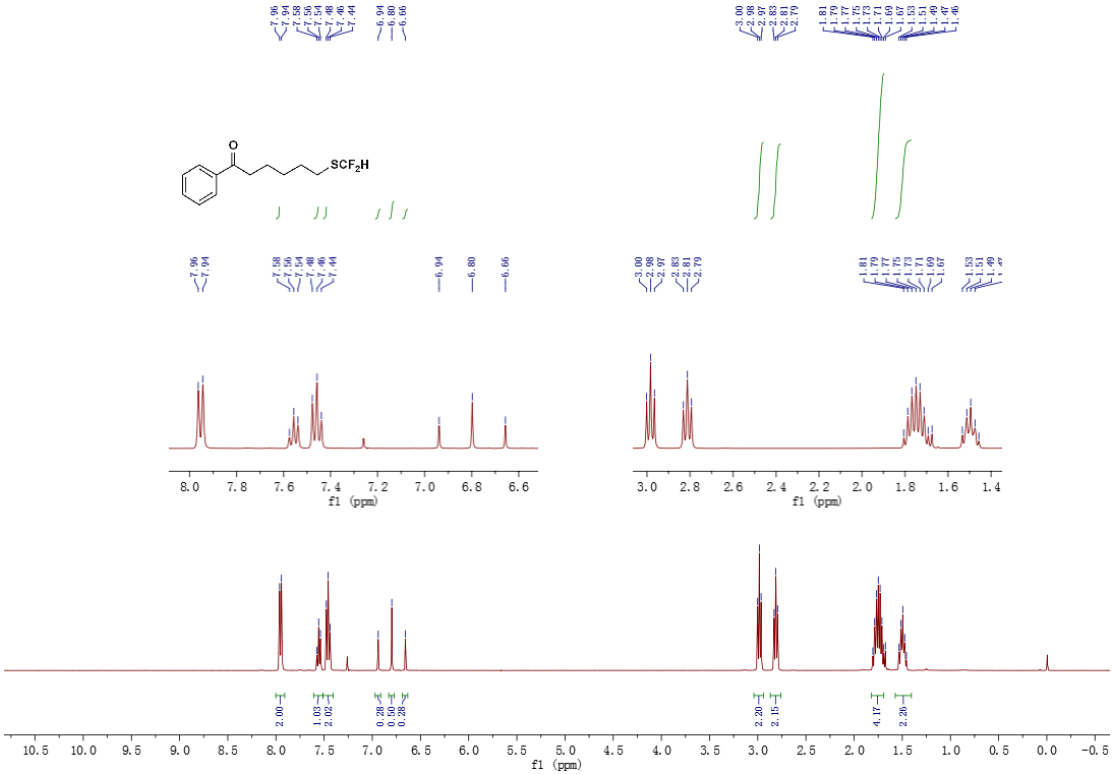

## $^{19}$F NMR spectrum of 5-((difluoromethyl)thio)-1-phenylundecan-1-one 4l



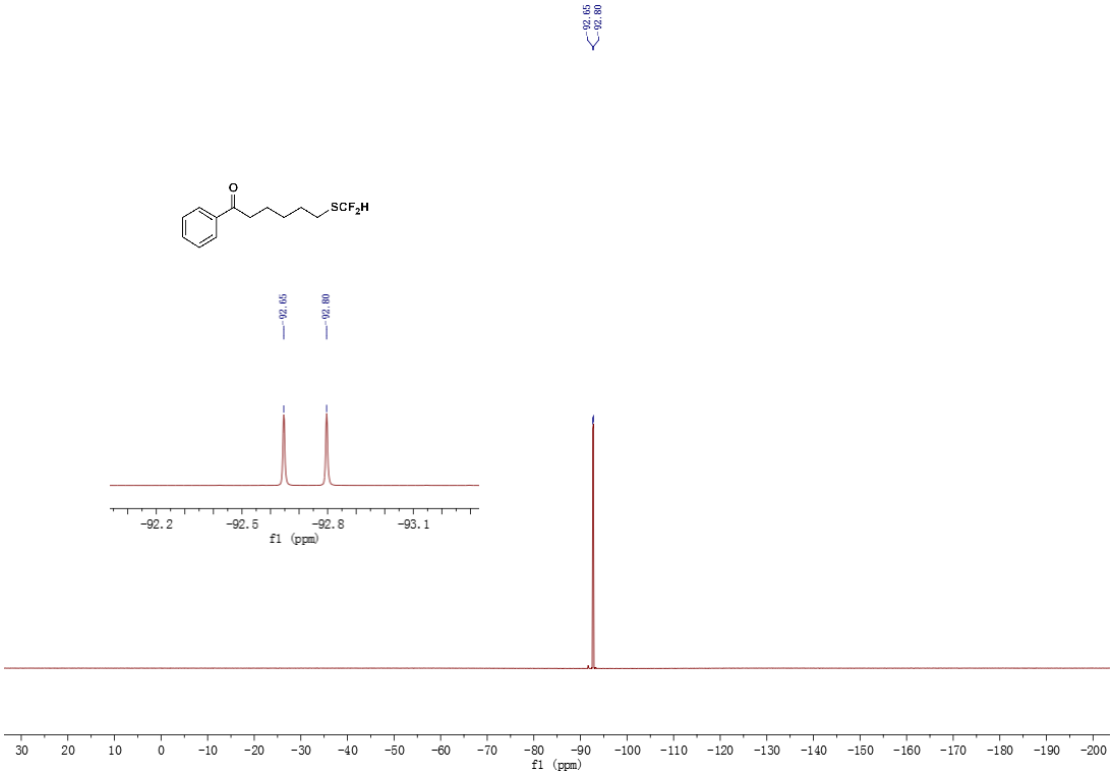
## $^{13}$C NMR spectrum of 5-((difluoromethyl)thio)-1-phenylundecan-1-one 4l



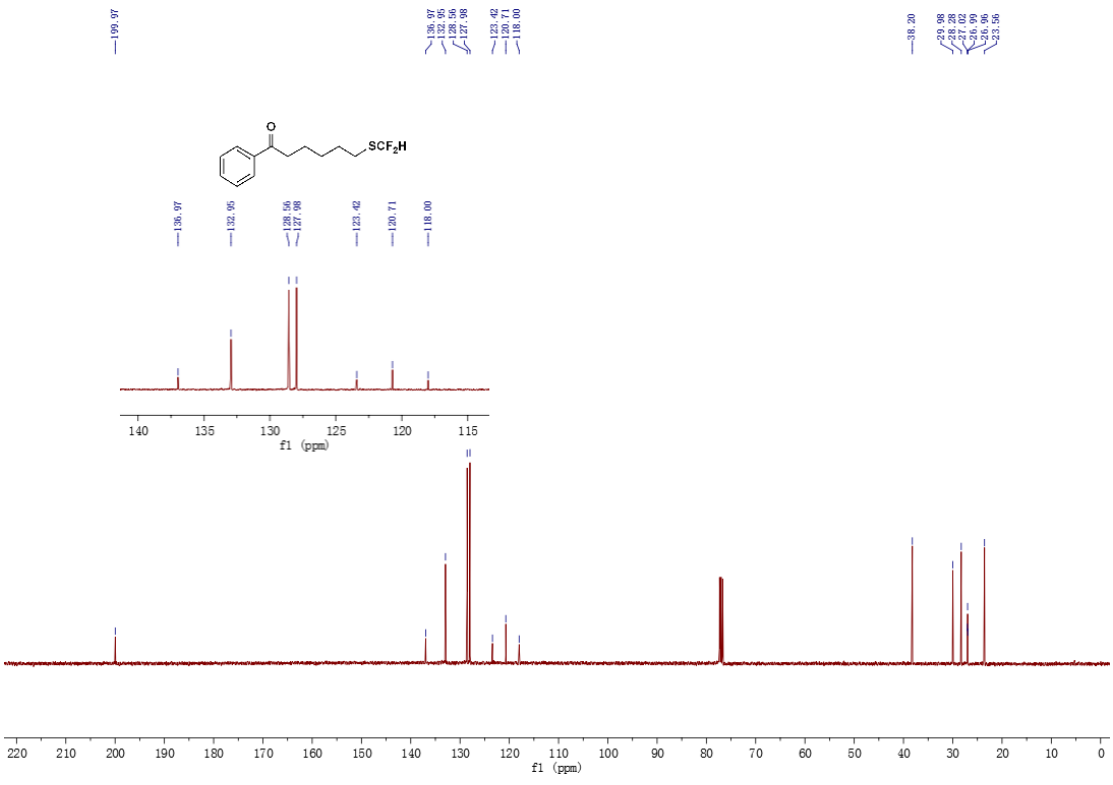

## $^{1}$H NMR spectrum of 6-((difluoromethyl)thio)-1-phenylhexan-1-one 4m



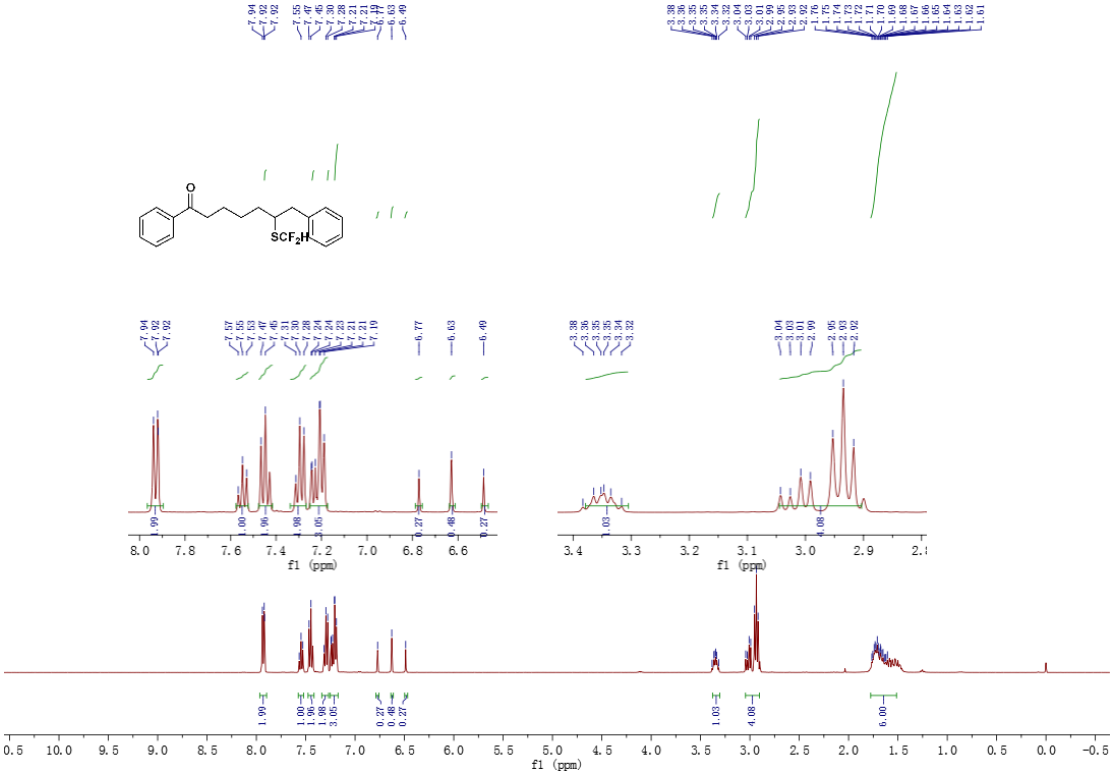
## $^{19}$F NMR spectrum of 6-((difluoromethyl)thio)-1-phenylhexan-1-one 4m



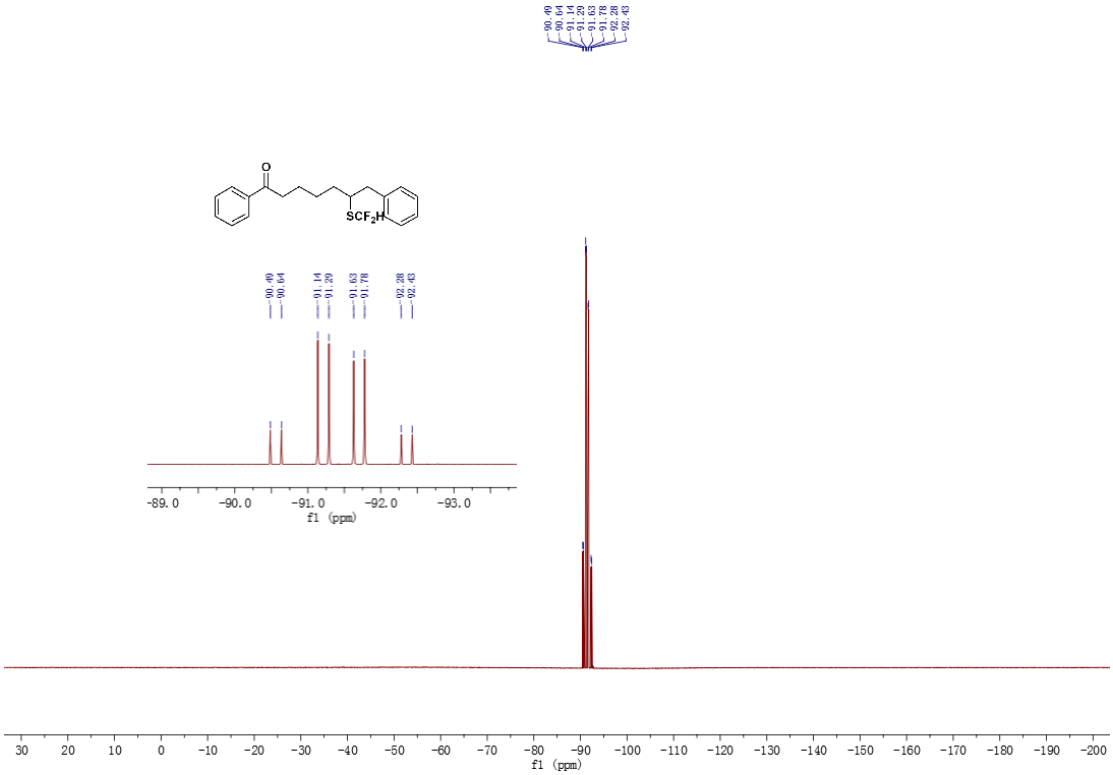

## $^{13}$C NMR spectrum of 6-((difluoromethyl)thio)-1-phenylhexan-1-one 4m



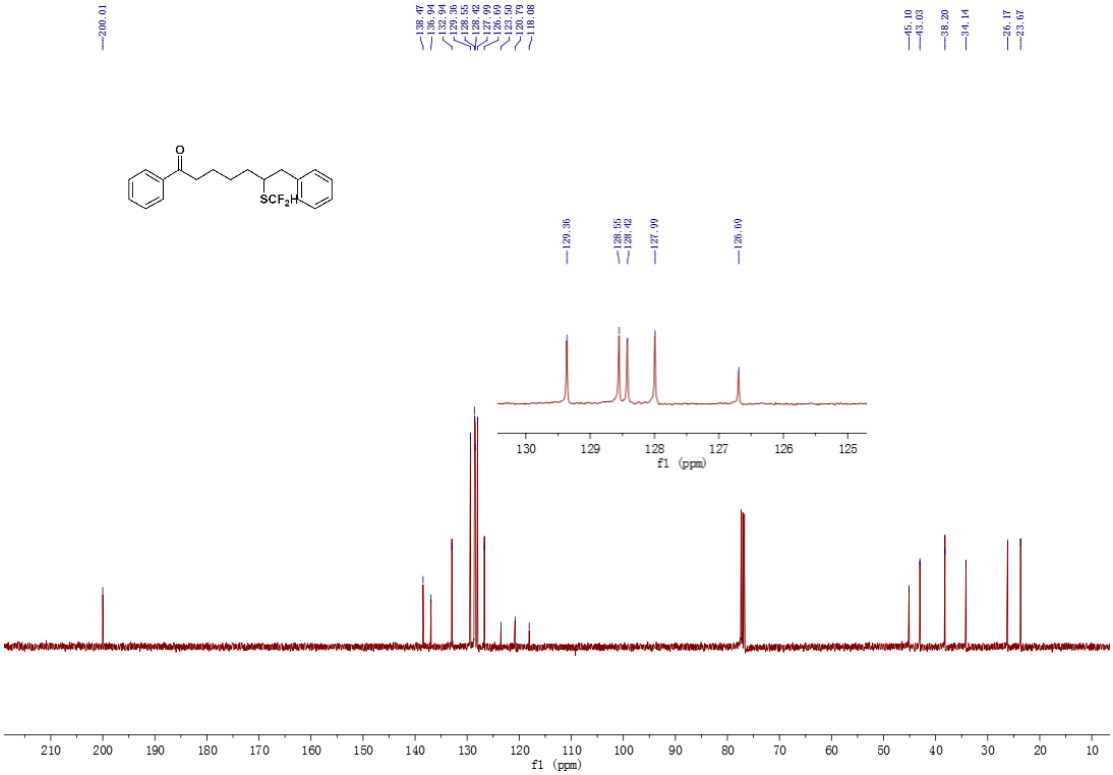
## $^{1}$H NMR spectrum of 6-((difluoromethyl)thio)-1,7-diphenylheptan-1-one 4n



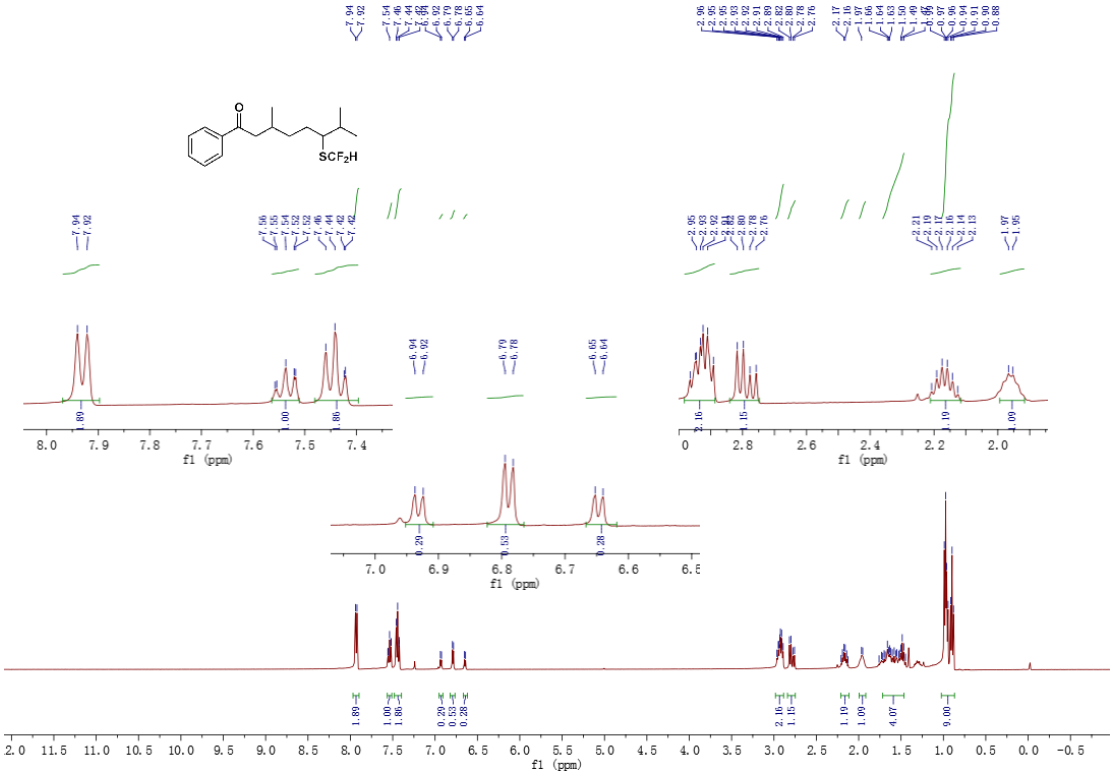
## $^{19}$F NMR spectrum of 6-((difluoromethyl)thio)-1,7-diphenylheptan-1-one 4n



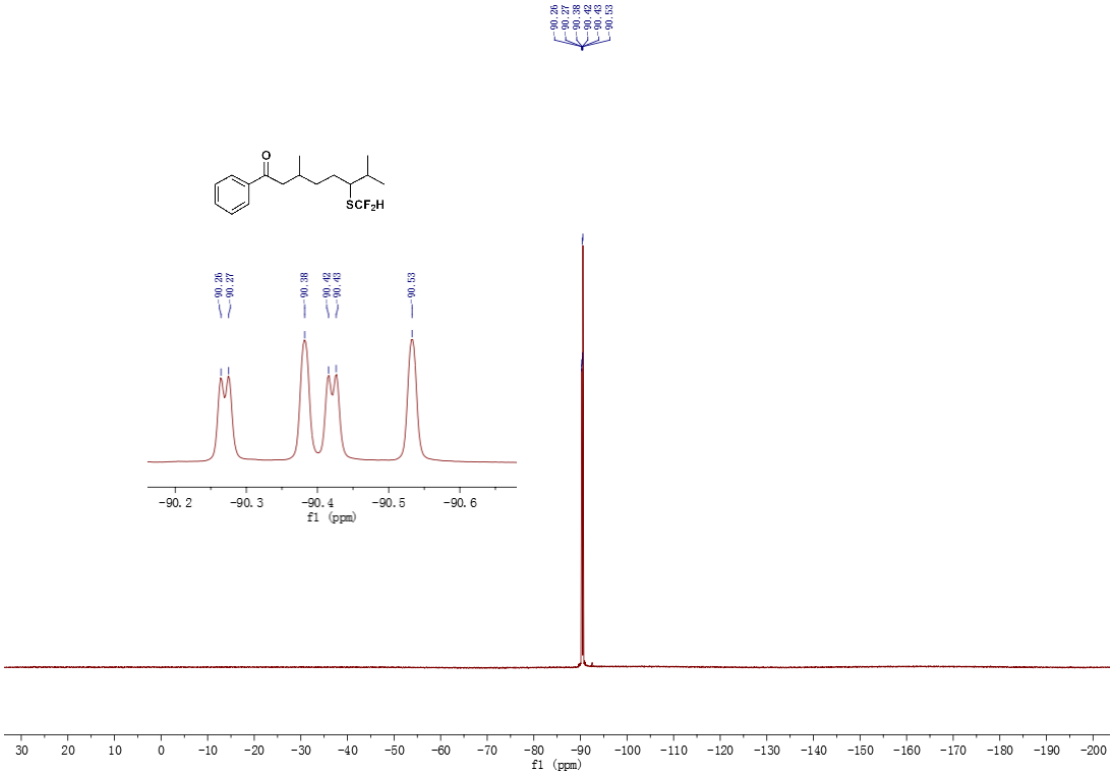
## $^{13}$C NMR spectrum of 6-((difluoromethyl)thio)-1,7-diphenylheptan-1-one 4n



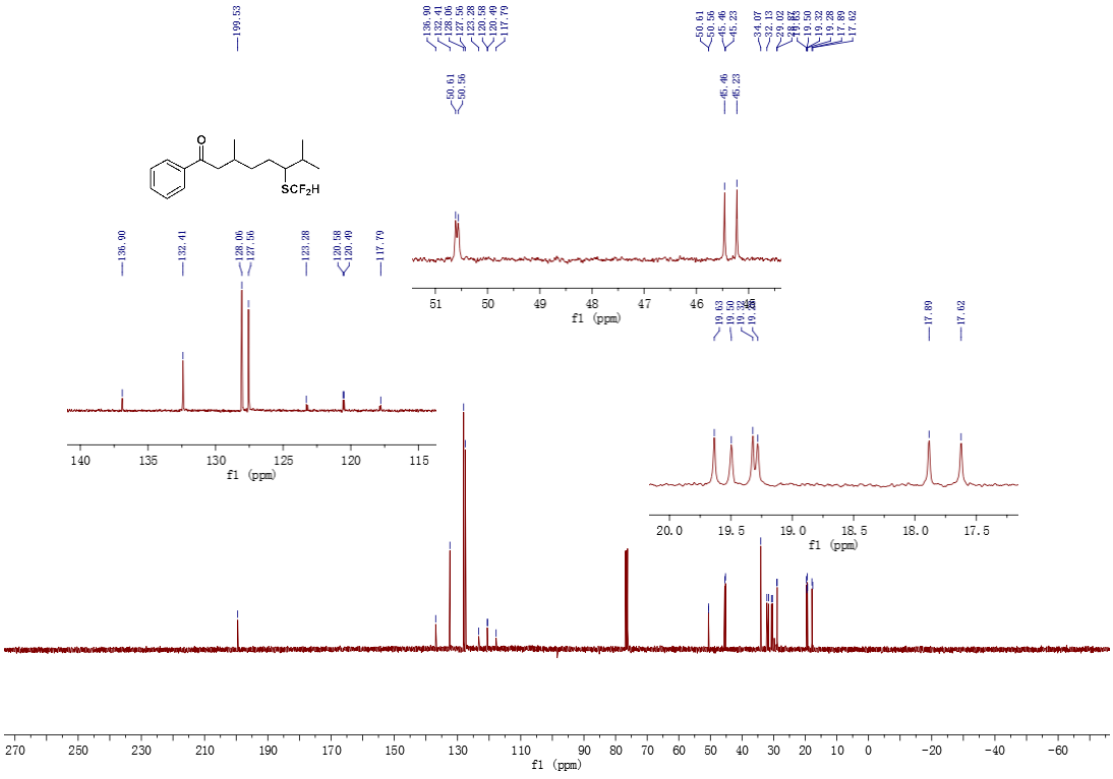
## $^{1}$H NMR spectrum of 6-((difluoromethyl)thio)-3,7-dimethyl-1-phenyloctan-1-one 4o



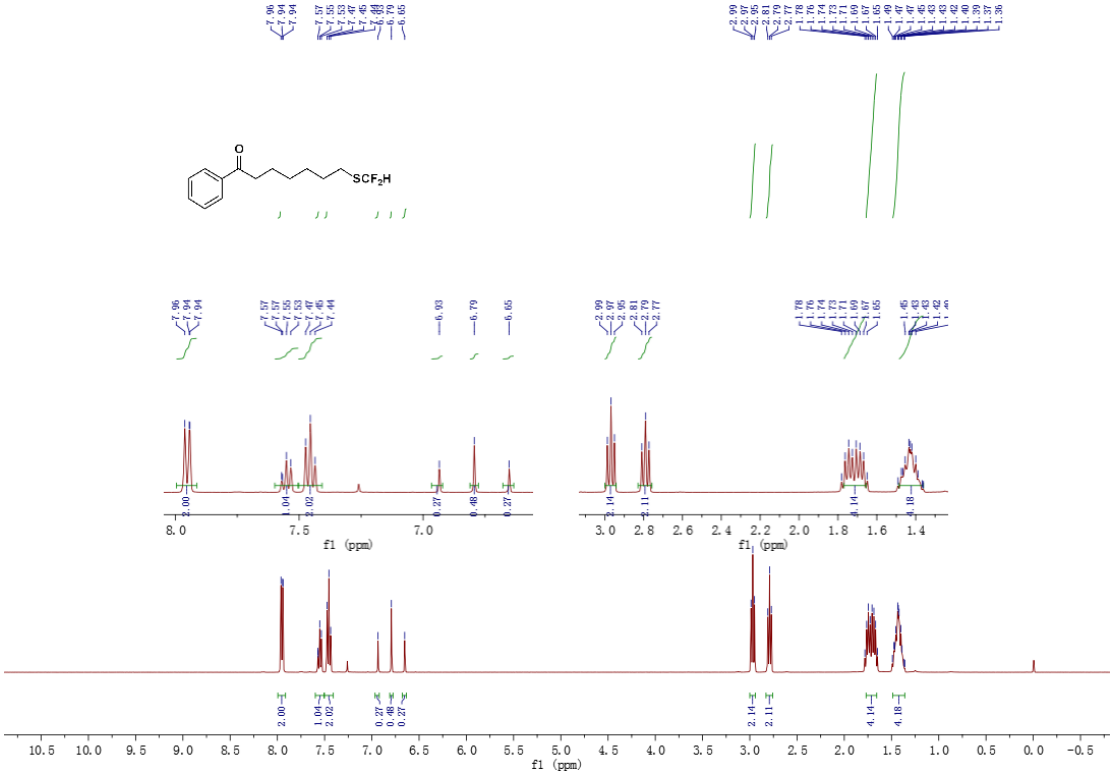
## $^{19}$F NMR spectrum of 6-((difluoromethyl)thio)-3,7-dimethyl-1-phenyloctan-1-one 4o



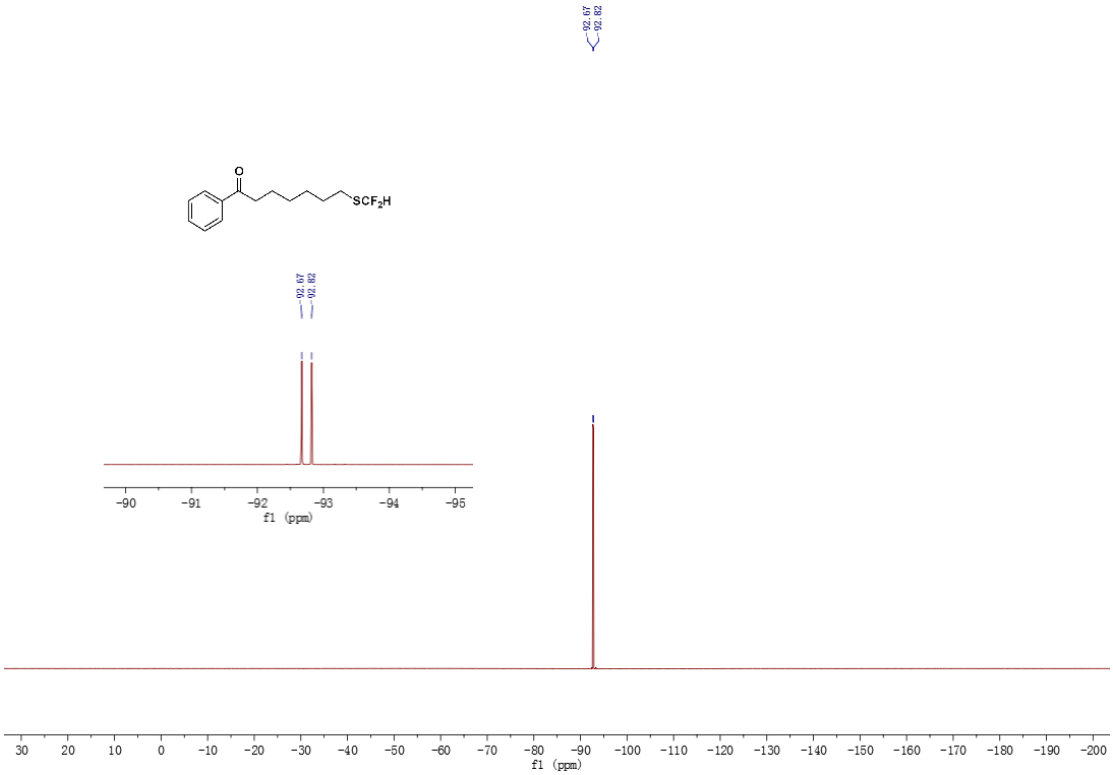

## $^{13}$C NMR spectrum of 6-((difluoromethyl)thio)-3,7-dimethyl-1-phenyloctan-1-one 4o



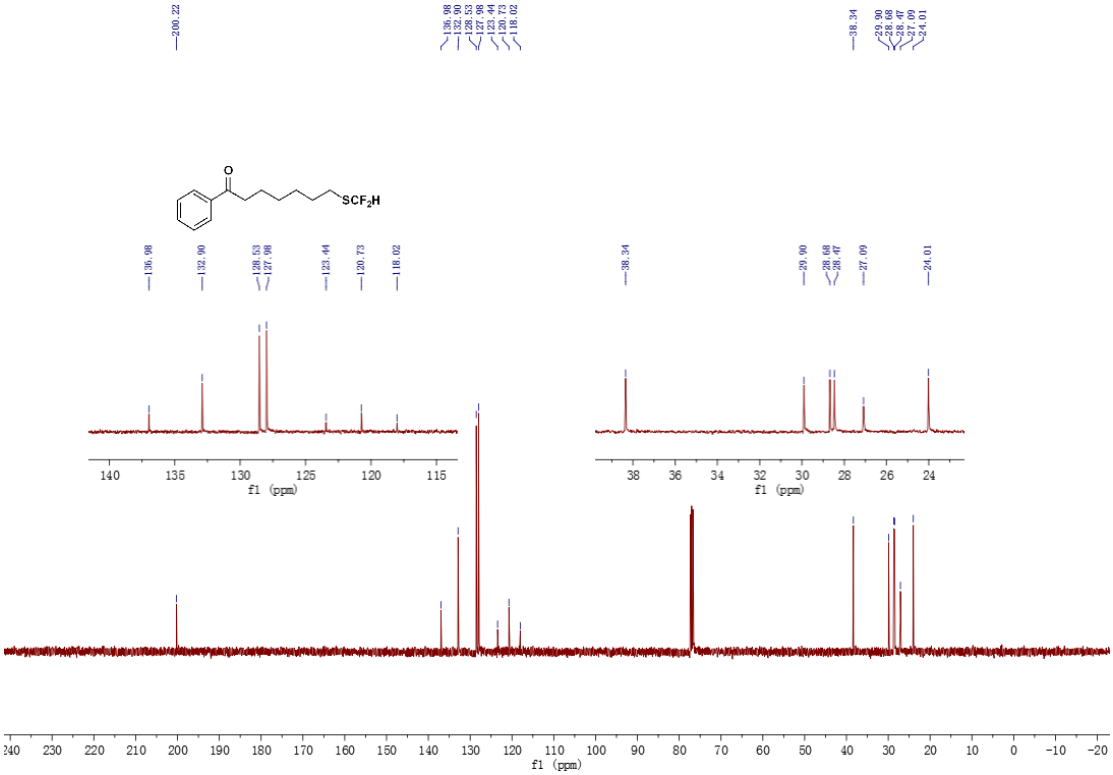
## $^{1}$H NMR spectrum of 7-((difluoromethyl)thio)-1-phenylheptan-1-one 4p



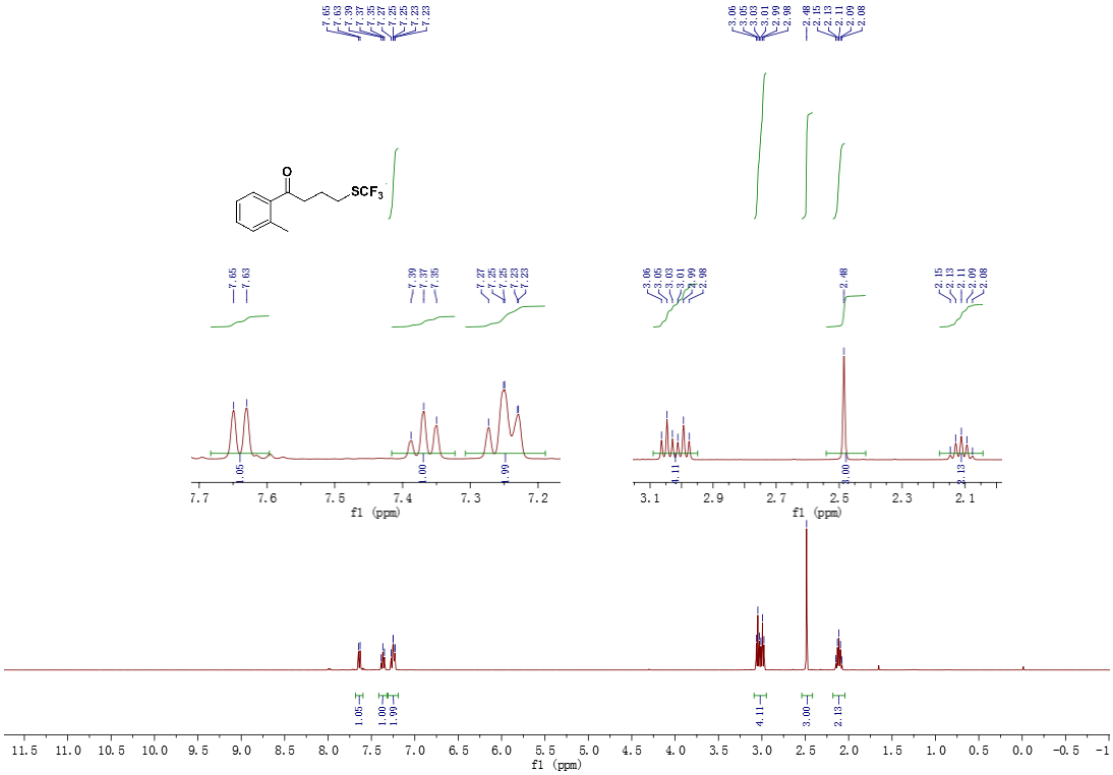

## $^{19}$F NMR spectrum of 7-((difluoromethyl)thio)-1-phenylheptan-1-one 4p



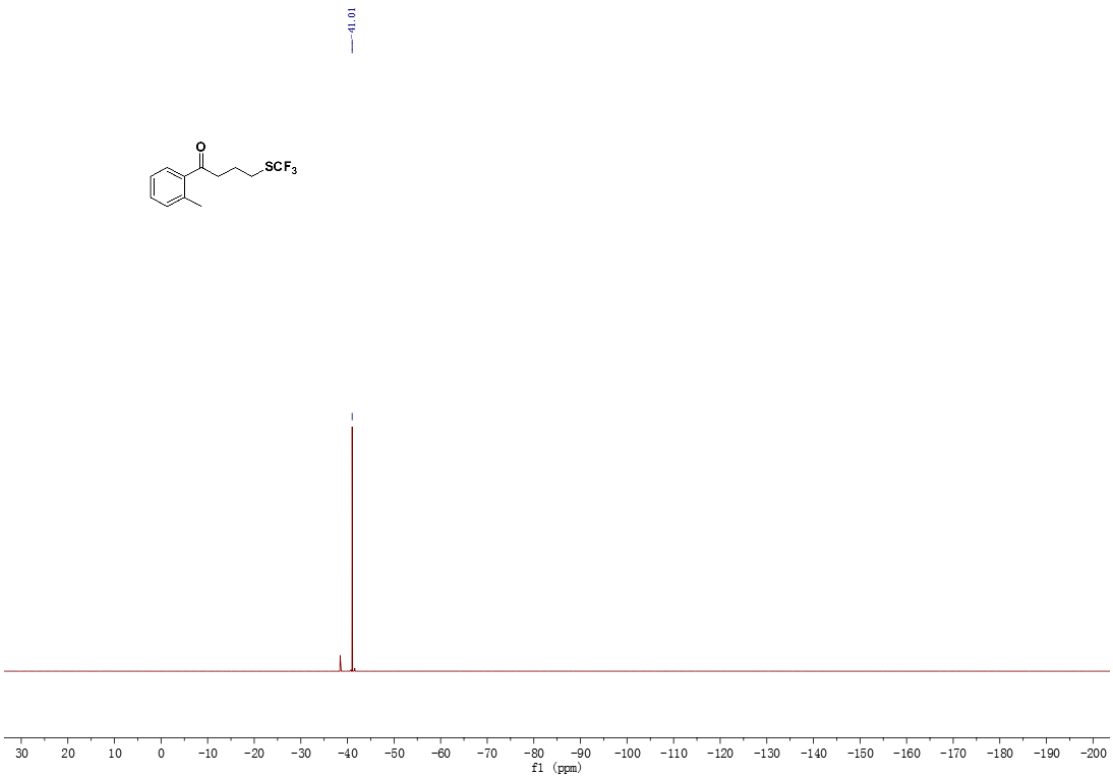
## $^{13}$C NMR spectrum of 7-((difluoromethyl)thio)-1-phenylheptan-1-one 4p



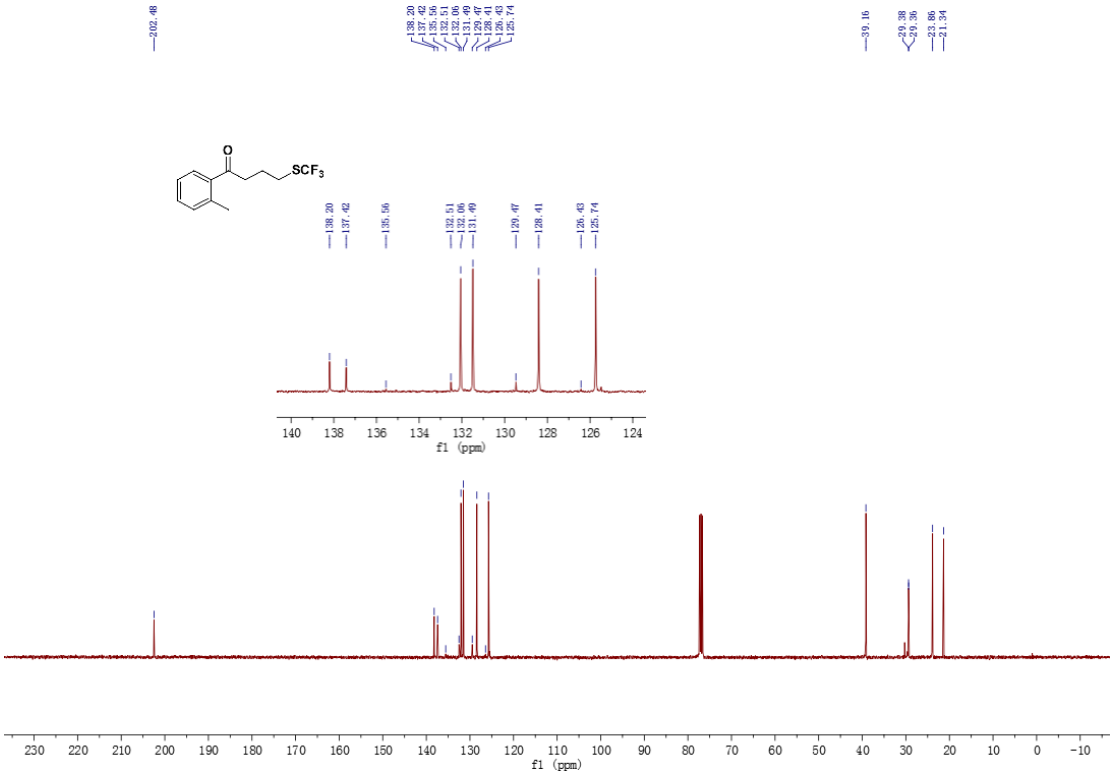

## $^{1}$H NMR spectrum of 1-(*o*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5a



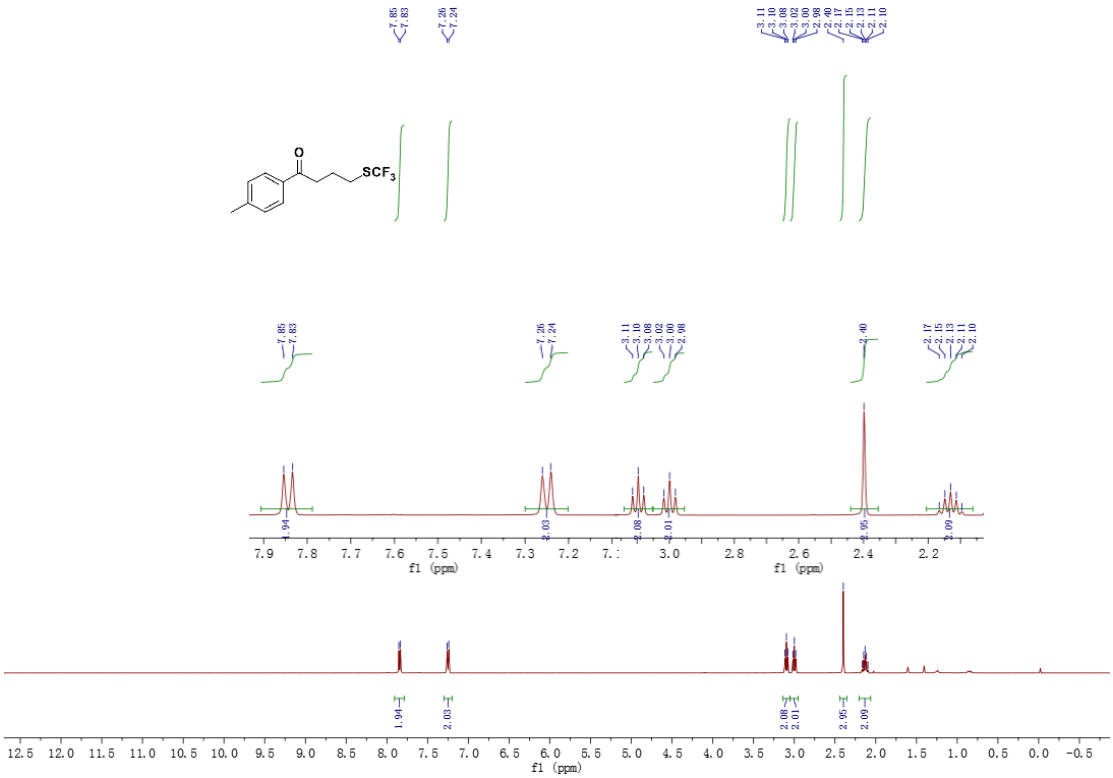
## $^{19}$F NMR spectrum of 1-(*o*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5a



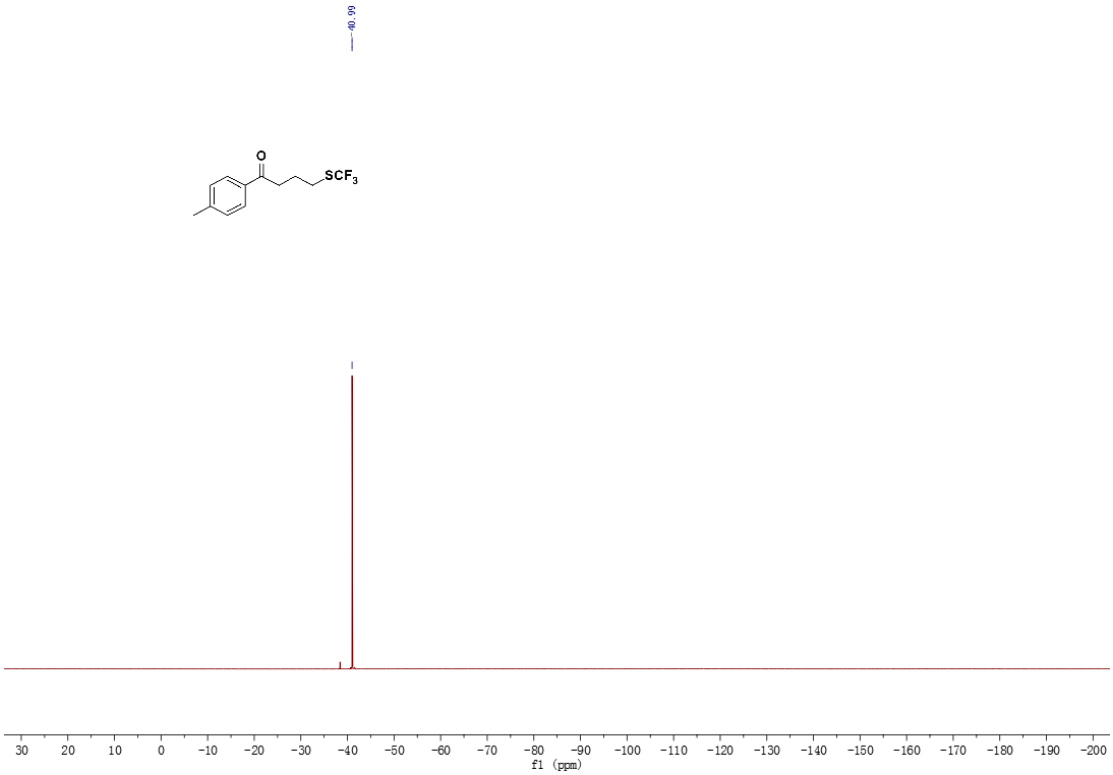

## $^{13}$C NMR spectrum of 1-(*o*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5a



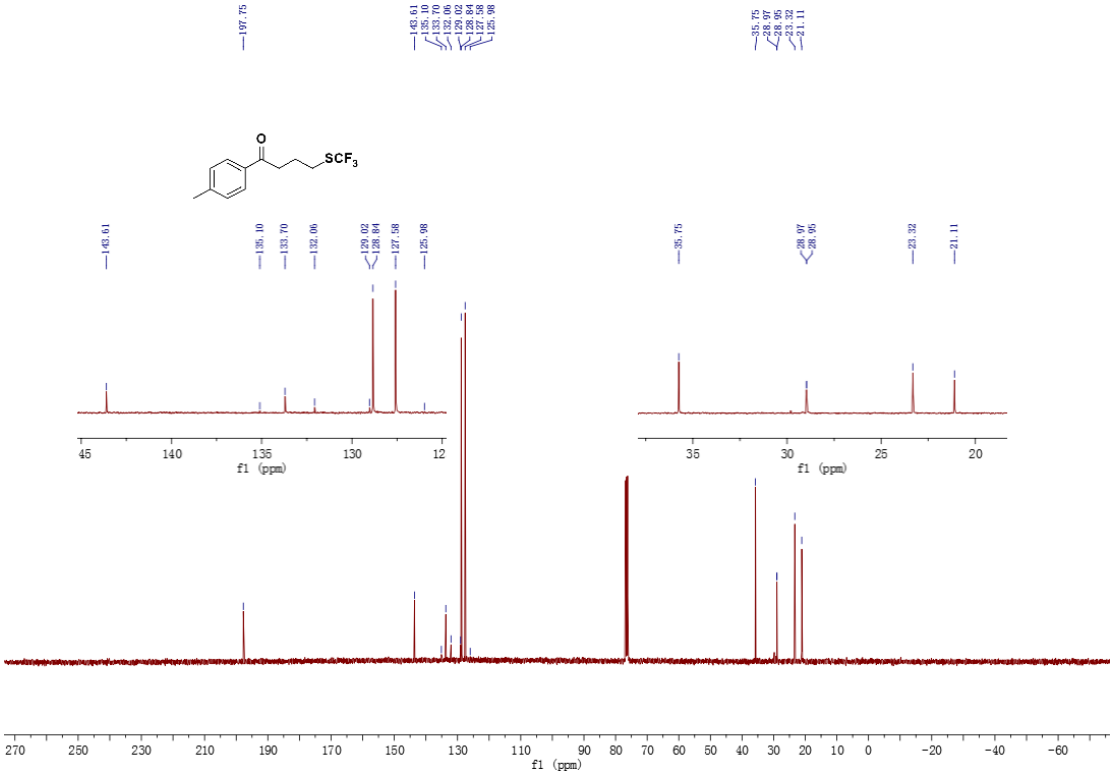
## $^{1}$H NMR spectrum of 1-(*p*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5b



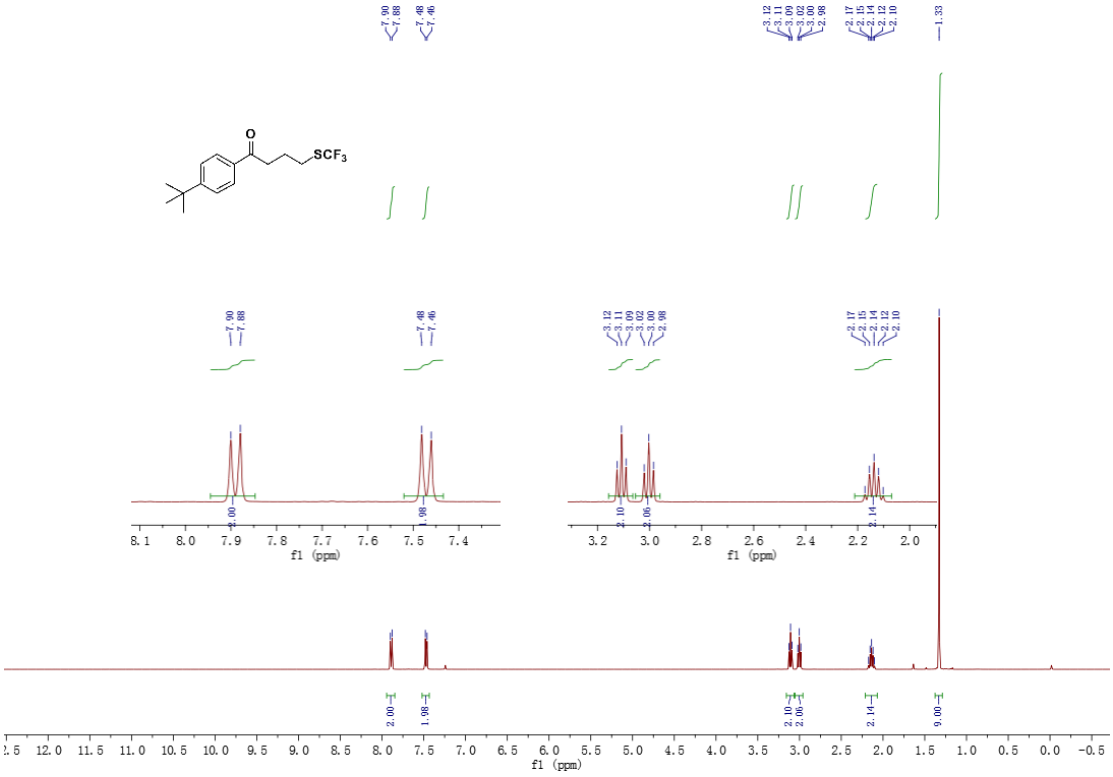

## $^{19}$F NMR spectrum of 1-(*p*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5b



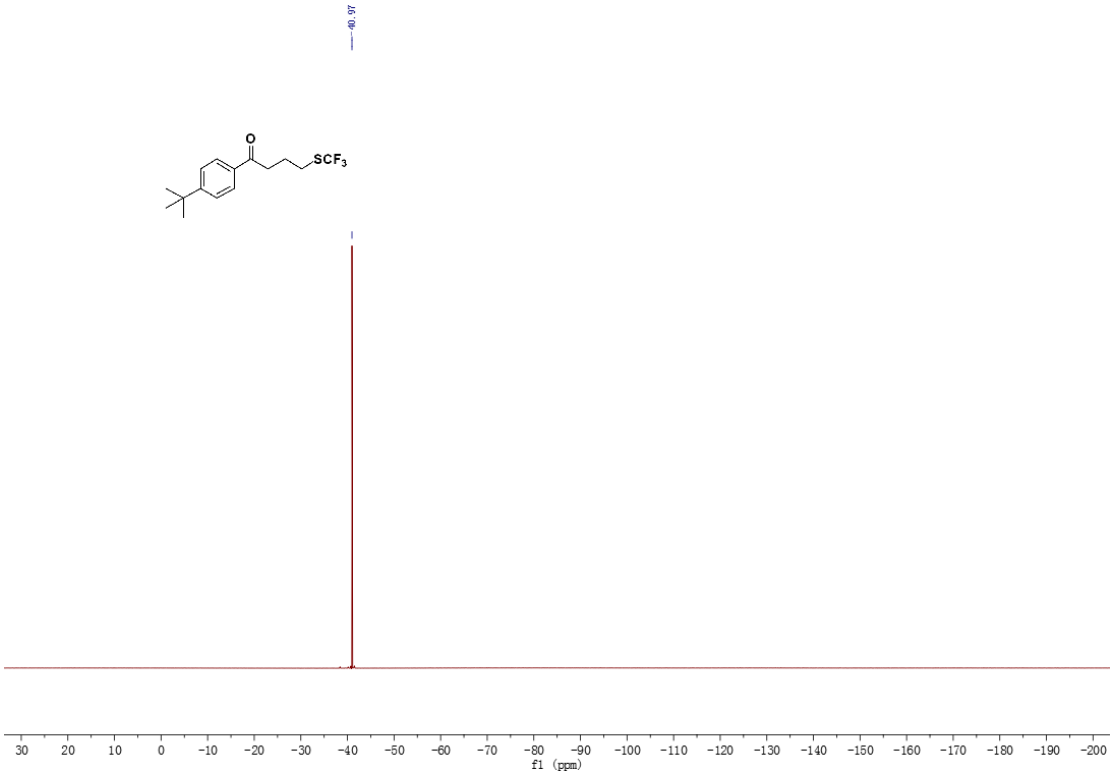
## $^{13}$C NMR spectrum of 1-(*p*-tolyl)-4-((trifluoromethyl)thio)butan-1-one 5b



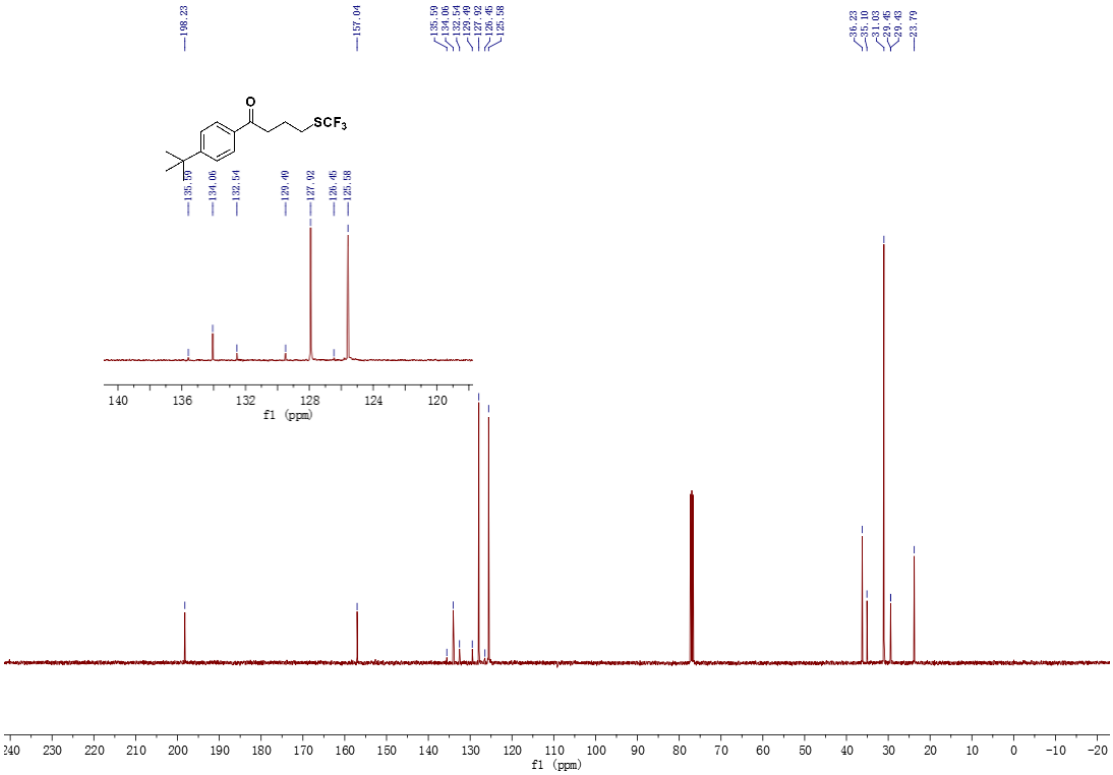

## $^{1}$H NMR spectrum of 1-(4-(*tert*-butyl)phenyl)-4-((trifluoromethyl)thio)butan-1-one 5c



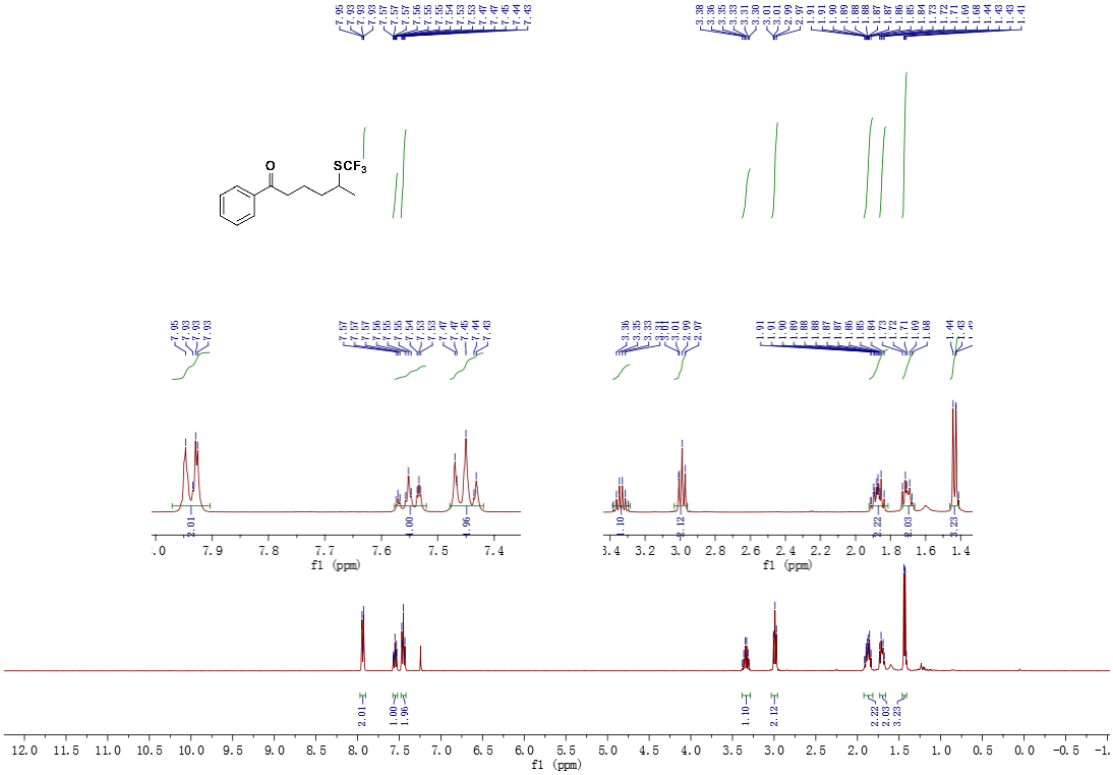
**$^{19}$F NMR spectrum of**
**1-(4-(*tert*-butyl)phenyl)-4-((trifluoromethyl)thio)butan-1-one 5c**



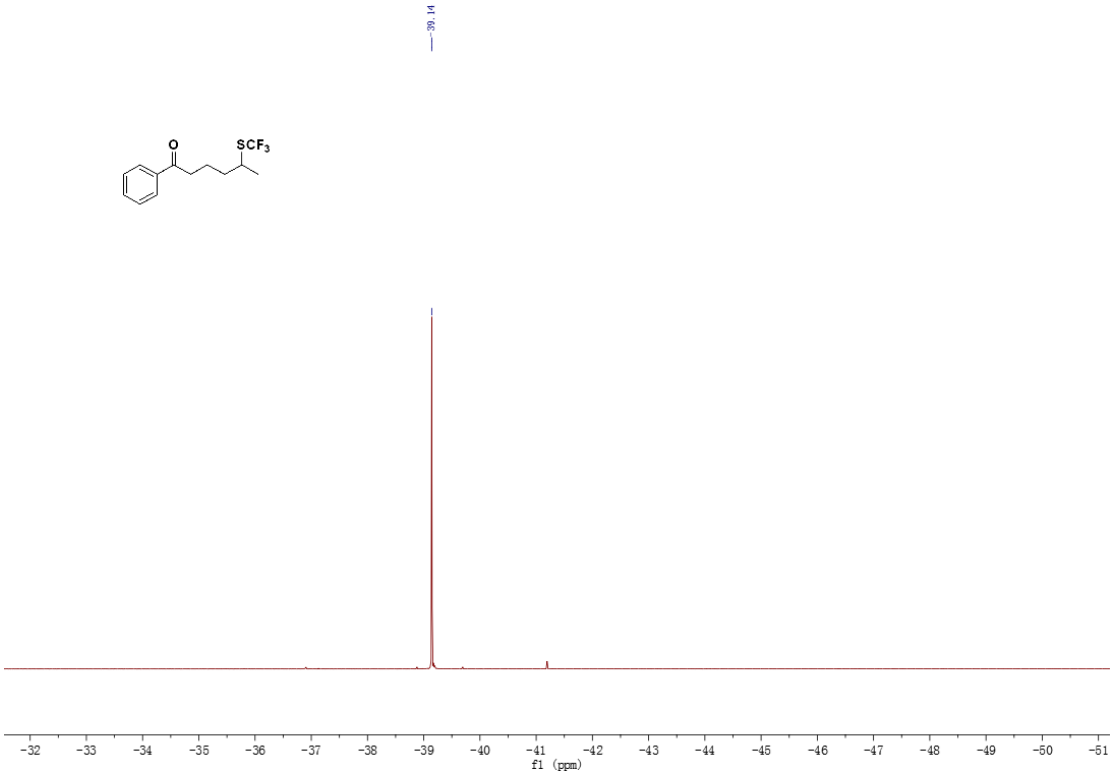

**$^{13}$C NMR spectrum of**
**1-(4-(*tert*-butyl)phenyl)-4-((trifluoromethyl)thio)butan-1-one 5c**



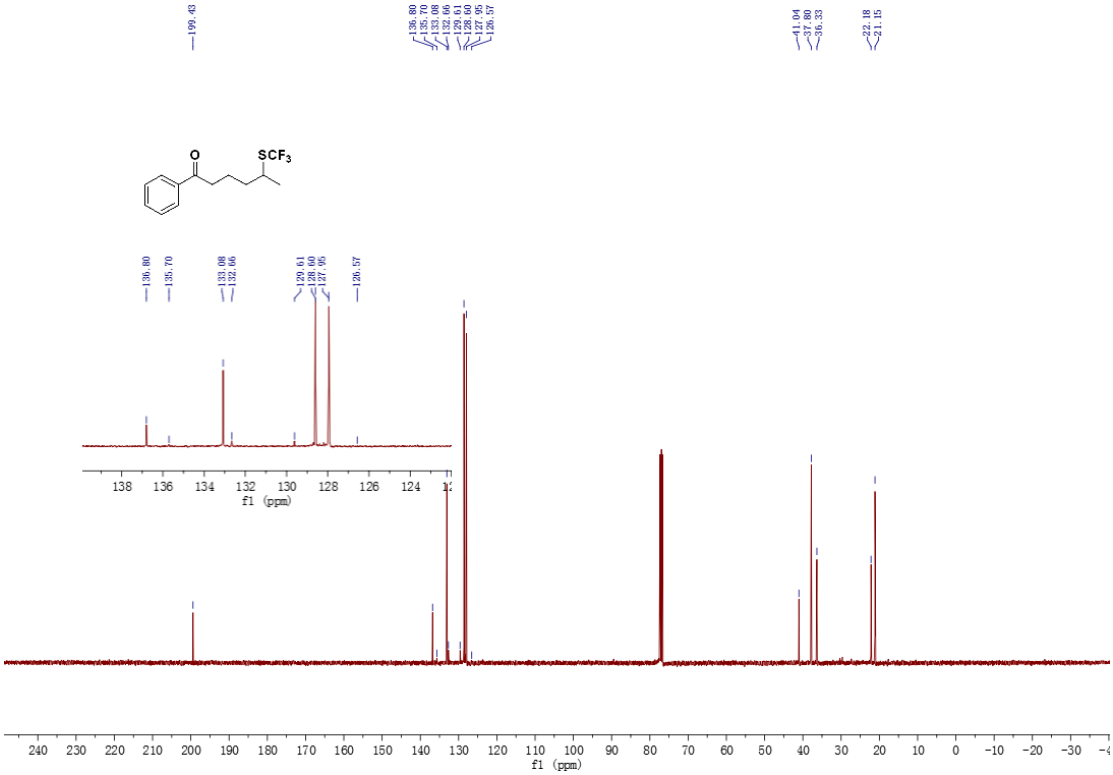
## $^{1}$H NMR spectrum of 1-phenyl-5-((trifluoromethyl)thio)hexan-1-one 5d



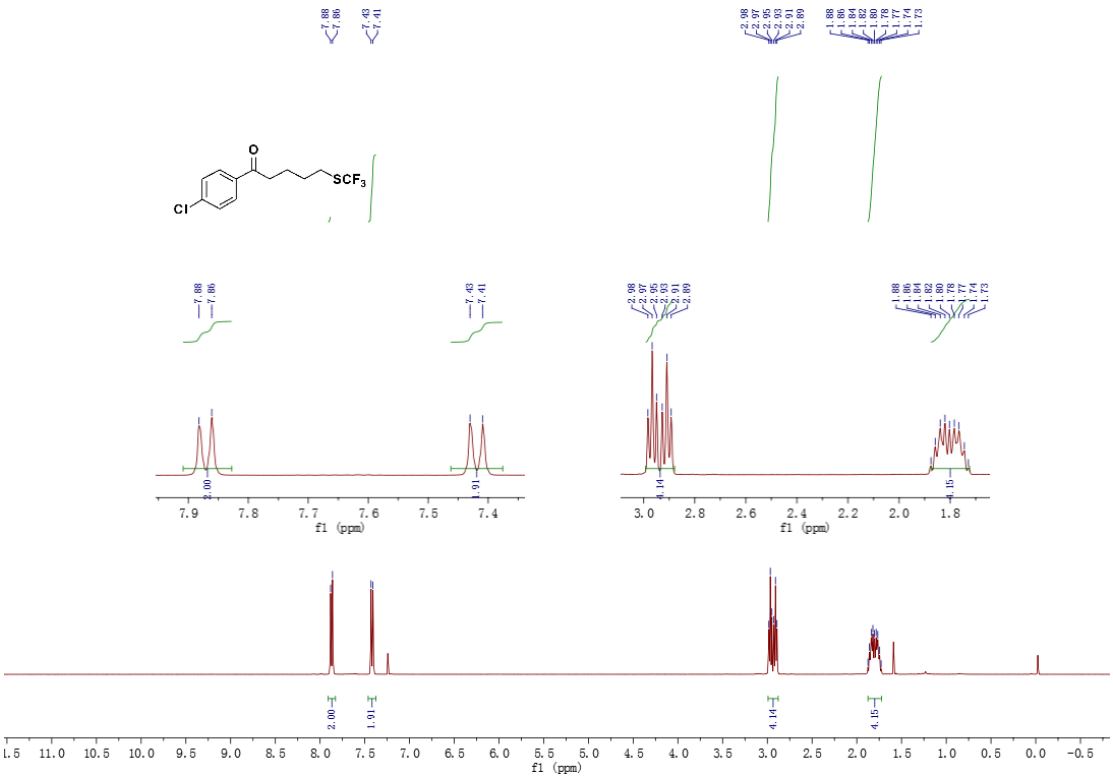

## $^{19}$F NMR spectrum of 1-phenyl-5-((trifluoromethyl)thio)hexan-1-one 5d



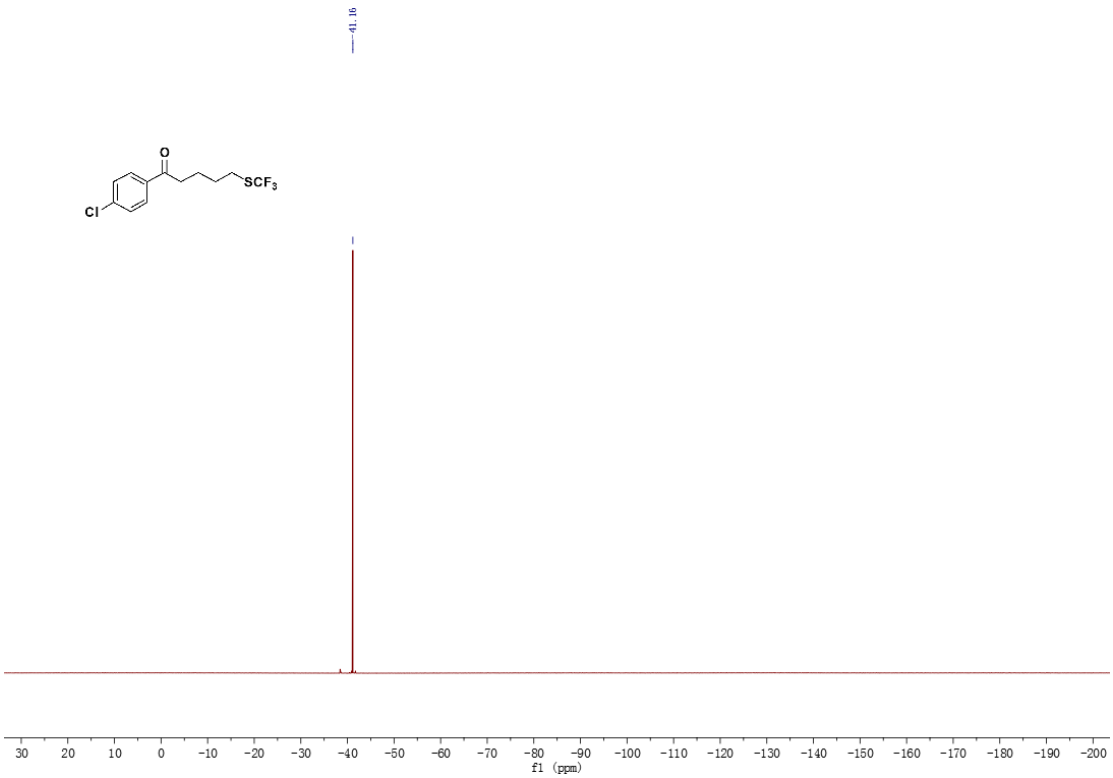
## $^{13}$C NMR spectrum of 1-phenyl-5-((trifluoromethyl)thio)hexan-1-one 5d



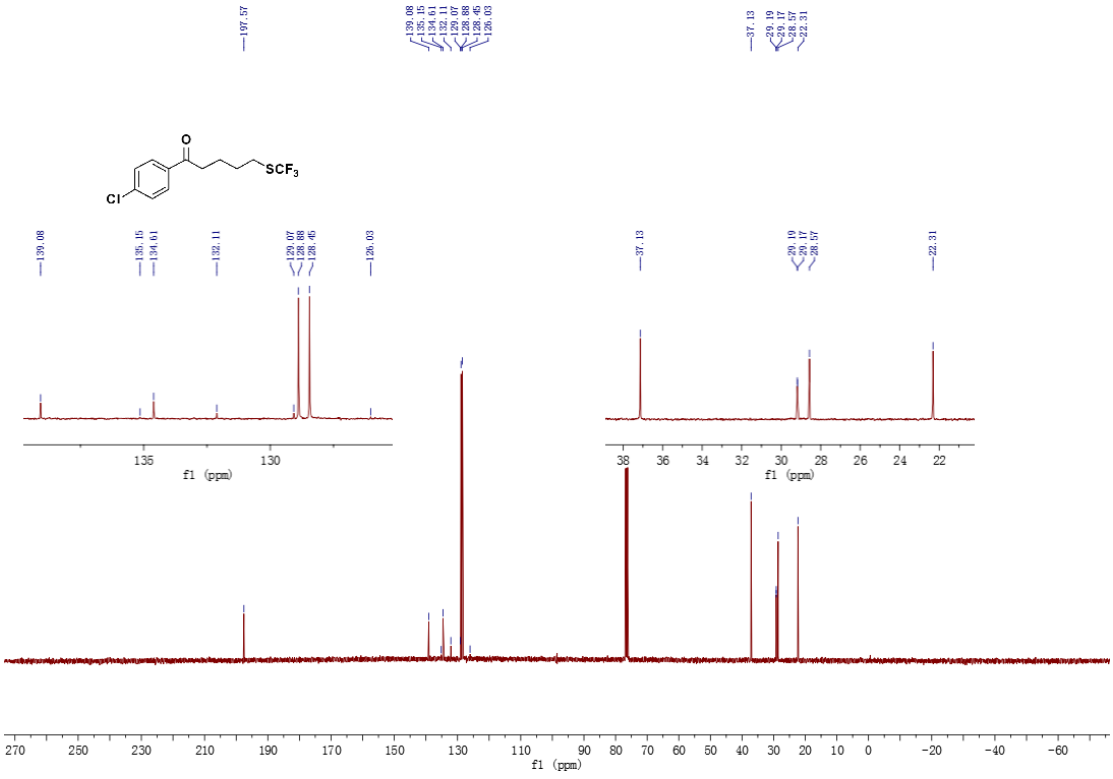
## $^{1}$H NMR spectrum of 1-(4-chlorophenyl)-5-((trifluoromethyl)thio)pentan-1-one 5e



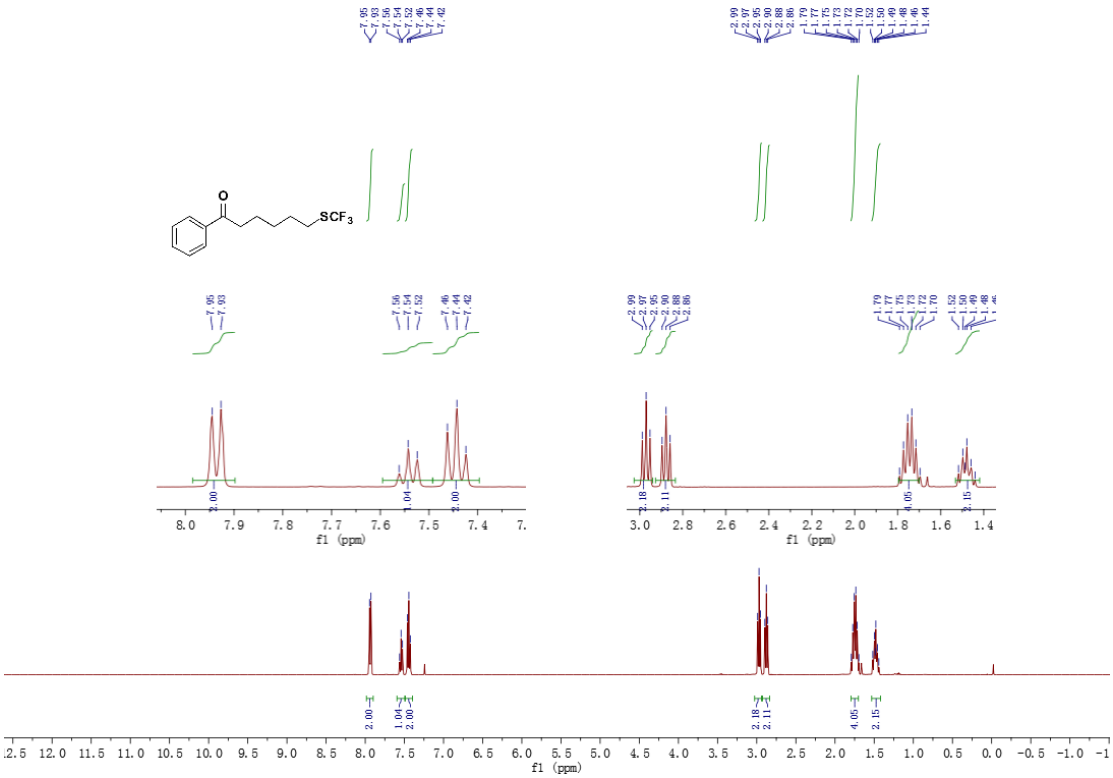
## $^{19}$F NMR spectrum of 1-(4-chlorophenyl)-5-((trifluoromethyl)thio)pentan-1-one 5e



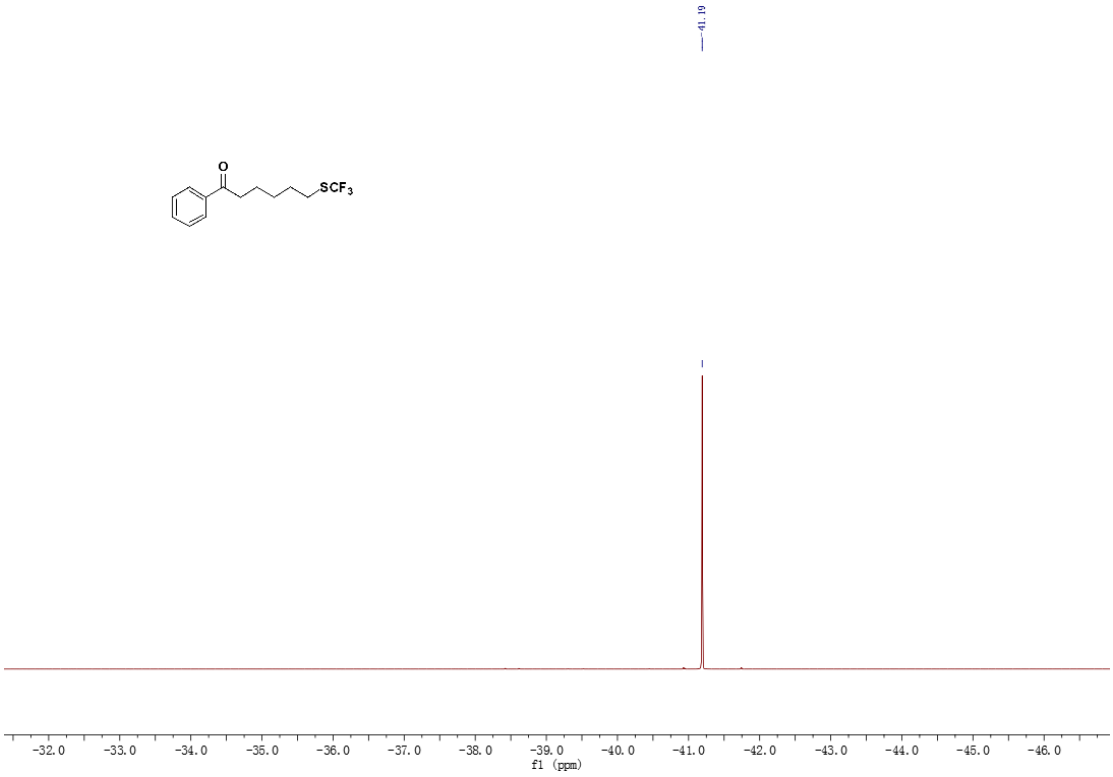

## $^{13}$C NMR spectrum of 1-(4-chlorophenyl)-5-((trifluoromethyl)thio)pentan-1-one 5e



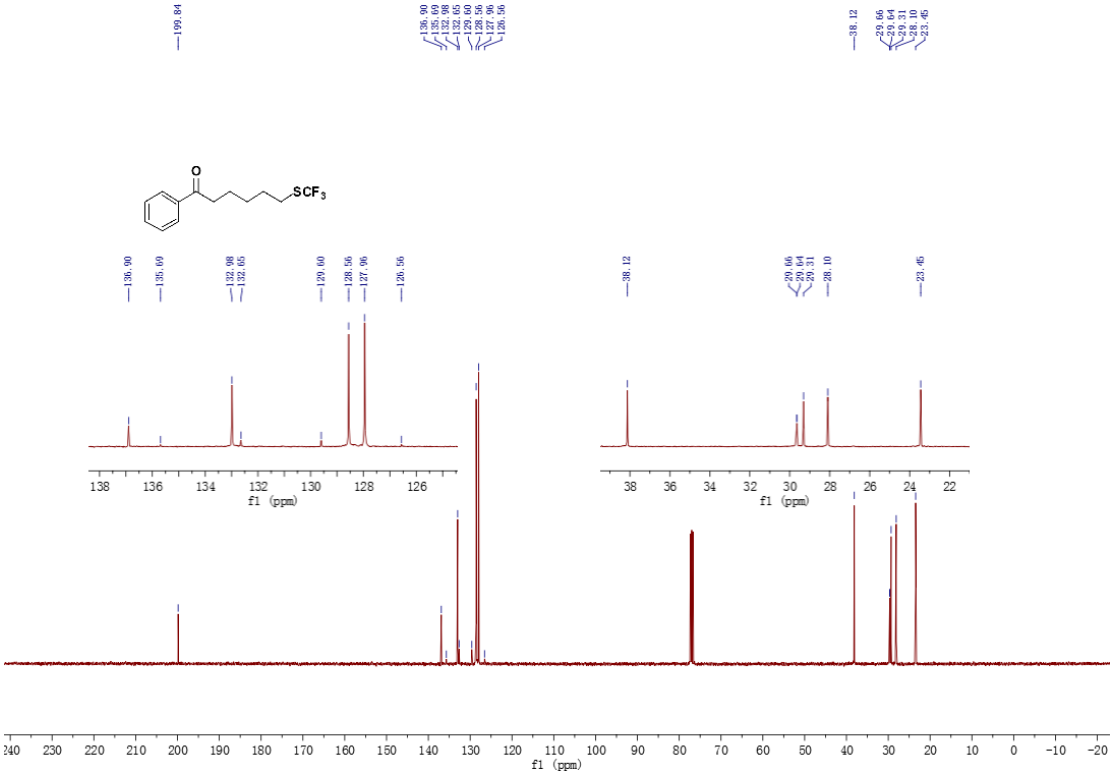
## $^{1}$H NMR spectrum of 1-phenyl-6-((trifluoromethyl)thio)hexan-1-one 5f



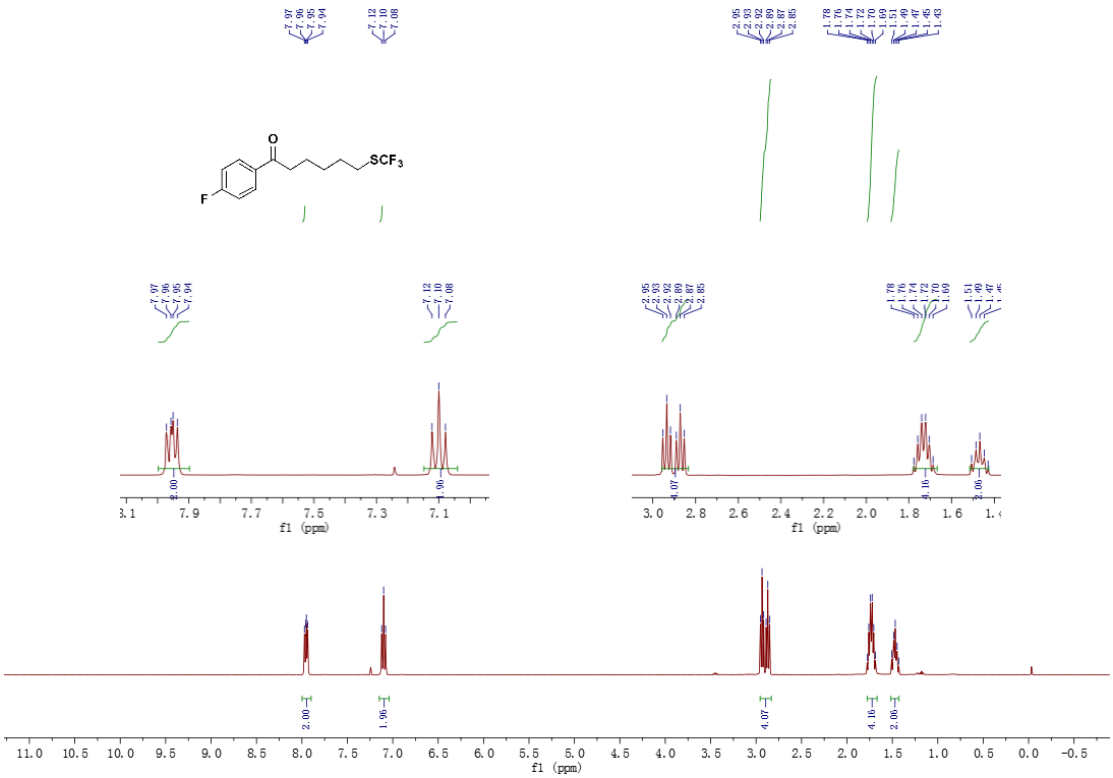

## $^{19}$F NMR spectrum of 1-phenyl-6-((trifluoromethyl)thio)hexan-1-one 5f



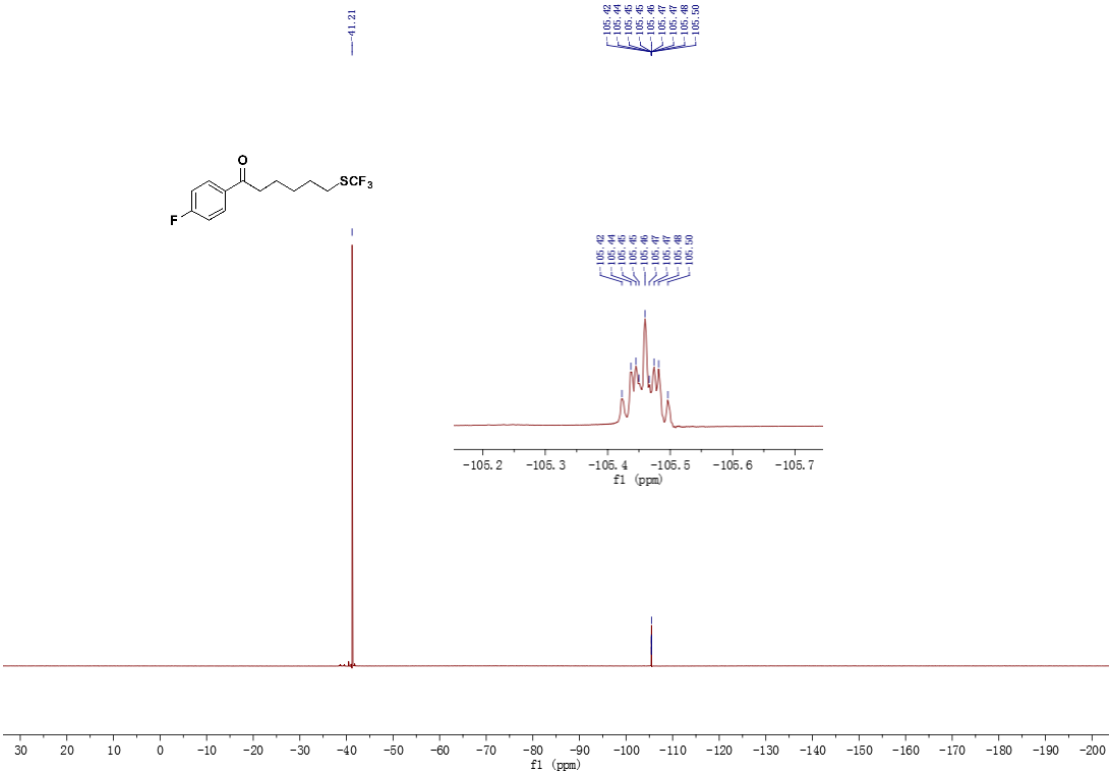
## $^{13}$C NMR spectrum of 1-phenyl-6-((trifluoromethyl)thio)hexan-1-one 5f



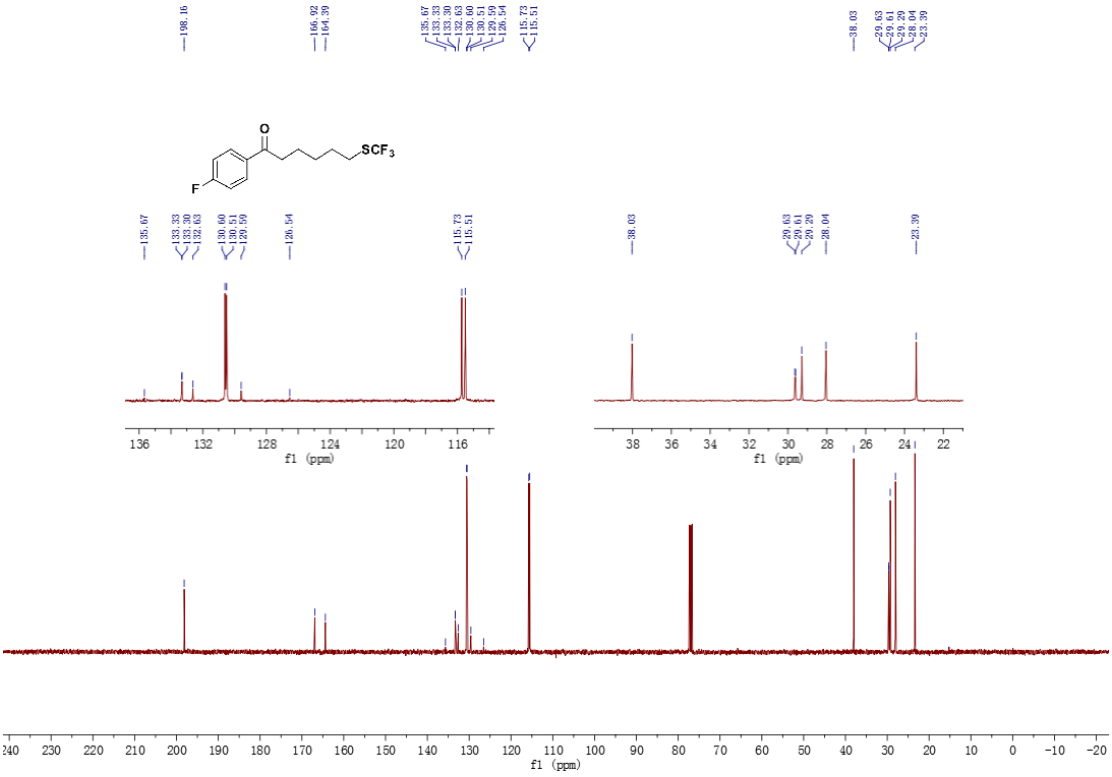
## $^{1}$H NMR spectrum of 1-(4-fluorophenyl)-6-((trifluoromethyl)thio)hexan-1-one 5g



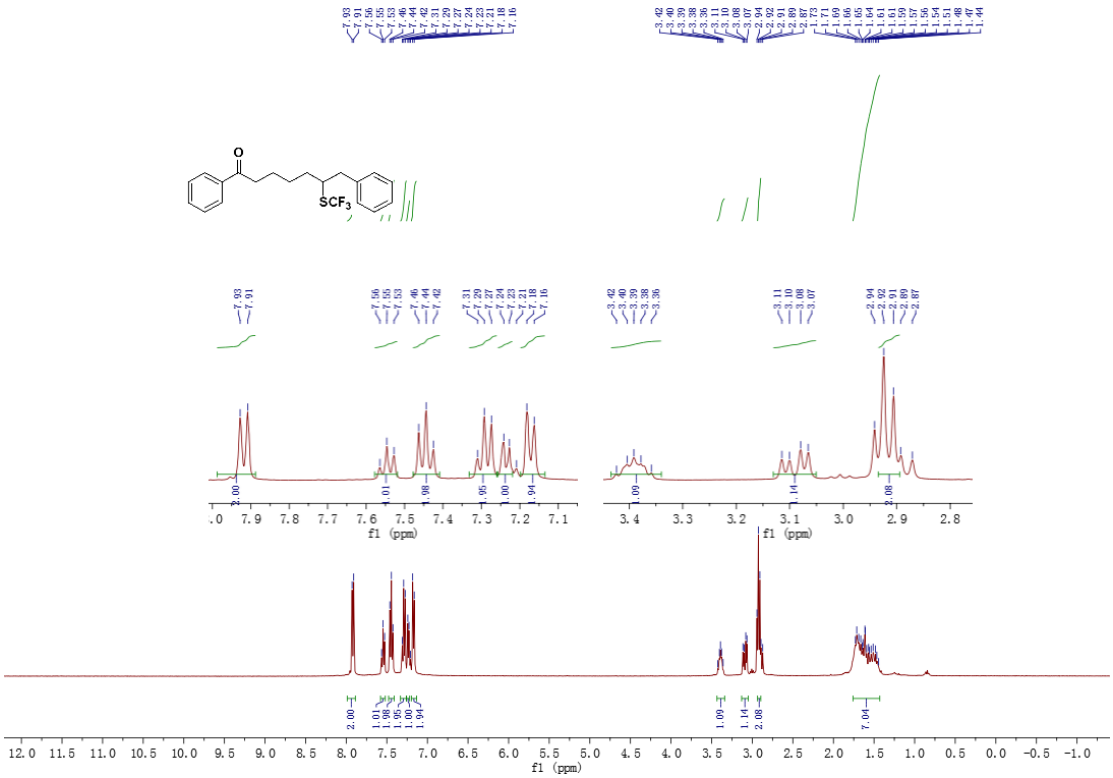
## $^{19}$F NMR spectrum of 1-(4-fluorophenyl)-6-((trifluoromethyl)thio)hexan-1-one 5g



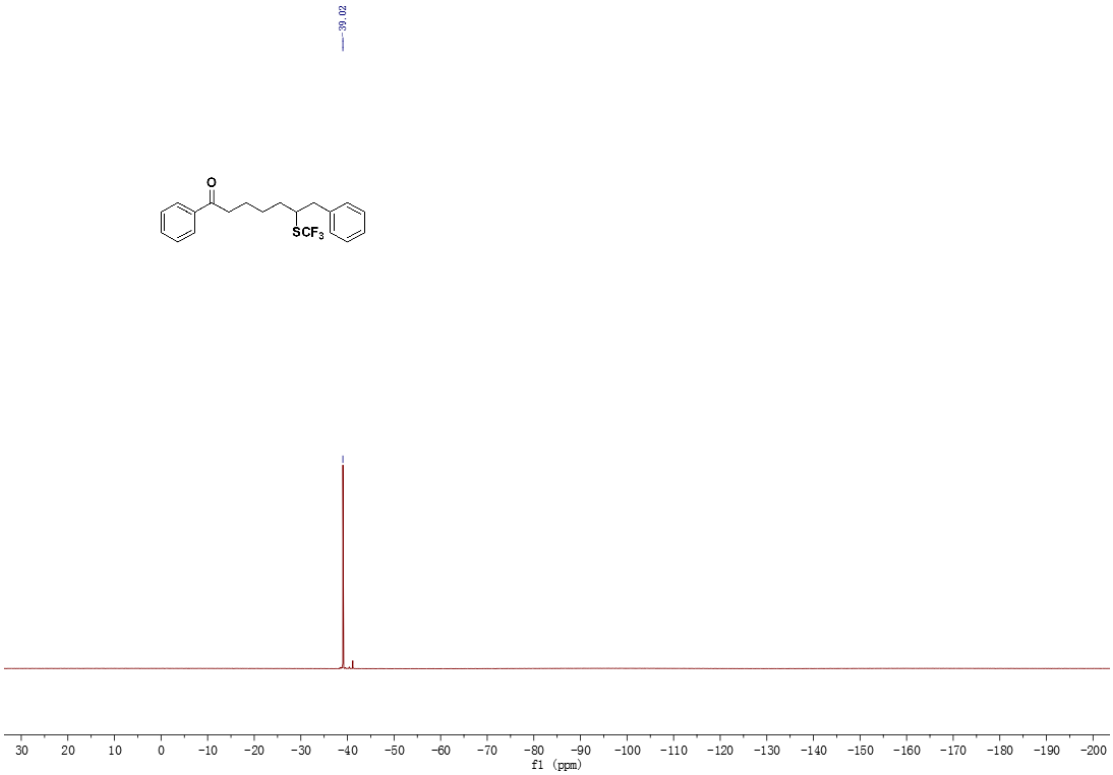

## $^{13}$C NMR spectrum of 1-(4-fluorophenyl)-6-((trifluoromethyl)thio)hexan-1-one 5g



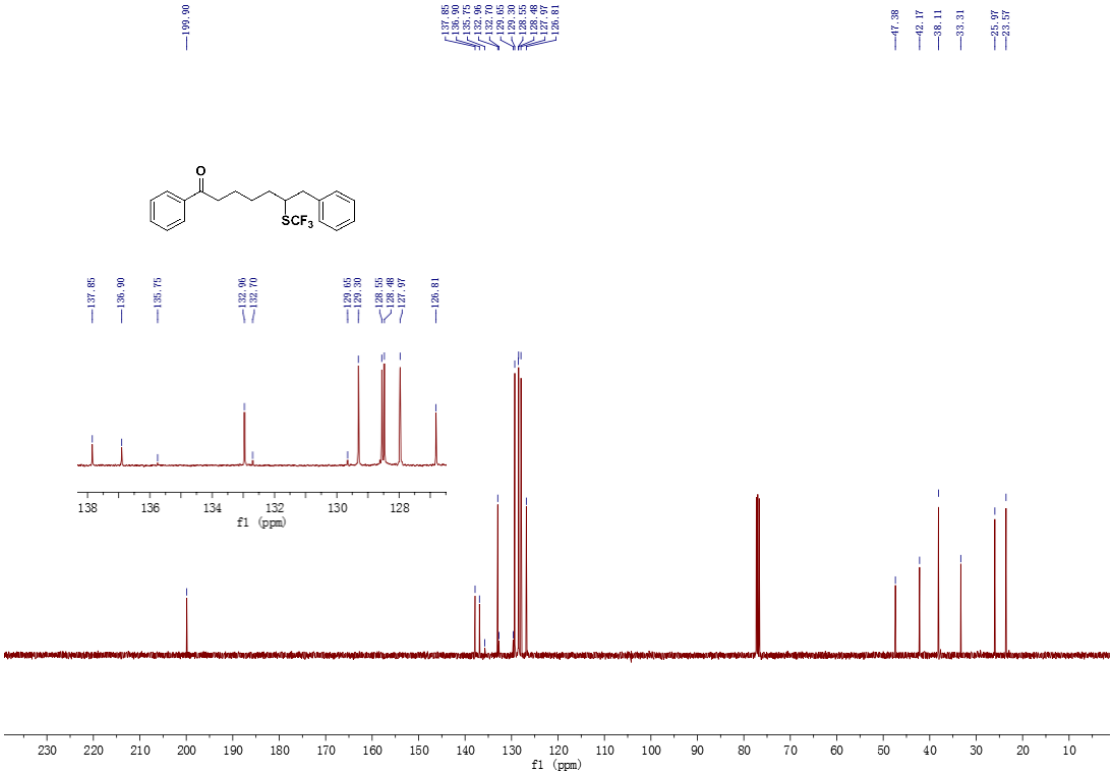
## $^{1}$H NMR spectrum of 1,7-diphenyl-6-((trifluoromethyl)thio)heptan-1-one 5h



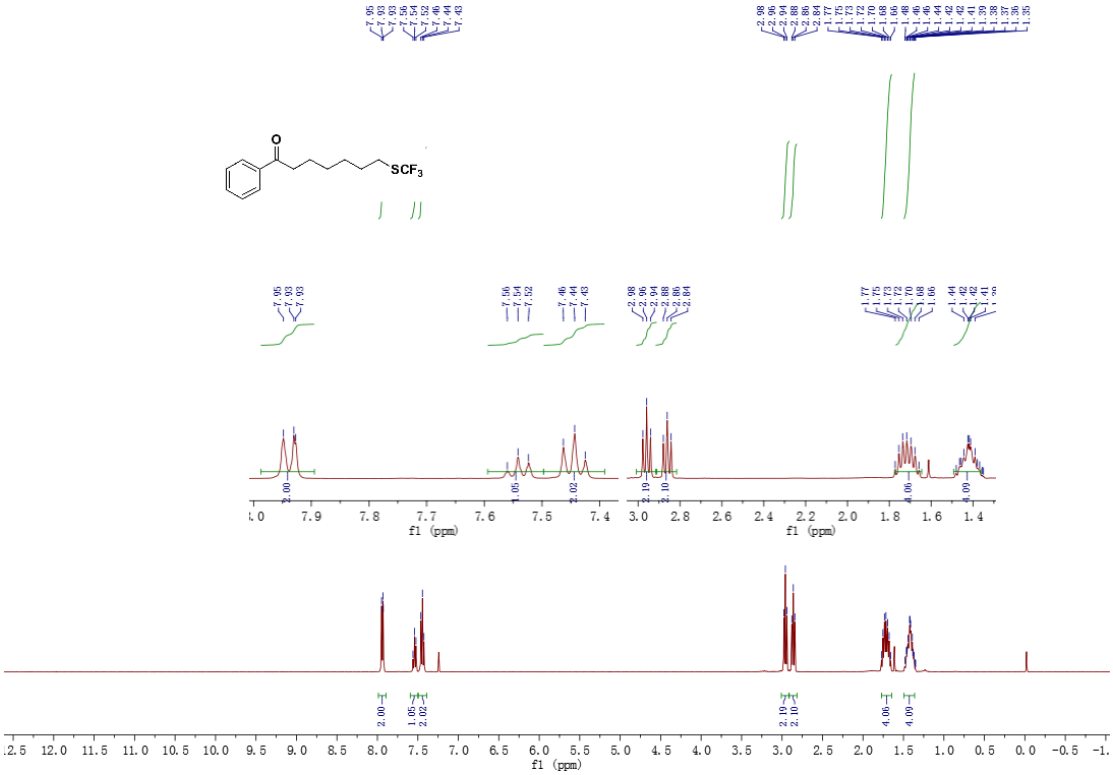

## $^{19}$F NMR spectrum of 1,7-diphenyl-6-((trifluoromethyl)thio)heptan-1-one 5h



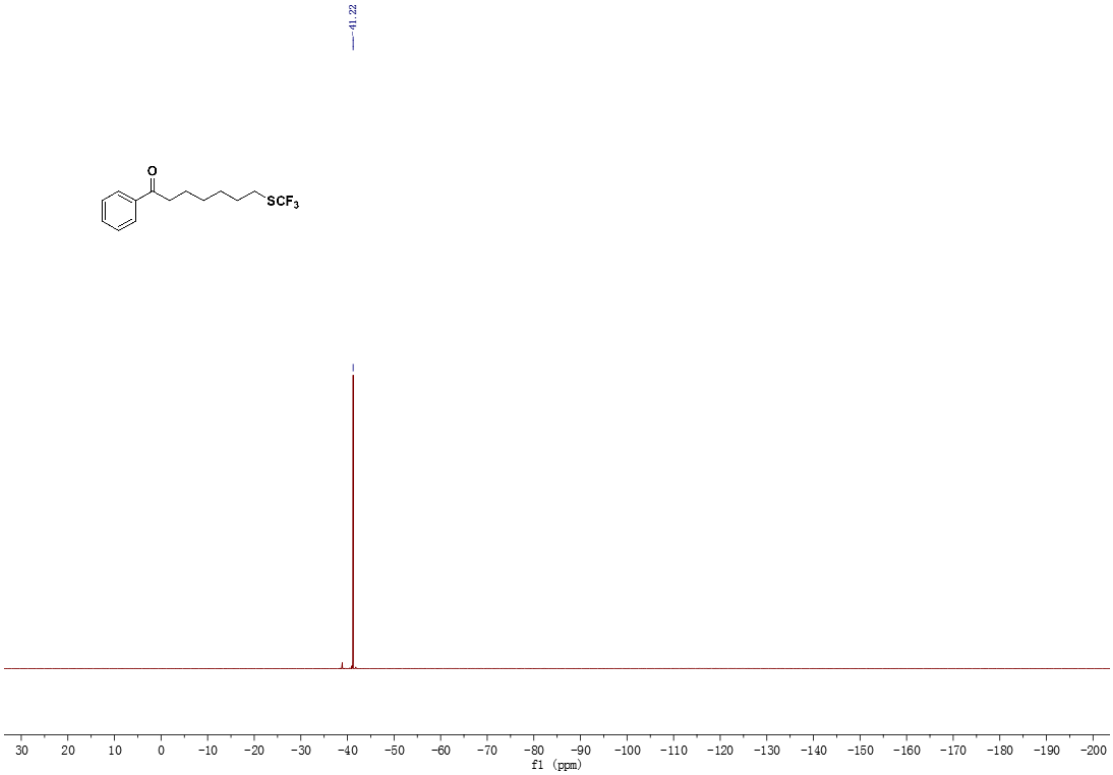
## $^{13}$C NMR spectrum of 1,7-diphenyl-6-((trifluoromethyl)thio)heptan-1-one 5h



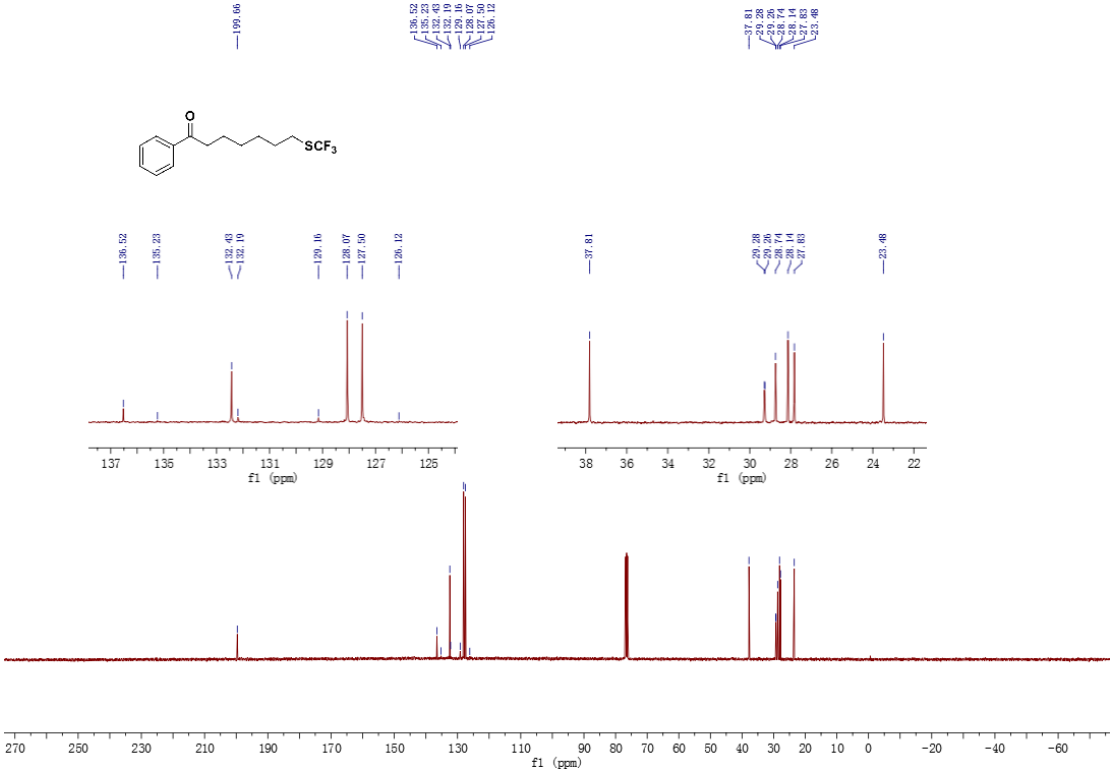

## $^{1}$H NMR spectrum of 1-phenyl-7-((trifluoromethyl)thio)heptan-1-one 5i



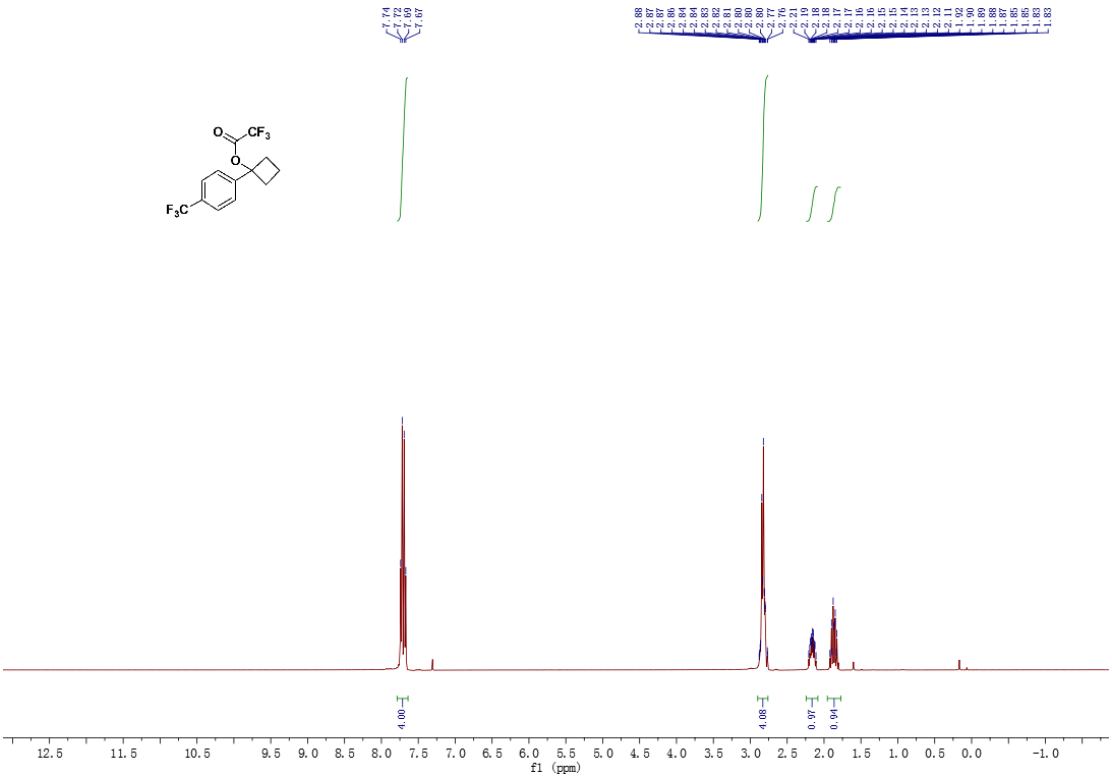
## $^{19}$F NMR spectrum of 1-phenyl-7-((trifluoromethyl)thio)heptan-1-one 5i



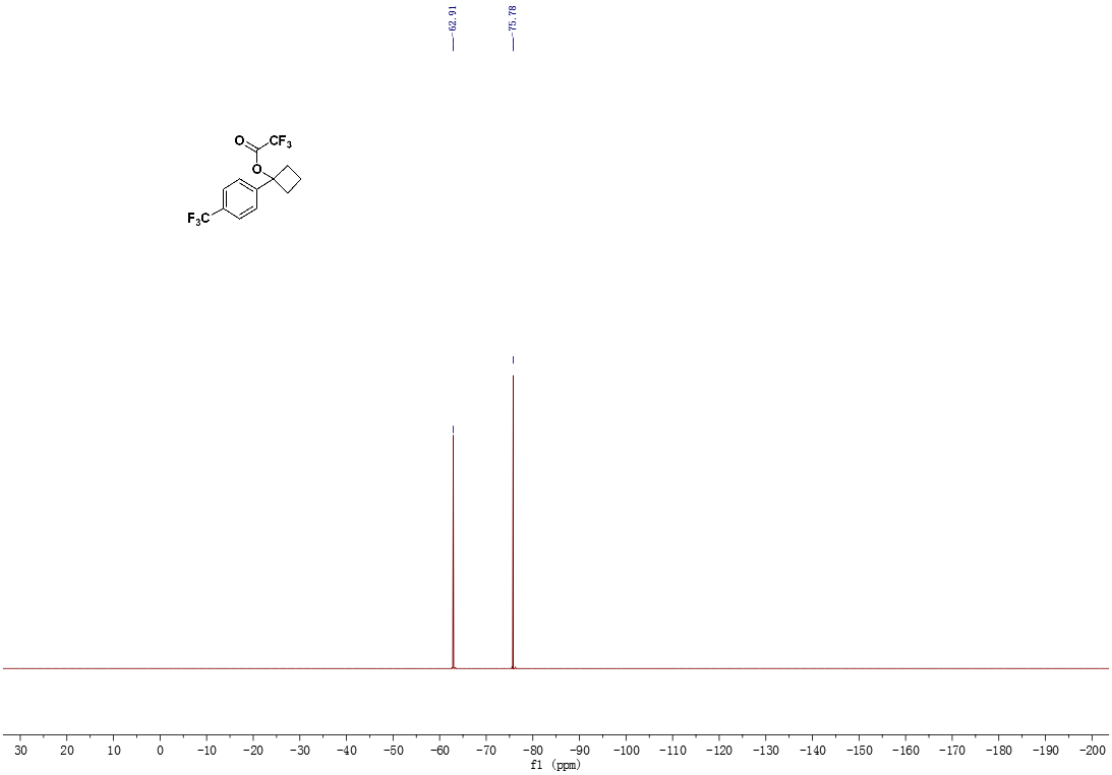

## $^{13}$C NMR spectrum of 1-phenyl-7-((trifluoromethyl)thio)heptan-1-one 5i



## $^{1}$H NMR spectrum of 1-(4-(trifluoromethyl)phenyl)cyclobutyl 2,2,2-trifluoroacetate




## $^{19}$F NMR spectrum of 1-(4-(trifluoromethyl)phenyl)cyclobutyl 2,2,2-trifluoroacetate



**$^{13}$C NMR spectrum of**
**1-(4-(trifluoromethyl)phenyl)cyclobutyl 2,2,2-trifluoroacetate**