Supporting Information

Rhodium-catalyzed denitrogenative thioacetalization of N-sulfonyl-1,2,3-triazoles with disulfides: an entry to diverse transformation of terminal alkynes

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General experimental procedures

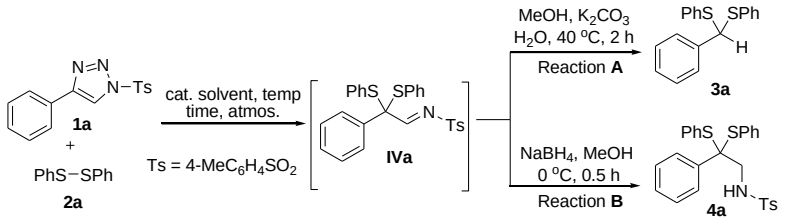
All reactions were carried out under nitrogen atmosphere. Proton and carbon magnetic resonance spectra (^{1}H NMR and ^{13}C NMR) were recorded using tetramethylsilane (TMS) in the solvent of $CDCl_3$ as the internal standard (^{1}H NMR: TMS at 0.00 ppm, $CHCl_3$ at 7.26 ppm; ^{13}C NMR: $CDCl_3$ at 77.4 ppm) or were recorded using tetramethylsilane (TMS) in the solvent of DMSO-d_6 as the internal standard (^{1}H NMR: TMS at 0.00 ppm, DMSO at 2.50 ppm; ^{13}C NMR: DMSO at 39.5 ppm).

Preparation of *N*-sulfonyl-1,2,3-triazoles (1a-r). *N*-Sulfonyl-1,2,3-triazoles (**1a-r**) were synthesized according to the known literatures.[1]

Optimization of conditions on rhodium-catalyzed thioacetalization

As shown in Table 1, our investigation for optimized conditions began by using model reaction of 4-phenyl-1-tosyl-1*H*-1,2,3-triazole (**1a**) with diphenyl disulfide (**2a**). The reaction was performed by using 2.5 mol% $Rh_2(Oct)_4$ as the catalyst, toluene as the solvent at 60 ^{o}C under nitrogen atmosphere for 6 h (entry 1), and **1a** almost quantitatively transformed into 2-phenyl-2,2-bis(phenylthio)-*N*-tosylethanimine (**IVa**) (determination by TCL). After a work-up, **IVa** was isolated in only 44% yield because of instability of **IVa** during the work-up (*note: structure of **IVa** was confirmed by ^{1}H, ^{13}C NMR and mass spectroscopy, see Supporting Information for the details*), so we decided to continue the following two procedures (Reactions **A** and **B**). When **IVa** was hydrolyzed in the presence of aqueous K_2CO_3 at 40 ^{o}C for 2 h (Reaction **A**), 1-(phenyl(phenylthio)methylthio)benzene (**3a**) was obtained in 75% yield (entry 1). Reduction of **IVa** with $NaBH_4$ provided 2-phenyl-2,2-bis(phenylthio)-*N*-tosylethanamine (**4a**) in 81% yield (Reaction **B**) (entry 1). Other rhodium catalysts were tested (entries 2-5), and they were inferior to $Rh_2(Oct)_4$. No **IVa** was found in the absence of catalyst (entry 6). Effect of solvents was investigated, and toluene was a suitable solvent (compare entries 1, 7-11). Yields decreased when temperature was lowered (entries 12 and 13). Only trace amount of products (**3a** and **4a**) were observed when nitrogen atmosphere was replaced with air (entry 14). Variation of time led to lower yields (entries 15 and 16).

Table 1 Optimization of conditions on rhodium-catalyzed thioacetalization of 4-phenyl-1-tosyl-1*H*-1,2,3-triazole (**1a**) with diphenyl disulfide (**2a**) leading to 2-phenyl-2,2-bis(phenylthio)-*N*-tosylethanimine (**IVa**), and synthesis of 1-(phenyl(phenylthio)methylthio)benzene (**3a**) and 2-phenyl-2,2-bis(phenylthio)-*N*-tosylethanamine (**4a**)[a]



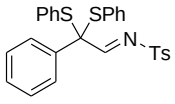
Entry	Cat.	Solvent	Temp (°C)	Time (h)	Yield of **3a**/**4a** (%)[b]
1	$Rh_2(Oct)_4$	PhMe	60	6	75/81
2	$Rh_2(OAc)_4$	PhMe	60	6	34/35
3	$[RhCp^*Cl_2]_2$	PhMe	60	6	0/0
4	$[Rh(COD)Cl]_2$	PhMe	60	6	0/0
5	$Rh(PPh_3)_3Cl$	PhMe	60	6	0/0
6	-	PhMe	60	6	0/0
7	$Rh_2(Oct)_4$	benzene	60	6	58/62
8	$Rh_2(Oct)_4$	*o*-xylene	60	6	75/79
9	$Rh_2(Oct)_4$	*p*-xylene	60	6	10/12
10	$Rh_2(Oct)_4$	mesitylene	60	6	66/68
11	$Rh_2(Oct)_4$	DCE	60	6	56/55
12	$Rh_2(Oct)_4$	PhMe	25	6	0/0
13	$Rh_2(Oct)_4$	PhMe	40	6	trace/trace
14[c]	$Rh_2(Oct)_4$	PhMe	60	6	trace/trace
15	$Rh_2(Oct)_4$	PhMe	60	3	31/40
16	$Rh_2(Oct)_4$	PhMe	60	12	59/65

[a] Reaction conditions: under nitrogen atmosphere, 4-phenyl-1-tosyl-1*H*-1,2,3-triazole (**1a**) (0.2 mmol), diphenyl disulfide (**2a**) (0.22 mmol), catalyst (0.005 mmol), solvent (2.0 mL), temperature (25-60 °C), time (3-12 h) in a sealed Schlenk tube for reaction of **1a** with **2a**. For Reaction **A**, MeOH (2.0 mL), K_2CO_3 (0.4 mmol), H_2O (0.2 mL) at 40 °C for 2 h; For Reaction **B**, $NaBH_4$ (0.2 mmol), MeOH (0.5 mL) at 0 °C for 0.5 h. OAc = acetate. Oct = octanoate. Cp* = 1,2,3,4,5-pentamethylcyclopenta-1,3-diene. COD = (1*Z*,5*Z*)-cycloocta-1,5-diene. DCE = 1,2-dichloroethane. [b] Isolated yield. [c] Under air.

General procedure for synthesis of compounds 3 and 4. A 25 mL Schlenk tube was evacuated and refilled with nitrogen atmosphere for three times, and then *N*-sulfonyl-1,2,3-triazole (**1**) (0.2 mmol), disulfide (**2**) (0.22 mmol), $Rh_2(Oct)_4$ (0.005

mmol, 4.0 mg), PhMe (2.0 mL) were added to the tube under nitrogen atmosphere. The tube was sealed, and the mixture was stirred at 60 ^{o}C till the reaction completed (TLC determination). The following procedures were performed for the resulting solution. For synthesis of **3**, methanol (2.0 mL), water (0.2 mL) and K_2CO_3 (0.4 mmol, 55 mg) were added to the tube with the solution, and the mixture was stirred at 40 ^{o}C for 2 h. The solvent in the resulting solution was removed, and the residue was purified by column chromatography on silica gel using petroleum ether/ethyl acetate as the eluent to provide the desired product (**3**); For synthesis of **4**, methanol (2.0 mL) and $NaBH_4$ (0.2 mmol, 7.6 mg) were added to the tube with the solution under condition of an ice bath, and the mixture was stirred at 0 ^{o}C for 0.5 h. The resulting solution was concentrated by a rotary evaporator, and the residue was purified by column chromatography on silica gel using dichloromethane/petroleum ether as the eluent to give the desired product (**4**).

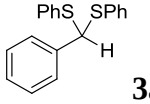
Characterization data of compounds IVa



IVa

2-Phenyl-2,2-bis(phenylthio)-*N*-tosylethanimine (IVa). Eluent: petroleum ether/ethyl acetate (10:1). Yield 43 mg (44%). White solid. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 7.08-7.12 (m, 4H), 7.23-7.31 (m, 13H), 7.68-7.70 (d, 2H, *J* = 8.68 Hz), 8.68 (s, 1H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.8, 70.3, 128.3, 128.4, 128.5, 128.7, 128.8, 129.4, 129.7, 129.9, 134.8, 136.1, 136.9, 144.8, 170.7. HR-MS (ESI) $[M+Na]^+$ m/z calcd for $C_{27}H_{23}NNaO_2S_3$ 512.0789, found 512.0795.

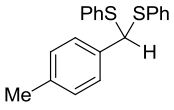
Characterization data of compounds 3a-l and 4a-u



3a

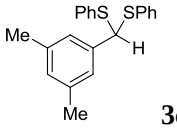
1-(Phenyl(phenylthio)methylthio)benzene (3a).[2] Eluent: petroleum ether/ethyl acetate (100:1). Yield 53 mg (75%) using **1a** as the substrate; 53 mg (75%) using **1k** as the substrate; 57 mg (81%) using **1p** as the substrate; 58 mg (82%) using **1q** as the

substrate; 62 mg (88%) using **1r** as the substrate. Yellow solid, m.p. 56-57 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.42 (s, 1H), 7.16-7.39 (m, 15H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 60.5, 127.9, 128.0, 128.2, 128.6, 129.0, 132.6, 134.6, 139.8. ESIMS $[M+Na]^+$ m/z 331.4.



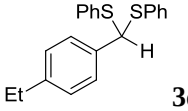
3b

1-((Phenylthio)(*p*-tolyl)methylthio)benzene (3b).[3] Eluent: petroleum ether/ethyl acetate (100:1). Yield 53 mg (82%) using **1b** as the substrate; 45 mg (70%) using **1l** as the substrate. Yellow solid, m.p. 75-76 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.30 (s, 3H), 5.41 (s, 1H), 7.06-7.07 (d, 2H, *J* = 7.8 Hz), 7.21-7.27 (m, 8H), 7.32-7.35 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.3, 60.2, 127.8, 127.9, 128.9, 129.3, 132.4, 134.9, 136.8, 138.0. ESIMS $[M+Na]^+$ m/z 345.3.



3c

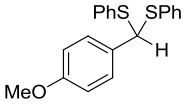
1-(Bis(phenylthio)methyl)-3,5-dimethylbenzene (3c). Eluent: petroleum ether/ethyl acetate (100:1). Yield 44 mg (66%). Yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.25 (s, 6H), 5.36 (s, 1H), 6.86 (s, 1H), 6.97 (s, 2H), 7.22-7.26 (m, 6H), 7.33-7.35 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.5, 60.7, 125.8, 127.9, 129.0, 130.0, 132.5, 135.1, 138.3, 139.7. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{21}H_{20}NaS_2$ 359.0904, found 359.0911.



3d

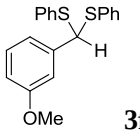
1-((4-Ethylphenyl)(phenylthio)methylthio)benzene (3d). Eluent: petroleum ether/ethyl acetate (100:1). Yield 57 mg (84%) using **1d** as substrate; 46 mg (67%) using **1m** as the substrate. Yellow solid, m.p. 63-64 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 1.18-1.22 (t, 3H, *J* = 7.32 Hz), 2.58-2.64 (q, 2H, *J* = 7.64 Hz), 5.42 (s, 1H), 7.08-7.11 (d, 2H, *J* = 8.24 Hz), 7.21-7.25 (m, 6H), 7.28-7.30 (d, 2H, *J* = 7.8 Hz), 7.33-7.35 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 15.6, 28.7, 60.4, 127.9, 128.0, 128.2, 129.0, 132.5, 135.0, 137.1, 144.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{21}H_{20}NaS_2$ 359.0904,

found 359.0908.



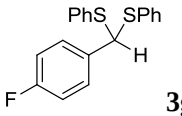
3e

1-((4-Methoxyphenyl)(phenylthio)methylthio)benzene (3e).[4] Eluent: petroleum ether/ethyl acetate (100:1). Yield 52 mg (77%) using **1e** as the substrate; 61 mg (90%) using **1n** as the substrate. Yellow solid, m.p. 82-83 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.75 (s, 3H), 5.42 (s, 1H), 6.77-6.79 (d, 2H, *J* = 8.24 Hz), 7.21-7.24 (m, 6H), 7.28-7.34 (m, 6H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 55.5, 59.9, 114.0, 127.9, 129.0, 129.3, 131.8, 132.6, 134.9, 159.5. ESIMS $[M+Na]^+$ m/z 361.6.



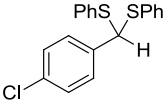
3f

1-((3-Methoxyphenyl)(phenylthio)methylthio)benzene (3f).[5] Eluent: petroleum ether/ethyl acetate (100:1). Yield 36 mg (52%). Yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.73 (s, 3H), 5.39 (s, 1H), 6.76-6.78 (dd, 1H, *J* = 8.24 Hz, *J* = 2.72 Hz), 6.90-6.95 (m, 2H), 7.15-7.19 (m, 1H), 7.21-7.25 (m, 6H), 7.34-7.36 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 55.3, 60.5, 113.1, 114.2, 120.3, 127.9, 129.0, 129.6, 132.6, 134.6, 141.3, 159.7. ESIMS $[M+Na]^+$ m/z 361.2.



3g

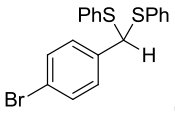
1-((4-Fluorophenyl)(phenylthio)methylthio)benzene (3g).[6] Eluent: petroleum ether/ethyl acetate (100:1). Yield 54 mg (83%). Yellow solid, m.p. 51-52 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.40 (s, 1H), 6.90-6.94 (m, 2H), 7.22-7.26 (m, 6H), 7.28-7.34 (m, 6H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 59.7, 115.5 (d, *J* = 21.9 Hz), 128.1, 129.1, 129.7 (d, *J* = 8.6 Hz), 132.9, 134.3, 135.6 (d, *J* = 2.9 Hz), 162.3. (d, *J* = 246.0 Hz) ESIMS $[M+Na]^+$ m/z 349.3.



3h

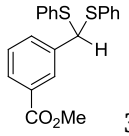
1-((4-Chlorophenyl)(phenylthio)methylthio)benzene (3h).[3] Eluent: petroleum ether/ethyl acetate (100:1). Yield 48 mg (70%) using **1h** as the substrate; 51 mg (74%)

using **1o** as the substrate. Yellow solid, m.p. 99-100 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.37 (s, 1H), 7.20-7.28 (m, 10H), 7.31-7.34 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 59.8, 128.2, 128.7, 129.1, 129.4, 132.9, 133.8, 134.1, 138.4. ESIMS $[M+Na]^+$ m/z 365.2.



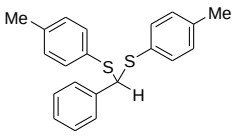
3i

1-((4-Bromophenyl)(phenylthio)methylthio)benzene (3i).[7] Eluent: petroleum ether/ethyl acetate (100:1). Yield 41 mg (53%). Yellow solid, m.p. 106-107 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.36 (s, 1H), 7.19-7.26 (m, 8H), 7.31-7.38 (m, 6H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 60.0, 122.1, 128.3, 129.2, 129.8, 131.8, 133.0, 134.2, 139.0. ESIMS $[M+Na]^+$ m/z 409.2, 411.1.



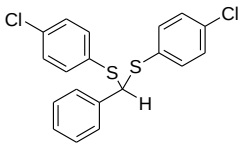
3j

Methyl 3-(bis(phenylthio)methyl)benzoate (3j). Eluent: petroleum ether/ethyl acetate (100: 1). Yield 30 mg (41%). Yellow solid, m.p. 63-64 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.89 (s, 3H), 5.46 (s, 1H), 7.22-7.25 (m, 6H), 7.30-7.35 (m, 5H), 7.53-7.55 (d, 1H, *J* = 7.80 Hz), 7.90-7.92 (d, 1H, *J* = 7.76 Hz), 8.02 (s, 1H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 52.3, 60.2, 128.2, 128.7, 129.0, 129.2, 129.3, 130.5, 132.4, 132.9, 134.1, 140.3, 166.7. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{21}H_{18}NaO_2S_2$ 389.0646, found 389.0639.



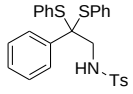
3k

1-((*p*-Tolylthio)(phenyl)methylthio)-4-methylbenzene (3k).[8] Eluent: petroleum ether/ethyl acetate (100:1). Yield 54 mg (81%) using **1a** as substrate; 59 mg (89%) using **1k** as the substrate. Yellow solid, m.p. 83-84 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.29 (s, 6H), 5.31 (s, 1H), 7.02-7.04 (d, 4H, *J* = 7.76 Hz), 7.20-7.26 (m, 7H), 7.31-7.33 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.3, 61.4, 128.0, 128.5, 129.7, 130.9, 133.3, 138.1, 140.1. ESIMS $[M+Na]^+$ m/z 359.3.



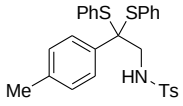
3l

1-((4-Chlorophenylthio)(phenyl)methylthio)-4-chlorobenzene (3l).[3] Eluent: petroleum ether/ethyl acetate (100:1). Yield 54 mg (71%). Yellow solid, m.p. 65-66 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.33 (s, 1H), 7.18-7.31 (m, 13H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 60.9, 127.9, 128.5, 128.7, 129.2, 132.6, 134.3, 134.4, 139.0. ESIMS $[M+Na]^+$ m/z 399.1.



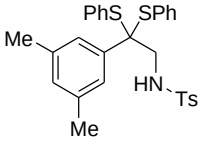
4a

2-Phenyl-2,2-bis(phenylthio)-*N*-tosylethanamine (4a). Eluent: dichloromethane/petroleum ether (2:1). Yield 79 mg (81%). White solid, m.p. 190-191 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.38-3.40 (d, 2H, *J* = 5.48 Hz), 5.16-5.19 (t, 1H, *J* = 5.48 Hz), 7.06-7.07 (m, 8H), 7.15-7.17 (m, 3H), 7.22-7.32 (m, 6H), 7.67-7.69 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.8, 46.8, 67.0, 127.4, 128.2, 128.4, 128.8, 129.8, 130.0, 136.7, 138.7, 143.7. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{25}NNaO_2S_3$ 514.0945, found 514.0928.



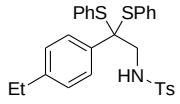
4b

2,2-Bis(phenylthio)-2-*p*-tolyl-*N*-tosylethanamine (4b). Eluent: dichloromethane/petroleum ether (2:1). Yield 83 mg (82%). White solid, m.p. 183-184 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.29 (s, 3H), 2.45 (s, 3H), 3.36-3.37 (d, 2H, *J* = 5.52 Hz), 5.14-5.16 (t, 1H, *J* = 5.52 Hz), 6.95-6.97 (d, 2H, *J* = 8.24 Hz), 7.07-7.09 (m, 8H), 7.18-7.20 (d, 2H, *J* = 8.28 Hz), 7.23-7.29 (m, 4H), 7.66-7.68 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.3, 21.8, 47.0, 66.9, 127.3, 128.3, 128.8, 129.7, 130.0, 135.6, 136.6, 138.0, 143.6. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{28}H_{27}NNaO_2S_3$ 528.1102, found 528.1111.



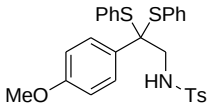
4c

2-(3,5-Dimethylphenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4c). Eluent: dichloromethane/petroleum ether (2:1). Yield 81 mg (78%). White solid, m.p. 178-179 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.15 (s, 6H), 2.44 (s, 3H), 3.37-3.39 (d, 2H, *J* = 5.04 Hz), 5.08-5.11 (t, 1H, *J* = 5.28 Hz), 6.80 (s, 1H), 6.84 (s, 2H), 7.09-7.12 (m, 8H), 7.25-7.29 (m, 4H), 7.65-7.67 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.5, 21.8, 46.9, 67.0, 125.9, 127.3, 128.8, 129.68, 129.74, 129.9, 130.0, 136.7, 137.6, 138.2, 143.6. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{29}H_{29}NNaO_2S_3$ 542.1258, found 542.1267.



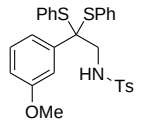
4d

2-(4-Ethylphenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4d). Eluent: dichloromethane/petroleum ether (2:1). Yield 89 mg (86%). White solid, m.p. 165-166 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 1.18-1.21 (t, 3H, *J* = 7.8 Hz), 2.46 (s, 3H), 2.56-2.61 (q, 2H, *J* = 7.64 Hz), 3.38-3.39 (d, 2H, *J* = 5.48 Hz), 5.14-5.17 (t, 1H, *J* = 5.52 Hz), 6.97-6.99 (d, 2H, *J* = 8.24 Hz), 7.05-7.08 (m, 8H), 7.21-7.30 (m, 6H), 7.67-7.69 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 15.8, 21.8, 28.6, 46.9, 66.9, 127.3, 127.6, 128.3, 128.8, 129.7, 129.9, 130.0, 135.7, 136.57, 136.63, 143.6, 144.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{29}H_{29}NNaO_2S_3$ 542.1258, found 542.1269.



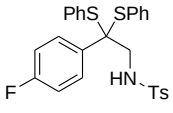
4e

2-(4-Methoxyphenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4e). Eluent: dichloromethane/petroleum ether (2:1). Yield 96 mg (92%). White solid, m.p. 175-176 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.35-3.37 (d, 2H, *J* = 5.48 Hz), 3.77 (s, 3H), 5.17-5.19 (t, 1H, *J* = 5.52 Hz), 6.68-6.70 (d, 2H, *J* = 9.16 Hz), 7.08-7.11 (m, 8H), 7.24-7.30 (m, 6H), 7.67-7.69 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.8, 47.0, 55.5, 66.7, 113.4, 127.3, 128.8, 129.7, 129.8, 129.9, 130.0, 130.6, 136.6, 143.7, 159.2. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{28}H_{27}NNaO_3S_3$ 544.1051, found 544.1039.



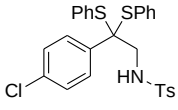
4f

2-(3-Methoxyphenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4f). Eluent: dichloromethane/petroleum ether. Yield 68 mg (65%). White solid, m.p. 181-182℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.45 (s, 3H), 3.37-3.38 (d, 2H, *J* = 5.48 Hz), 3.68 (s, 3H), 5.17-5.19 (t, 1H, *J* = 5.50 Hz), 6.72-6.74 (dd, 1H, *J* = 7.80 Hz, *J* = 2.28 Hz), 6.88-6.92 (m, 2H), 7.05-7.12 (m, 9H), 7.24-7.29 (m, 4H), 7.66-7.68 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.8, 55.4, 66.8, 113.9, 114.2, 120.4, 127.2, 128.8, 129.0, 129.66, 129.72, 129.9, 136.5, 140.0, 143.6, 159.3. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{28}H_{27}NNaO_3S_3$ 544.1051, found 544.1064.



4g

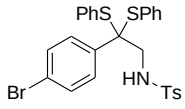
2-(4-Fluorophenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4g). Eluent: dichloromethane/petroleum ether (2:1). Yield 97 mg (95%). White solid, m.p. 191-192 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.36-3.38 (d, 2H, *J* = 5.52 Hz), 5.21-5.24 (t, 1H, *J* = 5.48 Hz), 6.82-6.87 (dd, 2H, *J* = 8.72 Hz, *J* = 8.72 Hz), 7.06-7.01 (m, 8H), 7.25-7.33 (m, 6H), 7.68-7.70 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.8, 66.2, 114.9 (d, *J* = 21.9 Hz), 127.2, 128.9, 129.4, 129.8, 129.9, 130.3 (d, *J* = 8.6 Hz), 134.5 (d, *J* = 3.8 Hz), 136.4, 136.6, 143.7, 162.0. (d, *J* = 247.9 Hz). HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{24}FNNaO_2S_3$ 532.0851, found 532.0843.



4h

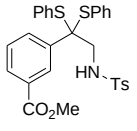
2-(4-Chlorophenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4h). Eluent: dichloromethane/petroleum ether (2:1). Yield 89 mg (85%). White solid, m.p. 195-196 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.35-3.36 (d, 2H, *J* = 5.52 Hz), 5.23-5.26 (t, 1H, *J* = 5.26 Hz), 7.08-7.13 (m, 10H), 7.25-7.29 (m, 6H), 7.67-7.69 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.7, 66.2, 127.2, 128.1, 128.9, 129.2, 129.7, 129.9, 133.8, 136.3, 136.5, 137.3, 143.7. HR-MS (ESI) $[M+H]^+$

m/z calcd for $C_{27}H_{24}ClNNaO_2S_3$ 548.0555, found 548.0565.



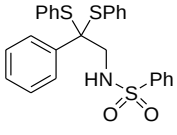
4i

2-(4-Bromophenyl)-2,2-bis(phenylthio)-*N*-tosylethanamine (4i). Eluent: dichloromethane/petroleum ether (2:1). Yield 78 mg (68%). White solid, m.p. 189-190 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.34-3.36 (d, 2H, *J* = 5.48 Hz), 5.22-5.25 (t, 1H, *J* = 5.50 Hz), 7.07-7.12 (m, 8H), 7.18-7.20 (d, 2H, *J* = 8.72 Hz), 7.25-7.30 (m, 6H), 7.66-7.68 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.8, 46.7, 66.4, 122.1, 127.3, 129.0, 129.3, 130.0, 130.1, 131.1, 136.4, 136.6, 138.0, 143.8. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{24}BrNNaO_2S_3$ 592.0050, 594.0030, found 592.0061, 594.0042.



4j

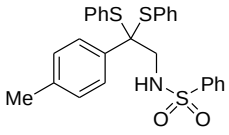
Methyl 3-(1,1-bis(phenylthio)-2-(tosylamino)ethyl)benzoate (4j). Eluent: dichloromethane/petroleum ether (2:1). Yield 58 mg (53%). White solid, m.p. 174-175 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.46 (s, 3H), 3.43-3.44 (d, 2H, *J* = 5.52 Hz), 3.90 (s, 3H), 5.30-5.33 (t, 1H, *J* = 5.50 Hz), 7.04-7.09 (m, 8H), 7.18-7.31 (m, 5H), 7.39-7.41 (d, 1H, *J* = 7.8 Hz), 7.70-7.73 (d, 2H, *J* = 8.24 Hz), 7.84-7.86 (d, 1H, *J* = 7.8 Hz), 8.12 (s, 1H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.7, 52.3, 66.7, 127.2, 128.1, 128.9, 129.1, 129.2, 129.6, 129.85, 129.91, 130.1, 132.6, 136.4, 136.6, 139.4, 143.7, 166.6. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{29}H_{27}NNaO_4S_3$ 572.1000, found 572.1009.



4k

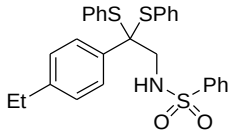
2-Phenyl-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (4k). Eluent: dichloromethane/petroleum ether (2:1). Yield 73 mg (76%). White solid, m.p. 183-184 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.40-3.41 (d, 2H, *J* = 5.52 Hz), 5.26-5.29 (t, 1H, *J* = 5.50 Hz), 7.07-7.08 (m, 8H), 7.15-7.17 (m, 3H), 7.22-7.27 (m, 2H),

7.30-7.32 (m, 2H), 7.48-7.52 (m, 2H), 7.59-7.61 (m, 1H), 7.80-7.82 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.6, 66.7, 127.2, 128.1, 128.3, 128.8, 129.3, 129.5, 129.8, 132.9, 136.6, 138.5, 139.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{26}H_{23}NNaO_2S_3$ 500.0789, found 500.0799.



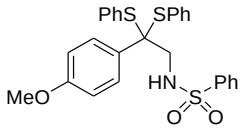
4l

2,2-Bis(phenylthio)-2-*p*-tolyl-*N*-benzenesulfonylethanamine (4l). Eluent: dichloromethane/petroleum ether (2:1). Yield 73 mg (74%). White solid, m.p. 165-166 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.28 (s, 3H), 3.37-3.39 (d, 2H, *J* = 5.52 Hz), 5.22-5.25 (t, 1H, *J* = 5.50 Hz), 6.95-6.97 (d, 2H, *J* = 8.24 Hz), 7.05-7.09 (m, 8H), 7.17-7.20 (d, 2H, *J* = 8.72 Hz), 7.22-7.26 (m, 2H), 7.46-7.50 (m, 2H), 7.57-7.59 (m, 1H), 7.78-7.80 (d, 2H, *J* = 8.72 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.2, 46.8, 66.7, 127.1, 128.1, 128.8, 129.3, 129.66, 129.71, 132.8, 135.5, 136.5, 137.9, 139.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{25}NNaO_2S_3$ 514.0945, found 514.0956.



4m

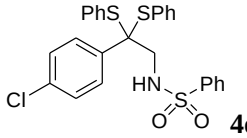
2-(4-Ethylphenyl)-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (4m). Eluent: dichloromethane/petroleum ether (2:1). Yield 85 mg (84%). White solid, m.p. 159-160 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 1.17-1.21 (t, 3H, *J* = 7.56 Hz), 2.55-2.61 (q, 2H, *J* = 7.48 Hz), 3.39-3.40 (d, 2H, *J* = 5.04 Hz), 5.22-5.25 (t, 1H, *J* = 5.28 Hz), 6.97-6.99 (d, 2H, *J* = 7.80 Hz), 7.05-7.08 (m, 8H), 7.20-7.24 (m, 4H), 7.47-7.51 (m, 2H), 7.58-7.62 (m, 1H), 7.79-7.81 (d, 2H, *J* = 7.32 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 15.7, 28.5, 46.8, 66.7, 127.1, 127.6, 128.2, 128.7, 129.3, 129.66, 129.71, 132.8, 135.5, 136.6, 139.4, 144.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{28}H_{27}NNaO_2S_3$ 528.1102, found 528.1114.



4n

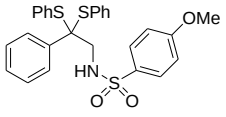
2-(4-Methoxyphenyl)-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (4n).

Eluent: dichloromethane/petroleum ether (2:1). Yield 93 mg (92%). White solid, m.p. 153-154 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.37-3.38 (d, 2H, *J* = 5.48 Hz), 3.77 (s, 3H), 5.22-5.25 (t, 1H, *J* = 5.26 Hz), 6.68-6.70 (d, 2H, *J* = 9.16 Hz), 7.08-7.11 (m, 7H), 7.23-7.28 (m, 5H), 7.49-7.53 (m, 2H), 7.59-7.63 (m, 1H), 7.80-7.82 (d, 2H, *J* = 7.76 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.9, 55.4, 66.6, 113.3, 127.1, 128.8, 129.3, 129.6, 129.7, 130.5, 132.8, 136.5, 139.5, 159.1. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{25}NNaO_3S_3$ 530.0894, found 530.0905.



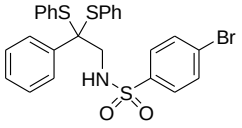
4o

2-(4-Chlorophenyl)-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (4o). Eluent: dichloromethane/petroleum ether (2:1). Yield 87 mg (85%). White solid, m.p. 172-173 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.36-3.38 (d, 2H, *J* = 5.52 Hz), 5.25-5.28 (t, 1H, *J* = 5.50 Hz), 7.07-7.14 (m, 10H), 7.24-7.30 (m, 4H), 7.49-7.53 (m, 2H), 7.60-7.64 (m, 1H), 7.80-7.82 (d, 2H, *J* = 7.32 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.6, 66.1, 127.1, 128.2, 128.9, 129.2, 129.3, 129.7, 130.0, 132.9, 133.8, 136.5, 137.3, 139.4. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{26}H_{22}ClNNaO_2S_3$ 534.0399, found 534.0375.



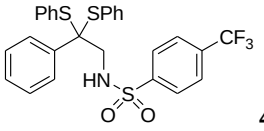
4p

4-Methoxy-*N*-(2-phenyl-2,2-bis(phenylthio)ethyl)benzenesulfonamide (4p). Eluent: dichloromethane/petroleum ether (2:1). Yield 83 mg (82%). White solid, m.p. 194-195 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.38-3.40 (d, 2H, *J* = 5.48 Hz), 3.88 (s, 3H), 5.18-5.21 (t, 1H, *J* = 5.50 Hz), 6.94-6.96 (d, 2H, *J* = 9.2 Hz), 7.07-7.11 (m, 8H), 7.14-7.18 (m, 3H), 7.23-7.27 (m, 2H), 7.31-7.33 (m, 2H), 7.72-7.74 (m, 2H, *J* = 8.72 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.6, 55.8, 66.8, 114.4, 128.0, 128.3, 128.8, 129.3, 129.6, 129.7, 131.0, 136.5, 138.6, 163.1. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{25}NNaO_3S_3$ 530.0894, found 530.0909.



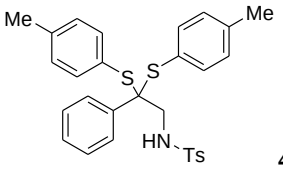
4q

4-Bromo-*N*-(2-phenyl-2,2-bis(phenylthio)ethyl)benzenesulfonamide (4q). Eluent: dichloromethane/petroleum ether (2:1). Yield 95 mg (85%). White solid, m.p. 210-211 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.57-3.58 (d, 2H, *J* = 5.24 Hz), 5.46-5.49 (t, 1H, *J* = 5.04 Hz), 7.23-7.29 (m, 8H), 7.34-7.36 (m, 3H), 7.42-7.49 (m, 4H), 7.76-7.82 (m, 4H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.6, 66.8, 127.8, 128.1, 128.2, 128.7, 128.8, 129.5, 129.7, 132.5, 136.3, 138.4, 138.5. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{26}H_{22}BrNO_2S_3$ 577.9894, 579.9873, found 577.9909, 579.9889.



4r

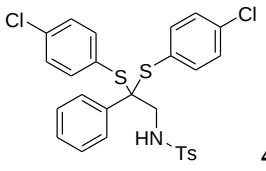
***N*-(2-Phenyl-2,2-bis(phenylthio)ethyl)-4-(trifluoromethyl)benzenesulfonamide (4r).** Eluent: dichloromethane/petroleum ether (2:1). Yield 97 mg (89%). White solid, m.p. 200-201 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.42-3.44 (d, 2H, *J* = 5.48 Hz), 5.42-5.44 (t, 1H, *J* = 5.04 Hz), 7.06-7.07 (m, 8H), 7.15-7.18 (m, 3H), 7.21-7.26 (m, 2H), 7.29-7.31 (m, 2H), 7.70-7.72 (d, 2H, *J* = 8.28 Hz), 7.88-7.90 (d, 2H, *J* = 8.28 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 46.7, 66.8, 123.4 (q, *J* = 270.8 Hz), 126.4 (q, *J* = 3.8 Hz), 127.6, 128.2, 128.8, 129.5, 129.8, 134.4 (q, *J* = 33.4 Hz), 136.2, 138.5, 142.9. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{22}F_3NNaO_2S_3$ 568.0662, found 568.0671.



4s

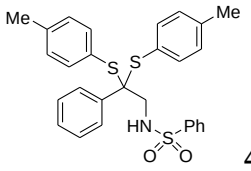
2,2-Bis(*p*-tolylthio)-2-phenyl-*N*-tosylethanamine (4s). Eluent: dichloromethane/petroleum ether (2:1). Yield 85 mg (82%). White solid, m.p. 177-178 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.26 (s, 6H), 2.47 (s, 3H), 3.33-3.35 (d, 2H, *J* = 5.52 Hz), 5.18-5.21 (t, 1H, *J* = 5.50 Hz), 6.85-6.88 (d, 4H, *J* = 8.24 Hz), 6.93-6.95 (d, 4H, *J* = 8.24 Hz), 7.16-7.19 (m, 3H), 7.29-7.34 (m, 4H), 7.69-7.71 (d, 2H, *J* = 8.28 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.4, 21.7, 46.4, 66.4, 126.0, 127.3,

127.9, 128.0, 128.4, 129.5, 129.8, 136.5, 136.6, 138.8, 140.0, 143.5. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{29}H_{29}NNaO_2S_3$ 542.1258, found 542.1275.



4t

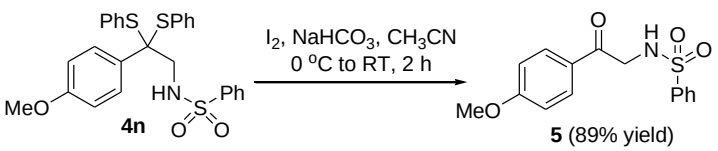
2,2-Bis(4-chlorophenylthio)-2-phenyl-*N*-tosylethanamine (4t). Eluent: dichloromethane/petroleum ether (2:1). Yield 87 mg (78%). White solid, m.p. 194-195 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.49 (s, 3H), 3.31-3.32 (d, 2H, *J* = 5.48 Hz), 5.12-5.14 (t, 1H, *J* = 5.50 Hz), 6.96-6.98 (d, 4H, *J* = 8.72 Hz), 7.02-7.04 (d, 4H, *J* = 8.72 Hz), 7.19-7.21 (m, 3H), 7.26-7.32 (m, 4H), 7.67-7.69 (d, 2H, *J* = 8.24 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.4, 67.0, 127.2, 127.9, 128.2, 128.3, 128.4, 129.0, 129.9, 136.2, 136.3, 137.5, 138.1, 143.9. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{27}H_{23}Cl_2NNaO_2S_3$ 582.0166, found 582.0185.



4u

2,2-Bis(*p*-tolylthio)-2-phenyl-*N*-benzenesulfonylethanamine (4u). Eluent: dichloromethane/petroleum ether (2:1). Yield 97 mg (96%). White solid, m.p. 151-152 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.24 (s, 6H), 3.36-3.38 (d, 2H, *J* = 5.52 Hz), 5.25-5.28 (t, 1H, *J* = 5.50 Hz), 6.85-6.87 (d, 4H, *J* = 8.28 Hz), 6.93-6.95 (d, 4H, *J* = 7.80 Hz), 7.15-7.18 (m, 3H), 7.31-7.33 (m, 2H), 7.48-7.51 (m, 2H), 7.59-7.60 (m, 1H), 7.80-7.82 (d, 2H, *J* = 7.8 Hz). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.4, 46.4, 66.4, 126.0, 127.2, 127.9, 128.0, 128.4, 129.3, 129.6, 132.8, 136.6, 138.8, 139.5, 140.0. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{28}H_{27}NNaO_2S_3$ 528.1102, found 528.1089.

Syntheisis of compound 5

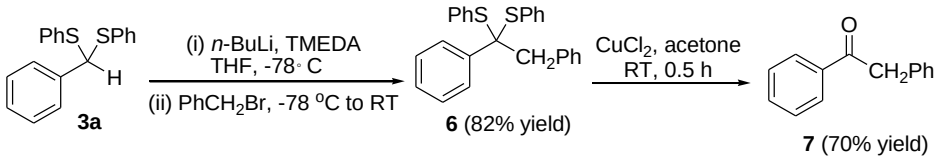


4n **5** (89% yield)

Syntheisis of compound 5.

2-(4-Methoxyphenyl)-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (**4n**) (0.11 mmol, 55 mg) in CH_3CN (2.0 mL) was added to $NaHCO_3$ saturated aqueous solution (2 mL), the mixture was cooled to 0 ℃, and I_2 (0.275 mmol, 70 mg) was added. After about 2 h, the resulting solution was quenched with a saturated aqueous $Na_2S_2O_3$ solution (1 mL). The solution was extracted with ethyl acetate (3×5 mL), and the combined organic phase was dried over anhydrous Na_2SO_4. The filtrate was concentrated by a rotary evaporator, and the residue was purified by a column chromatography on silica gel to provide the desired product (**5**) in 89% yield (29 mg). 1-(4-Methoxyphenyl)-2-(benzenesulfonylamino)ethanone (**5**). Eluent: dichloromethane/petroleum ether (2:1). White solid, m.p. 154-155 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.86 (s, 3H), 4.41-4.43 (d, 2H, *J* = 4.56 Hz), 5.75-5.77 (t, 1H, *J* = 4.12 Hz), 6.91-6.93 (d, 2H, *J* = 9.2 Hz), 7.47-7.56 (m, 3H), 7.81-7.84 (m, 2H, *J* = 8.72 Hz), 7.89-7.91 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) 48.3, 55.7, 114.3, 126.8, 127.2, 129.3, 130.3, 132.9, 139.2, 164.6, 190.8. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{15}H_{15}NNaO_4S$ 328.0619, found 328.0612.

Syntheisis of compounds 6 and 7

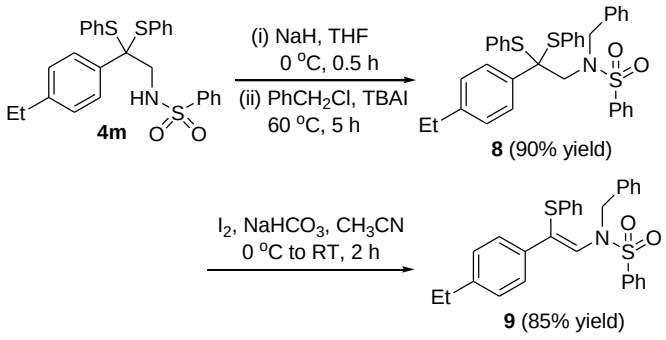


Syntheisis of compound 6. 1-(Phenyl(phenylthio)methylthio)benzene (**3a**) (0.32 mmol, 100 mg) in anhydrous THF (4.0 mL), and TMEDA (0.4 mmol, 46.4 mg) were added to a flask, the mixture was cooled to -78℃, and *n*-BuLi (0.4 mmol, 1.6 M in hexane) was added dropwise to the flask under N_2 atmosphere. The solution was stirred at room temperature for 0.5 h and cooled to -78℃, then benzyl bromide (0.4 mmol, 69 mg) was added. The mixture was stirred at room temperature overnight, and then quenched with water. The resulting solution was filtrated through a pad of silica gel, and the filtrate was concentrated. The residue was purified by column chromatography on silica gel to provide the desired product (**6**) in 82% yield (104 mg). 1,2-Diphenyl-1,1-bis(phenylthio)ethane (**6**).[9] Eluent: petroleum ether/ethyl acetate (100:1). Yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.58 (s, 2H), 6.88-6.90 (d,

2H, *J* = 7.32 Hz), 7.11-7.30 (m, 16H), 7.59-7.61 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) 47.1, 70.3, 126.7, 127.5, 127.6, 128.0, 128.1, 128.4, 128.8, 130.9, 133.1, 134.7, 136.0, 140.8. ESIMS $[M+Na]^+$ m/z 421.1.

Syntheisis of compound 7. 1,2-Diphenyl-1,1-bis(phenylthio)ethane (**6**) (0.23 mmol, 90 mg), $CuCl_2$ (0.58 mmol, 78 mg) and acetone (4.0 mL) were added to a flask, and the mixture was stirred for 0.5 h. The resulting solution was filtered, the filtrate was evaporated, and the residue was purified by column chromatography on silica gel to provide the desired product (**6**) in 70% yield (31 mg). 1,2-Diphenylethanone (**7**).[10] Eluent: petroleum ether/ethyl acetate (20:1). Yellow solid, m.p. 61-62 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 4.29 (s, 2H), 7.25-7.28 (m, 3H), 7.31-7.35 (m, 2H), 7.44-7.47 (m, 2H), 7.53-7.57 (m, 1H), 8.01-8.03 (m, 2H). ^{13}C NMR ($CDCl_3$, 100 MHz) δ 45.6, 127.0, 128.72, 128.76, 128.78, 129.6, 133.3, 134.6, 136.7, 197.7 ESIMS. $[M+Na]^+$ m/z 219.2.

Syntheisis of compounds 8 and 9



Syntheisis of compounds 8. 2-(4-Ethylphenyl)-2,2-bis(phenylthio)-*N*-benzenesulfonylethanamine (**4m**) (1 mmol, 505 mg) was dissolved in anhydrous THF (8 mL), and the solution was cooled to 0 ℃. NaH (1.5 mmol, 60 mg) was added to the solution, and the mixture was stirred at room temperature for 0.5 h, then benzyl chloride (1.5 mmol, 190 mg) in THF (2.0 mL) and tetrabutylammonium iodide (TBAI) (0.1 mmol, 37 mg) were added to the mixture at the same temperature. After a 5 h stirring at 60 ℃, the resulting solution was quenched with small amount of water at room temperature, and the solution was filtrated through a pad of silica gel. The filtrate was concentrated, and the residue was purified by column

chromatography to provide the desired product (**8**) in 90% yield (535 mg). N-Benzyl-*N*-(2-(4-ethylphenyl)-2,2-bis(phenylthio)ethyl)- benzenesulfonamide (**8**). Eluent: dichloromethane/petroleum ether (2:1). Yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 1.22-1.27 (t, 3H, *J* = 7.56 Hz), 2.59-2.67 (q, 2H, *J* = 7.56 Hz), 4.10 (s, 2H), 4.20 (s, 2H), 6.74-6.77 (m, 2H), 7.02-7.26 (m, 15H), 7.34-7.39 (m, 2H), 7.49-7.58 (m, 5H). ^{13}C NMR ($CDCl_3$, 75 MHz) δ 15.6, 28.4, 51.9, 56.9, 70.7, 127.3, 127.7, 127.8, 127.9, 128.1, 128.2, 128.5, 128.6, 129.3, 132.3, 133.2, 133.6, 135.4, 136.4, 140.8, 144.4. ESIMS $[M+Na]^+$ m/z 618.4.

Syntheisis of compounds 9. *N*-Benzyl-*N*-(2-(4-ethylphenyl)-2,2-bis(phenylthio)-ethyl)benzenesulfonamide (**8**) (0.5 mmol, 298 mg) was dissolved in CH_3CN (2.5 mL and saturated $NaHCO_3$ aqueous solution (2.5 mL), the solution was cooled to 0 ℃, and I_2 (1.25 mmol, 320 mg) was added protionwise to the solution. After 2 h, the mixture was quenched with a saturated aqueous $Na_2S_2O_3$ solution (1.0 mL). The solution was extracted with ethyl acetate (3×5 mL), the combined organic phase was dried over anhydrous Na_2SO_4. The filtrate was concentrated by a rotary evaporator, and the residue was purified by a column chromatography on silica gel to provide the desired product (**9**) in 85% yield (206 mg). *N*-Benzyl-*N*-(2-(4-ethylp henyl)-2-(phenylthio)vinyl)benzenesulfonamide (**9**). Eluent: dichloromethane/ petroleum ether (2:1). Yellow solid, m.p. 88-89 ℃. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 1.15-1.18 (t, 3H, *J* = 7.56 Hz), 2.51-2.57 (q, 2H, *J* = 7.64 Hz), 4.18 (s, 2H), 6.69 (s, 1H), 6.75-6.77 (d, 2H, *J* = 8.28 Hz), 6.85-6.90 (m, 4H), 7.02-7.10 (m, 5H), 7.16-7.25 (m, 3H), 7.56-7.60 (m, 2H), 7.65-7.69 (m, 1H), 7.84-7.86 (m, 2H). ^{13}C NMR ($CDCl_3$, 75 MHz) δ 15.3, 28.6, 51.6, 126.5, 127.2, 127.4, 127.5, 127.7, 128.30, 128.34, 128.8, 129.2, 129.4, 129.7, 130.3, 133.1, 133.4, 135.1, 135.7, 138.9, 144.7. HR-MS (ESI) $[M+H]^+$ m/z calcd for $C_{29}H_{27}NNaO_2S_2$ 508.1381, found 508.1364.

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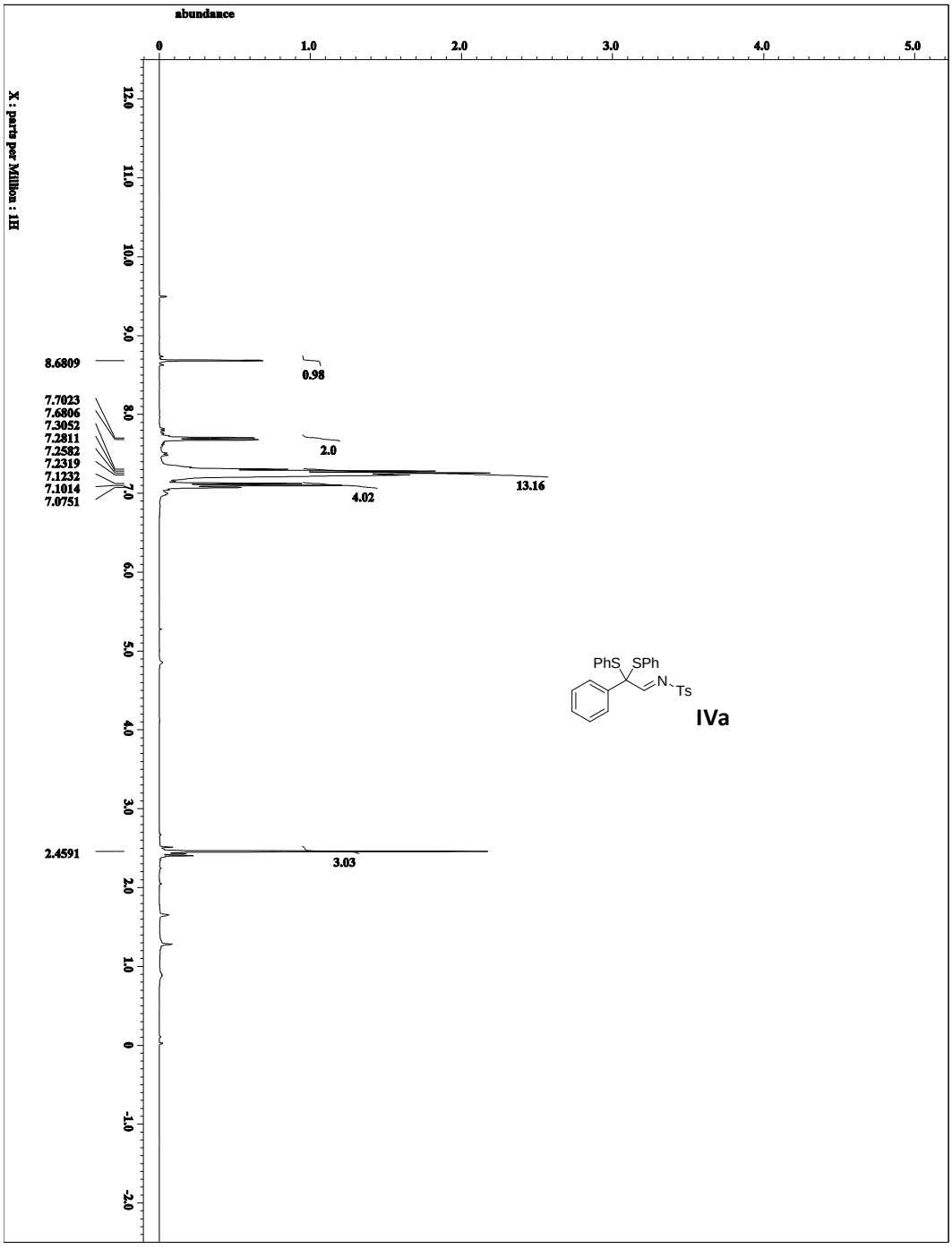
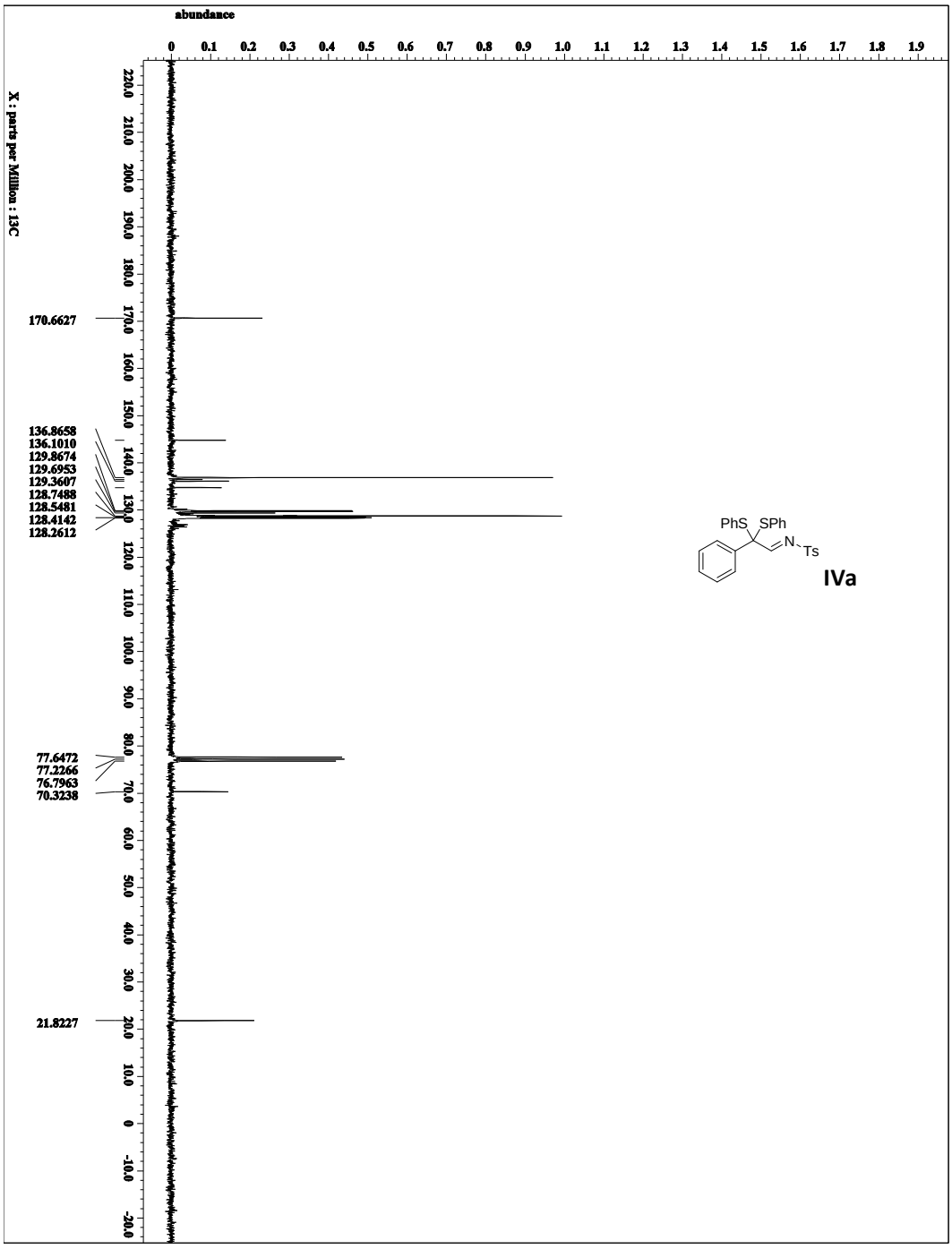
^{1}H and ^{13}C NMR spectra of compounds **IVa**, **3**, **4** and **6-10**

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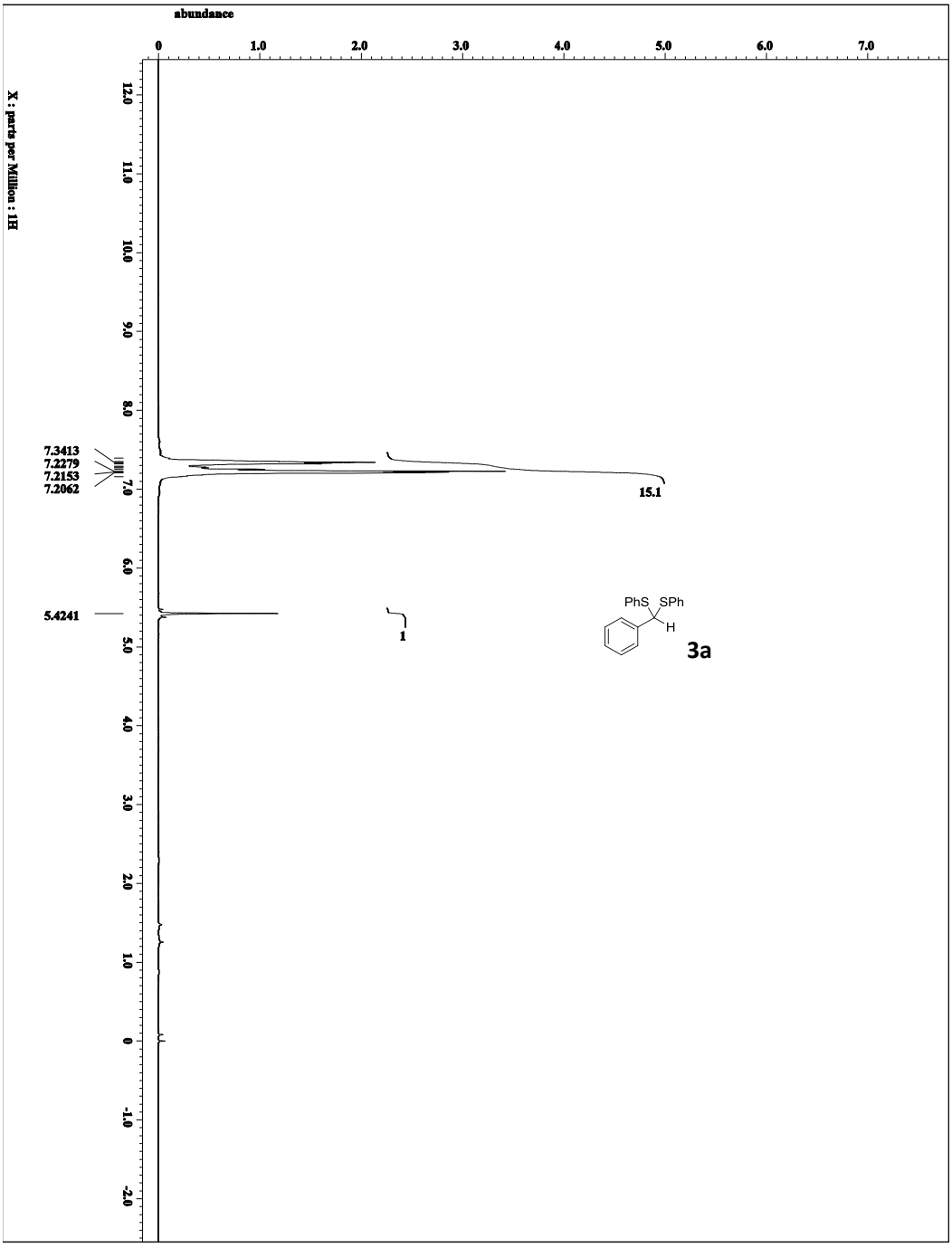
IVa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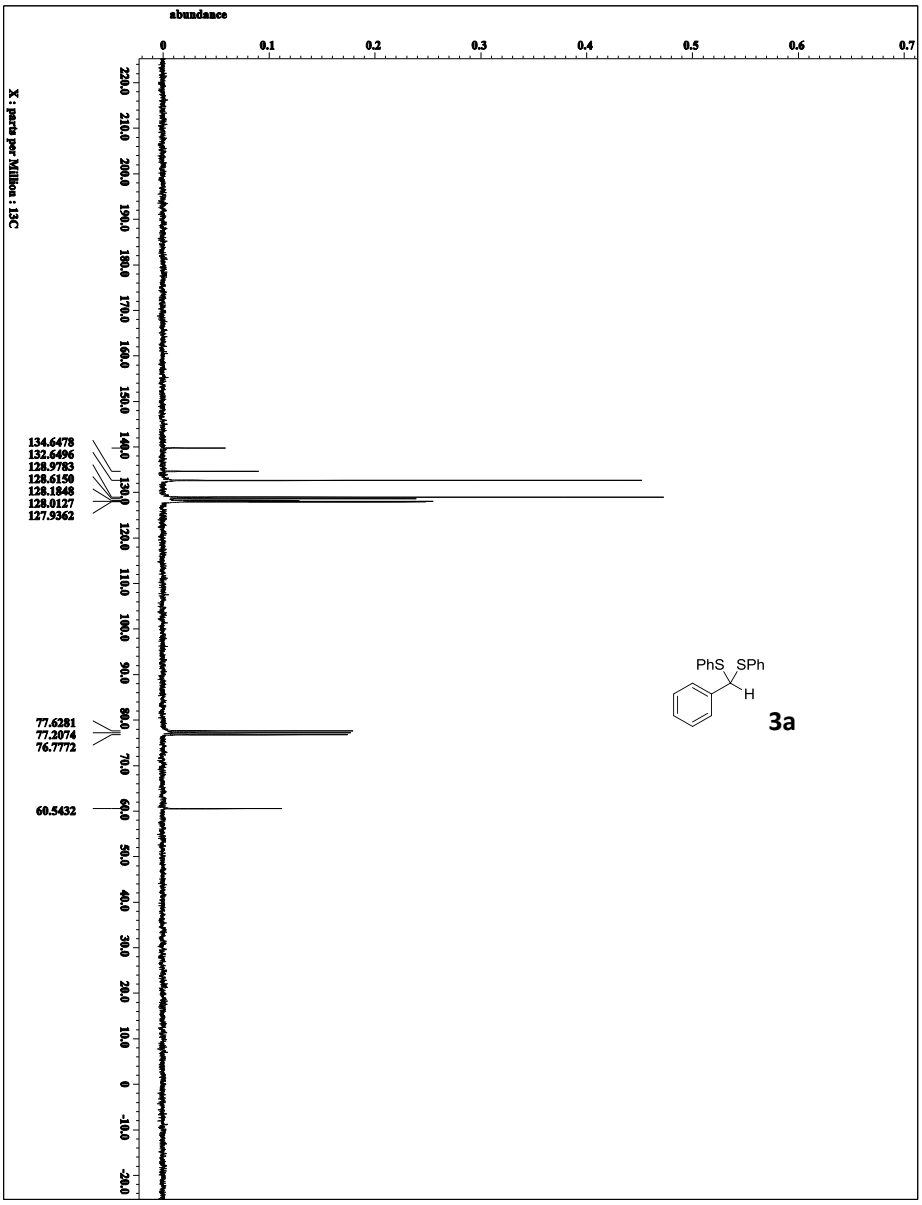
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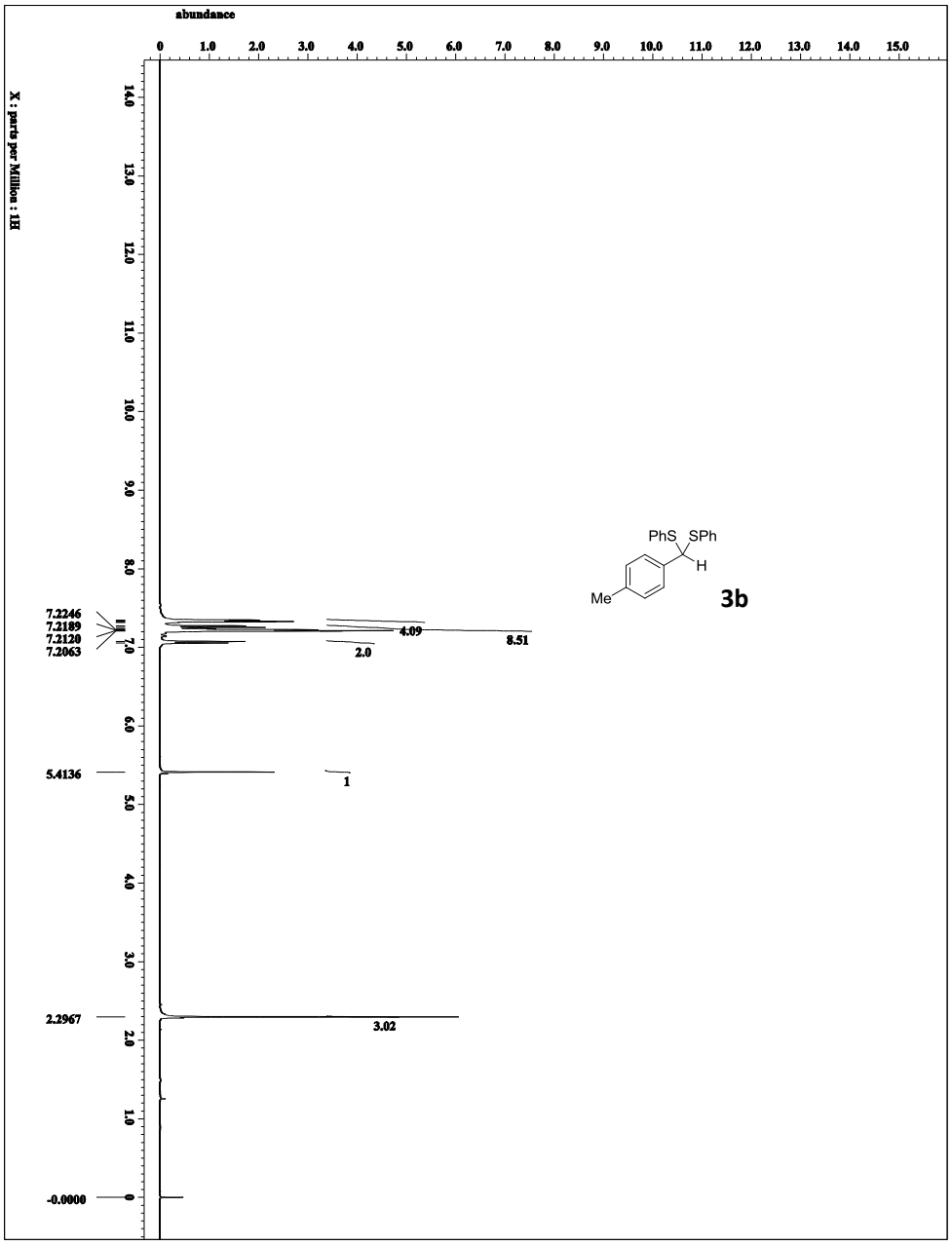
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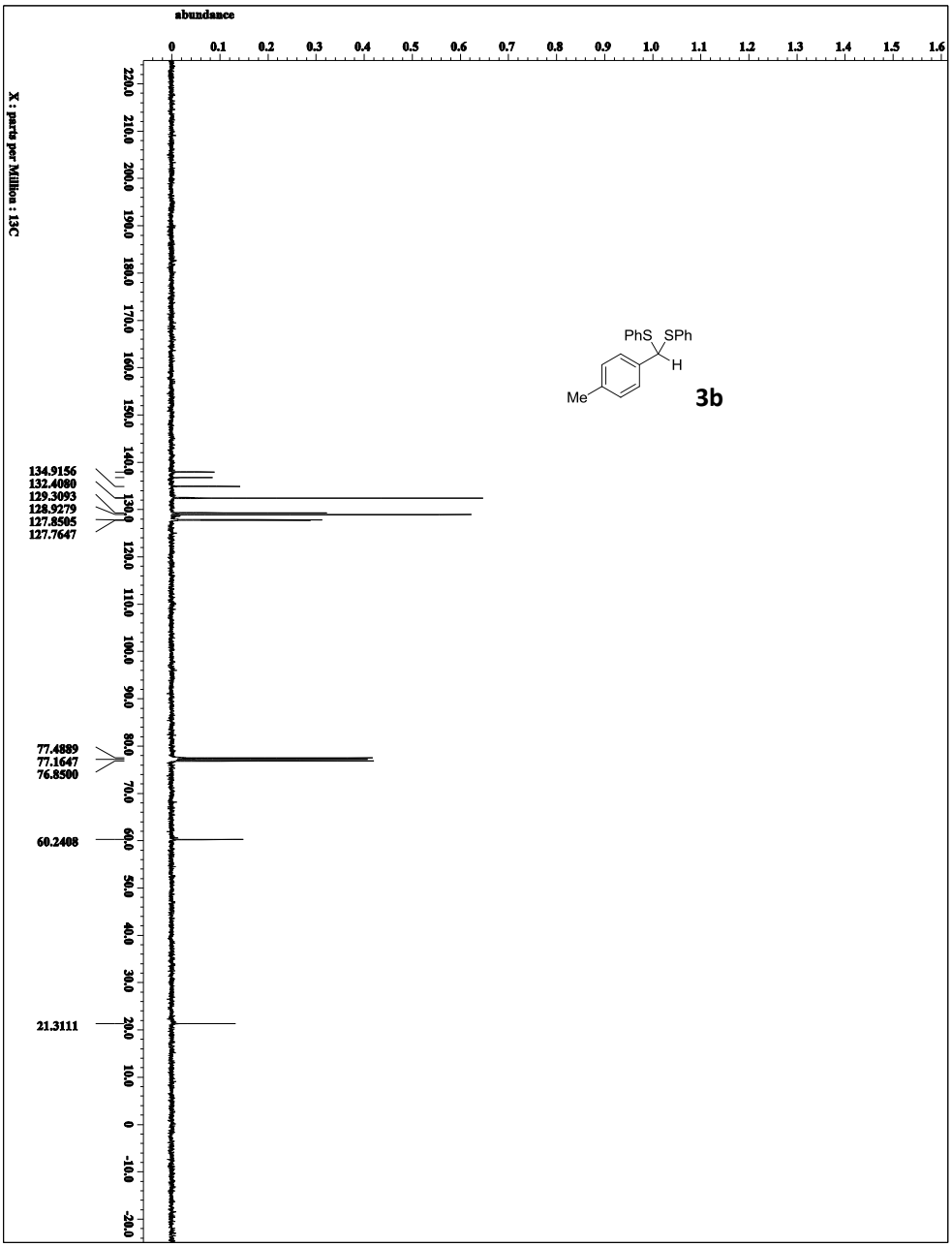
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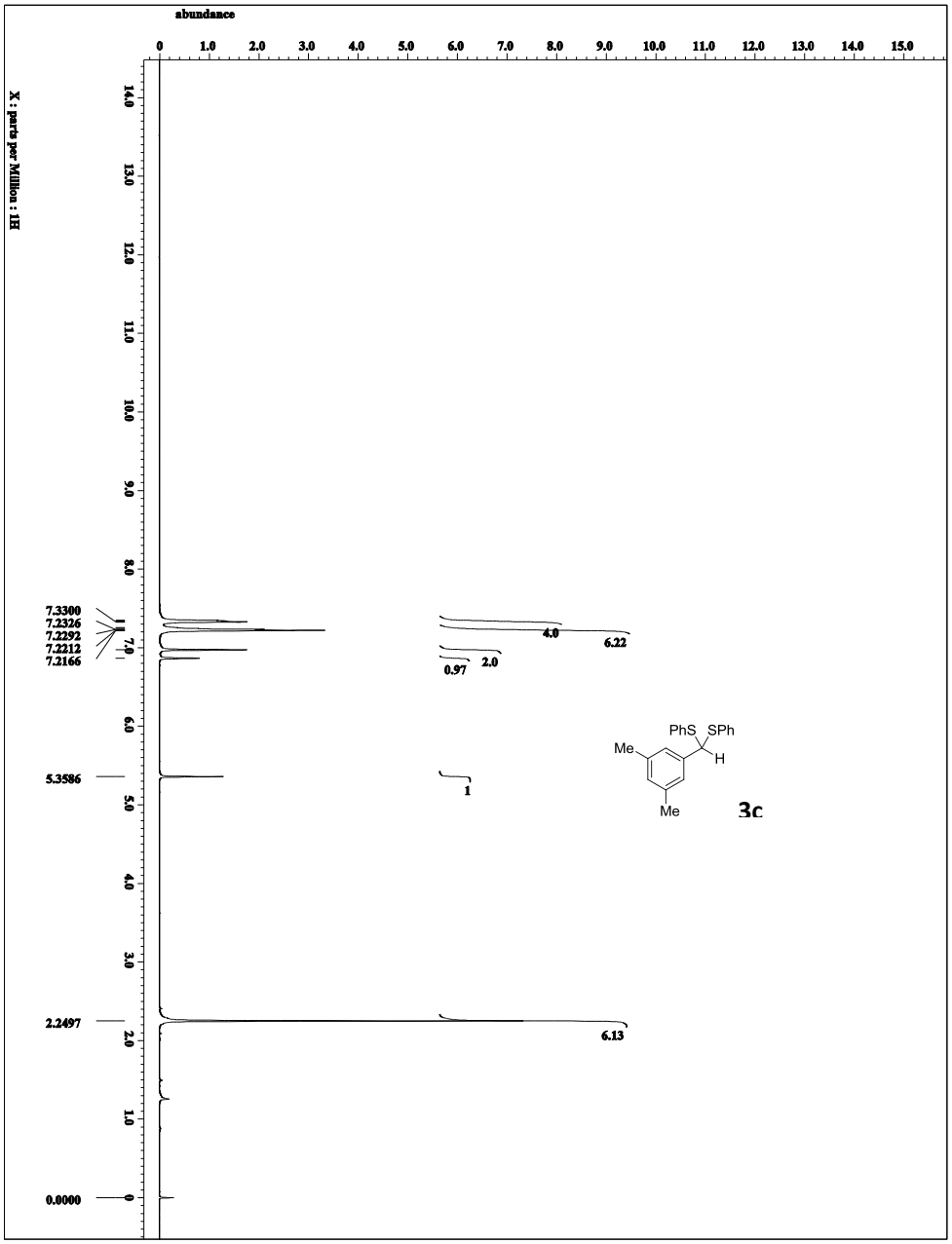
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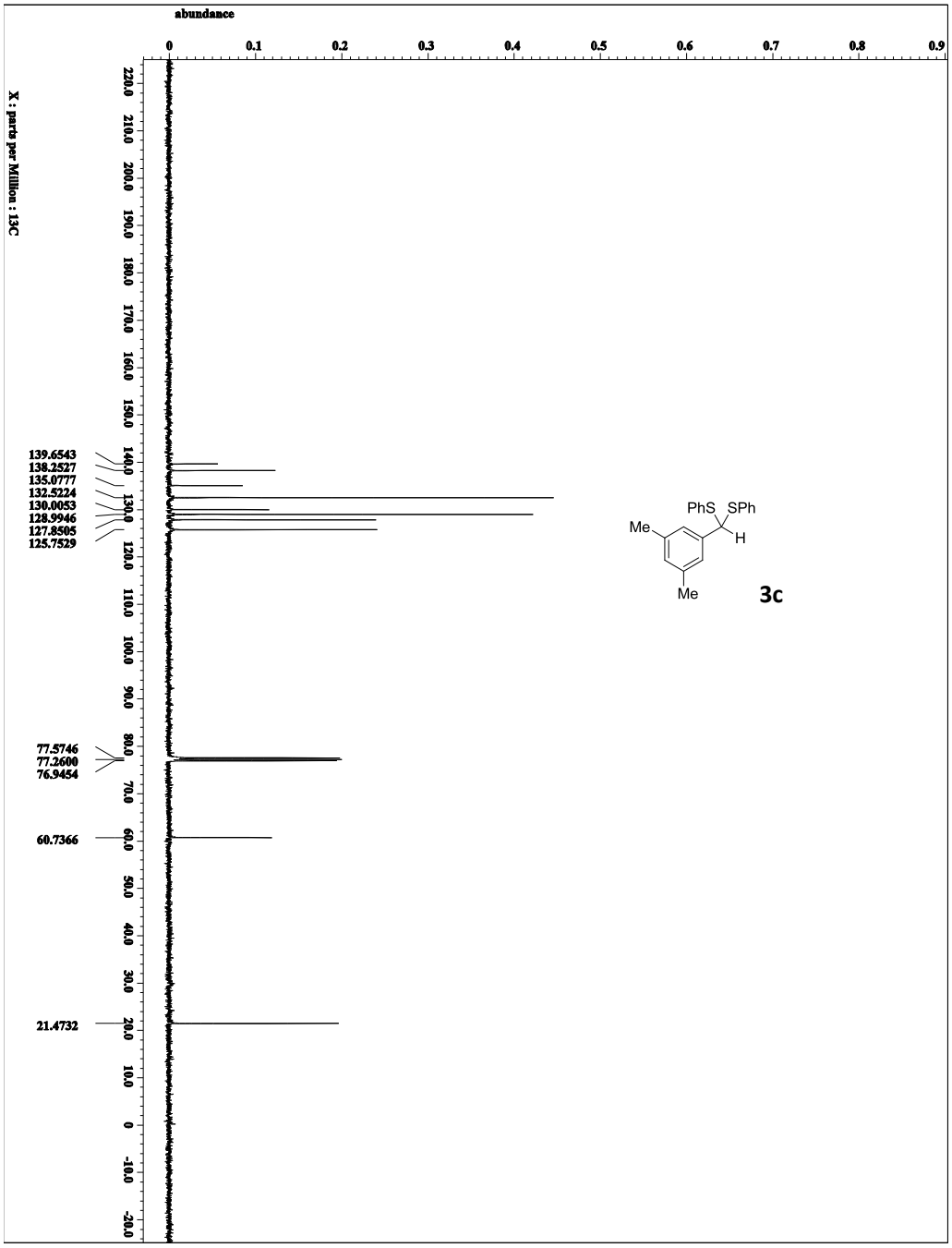
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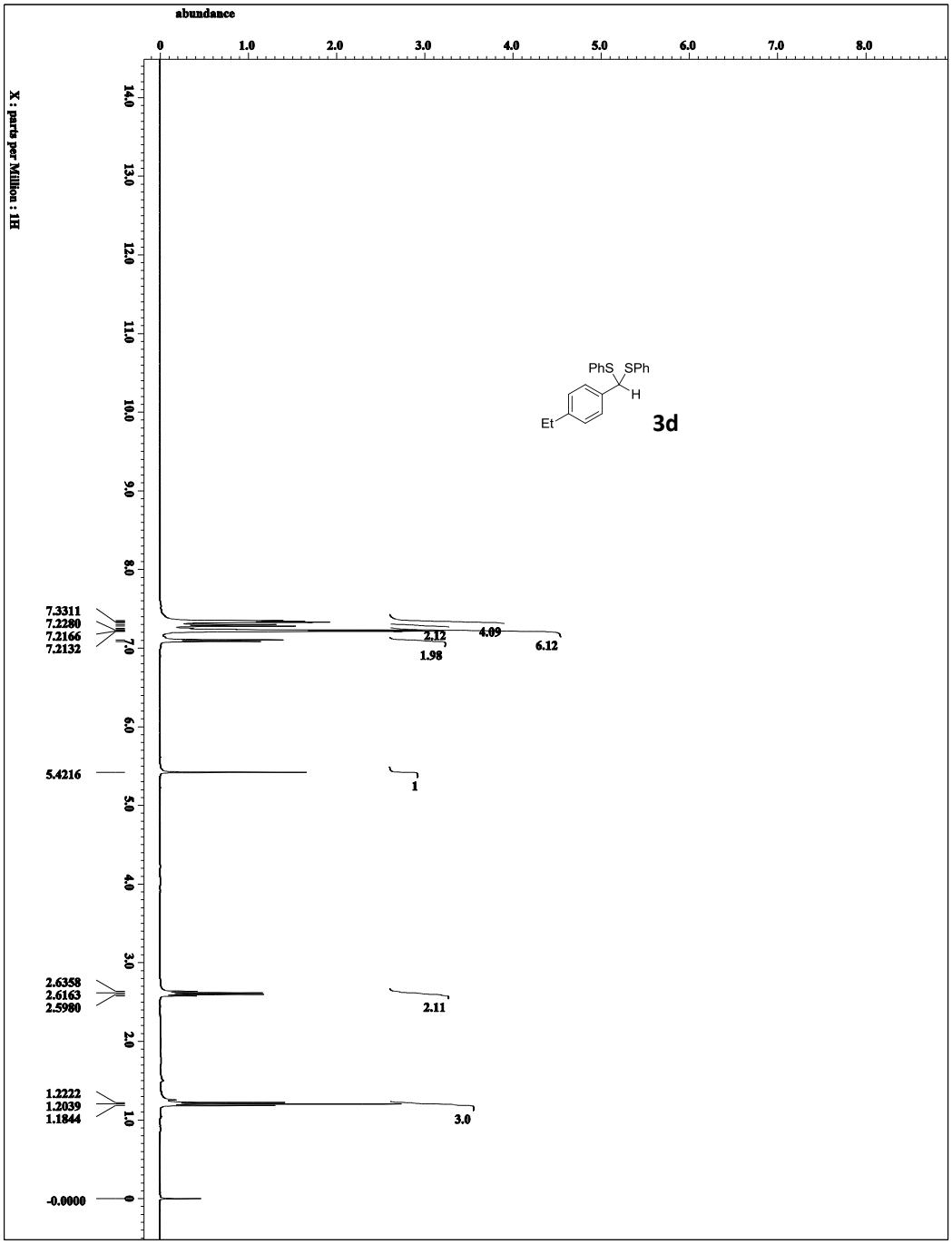
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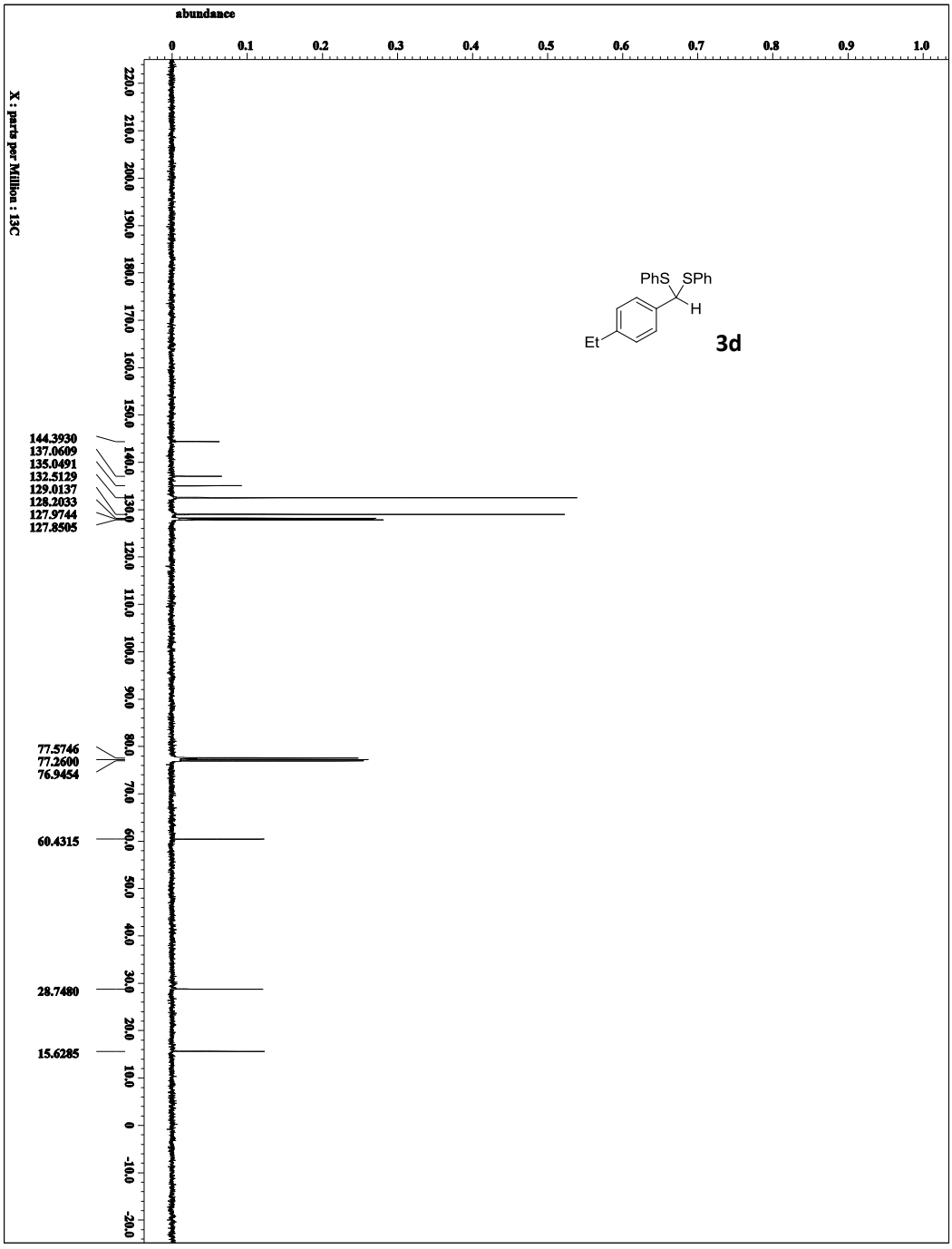
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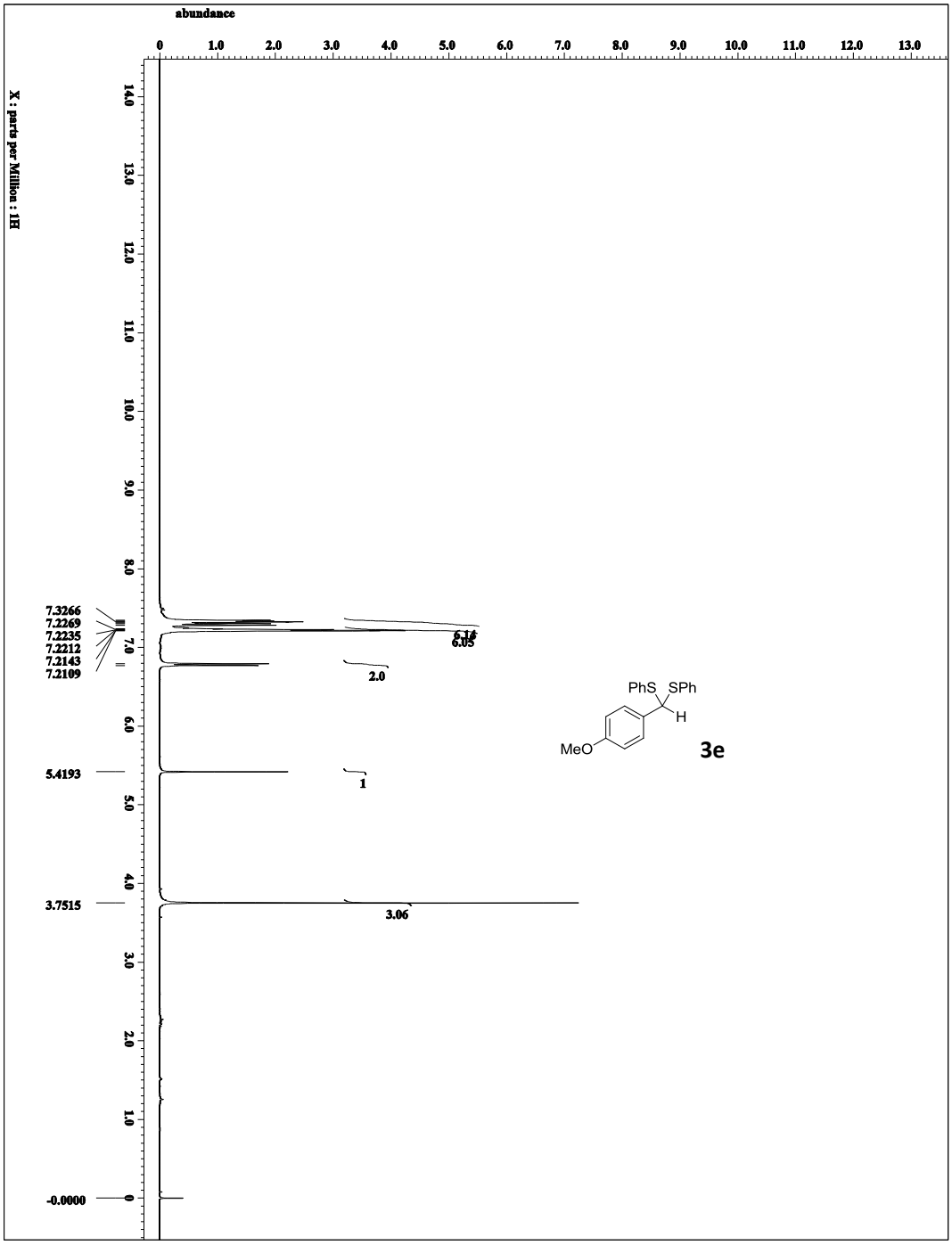
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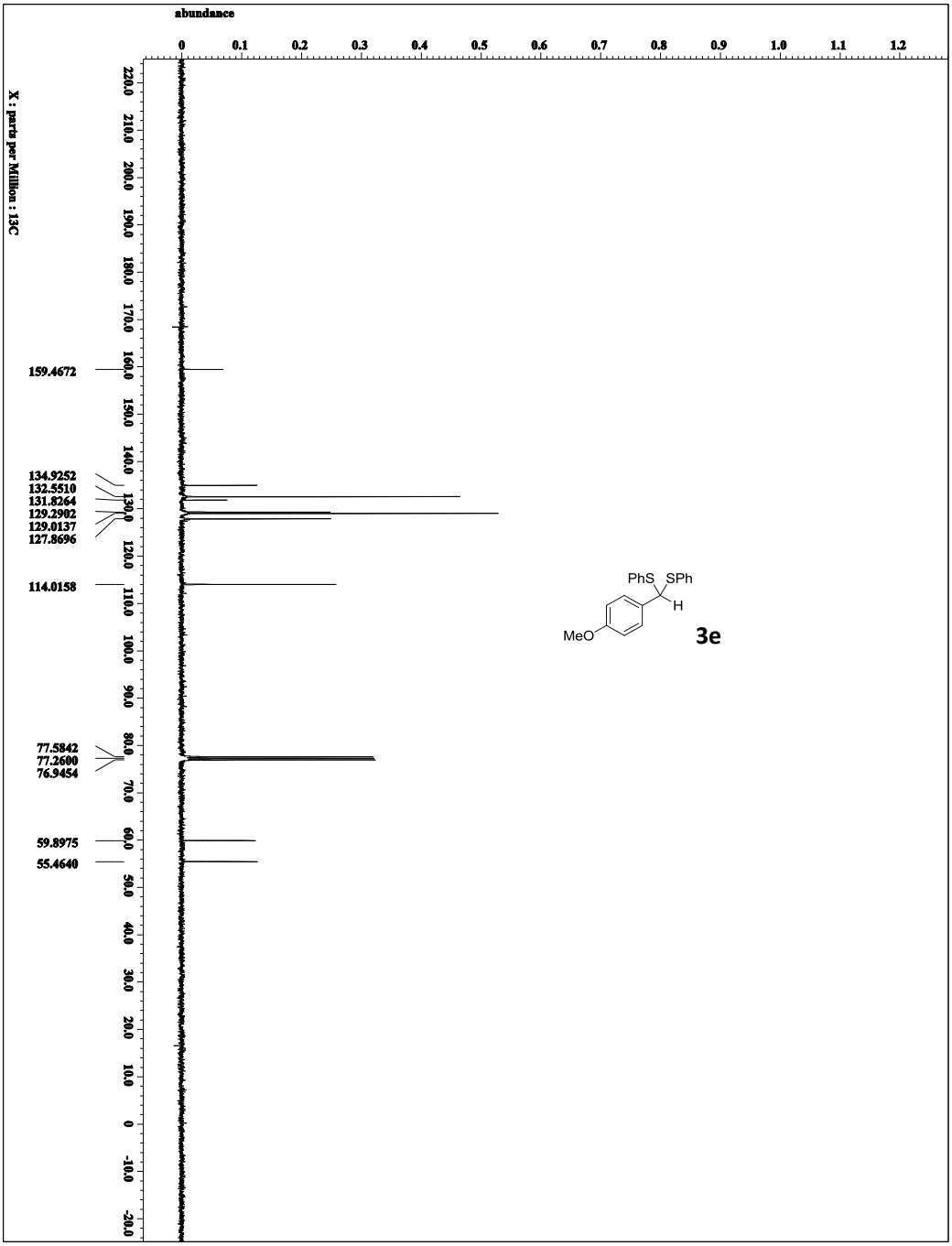
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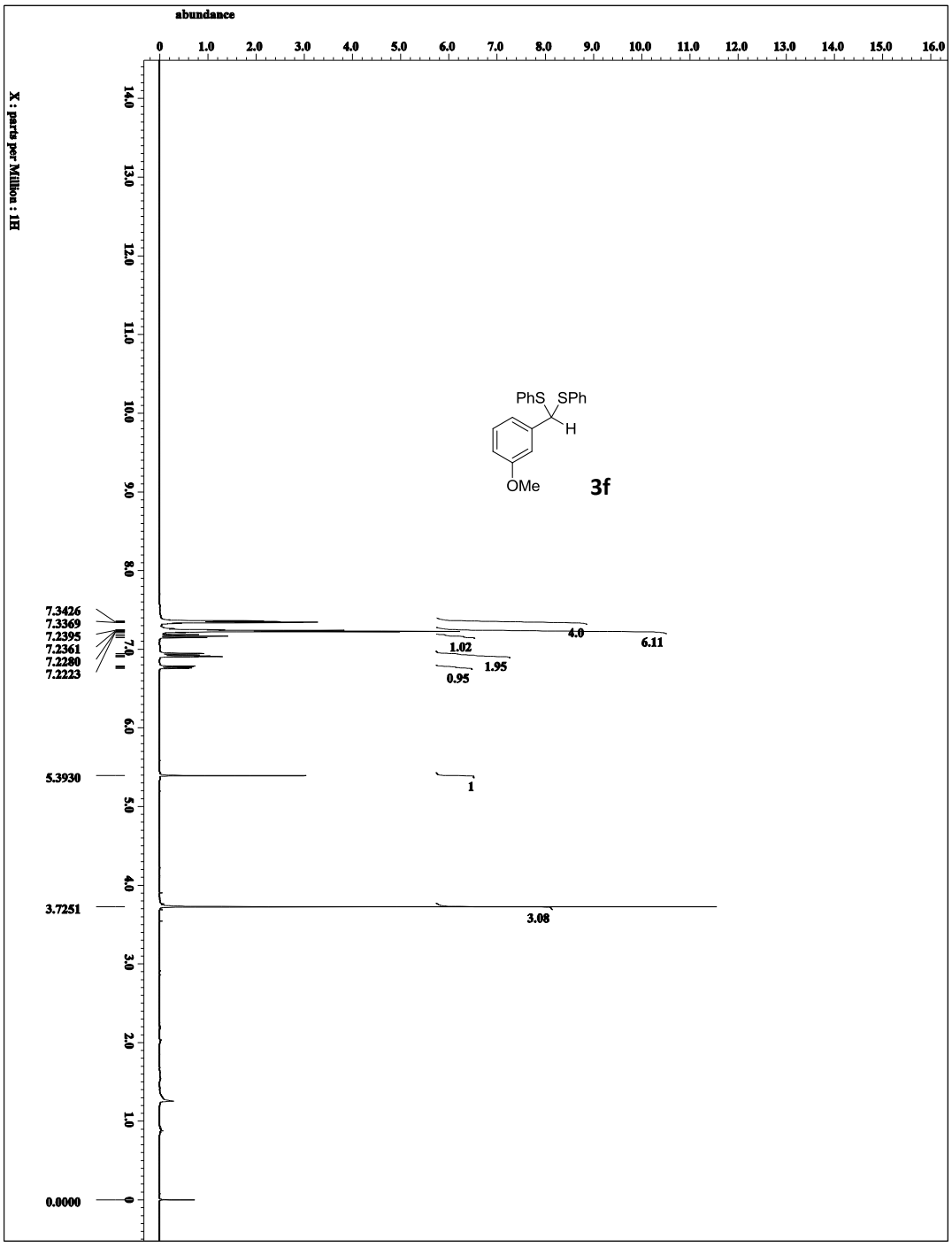
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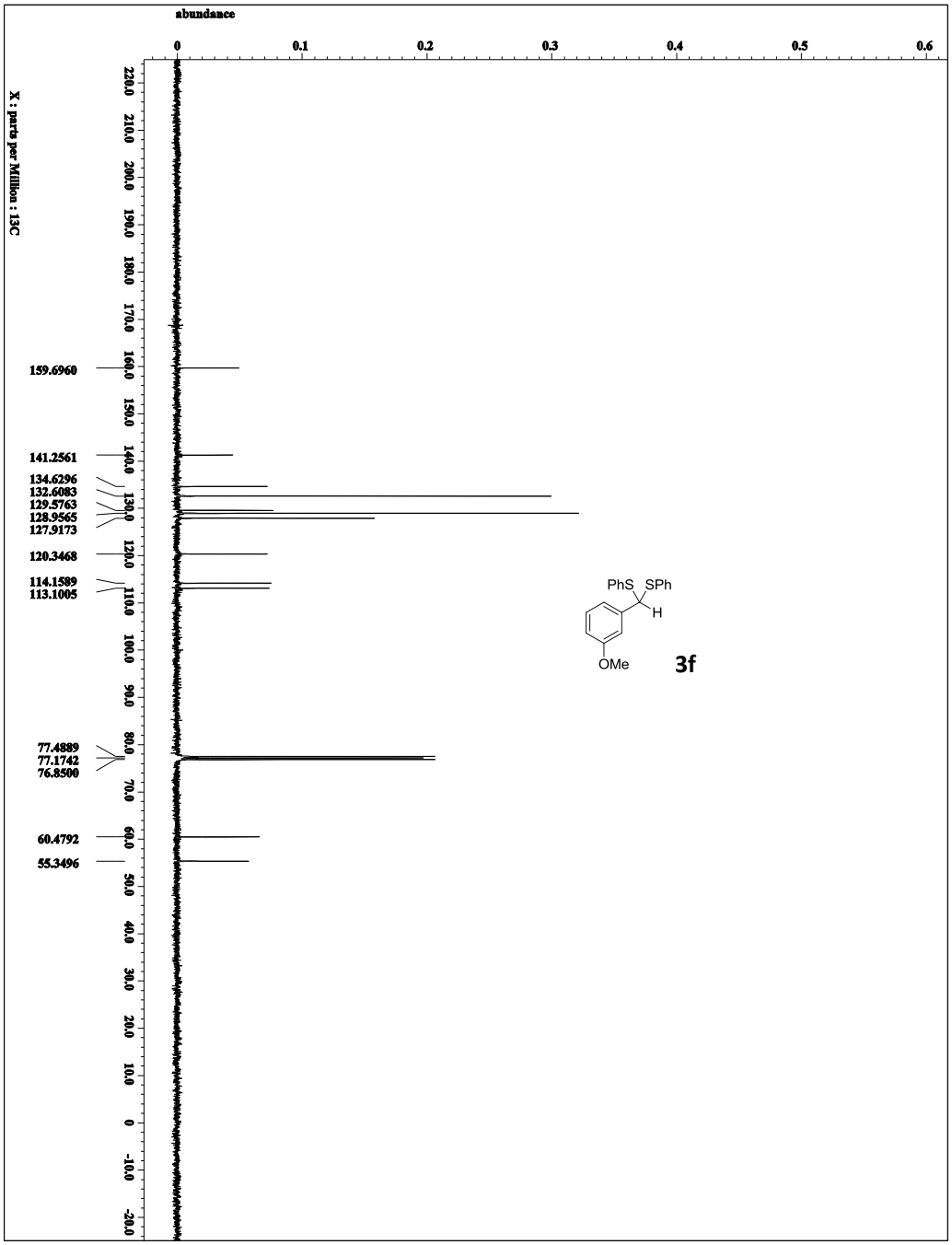
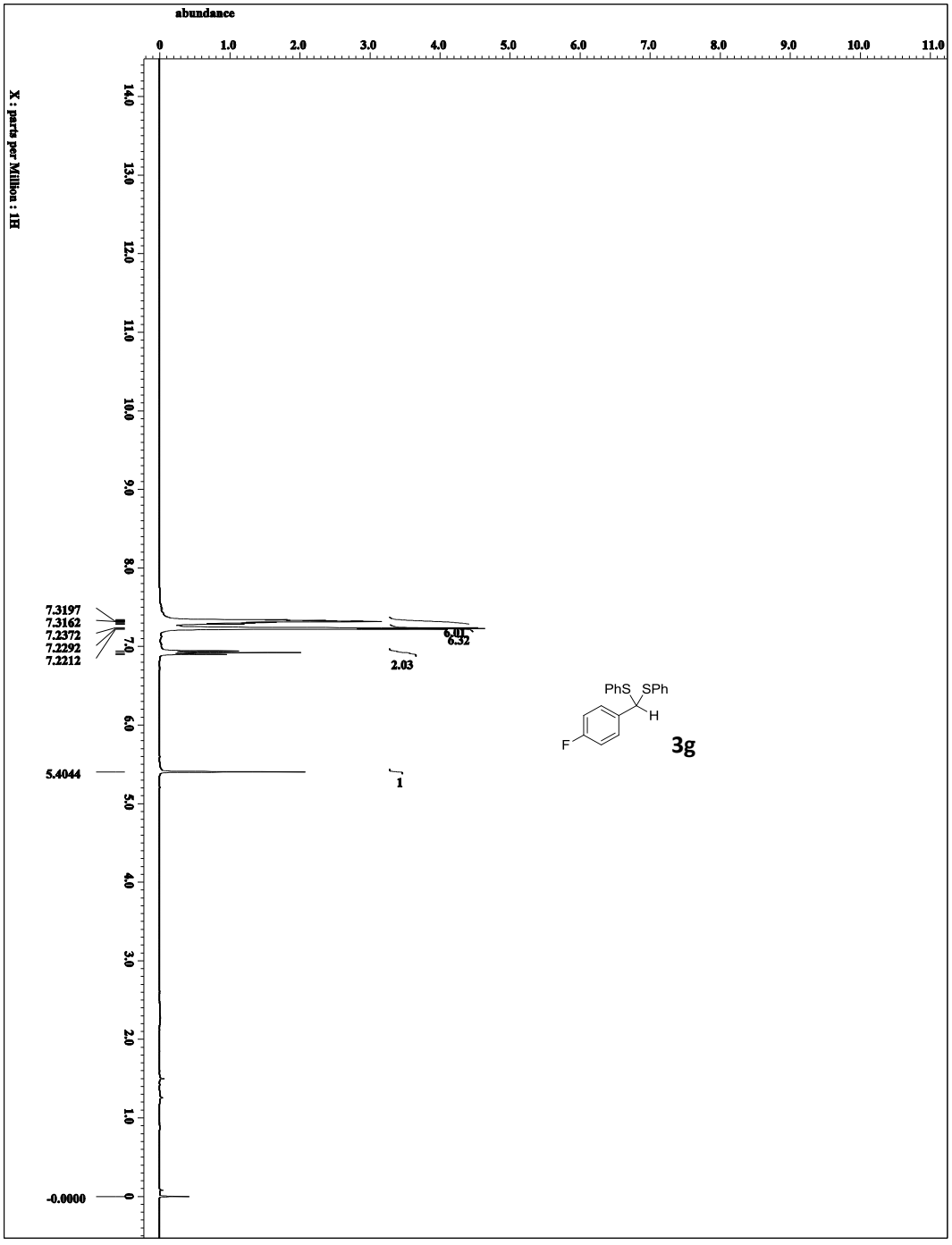
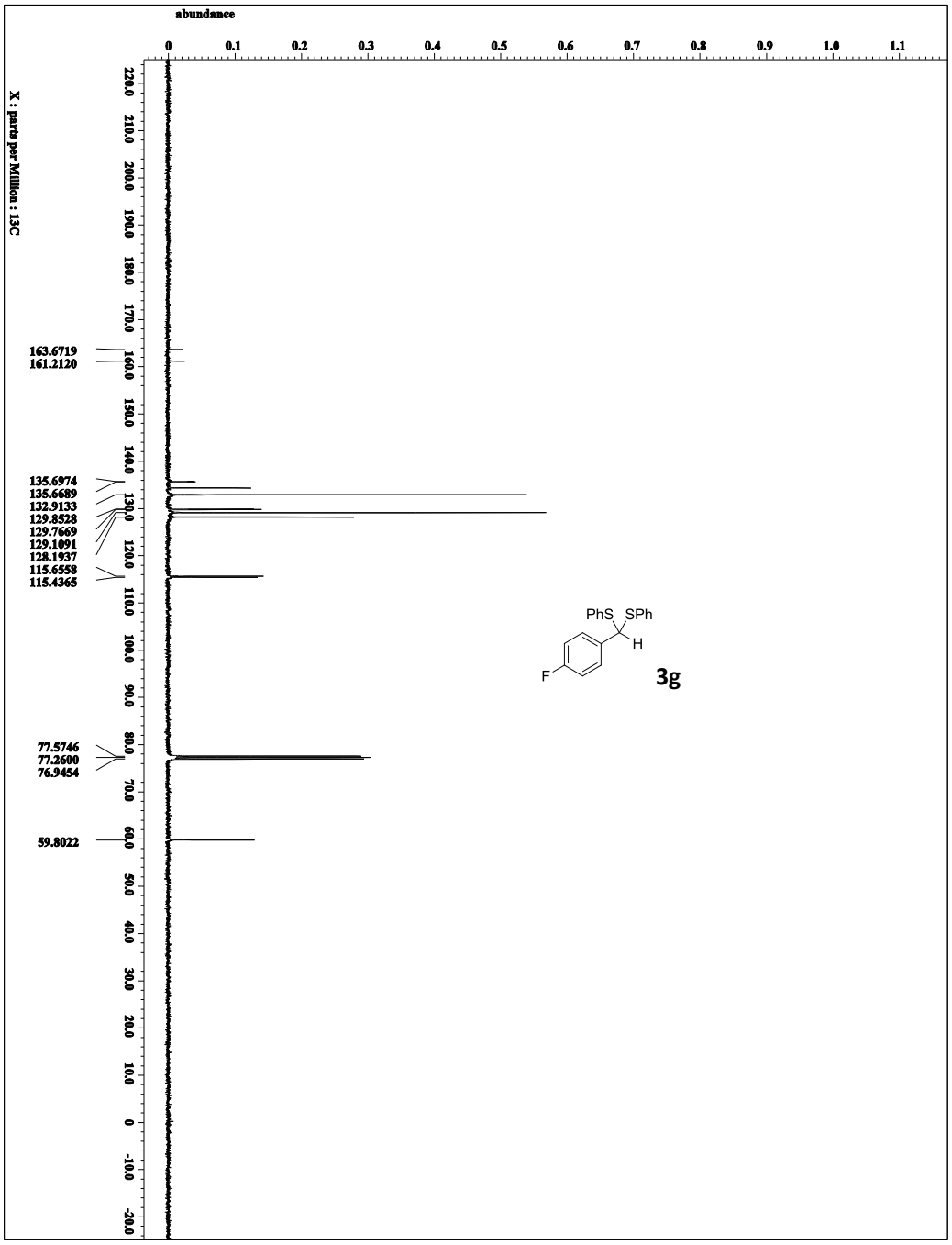
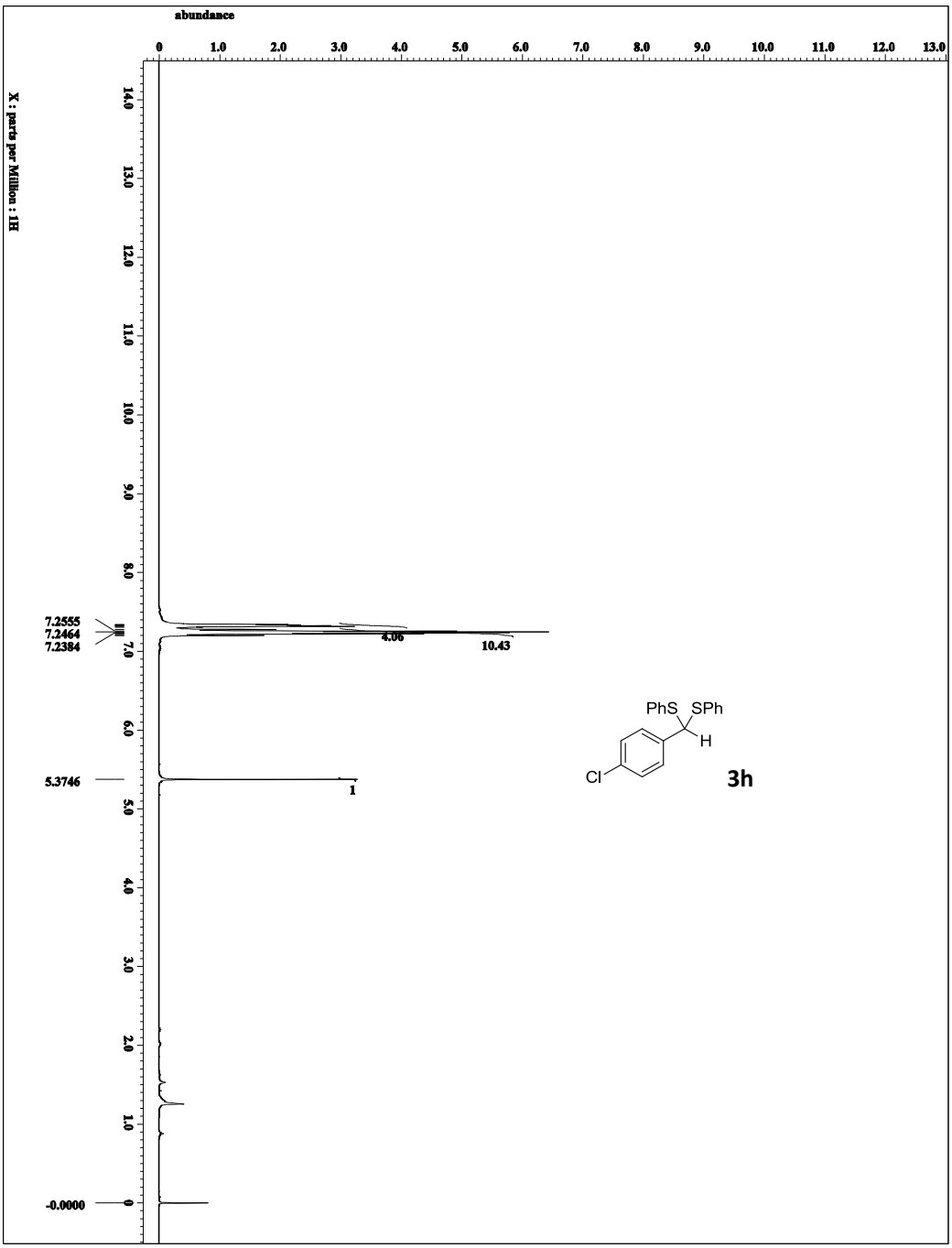
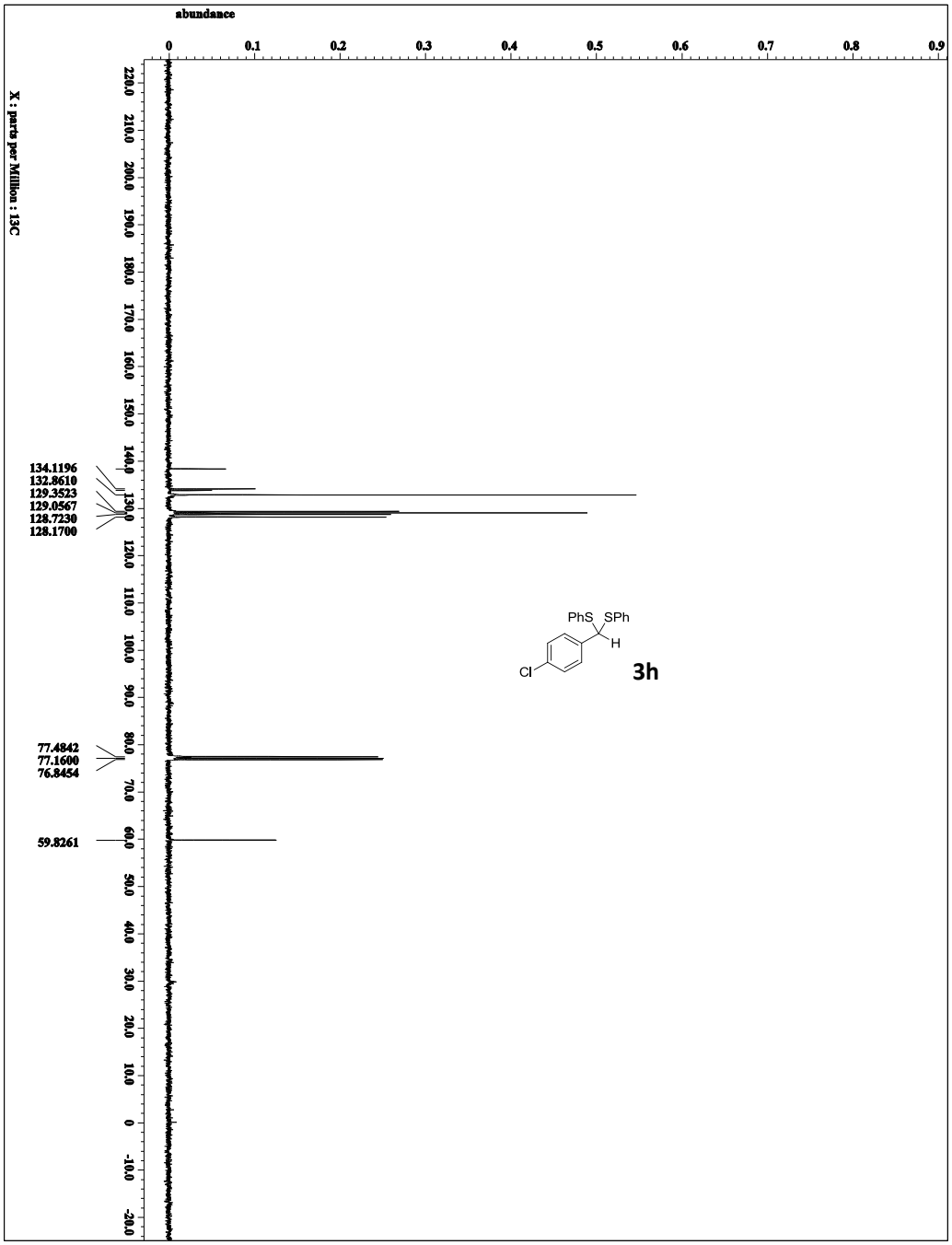
1
3.08

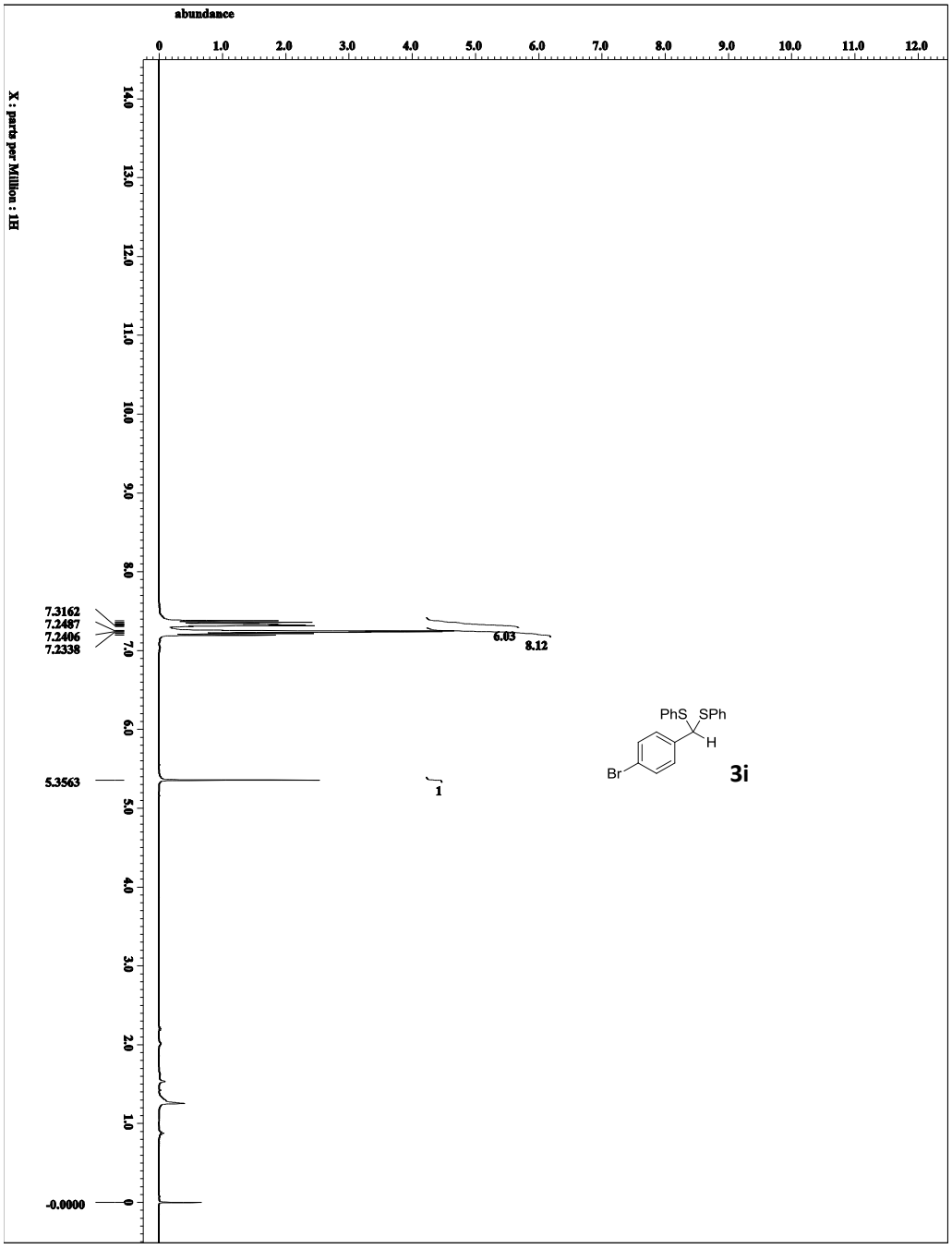

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
X : parts per Million : 13C
159.6960
141.2561
134.6296
132.6083
129.5763
128.9565
127.9173
120.3468
114.1589
113.1005
77.4889
77.1742
76.8500
60.4792
55.3496
PhS
SPh
H
OMe
3f

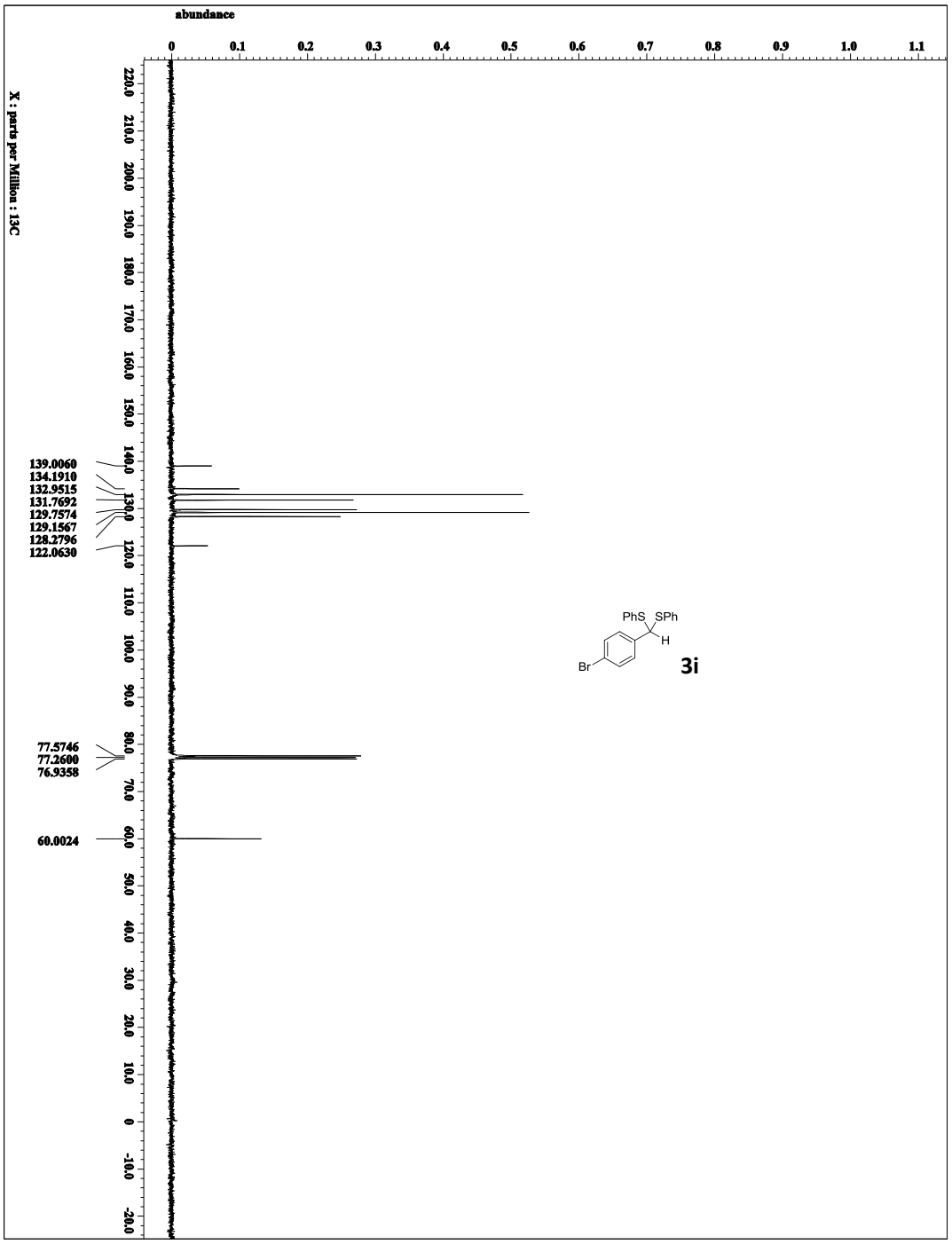

abundance
X : parts per Million : 1H
7.3197
7.3162
7.2372
7.2292
7.2212
5.4044
-0.0000
6.01
6.32
2.03
1
PhS
SPh
H
F
3g

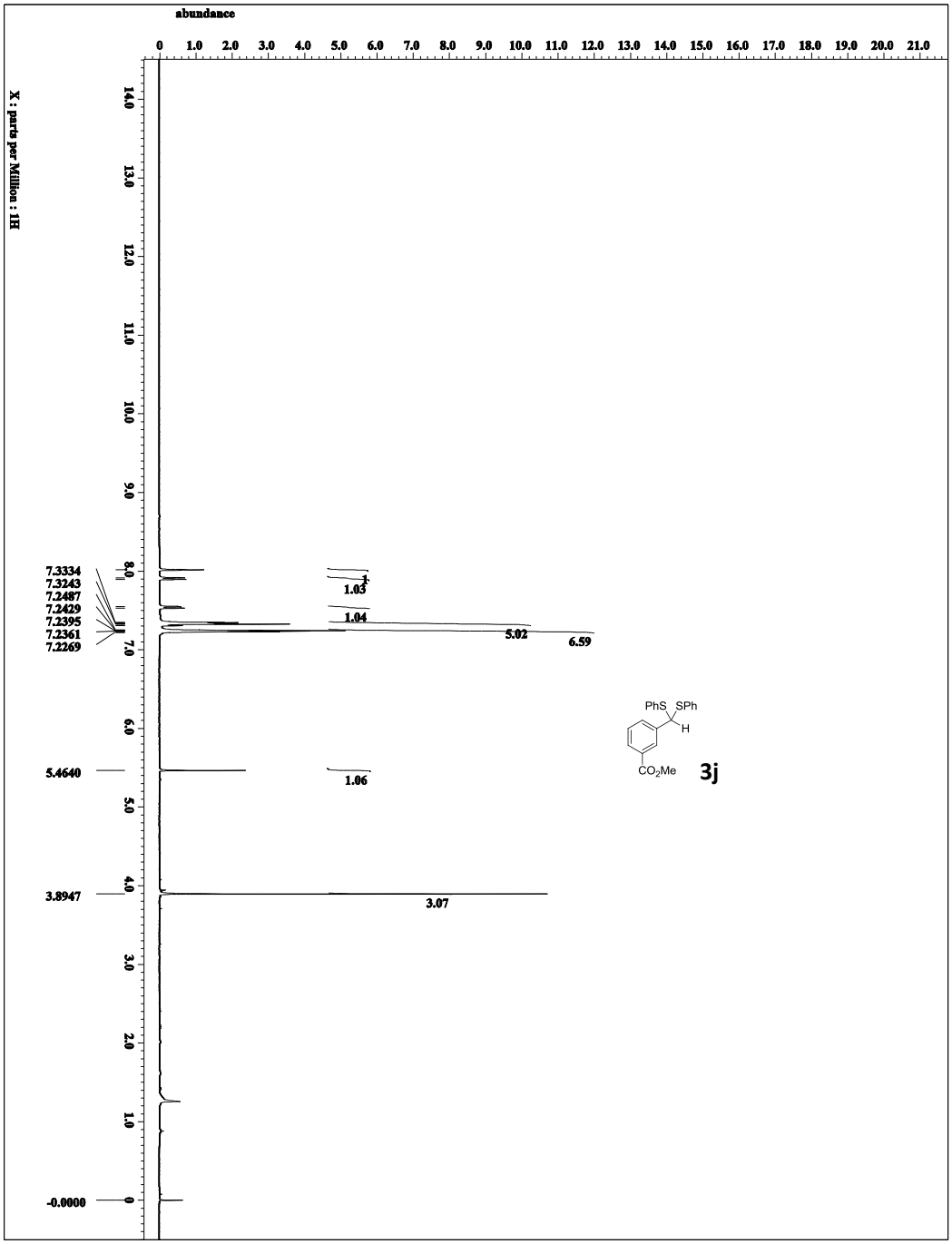

abundance
X : parts per Million : 13C
163.6719
161.2120
135.6974
135.6689
132.9133
129.8528
129.7669
129.1091
128.1937
115.6558
115.4365
77.5746
77.2600
76.9454
59.8022
PhS SPh
H
F
3g

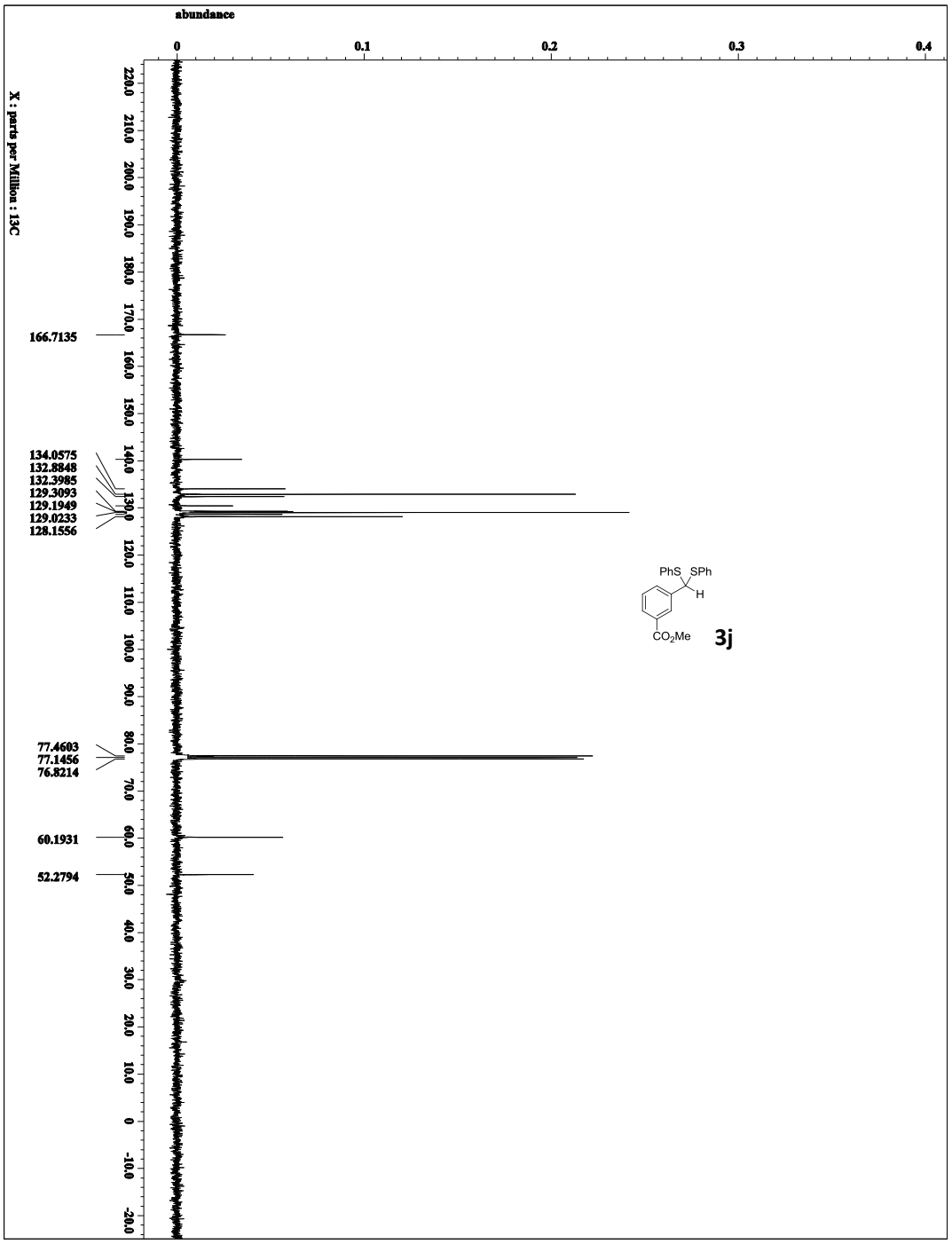

abundance
X : parts per Million : 1H
7.2555
7.2464
7.2384
4.06
10.43
5.3746
1
-0.0000
PhS
SPh
H
Cl
3h

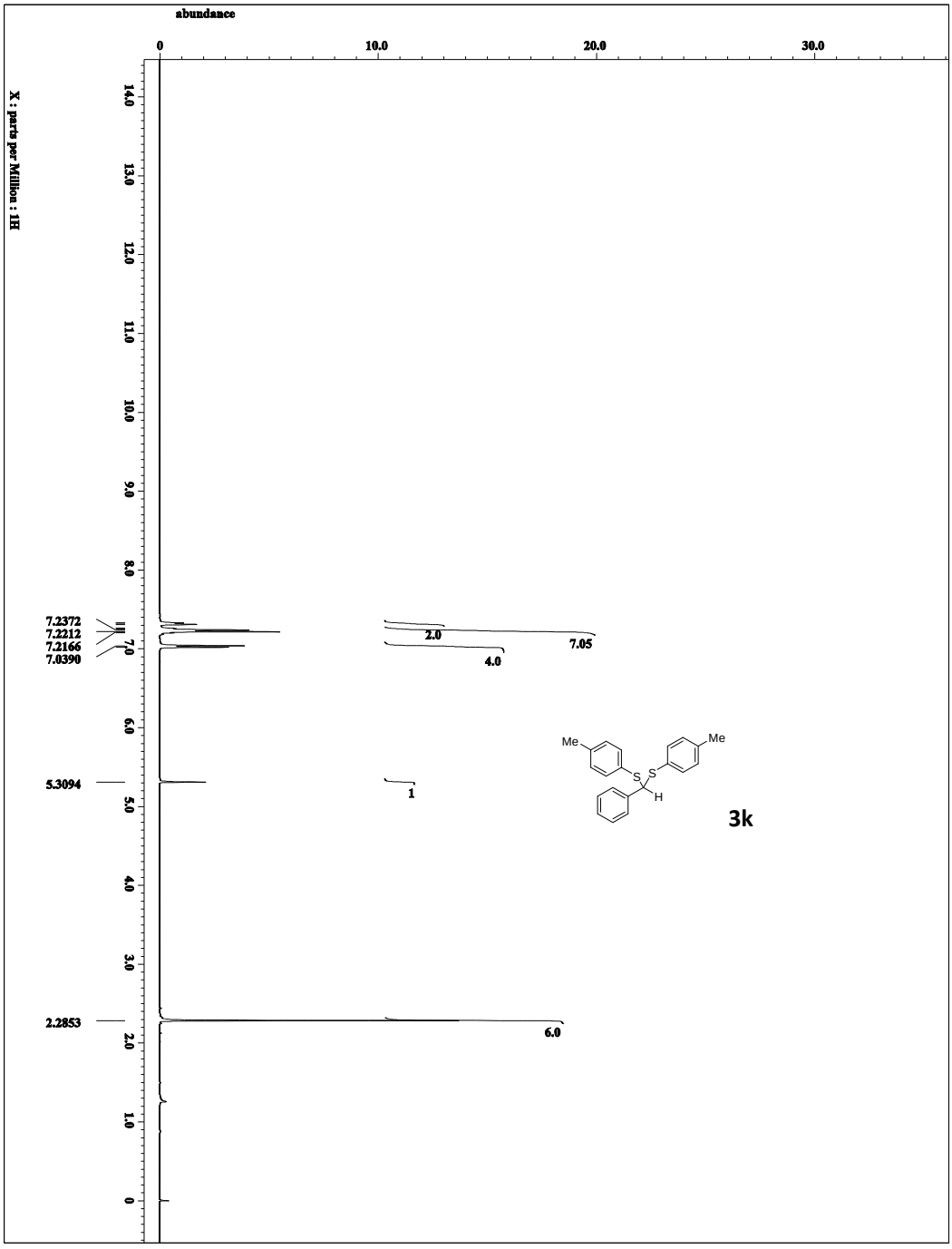

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
134.1196
132.8610
129.3523
129.0567
128.7230
128.1700
77.4842
77.1600
76.8454
59.8261
PhS
SPh
H
Cl
3h

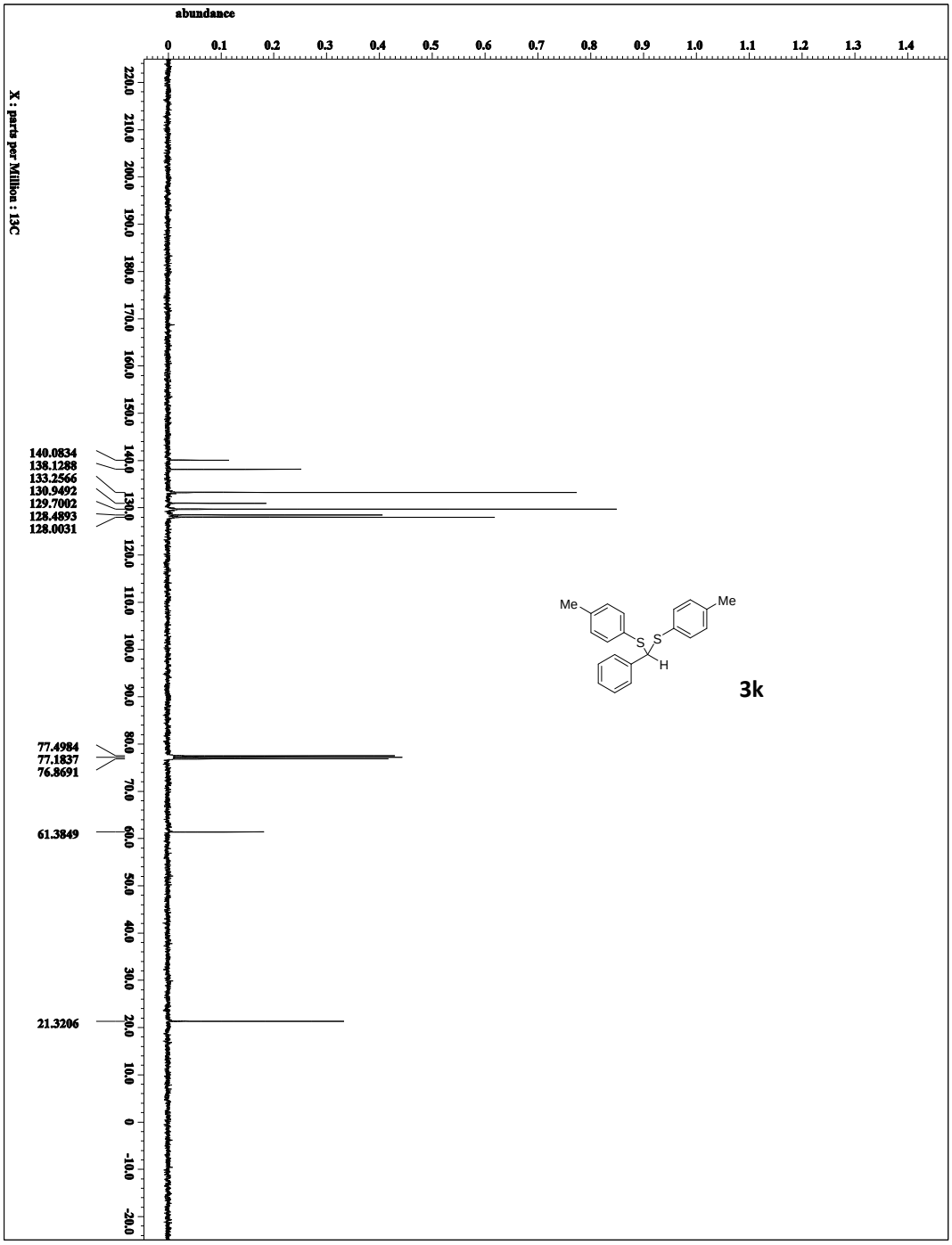

abundance
X : parts per Million : 1H
7.3162
7.2487
7.2406
7.2338
6.03
8.12
5.3563
1
-0.0000
PhS
SPh
H
Br
3i

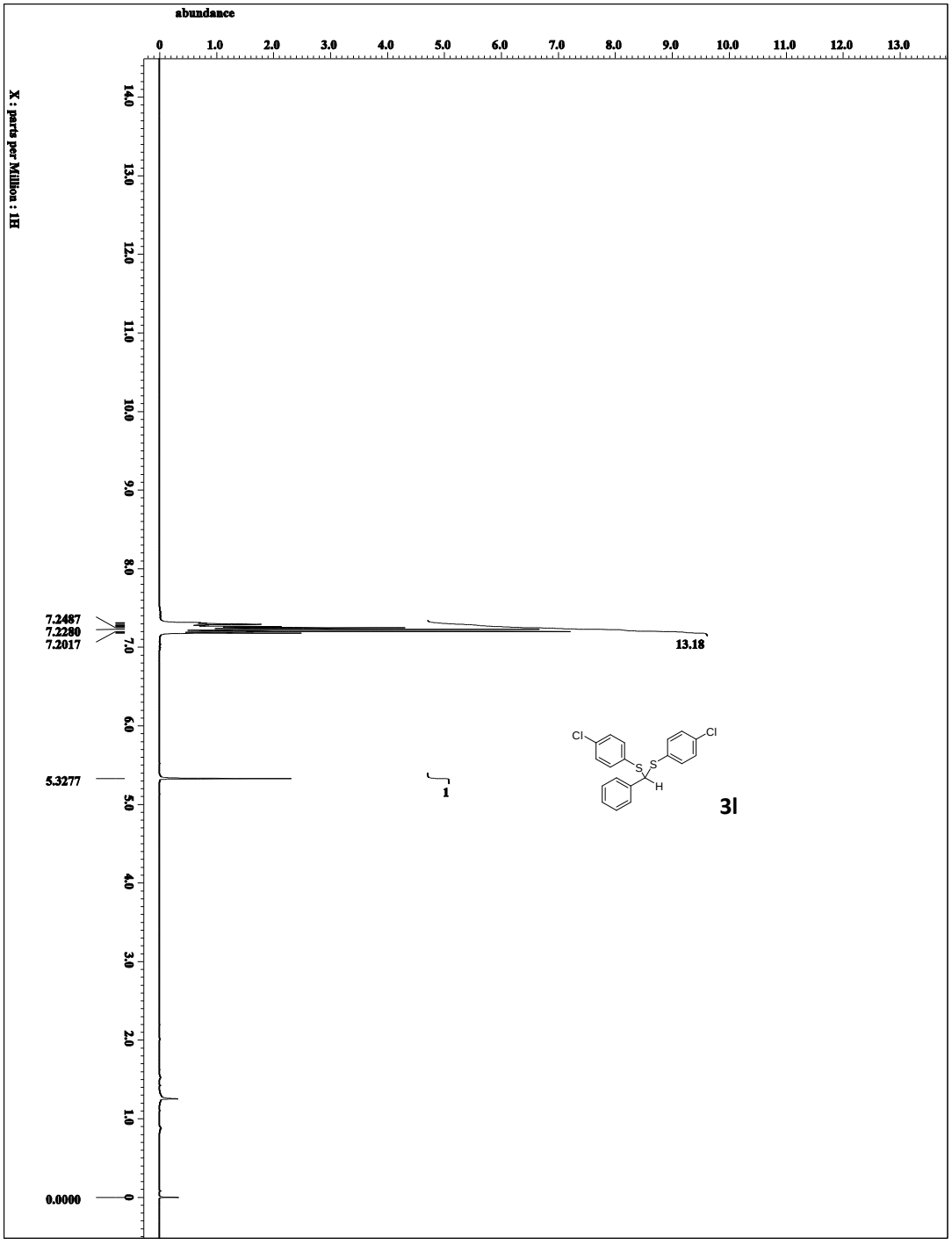

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
139.0060
134.1910
132.9515
131.7692
129.7574
129.1567
128.2796
122.0630
77.5746
77.2600
76.9358
60.0024
PhS
SPh
H
Br
3i

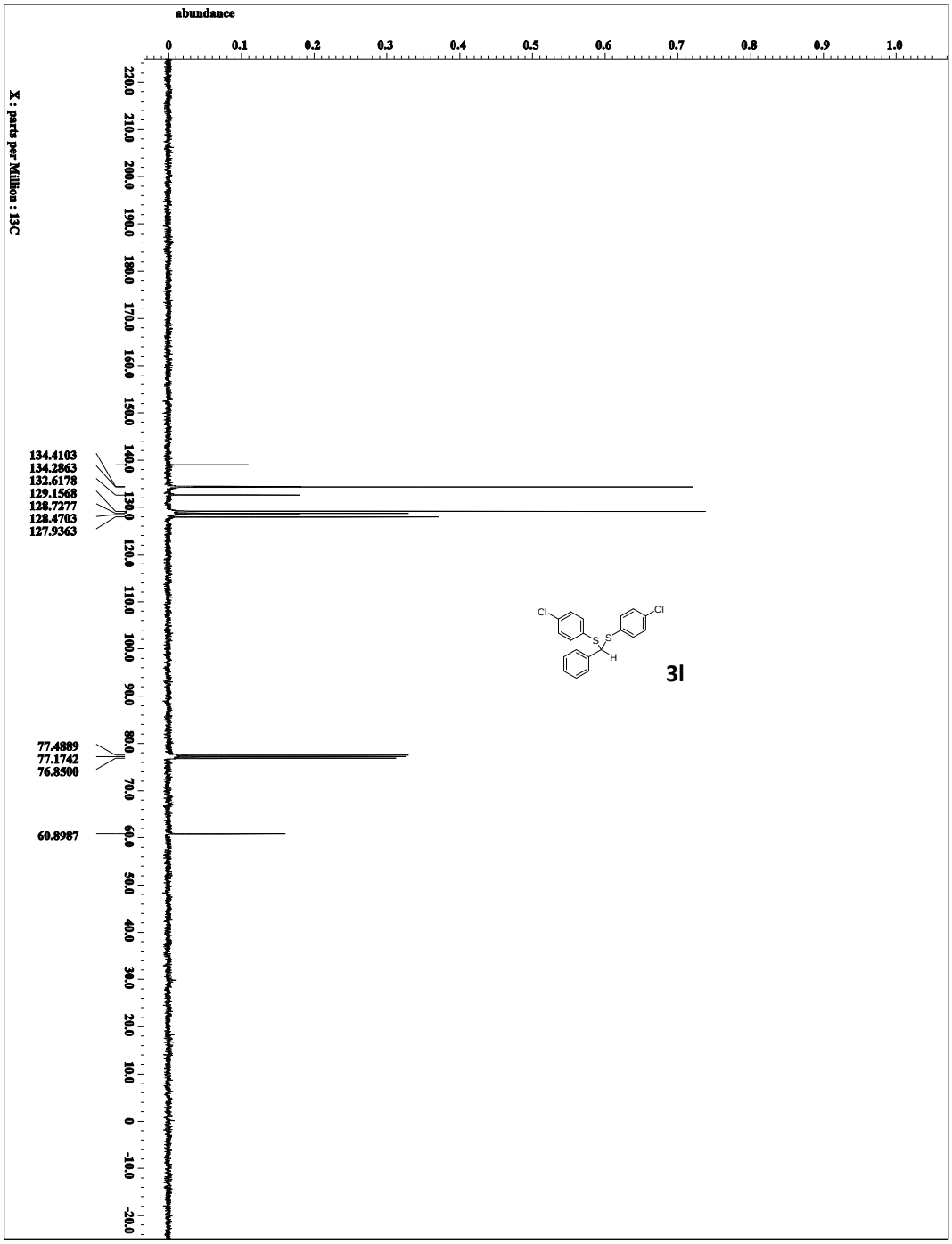

abundance
X : parts per Million : 1H
7.3334
7.3243
7.2487
7.2429
7.2395
7.2361
7.2269
5.4640
3.8947
-0.0000
1.03
1.04
5.02
6.59
1.06
3.07
PhS SPh
H
CO2Me
3j

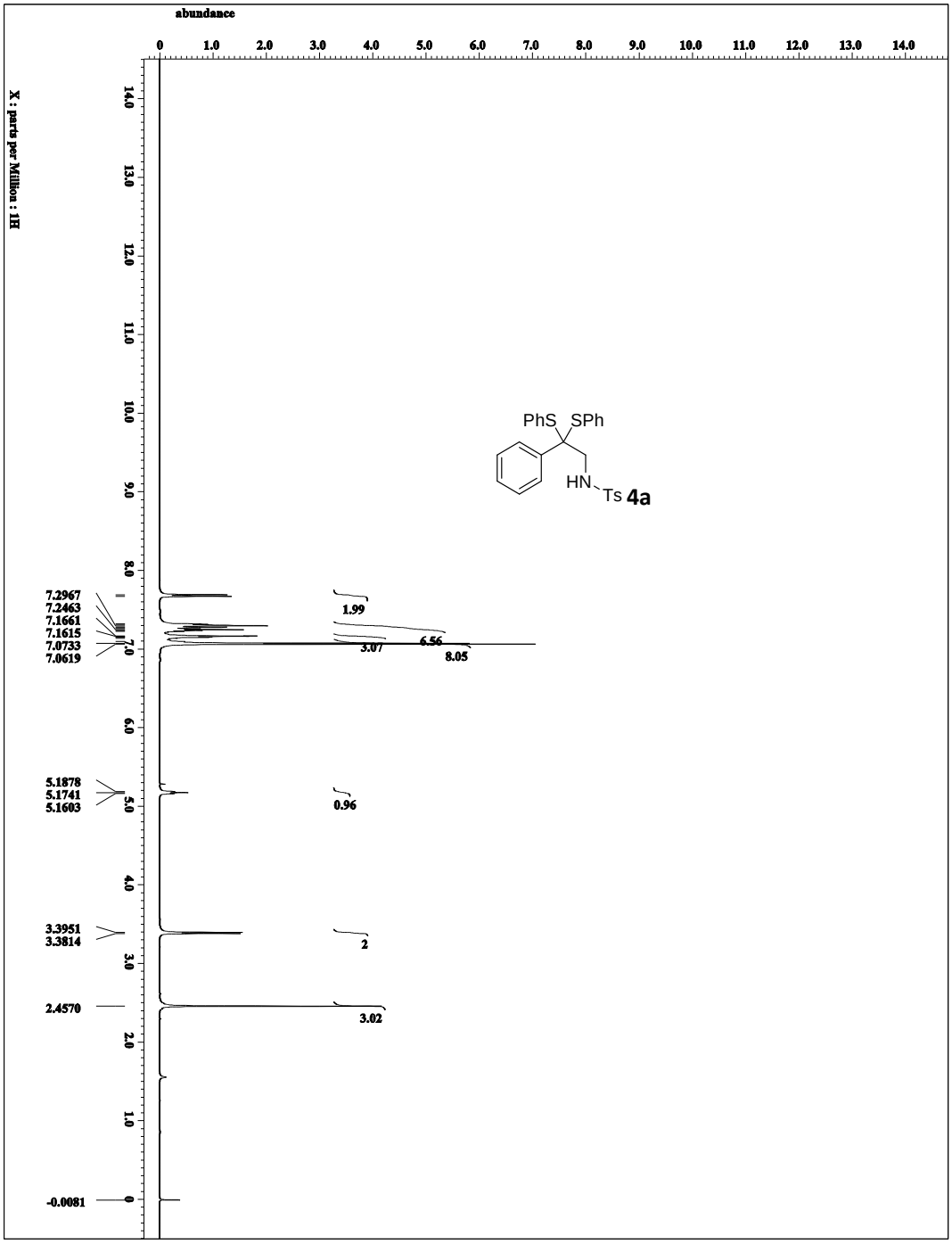

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
166.7135
134.0575
132.8848
132.3985
129.3093
129.1949
129.0233
128.1556
77.4603
77.1456
76.8214
60.1931
52.2794
PhS
SPh
H
CO2Me
3j

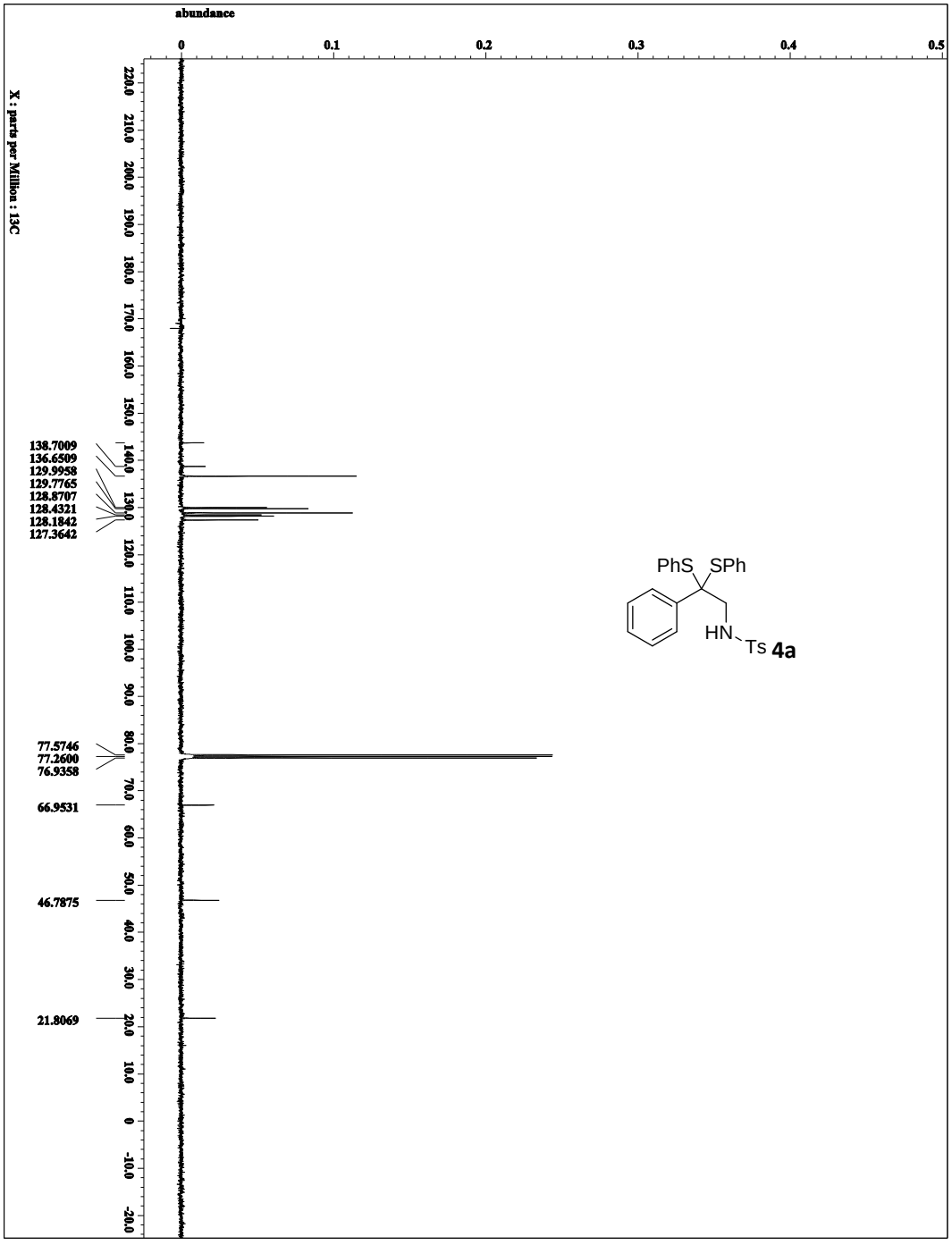

abundance
0
10.0
20.0
30.0
X : parts per Million : 1H
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.2372
7.2212
7.2166
7.0390
5.3094
2.2853
2.0
7.05
4.0
1
6.0
Me
Me
S
S
H
3k

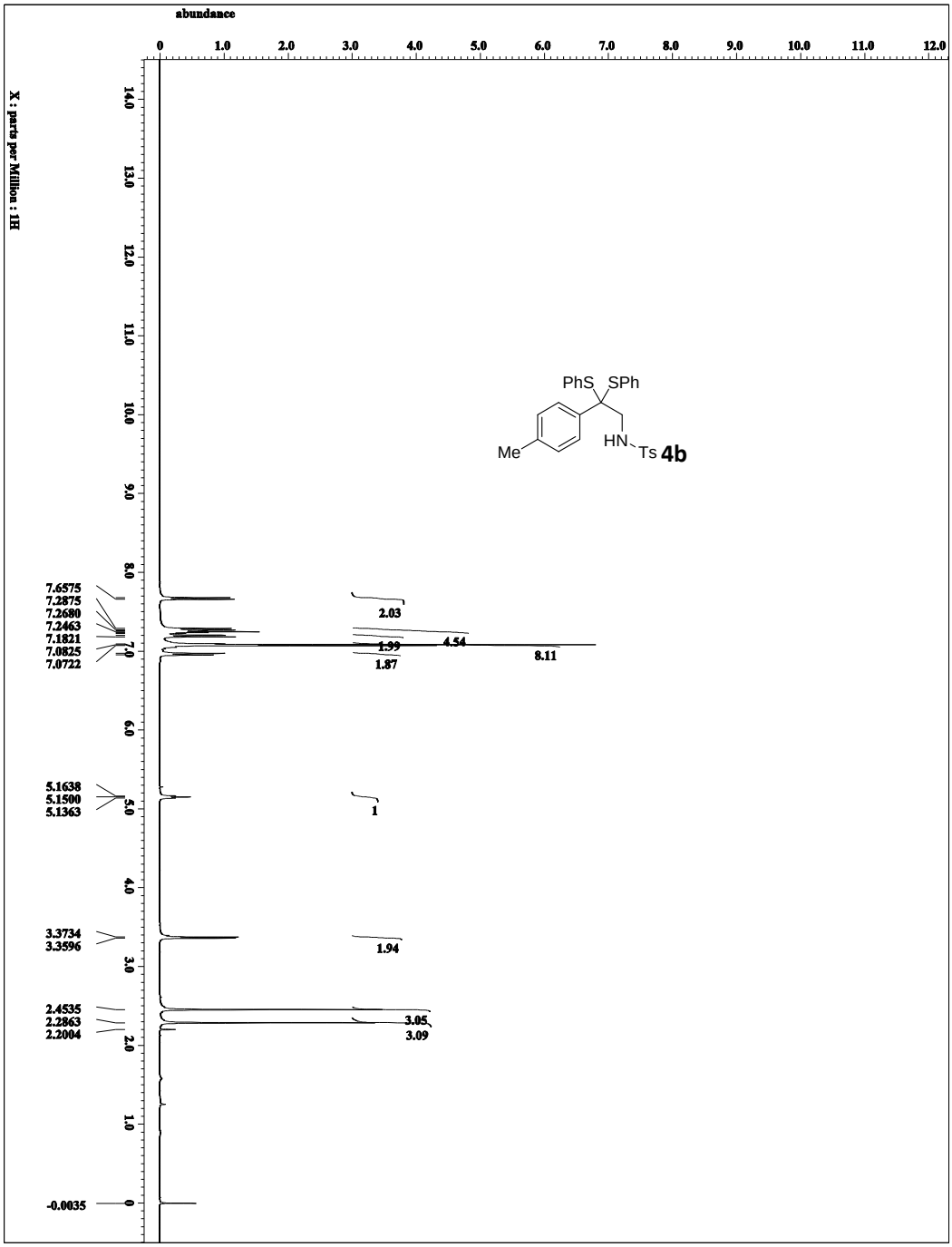

abundance
X : parts per Million : 13C
140.0834
138.1288
133.2566
130.9492
129.7002
128.4893
128.0031
77.4984
77.1837
76.8691
61.3849
21.3206
Me
Me
S
S
H
3k

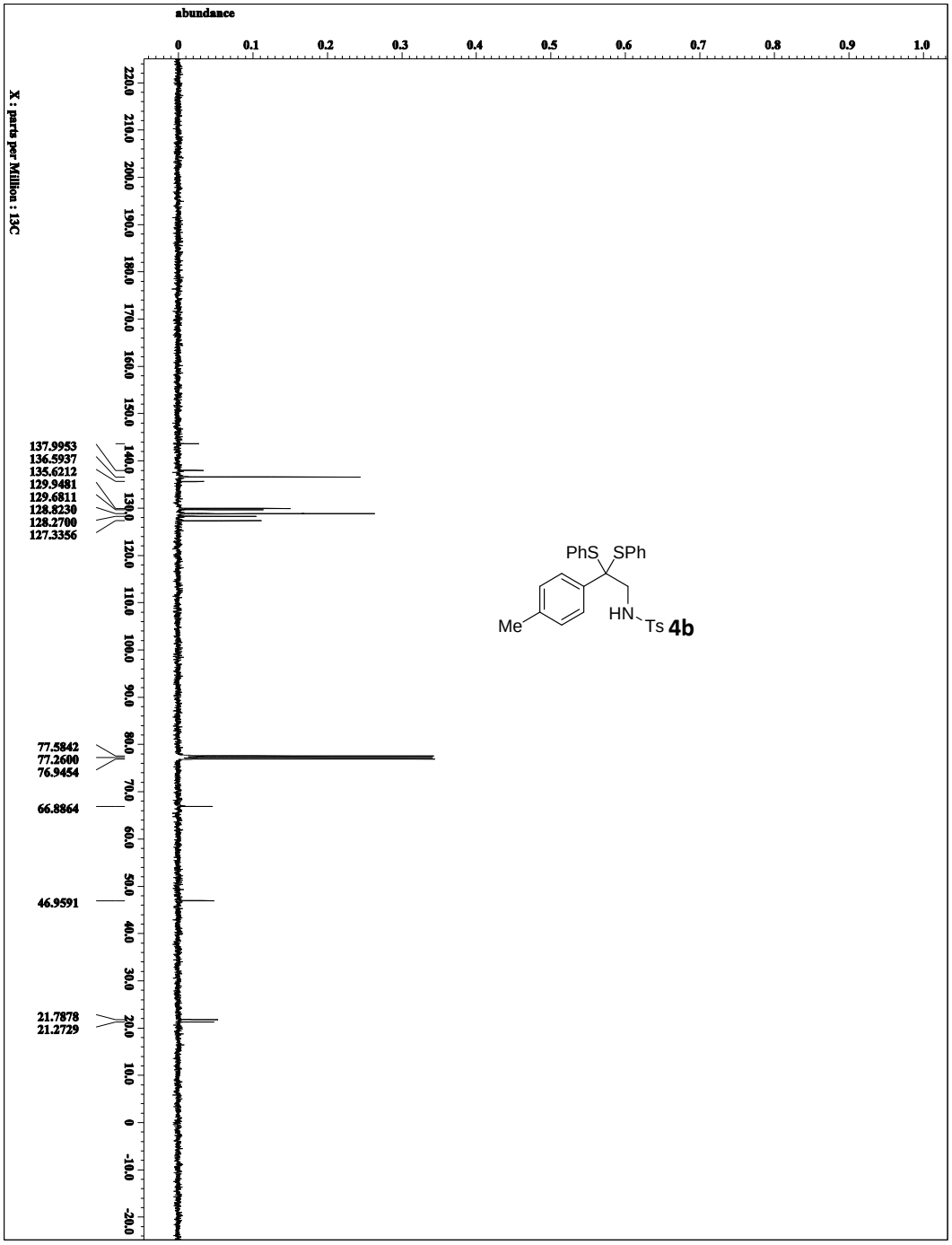

abundance
X : parts per Million : 1H
7.2487
7.2280
7.2017
13.18
5.3277
1
Cl
Cl
S
S
H
3l

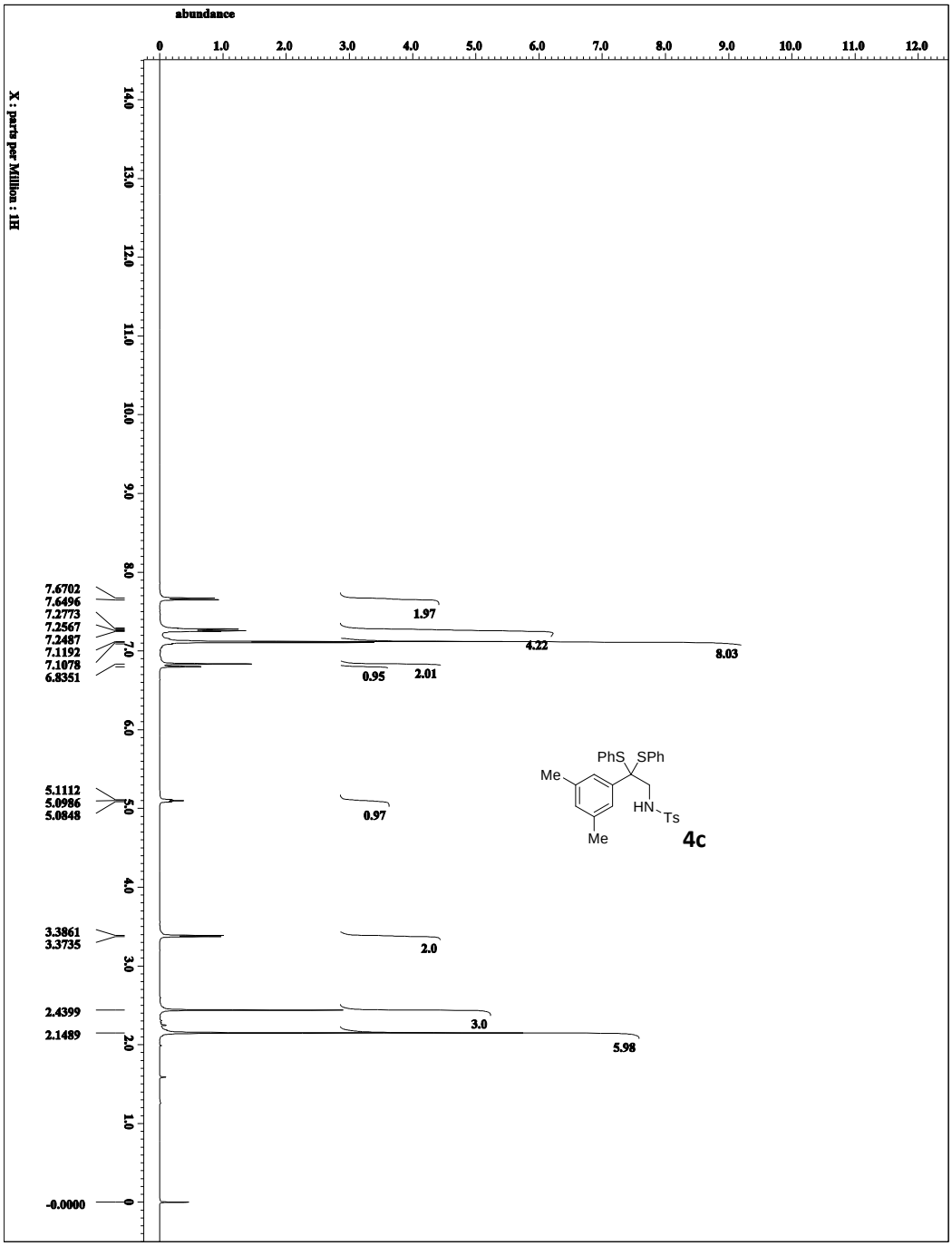

abundance
X : parts per Million : 13C
134.4103
134.2863
132.6178
129.1568
128.7277
128.4703
127.9363
77.4889
77.1742
76.8500
60.8987
Cl
Cl
S
S
H
3l

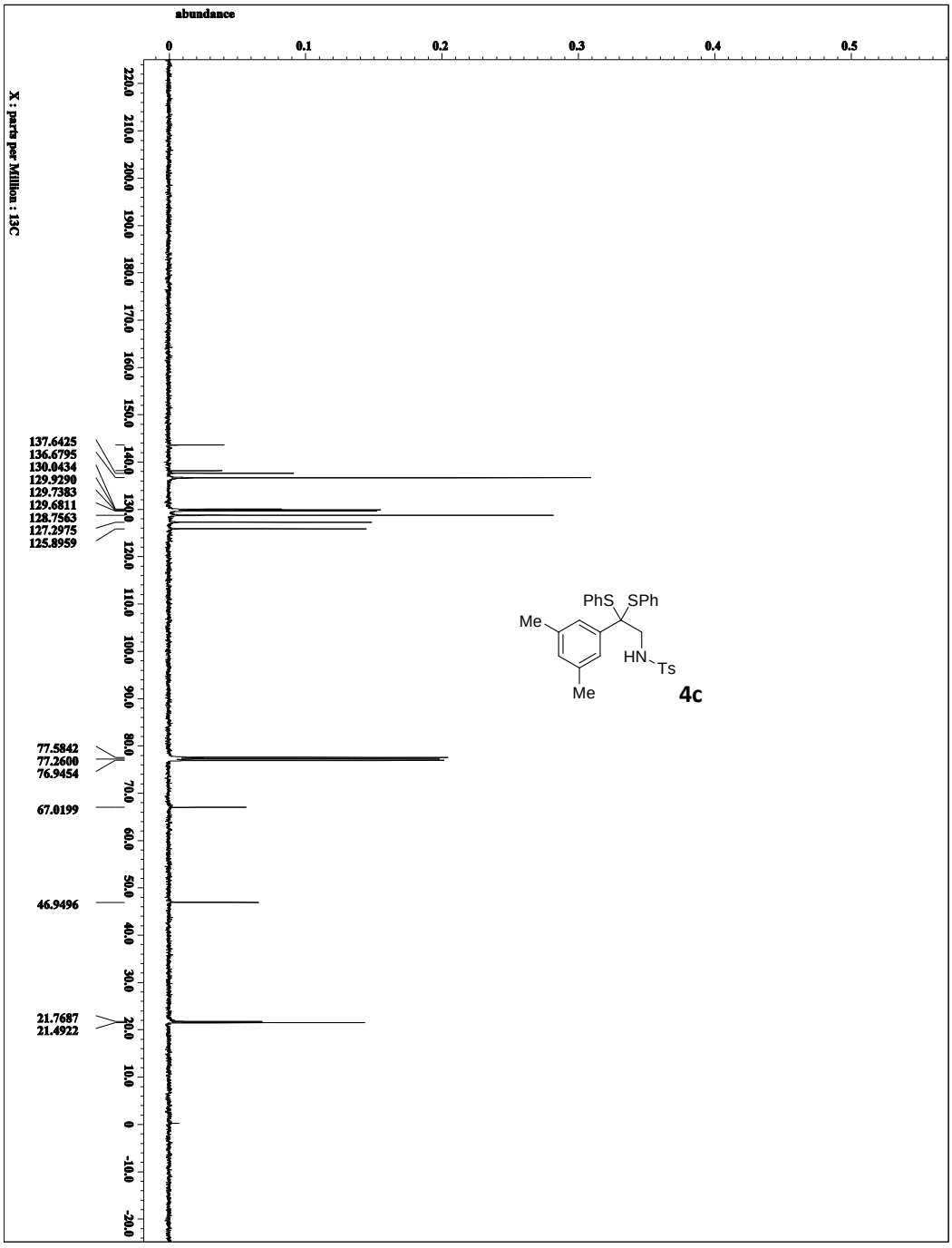

abundance
X : parts per Million : 1H
PhS SPh
HN Ts
4a
7.2967
7.2463
7.1661
7.1615
7.0733
7.0619
1.99
3.07
6.56
8.05
5.1878
5.1741
5.1603
0.96
3.3951
3.3814
2
2.4570
3.02
-0.0081

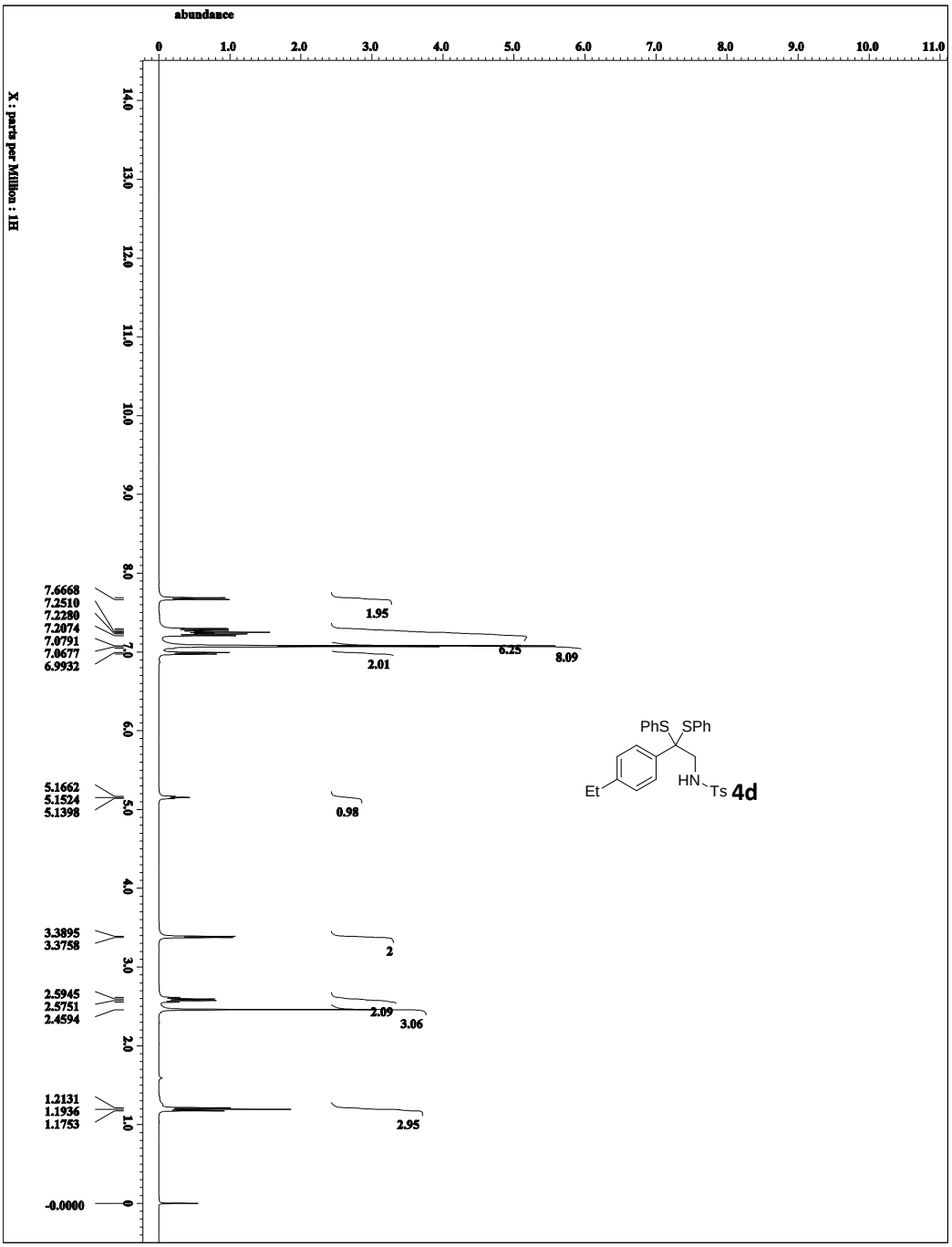

abundance
0
0.1
0.2
0.3
0.4
0.5
X : parts per Million : 13C
138.7009
136.6509
129.9958
129.7765
128.8707
128.4321
128.1842
127.3642
77.5746
77.2600
76.9358
66.9531
46.7875
21.8069
PhS
SPh
HN
Ts
4a

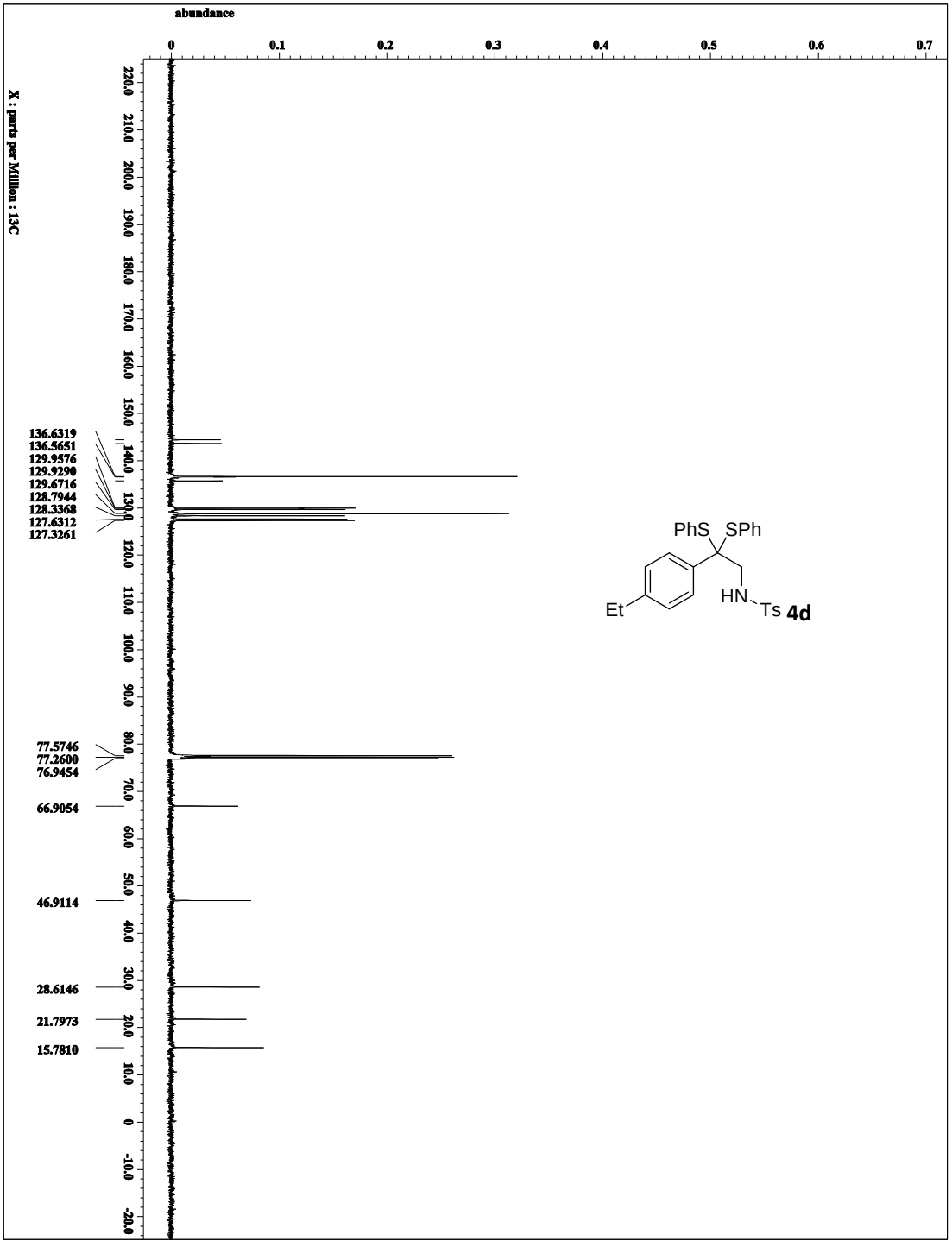

abundance
X : parts per Million : 1H
PhS
SPh
Me
HN
Ts
4b
7.6575
7.2875
7.2680
7.2463
7.1821
7.0825
7.0722
5.1638
5.1500
5.1363
3.3734
3.3596
2.4535
2.2863
2.2004
-0.0035
2.03
1.99
4.54
8.11
1.87
1
1.94
3.05
3.09

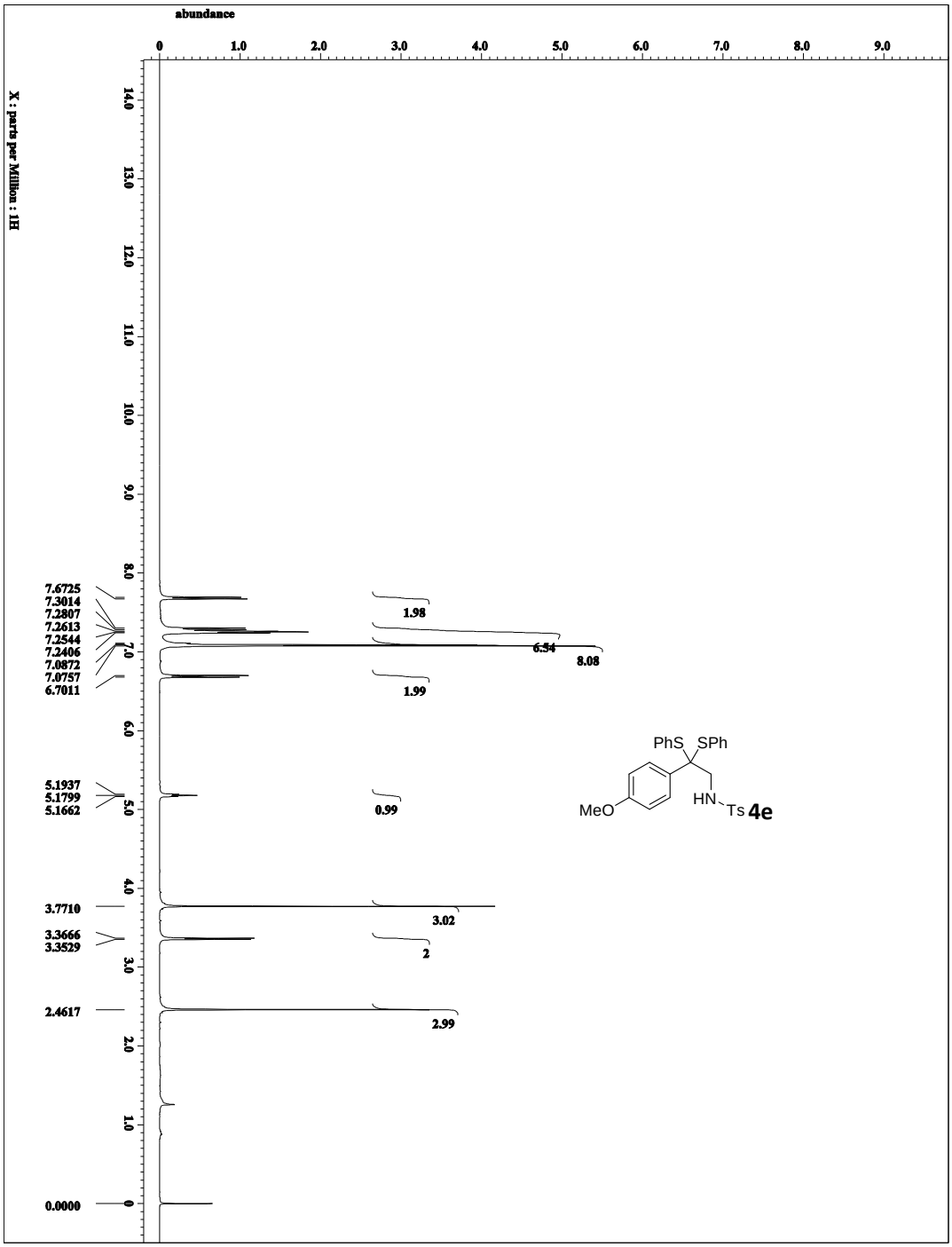

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
X : parts per Million : 13C
137.9953
136.5937
135.6212
129.9481
129.6811
128.8230
128.2700
127.3356
77.5842
77.2600
76.9454
66.8864
46.9591
21.7878
21.2729
PhS
SPh
Me
HN
Ts
4b

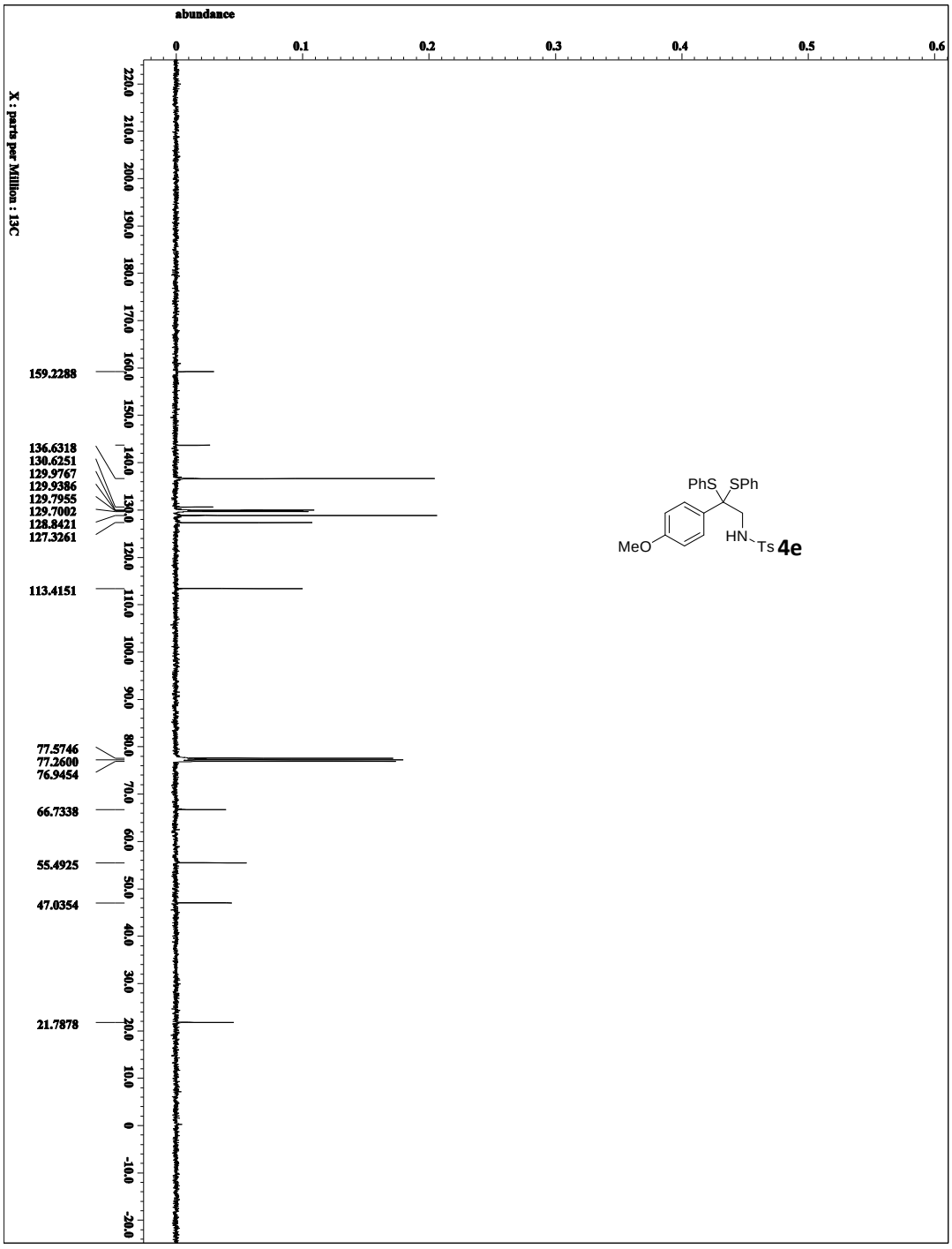

abundance
X : parts per Million : 1H
7.6702
7.6496
7.2773
7.2567
7.2487
7.1192
7.1078
6.8351
5.1112
5.0986
5.0848
3.3861
3.3735
2.4399
2.1489
-0.0000
1.97
4.22
8.03
0.95
2.01
0.97
2.0
3.0
5.98
PhS
SPh
Me
HN
Ts
Me
4c

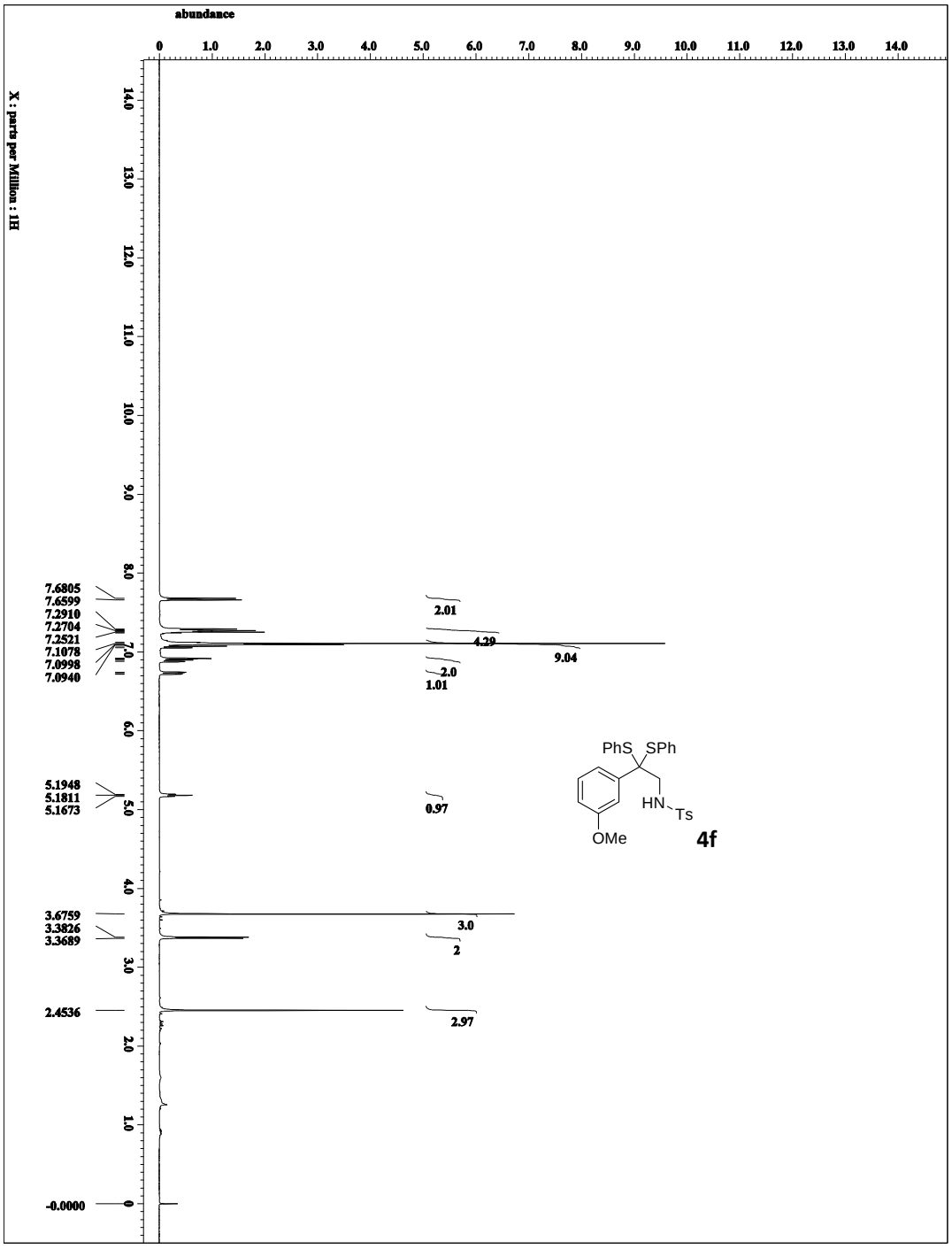

abundance
0
0.1
0.2
0.3
0.4
0.5
X : parts per Million : 13C
137.6425
136.6795
130.0434
129.9290
129.7383
129.6811
128.7563
127.2975
125.8959
77.5842
77.2600
76.9454
67.0199
46.9496
21.7687
21.4922
PhS
SPh
Me
HN
Ts
Me
4c

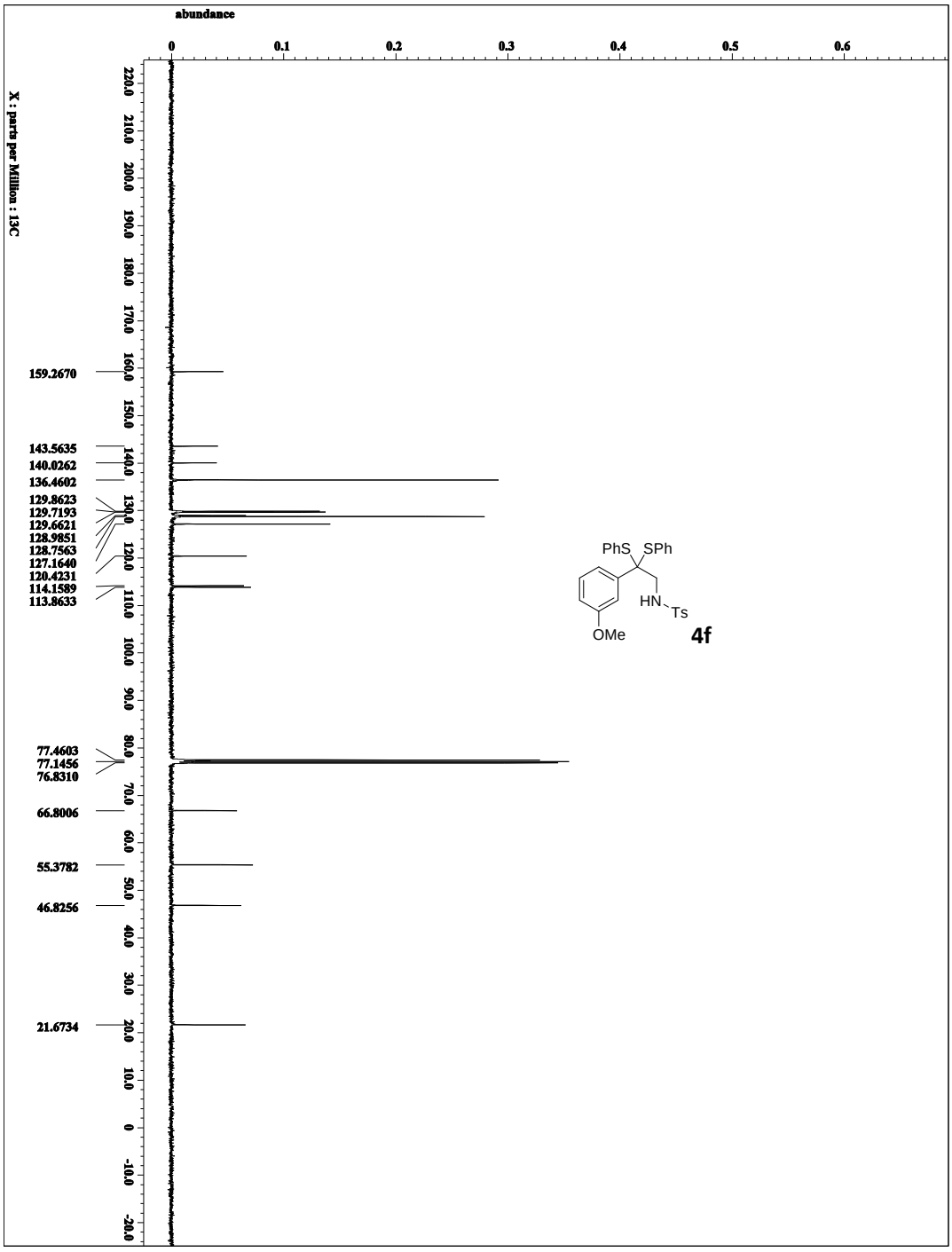

abundance
X : parts per Million : 1H
7.6668
7.2510
7.2280
7.2074
7.0791
7.0677
6.9932
5.1662
5.1524
5.1398
3.3895
3.3758
2.5945
2.5751
2.4594
1.2131
1.1936
1.1753
-0.0000
1.95
6.25
8.09
2.01
0.98
2
2.09
3.06
2.95
PhS
SPh
Et
HN
Ts
4d

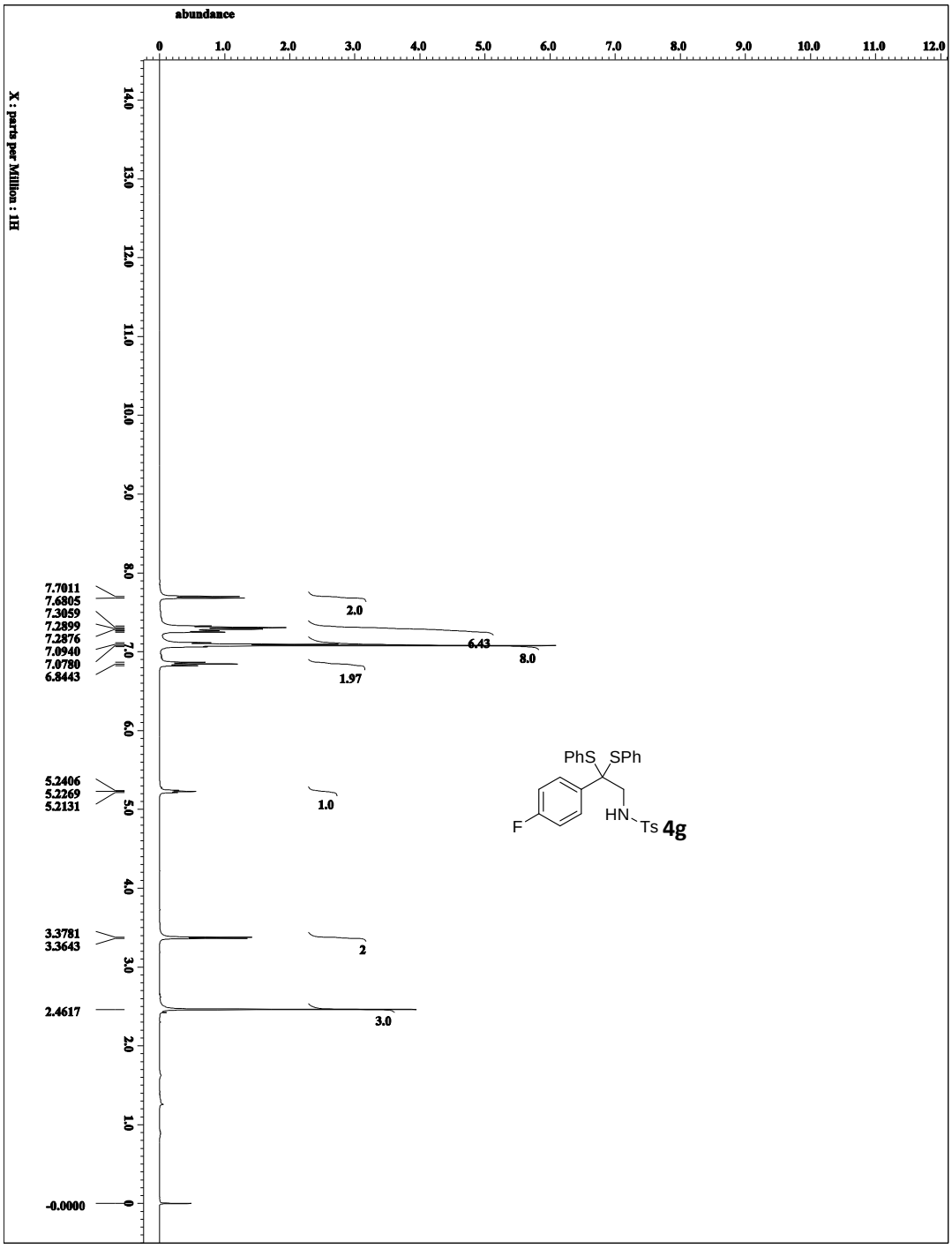

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
136.6319
136.5651
129.9576
129.9290
129.6716
128.7944
128.3368
127.6312
127.3261
77.5746
77.2600
76.9454
66.9054
46.9114
28.6146
21.7973
15.7810
PhS
SPh
HN
Ts
Et
4d

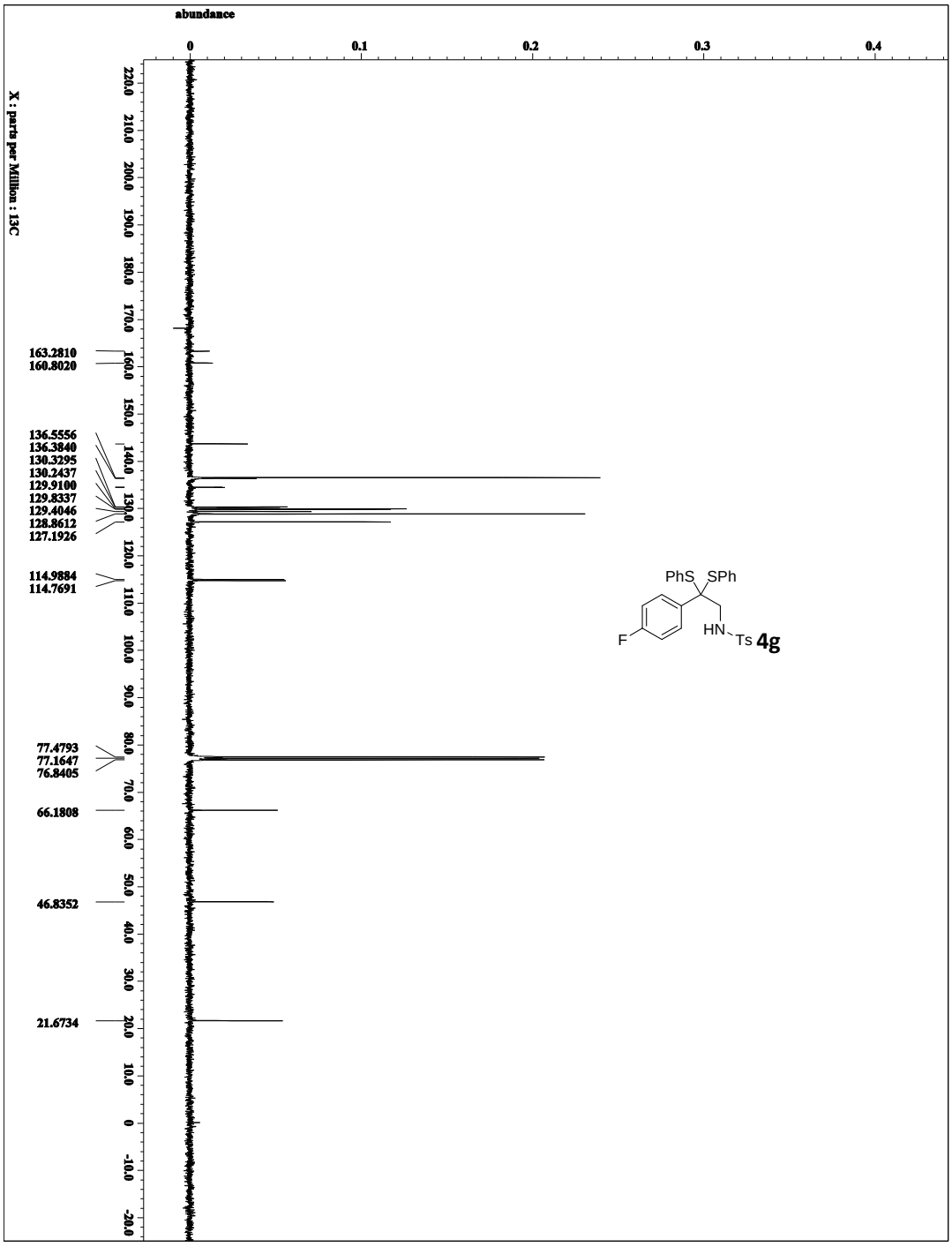

abundance
X : parts per Million : 1H
7.6725
7.3014
7.2807
7.2613
7.2544
7.2406
7.0872
7.0757
6.7011
5.1937
5.1799
5.1662
3.7710
3.3666
3.3529
2.4617
0.0000
1.98
6.54
8.08
1.99
0.99
3.02
2
2.99
PhS
SPh
HN
Ts
MeO
4e

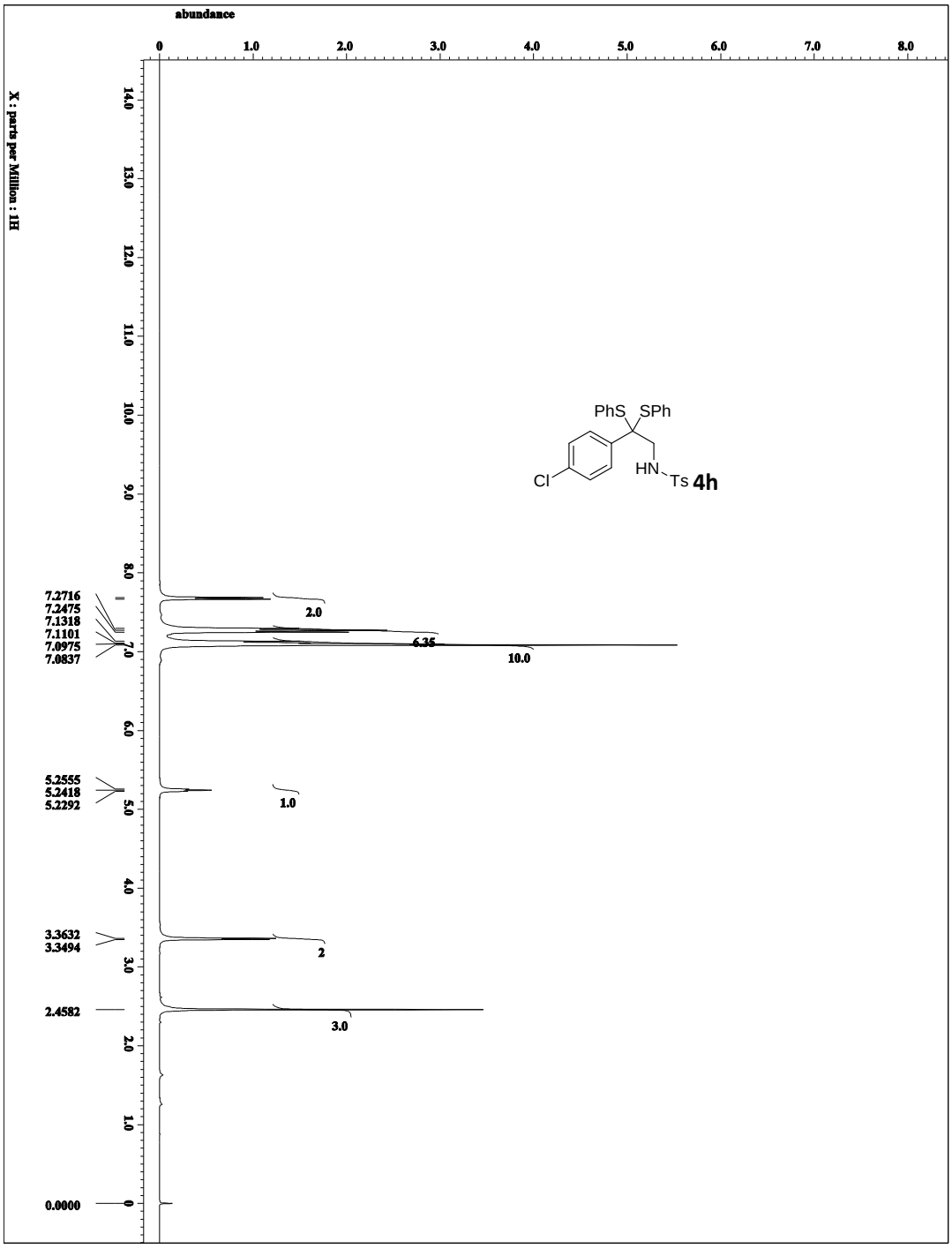

abundance
X : parts per Million : 13C
159.2288
136.6318
130.6251
129.9767
129.9386
129.7955
129.7002
128.8421
127.3261
113.4151
77.5746
77.2600
76.9454
66.7338
55.4925
47.0354
21.7878
PhS
SPh
MeO
HN
Ts
4e

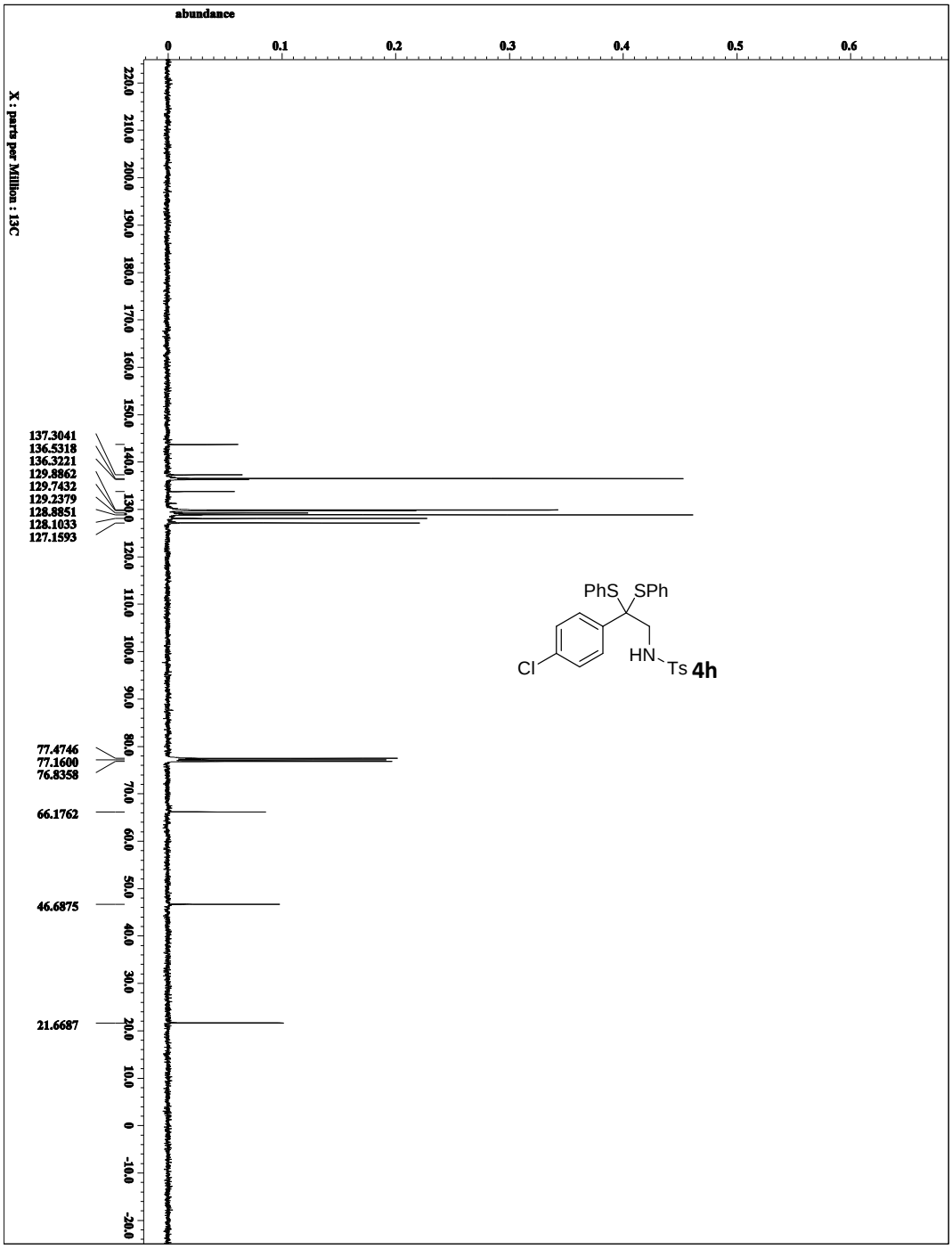

abundance
X : parts per Million : 1H
7.6805
7.6599
7.2910
7.2704
7.2521
7.1078
7.0998
7.0940
5.1948
5.1811
5.1673
3.6759
3.3826
3.3689
2.4536
-0.0000
2.01
4.29
9.04
2.0
1.01
0.97
3.0
2
2.97
PhS
SPh
HN
Ts
OMe
4f

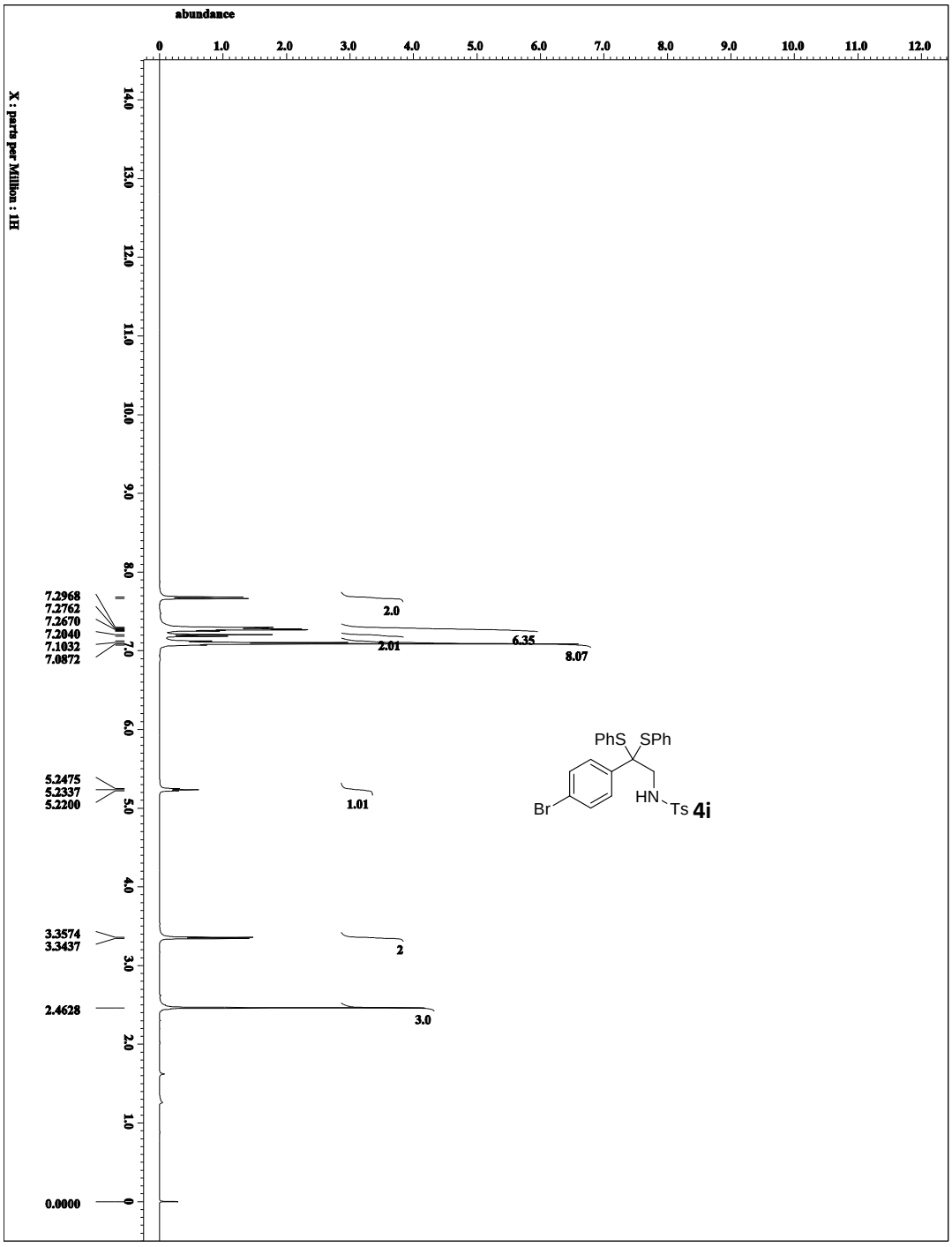

abundance
X : parts per Million : 13C
159.2670
143.5635
140.0262
136.4602
129.8623
129.7193
129.6621
128.9851
128.7563
127.1640
120.4231
114.1589
113.8633
77.4603
77.1456
76.8310
66.8006
55.3782
46.8256
21.6734
PhS
SPh
HN
Ts
OMe
4f

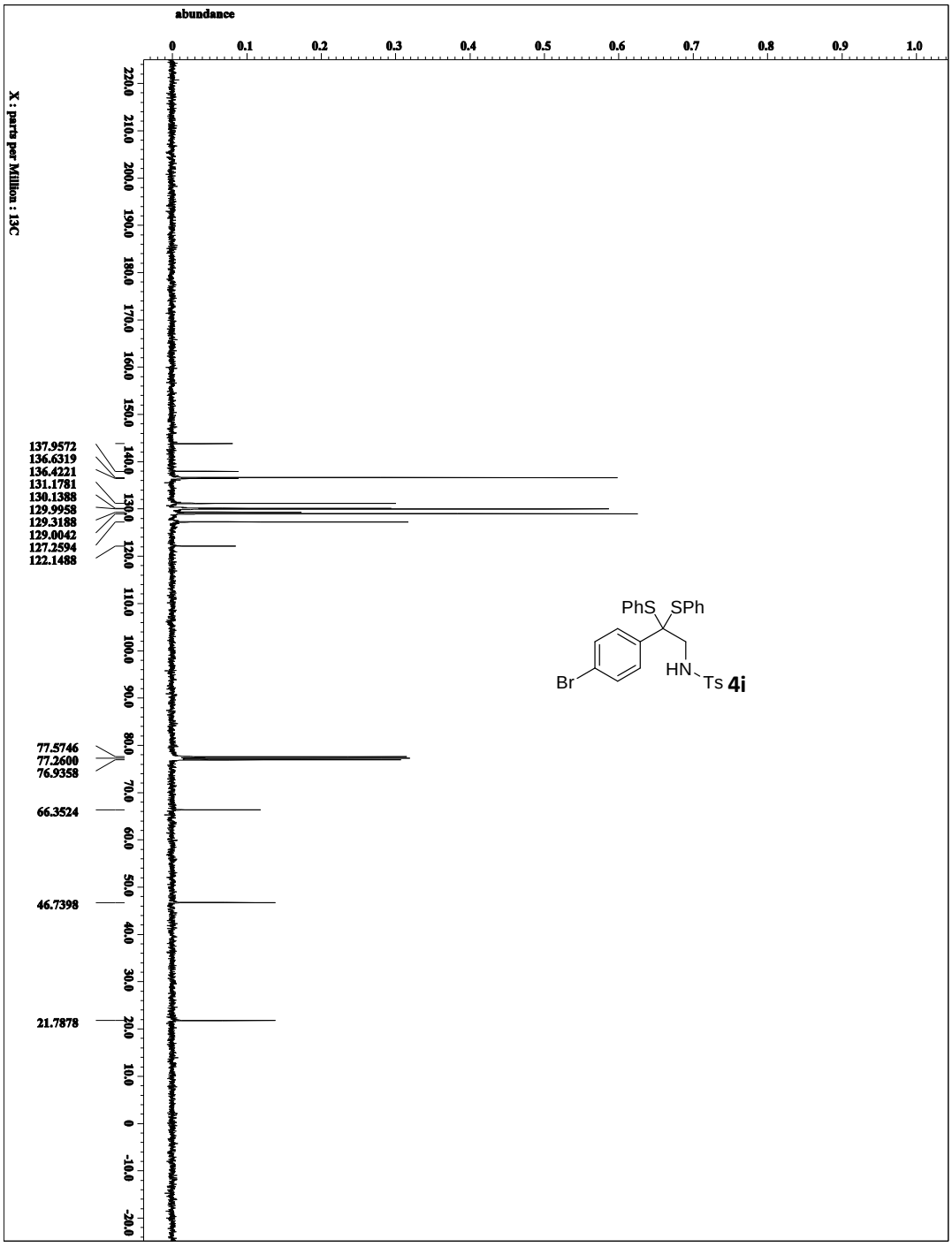

abundance
X : parts per Million : 1H
7.7011
7.6805
7.3059
7.2899
7.2876
7.0940
7.0780
6.8443
5.2406
5.2269
5.2131
3.3781
3.3643
2.4617
-0.0000
2.0
6.43
8.0
1.97
1.0
2
3.0
PhS
SPh
F
HN
Ts
4g

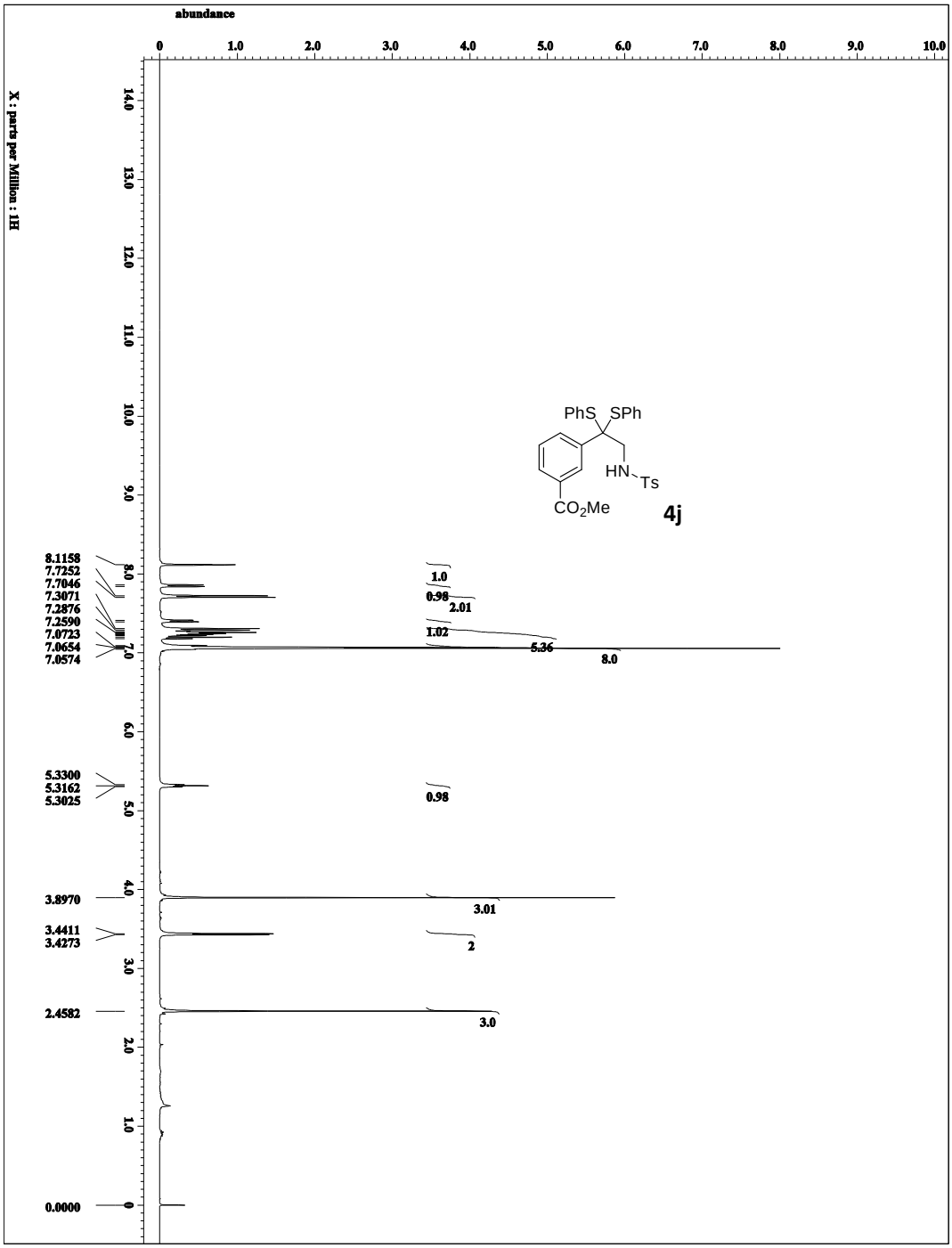

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
163.2810
160.8020
136.5556
136.3840
130.3295
130.2437
129.9100
129.8337
129.4046
128.8612
127.1926
114.9884
114.7691
77.4793
77.1647
76.8405
66.1808
46.8352
21.6734
PhS
SPh
F
HN
Ts
4g

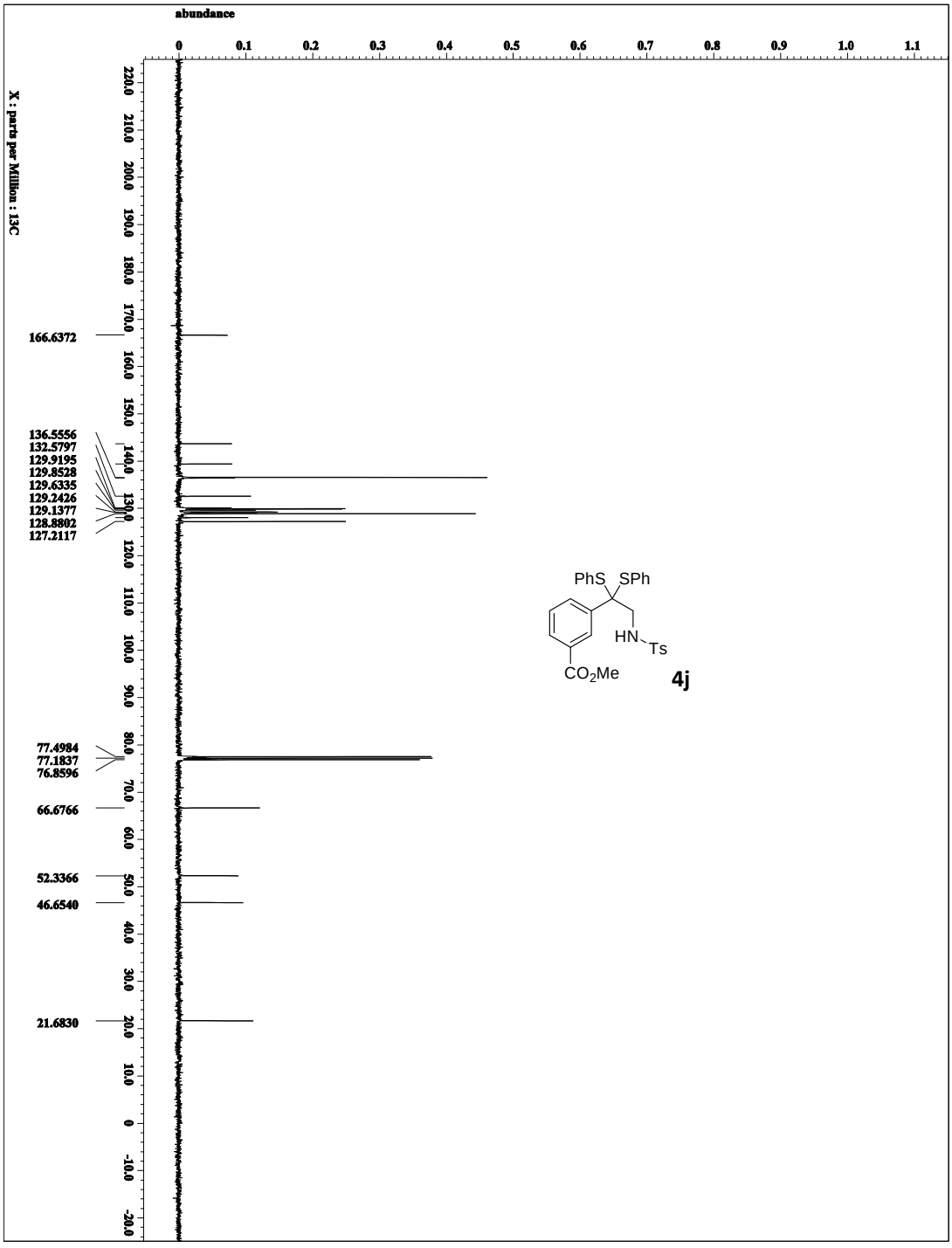

abundance
X : parts per Million : 1H
PhS
SPh
Cl
HN
Ts
4h
7.2716
7.2475
7.1318
7.1101
7.0975
7.0837
5.2555
5.2418
5.2292
3.3632
3.3494
2.4582
0.0000
2.0
6.35
10.0
1.0
2
3.0

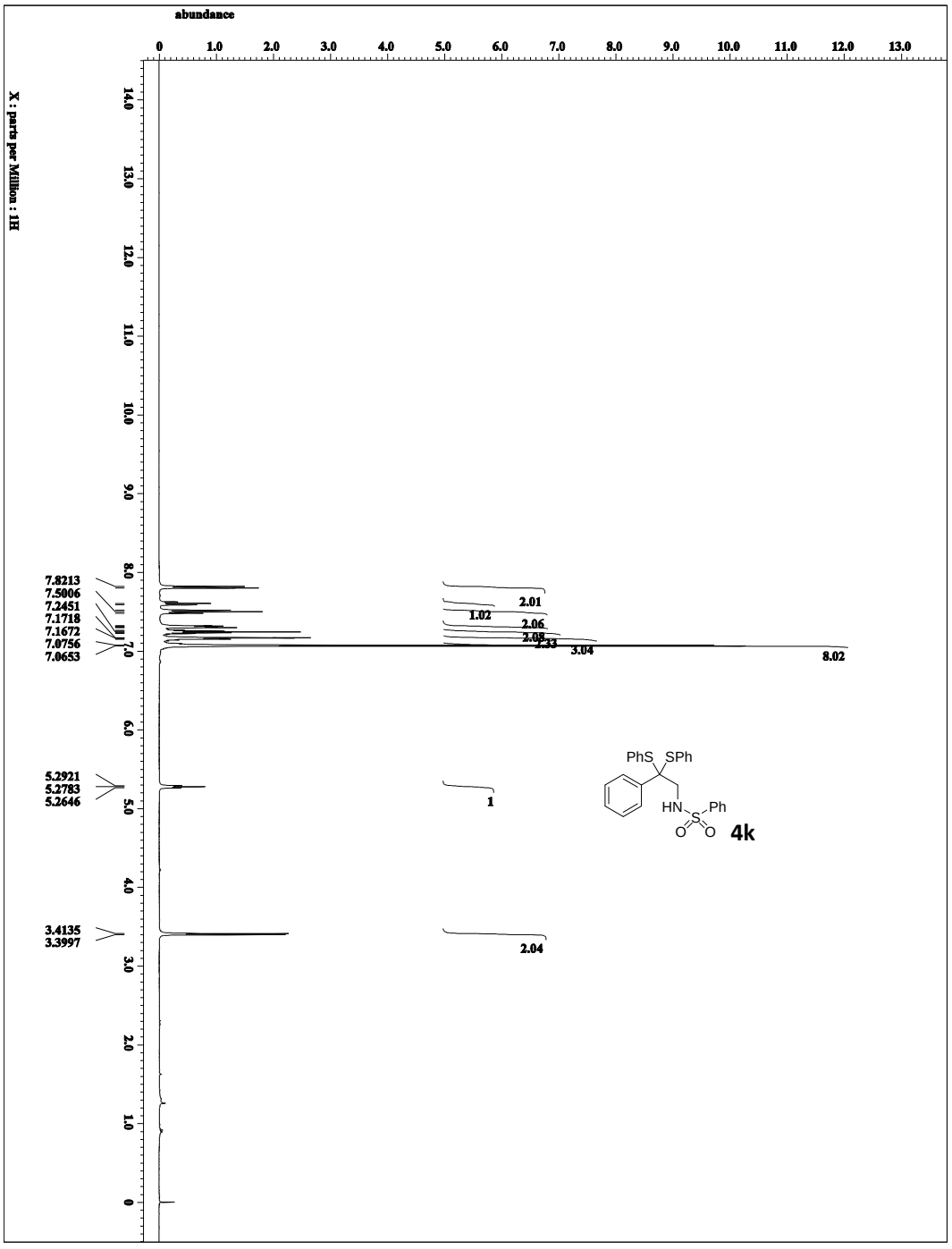

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
X : parts per Million : 13C
137.3041
136.5318
136.3221
129.8862
129.7432
129.2379
128.8851
128.1033
127.1593
77.4746
77.1600
76.8358
66.1762
46.6875
21.6687
PhS
SPh
Cl
HN
Ts
4h

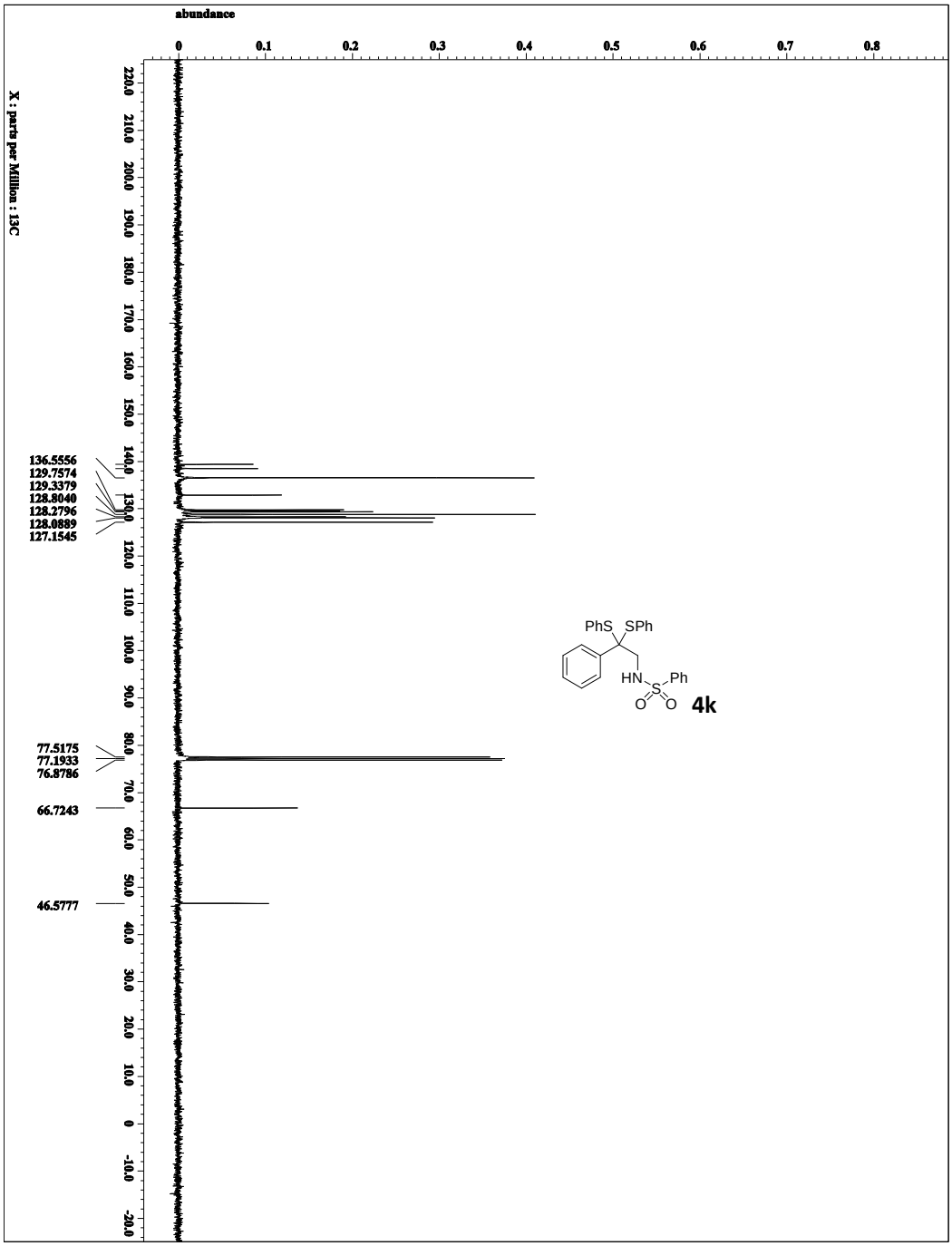

abundance
X : parts per Million : 1H
7.2968
7.2762
7.2670
7.2040
7.1032
7.0872
5.2475
5.2337
5.2200
3.3574
3.3437
2.4628
0.0000
2.0
2.01
6.35
8.07
1.01
2
3.0
PhS
SPh
HN
Ts
Br
4i

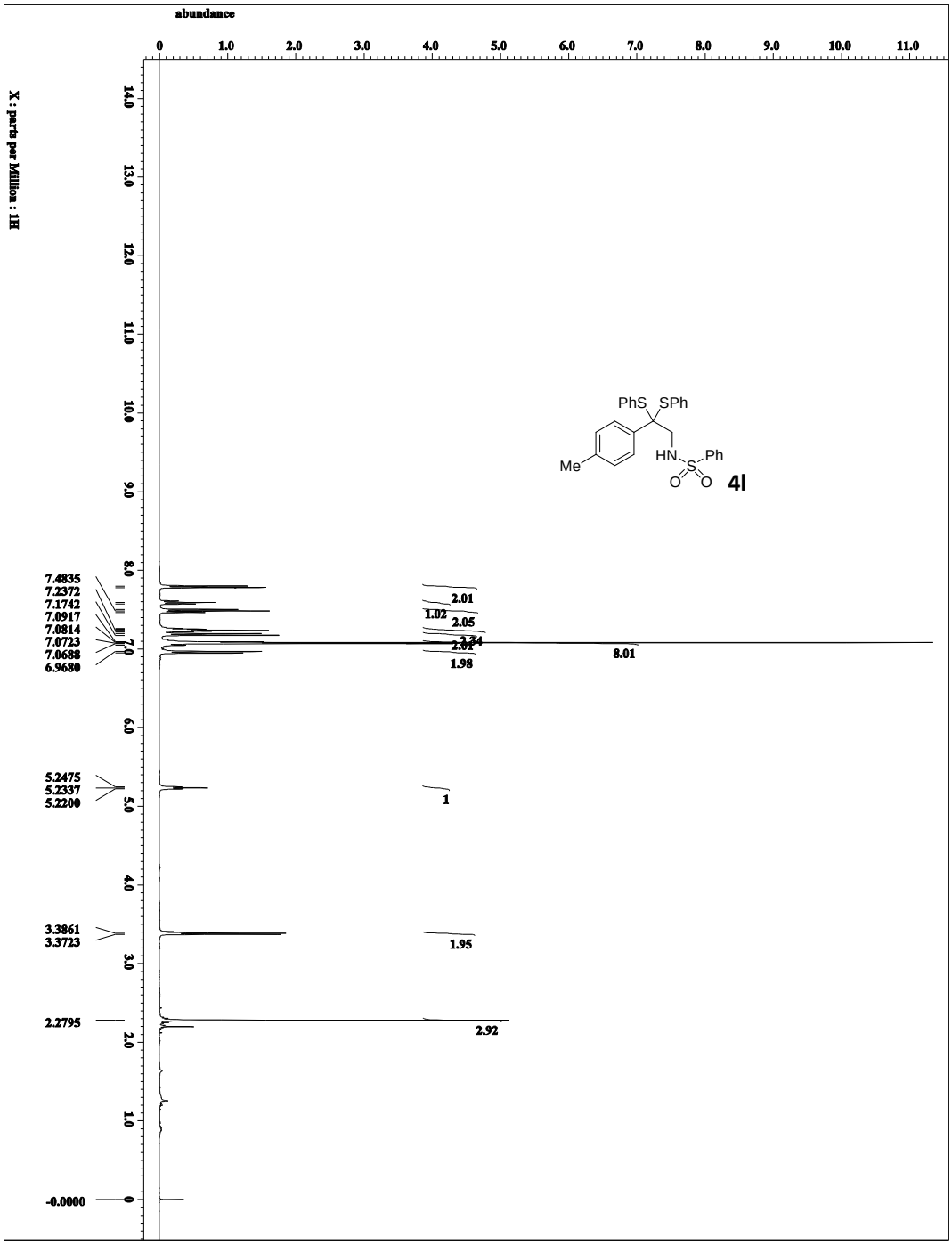

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
X : parts per Million : 13C
137.9572
136.6319
136.4221
131.1781
130.1388
129.9958
129.3188
129.0042
127.2594
122.1488
77.5746
77.2600
76.9358
66.3524
46.7398
21.7878
PhS
SPh
HN
Ts
Br
4i

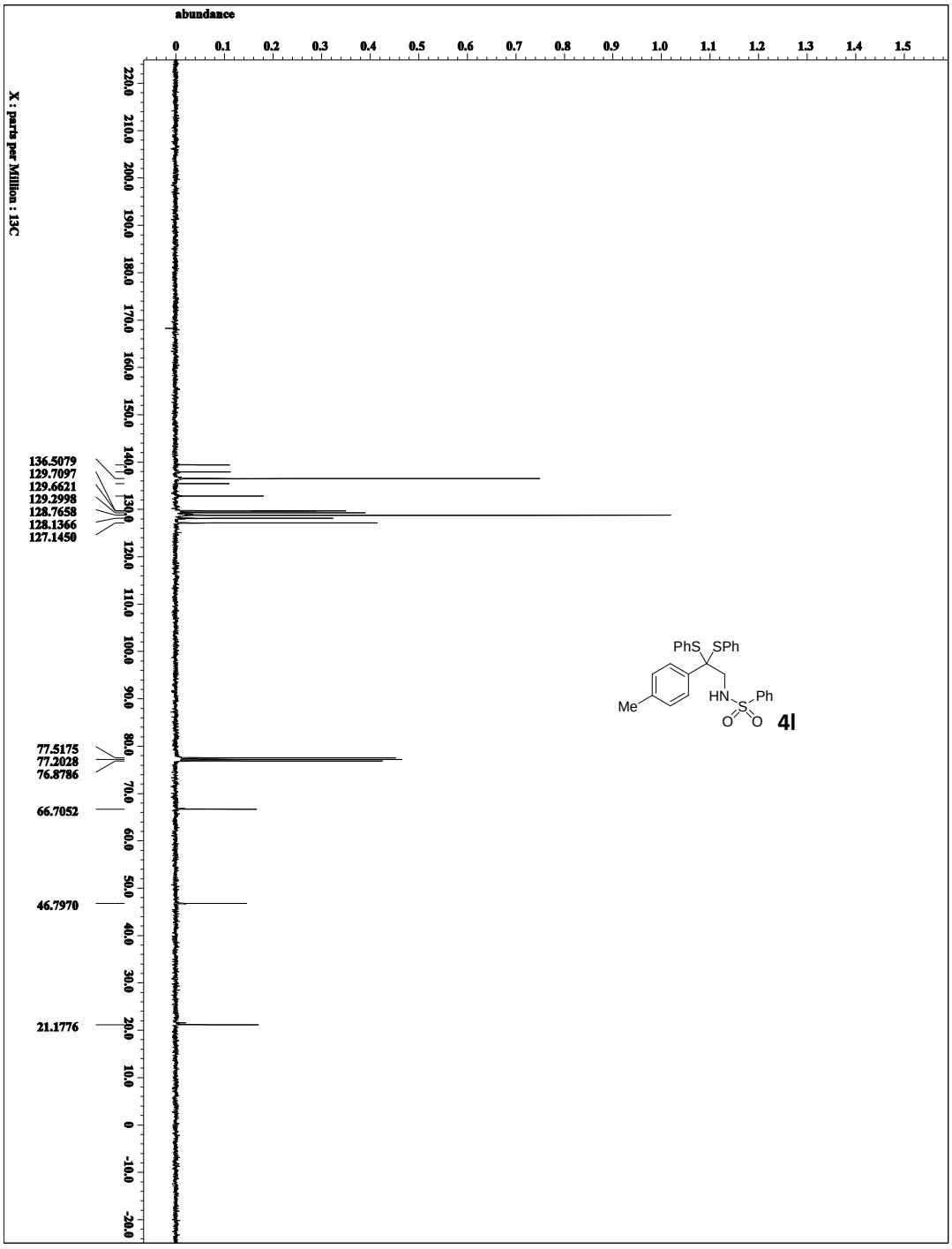

abundance
X : parts per Million : 1H
PhS
SPh
HN
Ts
CO2Me
4j
8.1158
7.7252
7.7046
7.3071
7.2876
7.2590
7.0723
7.0654
7.0574
5.3300
5.3162
5.3025
3.8970
3.4411
3.4273
2.4582
0.0000
1.0
0.98
2.01
1.02
5.36
8.0
0.98
3.01
2
3.0

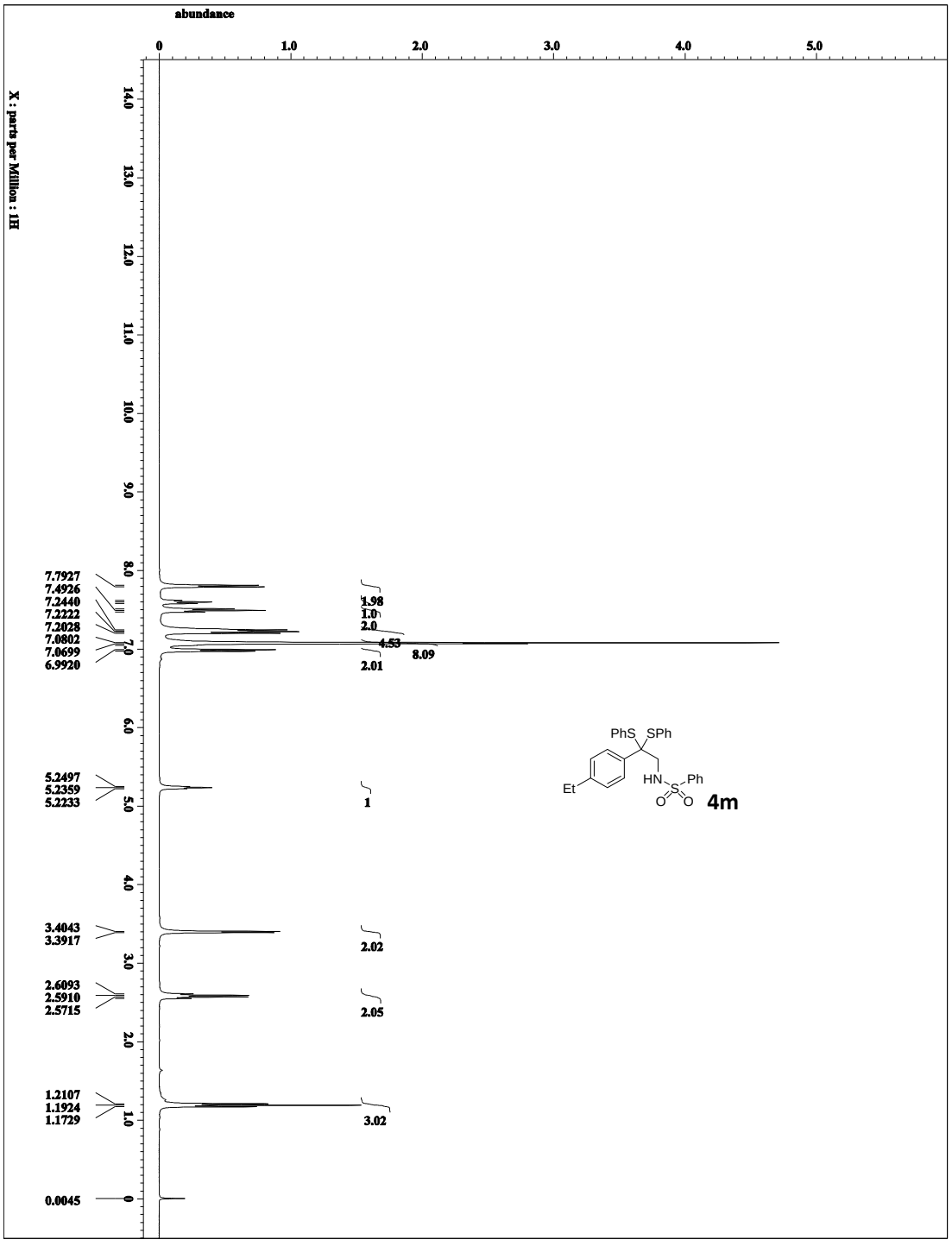

abundance
X : parts per Million : 13C
166.6372
136.5556
132.5797
129.9195
129.8528
129.6335
129.2426
129.1377
128.8802
127.2117
77.4984
77.1837
76.8596
66.6766
52.3366
46.6540
21.6830
PhS
SPh
HN
Ts
CO2Me
4j

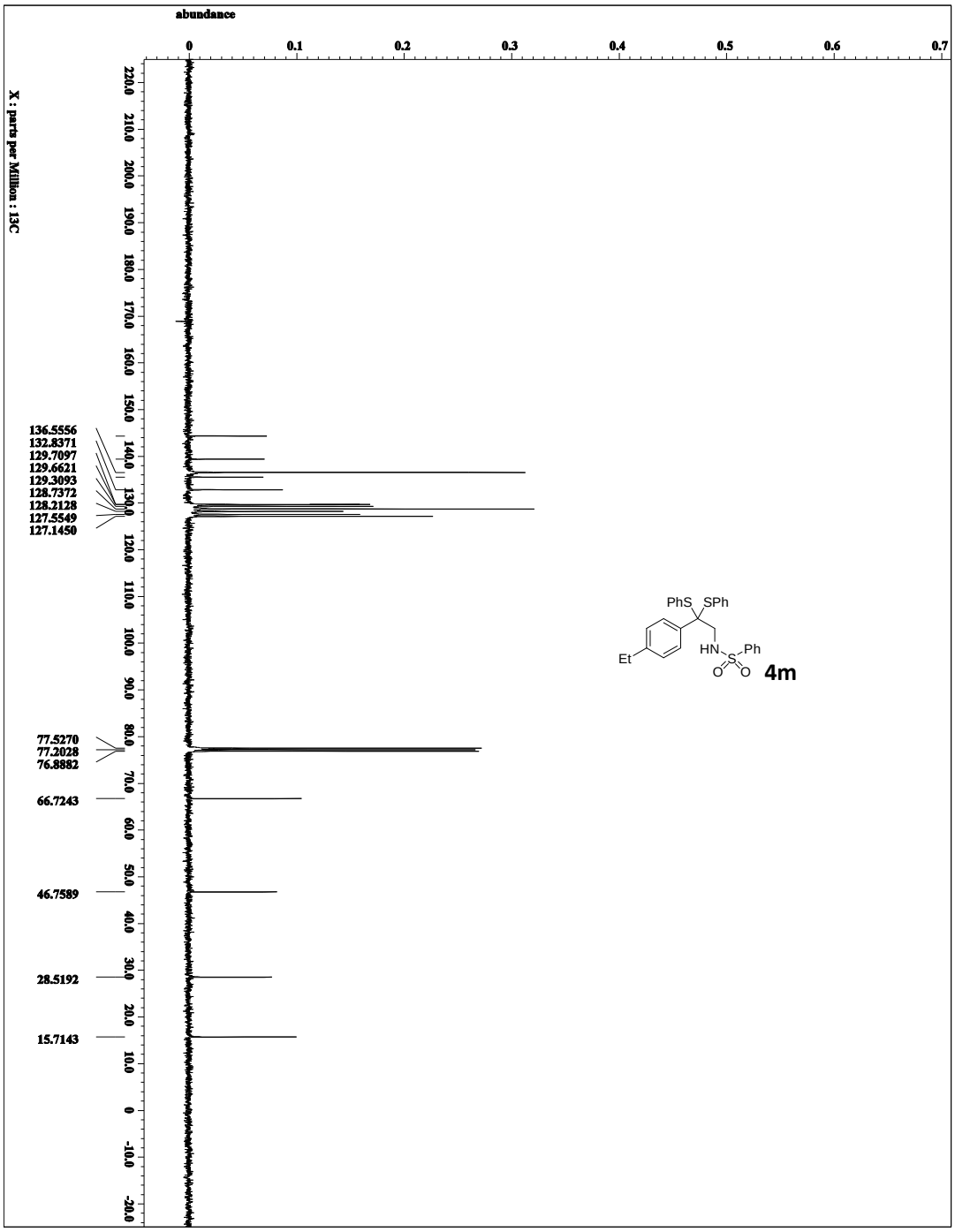

abundance
X : parts per Million : 1H
7.8213
7.5006
7.2451
7.1718
7.1672
7.0756
7.0653
5.2921
5.2783
5.2646
3.4135
3.3997
2.01
1.02
2.06
2.08
2.33
3.04
8.02
1
2.04
PhS
SPh
HN
S
Ph
O
O
4k

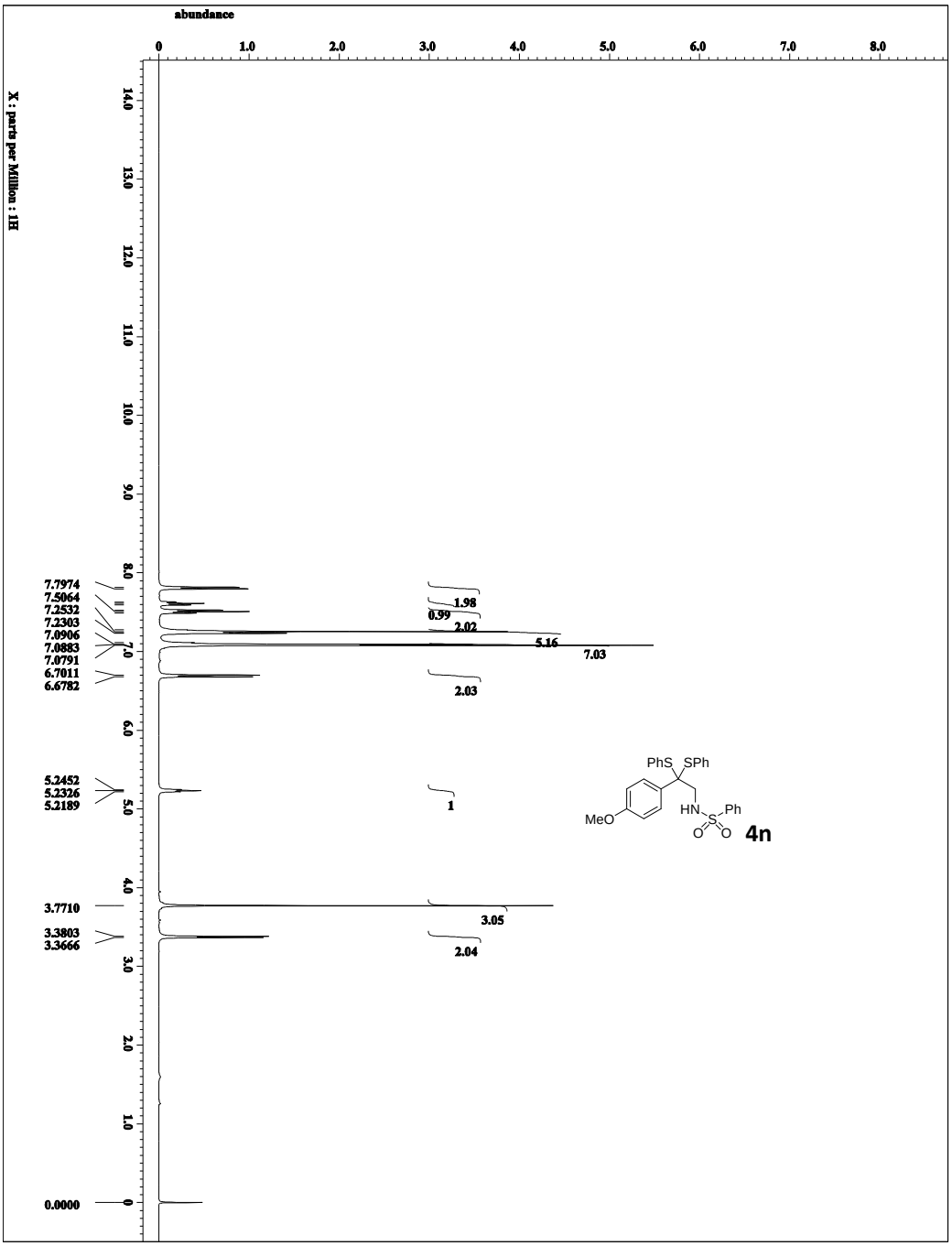

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
X : parts per Million : 13C
136.5556
129.7574
129.3379
128.8040
128.2796
128.0889
127.1545
77.5175
77.1933
76.8786
66.7243
46.5777
PhS
SPh
HN
Ph
S
O
O
4k

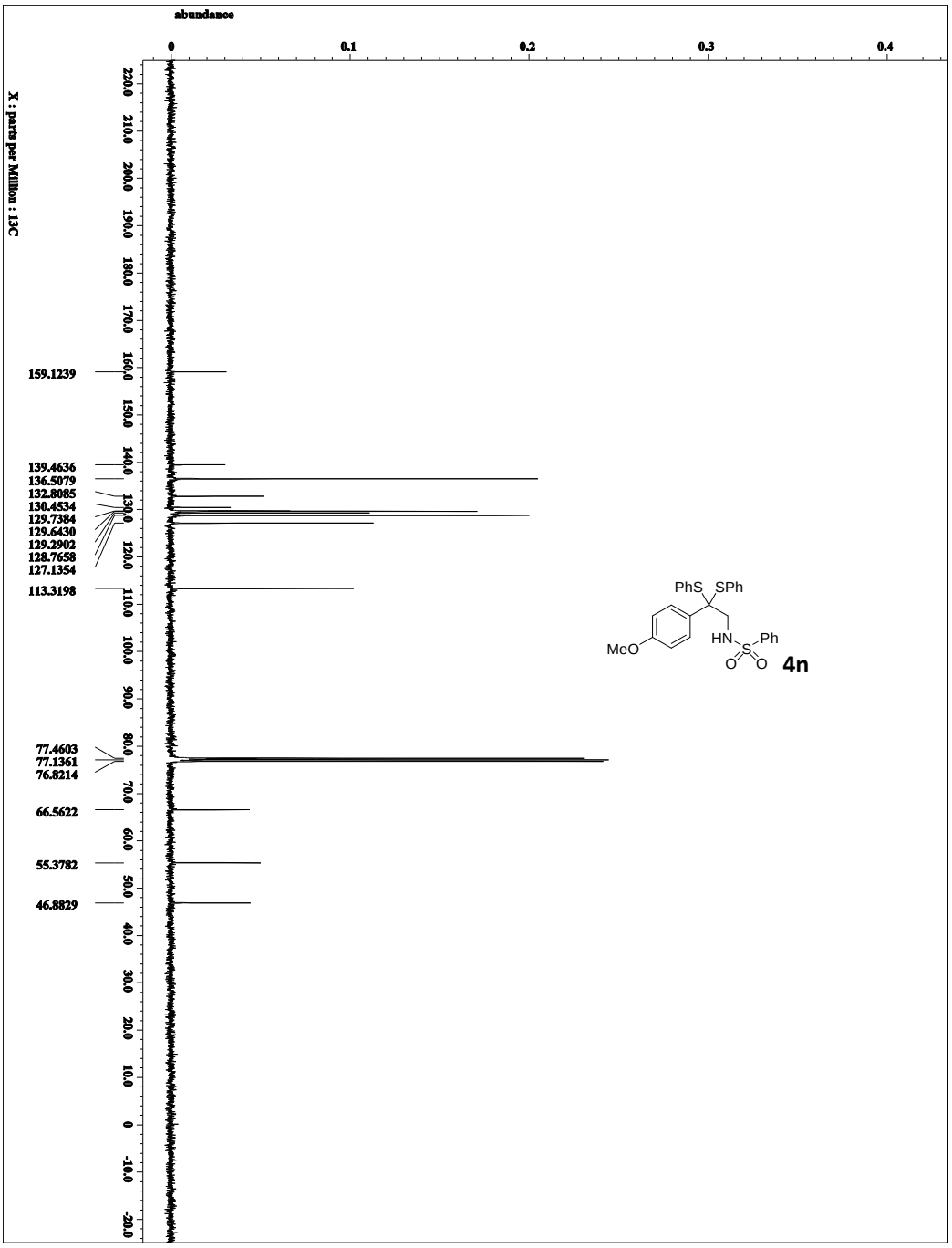

abundance
X : parts per Million : 1H
PhS
SPh
Me
HN
S
Ph
O
O
4l
7.4835
7.2372
7.1742
7.0917
7.0814
7.0723
7.0688
6.9680
5.2475
5.2337
5.2200
3.3861
3.3723
2.2795
-0.0000
2.01
1.02
2.05
2.24
2.02
1.98
8.01
1
1.95
2.92

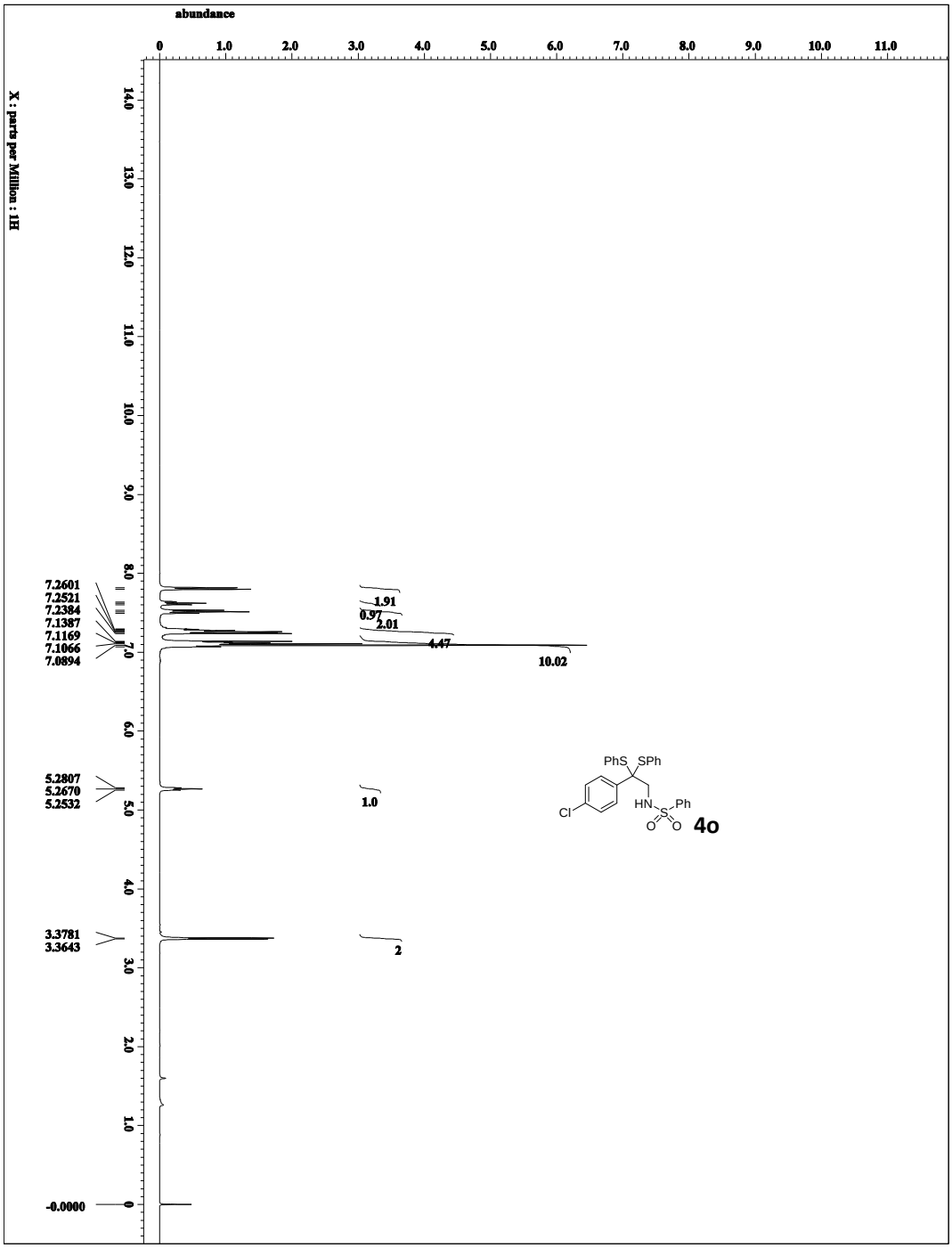

abundance
X : parts per Million : 13C
136.5079
129.7097
129.6621
129.2998
128.7658
128.1366
127.1450
77.5175
77.2028
76.8786
66.7052
46.7970
21.1776
PhS
SPh
HN
Ph
Me
O
O
4l

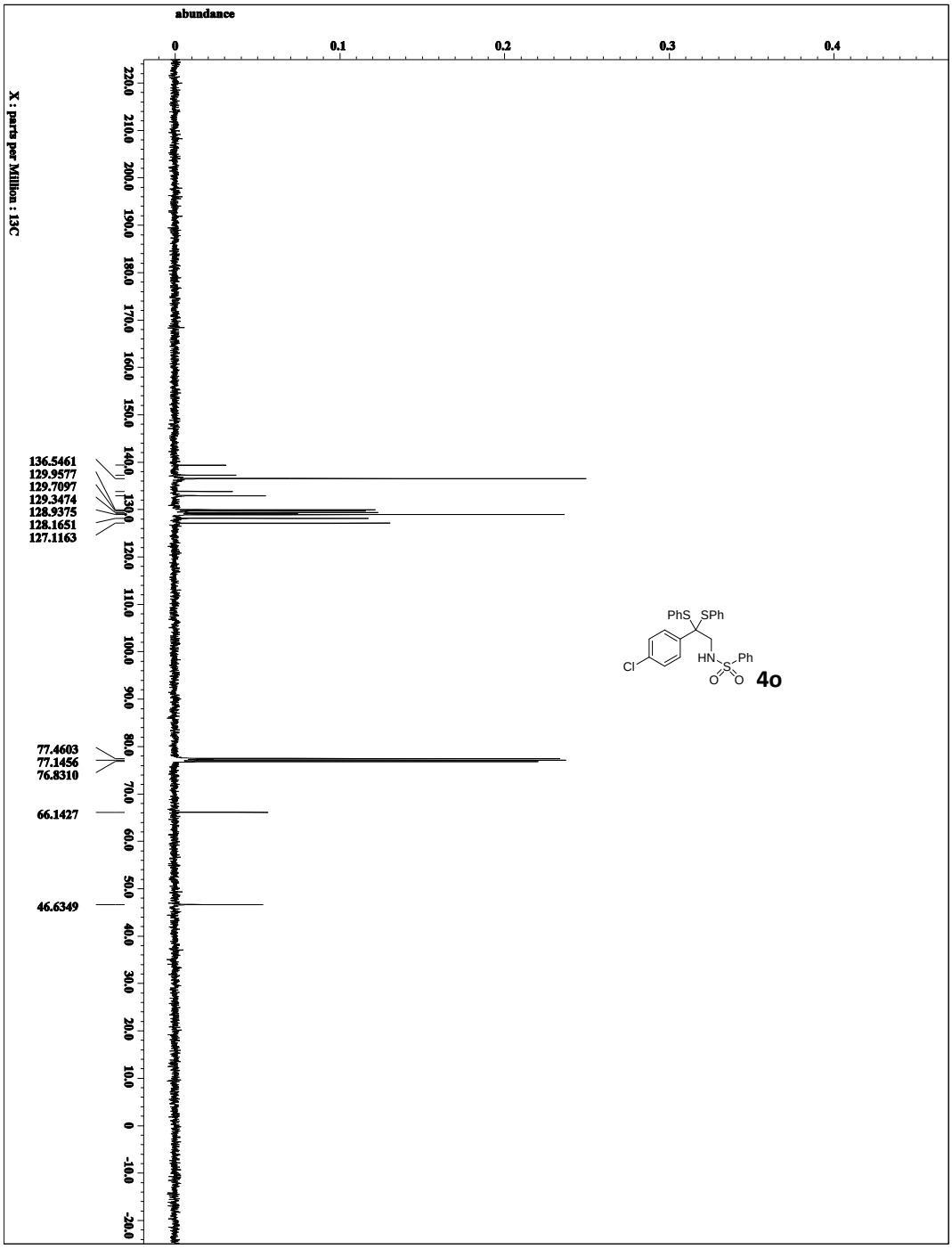

abundance
X : parts per Million : 1H
7.7927
7.4926
7.2440
7.2222
7.2028
7.0802
7.0699
6.9920
5.2497
5.2359
5.2233
3.4043
3.3917
2.6093
2.5910
2.5715
1.2107
1.1924
1.1729
0.0045
1.98
1.0
2.0
4.53
8.09
2.01
1
2.02
2.05
3.02
PhS
SPh
Et
HN
S
Ph
O
O
4m

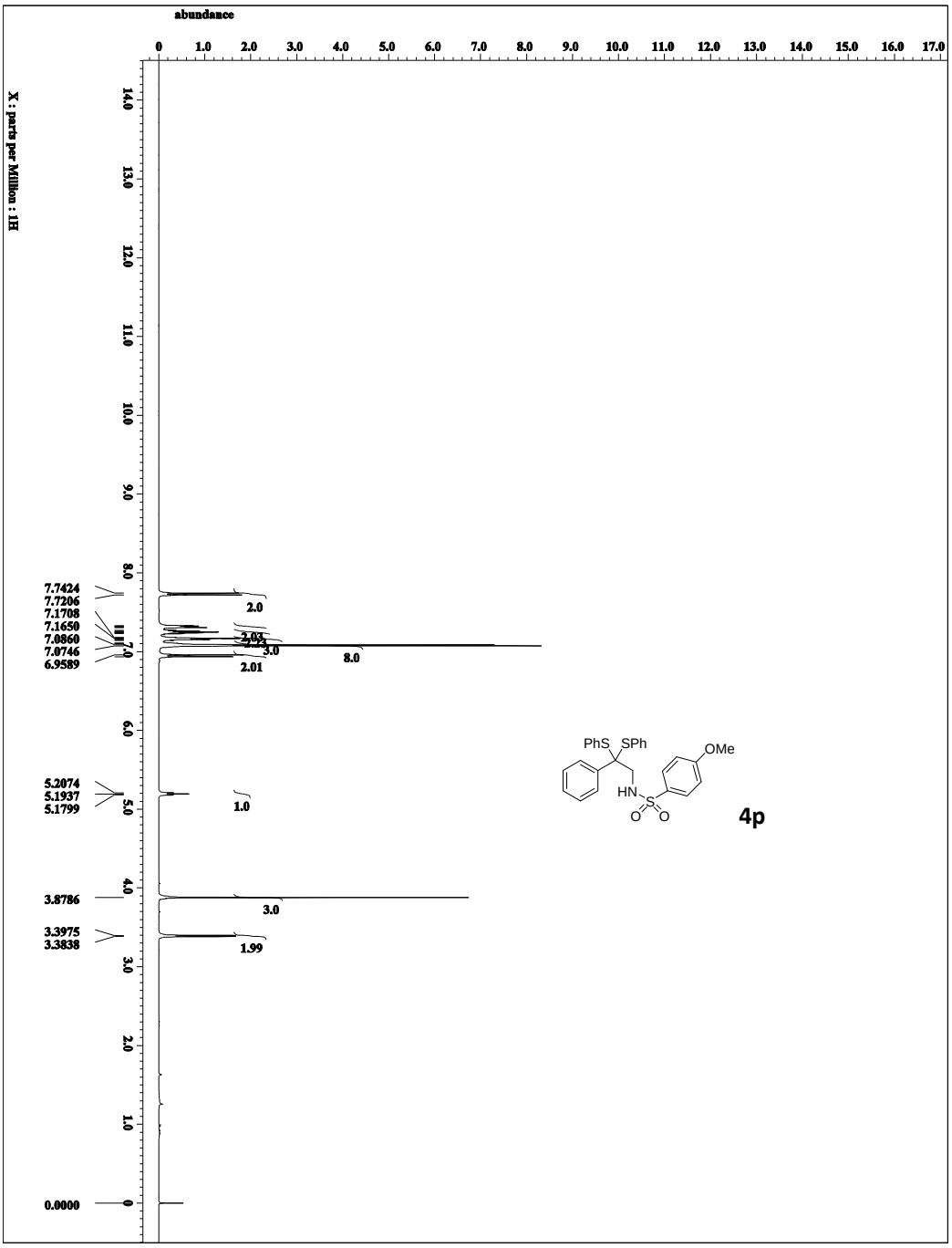

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
X : parts per Million : 13C
136.5556
132.8371
129.7097
129.6621
129.3093
128.7372
128.2128
127.5549
127.1450
77.5270
77.2028
76.8882
66.7243
46.7589
28.5192
15.7143
PhS
SPh
Et
HN
S
Ph
O
O
4m

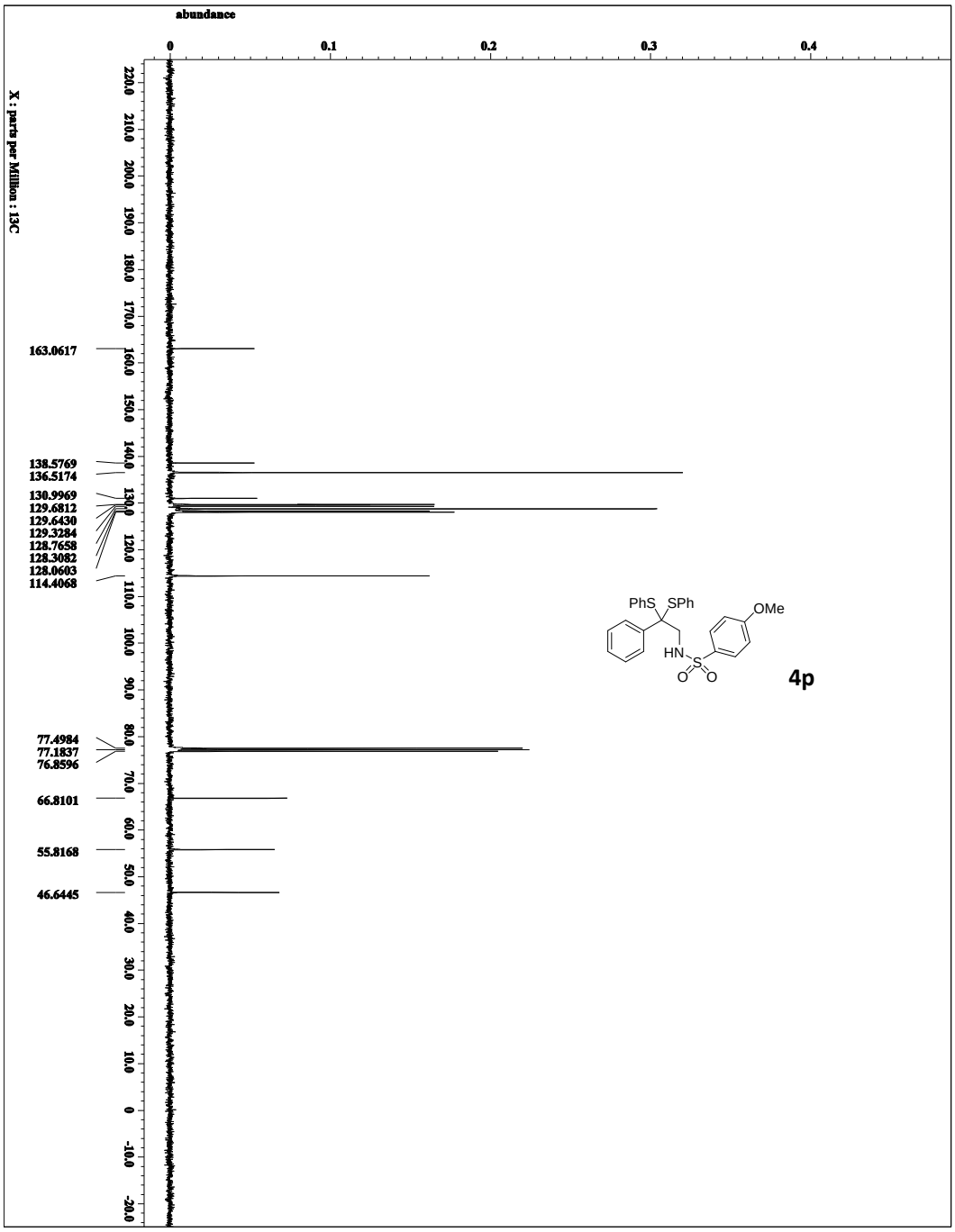

abundance
X : parts per Million : 1H
7.7974
7.5064
7.2532
7.2303
7.0906
7.0883
7.0791
6.7011
6.6782
5.2452
5.2326
5.2189
3.7710
3.3803
3.3666
0.0000
1.98
0.99
2.02
5.16
7.03
2.03
1
3.05
2.04
PhS
SPh
MeO
HN
Ph
4n

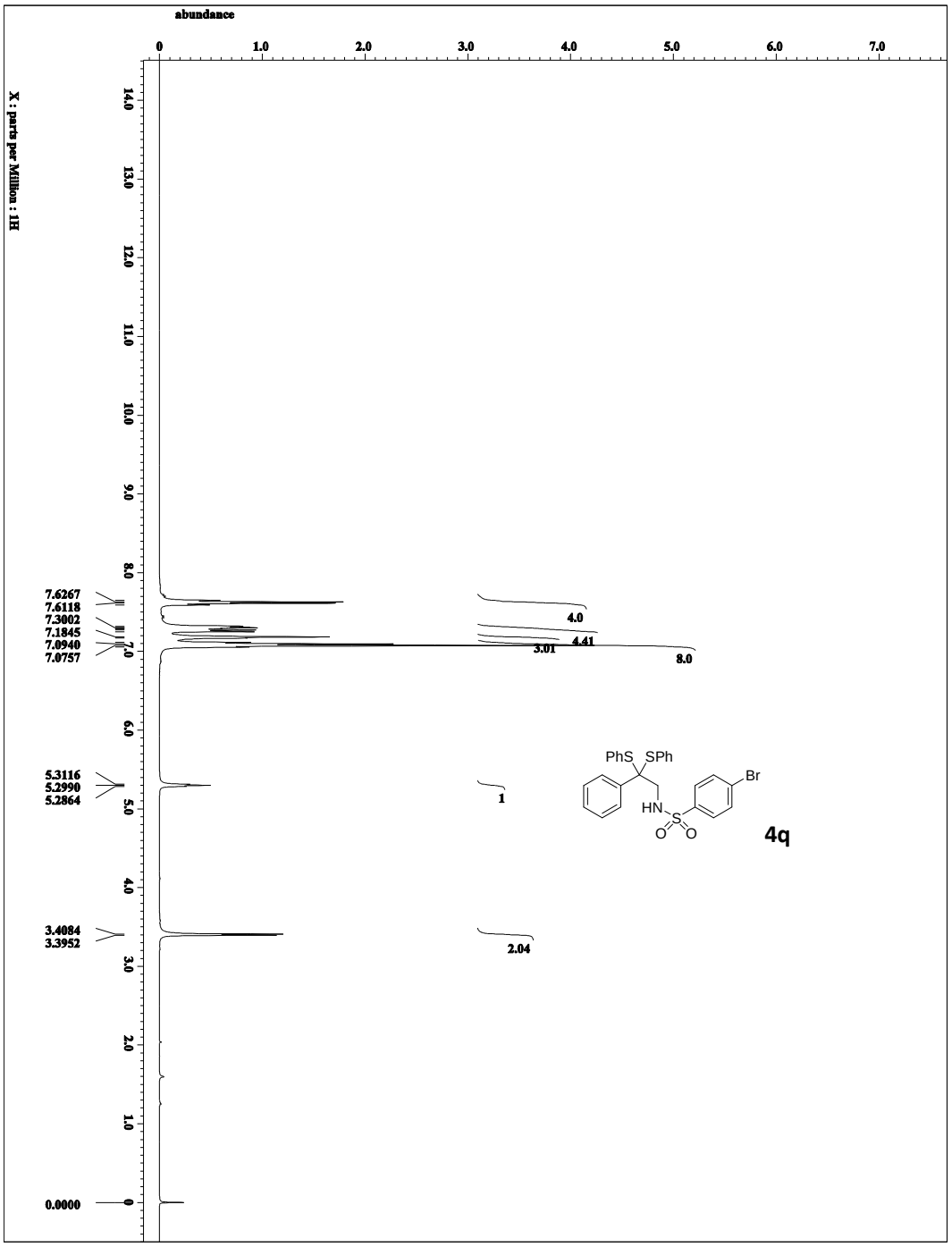

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
159.1239
139.4636
136.5079
132.8085
130.4534
129.7384
129.6430
129.2902
128.7658
127.1354
113.3198
77.4603
77.1361
76.8214
66.5622
55.3782
46.8829
PhS
SPh
MeO
HN
S
Ph
O
O
4n

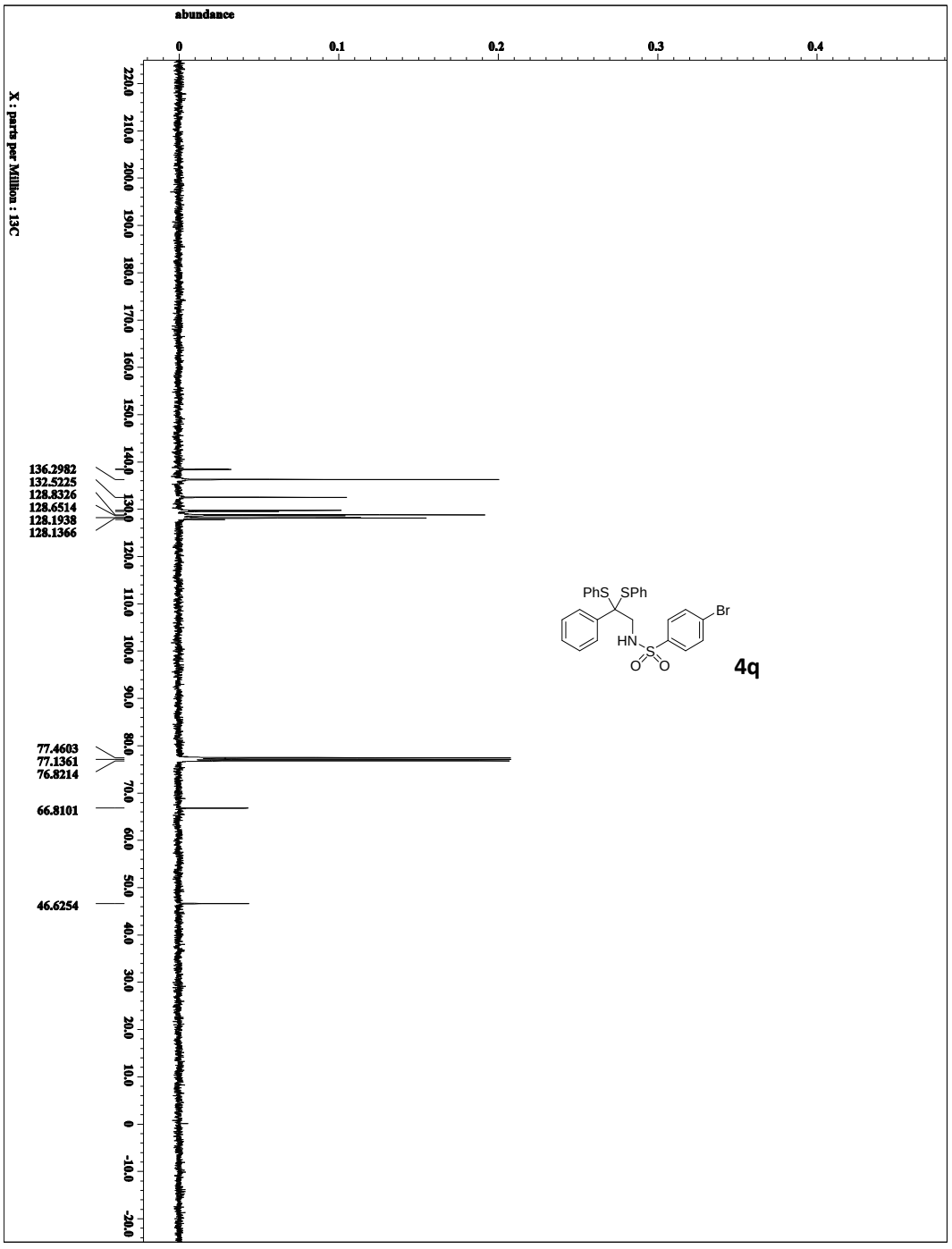

abundance
X : parts per Million : 1H
7.2601
7.2521
7.2384
7.1387
7.1169
7.1066
7.0894
5.2807
5.2670
5.2532
3.3781
3.3643
-0.0000
1.91
0.97
2.01
4.47
10.02
1.0
2
PhS
SPh
Cl
HN
S
Ph
O
O
4o

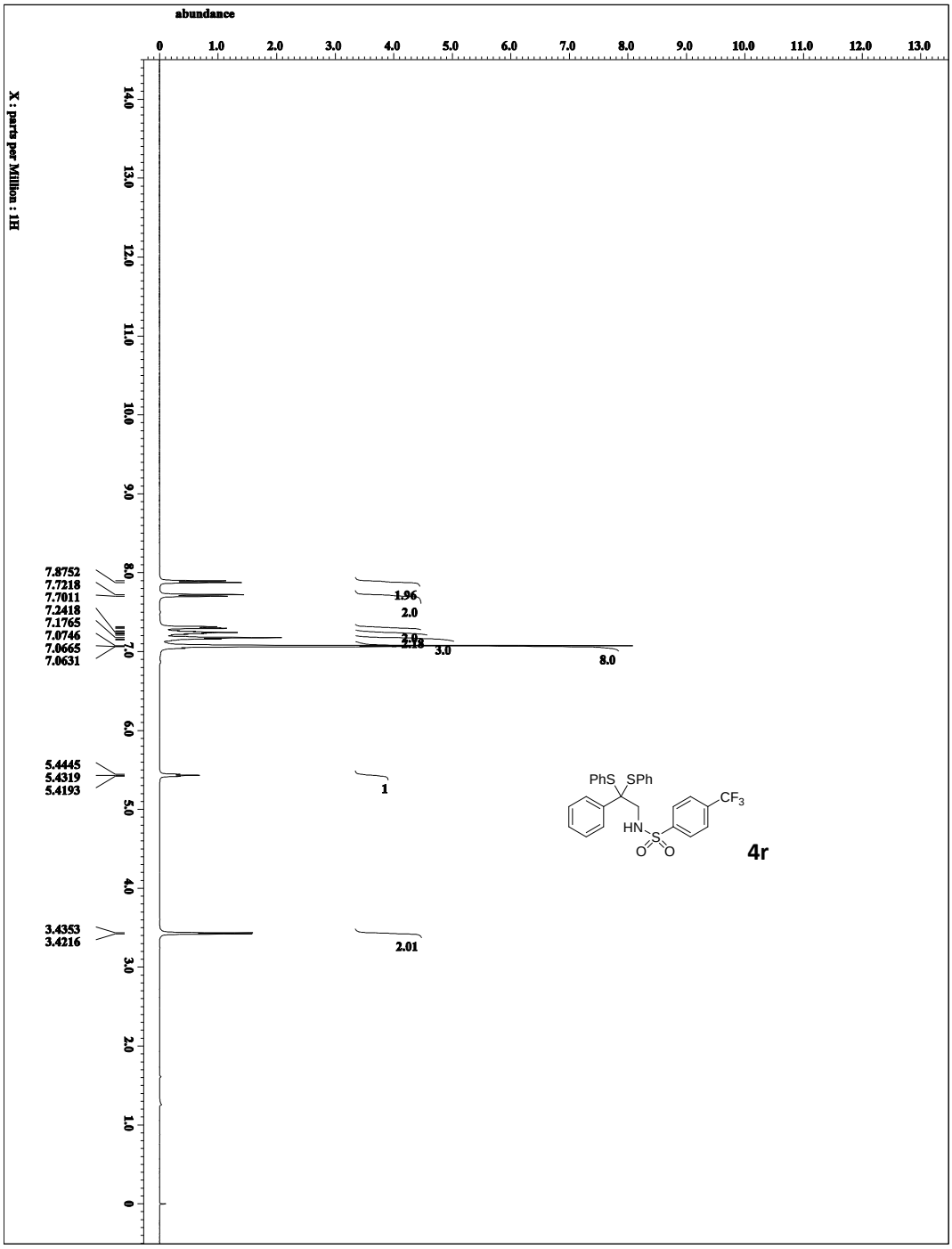

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
136.5461
129.9577
129.7097
129.3474
128.9375
128.1651
127.1163
77.4603
77.1456
76.8310
66.1427
46.6349
PhS
SPh
HN
Ph
S
O
O
Cl
4o

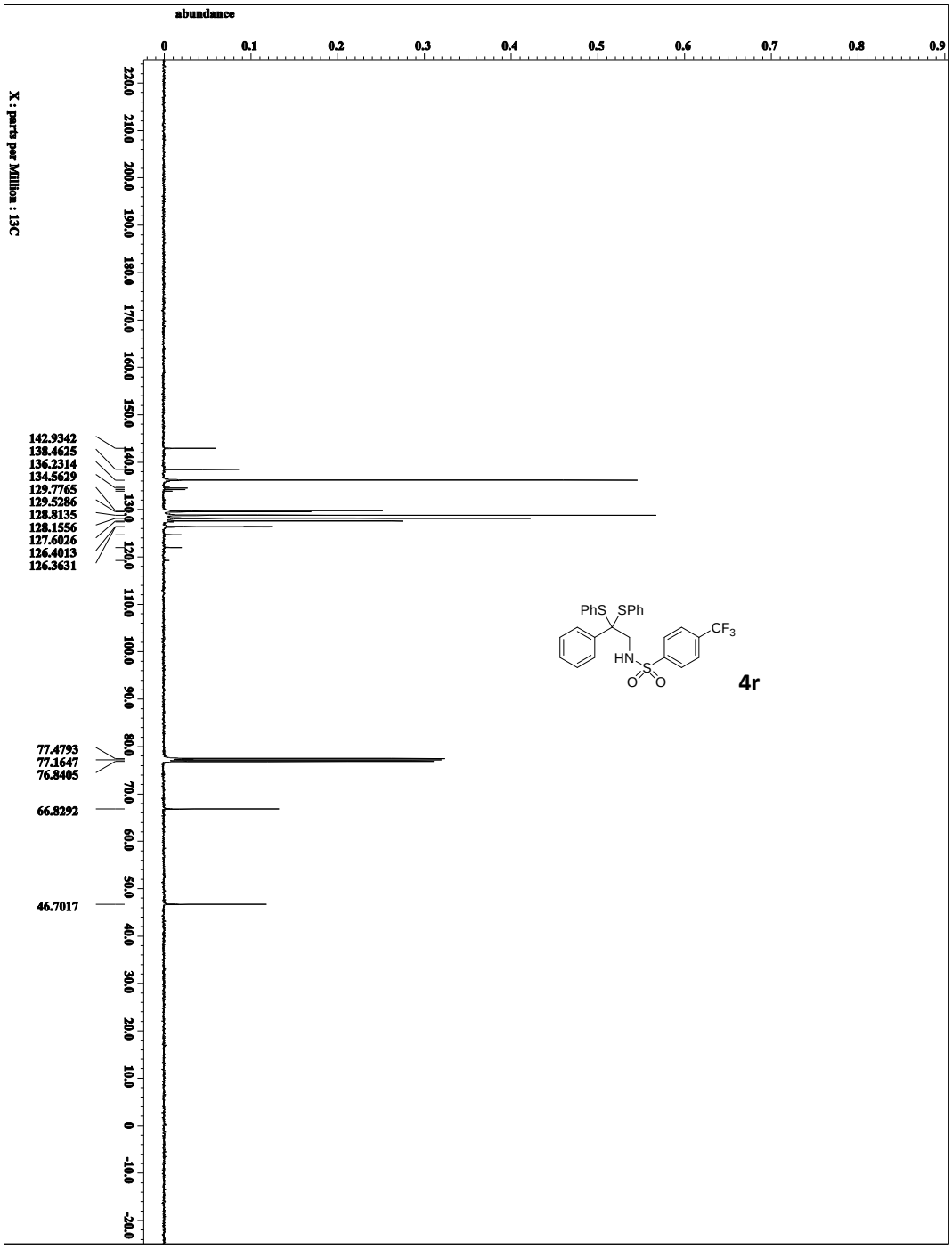

abundance
X : parts per Million : 1H
7.7424
7.7206
7.1708
7.1650
7.0860
7.0746
6.9589
5.2074
5.1937
5.1799
3.8786
3.3975
3.3838
0.0000
2.0
3.0
8.0
2.01
1.0
3.0
1.99
PhS
SPh
OMe
HN
S
O
O
4p

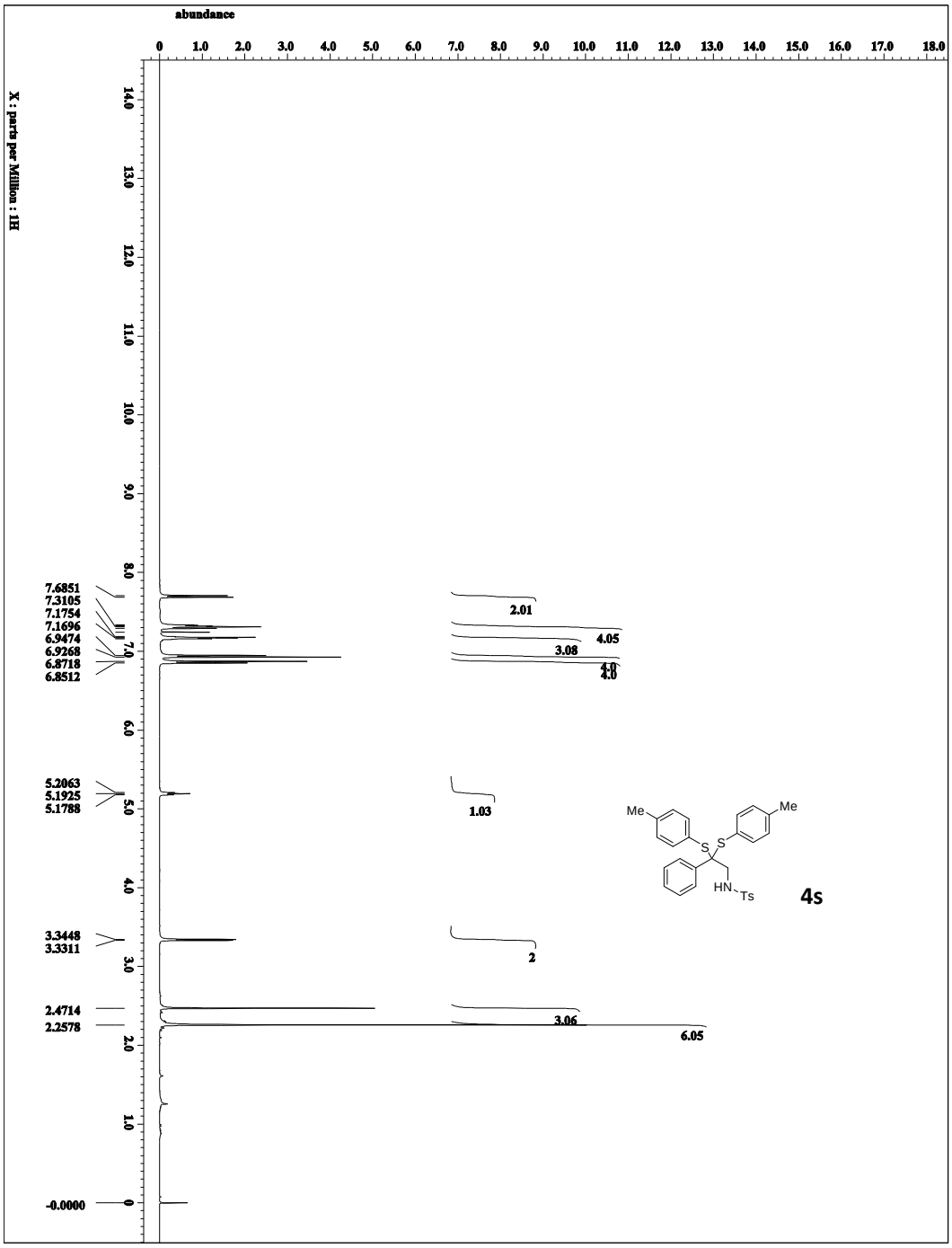

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
163.0617
138.5769
136.5174
130.9969
129.6812
129.6430
129.3284
128.7658
128.3082
128.0603
114.4068
77.4984
77.1837
76.8596
66.8101
55.8168
46.6445
PhS
SPh
OMe
HN
S
O
O
4p

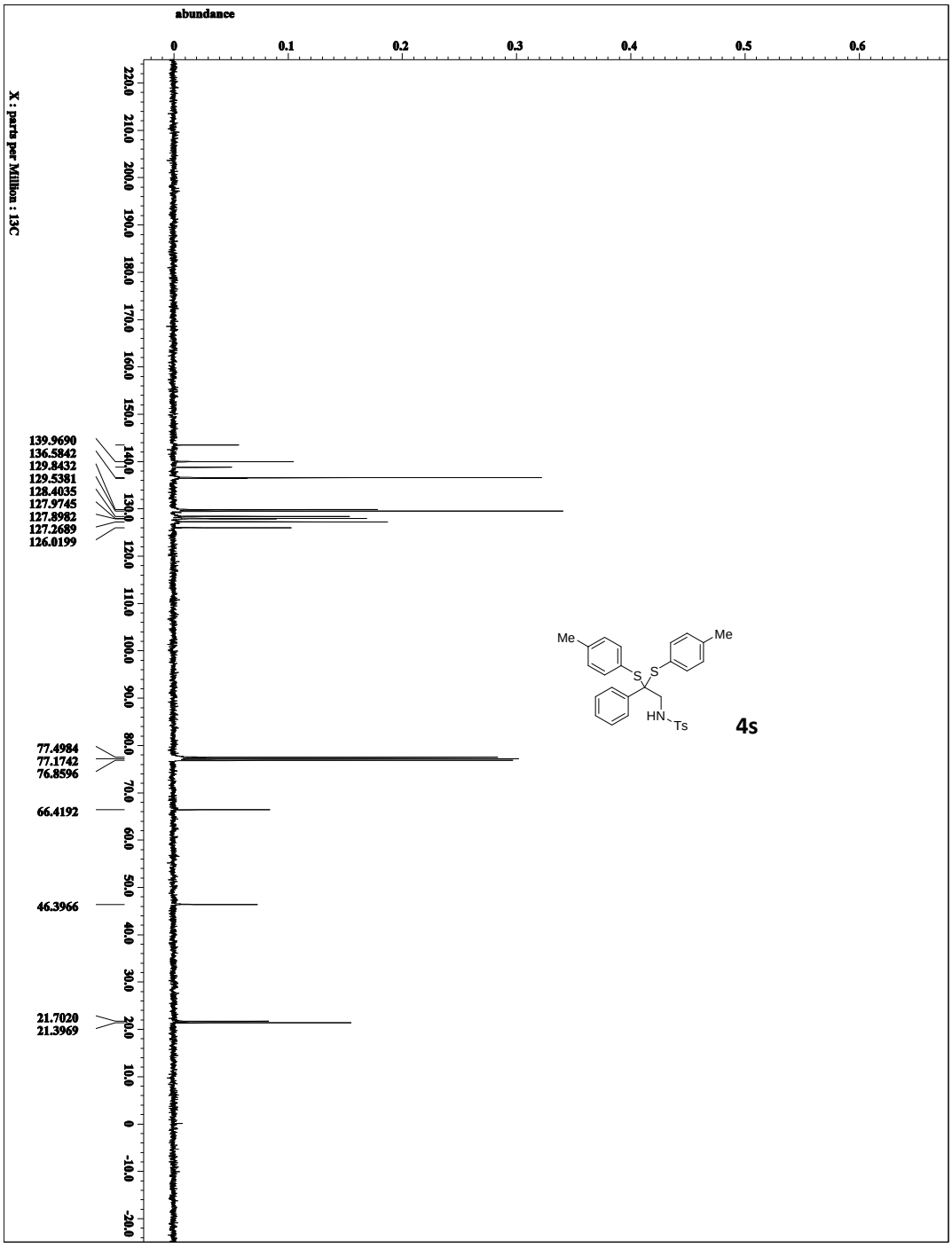

abundance
X : parts per Million : 1H
7.6267
7.6118
7.3002
7.1845
7.0940
7.0757
5.3116
5.2990
5.2864
3.4084
3.3952
0.0000
4.0
4.41
3.01
8.0
1
2.04
PhS
SPh
Br
HN
S
O
O
4q

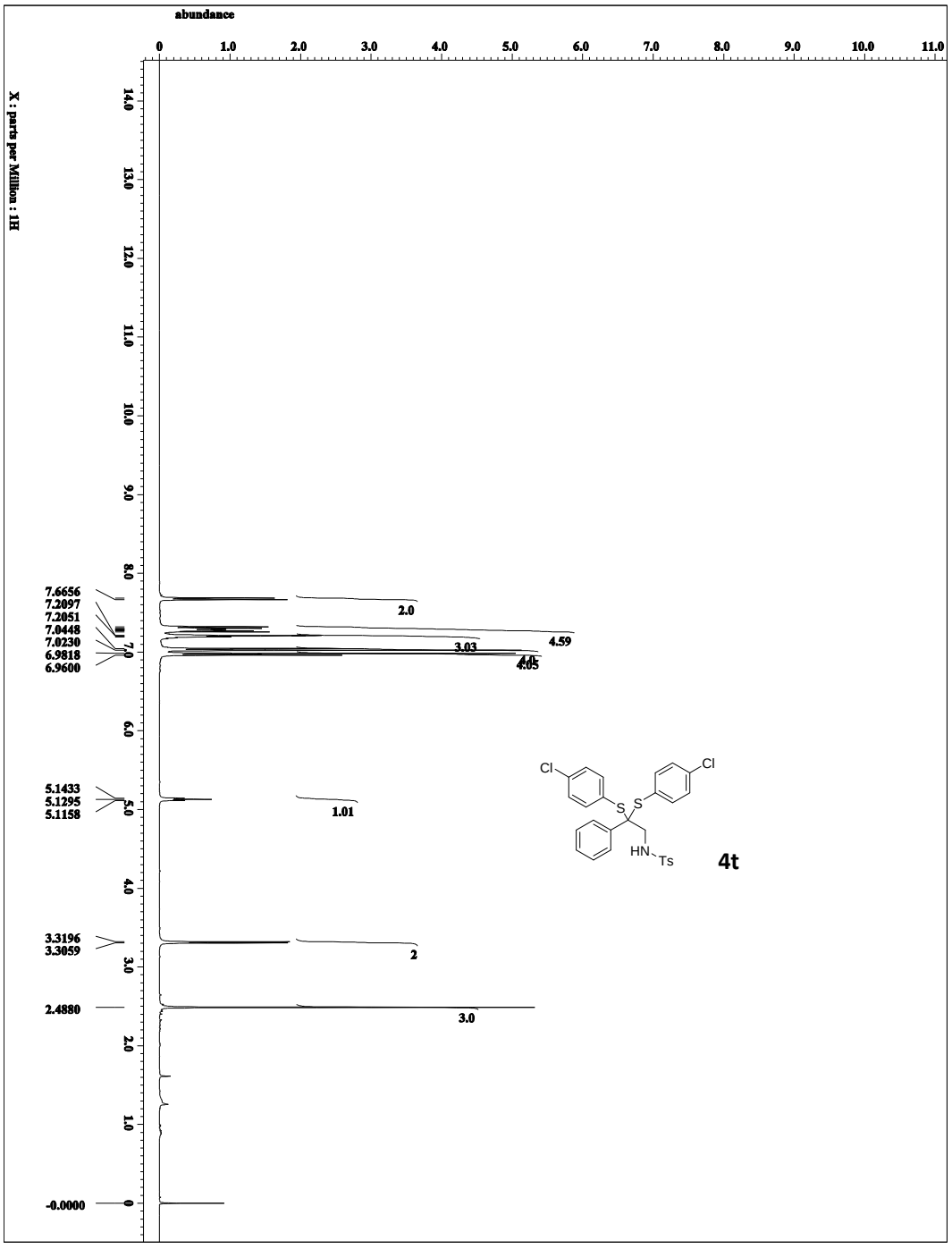

abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
136.2982
132.5225
128.8326
128.6514
128.1938
128.1366
77.4603
77.1361
76.8214
66.8101
46.6254
PhS
SPh
Br
HN
S
O
O
4q

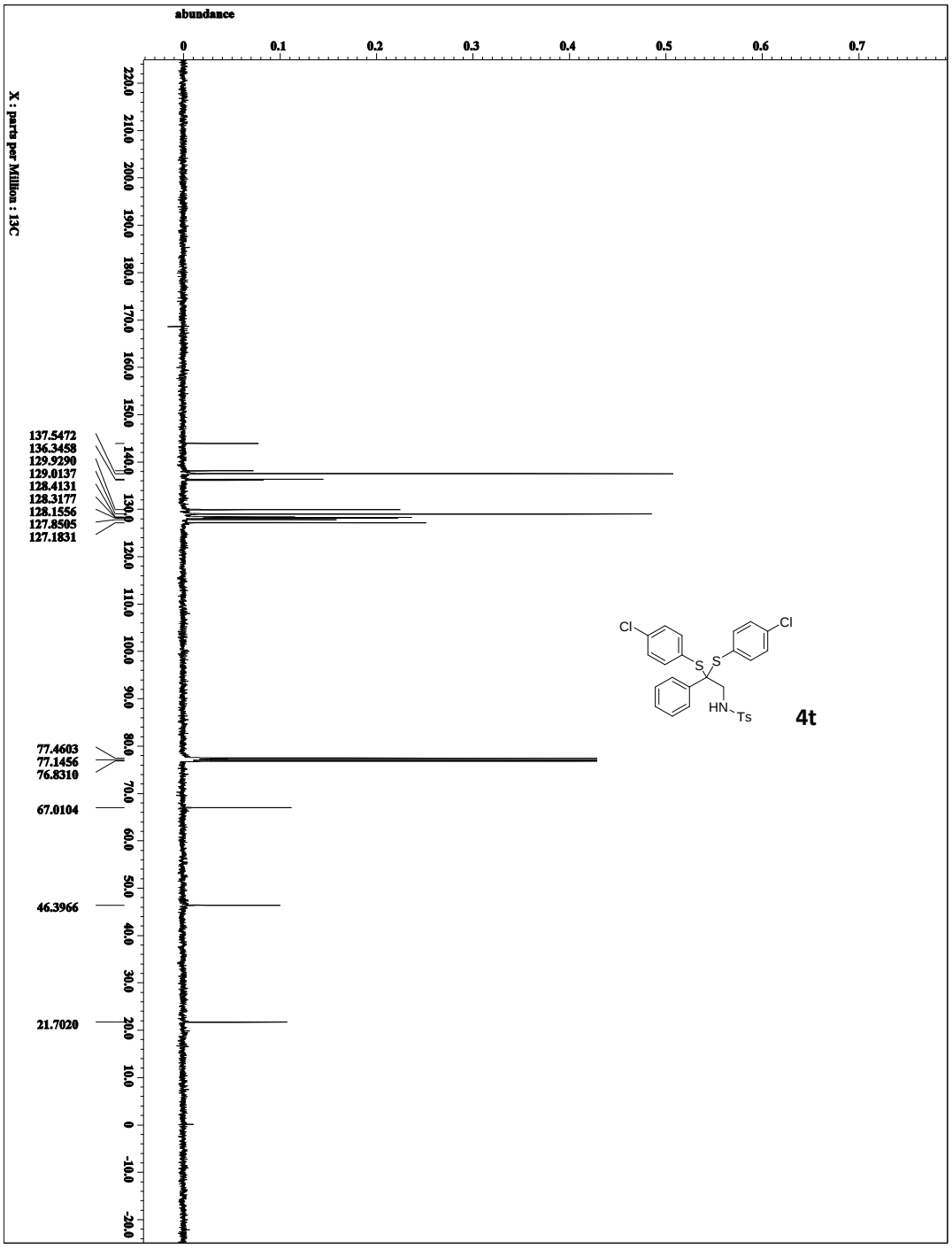

abundance
X : parts per Million : 1H
7.8752
7.7218
7.7011
7.2418
7.1765
7.0746
7.0665
7.0631
5.4445
5.4319
5.4193
3.4353
3.4216
1.96
2.0
3.0
8.0
1
2.01
PhS
SPh
CF3
HN
S
O
O
4r

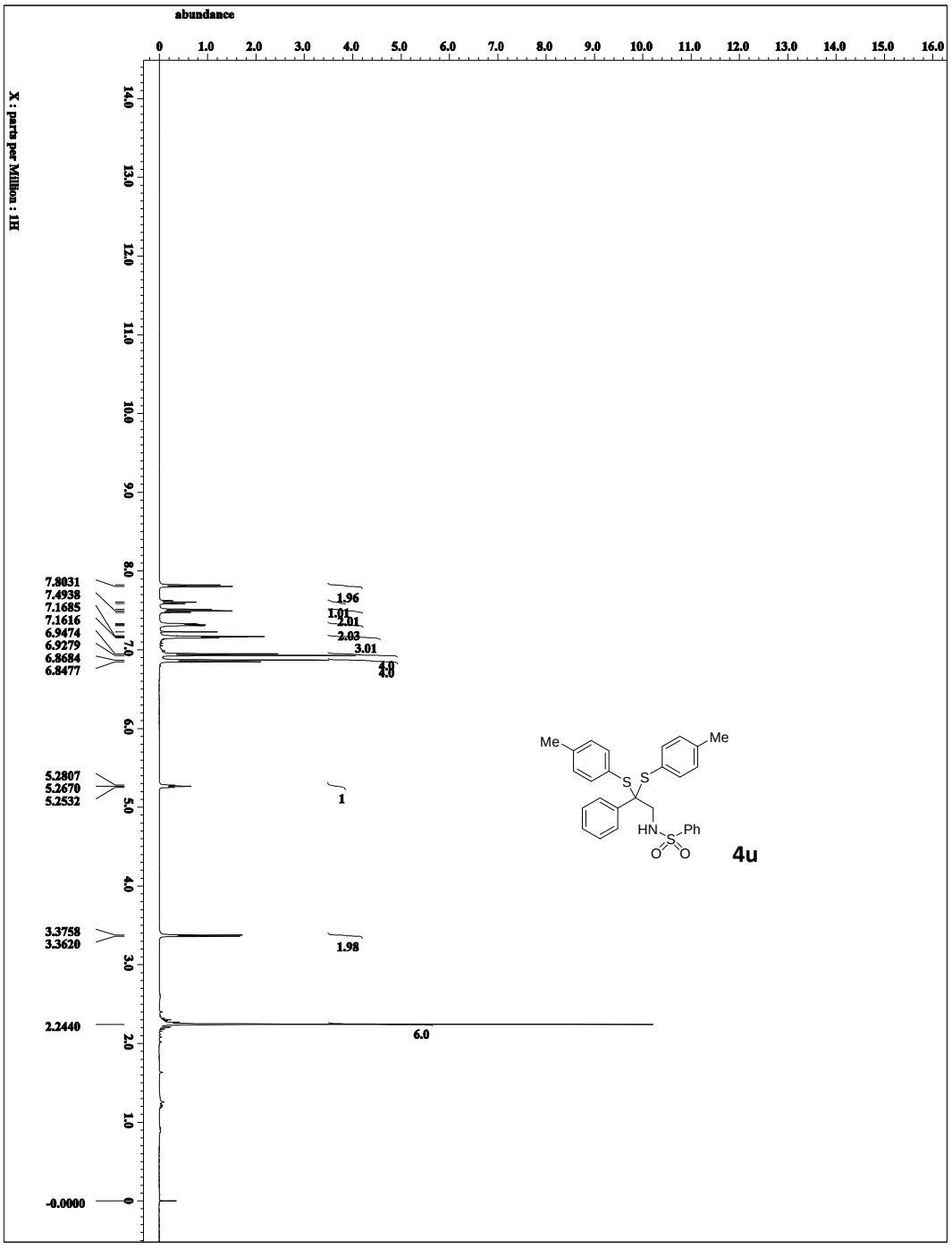

abundance
X : parts per Million : 13C
142.9342
138.4625
136.2314
134.5629
129.7765
129.5286
128.8135
128.1556
127.6026
126.4013
126.3631
77.4793
77.1647
76.8405
66.8292
46.7017
PhS
SPh
CF3
HN
S
O
O
4r

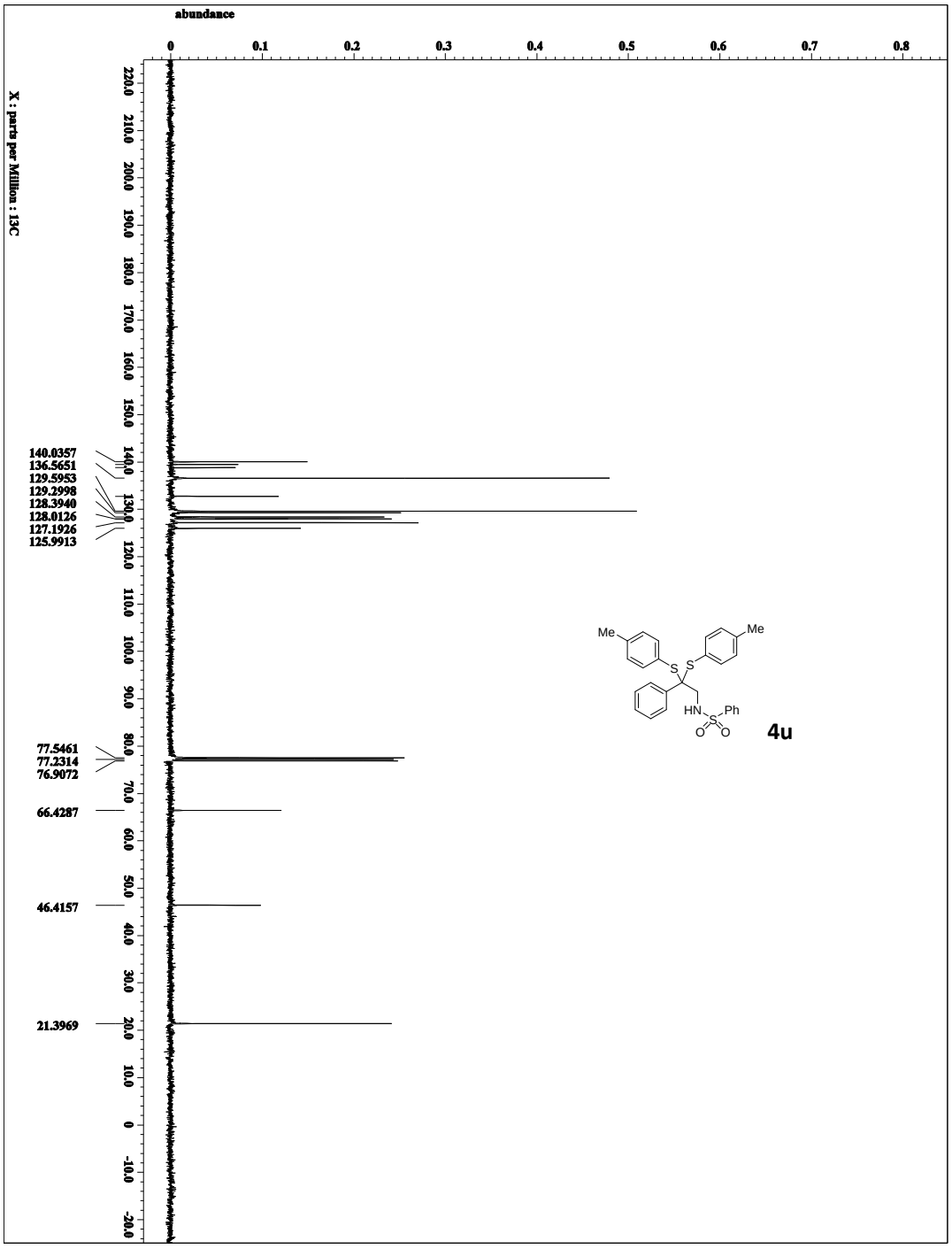

abundance
X : parts per Million : 1H
7.6851
7.3105
7.1754
7.1696
6.9474
6.9268
6.8718
6.8512
5.2063
5.1925
5.1788
3.3448
3.3311
2.4714
2.2578
-0.0000
2.01
4.05
3.08
4.0
4.0
1.03
2
3.06
6.05
Me
Me
S
S
HN
Ts
4s

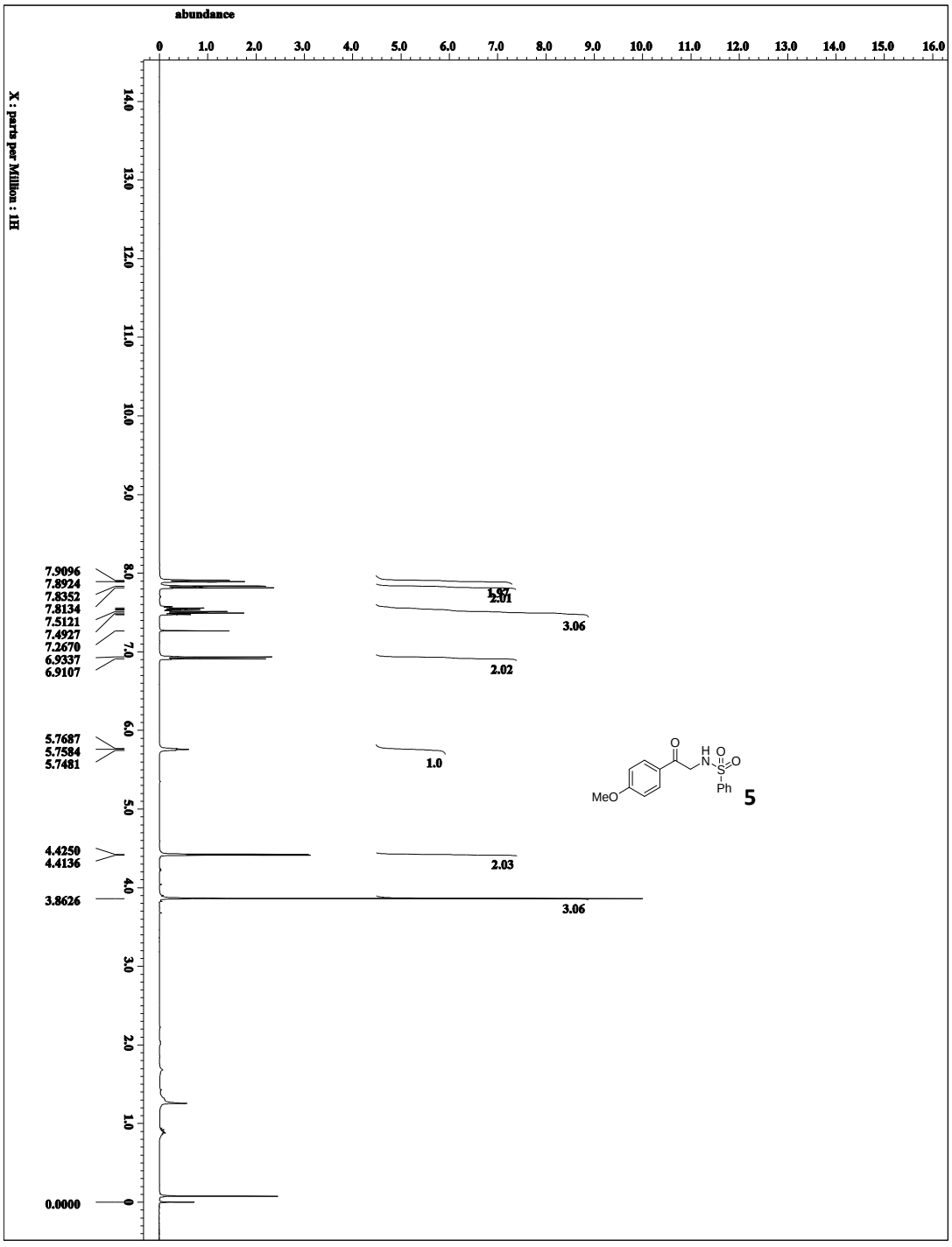

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
139.9690
136.5842
129.8432
129.5381
128.4035
127.9745
127.8982
127.2689
126.0199
77.4984
77.1742
76.8596
66.4192
46.3966
21.7020
21.3969
Me
Me
S
S
HN
Ts
4s

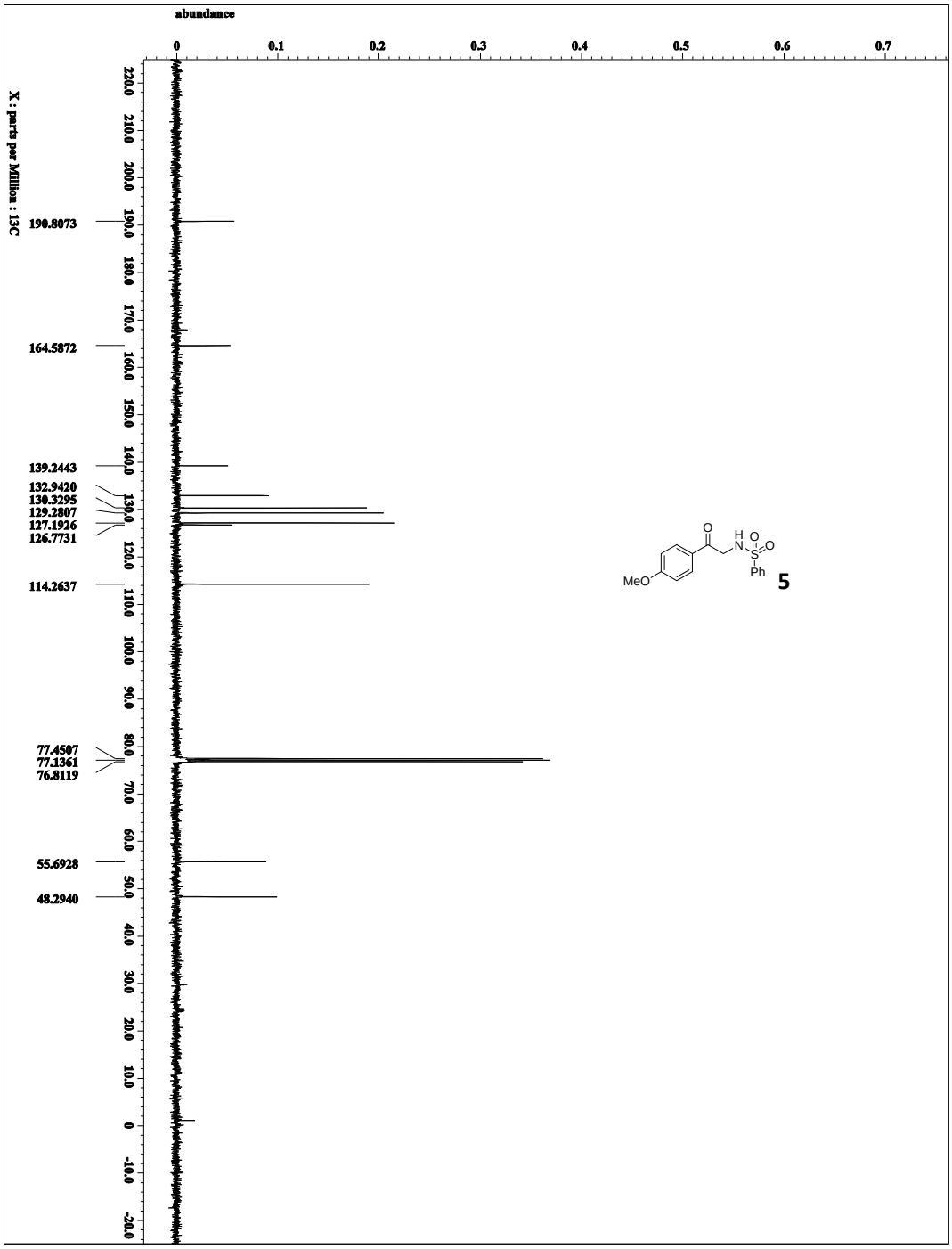

abundance
X : parts per Million : 1H
7.6656
7.2097
7.2051
7.0448
7.0230
6.9818
6.9600
5.1433
5.1295
5.1158
3.3196
3.3059
2.4880
-0.0000
2.0
4.59
3.03
4.05
1.01
2
3.0
Cl
Cl
S
S
HN
Ts
4t

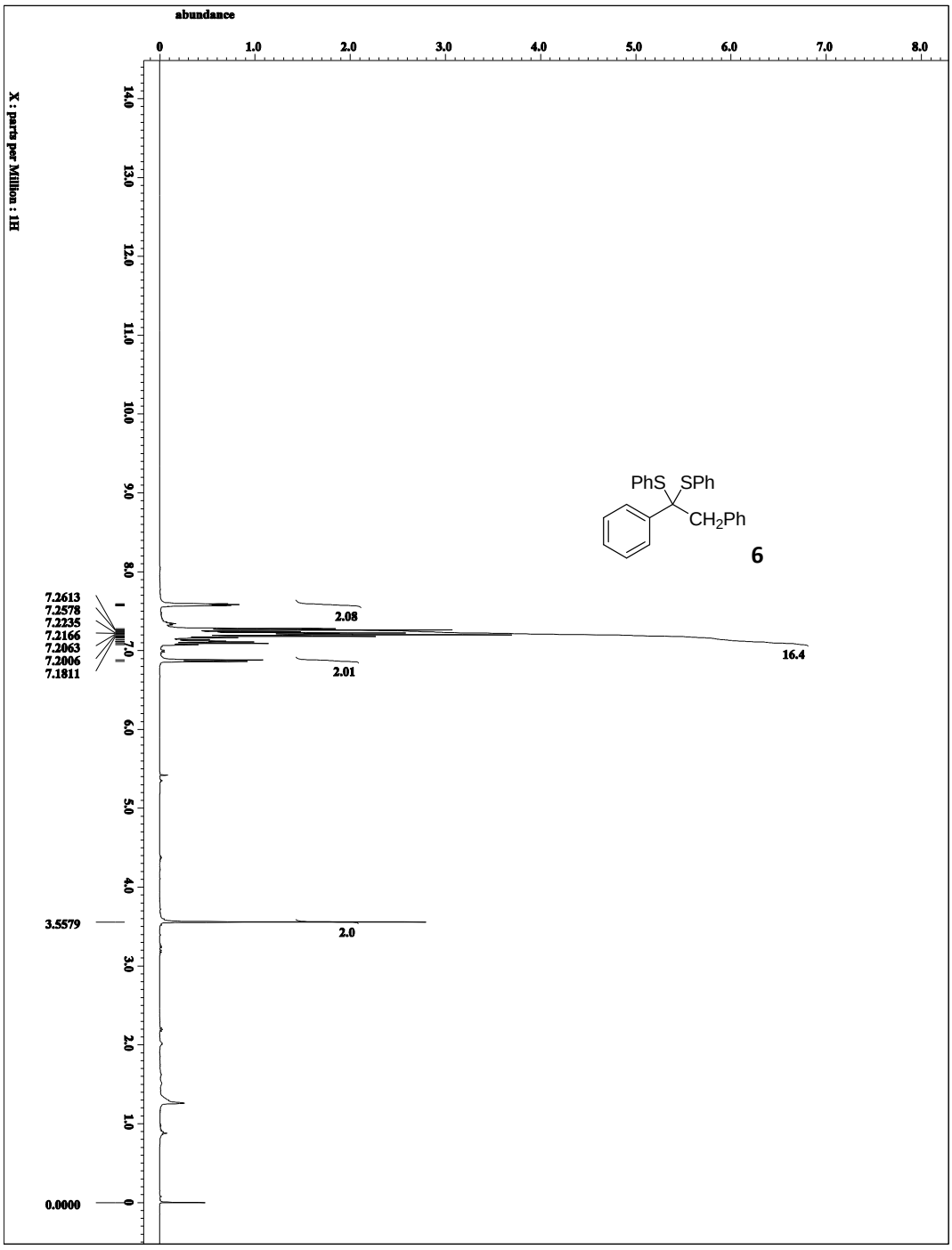

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
X : parts per Million : 13C
137.5472
136.3458
129.9290
129.0137
128.4131
128.3177
128.1556
127.8505
127.1831
77.4603
77.1456
76.8310
67.0104
46.3966
21.7020
Cl
Cl
S
S
HN
Ts
4t

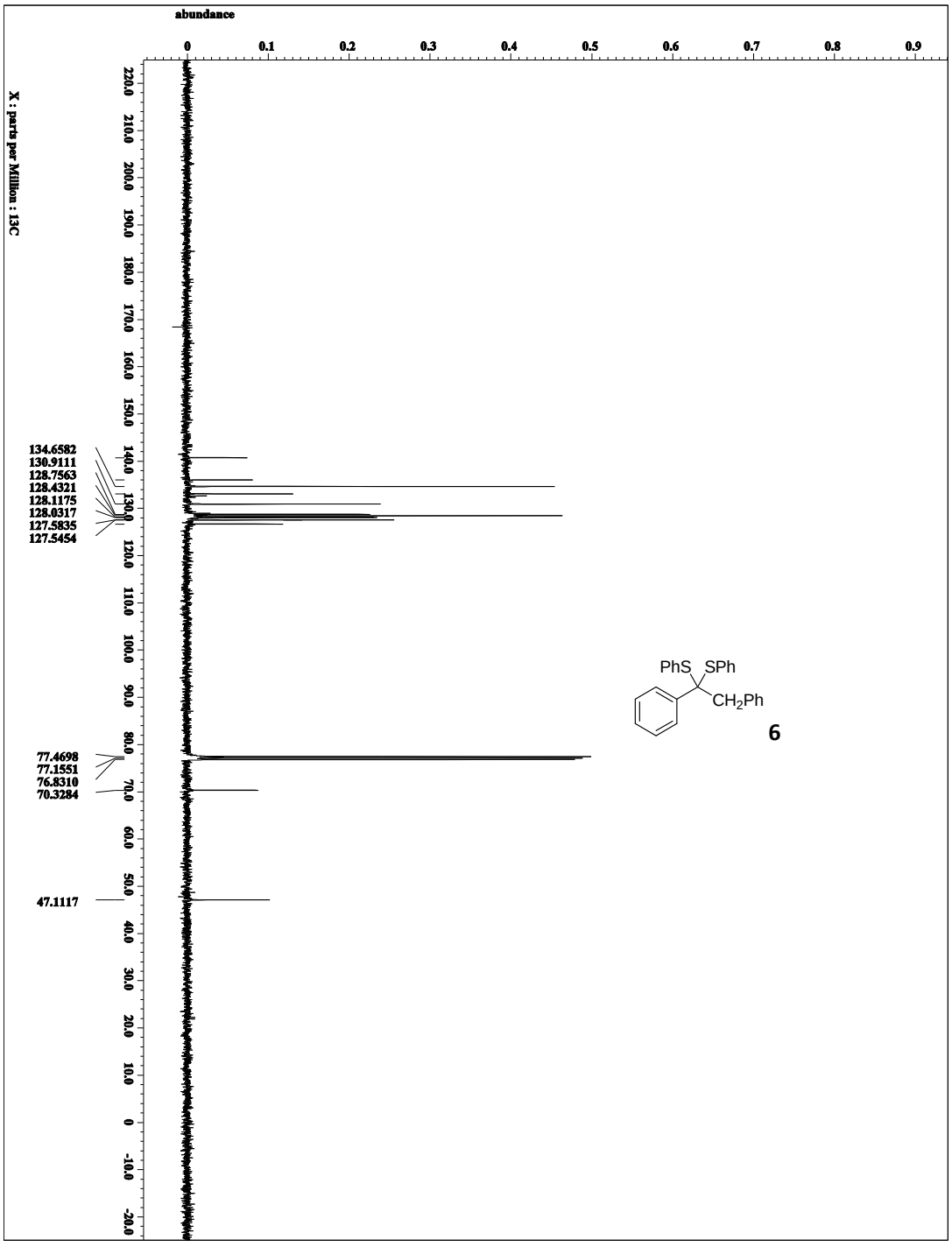

abundance
X : parts per Million : 1H
7.8031
7.4938
7.1685
7.1616
6.9474
6.9279
6.8684
6.8477
5.2807
5.2670
5.2532
3.3758
3.3620
2.2440
-0.0000
1.96
1.01
2.01
2.03
3.01
4.0
4.0
1
1.98
6.0
Me
Me
S
S
HN
Ph
O
O
4u

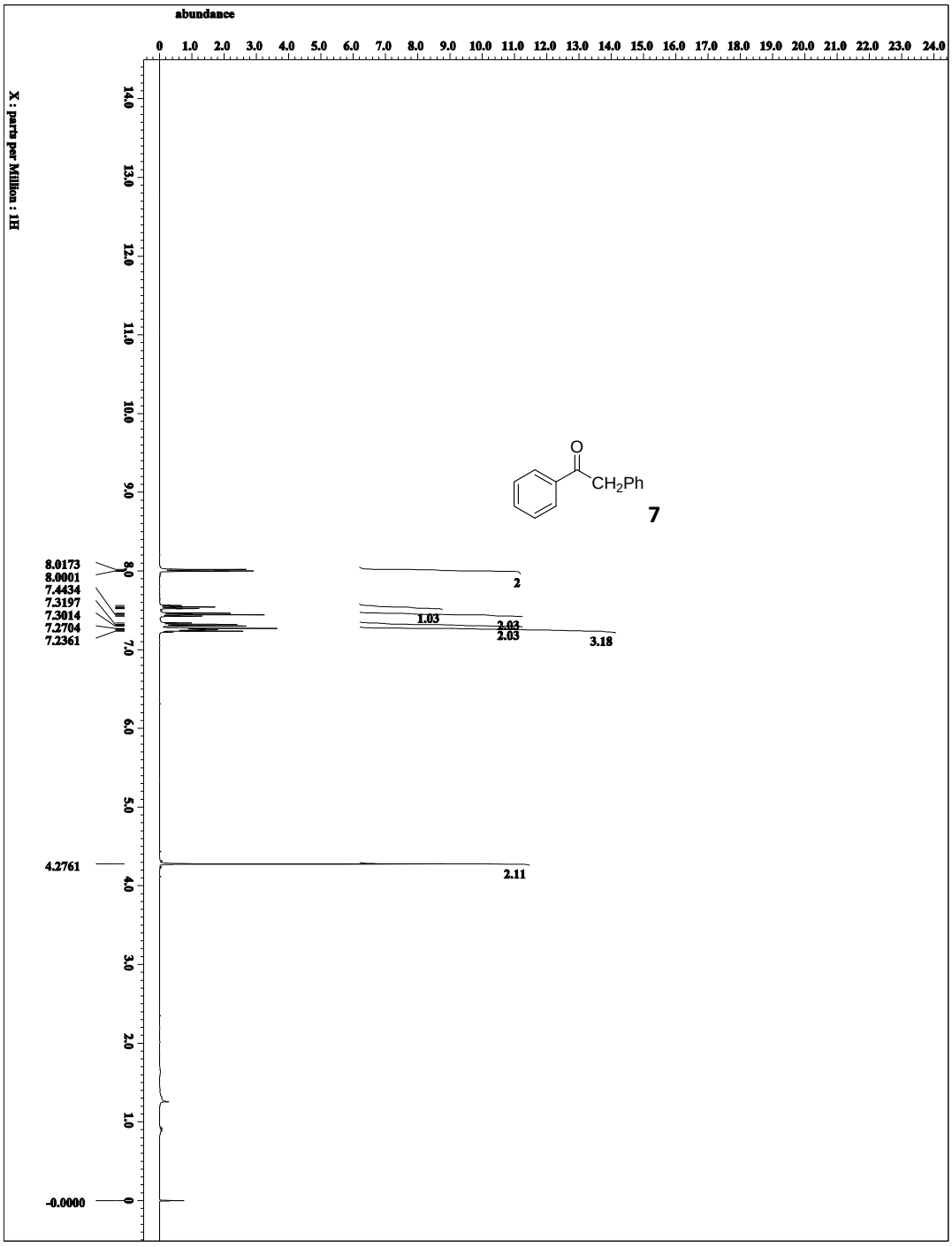

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
140.0357
136.5651
129.5953
129.2998
128.3940
128.0126
127.1926
125.9913
77.5461
77.2314
76.9072
66.4287
46.4157
21.3969
Me
Me
S
S
HN
Ph
O
O
4u


abundance
X : parts per Million : 1H
7.9096
7.8924
7.8352
7.8134
7.5121
7.4927
7.2670
6.9337
6.9107
5.7687
5.7584
5.7481
4.4250
4.4136
3.8626
0.0000
1.97
2.01
3.06
2.02
1.0
2.03
3.06
MeO
Ph
5

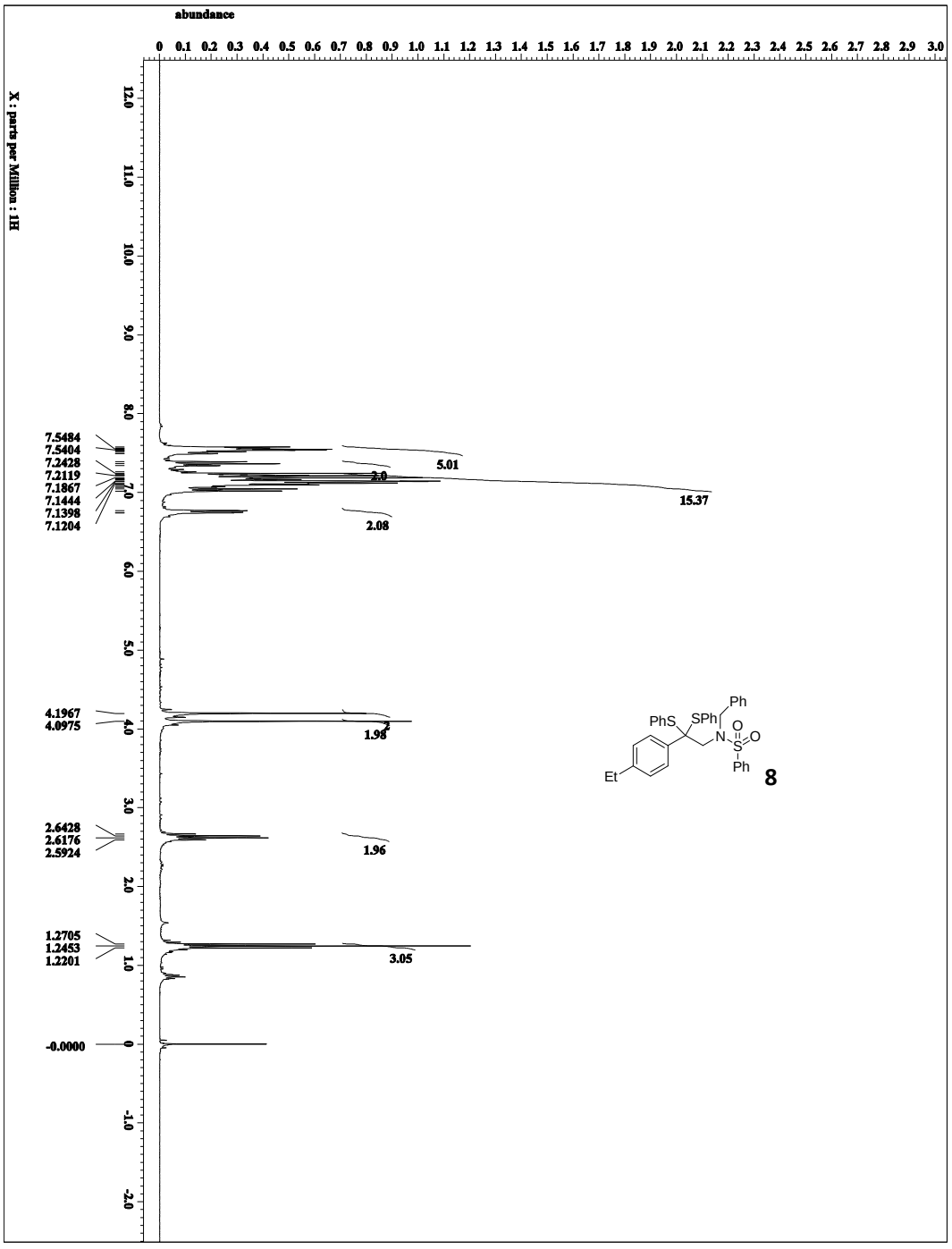

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
X : parts per Million : 13C
190.8073
164.5872
139.2443
132.9420
130.3295
129.2807
127.1926
126.7731
114.2637
77.4507
77.1361
76.8119
55.6928
48.2940
MeO
Ph
5

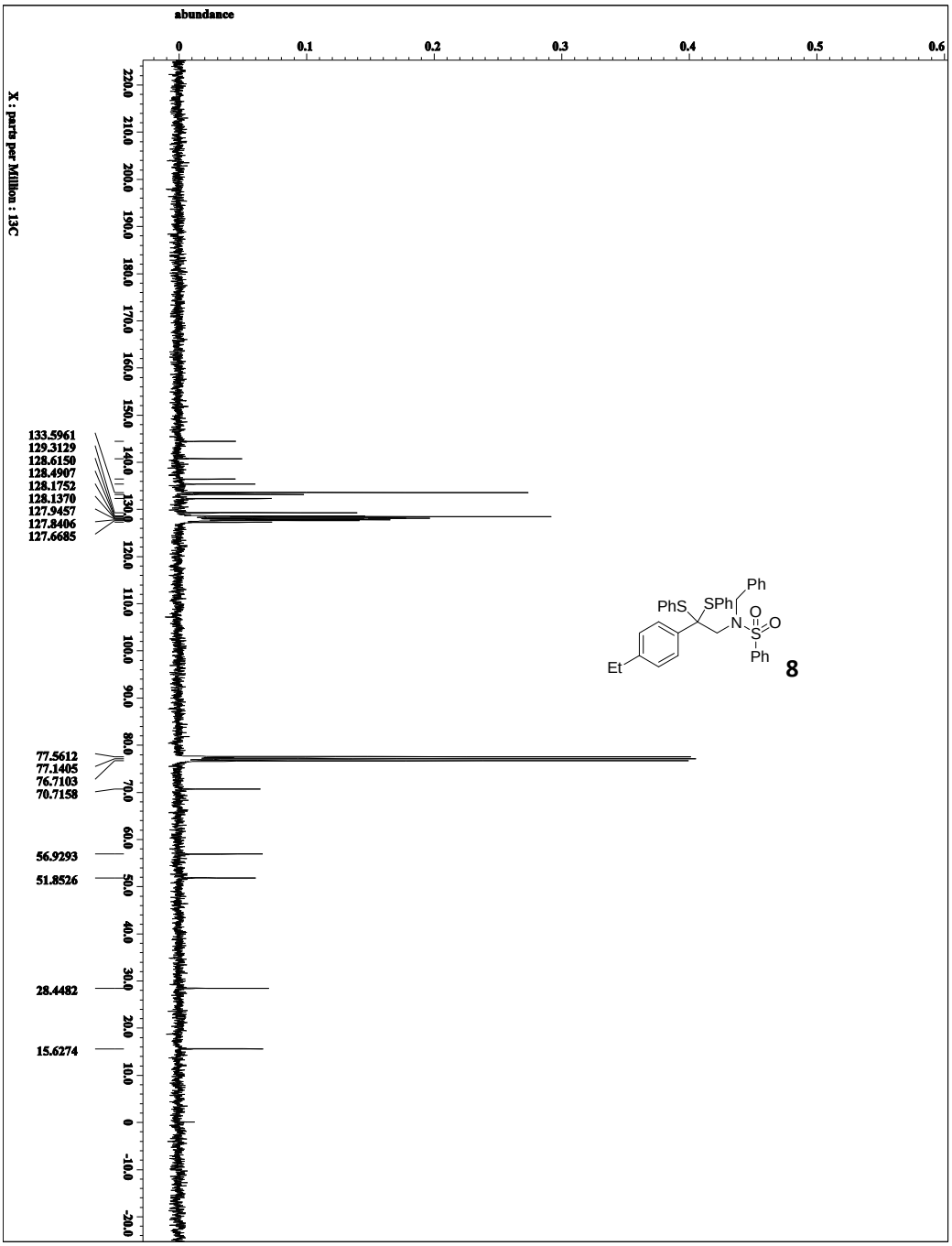

abundance
X : parts per Million : 1H
PhS
SPh
CH2Ph
6
7.2613
7.2578
7.2235
7.2166
7.2063
7.2006
7.1811
2.08
16.4
2.01
3.5579
2.0
0.0000

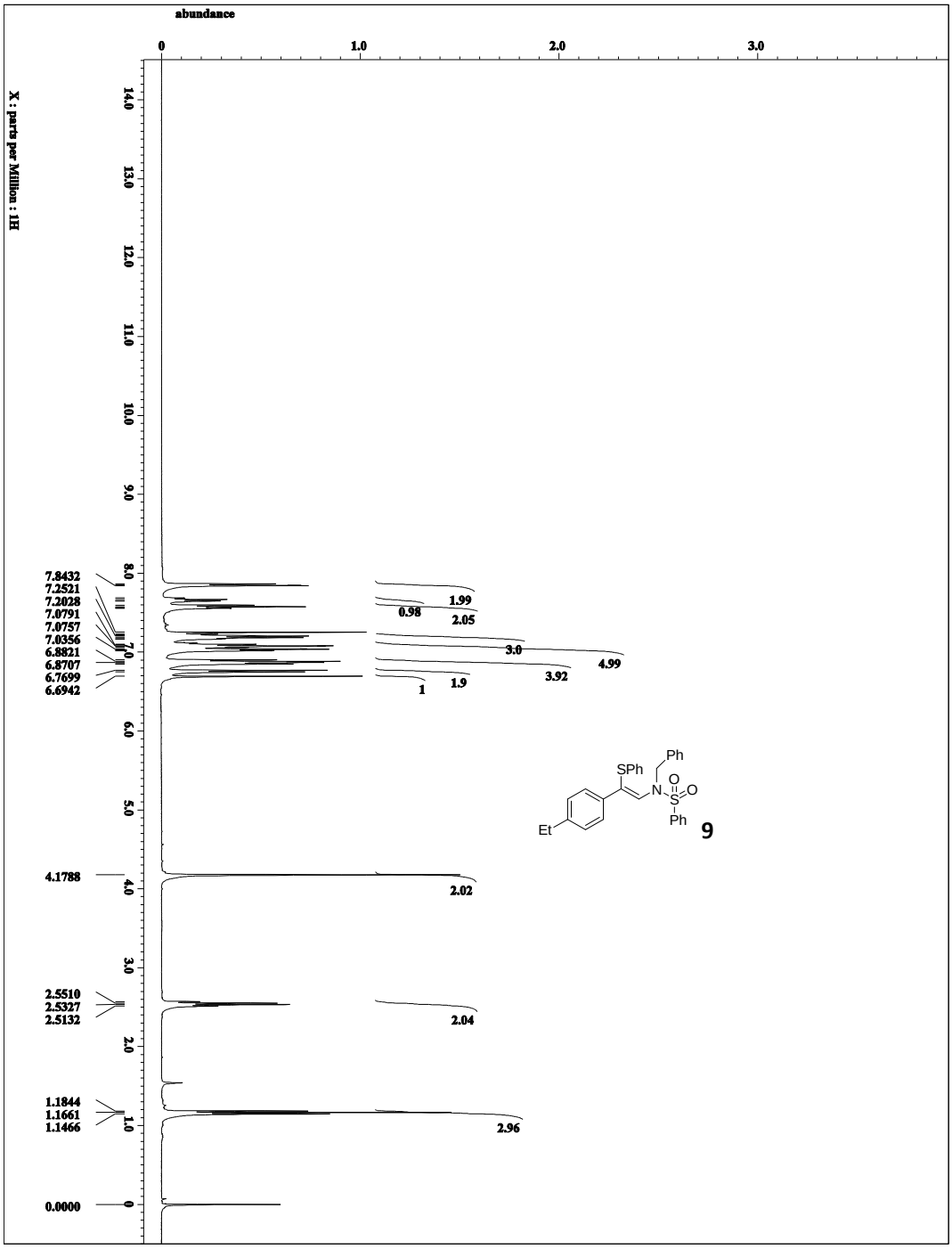

abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
134.6582
130.9111
128.7563
128.4321
128.1175
128.0317
127.5835
127.5454
77.4698
77.1551
76.8310
70.3284
47.1117
PhS
SPh
CH2Ph
6

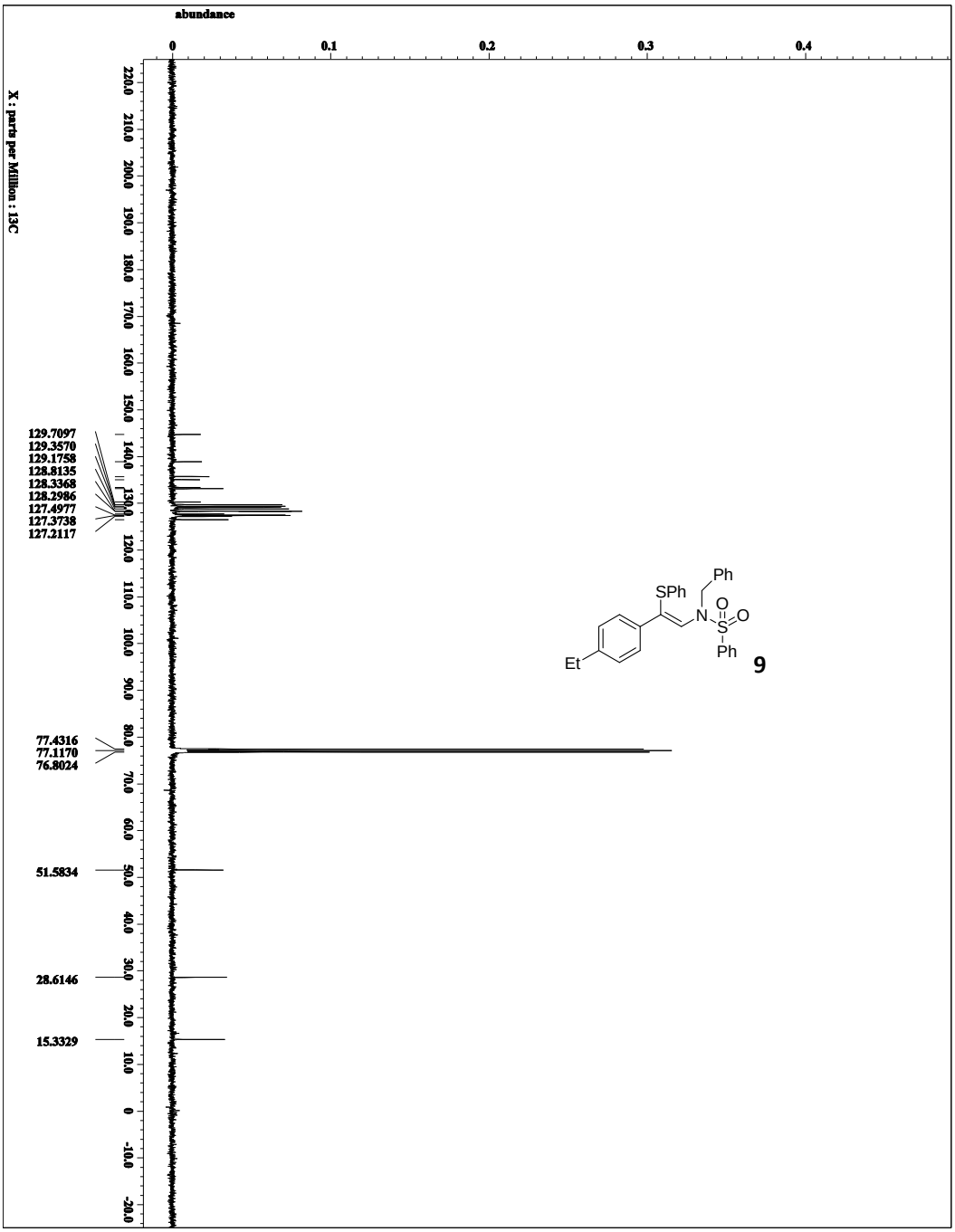

abundance
X : parts per Million : 1H
O
CH2Ph
7
8.0173
8.0001
7.4434
7.3197
7.3014
7.2704
7.2361
4.2761
-0.0000
2
1.03
2.03
2.03
3.18
2.11


abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
X : parts per Million : 13C
197.7199
133.2757
129.5763
128.7849
128.7563
128.7182
126.9924
77.4793
77.1551
76.8405
45.6052
O
CH2Ph
7


abundance
X : parts per Million : 1H
7.5484
7.5404
7.2428
7.2119
7.1867
7.1444
7.1398
7.1204
4.1967
4.0975
2.6428
2.6176
2.5924
1.2705
1.2453
1.2201
-0.0000
5.01
2.0
15.37
2.08
1.98
1.96
3.05
Ph
PhS
SPh
N
O
O
S
Ph
Et
8


abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
X : parts per Million : 13C
133.5961
129.3129
128.6150
128.4907
128.1752
128.1370
127.9457
127.8406
127.6685
77.5612
77.1405
76.7103
70.7158
56.9293
51.8526
28.4482
15.6274
Ph
PhS
SPh
O
N
S
O
Ph
Et
8


abundance
0
1.0
2.0
3.0
X : parts per Million : 1H
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.8432
7.2521
7.2028
7.0791
7.0757
7.0356
6.8821
6.8707
6.7699
6.6942
4.1788
2.5510
2.5327
2.5132
1.1844
1.1661
1.1466
0.0000
0.98
1.99
2.05
3.0
4.99
3.92
1
1.9
2.02
2.04
2.96
SPh
Ph
N
O
S
O
Ph
Et
9


abundance
0
0.1
0.2
0.3
0.4
X : parts per Million : 13C
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
129.7097
129.3570
129.1758
128.8135
128.3368
128.2986
127.4977
127.3738
127.2117
77.4316
77.1170
76.8024
51.5834
28.6146
15.3329
SPh
Ph
N
O
O
S
Ph
Et
9