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Cobalt-catalyzed C(sp^3)-H bond functionalization to access indole derivatives

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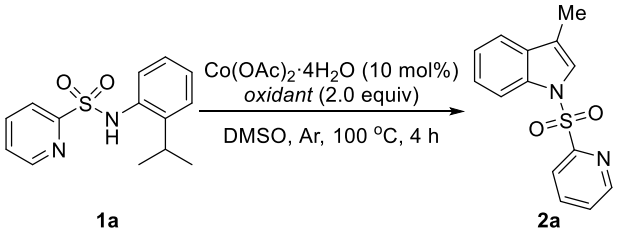
General Information

^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded at 600 MHz, 151 MHz, and 565 MHz respectively on a Bruker DPX instrument using Me_4Si as an internal standard. High resolution mass spectra (HRMS) for new compounds were measured on a Waters ACQUITY UPLC I-Class PLUS liquid chromatogram coupled with a Waters Xevo G2-XS QTof mass spectrometer. The column was ACOUITY UPLC BEH C18 LC Column (2.1-100 mm, Waters). Melting points were measured on a WC-1 instrument and uncorrected. Chemical shift multiplicities are reported as follows: (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad, dd = doublet of doublet, dt = doublet of triplet, td = triplet of doublet). Unless otherwise mentioned, all materials were commercially obtained and used without further purification, and all the reactions were performed under the Ar atmosphere unless otherwise noted. The substrates **1** was synthesized according to literature procedures.[1] The hydroxylamine-base compounds (**O1**-**O8**) were synthesized according to literature procedures.[2]

Experimental Section

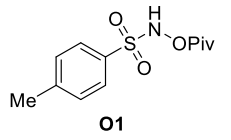
1. Optimization of reaction conditions

Table S1 Optimization of oxidants[a]

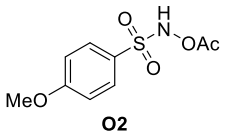


1a **2a**

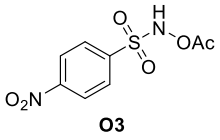
Oxidant	Yield (%)	Oxidant	Yield (%)
-	N.R.	NHPI	N.R.
AgOAc	N.R.	NFSI	N.R.
Ag_2CO_3	N.R.	DTBP	N.R.
$Mn(OAc)_2·4H_2O$	N.R.	**O1**	**46**
$Mn(OAc)_3·2H_2O$	N.R.	**O2**	28
$K_2S_2O_8$	N.R.	**O3**	trace
TBHP(in decane)	N.R.	**O4**	25
$PhI(OAc)_2$	trace	**O5**	33
DDQ	N.R.	**O6**	29
$H_2N\text{-}OSO_3H$	N.R.	**O7**	41
BPO	N.R.	**O8**	26



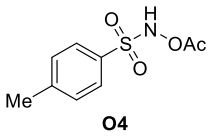
O1



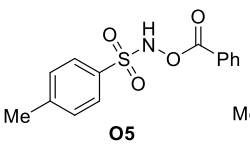
O2



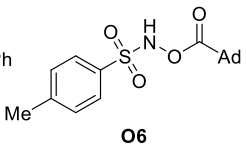
O3



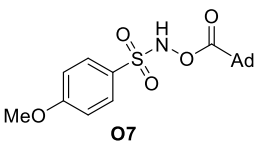
O4



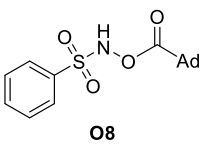
O5



O6



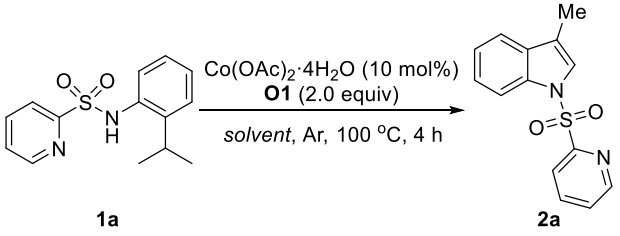
O7



O8

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), oxidant (2.0 equiv), DMSO (2.0 mL), Ar atmosphere, 4 h, 100 ℃, isolated yields.

Table S2 Optimization of solvents[a]

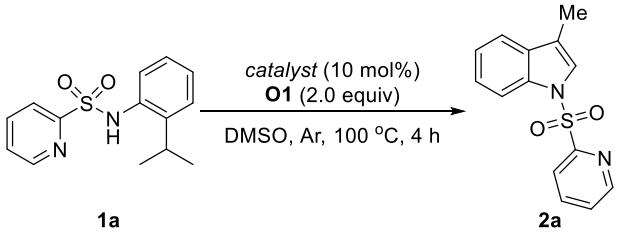


1a **2a**

Entry	Solvent	Yield (%)
1	**DMSO**	**46**
2	DMF	36
3	DCE	27
4	DCM	11
5	$PhCF_3$	trace
6	THF	5
7	$PhNO_2$	N.R.

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), **O1** (2.0 equiv), solvent (2.0 mL), Ar atmosphere, 4 h, 100 ℃, isolated yields.

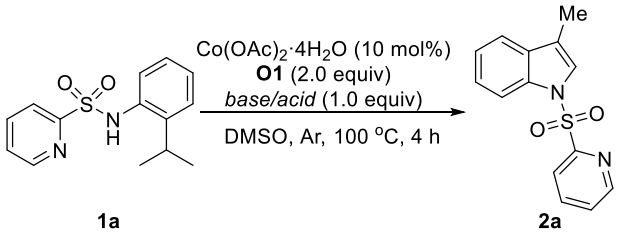
Table S3 Optimization of catalyst[a]



Entry	Catalyst	Yield (%)	Entry	Catalyst	Yield (%)
1	$Co(acac)_2$	N.R.	10	$Co(hfacac)_2$	N.R.
2	$Co(acac)_3$	N.R.	11	$Co(OOCC_6H_5)_2$	18
3	$CoCO_3$	N.R.	12	$CoSO_4$	7
4	CoF_2	N.R.	13	$Co(PPh_3)_3Cl_2$	21
5	$CoBr_2$ $6H_2O$	15	14	$Co(NO_3)_2$ $6H_2O$	trace
6	CoI_2	9	15	$CoCl_2$ $6H_2O$	trace
7	$Co(ClO_4)_2$ $6H_2O$	N.R.	16	$Ni(OAc)_2$ $4H_2O$	N.R.
8	$Co(salen)_2$	8	17	$Pd(OAc)_2$	N.R.
9	**$Co(OAc)_2$ $4H_2O$**	**46**	18	-	N.R.

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), **O1** (2.0 equiv), DMSO (2.0 mL), Ar atmosphere, 4 h, 100 ℃, isolated yields.

Table S4 Optimization of base/acid[a]

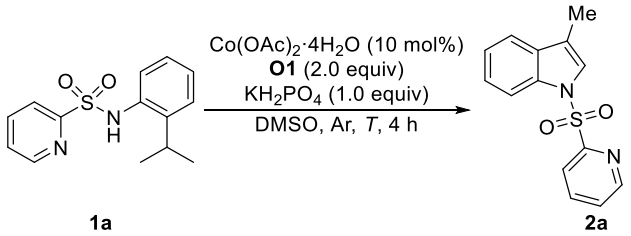


Entry	additive	Yield (%)	Entry	additive	Yield (%)
1	Na_2CO_3	24	16	Cs_2CO_3	20
2	$NaHCO_3$	38	17	$(NH_4)_2CO_3$	N.R.
3	NaOAc	38	18	NH_4HCO_3	N.R.
4	$NaOCH_3$	30	19	DABCO	25
5	NaOPiv H_2O	44	20	DMAP	34

6	$Na_2C_2O_4$	27	21	Et_3N	25
7	NaF	44	22	$(iPr)_2EtN$	trace
8	$Na_2HPO_4·12H_2O$	35	23	DBU	37
9	$NaH_2PO_4·2H_2O$	N.R.	24	Et_2NH	34
10	PhCOONa	42	25	PhCOOH	46
11	$K_2HPO_4·3H_2O$	53	26	CH_3COOH	51
12	**KH_2PO_4**	**54**	27	PivOH	53
13	K_2CO_3	47	28	1-AdCOOH	45
14	$KHCO_3$	39	39	CF_3COOH	N.R.
15	K_3PO_4	trace	30	HCOOH	13

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), **O1** (2.0 equiv), base/acid (1.0 equiv), DMSO (2.0 mL), Ar atmosphere, 4 h, 100 ℃, isolated yields.

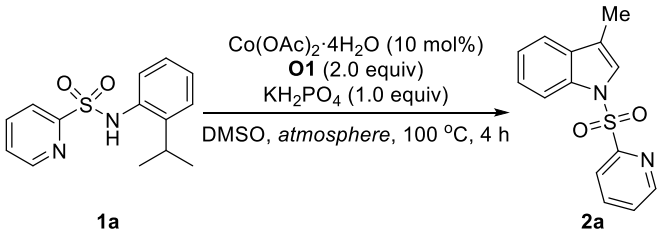
Table S5 Optimization of temperature[a]



Entry	T (^oC)	Yield (%)
1	70	31
2	80	43
3	90	51
4	**100**	**54**
5	110	45
6	120	28
7	130	19

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), **O1** (2.0 equiv), KH_2PO_4 (1.0 equiv), DMSO (2.0 mL), Ar atmosphere, 4 h, T, isolated yields.

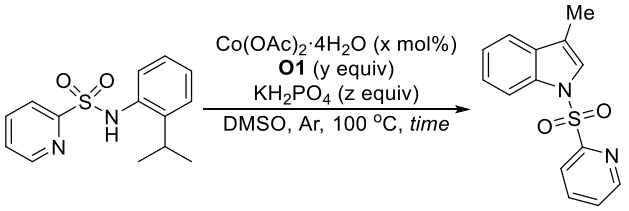
Table S6 Optimization of atmosphere[a]



Entry	Atmosphere	Yield (%)
1	**Ar**	**54**
2	Air	43
3	O_2	20

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2·4H_2O$ (10 mol%), **O1** (2.0 equiv), KH_2PO_4 (1.0 equiv), DMSO (2.0 mL), atmosphere, 4 h, 100 ^oC, isolated yields.

Table S7 Optimization of dosage and time[a]

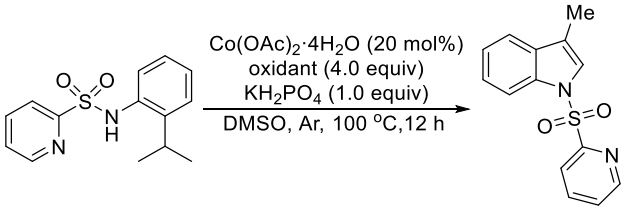


1a 2a

Entry	X	Y	Z	DMSO (mL)	Time/h	Yield (%)
1	10	2	1	2	4	54
2	15	2	1	2	4	53
3	20	2	1	2	4	55
4	20	3	1	2	4	57
5	20	4	1	2	4	58
6	20	4	1	3	4	56
7	20	4	1	4	4	59
8	20	4	1	4	2	44
9	20	4	1	4	6	57
10	20	4	1	4	8	58
11	20	4	1	4	10	66
12	**20**	**4**	**1**	**4**	**12**	**73**
13	20	4	2	4	12	67
14	20	4	3	4	12	66
15	20	4	1	4	14	69
16	20	4	0	4	12	58

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2$ ·$4H_2O$ (x mol%), **O1** (y equiv), KH_2PO_4 (z equiv), DMSO (2.0-4.0 mL), Ar atmosphere, time, 100 °C, isolated yields.

Table S8 Optimization of oxidant[a]



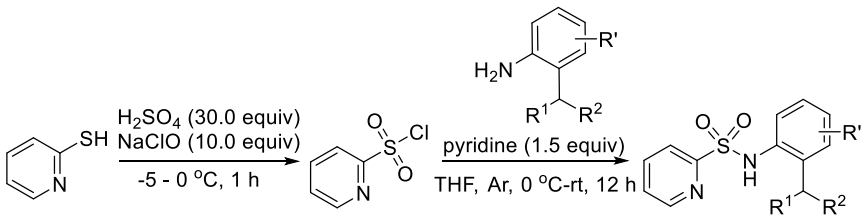
1a 2a

Entry	Oxidant	Yield (%)
1	**O1**	**73**
2[b]	**O1**	0
3	-	0
4	**O2**	32
5	**O3**	10
6	**O4**	28
7	**O5**	40
8	**O6**	37
9	**O7**	67

10	**O8**	39
11	Ag_2CO_3	0
12	$Mn(OAc)_2{\cdot}4H_2O$	0
13	$Cu(OAc)_2$	0

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2{\cdot}4H_2O$ (20 mol%), oxidant (4.0 equiv), KH_2PO_4 (1.0 equiv), DMSO (4.0 mL), Ar atmosphere, 12 h, 100 °C, isolated yields. [b]no $Co(OAc)_2{\cdot}4H_2O$.

2. General procedure for the synthesis of 1



The substituent aniline derivatives were synthesized according to literature procedures.[3-8]

According to the literature,[9] a multi-neck flask fitted with an addition funnel and thermometer was charged with 2-mercaptopyridine (1.00 g, 9 mmol) in sulfuric acid (15 mL, 30 equiv) and was cooled to −5 °C while open to atmosphere. 13% aqueous sodium hypochlorite (43 mL, 10 equiv) was added dropwise over approximately 40 minutes while maintaining the temperature below 0 °C. *Warning! This addition generates chlorine gas.* The system must not be closed and should be adequately ventilated. After complete addition, the mixture was stirred for an additional 20 minutes after which it was diluted with 50 mL water and extracted twice with 50 mL ethyl acetate. The organic layer was dried with sodium sulfate and concentrated without further purification to afford colorless oil (1.1 g, 70% yield).

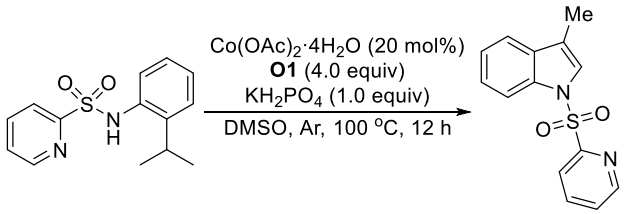
According to the literature,[1] the 2-pyridinesulfonyl chloride (1.5 equiv) was added dropwise to a stirring solution of anilines (1.0 equiv) and pyridine (1.5 equiv) in THF at 0 °C under Ar atmosphere. The mixture was stirred at room temperature for 12 h and then concentrated under vacuum. The residue was dissolved in EtOAc, washed with HCl (2 N), and extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was purified by flash column chromatography (PE/EA = 30/1 to 3/1) to give the corresponding product.

3. General procedure for the synthesis of 2

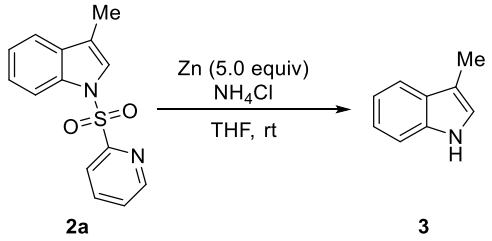
A 10 mL over-dried two-necked Schlenk tube was equipped with a magnetic stir bar and charged with the substrate **1** (0.2 mmol), $Co(OAc)_2{\cdot}4H_2O$ (20 mol%), **O1** (0.8 mmol, 4.0 equiv) and KH_2PO_4 (0.2 mmol, 1.0 equiv). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (4.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 °C for 12 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was

purified by preparative TLC on silica gel (PE/EA = 5/1) to give the corresponding product **2**.

4. Gram scale and removal of the directing group experiments

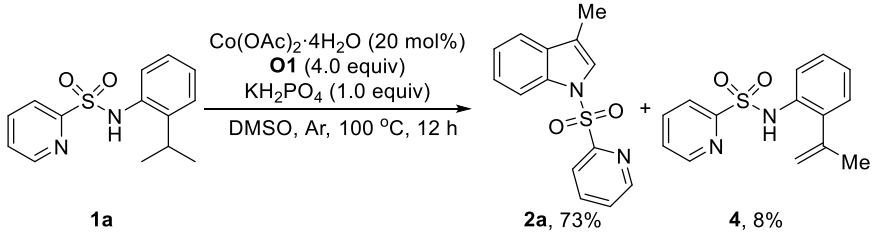


A 100 mL over-dried two-necked Schlenk bottle was equipped with a magnetic stir bar and charged with the substrate **1a** (3.6 mmol, 1 g), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%, 179 mg), **O1** (14.4 mmol, 4.0 equiv, 3.9 g) and KH_2PO_4 (0.2 mmol, 1.0 equiv, 489.6 mg). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (48.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 ℃ for 12 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was purified by flash column chromatography (PE/EA = 50/1 to 5/1) to give the corresponding product **2a** (636 mg, 65%).



According to the literature,[10] a suspension of 3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole **2a** (0.2 mmol) and activated powdered Zn (692 mg, 10 mmol) in a 1:1 mixture of THF/sat aq NH_4Cl (4 mL) was stirred at room temperature until consumption of the starting material (TLC monitoring, typically 72 h). The mixture was diluted with EtOAc and filtered through a pad of Celite to remove the residual Zn. The filtrate was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The residue was purified by preparative TLC on silica gel (PE/EA = 10/1) to give the corresponding product 3-methyl-1*H*-indole **3** (22.5mg, 86%). The obtained ^{1}H NMR spectra of **3** was consistent with the data reported in the literature.[11] ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.82 (s, 1H), 7.58 (d, *J* = 7.9 Hz, 1H), 7.32 (d, *J* = 8.1 Hz, 1H), 7.20 – 7.15 (m, 1H), 7.14 – 7.07 (m, 1H), 6.94 (d, *J* = 0.9 Hz, 1H), 2.33 (d, *J* = 1.0 Hz, 3H).

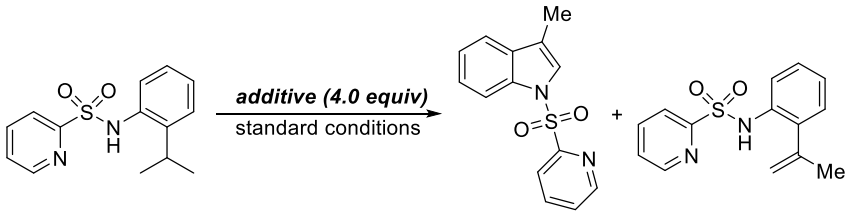
5. **Reaction analysis**



1a **2a**, 73% **4**, 8%

A 10 mL over-dried two-necked Schlenk tube was equipped with a magnetic stir bar and charged with the substrate **1a** (0.2 mmol, 55.2 mg), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%, 10 mg), **O1** (0.8 mmol, 4.0 equiv, 216.8 mg) and KH_2PO_4 (0.2 mmol, 1.0 equiv, 27.2 mg). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (4.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 ℃ for 12 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. Product was purified by preparative TLC on silica gel (PE/EA = 5/1). **1a** (5.5 mg)was recovered in 10% yield. 73% of the indole product **2a** (39.7 mg) and 8% of the dehydrogenation product **4** (4.5 mg) were obtained.

6. **Control experiments and mechanistic studies**



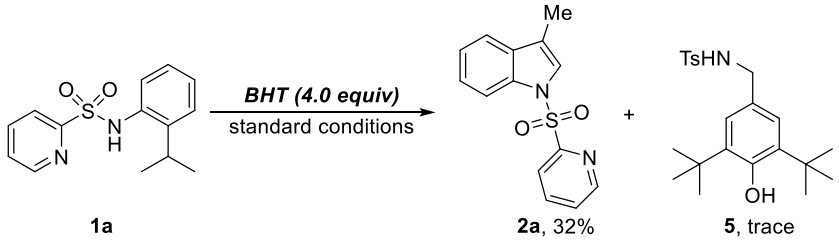
1a **2a** **4**

Entry	Additive	Recovery of **1a** (%)	Yield of **2a** (%)[a]	Yield of **4** (%)
1	TEMPO	32	31	20
2	BQ	89	0	trace
3	1,1-diphenylethylene	36	35	14

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%), **O1** (4.0 equiv), additive (4.0 equiv), KH_2PO_4 (1.0 equiv), DMSO (4.0 mL), Ar atmosphere, 12 h, 100 °C, isolated yields.

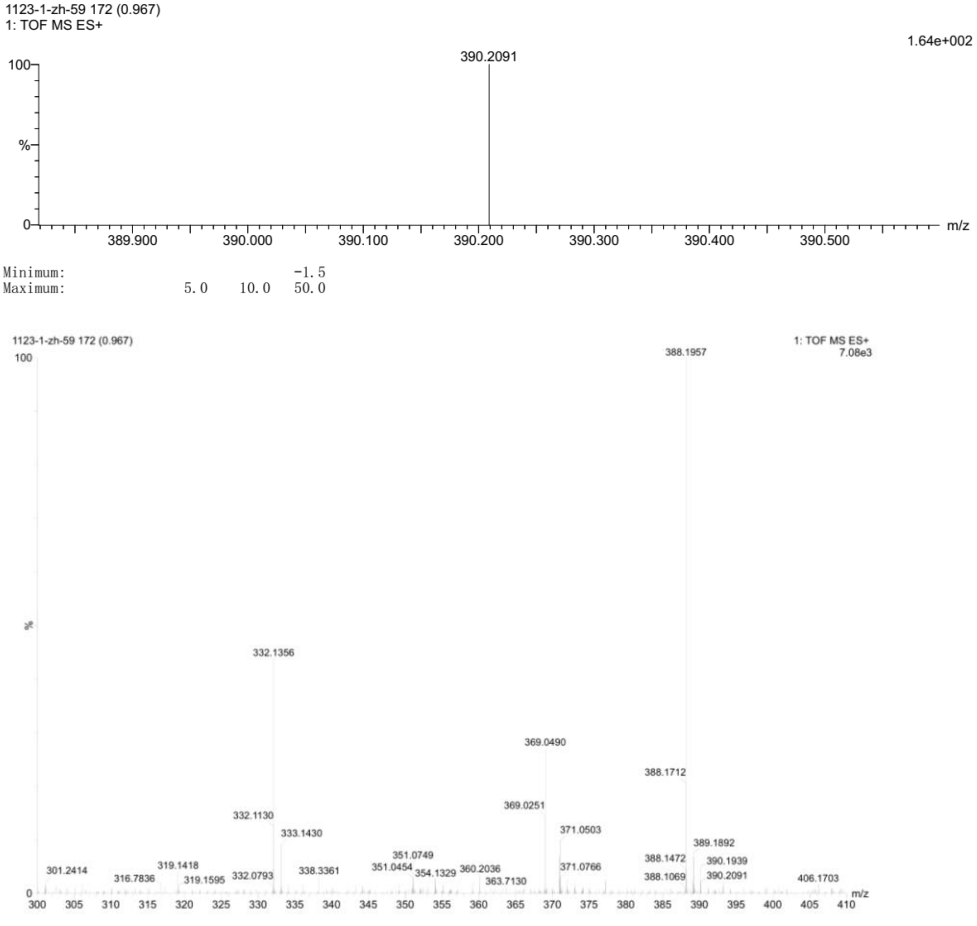
A 10 mL over-dried two-necked Schlenk tube was equipped with a magnetic stir bar and charged with the substrate **1a** (0.2 mmol, 55.2 mg), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%, 10 mg), **O1** (0.8 mmol, 4.0 equiv, 216.8 mg) additive (0.8 mmol, 4.0 equiv) and KH_2PO_4 (0.2 mmol, 1.0 equiv, 27.2 mg). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (4.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 ℃ for 12 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was purified

by preparative TLC on silica gel (PE/EA = 5/1) to give the corresponding product.

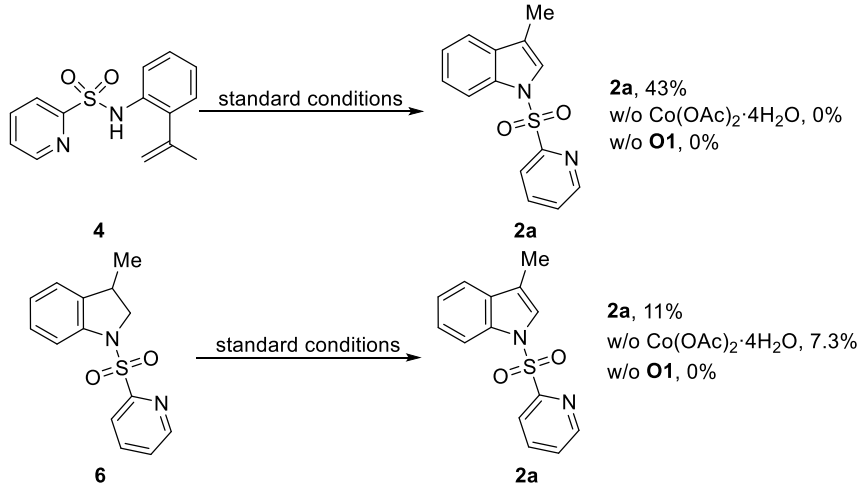


A 10 mL over-dried two-necked Schlenk tube was equipped with a magnetic stir bar and charged with the substrate **1a** (0.2 mmol, 55.2 mg), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%, 10 mg), **O1** (0.8 mmol, 4.0 equiv, 216.8 mg) BHT (0.8 mmol, 4.0 equiv, 176.3 mg) and KH_2PO_4 (0.2 mmol, 1.0 equiv, 27.2 mg). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (4.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 ℃ for 12 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was purified by preparative TLC on silica gel (PE/EA = 5/1) to give the corresponding product **2a** (17.4 mg, 32%) and the traces amount of compound **5**. Then, we successfully detected the TsNH-BHT adduct **5** by HRMS, illustrating the radical TsNH• was involved in the reaction process. The HRMS data for the compound **5**, HRMS (ESI) *m/z* calcd for $C_{22}H_{31}NO_3S+H^+$: 390.2098 $[M+H]^+$; found: 390.2091.

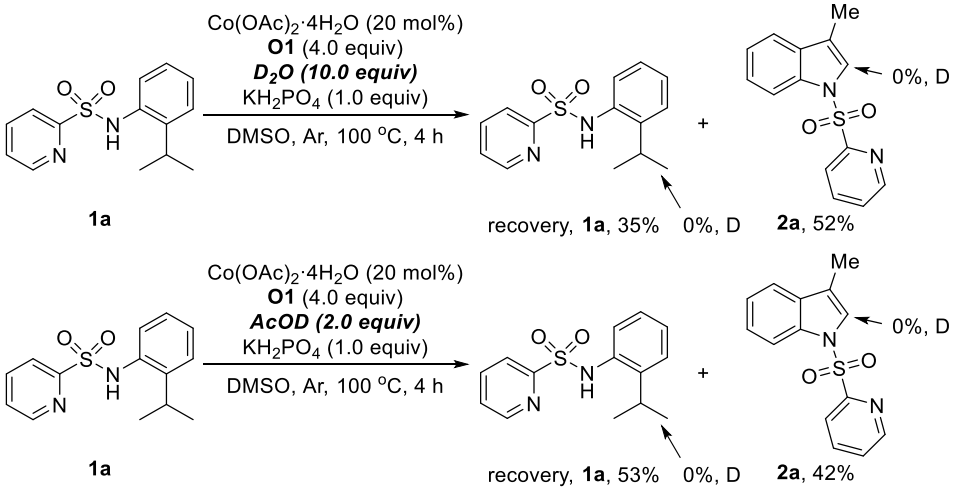
HRMS data for the compound 5



Control experiments

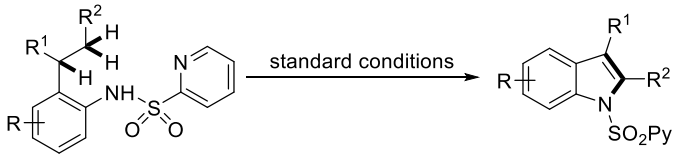


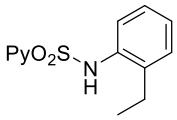
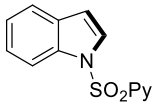
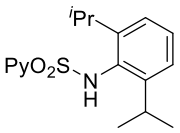
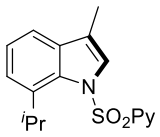
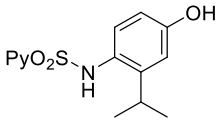
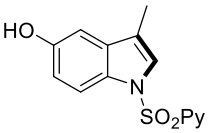
H/D exchange experiment



A 10 mL over-dried two-necked Schlenk tube was equipped with a magnetic stir bar and charged with the substrate **1a** (0.2 mmol, 55.2 mg), $Co(OAc)_2 \cdot 4H_2O$ (20 mol%, 10 mg), **O1** (0.8 mmol, 4.0 equiv, 216.8 mg), D_2O (2 mmol, 10.0 equiv, 36 μL) or AcOD (0.4 mmol, 2.0 equiv, 23 μL), and KH_2PO_4 (0.2 mmol, 1.0 equiv, 27.2 mg). The reaction vessel was then briefly evacuated and backfilled with argon (this sequence was repeated a total of three times). Anhydrous solvent DMSO (4.0 mL) was added to the reaction vessel via syringe. The vessel was heated at 100 ℃ for 4 h, and cooled down to room temperature. Next, the reaction mixture was diluted with saturated $NaHCO_3$. The resulting aqueous suspension was extracted with EtOAc. The organic layer was washed with brine, dried over anhydrous sodium sulfate, and concentrated under vacuum. The crude product was purified by preparative TLC on silica gel (PE/EA = 5/1) to give the recovered substrate **1a** (19.3 mg, 35%) or **1a** (29.3 mg, 53%) and the corresponding product **2a** (28.3 mg, 52%) or **2a** (22.9 mg, 42%). ^1H NMR analysis showed that the H contents in the recovered **1a** and the product **2a** were greater than 99%.

7. **Unsuccessful reaction**



Entry	Substrate **1**	Product **2**	yield (%)[a]
1			trace
2			0
3			0

[a]Reaction conditions: **1a** (0.2 mmol), $Co(OAc)_2$ $4H_2O$ (20 mol%), **O1** (4.0 equiv), KH_2PO_4 (1.0 equiv), DMSO (4.0 mL), Ar atmosphere, 12 h, 100 °C, isolated yields.

Characterization Data

Characterization of substrates

***N*-(2-isopropylphenyl)pyridine-2-sulfonamide (1a):** Follow by the general procedure **2**, the 2-isopropylaniline (10 mmol, 1.35g) was utilized as the starting material. white solid (2.3 g, 83%), mp: 140-141 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.75 (d, *J* = 4.6 Hz, 1H), 7.85 (d, *J* = 7.7 Hz, 1H), 7.81 (t, *J* = 7.6 Hz, 1H), 7.53 – 7.44 (m, 1H), 7.23 – 7.18 (m, 2H), 7.15 (t, *J* = 7.5 Hz, 1H), 7.09 – 7.03 (m, 1H), 6.94 (s, 1H), 3.30 – 3.20 (m, 1H), 1.08 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.2, 143.5, 137.8, 132.3, 127.2, 126.9, 126.4, 126.3, 125.6, 123.1, 27.2, 23.3. HRMS (ESI) *m/z* calcd for $C_{14}H_{16}N_2O_2S+H^+$: 277.1005 $[M+H]^+$; found: 277.1010.

***N*-(4-chloro-2-isopropylphenyl)pyridine-2-sulfonamide (1b):** Follow by the general procedure **2**, the 4-chloro-2-isopropylaniline (2.7 mmol, 456.3 mg) was utilized as the starting material. white solid (602 mg, 72%), mp: 124-125 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.74 (d, *J* = 4.8 Hz, 1H), 7.88 – 7.79 (m, 2H), 7.52 – 7.46 (m, 1H), 7.20 – 7.12 (m, 2H), 7.05 – 6.99 (m, 2H), 3.32 – 3.16 (m, 1H), 1.07 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.6, 150.2, 145.7, 138.0, 133.0, 130.9, 127.2, 127.0, 126.6, 126.5, 123.2, 27.5, 23.2. HRMS (ESI) *m/z* calcd for $C_{14}H_{15}ClN_2O_2S+H^+$: 311.0616 $[M+H]^+$; found: 311.0626.

***N*-(4-bromo-2-isopropylphenyl)pyridine-2-sulfonamide (1c):** Follow by the general procedure **2**, the 4-bromo-2-isopropylaniline (2.34 mmol, 498 mg) was utilized as the starting material. white solid (646 mg, 78%), mp: 139-140 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 (d, *J* = 4.4 Hz, 1H), 7.88 – 7.81 (m, 2H), 7.53 – 7.48 (m, 1H), 7.45 – 7.37 (m, 1H), 7.31 (d, *J* = 2.3 Hz, 1H), 7.21 – 7.14 (m, 1H), 7.14 – 7.06 (m, 1H), 3.27 (dd, *J* = 8.7, 4.4 Hz, 1H), 1.06 (dd, *J* = 6.8, 1.4 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.6, 150.2, 146.1, 138.1, 131.5, 129.6, 129.5, 127.5, 127.1, 123.2, 121.1, 27.5, 23.2. HRMS (ESI) *m/z* calcd for $C_{14}H_{15}BrN_2O_2S+H^+$: 355.0111 $[M+H]^+$; found: 355.0122.

***N*-(4-iodo-2-isopropylphenyl)pyridine-2-sulfonamide (1d):** Follow by the general procedure **2**, the 4-iodo-2-isopropylaniline (1.8 mmol, 469.8 mg) was utilized as the starting material. white solid (434 mg, 60%), mp: 155-156 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 (d, *J* = 4.6 Hz, 1H), 7.90 – 7.80 (m, 2H), 7.52 – 7.46 (m, 2H), 7.36 (dt, *J* = 11.7, 5.8 Hz, 1H), 7.12 (s, 1H), 6.99 (d, *J* = 8.5 Hz, 1H), 3.24 – 3.14 (m, 1H), 1.06 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.5, 150.2, 145.6, 138.1, 135.6, 135.5, 132.3, 127.3, 127.2, 127.1, 123.1, 92.4, 27.3, 23.2. HRMS (ESI) *m/z* calcd for $C_{14}H_{15}IN_2O_2S+H^+$: 402.9972 $[M+H]^+$; found: 402.9976.

***N*-(3-isopropyl-[1,1'-biphenyl]-4-yl)pyridine-2-sulfonamide (1e):** Follow by the general procedure **2**, the 3-isopropyl-[1,1'-biphenyl]-4-amine (2.84 mmol, 599 mg) was utilized as the starting material. white solid (669 mg, 67%), mp: 125-126 ℃, R_f = 0.45 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.76 (d, *J* = 4.3 Hz, 1H), 7.89 (d, *J* = 7.8 Hz, 1H), 7.83 (ddd, *J* = 13.1, 9.6, 4.7 Hz, 1H), 7.52 – 7.47 (m, 3H), 7.41 (dt, *J* = 7.7, 6.8 Hz, 3H), 7.32 (dd, *J* = 15.0, 7.6 Hz, 1H), 7.29 – 7.27 (m, 2H), 7.04 (s, 1H), 3.35 – 3.25 (m, 1H), 1.14 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.2, 143.8, 140.5, 140.1, 137.9, 131.6, 128.8, 127.4, 127.0, 126.9, 125.9, 125.1, 125.0, 123.2, 27.4, 23.4. HRMS (ESI) *m/z* calcd for $C_{20}H_{20}N_2O_2S+H^+$: 353.1318 $[M+H]^+$; found: 353.1328.

(*E*)-*N*-(2-isopropyl-4-styrylphenyl)pyridine-2-sulfonamide (1f): Follow by the general procedure **2**, the (*E*)-2-isopropyl-4-styrylaniline (3.15 mmol, 747 mg) was utilized as the starting material. white solid (703 mg, 59%), mp: 149-150 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.75 (d, *J* = 4.3 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.82 (td, *J* = 7.7, 1.5 Hz, 1H), 7.51 – 7.45 (m, 3H), 7.34 (t, *J* = 7.7 Hz, 2H), 7.29 (s, 1H), 7.26 – 7.25 (m, 1H), 7.24 (s, 2H), 7.04 (s, 1H), 7.01 (s, 2H), 3.24 (dq, *J* = 13.6, 6.8 Hz, 1H), 1.12 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.2, 143.5, 137.9, 137.1, 136.2, 131.6, 128.9, 128.7, 127.9, 127.7, 126.9, 126.5, 125.8, 124.6, 124.2, 123.2, 27.3, 23.3. HRMS (ESI) *m/z* calcd for $C_{22}H_{22}N_2O_2S+H^+$: 379.1475 $[M+H]^+$; found: 379.1482.

***N*-(2-isopropyl-4-(phenylethynyl)phenyl)pyridine-2-sulfonamide (1g):** Follow by the general procedure **2**, the 2-isopropyl-4-(phenylethynyl)aniline (1.85 mmol, 435 mg) was utilized as the starting material. yellow solid (410 mg, 59%), mp: 161-162 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 (dd, *J* = 4.7, 0.6 Hz, 1H), 7.87 (d, *J* = 7.8 Hz, 1H), 7.83 (td, *J* = 7.7, 1.7 Hz, 1H), 7.52 – 7.45 (m, 3H), 7.36 – 7.31 (m, 4H), 7.30 (d, *J* = 8.3 Hz, 1H), 7.23 (dd, *J* = 8.3, 1.9 Hz, 1H), 6.97 (s, 1H), 3.23 – 3.14 (m, 1H), 1.12 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.6, 150.2, 142.4, 137.9, 132.5, 131.6, 129.7, 129.7, 128.4, 127.0, 124.6, 123.2, 123.1, 121.7, 89.7, 88.9, 27.2, 23.1. HRMS (ESI) *m/z* calcd for $C_{22}H_{20}N_2O_2S+H^+$: 377.1318 $[M+H]^+$; found: 377.1329.

***N*-(4-(furan-3-yl)-2-isopropylphenyl)pyridine-2-sulfonamide (1h):** Follow by the general procedure **2**, the 4-(furan-3-yl)-2-isopropylaniline (3.3 mmol, 663 mg) was utilized as the starting

material. yellow solid (688 mg, 61%), mp: 142-143 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.76 (d, *J* = 4.1 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.82 (td, *J* = 7.7, 1.6 Hz, 1H), 7.66 (s, 1H), 7.48 (ddd, *J* = 7.5, 4.7, 1.1 Hz, 1H), 7.44 (dd, *J* = 5.6, 4.0 Hz, 1H), 7.28 (d, *J* = 1.9 Hz, 1H), 7.22 (d, *J* = 8.3 Hz, 1H), 7.17 (dd, *J* = 8.3, 2.0 Hz, 1H), 7.02 (s, 1H), 6.62 (d, *J* = 0.9 Hz, 1H), 3.32 – 3.21 (m, 1H), 1.11 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.2, 144.2, 143.7, 138.6, 137.9, 131.5, 131.1 126.9, 126.4, 125.9, 123.9, 123.7, 123.2, 108.8, 27.3, 23.4. HRMS (ESI) *m/z* calcd for $C_{18}H_{18}N_2O_3S+H^+$: 343.1111 $[M+H]^+$; found: 343.1121.

***N*-(2-isopropyl-4-(thiophen-3-yl)phenyl)pyridine-2-sulfonamide (1i):** Follow by the general procedure **2**, the 2-isopropyl-4-(thiophen-3-yl)aniline (3.44 mmol, 746 mg) was utilized as the starting material. yellow solid (800 mg, 65%), mp: 141-142 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.75 (dt, *J* = 14.4, 5.6 Hz, 1H), 7.86 (t, *J* = 7.7 Hz, 1H), 7.82 (td, *J* = 7.7, 1.7 Hz, 1H), 7.52 – 7.45 (m, 1H), 7.40 (d, *J* = 1.9 Hz, 1H), 7.37 (ddd, *J* = 7.9, 3.9, 2.2 Hz, 2H), 7.29 (ddd, *J* = 10.3, 6.6, 1.7 Hz, 2H), 7.27 – 7.25 (m, 1H), 6.92 (s, 1H), 3.31 – 3.22 (m, 1H), 1.12 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.2, 143.8, 141.7, 137.9, 134.8, 131.3, 126.9, 126.4, 126.2, 126.0, 124.5, 124.3, 123.2, 120.4, 27.4, 23.4. HRMS (ESI) *m/z* calcd for $C_{18}H_{18}N_2O_2S_2+H^+$: 359.0883 $[M+H]^+$; found: 359.0892.

***N*-(2-isopropyl-4-(naphthalen-1-yl)phenyl)pyridine-2-sulfonamide (1j):** Follow by the general procedure **2**, the 2-isopropyl-4-(naphthalen-1-yl)aniline (4.17 mmol, 1.1g) was utilized as the starting material. yellow solid (905 mg, 54%), mp: 176-177 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.79 (dd, *J* = 4.7, 0.7 Hz, 1H), 7.97 (d, *J* = 7.9 Hz, 1H), 7.88 (td, *J* = 7.9, 1.7 Hz, 2H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.79 (d, *J* = 8.5 Hz, 1H), 7.56 – 7.45 (m, 3H), 7.44 – 7.38 (m, 1H), 7.36 – 7.30 (m, 3H), 7.20 (dd, *J* = 8.1, 2.0 Hz, 1H), 6.96 (s, 1H), 3.39 – 3.27 (m, 1H), 1.14 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.0, 150.3, 143.3, 139.6, 137.9, 133.8, 131.5, 131.4, 128.4, 128.1, 128.1, 127.8, 126.9, 126.9, 126.1, 125.8, 125.7, 125.3, 123.1, 27.4, 23.4. HRMS (ESI) *m/z* calcd for $C_{24}H_{22}N_2O_2S+H^+$: 403.1475 $[M+H]^+$; found: 403.1483.

***N*-(2-isopropyl-4-methoxyphenyl)pyridine-2-sulfonamide (1k):** Follow by the general procedure **2**, the 2-isopropyl-4-methoxyaniline (2.5 mmol, 412.5 mg) was utilized as the starting material. white solid (574 mg, 75%), mp: 149-150 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.77 (d, *J* = 4.7 Hz, 1H), 7.93 – 7.73 (m, 2H), 7.59 – 7.37 (m, 1H), 7.00 (d, *J* = 8.8 Hz, 1H), 6.73 (t, *J* = 9.7 Hz, 2H), 6.56 (dd, *J* = 8.8, 2.9 Hz, 1H), 3.74 (s, 3H), 3.33 – 3.21 (m, 1H), 1.05 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 159.0, 157.0, 150.2, 147.2, 137.8, 128.6, 126.8, 124.8, 123.2, 112.1, 111.1, 55.3, 27.6, 23.4. HRMS (ESI) *m/z* calcd for $C_{15}H_{18}N_2O_3S+H^+$: 307.1111 $[M+H]^+$; found: 307.1120.

***N*-(2-isopropyl-4-phenethylphenyl)pyridine-2-sulfonamide (1l):** Follow by the general procedure **2**, the 2-isopropyl-4-phenethylaniline (1.2 mmol, 287 mg) was utilized as the starting material. white solid (410 mg, 90%), mp: 141-142 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.79 – 8.71 (m, 1H), 7.86 – 7.77 (m, 2H), 7.51 – 7.44 (m, 1H), 7.24 (t, *J* = 7.4 Hz, 2H), 7.17 (t, *J* = 7.4 Hz, 1H), 7.08 (dd, *J* = 12.1, 7.6 Hz, 3H), 6.91 – 6.84 (m, 2H), 6.75 (s, 1H), 3.26 – 3.14 (m, 1H), 2.89 – 2.79 (m, 4H), 1.02 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.2, 143.7, 141.4, 140.9, 137.8, 129.9, 128.5, 128.3, 126.8, 126.4, 126.4, 125.9, 125.9, 123.1, 37.7, 37.6, 27.2, 23.3. HRMS (ESI) *m/z* calcd for $C_{22}H_{24}N_2O_2S+H^+$: 381.1631 $[M+H]^+$; found: 381.1640.

***N*-(2-isopropyl-5-nitrophenyl)pyridine-2-sulfonamide (1m):** Follow by the general procedure **2**, the 2-isopropyl-5-nitroaniline (4 mmol, 720 mg) was utilized as the starting material. white solid

(899 mg, 70%), mp: 158-159 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.79 – 8.74 (m, 1H), 8.13 (d, *J* = 2.4 Hz, 1H), 8.00 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.96 (d, *J* = 7.8 Hz, 1H), 7.90 (td, *J* = 7.7, 1.7 Hz, 1H), 7.59 (s, 1H), 7.57 – 7.52 (m, 1H), 7.39 (d, *J* = 8.7 Hz, 1H), 3.42 (hept, *J* = 6.8 Hz, 1H), 1.16 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.3, 150.4, 146.2, 138.3, 133.7, 127.4, 127.2, 123.2, 121.6, 120.0, 119.9, 27.9, 22.9. HRMS (ESI) *m/z* calcd for $C_{14}H_{15}N_3O_4S+H^+$: 322.0856 $[M+H]^+$; found: 322.0863.

***N*-(2-(1-phenylethyl)phenyl)pyridine-2-sulfonamide (1n):** Follow by the general procedure **2**, the 2-(1-phenylethyl)aniline (1.75 mmol, 345 mg) was utilized as the starting material. white solid (355 mg, 60%), mp: 148-149 ℃, R_f = 0.55 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 – 8.68 (m, 1H), 7.88 – 7.79 (m, 2H), 7.47 (ddd, *J* = 7.3, 4.7, 1.4 Hz, 1H), 7.28 (ddd, *J* = 6.8, 3.7, 2.2 Hz, 4H), 7.19 (ddd, *J* = 8.8, 7.5, 1.3 Hz, 2H), 7.16 – 7.10 (m, 3H), 6.63 (s, 1H), 4.35 (q, *J* = 7.1 Hz, 1H), 1.49 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.1, 150.2, 144.8, 140.0, 137.9, 133.6, 128.9, 127.6, 127.5, 127.1, 126.9, 126.8, 126.6, 125.6, 122.9, 39.2, 21.7. HRMS (ESI) *m/z* calcd for $C_{19}H_{18}N_2O_2S+H^+$: 339.1162 $[M+H]^+$; found: 339.1167.

***N*-(2-(1-(4-methoxyphenyl)ethyl)phenyl)pyridine-2-sulfonamide (1o):** Follow by the general procedure **2**, the 2-(1-(4-methoxyphenyl)ethyl)aniline (1.8 mmol, 409 mg) was utilized as the starting material. white solid (550 mg, 83%), mp: 177-178 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.74 (d, *J* = 4.5 Hz, 1H), 7.88 – 7.79 (m, 2H), 7.51 – 7.46 (m, 1H), 7.29 – 7.25 (m, 2H), 7.18 (t, *J* = 7.4 Hz, 1H), 7.13 (d, *J* = 7.2 Hz, 2H), 7.06 (d, *J* = 8.7 Hz, 1H), 6.79 (d, *J* = 2.9 Hz, 1H), 6.62 (dd, *J* = 8.8, 2.9 Hz, 1H), 6.45 (d, *J* = 13.8 Hz, 1H), 4.35 (q, *J* = 7.1 Hz, 1H), 3.74 (s, 3H), 1.44 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 158.8, 157.2, 150.2, 144.9, 143.9, 137.9, 128.8, 128.7, 127.5, 126.8, 126.5, 126.1, 123.1, 114.1, 111.2, 55.3, 39.2, 21.6. HRMS (ESI) *m/z* calcd for $C_{20}H_{20}N_2O_3S+H^+$: 369.1268 $[M+H]^+$; found: 369.1278.

***N*-(2-(1-(p-tolyl)ethyl)phenyl)pyridine-2-sulfonamide (1p):** Follow by the general procedure **2**, the 2-(1-(p-tolyl)ethyl)aniline (2.4 mmol, 506.4 mg) was utilized as the starting material. white solid (566 mg, 67%), mp: 170-171 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.73 (d, *J* = 4.6 Hz, 1H), 7.90 – 7.76 (m, 2H), 7.47 (ddd, *J* = 7.1, 4.7, 1.5 Hz, 1H), 7.31 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.28 – 7.26 (m, 1H), 7.16 (dtd, *J* = 25.3, 7.5, 1.4 Hz, 2H), 7.08 (t, *J* = 8.0 Hz, 2H), 7.02 – 6.98 (m, 2H), 6.60 (s, 1H), 4.30 – 4.19 (m, 1H), 2.30 (s, 3H), 1.46 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.1, 150.2, 141.7, 139.8, 137.9, 136.3, 133.7, 129.7, 127.5, 127.4, 127.1, 126.9, 126.7, 125.4, 122.9, 38.9, 21.8, 20.9. HRMS (ESI) *m/z* calcd for $C_{20}H_{20}N_2O_2S+H^+$: 353.1318 $[M+H]^+$; found: 353.1327.

***N*-(2-(1-(4-(trifluoromethyl)phenyl)ethyl)phenyl)pyridine-2-sulfonamide (1q):** Follow by the general procedure **2**, the 2-(1-(4-(trifluoromethyl)phenyl)ethyl)aniline (1 mmol, 265 mg) was utilized as the starting material. white solid (284.2 mg, 70%), mp: 139-140 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.57 – 8.51 (m, 1H), 7.87 – 7.78 (m, 2H), 7.50 (d, *J* = 8.1 Hz, 2H), 7.43 (ddd, *J* = 7.4, 4.7, 1.3 Hz, 1H), 7.29 (s, 1H), 7.27 (d, *J* = 3.7 Hz, 1H), 7.26 (s, 1H), 7.24 – 7.18 (m, 2H), 7.11 – 7.07 (m, 2H), 4.75 (q, *J* = 7.1 Hz, 1H), 1.54 (d, *J* = 7.2 Hz, 3H). ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.33. ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.0, 149.4, 141.3, 138.1, 133.3, 128.6 ($^2J_{C-F}$ = 31.66 Hz), 128.1, 128.0, 127.7, 127.4, 126.9, 126.8, 125.5 ($^3J_{C-F}$ = 3.67 Hz), 124.2 ($^1J_{C-F}$ = 271.91 Hz), 123.1, 38.69, 21.56. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{20}H_{18}F_3N_2O_2S$ 407.1036; Found: 407.1043. HRMS (ESI) *m/z* calcd for $C_{20}H_{17}F_3N_2O_2S+H^+$: 407.1036 $[M+H]^+$; found: 407.1043.

***N*-(4-methoxy-2-(1-(4-(trifluoromethyl)phenyl)ethyl)phenyl)pyridine-2-sulfonamide (1r):**

Follow by the general procedure **2**, the 4-methoxy-2-(1-(4-(trifluoromethyl)phenyl)ethyl)aniline (1.25 mmol, 369 mg) was utilized as the starting material. white solid (382 mg, 70%), mp: 126-127 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.51 (d, *J* = 4.5 Hz, 1H), 7.86 – 7.76 (m, 2H), 7.50 (d, *J* = 8.2 Hz, 2H), 7.45 – 7.38 (m, 1H), 7.34 (s, 1H), 7.29 (d, *J* = 8.2 Hz, 2H), 6.85 (d, *J* = 8.8 Hz, 1H), 6.75 (d, *J* = 2.9 Hz, 1H), 6.56 (dd, *J* = 8.8, 2.9 Hz, 1H), 4.82 (q, *J* = 7.1 Hz, 1H), 3.71 (s, 3H), 1.52 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 159.2, 156.9, 150.0, 149.5, 144.7, 138.0, 129.5, 128.5 ($^2J_{C\text{-}F}$ = 32.29 Hz), 128.1, 126.9, 125.7, 125.5 ($^3J_{C\text{-}F}$ = 3.37 Hz), 124.2 ($^1J_{C\text{-}F}$ = 273.14 Hz), 123.3, 114.4, 111.4, 55.3, 38.8, 21.5. HRMS (ESI) *m/z* calcd for $C_{21}H_{19}F_3N_2O_3S+H^+$: 437.1141 $[M+H]^+$; found: 437.1149.

***N*-(4-methyl-2-(1-phenylethyl)phenyl)pyridine-2-sulfonamide (1s):** Follow by the general procedure **2**, the 4-methyl-2-(1-phenylethyl)aniline (2.2 mmol, 464.2 mg) was utilized as the starting material. white solid (480 mg, 62%), mp: 134-135 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.71 (d, *J* = 4.6 Hz, 1H), 7.82 (ddd, *J* = 10.1, 9.4, 4.6 Hz, 2H), 7.46 (ddd, *J* = 7.2, 4.7, 1.4 Hz, 1H), 7.29 – 7.24 (m, 2H), 7.19 (t, *J* = 7.4 Hz, 1H), 7.12 (d, *J* = 7.3 Hz, 2H), 7.10 – 7.06 (m, 1H), 7.05 (s, 1H), 6.92 (d, *J* = 8.1 Hz, 1H), 6.56 (s, 1H), 4.34 (q, *J* = 7.1 Hz, 1H), 2.28 (s, 3H), 1.46 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.2, 150.2, 145.0, 140.7, 137.9, 136.9, 130.8, 128.9, 128.3, 127.7, 127.5, 126.8, 126.5, 126.2, 122.9, 39.1, 21.7, 21.3. HRMS (ESI) *m/z* calcd for $C_{20}H_{20}N_2O_2S+H^+$: 353.1318 $[M+H]^+$; found: 353.1327.

***N*-(2-cyclopentylphenyl)pyridine-2-sulfonamide (1t):** Follow by the general procedure **2**, the 2-cyclopentylaniline (2.5 mmol, 403 mg) was utilized as the starting material. white solid (642 mg, 85%), mp: 122-123 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.76 (d, *J* = 20.3 Hz, 1H), 7.88 – 7.78 (m, 2H), 7.48 (s, 1H), 7.21 (dd, *J* = 15.7, 7.9 Hz, 2H), 7.13 (t, *J* = 7.4 Hz, 1H), 7.09 – 7.02 (m, 1H), 6.99 (s, 1H), 3.22 (p, *J* = 8.4 Hz, 1H), 1.89 – 1.72 (m, 4H), 1.66 (s, 2H), 1.42 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.1, 141.3, 137.9, 133.5, 127.1, 126.9, 126.8, 126.3, 125.5, 123.1, 39.2, 34.4, 25.6. HRMS (ESI) *m/z* calcd for $C_{16}H_{18}N_2O_2S$ $+H^+$: 303.1162 $[M+H]^+$; found: 303.1172.

***N*-(2-cyclohexylphenyl)pyridine-2-sulfonamide (1u):** Follow by the general procedure **2**, the 2-cyclohexylaniline (2 mmol, 350 mg) was utilized as the starting material. white solid (537 mg, 85%), mp: 115-116 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.77 – 8.73 (m, 1H), 7.85 – 7.75 (m, 2H), 7.51 – 7.44 (m, 1H), 7.28 (d, *J* = 7.9 Hz, 1H), 7.19 – 7.12 (m, 2H), 7.10 – 7.05 (m, 1H), 6.83 (s, 1H), 2.72 (tt, *J* = 11.4, 3.2 Hz, 1H), 1.76 (t, *J* = 13.4 Hz, 3H), 1.43 (d, *J* = 12.7 Hz, 2H), 1.38 – 1.16 (m, 5H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.8, 150.2, 142.3, 137.8, 132.2, 127.2, 126.9, 126.8, 126.4, 126.1, 123.0, 37.7, 33.9, 26.7, 26.0. HRMS (ESI) *m/z* calcd for $C_{17}H_{20}N_2O_2S+H^+$: 317.1318 $[M+H]^+$; found: 317.1329.

***N*-(2-cycloheptylphenyl)pyridine-2-sulfonamide (1v):** Follow by the general procedure **2**, the 2-cycloheptylaniline (2.5 mmol, 473 mg) was utilized as the starting material. white solid (783 mg, 95%), mp: 120-121 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.78 – 8.72 (m, 1H), 7.85 – 7.78 (m, 2H), 7.47 (ddd, *J* = 6.8, 4.7, 1.9 Hz, 1H), 7.26 (d, *J* = 6.6 Hz, 1H), 7.17 – 7.11 (m, 2H), 7.07 – 7.03 (m, 1H), 6.82 (s, 1H), 2.88 (td, *J* = 9.7, 4.8 Hz, 1H), 1.74 – 1.67 (m, 4H), 1.57 – 1.43 (m, 8H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.3, 144.3, 137.9, 131.6, 127.2, 127.1, 126.8, 126.1, 125.7, 122.9, 39.7, 36.2, 27.7, 27.2. HRMS (ESI) *m/z* calcd for $C_{18}H_{22}N_2O_2S+H^+$: 331.1475 $[M+H]^+$; found: 331.1480.

***N*-(2-propylphenyl)pyridine-2-sulfonamide (1w):** Follow by the general procedure **2**, the 2-propylaniline (3.7 mmol, 500 mg) was utilized as the starting material. white solid (970 mg,

95%), mp: 128-129 ℃, R_f = 0.6 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.71 (dd, *J* = 4.6, 0.7 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.81 (td, *J* = 7.7, 1.5 Hz, 1H), 7.50 – 7.43 (m, 1H), 7.23 (d, *J* = 7.6 Hz, 1H), 7.13 (s, 1H), 7.12 – 7.02 (m, 3H), 2.58 – 2.52 (m, 2H), 1.55 – 1.46 (m, 2H), 0.91 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.2, 137.9, 136.6, 136.6, 133.6, 129.9, 126.9, 126.7, 126.5, 124.6, 124.5, 122.9, 32.9, 23.2, 13.9. HRMS (ESI) *m/z* calcd for $C_{14}H_{16}N_2O_2S+H^+$: 277.1005 $[M+H]^+$; found: 277.1017.

***N*-(2-(1,2-diphenylethyl)-4-methylphenyl)pyridine-2-sulfonamide (1x):** Follow by the general procedure **2**, the 2-(1,2-diphenylethyl)-4-methylaniline (0.5 mmol, 144 mg) was utilized as the starting material. white solid (98.4 mg, 46%), mp: 146-147 ℃, R_f = 0.4 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.69 (d, *J* = 4.7 Hz, 1H), 7.83 (ddd, *J* = 10.8, 9.1, 4.6 Hz, 2H), 7.46 (ddd, *J* = 7.3, 4.7, 1.2 Hz, 1H), 7.22 (t, *J* = 7.4 Hz, 2H), 7.20 – 7.15 (m, 4H), 7.08 (s, 1H), 7.01 (dd, *J* = 15.5, 7.7 Hz, 3H), 6.92 – 6.83 (m, 3H), 6.02 (s, 1H), 4.50 (t, *J* = 7.8 Hz, 1H), 3.27 (dd, *J* = 13.2, 7.8 Hz, 1H), 3.15 (dd, *J* = 13.2, 7.8 Hz, 1H), 2.27 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.5, 150.3, 142.9, 139.8, 139.5, 137.8, 137.1, 131.1, 129.1, 128.7, 128.6, 128.3, 128.2, 127.8, 126.8, 126.7, 126.6, 126.3, 122.9, 46.5, 42.0, 21.3. HRMS (ESI) *m/z* calcd for $C_{26}H_{24}N_2O_2S+H^+$: 429.1631 $[M+H]^+$; found: 429.1644.

***N*-(4-methyl-2-(1-phenylpropyl)phenyl)pyridine-2-sulfonamide (1y):** Follow by the general procedure **2**, the 4-methyl-2-(1-phenylpropyl)aniline (2 mmol, 225 mg) was utilized as the starting material. white solid (439.2 mg, 60%), mp: 180-181 ℃, R_f = 0.45 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.76 – 8.69 (m, 1H), 7.85 – 7.78 (m, 2H), 7.47 (ddd, *J* = 7.1, 4.7, 1.5 Hz, 1H), 7.32 – 7.23 (m, 2H), 7.21 – 7.13 (m, 3H), 7.11 (dt, *J* = 16.9, 8.3 Hz, 2H), 6.92 (dd, *J* = 8.1, 1.5 Hz, 1H), 6.54 (s, 1H), 3.92 (t, *J* = 7.6 Hz, 1H), 2.31 (s, 3H), 1.94 – 1.81 (m, 2H), 0.76 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 157.3, 150.2, 143.5, 139.3, 137.9, 136.8, 131.2, 128.9, 128.1, 128.0, 127.7, 126.8, 126.6, 126.5, 122.9, 46.8, 28.4, 21.3, 12.4. HRMS (ESI) *m/z* calcd for $C_{21}H_{22}N_2O_2S+H^+$: 367.1475 $[M+H]^+$; found: 367.1483.

***N*-(2-(pentan-2-yl)phenyl)pyridine-2-sulfonamide (1z):** Follow by the general procedure **2**, the 2-(pentan-2-yl)aniline (2.15 mmol, 350 mg) was utilized as the starting material. white solid (399 mg, 61%), mp: 95-96 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.77 – 8.71 (m, 1H), 7.82 (ddd, *J* = 12.9, 9.4, 4.7 Hz, 2H), 7.49 – 7.44 (m, 1H), 7.22 (d, *J* = 8.0 Hz, 1H), 7.17 – 7.14 (m, 2H), 7.05 (ddd, *J* = 13.1, 6.7, 4.0 Hz, 1H), 6.85 (s, 1H), 3.05 (dd, *J* = 14.0, 7.0 Hz, 1H), 1.52 – 1.42 (m, 1H), 1.42 – 1.33 (m, 1H), 1.20 (dtt, *J* = 14.7, 12.8, 6.4 Hz, 1H), 1.08 (tdd, *J* = 12.9, 9.1, 5.4 Hz, 1H), 1.02 (d, *J* = 6.8 Hz, 3H), 0.84 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 150.2, 142.6, 137.9, 132.7, 127.2, 126.8, 126.7, 126.3, 125.5, 123.1, 40.1, 32.5, 21.5, 20.7, 14.2. HRMS (ESI) *m/z* calcd for $C_{16}H_{20}N_2O_2S+H^+$: 305.1318 $[M+H]^+$; found: 305.1329.

***N*-(2-(prop-1-en-2-yl)phenyl)pyridine-2-sulfonamide (4):** Follow by the general procedure **2**, the 2-(prop-1-en-2-yl)aniline (5 mmol, 665 mg) was utilized as the starting material. white solid (932 mg, 68%), mp: 98-99 ℃, R_f = 0.5 (PE/EA = 3/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.66 (s, 1H), 7.98 (d, *J* = 7.8 Hz, 1H), 7.84 (t, *J* = 7.7 Hz, 1H), 7.62 (d, *J* = 8.2 Hz, 1H), 7.45 (d, *J* = 8.9 Hz, 2H), 7.18 – 7.09 (m, 1H), 7.02 (dt, *J* = 14.6, 7.3 Hz, 2H), 5.37 (s, 1H), 4.96 (s, 1H), 1.91 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.5, 150.2, 141.9, 137.9 134.4, 132.6, 128.1, 127.9, 126.9, 124.2, 123.1, 119.5, 117.6, 24.5. HRMS (ESI) *m/z* calcd for $C_{14}H_{14}N_2O_2S+H^+$: 275.0849 $[M+H]^+$; found: 275.0858.

Characterization of products

3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2a): white solid, (39.7 mg, 73%), mp: 103-104 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.56 (dd, *J* = 4.6, 0.6 Hz, 1H), 8.07 (d, *J* = 7.9 Hz, 1H), 7.98 (d, *J* = 8.2 Hz, 1H), 7.84 (td, *J* = 7.8, 1.7 Hz, 1H), 7.45 (d, *J* = 7.7 Hz, 1H), 7.43 – 7.38 (m, 2H), 7.32 – 7.27 (m, 1H), 7.26 – 7.22 (m, 1H), 2.25 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.5, 150.4, 138.1, 135.3, 131.9, 127.4, 124.5, 123.9, 123.2, 122.3, 119.4, 118.3, 113.8, 9.7. HRMS (ESI) *m/z* calcd for $C_{14}H_{12}N_2O_2S+H^+$: 273.0692 $[M+H]^+$; found: 273.0699.

5-chloro-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2b): white solid, (35.5 mg, 58%), mp: 100-101 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.58 (d, *J* = 4.4 Hz, 1H), 8.07 (d, *J* = 7.9 Hz, 1H), 7.89 (ddd, *J* = 11.4, 9.5, 5.2 Hz, 2H), 7.48 – 7.40 (m, 3H), 7.24 (dd, *J* = 8.8, 2.0 Hz, 1H), 2.22 (d, *J* = 1.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.5, 138.1, 133.8, 133.2, 129.2, 127.6, 125.3, 124.7, 122.2, 119.2, 117.7, 114.9, 9.6. HRMS (ESI) *m/z* calcd for $C_{14}H_{11}ClN_2O_2S+H^+$: 307.0303 $[M+H]^+$; found: 307.0311.

5-bromo-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2c): white solid, (50.4 mg, 72%), mp: 112-113 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.59 (dd, *J* = 4.6, 0.7 Hz, 1H), 8.08 (t, *J* = 7.4 Hz, 1H), 7.91 – 7.83 (m, 2H), 7.59 (d, *J* = 1.8 Hz, 1H), 7.47 – 7.43 (m, 1H), 7.41 – 7.36 (m, 2H), 2.22 (d, *J* = 1.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.5, 138.1, 134.2, 133.7, 127.6, 127.4, 125.1, 122.2, 122.1, 117.6, 116.7, 115.4, 9.6. HRMS (ESI) *m/z* calcd for $C_{14}H_{11}BrN_2O_2S+H^+$: 350.9798 $[M+H]^+$; found: 350.9806.

5-iodo-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2d): white solid, (47 mg, 59%), mp: 164-165 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 – 8.55 (m, 1H), 8.07 (d, *J* = 7.9 Hz, 1H), 7.88 (td, *J* = 7.8, 1.7 Hz, 1H), 7.79 (d, *J* = 1.4 Hz, 1H), 7.76 (d, *J* = 8.7 Hz, 1H), 7.55 (dd, *J* = 8.7, 1.6 Hz, 1H), 7.45 (ddd, *J* = 7.6, 4.7, 1.0 Hz, 1H), 7.36 (d, *J* = 1.1 Hz, 1H), 2.21 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.3, 150.4, 138.1, 134.7, 134.1, 132.9, 128.4, 127.5, 124.7, 122.2, 117.3, 115.7, 87.3, 9.5. HRMS (ESI) *m/z* calcd for $C_{14}H_{11}IN_2O_2S+H^+$: 398.9659 $[M+H]^+$; found: 398.9663.

3-methyl-5-phenyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2e): white solid, (48.7 mg, 70%), mp: 164-165 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (d, *J* = 4.1 Hz, 1H), 8.10 (t, *J* = 8.9 Hz, 1H), 8.03 (d, *J* = 8.6 Hz, 1H), 7.87 (td, *J* = 7.8, 1.6 Hz, 1H), 7.63 (t, *J* = 9.9 Hz, 1H), 7.59 (d, *J* = 7.3 Hz, 2H), 7.52 (dd, *J* = 8.6, 1.6 Hz, 1H), 7.45 – 7.39 (m, 4H), 7.32 (dd, *J* = 17.0, 9.6 Hz, 1H), 2.29 (d, *J* = 1.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.5, 150.4, 141.3, 138.0, 136.7, 134.7, 132.3, 128.7, 127.4, 127.3, 127.0, 124.4, 124.0, 122.2, 118.5, 117.8, 114.0, 9.7. HRMS (ESI) *m/z* calcd for $C_{20}H_{16}N_2O_2S+H^+$: 349.1005 $[M+H]^+$; found: 349.1017.

(*E*)-3-methyl-1-(pyridin-2-ylsulfonyl)-5-styryl-1*H*-indole (2f): white solid, (30.7 mg, 41%), mp: 106-107 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (d, *J* = 4.0 Hz, 1H), 8.09 (d, *J* = 7.9 Hz, 1H), 7.96 (d, *J* = 8.6 Hz, 1H), 7.87 (td, *J* = 7.8, 1.7 Hz, 1H), 7.56 (s, 1H), 7.54 – 7.47 (m, 3H), 7.45 – 7.42 (m, 1H), 7.41 (d, *J* = 1.1 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.24 (s, 1H), 7.18 (d, *J* = 16.3 Hz, 1H), 7.13 – 7.04 (m, 1H), 2.29 (d, *J* = 1.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.5, 150.4, 138.0, 137.4, 134.9, 132.8, 132.3, 128.7, 128.6, 128.1, 127.5, 127.4, 126.4, 124.5, 123.1, 122.2, 118.4, 117.4, 114.0, 9.7. HRMS (ESI) *m/z* calcd for $C_{22}H_{18}N_2O_2S+H^+$: 375.1162 $[M+H]^+$; found: 375.1168.

3-methyl-5-(phenylethynyl)-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2g): white solid, (42.4 mg, 57%), mp: 110-111 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.63 – 8.56 (m, 1H),

8.09 (d, *J* = 7.9 Hz, 1H), 7.96 (d, *J* = 8.5 Hz, 1H), 7.88 (td, *J* = 7.8, 1.7 Hz, 1H), 7.65 (d, *J* = 0.9 Hz, 1H), 7.52 (dt, *J* = 8.4, 2.2 Hz, 2H), 7.49 – 7.41 (m, 3H), 7.38 – 7.29 (m, 3H), 2.26 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.4, 138.1, 134.9, 131.9, 131.5, 128.3, 128.1, 128.0, 127.5, 124.7, 123.3, 122.9, 122.2, 118.2, 113.9, 89.6, 88.6, 9.6. HRMS (ESI) *m/z* calcd for $C_{22}H_{16}N_2O_2S+H^+$: 373.1005 $[M+H]^+$; found: 373.1015.

5-(furan-3-yl)-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2h): white solid, (25 mg, 37%), mp: 140-141 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (dd, *J* = 4.7, 0.7 Hz, 1H), 8.08 (t, *J* = 9.8 Hz, 1H), 7.97 (d, *J* = 8.5 Hz, 1H), 7.87 (td, *J* = 7.8, 1.7 Hz, 1H), 7.72 (s, 1H), 7.53 (d, *J* = 1.2 Hz, 1H), 7.48 (t, *J* = 1.6 Hz, 1H), 7.45 – 7.36 (m, 3H), 6.74 – 6.69 (m, 1H), 2.28 (d, *J* = 1.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.5, 150.4, 143.7, 138.3, 138.1, 134.5, 132.4, 127.8, 127.4, 126.6, 124.5, 122.9, 122.2, 118.4, 116.5, 114.2, 109.1, 9.7. HRMS (ESI) *m/z* calcd for $C_{18}H_{14}N_2O_3S+H^+$: 339.0798 $[M+H]^+$; found: 339.0807.

3-methyl-1-(pyridin-2-ylsulfonyl)-5-(thiophen-3-yl)-1*H*-indole (2i): white solid, (34.7 mg, 49%), mp: 121-122 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.63 – 8.57 (m, 1H), 8.09 (d, *J* = 7.9 Hz, 1H), 7.99 (d, *J* = 8.6 Hz, 1H), 7.87 (td, *J* = 7.8, 1.7 Hz, 1H), 7.63 (d, *J* = 1.6 Hz, 1H), 7.53 (dd, *J* = 8.6, 1.7 Hz, 1H), 7.45 – 7.41 (m, 3H), 7.41 – 7.37 (m, 2H), 2.29 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.6, 150.5, 142.45, 138.1, 134.6, 132.4, 131.5, 127.4, 126.6, 126.2, 124.5, 123.5, 122.2, 119.9, 118.5, 117.1, 114.1, 9.7. HRMS (ESI) *m/z* calcd for $C_{18}H_{14}N_2O_2S_2+H^+$: 355.0570 $[M+H]^+$; found: 355.0576.

3-methyl-5-(naphthalen-1-yl)-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2j): white solid, (43 mg, 54%), mp: 142-143 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.66 (dd, *J* = 4.7, 0.7 Hz, 1H), 8.17 (d, *J* = 7.9 Hz, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.95 – 7.89 (m, 2H), 7.85 (t, *J* = 7.7 Hz, 2H), 7.57 (d, *J* = 1.1 Hz, 1H), 7.53 – 7.44 (m, 4H), 7.45 – 7.36 (m, 3H), 2.28 (d, *J* = 1.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.7, 150.6, 140.3, 138.2, 135.9, 134.6, 133.8, 131.9, 131.8, 128.3, 127.6, 127.5, 127.2, 126.8, 126.1, 126.0, 125.8, 125.3, 124.4, 122.4, 120.7, 118.4, 113.7, 9.7. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}N_2O_2S+H^+$: 399.1062 $[M+H]^+$; found: 399.1170.

5-methoxy-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2k): white solid, (25.4 mg, 42%), mp: 141-142 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.62 – 8.55 (m, 1H), 8.05 (dd, *J* = 7.9, 0.8 Hz, 1H), 7.92 – 7.77 (m, 2H), 7.43 – 7.40 (m, 1H), 7.38 (d, *J* = 1.1 Hz, 1H), 6.89 (dt, *J* = 5.3, 2.3 Hz, 2H), 3.83 (s, 3H), 2.22 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.5, 155.5, 150.4, 137.9, 132.9, 129.9, 127.3, 124.7, 122.2, 118.3, 114.7, 113.2, 102.0, 55.7, 9.8. HRMS (ESI) *m/z* calcd for $C_{15}H_{14}N_2O_3S+H^+$: 303.0798 $[M+H]^+$; found: 303.0805.

3-methyl-5-phenethyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2l): white solid, (38.4 mg, 51%), mp: 127-128 ℃, R_f = 0.6 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.59 (dd, *J* = 4.6, 0.7 Hz, 1H), 8.07 (d, *J* = 7.9 Hz, 1H), 7.91 – 7.81 (m, 2H), 7.42 – 7.39 (m, 1H), 7.38 (d, *J* = 1.1 Hz, 1H), 7.29 – 7.26 (m, 2H), 7.25 (s, 1H), 7.19 (dd, *J* = 12.5, 7.1 Hz, 3H), 7.12 (dd, *J* = 8.5, 1.5 Hz, 1H), 2.98 (dt, *J* = 7.8, 2.5 Hz, 2H), 2.92 (dt, *J* = 7.3, 2.5 Hz, 2H), 2.23 (d, *J* = 1.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.6, 150.4, 141.7, 137.9, 136.9, 133.9, 132.1, 128.4, 128.3, 127.3, 125.9, 125.3, 124.1, 122.2, 118.8, 118.2, 113.6, 38.4, 37.9, 9.7. HRMS (ESI) *m/z* calcd for $C_{22}H_{20}N_2O_2S+H^+$: 377.1318 $[M+H]^+$; found: 377.1320.

3-methyl-6-nitro-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2m): white solid, (20.3 mg, 32%), mp: 109-110 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.88 (d, *J* = 1.9 Hz, 1H), 8.61 – 8.57 (m, 1H), 8.18 (dd, *J* = 28.1, 4.8 Hz, 1H), 8.15 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.95 (td, *J* = 7.8, 1.7 Hz, 1H), 7.68 (d, *J* = 1.1 Hz, 1H), 7.59 – 7.53 (m, 1H), 7.52 – 7.43 (m, 1H), 2.32 (d, *J* = 1.1

Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.2, 150.7, 145.2, 138.4, 136.4, 134.3, 129.2, 127.9, 122.4, 119.5, 118.5, 117.9, 110.4, 9.6. HRMS (ESI) *m/z* calcd for $C_{14}H_{11}N_3O_4S+H^+$: 318.0543 $[M+H]^+$; found: 318.0548.

3-phenyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2n): white solid, (50.1 mg, 75%), mp: 101-102 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.61 (ddd, *J* = 4.6, 1.5, 0.8 Hz, 1H), 8.16 – 8.13 (m, 1H), 8.09 (d, *J* = 8.3 Hz, 1H), 7.89 (td, *J* = 7.8, 1.7 Hz, 1H), 7.80 (d, *J* = 5.6 Hz, 2H), 7.64 (dd, *J* = 5.0, 3.2 Hz, 2H), 7.50 – 7.42 (m, 3H), 7.40 – 7.33 (m, 2H), 7.32 – 7.28 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.6, 138.1, 135.7, 133.0, 129.4, 128.9, 127.9, 127.6, 127.5, 124.8, 123.9, 123.8, 123.7, 122.3, 120.4, 114.1. HRMS (ESI) *m/z* calcd for $C_{19}H_{14}N_2O_2S+H^+$: 335.0849 $[M+H]^+$; found: 335.0859.

3-(4-methoxyphenyl)-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2o): white solid, (37.1 mg, 51%), mp: 111-112 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (dd, *J* = 4.6, 0.7 Hz, 1H), 8.11 (d, *J* = 7.9 Hz, 1H), 7.97 (d, *J* = 9.1 Hz, 1H), 7.88 (tt, *J* = 7.8, 3.8 Hz, 1H), 7.74 (s, 1H), 7.63 – 7.59 (m, 2H), 7.51 – 7.41 (m, 3H), 7.36 (dd, *J* = 17.0, 9.6 Hz, 1H), 7.21 (d, *J* = 2.4 Hz, 1H), 6.96 (dd, *J* = 9.1, 2.5 Hz, 1H), 3.81 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.9, 155.4, 150.5, 138.1, 133.1, 130.4, 130.3, 128.9, 127.8, 127.6, 124.8, 123.8, 122.3, 114.9, 113.7, 102.9, 55.8. HRMS (ESI) *m/z* calcd for $C_{20}H_{16}N_2O_3S+H^+$: 365.0955 $[M+H]^+$; found: 365.0962.

1-(pyridin-2-ylsulfonyl)-3-(p-tolyl)-1*H*-indole (2p): white solid, (52.9 mg, 76%), mp: 111-112 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (dd, *J* = 4.7, 0.7 Hz, 1H), 8.13 (d, *J* = 7.9 Hz, 1H), 8.08 (d, *J* = 8.3 Hz, 1H), 7.88 (td, *J* = 7.8, 1.7 Hz, 1H), 7.82 – 7.74 (m, 2H), 7.52 (d, *J* = 8.0 Hz, 2H), 7.44 (ddd, *J* = 7.7, 4.7, 1.0 Hz, 1H), 7.38 – 7.31 (m, 1H), 7.28 (dd, *J* = 12.7, 4.7 Hz, 3H), 2.41 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.6, 138.1, 137.4, 135.7, 130.1, 129.6, 129.5, 127.8, 127.6, 124.8, 123.7, 123.6, 123.6, 122.3, 120.4, 114.1, 21.2. HRMS (ESI) *m/z* calcd for $C_{20}H_{16}N_2O_2S+H^+$: 349.1005 $[M+H]^+$; found: 349.1016.

1-(pyridin-2-ylsulfonyl)-3-(4-(trifluoromethyl)phenyl)-1*H*-indole (2q): white solid, (57.1 mg, 71%), mp: 121-122 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.62 (d, *J* = 4.5 Hz, 1H), 8.19 (d, *J* = 7.9 Hz, 1H), 8.09 (d, *J* = 8.3 Hz, 1H), 7.91 (tt, *J* = 13.8, 6.9 Hz, 1H), 7.87 (s, 1H), 7.75 (dt, *J* = 17.8, 8.3 Hz, 5H), 7.47 (dt, *J* = 12.0, 6.0 Hz, 1H), 7.38 (t, *J* = 7.7 Hz, 1H), 7.32 (dd, *J* = 14.9, 7.6 Hz, 1H). ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.47. ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.2, 150.6, 138.2, 136.8, 135.7, 129.5 ($^2J_{C\text{-}F}$ = 32.24 Hz), 128.8, 128.1, 127.7, 125.8 ($^3J_{C\text{-}F}$ = 4.00 Hz), 125.2, 124.8, 124.2 ($^1J_{C\text{-}F}$ = 271.94 Hz), 123.9, 122.4, 122.3, 120.1, 114.2. HRMS (ESI) *m/z* calcd for $C_{20}H_{13}F_3N_2O_2S+H^+$: 403.0723 $[M+H]^+$; found: 403.0727.

5-methoxy-1-(pyridin-2-ylsulfonyl)-3-(4-(trifluoromethyl)phenyl)-1*H*-indole (2r): white solid, (41.5 mg, 48%), mp: 128-129 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.64 – 8.58 (m, 1H), 8.15 (d, *J* = 7.9 Hz, 1H), 8.00 – 7.95 (m, 1H), 7.91 (td, *J* = 7.8, 1.7 Hz, 1H), 7.82 (s, 1H), 7.72 (s, 4H), 7.47 (ddd, *J* = 7.7, 4.7, 1.0 Hz, 1H), 7.17 (d, *J* = 2.4 Hz, 1H), 6.98 (dd, *J* = 9.1, 2.5 Hz, 1H), 3.82 (s, 3H). ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.47. ^{3}C NMR (151 MHz, $CDCl_3$) δ 157.0, 155.2, 150.6, 138.2, 136.9, 130.3, 129.8, 129.5 ($^2J_{C\text{-}F}$ = 32.12 Hz), 127.9, 127.7, 125.9 ($^3J_{C\text{-}F}$ = 3.81 Hz), 125.6, 124.2 ($^1J_{C\text{-}F}$ = 272.81 Hz), 122.3, 122.2, 115.0, 113.9, 102.7. 55.8. HRMS (ESI) *m/z* calcd for $C_{21}H_{15}F_3N_2O_3S+H^+$: 433.0828 $[M+H]^+$; found: 433.0839.

5-methyl-3-phenyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2s): white solid, (48.7 mg, 70%), mp: 100-101 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.62 – 8.57 (m, 1H), 8.12 (d, *J* = 7.9 Hz, 1H), 7.95 (d, *J* = 8.5 Hz, 1H), 7.90 – 7.84 (m, 1H), 7.74 (s, 1H), 7.64 – 7.59 (m, 2H), 7.56 (s, 1H), 7.49 – 7.41 (m, 3H), 7.39 – 7.34 (m, 1H), 7.17 (dd, *J* = 8.5, 0.9 Hz, 1H), 2.42 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 155.4, 150.5, 138.1, 133.9, 133.4, 133.2, 129.6, 128.9, 127.9, 127.5, 127.4, 126.2, 124.1, 123.6, 122.3, 120.3, 113.7, 21.5. HRMS (ESI) *m/z* calcd for $C_{20}H_{16}N_2O_2S+H^+$: 349.1005 $[M+H]^+$; found: 349.1015.

4-(pyridin-2-ylsulfonyl)-1,2,3,4-tetrahydrocyclopenta[*b*]indole (2t): white solid, (34.6 mg, 58%), mp: 118-119 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.58 (dd, *J* = 4.6, 0.7 Hz, 1H), 8.05 (d, *J* = 7.9 Hz, 1H), 8.01 – 7.93 (m, 1H), 7.85 (td, *J* = 7.8, 1.7 Hz, 1H), 7.45 – 7.36 (m, 1H), 7.34 – 7.29 (m, 1H), 7.22 – 7.15 (m, 2H), 3.29 – 3.18 (m, 2H), 2.75 (ddd, *J* = 9.2, 3.8, 1.9 Hz, 2H), 2.53 (dt, *J* = 10.5, 7.2 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.9, 150.5, 144.9, 140.4, 137.9, 127.4, 127.3, 126.3, 123.4, 123.1, 122.1, 118.9, 114.5, 27.9, 27.5, 24.2. HRMS (ESI) *m/z* calcd for $C_{16}H_{14}N_2O_2S+H^+$: 299.0849 $[M+H]^+$; found: 299.0858.

9-(pyridin-2-ylsulfonyl)-2,3,4,9-tetrahydro-1*H*-carbazole (2u): white solid, (37.4 mg, 60%), mp: 125-126 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.58 (dd, *J* = 4.6, 0.6 Hz, 1H), 8.09 – 8.06 (m, 1H), 8.01 (d, *J* = 7.9 Hz, 1H), 7.83 (td, *J* = 7.8, 1.7 Hz, 1H), 7.41 (ddd, *J* = 7.6, 4.7, 0.9 Hz, 1H), 7.36 – 7.31 (m, 1H), 7.24 – 7.18 (m, 2H), 3.17 (ddd, *J* = 6.3, 4.5, 1.9 Hz, 2H), 2.61 (ddd, *J* = 7.9, 4.0, 1.9 Hz, 2H), 1.95 – 1.88 (m, 2H), 1.87 – 1.76 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.3, 150.4, 137.9, 136.8, 136.1, 130.5, 127.2, 123.7, 123.3, 121.9, 118.2, 117.9, 114.3, 24.5, 23.3, 22.1, 21.2. HRMS (ESI) *m/z* calcd for $C_{17}H_{16}N_2O_2S+H^+$: 313.1005 $[M+H]^+$; found: 313.1017.

5-(pyridin-2-ylsulfonyl)-5,6,7,8,9,10-hexahydrocyclohepta[*b*]indole (2v): white solid, (42.4 mg, 65%), mp: 131-132 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 – 8.54 (m, 1H), 8.17 – 8.10 (m, 1H), 7.95 (t, *J* = 9.1 Hz, 1H), 7.82 (td, *J* = 7.8, 1.7 Hz, 1H), 7.41 (ddd, *J* = 7.6, 4.7, 1.0 Hz, 1H), 7.38 – 7.33 (m, 1H), 7.23 – 7.17 (m, 2H), 3.38 – 3.28 (m, 2H), 2.73 – 2.66 (m, 2H), 1.85 (dt, *J* = 11.9, 6.0 Hz, 2H), 1.79 – 1.68 (m, 4H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.2, 150.2, 140.2, 137.9, 136.1, 130.9, 127.2, 123.6, 123.3, 123.1, 121.8, 117.8, 115.1, 30.8, 27.1, 26.8, 26.3, 23.5. HRMS (ESI) *m/z* calcd for $C_{18}H_{18}N_2O_2S+H^+$: 327.1162 $[M+H]^+$; found: 327.1168.

2-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2w): white solid, (30.5 mg, 56%), mp: 108-109 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.58 (d, *J* = 3.9 Hz, 1H), 8.05 (dd, *J* = 7.9, 3.7 Hz, 2H), 7.86 (td, *J* = 7.8, 1.7 Hz, 1H), 7.42 (ddd, *J* = 7.6, 4.7, 1.1 Hz, 1H), 7.41 – 7.36 (m, 1H), 7.21-7.16 (m, 2H), 6.37 (s, 1H), 2.75 (d, *J* = 1.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 150.4, 139.1, 137.9, 133.2, 129.9, 127.4, 123.6, 123.5, 121.9, 119.9, 114.4, 109.3, 100.0, 15.8. HRMS (ESI) *m/z* calcd for $C_{14}H_{12}N_2O_2S+H^+$: 273.0691 $[M+H]^+$; found: 273.0701.

5-methyl-2,3-diphenyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2x): white solid, (39.8 mg, 47%), mp: 118-119 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.53 (dd, *J* = 4.6, 0.7 Hz, 1H), 8.20 (d, *J* = 8.5 Hz, 1H), 7.70 (td, *J* = 7.8, 1.7 Hz, 1H), 7.60 (d, *J* = 7.9 Hz, 1H), 7.37 (ddd, *J* = 7.6, 4.7, 1.0 Hz, 1H), 7.30 – 7.27 (m, 2H), 7.24 – 7.18 (m, 8H), 7.16 – 7.12 (m, 2H), 2.40 (s, 3H). ^{3}C NMR (151 MHz, $CDCl_3$) δ 155.9, 150.0, 137.5, 137.2, 136.3, 135.6, 133.8, 132.8, 132.1, 131.0, 130.3, 129.9, 128.4, 128.2, 127.2, 127.1, 126.9, 126.5, 122.4, 119.8, 115.7, 21.3. HRMS (ESI) *m/z* calcd for $C_{26}H_{20}N_2O_2S+H^+$: 425.1318 $[M+H]^+$; found: 425.1324.

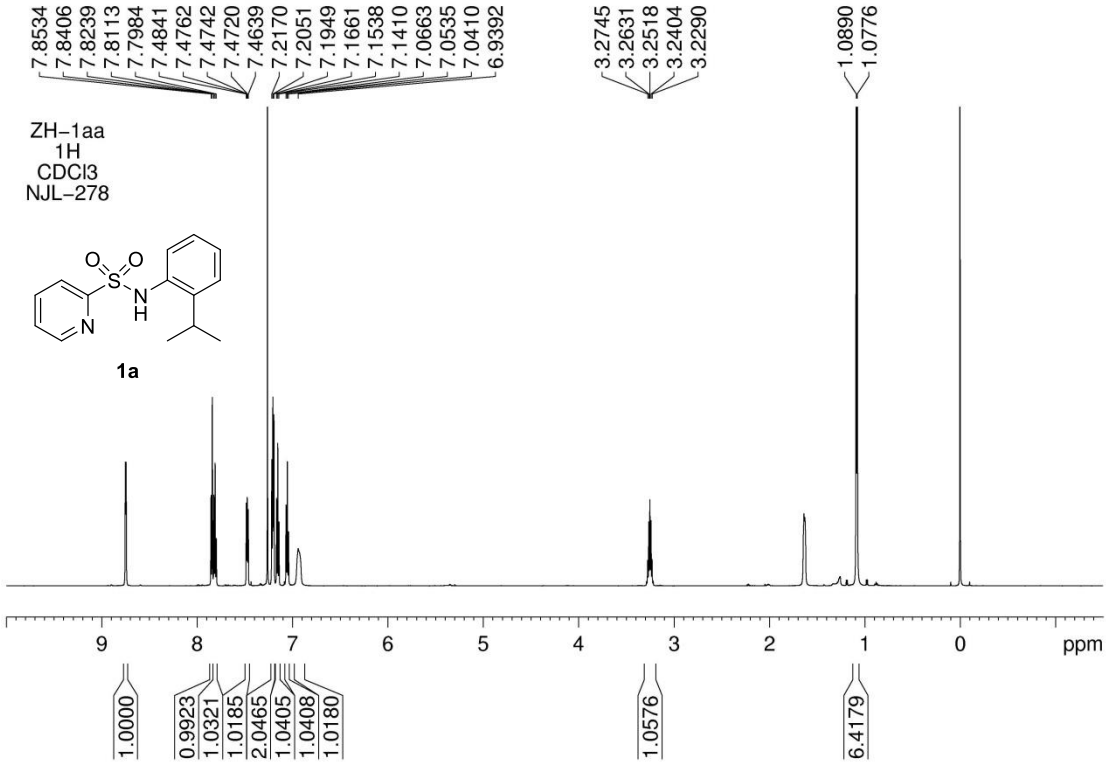
2,5-dimethyl-3-phenyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2y): white solid, (23.9 mg, 33%), mp: 121-122 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.60 (d, *J* = 4.6 Hz, 1H), 8.07 (d, *J* = 7.9 Hz, 1H), 8.02 (d, *J* = 8.5 Hz, 1H), 7.86 (td, *J* = 7.8, 1.6 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 2H), 7.44 – 7.41 (m, 1H), 7.40 – 7.35 (m, 3H), 7.17 (s, 1H), 7.07 (d, *J* = 8.6 Hz, 1H), 2.72 (s, 3H), 2.35 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.2, 150.4, 137.9, 134.8, 134.2, 133.3, 130.4, 130.1, 128.5, 127.3, 127.2, 125.3, 122.2, 122.0, 119.1, 114.1, 21.2, 13.5. HRMS (ESI) *m/z* calcd for

$C_{21}H_{18}N_2O_2S+H^+$: 363.1162 $[M+H]^+$; found: 363.1175.

3-propyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2z): white solid, (16.1 mg, 27%), mp: 105-106 ℃, R_f = 0.5 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.58 (ddd, *J* = 4.6, 1.5, 0.7 Hz, 1H), 8.08 (d, *J* = 7.9 Hz, 1H), 7.99 (d, *J* = 8.2 Hz, 1H), 7.85 (td, *J* = 7.8, 1.7 Hz, 1H), 7.48 (d, *J* = 7.6 Hz, 1H), 7.42 (td, *J* = 6.2, 1.0 Hz, 2H), 7.30 – 7.26 (m, 1H), 7.24 – 7.21 (m, 1H), 2.66 – 2.62 (m, 2H), 1.76 – 1.68 (m, 2H), 0.97 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 155.5, 150.4, 138.0, 135.5, 131.4, 127.4, 124.5, 123.6, 123.1, 122.2, 119.5, 113.9, 26.9, 22.1, 13.9. HRMS (ESI) *m/z* calcd for $C_{16}H_{16}N_2O_2S+H^+$: 301.1005 $[M+H]^+$; found: 301.1009.

2-ethyl-3-methyl-1-(pyridin-2-ylsulfonyl)-1*H*-indole (2z'): yellow solid, (24.1 mg, 40%), mp: 97-98 ℃, R_f = 0.6 (PE/EA = 5/1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.54 (d, *J* = 4.6 Hz, 1H), 8.12 – 8.06 (m, 1H), 7.95 (d, *J* = 7.9 Hz, 1H), 7.80 (td, *J* = 7.8, 1.7 Hz, 1H), 7.38 (ddt, *J* = 7.8, 6.6, 2.3 Hz, 2H), 7.21 (dt, *J* = 7.1, 3.2 Hz, 2H), 3.13 (q, *J* = 7.4 Hz, 2H), 2.17 (s, 3H), 1.31 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 156.1, 150.2, 140.0, 137.9, 136.2, 131.5, 127.2, 123.8, 123.4, 121.9, 118.3, 115.5, 114.8, 19.7, 14.9, 8.7. HRMS (ESI) *m/z* calcd for $C_{16}H_{16}N_2O_2S+H^+$: 301.1005 $[M+H]^+$; found: 301.1011.

NMR spectra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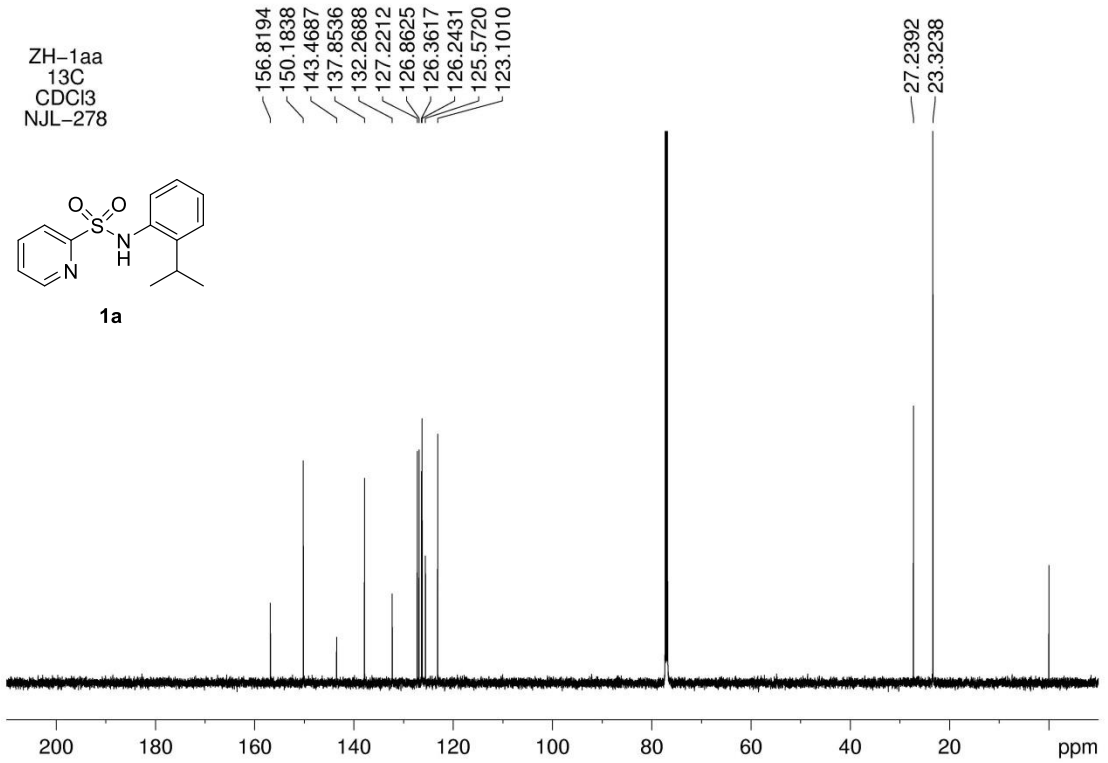
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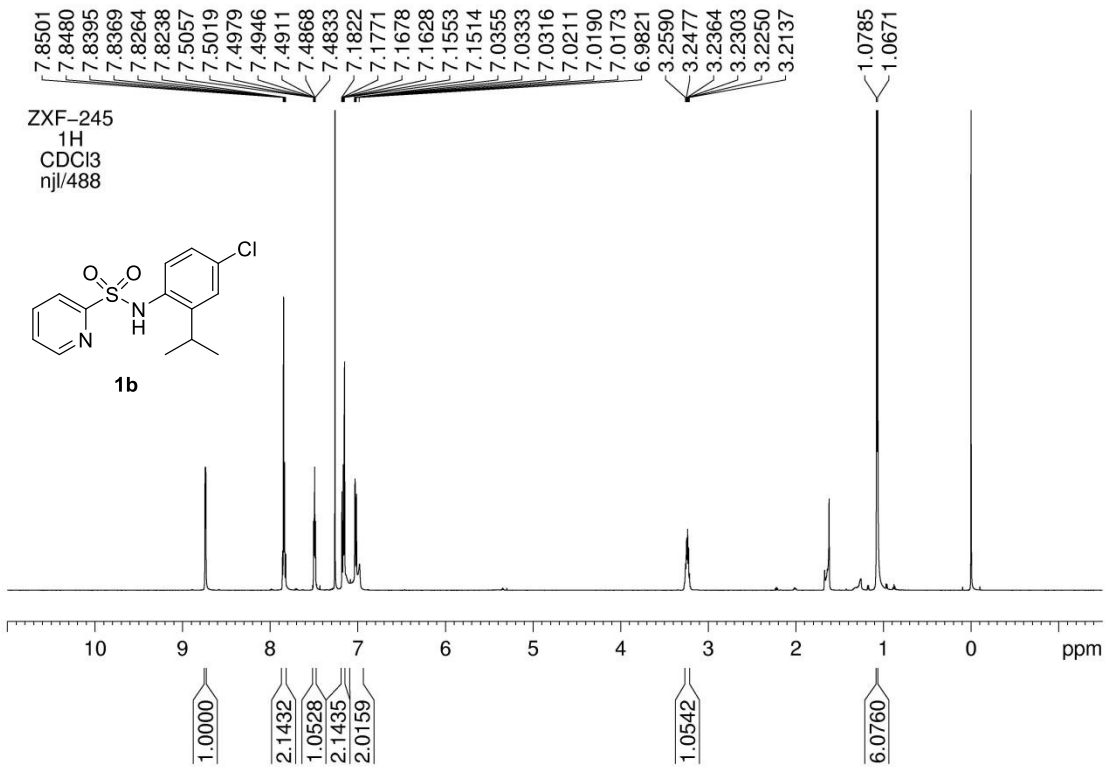
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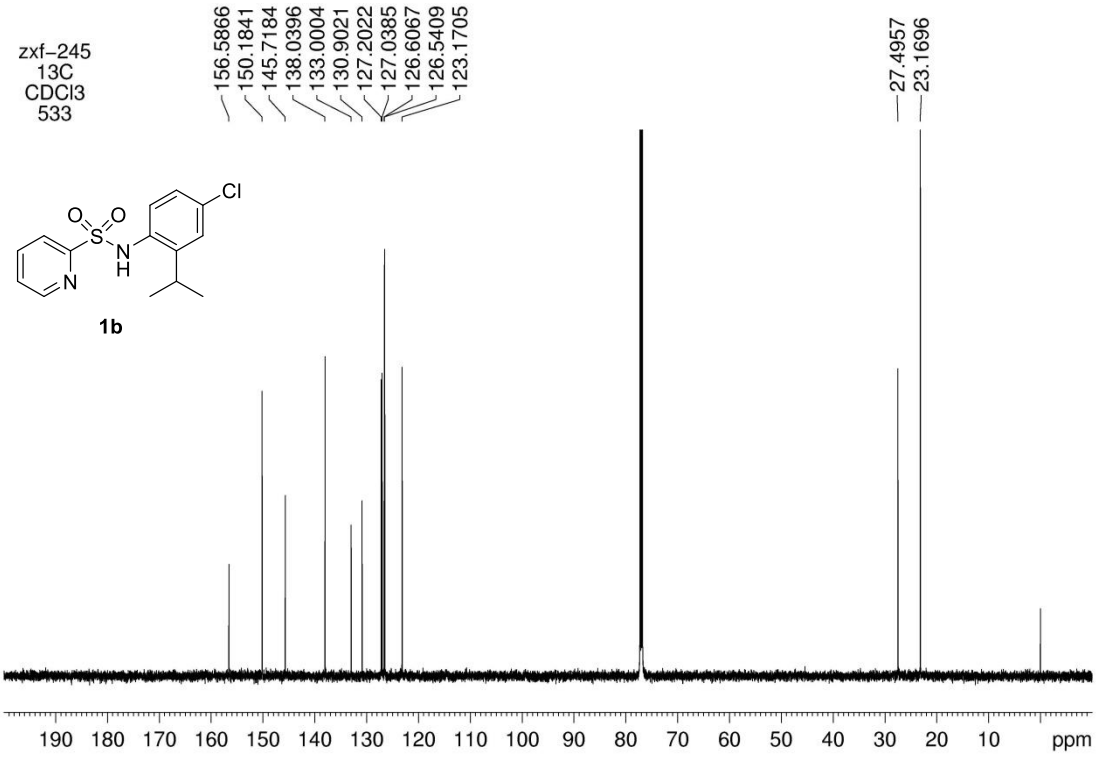
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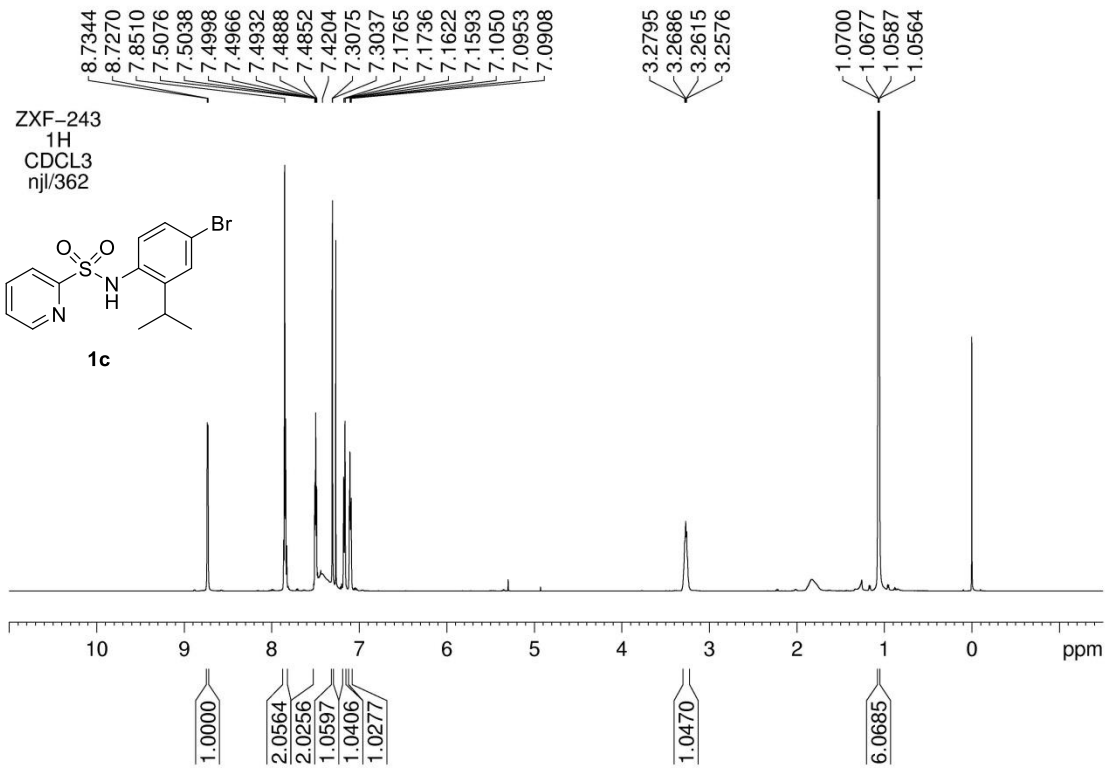
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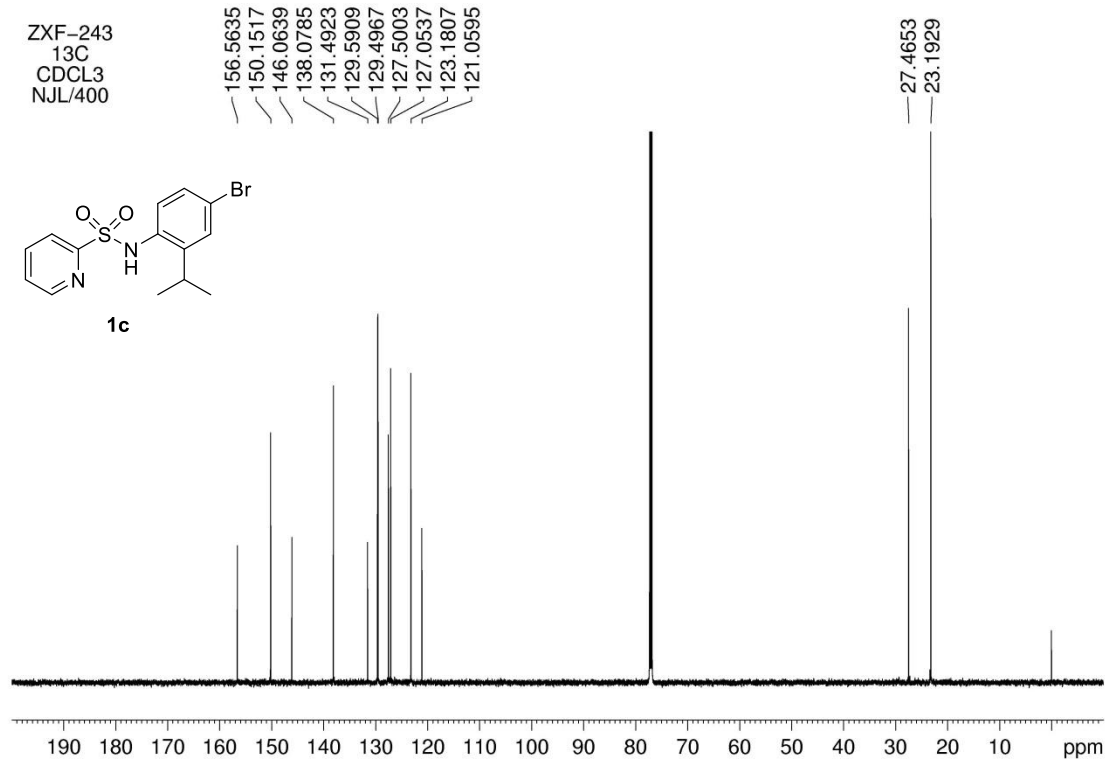
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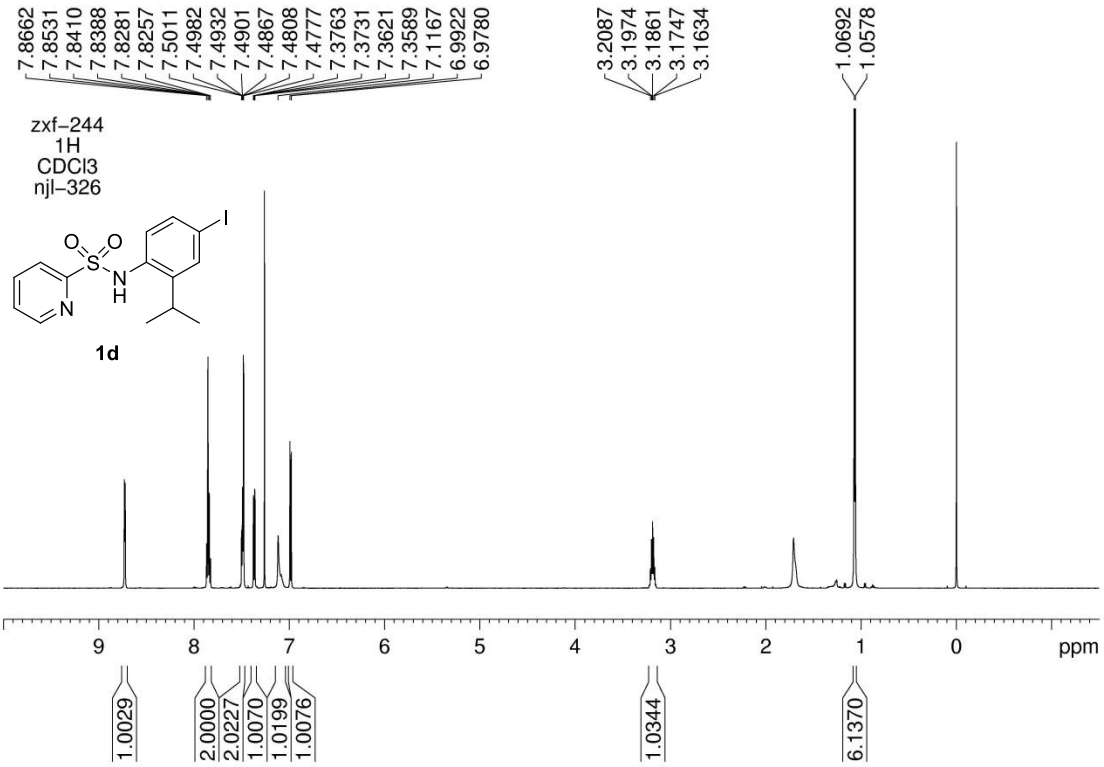
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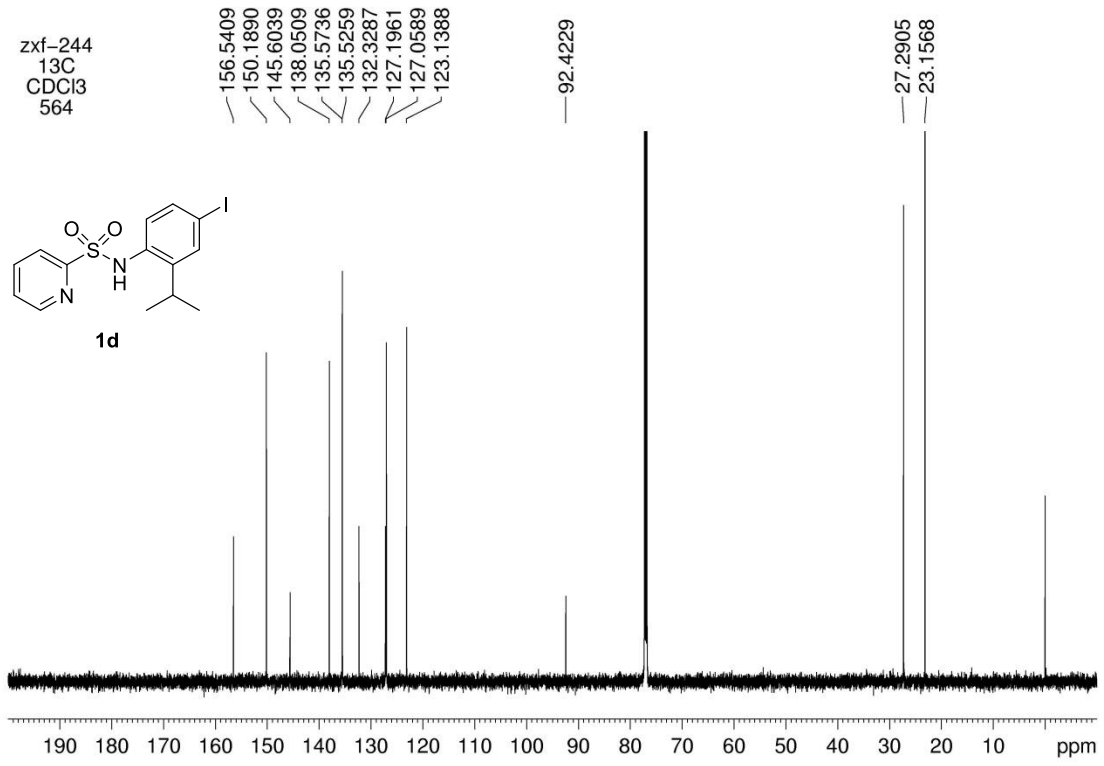
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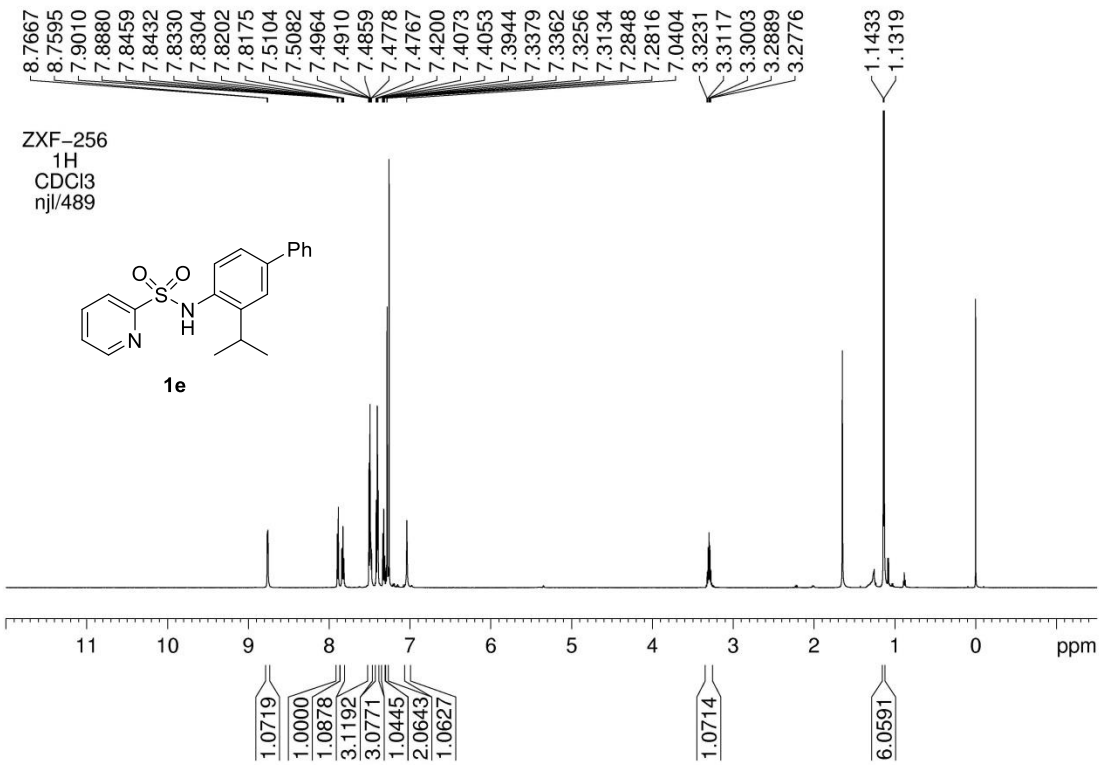
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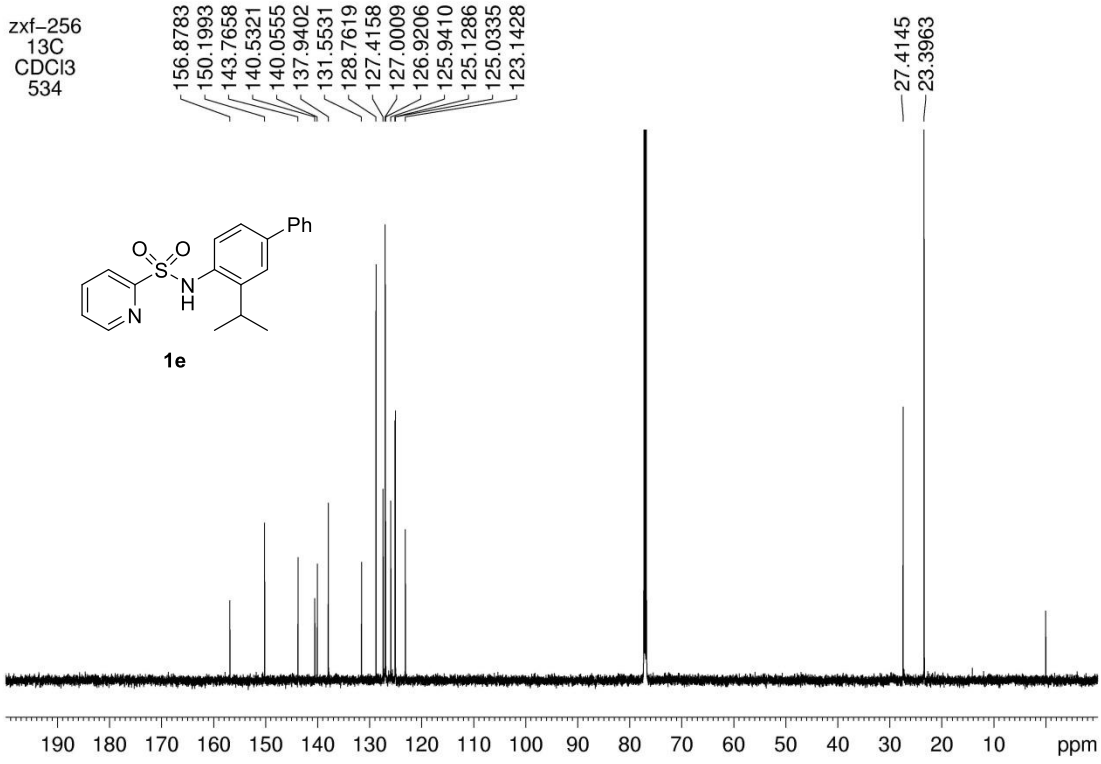
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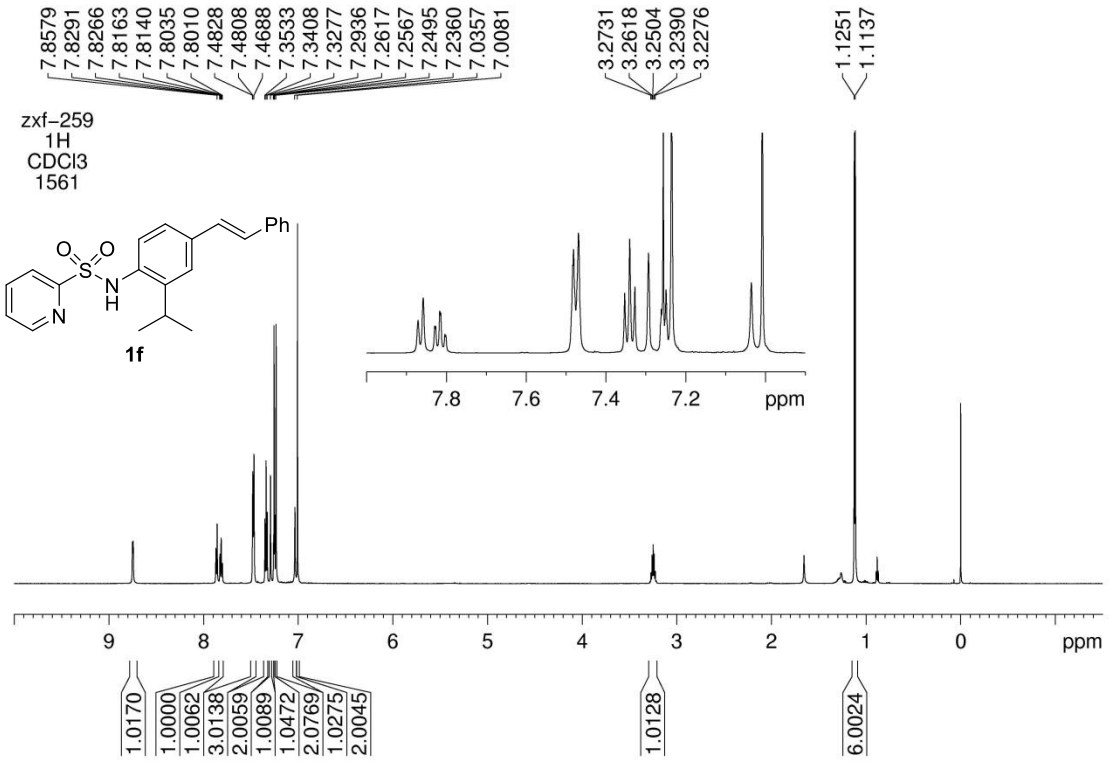
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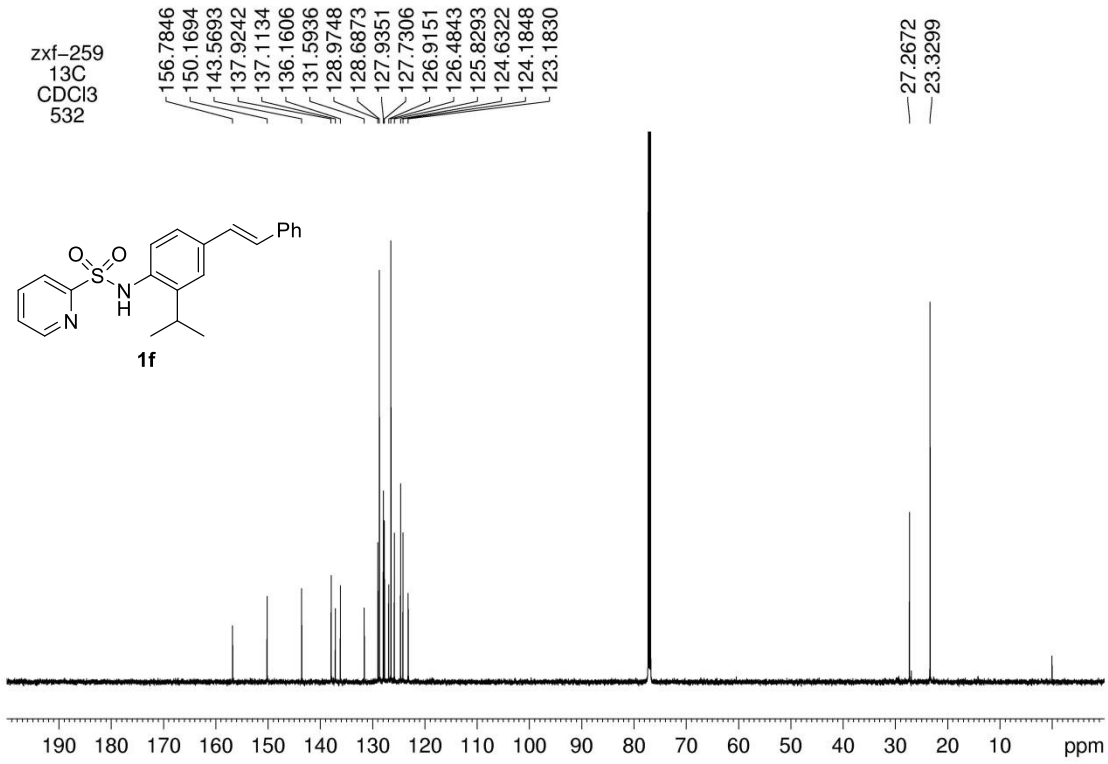
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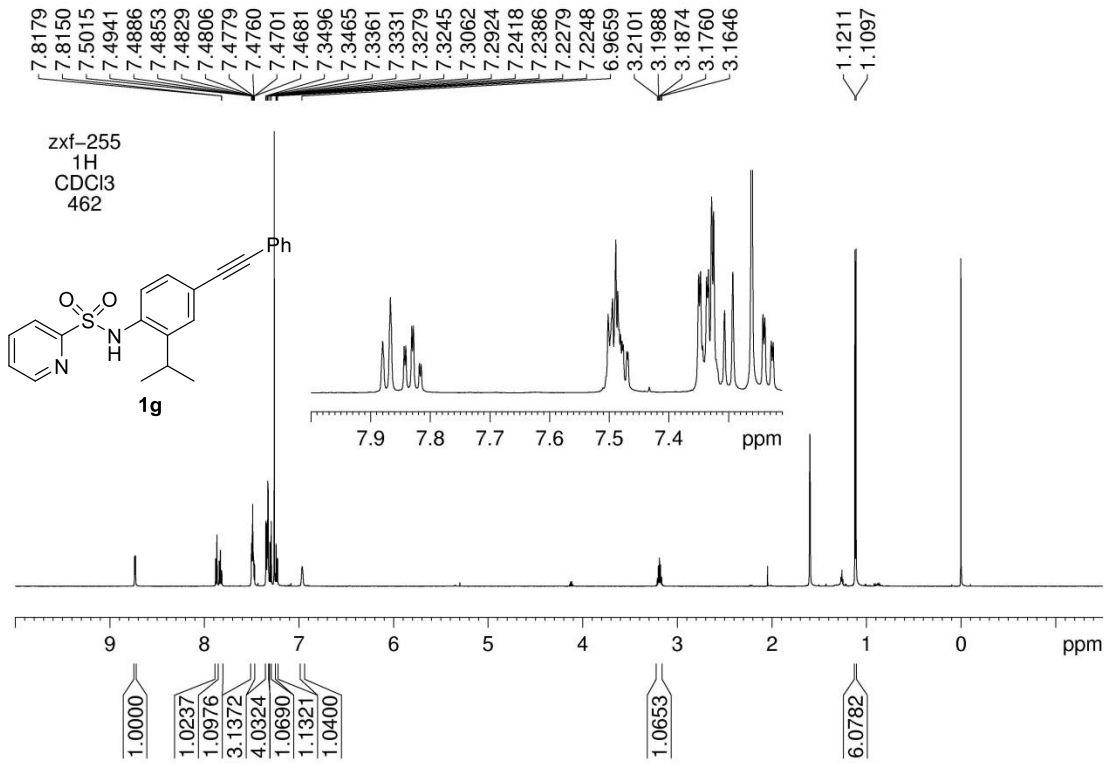
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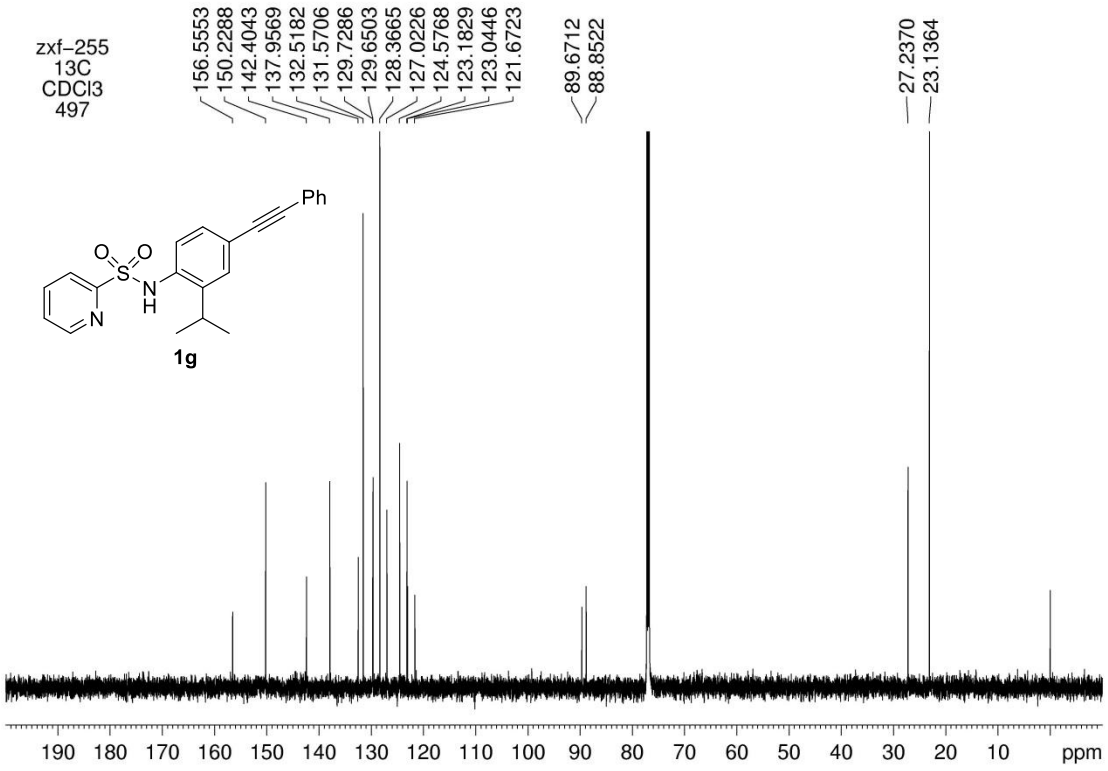
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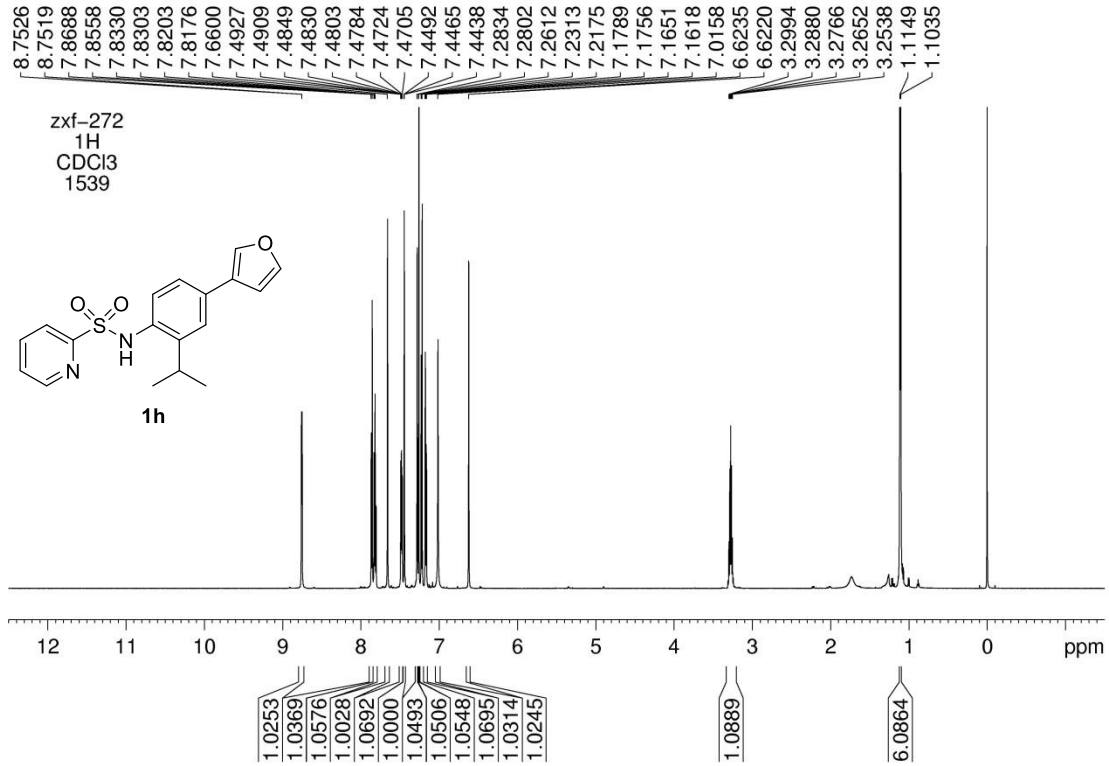
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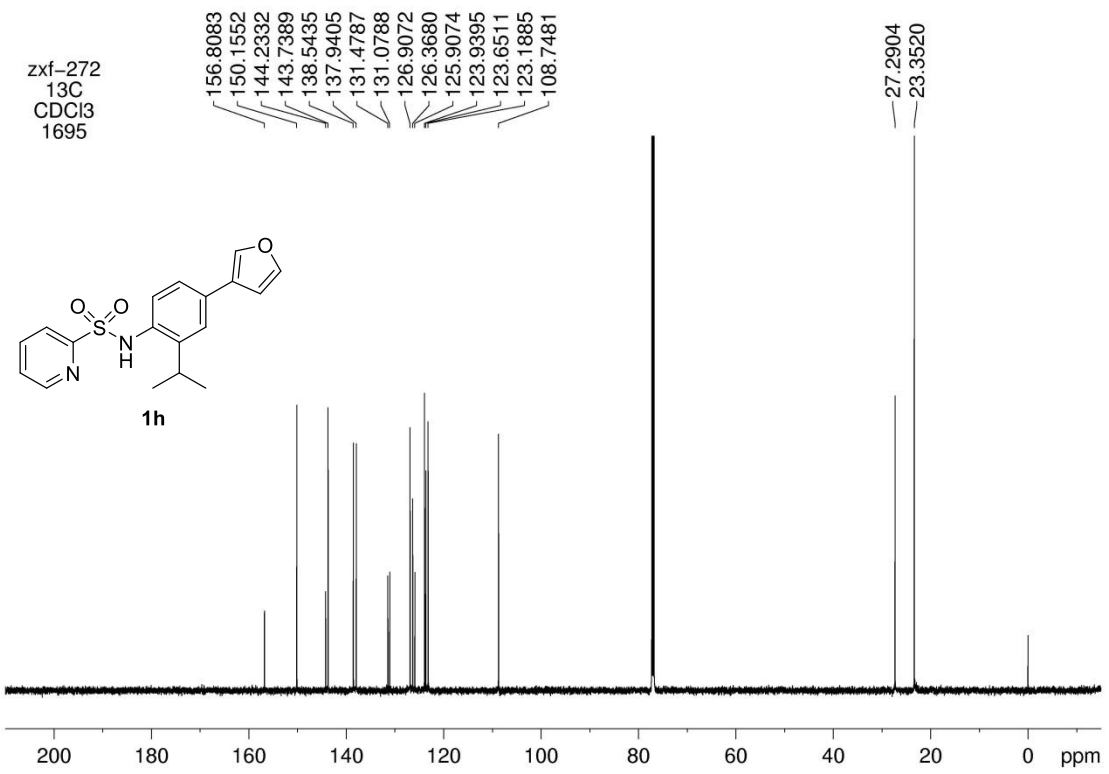
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131.4787
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123.6511
123.1885
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27.2904
23.3520
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CDCl3
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1h
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40
20
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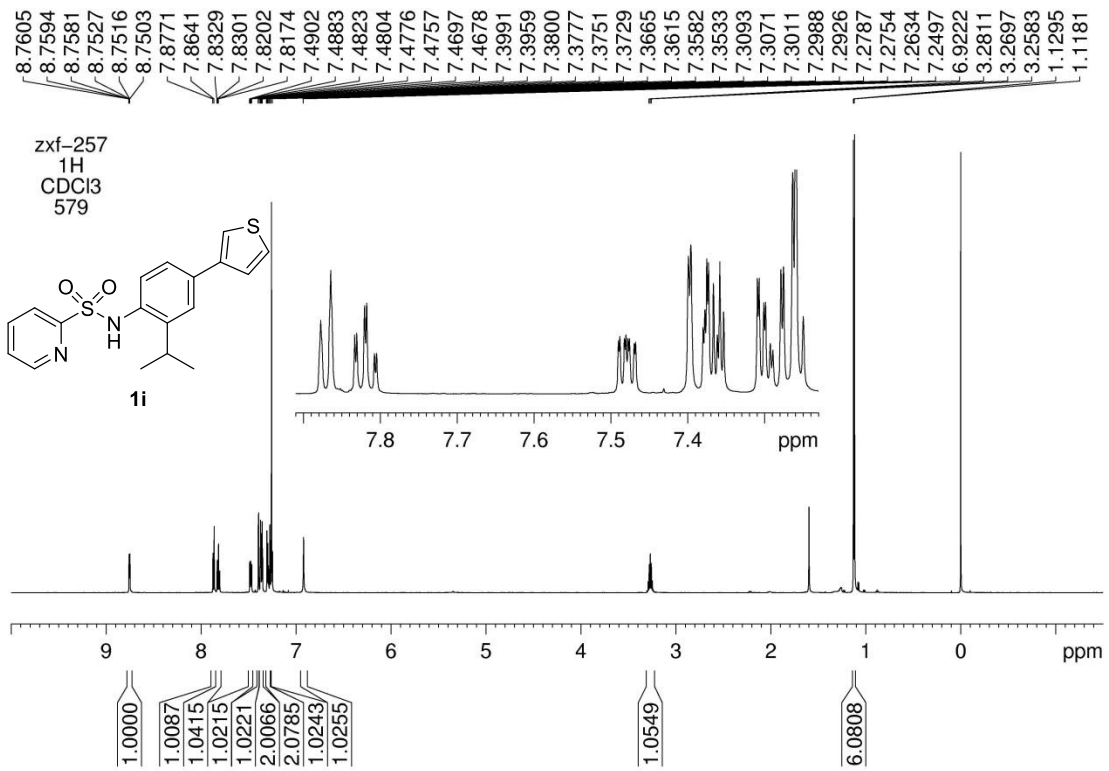
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7.8202
7.8174
7.4902
7.4883
7.4823
7.4804
7.4776
7.4757
7.4697
7.4678
7.3991
7.3959
7.3800
7.3777
7.3751
7.3729
7.3665
7.3615
7.3582
7.3533
7.3093
7.3071
7.3011
7.2988
7.2926
7.2787
7.2754
7.2634
7.2497
6.9222
3.2811
3.2697
3.2583
1.1295
1.1181
zxf-257
1H
CDCl3
579
1i
7.8
7.7
7.6
7.5
7.4
ppm
9
8
7
6
5
4
3
2
1
0
ppm
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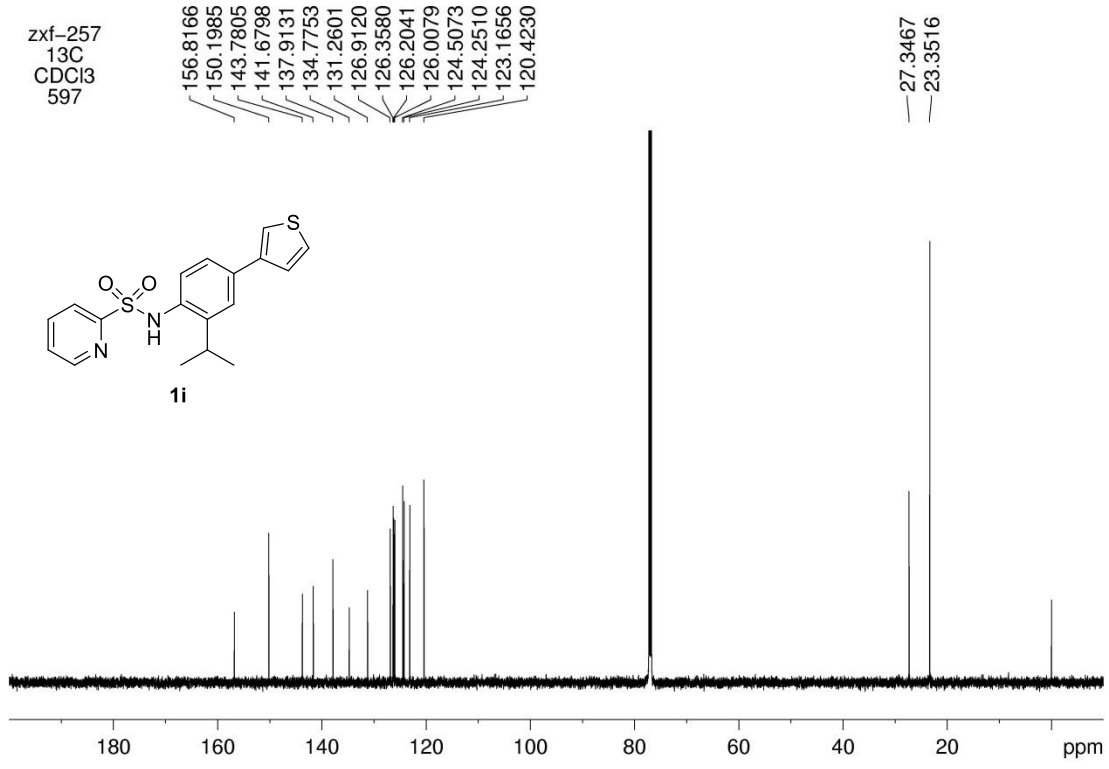
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124.2510
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1i
180
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140
120
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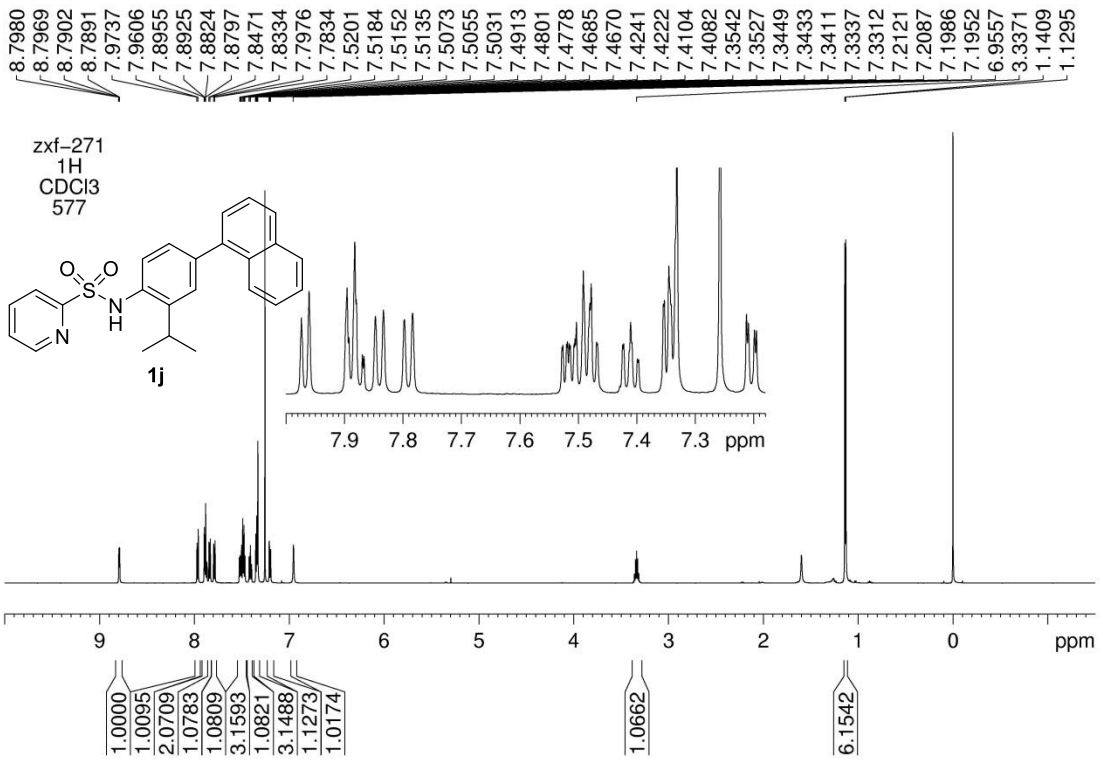
80
60
40
20
ppm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7.7834
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7.5184
7.5152
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7.5073
7.5055
7.5031
7.4913
7.4801
7.4778
7.4685
7.4670
7.4241
7.4222
7.4104
7.4082
7.3542
7.3527
7.3449
7.3433
7.3411
7.3337
7.3312
7.2121
7.2087
7.1986
7.1952
6.9557
3.3371
1.1409
1.1295
zxf−271
1H
CDCl3
577
1j
7.9 7.8 7.7 7.6 7.5 7.4 7.3 ppm
9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0095
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1.0809
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1.1273
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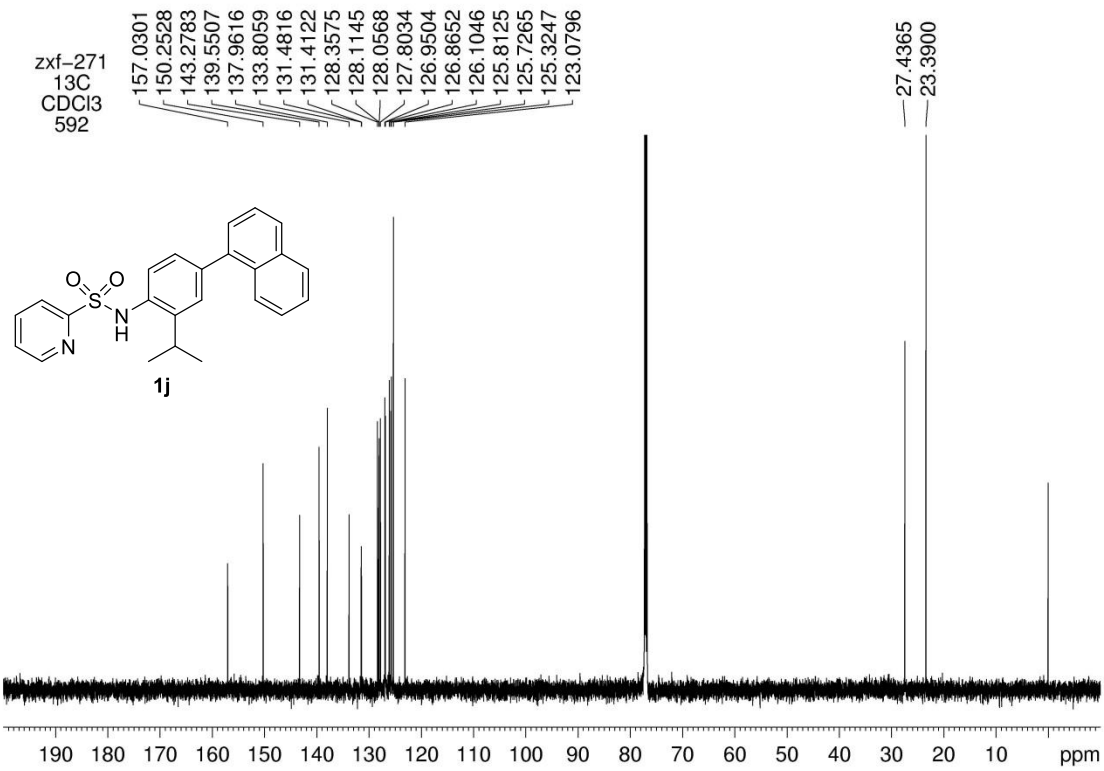
1.0662
6.1542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131.4816
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127.8034
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125.8125
125.7265
125.3247
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zxf−271
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CDCl3
592
1j
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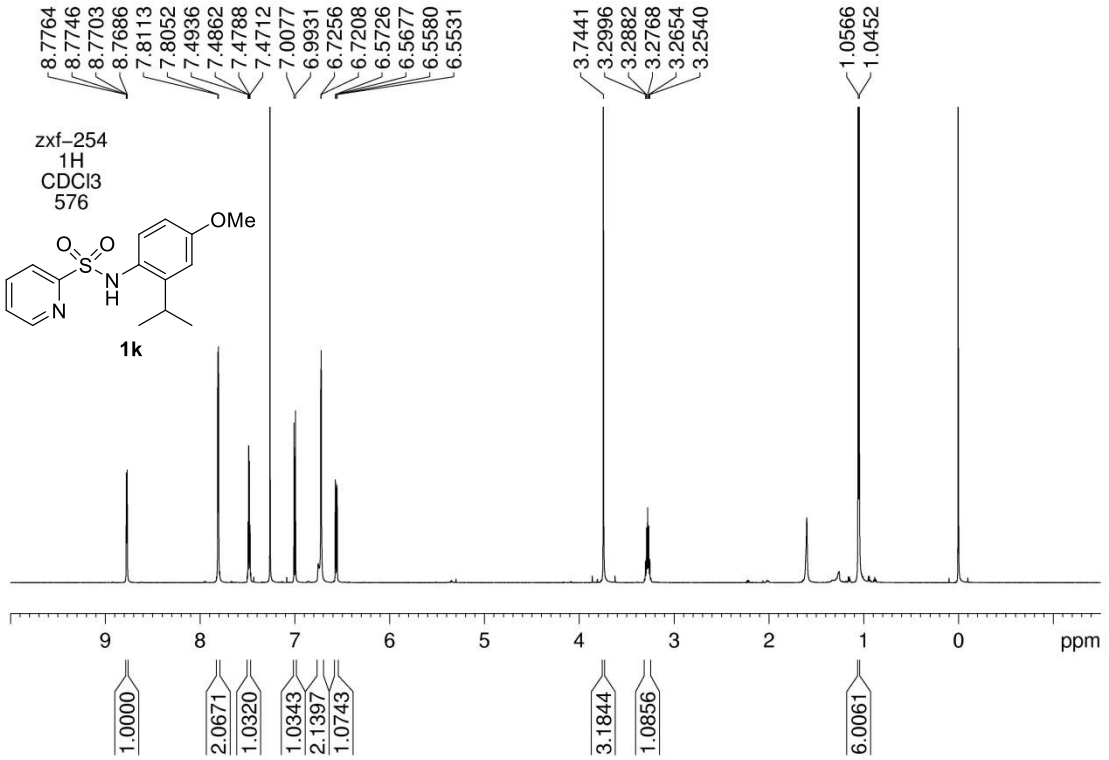
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6.9931
6.7256
6.7208
6.5726
6.5677
6.5580
6.5531
3.7441
3.2996
3.2882
3.2768
3.2654
3.2540
1.0566
1.0452
zxf-254
1H
CDCl3
576
OMe
1k
9
8
7
6
5
4
3
2
1
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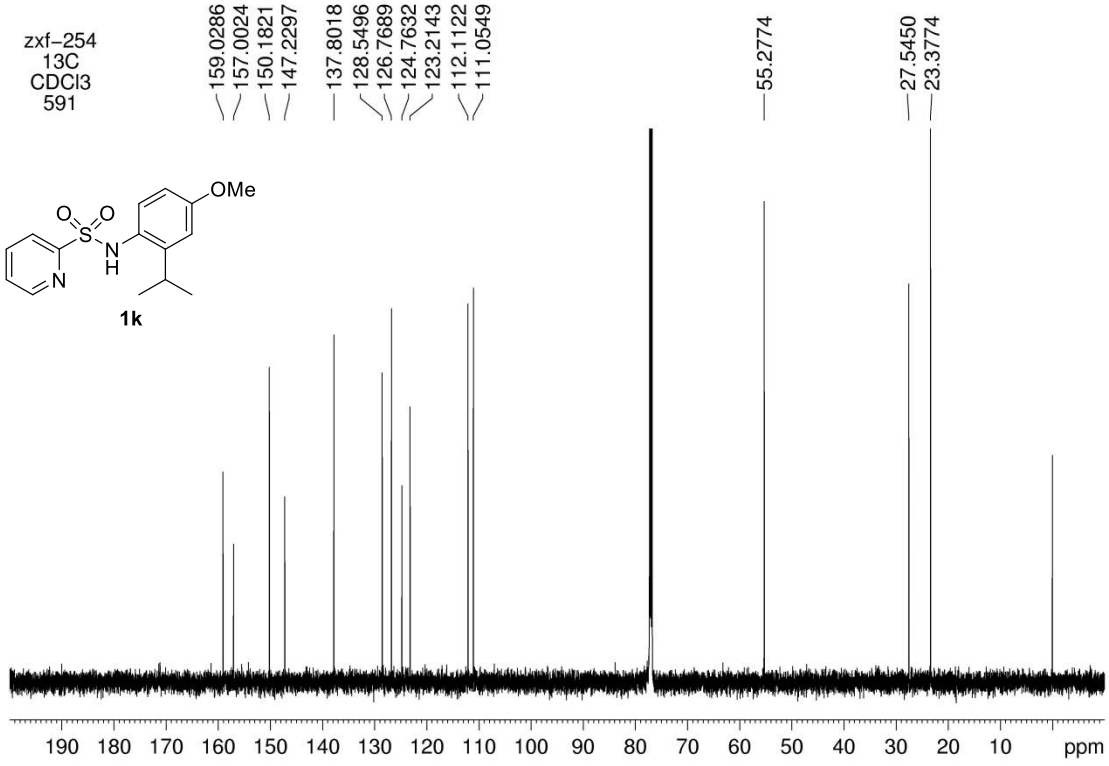
6.0061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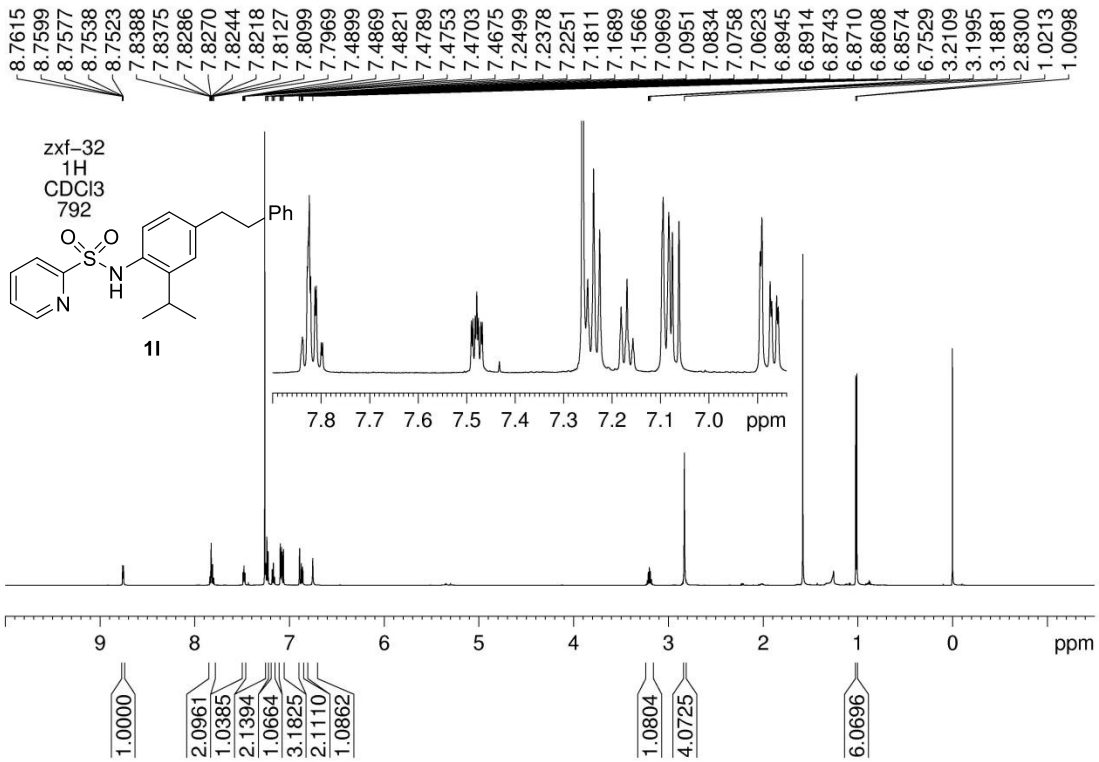
124.7632
123.2143
112.1122
111.0549
55.2774
27.5450
23.3774
OMe
1k
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.8127
7.8099
7.7969
7.4899
7.4869
7.4821
7.4789
7.4753
7.4703
7.4675
7.2499
7.2378
7.2251
7.1811
7.1689
7.1566
7.0969
7.0951
7.0834
7.0758
7.0623
6.8945
6.8914
6.8743
6.8710
6.8608
6.8574
6.7529
3.2109
3.1995
3.1881
2.8300
1.0213
1.0098
zxf-32
1H
CDCl3
792
Ph
1l
7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 ppm
9 8 7 6 5 4 3 2 1 0 ppm
1.0000
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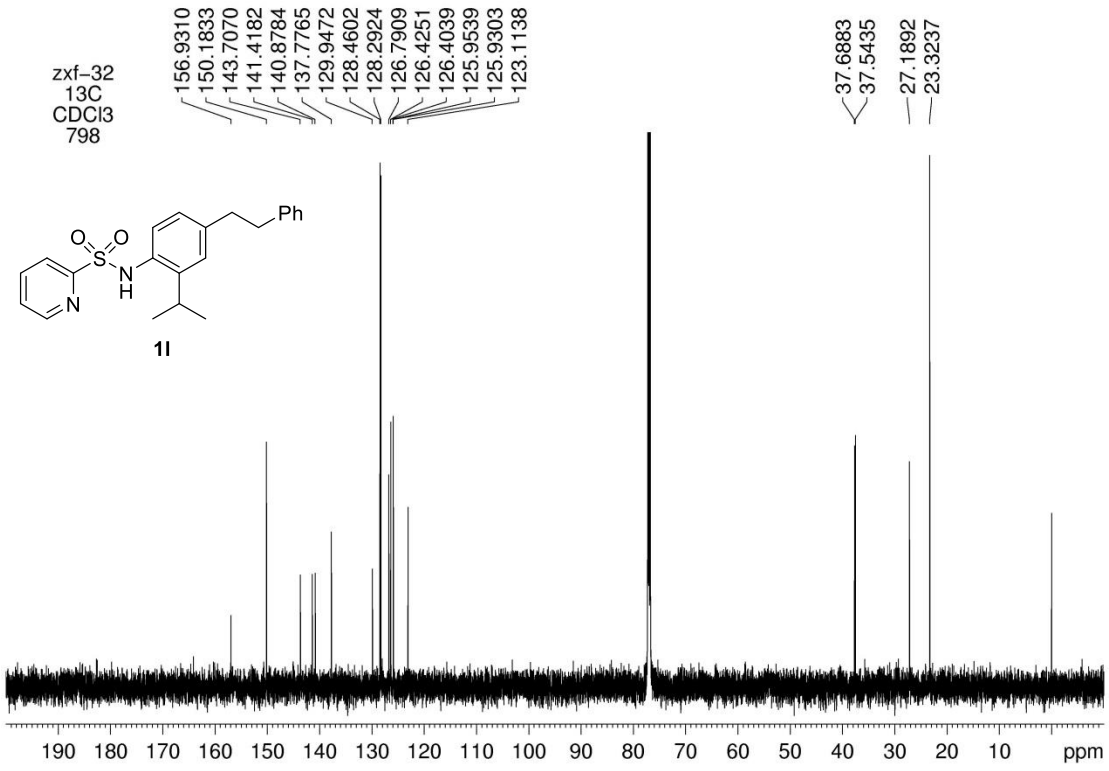
2.1394
1.0664
3.1825
2.1110
1.0862
1.0804
4.0725
6.0696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126.4039
125.9539
125.9303
123.1138
37.6883
37.5435
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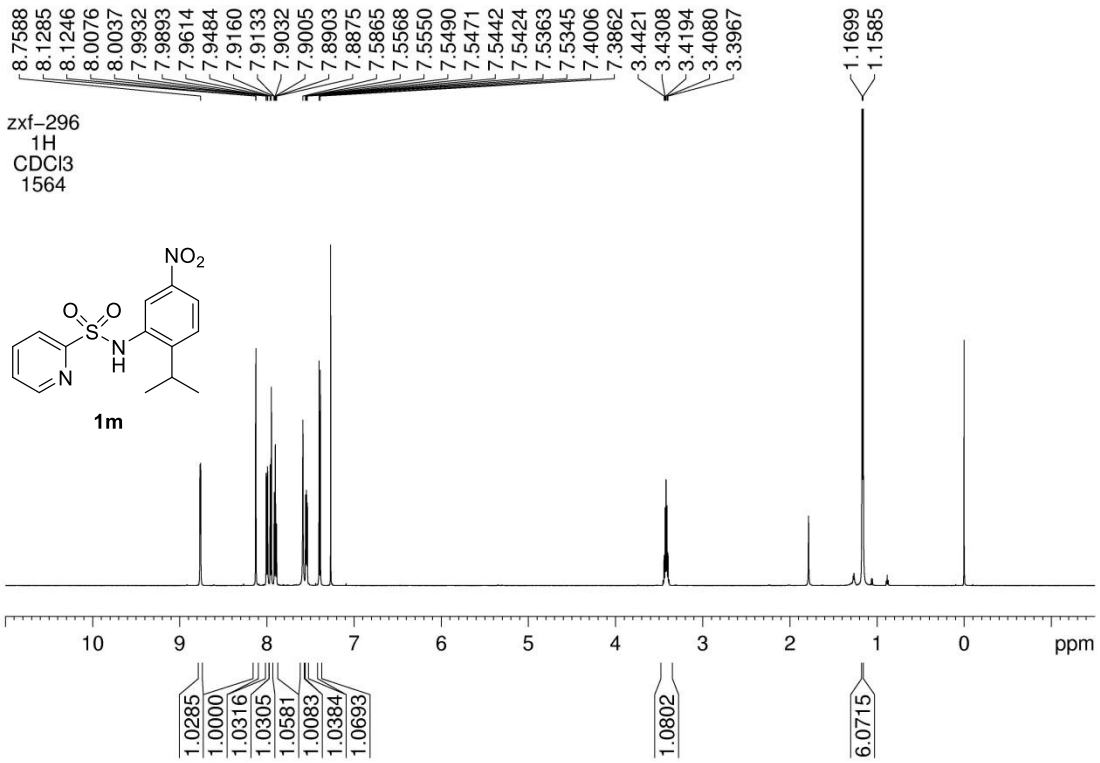
zxf-32
13C
CDCl3
798
Ph
1l
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.9032
7.9005
7.8903
7.8875
7.5865
7.5568
7.5550
7.5490
7.5471
7.5442
7.5424
7.5363
7.5345
7.4006
7.3862
3.4421
3.4308
3.4194
3.4080
3.3967
1.1699
1.1585
zxf-296
1H
CDCl3
1564
NO2
O
S
O
N
H
N
1m
10
9
8
7
6
5
4
3
2
1
0
ppm
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1.0384
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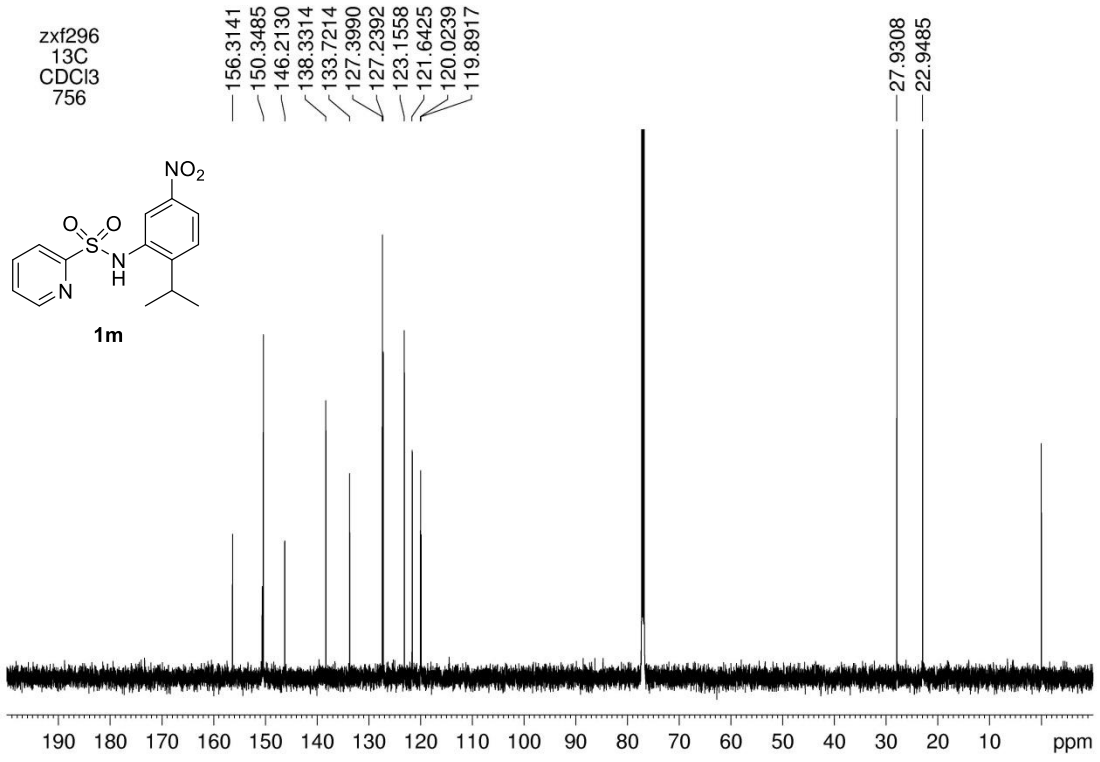
1.0802
6.0715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127.3990
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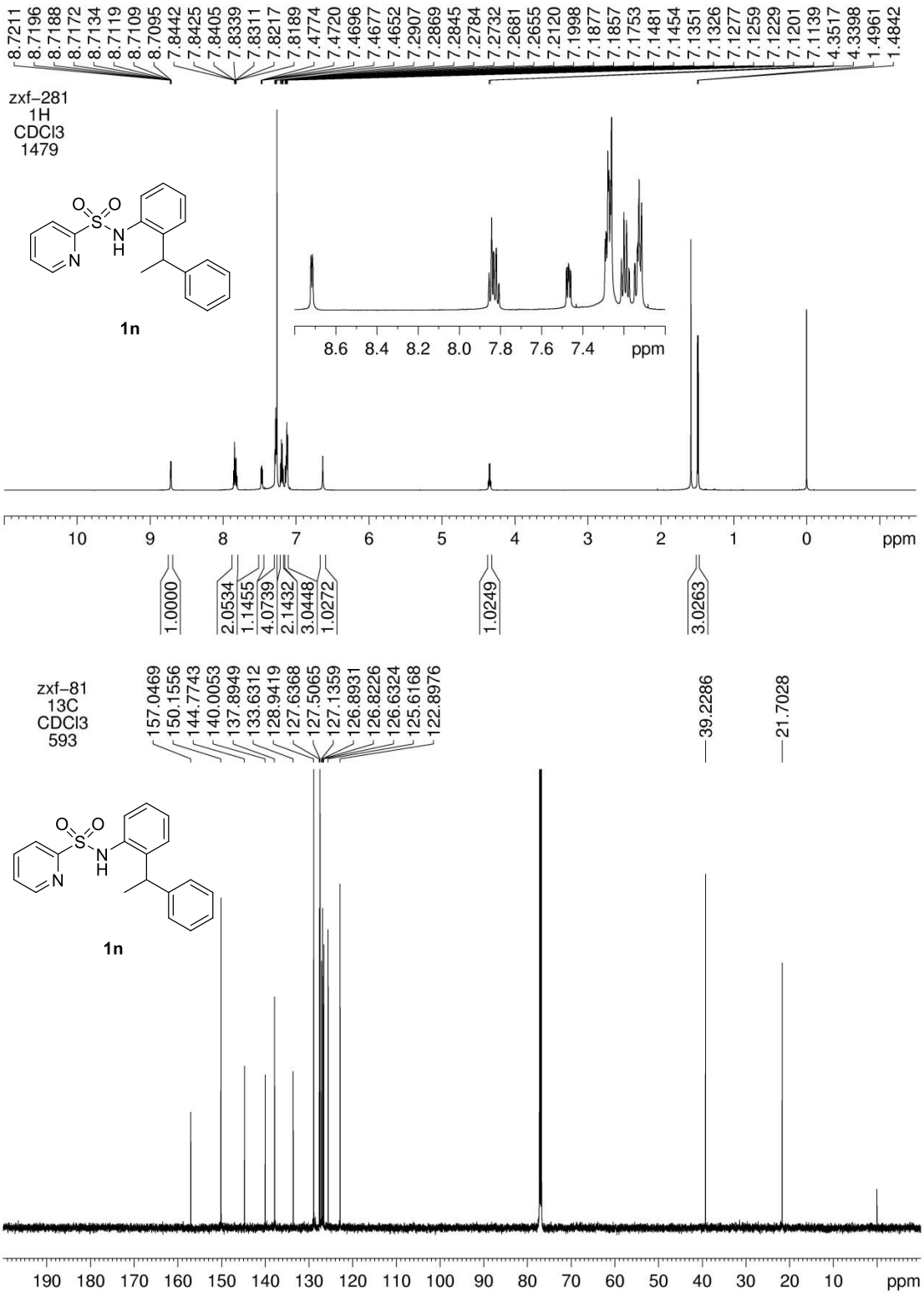
123.1558
121.6425
120.0239
119.8917
27.9308
22.9485
NO2
O
S
O
N
H
N
1m
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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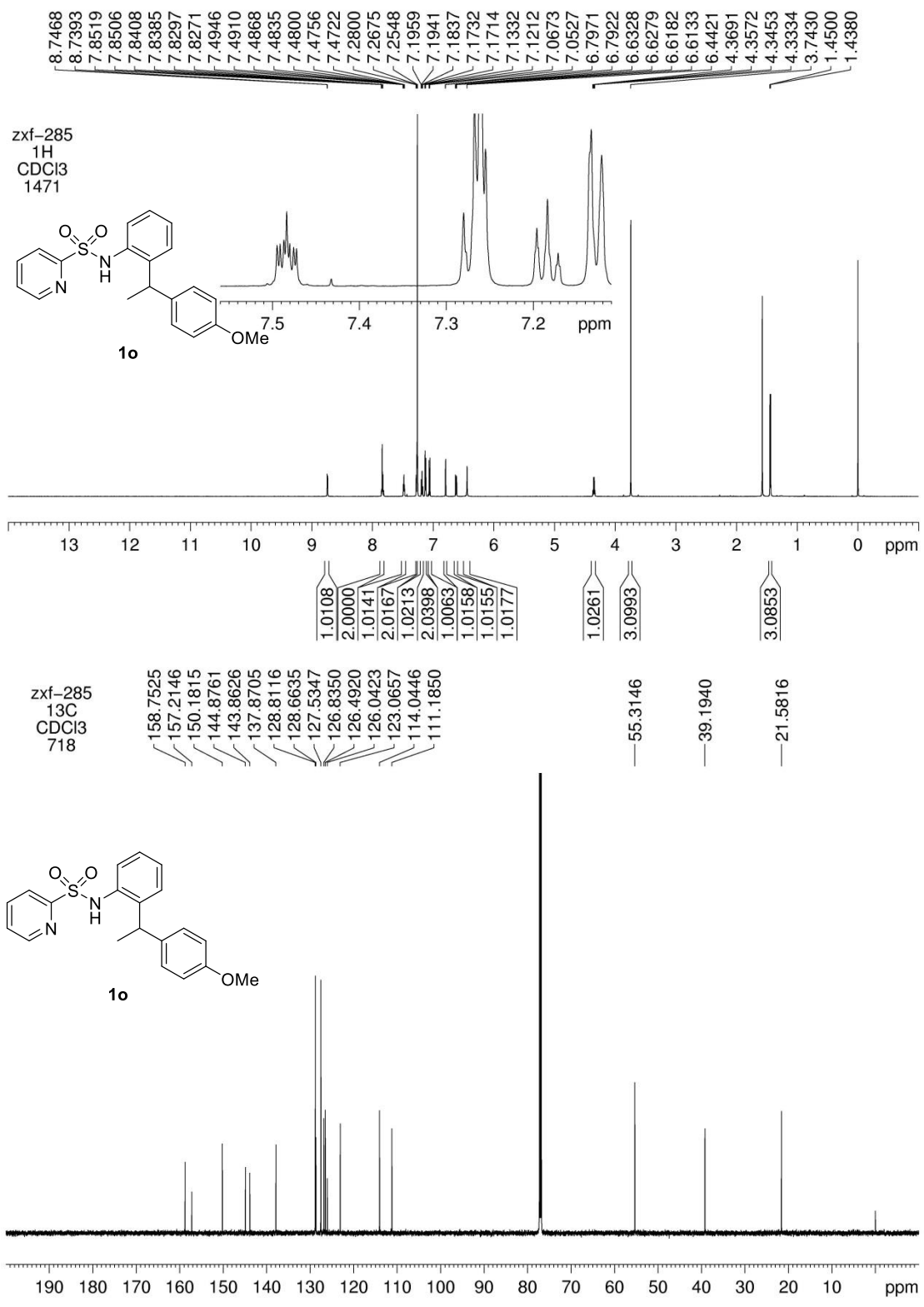
CDCl3
593
1n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7.4835
7.4800
7.4756
7.4722
7.2800
7.2675
7.2548
7.1959
7.1941
7.1837
7.1732
7.1714
7.1332
7.1212
7.0673
7.0527
6.7971
6.7922
6.6328
6.6279
6.6182
6.6133
6.4421
4.3691
4.3572
4.3453
4.3334
3.7430
1.4500
1.4380
zxf-285
1H
CDCl3
1471
1o
7.5
7.4
7.3
7.2
ppm
13
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
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1.0213
2.0398
1.0063
1.0158
1.0155
1.0177
1.0261
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3.0853
zxf-285
13C
CDCl3
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158.7525
157.2146
150.1815
144.8761
143.8626
137.8705
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126.4920
126.0423
123.0657
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111.1850
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39.1940
21.5816
1o
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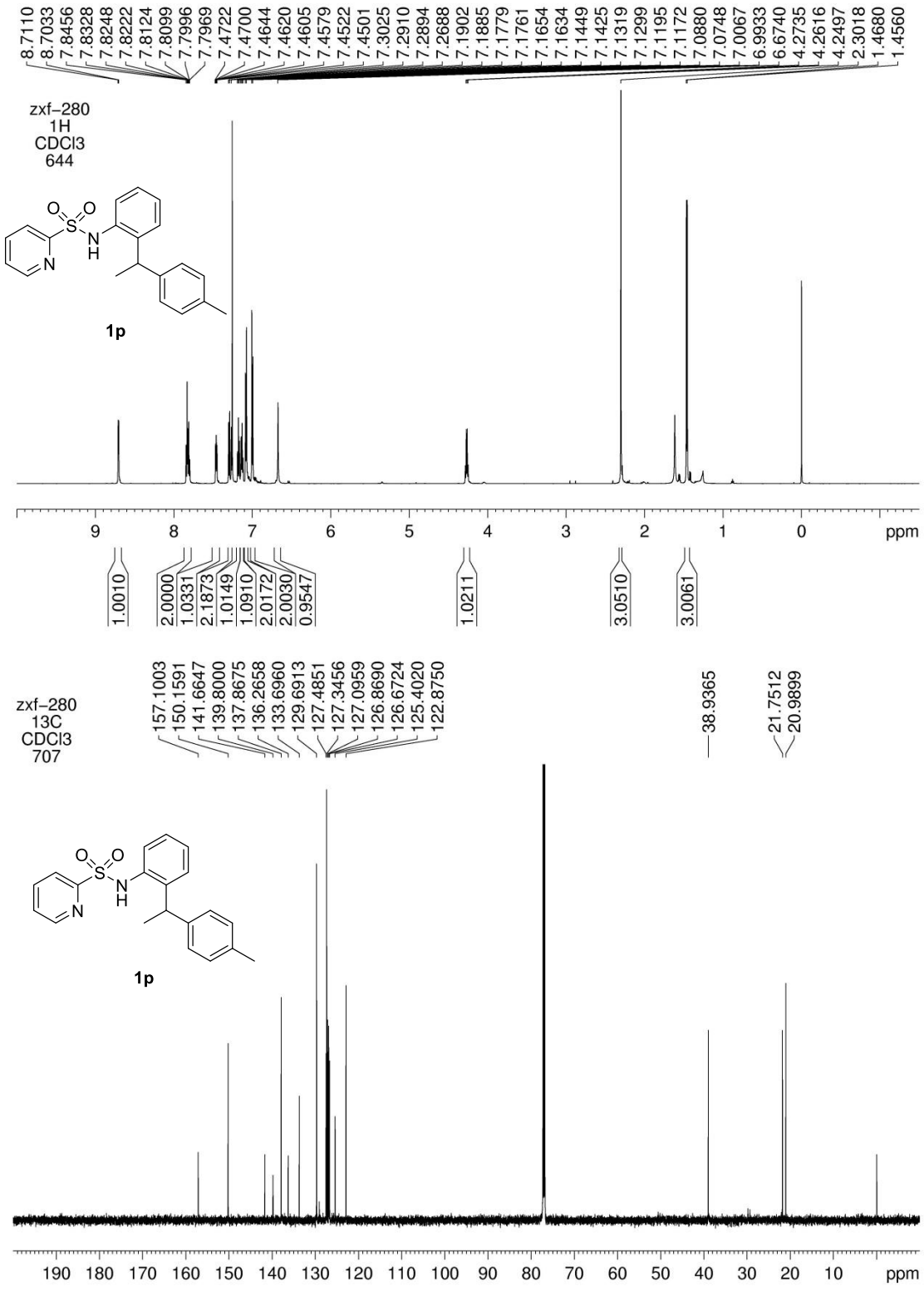
ppm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7.4722
7.4700
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7.4620
7.4605
7.4579
7.4522
7.4501
7.3025
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7.2894
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7.1902
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7.1425
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7.1299
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7.1172
7.0880
7.0748
7.0067
6.9933
6.6740
4.2735
4.2616
4.2497
2.3018
1.4680
1.4560
zxf–280
1H
CDCl3
644
1p
9
8
7
6
5
4
3
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ppm
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2.0172
2.0030
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1.0211
3.0510
3.0061
zxf–280
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CDCl3
707
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141.6647
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137.8675
136.2658
133.6960
129.6913
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127.3456
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126.6724
125.4020
122.8750
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20.9899
1p
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150
140
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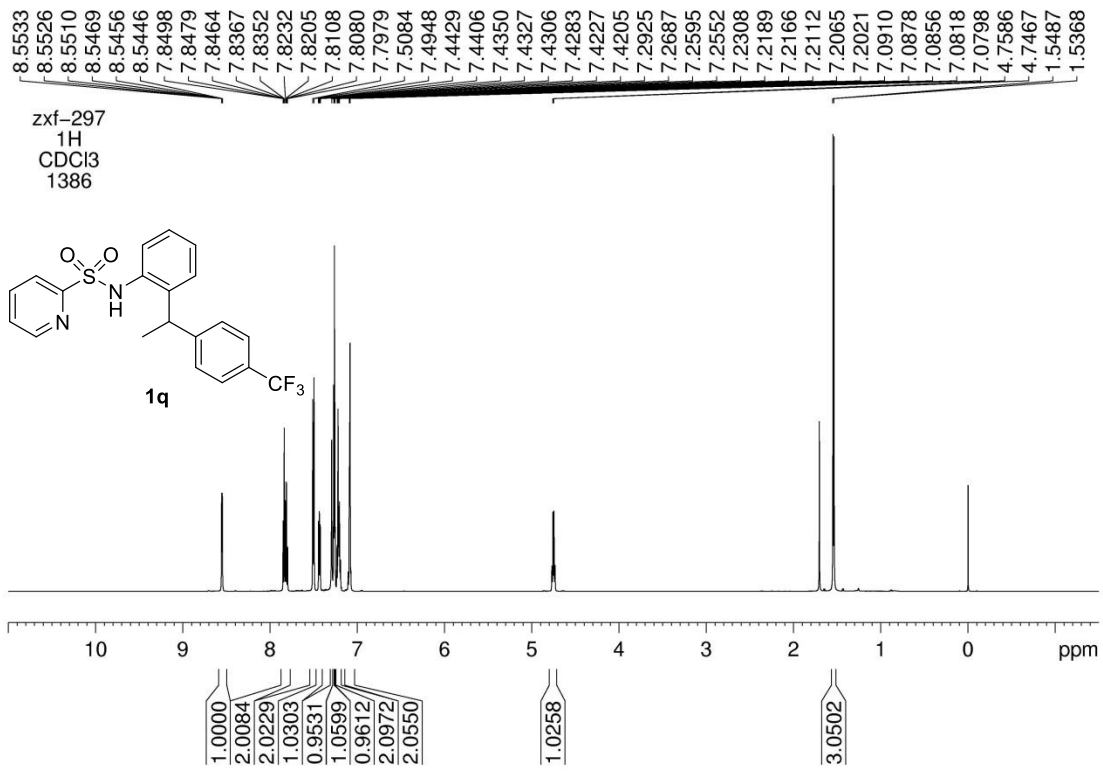
80
70
60
50
40
30
20
10
ppm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7.4948
7.4429
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7.4350
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1.5368
zxf–297
1H
CDCl3
1386
1q
10
9
8
7
6
5
4
3
2
1
0
ppm
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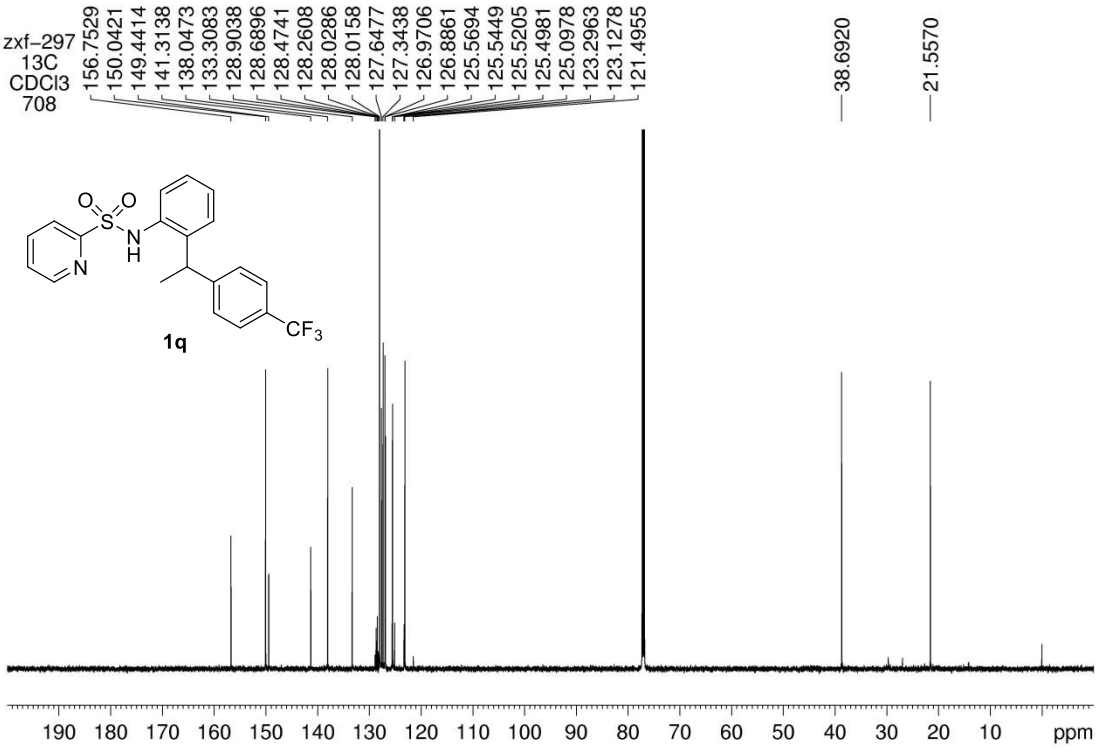
3.0502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127.6477
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125.5205
125.4981
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123.2963
123.1278
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21.5570
1q
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70
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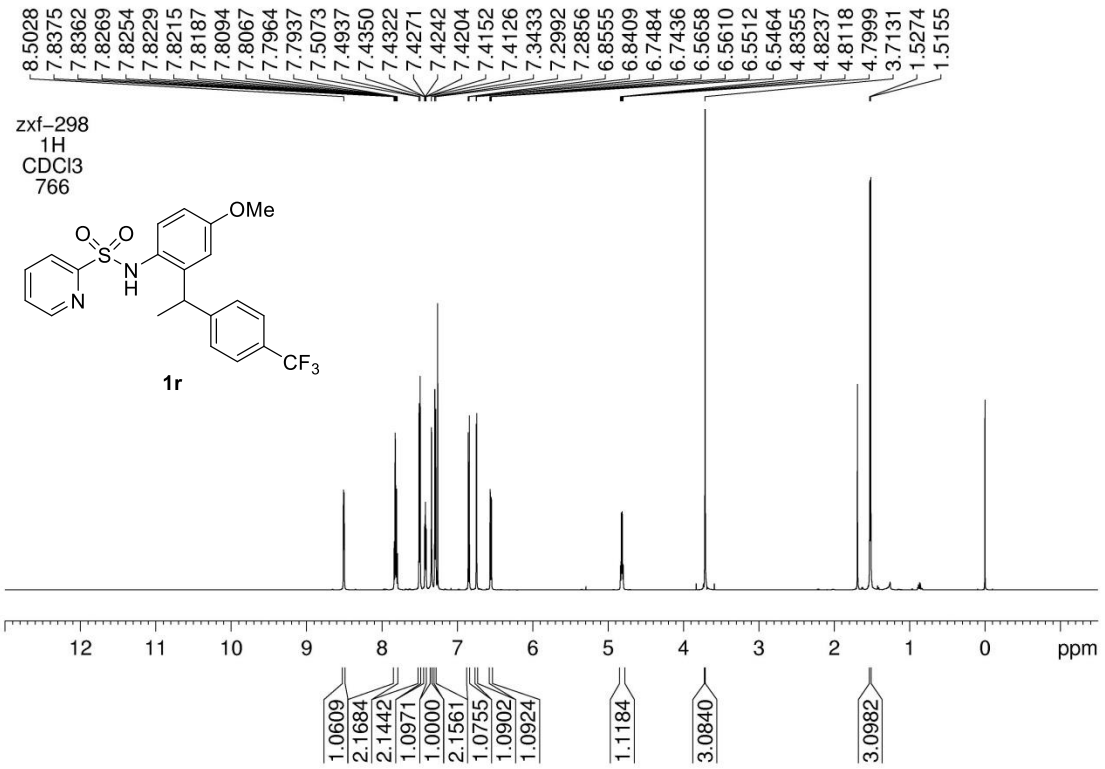
10
ppm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7.7937
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7.4937
7.4350
7.4322
7.4271
7.4242
7.4204
7.4152
7.4126
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7.2992
7.2856
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6.8409
6.7484
6.7436
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6.5512
6.5464
4.8355
4.8237
4.8118
4.7999
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1.5155
zxf-298
1H
CDCl3
766
OMe
O
S
O
N
H
N
CF3
1r
12
11
10
9
8
7
6
5
4
3
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1
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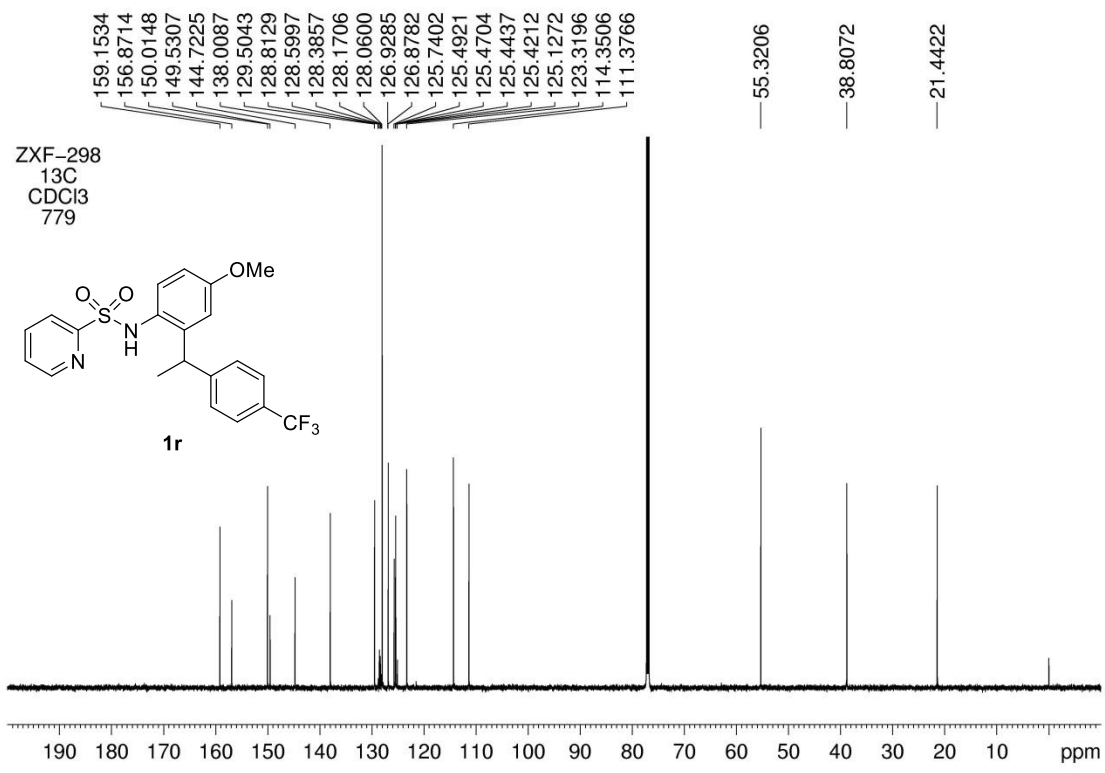
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128.0600
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125.7402
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125.1272
123.3196
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111.3766
55.3206
38.8072
21.4422
ZXF-298
13C
CDCl3
779
OMe
O
S
O
N
H
N
CF3
1r
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150
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120
110
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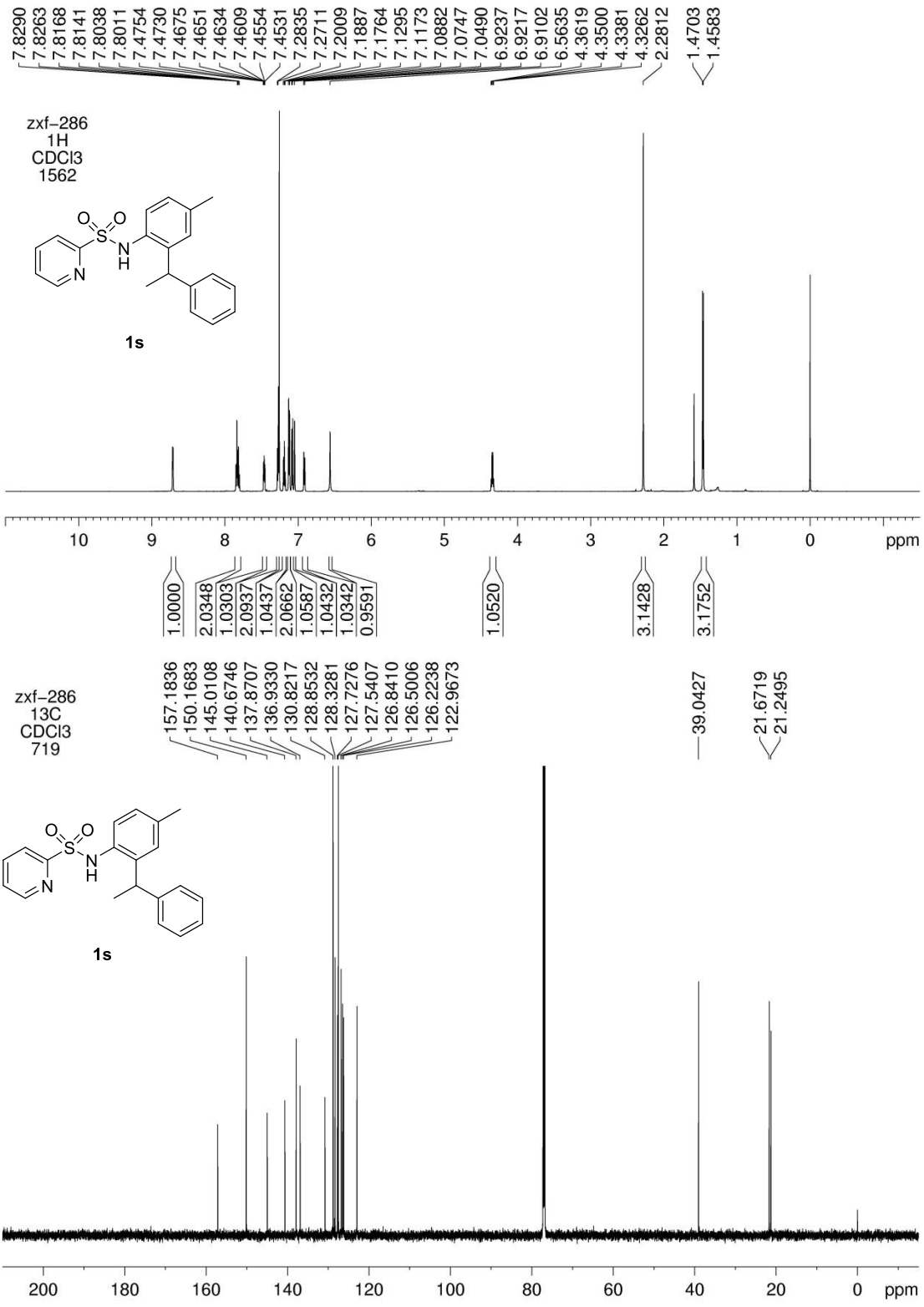
30
20
10
ppm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7.4531
7.2835
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7.1764
7.1295
7.1173
7.0882
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6.9237
6.9217
6.9102
6.5635
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4.3381
4.3262
2.2812
1.4703
1.4583
zxf-286
1H
CDCl3
1562
1s
10
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8
7
6
5
4
3
2
1
0
ppm
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0.9591
1.0520
3.1428
3.1752
157.1836
150.1683
145.0108
140.6746
137.8707
136.9330
130.8217
128.8532
128.3281
127.7276
127.5407
126.8410
126.5006
126.2238
122.9673
39.0427
21.6719
21.2495
zxf-286
13C
CDCl3
719
1s
200
180
160
140
120
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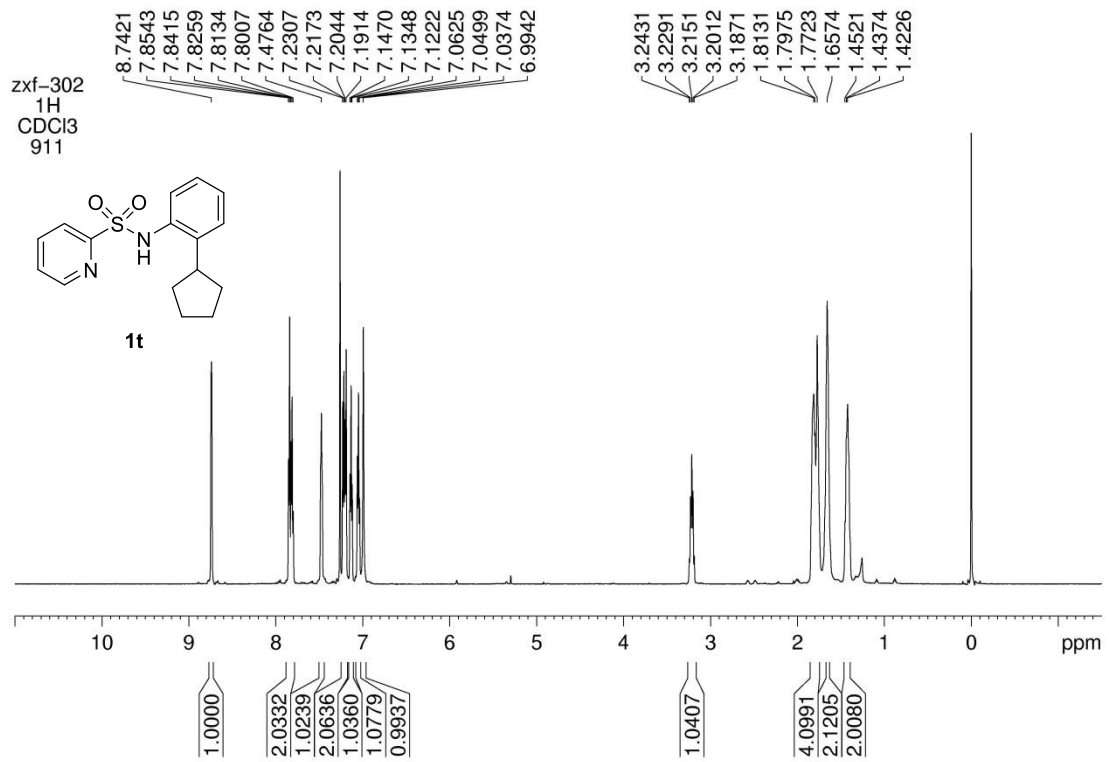
80
60
40
20
0
ppm


zxf-302
1H
CDCl3
911
8.7421
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7.8415
7.8259
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7.8007
7.4764
7.2307
7.2173
7.2044
7.1914
7.1470
7.1348
7.1222
7.0625
7.0499
7.0374
6.9942
3.2431
3.2291
3.2151
3.2012
3.1871
1.8131
1.7975
1.7723
1.6574
1.4521
1.4374
1.4226
1t
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
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2.0636
1.0360
1.0779
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1.0407
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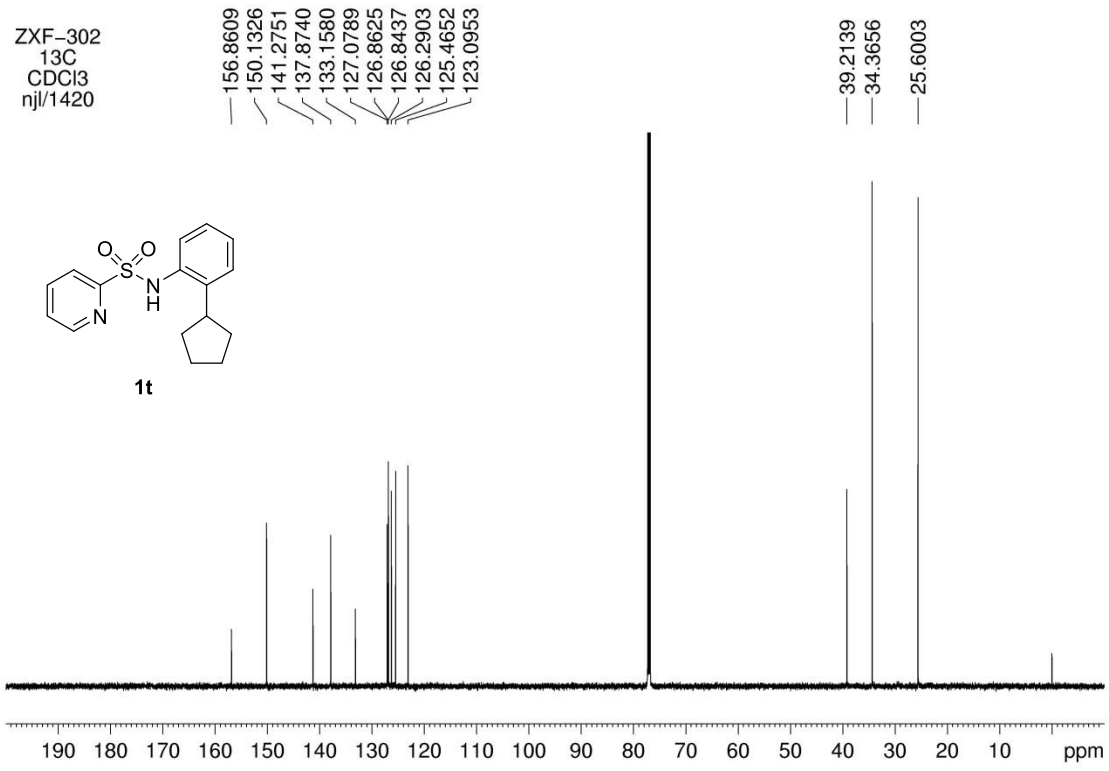
2.1205
2.0080


ZXF-302
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CDCl3
njl/1420
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141.2751
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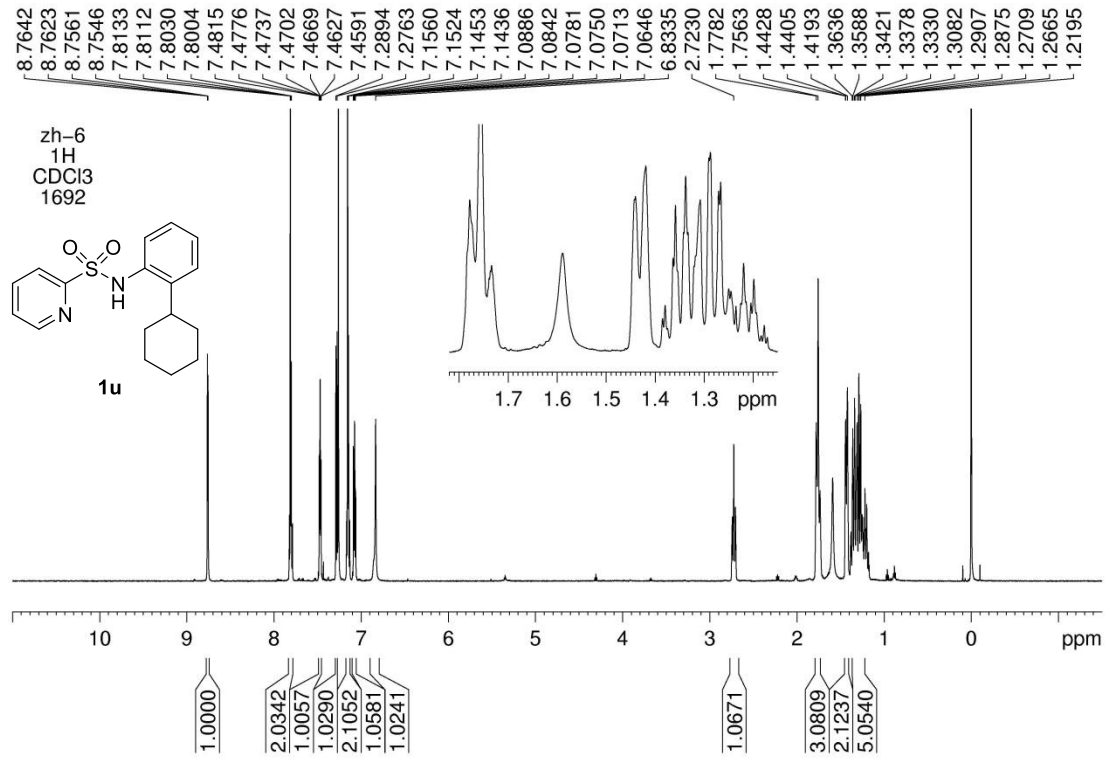
133.1580
127.0789
126.8625
126.8437
126.2903
125.4652
123.0953
39.2139
34.3656
25.6003
1t
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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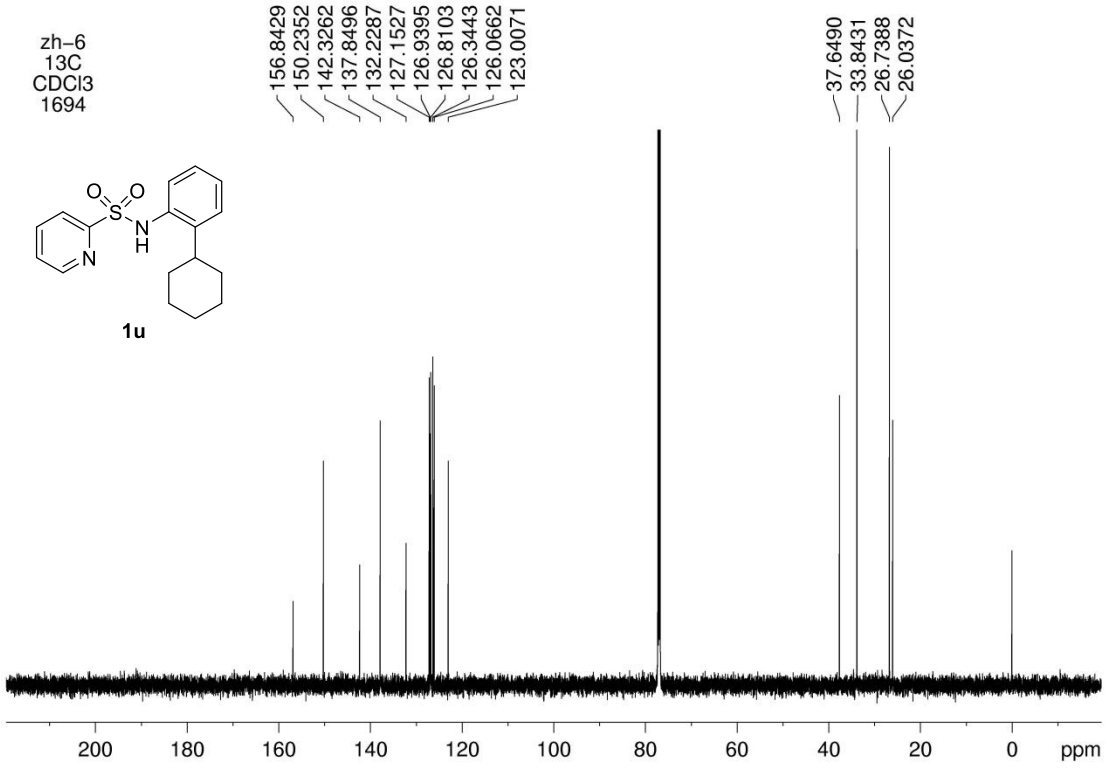
8.7623
8.7561
8.7546
8.8133
8.8112
8.8030
8.8004
7.4815
7.4776
7.4737
7.4702
7.4669
7.4627
7.4591
7.2894
7.2763
7.1560
7.1524
7.1453
7.1436
7.0886
7.0842
7.0781
7.0750
7.0713
7.0646
6.8335
2.7230
1.7782
1.7563
1.4428
1.4405
1.4193
1.3636
1.3588
1.3421
1.3378
1.3330
1.3082
1.2907
1.2875
1.2709
1.2665
1.2195
zh-6
1H
CDCl3
1692
1u
1.7 1.6 1.5 1.4 1.3 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
2.0342
1.0057
1.0290
2.1052
1.0581
1.0241
1.0671
3.0809
2.1237
5.0540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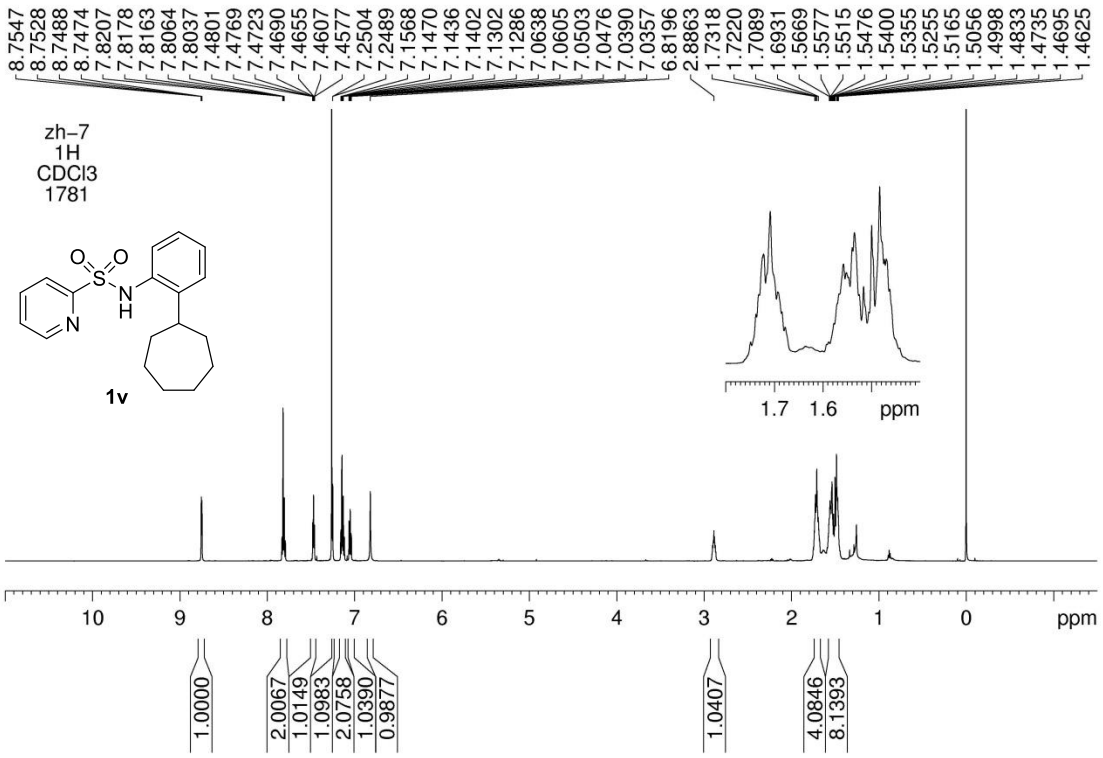
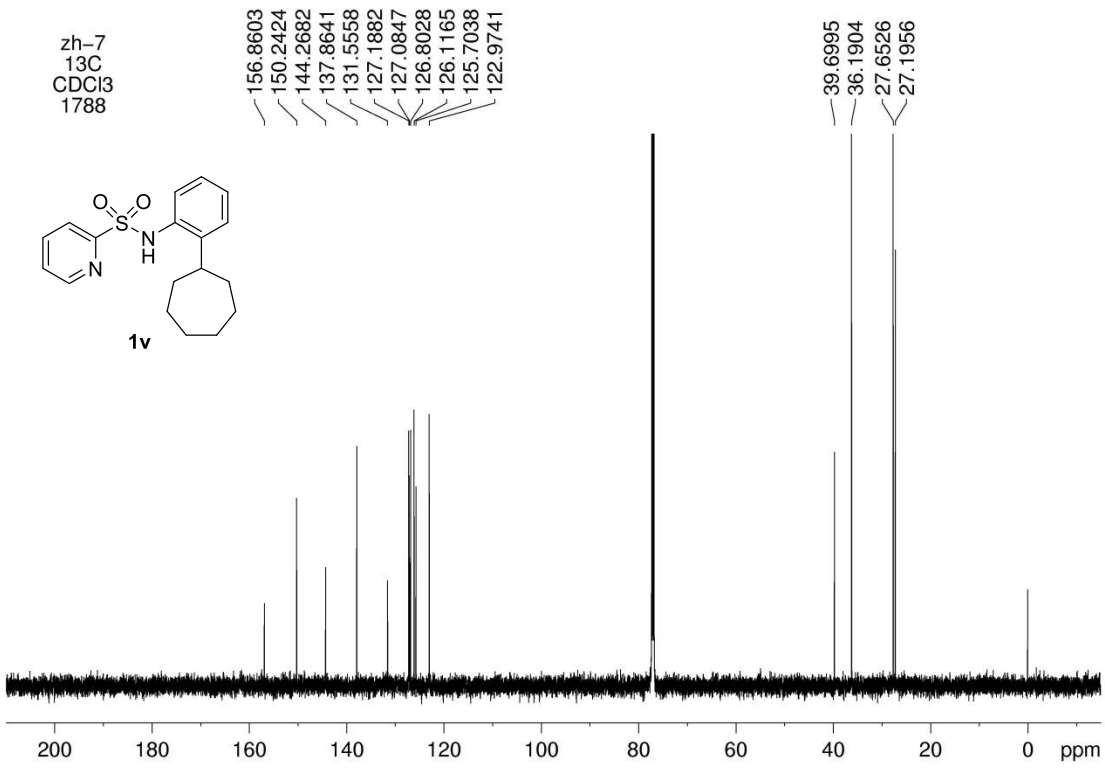
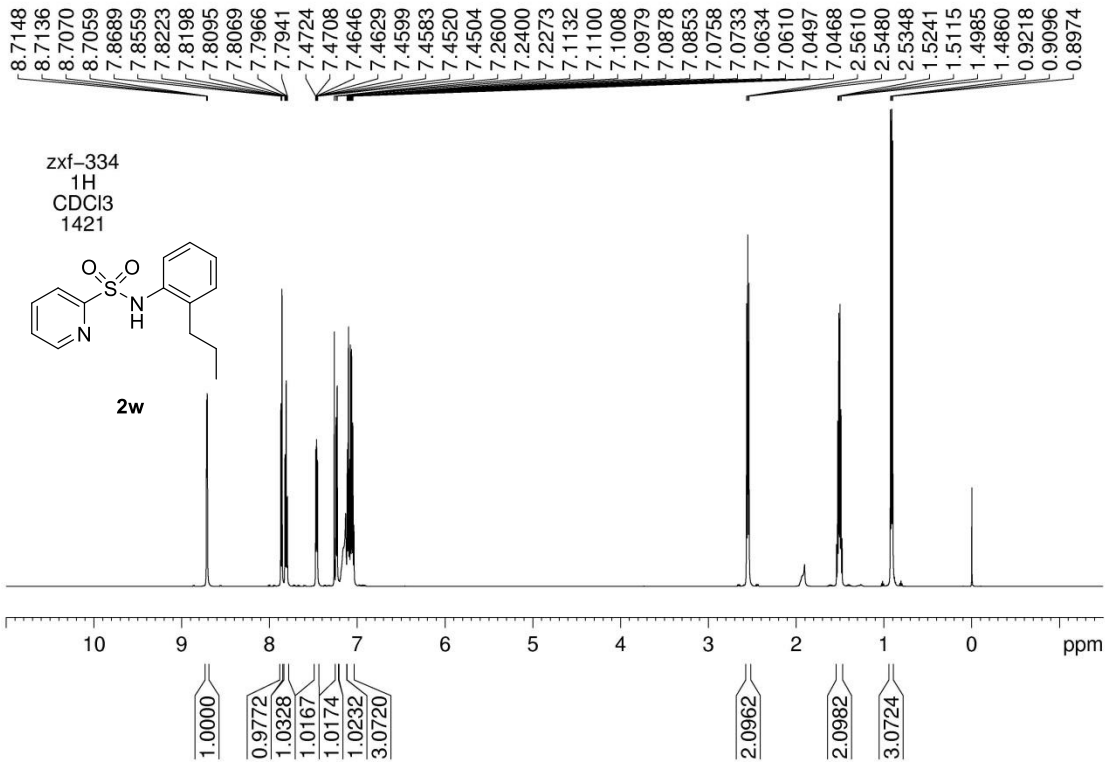
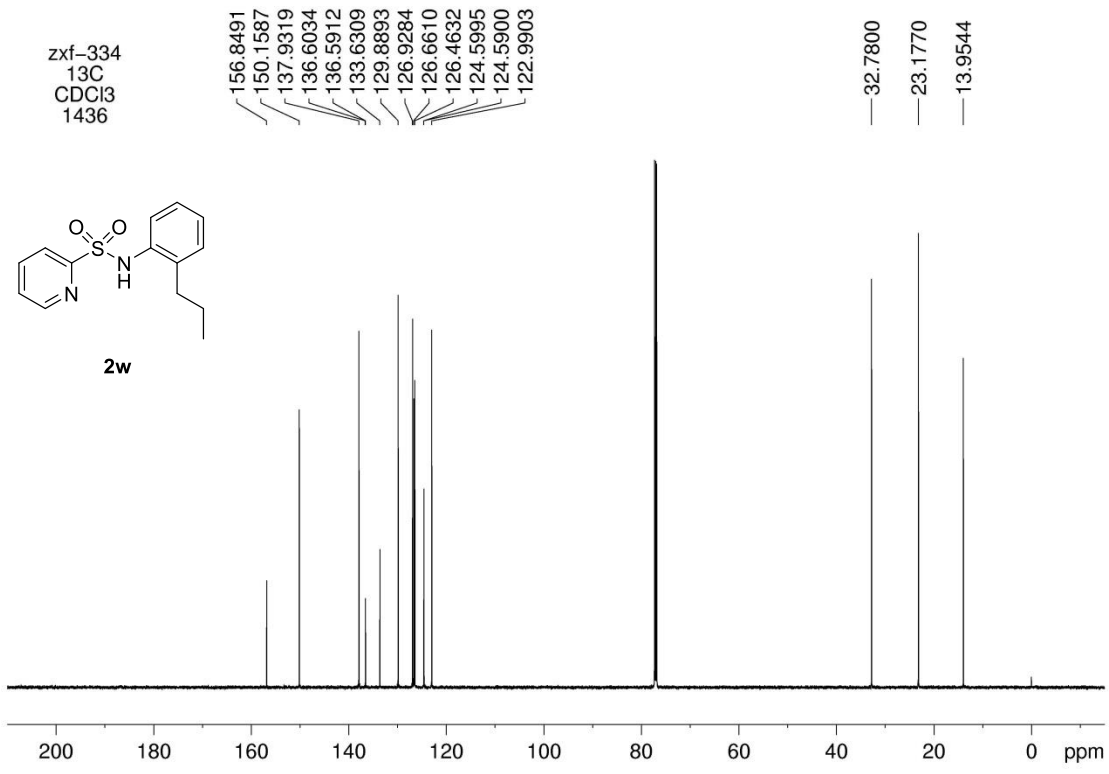
150.2352
142.3262
137.8496
132.2287
127.1527
126.9395
126.8103
126.3443
126.0662
123.0071
37.6490
33.8431
26.7388
26.0372
zh-6
13C
CDCl3
1694
1u
200 180 160 140 120 100 80 60 40 20 0 ppm


8.7547
8.7528
8.7488
8.7474
8.8207
7.8178
7.8163
7.8064
7.8037
7.4801
7.4769
7.4723
7.4690
7.4655
7.4607
7.4577
7.2504
7.2489
7.1568
7.1470
7.1436
7.1402
7.1302
7.1286
7.0638
7.0605
7.0503
7.0476
7.0390
7.0357
6.8196
2.8863
1.7318
1.7220
1.7089
1.6931
1.5669
1.5577
1.5515
1.5476
1.5400
1.5355
1.5255
1.5165
1.5056
1.4998
1.4833
1.4735
1.4695
1.4625
zh–7
1H
CDCl3
1781
1v
1.7 1.6 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
2.0067
1.0149
1.0983
2.0758
1.0390
0.9877
1.0407
4.0846
8.1393


zh–7
13C
CDCl3
1788
156.8603
150.2424
144.2682
137.8641
131.5558
127.1882
127.0847
126.8028
126.1165
125.7038
122.9741
39.6995
36.1904
27.6526
27.1956
1v
200 180 160 140 120 100 80 60 40 20 0 ppm


8.7148
8.7136
8.7070
8.7059
7.8689
7.8559
7.8223
7.8198
7.8095
7.8069
7.7966
7.7941
7.4724
7.4708
7.4646
7.4629
7.4599
7.4583
7.4520
7.4504
7.2600
7.2400
7.2273
7.1132
7.1100
7.1008
7.0979
7.0878
7.0853
7.0758
7.0733
7.0634
7.0610
7.0497
7.0468
2.5610
2.5480
2.5348
1.5241
1.5115
1.4985
1.4860
0.9218
0.9096
0.8974
zxf-334
1H
CDCl3
1421
2w
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
0.9772
1.0328
1.0167
1.0174
1.0232
3.0720
2.0962
2.0982
3.0724


zxf-334
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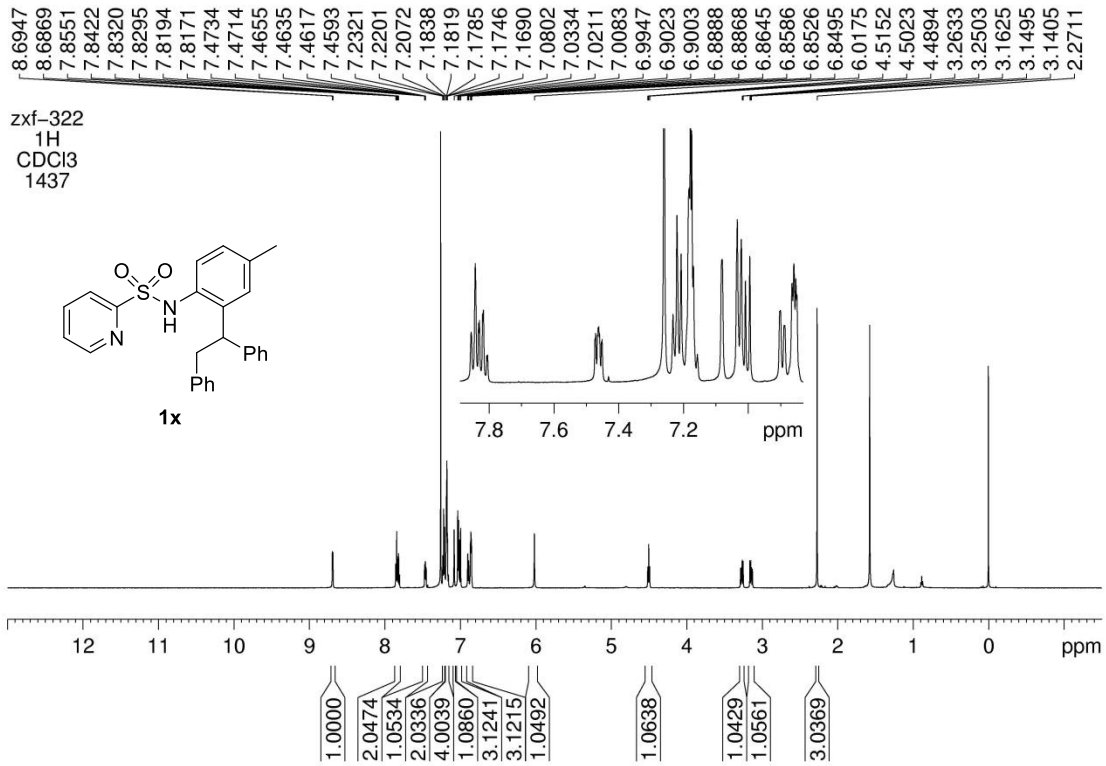
CDCl3
1436
156.8491
150.1587
137.9319
136.6034
136.5912
133.6309
129.8893
126.9284
126.6610
126.4632
124.5995
124.5900
122.9903
32.7800
23.1770
13.9544
2w
200
180
160
140
120
100
80
60
40
20
0
ppm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8.6869
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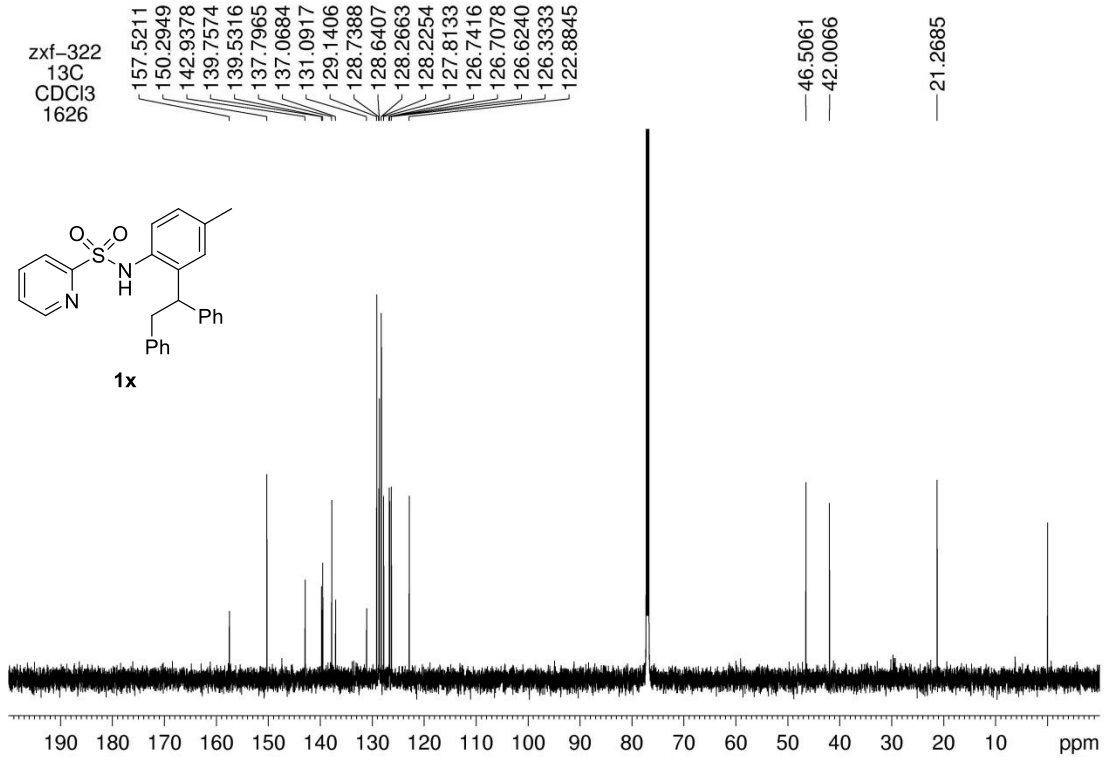
8.8422
8.8320
8.8295
8.8194
8.8171
7.4734
7.4714
7.4655
7.4635
7.4617
7.4593
7.2321
7.2201
7.2072
7.1838
7.1819
7.1785
7.1746
7.1690
7.0802
7.0334
7.0211
7.0083
6.9947
6.9023
6.9003
6.8888
6.8868
6.8645
6.8586
6.8526
6.8495
6.0175
4.5152
4.5023
4.4894
3.2633
3.2503
3.1625
3.1495
3.1405
2.2711
zxf-322
1H
CDCl3
1437
1x
7.8
7.6
7.4
7.2
ppm
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
2.0474
1.0534
2.0336
4.0039
1.0860
3.1241
3.1215
1.0492
1.0638
1.0429
1.0561
3.0369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CDCl3
1626
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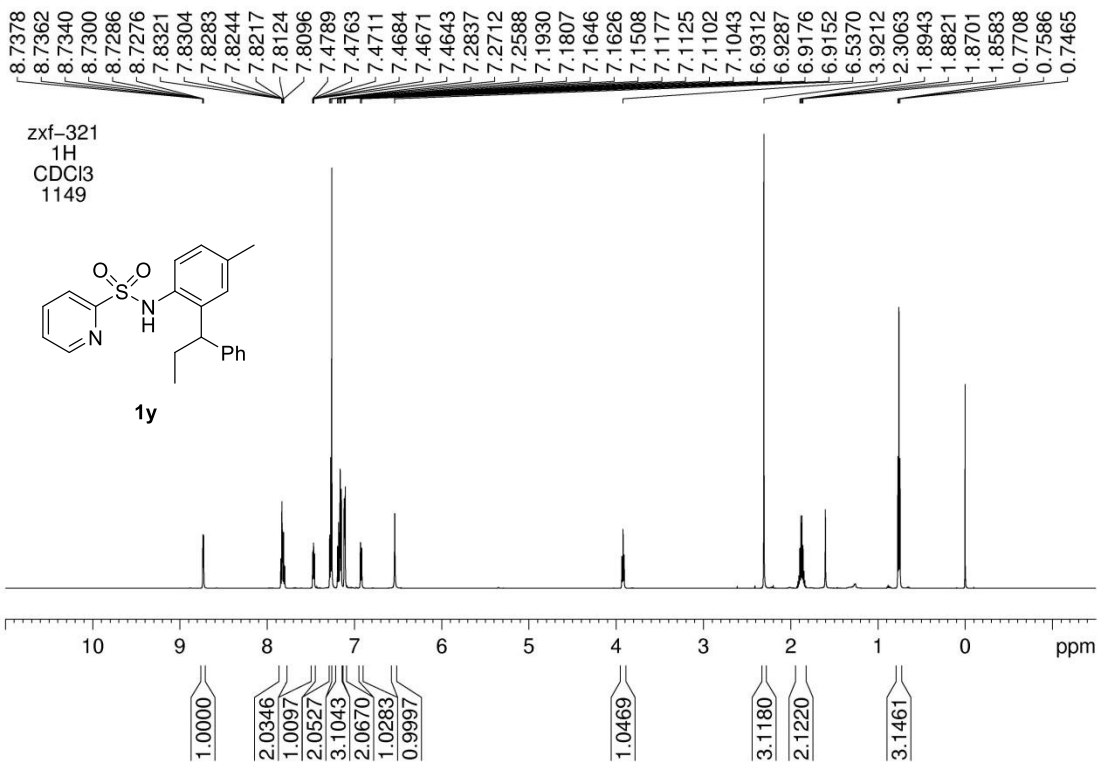
139.5316
137.7965
137.0684
131.0917
129.1406
128.7388
128.6407
128.2663
128.2254
127.8133
126.7416
126.7078
126.6240
126.3333
122.8845
46.5061
42.0066
21.2685
1x
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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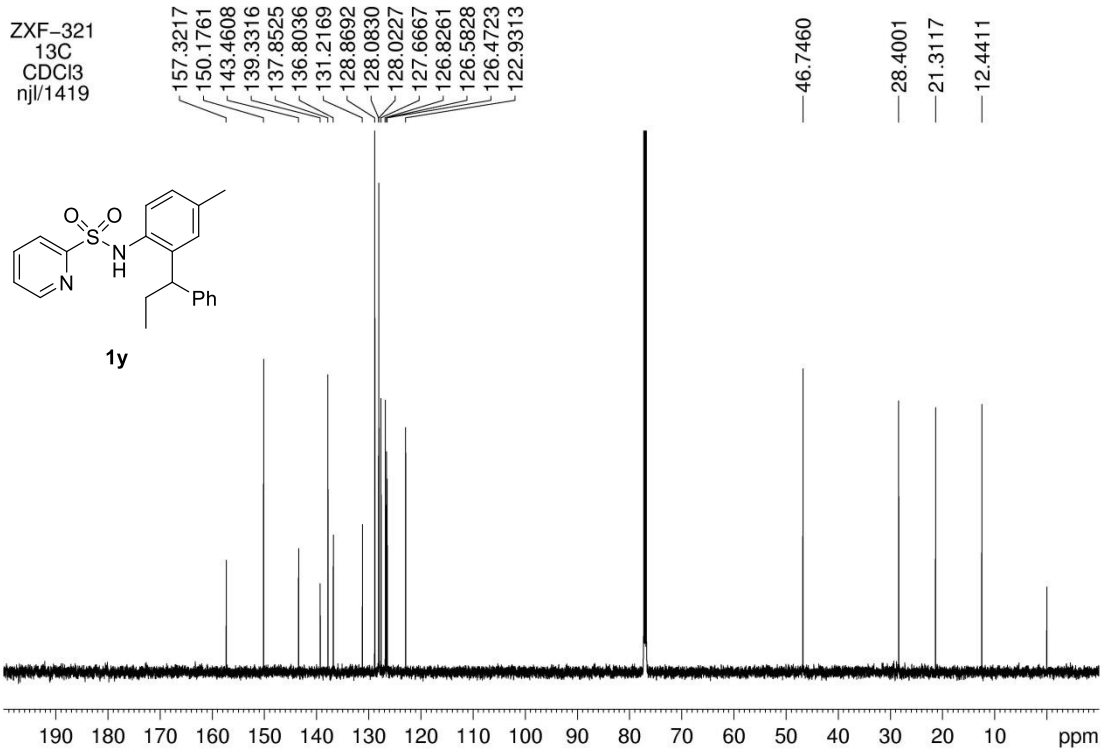
8.7340
8.7300
8.7286
8.7276
7.8321
7.8304
7.8283
7.8244
7.8217
7.8124
7.8096
7.4789
7.4763
7.4711
7.4684
7.4671
7.4643
7.2837
7.2712
7.2588
7.1930
7.1807
7.1646
7.1626
7.1508
7.1177
7.1125
7.1102
7.1043
6.9312
6.9287
6.9176
6.9152
6.5370
3.9212
2.3063
1.8943
1.8821
1.8701
1.8583
0.7708
0.7586
0.7465
zxf-321
1H
CDCl3
1149
1y
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
2.0346
1.0097
2.0527
3.1043
2.0670
1.0283
0.9997
1.0469
3.1180
2.1220
3.1461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CDCl3
njl/1419
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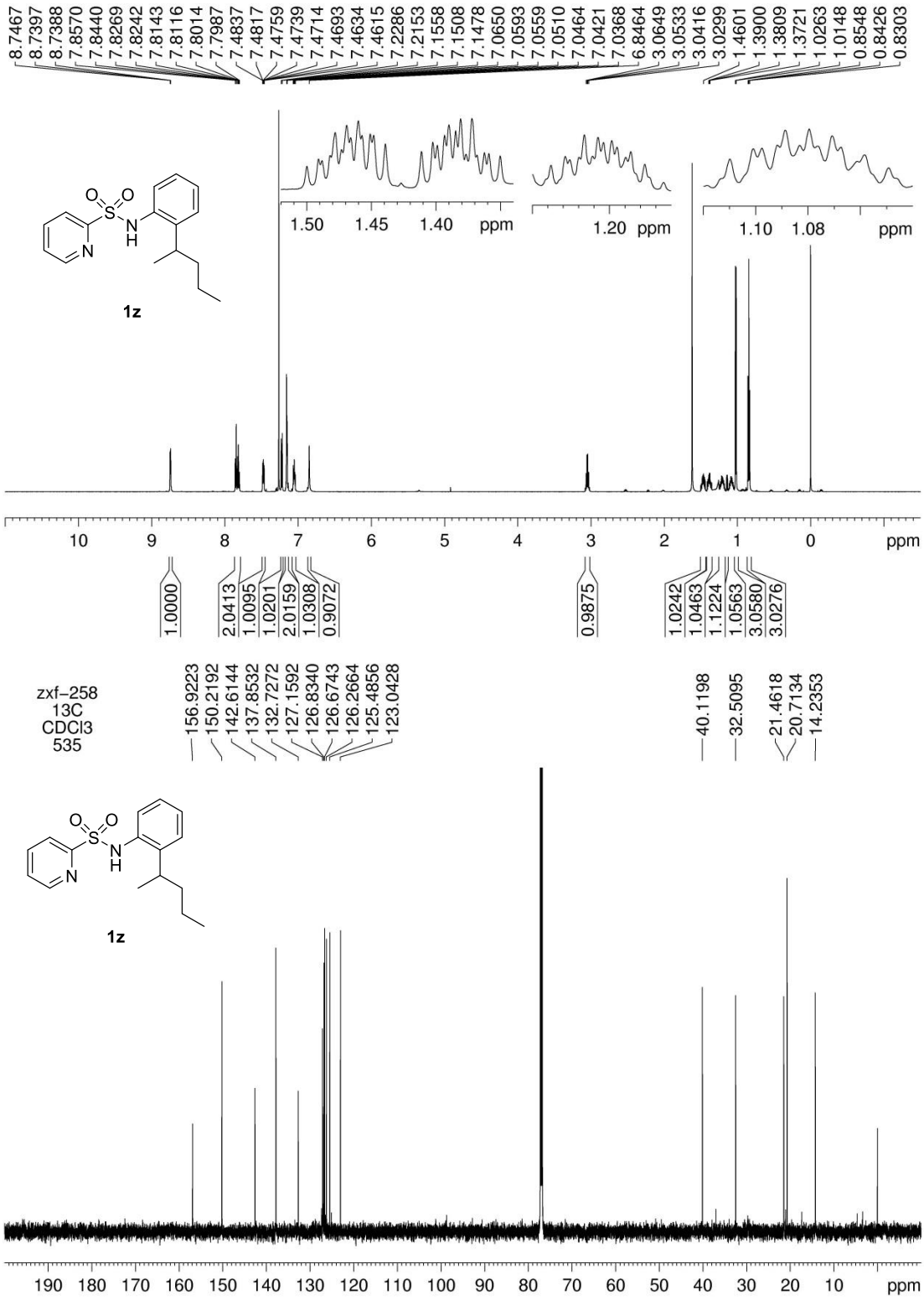
150.1761
143.4608
139.3316
137.8525
136.8036
131.2169
128.8692
128.0830
128.0227
127.6667
126.8261
126.5828
126.4723
122.9313
46.7460
28.4001
21.3117
12.4411
1y
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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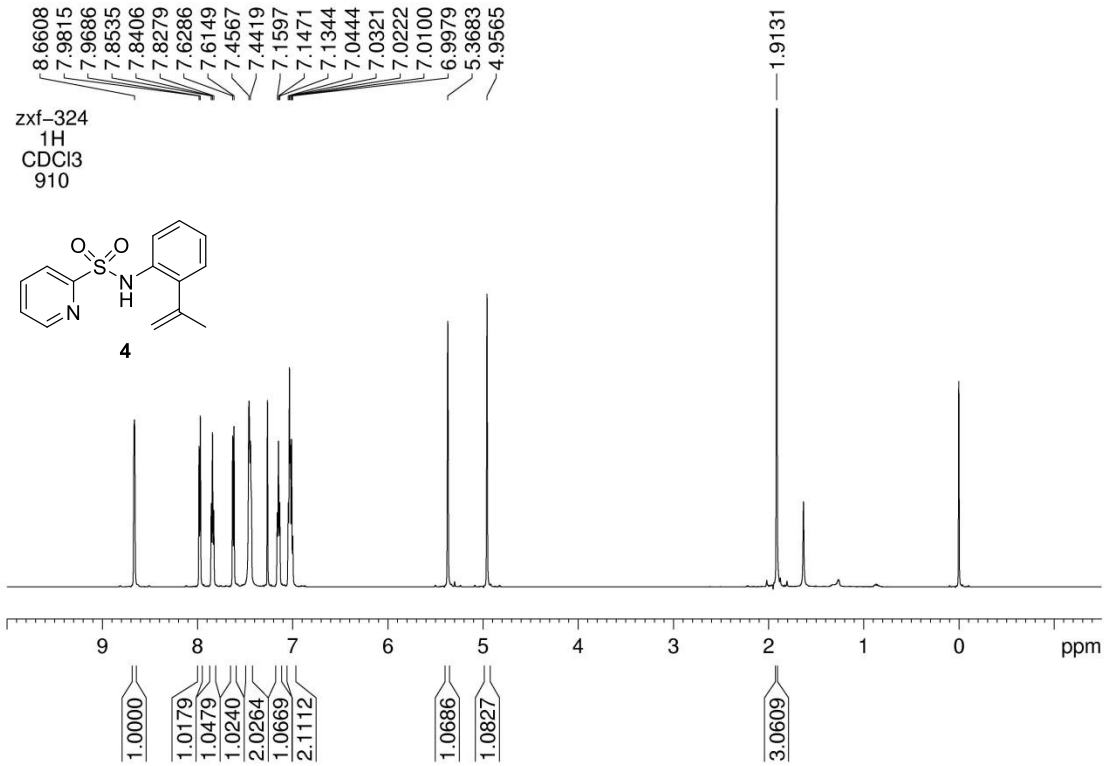
8.7570
7.8440
7.8269
7.8242
7.8143
7.8116
7.8014
7.7987
7.4837
7.4817
7.4759
7.4739
7.4714
7.4693
7.4634
7.4615
7.2286
7.2153
7.1558
7.1508
7.1478
7.0650
7.0593
7.0559
7.0510
7.0464
7.0421
7.0368
6.8464
3.0649
3.0533
3.0416
3.0299
1.4601
1.3900
1.3809
1.3721
1.0263
1.0148
0.8548
0.8426
0.8303
1.50 1.45 1.40 ppm
1.20 ppm
1.10 1.08 ppm
1z
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
2.0413
1.0095
1.0201
2.0159
1.0308
0.9072
0.9875
1.0242
1.0463
1.1224
1.0563
3.0580
3.0276
zxf-258
13C
CDCl3
535
156.9223
150.2192
142.6144
137.8532
132.7272
127.1592
126.8340
126.6743
126.2664
125.4856
123.0428
40.1198
32.5095
21.4618
20.7134
14.2353
1z
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.9815
7.9686
7.8535
7.8406
7.8279
7.6286
7.6149
7.4567
7.4419
7.1597
7.1471
7.1344
7.0444
7.0321
7.0222
7.0100
6.9979
5.3683
4.9565
1.9131
zxf-324
1H
CDCl3
910
4
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
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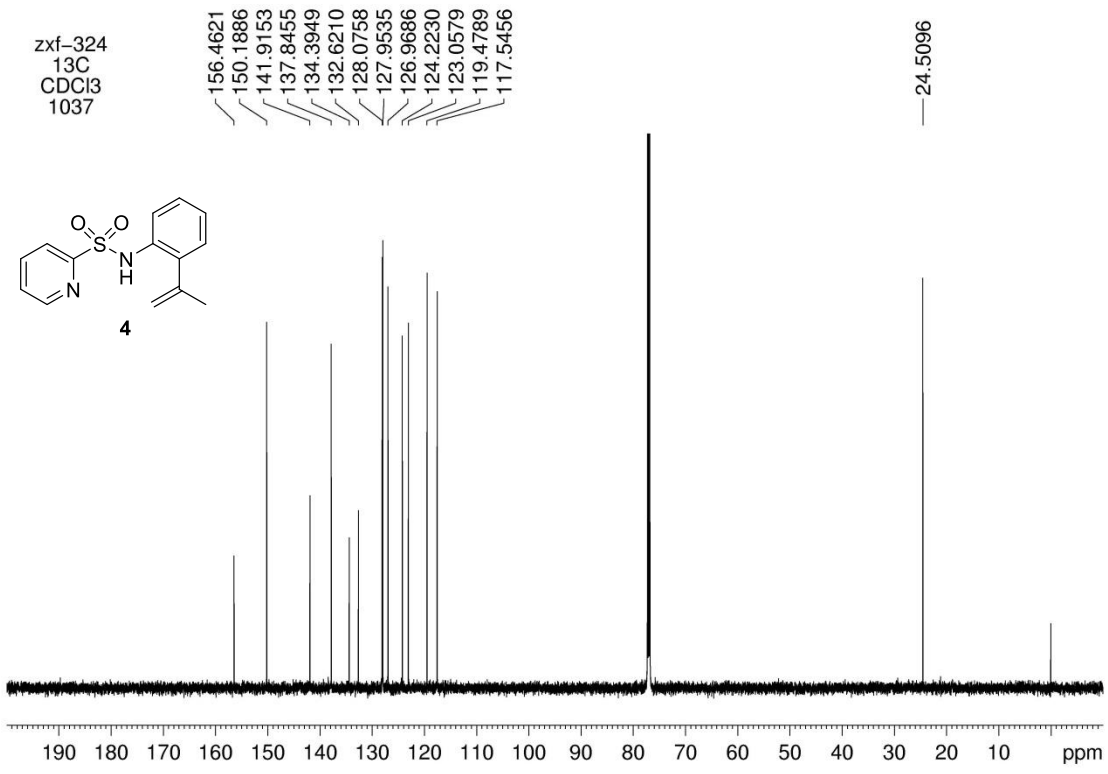
1.0479
1.0240
2.0264
1.0669
2.1112
1.0686
1.0827
3.0609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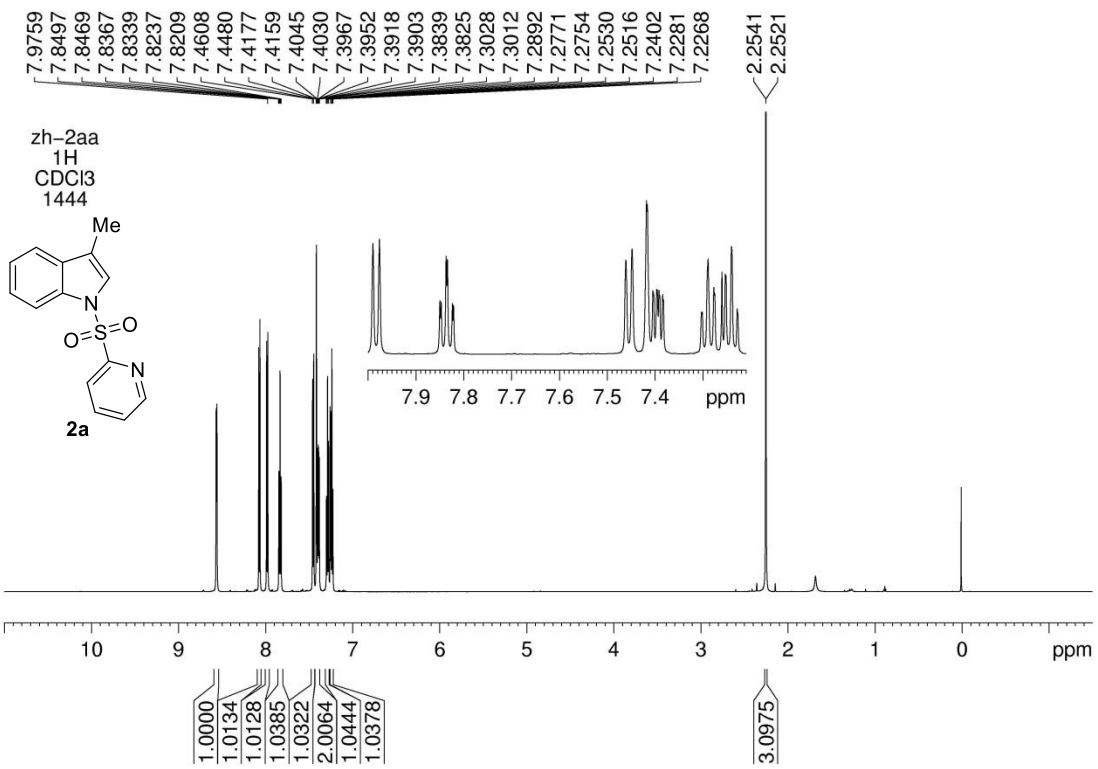
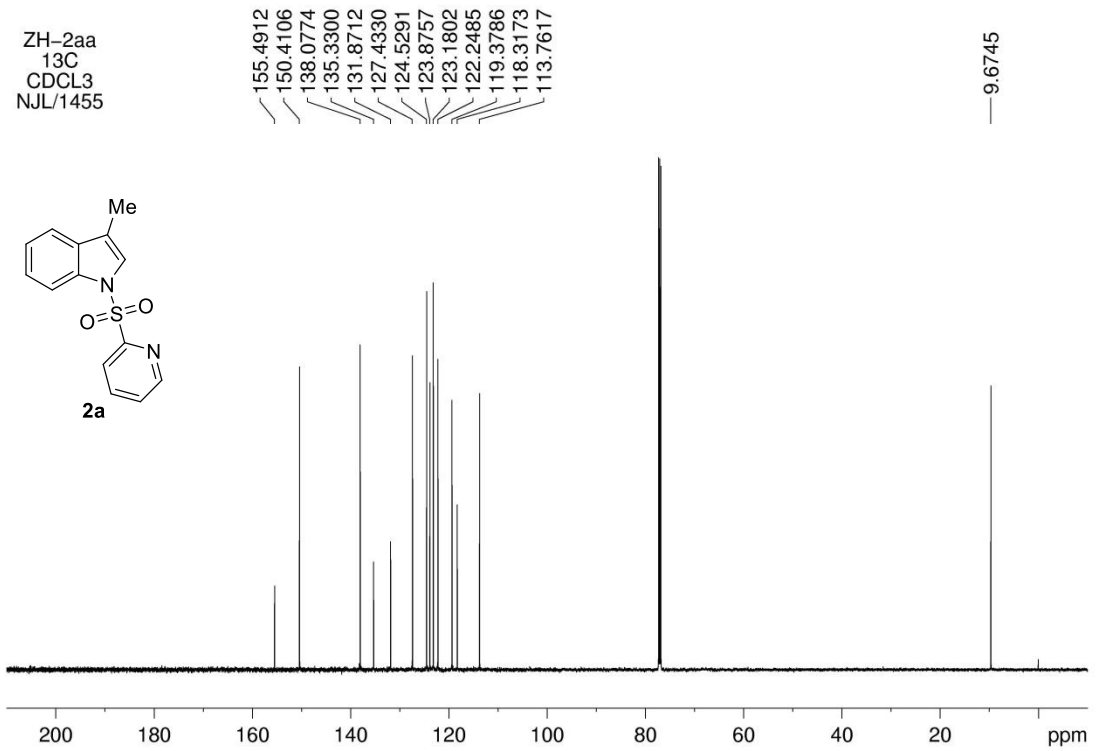
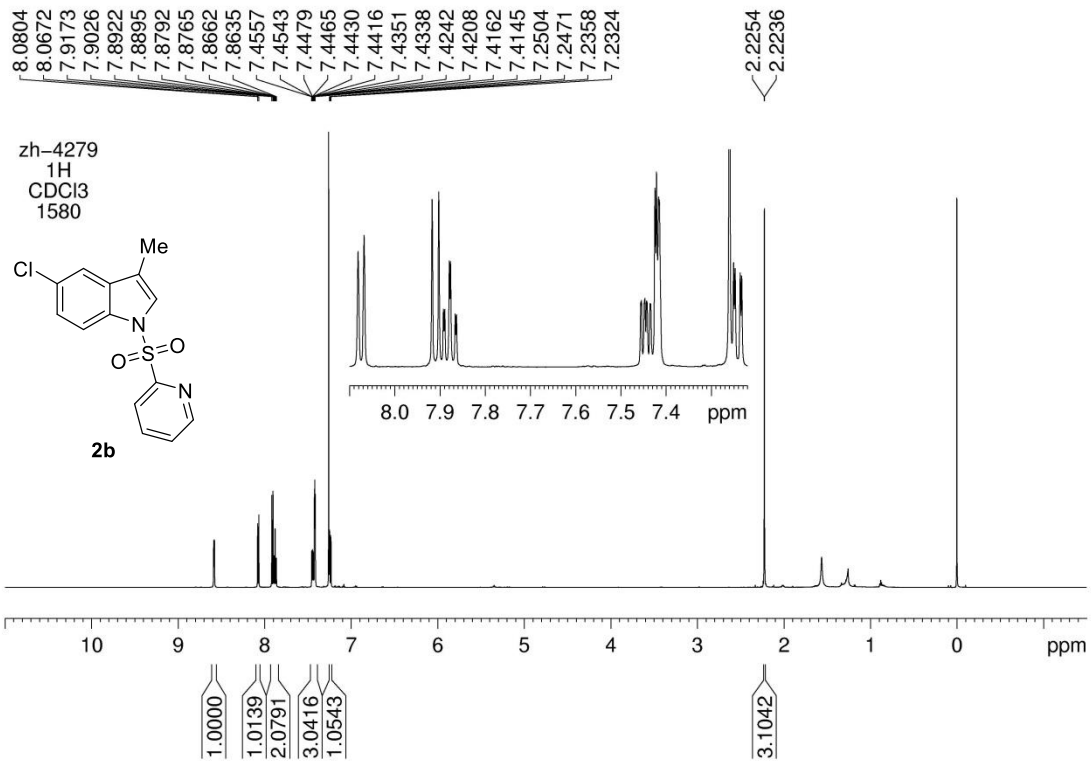
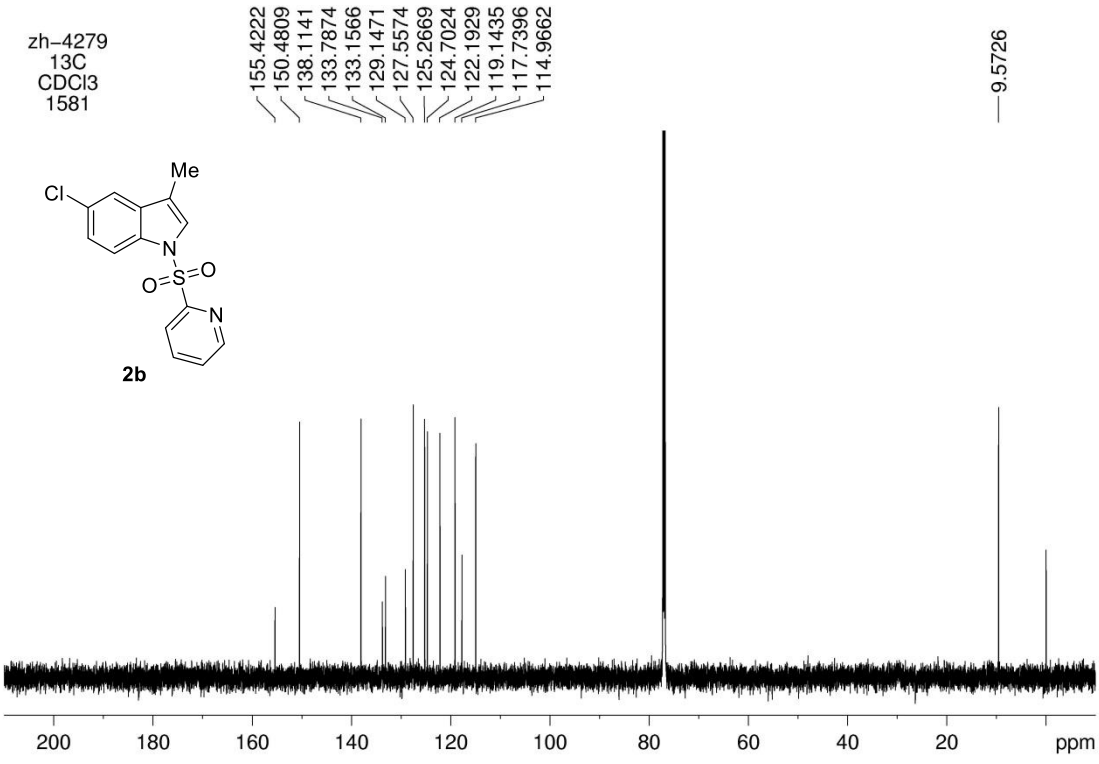
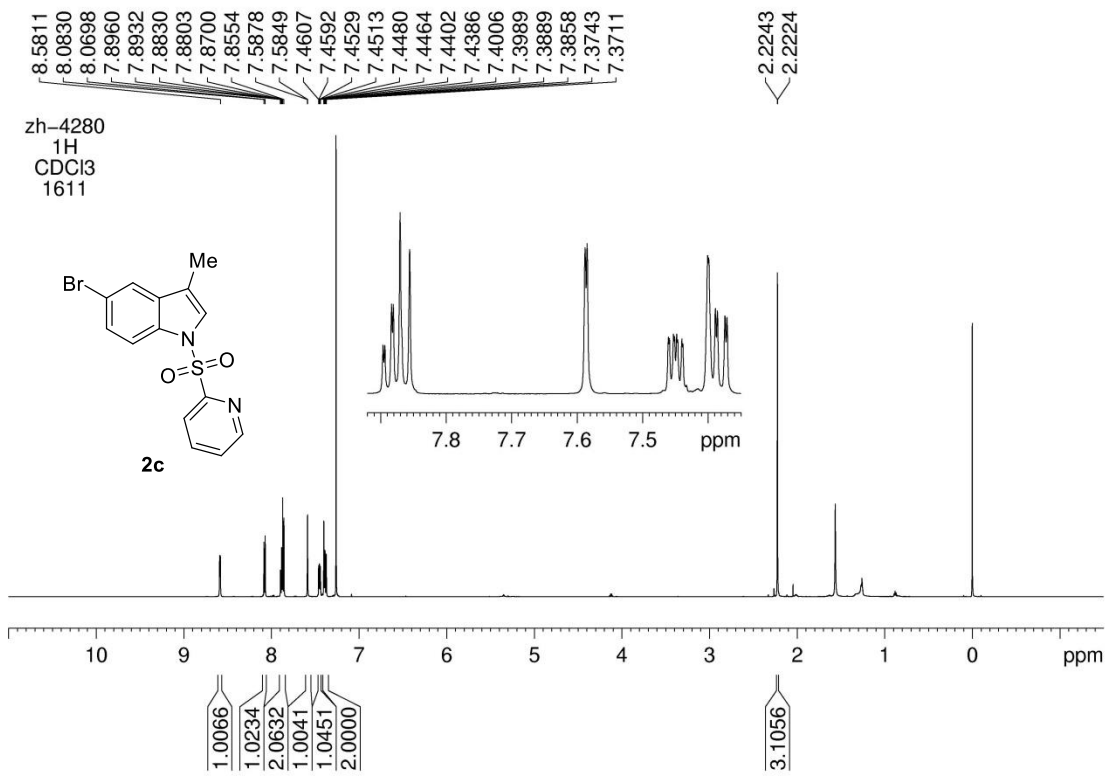
CDCl3
1037
156.4621
150.1886
141.9153
137.8455
134.3949
132.6210
128.0758
127.9535
126.9686
124.2230
123.0579
119.4789
117.5456
24.5096
4
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


7.9759
7.8497
7.8469
7.8367
7.8339
7.8237
7.8209
7.4608
7.4480
7.4177
7.4159
7.4045
7.4030
7.3967
7.3952
7.3918
7.3903
7.3839
7.3825
7.3028
7.3012
7.2892
7.2771
7.2754
7.2530
7.2516
7.2402
7.2281
7.2268
2.2541
2.2521
zh–2aa
1H
CDCl3
1444
Me
N
O=S=O
N
2a
7.9 7.8 7.7 7.6 7.5 7.4 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0134
1.0128
1.0385
1.0322
2.0064
1.0444
1.0378
3.0975


ZH–2aa
13C
CDCL3
NJL/1455
155.4912
150.4106
138.0774
135.3300
131.8712
127.4330
124.5291
123.8757
123.1802
122.2485
119.3786
118.3173
113.7617
9.6745
Me
N
O=S=O
N
2a
200 180 160 140 120 100 80 60 40 20 ppm


8.0804
8.0672
7.9173
7.9026
7.8922
7.8895
7.8792
7.8765
7.8662
7.8635
7.4557
7.4543
7.4479
7.4465
7.4430
7.4416
7.4351
7.4338
7.4242
7.4208
7.4162
7.4145
7.2504
7.2471
7.2358
7.2324
2.2254
2.2236
zh–4279
1H
CDCl3
1580
Me
Cl
N
O=S=O
N
2b
8.0 7.9 7.8 7.7 7.6 7.5 7.4 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0139
2.0791
3.0416
1.0543
3.1042


zh–4279
13C
CDCl3
1581
155.4222
150.4809
138.1141
133.7874
133.1566
129.1471
127.5574
125.2669
124.7024
122.1929
119.1435
117.7396
114.9662
9.5726
Me
Cl
N
O=S=O
N
2b
200 180 160 140 120 100 80 60 40 20 ppm


8.5811
8.0830
8.0698
7.8960
7.8932
7.8830
7.8803
7.8700
7.8554
7.5878
7.5849
7.4607
7.4592
7.4529
7.4513
7.4480
7.4464
7.4402
7.4386
7.4006
7.3989
7.3889
7.3858
7.3743
7.3711
2.2243
2.2224
zh-4280
1H
CDCl3
1611
Me
Br
N
O=S=O
N
2c
7.8
7.7
7.6
7.5
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
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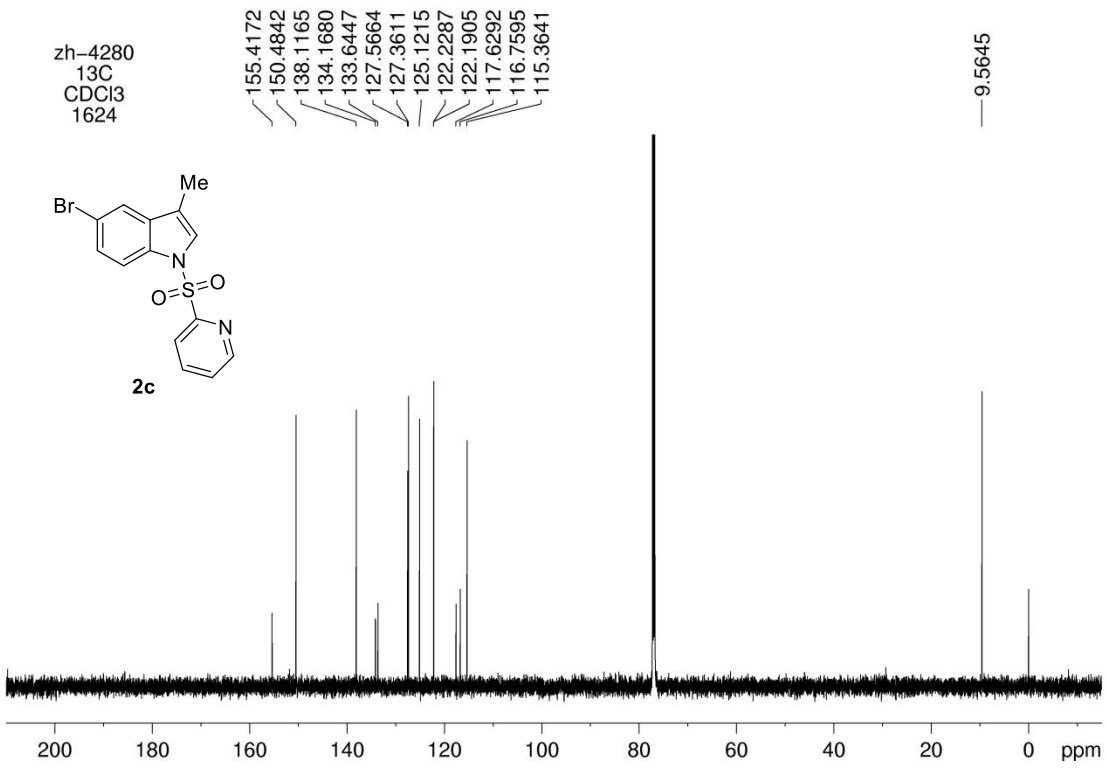
1.0234
2.0632
1.0041
1.0451
2.0000
3.1056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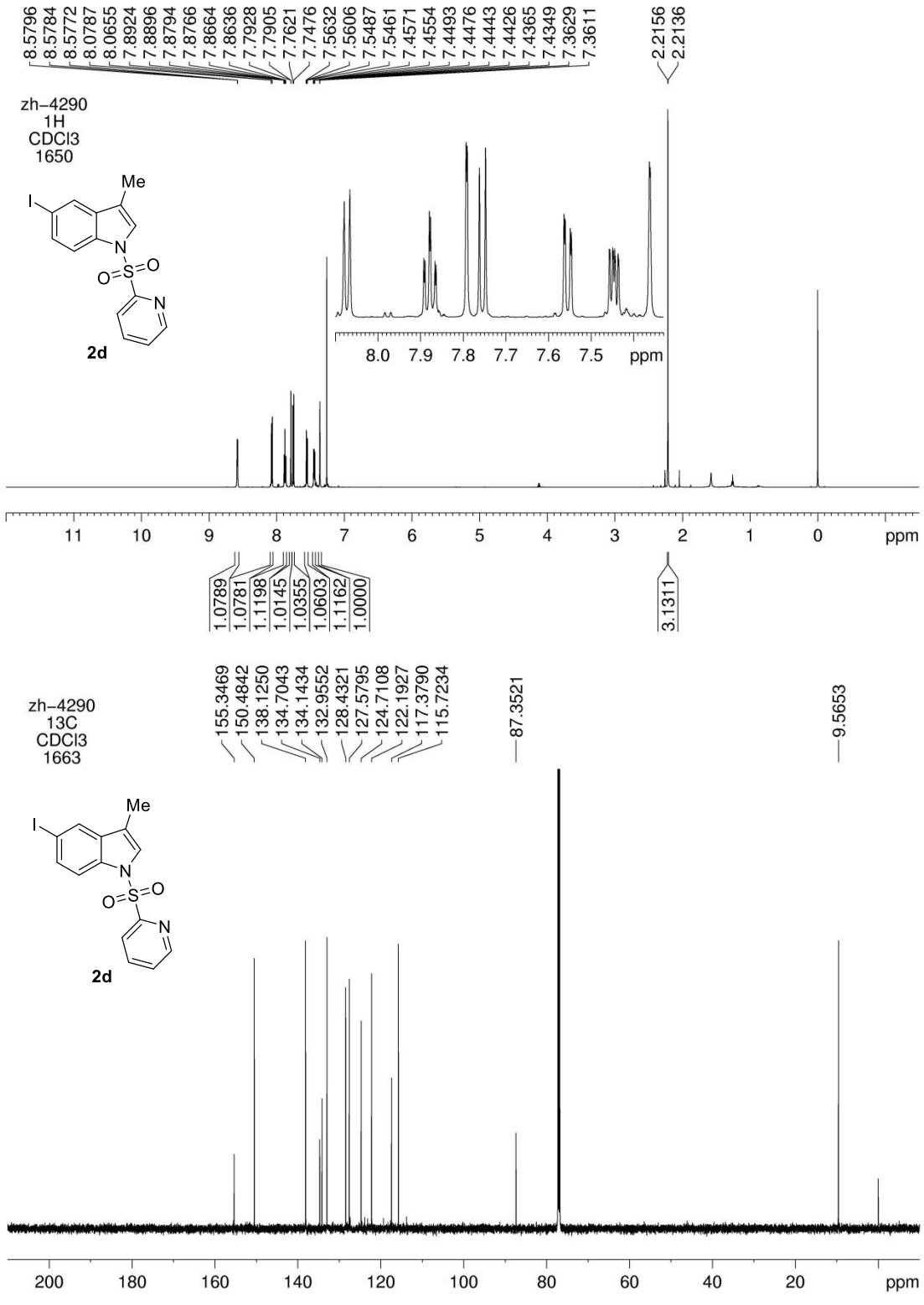
CDCl3
1624
155.4172
150.4842
138.1165
134.1680
133.6447
127.5664
127.3611
125.1215
122.2287
122.1905
117.6292
116.7595
115.3641
9.5645
Me
Br
N
O=S=O
N
2c
200
180
160
140
120
100
80
60
40
20
0
ppm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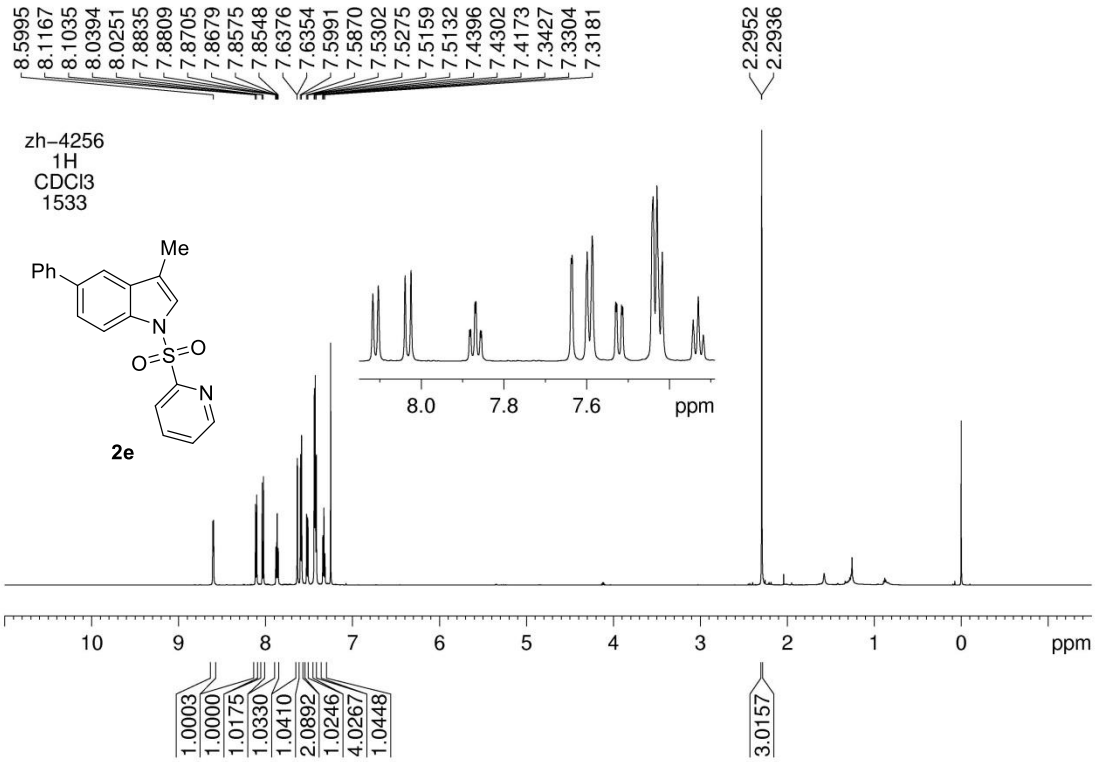
8.5784
8.5772
8.0787
8.0655
7.8924
7.8896
7.8794
7.8766
7.8664
7.8636
7.7928
7.7905
7.7621
7.7476
7.5632
7.5606
7.5487
7.5461
7.4571
7.4554
7.4493
7.4476
7.4443
7.4426
7.4365
7.4349
7.3629
7.3611
2.2156
2.2136
zh–4290
1H
CDCl3
1650
Me
I
N
O=S=O
N
2d
8.0 7.9 7.8 7.7 7.6 7.5 ppm
11 10 9 8 7 6 5 4 3 2 1 0 ppm
1.0789
1.0781
1.1198
1.0145
1.0355
1.0603
1.1162
1.0000
3.1311
zh–4290
13C
CDCl3
1663
155.3469
150.4842
138.1250
134.7043
134.1434
132.9552
128.4321
127.5795
124.7108
122.1927
117.3790
115.7234
87.3521
9.5653
Me
I
N
O=S=O
N
2d
200 180 160 140 120 100 80 60 40 20 ppm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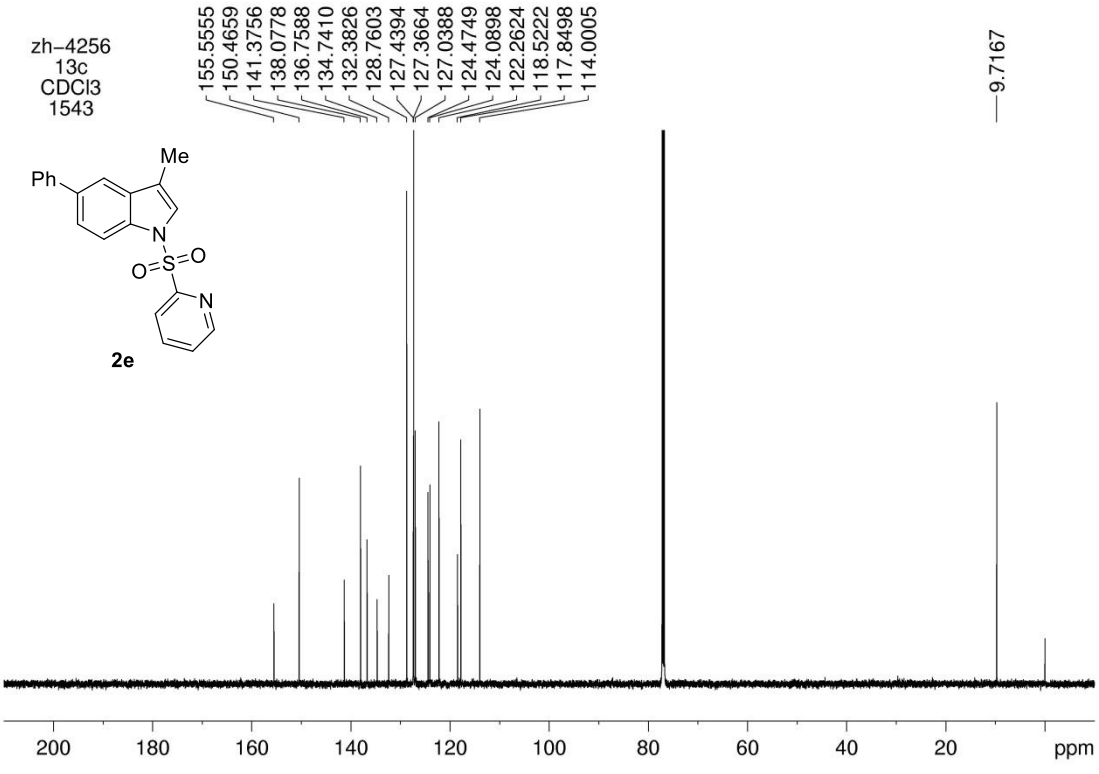
8.1167
8.1035
8.0394
8.0251
7.8835
7.8809
7.8705
7.8679
7.8575
7.8548
7.6376
7.6354
7.5991
7.5870
7.5302
7.5275
7.5159
7.5132
7.4396
7.4302
7.4173
7.3427
7.3304
7.3181
2.2952
2.2936
zh-4256
1H
CDCl3
1533
Me
Ph
N
O=S=O
N
2e
8.0
7.8
7.6
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0003
1.0000
1.0175
1.0330
1.0410
2.0892
1.0246
4.0267
1.0448
3.0157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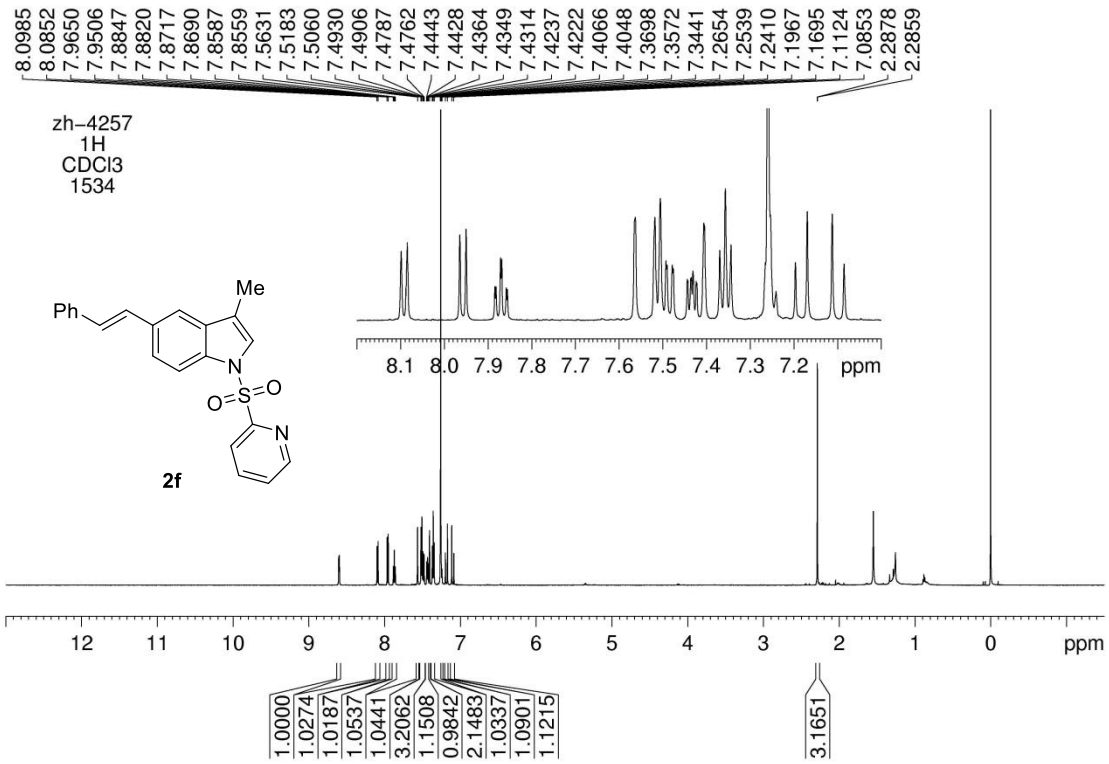
150.4659
141.3756
138.0778
136.7588
134.7410
132.3826
128.7603
127.4394
127.3664
127.0388
124.4749
124.0898
122.2624
118.5222
117.8498
114.0005
9.7167
zh-4256
13c
CDCl3
1543
Me
Ph
N
O=S=O
N
2e
200
180
160
140
120
100
80
60
40
20
ppm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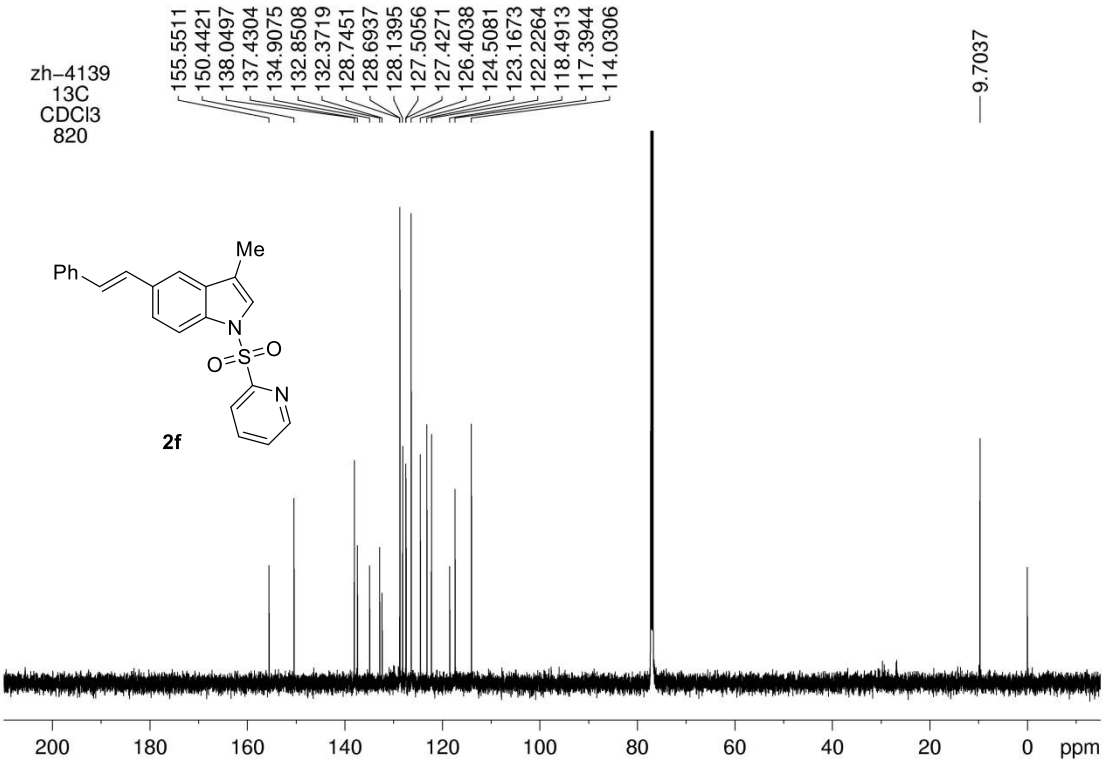
8.0852
7.9650
7.9506
7.8847
7.8820
7.8717
7.8690
7.8587
7.8559
7.5631
7.5183
7.5060
7.4930
7.4906
7.4787
7.4762
7.4443
7.4428
7.4364
7.4349
7.4314
7.4237
7.4222
7.4066
7.4048
7.3698
7.3572
7.3441
7.2654
7.2539
7.2410
7.1967
7.1695
7.1124
7.0853
2.2878
2.2859
zh–4257
1H
CDCl3
1534
Me
Ph
N
O=S=O
N
2f
8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 7.3 7.2 ppm
12 11 10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0274
1.0187
1.0537
1.0441
3.2062
1.1508
0.9842
2.1483
1.0337
1.0901
1.1215
3.1651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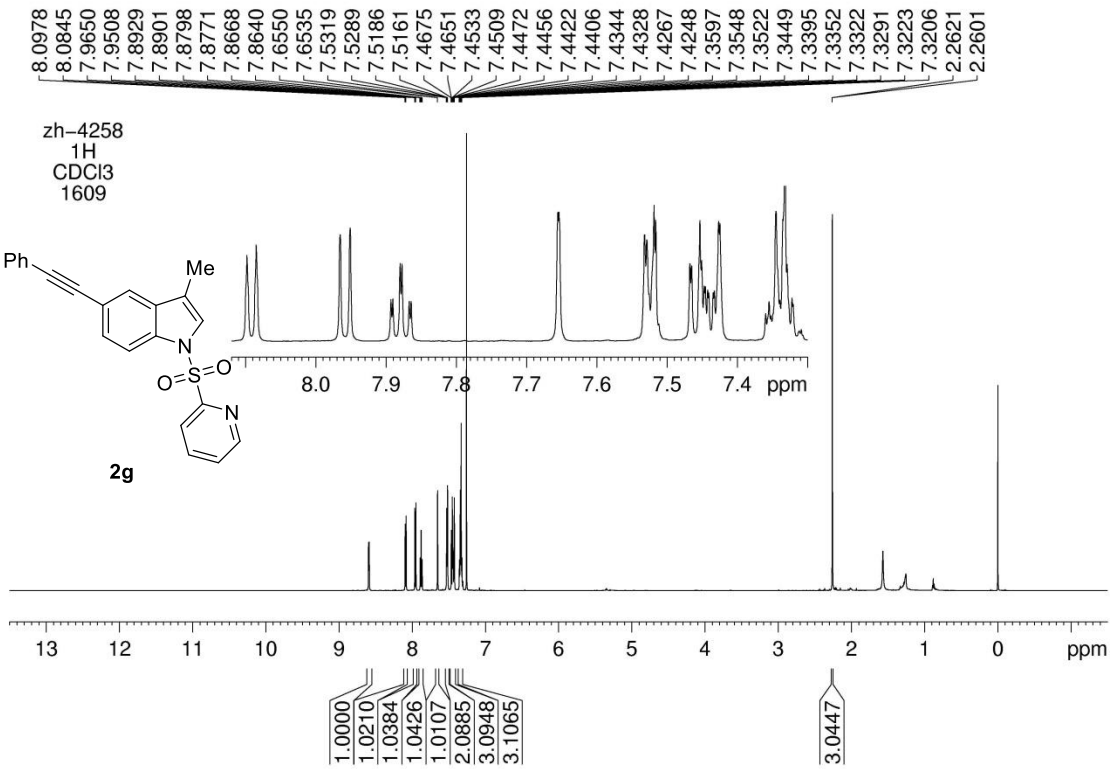
150.4421
138.0497
137.4304
134.9075
132.8508
132.3719
128.7451
128.6937
128.1395
127.5056
127.4271
126.4038
124.5081
123.1673
122.2264
118.4913
117.3944
114.0306
9.7037
zh–4139
13C
CDCl3
820
Me
Ph
N
O=S=O
N
2f
200 180 160 140 120 100 80 60 40 20 0 ppm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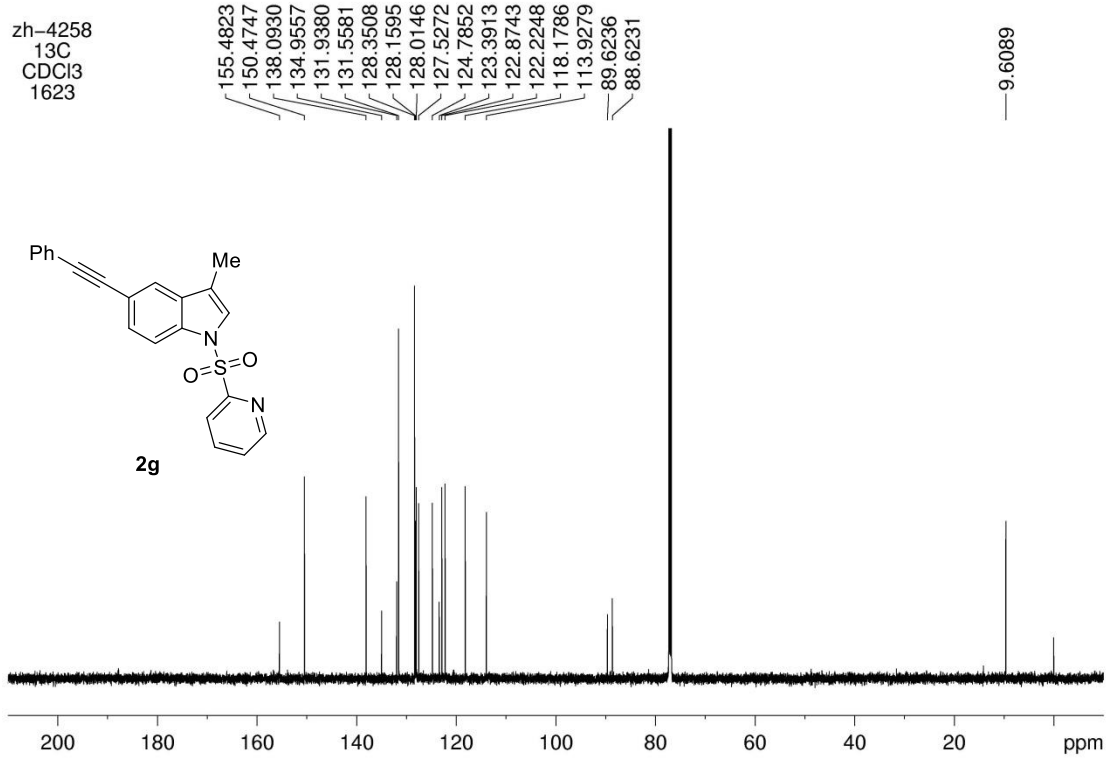
8.0845
7.9650
7.9508
7.8929
7.8901
7.8798
7.8771
7.8668
7.8640
7.6550
7.6535
7.5319
7.5289
7.5186
7.5161
7.4675
7.4651
7.4533
7.4509
7.4472
7.4456
7.4422
7.4406
7.4344
7.4328
7.4267
7.4248
7.3597
7.3548
7.3522
7.3449
7.3395
7.3352
7.3322
7.3291
7.3223
7.3206
2.2621
2.2601
zh-4258
1H
CDCl3
1609
Ph
Me
N
O=S=O
N
2g
8.0
7.9
7.8
7.7
7.6
7.5
7.4 ppm
13
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0210
1.0384
1.0426
1.0107
2.0885
3.0948
3.1065
3.0447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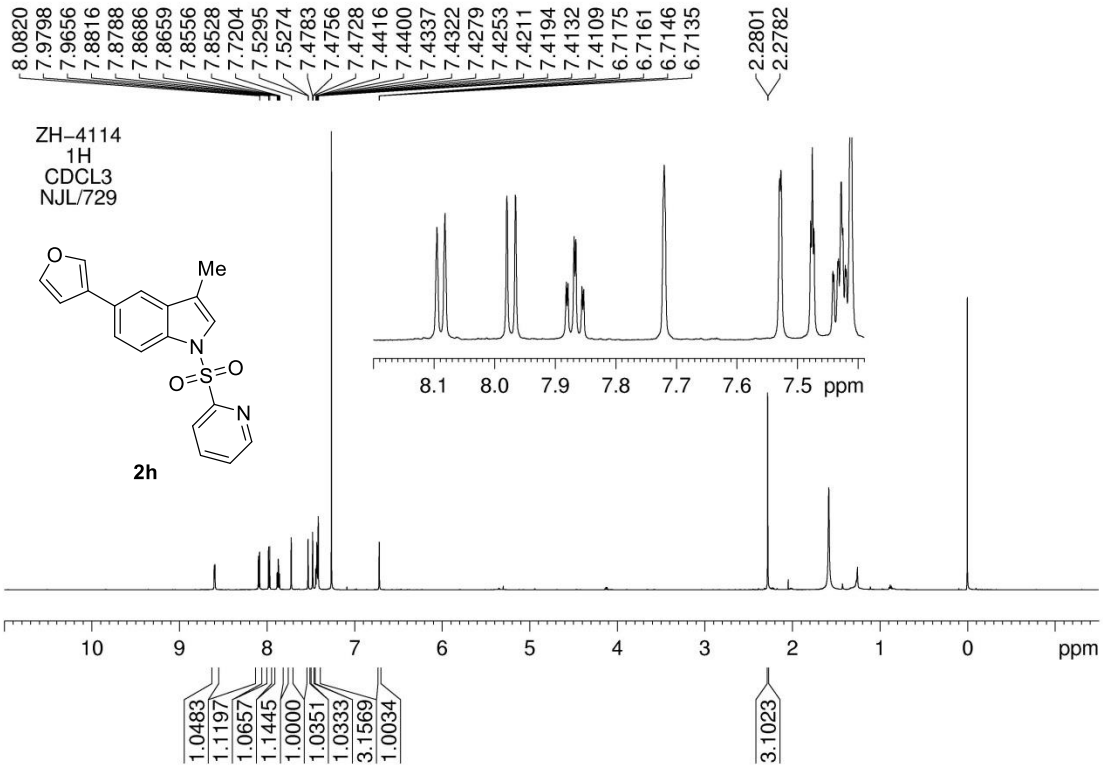
CDCl3
1623
155.4823
150.4747
138.0930
134.9557
131.9380
131.5581
128.3508
128.1595
128.0146
127.5272
124.7852
123.3913
122.8743
122.2248
118.1786
113.9279
89.6236
88.6231
9.6089
Ph
Me
N
O=S=O
N
2g
200
180
160
140
120
100
80
60
40
20
ppm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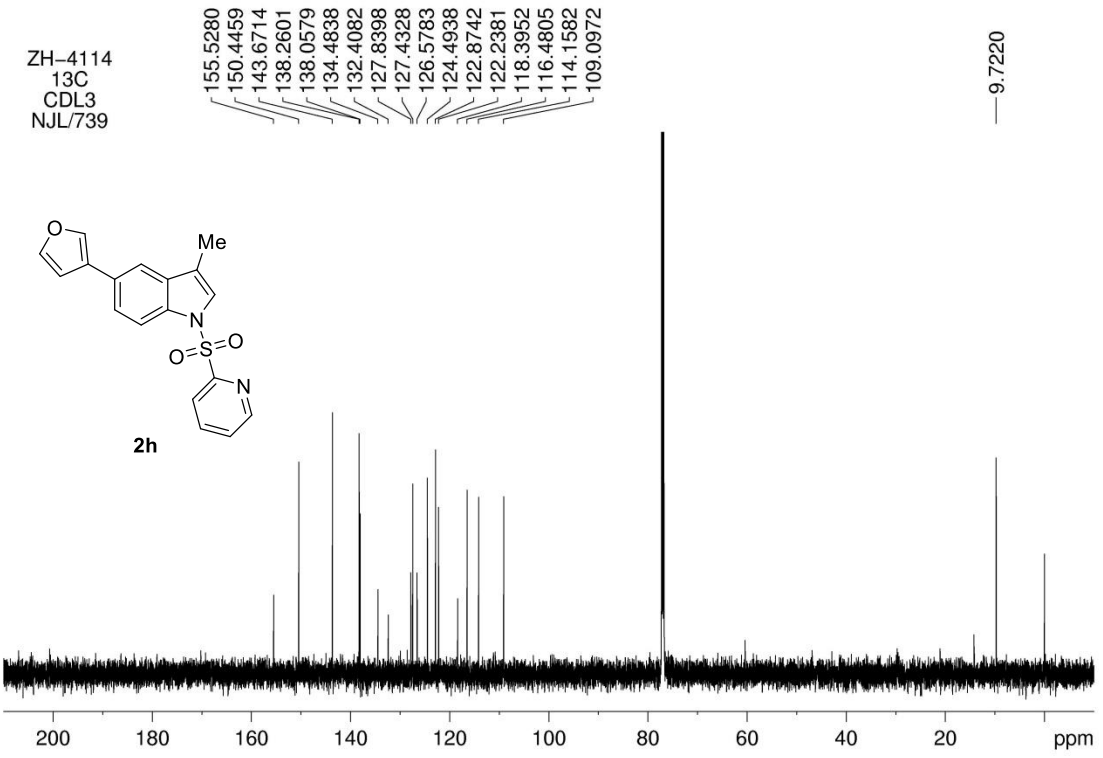
7.8788
7.8686
7.8659
7.8556
7.8528
7.7204
7.5295
7.5274
7.4783
7.4756
7.4728
7.4416
7.4400
7.4337
7.4322
7.4279
7.4253
7.4211
7.4194
7.4132
7.4109
6.7175
6.7161
6.7146
6.7135
2.2801
2.2782
ZH–4114
1H
CDCL3
NJL/729
Me
O
N
S
O
O
N
2h
8.1
8.0
7.9
7.8
7.7
7.6
7.5 ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0483
1.1197
1.0657
1.1445
1.0000
1.0351
1.0333
3.1569
1.0034
3.1023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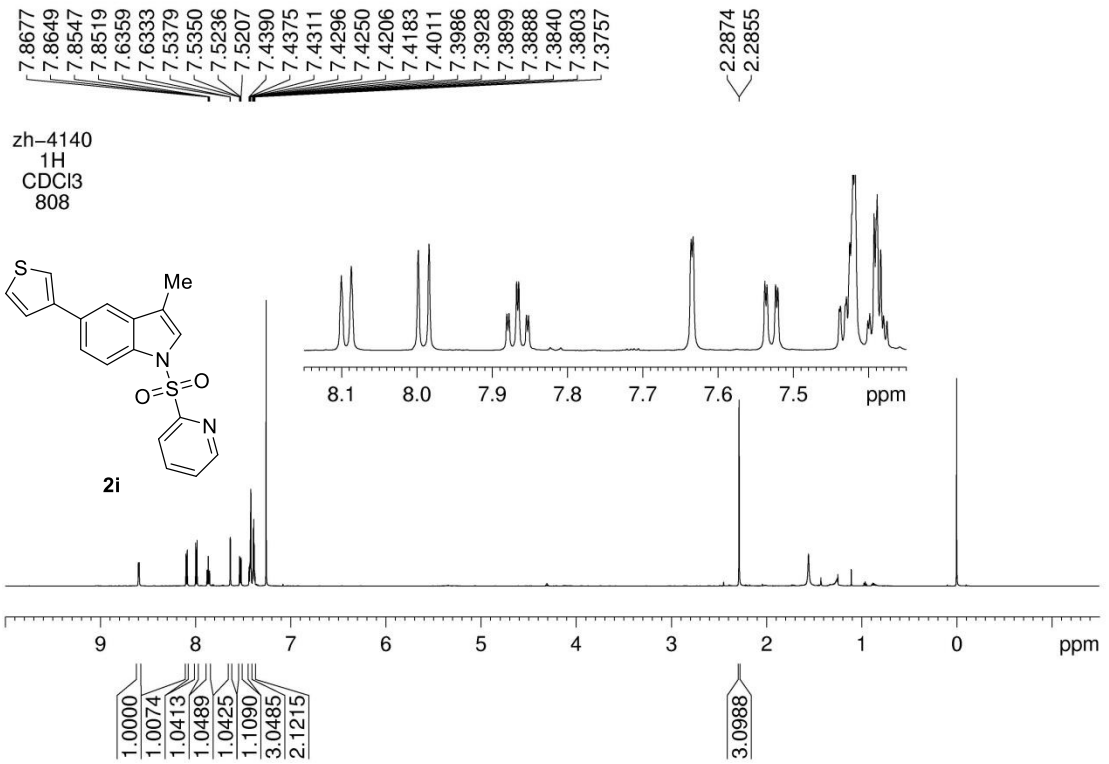
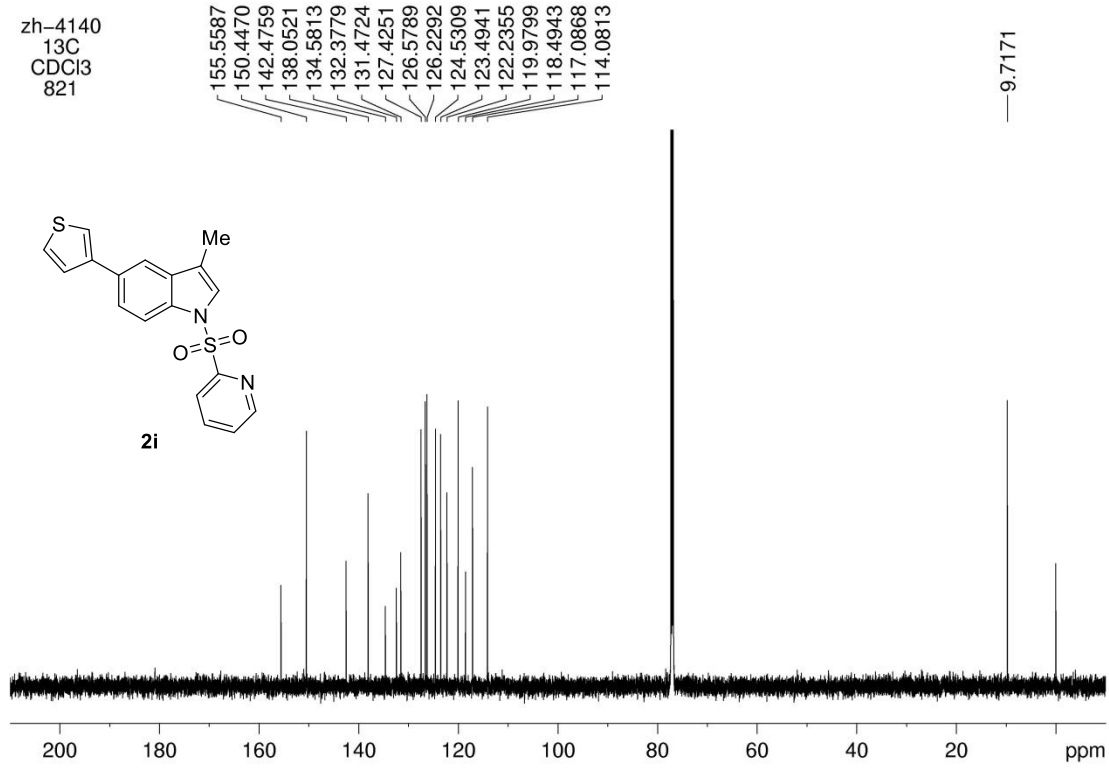
150.4459
143.6714
138.2601
138.0579
134.4838
132.4082
127.8398
127.4328
126.5783
124.4938
122.8742
122.2381
118.3952
116.4805
114.1582
109.0972
9.7220
ZH–4114
13C
CDL3
NJL/739
Me
O
N
S
O
O
N
2h
200
180
160
140
120
100
80
60
40
20
ppm


7.8677
7.8649
7.8547
7.8519
7.6359
7.6333
7.5379
7.5350
7.5236
7.5207
7.4390
7.4375
7.4311
7.4296
7.4250
7.4206
7.4183
7.4011
7.3986
7.3928
7.3899
7.3888
7.3840
7.3803
7.3757
2.2874
2.2855
zh–4140
1H
CDCl3
808
Me
S
N
O=S=O
N
2i
8.1
8.0
7.9
7.8
7.7
7.6
7.5
ppm
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0074
1.0413
1.0489
1.0425
1.1090
3.0485
2.1215
3.0988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CDCl3
821
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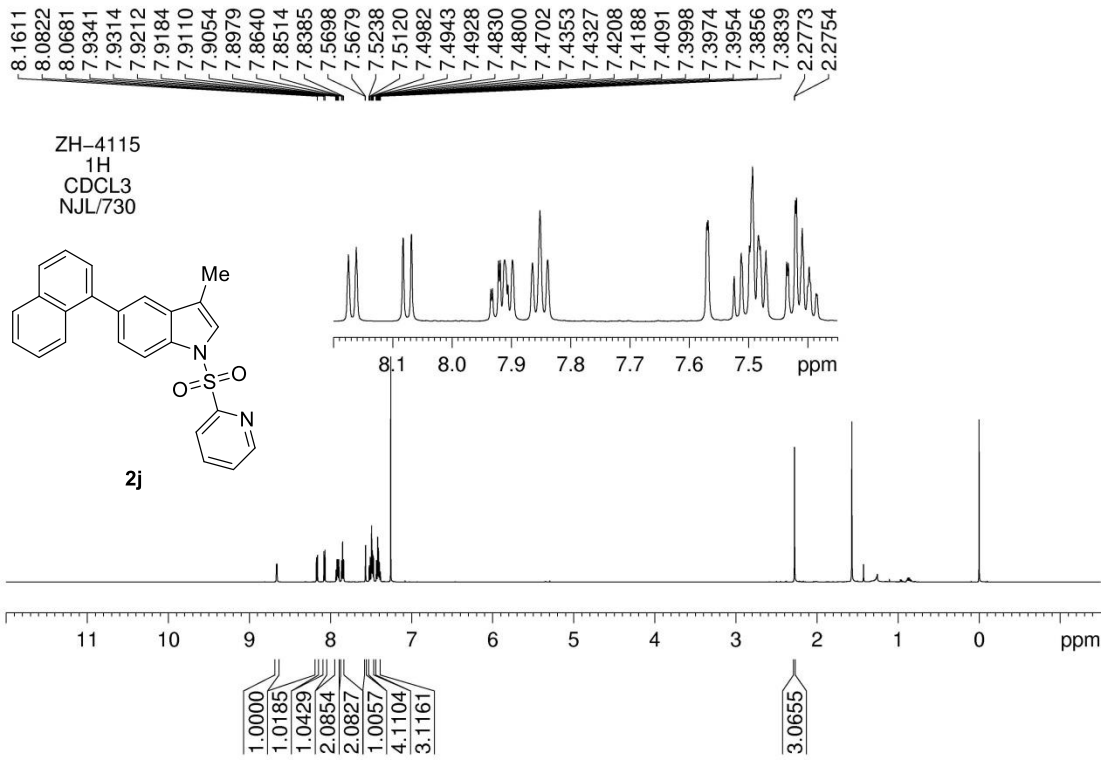
142.4759
138.0521
134.5813
132.3779
131.4724
127.4251
126.5789
126.2292
124.5309
123.4941
122.2355
119.9799
118.4943
117.0868
114.0813
9.7171
Me
S
N
O=S=O
N
2i
200
180
160
140
120
100
80
60
40
20
ppm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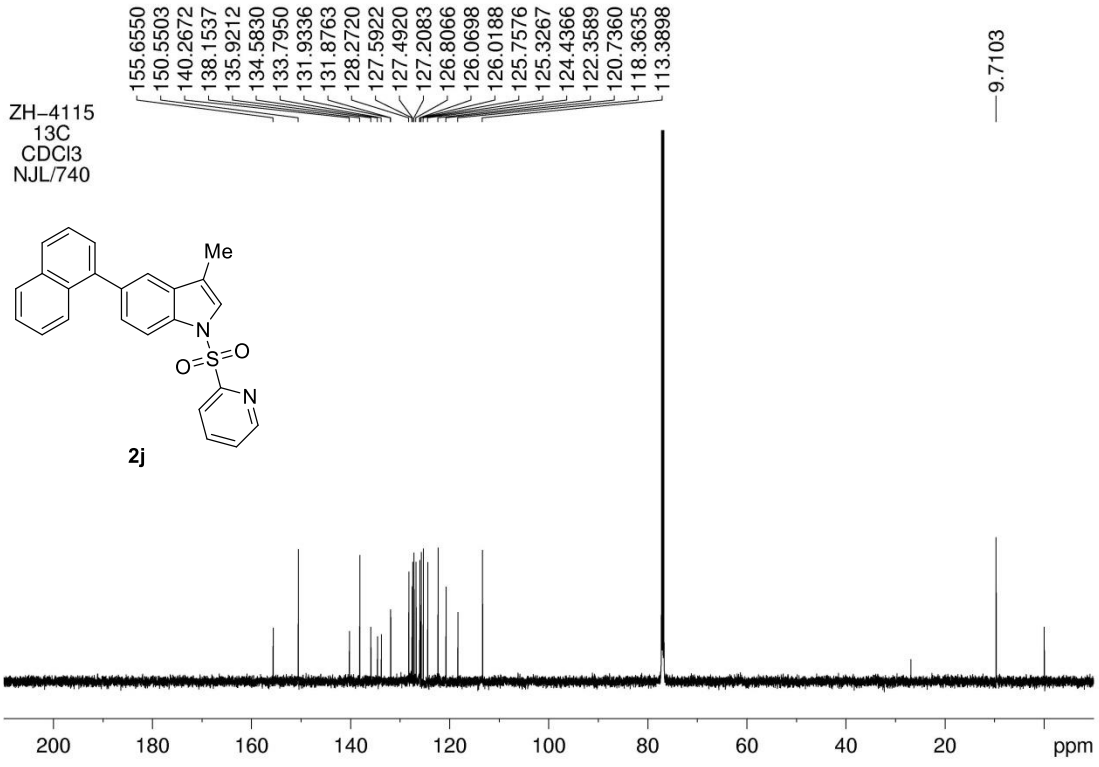
8.0822
8.0681
7.9341
7.9314
7.9212
7.9184
7.9110
7.9054
7.8979
7.8640
7.8514
7.8385
7.5698
7.5679
7.5238
7.5120
7.4982
7.4943
7.4928
7.4830
7.4800
7.4702
7.4353
7.4327
7.4208
7.4188
7.4091
7.3998
7.3974
7.3954
7.3856
7.3839
2.2773
2.2754
ZH–4115
1H
CDCL3
NJL/730
Me
N
O=S=O
N
2j
8.1 8.0 7.9 7.8 7.7 7.6 7.5 ppm
11 10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0185
1.0429
2.0854
2.0827
1.0057
4.1104
3.1161
3.0655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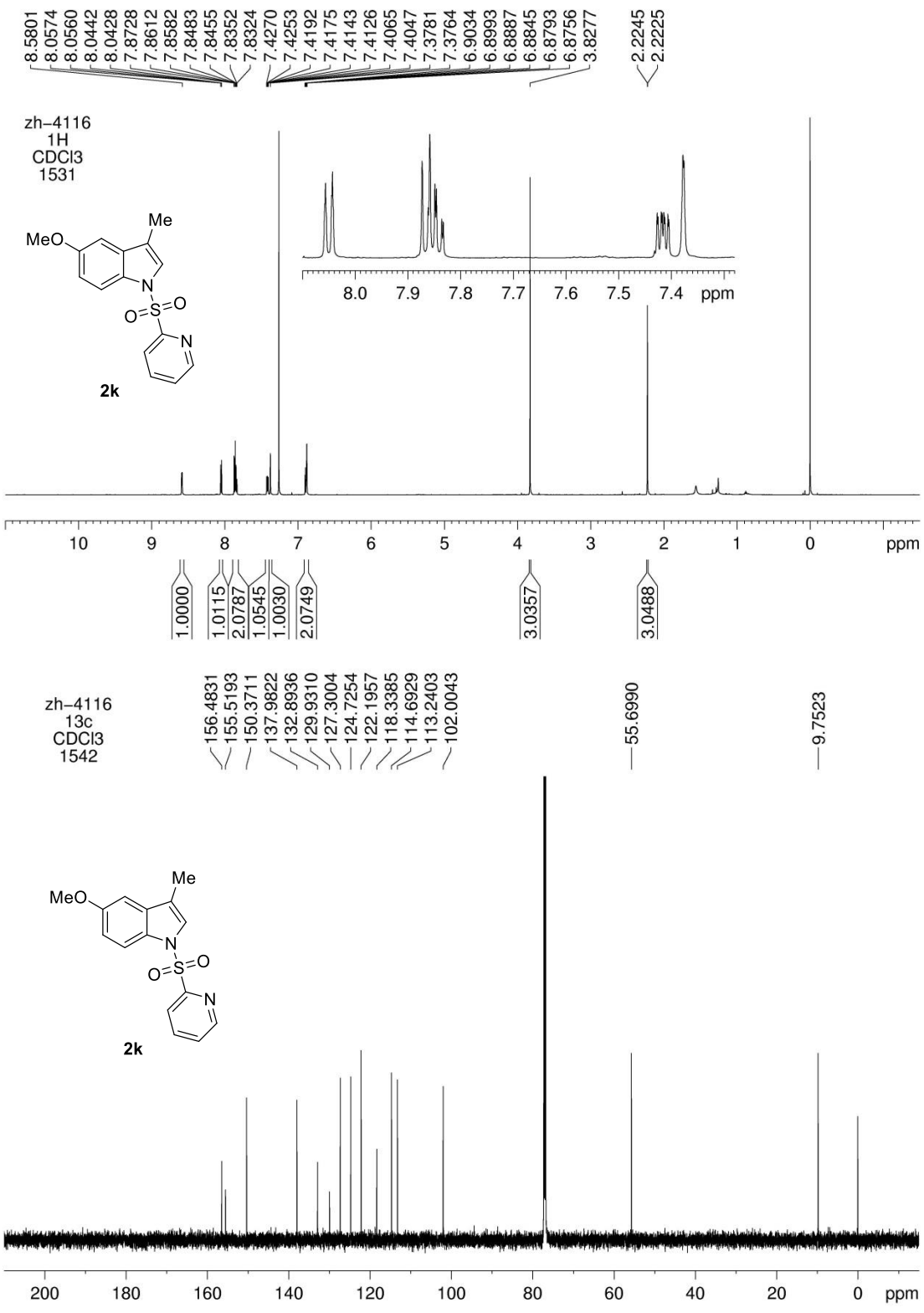
150.5503
140.2672
138.1537
135.9212
134.5830
133.7950
131.9336
131.8763
128.2720
127.5922
127.4920
127.2083
126.8066
126.0698
126.0188
125.7576
125.3267
124.4366
122.3589
120.7360
118.3635
113.3898
9.7103
ZH–4115
13C
CDCl3
NJL/740
Me
N
O=S=O
N
2j
200 180 160 140 120 100 80 60 40 20 ppm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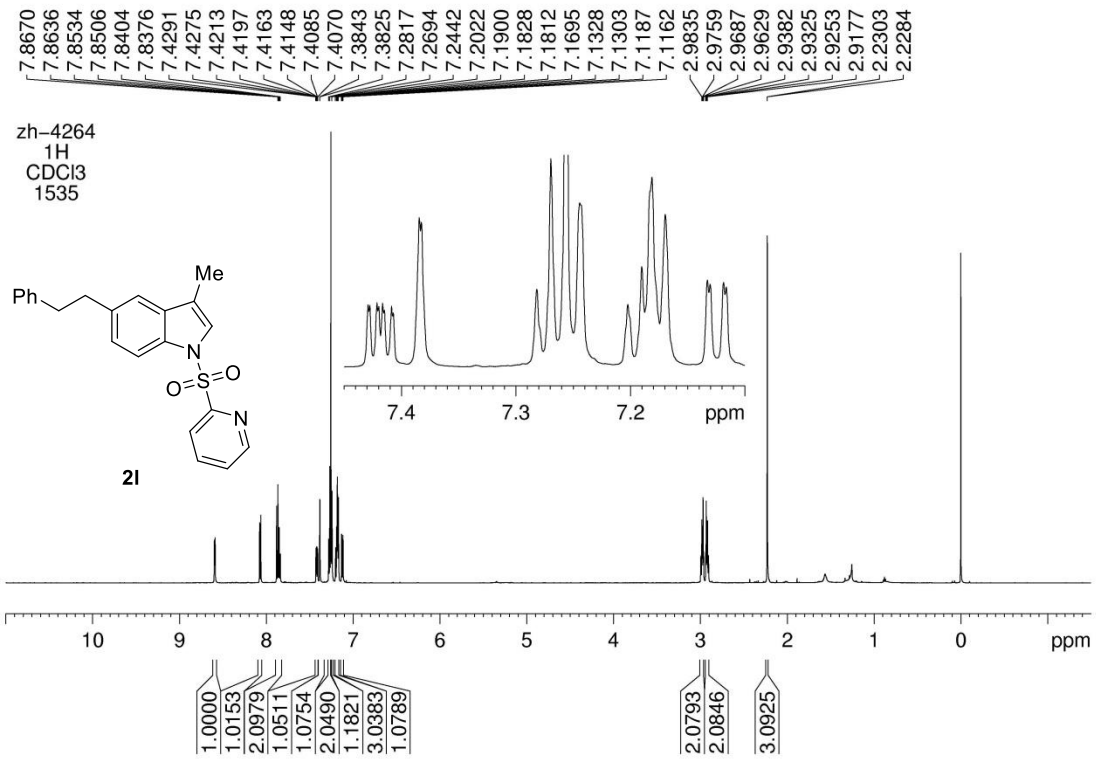
8.0574
8.0560
8.0442
8.0428
7.8728
7.8612
7.8582
7.8483
7.8455
7.8352
7.8324
7.4270
7.4253
7.4192
7.4175
7.4143
7.4126
7.4065
7.4047
7.3781
7.3764
6.9034
6.8993
6.8887
6.8845
6.8793
6.8756
3.8277
2.2245
2.2225
zh–4116
1H
CDCl3
1531
Me
MeO
N
O=S=O
N
2k
8.0
7.9
7.8
7.7
7.6
7.5
7.4
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0115
2.0787
1.0545
1.0030
2.0749
3.0357
3.0488
zh–4116
13c
CDCl3
1542
156.4831
155.5193
150.3711
137.9822
132.8936
129.9310
127.3004
124.7254
122.1957
118.3385
114.6929
113.2403
102.0043
55.6990
9.7523
Me
MeO
N
O=S=O
N
2k
200
180
160
140
120
100
80
60
40
20
0
ppm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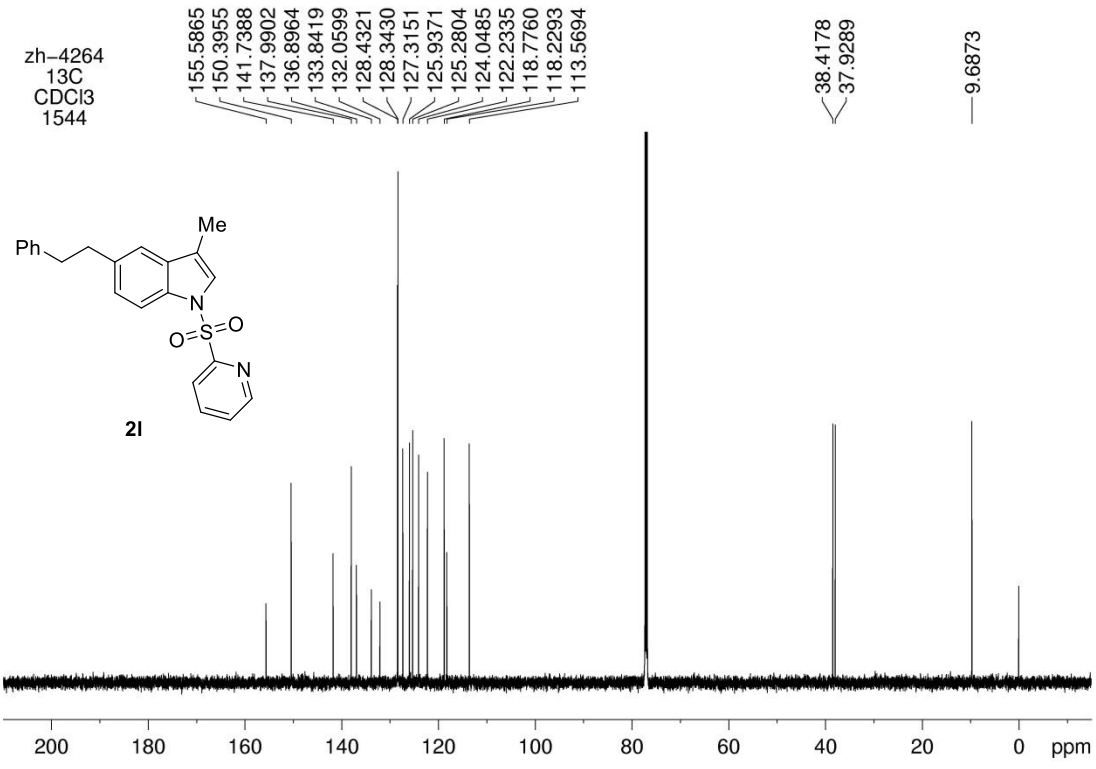
7.8636
7.8534
7.8506
7.8404
7.8376
7.4291
7.4275
7.4213
7.4197
7.4163
7.4148
7.4085
7.4070
7.3843
7.3825
7.2817
7.2694
7.2442
7.2022
7.1900
7.1828
7.1812
7.1695
7.1328
7.1303
7.1187
7.1162
2.9835
2.9759
2.9687
2.9629
2.9382
2.9325
2.9253
2.9177
2.2303
2.2284
zh–4264
1H
CDCl3
1535
Me
Ph
N
S
O
O
N
2l
7.4
7.3
7.2
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0153
2.0979
1.0511
1.0754
2.0490
1.1821
3.0383
1.0789
2.0793
2.0846
3.0925


zh–4264
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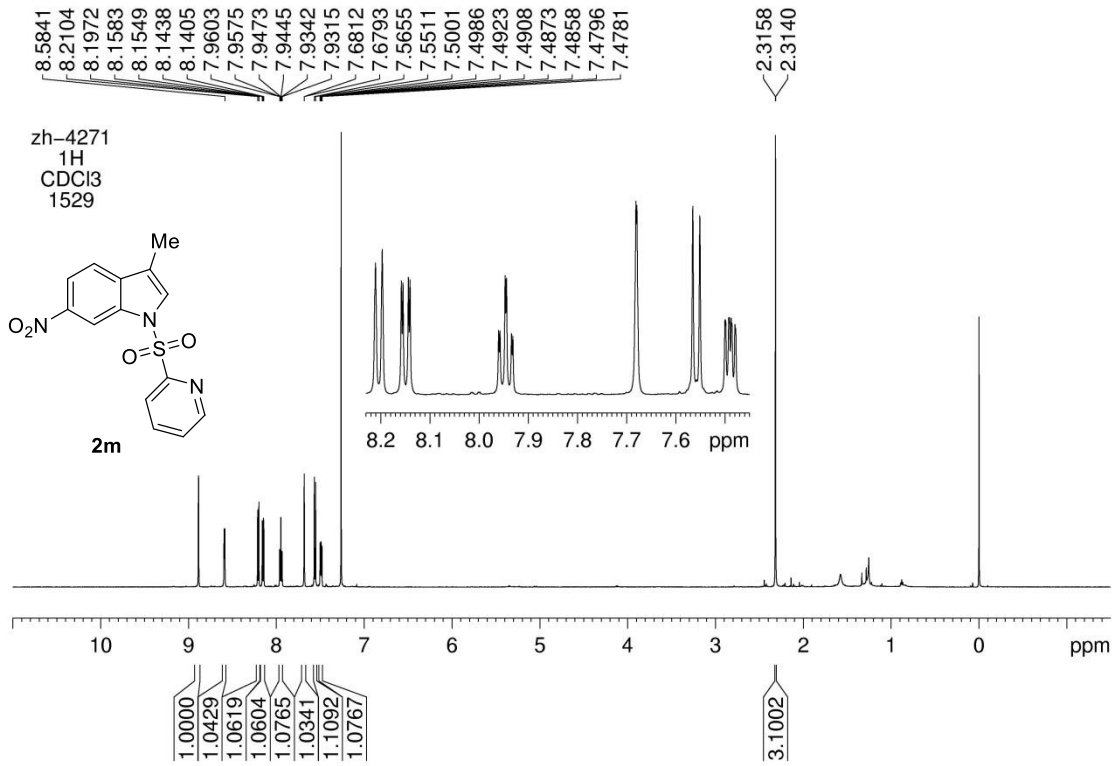
CDCl3
1544
155.5865
150.3955
141.7388
137.9902
136.8964
133.8419
132.0599
128.4321
128.3430
127.3151
125.9371
125.2804
124.0485
122.2335
118.7760
118.2293
113.5694
38.4178
37.9289
9.6873
Me
Ph
N
S
O
O
N
2l
200
180
160
140
120
100
80
60
40
20
0
ppm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8.1972
8.1583
8.1549
8.1438
8.1405
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7.9575
7.9473
7.9445
7.9342
7.9315
7.6812
7.6793
7.5655
7.5511
7.5001
7.4986
7.4923
7.4908
7.4873
7.4858
7.4796
7.4781
2.3158
2.3140
zh–4271
1H
CDCl3
1529
Me
O2N
N
O=S=O
N
2m
8.2 8.1 8.0 7.9 7.8 7.7 7.6 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
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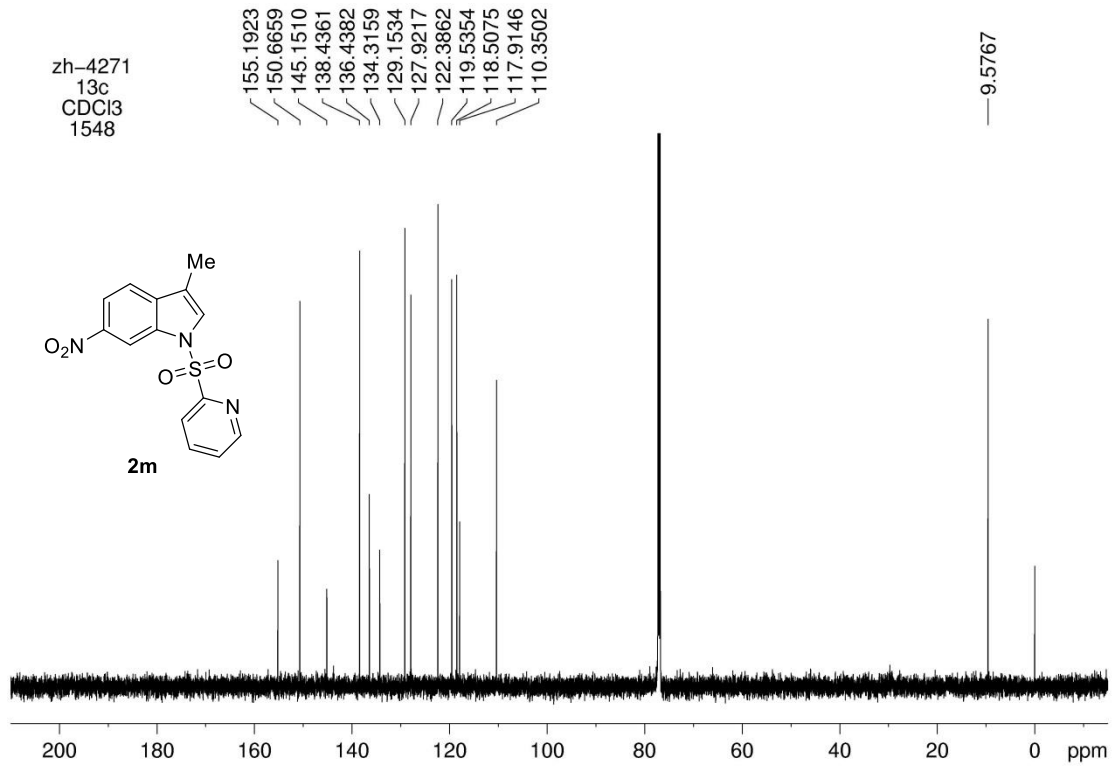
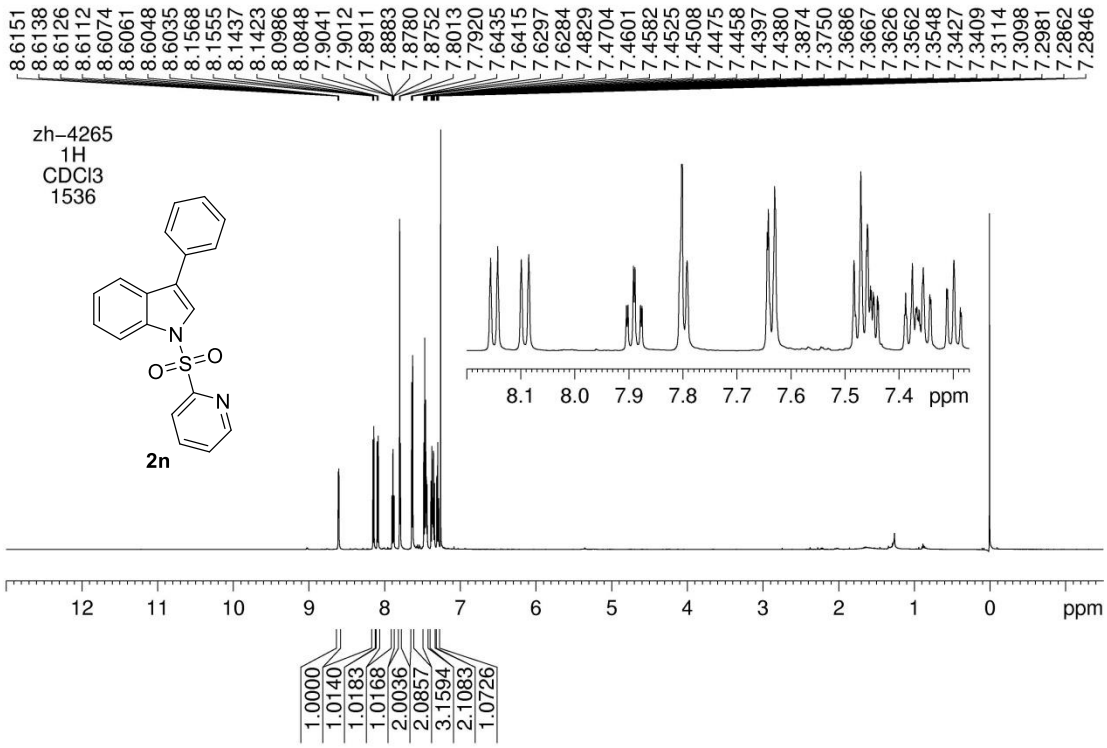
1.0765
1.0341
1.1092
1.0767
3.1002


zh–4271
13c
CDCl3
1548
155.1923
150.6659
145.1510
138.4361
136.4382
134.3159
129.1534
127.9217
122.3862
119.5354
118.5075
117.9146
110.3502
9.5767
Me
O2N
N
O=S=O
N
2m
200 180 160 140 120 100 80 60 40 20 0 ppm


8.6151
8.6138
8.6126
8.6112
8.6074
8.6061
8.6048
8.6035
8.1568
8.1555
8.1437
8.1423
8.0986
8.0848
7.9041
7.9012
7.8911
7.8883
7.8780
7.8752
7.8013
7.7920
7.6435
7.6415
7.6297
7.6284
7.4829
7.4704
7.4601
7.4582
7.4525
7.4508
7.4475
7.4458
7.4397
7.4380
7.3874
7.3750
7.3686
7.3667
7.3626
7.3562
7.3548
7.3427
7.3409
7.3114
7.3098
7.2981
7.2862
7.2846
zh–4265
1H
CDCl3
1536
2n
8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 ppm
12 11 10 9 8 7 6 5 4 3 2 1 0 ppm
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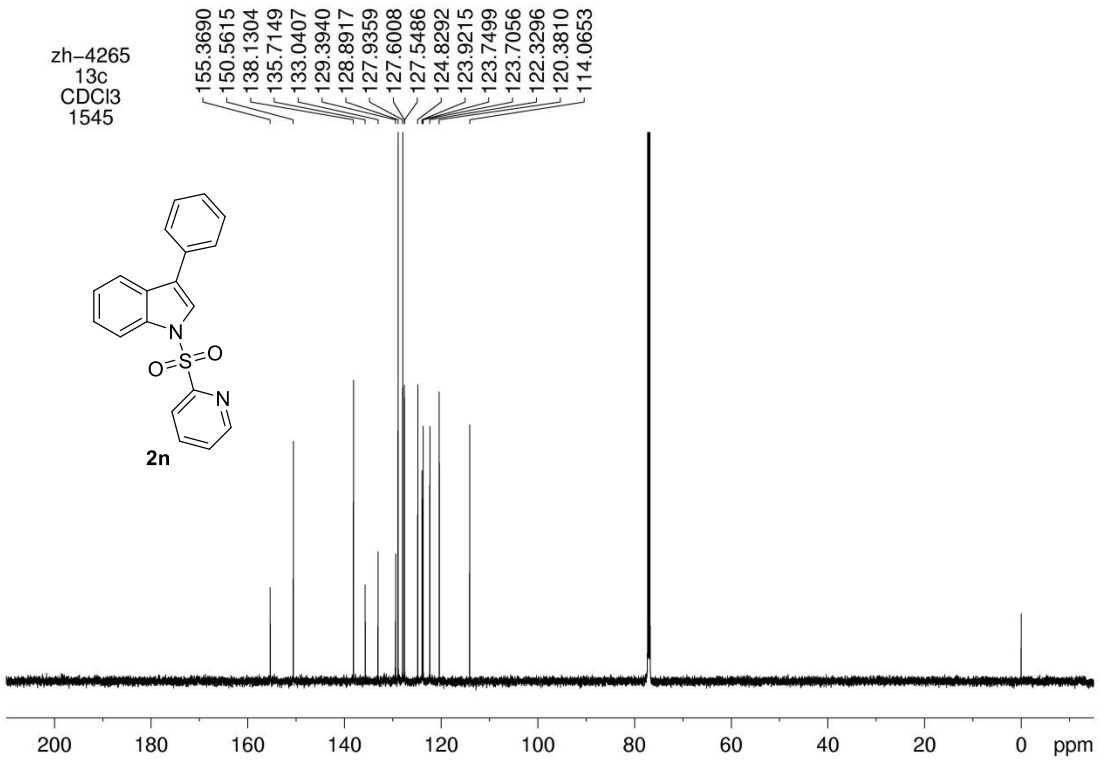
1.0140
1.0183
1.0168
2.0036
2.0857
3.1594
2.1083
1.0726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123.9215
123.7499
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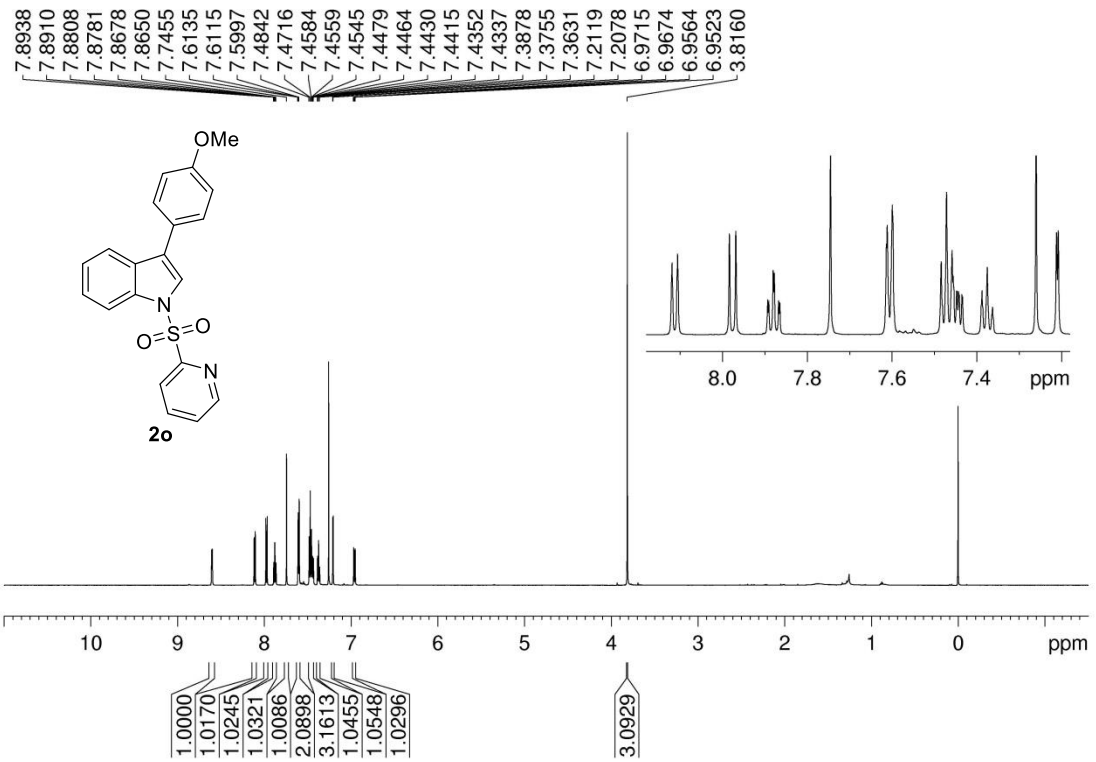
120.3810
114.0653
zh–4265
13c
CDCl3
1545
2n
200 180 160 140 120 100 80 60 40 20 0 ppm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7.8678
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7.7455
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7.6115
7.5997
7.4842
7.4716
7.4584
7.4559
7.4545
7.4479
7.4464
7.4430
7.4415
7.4352
7.4337
7.3878
7.3755
7.3631
7.2119
7.2078
6.9715
6.9674
6.9564
6.9523
3.8160
OMe
N
O=S=O
N
2o
8.0
7.8
7.6
7.4
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
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1.0321
1.0086
2.0898
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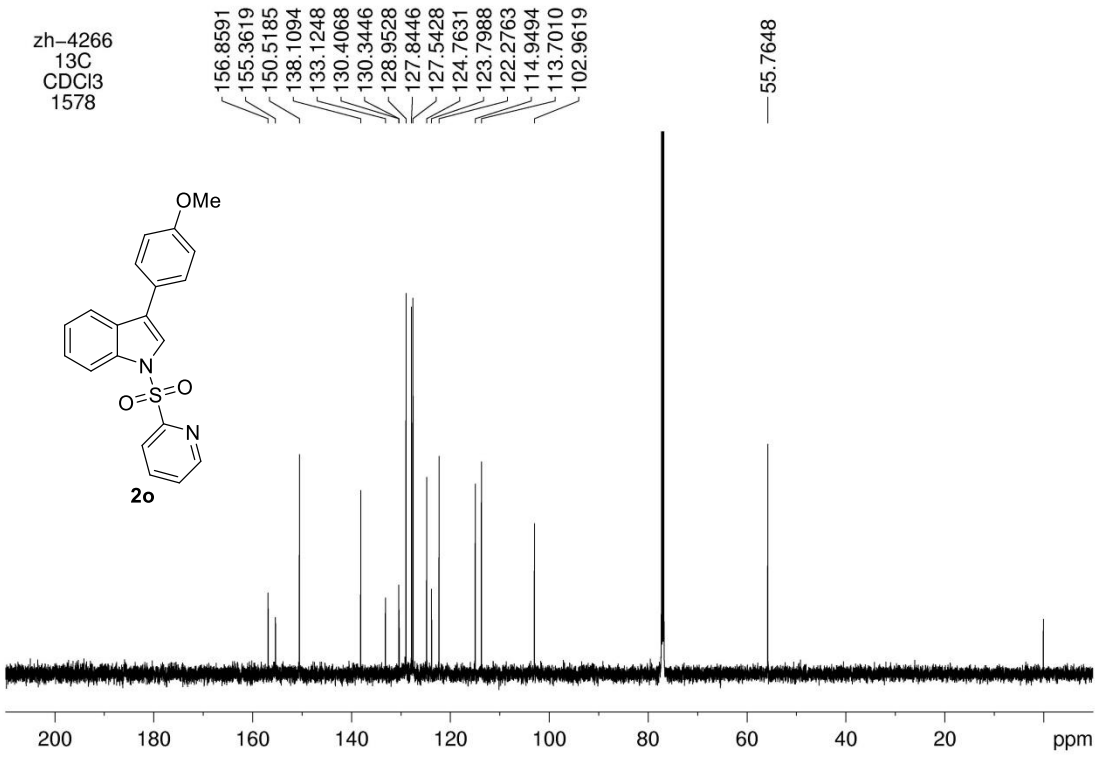
1.0455
1.0548
1.0296
3.0929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CDCl3
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127.8446
127.5428
124.7631
123.7988
122.2763
114.9494
113.7010
102.9619
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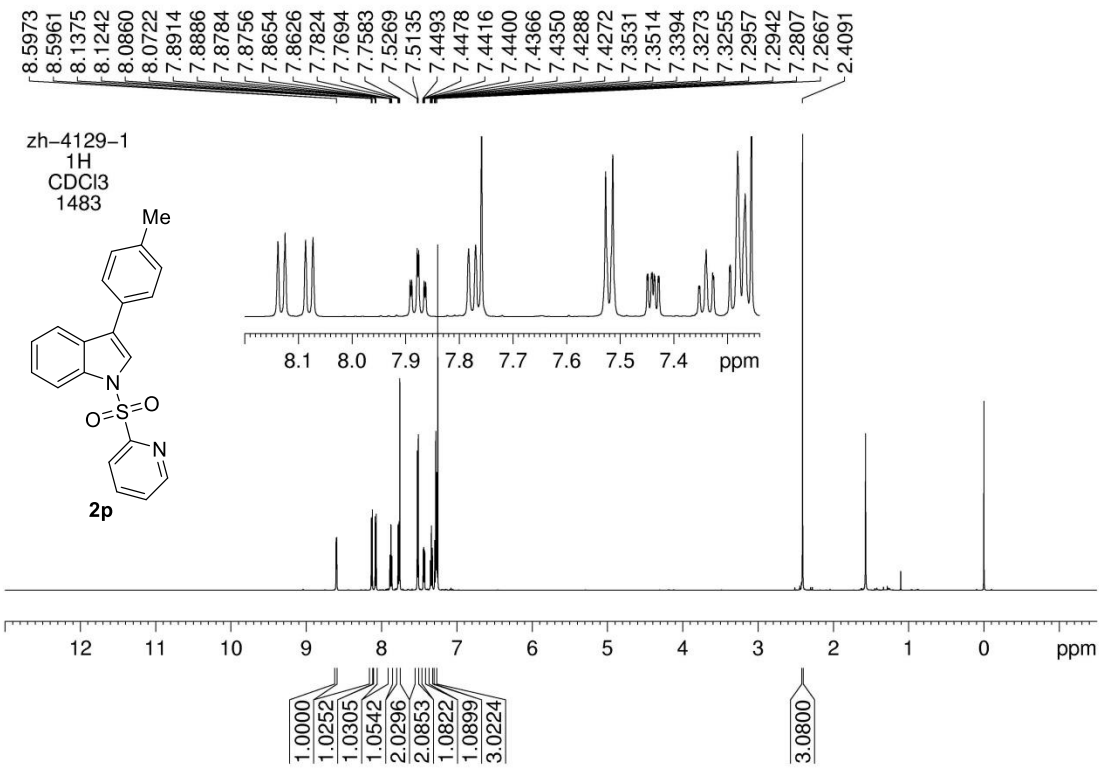
OMe
N
O=S=O
N
2o
200
180
160
140
120
100
80
60
40
20
ppm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7.8914
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7.8784
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7.8654
7.8626
7.7824
7.7694
7.7583
7.5269
7.5135
7.4493
7.4478
7.4416
7.4400
7.4366
7.4350
7.4288
7.4272
7.3531
7.3514
7.3394
7.3273
7.3255
7.2957
7.2942
7.2807
7.2667
2.4091
zh–4129–1
1H
CDCl3
1483
Me
N
S
O
O
N
2p
8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 ppm
12 11 10 9 8 7 6 5 4 3 2 1 0 ppm
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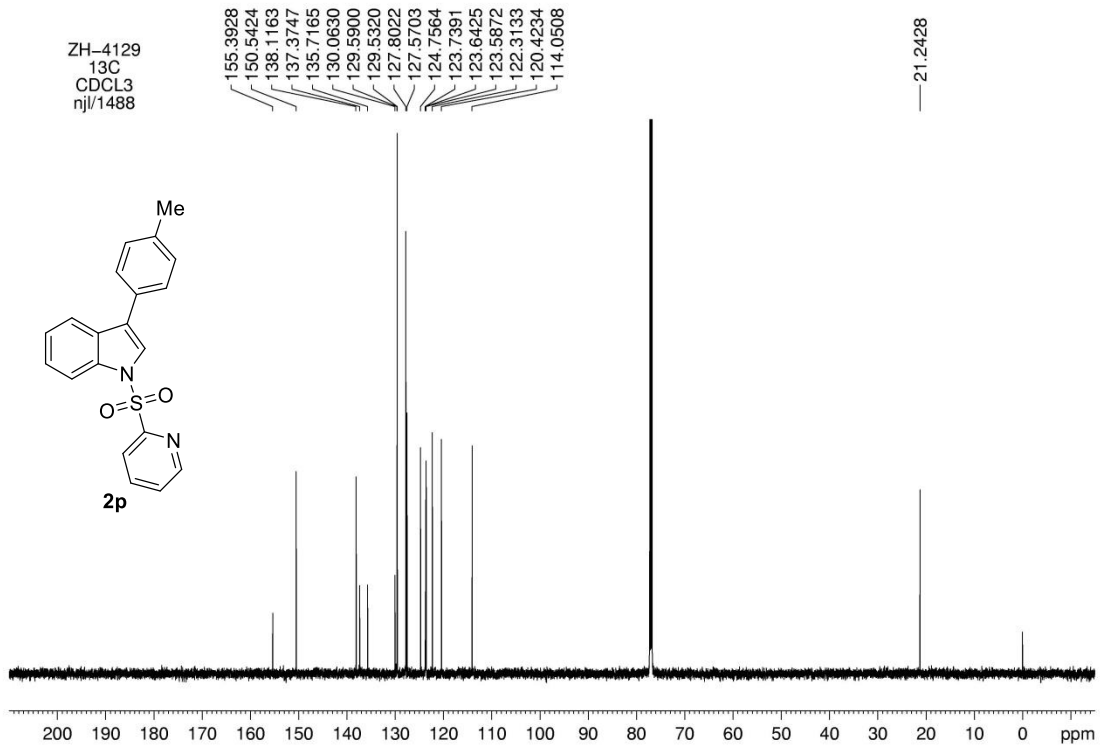
1.0305
1.0542
2.0296
2.0853
1.0822
1.0899
3.0224
3.0800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njl/1488
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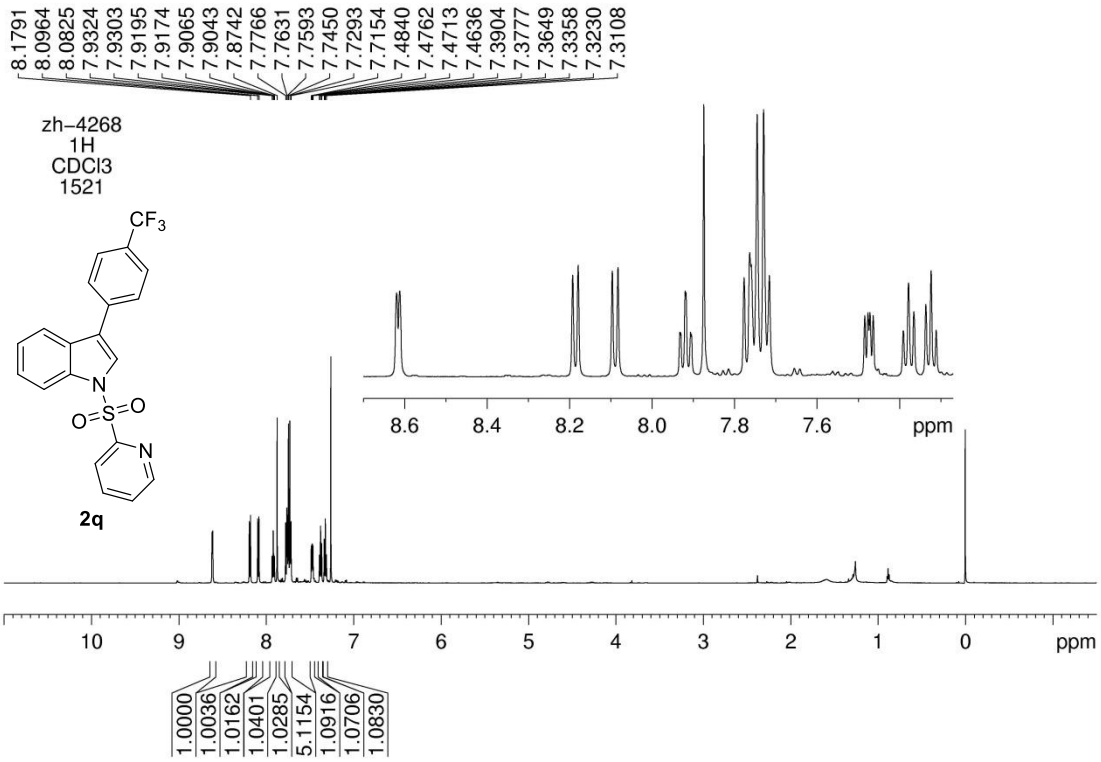
129.5900
129.5320
127.8022
127.5703
124.7564
123.7391
123.6425
123.5872
122.3133
120.4234
114.0508
21.2428
Me
N
S
O
O
N
2p
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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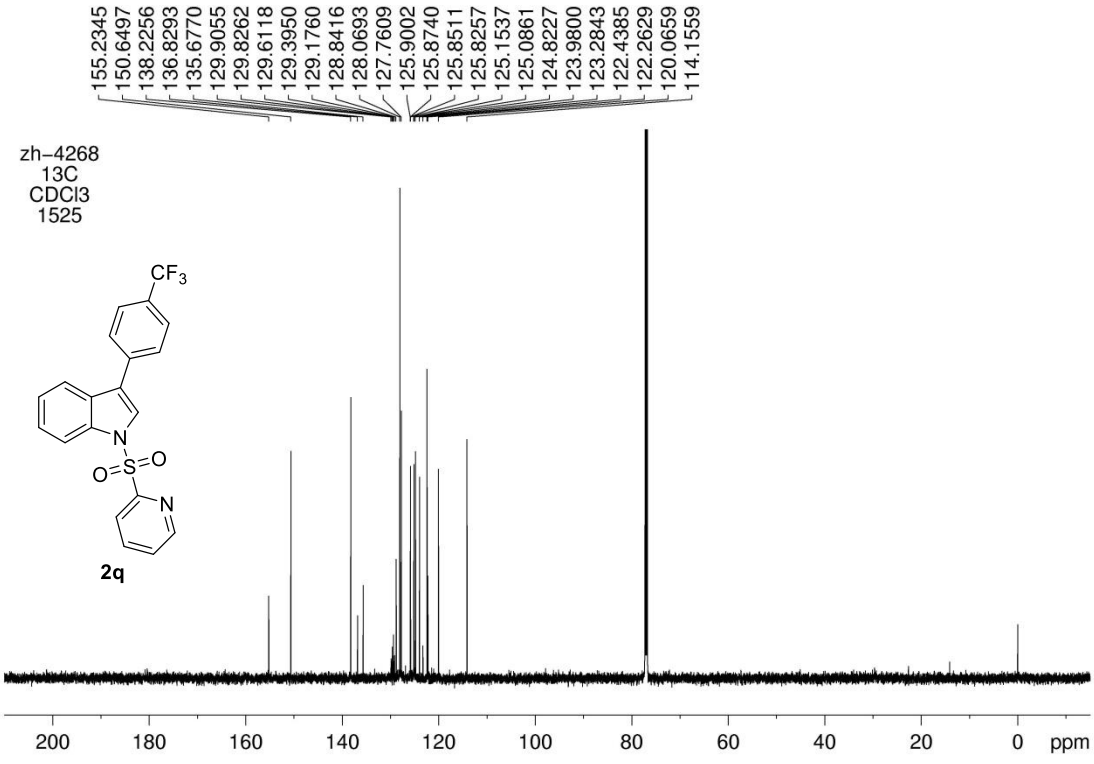
7.9043
7.8742
7.7766
7.7631
7.7593
7.7450
7.7293
7.7154
7.4840
7.4762
7.4713
7.4636
7.3904
7.3777
7.3649
7.3358
7.3230
7.3108
zh–4268
1H
CDCl3
1521
CF3
N
S
O
O
N
2q
8.6
8.4
8.2
8.0
7.8
7.6
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0036
1.0162
1.0401
1.0285
5.1154
1.0916
1.0706
1.0830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150.6497
138.2256
136.8293
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129.8262
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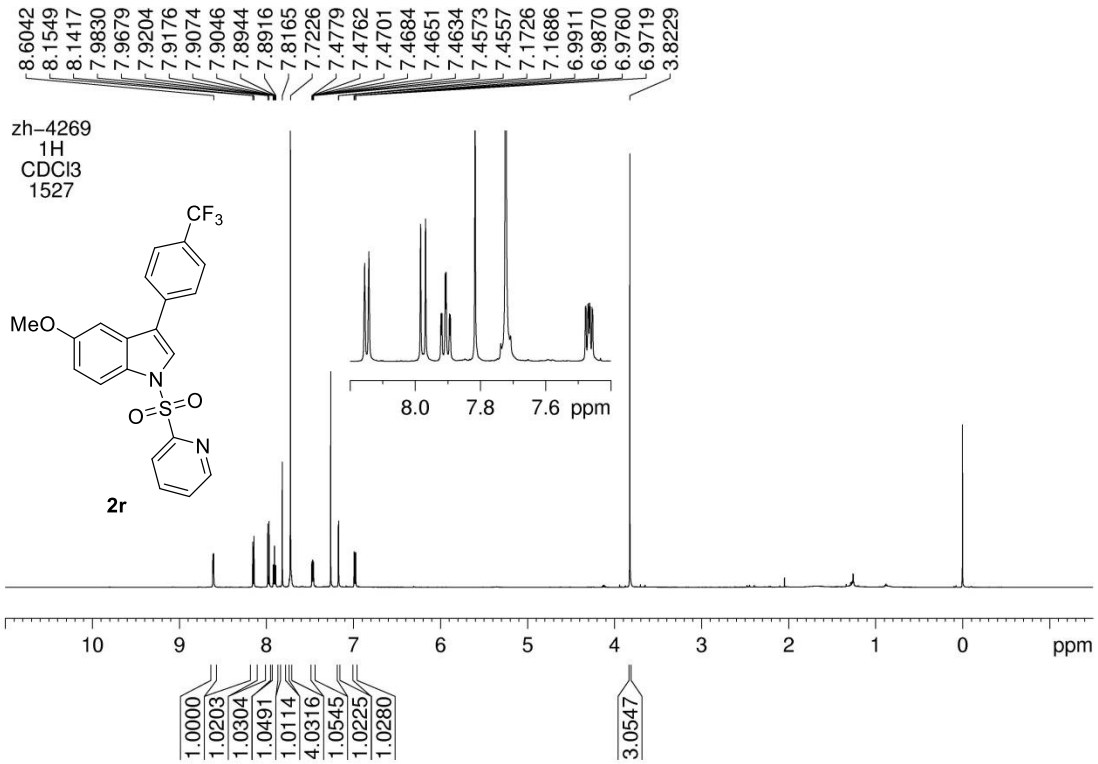
129.3950
129.1760
128.8416
128.0693
127.7609
125.9002
125.8740
125.8511
125.8257
125.1537
125.0861
124.8227
123.9800
123.2843
122.4385
122.2629
120.0659
114.1559
zh–4268
13C
CDCl3
1525
CF3
N
S
O
O
N
2q
200
180
160
140
120
100
80
60
40
20
0
ppm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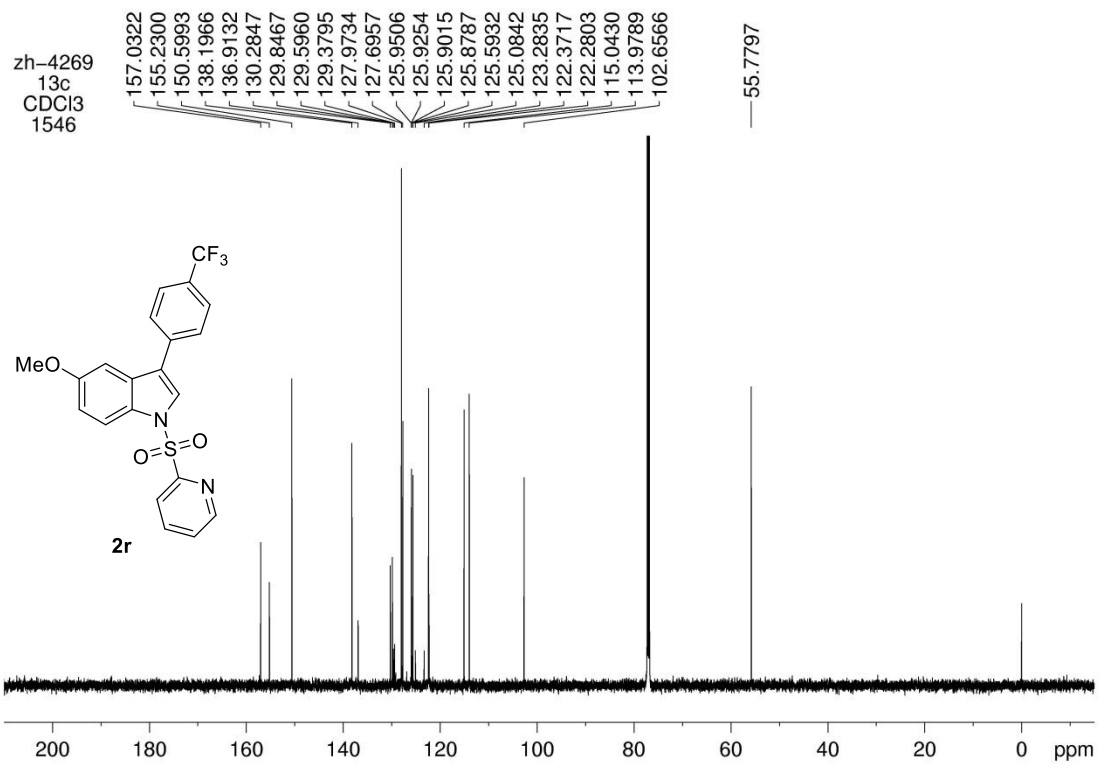
8.1549
8.1417
7.9830
7.9679
7.9204
7.9176
7.9074
7.9046
7.8944
7.8916
7.8165
7.7226
7.4779
7.4762
7.4701
7.4684
7.4651
7.4634
7.4573
7.4557
7.1726
7.1686
6.9911
6.9870
6.9760
6.9719
3.8229
zh–4269
1H
CDCl3
1527
CF3
MeO
N
O=S=O
N
2r
8.0
7.8
7.6 ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
1.0203
1.0304
1.0491
1.0114
4.0316
1.0545
1.0225
1.0280
3.0547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129.8467
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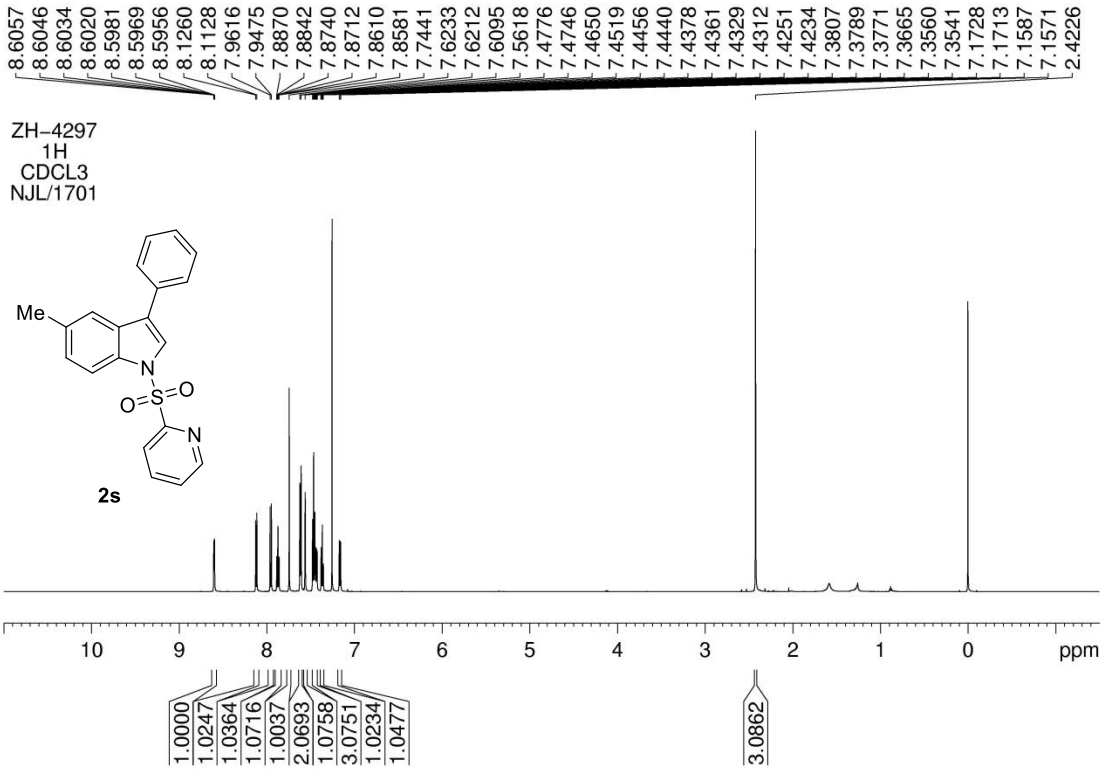
127.6957
125.9506
125.9254
125.9015
125.8787
125.5932
125.0842
123.2835
122.3717
122.2803
115.0430
113.9789
102.6566
55.7797
zh–4269
13c
CDCl3
1546
CF3
MeO
N
O=S=O
N
2r
200
180
160
140
120
100
80
60
40
20
0
ppm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8.1128
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7.9475
7.8870
7.8842
7.8740
7.8712
7.8610
7.8581
7.7441
7.6233
7.6212
7.6095
7.5618
7.4776
7.4746
7.4650
7.4519
7.4456
7.4440
7.4378
7.4361
7.4329
7.4312
7.4251
7.4234
7.3807
7.3789
7.3771
7.3665
7.3560
7.3541
7.1728
7.1713
7.1587
7.1571
2.4226
ZH-4297
1H
CDCL3
NJL/1701
Me
N
O=S=O
N
2s
10
9
8
7
6
5
4
3
2
1
0
ppm
1.0000
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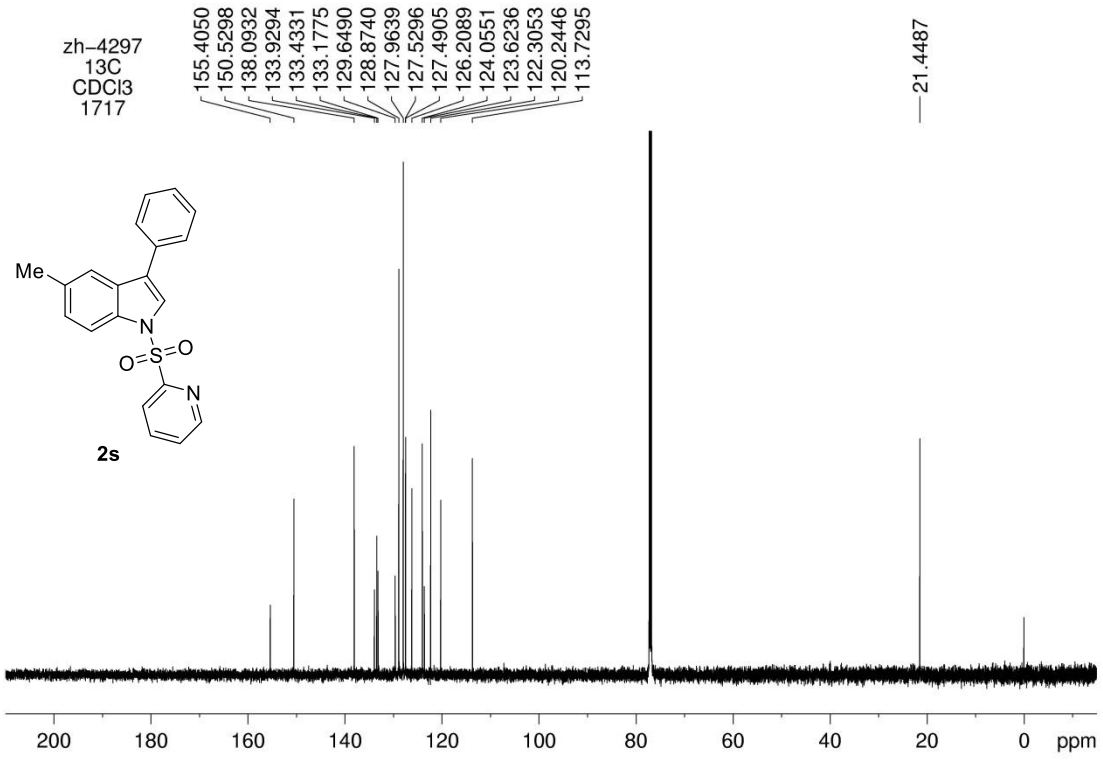
1.0716
1.0037
2.0693
1.0758
3.0751
1.0234
1.0477
3.0862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CDCl3
1717
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133.1775
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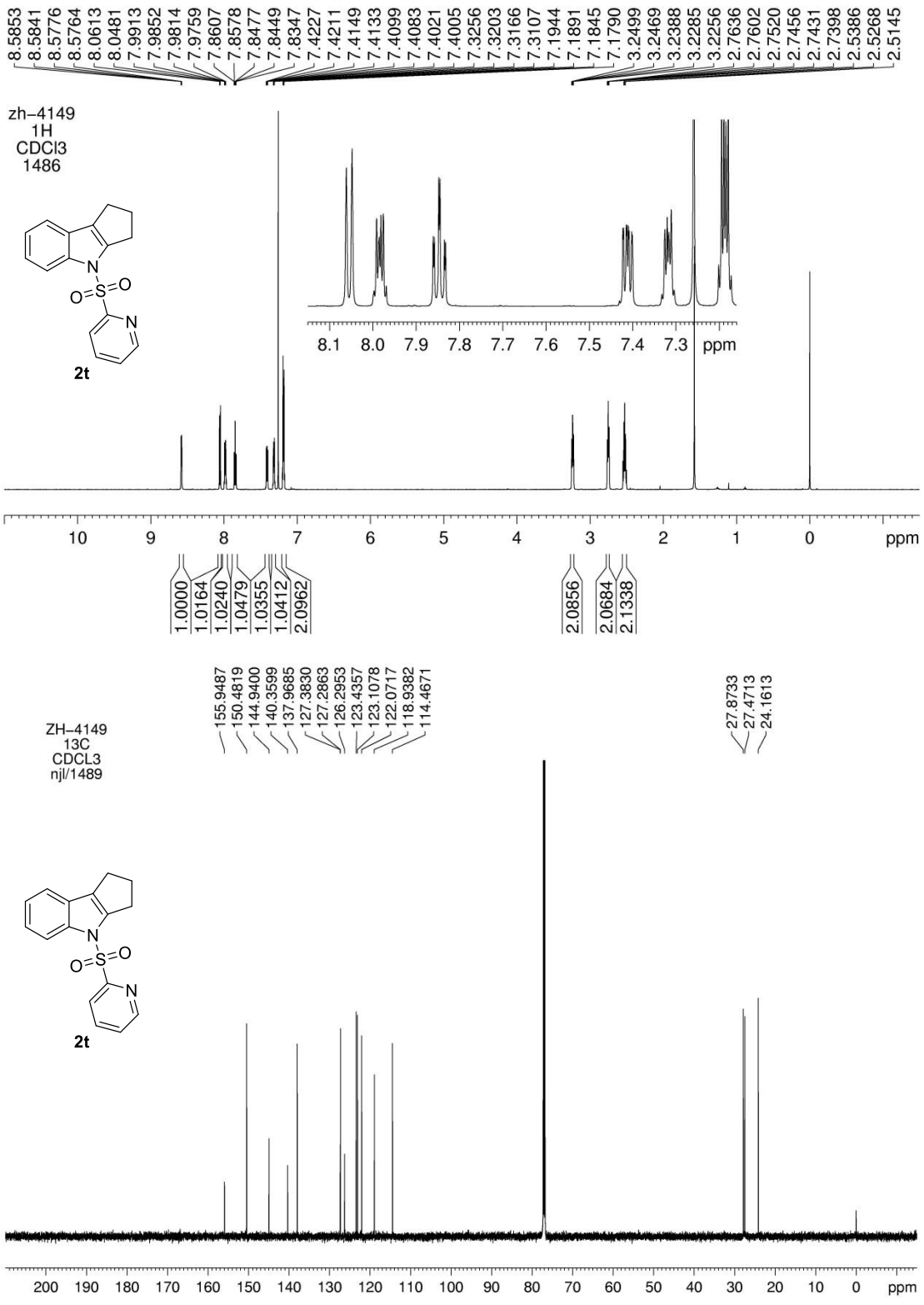
128.8740
127.9639
127.5296
127.4905
126.2089
124.0551
123.6236
122.3053
120.2446
113.7295
21.4487
Me
N
O=S=O
N
2s
200
180
160
140
120
100
80
60
40
20
0
ppm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7.9814
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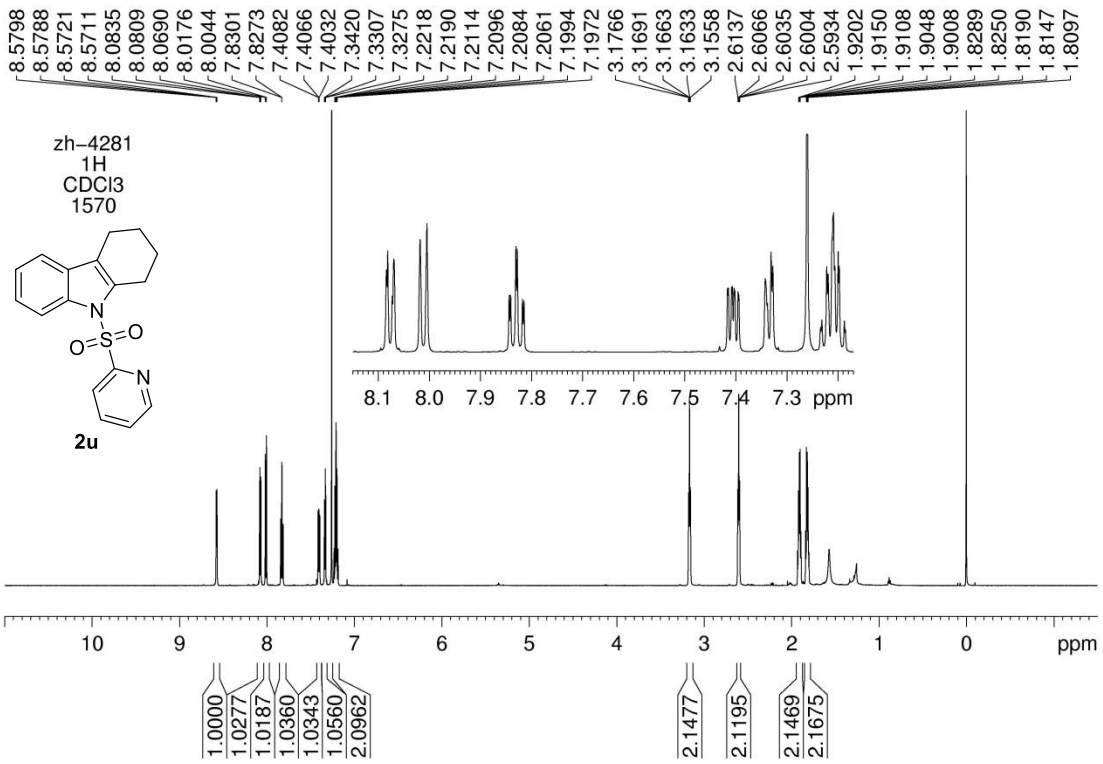
7.8607
7.8578
7.8477
7.8449
7.8347
7.4227
7.4211
7.4149
7.4133
7.4099
7.4083
7.4021
7.4005
7.3256
7.3203
7.3166
7.3107
7.1944
7.1891
7.1845
7.1790
3.2499
3.2469
3.2388
3.2285
3.2256
2.7636
2.7602
2.7520
2.7456
2.7431
2.7398
2.5386
2.5268
2.5145
zh–4149
1H
CDCl3
1486
2t
8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 7.3 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
1.0164
1.0240
1.0479
1.0355
1.0412
2.0962
2.0856
2.0684
2.1338
155.9487
150.4819
144.9400
140.3599
137.9685
127.3830
127.2863
126.2953
123.4357
123.1078
122.0717
118.9382
114.4671
27.8733
27.4713
24.1613
ZH–4149
13C
CDCL3
njl/1489
2t
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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7.4082
7.4066
7.4032
7.3420
7.3307
7.3275
7.2218
7.2190
7.2114
7.2096
7.2084
7.2061
7.1994
7.1972
3.1766
3.1691
3.1663
3.1633
3.1558
2.6137
2.6066
2.6035
2.6004
2.5934
1.9202
1.9150
1.9108
1.9048
1.9008
1.8289
1.8250
1.8190
1.8147
1.8097
zh–4281
1H
CDCl3
1570
2u
8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 7.3 ppm
10 9 8 7 6 5 4 3 2 1 0 ppm
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1.0360
1.0343
1.0560
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2.1477
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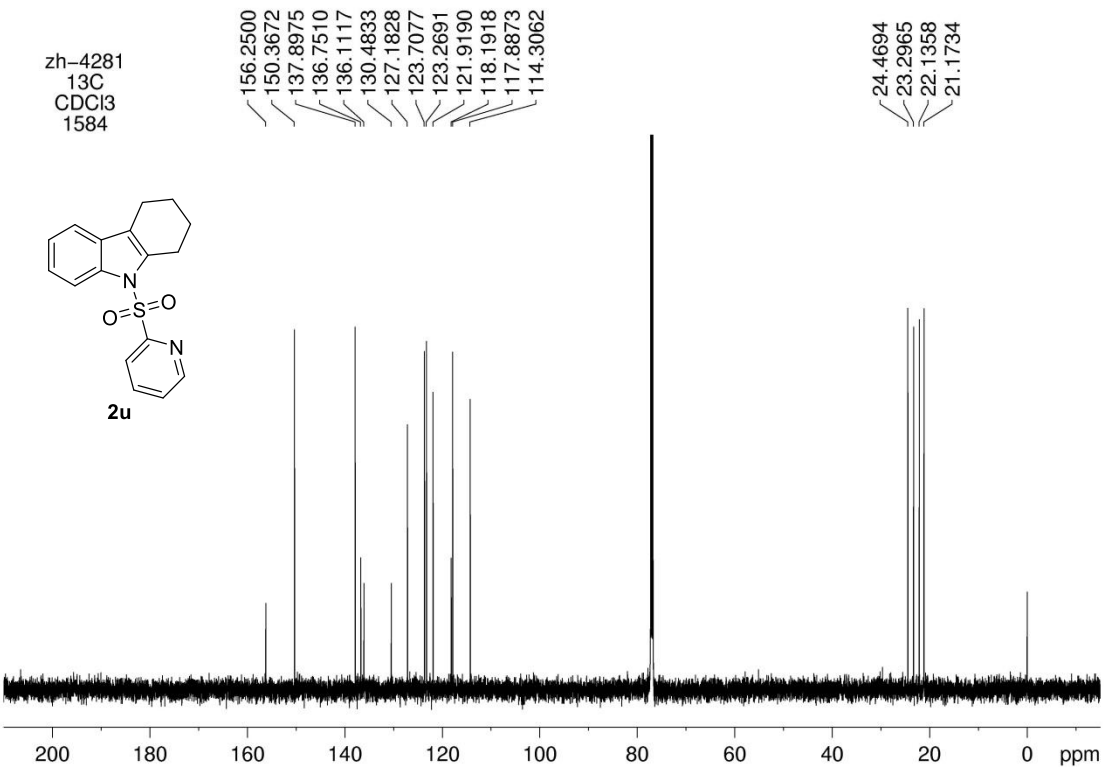
2.1675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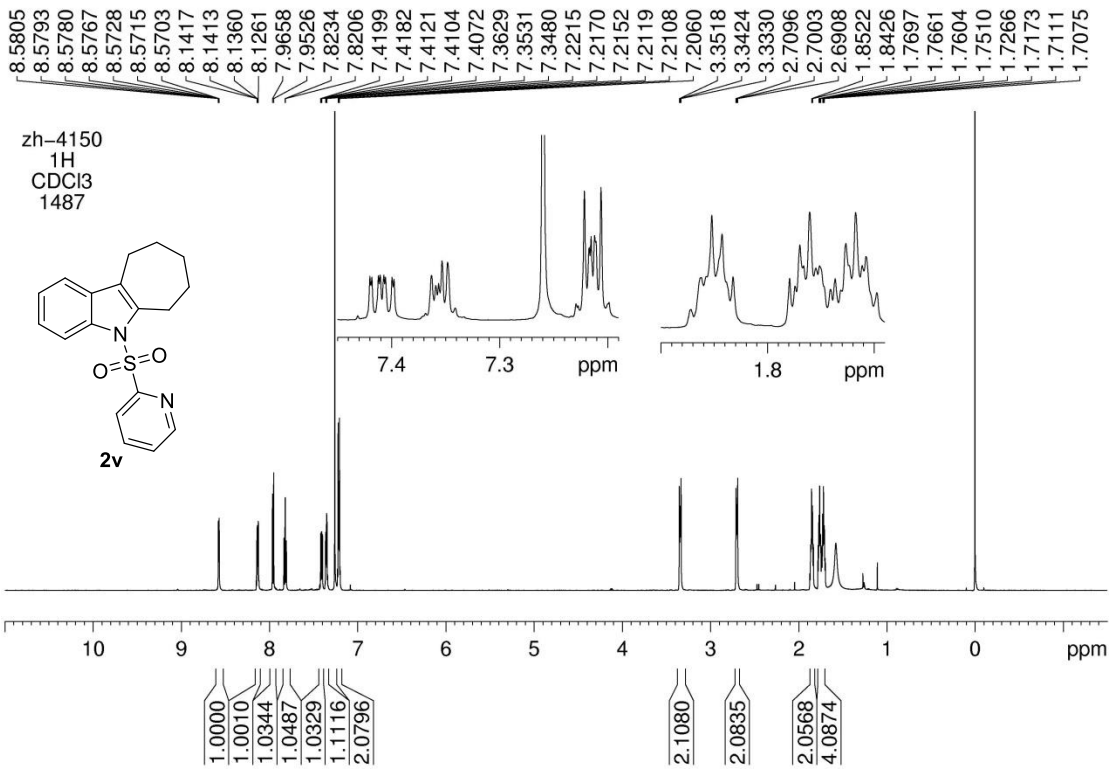
118.1918
117.8873
114.3062
24.4694
23.2965
22.1358
21.1734
zh–4281
13C
CDCl3
1584
2u
200 180 160 140 120 100 80 60 40 20 0 ppm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8.1413
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7.9658
7.9526
7.8234
7.8206
7.4199
7.4182
7.4121
7.4104
7.4072
7.3629
7.3531
7.3480
7.2215
7.2170
7.2152
7.2119
7.2108
7.2060
3.3518
3.3424
3.3330
2.7096
2.7003
2.6908
1.8522
1.8426
1.7697
1.7661
1.7604
1.7510
1.7266
1.7173
1.7111
1.7075
zh–4150
1H
CDCl3
1487
2v
7.4
7.3
ppm
1.8
ppm
10
9
8
7
6
5
4
3
2
1
0
ppm
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1.0487
1.0329
1.1116
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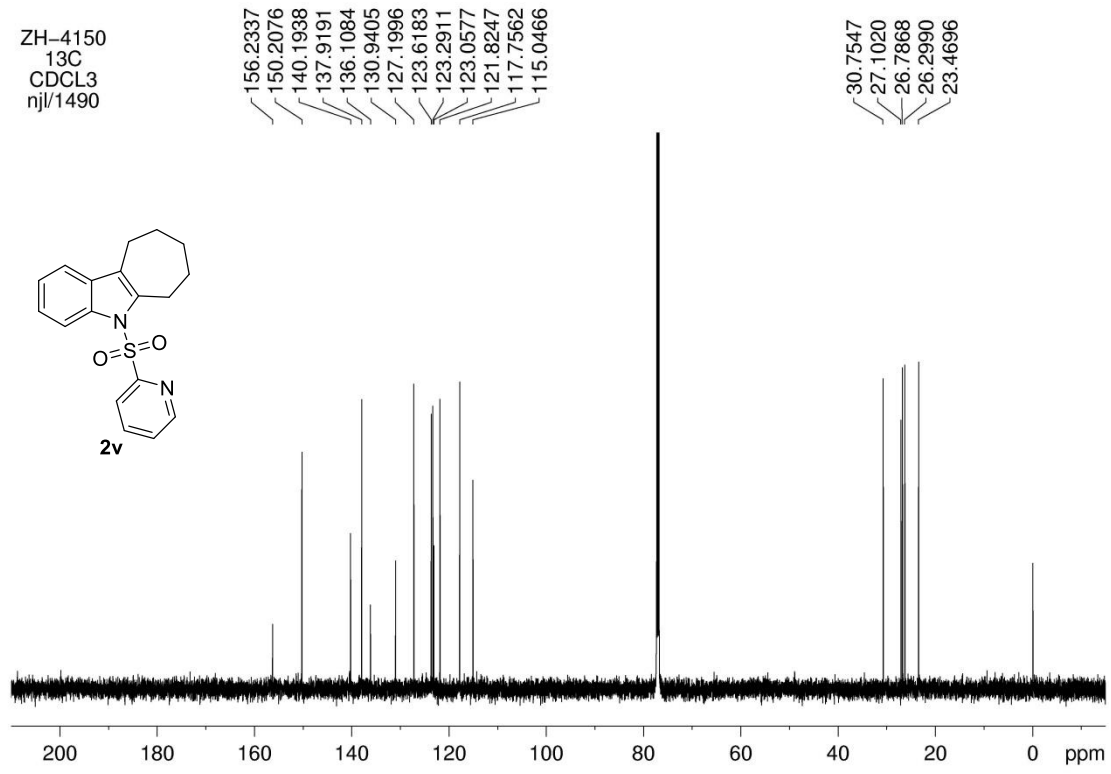
2.1080
2.0835
2.0568
4.0874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njl/1490
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123.0577
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115.0466
30.7547
27.1020
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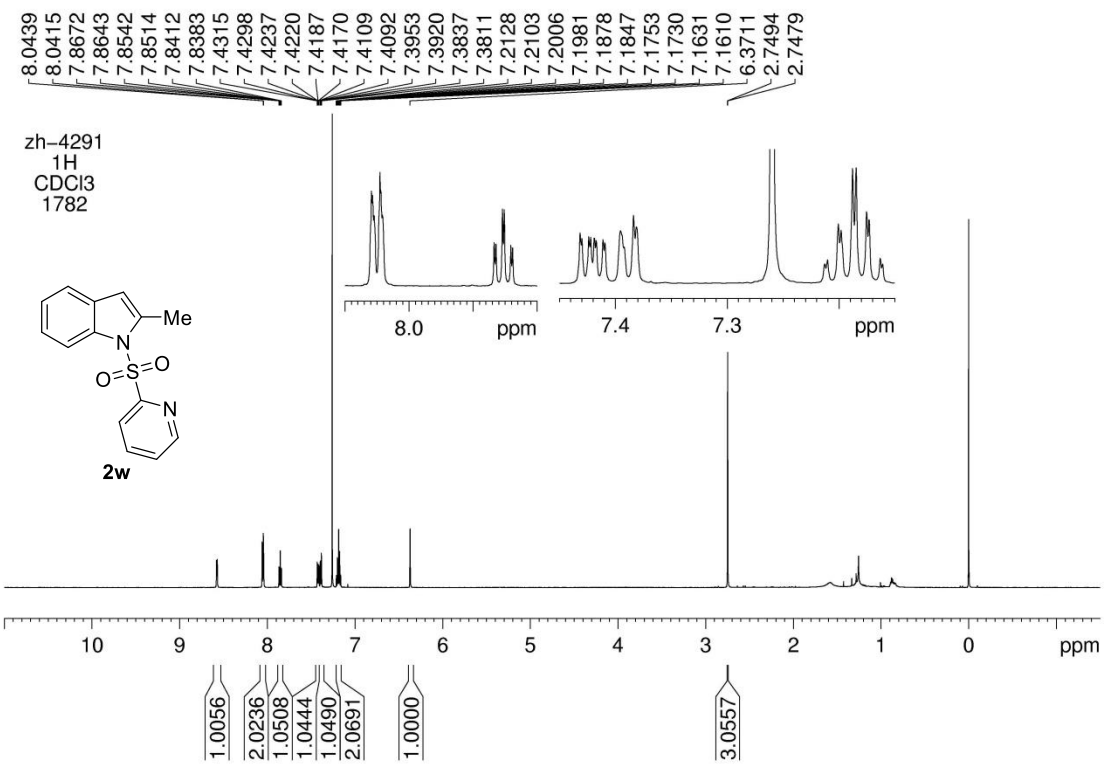
23.4696
2v
200
180
160
140
120
100
80
60
40
20
0
ppm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7.4237
7.4220
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7.4170
7.4109
7.4092
7.3953
7.3920
7.3837
7.3811
7.2128
7.2103
7.2006
7.1981
7.1878
7.1847
7.1753
7.1730
7.1631
7.1610
6.3711
2.7494
2.7479
zh–4291
1H
CDCl3
1782
Me
N
O=S=O
N
2w
8.0
ppm
7.4
7.3
ppm
10
9
8
7
6
5
4
3
2
1
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ppm
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1.0490
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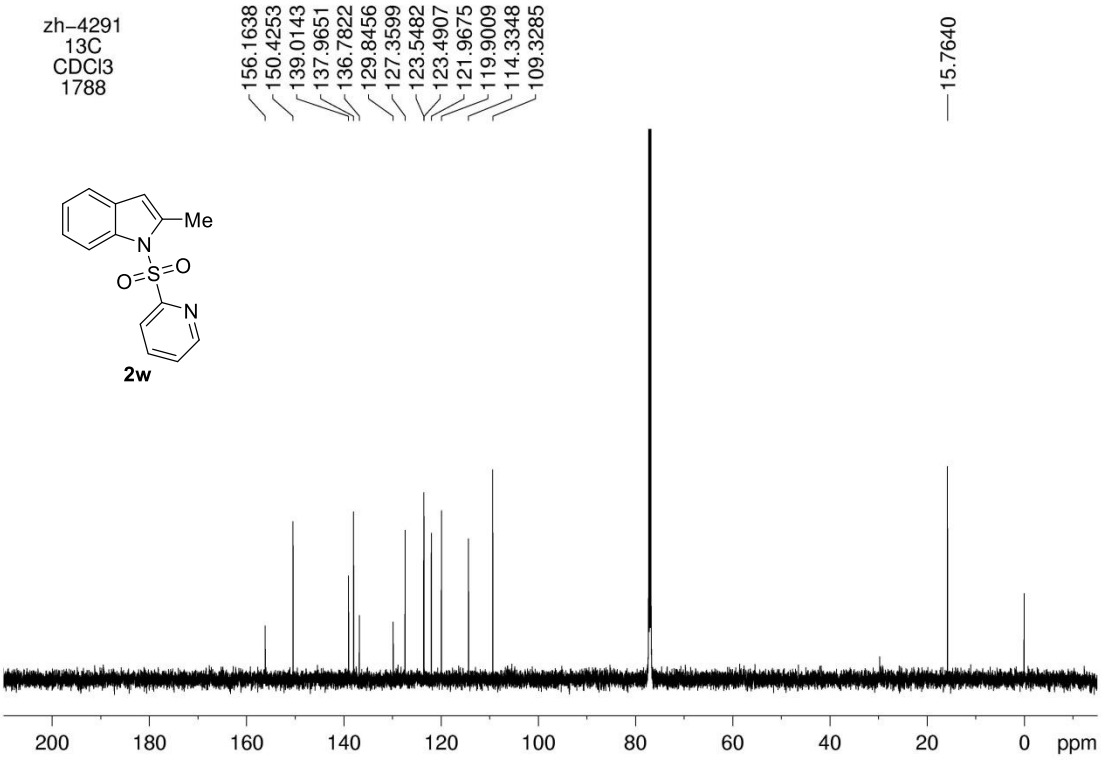
3.0557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129.8456
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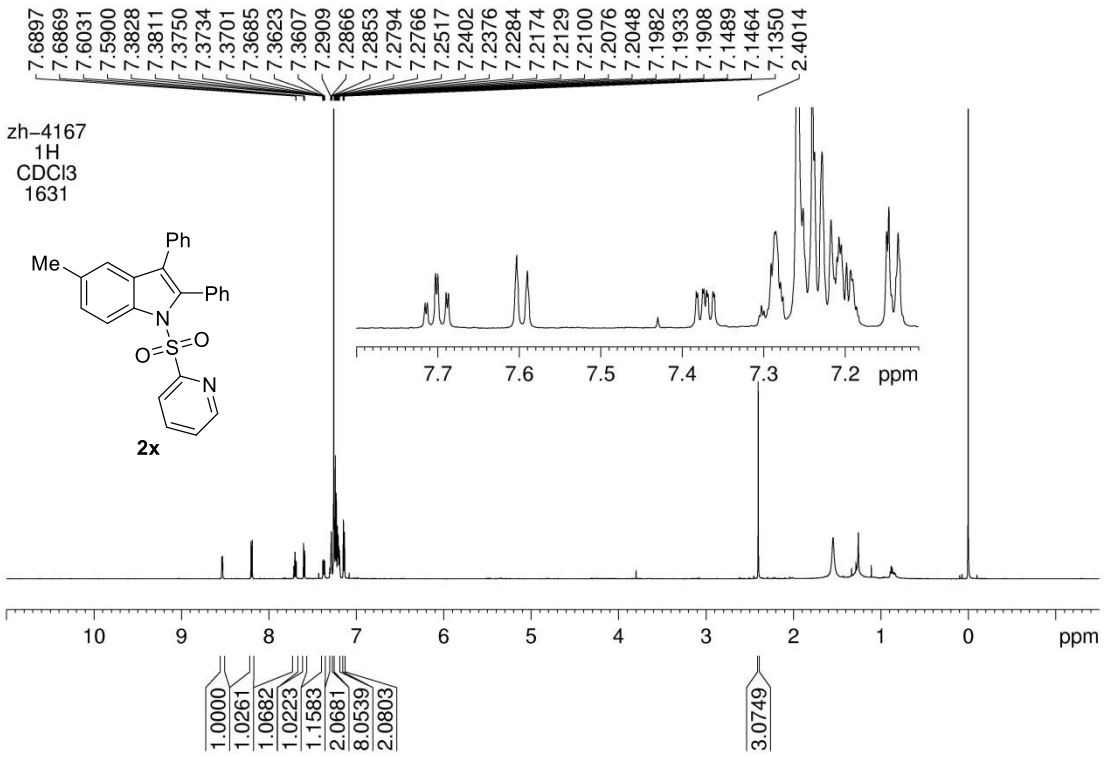
121.9675
119.9009
114.3348
109.3285
15.7640
Me
N
O=S=O
N
2w
200
180
160
140
120
100
80
60
40
20
0
ppm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7.5900
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7.3623
7.3607
7.2909
7.2866
7.2853
7.2794
7.2766
7.2517
7.2402
7.2376
7.2284
7.2174
7.2129
7.2100
7.2076
7.2048
7.1982
7.1933
7.1908
7.1489
7.1464
7.1350
2.4014
zh–4167
1H
CDCl3
1631
Ph
Me
Ph
N
O=S=O
N
2x
7.7
7.6
7.5
7.4
7.3
7.2
ppm
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9
8
7
6
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4
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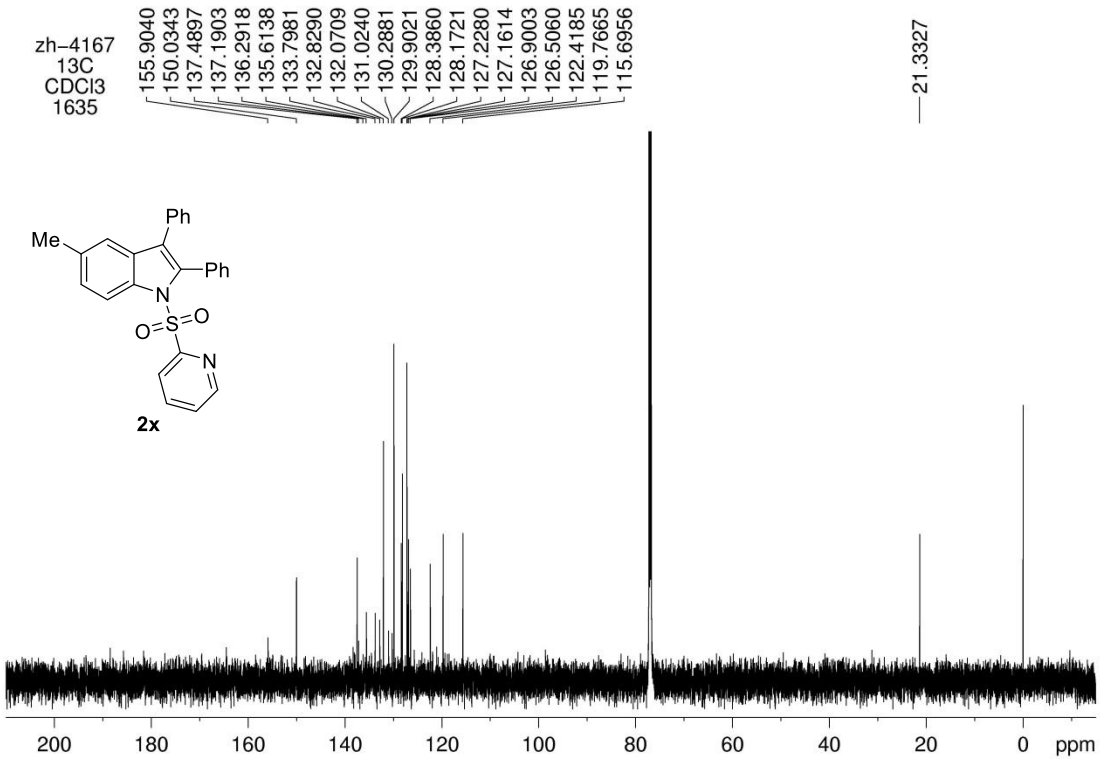
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128.3860
128.1721
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127.1614
126.9003
126.5060
122.4185
119.7665
115.6956
21.3327
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Me
Ph
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O=S=O
N
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200
180
160
140
120
100
80
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0
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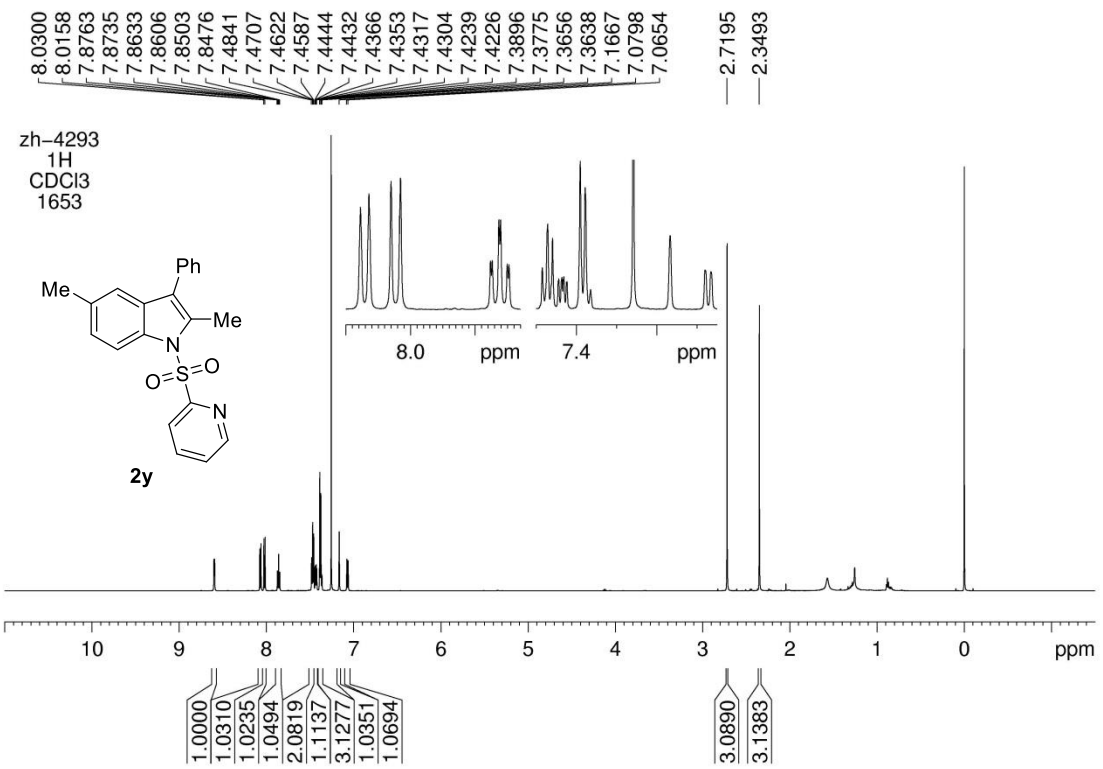
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N
2y
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10 9 8 7 6 5 4 3 2 1 0 ppm
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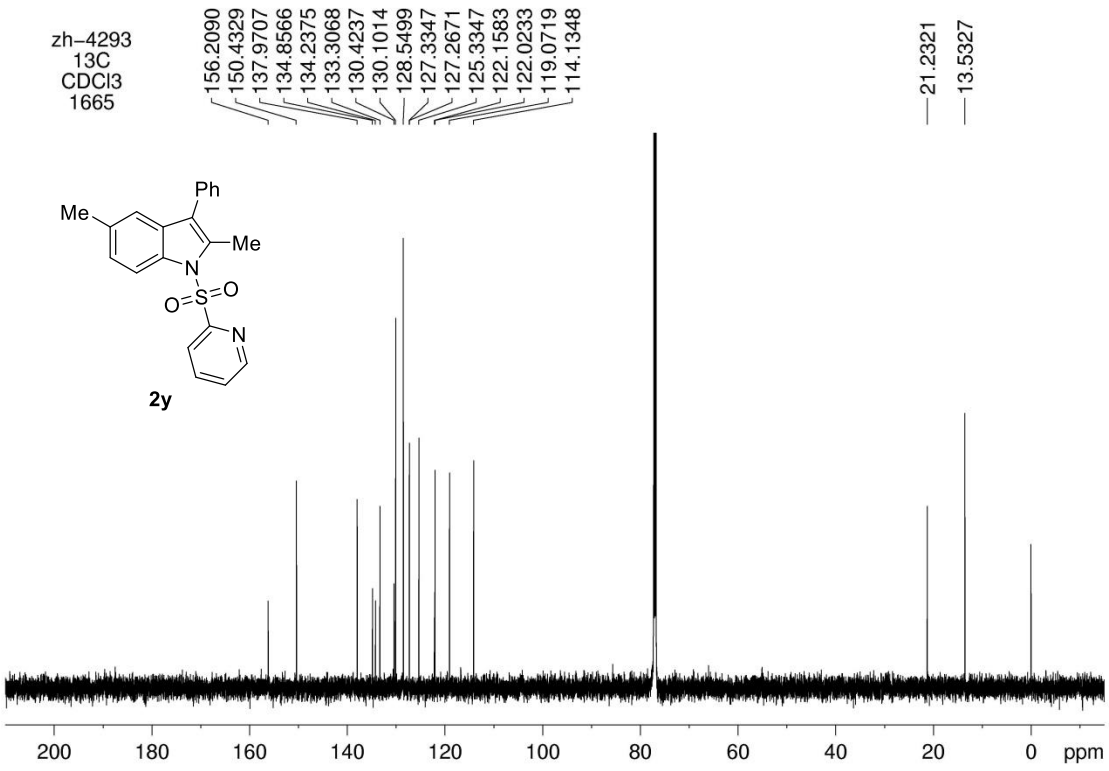
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119.0719
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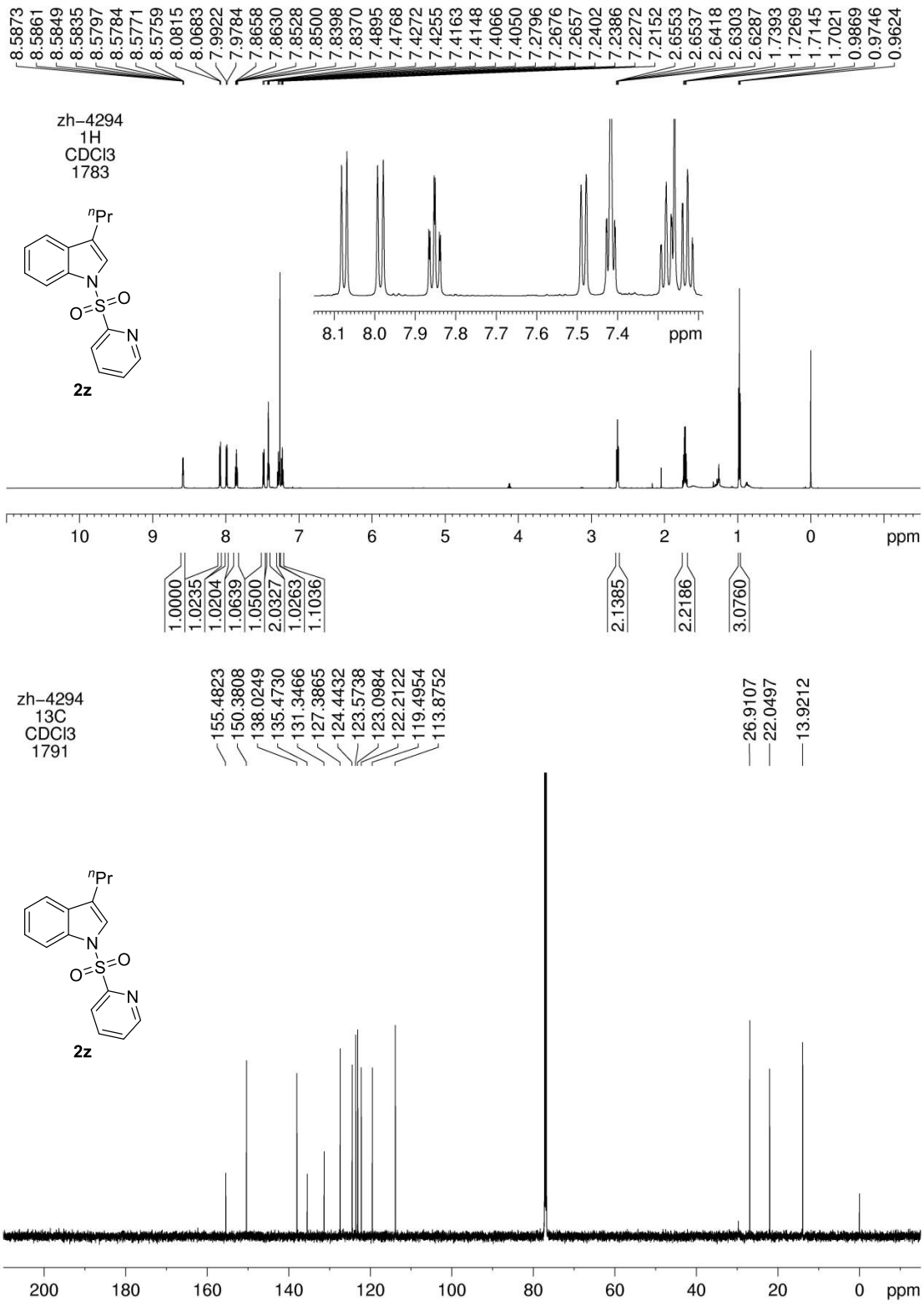
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7.2386
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2.6303
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1.7393
1.7269
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zh–4294
1H
CDCl3
1783
nPr
N
O=S=O
N
2z
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10 9 8 7 6 5 4 3 2 1 0 ppm
1.0000
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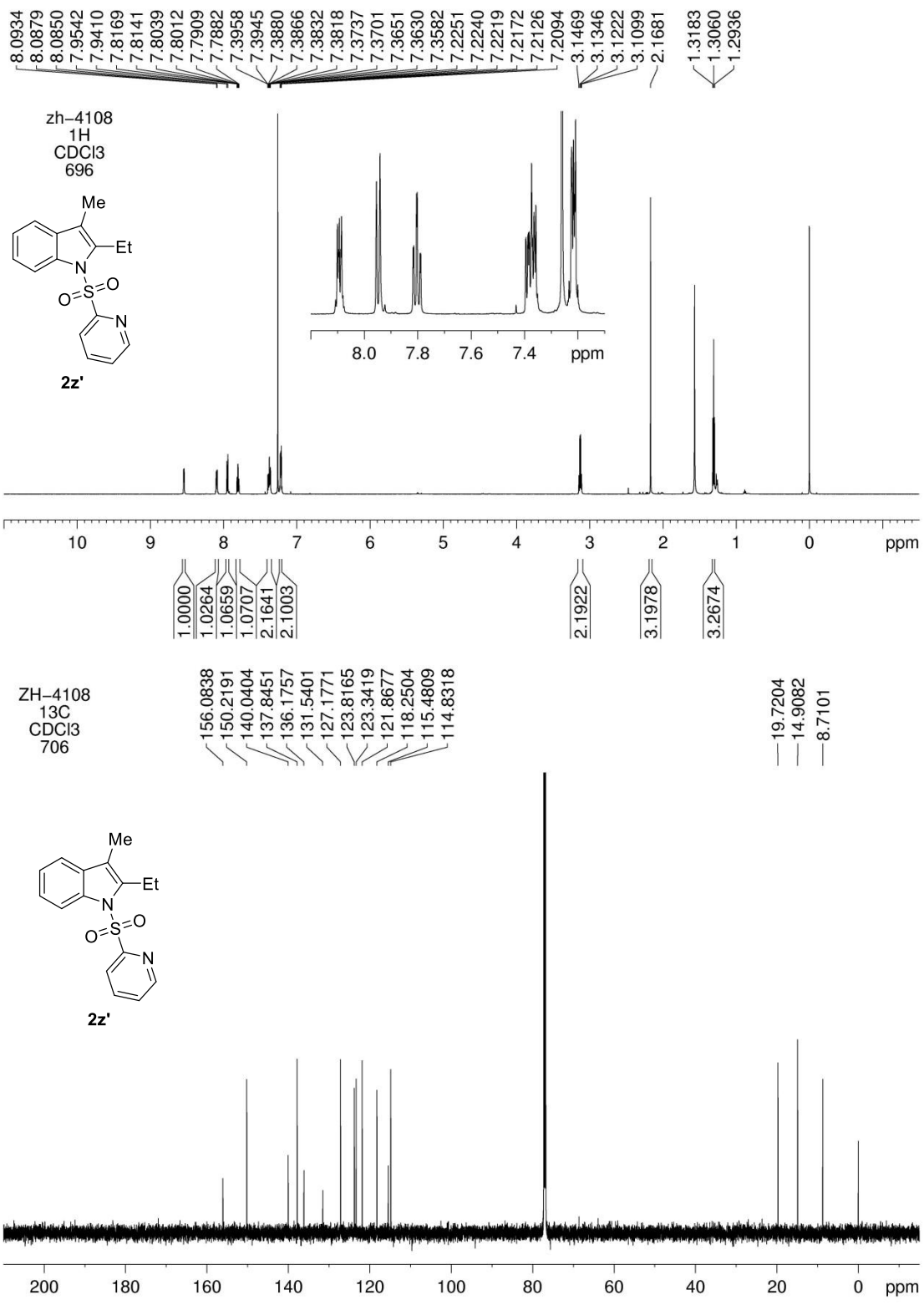
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7.3737
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7.3630
7.3582
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Me
Et
N
S
O
O
N
2z'
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7.4
ppm
10
9
8
7
6
5
4
3
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14.9082
8.7101
Me
Et
N
S
O
O
N
2z'
200
180
160
140
120
100
80
60
40
20
0
ppm

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