Supporting information for

Synthesis of novel homochiral sulfanyl- and sulfoxide-substituted naphthyltriazoles and study of the conformational stability

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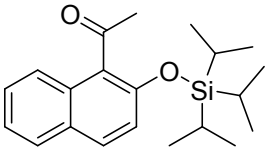
1 General experimental information

Chemicals received from commercial sources (Sigma Aldrich, Acros Organics, J&K Scientific, Alfa Aesar, Fluorochem, or TCI Chemicals) were used without further purification. 4-Nitrophenyl azide was prepared according to known literature procedure. All triazolization reactions were performed in oven-dried glassware, but no special precautions were taken for the exclusion of moisture. All reactions were carried out under argon atmosphere. Dry reaction solvents (toluene and THF) were purchased from commercial sources. Thin-layer chromatography (TLC) was performed on silica gel 0.20 mm 60 with fluorescent indicator UV254 (pre-coated aluminum sheets) from Merck. For column chromatography 60-200 mesh silica gel 60 (Acros) was used as stationary phase. NMR spectra were acquired on commercial instruments (Bruker Avance 300 MHz, Bruker AMX 400 MHz or Bruker Avance II^{+} 600 MHz) and chemical shifts (δ) are reported in parts per million (ppm) referenced to tetramethylsilane (^{1}H), or the internal (NMR) solvent signal (^{13}C). High resolution mass spectra were acquired on a quadrupole orthogonal acceleration time-of-flight mass spectrometer (Synapt G2 HDMS, Waters, Milford, MA, USA). Samples were infused at 3μL/min and spectra were obtained in positive mode with a resolution of 15 000 (FWHM) using leucine enkephalin as lock mass. Melting points (uncorrected) were determined using a Reichert Thermovar apparatus. Theoretical calculations were performed using the Gaussian 09 rev E.01 software. The structure of local minimum (ground state) and transition states were optimized at B3LYP/6-311+G* level. In all cases, the effect of the solvent (DMSO) was assessed using the Tomasi's polarized continuum model (PCM). The characterization of these stationary points (local minimums and transition states) was performed by Hessian matrix calculation, obtaining positives eigenvalues for the local minimums and one negative eigenvalue for each transition state. The energy values presented in the results section derived from the thermal enthalpies and thermal Gibbs free energies calculated at 423 K and 1 atm.

2 Experimental procedures toward sulfanyl-substituted naphthyl ketones

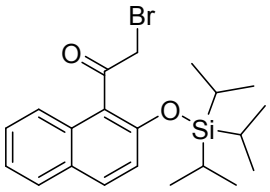
1-(2-((Triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one (2)



2′-Hydroxy-1′-acetonaphthone **1** (10.00 g, 0.05370 mol), triisopropylsilyl chloride (13.79 mL, 0.06444 mol), and 4-dimethylaminopyridine (1.312 g, 0.01074 mol) were dissolved in CH_2Cl_2 (200 mL). Diisopropylamine (16.57 mL, 0.1181 mol) was added over five minutes, and the reaction mixture was stirred under inert atmosphere at room temperature until full conversion. The organic layer was washed with water and brine, dried over Na_2SO_4, concentrated under reduced pressure, and purified *via* flash chromatography to yield **2** (18.30 g, 0.05342 mmol) as a light-yellow oil in quantitative yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.79 – 7.66 (m, 3H), 7.45 (ddd, J = 8.4, 6.9, 1.3 Hz, 1H), 7.35 (ddd, J = 8.0, 7.0, 1.1 Hz, 1H), 7.08 (d, J = 9.0 Hz, 1H), 2.66 (s, 3H), 1.40 – 1.22 (m, 3H), 1.15 – 1.09 (m, 18H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 204.98, 150.30, 130.91, 130.66, 129.17, 128.20, 127.73, 127.49, 124.21, 123.85, 120.19, 32.84, 18.12, 13.44. HRMS (ESI$^+$) m/z calcd for $C_{21}H_{30}O_2Si$ $[M+H]^+$ 343.2088, found 343.2081.

2-Bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one (3)



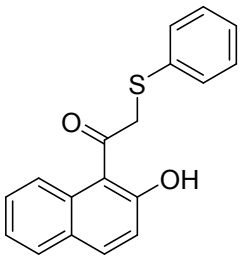
1-(2-((Triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one **2** (18.30 g, 0.05342 mmol) was dissolved in THF (175 mL). Trimethylphenylammonium tribromide (20.08 g, 0.05342 mmol) was added in small portions over one hour. After two hours and the full disappearance of the yellow color, THF was evaporated and the residue was partitioned between a saturated $Na_2S_2O_3$ solution and CH_2Cl_2. The aqueous layer was back-extracted twice with CH_2Cl_2, all organic layers were collected, dried over $MgSO_4$, filtered, and evaporated under reduced pressure. The crude product was purified *via* silica gel column chromatography using dichloromethane/petroleum ether (20/80) as the eluent affording **3** as a white solid in 65% yield (14.63 g, 0.03472 mmol).

Mp: 31-33 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.80 (t, J = 8.9 Hz, 2H), 7.68 (d, J = 8.5 Hz, 1H), 7.49 (dd, J = 11.3, 4.0 Hz, 1H), 7.38 (dd, J = 8.0, 7.0 Hz, 1H), 7.09 (d, J = 9.0 Hz, 1H), 4.56 (s, 2H), 1.43 – 1.25 (m, 3H), 1.12 (d, J = 7.4 Hz, 18H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 196.77, 151.46, 132.06, 131.80, 129.16, 128.21, 128.04, 124.64, 124.03, 123.82, 119.85, 37.19, 18.11, 13.47. HRMS (ESI^+) m/z calcd for $C_{21}H_{29}BrO_2Si$ $[M+H]^+$ 421.1193, found 421.1193.

General procedure A for the substitution of 3 with thiols and one-pot deprotection:

To an oven-dried reaction tube equipped with a magnetic stirring bar, thiol (1.2 equiv) and cesium carbonate (1.2 equiv) were mixed in dry DMF (5 mL) under inert atmosphere. To the resulting suspension, a solution of 2-bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one (1 equiv) **3** in DMF (5 mL) was added at room temperature. After full conversion, as indicated by TLC, tetra-n-butylammonium fluoride monohydrate was added (1 equiv) and stirred for an additional 30 minutes. The reaction mixture was partitioned between EtOAc and water, and subsequently the organic layer was washed four more times with brine. The organic layer was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The crude product was purified *via* silica gel column chromatography using ethyl acetate/petroleum ether (5/95) as the eluent affording **4**.

1-(2-Hydroxynaphthalen-1-yl)-2-(phenylthio)ethan-1-one (4a)

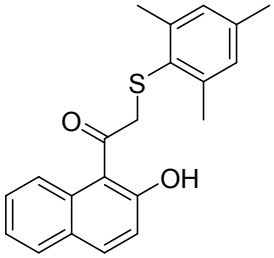


1-(2-Hydroxynaphthalen-1-yl)-2-(phenylthio)ethan-1-one **4a** was prepared according to general procedure A by making use of 2-bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one **3** (1.893 g, 4.491 mmol), thiophenol (0.550 mL, 5.389 mmol), cesium carbonate (1.756 g, 5.389 mmol), and TBAF hydrate (1.255 g, 4.491 mmol). A yellow solid was obtained in 93% yield (1.229 g, 4.177 mmol).

Mp: 158-160 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 12.33 (s, 1H), 7.97 (d, J = 8.5 Hz, 1H), 7.87 (d, J = 9.0 Hz, 1H), 7.77 (dd, J = 8.0, 1.3 Hz, 1H), 7.57 – 7.50 (m, 1H), 7.42 – 7.34 (m, 3H), 7.29 – 7.18 (m, 3H), 7.11 (d, J = 9.0 Hz, 1H), 4.48 (s, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ

(ppm) 201.10, 163.27, 137.66, 134.67, 131.44, 130.95, 129.67, 129.18, 128.67, 128.56, 127.41, 124.52, 124.24, 119.70, 114.90, 45.73. HRMS (ESI$^+$) m/z calcd for $C_{18}H_{14}O_2S$ $[M+H]^+$ 295.0787, found 295.0789.

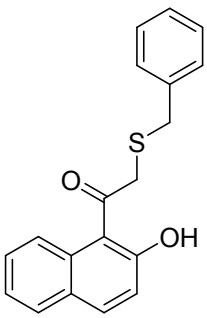
1-(2-Hydroxynaphthalen-1-yl)-2-(mesitylthio)ethan-1-one (4b)



1-(2-Hydroxynaphthalen-1-yl)-2-(mesitylthio)ethan-1-one **4b** was prepared according to general procedure A by making use of 2-bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one **3** (3.00 g, 7.118 mmol), mesitylthiol (1.289 mL, 8.542 mmol), cesium carbonate (2.783 g, 8.542 mmol), and TBAF hydrate (1.989 g, 7.118 mmol). A yellow solid was obtained in 71% yield (1.700 g, 5.054 mmol).

Mp: 68-71 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 12.68 (s, 1H), 8.04 (d, J = 8.5 Hz, 1H), 7.86 (d, J = 9.0 Hz, 1H), 7.75 (d, J = 7.9 Hz, 1H), 7.51 (t, J = 7.7 Hz, 1H), 7.37 (t, J = 7.5 Hz, 1H), 7.10 (d, J = 9.0 Hz, 1H), 6.88 (s, 2H), 4.13 (s, 2H), 2.44 (s, 6H), 2.25 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 201.57, 163.67, 143.35, 139.04, 137.36, 131.85, 129.53, 129.33, 128.85, 128.73, 128.33, 124.73, 124.11, 119.85, 114.97, 45.10, 21.82, 21.08. HRMS (ESI$^+$) m/z calcd for $C_{21}H_{20}O_2S$ $[M+H]^+$ 337.1257, found 337.1253.

2-(Benzylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one (4c)

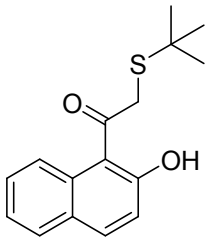


2-(Benzylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4c** was prepared according to general procedure A by making use of 2-bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one **3** (3.00 g, 7.118 mmol), benzylthiol (1.000 mL, 8.542 mmol), cesium carbonate (2.783 g,

8.542 mmol), and TBAF hydrate (1.989 g, 6.762 mmol). A yellow oil was obtained in 95% yield (2.085 g, 5.054 mmol).

^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 12.60 (s, 1H), 7.87 (dd, J = 8.4, 6.1 Hz, 2H), 7.75 (dd, J = 8.0, 1.3 Hz, 1H), 7.47 (ddd, J = 8.5, 7.0, 1.5 Hz, 1H), 7.38 – 7.22 (m, 6H), 7.12 (d, J = 9.0 Hz, 1H), 3.88 (s, 2H), 3.80 (s, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 202.14, 163.49, 137.56, 137.32, 131.53, 129.57, 129.33, 128.67, 128.64, 128.45, 127.40, 124.75, 124.14, 119.72, 114.74, 39.85, 36.60. HRMS (ESI$^+$) m/z calcd for $C_{21}H_{20}O_2S$ $[M+H]^+$ 337.1257, found 337.1253.

2-(*Tert*-butylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one (4d)



2-(*Tert*-butylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4d** was prepared according to general procedure A by making use of 2-bromo-1-(2-((triisopropylsilyl)oxy)naphthalen-1-yl)ethan-1-one **3** (2.40 g, 5.701 mmol), *tert*-butylthiol (0.771 mL, 6.841 mmol), cesium carbonate (2.229 g, 6.841 mmol), and TBAF hydrate (1.593 g, 5.701 mmol). A yellow oil was obtained in 53% yield (0.829 g, 3.022 mmol).

^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 12.53 (s, 1H), 8.12 (d, J = 8.4 Hz, 1H), 7.84 (d, J = 8.9 Hz, 1H), 7.74 (d, J = 7.9 Hz, 1H), 7.55 (t, J = 7.6 Hz, 1H), 7.37 (t, J = 7.2 Hz, 1H), 7.10 (d, J = 9.0 Hz, 1H), 4.05 (s, 2H), 1.34 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 202.99, 163.28, 137.48, 131.54, 129.52, 128.59, 128.39, 124.66, 124.14, 119.67, 115.05, 43.72, 39.93, 30.83. HRMS (ESI$^+$) m/z calcd for $C_{16}H_{18}O_2S$ $[M+Na]^+$ 297.0920, found 297.0908.

3 Experimental procedures toward 1,2,3-triazole-based atropisomers

General procedure B for the triazolization reaction towards naphthyltriazoles 7 – 10:

To an oven-dried reaction tube equipped with a magnetic stirring bar, naphthyl ketone **4** (1 equiv), chiral amine **5** (1.3 equiv), and 4-nitrophenyl azide **6** (1.3 equiv) were dissolved in dry toluene under inert atmosphere. The mixture was heated at 110 °C overnight. The crude reaction mixture was immediately purified *via* silica gel column chromatography using dichloromethane, then ethyl acetate/dichloromethane as the eluent affording both separated

diastereomers. The first eluting diastereomers was recrystallized from chloroform/petroleum ether, the second eluting diastereomers was recrystallized from chloroform.

(S_a,*R*)-1-(1-(1-Phenylethyl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (7a-1) and (R_a,*R*)-1-(1-(1-phenylethyl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (7a-2)

(S_a,*R*)-1-(1-(1-Phenylethyl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **7a-1** and (R_a,*R*)-1-(1-(1-phenylethyl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **7a-2** were prepared according to general procedure B by making use of 1-(2-hydroxynaphthalen-1-yl)-2-(phenylthio)ethan-1-one **4a** (350 mg, 1.19 mmol), (*R*)-1-phenylethan-1-amine **5a** (188 mg, 1.55 mmol), and 4-nitrophenyl azide **6** (254 mg, 1.55 mmol).

7a-1: Yield: 32% (159 mg, 0.375 mmol). Off-white solid. Mp = 178-181 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.76 (d, J = 8.7 Hz, 2H, arom. H), 7.40 – 7.11 (m, 10H, arom. H), 7.00 – 6.87 (m, 4H, arom. H), 5.23 (q, J = 7.0 Hz, 1H, CH), 1.87 (d, J = 7.1 Hz, 3H, CH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.42 (arom. C), 140.10 (arom. C), 139.67 (arom. C), 134.22 (arom. C), 134.16 (arom. C), 133.03 (arom. C), 132.61 (arom. C), 130.54 (arom. C), 128.84 (arom. C), 128.76 (arom. C), 128.73 (arom. C), 128.62 (arom. C), 128.38 (arom. C), 127.82 (arom. C), 127.03 (arom. C), 126.82 (arom. C), 124.03 (arom. C), 122.84 (arom. C), 118.03 (arom. C), 105.07 (arom. C), 59.83 (CH), 21.37 (CH_3). HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3OS$ $[M+H]^+$ 424.1478, found 424.1476.

7a-2: Yield: 31% (158 mg, 0.373 mmol). Off-white solid. Mp = 199-201 °C. ^{1}H NMR (300 MHz, DMSO-d_6): δ (ppm) 10.56 (s, 1H), 7.94 (d, J = 8.9 Hz, 1H), 7.80 (d, J = 8.0 Hz, 1H), 7.31 (d, J = 9.0 Hz, 1H), 7.27 – 7.01 (m, 10H), 6.89 (d, J = 3.4 Hz, 2H), 6.65 (d, J = 8.3 Hz, 1H), 5.35 (q, J = 6.6 Hz, 1H), 1.98 (d, J = 6.8 Hz, 3H). ^{13}C NMR (75 MHz, DMSO-d_6): δ (ppm) 153.95, 139.88, 136.48, 135.70, 135.14, 132.63, 131.85, 128.62, 128.01, 127.78, 127.37, 127.32, 126.44, 125.97, 125.83, 122.78, 122.57, 117.58, 104.43, 58.46, 20.86. HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3OS$ $[M+H]^+$ 424.1478, found 424.1481.

(S_a,*R*)-1-(1-(3,3-Dimethylbutan-2-yl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (7b-1) and (R_a,*R*)-1-(1-(3,3-dimethylbutan-2-yl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (7b-2)

(S_a,*R*)-1-(1-(3,3-Dimethylbutan-2-yl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **7b-1** and (R_a,*R*)-1-(1-(3,3-dimethylbutan-2-yl)-4-(phenylthio)-1*H*-1,2,3-triazol-5-

yl)naphthalen-2-ol **7b-2** were prepared according to general procedure B by making use of 1-(2-hydroxynaphthalen-1-yl)-2-(phenylthio)ethan-1-one **4a** (500 mg, 1.70 mmol), (*R*)-3,3-dimethylbutan-2-amine **5b** (224 mg, 2.21 mmol), and 4-nitrophenyl azide **6** (363 mg, 2.21 mmol).

7b-1: Yield: 42% (288 mg, 0.714 mmol). Off-white solid. Mp = 210-212 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.87 (d, J = 9.0 Hz, 1H), 7.83 – 7.75 (m, 1H), 7.39 – 7.28 (m, 2H), 7.24 – 7.12 (m, 3H), 7.06 – 6.95 (m, 3H), 6.83 (d, J = 9.0 Hz, 1H), 5.33 (s, 1H), 3.64 (q, J = 6.8 Hz, 1H), 1.57 (d, J = 6.9 Hz, 3H), 0.84 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.06, 138.64, 134.96, 134.41, 133.15, 132.64, 130.17, 128.96, 128.92, 128.70, 127.63, 126.99, 124.18, 123.06, 118.29, 105.86, 64.61, 35.69, 26.93, 16.15. HRMS (ESI$^+$) m/z calcd for $C_{24}H_{25}N_3OS$ $[M+H]^+$ 404.1791, found 424.1783.

7b-2: Yield: 43% (295 mg, 0.730 mmol). Off-white solid. Mp = 224-227 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.84 (d, J = 8.9 Hz, 1H), 7.79 – 7.72 (m, 1H), 7.30 – 7.13 (m, 4H), 7.11 – 6.96 (m, 5H), 4.03 (q, J = 6.9 Hz, 1H), 1.69 (d, J = 6.9 Hz, 3H), 0.77 (s, 9H). ^{13}C NMR (75 MHz, MeOH-d_4): δ (ppm) 155.40, 139.21, 137.65, 136.58, 134.40, 133.49, 129.79, 129.69, 129.43, 129.34, 127.95, 127.24, 125.29, 124.42, 118.23, 106.64, 65.91, 36.16, 27.49, 16.06. HRMS (ESI$^+$) m/z calcd for $C_{24}H_{25}N_3OS$ $[M+H]^+$ 404.1791, found 424.1786.

(S_a,*R*)-1-(4-(Mesitylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (8a-1) and (R_a,*R*)-1-(4-(mesitylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (8a-2)

(S_a,*R*)-1-(4-(Mesitylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **8a-1** and (R_a,*R*)-1-(4-(mesitylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **8a-2** were prepared according to general procedure B by making use of 1-(2-hydroxynaphthalen-1-yl)-2-(mesitylthio)ethan-1-one **4b** (350 mg, 1.04 mmol), (*R*)-1-phenylethan-1-amine **5a** (164 mg, 1.35 mmol), and 4-nitrophenyl azide **6** (222 mg, 1.35 mmol).

8a-1: Yield: 31% (150 mg, 0.322 mmol). Off-white solid. Mp = 94-97 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.87 – 7.69 (m, 2H), 7.34 – 7.17 (m, 5H), 7.05 – 6.90 (m, 3H), 6.71 (d, J = 8.1 Hz, 1H), 6.44 (s, 2H), 4.98 (q, J = 6.9 Hz, 1H), 4.61 (s, 1H), 2.11 (s, 6H), 2.00 (s, 3H), 1.92 (d, J = 7.0 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.20, 142.78, 142.64, 140.09, 138.38, 132.96, 132.32, 130.39, 128.86, 128.85, 128.40, 127.60, 126.81, 126.60, 123.88, 122.84, 117.80, 105.48, 59.62, 21.80, 21.42, 20.90. HRMS (ESI$^+$) m/z calcd for $C_{29}H_{27}N_3OS$ $[M+H]^+$ 466.1947, found 466.1947.

8a-2: Yield: 28% (135 mg, 0.290 mmol). Off-white solid. Mp = 203-206 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.75 (d, J = 8.7 Hz, 1H), 7.65 (t, J = 7.8 Hz, 1H), 7.12 (d, J = 7.2 Hz, 1H), 7.05 – 6.80 (m, 7H), 6.52 – 6.34 (m, 3H), 5.23 (q, J = 6.7 Hz, 1H), 2.03 (s, 3H), 1.98 – 1.87 (m, 9H). ^{13}C NMR (75 MHz, MeOH-d_4): δ (ppm) 155.22, 143.31, 141.79, 141.44, 139.16, 134.92, 134.55, 132.93, 129.64, 129.45, 129.31, 128.80, 127.63, 127.54, 124.54, 123.95, 118.11, 106.26, 60.57, 21.75, 21.62, 20.93. HRMS (ESI$^+$) m/z calcd for $C_{29}H_{27}N_3OS$ $[M+H]^+$ 466.1947, found 466.1949.

(S_a,*R*)-1-(1-(3,3-Dimethylbutan-2-yl)-4-(mesitylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (8b-1) and (R_a,*R*)-1-(1-(3,3-dimethylbutan-2-yl)-4-(mesitylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (8b-2)

(S_a,*R*)-1-(1-(3,3-Dimethylbutan-2-yl)-4-(mesitylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **8b-1** and (R_a,*R*)-1-(1-(3,3-dimethylbutan-2-yl)-4-(mesitylthio)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **8b-2** were prepared according to general procedure B by making use of 1-(2-hydroxynaphthalen-1-yl)-2-(mesitylthio)ethan-1-one **4b** (350 mg, 1.04 mmol), (*R*)-3,3-dimethylbutan-2-amine **5b** (137 mg, 1.35 mmol), and 4-nitrophenyl azide **6** (222 mg, 1.35 mmol).

8b-1: Yield: 38% (174 mg, 0.390 mmol). Off-white solid. Mp = 176-179 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.84 (d, J = 8.5 Hz, 1H), 7.75 (d, J = 7.4 Hz, 1H), 7.32 – 7.16 (m, 3H), 6.67 (d, J = 8.1 Hz, 1H), 6.48 (s, 2H), 5.26 (br s, 1H), 3.55 (q, J = 6.1 Hz, 1H), 2.14 (s, 6H), 2.00 (s, 3H), 1.49 (d, J = 6.4 Hz, 3H), 0.84 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 152.94, 142.46, 141.01, 138.30, 133.13, 132.31, 132.27, 131.61, 128.92, 128.44, 127.35, 127.11, 123.93, 123.09, 118.12, 106.11, 64.14, 35.59, 26.95, 21.81, 20.89, 16.40. HRMS (ESI$^+$) m/z calcd for $C_{27}H_{31}N_3OS$ $[M+H]^+$ 446.2260, found 446.2259.

8b-2: Yield: 35% (163 mg, 0.365 mmol). Off-white solid. Mp = 121-123 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 8.09 (br s, 1H), 7.81 – 7.69 (m, 2H), 7.33 – 7.20 (m, 4H), 6.56 (s, 2H), 3.95 (q, J = 6.8 Hz, 1H), 2.07 (s, 3H), 2.03 (s, 6H), 1.64 (d, J = 6.9 Hz, 3H), 0.82 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.81, 142.48, 139.95, 137.97, 133.74, 133.44, 131.83, 128.85, 128.67, 128.20, 127.55, 126.97, 124.70, 123.49, 118.10, 106.25, 64.41, 35.44, 27.30, 21.62, 20.97, 16.34. HRMS (ESI$^+$) m/z calcd for $C_{27}H_{31}N_3OS$ $[M+H]^+$ 446.2260, found 446.2258.

(S_a,*R*)-1-(4-(Benzylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (9a-1) and (R_a,*R*)-1-(4-(benzylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (9a-2)

(S_a,*R*)-1-(4-(Benzylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **9a-1** and (R_a,*R*)-1-(4-(benzylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **9a-2** were prepared according to general procedure B by making use of 2-(benzylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4c** (500 mg, 1.62 mmol), (*R*)-1-phenylethan-1-amine **5a** (255 mg, 2.11 mmol), and 4-nitrophenyl azide **6** (346 mg, 2.11 mmol).

9a-1: Yield: 31% (220 mg, 0.502 mmol). Off-white solid. Mp = 175-177 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.88 – 7.76 (m, 2H), 7.41 – 7.32 (m, 2H), 7.20 – 7.05 (m, 9H), 6.97 – 6.81 (m, 2H), 5.46 (s, 1H), 5.04 (q, J = 7.0 Hz, 1H), 4.16 (d, J = 12.8 Hz, 1H), 4.04 (d, J = 12.8 Hz, 1H), 1.91 (d, J = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.40, 140.72, 139.98, 137.61, 133.26, 132.53, 132.28, 129.04, 128.81, 128.71, 128.63, 128.49, 128.24, 127.97, 127.32, 126.54, 124.00, 122.85, 118.24, 104.97, 59.60, 38.80, 21.25. HRMS (ESI$^+$) m/z calcd for $C_{27}H_{23}N_3OS$ $[M+H]^+$ 438.1635, found 438.1630.

9a-2: Yield: 30% (213 mg, 0.487 mmol). Off-white solid. Mp = 187-189 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.89 (d, J = 8.9 Hz, 1H), 7.73 (d, J = 8.0 Hz, 1H), 7.24 (d, J = 8.9 Hz, 1H), 7.20 – 6.93 (m, 10H), 6.81 (dd, J = 7.6, 1.6 Hz, 2H), 6.45 (d, J = 8.4 Hz, 1H), 5.31 (q, J = 7.0 Hz, 1H), 4.03 (d, J = 12.7 Hz, 1H), 3.84 (d, J = 12.7 Hz, 1H), 1.98 (d, J = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, MeOH-d_4): δ (ppm) 155.34, 141.53, 140.76, 139.09, 136.53, 134.37, 133.41, 129.94, 129.67, 129.33, 129.30, 128.97, 128.79, 128.10, 127.97, 127.44, 124.62, 124.29, 118.32, 106.50, 60.78, 40.00, 21.58. HRMS (ESI$^+$) m/z calcd for $C_{27}H_{23}N_3OS$ $[M+H]^+$ 438.1635, found 438.1622.

(S_a,*R*)-1-(4-(Benzylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (9b-1) and (R_a,*R*)-1-(4-(benzylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (9b-2)

(S_a,*R*)-1-(4-(Benzylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **9b-1** and (R_a,*R*)-1-(4-(benzylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **9b-2** were prepared according to general procedure B by making use of 2-(benzylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4c** (500 mg, 1.62 mmol), (*R*)-3,3-dimethylbutan-2-amine **5b** (213 mg, 2.11 mmol), and 4-nitrophenyl azide **6** (346 mg, 2.11 mmol).

9b-1: Yield: 41% (280 mg, 0.670 mmol). Off-white solid. Mp = 190-193 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.86 (d, J = 8.9 Hz, 1H), 7.83 – 7.76 (m, 1H), 7.38 – 7.31 (m, 2H), 7.27 (d, J = 9.0 Hz, 1H), 7.13 (s, 5H), 6.85 – 6.78 (m, 1H), 5.79 (s, 1H), 4.29 (d, J = 12.9 Hz, 1H), 4.03 (d, J = 12.9 Hz, 1H), 3.56 (q, J = 6.9 Hz, 1H), 1.52 (d, J = 6.9 Hz, 3H), 0.80 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.12, 138.85, 137.81, 133.48, 133.42, 132.45, 129.06, 128.86, 128.63, 128.57, 127.67, 127.41, 124.00, 123.10, 118.58, 105.56, 64.23, 38.72, 35.58, 26.89, 16.08. HRMS (ESI$^+$) m/z calcd for $C_{25}H_{27}N_3OS$ $[M+H]^+$ 418.1947, found 418.1945.
9b-2: Yield: 42% (287 mg, 0.687 mmol). Off-white solid. Mp = 209-212 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.91 (d, J = 8.9 Hz, 1H), 7.85 – 7.77 (m, 1H), 7.35 – 7.25 (m, 2H), 7.21 (d, J = 8.9 Hz, 1H), 7.18 – 7.11 (m, 3H), 7.09 – 7.00 (m, 3H), 4.07 – 3.91 (m, 2H), 3.82 (d, J = 12.8 Hz, 1H), 1.65 (d, J = 6.9 Hz, 3H), 0.76 (s, 9H). ^{13}C NMR (75 MHz, MeOH-d_4): δ (ppm) 155.47, 139.44, 139.16, 136.92, 134.70, 134.23, 133.41, 131.83, 129.97, 129.92, 129.28, 128.09, 125.53, 124.46, 118.32, 106.92, 65.56, 39.91, 36.14, 27.50, 16.08. HRMS (ESI$^+$) m/z calcd for $C_{25}H_{27}N_3OS$ $[M+H]^+$ 418.1947, found 418.1941.

(S_a,*R*)-1-(4-(*Tert*-butylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (10a-1) and (R_a,*R*)-1-(4-(*tert*-butylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (10a-2)

(S_a,*R*)-1-(4-(*Tert*-butylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **10a-1** and (R_a,*R*)-1-(4-(*tert*-butylthio)-1-(1-phenylethyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **10a-2** were prepared according to general procedure B by making use of 2-(*tert*-butylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4d** (500 mg, 1.83 mmol), (*R*)-1-phenylethan-1-amine **5a** (287 mg, 2.37 mmol), and 4-nitrophenyl azide **6** (389 mg, 2.37 mmol).
10a-1: Yield: 20% (147 mg, 0.364 mmol). Light brown solid. Mp = 191-193 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.87 (t, J = 8.5 Hz, 2H), 7.51 – 7.34 (m, 2H), 7.23 – 7.09 (m, 5H), 7.05 – 6.94 (m, 2H), 5.99 (s, 1H), 5.16 (q, J = 7.0 Hz, 1H), 1.95 (d, J = 7.1 Hz, 3H), 1.21 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$): δ (ppm) 153.54, 139.81, 139.31, 139.28, 135.79, 133.27, 132.41, 128.76, 128.69, 128.23, 127.77, 126.84, 123.92, 123.10, 118.40, 105.70, 59.71, 47.91, 31.36, 21.36. HRMS (ESI$^+$) m/z calcd for $C_{24}H_{25}N_3OS$ $[M+Na]^+$ 426.1611, found 426.1622.
10a-2: Yield: 21% (155 mg, 0.383 mmol). Light brown solid. Mp = 231-234 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.89 (d, J = 9.0 Hz, 1H), 7.72 (d, J = 8.0 Hz, 1H), 7.25 (d, J = 8.9 Hz, 1H), 7.21 – 7.15 (m, 1H), 7.10 – 7.01 (m, 1H), 6.99 – 6.89 (m, 3H), 6.85 – 6.75 (m, 2H), 6.61 (d, J = 8.4 Hz, 1H), 5.42 (q, J = 7.0 Hz, 1H), 2.04 (d, J = 7.1 Hz, 3H), 1.14 (s, 9H). ^{13}C

NMR (151 MHz, MeOH-d_4): δ (ppm) 155.14, 141.60, 139.60, 139.22, 134.57, 133.32, 129.63, 129.32, 128.98, 128.76, 127.73, 127.36, 124.74, 124.27, 118.15, 107.22, 60.96, 48.08, 31.40, 21.37. HRMS (ESI$^+$) m/z calcd for $C_{24}H_{25}N_3OS$ $[M+Na]^+$ 426.1611, found 426.1622.

(S_a,*R*)-1-(4-(*Tert*-butylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (10b-1) and (R_a,*R*)-1-(4-(*tert*-butylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (10b-2)

(S_a,*R*)-1-(4-(*Tert*-butylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **10b-1** and (R_a,*R*)-1-(4-(*tert*-butylthio)-1-(3,3-dimethylbutan-2-yl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **10b-2** were prepared according to general procedure B by making use of 2-(*tert*-butylthio)-1-(2-hydroxynaphthalen-1-yl)ethan-1-one **4d** (750 mg, 2.74 mmol), (*R*)-3,3-dimethylbutan-2-amine **5b** (360 mg, 3.56 mmol), and 4-nitrophenyl azide **6** (583 mg, 3.56 mmol).

10b-1: Yield: 25% (263 mg, 0.684 mmol). Off-white solid. Mp = 206-209 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 7.92 (d, J = 8.7 Hz, 1H), 7.85 (d, J = 7.5 Hz, 1H), 7.53 – 7.28 (m, 3H), 7.06 (d, J = 7.7 Hz, 1H), 5.92 (s, 1H), 3.66 (d, J = 6.4 Hz, 1H), 1.61 (d, J = 6.6 Hz, 3H), 1.21 (s, 9H), 0.80 (s, 9H). ^{13}C NMR (75 MHz, $CDCl_3$): δ (ppm) 153.07, 137.97, 136.27, 133.35, 132.44, 128.97, 128.84, 127.56, 124.07, 123.28, 118.76, 106.58, 64.49, 48.20, 35.79, 31.40, 26.89, 15.93. HRMS (ESI$^+$) m/z calcd for $C_{22}H_{29}N_3OS$ $[M+H]^+$ 384.2104, found 384.2133.

10b-2: Yield: 28% (294 mg, 0.766 mmol). Off-white solid. Mp = 156-158 °C. ^{1}H NMR (300 MHz, MeOH-d_4): δ (ppm) 7.90 (d, J = 8.9 Hz, 1H), 7.83 – 7.75 (m, 1H), 7.36 – 7.14 (m, 4H), 4.03 (q, J = 6.9 Hz, 1H), 1.70 (d, J = 6.9 Hz, 3H), 1.09 (s, 9H), 0.74 (s, 9H). ^{13}C NMR (75 MHz, MeOH-d_4): δ (ppm) 155.38, 140.20, 137.95, 134.55, 133.32, 129.83, 129.26, 127.82, 125.62, 124.41, 118.14, 107.66, 65.76, 48.14, 36.17, 31.33, 27.51, 16.02. HRMS (ESI$^+$) m/z calcd for $C_{22}H_{29}N_3OS$ $[M+H]^+$ 384.2104, found 384.2133.

General procedure C for the oxidation reaction towards sulfoxides 11 and 12:

To an oven-dried reaction tube equipped with a magnetic stirring bar, naphthyltriazole (1 equiv) was dissolved in dichloromethane, and $MgSO_4$ (5 equiv) was added. *meta*-Chloroperoxybenzoic acid (1 equiv) was added in small portions over 10 minutes, the reaction was further stirred until full conversion. Saturated Na_2CO_3 was added to the reaction mixture, and the organic layer washed twice with saturated Na_2CO_3. The organic layer was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The mixture was purified *via* silica gel

column chromatography using ethyl acetate/dichloromethane as the eluent affording both separated diastereomers.

(*S*$_a$,*S*$_s$,*R*)-1-(1-(1-Phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (11-1) and (*S*$_a$,*R*$_s$,*R*)-1-(1-(1-phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (11-2)

(*S*$_a$,*S*$_s$,*R*)-1-(1-(1-Phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **11-1** and (*S*$_a$,*R*$_s$,*R*)-1-(1-(1-phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **11-2** were prepared according to general procedure C by making use of naphthyltriazole **7a-1** (50 mg, 0.118 mmol), $MgSO_4$ (71 mg, 0.590 mmol), and mCPBA (70%, 29 mg, 0.118 mmol).

11-1: Yield: 47% (24.3 mg, 0.0555 mmol). Off-white solid. Mp = 139-142 °C. ^{1}H NMR (300 MHz, DMSO-d_6): δ (ppm) 10.56 (s, 1H), 8.05 (d, J = 9.0 Hz, 1H), 7.95 (d, J = 7.8 Hz, 1H), 7.61 – 7.52 (m, 2H), 7.50 – 7.36 (m, 5H), 7.32 (d, J = 9.0 Hz, 1H), 7.28 – 7.20 (m, 3H), 7.18 – 7.09 (m, 2H), 7.01 (d, J = 8.1 Hz, 1H), 5.16 (q, J = 6.9 Hz, 1H), 1.81 (d, J = 7.0 Hz, 3H). ^{13}C NMR (75 MHz, DMSO-d_6): δ (ppm) 155.19, 148.02, 142.28, 139.10, 134.95, 132.88, 130.67, 128.89, 128.61, 128.36, 128.04, 127.57, 126.92, 124.39, 123.49, 122.14, 117.92, 102.34, 57.99, 21.04. HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3O_2S$ $[M+H]^+$ 440.1427, found 440.1430.

11-2: Yield: 46% (23.8 mg, 0.0543 mmol). Off-white solid. Mp = 157-160 °C. ^{1}H NMR (300 MHz, DMSO-d_6): δ (ppm) 10.45 (s, 1H), 8.01 (d, J = 9.0 Hz, 1H), 7.94 (d, J = 7.8 Hz, 1H), 7.54 – 7.35 (m, 7H), 7.32 – 7.14 (m, 6H), 6.96 (d, J = 8.3 Hz, 1H), 5.16 (q, J = 6.4 Hz, 1H), 1.74 (d, J = 6.9 Hz, 3H). ^{13}C NMR (75 MHz, DMSO-d_6): δ (ppm) 154.79, 147.69, 142.03, 139.07, 134.50, 133.35, 132.74, 130.86, 128.89, 128.57, 128.29, 128.01, 127.92, 127.53, 127.09, 124.36, 123.43, 122.26, 117.86, 102.24, 57.92, 21.27. HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3O_2S$ $[M+H]^+$ 440.1427, found 440.1425.

(*R*$_a$,*R*$_s$,*R*)-1-(1-(1-Phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (12-1) and (*R*$_a$,*S*$_s$,*R*)-1-(1-(1-phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol (12-2)

(*R*$_a$,*R*$_s$,*R*)-1-(1-(1-Phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **12-1** and (*R*$_a$,*S*$_s$,*R*)-1-(1-(1-phenylethyl)-4-(phenylsulfinyl)-1*H*-1,2,3-triazol-5-yl)naphthalen-2-ol **12-2** were prepared according to general procedure C by making use of naphthyltriazole **7a-2** (50 mg, 0.118 mmol), $MgSO_4$ (71 mg, 0.590 mmol), and mCPBA (70%, 29 mg, 0.118 mmol).

12-1: Yield: 41% (21.2 mg, 0.0484 mmol). Off-white solid. Mp = 139-142 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 8.37 (br s, 1H), 7.81 (d, J = 8.9 Hz, 1H), 7.64 (d, J = 8.1 Hz, 1H), 7.30 (d, J = 8.9 Hz, 1H), 7.25 – 7.04 (m, 8H), 6.81 – 6.65 (m, 4H), 5.89 (d, J = 8.3 Hz, 1H), 4.90 (q, J = 7.0 Hz, 1H), 1.79 (d, J = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, DMSO-d_6): δ (ppm) 154.84, 147.89, 142.50, 139.46, 134.72, 132.86, 132.63, 130.75, 129.00, 128.33, 128.21, 127.88, 127.51, 127.21, 126.42, 124.30, 123.32, 122.43, 117.82, 102.58, 58.46, 21.35. HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3O_2S$ $[M+H]^+$ 440.1427, found 440.1431.

12-2: Yield: 46% (21.8 mg, 0.0496 mmol). Off-white solid. Mp = 157-160 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ (ppm) 9.22 (s, 1H), 7.87 – 7.80 (m, 2H), 7.77 (d, J = 8.1 Hz, 1H), 7.69 (d, J = 8.9 Hz, 1H), 7.57 – 7.49 (m, 3H), 7.33 – 7.26 (m, 1H), 7.19 – 7.13 (m, 1H), 7.09 (d, J = 8.9 Hz, 1H), 7.06 – 6.96 (m, 3H), 6.94 – 6.87 (m, 2H), 6.67 (d, J = 8.2 Hz, 1H), 5.24 (q, J = 7.0 Hz, 1H), 1.97 (d, J = 7.1 Hz, 3H). ^{13}C NMR (75 MHz, DMSO-d_6): δ (ppm) 154.33, 147.83, 141.20, 139.43, 134.57, 133.20, 132.68, 130.91, 128.75, 128.34, 128.12, 127.89, 127.44, 127.04, 126.40, 124.42, 123.26, 122.85, 117.70, 102.65, 58.35, 21.05. HRMS (ESI$^+$) m/z calcd for $C_{26}H_{21}N_3O_2S$ $[M+H]^+$ 440.1427, found 440.1423.

4 Crystal structure determination of 7a-2, 11-1, 11-2, and 12-1

Single crystals were obtained by crystallization from ethyl acetate and petroleum ether for **7a-2**, **11-1**, **11-2**, and **12-1**. X-ray intensity data were collected at 100(1) K on an Agilent SuperNova diffractometer with Eos CCD detector using MoKα radiation. The images were processed (unit cell determination, intensity data integration, correction for Lorentz and polarization effects, and empirical absorption correction) using CrysAlisPRO[1]. Using Olex2[2], the structure was solved with the ShelXS[3] structure solution program using Direct Methods and refined with the ShelXL[4] refinement package using full-matrix least-squares minimization on F^2. For **7a-2**, hydrogen atom H25 was found in a difference electron density map and refined freely. All other H atoms were placed in idealized positions and refined in the riding mode. Non-hydrogen atoms were refined anisotropically and hydrogen atoms in the riding mode with isotropic temperature factors fixed at 1.2 times U_{eq} of the parent atoms (1.5 for methyl groups). Deposition Numbers CCDC 2076357-2076360 contain the supplementary crystallographic data for this paper. These data are provided free of charge by the joint Cambridge Crystallographic Data Centre and Fachinformationszentrum Karlsruhe Access Structures service www.ccdc.cam.ac.uk/structures.

Crystal Data for 7a-2 ($C_{26}H_{21}N_3OS$, M = 423.52 g/mol): monoclinic, space group $P2_1$ (no. 4), a = 8.6611(3), b = 13.0943(3), c = 10.2975(3) Å, β = 110.729(3)°, V = 1092.25(6) Å^3, Z = 2, T = 100(1) K, μ(MoKα) = 0.171 mm^{-1}, D_{calc} = 1.288 g/cm^3, 36101 reflections measured (5.028° ≤ 2θ ≤ 52.730°), 4474 unique (R_{int} = 0.0377, R_{sigma} = 0.0212) that were used in all calculations. The final R_1 was 0.0262 (I > 2σ(I)), and wR_2 was 0.0626 for all data. Flack parameter x = -0.046(19) using 2137 Bijvoet pairs.

Crystal Data for 11-1 ($C_{26}H_{21}N_3O_2S$, M = 439.52 g/mol): orthorhombic, space group $P2_12_12_1$ (no. 19), a = 21.3972(3), b = 14.6607(2), c = 6.86195(11) Å, V = 2152.58(5) Å^3, Z = 4, T = 100(1) K, μ(MoKα) = 0.180 mm^{-1}, D_{calc} = 1.356 g/cm^3, 15539 reflections measured (5.558° ≤ 2θ ≤ 52.736°), 4400 unique (R_{int} = 0.0297, R_{sigma} = 0.0334) that were used in all calculations. The final R_1 was 0.0318 (I > 2σ(I)), and wR_2 was 0.0723 for all data. Flack parameter x = -0.04(3) using 1872 Bijvoet pairs.

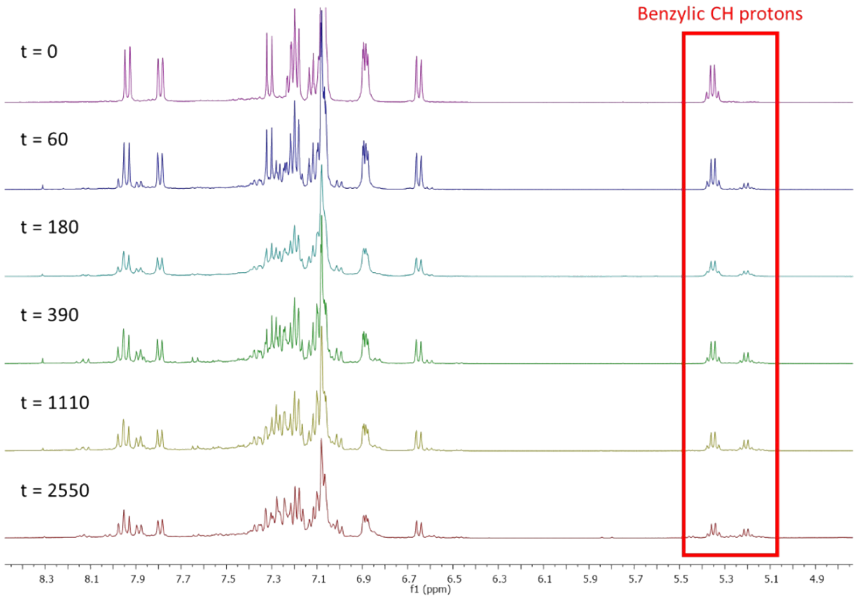
Crystal Data for 11-2 ($C_{26}H_{21}N_3O_2S$, M = 439.52 g/mol): orthorhombic, space group $P2_12_12_1$ (no. 19), a = 8.2288(5), b = 10.1233(6), c = 25.6942(15) Å, V = 2140.4(2) Å^3, Z = 4, T = 100(1) K, μ(MoKα) = 0.181 mm^{-1}, D_{calc} = 1.364 g/cm^3, 19890 reflections measured (5.124° ≤ 2θ ≤ 52.742°), 4376 unique (R_{int} = 0.0624, R_{sigma} = 0.0648) that were used in all calculations. The

final R_1 was 0.0464 ($I > 2\sigma(I)$), and wR_2 was 0.0873 for all data. Flack parameter x = -0.02(6) using 1863 Bijvoet pairs.

Crystal Data for 12-1 ($C_{26}H_{21}N_3O_2S$, M = 439.52 g/mol): orthorhombic, space group $P2_12_12_1$ (no. 19), a = 6.84610(10), b = 15.7021(3), c = 21.1251(4) Å, V = 2270.91(7) Å^3, Z = 4, T = 100(1) K, $\mu(MoK\alpha)$ = 0.170 mm^{-1}, D_{calc} = 1.286 g/cm^3, 11256 reflections measured ($5.184° \leq 2\theta \leq 52.680°$), 4637 unique ($R_{int}$ = 0.0351, R_{sigma} = 0.0438) that were used in all calculations. The final R_1 was 0.0371 ($I > 2\sigma(I)$), and wR_2 was 0.0865 for all data. Flack parameter x = 0.00(4) using 1671 Bijvoet pairs.

5 Experimental determination rotational stability

Kinetic studies were performed with one of the obtained atropisomers, *i.e.* **7a-2**. The racemization of atropisomers, unlike in the case of point chirality, does not occur through breaking bonds but rather *via* the rotation of the two groups joint by the stereogenic axis. This is, due to the time-dependency of the rotation phenomenon, related to a half-life time of atropisomerization which is highly dependent on various structural factors of the atropisomers. The racemization upon heating is a first order process which takes place according to the Eyring-Polanyi equation. The calculation of the half-life time ($t_{1/2}$) and the rotational energy barrier are essential to determine the stability of the atropisomer against rotation/racemization. First, ^{1}H NMR experiments at slightly elevated temperatures (60 °C and 70 °C) were conducted to see whether the racemization is occurring, but no racemization was observed at these temperatures. After heating the sample at 130 °C in an oil bath over a time span of 12 h, the compound started to racemize slowly. Nevertheless, the time it took for the mixture to almost racemize was too long (±5 days) to accurately determine $t_{1/2}$ and the rotational energy barrier. The temperature was increased to 150 °C and the sample was heated for 4 h. Clear racemization was visible and a new sample (approximately 25 mg) was heated to 150 °C in DMSO-d_6 and measured periodically *via* ^{1}H NMR (every 30 minutes in the beginning, every 1 h or 2 h when only little changes were observed). Integration of the benzylic protons of both diastereomers *via* ^{1}H NMR (some selected NMR spectra are presented together with all the NMR integrations over time, Figure S1) and determination of the percentage diastereomer displays a logarithmic progress (Figure S2). From this, the A_e equilibrium concentration can be calculated as being 0.41, and not exactly 0.5. This is due to the formation of diastereomers in which one diastereomer is slightly more stable, and therefore these show minor difference in energy.



NMR integration		
t (min)	Int **7a-2**	Int **7a-1**
0	1,000	0,000
30	1,000	0,140
60	1,000	0,230
90	1,000	0,300
120	1,000	0,340
150	1,000	0,370
180	1,000	0,410
210	1,000	0,440
270	1,000	0,470
390	1,000	0,530
570	1,000	0,590
750	1,000	0,620
930	1,000	0,640
1110	1,000	0,660
1290	1,000	0,670
1430	1,000	0,680
1650	1,000	0,680
1830	1,000	0,680
2550	1,000	0,690

Figure S1: selected NMR spectra and integrations of the rotational stability studies.

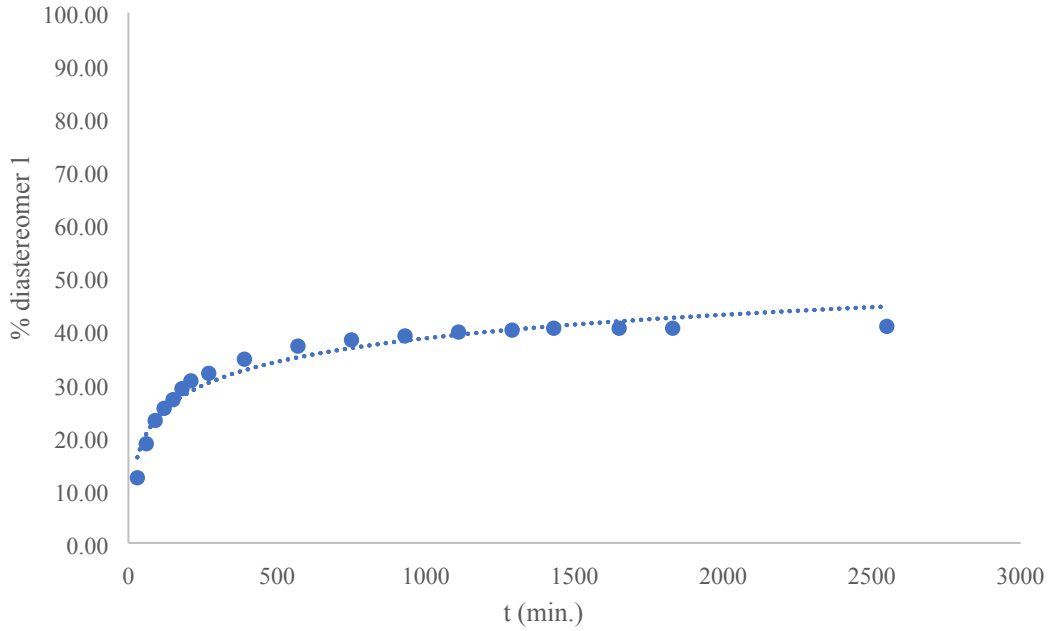


Figure S2: plot of the percentage of diastereomer being formed at 150 °C *vs* time t.

Plotting $\ln((A_t-A_e)/(A_0-A_e))$, where A_t is the concentration of diastereomer at time t, A_0 is the initial diastereomer concentration and A_e is the concentration at equilibrium, versus time. Fitting a linear curve yields an equation, in which a reversible first order reaction was assumed (Figure S3). From the graph (Figure S3) the rate constant k (= 0.0031) was obtained from the slope by following the equation:

$$\ln\left(\frac{(A_t - A_e)}{(A_0 - A_e)}\right) = -kt$$

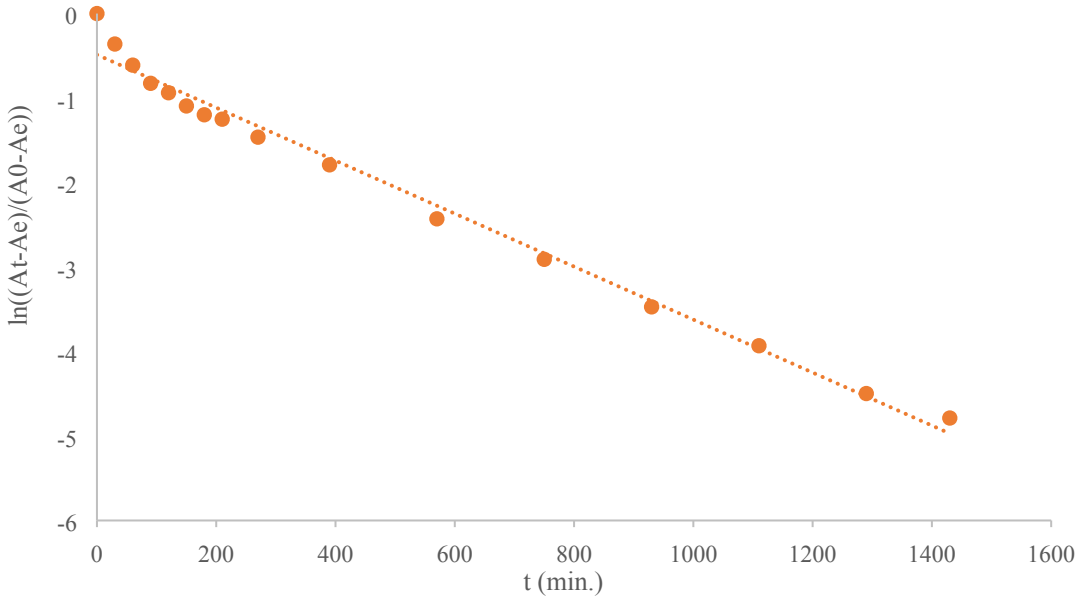


Figure S3: plot of $\ln((A_t-A_e)/(A_0-A_e))$ *vs* time t, in which A_t is the concentration of diastereomer at time t, A_0 is the concentration at t=0 and A_e is the equilibrium concentration.

Next, $t_{1/2}$ of the racemization at 150 °C can be determined:

$$t_{1/2} = \frac{\ln(2)}{k}$$

Furthermore, starting from these previously calculated terms, the rotational energy barrier ($\Delta G^{\neq}$) can be determined from the Eyring-Polanyi equation, in which K_B is the Boltzmann constant (1.38 x 10^{-23} J/K), T is the temperature (423.15 K), h is Planck's constant (6.62 x 10^{-34} J s), R is the gas constant (8.31 J/(K mol)), and $\Delta G^{\neq}$ is the Gibbs free energy:

$$k = \frac{K_B T}{h} e^{-\frac{\Delta G^{\neq}}{RT}}$$

The calculations with these formulas afforded the values of $t_{1/2}$ at 150 °C as 3.7 hours and the free energy barrier for racemization to be 34 kcal/mol.

6 Theoretical calculations data rotational stability

Methodology

Full geometry optimization at DFT level by applying the B3LYP/6-311+G(d) basis set,[5, 6] was performed. In all cases, the effect of the solvent (DMSO) was assessed using the Tomassi's polarized continuum model[7] (PCM) and temperature at 423 K as implemented in Gaussian09 software.[8] The stationary points, ground states (GS) and transition states (TS), were identified by a scan of the distinguished dihedral rotation angle with full optimization of the remaining geometric parameters. The characterization of the stationary points was performed by Hessian matrix calculations, obtaining positive eigenvalues for each GS and one negative eigenvalue for each TS.[9] The same geometry optimization was repeated including the dispersion effects using empirical Grimme's D3 (GD3) correction term.[10]

Subsequently, for all stationary points, B3LYP/6-311+G(2d,2p) method was used to acquire high level evaluation for single point energy. Such single point calculation was respective on the base of the preliminary geometry optimization at both B3LYP/6-311+G(d) and B3LYP/6-311+G(d)-GD3 methods.

Table S1: Calculated stationary point energies (kcal/mol) with B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d) method.

	GS_1	GS_2	TS_0	TS_{180}
ΔH	0.0	1.8	40.7	54.7
ΔG	0.0	0.8	45.3	56.4

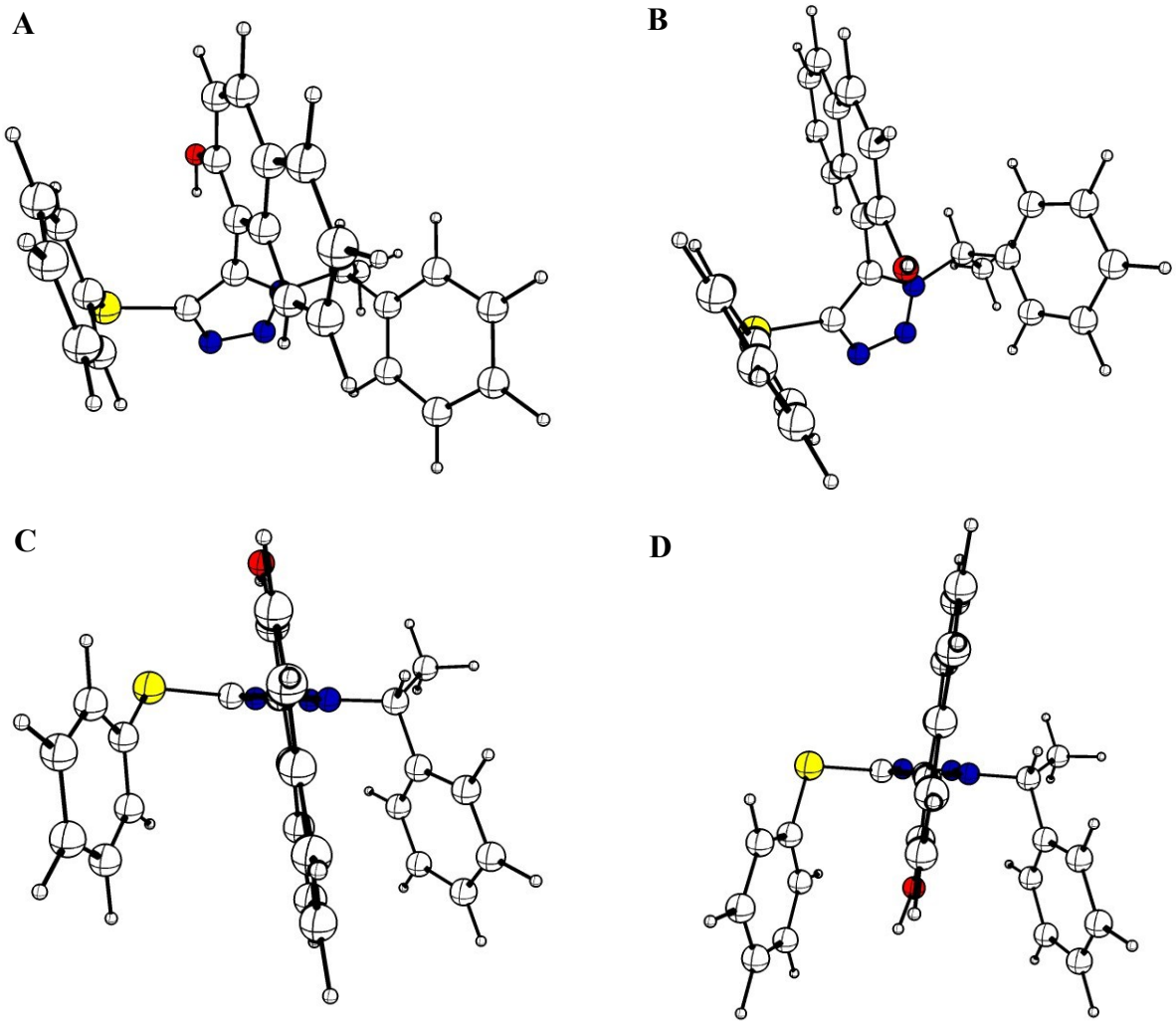


Figure S4: GS_1 and GS_2 geometries (A and B, respectively) and their top view (C and D, respectively) resulting from the B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d) method.

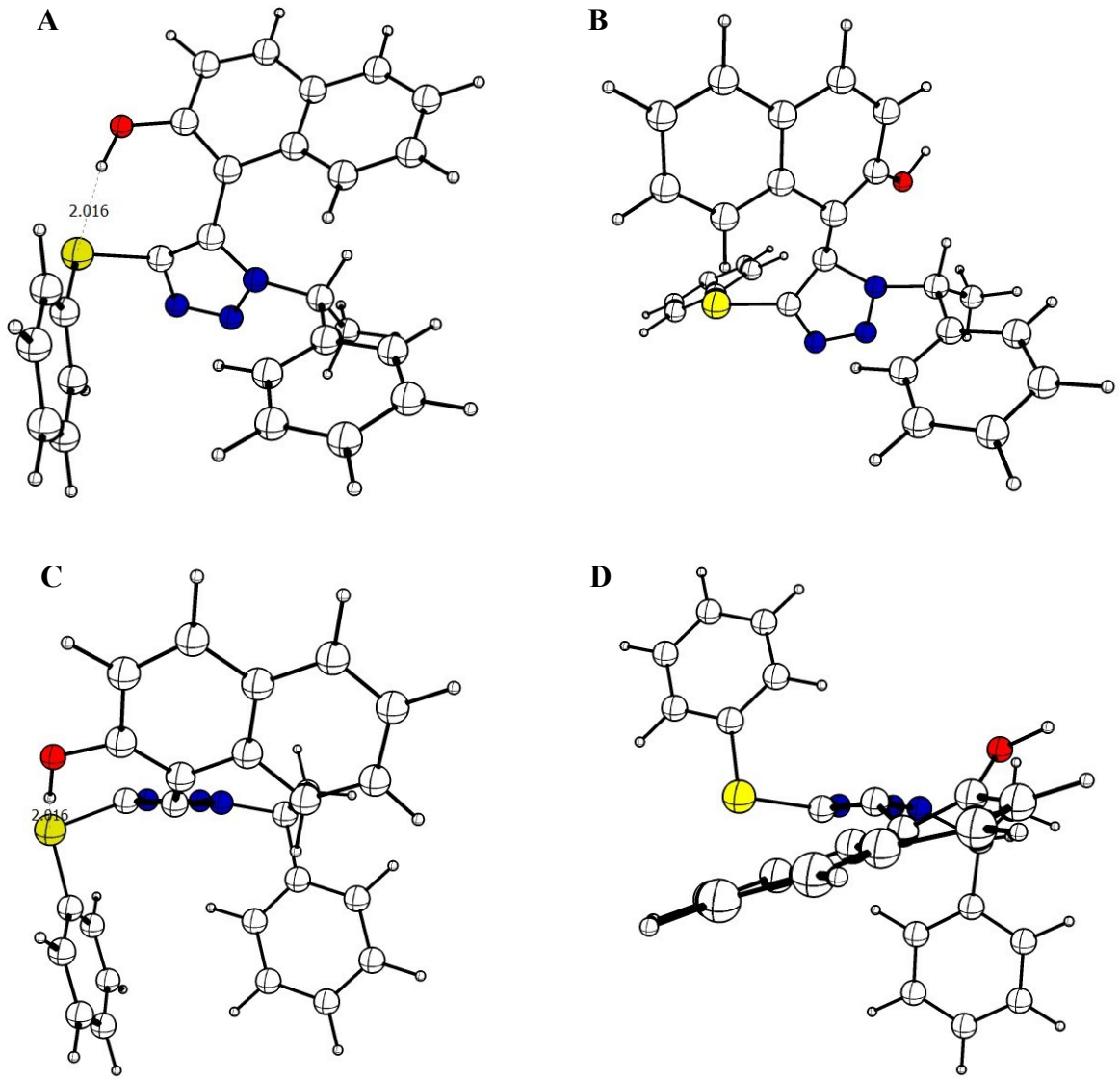


Figure S5: TS_0 and TS_{180} geometries (A and B, respectively) and their top view (C and D, respectively) resulting from the B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d) method.

Ground state 1 (GS_1)

Method: B3LYP/6-311+G(2d,2p)//B3LYP/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.4643991 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: 15.8898

Zero-point correction=	0.408738 (Hartree/Particle)
Thermal correction to Energy=	0.458736
Thermal correction to Enthalpy=	0.460075
Thermal correction to Gibbs Free Energy=	0.308909
Sum of electronic and zero-point Energies=	-1641.055661
Sum of electronic and thermal Energies=	-1641.005663
Sum of electronic and thermal Enthalpies=	-1641.004324
Sum of electronic and thermal Free Energies=	-1641.155490

1	C	-3.3829620	-0.7727360	-1.0717010
2	C	-2.1566760	-0.1242030	-1.1779540
3	N	-1.3381740	-1.0789570	-1.7081020
4	N	-2.0100760	-2.2246020	-1.9134050
5	N	-3.2446330	-2.0462050	-1.5339860
6	S	-4.9336830	-0.1073800	-0.5461500
7	C	0.0998520	-0.9664160	-2.0656560
8	H	0.3061390	0.1021540	-2.0030980
9	C	0.3204100	-1.4261130	-3.5104020
10	H	0.1075520	-2.4888260	-3.6289800
11	H	1.3625010	-1.2516370	-3.7841200
12	H	-0.3156880	-0.8630940	-4.1971070
13	C	0.9974520	-1.6794780	-1.0631360
14	C	1.9766720	-0.9493080	-0.3832690
15	C	2.8495600	-1.5808630	0.5035390
16	C	2.7463730	-2.9528870	0.7252110
17	C	1.7697740	-3.6890780	0.0521230
18	C	0.9037520	-3.0584740	-0.8392320
19	H	2.0618180	0.1206120	-0.5468400
20	H	3.6047300	-0.9990190	1.0217320
21	H	3.4212300	-3.4465220	1.4167840
22	H	1.6833090	-4.7578340	0.2192330
23	H	0.1490650	-3.6413910	-1.3548730
24	C	-1.7471430	1.2582890	-0.8583050
25	C	-1.2627230	1.6026360	0.4470970
26	C	-0.8810260	2.9552560	0.7150780
27	C	-0.9984720	3.9211390	-0.3208970
28	C	-1.4749460	3.5807050	-1.5573900
29	C	-1.8568350	2.2440200	-1.8279170

30	C	-1.1478690	0.6522080	1.4954420
31	C	-0.3995570	3.3014980	2.0033770
32	H	-0.7070440	4.9468420	-0.1180740
33	H	-1.5736180	4.3148820	-2.3489050
34	C	-0.6794520	1.0208050	2.7371180
35	H	-0.6031300	0.2775290	3.5239720
36	C	-0.2986730	2.3560280	2.9980220
37	H	-0.1119650	4.3313860	2.1921580
38	H	0.0694070	2.6313630	3.9805930
39	H	-1.4399210	-0.3766440	1.3186000
40	O	-2.3232470	2.0147620	-3.0882560
41	H	-2.6264730	1.1013690	-3.1903280
42	C	-4.9863040	-0.5029820	1.2140560
43	C	-5.6380330	0.4077660	2.0510800
44	C	-5.7751120	0.1255310	3.4102130
45	C	-5.2498980	-1.0521570	3.9412830
46	C	-4.5958390	-1.9550590	3.1019200
47	C	-4.4717370	-1.6915530	1.7383120
48	H	-6.0289640	1.3360040	1.6477000
49	H	-6.2813840	0.8369880	4.0543440
50	H	-5.3486450	-1.2650990	5.0003310
51	H	-4.1874860	-2.8760280	3.5052970
52	H	-3.9794340	-2.4077870	1.0908900

First Transition State (TS_0)

Method: B3LYP/6-311+G(2d,2p)//B3LYP/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.4085835 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: -8.1102

Zero-point correction=	0.408299 (Hartree/Particle)
Thermal correction to Energy=	0.456405
Thermal correction to Enthalpy=	0.457744
Thermal correction to Gibbs Free Energy=	0.313721
Sum of electronic and zero-point Energies=	-1640.000285
Sum of electronic and thermal Energies=	-1640.952179
Sum of electronic and thermal Enthalpies=	-1640.950840
Sum of electronic and thermal Free Energies=	-1641.094863

1	C	-3.4459520	-0.2539240	-1.2408250
2	C	-2.2955350	0.2821300	-0.5925540
3	N	-1.3182570	-0.5995820	-1.1076590
4	N	-1.8706810	-1.5694670	-1.8614940

5	N	-3.1402460	-1.3717810	-1.9344840
6	S	-5.1910300	-0.0716380	-0.8705360
7	C	0.1735450	-0.6643380	-1.1543820
8	H	0.5337830	0.3188800	-0.8907310
9	C	0.6524570	-0.9266440	-2.5933480
10	H	0.4164760	-1.9344650	-2.9293150
11	H	1.7352360	-0.7927790	-2.6277560
12	H	0.2021090	-0.2088460	-3.2823530
13	C	0.7416610	-1.6759940	-0.1626330
14	C	2.1205240	-1.6457970	0.0897480
15	C	2.7084870	-2.5597650	0.9604980
16	C	1.9254980	-3.5207250	1.6022440
17	C	0.5535800	-3.5536200	1.3645270
18	C	-0.0345510	-2.6378060	0.4889700
19	H	2.7423140	-0.8978300	-0.3922050
20	H	3.7775420	-2.5171920	1.1421070
21	H	2.3811990	-4.2325960	2.2825860
22	H	-0.0676200	-4.2929870	1.8596950
23	H	-1.1029200	-2.6858000	0.3184240
24	C	-1.9603200	1.6860000	-0.1738600
25	C	-0.5941050	2.1348150	0.0949490
26	C	-0.1305220	3.4407640	-0.2373790
27	C	-1.0541500	4.3808620	-0.7632390
28	C	-2.3705300	4.0501730	-0.8224340
29	C	-2.8345920	2.7328760	-0.5373130
30	C	0.2448120	1.3720200	0.9540950
31	C	1.1960780	3.8271420	0.0822530
32	H	-0.7167370	5.3738100	-1.0415420
33	H	-3.1196460	4.7613680	-1.1508420
34	C	1.5080850	1.7900930	1.3124850
35	H	2.1075340	1.1762830	1.9761090
36	C	2.0140840	3.0149660	0.8333900
37	H	1.5343420	4.8104340	-0.2299690
38	H	3.0164850	3.3347050	1.0969480
39	H	-0.1295890	0.4366410	1.3540890
40	O	-4.1583340	2.6417550	-0.7661800
41	H	-4.5668550	1.7892230	-0.5008350
42	C	-5.3742970	-1.0721660	0.6261010
43	C	-5.8219620	-0.4564780	1.7969580
44	C	-6.0354380	-1.2252060	2.9422650
45	C	-5.7915410	-2.5975820	2.9211990
46	C	-5.3423940	-3.2069070	1.7479460
47	C	-5.1428520	-2.4500690	0.5948610
48	H	-6.0023610	0.6124990	1.8176350
49	H	-6.3840570	-0.7461220	3.8510730
50	H	-5.9524090	-3.1918790	3.8143530

51	H	-5.1574390	-4.2757140	1.7254210
52	H	-4.8061350	-2.9243020	-0.3196380

Second Transition State (TS_{180})

Method: B3LYP/6-311+G(2d,2p)//B3LYP/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.3795931 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: -24.2772

Zero-point correction=	0.407759 (Hartree/Particle)
Thermal correction to Energy=	0.456471
Thermal correction to Enthalpy=	0.457810
Thermal correction to Gibbs Free Energy=	0.311767
Sum of electronic and zero-point Energies=	-1640.971834
Sum of electronic and thermal Energies=	-1640.923122
Sum of electronic and thermal Enthalpies=	-1640.921789
Sum of electronic and thermal Free Energies=	-1641.067826

1	C	-2.2060350	-0.7797190	1.0003250
2	C	-1.7944610	0.0637650	-0.0713340
3	N	-1.3575630	-0.9958940	-0.9560910
4	N	-1.7438270	-2.1991630	-0.5353170
5	N	-2.2750970	-2.0782910	0.6384570
6	S	-3.0636340	-0.3234600	2.5069990
7	C	-0.2274450	-1.1165810	-1.9366400
8	H	-0.0100370	-0.1313480	-2.3129670
9	C	-0.6863220	-1.9692030	-3.1267870
10	H	-0.8740330	-3.0009840	-2.8324920
11	H	0.0779390	-1.9648380	-3.9043310
12	H	-1.5995760	-1.5499950	-3.5519370
13	C	1.0617780	-1.6142750	-1.2749240
14	C	2.1934930	-1.7723700	-2.0895390
15	C	3.4141530	-2.1790080	-1.5559460
16	C	3.5353260	-2.4273440	-0.1882940
17	C	2.4243260	-2.2562530	0.6333360
18	C	1.2002720	-1.8510830	0.0959070
19	H	2.1302000	-1.5701230	-3.1535470
20	H	4.2716690	-2.2972450	-2.2105920
21	H	4.4849580	-2.7441190	0.2301930
22	H	2.5031200	-2.4359620	1.7007760
23	H	0.3624880	-1.7216380	0.7678350
24	C	-0.9601670	1.3010620	-0.2474410
25	C	-1.0142400	2.4201600	0.7093250

26	C	-0.7310460	3.7745410	0.3470900
27	C	-0.4277670	4.0782070	-1.0036480
28	C	-0.5416210	3.1024560	-1.9442490
29	C	-1.0028790	1.8115250	-1.5758010
30	C	-1.1092700	2.1639530	2.1023460
31	C	-0.7325380	4.7973260	1.3284440
32	H	-0.1509270	5.0893730	-1.2828150
33	H	-0.4089020	3.3290000	-2.9983350
34	C	-1.1110570	3.1696910	3.0456430
35	H	-1.2040870	2.9166990	4.0968190
36	C	-0.9498590	4.5134050	2.6565730
37	H	-0.5406110	5.8164620	1.0073010
38	H	-0.9529970	5.3048410	3.3981790
39	H	-1.1323440	1.1421800	2.4494770
40	O	-1.6092340	1.1012540	-2.5672960
41	H	-1.5808040	1.5884800	-3.4015010
42	C	-4.5479110	-1.3405140	2.4423820
43	C	-5.4538750	-1.2363380	1.3815110
44	C	-6.6317770	-1.9785930	1.4026650
45	C	-6.9232430	-2.8083780	2.4883590
46	C	-6.0261050	-2.8985620	3.5508070
47	C	-4.8338990	-2.1719070	3.5274300
48	H	-5.2382360	-0.5821920	0.5438140
49	H	-7.3290480	-1.9002480	0.5749040
50	H	-7.8453600	-3.3796620	2.5038230
51	H	-6.2435760	-3.5430030	4.3962060
52	H	-4.1281280	-2.2566390	4.3464340

Ground state 2 (GS_2)

Method: B3LYP/6-311+G(2d,2p)//B3LYP/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.4651263 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: 9.9431

Zero-point correction= 0.408461 (Hartree/Particle)
Thermal correction to Energy= 0.458683
Thermal correction to Enthalpy= 0.460023
Thermal correction to Gibbs Free Energy= 0.307630
Sum of electronic and zero-point Energies= -1641.056665
Sum of electronic and thermal Energies= -1641.006443
Sum of electronic and thermal Enthalpies= -1641.005103
Sum of electronic and thermal Free Energies= -1641.157496

1	C	-3.4310170	-0.6370850	0.5993840

2	C	-2.3488160	-0.0885810	-0.0762320
3	N	-2.2182970	-0.8858780	-1.1710130
4	N	-3.1531470	-1.8567180	-1.1721100
5	N	-3.8903120	-1.7070010	-0.1078200
6	S	-4.2265540	-0.0378250	2.0567540
7	C	-1.2156560	-0.7887200	-2.2583150
8	H	-0.8589060	0.2403920	-2.2066170
9	C	-1.8802810	-1.0087990	-3.6210850
10	H	-2.2539080	-2.0276750	-3.7238210
11	H	-1.1420780	-0.8326620	-4.4055360
12	H	-2.7106140	-0.3140960	-3.7651090
13	C	-0.0276240	-1.7138010	-2.0253210
14	C	1.2675600	-1.1959700	-2.1157880
15	C	2.3786420	-2.0253930	-1.9599820
16	C	2.2044460	-3.3847800	-1.7049180
17	C	0.9141910	-3.9089460	-1.6114090
18	C	-0.1948980	-3.0802570	-1.7743490
19	H	1.4125660	-0.1370800	-2.3081770
20	H	3.3773120	-1.6070540	-2.0321550
21	H	3.0665450	-4.0313780	-1.5781270
22	H	0.7699500	-4.9658080	-1.4115840
23	H	-1.1927150	-3.4985970	-1.6980720
24	C	-1.5024950	1.0836880	0.2178530
25	C	-1.8598710	2.3839260	-0.2636760
26	C	-1.0234210	3.5016110	0.0545940
27	C	0.1366930	3.2869030	0.8435630
28	C	0.4620040	2.0374940	1.3014660
29	C	-0.3625110	0.9284130	0.9897600
30	C	-3.0193120	2.6170900	-1.0516430
31	C	-1.3721960	4.7921950	-0.4206440
32	H	0.7730550	4.1320390	1.0859640
33	H	1.3509450	1.8863550	1.9062660
34	C	-3.3300390	3.8824620	-1.4969730
35	H	-4.2216300	4.0362110	-2.0960890
36	C	-2.5016860	4.9837370	-1.1817920
37	H	-0.7287450	5.6304450	-0.1710570
38	H	-2.7597670	5.9744720	-1.5402030
39	H	-3.6709760	1.7873700	-1.3015910
40	O	-0.0566640	-0.3198540	1.4402300
41	H	0.7612550	-0.3094000	1.9540460
42	C	-3.4603140	-0.9806430	3.3896700
43	C	-3.4382930	-0.3805310	4.6531100
44	C	-2.9191220	-1.0765260	5.7442360
45	C	-2.4074510	-2.3638290	5.5803490
46	C	-2.4270150	-2.9553400	4.3168370
47	C	-2.9603760	-2.2744500	3.2228070

48	H	-3.8161390	0.6282970	4.7844680
49	H	-2.9050770	-0.6031570	6.7205930
50	H	-1.9965600	-2.9006660	6.4286580
51	H	-2.0340290	-3.9574690	4.1786610
52	H	-2.9838840	-2.7496890	2.2493590

Ground state 1 (GS_1)

Method: B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.5287394 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: 14.5253

Zero-point correction=	0.409284 (Hartree/Particle)
Thermal correction to Energy=	0.459008
Thermal correction to Enthalpy=	0.460347
Thermal correction to Gibbs Free Energy=	0.312566
Sum of electronic and zero-point Energies=	-1641.119455
Sum of electronic and thermal Energies=	-1641.069731
Sum of electronic and thermal Enthalpies=	-1641.068392
Sum of electronic and thermal Free Energies=	-1641.216173

1	C	-3.4234290	-1.5645060	-1.2702480
2	C	-2.3495580	-0.6844050	-1.2227500
3	N	-1.3913900	-1.3159980	-1.9653610
4	N	-1.8375590	-2.4888980	-2.4302930
5	N	-3.0673470	-2.6503590	-2.0072180
6	S	-5.0700010	-1.4067110	-0.6318330
7	C	-0.0257810	-0.8271230	-2.2606350
8	H	-0.1132840	0.2601930	-2.2267150
9	C	0.4038950	-1.2462630	-3.6679250
10	H	0.5106110	-2.3284670	-3.7432110
11	H	1.3700970	-0.7885480	-3.8866820
12	H	-0.3201940	-0.9102190	-4.4128910
13	C	0.9632310	-1.2646840	-1.1929020
14	C	1.8508600	-0.3313040	-0.6544400
15	C	2.7780220	-0.7134400	0.3139190
16	C	2.8201170	-2.0346950	0.7572870
17	C	1.9366370	-2.9727440	0.2204150
18	C	1.0159900	-2.5904590	-0.7536140
19	H	1.8071470	0.7039940	-0.9790940
20	H	3.4556600	0.0237540	0.7318650
21	H	3.5331140	-2.3317200	1.5193820
22	H	1.9619430	-4.0022170	0.5625900
23	H	0.3262350	-3.3222900	-1.1606700
24	C	-2.1720100	0.6220760	-0.5704630
25	C	-1.4881210	0.7312420	0.6817530

26	C	-1.3450360	2.0184080	1.2859790
27	C	-1.9052140	3.1489460	0.6323040
28	C	-2.5748040	3.0245190	-0.5554920
29	C	-2.7114270	1.7528830	-1.1603310
30	C	-0.9609340	-0.3956700	1.3608460
31	C	-0.6623720	2.1326600	2.5235460
32	H	-1.8023430	4.1263190	1.0933250
33	H	-3.0123240	3.8826180	-1.0528810
34	C	-0.3034730	-0.2539340	2.5601720
35	H	0.0969140	-1.1301210	3.0590010
36	C	-0.1454490	1.0206160	3.1488820
37	H	-0.5577130	3.1156460	2.9730800
38	H	0.3764720	1.1182570	4.0950220
39	H	-1.0759420	-1.3808860	0.9267150
40	O	-3.4025040	1.7253860	-2.3358950
41	H	-3.4789710	0.8180940	-2.6663310
42	C	-4.7675120	-0.5789350	0.9413110
43	C	-5.1382620	0.7595520	1.0902000
44	C	-4.9190220	1.4054440	2.3054220
45	C	-4.3305450	0.7187880	3.3672820
46	C	-3.9687830	-0.6195710	3.2167050
47	C	-4.1917780	-1.2743270	2.0072220
48	H	-5.5711410	1.2972950	0.2547080
49	H	-5.1926600	2.4493760	2.4144980
50	H	-4.1477330	1.2274440	4.3078120
51	H	-3.5038090	-1.1544910	4.0377080
52	H	-3.9057510	-2.3130870	1.8863430

First Transition State (TS_0)

Method: B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.4617104 A.U. after 2 cycles

Lowest frequency: -23.8878

Zero-point correction=	0.409136 (Hartree/Particle)
Thermal correction to Energy=	0.456880
Thermal correction to Enthalpy=	0.458220
Thermal correction to Gibbs Free Energy=	0.317701
Sum of electronic and zero-point Energies=	-1641.052576
Sum of electronic and thermal Energies=	-1641.004830
Sum of electronic and thermal Enthalpies=	-1641.003490
Sum of electronic and thermal Free Energies=	-1641.144009

1	C	-3.4700530	-0.0453190	-1.3536670
2	C	-2.2864280	0.4298940	-0.7133510
3	N	-1.3303120	-0.3726450	-1.3661530
4	N	-1.9065160	-1.2164120	-2.2465230

5	N	-3.1804920	-1.0230890	-2.2388820
6	S	-5.1500890	-0.1158310	-0.7209100
7	C	0.1055820	-0.6867030	-1.1363980
8	H	0.6135920	0.2562230	-0.9875730
9	C	0.7462570	-1.3297860	-2.3743290
10	H	0.3660660	-2.3313240	-2.5647250
11	H	1.8208890	-1.3948050	-2.1932010
12	H	0.5843150	-0.7137950	-3.2604440
13	C	0.2721070	-1.5605460	0.1013200
14	C	1.5439880	-1.6633220	0.6789630
15	C	1.7541880	-2.4631300	1.7996390
16	C	0.6919270	-3.1732700	2.3627510
17	C	-0.5765900	-3.0749870	1.7944810
18	C	-0.7857340	-2.2741230	0.6705410
19	H	2.3738390	-1.1047330	0.2568920
20	H	2.7452480	-2.5259530	2.2370370
21	H	0.8524830	-3.7925080	3.2390920
22	H	-1.4139600	-3.6148250	2.2236570
23	H	-1.7843240	-2.2123650	0.2539960
24	C	-1.9761230	1.7938050	-0.1661430
25	C	-0.6205630	2.3519410	-0.1035420
26	C	-0.3290890	3.6956330	-0.4775050
27	C	-1.4091830	4.5804780	-0.7429430
28	C	-2.6778300	4.1537030	-0.5146500
29	C	-2.9758890	2.7857650	-0.2347340
30	C	0.4104390	1.6619300	0.5821440
31	C	1.0023520	4.1759960	-0.4182530
32	H	-1.2101020	5.6051170	-1.0389360
33	H	-3.5279690	4.8175070	-0.6207890
34	C	1.6905860	2.1662740	0.6945550
35	H	2.4422480	1.6022510	1.2368460
36	C	2.0104540	3.4172940	0.1348970
37	H	1.2002410	5.1874540	-0.7595980
38	H	3.0207930	3.8063530	0.1998000
39	H	0.1717930	0.7296820	1.0767100
40	O	-4.3072420	2.6005940	-0.1766650
41	H	-4.5932470	1.6799800	0.0066590
42	C	-4.8804850	-1.3849780	0.5412850
43	C	-4.8213630	-1.0192850	1.8878510
44	C	-4.5774240	-1.9936700	2.8561850
45	C	-4.3864910	-3.3231170	2.4806560
46	C	-4.4500790	-3.6834920	1.1337120
47	C	-4.7040550	-2.7181640	0.1607790
48	H	-4.9541580	0.0167710	2.1789250
49	H	-4.5273600	-1.7092980	3.9018230
50	H	-4.1869520	-4.0766940	3.2349780
51	H	-4.3015120	-4.7164910	0.8378400
52	H	-4.7450030	-2.9925470	-0.8866800

Second Transition State (TS_{180})

Method: B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d)

SCF Done: E(RB3LYP) = -1641.4393757 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: -31.9143

Zero-point correction=	0.408314 (Hartree/Particle)
Thermal correction to Energy=	0.456825
Thermal correction to Enthalpy=	0.458165
Thermal correction to Gibbs Free Energy=	0.313121
Sum of electronic and zero-point Energies=	-1641.031062
Sum of electronic and thermal Energies=	-1640.982551
Sum of electronic and thermal Enthalpies=	-1640.981211
Sum of electronic and thermal Free Energies=	-1641.126255

1	C	-2.2060350	-0.7797190	1.0003250
2	C	-1.7944610	0.0637650	-0.0713340
3	N	-1.3575630	-0.9958940	-0.9560910
4	N	-1.7438270	-2.1991630	-0.5353170
5	N	-2.2750970	-2.0782910	0.6384570
6	S	-3.0636340	-0.3234600	2.5069990
7	C	-0.2274450	-1.1165810	-1.9366400
8	H	-0.0100370	-0.1313480	-2.3129670
9	C	-0.6863220	-1.9692030	-3.1267870
10	H	-0.8740330	-3.0009840	-2.8324920
11	H	0.0779390	-1.9648380	-3.9043310
12	H	-1.5995760	-1.5499950	-3.5519370
13	C	1.0617780	-1.6142750	-1.2749240
14	C	2.1934930	-1.7723700	-2.0895390
15	C	3.4141530	-2.1790080	-1.5559460
16	C	3.5353260	-2.4273440	-0.1882940
17	C	2.4243260	-2.2562530	0.6333360
18	C	1.2002720	-1.8510830	0.0959070
19	H	2.1302000	-1.5701230	-3.1535470
20	H	4.2716690	-2.2972450	-2.2105920
21	H	4.4849580	-2.7441190	0.2301930
22	H	2.5031200	-2.4359620	1.7007760
23	H	0.3624880	-1.7216380	0.7678350
24	C	-0.9601670	1.3010620	-0.2474410
25	C	-1.0142400	2.4201600	0.7093250
26	C	-0.7310460	3.7745410	0.3470900
27	C	-0.4277670	4.0782070	-1.0036480
28	C	-0.5416210	3.1024560	-1.9442490
29	C	-1.0028790	1.8115250	-1.5758010
30	C	-1.1092700	2.1639530	2.1023460
31	C	-0.7325380	4.7973260	1.3284440

32	H	-0.1509270	5.0893730	-1.2828150
33	H	-0.4089020	3.3290000	-2.9983350
34	C	-1.1110570	3.1696910	3.0456430
35	H	-1.2040870	2.9166990	4.0968190
36	C	-0.9498590	4.5134050	2.6565730
37	H	-0.5406110	5.8164620	1.0073010
38	H	-0.9529970	5.3048410	3.3981790
39	H	-1.1323440	1.1421800	2.4494770
40	O	-1.6092340	1.1012540	-2.5672960
41	H	-1.5808040	1.5884800	-3.4015010
42	C	-4.5479110	-1.3405140	2.4423820
43	C	-5.4538750	-1.2363380	1.3815110
44	C	-6.6317770	-1.9785930	1.4026650
45	C	-6.9232430	-2.8083780	2.4883590
46	C	-6.0261050	-2.8985620	3.5508070
47	C	-4.8338990	-2.1719070	3.5274300
48	H	-5.2382360	-0.5821920	0.5438140
49	H	-7.3290480	-1.9002480	0.5749040
50	H	-7.8453600	-3.3796620	2.5038230
51	H	-6.2435760	-3.5430030	4.3962060
52	H	-4.1281280	-2.2566390	4.3464340

Ground state 2 (GS_2)

Method: B3LYP-GD3/6-311+G(2d,2p)//B3LYP-GD3/6-311+G(d)

SCF Done: E(RB3LYP) = -1641. 5258446 A.U. after 2 cycles

Integration grid: FineGrid

Lowest frequency: 13.3876

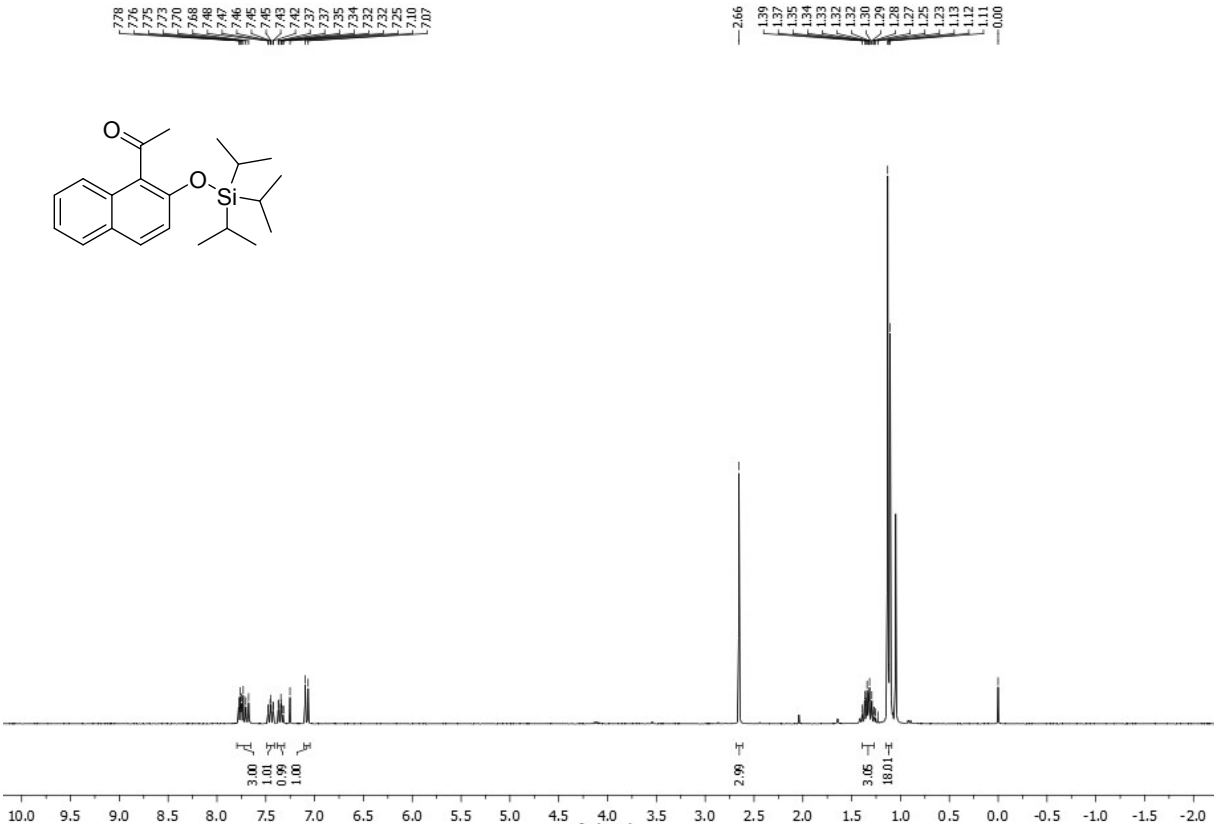
Zero-point correction= 0.409026 (Hartree/Particle)
Thermal correction to Energy= 0.458983
Thermal correction to Enthalpy= 0.460322
Thermal correction to Gibbs Free Energy= 0.310880
Sum of electronic and zero-point Energies= -1641.116819
Sum of electronic and thermal Energies= -1641.006862
Sum of electronic and thermal Enthalpies= -1641.065523
Sum of electronic and thermal Free Energies= -1641.214965

1	C	-3.4310170	-0.6370850	0.5993840
2	C	-2.3488160	-0.0885810	-0.0762320
3	N	-2.2182970	-0.8858780	-1.1710130
4	N	-3.1531470	-1.8567180	-1.1721100
5	N	-3.8903120	-1.7070010	-0.1078200
6	S	-4.2265540	-0.0378250	2.0567540
7	C	-1.2156560	-0.7887200	-2.2583150
8	H	-0.8589060	0.2403920	-2.2066170
9	C	-1.8802810	-1.0087990	-3.6210850

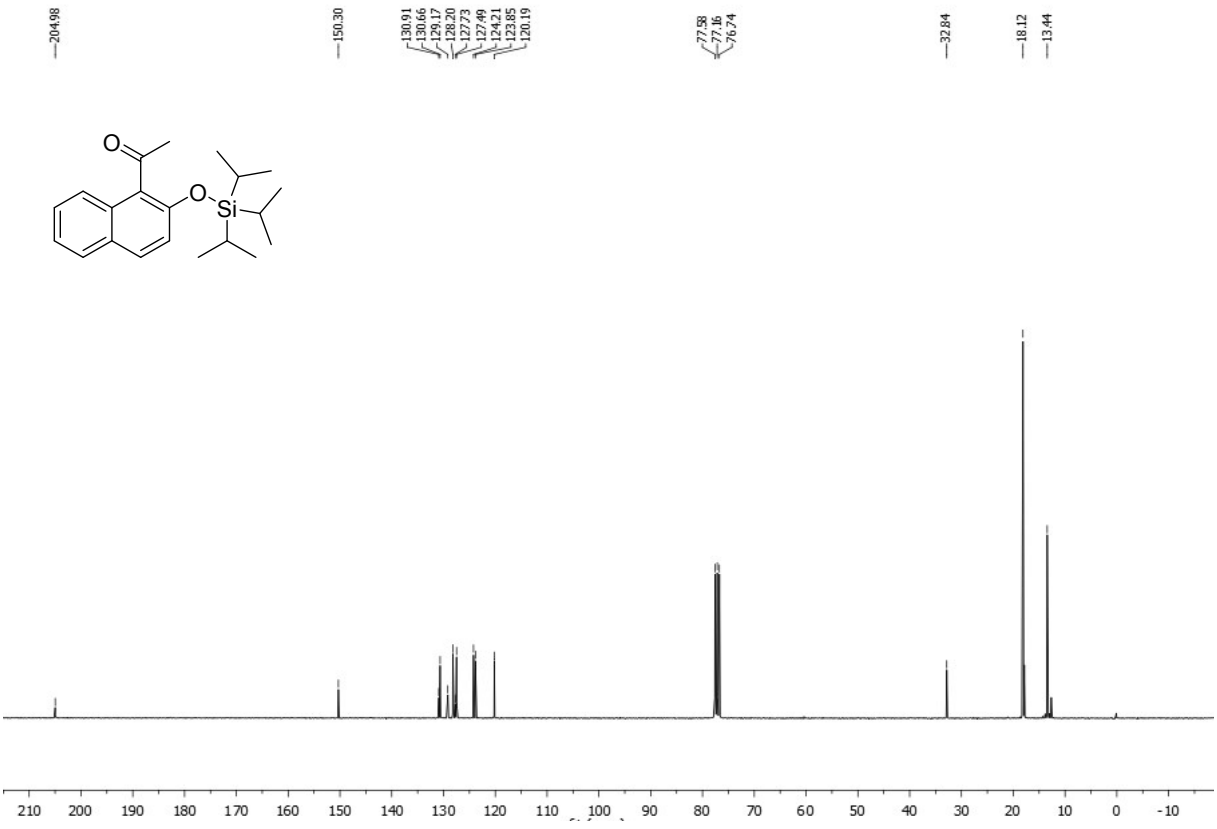
10	H	-2.2539080	-2.0276750	-3.7238210
11	H	-1.1420780	-0.8326620	-4.4055360
12	H	-2.7106140	-0.3140960	-3.7651090
13	C	-0.0276240	-1.7138010	-2.0253210
14	C	1.2675600	-1.1959700	-2.1157880
15	C	2.3786420	-2.0253930	-1.9599820
16	C	2.2044460	-3.3847800	-1.7049180
17	C	0.9141910	-3.9089460	-1.6114090
18	C	-0.1948980	-3.0802570	-1.7743490
19	H	1.4125660	-0.1370800	-2.3081770
20	H	3.3773120	-1.6070540	-2.0321550
21	H	3.0665450	-4.0313780	-1.5781270
22	H	0.7699500	-4.9658080	-1.4115840
23	H	-1.1927150	-3.4985970	-1.6980720
24	C	-1.5024950	1.0836880	0.2178530
25	C	-1.8598710	2.3839260	-0.2636760
26	C	-1.0234210	3.5016110	0.0545940
27	C	0.1366930	3.2869030	0.8435630
28	C	0.4620040	2.0374940	1.3014660
29	C	-0.3625110	0.9284130	0.9897600
30	C	-3.0193120	2.6170900	-1.0516430
31	C	-1.3721960	4.7921950	-0.4206440
32	H	0.7730550	4.1320390	1.0859640
33	H	1.3509450	1.8863550	1.9062660
34	C	-3.3300390	3.8824620	-1.4969730
35	H	-4.2216300	4.0362110	-2.0960890
36	C	-2.5016860	4.9837370	-1.1817920
37	H	-0.7287450	5.6304450	-0.1710570
38	H	-2.7597670	5.9744720	-1.5402030
39	H	-3.6709760	1.7873700	-1.3015910
40	O	-0.0566640	-0.3198540	1.4402300
41	H	0.7612550	-0.3094000	1.9540460
42	C	-3.4603140	-0.9806430	3.3896700
43	C	-3.4382930	-0.3805310	4.6531100
44	C	-2.9191220	-1.0765260	5.7442360
45	C	-2.4074510	-2.3638290	5.5803490
46	C	-2.4270150	-2.9553400	4.3168370
47	C	-2.9603760	-2.2744500	3.2228070
48	H	-3.8161390	0.6282970	4.7844680
49	H	-2.9050770	-0.6031570	6.7205930
50	H	-1.9965600	-2.9006660	6.4286580
51	H	-2.0340290	-3.9574690	4.1786610
52	H	-2.9838840	-2.7496890	2.2493590

7 Copies of the NMR spectra

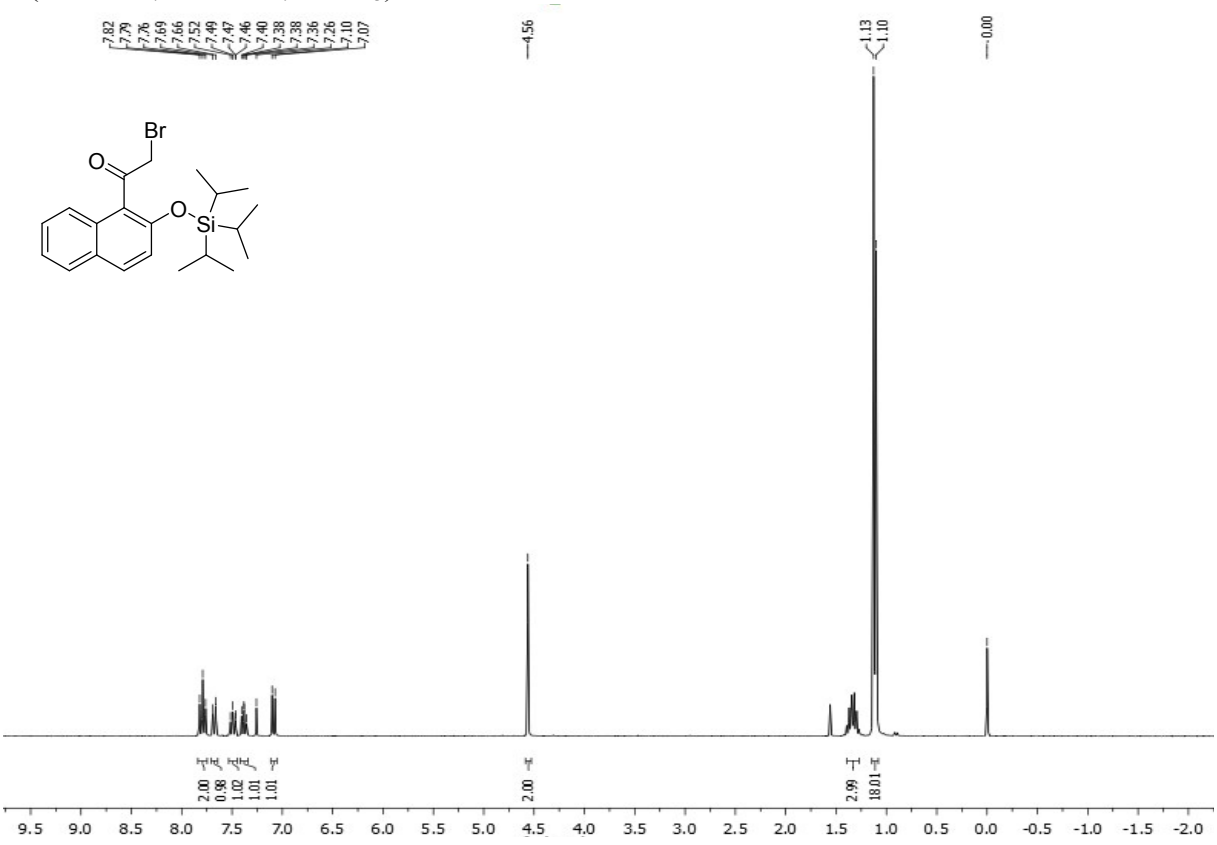
2 (^{1}H NMR, 300MHz, $CDCl_3$)



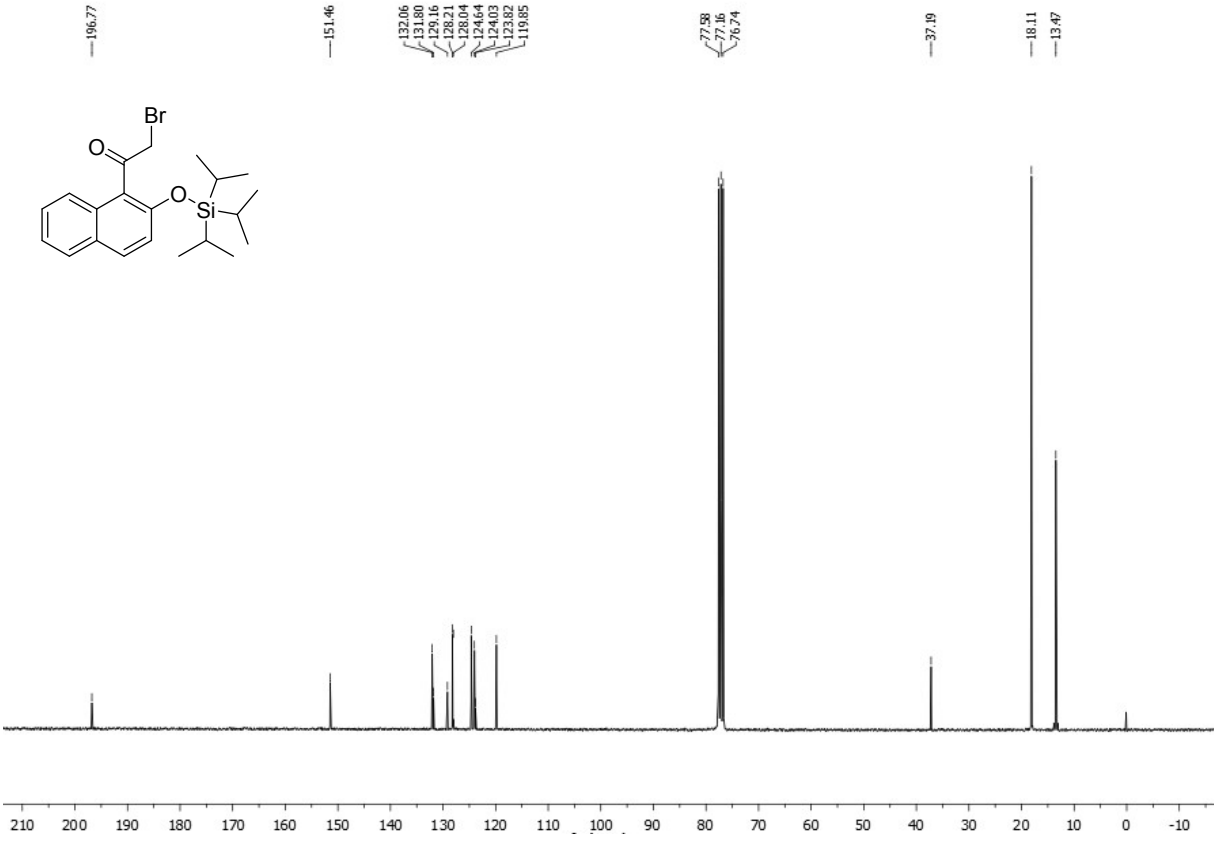
2 (^{13}C NMR, 75 MHz, $CDCl_3$)



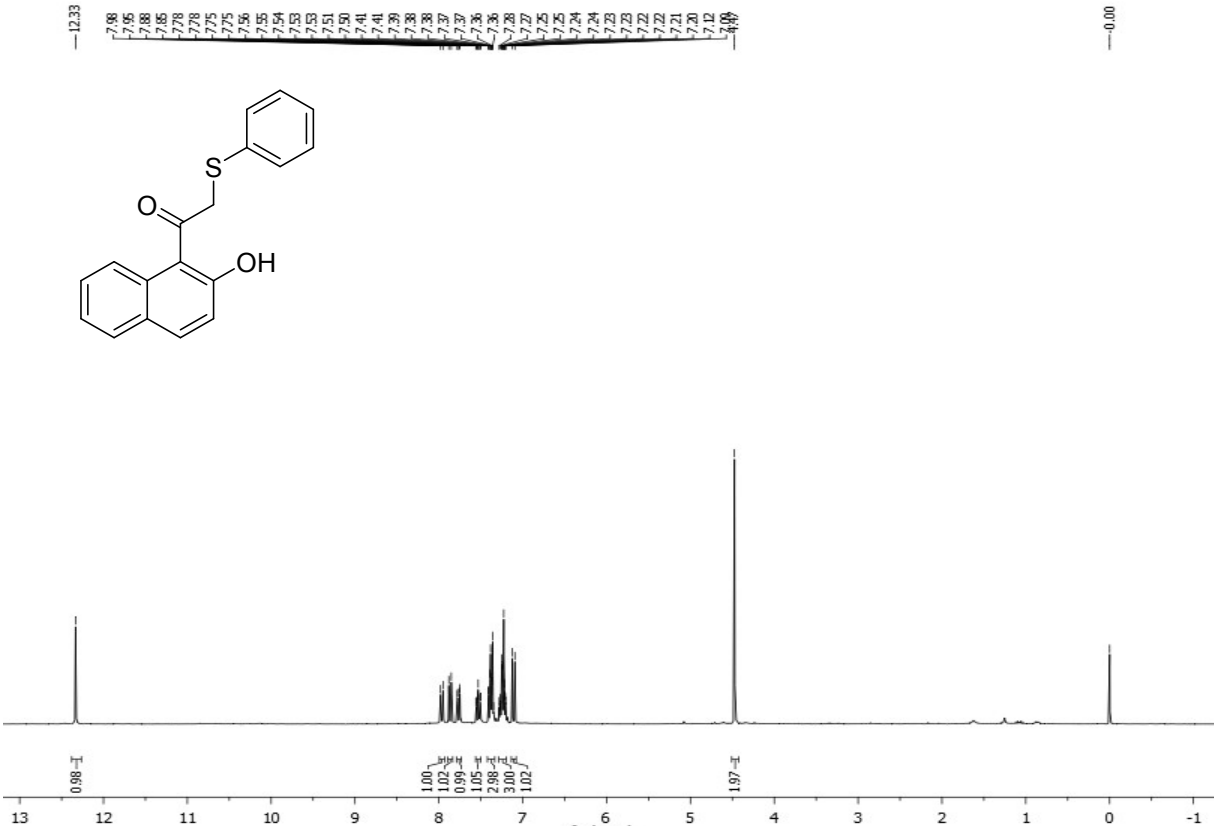
3 (^{1}H NMR, 300MHz, $CDCl_3$)



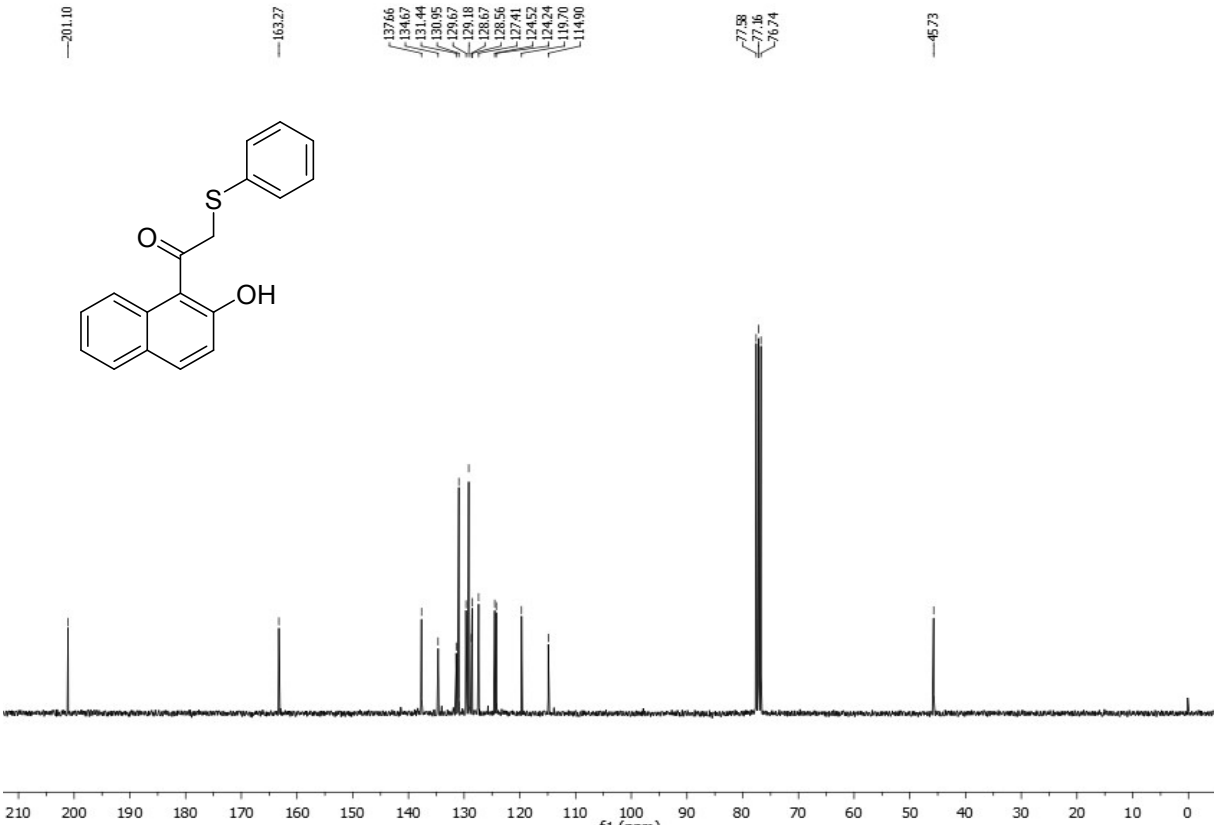
3 (^{13}C NMR, 75 MHz, $CDCl_3$)



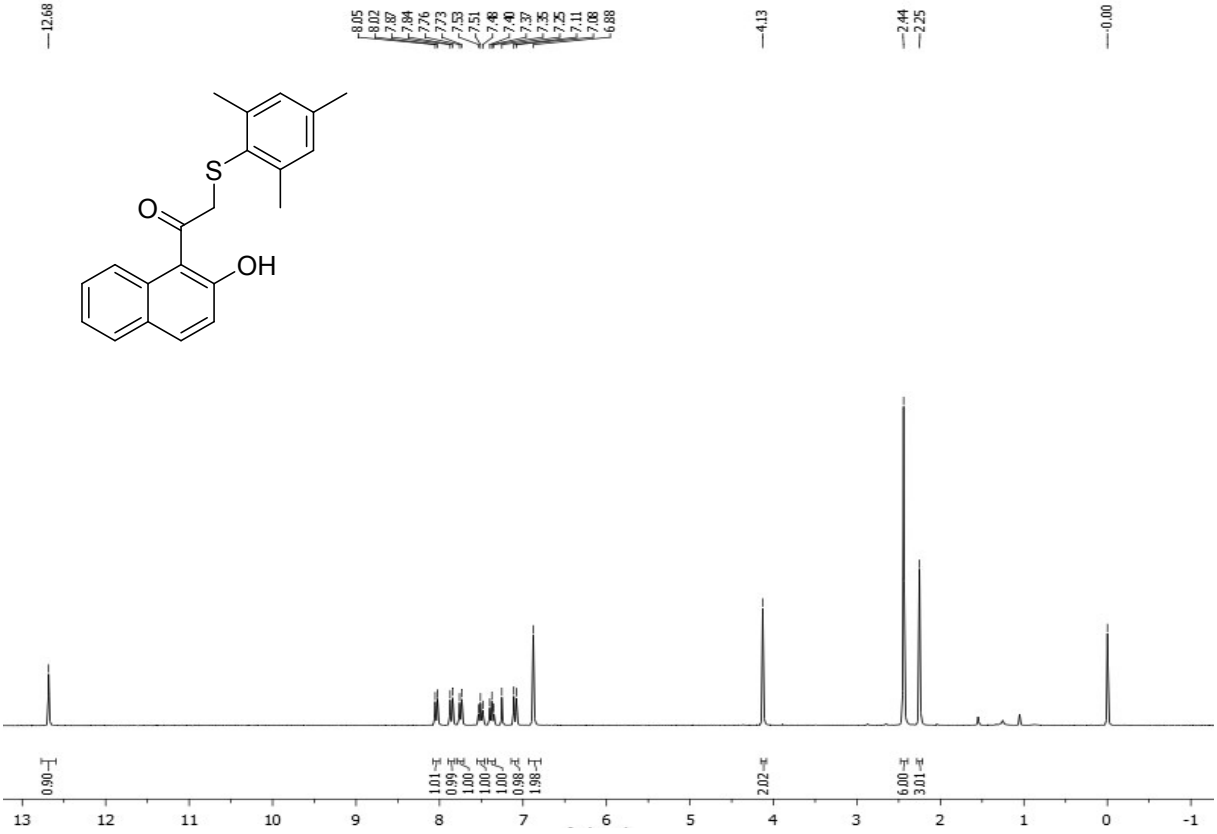
4a (^{1}H NMR, 300MHz, $CDCl_3$)



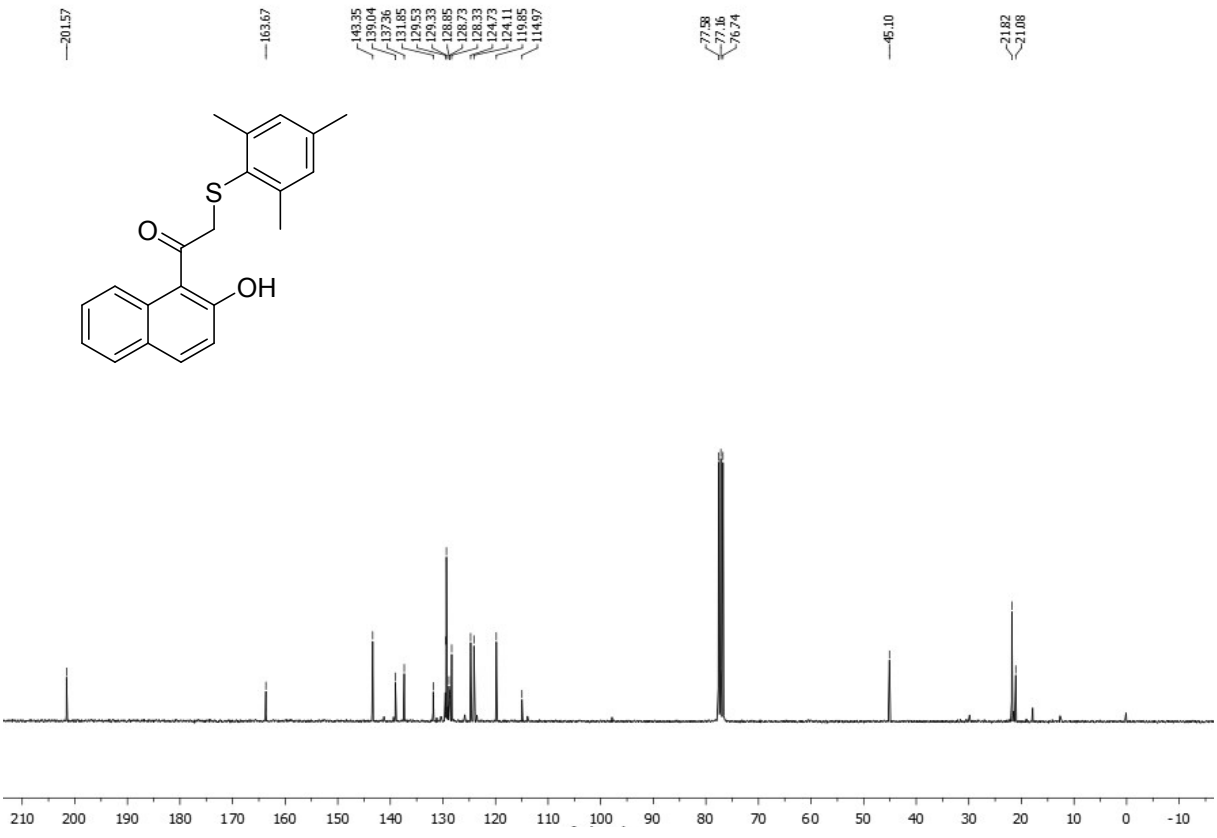
4a (^{13}C NMR, 75 MHz, $CDCl_3$)



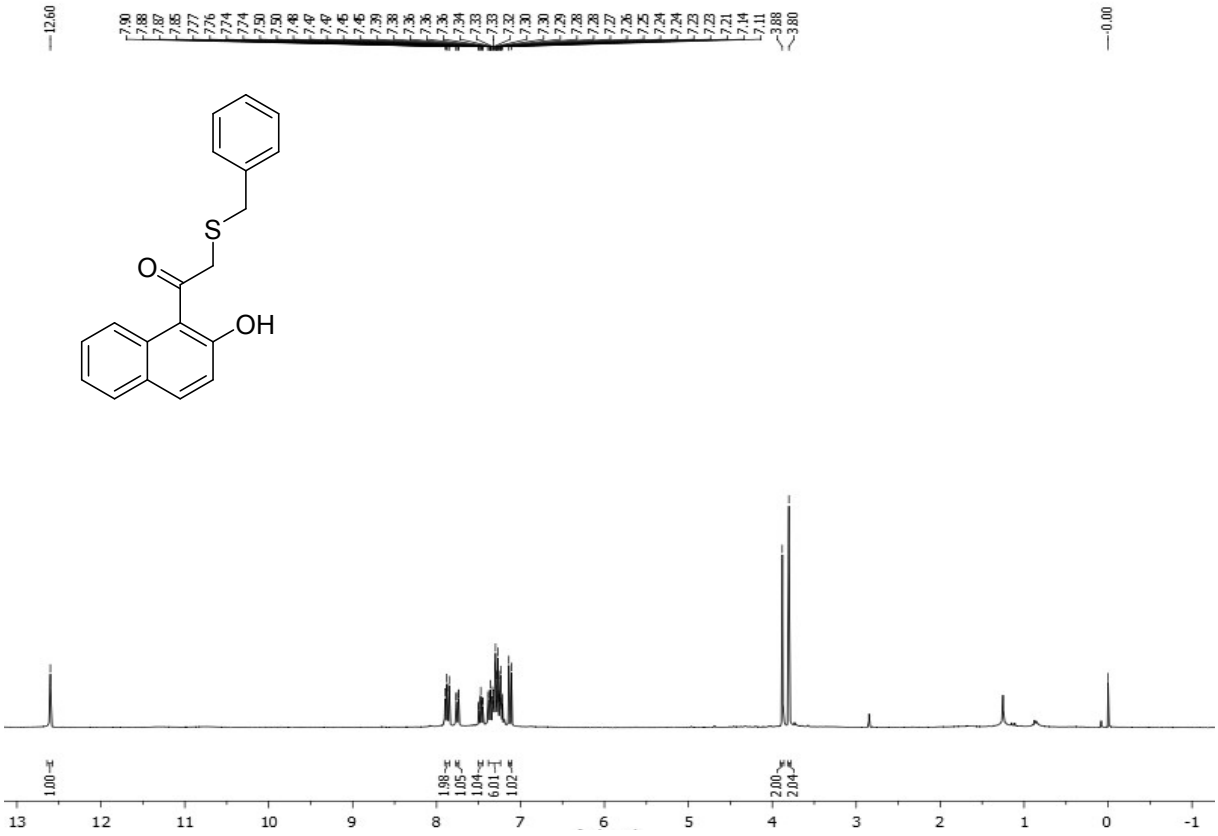
4b (^{1}H NMR, 300MHz, $CDCl_3$)



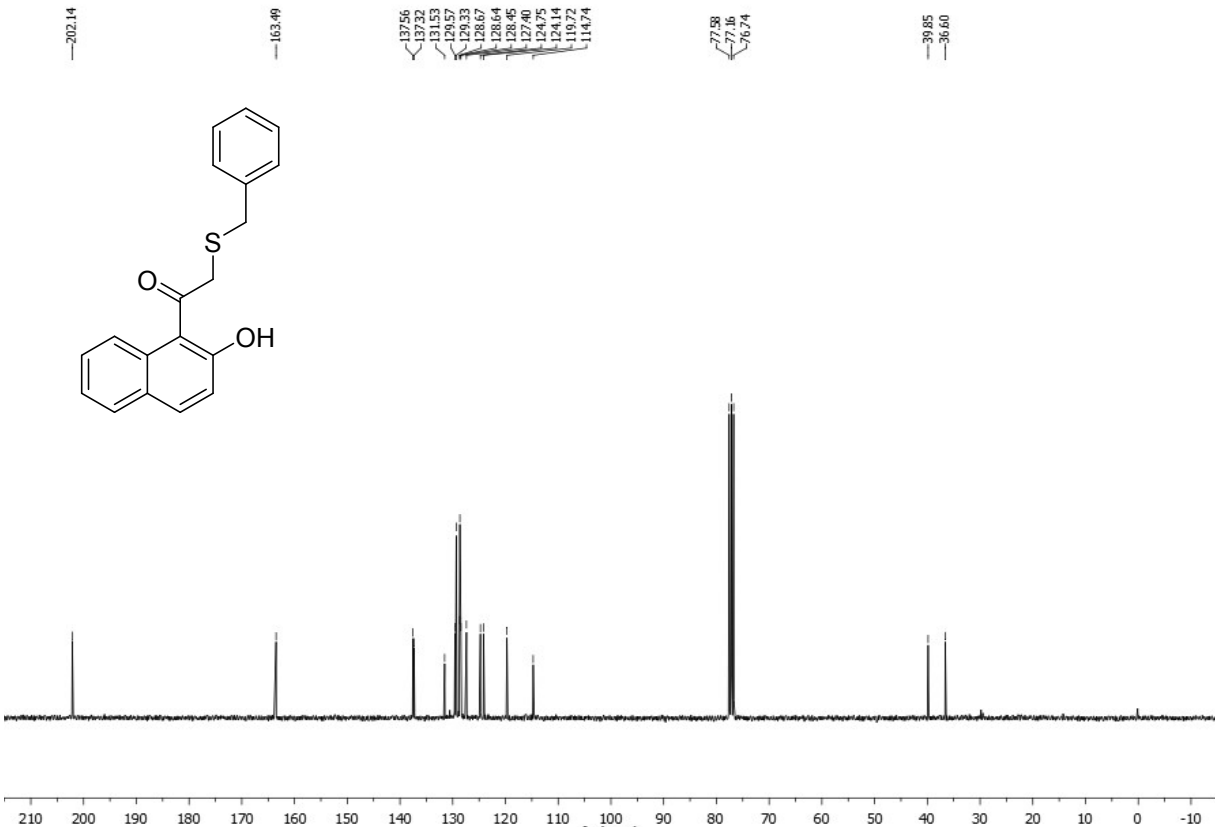
4b (^{13}C NMR, 75 MHz, $CDCl_3$)



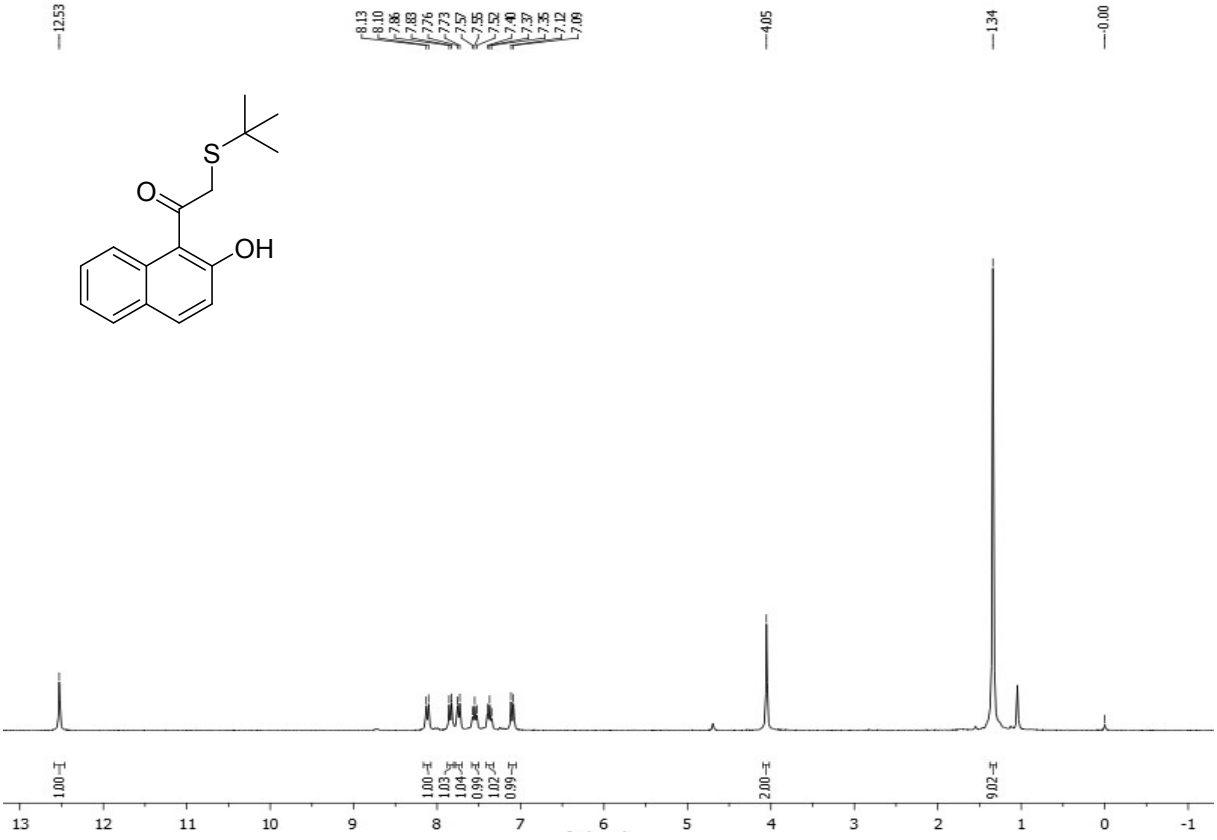
4c (^{1}H NMR, 300MHz, $CDCl_3$)



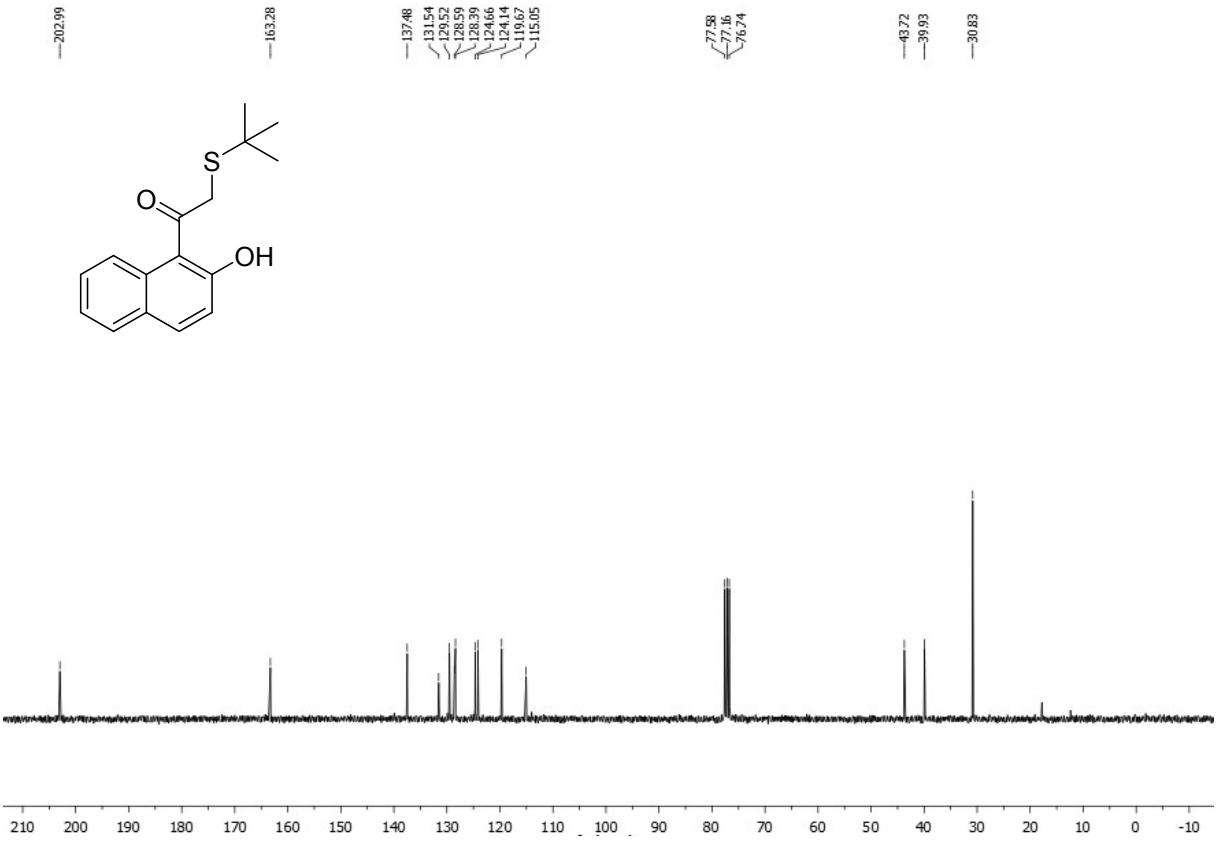
4c (^{13}C NMR, 75 MHz, $CDCl_3$)



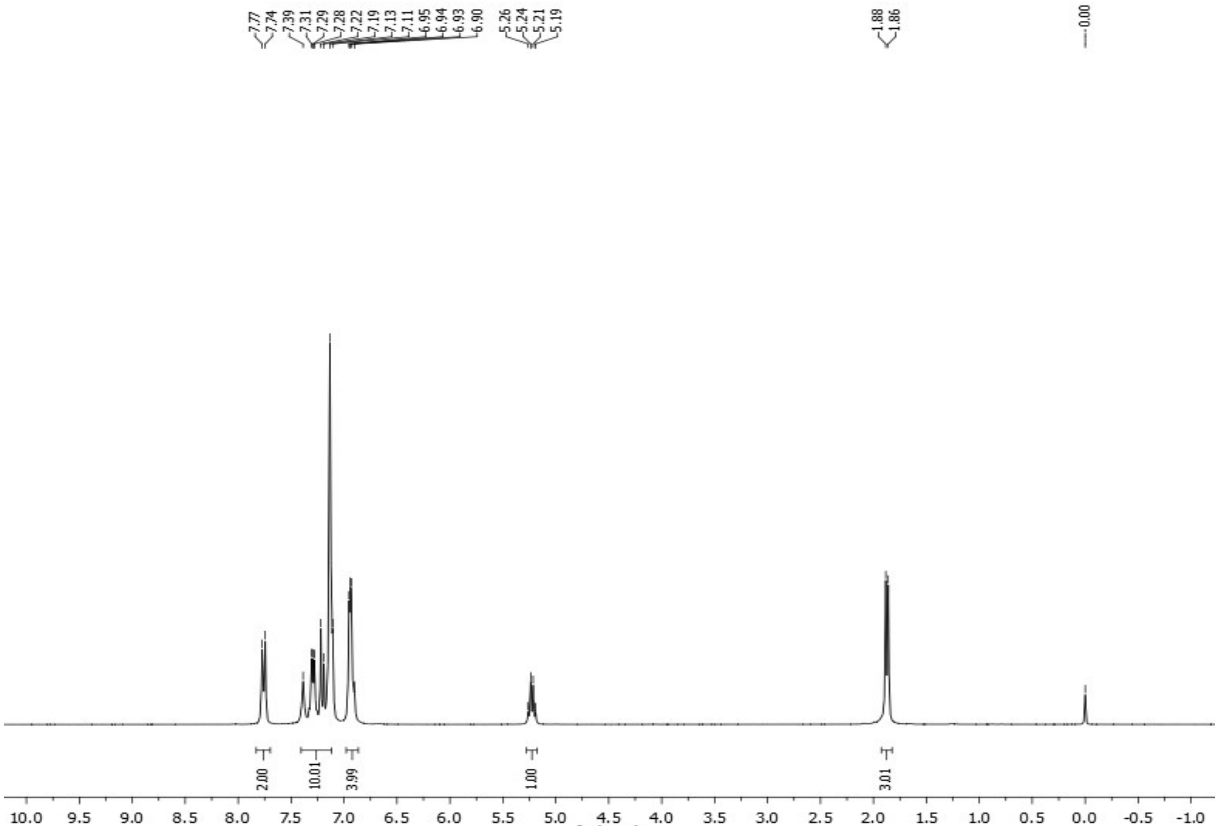
4d (^{1}H NMR, 300MHz, $CDCl_3$)



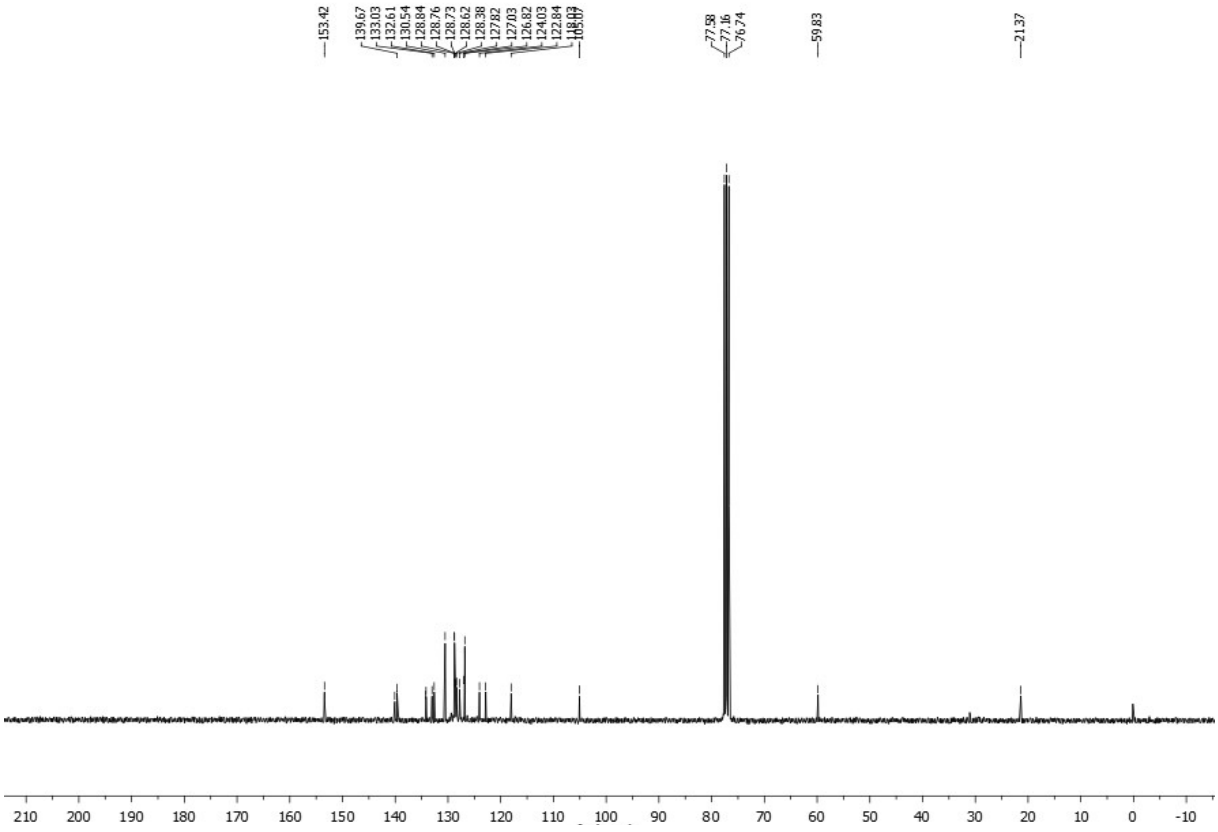
4d (^{13}C NMR, 75 MHz, $CDCl_3$)



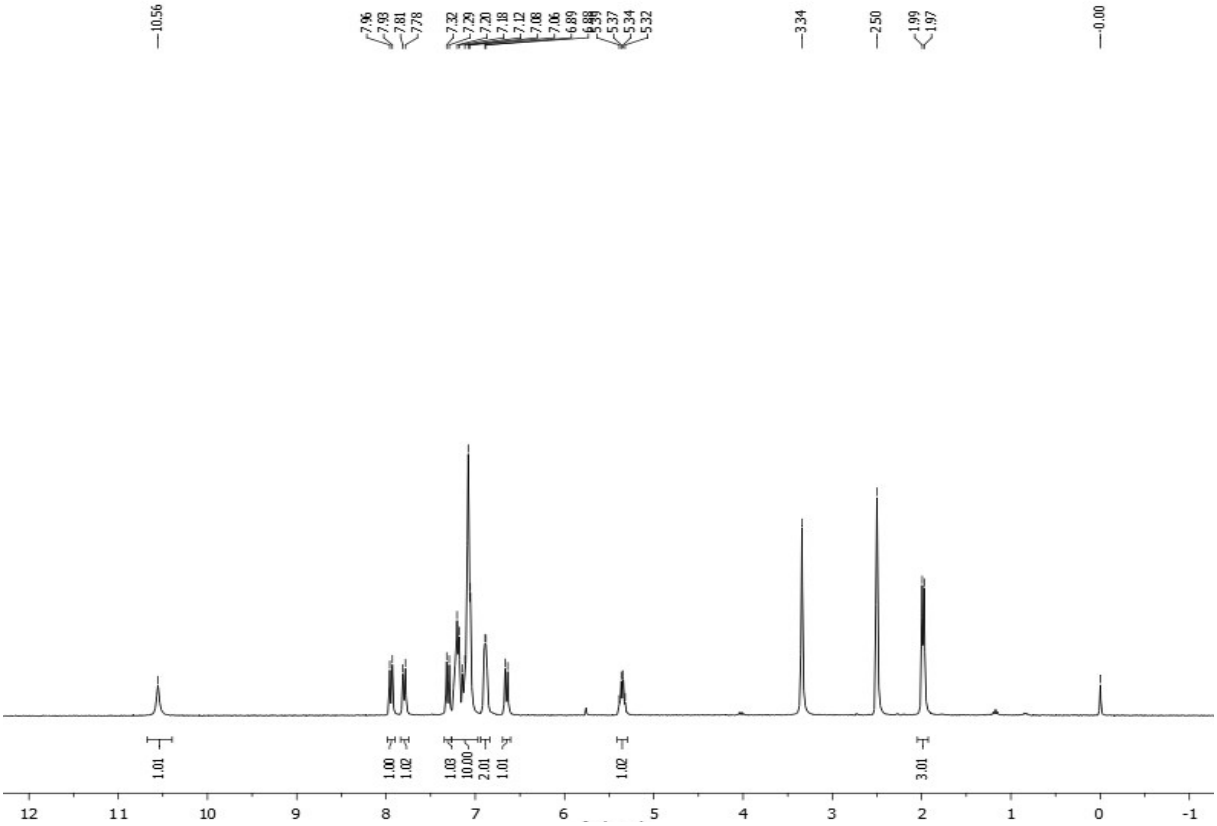
7a-1 (^{1}H NMR, 300MHz, $CDCl_3$)



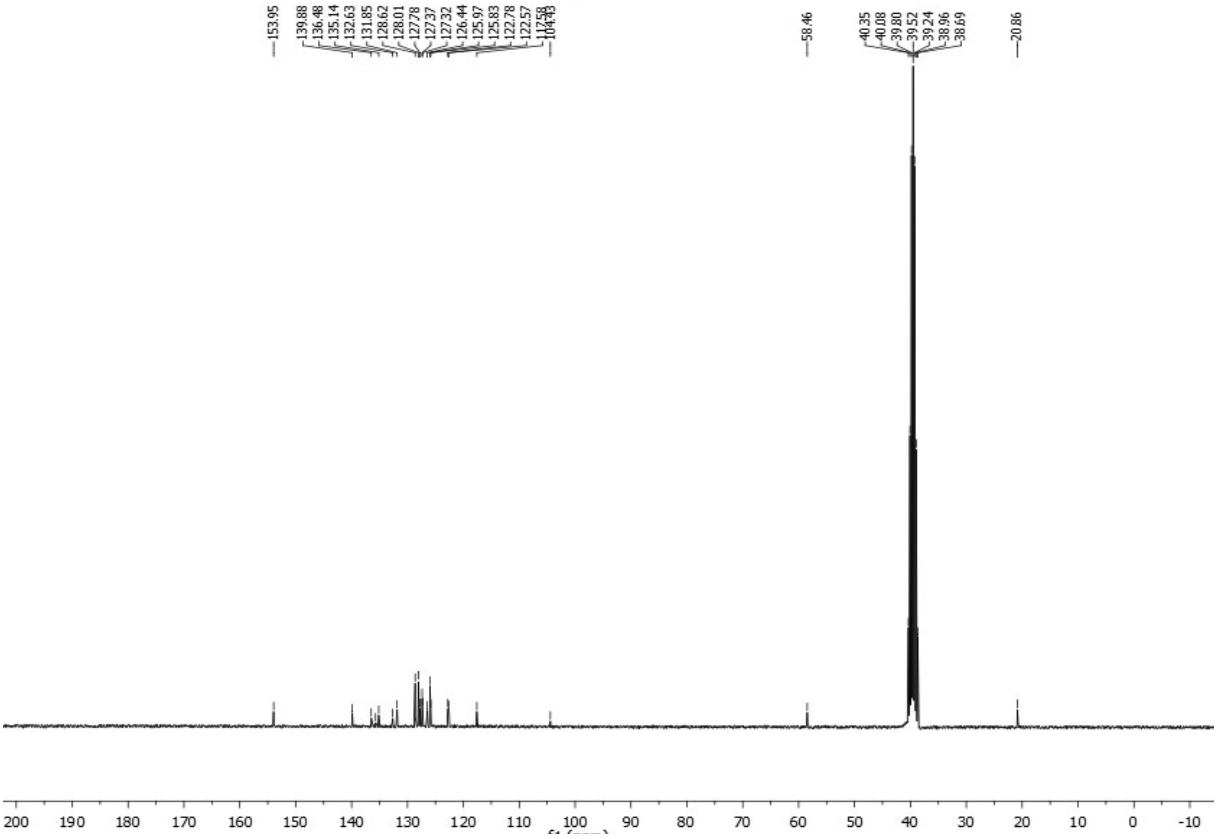
7a-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



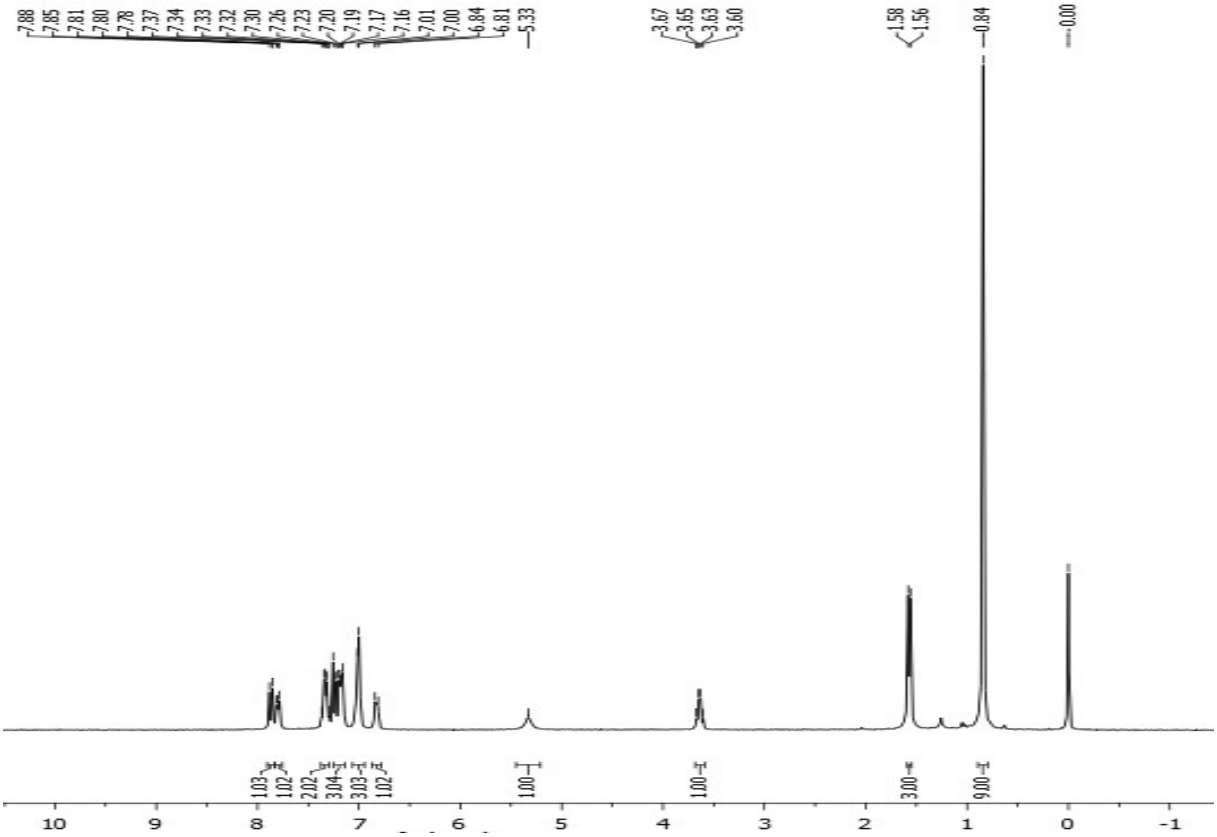
7a-2 (^{1}H NMR, 300MHz, DMSO-d_6)



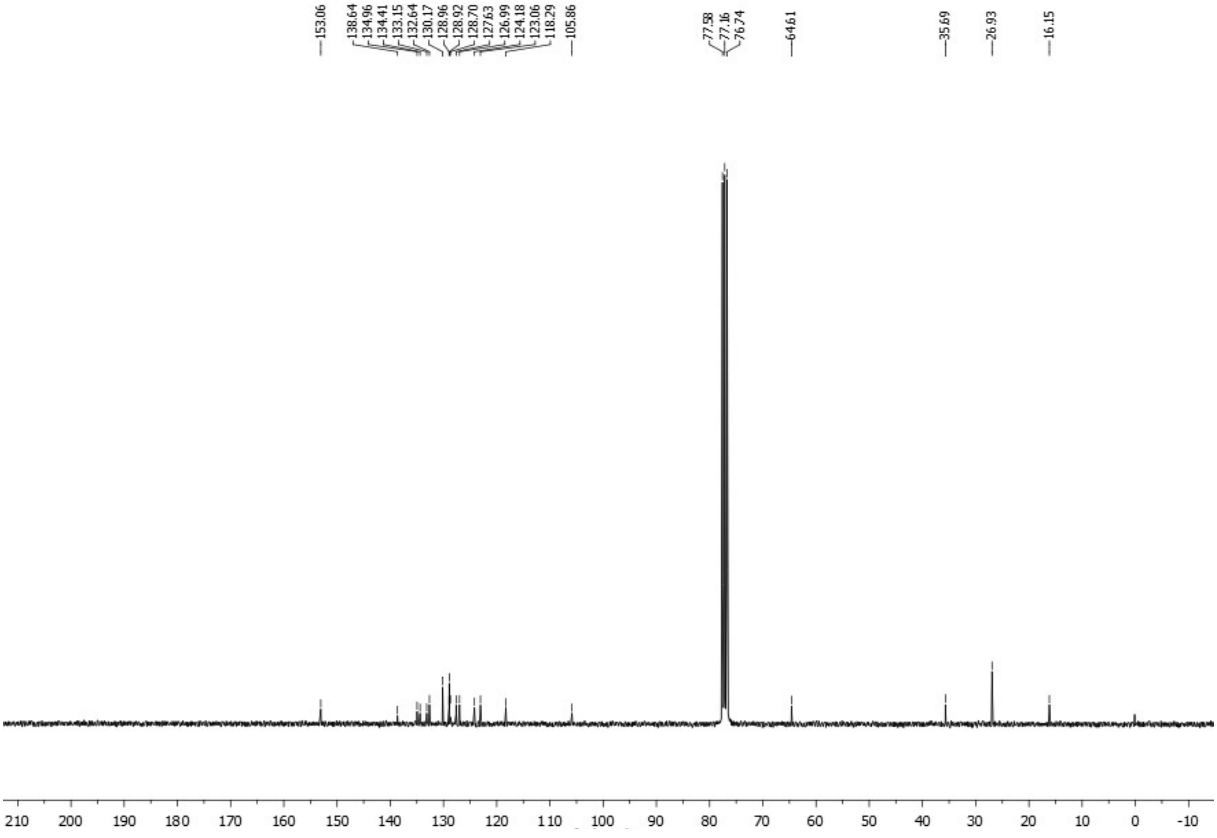
7a-2 (^{13}C NMR, 75 MHz, DMSO-d_6)



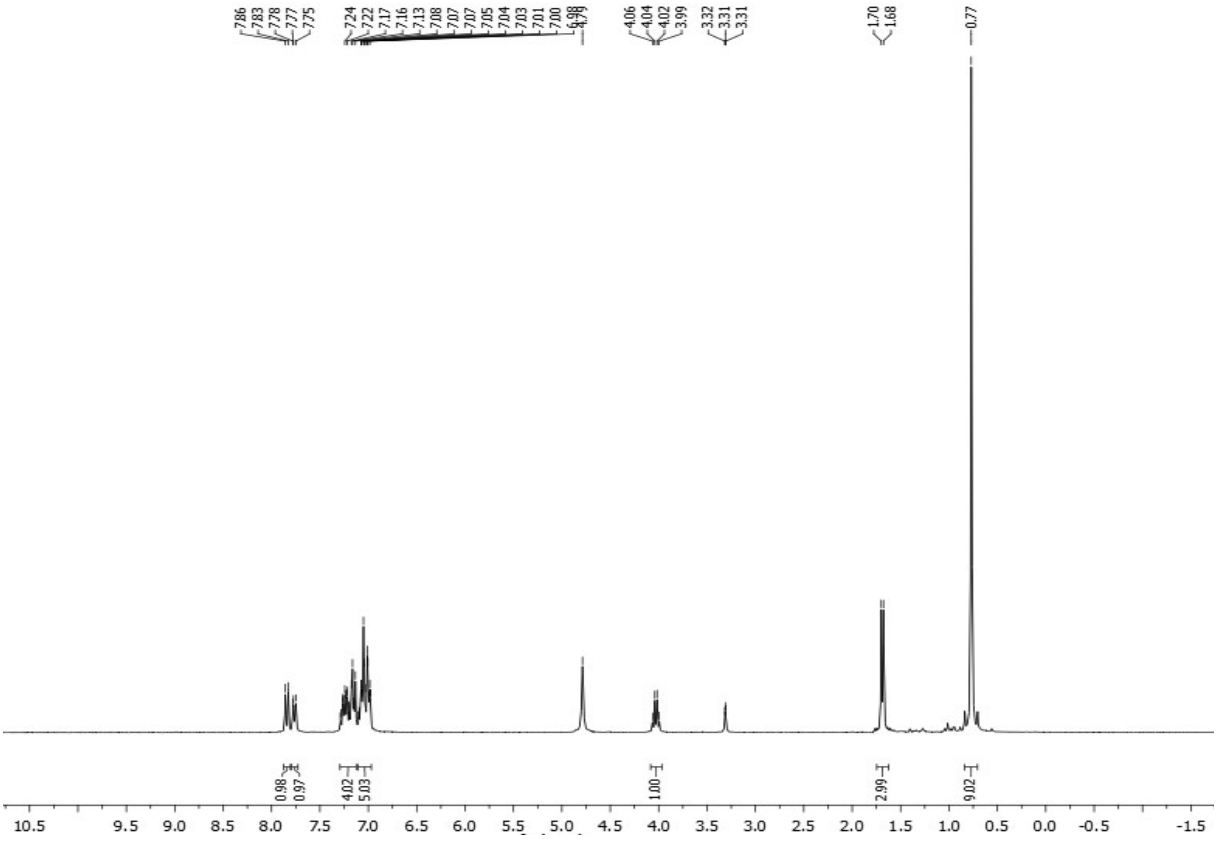
7b-1 (^{1}H NMR, 300MHz, $CDCl_3$)



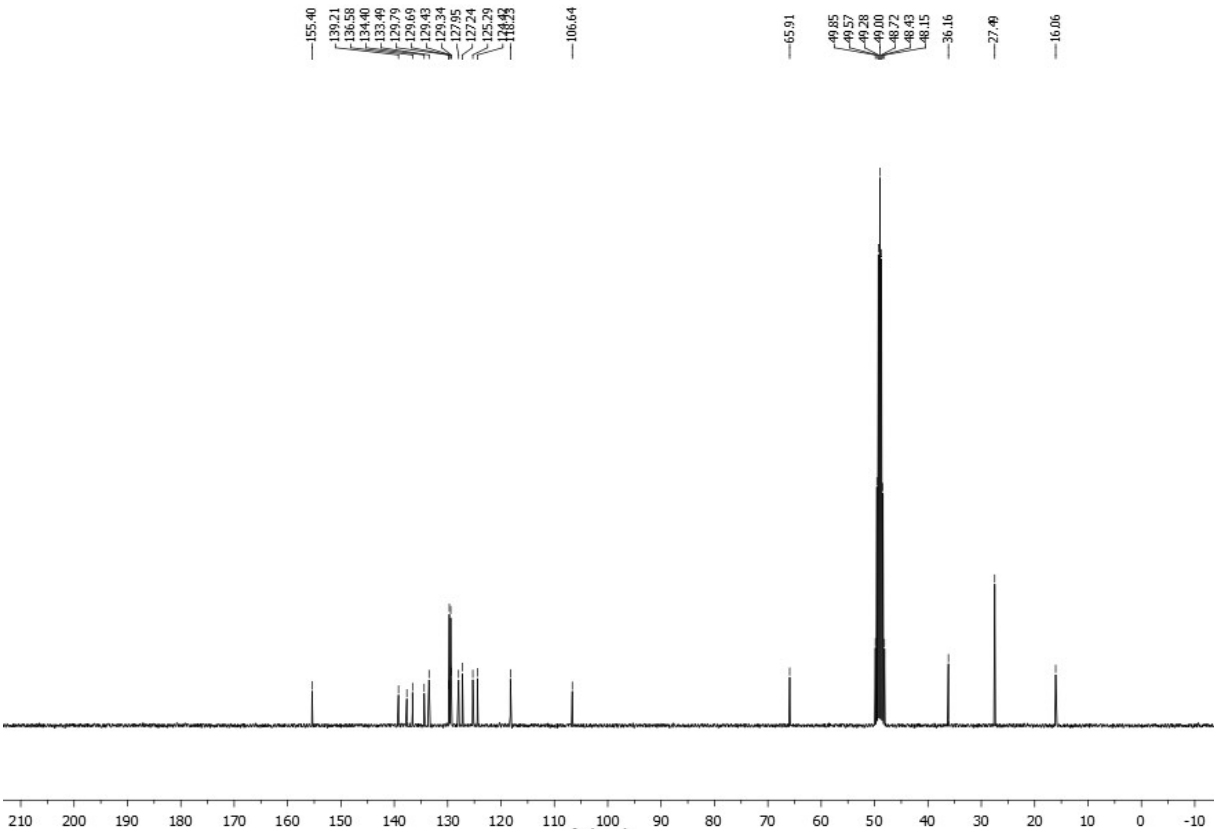
7b-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



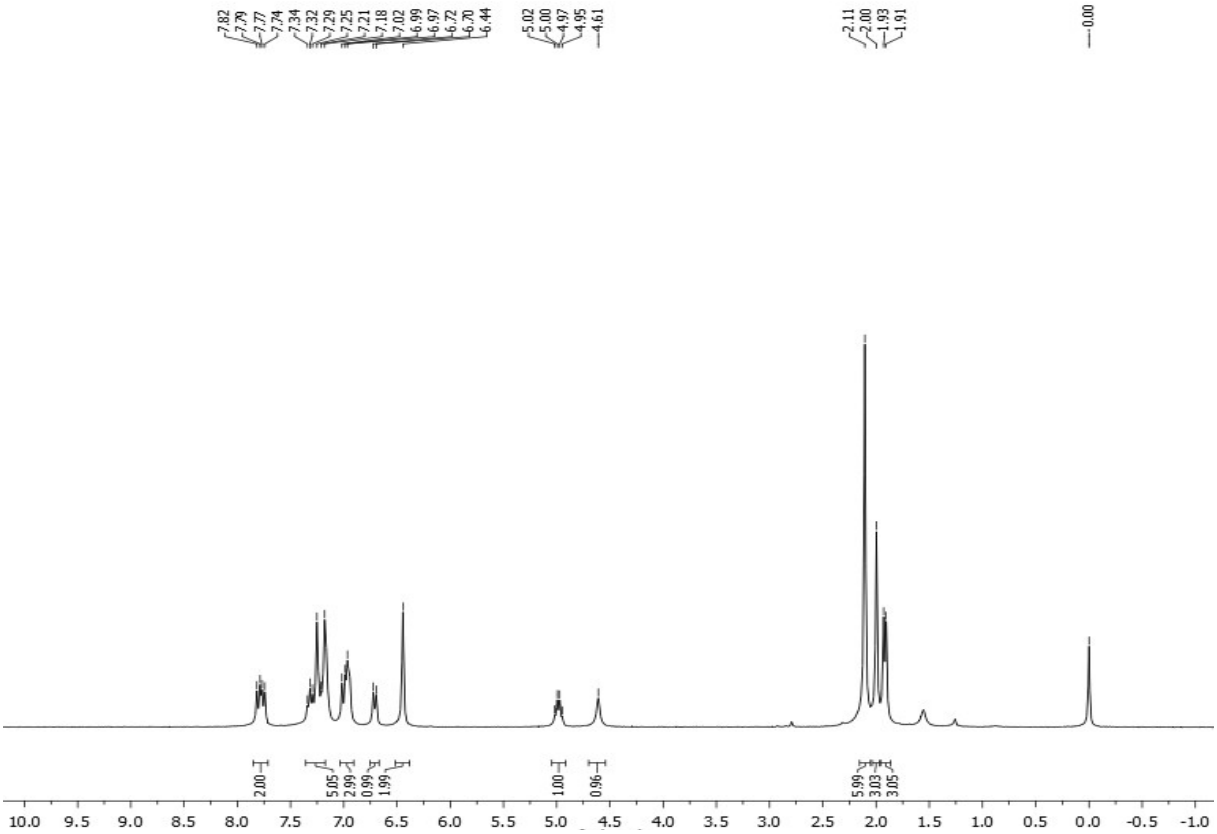
7b-2 (^{1}H NMR, 300MHz, MeOH-d_4)



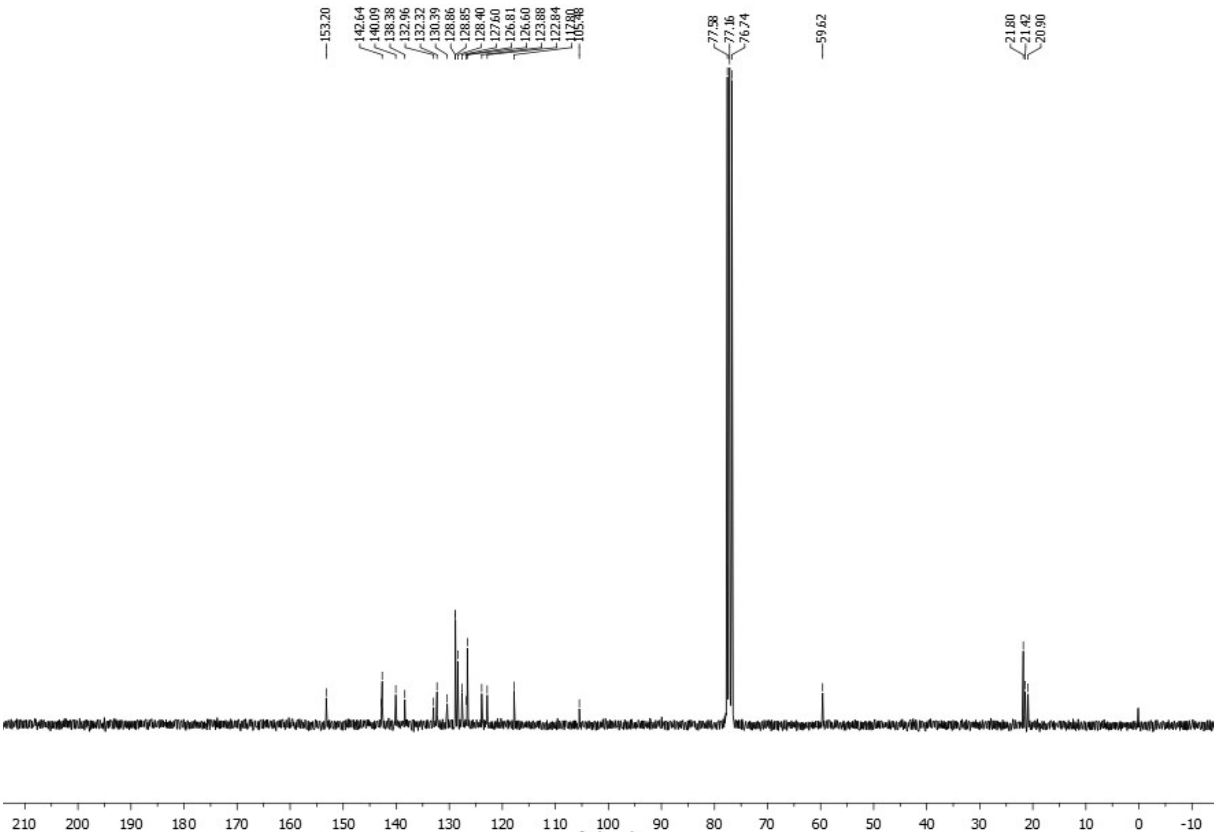
7b-2 (^{13}C NMR, 75 MHz, MeOH-d_4)



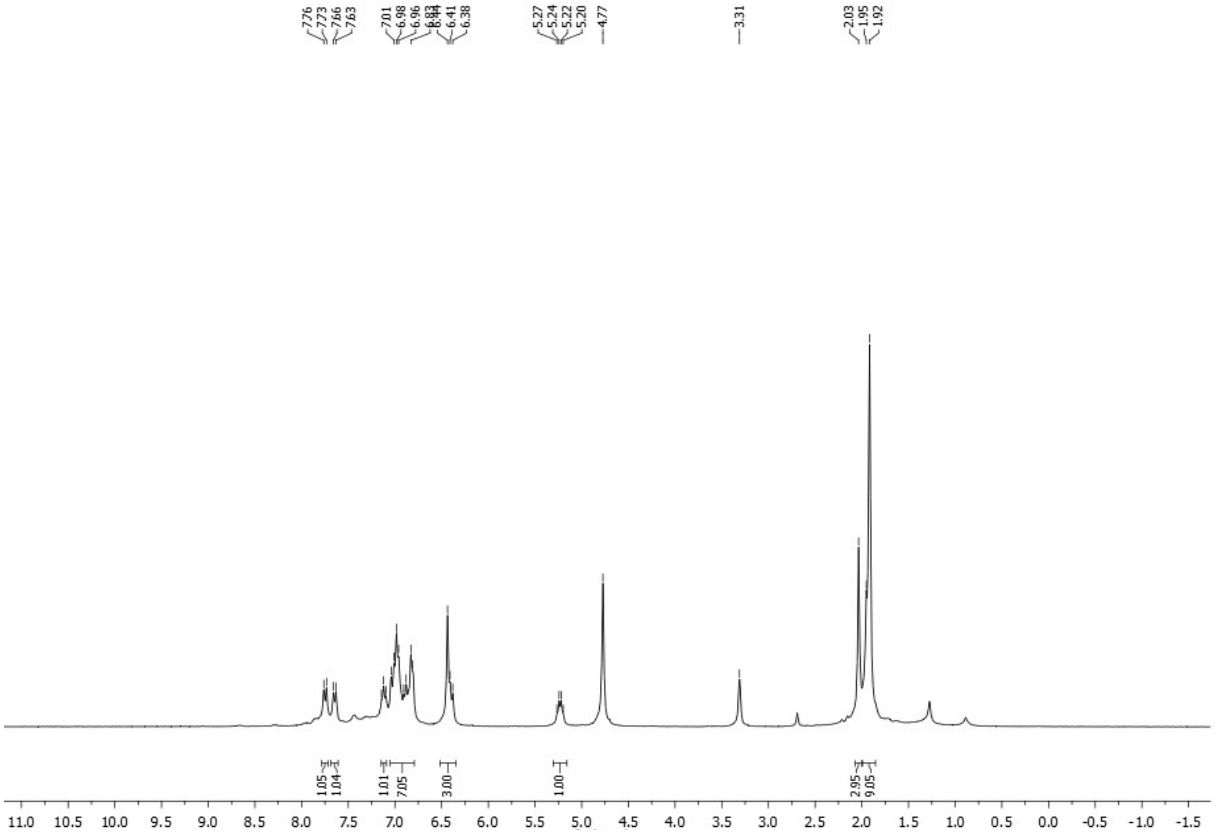
8a-1 (^{1}H NMR, 300MHz, $CDCl_3$)



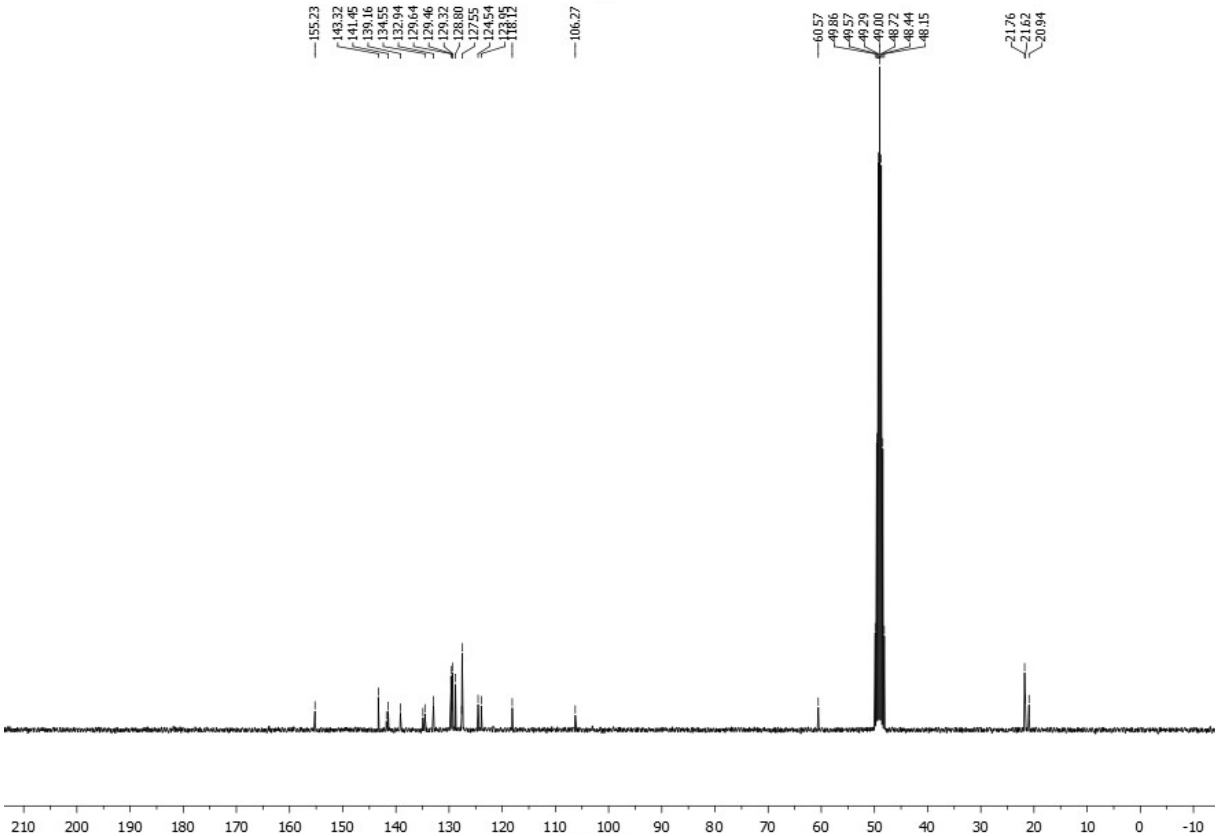
8a-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



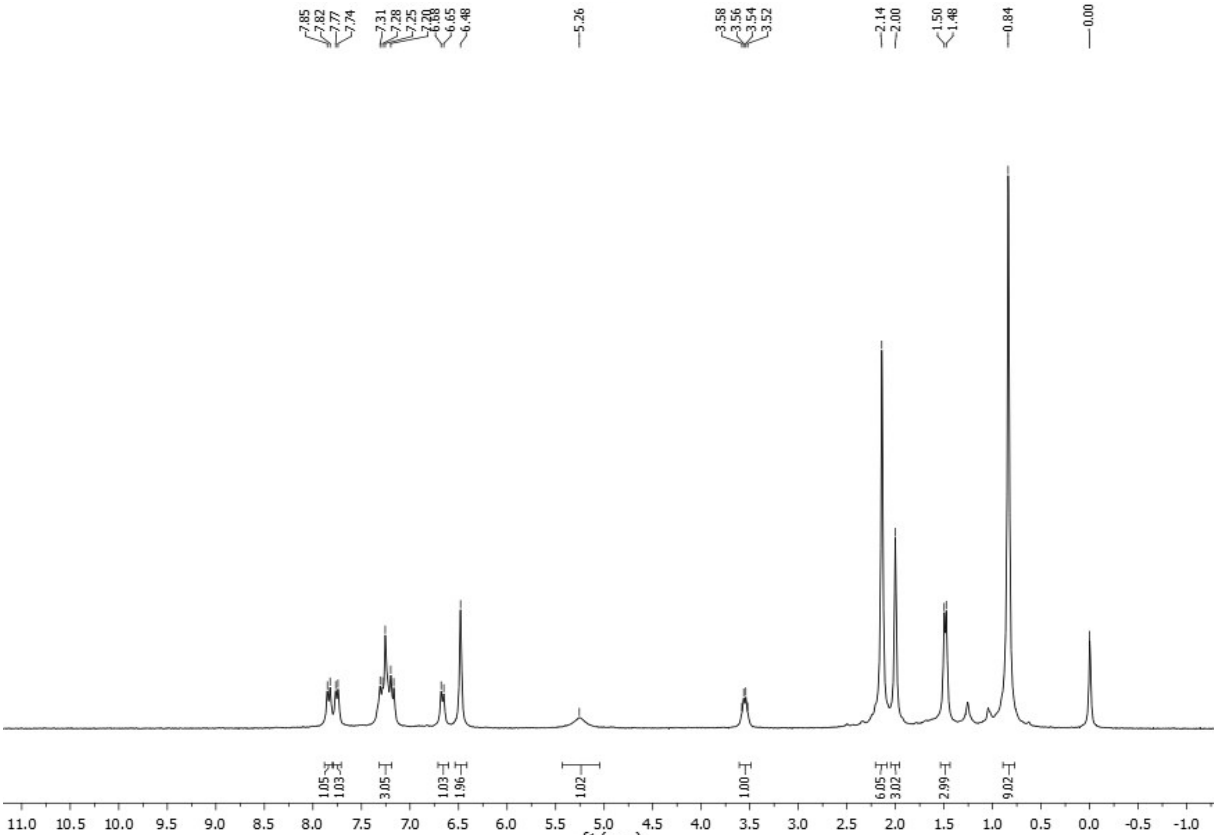
8a-2 (^{1}H NMR, 300MHz, MeOH-d_4)



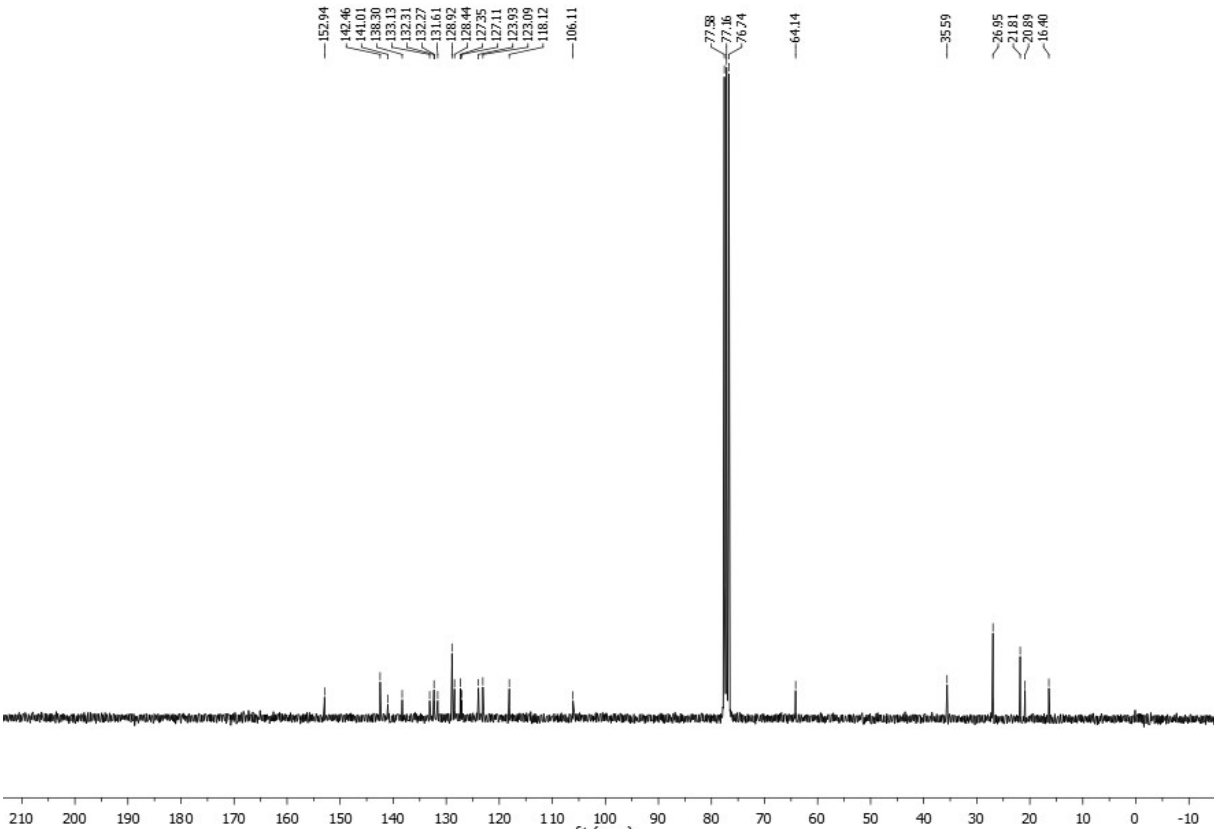
8a-2 (^{13}C NMR, 75 MHz, MeOH-d_4)



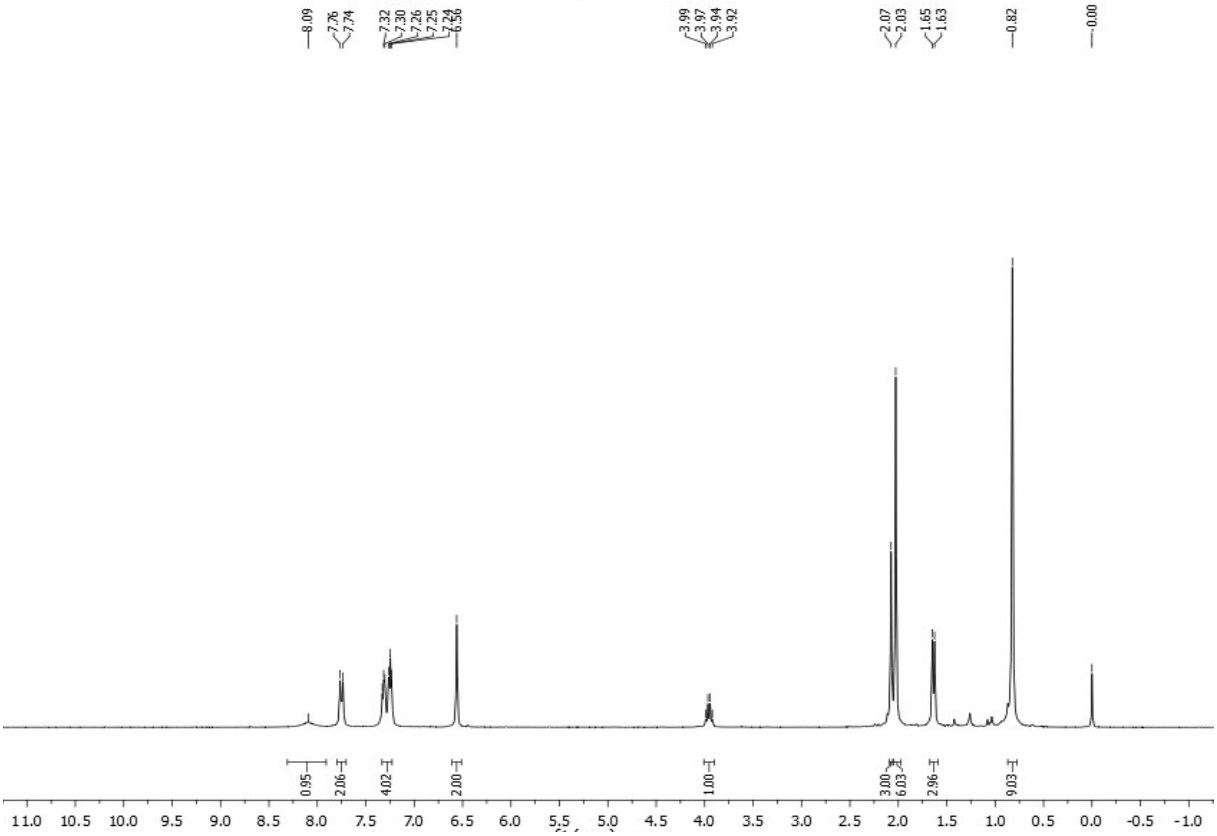
8b-1 (^{1}H NMR, 300MHz, $CDCl_3$)



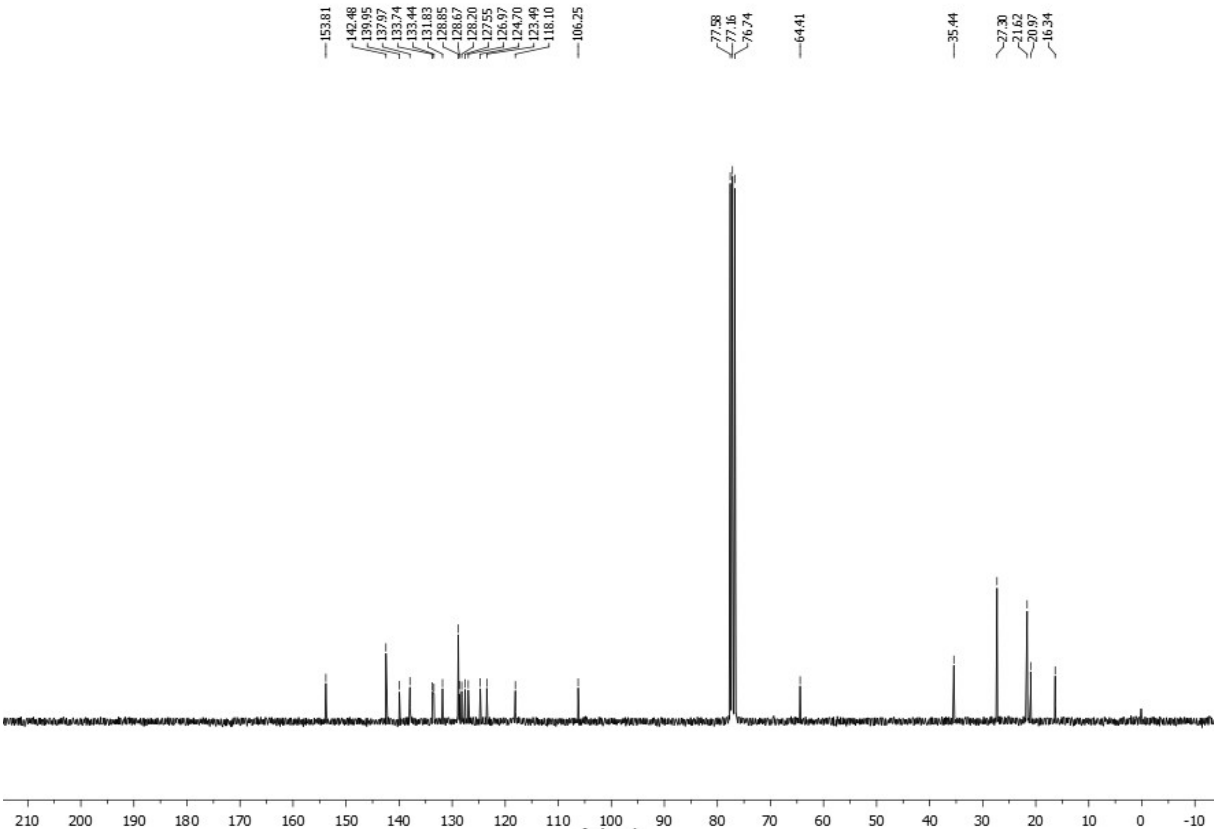
8b-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



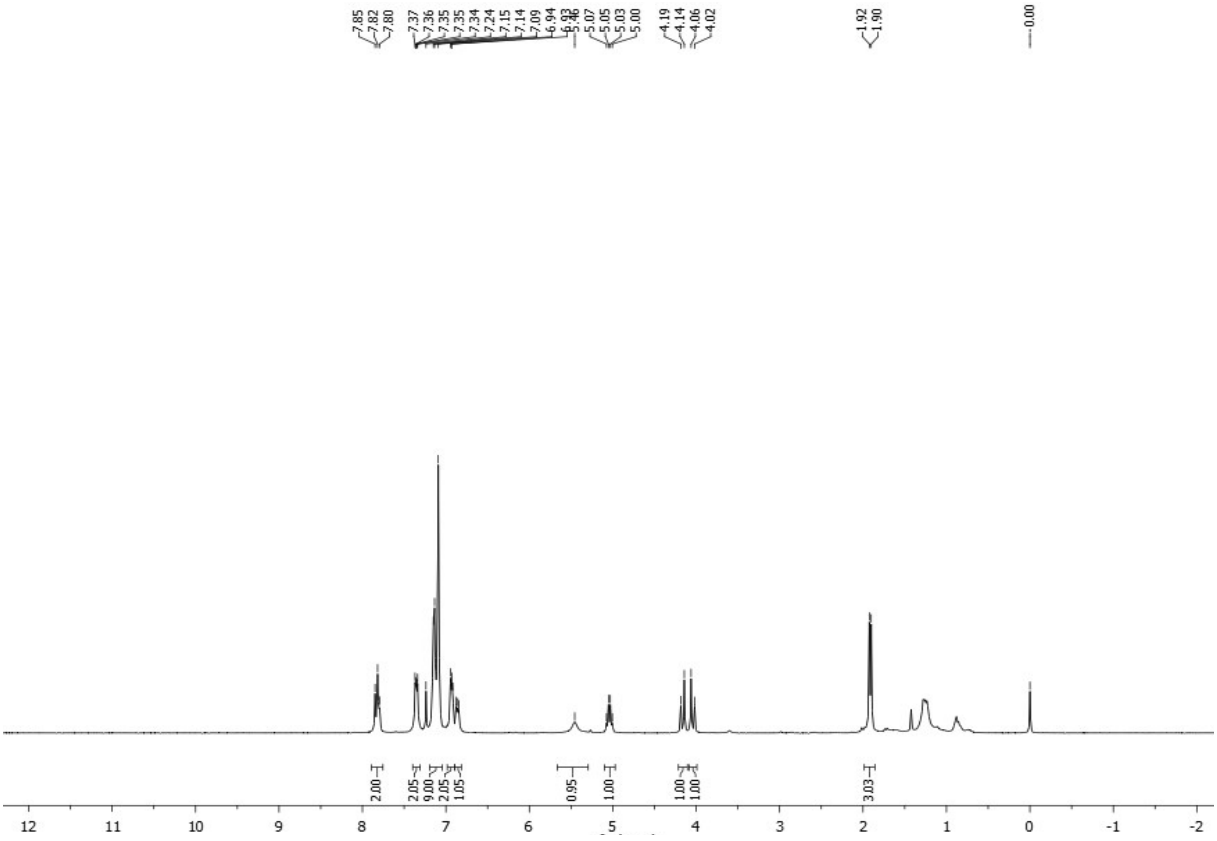
8b-2 (^{1}H NMR, 300MHz, $CDCl_3$)



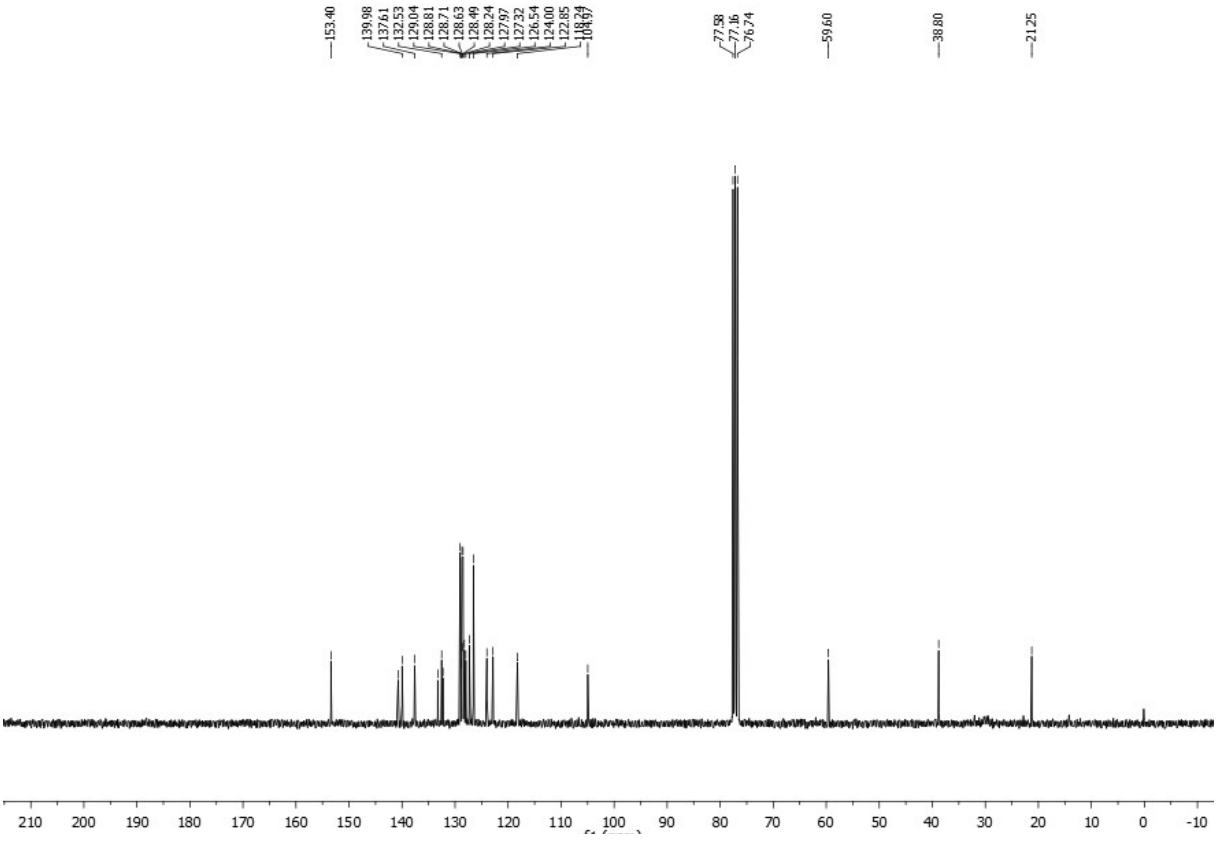
8b-2 (^{13}C NMR, 75 MHz, $CDCl_3$)



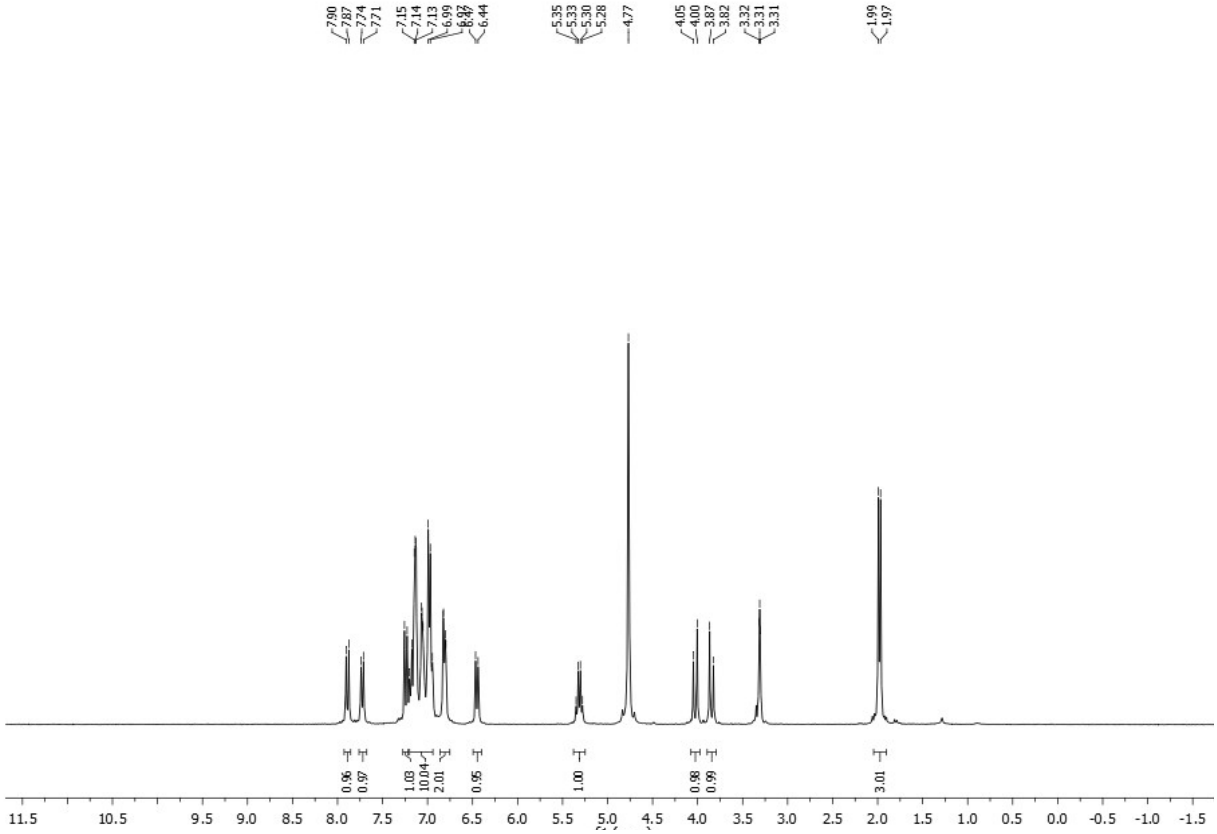
9a-1 (^{1}H NMR, 300MHz, $CDCl_3$)



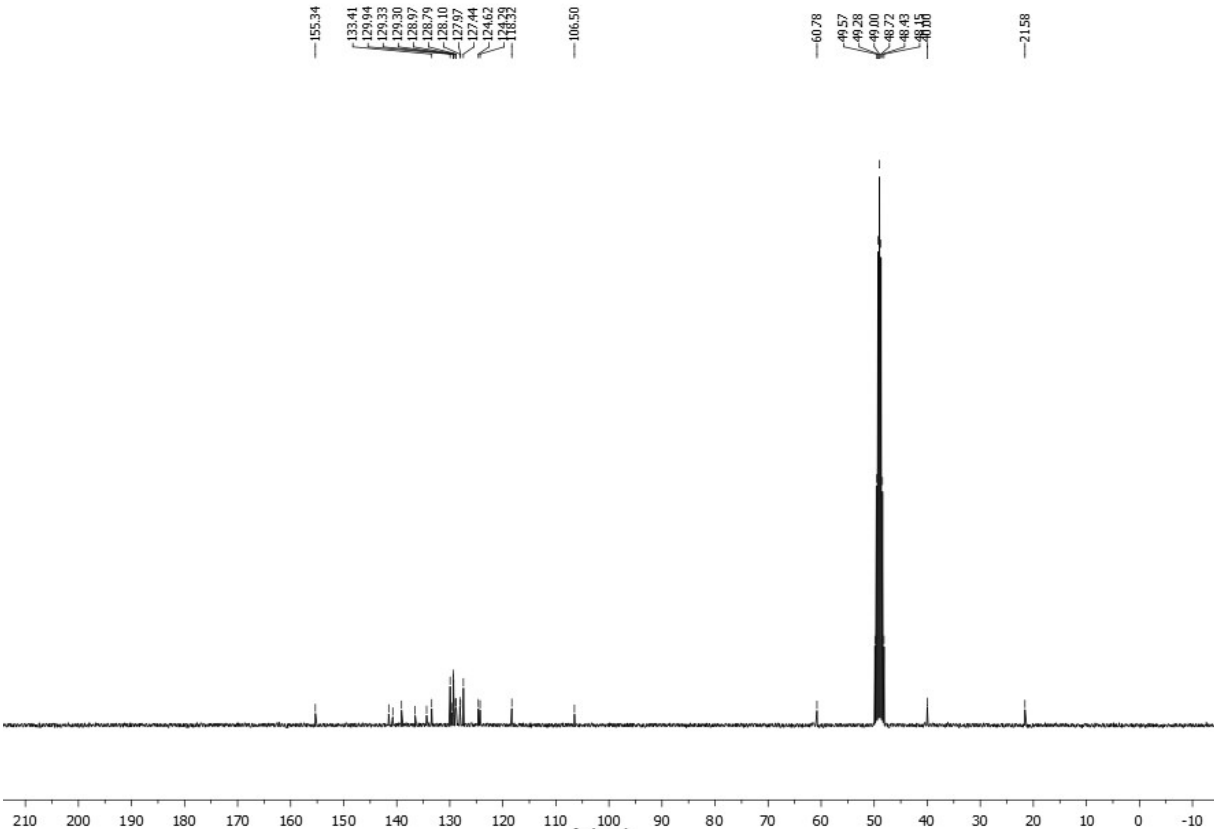
9a-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



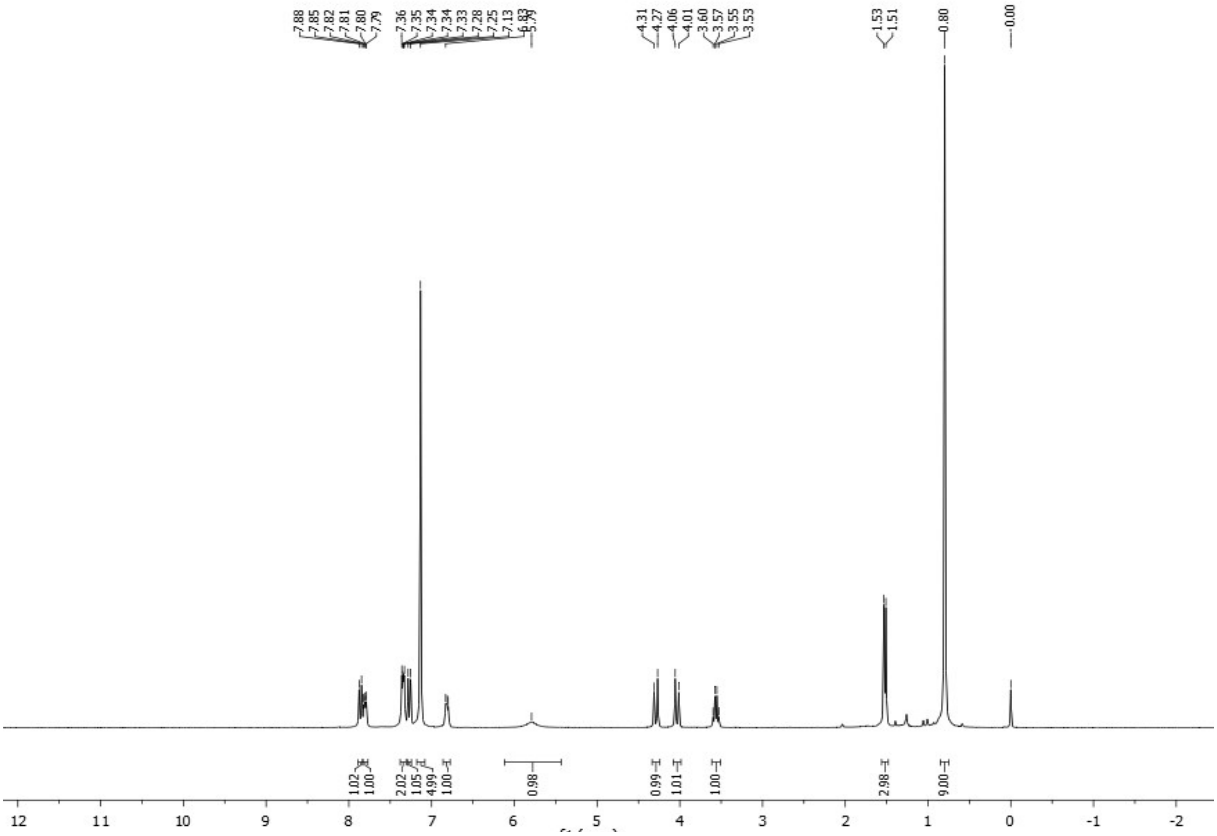
9a-2 (^{1}H NMR, 300MHz, MeOH-d_4)



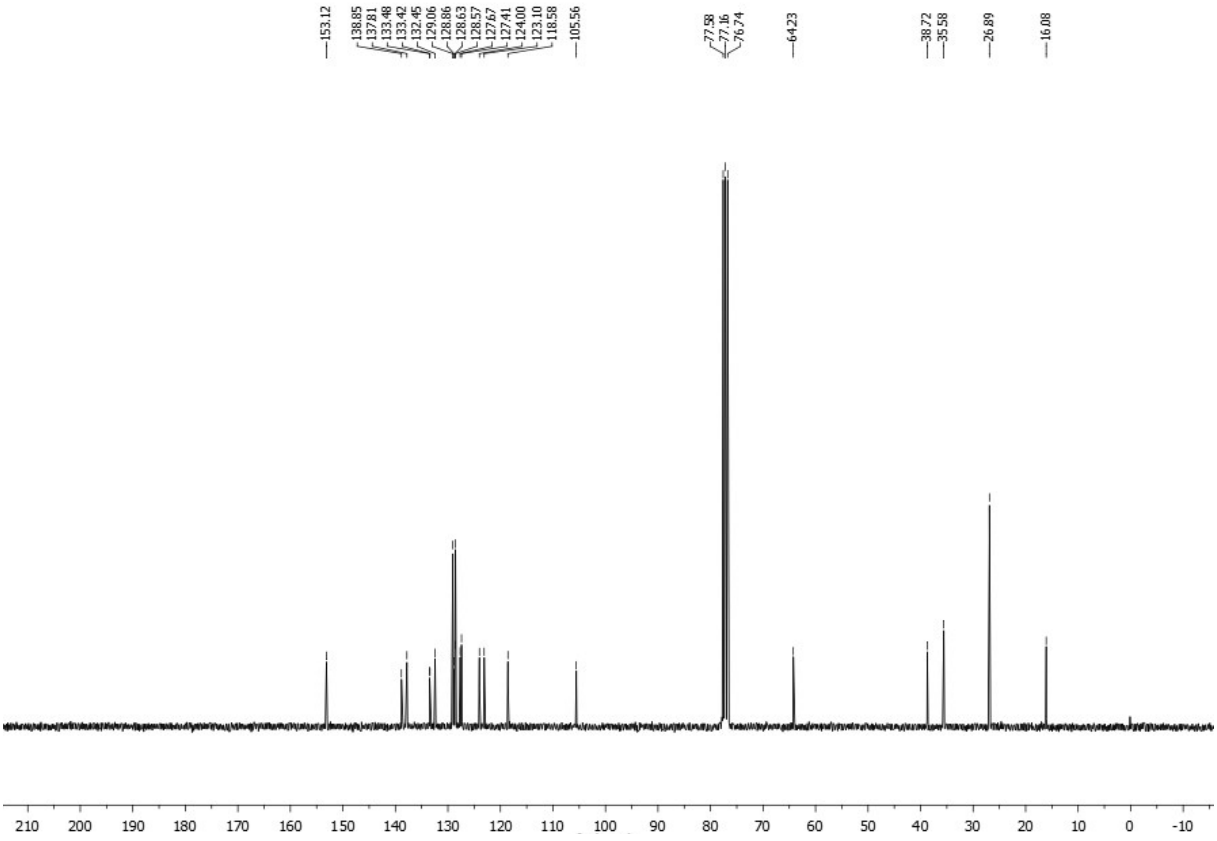
9a-2 (^{13}C NMR, 75 MHz, MeOH-d_4)



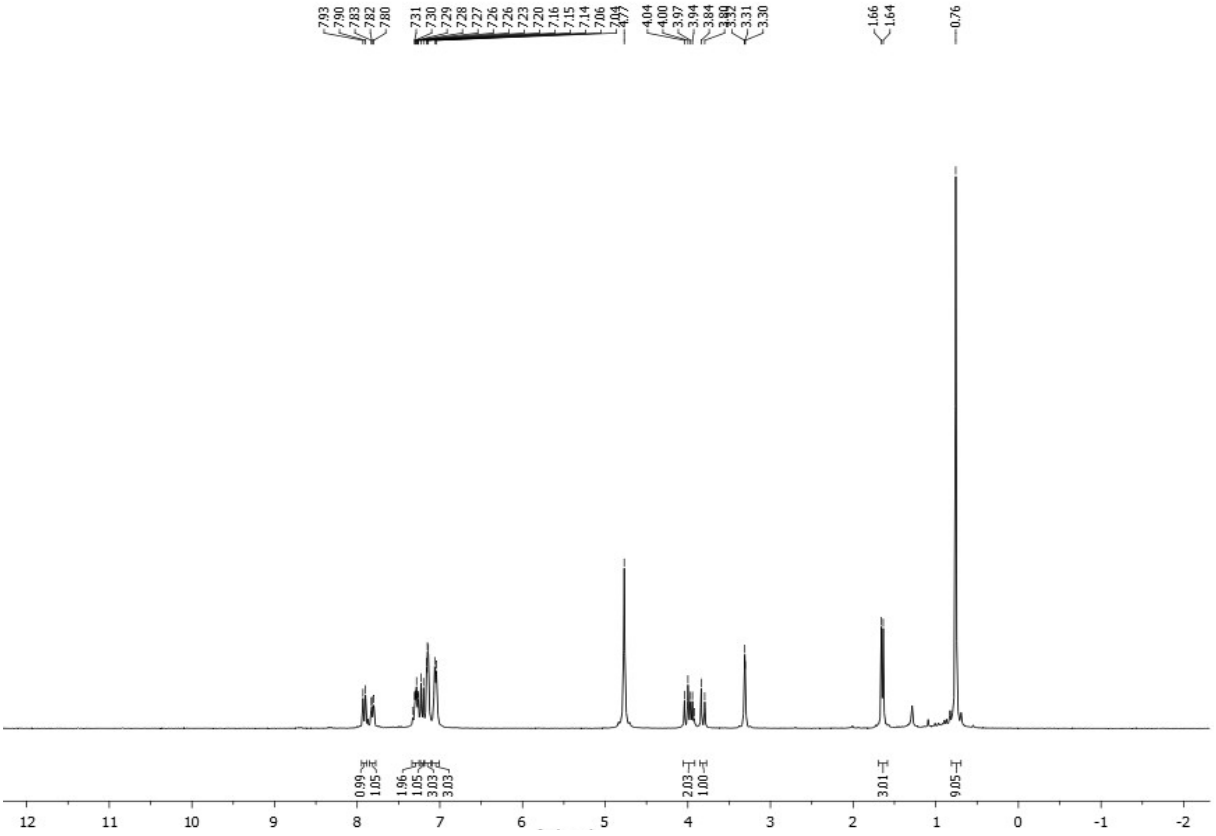
9b-1 (^{1}H NMR, 300MHz, $CDCl_3$)



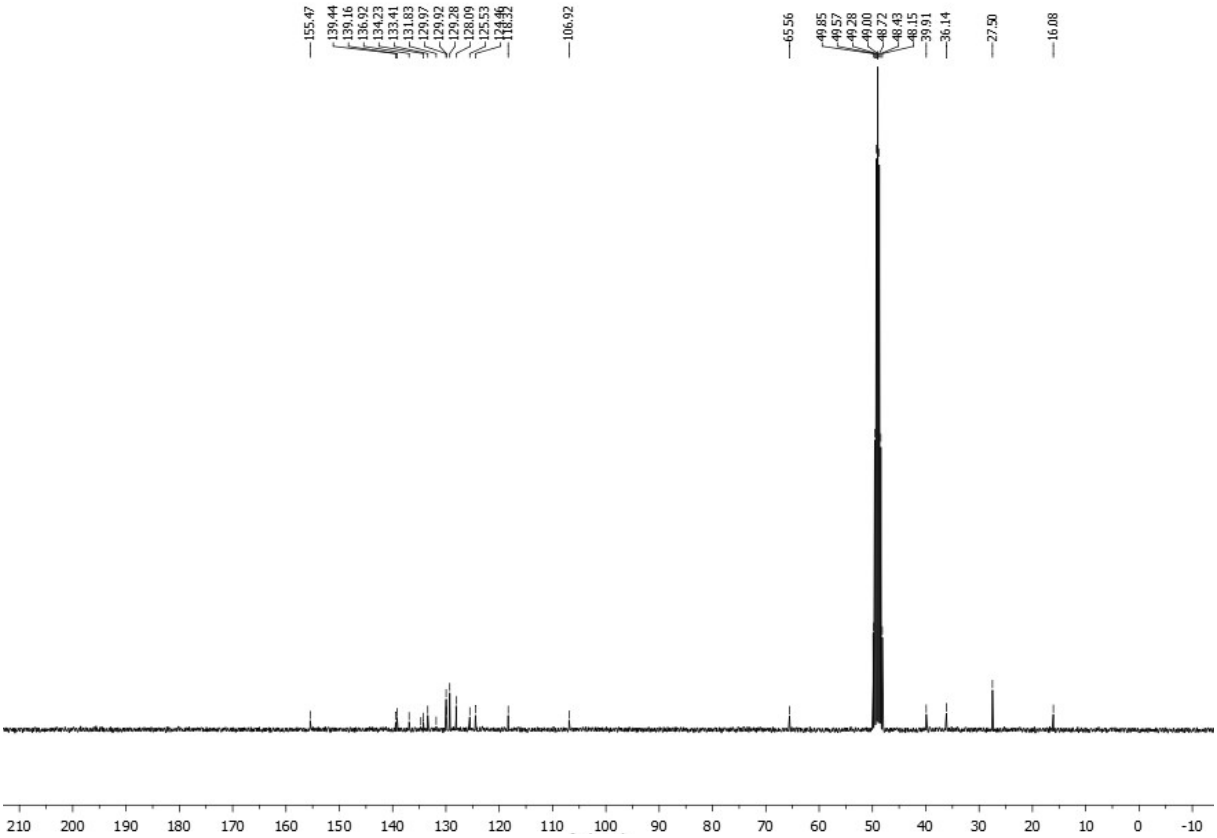
9b-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



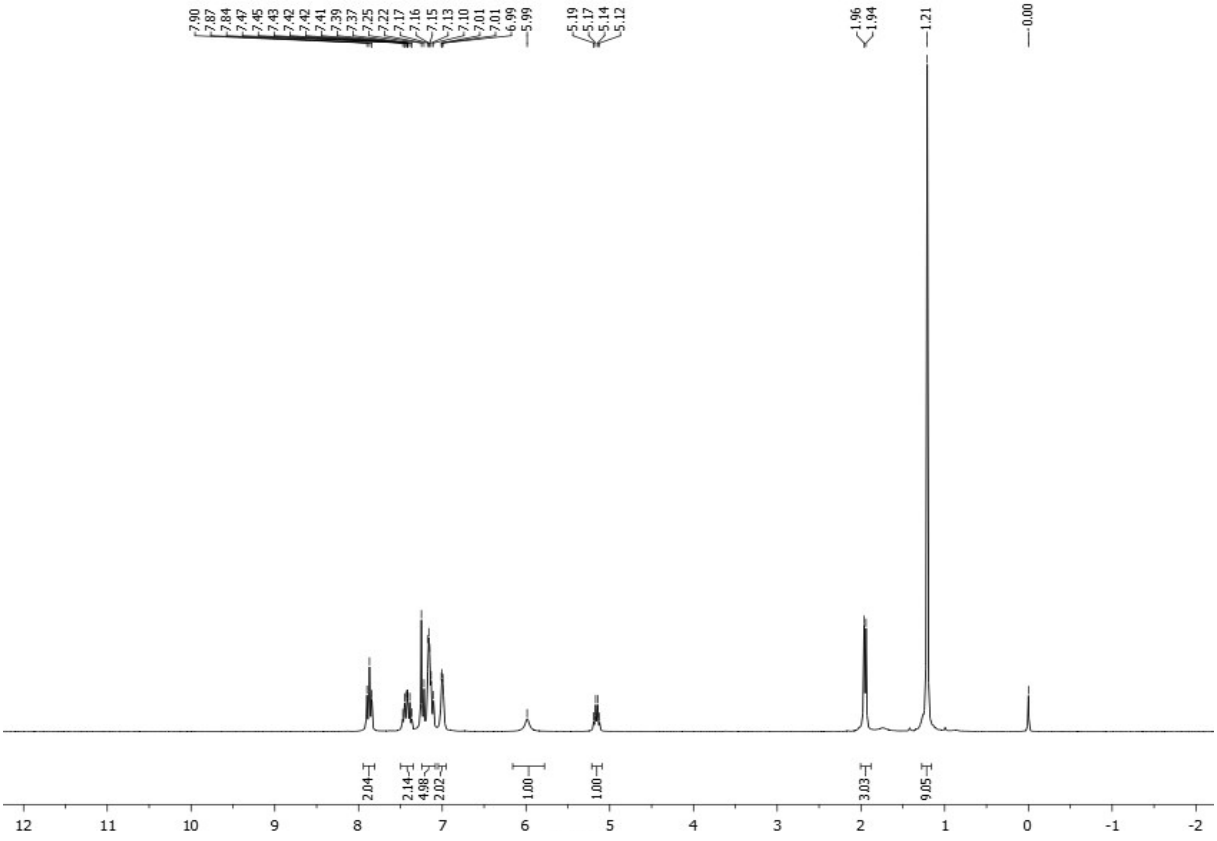
9b-2 (^{1}H NMR, 300MHz, MeOH-d_4)



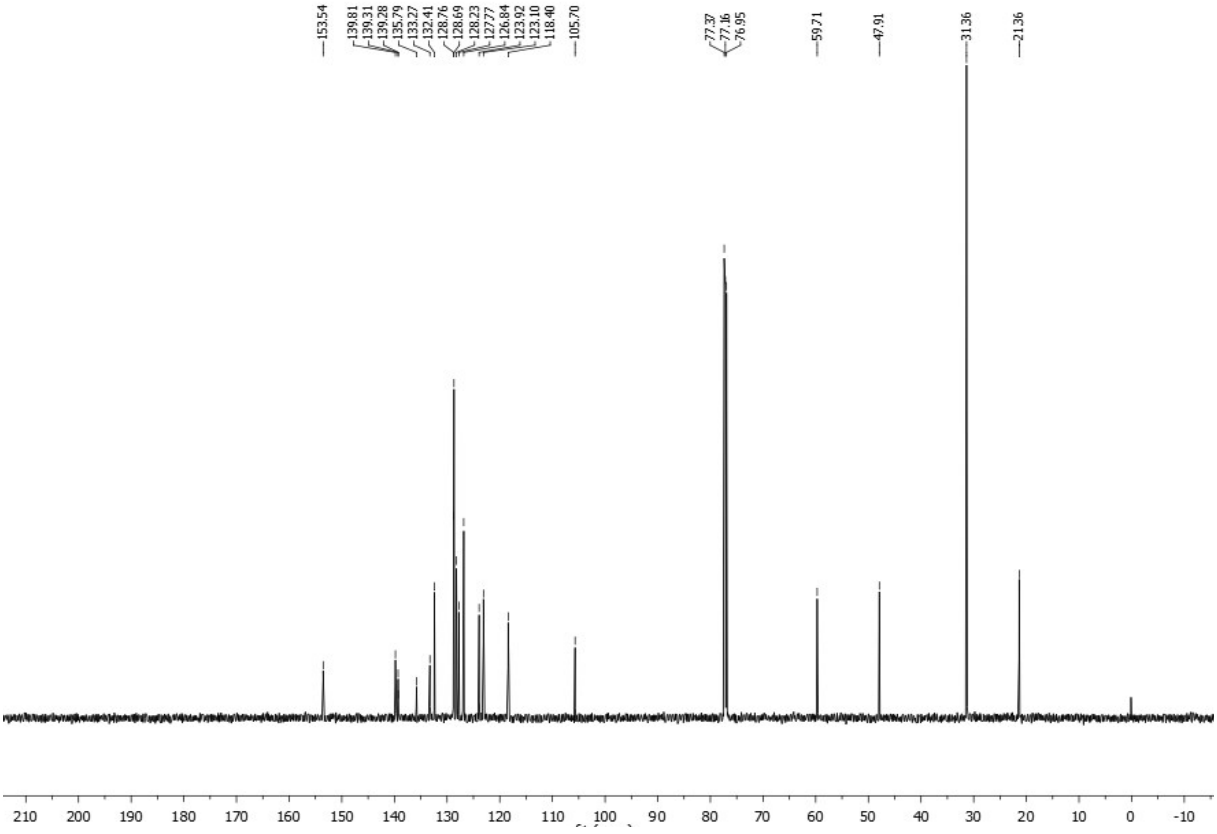
9b-2 (^{13}C NMR, 75 MHz, MeOH-d_4)



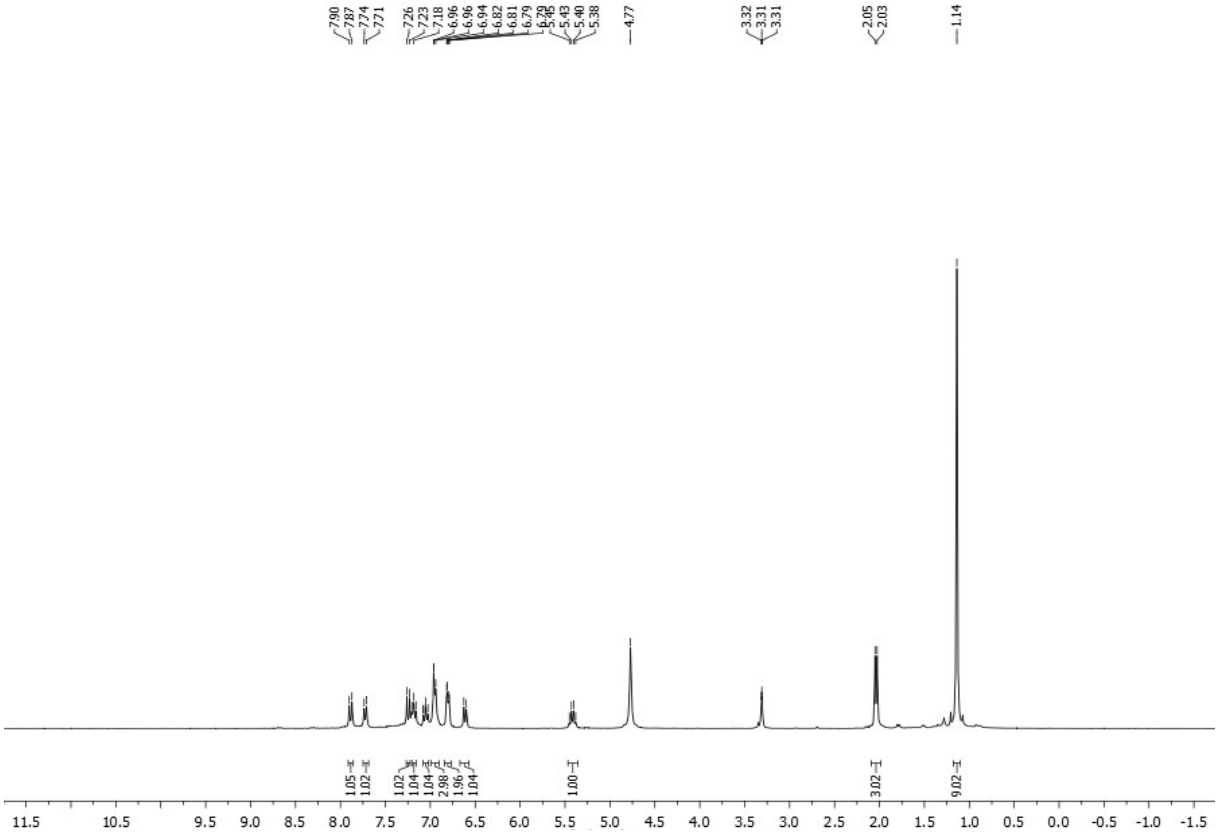
10a-1 (^{1}H NMR, 300MHz, $CDCl_3$)



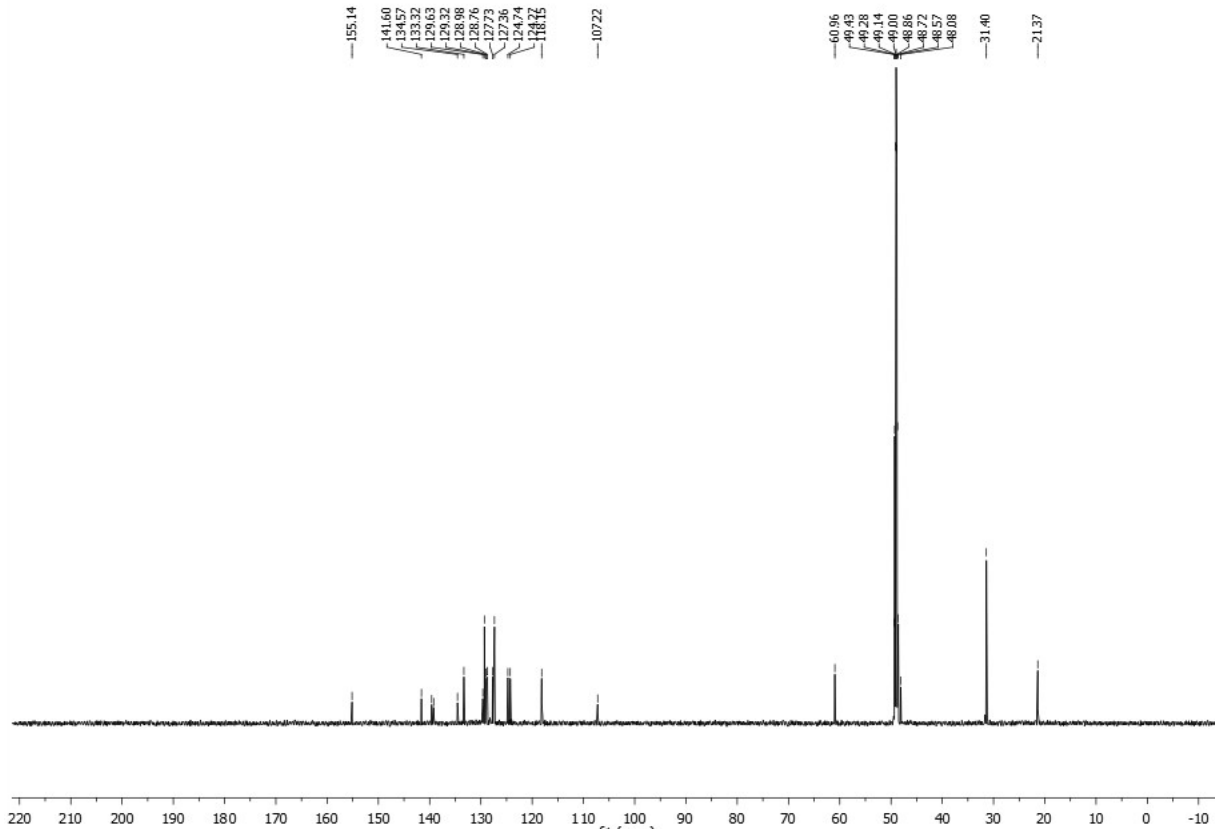
10a-1 (^{13}C NMR, 151 MHz, $CDCl_3$)



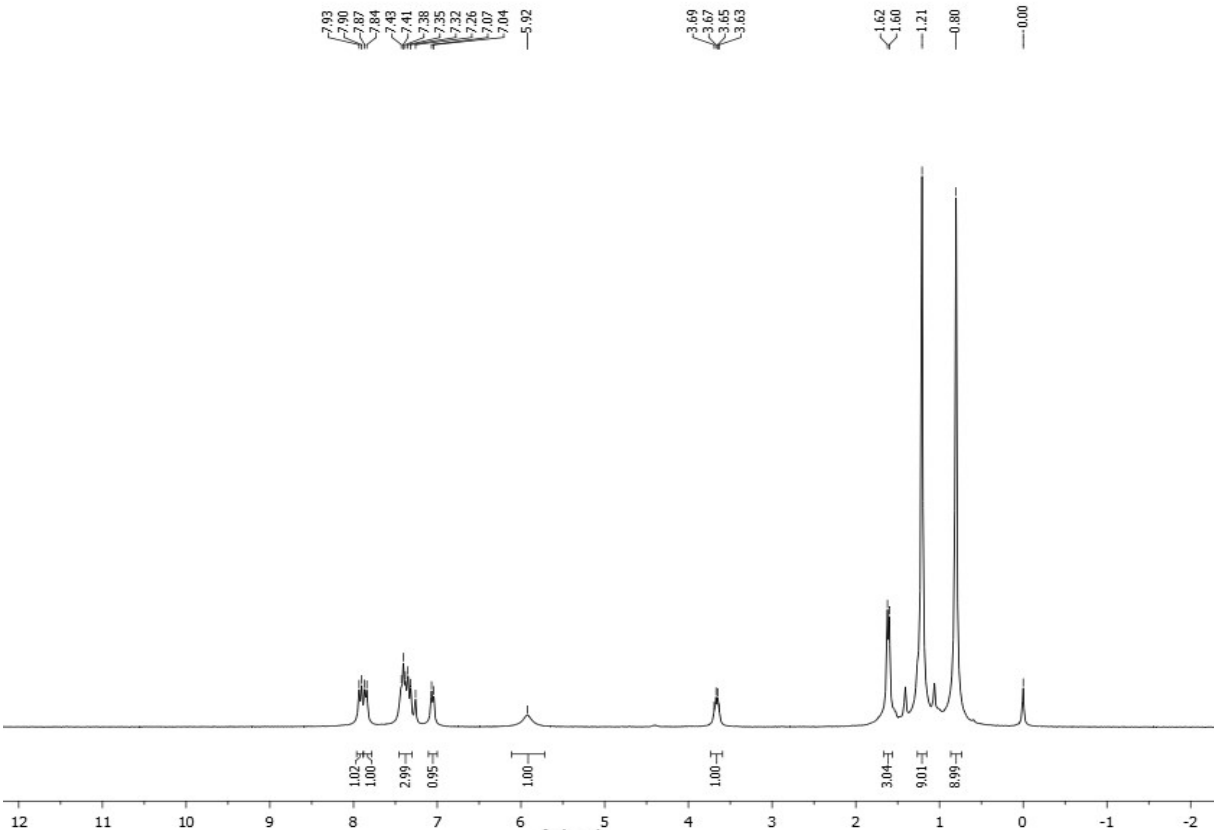
10a-2 (^{1}H NMR, 300MHz, MeOH-d_4)



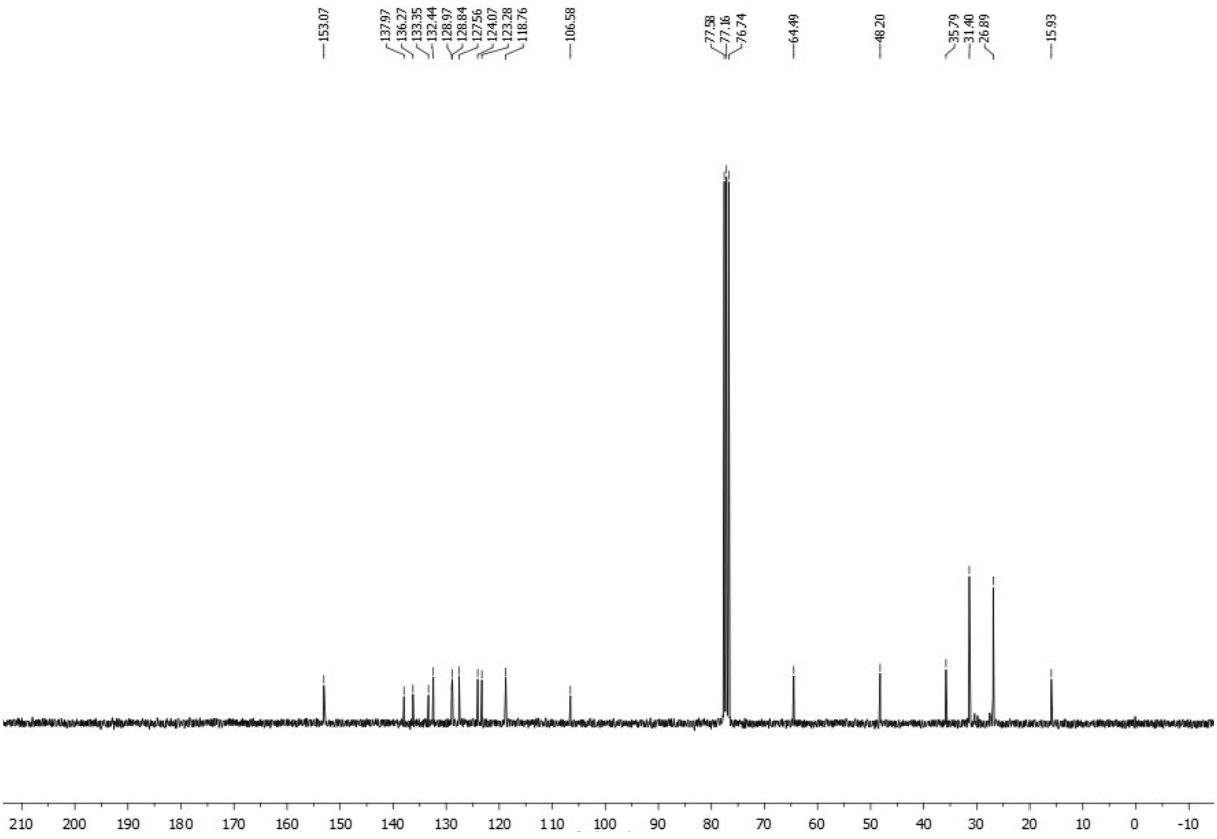
10a-2 (^{13}C NMR, 151 MHz, MeOH-d_4)



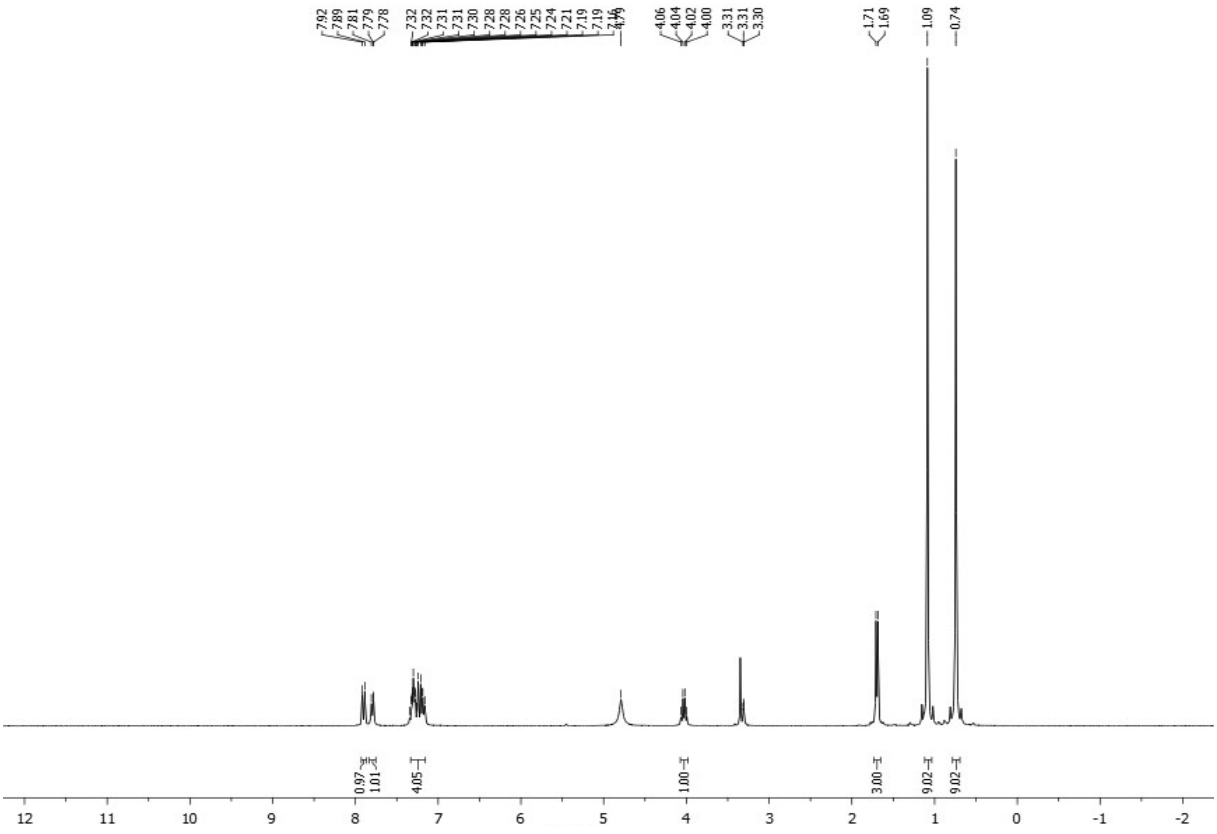
10b-1 (^{1}H NMR, 300MHz, $CDCl_3$)



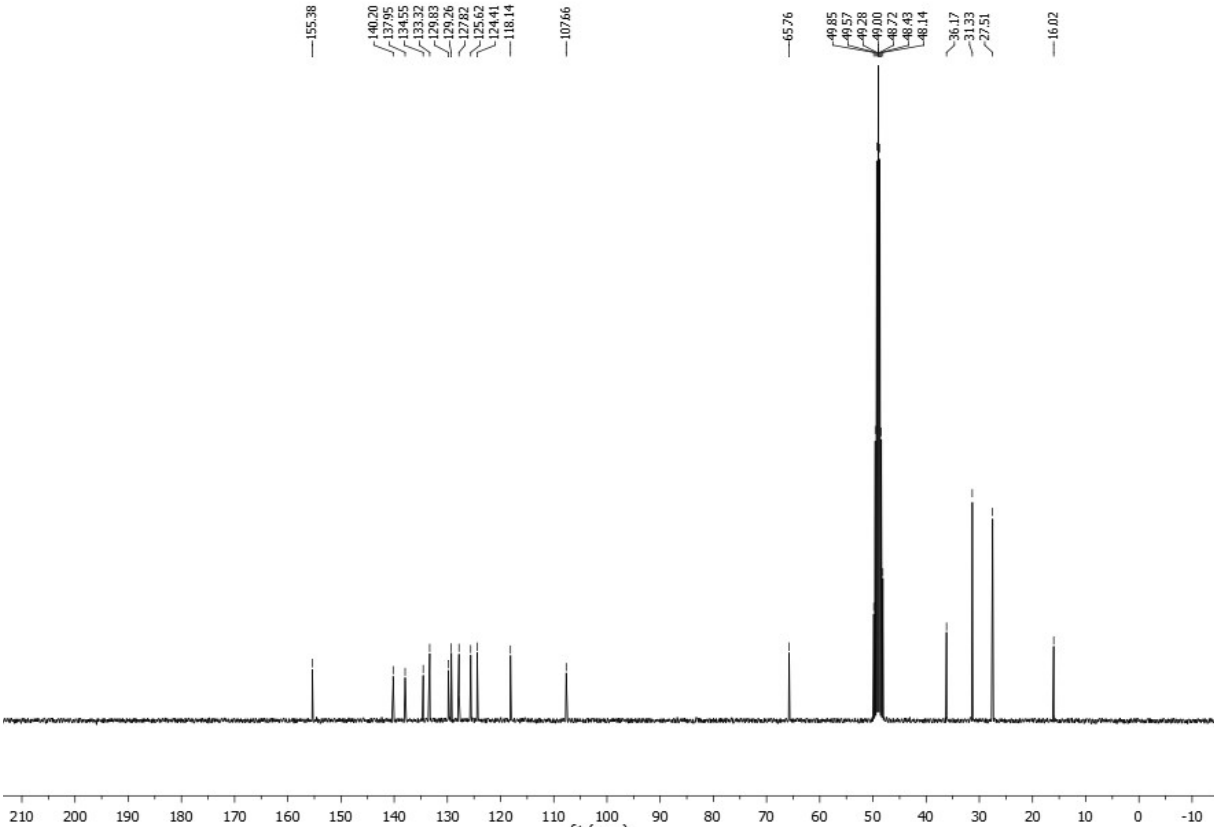
10b-1 (^{13}C NMR, 75 MHz, $CDCl_3$)



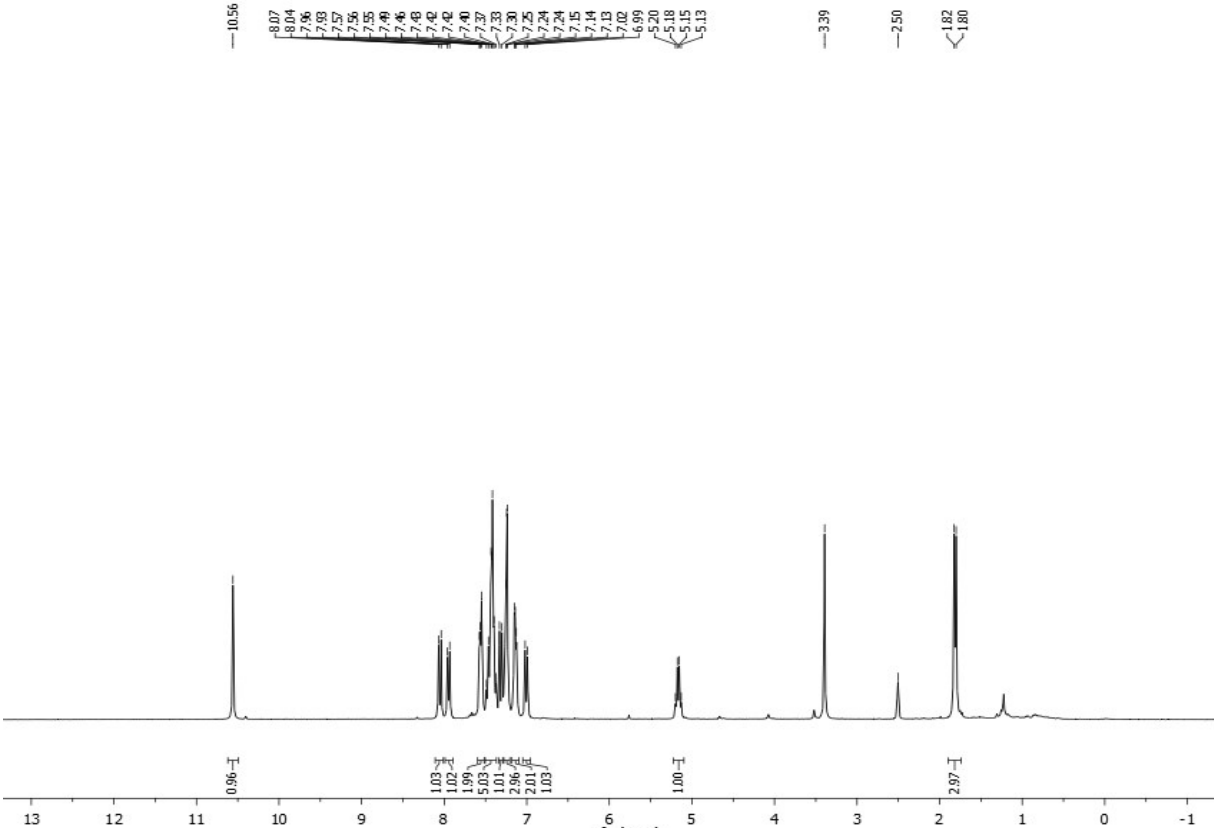
10b-2 (^{1}H NMR, 300MHz, MeOH-d_4)



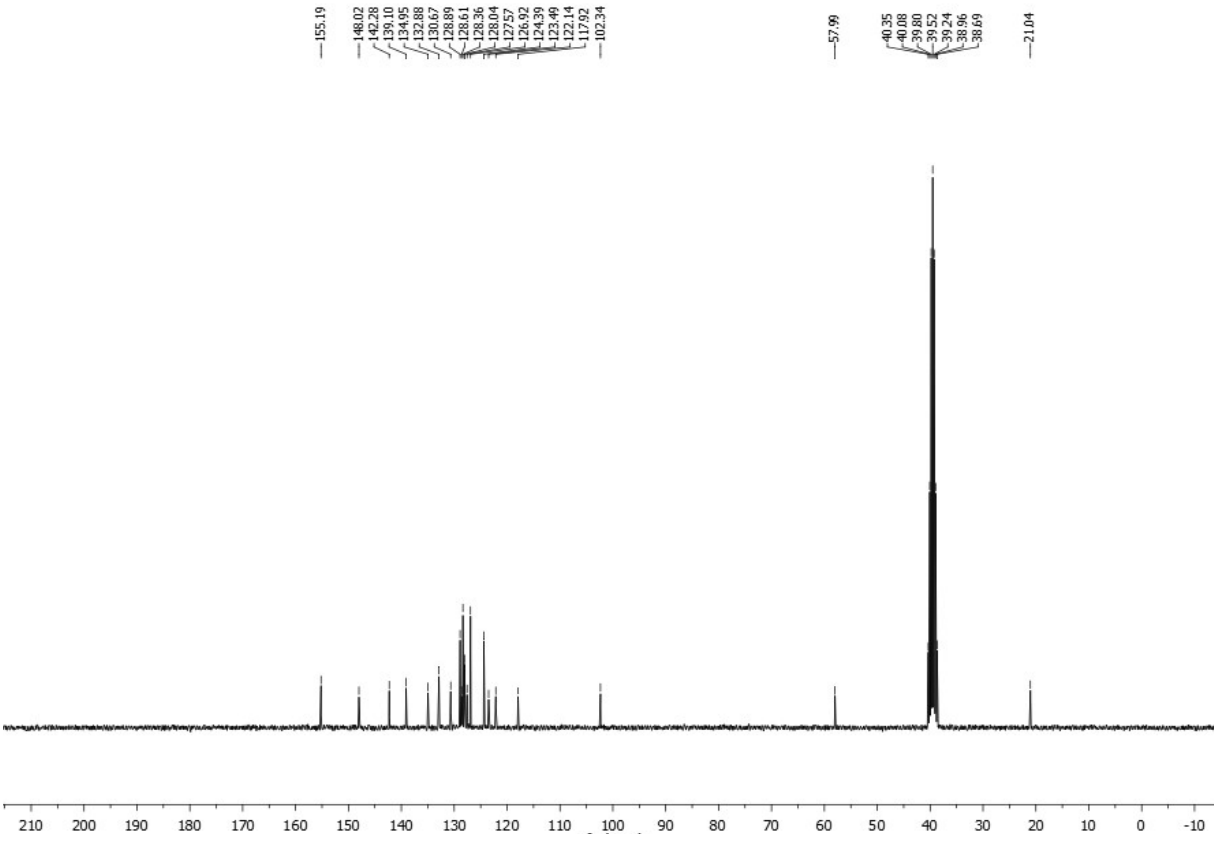
10b-2 (^{13}C NMR, 75 MHz, MeOH-d_4)



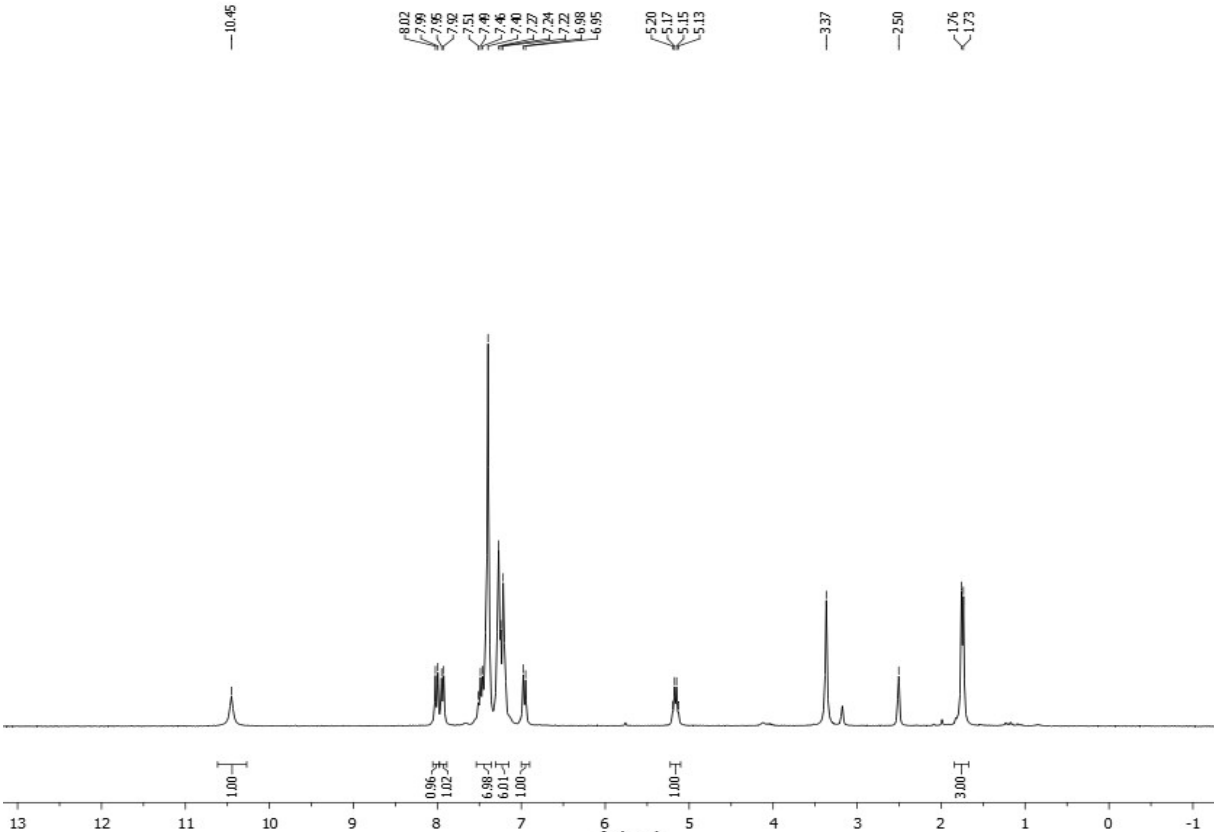
11-1 (^{1}H NMR, 300MHz, DMSO-d_6)



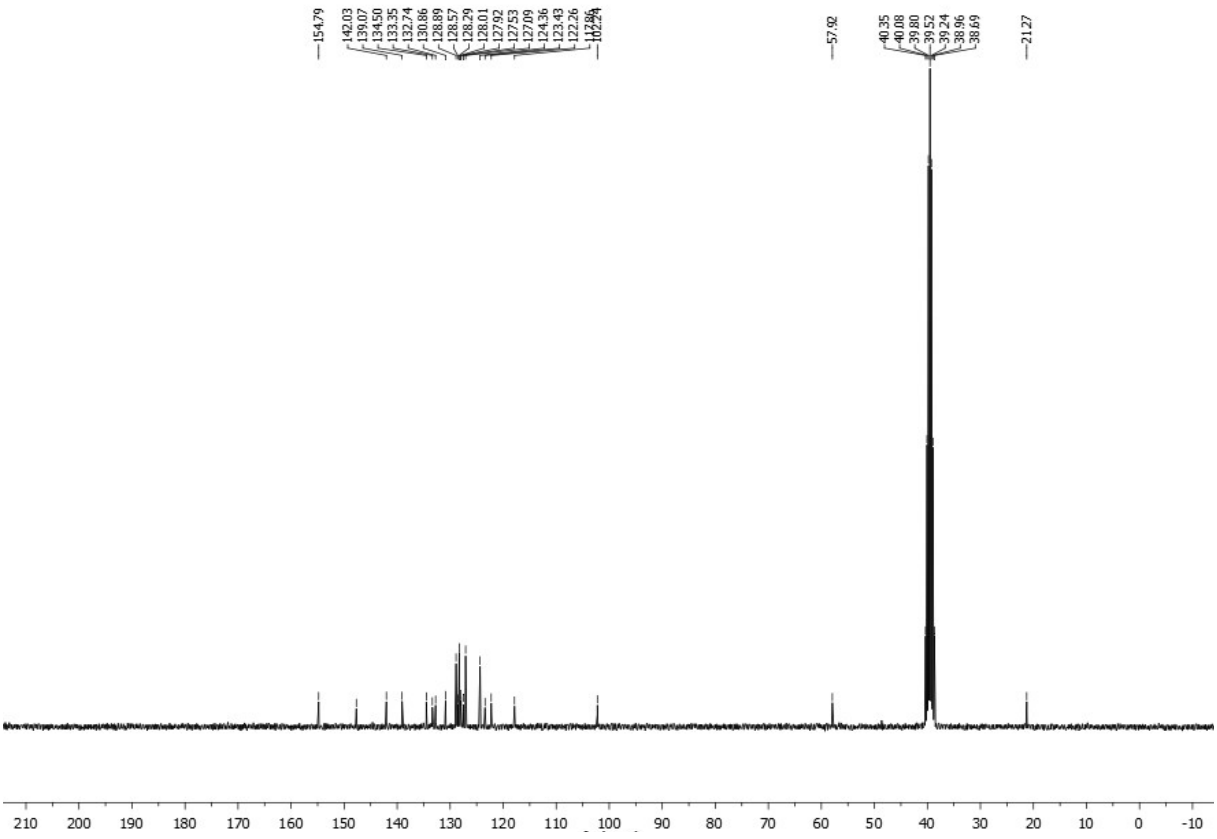
11-1 (^{13}C NMR, 75 MHz, DMSO-d_6)



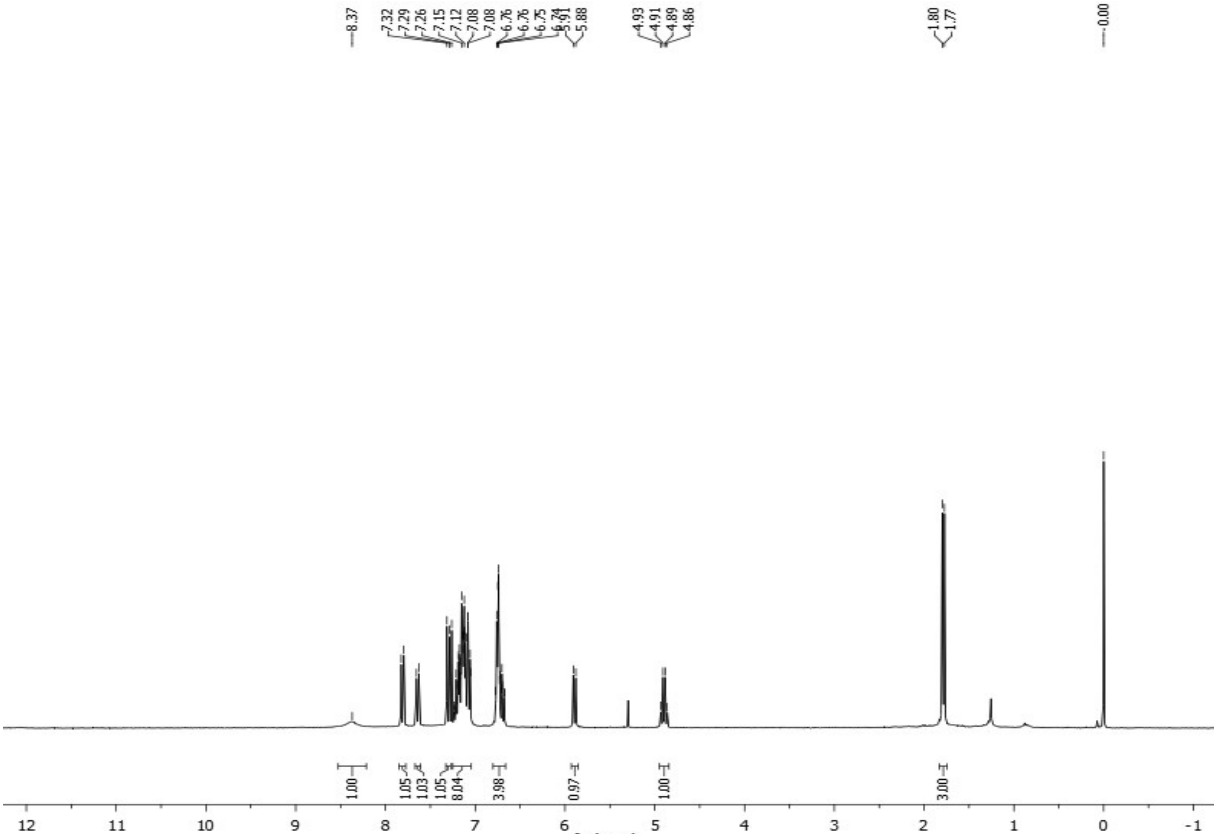
11-2 (^{1}H NMR, 300MHz, DMSO-d_6)



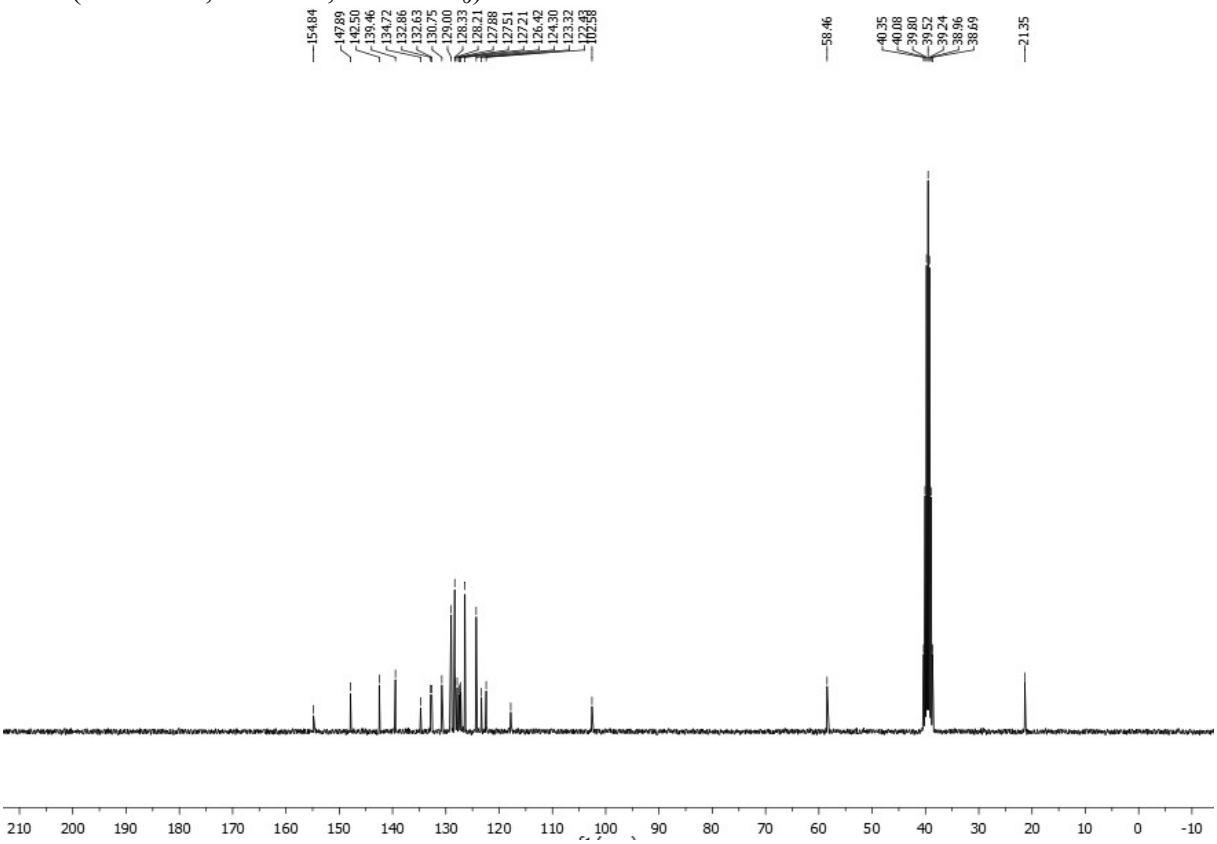
11-2 (^{13}C NMR, 75 MHz, DMSO-d_6)



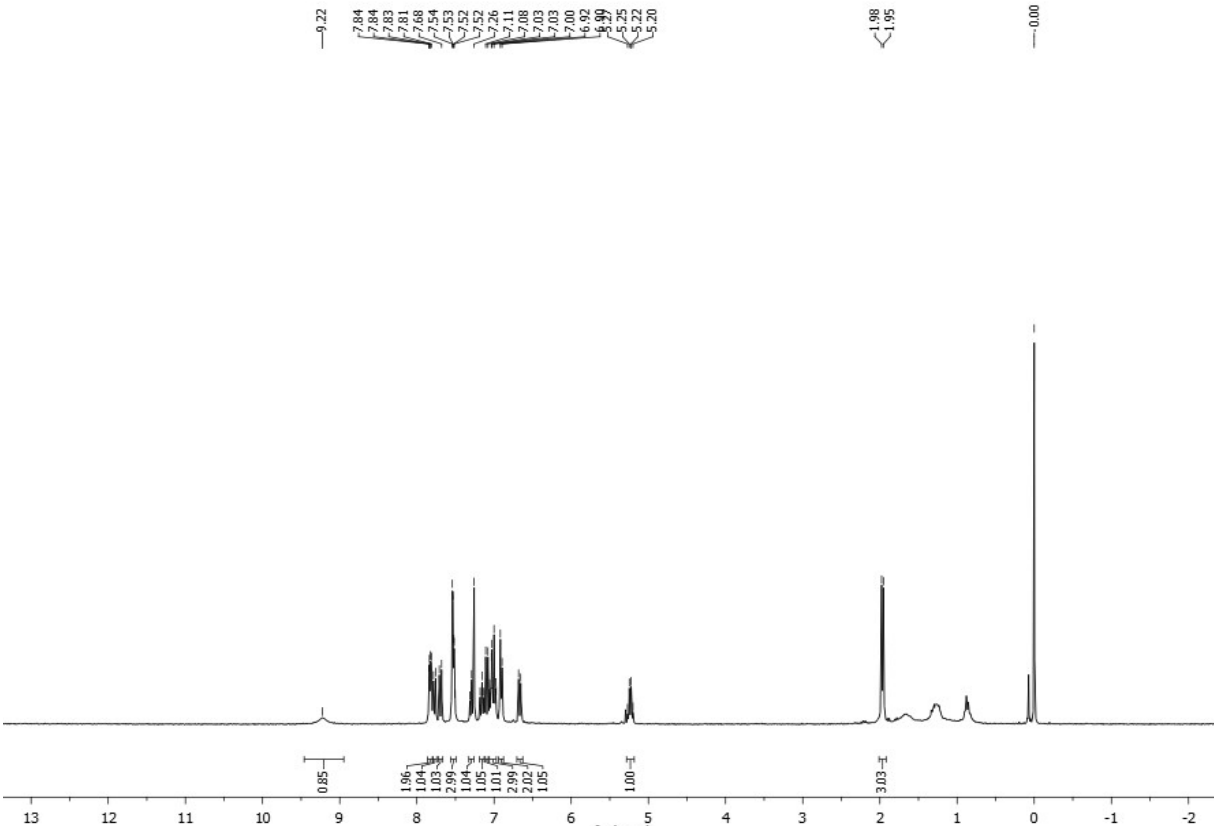
12-1 (^{1}H NMR, 300MHz, $CDCl_3$)



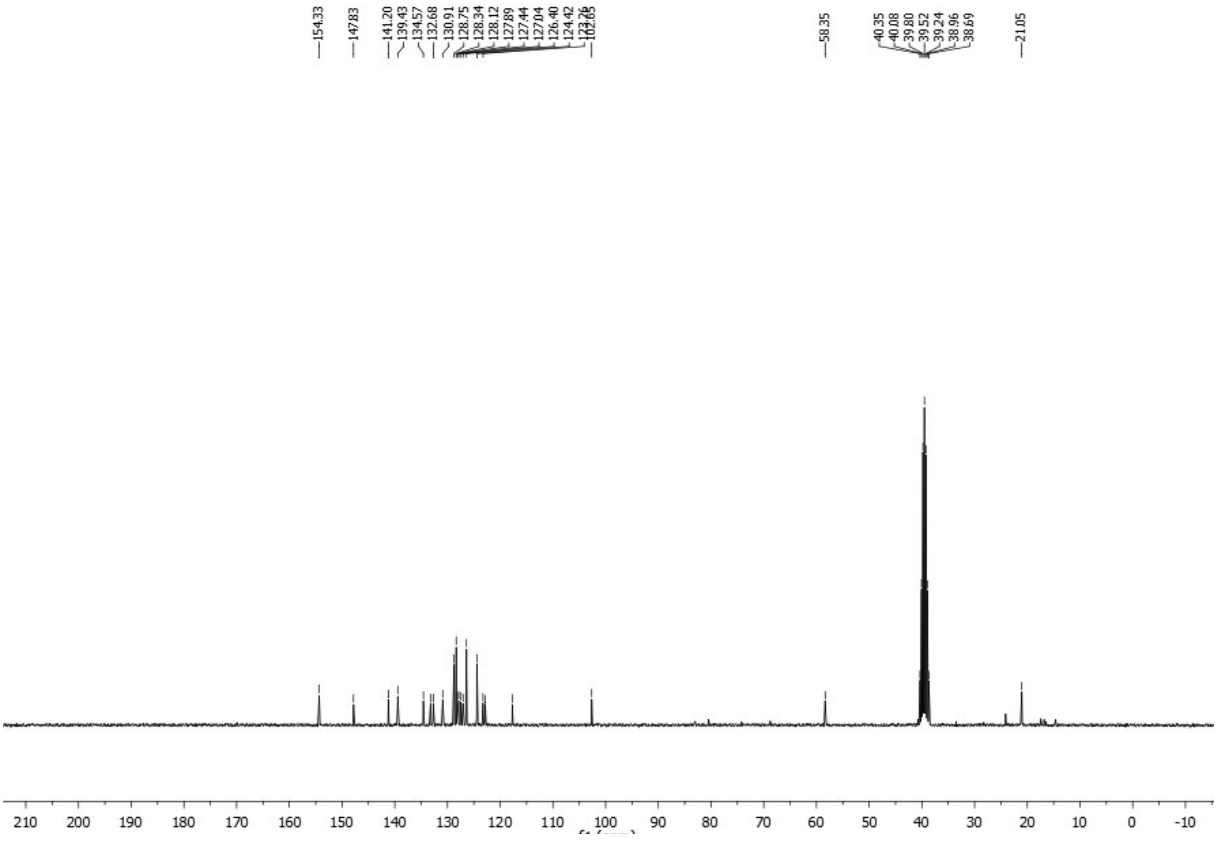
12-1 (^{13}C NMR, 75 MHz, DMSO-d_6)



12-2 (^{1}H NMR, 300MHz, $CDCl_3$)



12-2 (^{13}C NMR, 75 MHz, DMSO-d_6)



8 References

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