Electronic Supplementary Information

Silver-Catalyzed Three-Component Reaction via Stabilized Cation: Synthesis of Polysubstituted Tetrahydronaphthols and Tetrahydronaphthylamines

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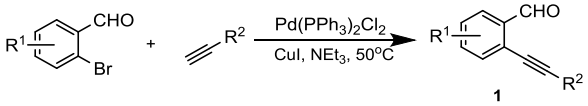
1.Experimental procedures and spectroscopic data

1. 1 General information

All reactions were carried out under an inert atmosphere of dry N_2 in Schlenk tube, solvents were purified by standard method. ^1H, ^{13}C, ^{19}F NMR spectra were recorded on a Bruker AVANCE 400 (400 MHz for ^1H; 100 MHz for ^{13}C; 376 MHz for ^{19}F), ^1H NMR and ^{13}C NMR chemical shifts were determined relative to internal standard TMS at δ 0.0 and ^{19}F NMR chemical shifts were determined relative to $CFCl_3$ as external standard. Chemical shifts (δ) are reported in ppm, and coupling constants (J) are in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d =doublet, t = triplet, q = quartet, m = multiplet, br = broad. Infrared (IR) spectra are recorded on a Nicolet 210 spectrophotometer and were recorded in potassium bromide (KBr) pellet. Mass spectra (MS) were obtained using EI mass spectrometer. Melting points were determined using a hot stage apparatus. All reagents were used as received from commercial sources, unless specified otherwise, or prepared as described in the literature.

1.2 General procedure for the synthesis of enynals

1.2.1 Enynals were prepared according to the literature procedures [1-4]:

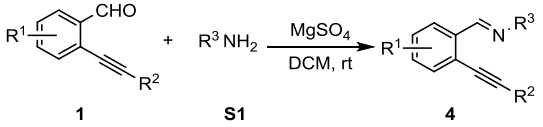


To a solution of the corresponding 2-bromobenzaldehyde (1.0 equiv.), $Pd(PPh_3)_2Cl_2$ (2.0 mol %), and CuI (1.0 mol %) in NEt_3 (0.25 M) was added the appropriate acetylene (1.2 equiv.). The resulting mixture was stirred under nitrogen atmosphere at 50 ℃ overnight. After the reaction was finished, the mixture was filtered by short silica, then the solvent was evaporated under reduced pressure and the residue was purified by flash chromatography on silica gel to afford the desired product **1.**

Spectral data of product **1** was consistent with data reported in the literature [1].

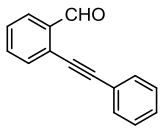
1.3 Preparation of 2-alkynylarylaldimines

2-Alkynylarylaldimines were prepared according to the literature procedures [5]:



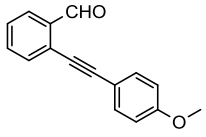
A solution of aryl amines **S1** (5 mmol) and enynals **1** (5.0 mmol) in CH_2Cl_2 (20 mL) was added $MgSO_4$ (2.0 g), the reaction mixture was stirred at room temperature overnight. After the reaction was finished ,the mixture was filtered through short pad of celite and the filtrate was concentrated under reduced pressure to afford 2-Alkynylarylaldimines **4** which were used as such without further purification.

2-(Phenylethynyl)benzaldehyde (1a)[1]



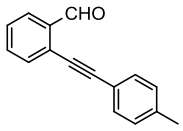
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.63 (s, 1H), 7.92 (dd, J = 7.8, 0.9 Hz, 1H), 7.63 – 7.59 (m, 1H), 7.54 (ddd, J = 8.9, 5.0, 1.5 Hz, 3H), 7.41 (t, J = 7.6 Hz, 1H), 7.38 – 7.34 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.7, 135.9, 133.8, 133.3, 131.7, 129.1, 128.6, 128.6, 127.3, 126.9, 122.4, 96.4, 85.9.

2-((4-Methoxyphenyl)ethynyl)benzaldehyde (1b)[1]



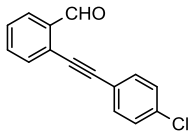
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.64 (s, 1H), 7.93 (d, J = 7.8 Hz, 1H), 7.61 (d, J = 7.7 Hz, 1H), 7.55 (s, 1H), 7.50 (d, J = 8.7 Hz, 2H), 7.41 (t, J = 7.5 Hz, 1H), 6.90 (d, J = 8.7 Hz, 2H), 3.83 (d, J = 1.1 Hz, 3H). **^{13}C NMR** (100MHz, $CDCl_3$) δ 191.8, 160.3, 135.7, 133.8, 133.2, 133.1, 128.2, 127.4, 127.3, 114.4, 114.3, 96.6, 83.8, 55.4.

2-(p-Tolylethynyl)benzaldehyde (1c)[1]



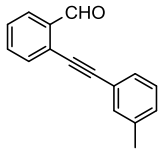
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.65 (d, J = 0.6 Hz, 1H), 7.94 (dd, J = 7.8, 0.9 Hz, 1H), 7.62 (dd, J = 7.7, 0.8 Hz, 1H), 7.56 (td, J = 7.5, 1.4 Hz, 1H), 7.44 (dd, J = 14.4, 7.8 Hz, 3H), 7.18 (d, J = 7.9 Hz, 2H), 2.38 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.8, 139.4, 135.8, 133.7, 133.2, 131.6, 129.3, 128.4, 127.2, 127.2, 119.3, 96.7, 84.4, 21.6.

2-((4-Chlorophenyl)ethynyl)benzaldehyde (1d)[1]



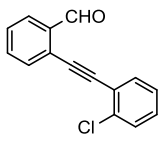
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.61 (s, 1H), 7.95 (dd, J = 7.8, 0.6 Hz, 1H), 7.64 (dd, J = 7.7, 0.8 Hz, 1H), 7.60 (dd, J = 7.3, 1.1 Hz, 1H), 7.50 (d, J = 1.8 Hz, 1H), 7.49 – 7.46 (m, 2H), 7.39 – 7.34 (m, 2H)**. ^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.4, 135.9, 135.2, 133.8, 133.3, 132.9, 128.9, 127.5, 126.4, 120.9, 95.1, 85.9.

2-(m-Tolylethynyl)benzaldehyde (1e)[1]



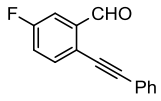
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.65 (d, J = 0.6 Hz, 1H), 7.94 (dd, J = 7.8, 0.9 Hz, 1H), 7.62 (dd, J = 7.7, 0.8 Hz, 1H), 7.56 (td, J = 7.6, 1.3 Hz, 1H), 7.43 (t, J = 7.5 Hz, 1H), 7.40 – 7.33 (m, 2H), 7.26 (dd, J = 10.2, 4.9 Hz, 1H), 7.19 (d, J = 7.6 Hz, 1H), 2.36 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.7, 138.3, 135.9, 133.8, 133.2, 132.3, 130.0, 128.8, 128.5, 128.5, 127.3, 127.0, 122.2, 96.7, 84.6, 21.24.

2-((2-Chlorophenyl)ethynyl)benzaldehyde (1f)[1]



^{1}H NMR (400 MHz, $CDCl_3$) δ 10.72 (d, J = 0.8 Hz, 1H), 7.96 (dd, J = 7.8, 0.9 Hz, 1H), 7.67 (dd, J = 7.7, 0.7 Hz, 1H), 7.61 – 7.56 (m, 2H), 7.49 – 7.43 (m, 2H), 7.33 – 7.24 (m, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.8, 136.3, 136.1, 133.8, 133.4, 130.1, 129.5, 129.0, 127.2, 126.7, 126.4, 122.4, 93.0, 80.0.

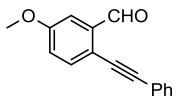
5-Fluoro-2-(phenylethynyl)benzaldehyde (1g)[1]



^{1}H NMR (400 MHz, $CDCl_3$) δ 10.58 (d, J = 3.2 Hz, 1H), 7.65 – 7.58 (m, 2H), 7.57 – 7.51 (m, 2H), 7.40 – 7.35 (m, 3H), 7.27 (td, J = 8.1, 2.6 Hz, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 190.4, 162.4 (d, J = 251.0 Hz), 137.8 (d, J = 6.6 Hz), 135.3 (d, J = 7.6

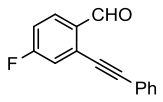
Hz), 131.7, 129.2, 128.6, 123.0, 123.0, 122.1, 121.5, 121.2, 113.8, 113.6, 96.1, 83.9. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -108.9.

5-Methoxy-2-(phenylethynyl)benzaldehyde (1h)[1]



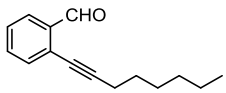
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.60 (s, 1H), 7.56 – 7.52 (m, 3H), 7.42 (d, J = 2.8 Hz, 1H), 7.35 (dd, J = 6.6, 3.8 Hz, 3H), 7.12 (dd, J = 8.6, 2.8 Hz, 1H), 3.86 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.5, 159.8, 137.2, 134.6, 131.5, 128.8, 128.5, 122.7, 121.7, 119.6, 109.9, 94.9, 84.9, 55.6.

4-Fluoro-2-(phenylethynyl)benzaldehyde (1i)[1]



^{1}H NMR (400 MHz, $CDCl_3$) δ 10.55 (s, 1H), 7.96 (dd, J = 8.7, 5.9 Hz, 1H), 7.60 – 7.53 (m, 2H), 7.44 – 7.37 (m, 3H), 7.30 (dd, J = 9.0, 2.2 Hz, 1H), 7.13 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 190.0, 165.7 (d, J = 255.0 Hz), 164.4, 132.6 (d, J = 2.9 Hz), 131.8, 130.1 (d, J = 10.3 Hz), 129.5, 129.4, 129.3, 128.6, 121.8, 119.8, 119.6, 116.6, 116.4, 97.4, 83.8 (d, J = 3.0 Hz). **^{19}F NMR** (376 MHz, $CDCl_3$) δ -103.27.

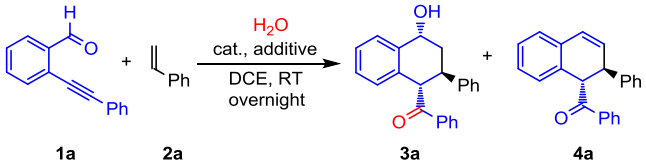
2-(Oct-1-yn-1-yl)benzaldehyde (1j) [1]



^{1}H NMR (400 MHz, $CDCl_3$) δ 10.54 (d, J = 0.7 Hz, 1H), 7.90 – 7.86 (m, 1H), 7.52 – 7.47 (m, 2H), 7.40 – 7.35 (m, 1H), 2.48 (t, J = 7.1 Hz, 2H), 1.64 (dd, J = 9.5, 5.3 Hz, 2H), 1.47 (dq, J = 9.7, 7.0 Hz, 2H), 1.32 (td, J = 7.1, 3.4 Hz, 4H), 0.93 – 0.89 (m, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.2, 136.0, 133.6, 133.2, 127.9, 127.8, 126.9, 98.2, 76.3, 31.3, 28.6, 28.5, 22.5, 19.6, 14.0.

1.4 Optimization of the reaction conditions for Synthesis of 3a

Table S1 Optimization of the Reaction Conditions for Synthesis of 3a[a]

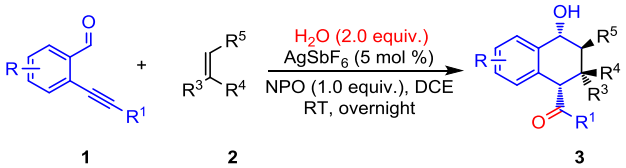


1a 2a 3a 4a

Entry	cat. (5 mol %)	additive	H_2O (equiv.)	Yield (%)		*dr*
				3a	**4a**	**3a**
1	$AgNTf_2$	-	-	ND	74	9:1
2	$AgNTf_2$	-	0.5	24	51	9:1
3	$AgNTf_2$	-	1.0	28	52	9:1
4	$AgNTf_2$	-	2.0	46	25	9:1
5	$AgNTf_2$	TEA	2.0	ND	ND	-
6	$AgNTf_2$	Imine	2.0	ND	ND	-
7	$AgNTf_2$	DMAP	2.0	ND	ND	-
8	$AgNTf_2$	Pyridine	2.0	ND	ND	-
9	$AgNTf_2$	NB	2.0	trace	ND	-
10	$AgNTf_2$	o-DNB	2.0	48	trace	9:1
11	$AgNTf_2$	PNO	2.0	13	trace	9:1
12	**$AgNTf_2$**	**NPO**	**2.0**	**90[b]**	**ND**	**9:1**
13[c]	$AgNTf_2$	NPO	2.0	83	trace	9:1
14[d]	$AgNTf_2$	NPO	2.0	81	6	9:1
14[d]	$AgNTf_2$	NPO	1.0	77	14	9:1
15	**$AgSbF_6$**	**NPO**	**2.0**	**89[b]**	**trace**	**9:1**
16	AgOTf	NPO	2.0	47	24	9:1
17	Ag_2CO_3	NPO	2.0	trace	ND	-
18	-	NPO	2.0	ND	ND	-

[a] Unless otherwise noted, the reaction was performed in DCE at rt for 12 h using 5 mol % catalyst, 1.0 equiv. of additive and 2.0 equiv. of H_2O under N_2. The molar ratio of **1a**:**2a** = 1:5. [**1a**] = 0.2M. NPO: 4-nitropyridine N-oxide; PNO: pyridine N-oxide; TEA: triethyl amine; DMAP: N,N-dimethylamino-pyridine; NB: nitrobenzene; *o*-DNB: 1,2-dinitrobenzene; Imine: (E)-N,1-diphenylmethanimine. The yields were determined by ^1H NMR. [b] Isolated yield. [c] 0.5 equivalent NPO. [d] 0.1 equiv. of NPO.

1.5 General procedure for the synthesis of 3a-3z



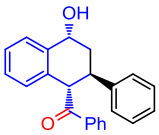
1 2 3

To a dichloroethane (DCE, 1.0 mL) suspension of $AgSbF_6$ (5 mol %) in Schlenk tube with a magnetic

bar under a nitrogen atmosphere, was added 4-Nitropyridine N-oxide (NPO, 0.20 mmol), olefin (**2**, 1.0 mmol), H_2O (0.4 mmol) and enynals (**1**, 0.2 mmol), the reaction was stirred at room temperature unless being noted. The reaction was monitored by TLC. The reaction mixture was purified by chromatography with petroleum / ethyl acetate, 4/1, **3** was obtained.

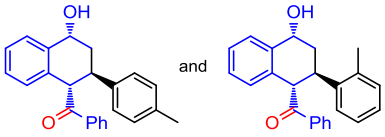
Spectral data of product **3** was consistent with data reported in the literature [6].

Tetrahydronaphthol (3a)[6]



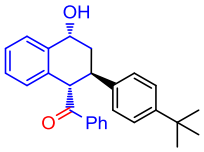
Yield: 89%; dr (*E:Z*) = 9:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 7.8 Hz, 2H), 7.46 (d, *J* = 8.1 Hz, 2H), 7.33 (t, *J* = 7.6 Hz, 2H), 7.29 – 7.23 (m, 1H), 7.21 – 7.11 (m, 6H), 6.92 (d, *J* = 7.7 Hz, 1H), 4.94 (d, *J* = 9.3 Hz, 1H), 4.87 (s, 1H), 3.93 – 3.83 (m, 1H), 3.07 (br, 1H), 2.38 – 2.29 (m, 1H), 2.27 – 2.17 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.4, 143.5, 138.2, 137.4, 135.2, 133.2, 130.1, 129.0, 128.7, 128.6, 128.5, 128.4, 127.5, 127.5, 126.8, 67.8, 54.9, 39.4, 37.9.

Tetrahydronaphthol (3b)[6]



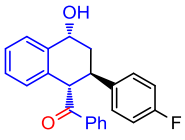
Yield: 92%; dr (*E:Z*) = 10:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 7.6 Hz, 2H), 7.50 – 7.42 (m, 2H), 7.33 (t, *J* = 7.6 Hz, 2H), 7.24 (d, *J* = 9.5 Hz, 1H), 7.15 (t, *J* = 7.5 Hz, 1H), 7.02 (q, *J* = 7.8 Hz, 3H), 6.97 – 6.88 (m, 2H), 4.91 (t, *J* = 9.7 Hz, 1H), 4.85 (s, 1H), 3.89 – 3.80 (m, 1H), 3.14 (br, 1H), 2.34 – 2.26 (m, 1H), 2.23 (d, *J* = 10.1 Hz, 3H), 2.17 (d, *J* = 15.7 Hz, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.4, 140.5, 138.2, 137.4, 136.3, 135.3, 133.1, 130.1, 129.3, 1291, 129.0, 128.6, 128.4, 127.4, 127.4, 67.8, 55.1, 38.9, 38.1, 21.0.

Tetrahydronaphthol (3c)[6]



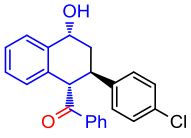
Yield: 80%; dr (*E:Z*) = 9:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 – 7.67 (m, 2H), 7.49 – 7.43 (m, 2H), 7.31 (t, *J* = 7.8 Hz, 2H), 7.22 (dd, *J* = 15.7, 8.6 Hz, 3H), 7.15 (td, *J* = 7.6, 1.3 Hz, 1H), 7.09 – 7.06 (m, 2H), 6.91 (d, *J* = 7.7 Hz, 1H), 4.92 (d, *J* = 9.0 Hz, 1H), 4.84 (t, *J* = 3.5 Hz, 1H), 3.83 (m, 1H), 2.97 (br, 1H), 2.33 (m, 1H), 2.27 – 2.18 (m, 1H), 1.24 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.8, 149.6, 140.4, 138.4, 137.5, 135.3, 133.0, 130.0, 129.0, 129.6, 128.5, 127.4, 127.1, 125.5, 67.7, 54.9, 39.0, 37.8, 34.4, 31.34.

Tetrahydronaphthol (3d)[6]



Yield: 93%, dr (*E:Z*) = 10:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 – 7.69 (m, 2H), 7.53 – 7.43 (m, 2H), 7.35 (t, *J* = 7.8 Hz, 2H), 7.25 (s, 1H), 7.16 (td, *J* = 7.6, 1.3 Hz, 1H), 7.14 – 7.07 (m, 2H), 6.95 – 6.83 (m, 3H), 4.88 (t, *J* = 7.1 Hz, 2H), 3.94 – 3.84 (m, 1H), 3.03 (br, 1H), 2.36 – 2.27 (m, 1H), 2.25 – 2.15 (m, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 203.3, 161.6 (d, *J* = 243 Hz), 139.2, 139.1, 137.9, 137.4, 135.2, 133.3, 130.2, 129.1, 129.0, 128.9, 128.7, 128.3, 127.6, 115.5, 115.3, 67.7, 55.2, 38.6, 38.0. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -116.0.

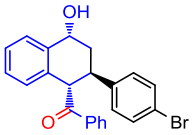
Tetrahydronaphthol (3e)[6]



Yield: 70%, dr (*E:Z*) = 4:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 7.8 Hz, 2H), 7.54 – 7.43 (m, 2H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.26 (d, *J* = 8.4 Hz, 1H), 7.16 (d, *J* = 8.4 Hz, 3H), 7.08 (d, *J* = 8.4 Hz, 2H), 6.91 (d, *J* = 7.7 Hz, 1H), 4.87 (d, *J* = 9.3

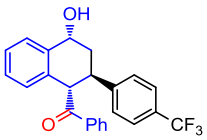
Hz, 2H), 3.94 – 3.84 (m, 1H), 3.11 (br, 1H), 2.37 – 2.25 (m, 1H), 2.26 – 2.12 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.0, 142.0, 137.9, 137.3, 135.0, 133.4, 132.5, 130.1, 129.0, 129.0, 128.8, 128.8, 128.7, 128.3, 127.6, 67.6, 54.9, 38.7, 37.8.

Tetrahydronaphthol (3f)[6]



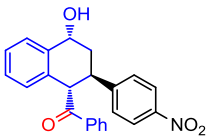
Yield: 83%, dr (*E:Z*) = 5:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 – 7.70 (m, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.45 (d, *J* = 7.5 Hz, 1H), 7.37 (t, *J* = 7.8 Hz, 2H), 7.30 (dd, *J* = 15.2, 7.9 Hz, 3H), 7.17 (t, *J* = 7.5 Hz, 1H), 7.03 (d, *J* = 8.4 Hz, 2H), 6.91 (d, *J* = 7.7 Hz, 1H), 4.87 (d, *J* = 9.7 Hz, 2H), 3.92 – 3.83 (m, 1H), 3.01 (br, 1H), 2.35 – 2.26 (m, 1H), 2.23 – 2.12 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.9, 142.5, 137.9, 137.3, 134.9, 133.4, 131.7, 130.1, 129.3, 128.9, 128.8, 128.7, 128.4, 127.6, 120.6, 67.6, 54.8, 38.7, 37.8.

Tetrahydronaphthol (3g)[6]



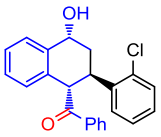
Yield: 68%, dr (*E:Z*) = 4:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.80 – 7.74 (m, 2H), 7.56 – 7.48 (m, 4H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.33 – 7.28 (m, 3H), 7.22 (td, *J* = 7.6, 1.2 Hz, 1H), 6.98 – 6.92 (m, 1H), 4.95 (dd, *J* = 7.9, 4.9 Hz, 2H), 4.06 – 3.98 (m, 1H), 3.03 (br, 1H), 2.37 (dt, *J* = 13.5, 3.4 Hz, 1H), 2.32 – 2.22 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.8, 147.6, 137.8, 137.2, 134.8, 133.4, 130.2, 129.06 – 128.63, 128.3 (d, *J* = 4.3 Hz), 128.0, 127.7, 125.6 (q, *J* = 3.7 Hz), 67.5, 54.7, 39.2, 37.7. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.5.

Tetrahydronaphthol (3h)[6]



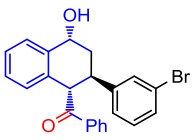
Yield: 46%, dr (*E:Z*) = 2:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.07 (d, *J* = 8.7 Hz, 2H), 7.76 (dd, *J* = 13.4, 6.0 Hz, 2H), 7.56 (dd, *J* = 13.1, 6.2 Hz, 1H), 7.47 (d, *J* = 7.2 Hz, 1H), 7.40 – 7.32 (m, 5H), 7.18 (dd, *J* = 7.6, 1.2 Hz, 1H), 6.91 (d, *J* = 8.2 Hz, 1H), 4.94 (dd, *J* = 10.9, 6.8 Hz, 2H), 4.13 – 4.03 (m, 1H), 2.38 – 2.31 (m, 1H), 2.30 – 2.21 (m, 1H). **^{13}C NMR** (100MHz, $CDCl_3$) δ 202.3, 151.1, 146.9, 137.5, 137.1, 134.6, 133.6, 130.2, 129.0, 128.9, 128.7, 128.5, 127.8, 123.9, 67.4, 54.5, 39.2, 37.5.

Tetrahydronaphthol (3i)[6]



Yield: 85%, dr (*E:Z*) = 6:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 – 7.82 (m, 2H), 7.57 – 7.49 (m, 2H), 7.39 (t, *J* = 7.7 Hz, 2H), 7.34 – 7.28 (m, 3H), 7.20 (dtd, *J* = 9.0, 7.6, 1.4 Hz, 2H), 7.12 (td, *J* = 7.6, 1.7 Hz, 1H), 7.02 – 6.97 (m, 1H), 5.13 (d, *J* = 8.5 Hz, 1H), 4.89 (t, *J* = 3.6 Hz, 1H), 4.51 – 4.40 (m, 1H), 3.33 (br, 1H), 2.35 (dt, *J* = 13.6, 4.3 Hz, 1H), 2.32 – 2.24 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.7, 140.8, 138.5, 136.8, 134.7, 133.8, 133.3, 132.9, 130.1, 129.8, 129.0, 128.7, 128.6, 128.0, 127.6, 127.2, 67.7, 53.0, 36.8, 36.2.

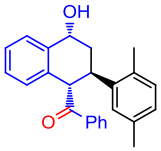
Tetrahydronaphthol (3j)[6]



Yield: 79%, dr (*E:Z*) = 5:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.81 – 7.70 (m, 2H), 7.49 (t, *J* = 7.4 Hz, 1H), 7.44 (d, *J* = 6.9 Hz, 1H), 7.39 – 7.29 (m, 3H), 7.29 – 7.22 (m, 2H), 7.15 (td, *J* = 7.6, 1.3 Hz, 1H), 7.10 – 7.00 (m, 2H), 6.90 (t, *J* = 9.3 Hz, 1H), 4.87 (dd, *J* = 9.9, 6.5 Hz, 2H), 3.96 – 3.77 (m, 1H), 3.31 (br, 1H), 2.29 (dt, *J*

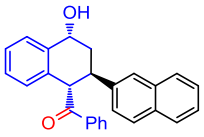
= 13.6, 3.4 Hz, 1H), 2.23 – 2.10 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.1, 145.9, 137.8, 137.3, 134.9, 133.4, 130.7, 130.2, 130.0, 129.0, 128.8, 128.7, 128.4, 128.4, 127.6, 126.3, 122.7, 67.5, 54.8, 39.1, 37.7.

Tetrahydronaphthol (3k)[6]



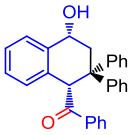
Yield: 81%, dr (*E*:*Z*) = 13:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77 – 7.71 (m, 2H), 7.46 (m, 2H), 7.32 (dd, *J* = 10.7, 4.8 Hz, 2H), 7.27 (t, *J* = 7.5 Hz, 1H), 7.17 (td, *J* = 7.6, 1.3 Hz, 1H), 7.08 (s, 1H), 6.95 (d, *J* = 7.7 Hz, 1H), 6.89 (d, *J* = 7.7 Hz, 1H), 6.84 (t, *J* = 6.4 Hz, 1H), 5.04 (d, *J* = 9.3 Hz, 1H), 4.85 (t, *J* = 3.1 Hz, 1H), 4.13 (m, 1H), 3.30 (br, 1H), 2.22 (s, 3H), 2.07 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.9, 141.6, 138.3, 137.4, 135.6, 135.5, 133.2, 132.7, 130.5, 130.1, 128.9, 128.7, 128.6, 128.5, 127.5, 127.2, 127.1, 68.0, 54.2, 38.4, 34.3, 21.2, 19.0.

Tetrahydronaphthol (3l)[6]



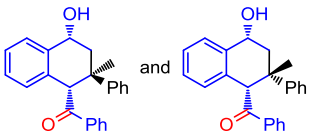
Yield: 84%, dr (*E*:*Z*) = 10:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 (dd, *J* = 10.9, 7.8 Hz, 4H), 7.71 – 7.66 (m, 1H), 7.61 (s, 1H), 7.51 (d, *J* = 6.9 Hz, 1H), 7.49 – 7.39 (m, 3H), 7.38 – 7.28 (m, 4H), 7.21 (td, *J* = 7.6, 1.4 Hz, 1H), 6.99 (d, *J* = 7.7 Hz, 1H), 5.10 (d, *J* = 9.2 Hz, 1H), 4.94 (t, *J* = 3.2 Hz, 1H), 4.16 – 4.06 (m, 1H), 3.18 (br, 1H), 2.43 (dt, *J* = 13.7, 3.8 Hz, 1H), 2.33 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.3, 141.0, 138.2, 137.3, 135.1, 133.5, 133.2, 132.5, 130.1, 129.0, 128.7, 128.6, 128.5, 127.7, 127.6, 126.3, 126.1, 125.6, 67.8, 54.7, 39.4, 38.1.

Tetrahydronaphthol (3m)[6]



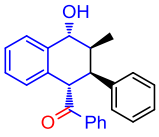
Yield: 81%, dr (*E*:*Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.68 – 7.58 (m, 3H), 7.39 – 7.30 (m, 1H), 7.25 – 7.19 (m, 3H), 7.17 – 7.09 (m, 6H), 7.07 (d, *J* = 7.3 Hz, 3H), 6.94 (dd, *J* = 10.4, 4.8 Hz, 2H), 6.84 (dd, *J* = 8.2, 6.4 Hz, 1H), 5.79 (s, 1H), 4.13 (dd, *J* = 10.6, 5.8 Hz, 1H), 3.49 (dd, *J* = 12.1, 10.9 Hz, 1H), 2.75 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 201.7, 146.7, 145.9, 140.5, 138.6, 134.8, 132.4, 128.4, 128.2, 128.1, 127.8, 127.8, 127.8, 127.5, 127.4, 126.4, 126.2, 67.6, 53.1, 49.8, 38.9.

Tetrahydronaphthol (3n)[6]



Yield: 89%, dr (*E*:*Z*) = 2:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.16 – 8.13 (m, 1H), 7.78 (d, *J* = 7.8 Hz, 1H), 7.65 – 7.58 (m, 3H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.42 – 7.32 (m, 5H), 7.26 (dt, *J* = 7.5, 1.5 Hz, 4H), 7.22 – 7.11 (m, 3H), 7.11 – 7.04 (m, 3H), 7.00 – 6.94 (m, 3H), 5.54 (s, 1H), 5.08 (s, 1H), 4.99 (dd, *J* = 9.3, 7.0 Hz, 1H), 4.35 (t, *J* = 8.2 Hz, 1H), 3.12 – 3.02 (m, 1H), 2.84 (br, 1H), 2.62 (d, *J* = 8.3 Hz, 1H), 2.41 (m, 1H), 1.43 (s, 3H), 1.29 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 202.1, 201.9, 146.5, 145.5, 140.2, 139.3, 138.8, 138.5, 134.7, 134.1, 133.5, 132.4, 129.0, 128.9, 128.8, 128.5, 128.3, 128.2, 128.1, 128.0, 127.6, 127.5, 127.5, 126.5, 126.3, 126.0, 125.74, 67.7, 67.1, 56.3, 52.3, 42.6, 41.8, 41.2, 38.1, 30.5, 27.2.

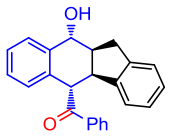
Tetrahydronaphthol (3o)[6]



Yield: 77%, dr (*E*:*Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 – 7.65 (m, 2H), 7.48 (t, *J* = 7.4 Hz, 1H), 7.43 (dd, *J* = 7.5, 0.9 Hz, 1H), 7.32 (t, *J* = 7.8 Hz, 2H), 7.26 (dd, *J*

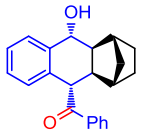
= 10.0, 4.4 Hz, 1H), 7.23 (t, *J* = 6.4 Hz, 2H), 7.19 – 7.15 (m, 2H), 7.14 – 7.10 (m, 2H), 6.91 (d, *J* = 7.6 Hz, 1H), 5.01 (d, *J* = 8.1 Hz, 1H), 4.67 (d, *J* = 2.2 Hz, 1H), 3.41 (dd, *J* = 11.8, 8.2 Hz, 1H), 2.19 (m, 1H), 0.99 (d, *J* = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 204.0, 143.6, 139.7, 137.0, 134.6, 133.4, 130.0, 129.2, 128.8, 128.7, 128.6, 128.4, 128.2, 127.5, 126.8, 73.0, 56.0, 45.7, 39.8, 16.2.

Tetrahydronaphthol (3p)[6]



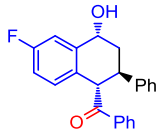
Yield: 86%, dr (*E:Z*) = 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.09 (d, *J* = 7.4 Hz, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.55 – 7.47 (m, 3H), 7.23 (dd, *J* = 9.2, 5.2 Hz, 1H), 7.14 (d, *J* = 5.2 Hz, 4H), 7.11 – 7.06 (m, 1H), 6.88 (d, *J* = 7.5 Hz, 1H), 4.86 (d, *J* = 5.2 Hz, 1H), 4.68 (d, *J* = 5.7 Hz, 1H), 4.17 (br, 1H), 4.13 (dd, *J* = 8.6, 5.2 Hz, 1H), 3.21 – 3.05 (m, 2H), 2.79 (dd, *J* = 15.0, 5.4 Hz, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 203.6, 146.1, 142.5, 139.8, 136.9, 134.2, 134.0, 129.2, 129.1, 128.2, 127.7, 127.6, 127.5, 127.3, 127.1, 124.9, 124.3, 72.1, 52.1, 45.5, 44.8, 36.5.

Tetrahydronaphthol (3q)[6]



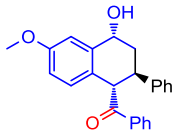
Yield: 31%, dr (*E:Z*) = 6:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.03 – 7.97 (m, 2H), 7.58 (td, *J* = 7.3, 5.4 Hz, 2H), 7.49 (dd, *J* = 11.9, 7.9 Hz, 2H), 7.31 – 7.25 (m, 1H), 7.08 (t, *J* = 7.5 Hz, 1H), 6.76 (d, *J* = 7.6 Hz, 1H), 4.50 (d, *J* = 9.6 Hz, 1H), 4.28 (d, *J* = 10.8 Hz, 1H), 2.57 (d, *J* = 3.5 Hz, 1H), 2.40 (t, *J* = 10.1 Hz, 1H), 1.96 (d, *J* = 3.5 Hz, 1H), 1.69 (d, *J* = 10.4 Hz, 1H), 1.66 – 1.58 (m, 2H), 1.57 – 1.50 (m, 1H), 1.33 (d, *J* = 8.0 Hz, 1H), 1.27 (d, *J* = 9.7 Hz, 2H), 1.17 (d, *J* = 10.4 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) *δ* 202.8, 140.7, 138.3, 135.8, 133.5, 128.9, 128.5, 126.9, 126.8, 125.5, 122.7, 70.7, 52.2, 48.2, 45.6, 41.8, 40.1, 33.7, 29.6, 29.4.

Tetrahydronaphthol (3r)[6]



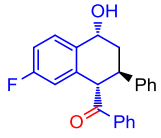
Yield: 88%, dr (*E:Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.74 (d, *J* = 7.8 Hz, 2H), 7.50 (t, *J* = 7.3 Hz, 1H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.25 – 7.17 (m, 3H), 7.17 – 7.11 (m, 3H), 6.88 (d, *J* = 6.5 Hz, 2H), 4.92 (d, *J* = 8.5 Hz, 1H), 4.80 (s, 1H), 3.86 – 3.78 (m, 1H), 3.05 (br, 1H), 2.37 – 2.17 (m, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 203.1, 161.8 ((d, *J* = 245 Hz) , 143.2, 140.7, 140.6, 137.1, 133.3, 130.7, 130.2, 130.1, 128.9, 128.7, 128.7, 127.4, 126.9, 116.2, 116.0, 115.9, 115.7, 67.4, 53.7, 39.5, 37.6. **^{19}F NMR** (376 MHz, $CDCl_3$) *δ* -114.6.

Tetrahydronaphthol (3s)[6]



Yield: 83%, dr (*E:Z*) = 4:1. **^{1}H NMR** (400 MHz, DMSO) *δ* 7.84 (d, *J* = 7.5 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.20 (t, *J* = 7.1 Hz, 4H), 7.09 (d, *J* = 7.8 Hz, 1H), 7.01 (d, *J* = 2.7 Hz, 1H), 6.75 (dd, *J* = 8.5, 2.7 Hz, 1H), 6.66 (d, *J* = 8.5 Hz, 1H), 5.40 (d, *J* = 4.2 Hz, 1H), 4.99 (d, *J* = 10.3 Hz, 1H), 4.76 – 4.66 (m, 1H), 3.82 – 3.76 (m, 1H), 3.74 (s, 3H), 2.27 (td, *J* = 13.1, 3.7 Hz, 1H), 2.01 (dt, *J* = 13.3, 3.2 Hz, 1H). **^{13}C NMR** (100 MHz, DMSO) *δ* 202.7, 158.2, 144.3, 140.6, 137.8, 133.5, 129.1, 129.0, 128.7, 128.7, 128.6, 127.9, 126.8, 115.0, 114.4, 66.1, 55.5, 53.5, 39.38, 38.5.

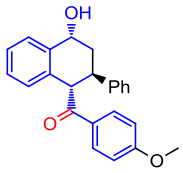
Tetrahydronaphthol (3t)[6]



Yield: 83%, dr (*E:Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.73 (d, *J* = 7.9 Hz, 2H), 7.49 (t, *J* = 7.4 Hz, 1H), 7.44 (dd, *J* = 8.4, 6.0 Hz, 1H), 7.34 (t, *J* = 7.7 Hz, 2H), 7.23 – 7.17 (m, 2H), 7.17 – 7.11 (m, 3H), 6.96 (m, 1H), 6.61 (dd, *J* = 9.6, 2.0 Hz, 1H), 4.91

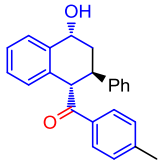
(d, *J* = 9.2 Hz, 1H), 4.85 (s, 1H), 3.90 – 3.80 (m, 1H), 3.11 (br, 1H), 2.37 – 2.18 (m, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.8, 161.4 (d, , *J* = 246 Hz) 143.1, 137.4, 137.3, 137.2, 134.3, 131.8, 131.7, 128.9, 128.7, 127.5, 127.0, 114.9, 114.8, 114.7, 114.6, 67.1, 54.6, 39.2, 37.9. **^{19}F NMR** (376 MHz, $CDCl_3$) *δ* -112.81.

Tetrahydronaphthol (3u)[6]



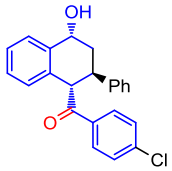
Yield: 77%, dr (*E:Z*) = 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.79 – 7.73 (m, 2H), 7.44 (d, *J* = 6.9 Hz, 1H), 7.28 – 7.23 (m, 1H), 7.21 (d, *J* = 9.0 Hz, 1H), 7.19 – 7.14 (m, 4H), 7.14 – 7.10 (m, 1H), 6.91 (d, *J* = 7.7 Hz, 1H), 6.83 – 6.78 (m, 2H), 4.89 (d, *J* = 9.2 Hz, 1H), 4.85 (s, 1H), 3.87 (m, 1H), 3.78 (s, 3H), 2.34 (m, 1H), 2.20 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 201.8, 163.7 143.8, 138.3, 135.5, 131.5, 130.3, 130.0, 128.6, , 128.4, 127.5, 127.4, 126.8, 113.8, 67.8, 55.5, 54.4, 39.4, 38.0.

Tetrahydronaphthol (3v)[6]



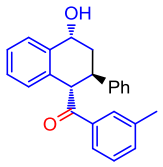
Yield: 83%, dr (*E:Z*) = 10:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.66 (d, *J* = 8.3 Hz, 2H), 7.44 (m, 1H), 7.28 – 7.23 (m, 1H), 7.21 – 7.17 (m, 3H), 7.17 – 7.10 (m, 5H), 6.91 (d, *J* = 7.7 Hz, 1H), 4.92 (d, *J* = 9.2 Hz, 1H), 4.86 (t, *J* = 3.3 Hz, 1H), 3.88 (m, 1H), 3.23 (br, 1H), 2.36 – 2.30 (m, 4H), 2.20 m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 203.0, 144.1, 143.7, 138.2, 135.4, 134.9, 130.0, 129.4, 129.2, 128.6, 128.4, 127.6, 127.4, 126.8, 67.8, 54.6, 39.3, 37.9, 21.6.

Tetrahydronaphthol (3w)[6]



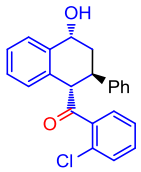
Yield: 85%, dr (*E:Z*) = 10:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.65 (d, *J* = 8.6 Hz, 2H), 7.45 (d, *J* = 7.5 Hz, 1H), 7.31 – 7.24 (m, 3H), 7.23 – 7.17 (m, 2H), 7.15 (dd, *J* = 10.0, 5.1 Hz, 4H), 6.88 (d, *J* = 7.7 Hz, 1H), 4.88 (t, *J* = 3.2 Hz, 1H), 4.84 (d, *J* = 9.8 Hz, 1H), 3.90 – 3.82 (m, 1H), 3.11 (br, 1H), 2.32 (m, 1H), 2.27 – 2.18 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 202.2, 143.2, 139.7, 137.9, 135.6, 135.0, 130.4, 130.3, 128.9, 128.7, 128.3, 127.6, 127.5, 127.0, 67.7, 55.5, 39.4, 37.8.

Tetrahydronaphthol (3x)[6]



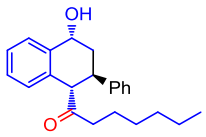
Yield: 76%, dr (*E:Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.56 – 7.50 (m, 2H), 7.46 – 7.42 (m, 1H), 7.30 – 7.20 (m, 3H), 7.20 – 7.09 (m, 6H), 6.90 (d, *J* = 7.7 Hz, 1H), 4.94 (d, *J* = 9.3 Hz, 1H), 4.84 (t, *J* = 3.0 Hz, 1H), 3.88 (m, 1H), 3.27 (br, 1H), 2.33 (m, 1H), 2.28 (s, 3H), 2.25 – 2.16 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 203.7, 143.7, 138.4, 138.3, 137.5, 135.4, 134.0, 130.1, 129.5, 128.6, 128.6, 128.5, 128.4, 127.6, 127.4, 126.8, 126.2, 67.8, 54.8, 39.4, 37.9, 21.3.

Tetrahydronaphthol (3y)[6]



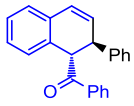
Yield: 71%, dr (*E:Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.44 (dd, *J* = 7.5, 1.1 Hz, 1H), 7.30 – 7.23 (m, 3H), 7.22 – 7.15 (m, 2H), 7.15 – 7.03 (m, 6H), 6.99 (d, *J* = 1.5 Hz, 1H), 4.97 (d, *J* = 8.8 Hz, 1H), 4.76 (t, *J* = 3.5 Hz, 1H), 3.83 – 3.72 (m, 1H), 3.08 (br, 1H), 2.29 (m, 1H), 2.15 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 205.3, 143.4, 139.1, 138.6, 134.2, 131.9, 131.5, 130.6, 130.0, 129.8, 129.0, 128.7, 128.5, 127.7, 127.6, 126.8, 126.6, 67.5, 57.8, 39.5.

Tetrahydronaphthol (3z)[6]



Yield: 79%, dr (*E:Z*) > 20:1. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 7.5 Hz, 1H), 7.34 – 7.28 (m, 3H), 7.24 (dd, *J* = 11.3, 5.8 Hz, 4H), 6.97 (d, *J* = 7.2 Hz, 1H), 4.84 (s, 1H), 4.12 (d, *J* = 10.0 Hz, 1H), 3.67 – 3.58 (m, 1H), 2.73 (s, 1H), 2.43 – 2.34 (m, 1H), 2.30 – 2.17 (m, 2H), 2.08 (td, *J* = 13.3, 3.1 Hz, 1H), 1.47 – 1.35 (m, 2H), 1.25 – 1.18 (m, 2H), 1.12 (dd, *J* = 11.0, 7.7 Hz, 4H), 0.83 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 213.0, 143.5, 137.9, 134.1, 130.2, 128.8, 128.6, 128.1, 127.5, 127.5, 126.9, 67.7, 59.9, 42.5, 38.3, 31.4, 28.6, 23.2, 22.4, 14.0.

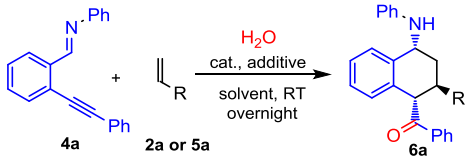
phenyl-2-phenyl-1,2-dihydronaphthalen-1-yl)methanone (4a)



^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.8 Hz, 2H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.21 (d, *J* = 4.1 Hz, 5H), 7.16 (d, *J* = 6.0 Hz, 2H), 7.05 (t, *J* = 7.3 Hz, 1H), 6.84 (d, *J* = 7.5 Hz, 1H), 6.62 (d, *J* = 9.6 Hz, 1H), 5.97 (dd, *J* = 9.6, 4.1 Hz, 1H), 5.01 (d, *J* = 7.9 Hz, 1H), 4.21 – 4.16 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 201.1, 142.9, 137.2, 133.7, 133.0, 131.9, 130.3, 128.7, 128.7, 128.6, 128.0, 127.9, 127.8, 127.7, 127.4, 127.0, 126.6, 53.5, 44.0.

1.6 Optimization of the reaction conditions for Synthesis of 6a

Table S2. Optimization of the Reaction Conditions for Synthesis of **6a**[a]

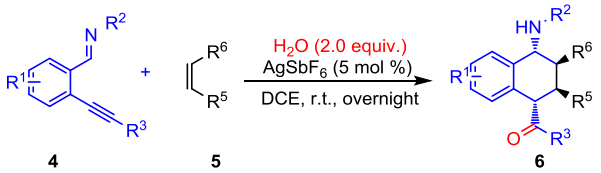


Entry	R	cat. (5 mol %)	temp (^{o}C)	solvent	additive	H_2O (equiv)	yield (%)	dr
1	Ph	$AgSbF_6$	rt	DCE	NPO (1.0 eq)	2.0	ND	-
2	OEt	$AgSbF_6$	rt	DCE	NPO (1.0 eq)	2.0	77	13:1
3	**OEt**	**$AgSbF_6$**	**rt**	**DCE**	**-**	**2.0**	**86**	**13:1**
4	OEt	$AgSbF_6$	rt	CH_2Cl_2	-	1.0	82	13:1
5	OEt	$AgSbF_6$	rt	CH_2Cl_2	-	1.0	85	13:1
6	OEt	-	rt	CH_2Cl_2	-	-	ND	-
7	Ph	$AgSbF_6$	40	DCE	-	2.0	ND	-
8	Ph	$AgSbF_6$	60	DCE	-	2.0	trace	> 20:1
9	Ph	$AgSbF_6$	80	DCE	-	2.0	30	> 20:1
10	**Ph**	**$AgSbF_6$**	**100**	**DCE**	**-**	**2.0**	**50**	**> 20:1**
12	Ph	$AgSbF_6$	110	DCE	-	2.0	44	> 20:1
13	Ph	$AgSbF_6$	100	toluene	-	2.0	35	> 20:1
14	Ph	$AgSbF_6$	100	THF	-	2.0	27	> 20:1
15	Ph	$AgSbF_6$	100	1,4-dioxane	-	2.0	16	> 20:1
16	Ph	$AgSbF_6$	100	CH_3CN	-	2.0	45	> 20:1
17	Ph	$AgSbF_6$	100	DCE	NPO (1.0 eq)	2.0	22	> 20:1

[a] Unless otherwise noted, the reaction was performed in DCE for 12 h using 5 mol % catalyst, 1.0 equiv.

of additive and 2.0 equiv. of H_2O under N_2. The molar ratio of 4a:2a or 5a = 1:5. [**1a**] = 0.2M. NPO: 4-nitropyridine N-oxide; The yields and dr value were determined by ^{1}H NMR. ^{b} Isolated yield.

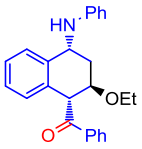
1.7 General procedure for the synthesis of 6a-6u



4 5 6

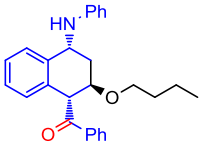
To a dichloromethane (DCE, 1.0 mL) suspension of $AgSbF_6$ (5 mol %) in Schlenk tube with a magnetic bar under a nitrogen atmosphere, was added olefin (**5**, 1.0 mmol), enynimines (4, 0.2 mmol) and H_2O (0.4 mmol), the reaction was stirred at room temperature unless being noted. The reaction was monitored by TLC. The reaction mixture was purified by chromatography with petroleum / ethyl acetate, 20/1, **6** was obtained.

Tetrahydronaphthylaminess (6a)



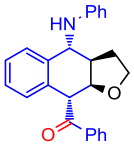
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 86%, 63.8 mg, *dr* = 13:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.09 (m, 2H), 7.62 (dd, *J* = 8.3, 6.4 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.42 (d, *J* = 7.5 Hz, 1H), 7.24 – 7.19 (m, 3H), 7.16 – 7.12 (m, 1H), 6.88 (d, *J* = 7.7 Hz, 1H), 6.75 – 6.69 (m, 3H), 4.98 (d, *J* = 6.9 Hz, 1H), 4.84 (t, *J* = 4.9 Hz, 1H), 4.26 – 4.20 (m, 1H), 3.58 – 3.51 (m, 1H), 3.35 (m, 1H), 2.42 (m, 1H), 2.09 – 2.02 (m, 1H), 1.03 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 202.7, 147.3, 138.2, 138.1, 134.7, 133.5, 129.5, 129.0, 128.9, 128.7, 127.9, 127.3, 117.5, 113.0, 75.1, 64.7, 53.2, 50.6, 32.4, 15.4. **IR** (KBr, cm^{-1}) 3398, 3057, 2973, 2927, 2865, 1680, 1598, 1500, 1442, 1322, 1212, 1171, 1093, 989, 748, 695, 508. **HRMS** (ESI) Calcd for $C_{25}H_{26}NO_2$ $(M+H)^+$ 372.1958, found 372.1962.

Tetrahydronaphthylaminess (6b)



Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 78%, 62.2 mg, *dr* = 13:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.07 (m, 2H), 7.62 (ddd, *J* = 6.6, 3.9, 1.2 Hz, 1H), 7.53 (dd, *J* = 10.5, 4.7 Hz, 2H), 7.42 (d, *J* = 7.4 Hz, 1H), 7.26 – 7.18 (m, 4H), 7.14 (td, *J* = 7.5, 1.4 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.73 (dd, *J* = 7.8, 6.6 Hz, 3H), 4.98 (d, *J* = 6.9 Hz, 1H), 4.85 (t, *J* = 4.8 Hz, 1H), 4.24 – 4.18 (m, 1H), 3.50 (dt, *J* = 9.2, 6.4 Hz, 1H), 3.27 (dt, *J* = 9.2, 6.6 Hz, 1H), 2.42 (m, 1H), 2.04 (m, 1H), 1.38 (m, 2H), 1.18 (dd, *J* = 15.1, 7.4 Hz, 2H), 0.77 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.8, 147.3 138.2, 138.1, 134.7, 133.4, 129.5, 128.9, 128.9, 128.8, 128.7, 127.9, 127.3, 117.4, 113.0, 75.4, 69.1, 53.1, 50.6, 32.2, 31.9, 19.2, 13.8. **IR** (KBr, cm^{-1}) 3397, 3057, 3019, 2969, 2924, 2863, 1680, 1597, 1502, 1439, 1365, 1321,1212, 1171, 1125, 1090, 989, 943, 869, 747, 694, 628, 507, 472. **HRMS** (ESI) Calcd for $C_{27}H_{30}NO_2$ $(M+H)^+$ 400.2271, found 400.2273.

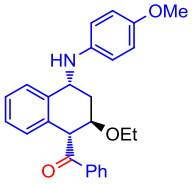
Tetrahydronaphthylaminess (6c)



Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 52%, 38.4mg, *dr* = 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 7.3 Hz, 2H), 7.60 (t, *J* = 7.4 Hz, 1H),

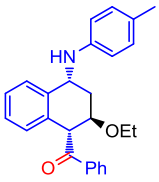
7.49 (t, *J* = 7.6 Hz, 2H), 7.35 (s, 1H), 7.20 (t, *J* = 7.8 Hz, 3H), 7.13 (t, *J* = 7.0 Hz, 1H), 6.93 (s, 1H), 6.74 (t, *J* = 7.3 Hz, 1H), 6.68 (d, *J* = 7.8 Hz, 2H), 4.81 (d, *J* = 7.5 Hz, 1H), 4.75 – 4.68 (m, 1H), 4.37 (d, *J* = 9.2 Hz, 1H), 4.21 (s, 1H), 4.05 – 3.95 (m, 1H), 3.70 (td, *J* = 8.8, 6.3 Hz, 1H), 2.57 – 2.43 (m, 1H), 2.31 – 2.20 (m, 1H), 1.93 – 1.84 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 200.9, 147.7, 139.7, 137.8, 134.3, 133.6, 129.5, 128.8, 127.4, 127.3, 127.2, 125.6, 117.7, 113.0, 79.1, 67.8, 56.7, 51.56, 4.91, 31.5. **IR** (KBr, cm^{-1}) 3377, 3057, 2975, 2913, 2866, 1921, 1673, 1594, 1509, 1440, 1363, 1319, 1273, 1210, 1171, 1066, 991, 946, 865, 807, 742, 692, 644, 578, 507, 459. **HRMS** (ESI) Calcd for $C_{25}H_{24}NO_2$ $(M+H)^+$ 370.1802, found 370.1800.

Tetrahydronaphthylaminess (6d)



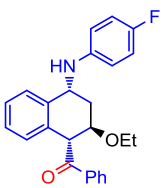
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 56%, 45.0 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.09 (m, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.43 (d, *J* = 7.5 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.13 (td, *J* = 7.5, 1.2 Hz, 1H), 6.88 (d, *J* = 7.7 Hz, 1H), 6.86 – 6.78 (m, 2H), 6.72 – 6.67 (m, 2H), 4.96 (d, *J* = 7.0 Hz, 1H), 4.75 (t, *J* = 4.8 Hz, 1H), 4.27 – 4.20 (m, 1H), 3.76 (s, 3H), 3.58 – 3.50 (m, 1H), 3.40 – 3.30 (m, 1H), 2.41 (m, 1H), 2.02 (m, 1H), 1.03 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100MHz, $CDCl_3$) δ 202.8, 152.2, 141.5, 138.3, 138.3, 134.6, 133.4, 128.9, 128.9, 128.9, 128.7, 127.8, 127.3, 115.1, 114.6, 75.0, 64.7, 55.8, 53.3, 51.7, 32.4, 15.4. **IR** (KBr, cm^{-1}) 3399, 3062, 2973, 2929, 2866, 2832, 1680, 1587, 1511,1447, 1336, 1285, 1238, 1173, 1126, 1089, 1035, 988, 822, 749, 696, 623. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_3$ $(M+H)^+$ 402.2064, found 402.2067.

Tetrahydronaphthylaminess (6e)



Yellow solid, m.p = 107-108 ^{o}C, purified by chromatography (PE/EA = 20/1), yield = 86%, 66.2 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 7.5 Hz, 2H), 7.62 (t, *J* = 7.3 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.20 (dd, *J* = 12.8, 5.3 Hz, 1H), 7.13 (t, *J* = 7.4 Hz, 1H), 7.03 (d, *J* = 7.8 Hz, 2H), 6.87 (d, *J* = 7.6 Hz, 1H), 6.65 (d, *J* = 8.0 Hz, 2H), 4.96 (d, *J* = 6.8 Hz, 1H), 4.80 (s, 1H), 4.23 (t, *J* = 7.6 Hz, 1H), 3.96 (br, 1H), 3.59 – 3.50 (m, 1H), 3.39 – 3.29 (m, 1H), 2.46 – 2.37 (m, 1H), 2.26 (s, 3H), 2.04 (dd, *J* = 15.7, 6.5 Hz, 1H), 1.03 (td, *J* = 7.0, 1.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.7, 145.1, 138.3, 138.3, 134.7, 133.4, 130.0, 129.0, 128.9, 128.9, 128.7, 127.9, 127.3, 126.7, 113.2, 75.1, 64.7, 53.2, 51.0, 32.4, 20.5, 15.4. **IR** (KBr, cm^{-1}) 3398, 3061, 3022, 2974, 2923, 2865, 1860, 1612, 1518, 1445, 1366, 1331, 1289, 1212, 1173, 1127, 1090, 989, 946, 905, 809, 750, 696, 625, 580, 508, 465. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_2$ $(M+H)^+$ 386.2115, found 386.2118.

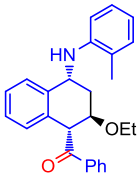
Tetrahydronaphthylaminess (6f)



Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 60%, 46.7 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 – 8.09 (m, 2H), 7.62 (t, *J* = 7.3 Hz, 1H), 7.53 (t, *J* = 7.7 Hz, 2H), 7.41 (d, *J* = 7.6 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.13 (t, *J* = 7.5 Hz, 1H), 6.90 (dd, *J* = 16.6, 7.7 Hz, 3H), 6.69 – 6.59 (m, 2H), 5.02 – 4.95 (m, 1H), 4.76 (s, 1H), 4.26 – 4.18 (m, 1H), 3.54 (m, 1H), 3.42 – 3.29 (m, 1H), 2.39 (m, 1H), 2.07 – 1.99 (m, 1H), 1.04 (td, *J* = 7.0, 1.6 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.7, 155.8 (d, *J* = 233Hz), 143.6, 138.1, 138.0, 134.6, 133.5, 128.9, 128.8, 128.8, 127.9, 127.3, 115.9, 115.7, 114.0, 75.0, 64.7, 53.1, 51.3, 32.1, 15.3. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -127.8. **IR** (KBr, cm^{-1}) 3401, 3063, 2975,

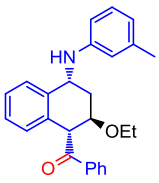
2929, 2867, 1680, 1606, 1589, 1510, 1445, 1326, 1281, 1216, 1125, 1092, 989, 907, 822, 753, 696, 623, 508. **HRMS** (ESI) Calcd for $C_{25}H_{25}FNO_2$ $(M+H)^+$ 390.1864, found 390.1861.

Tetrahydronaphthylaminess (6g)



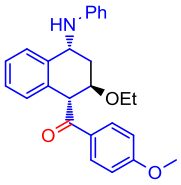
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 65%, 50.2 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.09 (m, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.43 (d, *J* = 7.5 Hz, 1H), 7.21 (t, *J* = 5.6 Hz, 1H), 7.14 (dd, *J* = 11.8, 4.4 Hz, 2H), 7.09 (d, *J* = 7.2 Hz, 1H), 6.90 (d, *J* = 7.6 Hz, 1H), 6.82 (d, *J* = 8.0 Hz, 1H), 6.68 (t, *J* = 7.3 Hz, 1H), 4.98 (d, *J* = 6.6 Hz, 1H), 4.91 (t, *J* = 4.8 Hz, 1H), 4.28 – 4.20 (m, 1H), 3.54 (dq, *J* = 9.2, 7.0 Hz, 1H), 3.35 (dq, *J* = 9.2, 7.0 Hz, 1H), 2.44 (m, 1H), 2.15 (s, 3H), 2.07 (m, 1H), 1.04 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.5, 145.3, 138.4, 138.1, 134.7, 133.4, 130.5, 128.9, 128.9, 128.8, 128.7, 127.9, 127.4, 127.2, 122.2, 117.0, 109.8, 75.1, 64.7, 53.3, 50.4, 32.3, 17.8, 15.4. **IR** (KBr, cm^{-1}) 3429, 3060, 2975, 2924, 2856, 1683, 1667, 1593, 1509, 1444, 1313, 1250, 1210, 1171, 1085, 1040, 987, 914, 802, 746, 697, 628, 574, 477. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_2$ $(M+H)^+$ 386.2115, found 386.2113.

Tetrahydronaphthylaminess (6h)



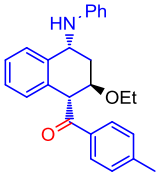
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 73%, 56.4 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 – 8.08 (m, 2H), 7.62 (m, 1H), 7.53 (dd, *J* = 10.5, 4.7 Hz, 2H), 7.42 (d, *J* = 7.5 Hz, 1H), 7.20 (t, *J* = 7.3 Hz, 1H), 7.16 – 7.08 (m, 2H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.59 – 6.52 (m, 3H), 4.97 (d, *J* = 7.0 Hz, 1H), 4.84 (t, *J* = 4.8 Hz, 1H), 4.27 – 4.20 (m, 1H), 3.55 (dq, *J* = 9.2, 7.0 Hz, 1H), 3.35 (dq, *J* = 9.3, 7.0 Hz, 1H), 2.47 – 2.37 (m, 1H), 2.30 (s, 3H), 2.04 (m, 1H), 1.04 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.7, 147.3, 139.2, 138.2, 138.2, 134.6, 133.4, 129.3, 128.9, 128.90, 128.8, 128.7, 127.8, 127.3, 118.3, 113.7, 110.0, 75.1, 64.7, 53.2, 50.6, 32.4, 21.7, 15.3. **IR** (KBr, cm^{-1}) 3396, 3057, 3025, 2973, 2924, 2863, 1680, 1597, 1486, 1444, 1327, 1289, 1213, 1172, 1091, 990, 909, 849, 762, 695, 590, 476. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_2$ $(M+H)^+$ 386.2115, found 386.2113.

Tetrahydronaphthylaminess (6j)



Yellow solid, m. p. = 83-84 °C, purified by chromatography (PE/EA = 15/1), yield = 75%, 60.3 mg, *dr* = 15:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.08 (m, 2H), 7.41 (d, *J* = 7.5 Hz, 1H), 7.24 – 7.17 (m, 3H), 7.12 (td, *J* = 7.5, 1.4 Hz, 1H), 7.02 – 6.98 (m, 2H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.75 – 6.69 (m, 3H), 4.93 (d, *J* = 6.8 Hz, 1H), 4.83 (t, *J* = 4.8 Hz, 1H), 4.25 – 4.20 (m, 1H), 3.88 (s, 3H), 3.57 – 3.50 (m, 1H), 3.35 (dq, *J* = 9.3, 7.0 Hz, 1H), 2.43 (m, 1H), 2.07 – 2.00 (m, 1H), 1.04 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 200.9, 163.9, 147.3, 138.1, 134.9, 131.3, 131.2, 129.4, 128.9, 128.7, 127.8, 127.2, 117.3, 114.0, 113.0, 75.1, 64.7, 55.5, 52.7, 50.6, 32.4, 15.4. **IR** (KBr, cm^{-1}) 3396, 3057, 2973, 2928, 2872, 2843, 1732, 1670, 1600, 1504, 1451, 1424, 1366,1320, 1259, 1216, 1170, 1089, 1079, 1026, 984, 950, 907, 837, 745, 691, 622, 586, 510, 468. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_3$ $(M+H)^+$ 402.2064, found 402.2060.

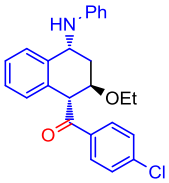
Tetrahydronaphthylaminess (6k)



Brown solid, m. p. = 131-132 °C,purified by chromatography (PE/EA = 20/1), yield = 80%, 61.8mg, *dr* = 19:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 8.1 Hz, 2H), 7.42

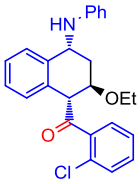
(d, *J* = 7.7 Hz, 1H), 7.33 (d, *J* = 8.2 Hz, 2H), 7.23 (s, 1H), 7.23 – 7.16 (m, 3H), 7.13 (dd, *J* = 10.6, 4.2 Hz, 1H), 6.88 (d, *J* = 7.7 Hz, 1H), 6.75 – 6.70 (m, 3H), 4.95 (d, *J* = 6.8 Hz, 1H), 4.84 (s, 1H), 4.27 – 4.20 (m, 1H), 3.58 – 3.50 (m, 1H), 3.36 (dq, *J* = 9.1, 7.0 Hz, 1H), 2.45 (s, 3H), 2.34 – 2.16 (m, 1H), 2.09 – 2.01 (m, 1H), 1.04 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 202.1, 147.3, 144.4, 138.1, 135.7, 134.8, 129.5, 129.4, 129.0, 128.9, 128.7, 127.8, 127.2, 117.4, 112.9, 75.0, 64.7, 52.9, 50.6, 32.3, 21.7, 15.4. **IR** (KBr, cm^{-1}) 3396, 3056, 3021, 2974, 2926, 2862, 1677, 1602, 1502, 1440, 1371, 1324, 1284, 1177, 1124, 1092, 988, 949, 908, 822, 745, 691, 625, 589, 510, 472. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_2$ $(M+H)^+$ 386.2115, found 386.2118.

Tetrahydronaphthylaminess (6l)



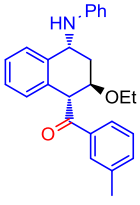
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 78%, 63.2mg, *dr* = 17:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.07 – 8.04 (m, 2H), 7.52 – 7.48 (m, 2H), 7.41 (d, *J* = 7.5 Hz, 1H), 7.24 – 7.19 (m, 3H), 7.16 – 7.12 (m, 1H), 6.84 (d, *J* = 7.6 Hz, 1H), 6.76 – 6.69 (m, 3H), 4.90 (d, *J* = 7.2 Hz, 1H), 4.83 (t, *J* = 4.6 Hz, 1H), 4.24 – 4.17 (m, 1H), 3.58 – 3.52 (m, 1H), 3.31 (dq, *J* = 9.3, 7.0 Hz, 1H), 2.44 (m, 1H), 2.05 – 1.98 (m, 1H), 1.02 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 201.7, 147.1, 140.0, 138.0, 136.6, 134.5, 130.3, 129.4, 129.1, 129.1, 128.5, 128.0, 127.4, 117.5, 112.9, 75.1, 64.7, 53.2, 50.7, 32.3, 15.3. **IR** (KBr, cm^{-1}) 3396, 3057, 2972, 2926, 2865, 1682, 1596, 1497, 1439, 1321, 1280, 1211, 1170, 1092, 998, 907, 828, 748, 691, 630, 543, 470. **HRMS** (ESI) Calcd for $C_{25}H_{25}ClNO_2$ $(M+H)^+$ 406.1568, found 406.1569.

Tetrahydronaphthylaminess (6m)



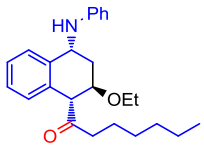
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 68%, 55.1mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.59 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.46 (dt, *J* = 9.4, 4.8 Hz, 2H), 7.41 (td, *J* = 7.6, 1.8 Hz, 1H), 7.34 (td, *J* = 7.4, 1.3 Hz, 1H), 7.25 – 7.17 (m, 4H), 7.07 (dd, *J* = 7.0, 1.7 Hz, 1H), 6.75 – 6.67 (m, 3H), 4.83 (t, *J* = 5.2 Hz, 2H), 4.22 – 4.15 (m, 1H), 3.96 (br, 1H), 3.53 (dq, *J* = 9.1, 7.0 Hz, 1H), 3.34 (dq, *J* = 9.2, 7.0 Hz, 1H), 2.36 (m, 1H), 2.08 (m, 1H), 1.05 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 204.2, 147.3, 139.8, 138.2, 133.3, 132.0, 131.3, 130.8, 129.7, 129.5, 129.3, 128.8, 127.8, 127.6, 126.9, 117.4, 112.9, 74.8, 64.4, 57.0, 50.1, 32.1, 15.3. **IR** (KBr, cm^{-1}) 3399, 3058, 2973, 2927, 2869, 1696, 1597, 1502, 1424, 1371, 1318, 1253, 1208, 1094, 1073, 988, 950, 871, 748, 695, 640, 509, 466. **HRMS** (ESI) Calcd for $C_{25}H_{25}ClNO_2$ $(M+H)^+$ 406.1568, found 406.1571.

Tetrahydronaphthylaminess (6n)



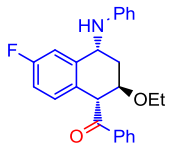
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 72%, 55.4mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.96 – 7.87 (m, 2H), 7.47 – 7.40 (m, 3H), 7.24 – 7.18 (m, 3H), 7.14 (td, *J* = 7.5, 1.3 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.73 (dd, *J* = 7.5, 5.2 Hz, 3H), 4.97 (d, *J* = 6.9 Hz, 1H), 4.85 (t, *J* = 4.5 Hz, 1H), 4.27 – 4.20 (m, 1H), 4.07 (br, 1H), 3.55 (dq, *J* = 9.2, 7.0 Hz, 1H), 3.36 (dq, *J* = 9.3, 7.0 Hz, 1H), 2.48 – 2.38 (m, 4H), 2.05 (m, 1H), 1.05 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.8, 147.2, 138.7, 138.2, 138.0, 134.7, 134.2, 129.4, 129.3, 128.9, 128.7, 128.7, 127.8, 127.2, 126.1, 117.4, 112.9, 75.0, 64.7, 53.1, 50.6, 32.3, 21.4, 15.3. **IR** (KBr, cm^{-1}) 3396, 3054, 2970, 2922, 2868, 1678, 1597, 1500, 1426, 1366, 1318, 1243, 1165, 1091, 990, 954, 750, 693, 631, 587, 466. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_2$ $(M+H)^+$ 386.2115, found 386.2115.

Tetrahydronaphthylaminess (6o)



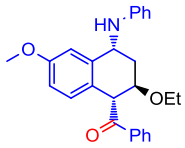
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 81%, 61.4mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42 – 7.36 (m, 1H), 7.21 (dt, *J* = 10.2, 5.9 Hz, 4H), 6.97 – 6.90 (m, 1H), 6.76 – 6.65 (m, 3H), 4.78 (t, *J* = 4.9 Hz, 1H), 4.05 – 3.99 (m, 2H), 3.58 (m, 1H), 3.37 (dq, *J* = 9.2, 7.0 Hz, 1H), 2.76 – 2.58 (m, 2H), 2.39 – 2.31 (m, 1H), 1.94 (m, 1H), 1.69 – 1.59 (m, 2H), 1.32 (dt, *J* = 11.6, 6.0 Hz, 6H), 1.14 (t, *J* = 7.0 Hz, 3H), 0.89 (t, *J* = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 212.3, 147.2, 137.7, 133.7, 129.4, 129.1, 128.4, 127.9, 127.45, 117.5, 112.9, 74.6, 64.2, 58.4, 50.6, 44.5, 32.1, 31.6, 28.9, 23.4, 22.5, 15.4, 14.0. **IR** (KBr, cm^{-1}) 3396, 3056, 2966, 2925, 2859, 1711, 1600, 1502, 1440, 1368, 1314, 1248, 1171, 1126, 1096, 956, 869, 749, 693, 628, 507, 465. **HRMS** (ESI) Calcd for $C_{25}H_{34}NO_2$ $(M+H)^+$ 380.2584, found 380.2586.

Tetrahydronaphthylaminess (6p)



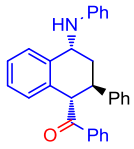
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 46%, 35.5mg, *dr* = 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.10 (d, *J* = 7.9 Hz, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.7 Hz, 2H), 7.24 – 7.18 (m, 3H), 6.85 (d, *J* = 6.8 Hz, 2H), 6.73 (dd, *J* = 12.4, 7.8 Hz, 3H), 4.96 (d, *J* = 5.4 Hz, 1H), 4.82 (s, 1H), 4.21 – 4.12 (m, 1H), 4.04 (br, 1H), 3.57 (dt, *J* = 7.1, 6.5 Hz, 1H), 3.46 – 3.37 (m, 1H), 2.24 (m, 1H), 2.19 – 2.10 (m, 1H), 1.09 (td, *J* = 7.0, 1.5 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 201.7, 161.9 (d, *J* = 244.0 Hz), 147.1, 141.0, 140.9, 137.6, 133.6, 130.6, 130.5, 129.8, 129.8, 129.5, 128.9, 128.8, 117.7, 115.1, 114.9, 114.9, 114.7, 113.1, 74.8, 64.7, 52.2, 49.8, 31.7, 15.4. **^{19}F NMR** (376 MHz, $CDCl_3$) *δ* -114.7, -114.7. **IR** (KBr, cm^{-1}) 3396, 3351, 3056, 2974, 2927, 2863, 1681, 1603, 1500, 1445, 1369, 1322, 1248, 1212, 1176, 1091, 993, 963, 914, 878, 809, 748, 695, 566, 512, 467. **HRMS** (ESI) Calcd for $C_{25}H_{25}FNO_2$ $(M+H)^+$ 390.1864, found 390.1869.

Tetrahydronaphthylaminess (6q)



White solid, m. p. = 108-109 °C,purified by chromatography (PE/EA = 15/1), yield = 52%, 41.8mg, *dr* = 18:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.10 (d, *J* = 7.4 Hz, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.22 (dd, *J* = 10.7, 4.9 Hz, 2H), 6.97 (d, *J* = 2.6 Hz, 1H), 6.79 (d, *J* = 8.6 Hz, 1H), 6.75 – 6.69 (m, 4H), 4.91 (d, *J* = 6.6 Hz, 1H), 4.81 (t, *J* = 5.0 Hz, 1H), 4.24 – 4.17 (m, 1H), 3.70 (s, 3H), 3.58 – 3.50 (m, 1H), 3.40 – 3.30 (m, 1H), 2.37 (m, 1H), 2.05 (m, 1H), 1.04 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 202.7, 158.7, 147.2, 139.4, 138.1, 133.4, 129.7, 129.4, 128.8, 126.6, 117.5, 114.7, 113.0, 75.1, 64.7, 55.3, 52.5, 50.71, 32.1, 15.4. **IR** (KBr, cm^{-1}) 3395, 3055, 2970, 2927, 2867, 2839, 1680, 1603, 1501, 1438, 1368, 1323, 1250, 1181, 1035, 992, 874, 809, 750, 695, 572, 512, 473. **HRMS** (ESI) Calcd for $C_{26}H_{28}NO_3$ $(M+H)^+$ 402.2064, found 402.2069.

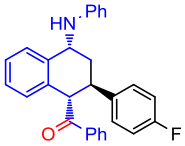
Tetrahydronaphthylaminess (6r)



Brown solid, m. p. = 82-83 °C, purified by chromatography (PE/EA = 20/1), yield = 50%, 40.3mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 7.77 – 7.71 (m, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.44 (d, *J* = 7.1 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.25 (s, 1H), 7.21 – 7.14 (m, 7H), 7.13 – 7.08 (m, 1H), 6.91 (d, *J* = 7.7 Hz, 1H), 6.75 – 6.66 (m, 3H), 5.07 (d, *J* = 9.2 Hz, 1H), 4.76 (t, *J* = 3.4 Hz, 1H), 4.36 (br, 1H), 3.72 (m, 1H), 2.47 (dt, *J* = 13.3, 3.4 Hz, 1H),

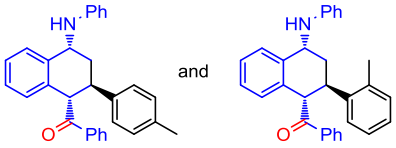
2.28 – 2.19 (m, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.6, 147.1, 143.5, 138.2, 137.8, 136.1, 133.2, 130.3, 129.5, 128.7, 128.7, 128.6, 128.5, 128.2, 127.6, 127.4, 126.8, 117.4, 113.0, 53.6, 50.9, 40.2, 34.0. **IR** (KBr, cm^{-1}) 3407, 3337, 3058, 3021, 2944, 2919, 2857, 1678, 1595, 1499, 1441, 1326, 1256, 1211, 1169, 1111, 1068, 994, 909, 865, 758, 696, 589, 541, 505, 473. **HRMS** (ESI) Calcd for $C_{29}H_{26}NO$ $(M+H)^+$ 404.2009, found 404.2014.

Tetrahydronaphthylaminess (6s)



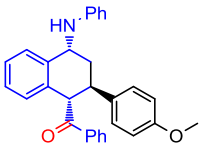
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 33%, 27.8mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77 – 7.72 (m, 2H), 7.50 (dd, *J* = 10.6, 4.2 Hz, 1H), 7.42 (d, *J* = 6.9 Hz, 1H), 7.37 (t, *J* = 7.7 Hz, 2H), 7.22 (t, *J* = 7.1 Hz, 2H), 7.18 – 7.15 (m, 2H), 7.11 (ddd, *J* = 8.7, 4.6, 1.6 Hz, 2H), 6.91 – 6.80 (m, 3H), 6.73 – 6.67 (m, 3H), 5.00 (d, *J* = 9.5 Hz, 1H), 4.76 (s, 1H), 4.31 (br, 1H), 3.72 (m, 1H), 2.44 (dt, *J* = 13.3, 3.3 Hz, 1H), 2.18 (d, *J* = 3.1 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 203.4, 161.6 (d, *J* = 244.0 Hz), 146.9, 139.2, 139.1, 138.1, 137.5, 136.0, 133.3, 130.4, 129.4, 129.1, 129.0, 128.7, 128.6, 128.4, 128.2, 127.4, 117.4, 115.5, 115.2, 112.9, 53.8, 51.0, 39.4, 34.1. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.92. **IR** (KBr, cm^{-1}) 3402, 3055, 3016, 2951, 2920, 2856, 1677, 1597, 1503, 1437, 1322, 1303, 1221, 1166, 1108, 1068, 996, 905, 828, 748, 696, 543, 504. **HRMS** (ESI) Calcd for $C_{29}H_{25}FNO$ $(M+H)^+$ 422.1915, found 422.1919.

Tetrahydronaphthylaminess (6t)



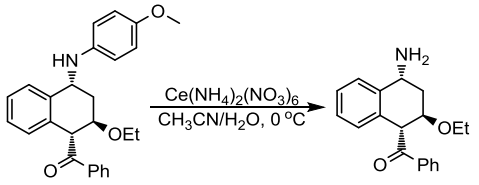
Yellow oil, purified by chromatography (PE/EA = 20/1), yield = 70%, 50.0mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.74 (dd, *J* = 10.0, 4.2 Hz, 2H), 7.46 (m, 2H), 7.37 – 7.31 (m, 2H), 7.22 (t, *J* = 7.4 Hz, 1H), 7.15 (dd, *J* = 15.9, 7.7 Hz, 3H), 6.95 (m, 5H), 6.71 – 6.65 (m, 3H), 5.05 (dd, *J* = 9.1, 4.4 Hz, 1H), 4.73 (d, *J* = 3.3 Hz, 1H), 4.32 (br, 1H), 3.73 – 3.64 (m, 1H), 2.44 (m, 1H), 2.24 – 2.14 (m, 4H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.7, 203.5, 147.1, 143.4, 140.4, 138.2, 138.1, 138.1, 137.91, 137.8, 136.3, 136.2, 136.1, 133.1, 130.3, 130.2, 129.4, 129.3, 128.7, 128.7, 128.6, 128.5, 128.5, 128.18, 128.1, 127.5, 127.4, 127.3, 124.4, 117.3, 113.0, 53.6, 50.9, 40.0, 39.6, 34.2, 34.1, 21.4, 21.0. **IR** (KBr, cm^{-1}) 3041, 3055, 3017, 2951, 2919, 2858, 1727, 1678, 1598, 1502, 1438, 1321, 1253, 1212, 1173, 1111, 1070, 993, 905, 864, 818, 746, 696, 544, 506. **HRMS** (ESI) Calcd for $C_{30}H_{28}NO$ $(M+H)^+$ 418.2165, found 418.2171.

Tetrahydronaphthylaminess (6u)



Yellow oil, purified by chromatography (PE/EA = 15/1), yield = 77%, 66.7mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 7.6 Hz, 2H), 7.49 – 7.38 (m, 2H), 7.33 (t, *J* = 7.6 Hz, 2H), 7.22 – 7.11 (m, 4H), 7.05 (d, *J* = 8.4 Hz, 2H), 6.89 (d, *J* = 7.5 Hz, 1H), 6.67 (t, *J* = 8.2 Hz, 5H), 5.02 (d, *J* = 9.1 Hz, 1H), 4.73 (s, 1H), 4.32 (br, 1H), 3.73 – 3.57 (m, 4H), 2.41 (d, *J* = 13.3 Hz, 1H), 2.16 (td, *J* = 13.1, 3.4 Hz, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 203.6, 158.3, 147.1, 138.2, 137.8, 136.2, 135.6, 133.2, 130.3, 129.5, 128.78, 128.7, 128.5, 128.1, 127.3, 117.4, 114.0, 113.0, 55.2, 53.8, 51.0, 39.3, 34.3. **IR** (KBr, cm^{-1}) 3403, 3056, 3014, 2948, 2919, 2838, 1677, 1602, 1505, 1435, 1307, 1250, 1212, 1179, 1110, 1033, 993, 904, 824, 743, 696, 547. **HRMS** (ESI) Calcd for $C_{20}H_{28}NO_2$ $(M+H)^+$ 434.2115, found 434.2115.

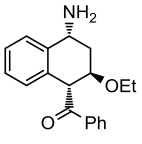
1.8 Chemical transformation of 6d



6d **7**, 75%, *dr* > 20:1

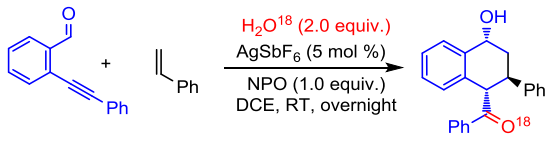
To a solution of compound **6d** (41.2mg, 0.2mmol) in MeCN/H_2O (4:1, 1mL) was added ceric ammonium nitrate (548.2 mg, 0.8 mmol) at 0 C, and the reaction mixture was stirred for 1 hour. The reaction was quenched with 10% aqueous NaOH and adjusted to pH = 9 to give a mass. The mass was filtered through a pad of celite, washed with DCM. The solution was extracted with DCM. The organic phase was washed with brine and dried over anhydrous Na_2SO_4. The solvent was removed and the residue was purified on PE:EA=10:1 to give a brown oil.

(4-Amino-2-ethoxy-1,2,3,4-tetrahydronaphthalen-1-yl)(phenyl)methanone (7)



Brown solid, m. p. = 104-105 °C, purified by chromatography (PE/EA = 10/1), yield = 75%, 44.3 mg, *dr* > 20:1; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 – 7.83 (m, 2H), 7.46 – 7.39 (m, 3H), 7.35 (m, 2H), 7.24 (qd, *J* = 4.7, 1.7 Hz, 2H), 5.64 (dd, *J* = 3.2, 1.9 Hz, 1H), 5.13 (d, *J* = 3.3 Hz, 1H), 3.81 (dt, *J* = 8.6, 3.0 Hz, 1H), 3.66 (dq, *J* = 9.2, 7.0 Hz, 1H), 3.43 (dq, *J* = 9.2, 7.0 Hz, 1H), 2.30 – 2.20 (m, 1H), 1.37 – 1.32 (m, 1H), 1.09 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) *δ* 173.8, 140.7, 136.2, 134.4, 130.6, 128.6, 126.6, 126.3, 126.3, 125.5, 122.8, 73.6, 63.9, 62.1, 47.2, 34.4, 15.2. **IR** (KBr, cm^{-1}) 3650, 3072, 2968, 2925, 2857, 1731, 1679, 1603, 1568, 1448, 1347, 1164, 1096, 1049, 968, 874, 759, 692, 580, 523. **HRMS** (ESI) Calcd for $C_{19}H_{29}NO_2$ $(M+H)^+$ 296.1642, found 296.1639.

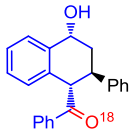
1.9 Procedure for the preparation of the O^{18}-3a



1a **2a** **O^{18}-3a**

To a dichloroethane (DCE, 1.0 mL) suspension of $AgSbF_6$ (5 mol %) in Schlenk tube with a magnetic bar under a nitrogen atmosphere, was added 4-Nitropyridine N-oxide (NPO, 0.20 mmol), olefin (**2a**, 1.0 mmol), H_2O^{18} (0.4 mmol) and enynals (1a, 0.2mmol), the reaction was stirred at room temperature. The reaction was monitored by TLC. The reaction mixture was purified by chromatography with petroleum / ethyl acetate, 4/1, **O^{18}-3a** was obtained. The labled ^{18}O was on the carbonyl group as the ^{13}C NMR illustrated (Figure S1).

^{18}O-3a



^{13}C NMR (100 MHz, $CDCl_3$) δ 203.4, 143.5, 138.1, 137.3, 135.2, 133.2, 130.0, 128.9,128.6, 128.6, 128.6, 128.4, 127.5, 127.5, 126.8, 67.8, 54.8, 39.3, 37.8. **HRMS** (ESI) Calcd for $(M+Na)^+$ 353.13930, found 353.13980.

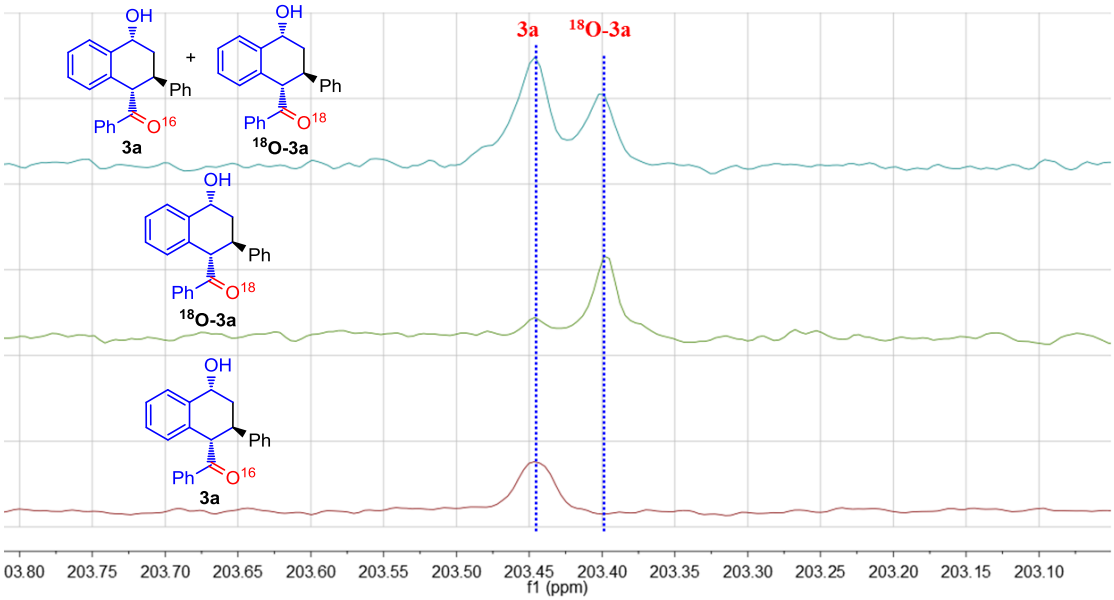


Figure S1. Comparison and assignment of the carbonyl carbon signal in ^{13}C NMR spectra of **^{18}O-3a** and **3a**

2. References

[1] Zhu, S.; Zhang, Z.; Huang, X.; Jiang, H.; Guo, Z. *Chem. Eur. J.* **2013**, *19*, 4695.

[2] Zhu, S.; Huang, H.; Zhang, Z.; Ma, T.; Jiang, H. *J. Org. Chem.* **2014**, *79*, 6113.

[3] Zhu, S.; Hu, L.; Jiang, H. *Org. Biomol. Chem.* **2014**, *12*, 4104.

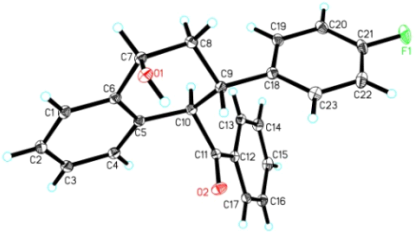
[4] Zhu, S.; Guo, Z.; Huang, Z.; Jiang, H. *Chem. Eur. J.* **2014**, *20*, 2425.

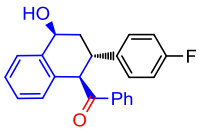
[5] Obika, S.; Kono, S.; Yasui, Y.; Yanada, R.; Takemoto, Y. *J. Org. Chem.***2007**, *72*, 4462.

[6] Zhu, S.; Liang, R.; Jiang, H.; Wu, W. *Angew. Chem., Int. Ed.* **2012**, *51*, 10861.

3. X-Ray diffraction analysis

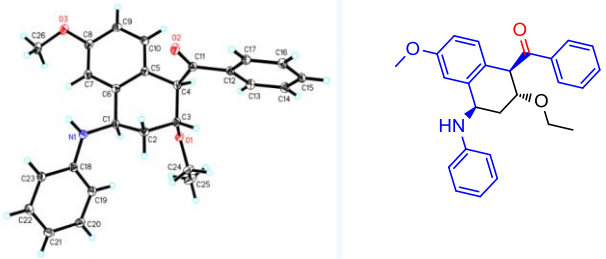
3.1 Crystal data and structure refinement for 3d





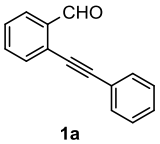
CCDC number	1589273
Identification code	**3d**
Empirical formula	$C_{23}H_{19}FO_2$
Formula weight	346.38
Temperature/K	100.00(10)
Crystal system	triclinic
Space group	P-1
a/Å	8.9683(5)
b/Å	9.8217(5)
c/Å	11.3530(7)
α/°	75.074(5)
β/°	77.458(5)
γ/°	63.345(5)
Volume/Å^3	857.58(9)
Z	2
ρ_{calc}g/cm^3	1.341
μ/mm^{-1}	0.092
F(000)	364.0
Crystal size/mm^3	0.14 × 0.12 × 0.11
Radiation	MoKα (λ = 0.71073)
2θ range for data collection/ °	4.72 to 59.058
Index ranges	-12 ≤ h ≤ 12, -13 ≤ k ≤ 13, -15 ≤ l ≤ 15
Reflections collected	14359
Independent reflections	4222 [R_{int} = 0.0439, R_{sigma} = 0.0516]
Data/restraints/parameters	4222/0/236
Goodness-of-fit on F^2	1.034
Final R indexes [I>=2σ (I)]	R_1 = 0.0489, wR_2 = 0.1073
Final R indexes [all data]	R_1 = 0.0681, wR_2 = 0.1198
Largest diff. peak/hole / e Å^{-3}	0.28/-0.30

3.2 Crystal data and structure refinement for 6q

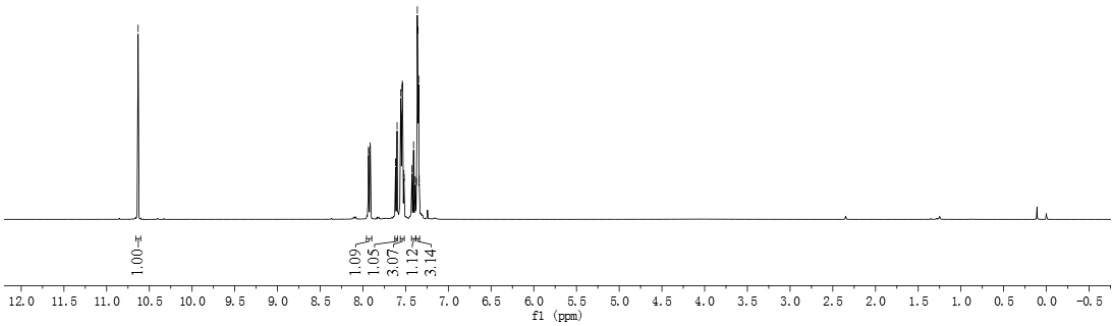


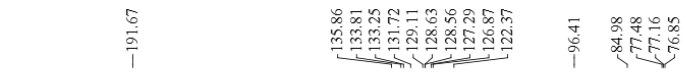
CCDC number	1524750
Identification code	**6q**
Empirical formula	$C_{26}H_{27}NO_3$
Formula weight	401.48
Temperature/K	100.00(10)
Crystal system	triclinic
Space group	P-1
a/Å	9.2089(3)
b/Å	10.5763(4)
c/Å	10.9769(4)
α/°	100.503(3)
β/°	95.221(3)
γ/°	91.160(3)
Volume/Å^3	1046.09(7)
Z	2
ρ_{calc}g/cm^3	1.275
μ/mm^{-1}	0.658
F(000)	428.0
Crystal size/mm^3	0.25 × 0.21 × 0.18
Radiation	Cu Kα (λ = 1.54184)
2θ range for data collection/ °	8.23 to 147.28
Index ranges	-9 ≤ h ≤ 11, -10 ≤ k ≤ 13, -13 ≤ l ≤ 13
Reflections collected	6974
Independent reflections	4070 [R_{int} = 0.0153, R_{sigma} = 0.0185]
Data/restraints/parameters	4070/0/273
Goodness-of-fit on F^2	1.044
Final R indexes [I>=2σ (I)]	R_1 = 0.0398, wR_2 = 0.1020
Final R indexes [all data]	R_1 = 0.0418, wR_2 = 0.1039
Largest diff. peak/hole / e Å^{-3}	0.34/-0.35

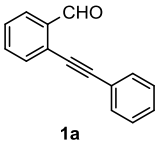
4. Copies of NMR spectra



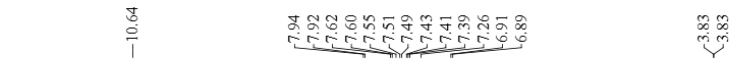
1a

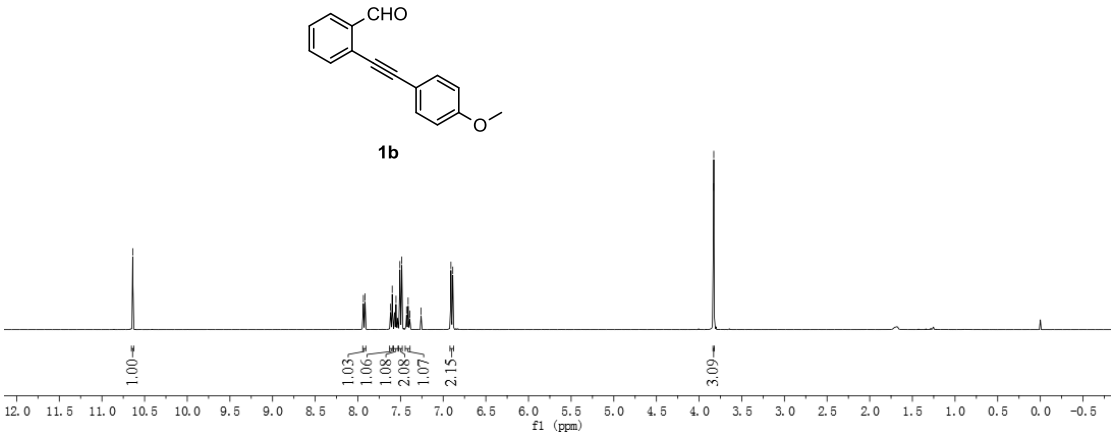




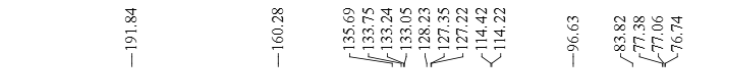


1a


10.64
7.94
7.92
7.62
7.60
7.55
7.51
7.49
7.43
7.41
7.39
7.26
6.91
6.89
3.83
3.83


CHO
O
1.00
1.03
1.06
1.08
2.08
1.07
2.15
3.09
f1 (ppm)

1b


191.84
160.28
135.69
133.75
133.24
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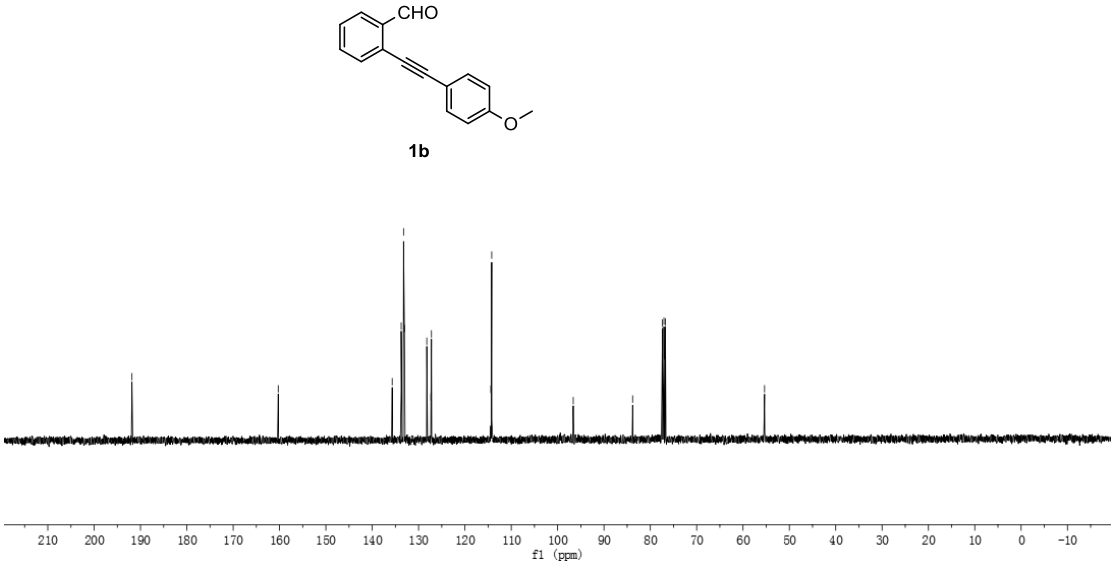
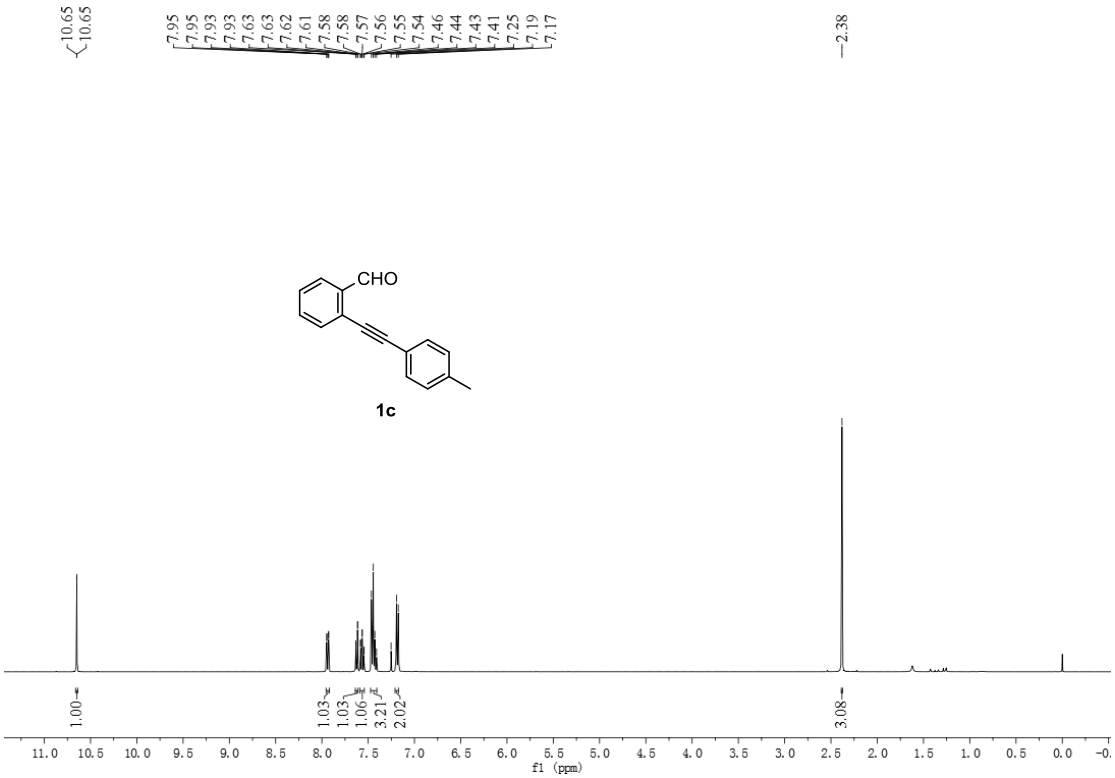
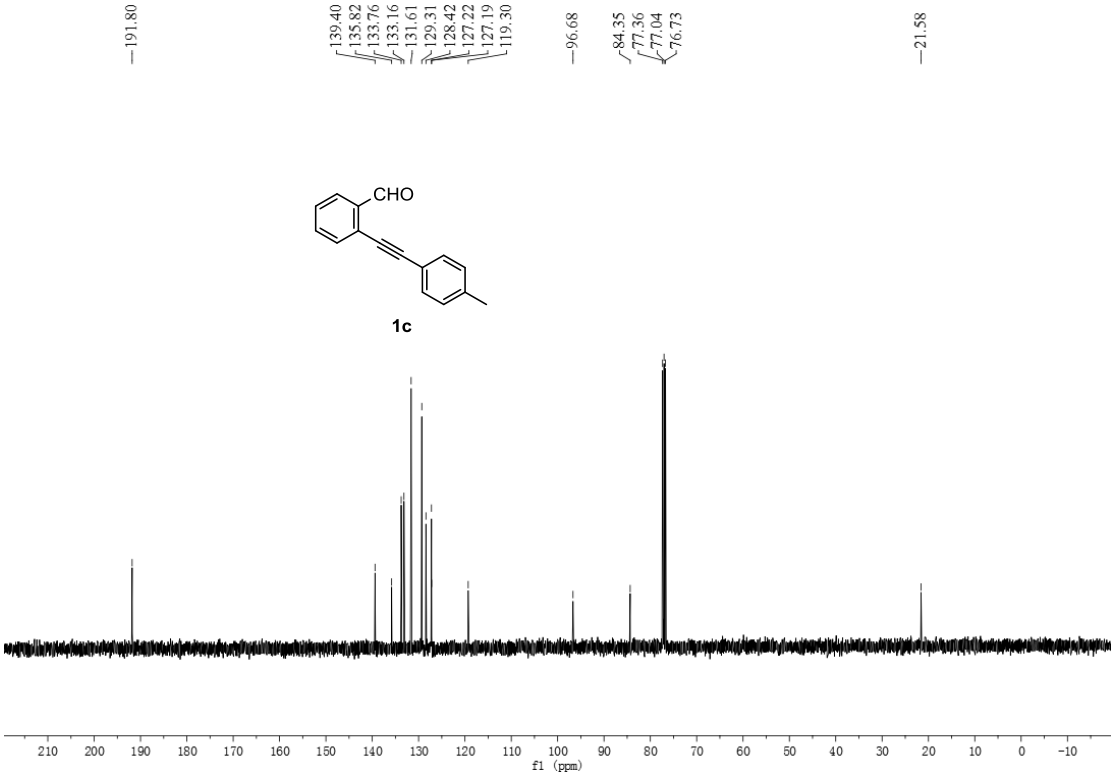
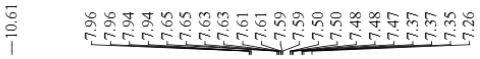
128.23
127.35
127.22
114.42
114.22
96.63
83.82
77.38
77.06
76.74
55.35

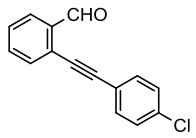

CHO
O
f1 (ppm)

1b

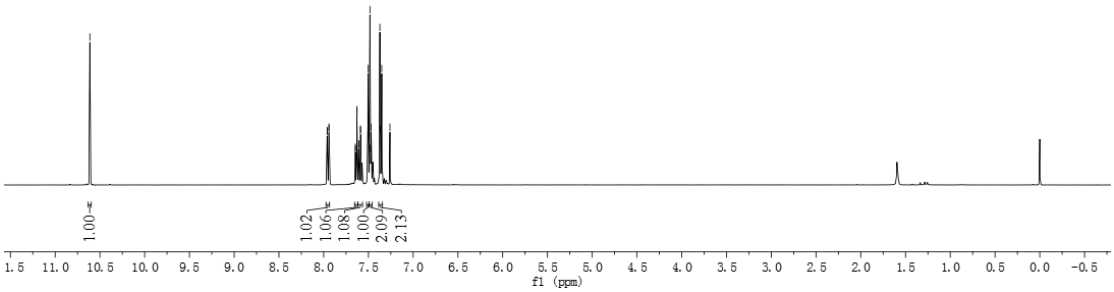

10.65
10.65
7.95
7.95
7.93
7.93
7.63
7.62
7.61
7.58
7.58
7.57
7.56
7.55
7.54
7.46
7.44
7.43
7.41
7.25
7.19
7.17
2.38
CHO
1c
1.00
1.03
1.03
1.06
3.21
2.02
3.08
f1 (ppm)


191.80
139.40
135.82
133.76
133.16
131.61
129.31
128.42
127.22
127.19
119.30
96.68
84.35
77.36
77.04
76.73
21.58
CHO
1c
f1 (ppm)

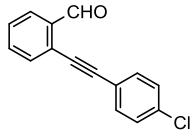

10.61
7.96
7.96
7.94
7.94
7.65
7.65
7.63
7.63
7.61
7.61
7.59
7.59
7.50
7.50
7.48
7.48
7.47
7.37
7.37
7.35
7.26


CHO
Cl

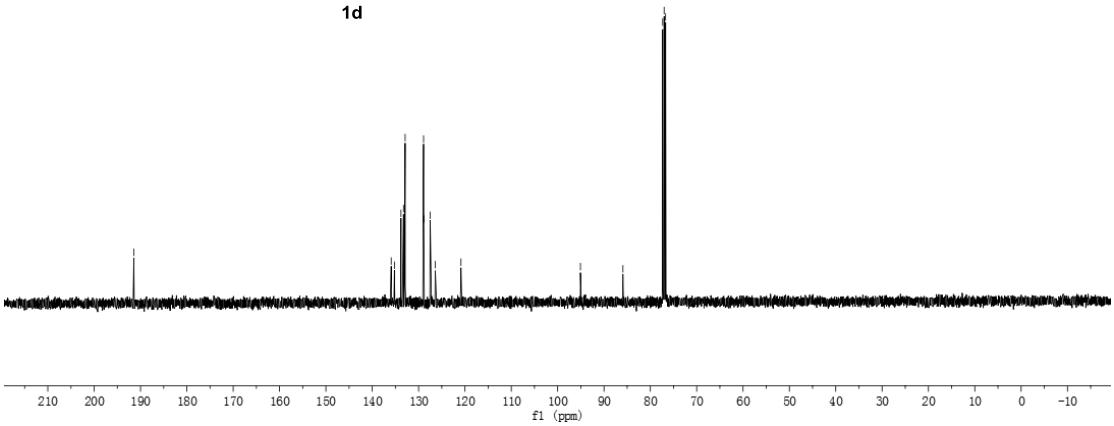
1d

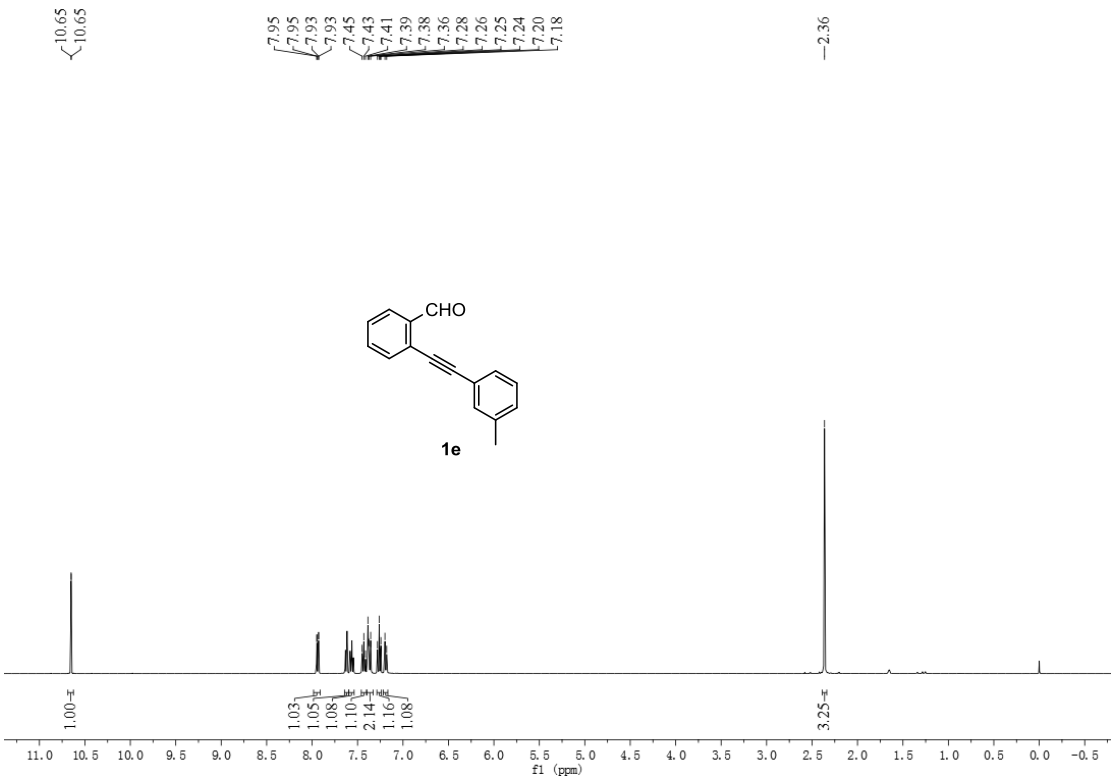

1.00
1.02
1.06
1.08
1.00
2.09
2.13
f1 (ppm)

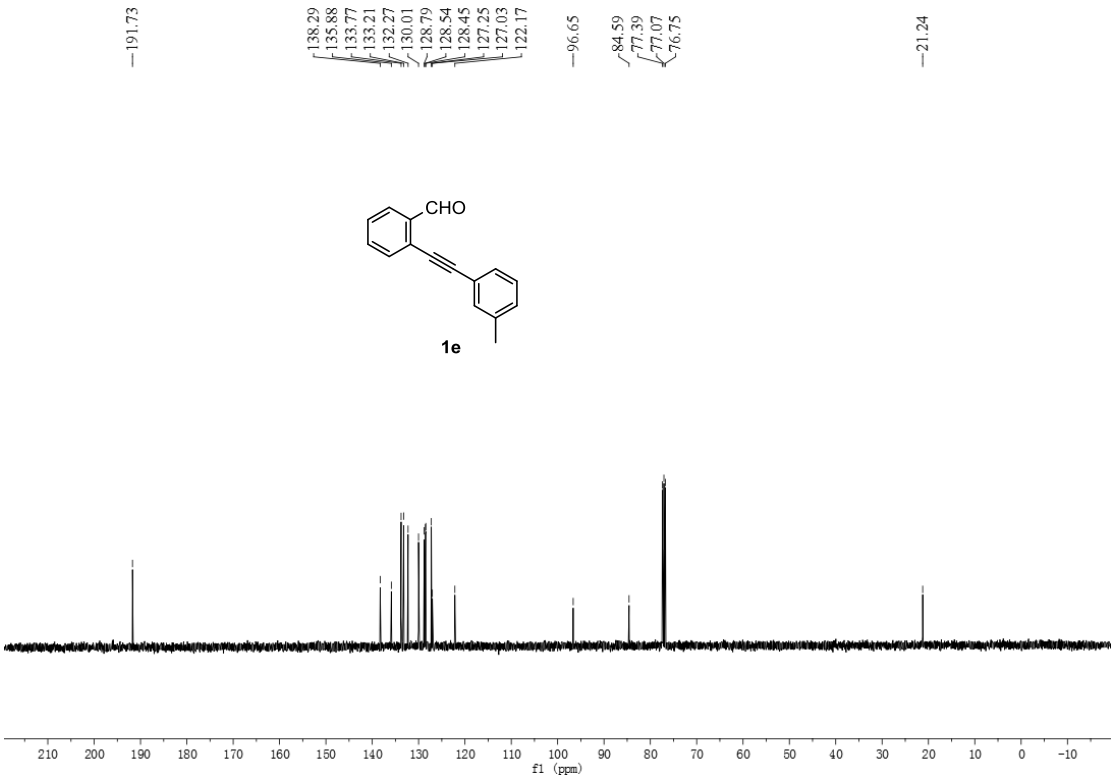

191.44
135.91
135.22
133.80
133.26
132.90
128.93
128.85
127.50
126.41
120.86
95.08
85.91
77.34
77.02
76.71

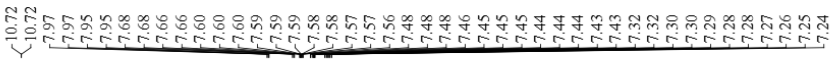

CHO
Cl

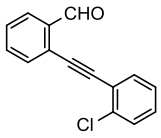
1d


f1 (ppm)

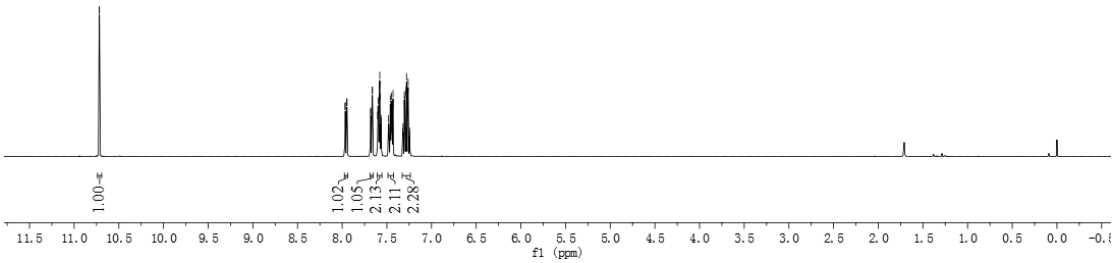

10.65
10.65
7.95
7.95
7.93
7.93
7.45
7.43
7.41
7.39
7.38
7.36
7.28
7.26
7.25
7.24
7.20
7.18
2.36
CHO
1e
1.00
1.03
1.05
1.08
1.10
2.14
1.16
1.08
3.25
f1 (ppm)

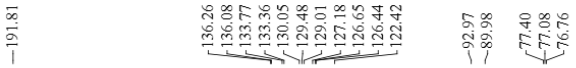

191.73
138.29
135.88
133.77
133.21
132.27
130.01
128.79
128.54
128.45
127.25
127.03
122.17
96.65
84.59
77.39
77.07
76.75
21.24
CHO
1e
f1 (ppm)

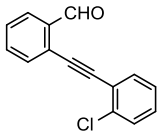

10.72
10.72
7.97
7.97
7.95
7.95
7.68
7.68
7.66
7.66
7.60
7.60
7.60
7.59
7.59
7.59
7.59
7.58
7.58
7.57
7.57
7.56
7.48
7.48
7.46
7.45
7.45
7.44
7.44
7.44
7.43
7.32
7.32
7.30
7.30
7.29
7.28
7.28
7.27
7.26
7.25
7.24


CHO
Cl

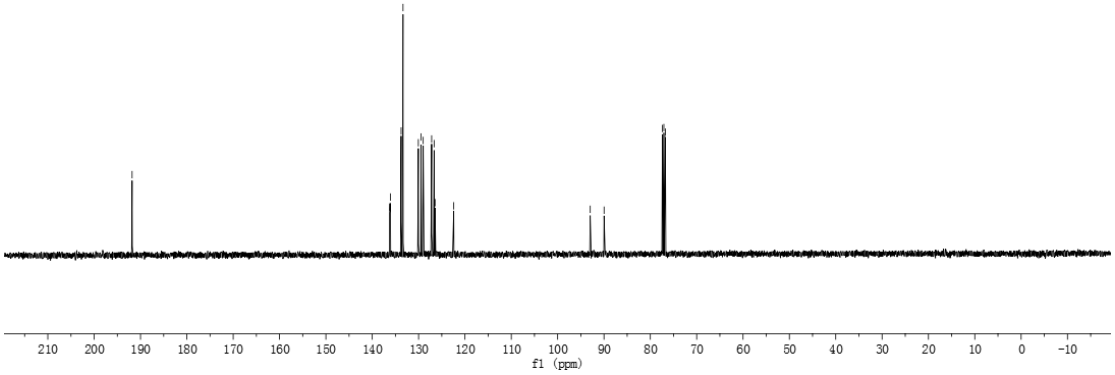
1f

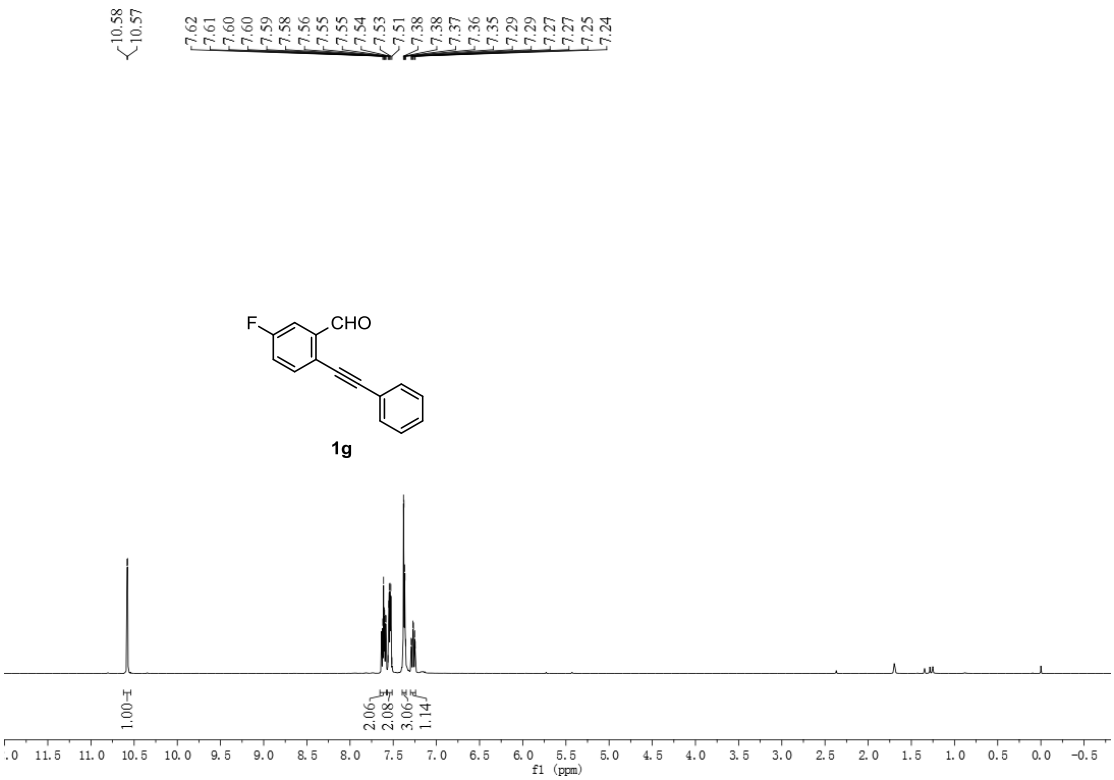

1.00
1.02
1.05
2.13
2.11
2.28
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

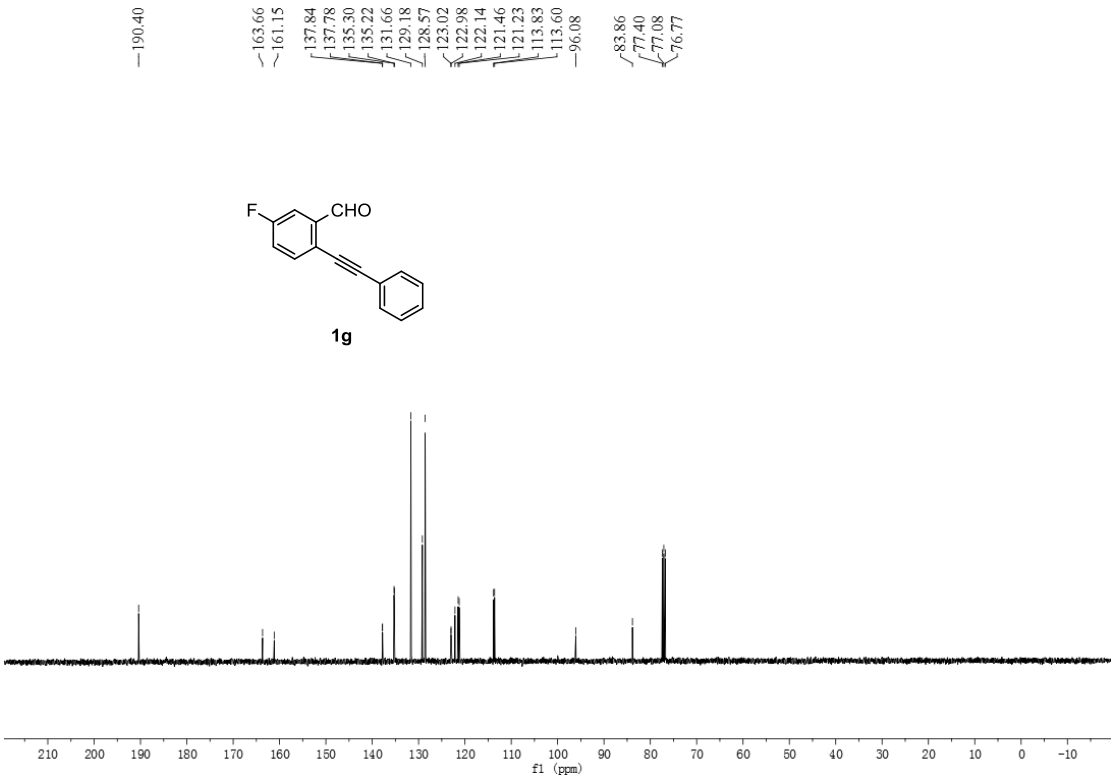

191.81
136.26
136.08
133.77
133.36
130.05
129.48
129.01
127.18
126.65
126.44
122.42
92.97
89.98
77.40
77.08
76.76

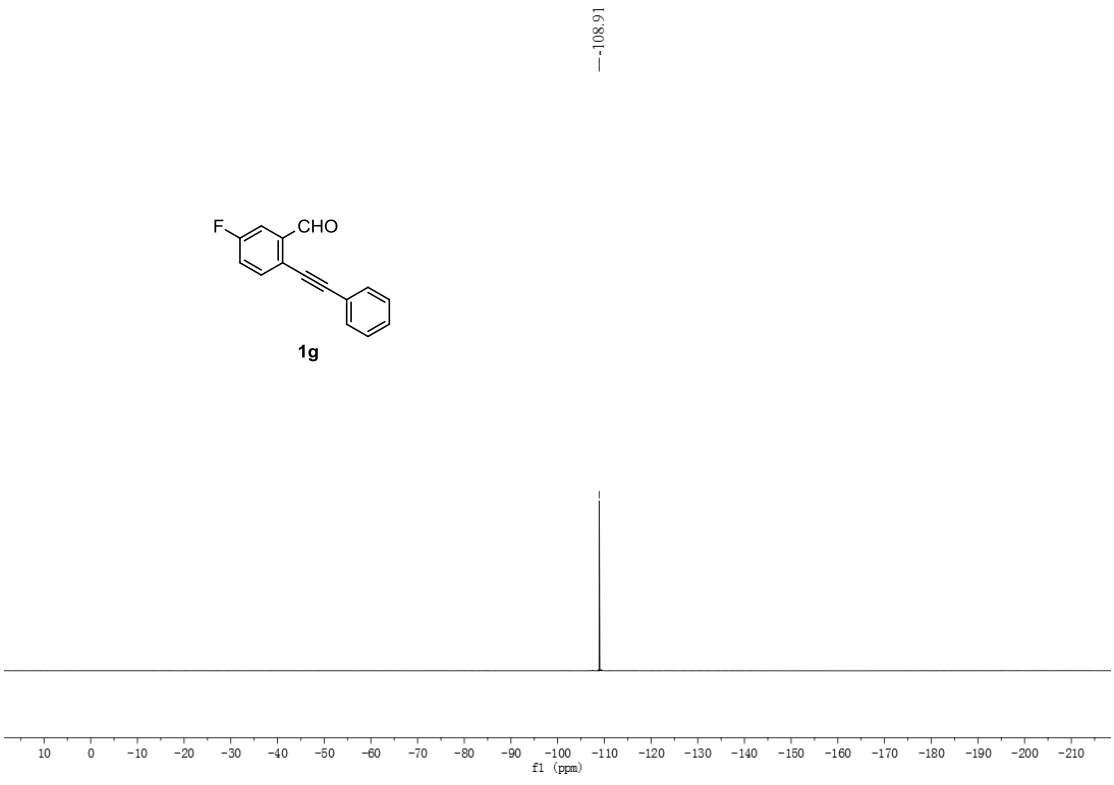

CHO
Cl

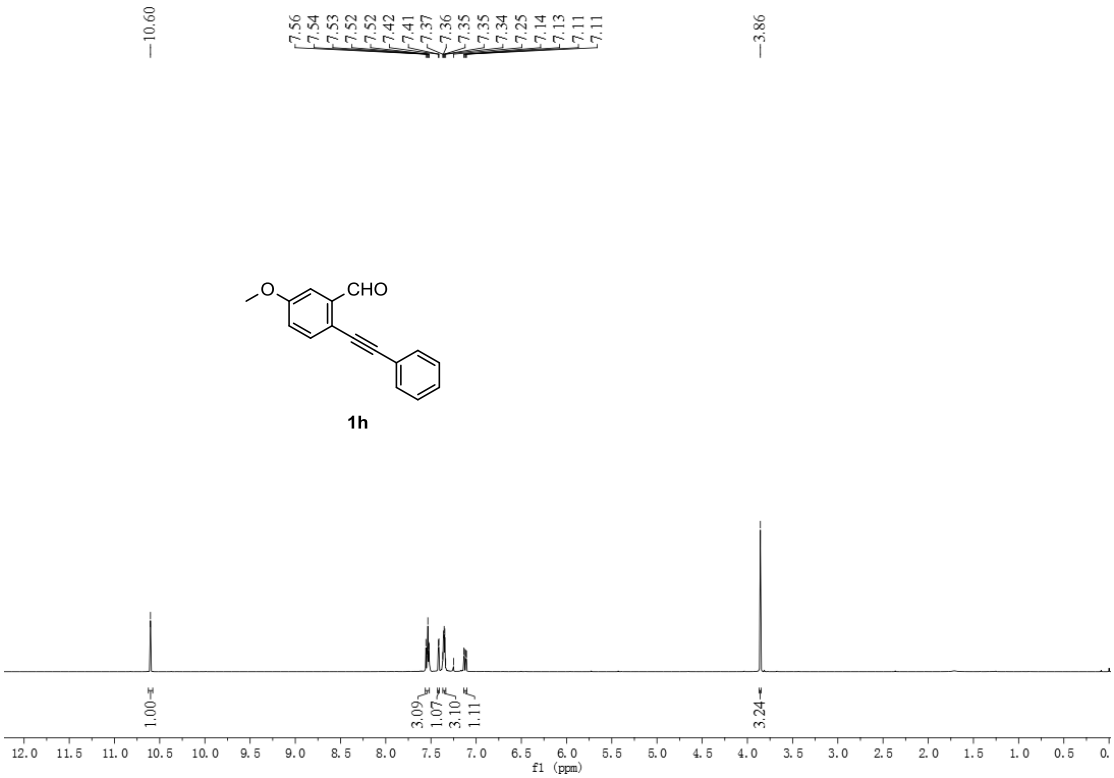
1f

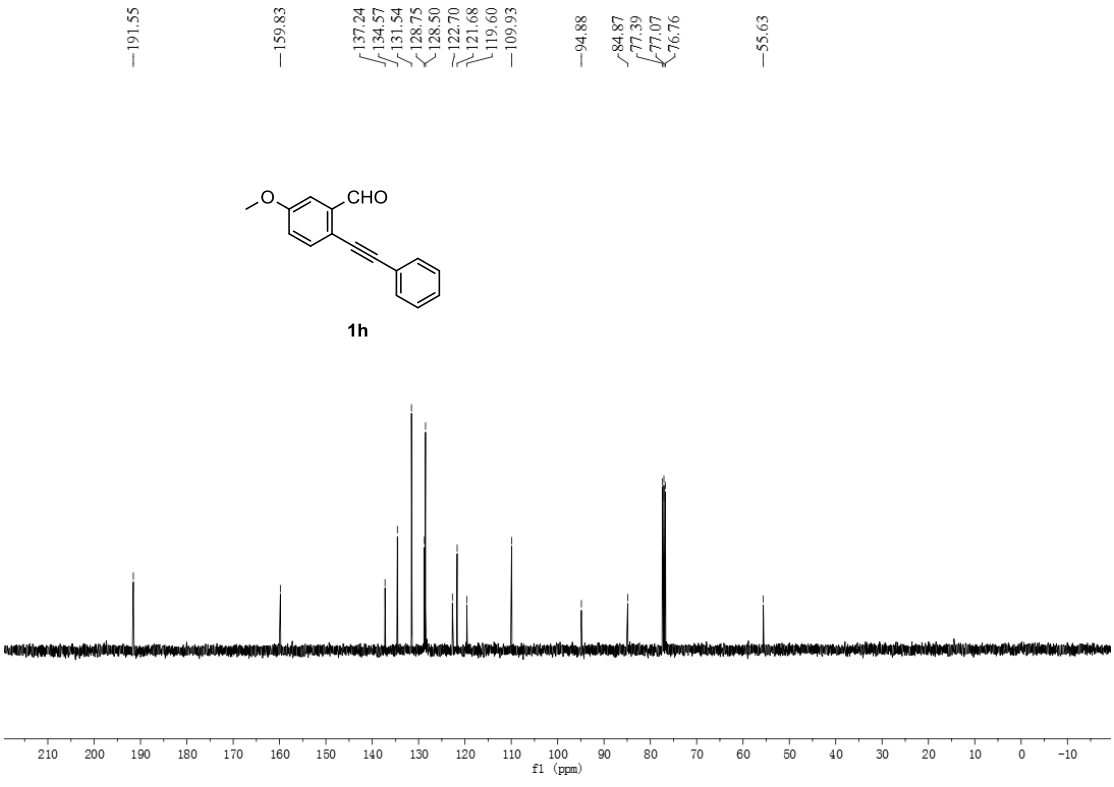

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


10.58
10.57
7.62
7.61
7.60
7.60
7.59
7.58
7.56
7.55
7.55
7.54
7.53
7.51
7.38
7.38
7.37
7.36
7.35
7.29
7.29
7.27
7.27
7.25
7.24
F
CHO
1g
1.00
2.06
2.08
3.06
1.14
f1 (ppm)


190.40
163.66
161.15
137.84
137.78
135.30
135.22
131.66
129.18
128.57
123.02
122.98
122.14
121.46
121.23
113.83
113.60
96.08
83.86
77.40
77.08
76.77
F
CHO
1g
f1 (ppm)


-108.91
F
CHO
1g
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


10.60
7.56
7.54
7.53
7.52
7.52
7.42
7.41
7.37
7.36
7.35
7.35
7.34
7.25
7.14
7.13
7.11
7.11
3.86
O
CHO
1h
1.00
3.09
1.07
3.10
1.11
3.24
f1 (ppm)


191.55
159.83
137.24
134.57
131.54
128.75
128.50
122.70
121.68
119.60
109.93
94.88
84.87
77.39
77.07
76.76
55.63
O
CHO
1h
f1 (ppm)


10.55
7.98
7.96
7.96
7.94
7.57
7.57
7.56
7.55
7.55
7.40
7.40
7.39
7.38
7.37
7.37
7.31
7.31
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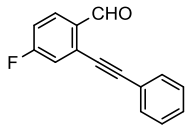
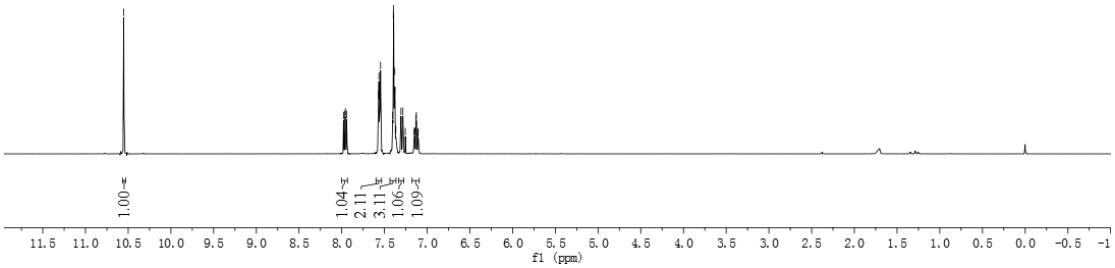
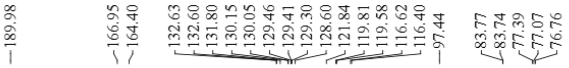
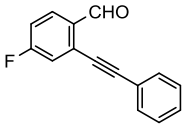
7.15
7.15
7.13
7.13
7.11
7.11
7.11


CHO
F

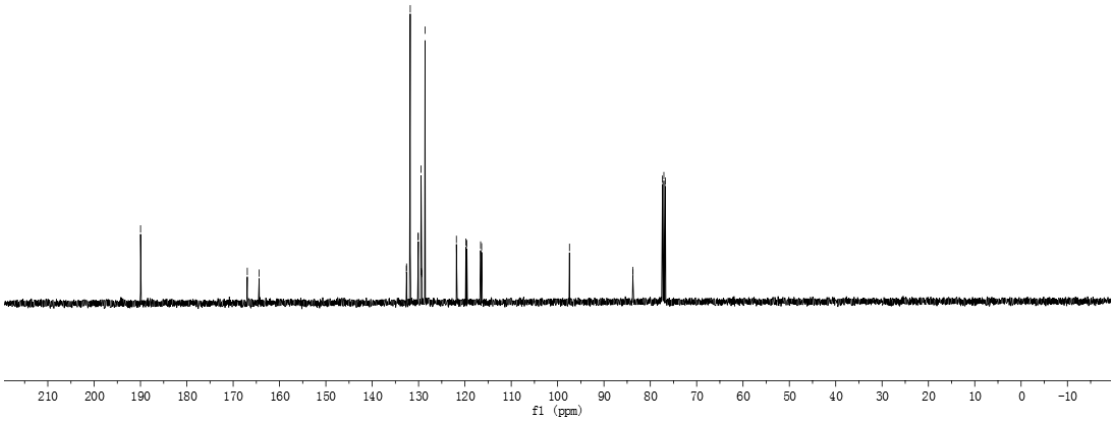
1i

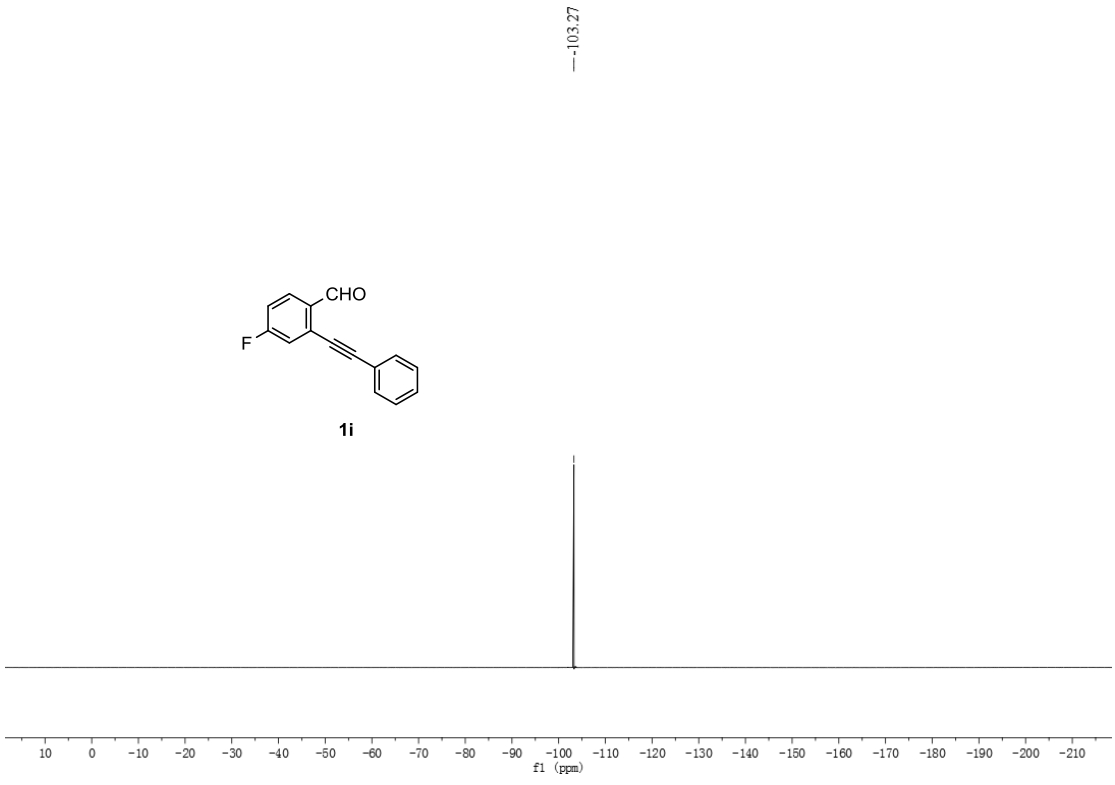

1.00
1.04
2.11
3.11
1.06
1.09
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)


189.98
166.95
164.40
132.63
132.60
131.80
130.15
130.05
129.46
129.41
129.30
128.60
121.84
119.81
119.58
116.62
116.40
97.44
83.77
83.74
77.39
77.07
76.76


CHO
F

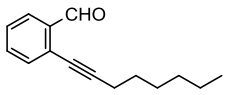
1i


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

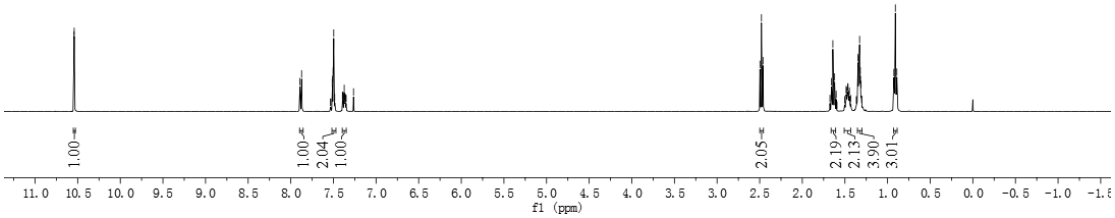

-103.27
CHO
F
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

1i

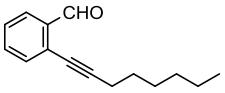

10.54
10.54
7.89
7.87
7.87
7.53
7.53
7.51
7.51
7.50
7.50
7.50
7.49
7.39
7.39
7.39
7.39
7.38
7.37
7.37
7.37
7.36
7.35
7.35
7.26
2.50
2.48
2.46
1.66
1.64
1.62
1.49
1.48
1.47
1.46
1.35
1.34
1.33
1.32
1.31
0.93
0.92
0.91
0.90


CHO

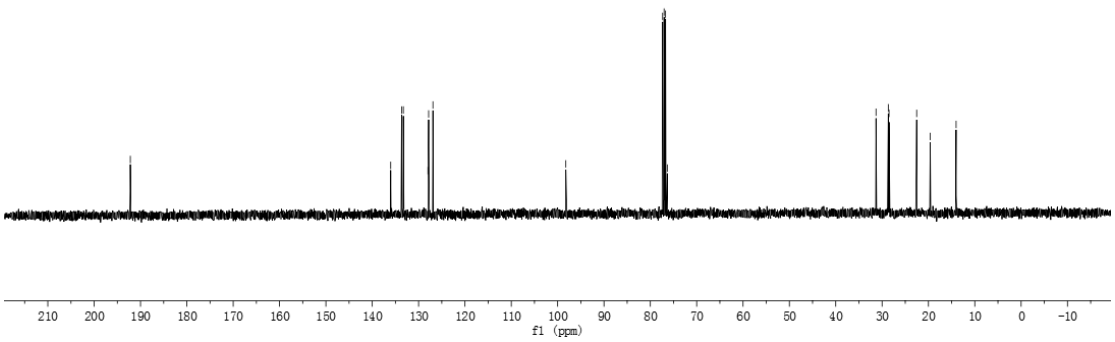
1j

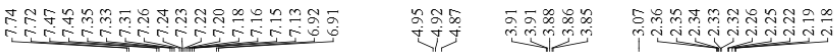

1.00
1.00
2.04
1.00
2.05
2.19
2.13
3.90
3.01
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


192.20
136.02
133.66
133.29
127.99
127.83
126.91
98.24
77.35
77.03
76.71
76.34
31.31
28.66
28.50
22.54
19.61
14.03


CHO

1j


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.74
7.72
7.47
7.45
7.35
7.33
7.31
7.26
7.24
7.23
7.22
7.20
7.18
7.16
7.15
7.13
6.92
6.91
4.95
4.92
4.87
3.91
3.91
3.88
3.86
3.85
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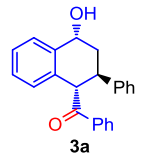
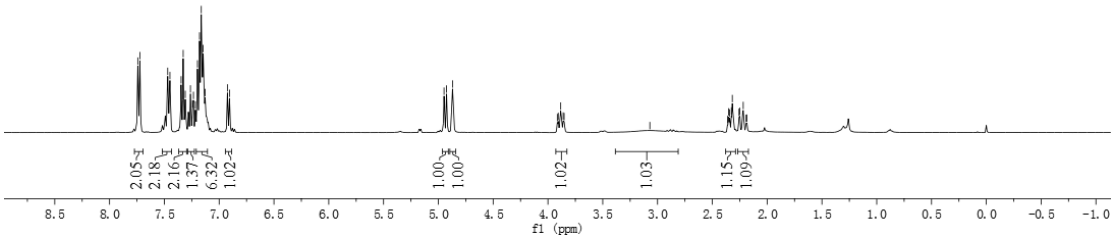
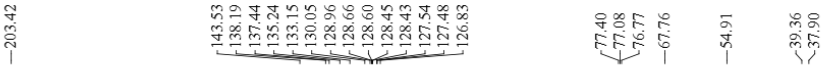
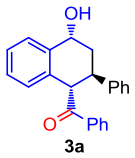
2.33
2.32
2.26
2.25
2.22
2.19
2.18


OH
Ph
O
Ph

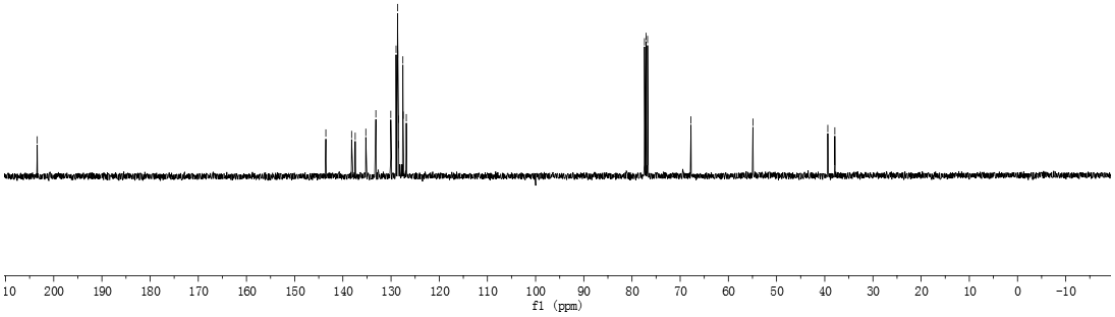
3a


2.05
2.18
2.16
1.37
6.32
1.02
1.00
1.00
1.02
1.03
1.15
1.09
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

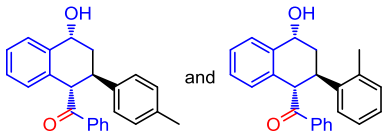

203.42
143.53
138.19
137.44
135.24
133.15
130.05
128.96
128.66
128.60
128.45
128.43
127.54
127.48
126.83
77.40
77.08
76.77
67.76
54.91
39.36
37.90


OH
Ph
O
Ph

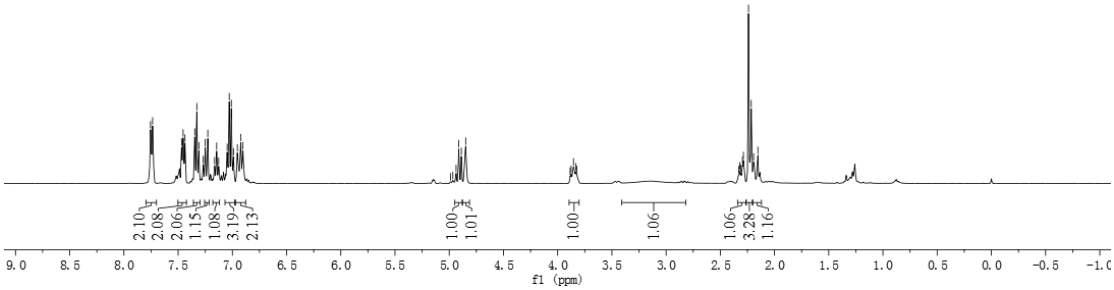
3a

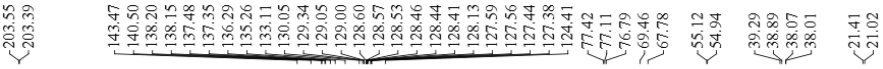

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

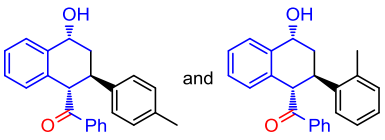

7.75
7.74
7.47
7.45
7.44
7.35
7.33
7.31
7.27
7.25
7.23
7.16
7.15
7.13
7.05
7.03
7.01
6.99
6.95
6.92
6.90
4.99
4.97
4.94
4.91
4.89
4.85
3.88
3.88
3.85
3.83
3.82
2.33
2.32
2.31
2.30
2.29
2.24
2.21
2.19
2.15


OH
and
OH
O
Ph
O
Ph

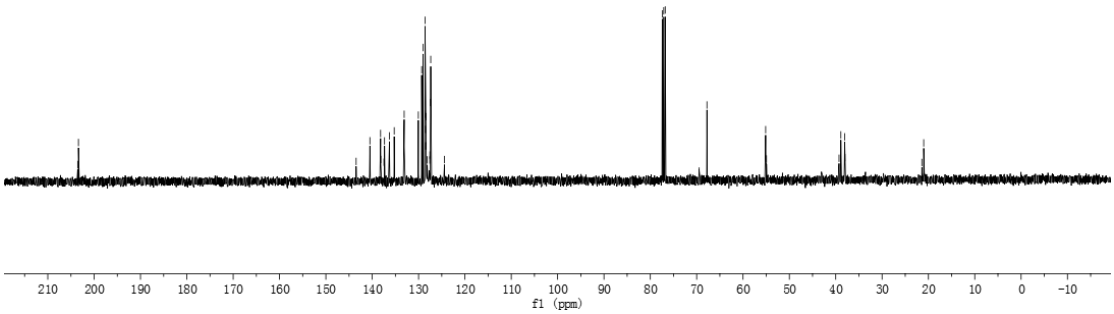
3b

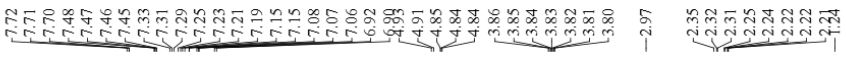

2.10
2.08
2.06
1.15
1.08
3.19
2.13
1.00
1.01
1.00
1.06
1.06
3.28
1.16
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


203.55
203.39
143.47
140.50
138.20
138.15
137.48
137.35
136.29
135.26
133.11
130.05
129.34
129.05
129.00
128.60
128.57
128.53
128.46
128.44
128.41
128.13
127.59
127.56
127.44
127.38
124.41
77.42
77.11
76.79
69.46
67.78
55.12
54.94
39.29
38.89
38.07
38.01
21.41
21.02


OH
and
OH
O
Ph
O
Ph

3b


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.72
7.71
7.70
7.48
7.47
7.46
7.45
7.33
7.31
7.29
7.25
7.23
7.21
7.19
7.15
7.15
7.08
7.07
7.06
6.92
6.90
4.93
4.91
4.85
4.84
4.84
3.86
3.85
3.84
3.83
3.82
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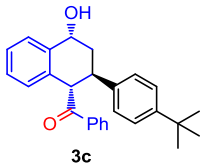
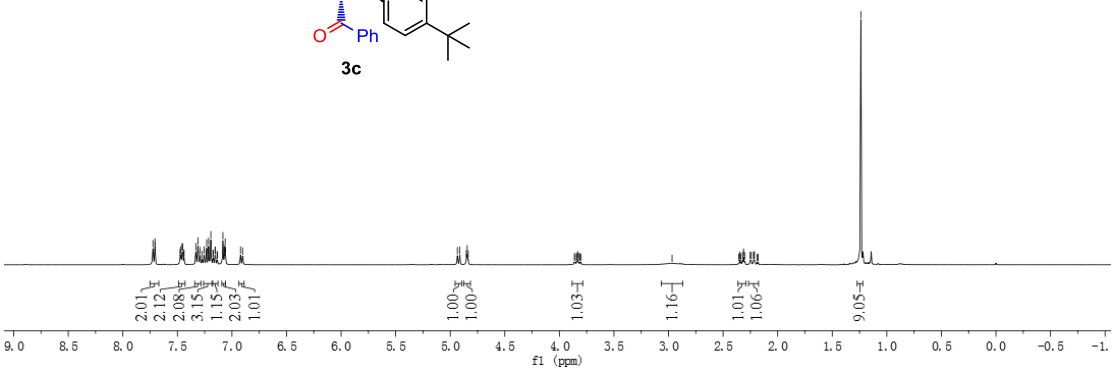
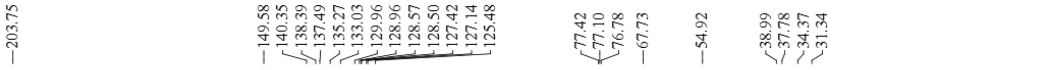
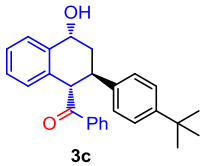
2.25
2.24
2.22
2.22
2.21
1.24


OH
O
Ph

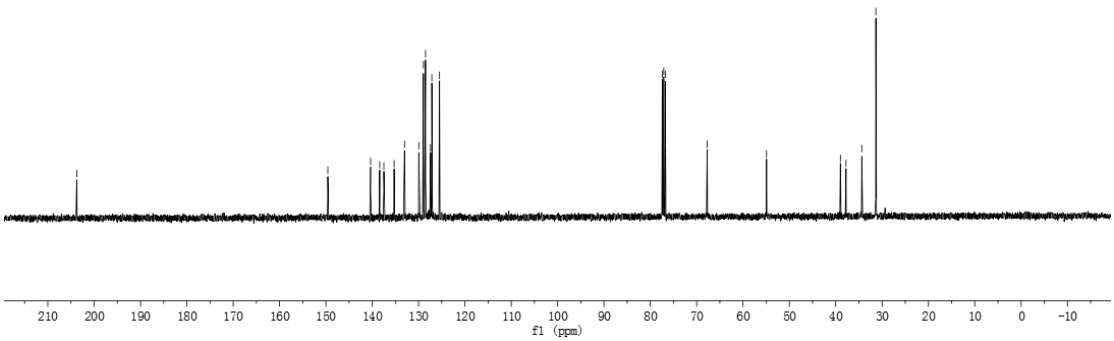
3c


2.01
2.12
2.08
3.15
1.15
2.03
1.01
1.00
1.00
1.03
1.16
1.01
1.06
9.05
f1 (ppm)


203.75
149.58
140.35
138.39
137.49
135.27
133.03
129.96
128.96
128.57
128.50
127.42
127.14
125.48
77.42
77.10
76.78
67.73
54.92
38.99
37.78
34.37
31.34


OH
O
Ph

3c


f1 (ppm)


7.74
7.72
7.72
7.50
7.48
7.46
7.45
7.37
7.35
7.33
7.27
7.25
7.17
7.16
7.13
7.12
7.11
7.10
6.92
6.90
6.88
4.89
4.86
3.92
3.91
3.90
3.89
3.88
3.87
3.86
3.03
2.36
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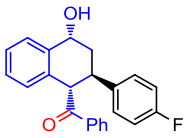
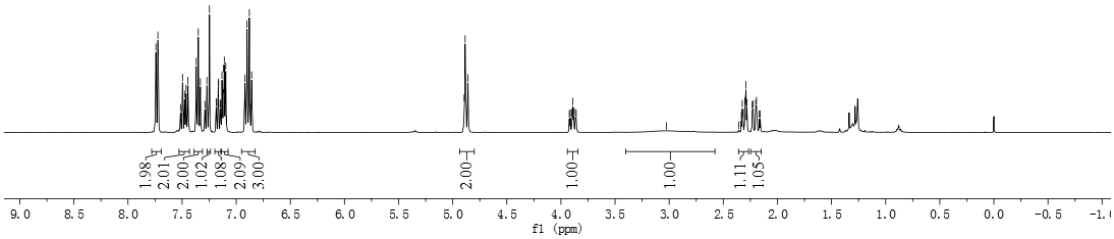
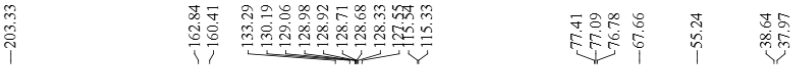
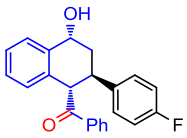
2.23
2.22
2.20
2.19
2.17
2.16


OH
O
Ph
F

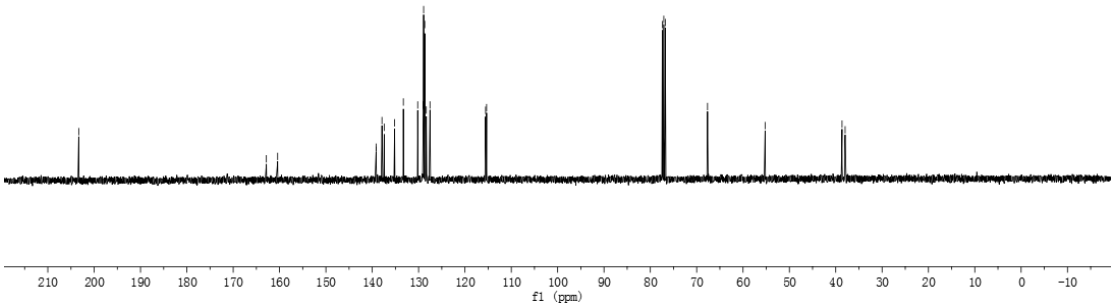
3d

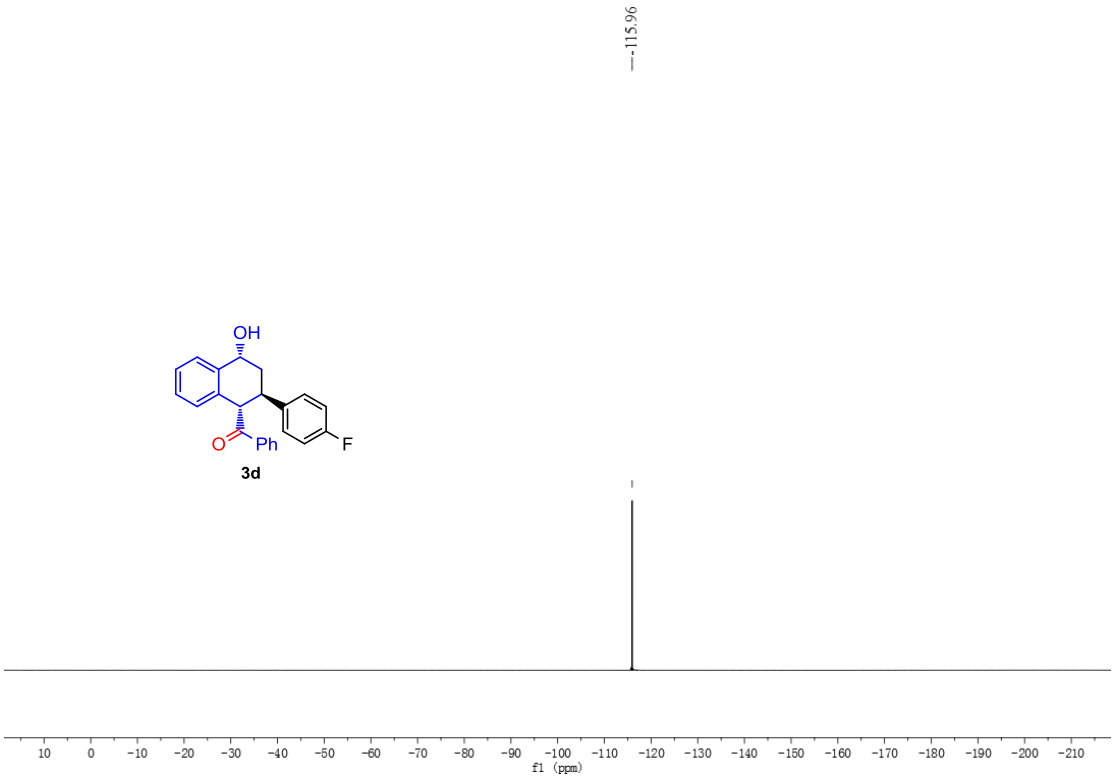

1.98
2.01
2.00
1.02
1.08
2.09
3.00
2.00
1.00
1.00
1.11
1.05
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

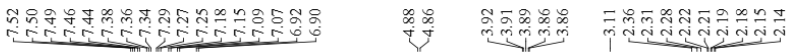

203.33
162.84
160.41
133.29
130.19
129.06
128.98
128.92
128.71
128.68
128.33
115.33
77.41
77.09
76.78
67.66
55.24
38.64
37.97


OH
O
Ph
F

3d


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-115.96
OH
O
Ph
F
3d
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


7.52
7.50
7.49
7.46
7.44
7.38
7.36
7.34
7.29
7.27
7.25
7.18
7.15
7.09
7.07
6.92
6.90
4.88
4.86
3.92
3.91
3.89
3.86
3.86
3.11
2.36
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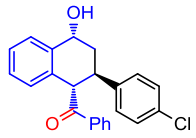
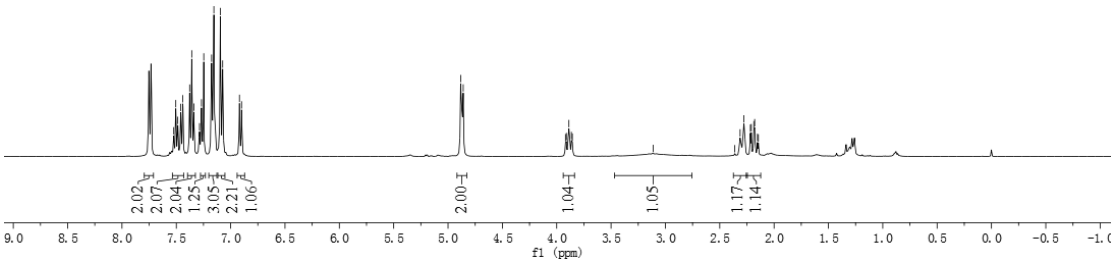
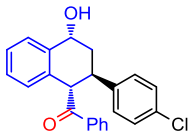
2.28
2.22
2.21
2.19
2.18
2.15
2.14


OH
O
Ph
Cl

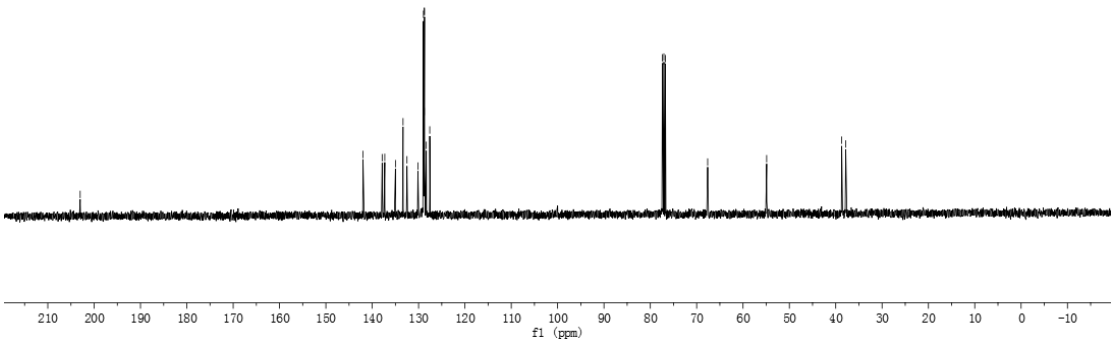
3e


2.02
2.07
2.04
1.25
3.05
2.21
1.06
2.00
1.04
1.05
1.17
1.14
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

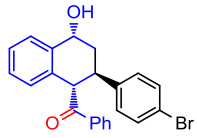

203.01
141.99
137.86
137.29
134.99
133.35
132.50
130.14
128.95
128.92
128.79
128.76
128.72
128.34
127.59
77.39
77.07
76.75
67.63
54.90
38.71
37.84


OH
O
Ph
Cl

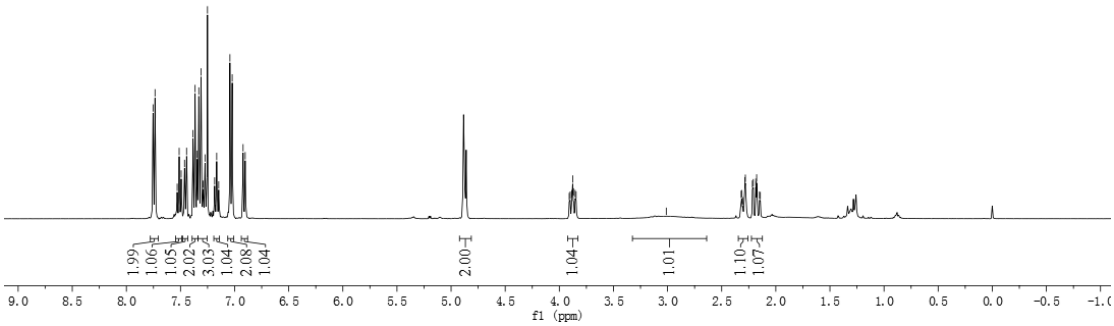
3e

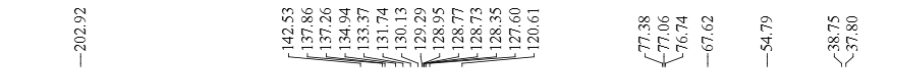

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.75
7.74
7.73
7.53
7.51
7.49
7.46
7.44
7.38
7.37
7.35
7.33
7.31
7.29
7.27
7.25
7.18
7.17
7.15
7.04
7.02
6.92
6.90
3.91
3.90
3.88
3.88
3.87
3.85
3.84
3.01
2.32
2.32
2.31
2.29
2.28
2.22
2.21
2.19
2.18
2.18
2.15
2.14


OH
O
Ph
Br

3f


1.99
1.06
1.05
2.02
3.03
1.04
2.08
1.04
2.00
1.04
1.01
1.10
1.07
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


202.92
142.53
137.86
137.26
134.94
133.37
131.74
130.13
129.29
128.95
128.77
128.73
128.35
127.60
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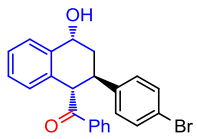
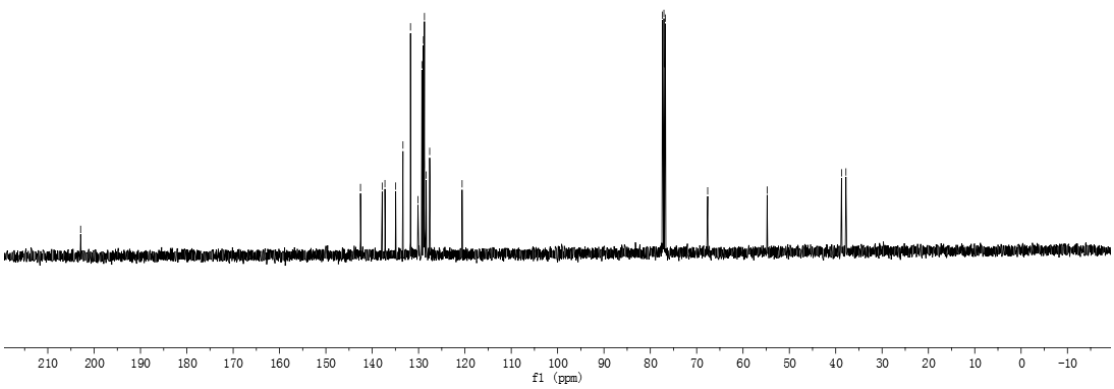
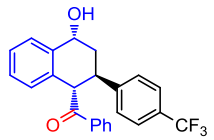
77.06
76.74
67.62
54.79
38.75
37.80

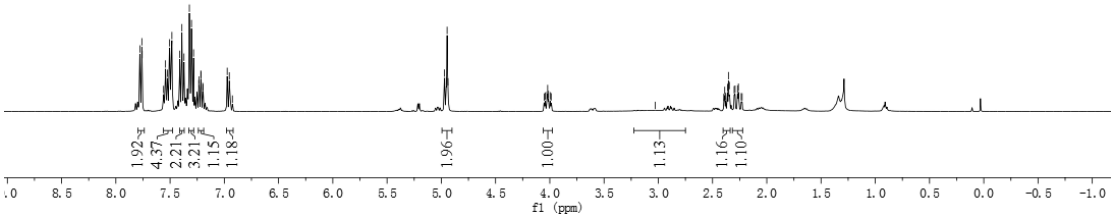

OH
O
Ph
Br

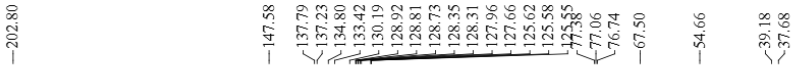
3f

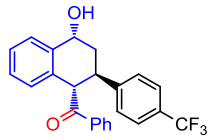

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


OH
O
Ph
CF3

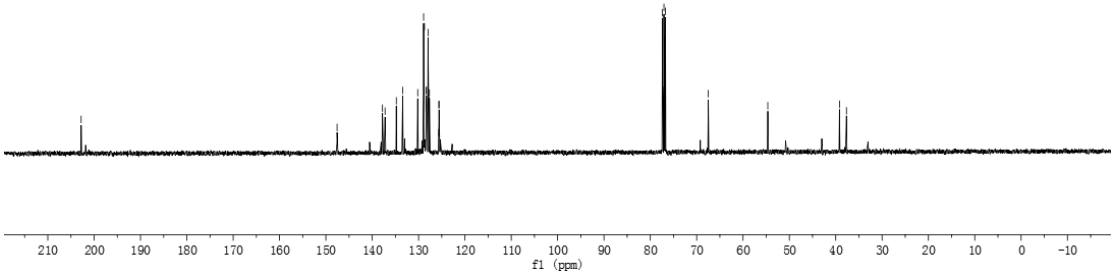
3g

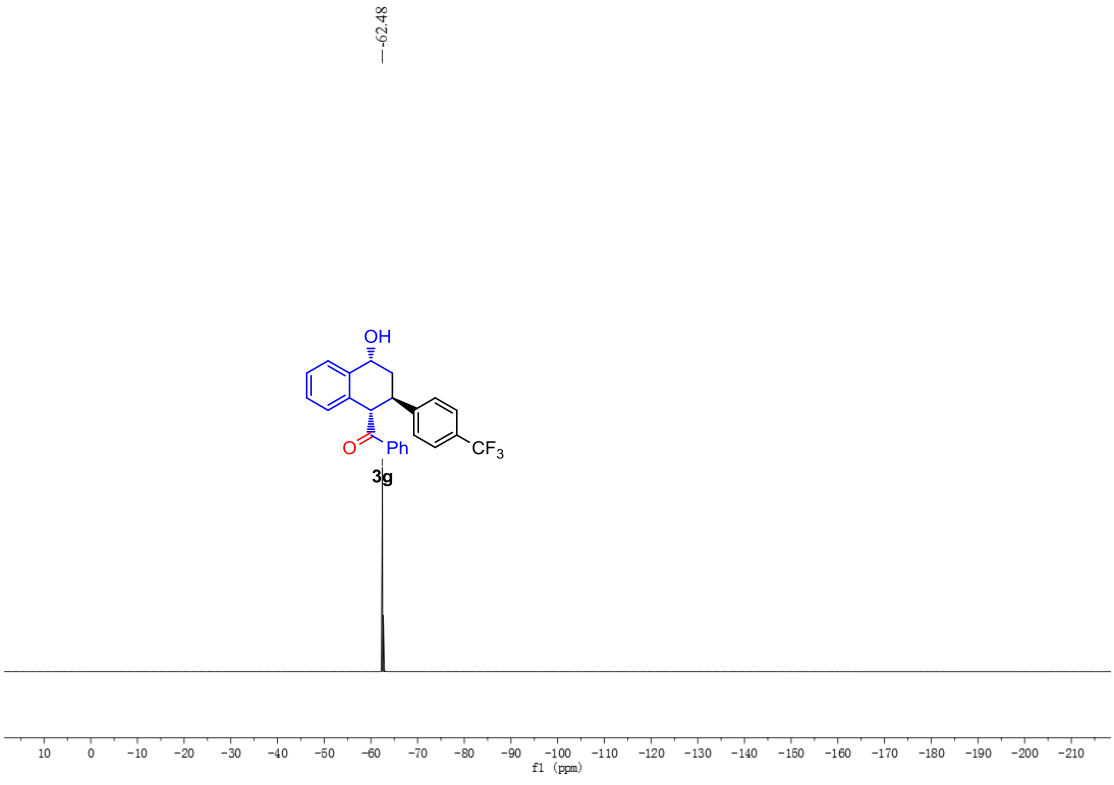

1.92
4.37
2.21
3.21
1.15
1.18
1.96
1.00
1.13
1.16
1.10
f1 (ppm)

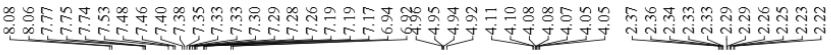


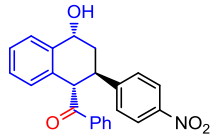

OH
O
Ph
CF3

3g

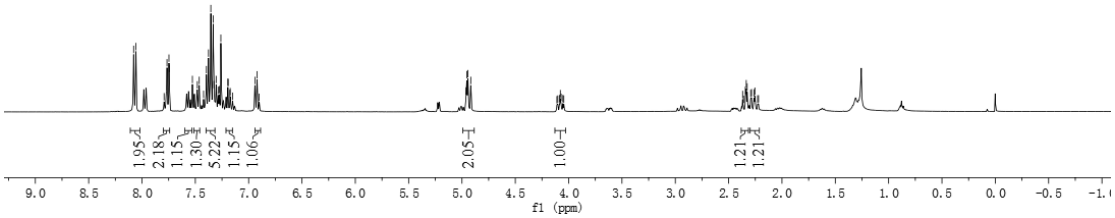

f1 (ppm)

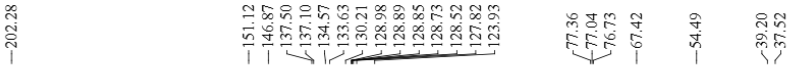

-62.48
OH
O
Ph
CF3
3g
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


8.08
8.06
7.77
7.75
7.74
7.53
7.48
7.46
7.40
7.38
7.35
7.33
7.33
7.30
7.29
7.28
7.26
7.19
7.19
7.17
6.94
4.96
4.95
4.94
4.92
4.11
4.10
4.08
4.08
4.07
4.05
4.05
2.37
2.36
2.34
2.33
2.33
2.29
2.29
2.26
2.25
2.23
2.22


OH
O
Ph
NO2

3h


1.95
2.18
1.15
1.30
5.22
1.15
1.06
2.05
1.00
1.21
1.21
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


202.28
151.12
146.87
137.50
137.10
134.57
133.63
130.21
128.98
128.89
128.85
128.73
128.52
127.82
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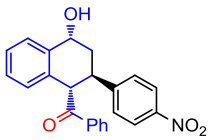
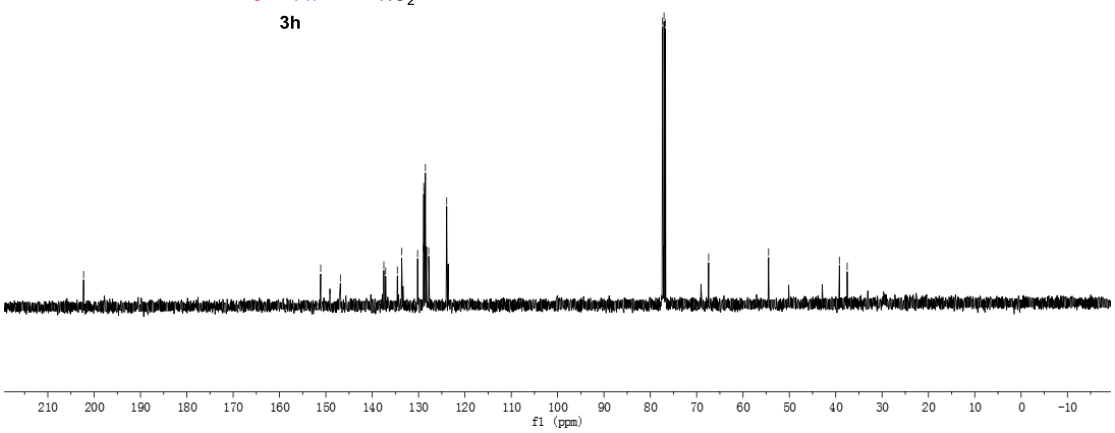
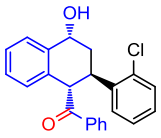
77.04
76.73
67.42
54.49
39.20
37.52


OH
O
Ph
NO2

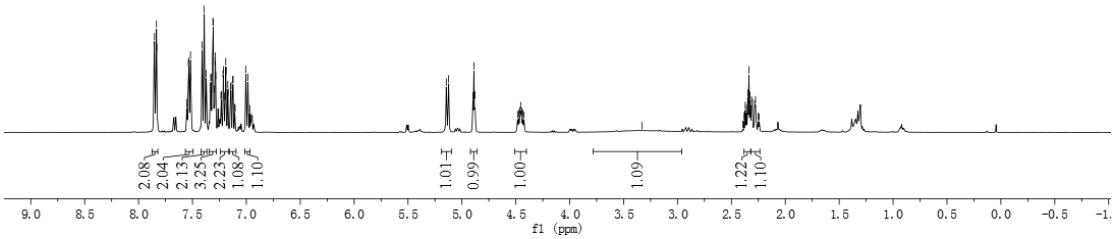
3h

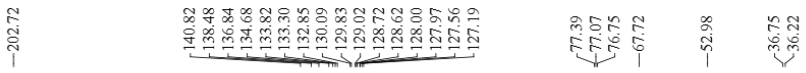

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

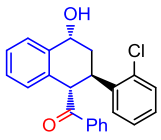

7.85 7.83 7.83 7.55 7.55 7.54 7.53 7.52 7.51 7.41 7.39 7.37 7.33 7.33 7.31 7.31 7.30 7.29 7.29 7.28 7.24 7.23 7.22 7.21 7.21 7.20 7.19 7.19 7.17 7.17 7.15 7.14 7.13 7.12 7.11 7.10 7.00 6.99 6.97 5.15 5.12 4.90 4.89 4.88 4.47 4.46 4.45 4.45 4.43 2.37 2.36 2.35 2.34 2.33 2.31 2.30 2.29 2.28


OH
Cl
O
Ph

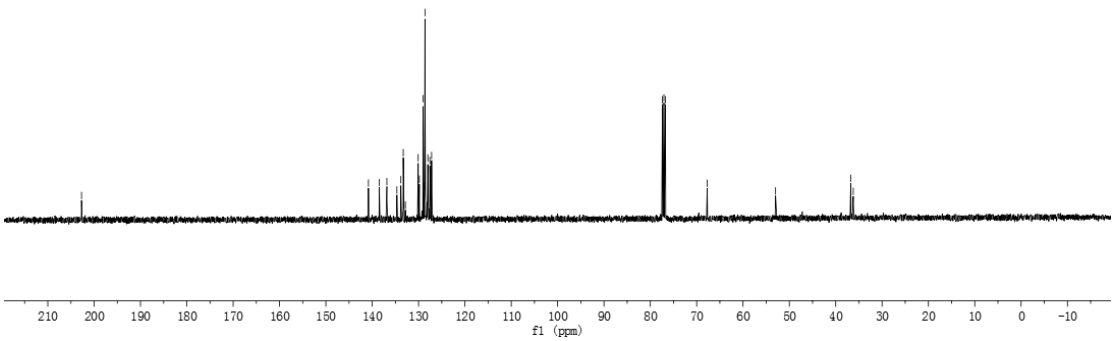
3i

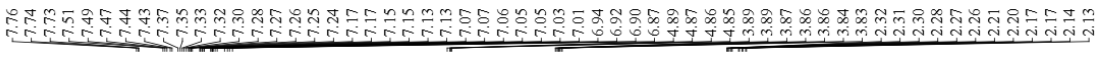

2.08 2.04 2.13 3.25 2.23 1.08 1.10 1.01 0.99 1.00 1.09 1.22 1.10
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


202.72
140.82 138.48 136.84 134.68 133.82 133.30 132.85 130.09 129.83 129.02 128.72 128.62 128.00 127.97 127.56 127.19
77.39 77.07 76.75
67.72
52.98
36.75 36.22


OH
Cl
O
Ph

3i


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.76
7.74
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7.47
7.44
7.43
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7.35
7.33
7.32
7.30
7.28
7.27
7.26
7.25
7.24
7.17
7.17
7.15
7.15
7.13
7.13
7.07
7.07
7.06
7.05
7.05
7.03
7.01
6.94
6.92
6.90
6.87
4.89
4.87
4.86
4.85
3.89
3.89
3.87
3.86
3.86
3.84
3.83
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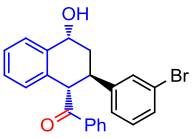
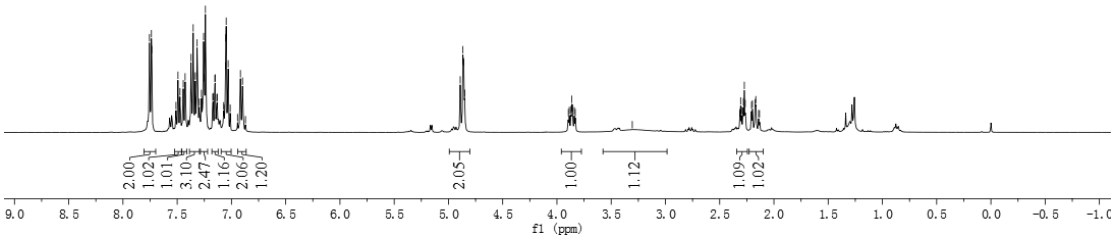
2.20
2.17
2.17
2.14
2.13


OH
Br
O
Ph

3j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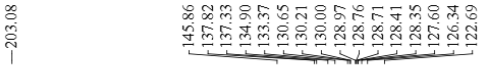
1.02
1.01
3.10
2.47
1.16
2.06
1.20
2.05
1.00
1.12
1.09
1.02
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)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145.86
137.82
137.33
134.90
133.37
130.65
130.21
130.00
128.97
128.76
128.71
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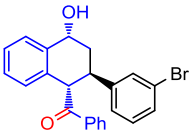
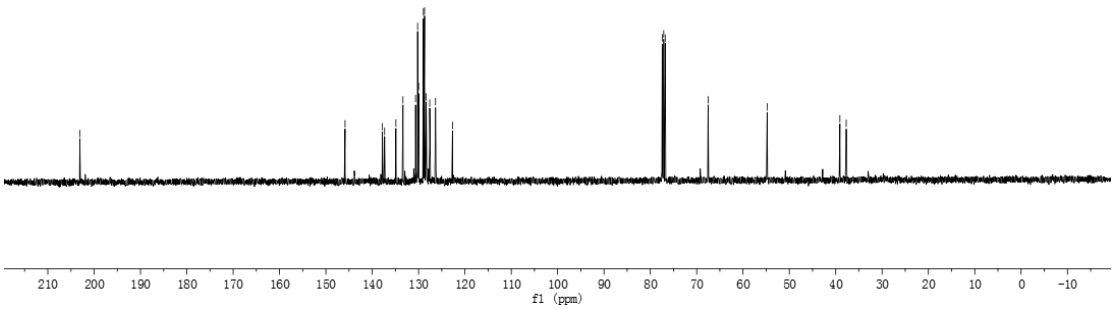
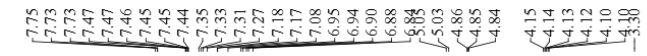
77.11
76.79
67.53
54.79
39.10
37.74


OH
Br
O
Ph

3j


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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7.73
7.73
7.47
7.47
7.46
7.45
7.45
7.44
7.35
7.33
7.31
7.27
7.18
7.17
7.08
6.95
6.94
6.90
6.88
5.05
5.03
4.86
4.85
4.84
4.15
4.14
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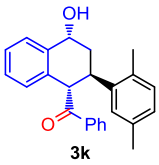
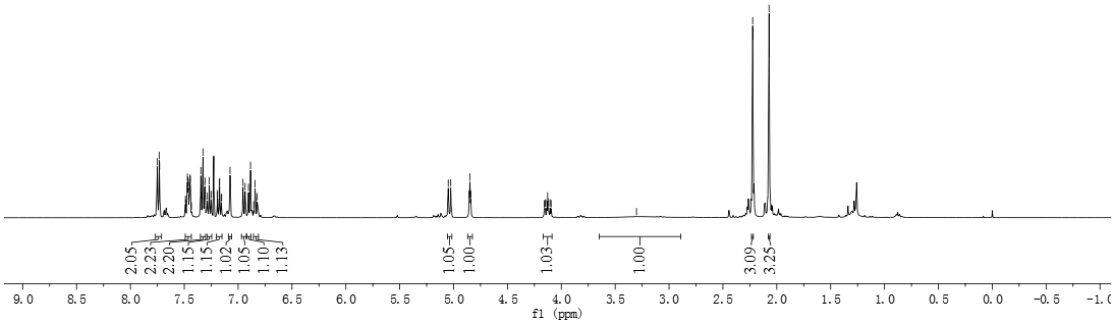
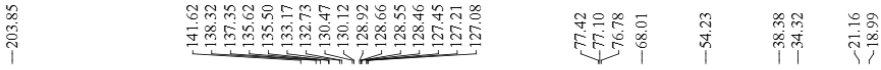
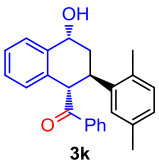
4.12
4.10
4.10
3.30
2.22
2.07


OH
O
Ph

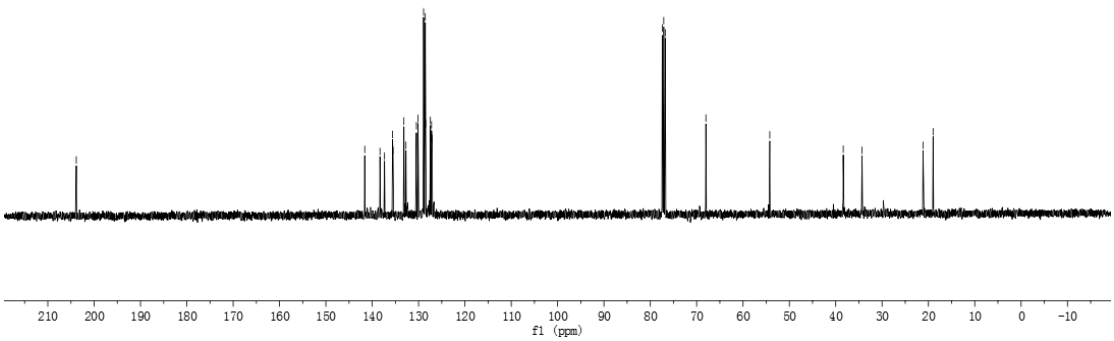
3k

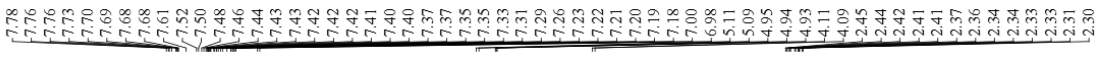

2.05
2.23
2.20
1.15
1.15
1.02
1.05
1.10
1.13
1.05
1.00
1.03
1.00
3.09
3.25
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

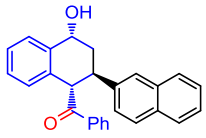

203.85
141.62
138.32
137.35
135.62
135.50
133.17
132.73
130.47
130.12
128.92
128.66
128.55
128.46
127.45
127.21
127.08
77.42
77.10
76.78
68.01
54.23
38.38
34.32
21.16
18.99


OH
O
Ph

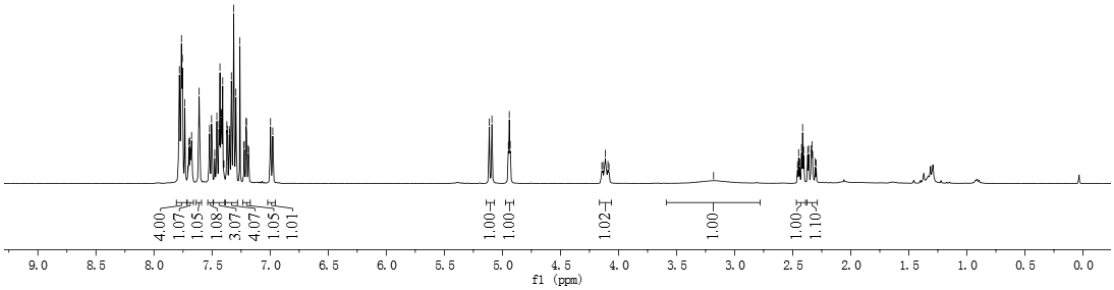
3k

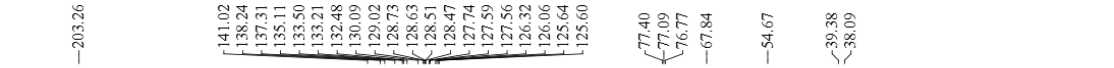

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.78
7.76
7.76
7.73
7.70
7.69
7.68
7.68
7.61
7.52
7.50
7.48
7.46
7.44
7.43
7.43
7.42
7.42
7.42
7.41
7.40
7.40
7.37
7.37
7.35
7.35
7.33
7.31
7.29
7.26
7.23
7.22
7.21
7.20
7.19
7.18
7.00
6.98
5.11
5.09
4.95
4.94
4.93
4.11
4.09
2.45
2.44
2.42
2.41
2.41
2.37
2.36
2.34
2.34
2.33
2.33
2.31
2.30


OH
O
Ph

3l


4.00
1.07
1.05
1.08
3.07
4.07
1.05
1.01
1.00
1.00
1.02
1.00
1.00
1.10
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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141.02
138.24
137.31
135.11
133.50
133.21
132.48
130.09
129.02
128.73
128.63
128.51
128.47
127.74
127.59
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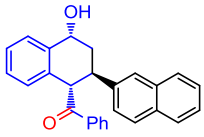
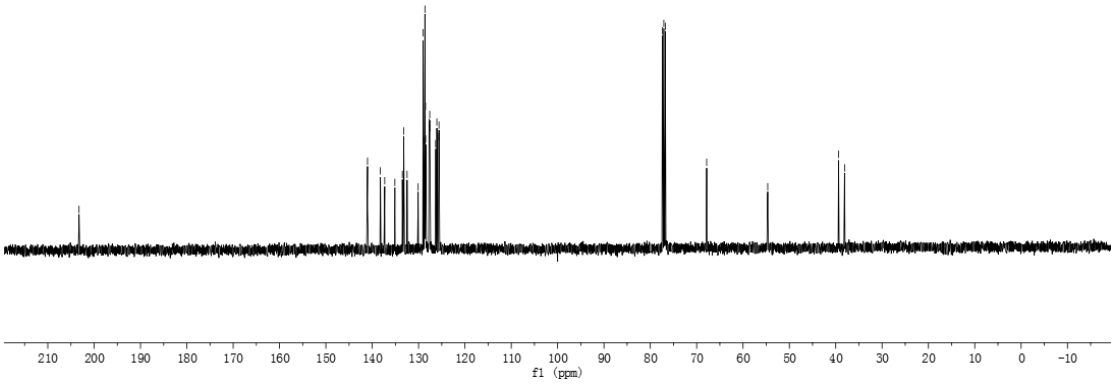
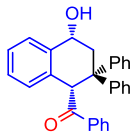
77.09
76.77
67.84
54.67
39.38
38.09


OH
O
Ph

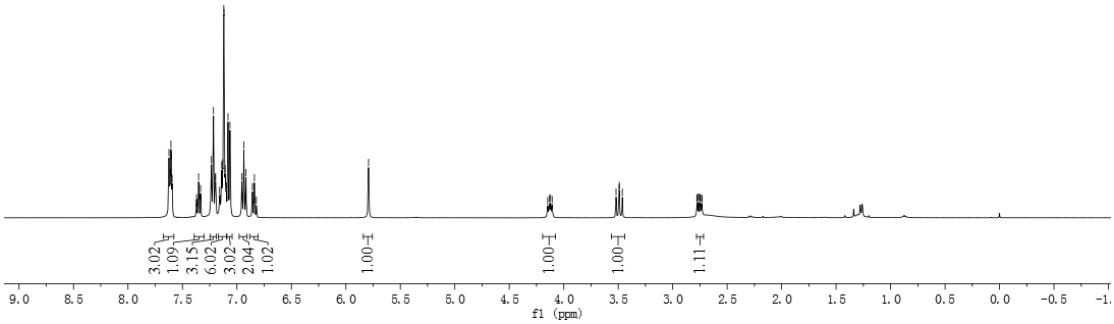
3l


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

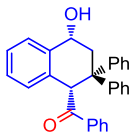

7.62
7.61
7.61
7.61
7.60
7.23
7.21
7.20
7.14
7.13
7.13
7.12
7.12
7.11
7.08
7.06
6.94
6.92
5.79
4.15
4.13
4.12
4.11
3.52
3.49
3.49
2.78
2.78
2.76
2.76
2.75
2.75
2.73
2.73


OH
Ph
Ph
O
Ph

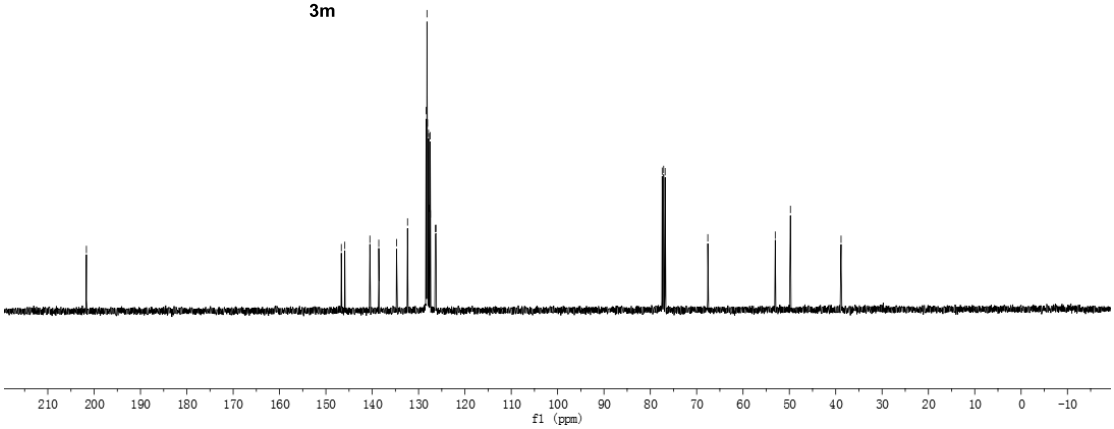
3m

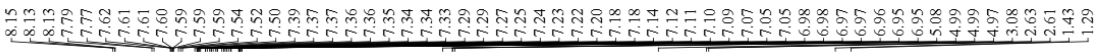

3.02
1.09
3.15
6.02
3.02
2.04
1.02
1.00
1.00
1.00
1.11
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

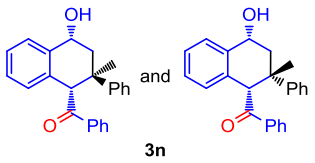

201.67
146.67
145.92
140.51
138.59
134.76
132.38
128.38
128.19
128.07
127.85
127.79
127.75
127.49
127.44
126.40
126.24
77.44
77.12
76.80
67.59
53.05
49.77
38.85


OH
Ph
Ph
O
Ph

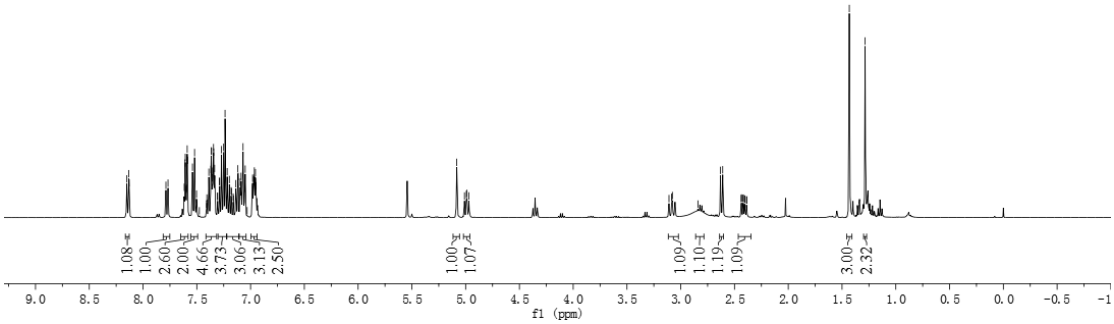
3m

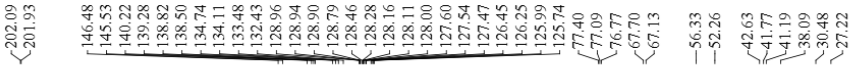

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

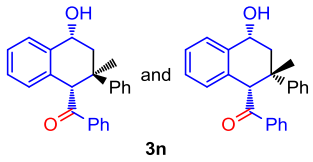




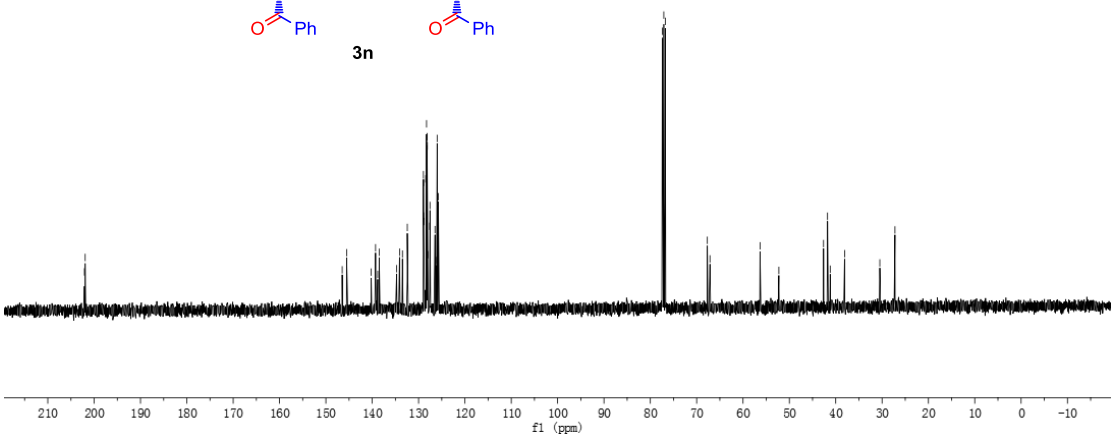
3n

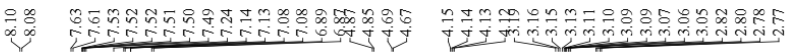






3n




8.10
8.08
7.63
7.61
7.53
7.52
7.52
7.51
7.50
7.49
7.24
7.14
7.13
7.08
7.08
6.89
6.87
4.85
4.69
4.67
4.15
4.14
4.13
4.12
3.16
3.15
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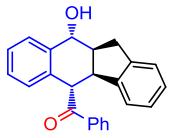
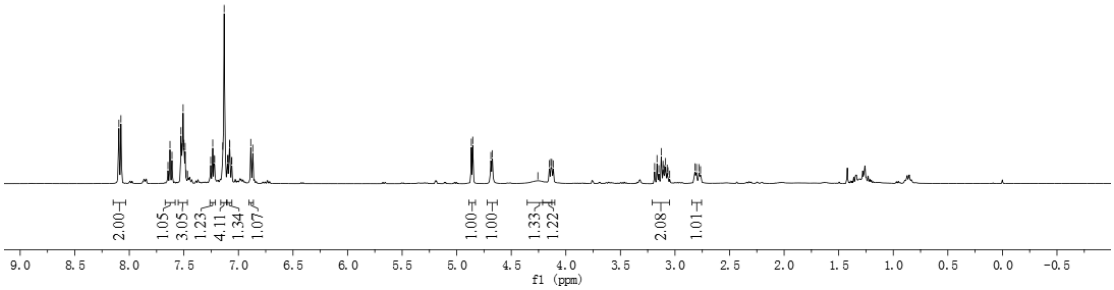
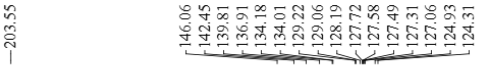
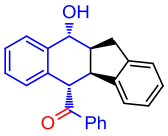
3.06
3.05
2.82
2.80
2.78
2.77


OH
O
Ph

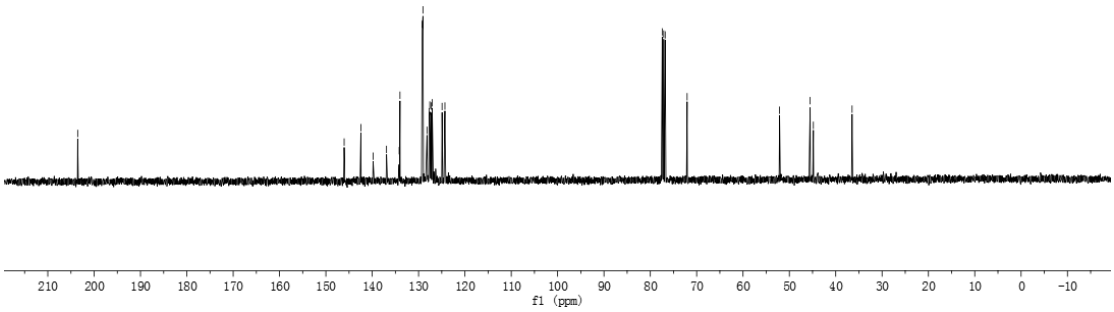
3o

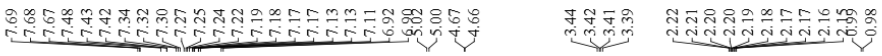

2.00
1.05
3.05
1.23
4.11
1.34
1.07
1.00
1.00
1.33
1.22
2.08
1.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

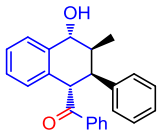

203.55
146.06
142.45
139.81
136.91
134.18
134.01
129.22
129.06
128.19
127.72
127.58
127.49
127.31
127.06
124.93
124.31
77.43
77.11
76.79
72.06
52.11
45.52
44.82
36.47


OH
O
Ph

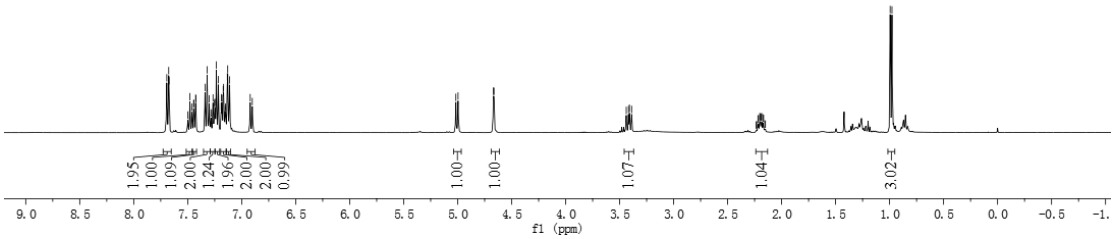
3o

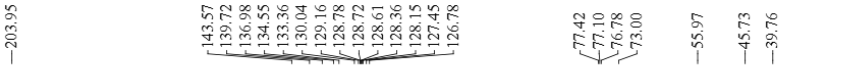

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

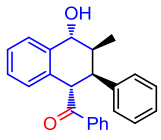

7.69
7.68
7.67
7.48
7.43
7.42
7.34
7.32
7.30
7.27
7.25
7.24
7.22
7.19
7.18
7.17
7.17
7.13
7.13
7.11
6.92
5.02
5.00
4.67
4.66
3.44
3.42
3.41
3.39
2.22
2.21
2.20
2.20
2.19
2.18
2.17
2.17
2.16
2.15
0.99
0.98


OH
O
Ph

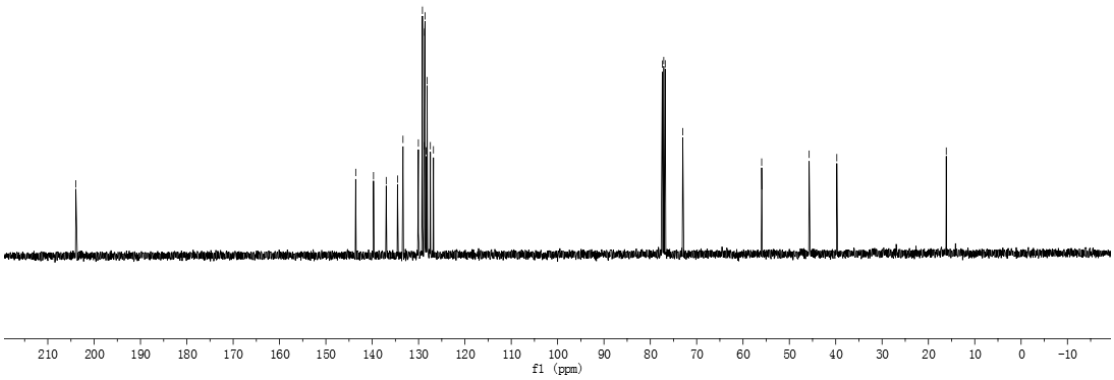
3p


1.95
1.00
1.09
2.00
1.24
1.96
2.00
2.00
0.99
1.00
1.00
1.07
1.04
3.02
f1 (ppm)

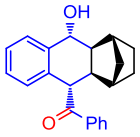

203.95
143.57
139.72
136.98
134.55
133.36
130.04
129.16
128.78
128.72
128.61
128.36
128.15
127.45
126.78
77.42
77.10
76.78
73.00
55.97
45.73
39.76
16.15


OH
O
Ph

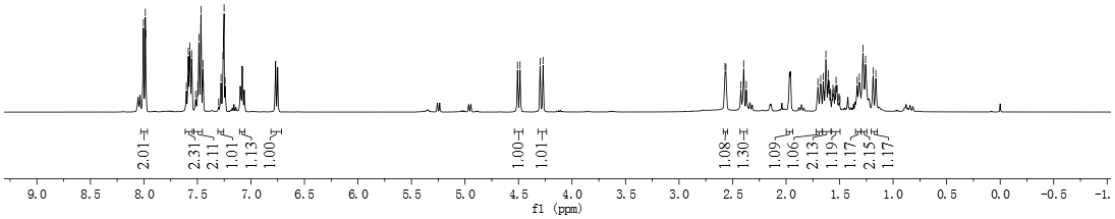
3p


f1 (ppm)

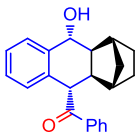

8.00
7.99
7.98
7.60
7.59
7.58
7.57
7.57
7.55
7.52
7.50
7.49
7.47
7.45
7.30
7.28
7.26
7.25
7.24
4.51
4.49
4.30
4.27
2.57
2.56
2.42
2.40
2.37
1.70
1.68
1.65
1.63
1.61
1.60
1.60
1.56
1.54
1.53
1.52
1.34
1.32
1.28
1.26
1.19


OH
O
Ph

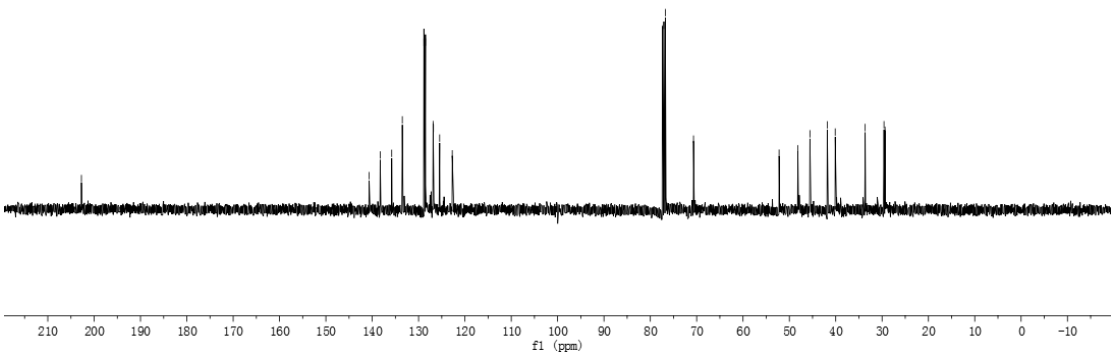
3q


2.01
2.31
2.11
1.01
1.13
1.00
1.00
1.01
1.08
1.30
1.09
1.06
2.13
1.19
1.17
2.15
1.17
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


202.75
140.67
138.28
135.80
133.51
128.86
128.52
126.86
126.80
125.45
122.73
77.39
77.08
76.76
70.68
52.21
48.17
45.57
41.82
40.11
33.65
29.58
29.36


OH
O
Ph

3q


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.75
7.73
7.52
7.50
7.48
7.37
7.35
7.34
7.25
7.23
7.21
7.19
7.18
7.16
7.15
7.14
6.89
6.88
4.93
4.91
4.80
3.85
3.84
3.82
3.81
3.80
3.79
3.05
2.36
2.35
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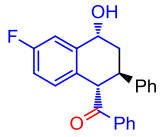
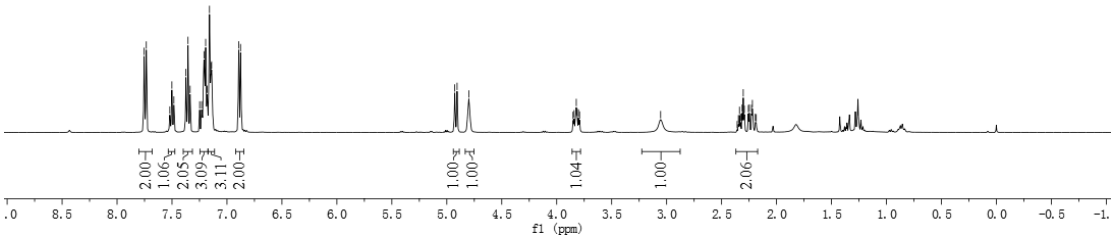
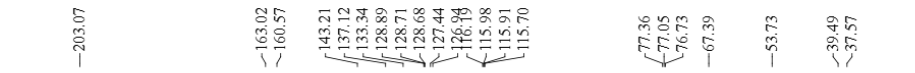
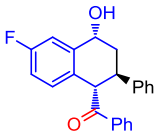
2.26
2.25
2.23
2.22
2.19
2.18


OH
F
Ph
O
Ph

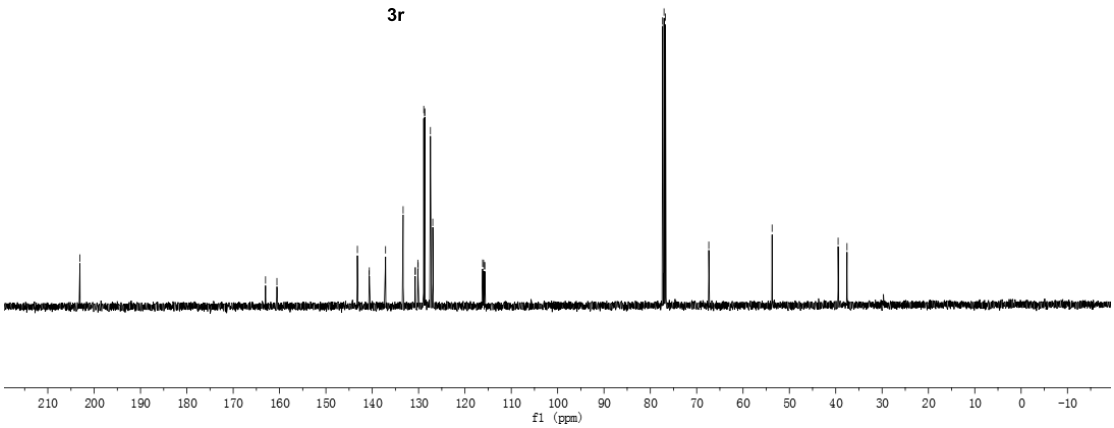
3r

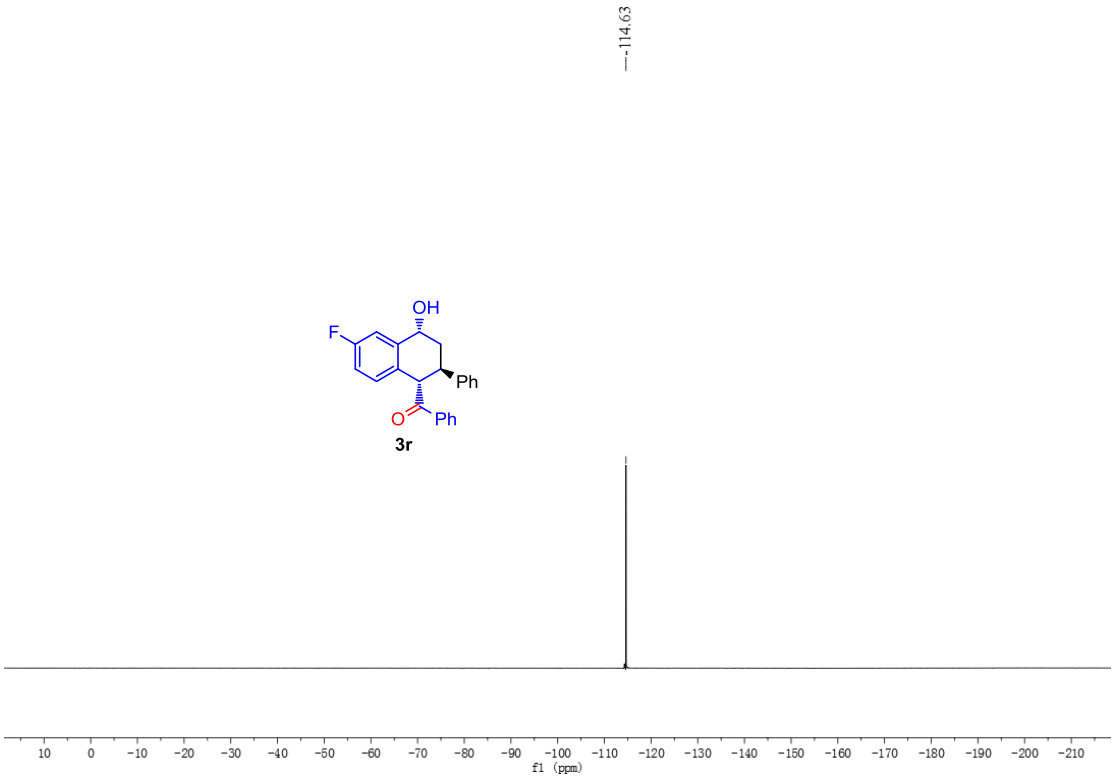

2.00
1.06
2.05
3.09
3.11
2.00
1.00
1.00
1.04
1.00
2.06
f1 (ppm)


203.07
163.02
160.57
143.21
137.12
133.34
128.89
128.71
128.68
127.44
126.94
116.19
115.98
115.91
115.70
77.36
77.05
76.73
67.39
53.73
39.49
37.57

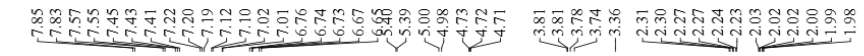

OH
F
Ph
O
Ph

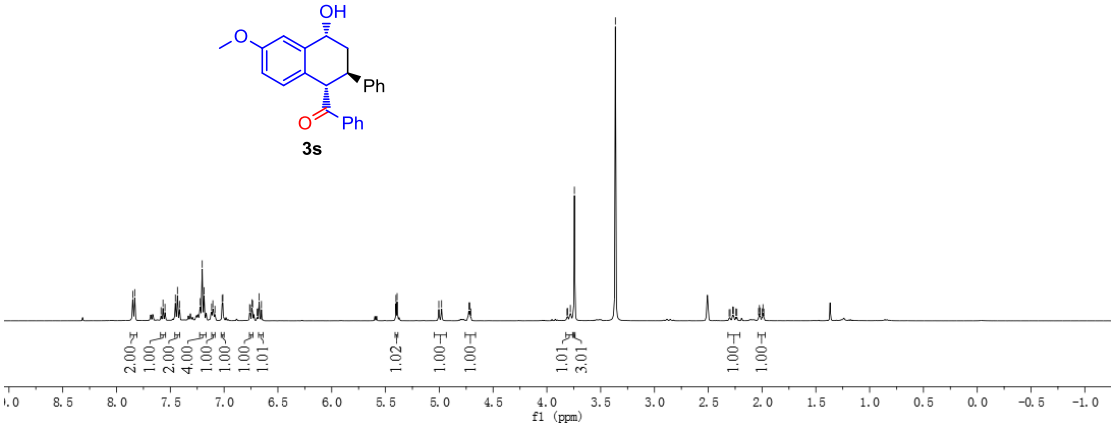
3r

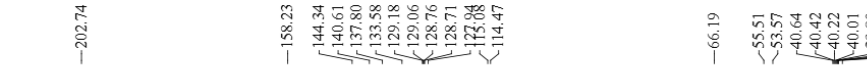

f1 (ppm)

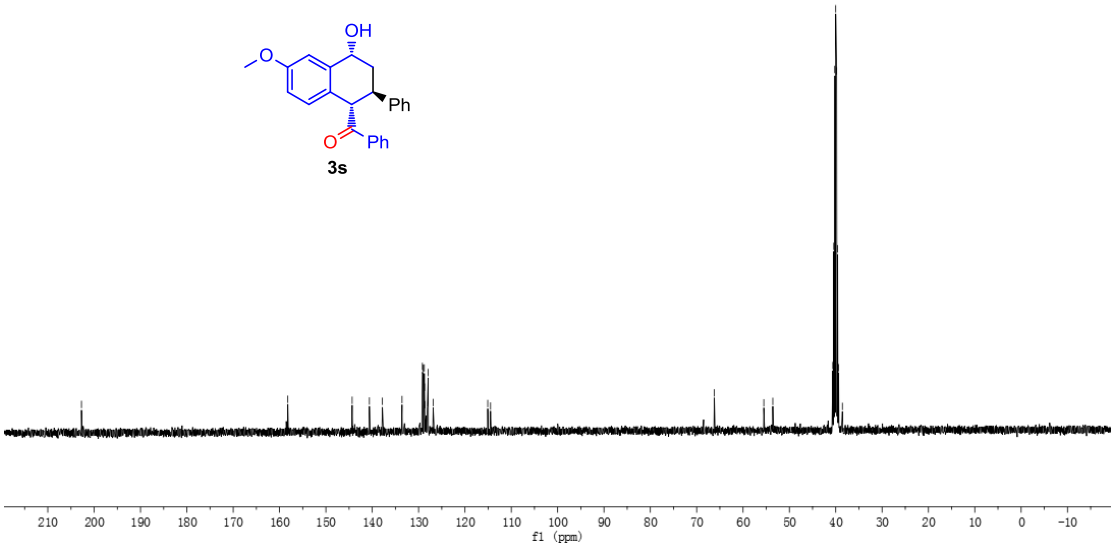

-114.63
OH
F
Ph
O
Ph
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

3r


7.85
7.83
7.57
7.55
7.45
7.43
7.41
7.22
7.20
7.19
7.12
7.10
7.02
7.01
6.76
6.74
6.73
6.67
6.65
5.40
5.39
5.00
4.98
4.73
4.72
4.71
3.81
3.81
3.78
3.74
3.36
2.31
2.30
2.27
2.27
2.24
2.23
2.03
2.02
2.02
2.00
1.99
1.98


OH
O
Ph
O
Ph
3s
2.00
1.00
2.00
4.00
1.00
1.00
1.01
1.02
1.00
1.00
1.01
3.01
1.00
1.00
f1 (ppm)


202.74
158.23
144.34
140.61
137.80
133.58
129.18
129.06
128.76
128.71
127.04
115.08
114.47
66.19
55.51
53.57
40.64
40.42
40.22
40.01
39.80
39.59
39.48
39.38
38.57


OH
O
Ph
O
Ph
3s
f1 (ppm)


7.74
7.72
7.49
7.44
7.44
7.36
7.34
7.32
7.20
7.18
7.16
7.14
6.62
6.61
6.60
6.59
4.93
4.90
4.85
3.88
3.87
3.85
3.85
3.83
3.82
3.11
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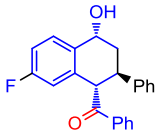
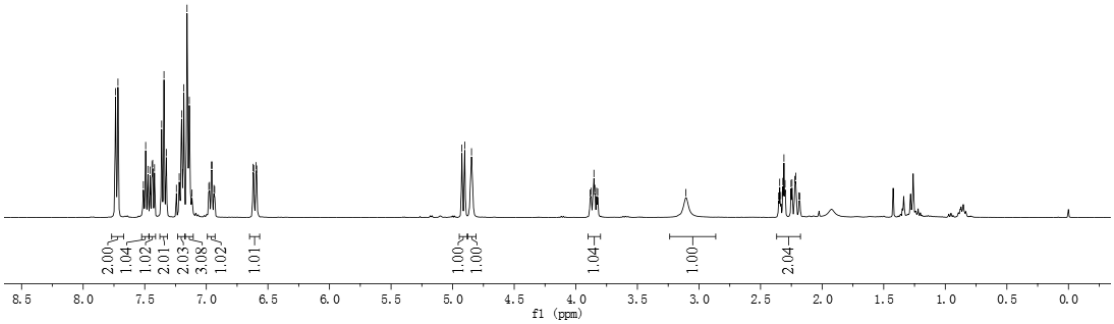
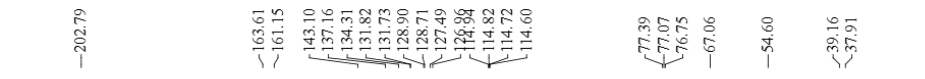
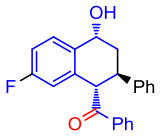
2.25
2.24
2.22
2.21
2.19
2.18


OH
F
Ph
O
Ph

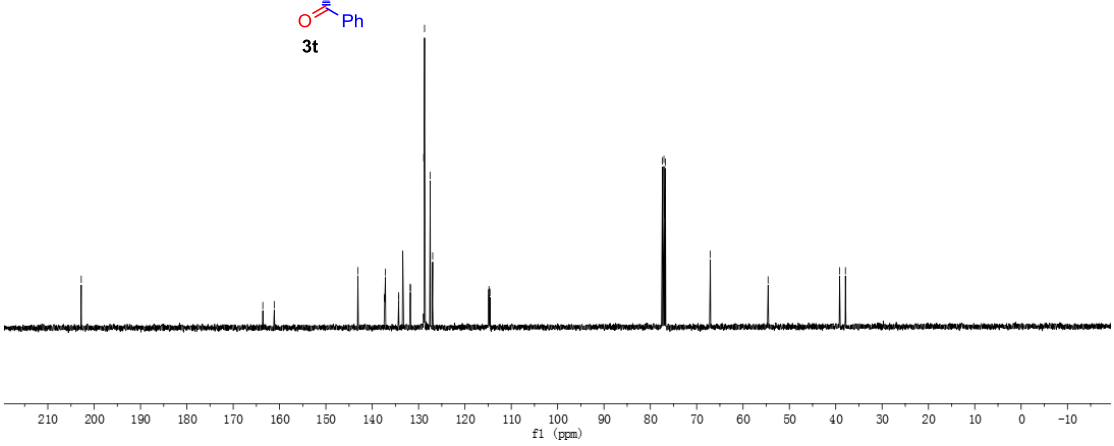
3t

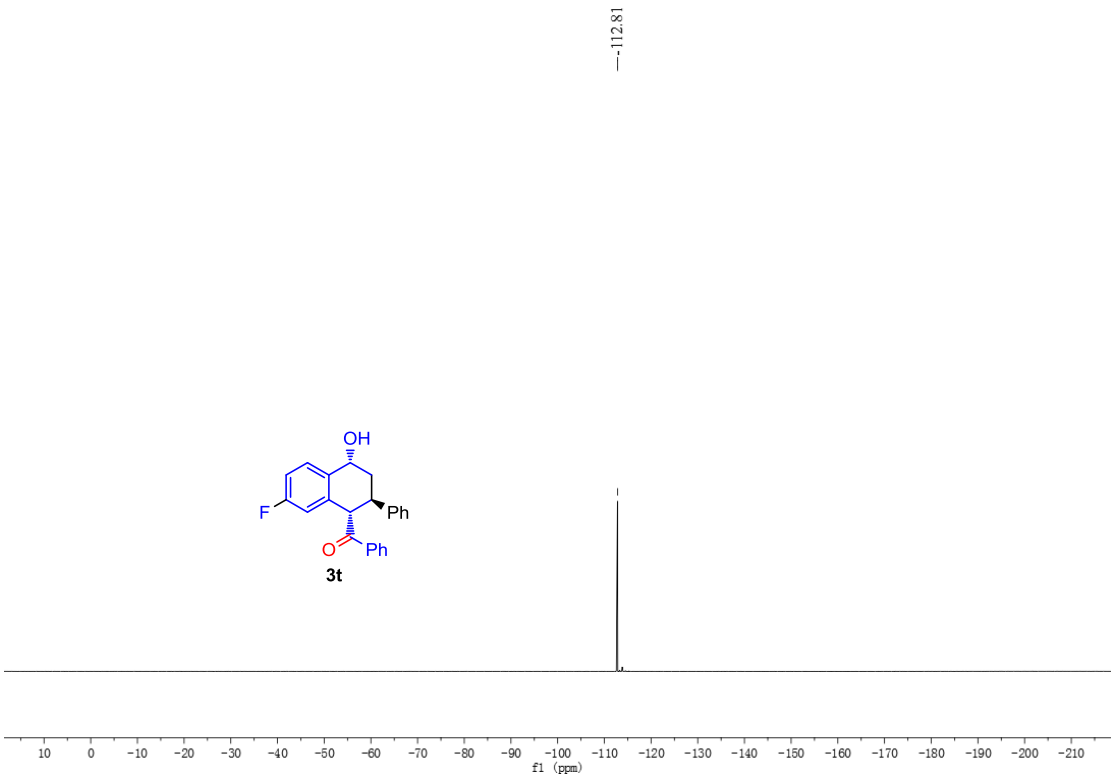

2.00
1.04
1.02
2.01
2.03
3.08
1.02
1.01
1.00
1.00
1.04
1.00
2.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

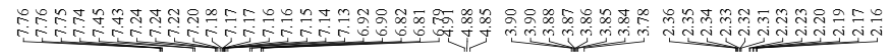

202.79
163.61
161.15
143.10
137.16
134.31
131.82
131.73
128.90
128.71
127.49
126.96
114.94
114.82
114.72
114.60
77.39
77.07
76.75
67.06
54.60
39.16
37.91


OH
F
Ph
O
Ph

3t


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-112.81
OH
F
Ph
O
Ph
3t
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.76
7.76
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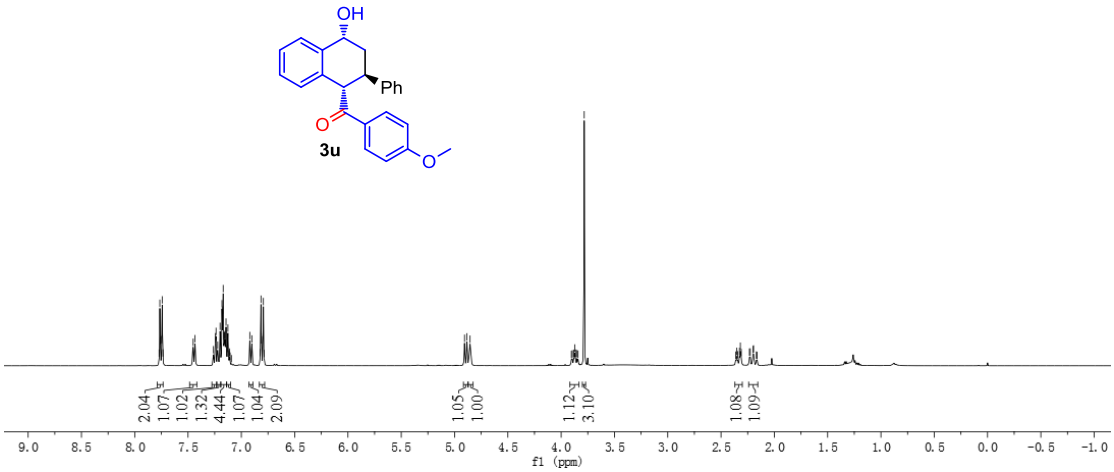
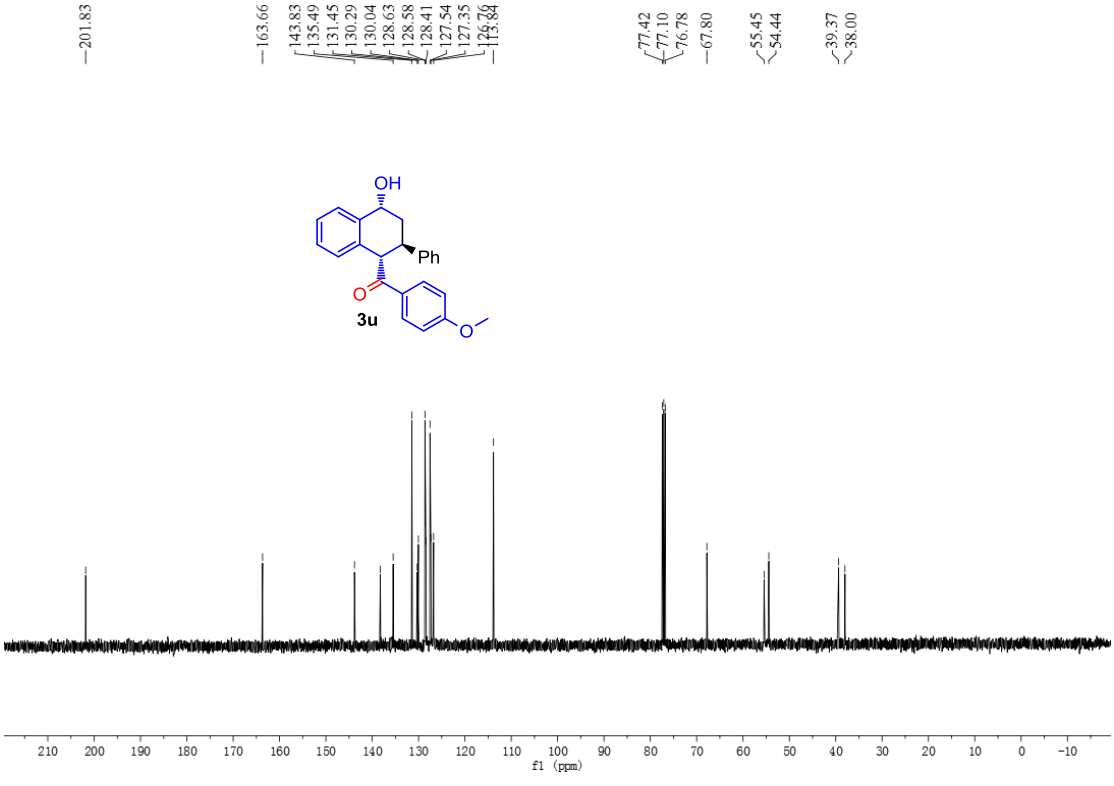
7.74
7.45
7.43
7.24
7.24
7.22
7.20
7.18
7.17
7.17
7.16
7.16
7.15
7.14
7.13
6.92
6.90
6.82
6.81
6.79
4.91
4.88
4.85
3.90
3.90
3.88
3.87
3.86
3.85
3.84
3.78
2.36
2.35
2.34
2.33
2.32
2.31
2.23
2.23
2.20
2.19
2.17
2.16


OH
Ph
O
O
3u
2.04
1.07
1.02
1.32
4.44
1.07
1.04
2.09
1.05
1.00
1.12
3.10
1.08
1.09
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


201.83
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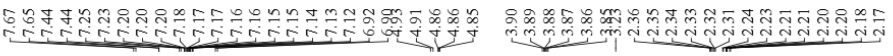
143.83
135.49
131.45
130.29
130.04
128.63
128.58
128.41
127.54
127.35
126.26
113.84
77.42
77.10
76.78
67.80
55.45
54.44
39.37
38.00
OH
Ph
O
O
3u
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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7.44
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7.23
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7.20
7.20
7.18
7.17
7.17
7.16
7.16
7.15
7.15
7.14
7.13
7.12
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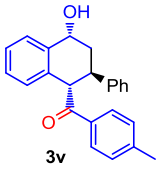
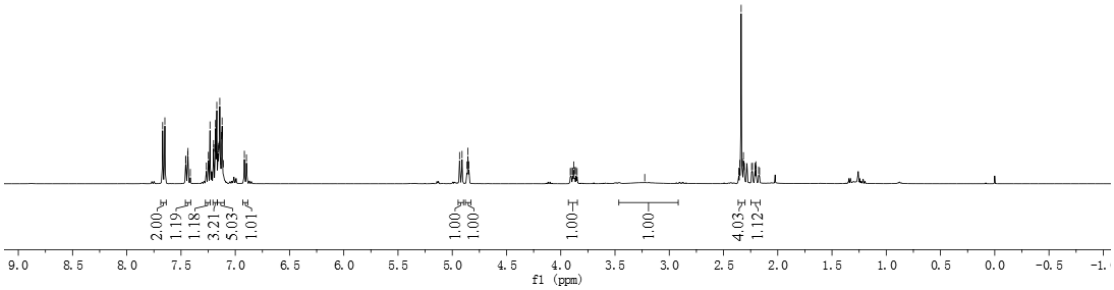
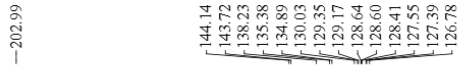
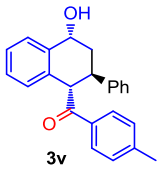
6.89
4.93
4.91
4.86
4.86
4.85
3.90
3.89
3.88
3.87
3.86
2.36
2.35
2.34
2.33
2.32
2.31
2.24
2.23
2.21
2.21
2.20
2.20
2.18
2.17


OH
Ph
O

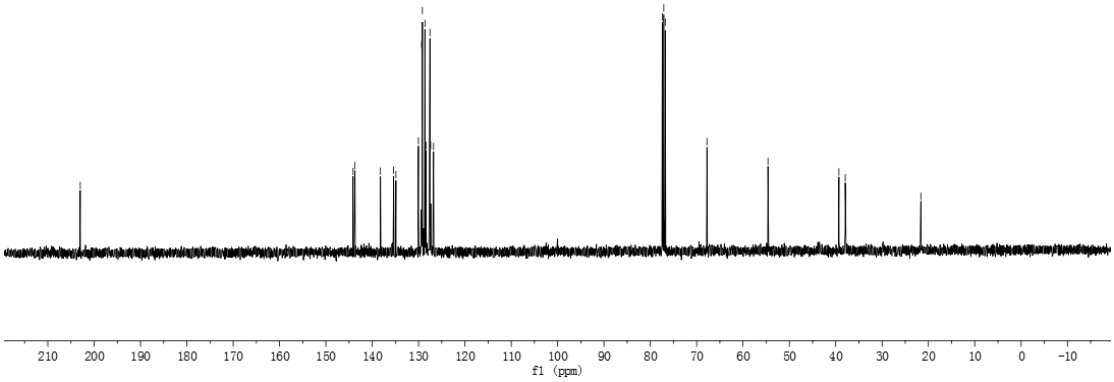
3v


2.00
1.19
1.18
3.21
5.03
1.01
1.00
1.00
1.00
1.00
4.03
1.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

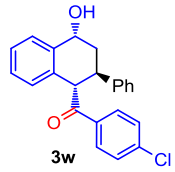

202.99
144.14
143.72
138.23
135.38
134.89
130.03
129.35
129.17
128.64
128.60
128.41
127.55
127.39
126.78
77.42
77.10
76.78
67.78
54.62
39.31
37.94
21.63

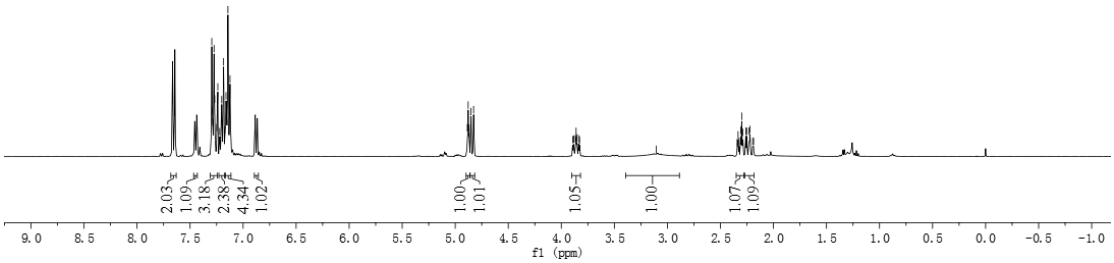

OH
Ph
O

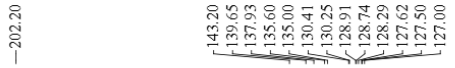
3v


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.30
7.29
7.29
7.27
7.27
7.25
7.24
7.22
7.20
7.18
7.17
7.16
7.16
7.14
7.12
4.89
4.88
4.87
4.85
4.83
3.89
3.88
3.87
3.86
3.85
3.84
3.11
2.34
2.33
2.32
2.31
2.30
2.29
2.26
2.25
2.23
2.22
2.20
2.19


OH
Ph
O
Cl
3w


2.03
1.09
3.18
2.38
4.34
1.02
1.00
1.01
1.05
1.00
1.07
1.09
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


202.20
143.20
139.65
137.93
135.60
135.00
130.41
130.25
128.91
128.74
128.29
127.62
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127.00
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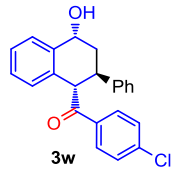
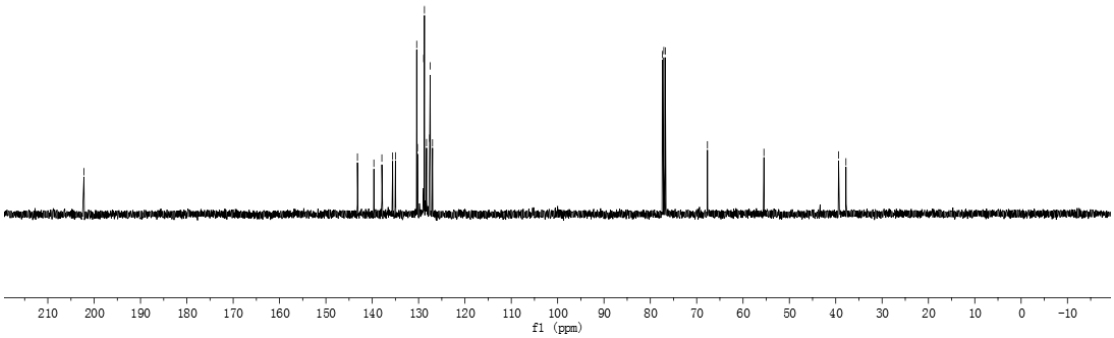
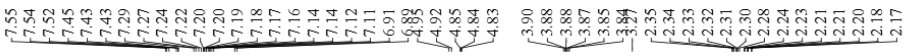
77.10
76.78
67.68
55.49
39.38
37.80


OH
Ph
O
Cl
3w


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.55
7.54
7.52
7.45
7.43
7.43
7.29
7.27
7.24
7.22
7.20
7.20
7.19
7.18
7.17
7.16
7.14
7.14
7.12
7.11
6.91
6.89
4.93
4.92
4.85
4.84
4.83
3.90
3.88
3.88
3.87
3.85
3.84
3.27
2.35
2.34
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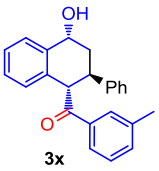
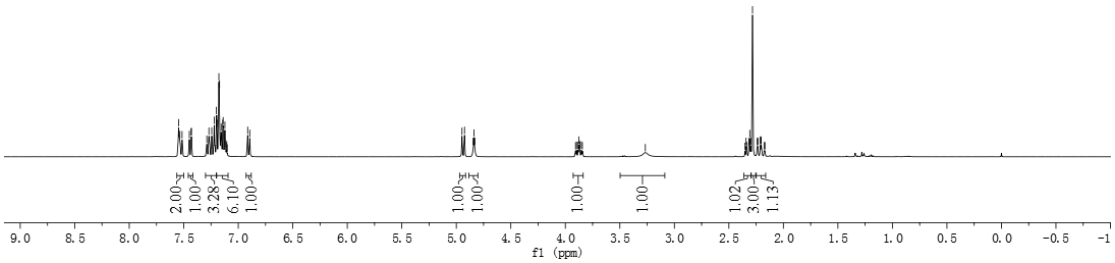
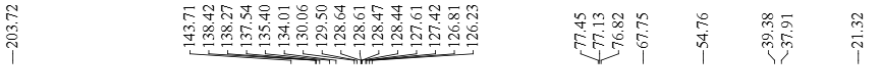
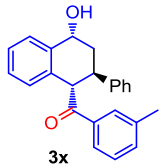
2.23
2.21
2.21
2.20
2.18
2.17


OH
Ph
O

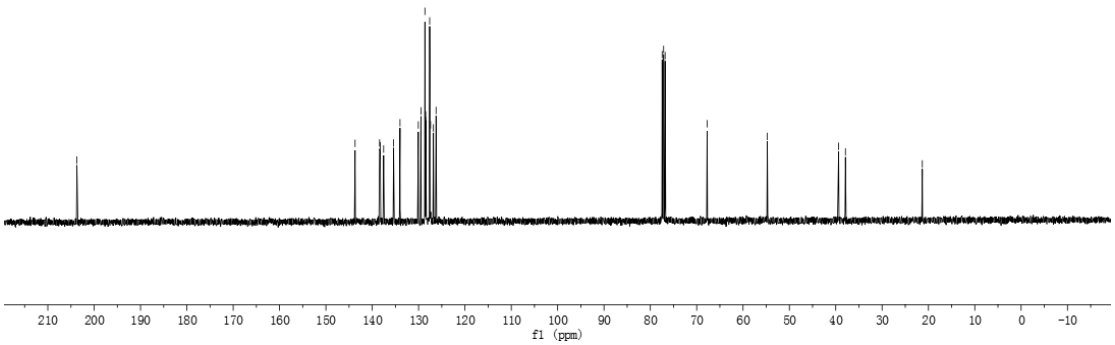
3x


2.00
1.00
3.28
6.10
1.00
1.00
1.00
1.00
1.00
1.02
3.00
1.13
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)


203.72
143.71
138.42
138.27
137.54
135.40
134.01
130.06
129.50
128.64
128.61
128.47
128.44
127.61
127.42
126.81
126.23
77.45
77.13
76.82
67.75
54.76
39.38
37.91
21.32


OH
Ph
O

3x


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.29
7.27
7.27
7.25
7.25
7.22
7.21
7.16
7.16
7.14
7.13
7.12
7.12
7.11
7.11
7.10
7.10
7.05
7.05
6.99
6.98
4.98
4.96
4.77
4.76
4.76
3.80
3.80
3.78
3.77
3.77
3.75
3.74
3.08
2.31
2.31
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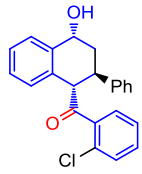
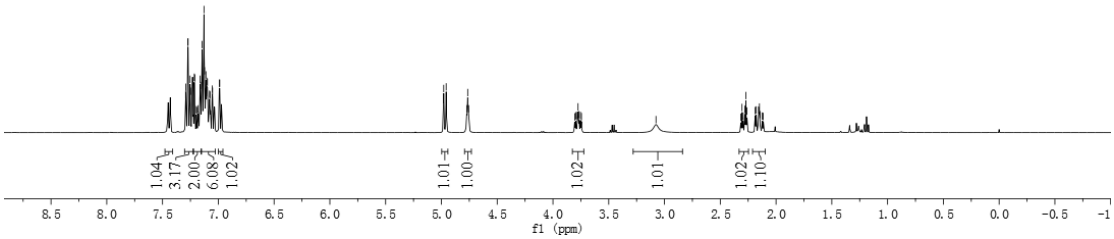
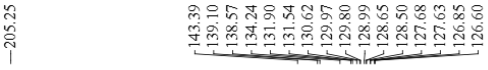
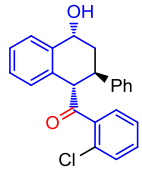
2.16
2.15
2.15
2.14
2.12
2.11


OH
Ph
O
Cl

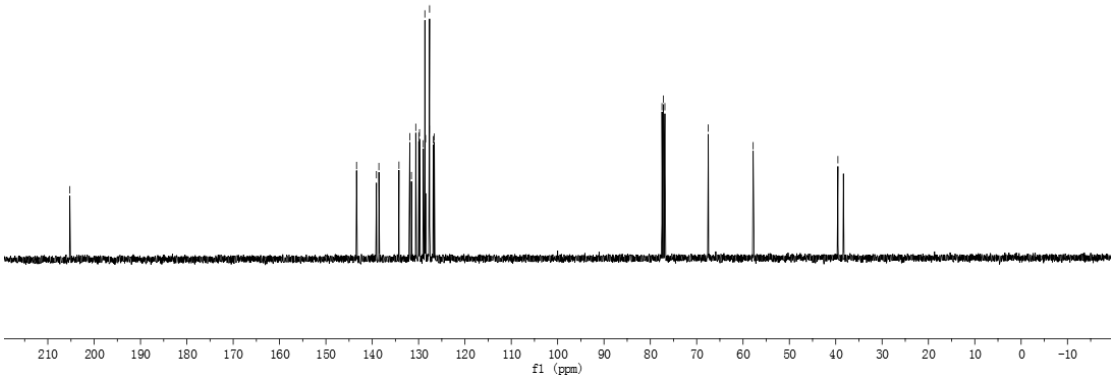
3y


1.04
3.17
2.00
6.08
1.02
1.01
1.00
1.02
1.01
1.02
1.10
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

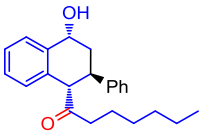

205.25
143.39
139.10
138.57
134.24
131.90
131.54
130.62
129.97
129.80
128.99
128.65
128.50
127.68
127.63
126.85
126.60
77.49
77.18
76.86
67.50
57.81
39.53


OH
Ph
O
Cl

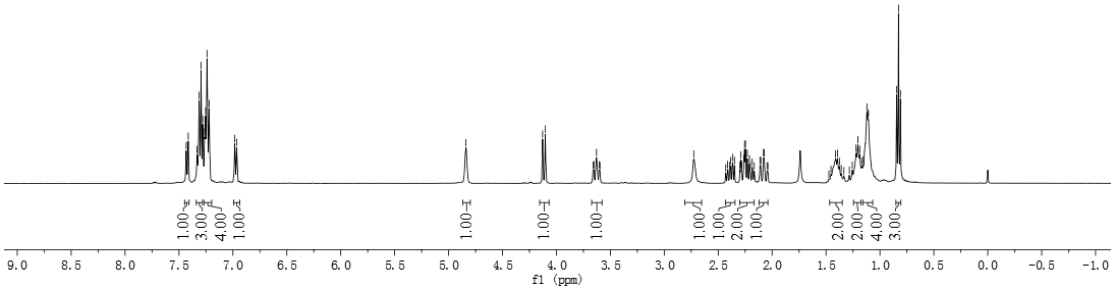
3y


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

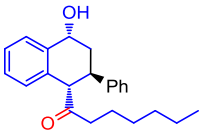

7.43
7.41
7.33
7.31
7.30
7.28
7.26
7.25
7.24
7.22
6.98
6.97
4.84
4.13
4.10
3.66
3.65
3.63
3.60
3.60
2.73
2.41
2.39
2.39
2.36
2.35
2.30
2.29
2.28
2.26
2.26
2.25
2.23
2.21
2.20
2.18
2.17
2.11
2.10
2.08
2.07
2.05
2.04
1.41
1.39
1.38
1.26
1.22
1.20
1.19
1.17
1.15
1.12
1.11
1.11
0.85
0.83
0.81


OH
Ph
O

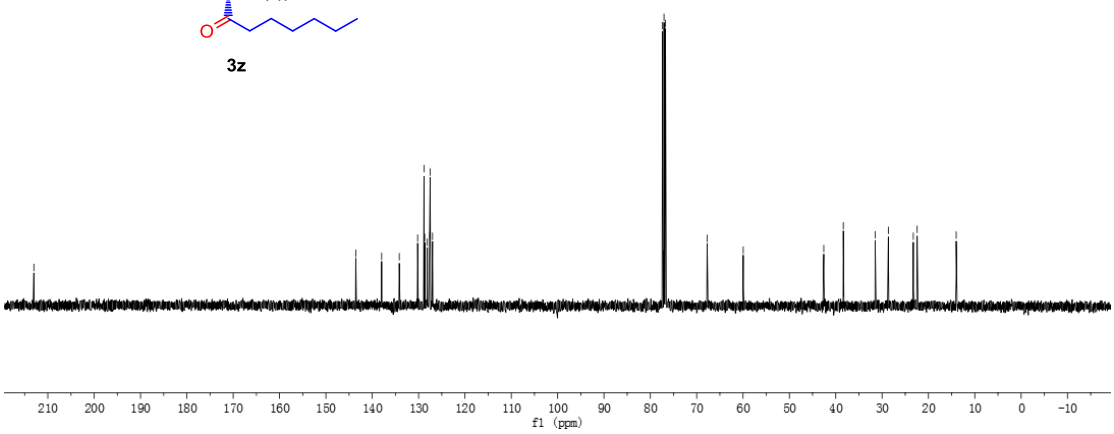
3z

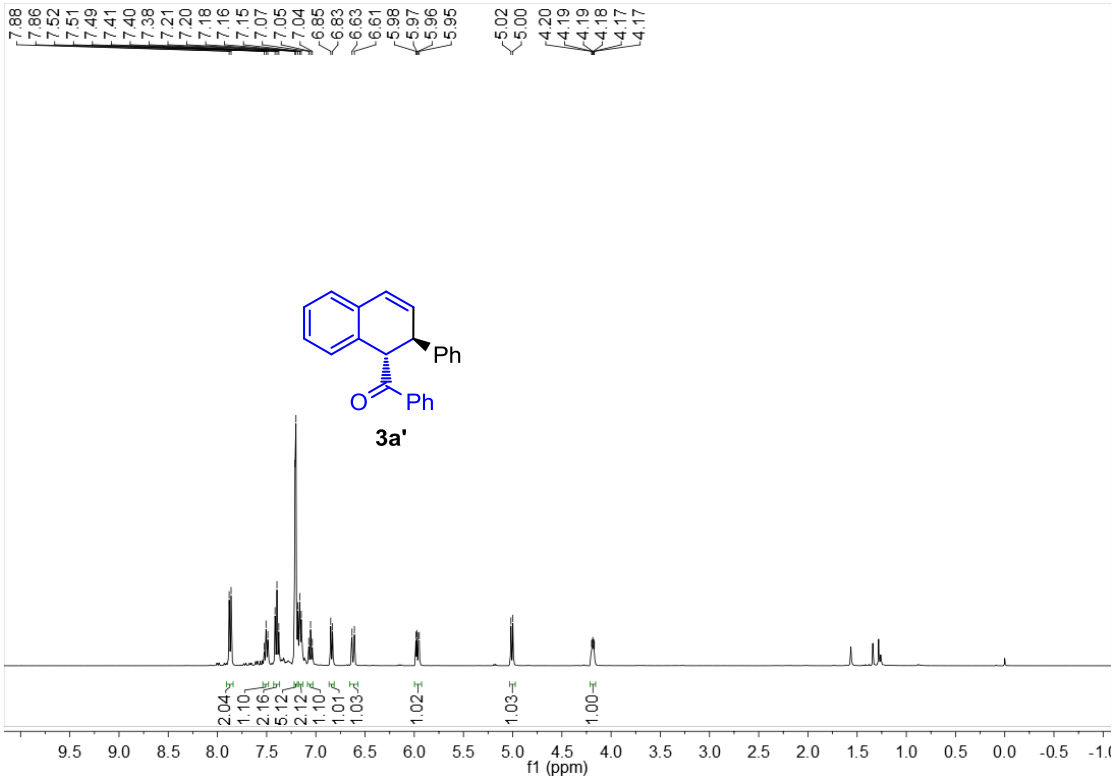

1.00
3.00
4.00
1.00
1.00
1.00
1.00
1.00
2.00
1.00
2.00
2.00
4.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

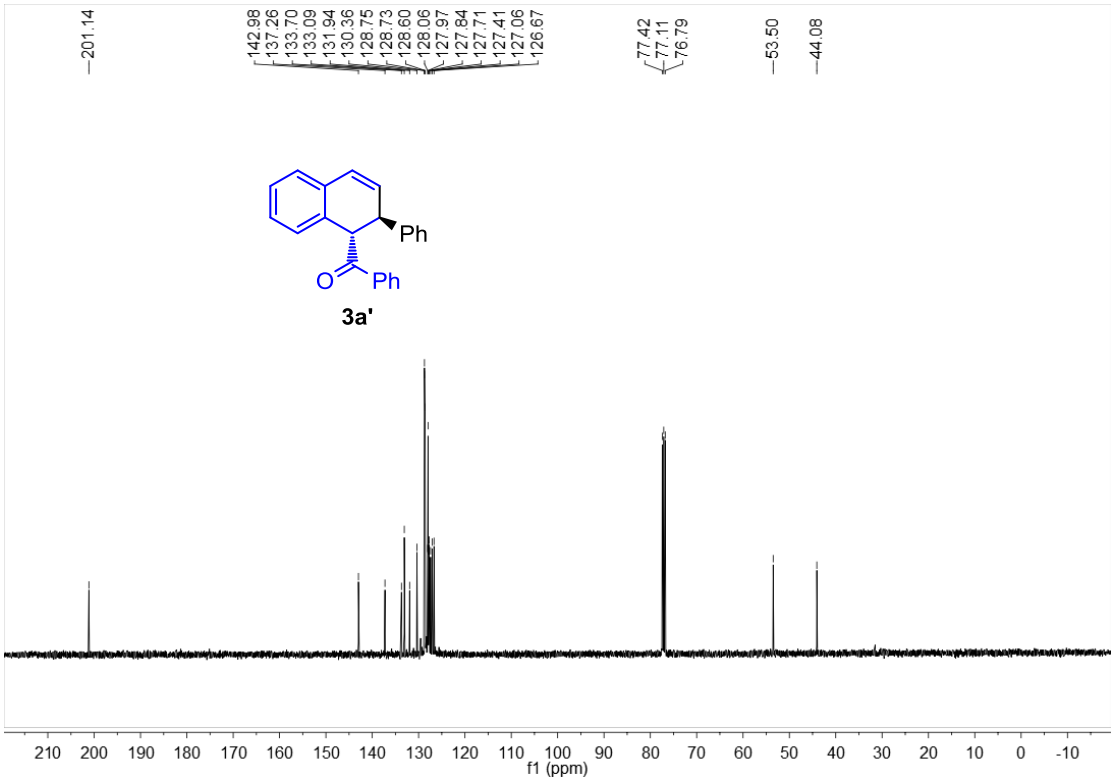

213.01
143.56
137.97
134.17
130.21
128.84
128.68
128.12
127.58
127.51
126.99
77.37
77.05
76.74
67.75
59.96
42.58
38.37
31.49
28.65
23.26
22.43
14.01


OH
Ph
O

3z


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.88
7.86
7.52
7.51
7.49
7.41
7.40
7.38
7.21
7.20
7.18
7.16
7.15
7.07
7.05
7.04
6.85
6.83
6.63
6.61
5.98
5.97
5.96
5.95
5.02
5.00
4.20
4.19
4.19
4.18
4.17
4.17
Ph
O
Ph
3a'
2.04
1.10
2.16
5.12
2.12
1.10
1.01
1.03
1.02
1.03
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


201.14
142.98
137.26
133.70
133.09
131.94
130.36
128.75
128.73
128.60
128.06
127.97
127.84
127.71
127.41
127.06
126.67
77.42
77.11
76.79
53.50
44.08
Ph
O
Ph
3a'
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.12
8.10
8.10
7.62
7.60
7.55
7.53
7.51
7.43
7.41
7.23
7.22
7.21
7.20
7.20
7.19
7.18
7.15
7.15
7.13
7.13
7.12
6.89
6.87
6.74
6.73
6.71
4.99
4.97
4.86
4.84
4.83
4.25
4.24
4.23
4.23
4.22
3.57
3.55
3.54
3.53
3.37
3.35
3.35
3.33
2.44
2.43
2.41
2.40
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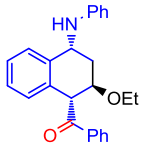
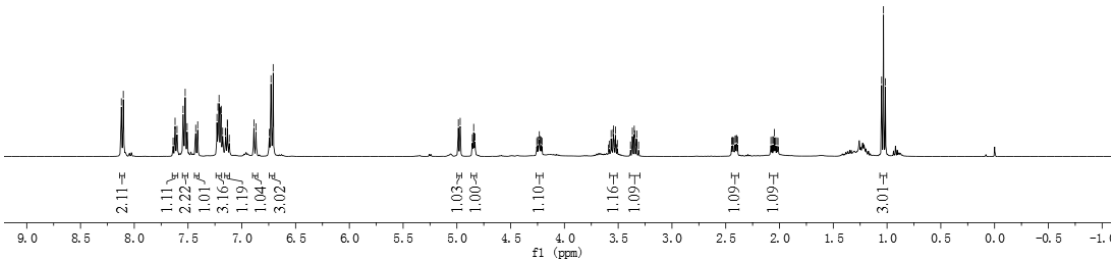
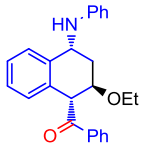
2.08
2.07
2.06
2.05
1.05
1.03
1.02


HN
Ph
OEt
O
Ph

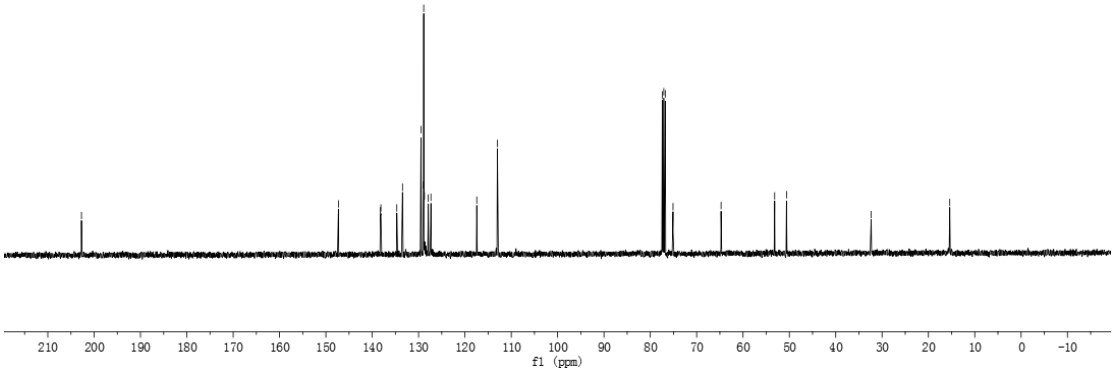
6a

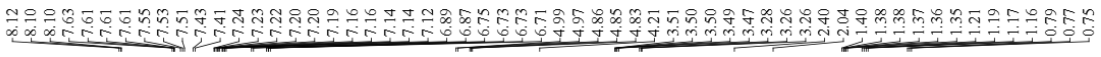

2.11
1.11
2.22
1.01
3.16
1.19
1.04
3.02
1.03
1.00
1.10
1.16
1.09
1.09
1.09
3.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

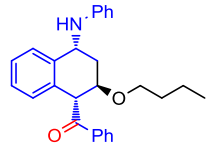

202.74
147.30
133.47
129.48
128.96
128.89
128.74
117.34
117.43
113.00
77.41
77.09
76.77
75.10
64.74
53.17
50.61
32.35
15.39


HN
Ph
OEt
O
Ph

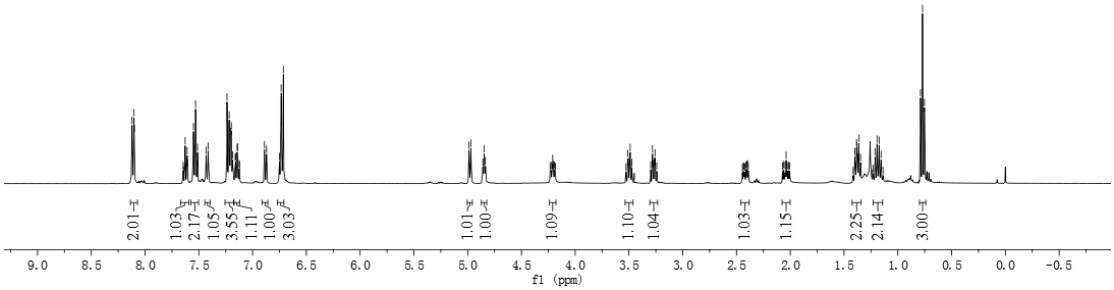
6a


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

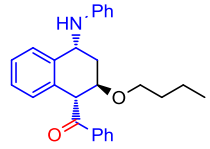

8.12
8.10
8.10
7.63
7.61
7.61
7.61
7.55
7.53
7.51
7.43
7.41
7.24
7.23
7.22
7.20
7.20
7.19
7.16
7.16
7.14
7.14
7.12
6.89
6.87
6.75
6.73
6.73
6.71
4.99
4.97
4.86
4.85
4.83
4.21
3.51
3.50
3.49
3.47
3.28
3.26
3.26
2.40
2.04
1.40
1.38
1.38
1.37
1.36
1.35
1.21
1.19
1.17
1.16
0.79
0.77
0.75


HN
Ph
O
O
Ph

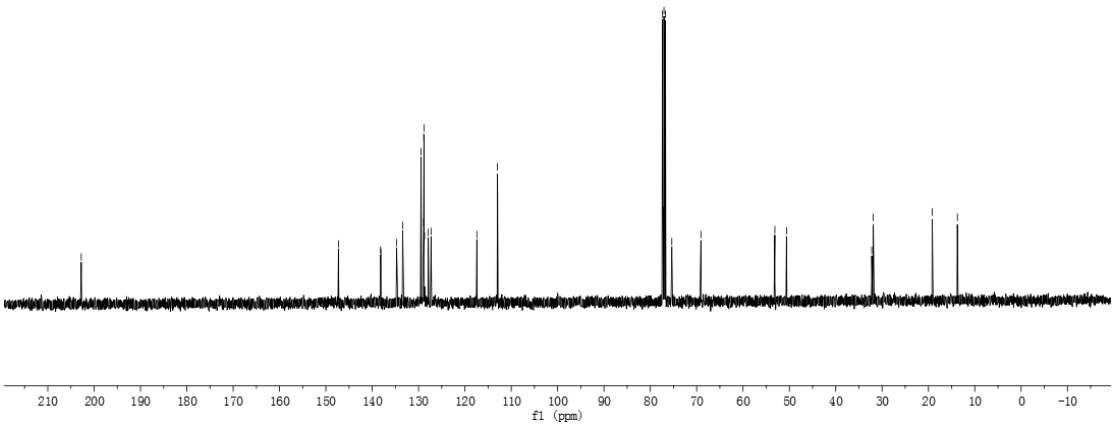
6b

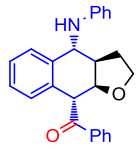

2.01
1.03
2.17
1.05
3.55
1.11
1.00
3.03
1.01
1.00
1.09
1.10
1.04
1.03
1.15
2.25
2.14
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


202.78
147.29
133.44
129.47
128.93
128.88
128.84
117.42
112.98
77.37
77.06
76.74
75.36
69.09
53.13
50.61
32.23
31.90
19.17
13.75

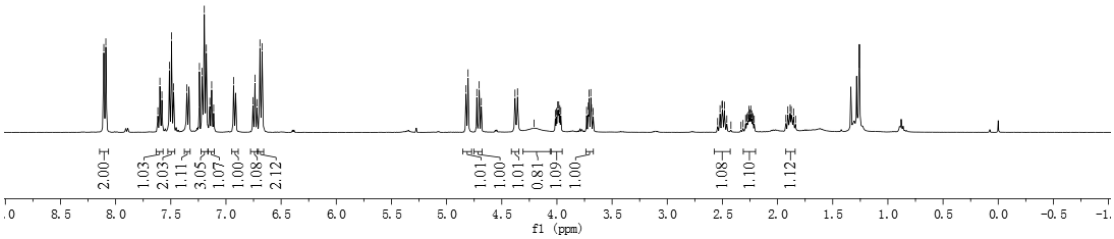

HN
Ph
O
O
Ph

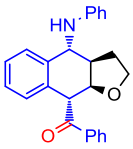
6b


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

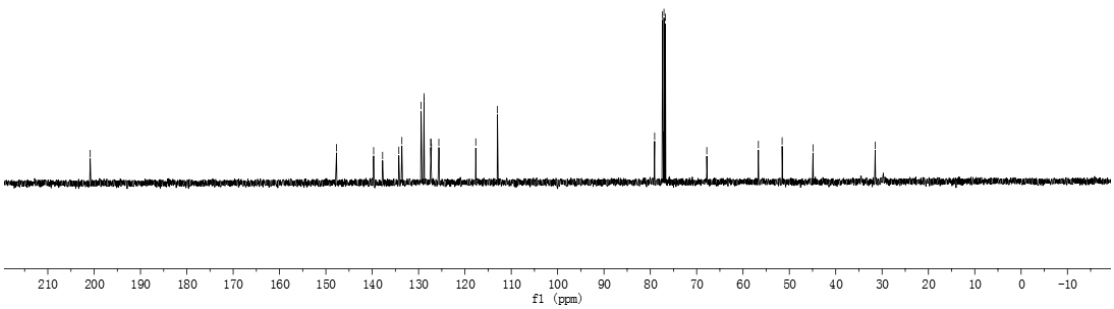

HN
Ph
O
O
Ph

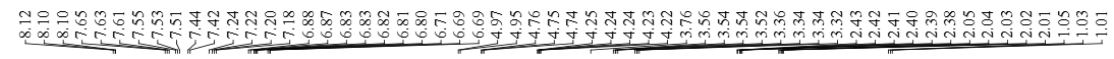
6c

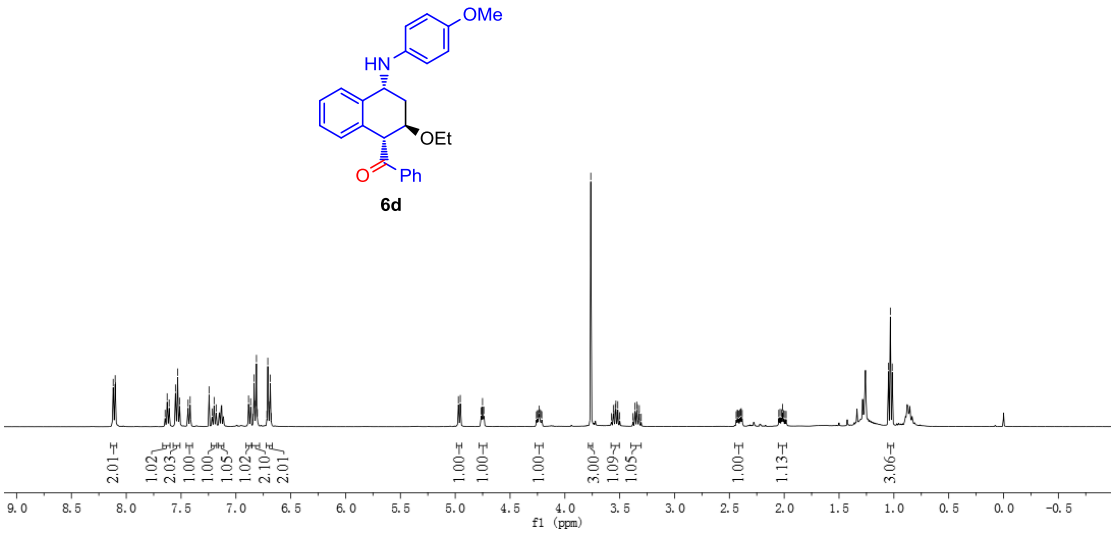

2.00
1.03
2.03
1.11
3.05
1.07
1.00
1.08
2.12
1.01
1.00
1.01
0.81
1.09
1.00
1.08
1.10
1.12
f1 (ppm)

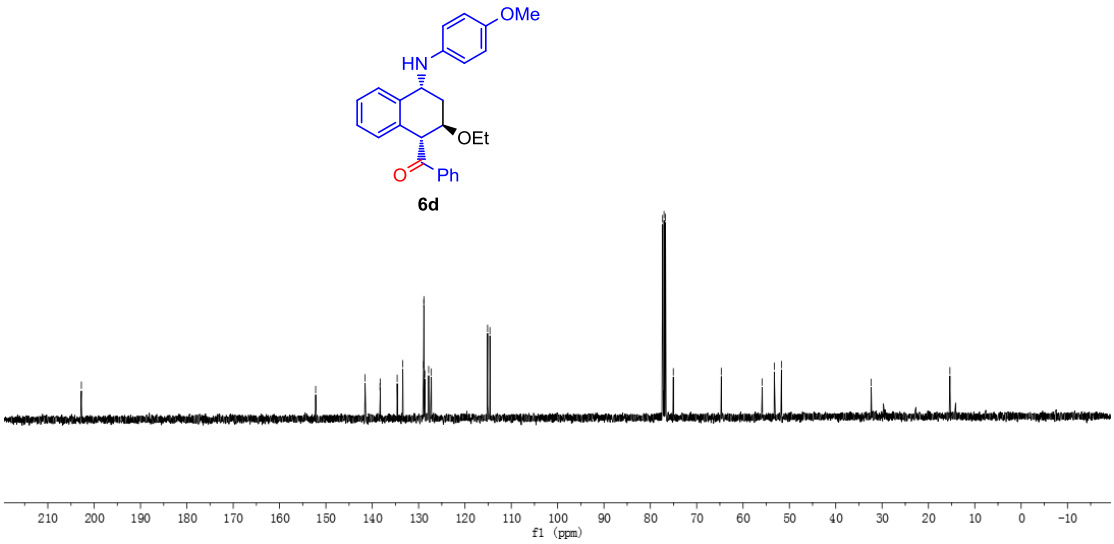

HN
Ph
O
O
Ph

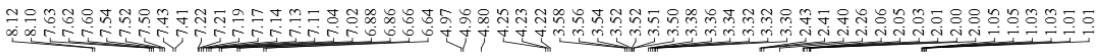
6c

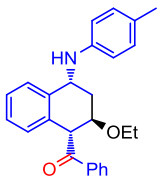

f1 (ppm)



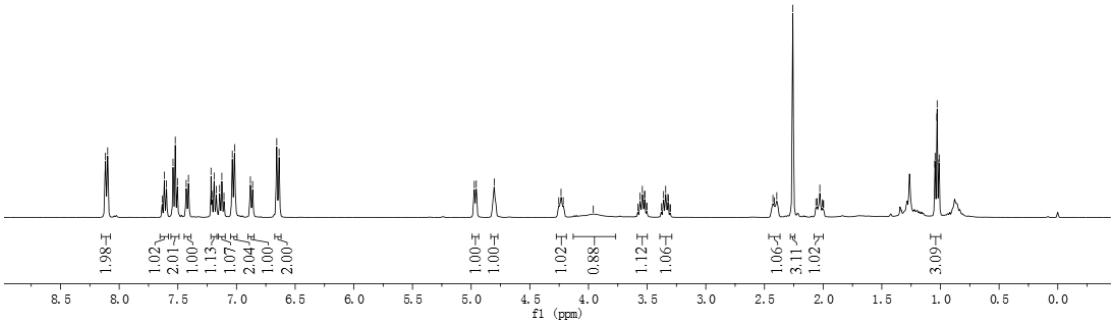

OMe
HN
OEt
O
Ph
6d
2.01
1.02
2.03
1.00
1.05
1.02
2.10
2.01
1.00
1.00
1.00
3.00
1.09
1.05
1.00
1.13
3.06
f1 (ppm)

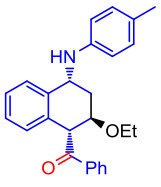

OMe
HN
OEt
O
Ph
6d
f1 (ppm)



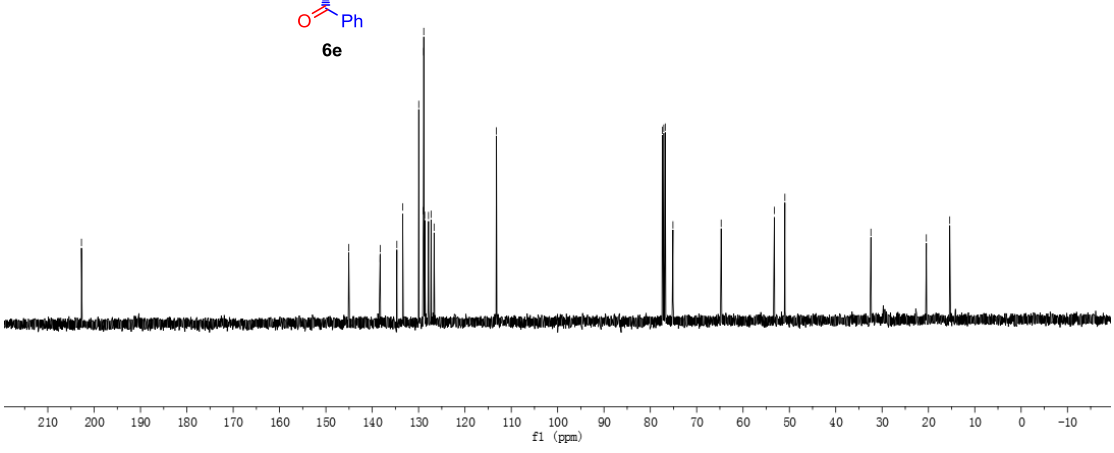

HN
OEt
O
Ph

6e


1.98
1.02
2.01
1.00
1.13
1.07
2.04
1.00
2.00
1.00
1.00
1.02
0.88
1.12
1.06
1.06
3.11
1.02
3.09
f1 (ppm)


HN
OEt
O
Ph

6e


f1 (ppm)


8.12
8.11
8.10
7.64
7.62
7.60
7.55
7.53
7.51
7.42
7.40
7.23
7.21
7.20
7.18
7.15
7.13
7.12
6.94
6.91
6.89
6.87
6.66
6.65
6.65
6.64
6.63
4.99
4.98
4.98
4.76
4.23
4.23
4.22
4.21
3.56
3.56
3.54
3.53
3.52
3.52
3.37
3.36
3.35
3.35
3.34
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2.38
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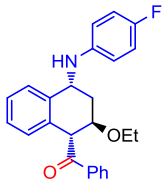
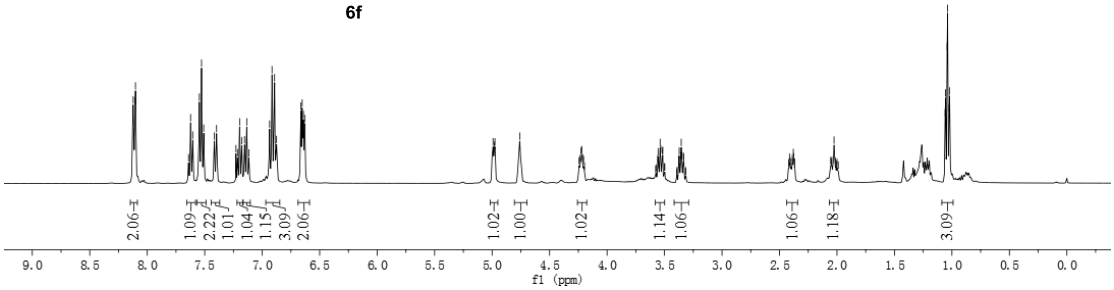
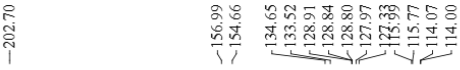
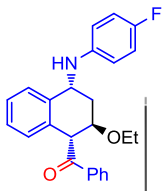
2.03
1.06
1.06
1.04
1.04
1.02
1.02


F
HN
OEt
O
Ph

6f

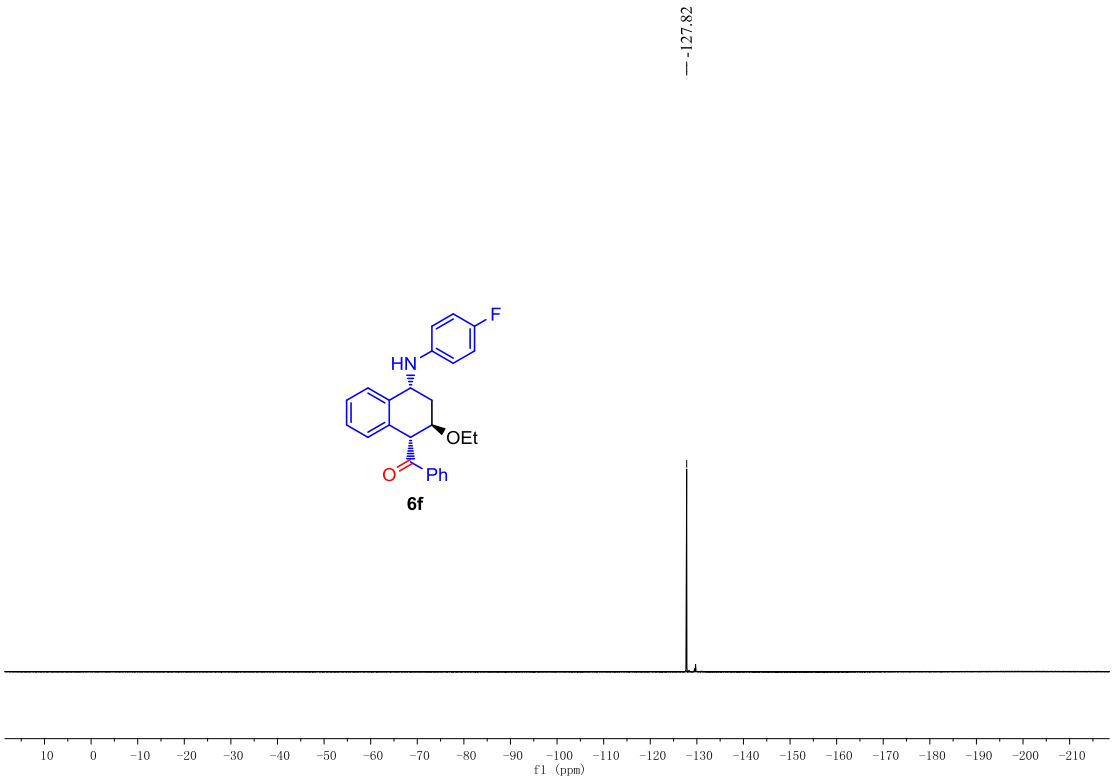

2.06
1.09
2.22
1.01
1.04
1.15
3.09
2.06
1.02
1.00
1.02
1.14
1.06
1.06
1.18
3.09
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

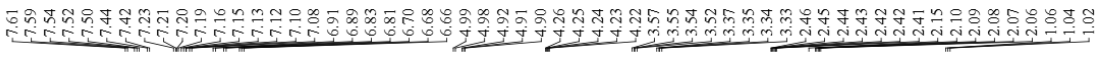

202.70
156.99
154.66
134.65
133.52
128.91
128.84
128.80
127.97
127.33
127.33
115.99
115.77
114.07
114.00
77.41
77.10
76.78
75.02
64.73
53.10
51.37
32.15
15.38

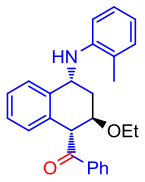

F
HN
OEt
O
Ph

6f

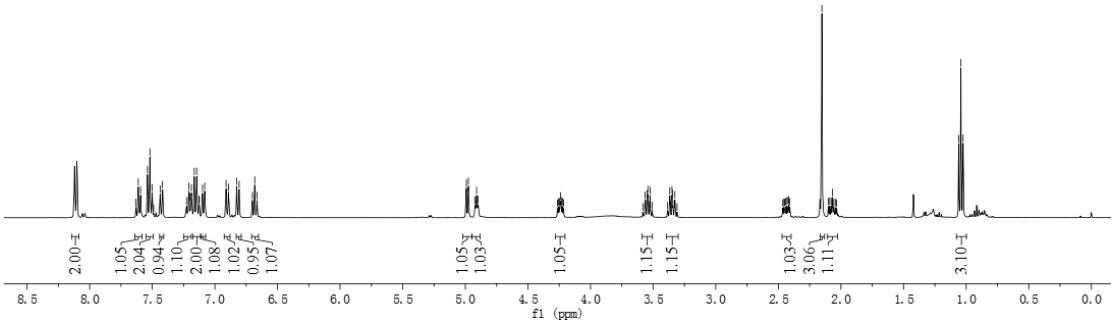
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

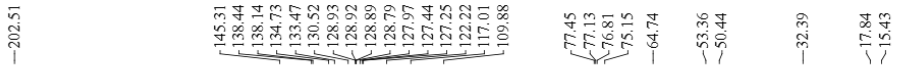

-127.82
F
HN
OEt
O
Ph
6f
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
−110
−120
−130
−140
−150
−160
−170
−180
−190
−200
−210
f1 (ppm)

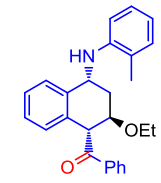



HN
OEt
O
Ph

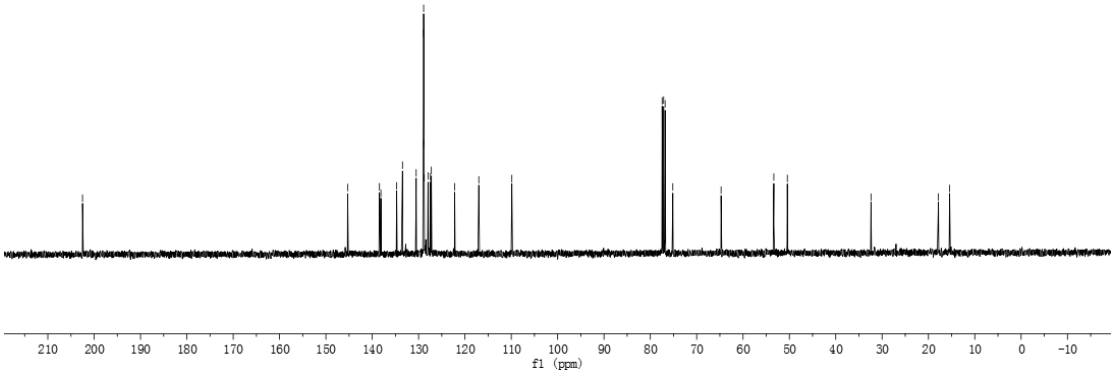
6g

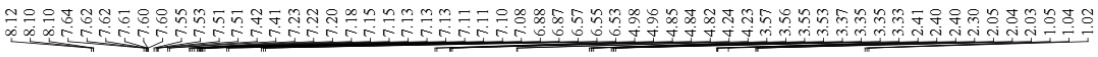

2.00
1.05
2.04
0.94
1.10
2.00
1.08
1.02
0.95
1.07
1.05
1.03
1.05
1.15
1.15
1.03
3.06
1.11
3.10
f1 (ppm)

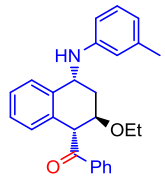



HN
OEt
O
Ph

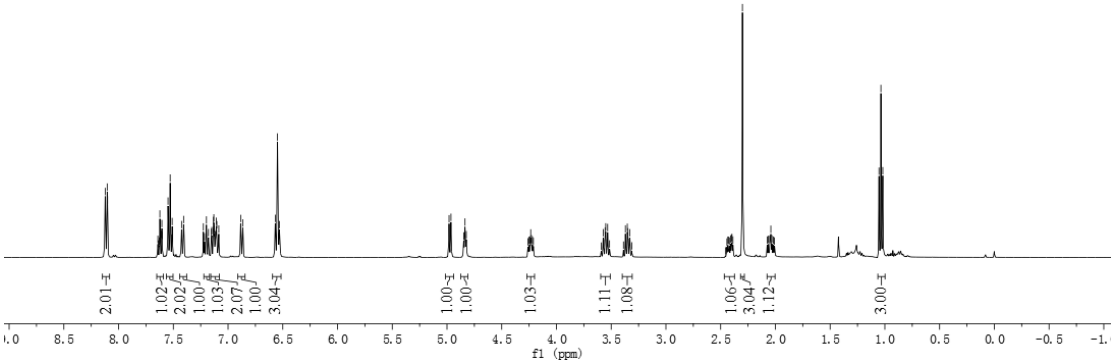
6g

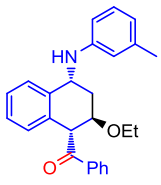

f1 (ppm)



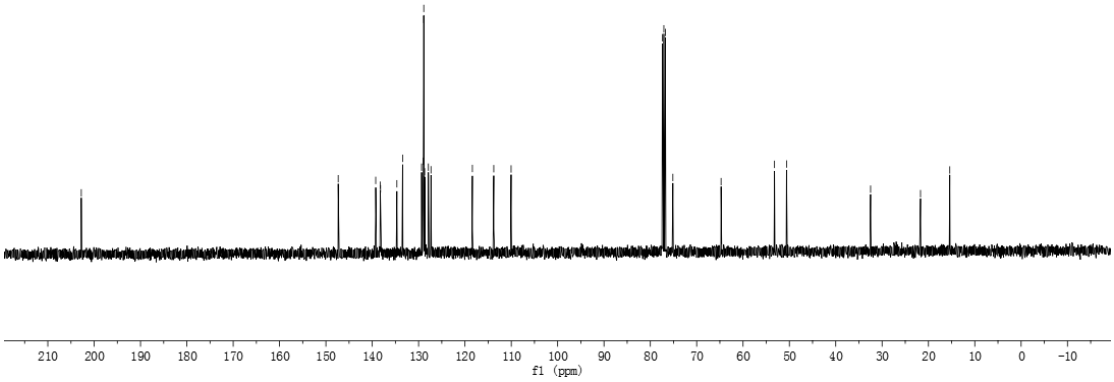

HN
OEt
O
Ph

6h

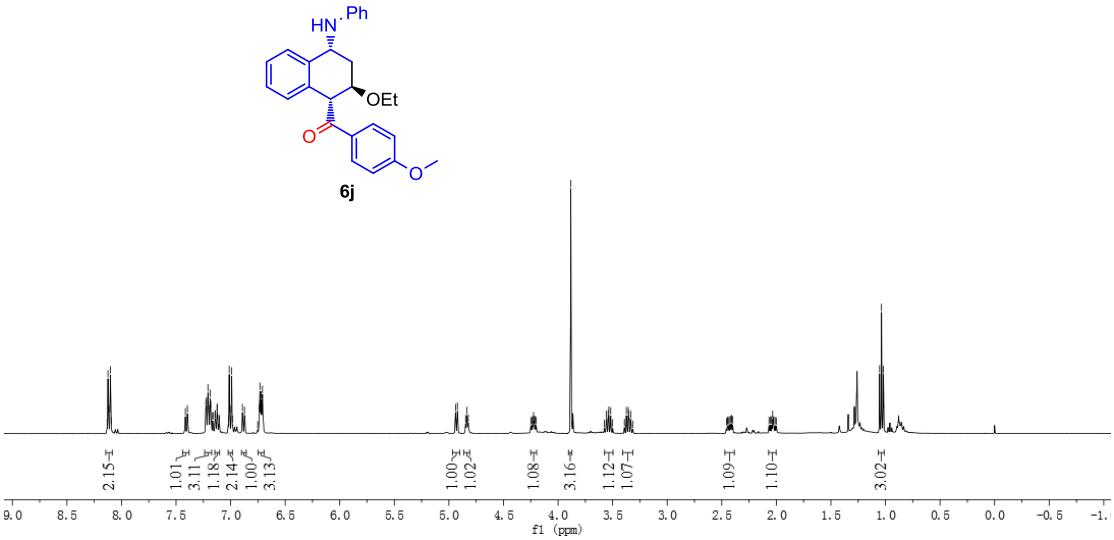

2.01
1.02
2.02
1.00
1.03
2.07
1.00
3.04
1.00
1.00
1.03
1.11
1.08
1.06
3.04
1.12
3.00
f1 (ppm)


HN
OEt
O
Ph

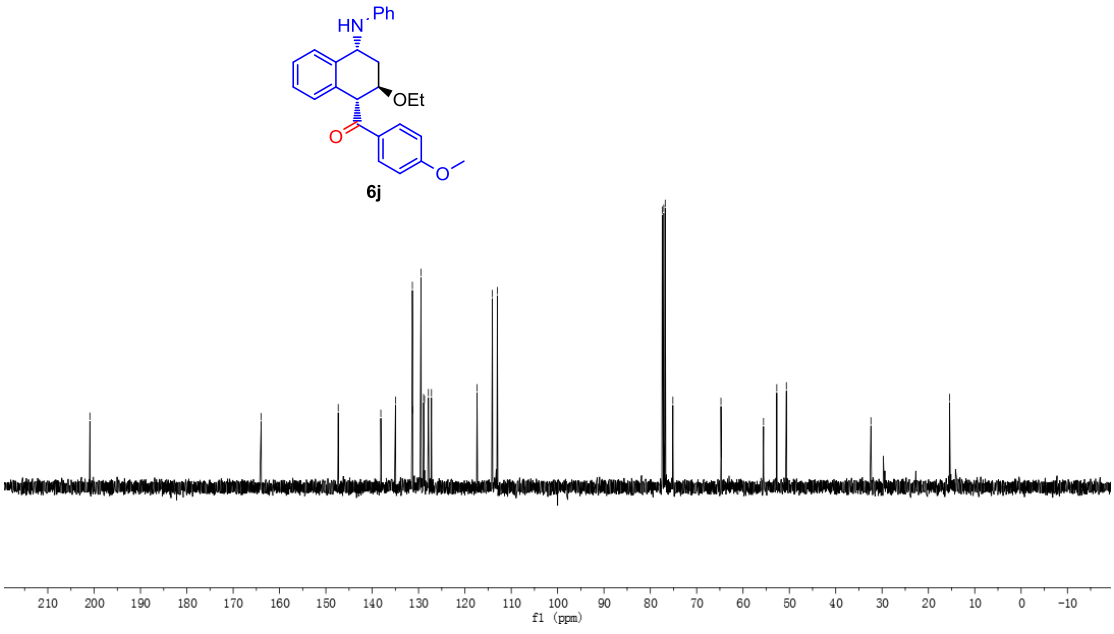
6h

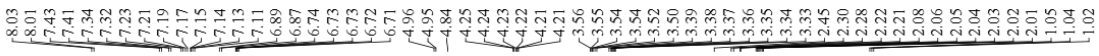

f1 (ppm)


8.12
8.12
8.11
8.10
7.41
7.40
7.23
7.22
7.21
7.20
7.19
7.18
7.16
7.16
7.14
7.14
7.12
7.12
7.11
7.10
7.02
7.01
7.01
7.00
6.99
6.98
6.89
6.87
6.74
6.73
6.72
6.72
6.71
4.94
4.92
4.85
4.83
4.82
4.23
4.22
4.21
3.88
3.56
3.54
3.53
3.52
3.37
3.36
3.35
3.33
2.42
2.41
2.41
2.40
2.03
1.05
1.04
1.02


HN
Ph
OEt
O
O
6j
2.15
1.01
3.11
1.18
2.14
1.00
3.13
1.00
1.02
1.08
3.16
1.12
1.07
1.09
1.10
3.02
f1 (ppm)


200.92
163.95
147.33
131.34
129.47
128.92
127.88
127.31
127.38
114.07
113.00
77.42
77.10
76.78
75.14
64.76
55.57
52.71
50.65
32.40
15.44


HN
Ph
OEt
O
O
6j
f1 (ppm)


8.03
8.01
7.43
7.41
7.34
7.32
7.23
7.21
7.19
7.17
7.15
7.14
7.13
7.11
6.89
6.87
6.74
6.73
6.72
6.71
4.96
4.95
4.84
4.25
4.24
4.23
4.22
4.21
3.56
3.55
3.54
3.54
3.52
3.50
3.39
3.38
3.37
3.36
3.35
3.34
3.33
2.45
2.30
2.28
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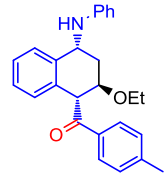
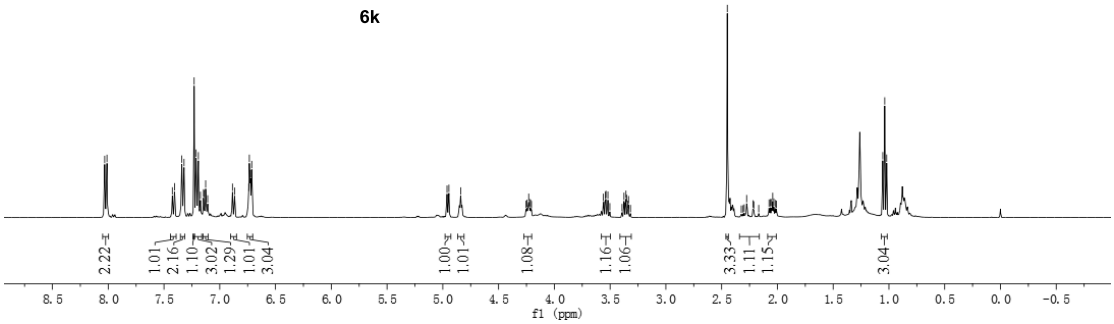
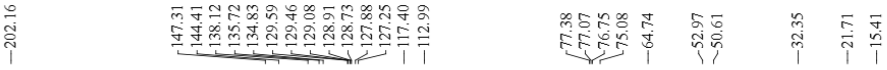
2.04
2.03
2.02
2.01
1.05
1.04
1.02


HN
Ph
OEt
O

6k


2.22
1.01
2.16
1.10
3.02
1.29
1.01
3.04
1.00
1.01
1.08
1.16
1.06
3.33
1.11
1.15
3.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


202.16
147.31
144.41
138.12
135.72
134.83
129.59
129.46
129.08
128.91
128.73
127.88
127.25
117.40
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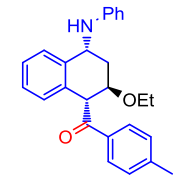
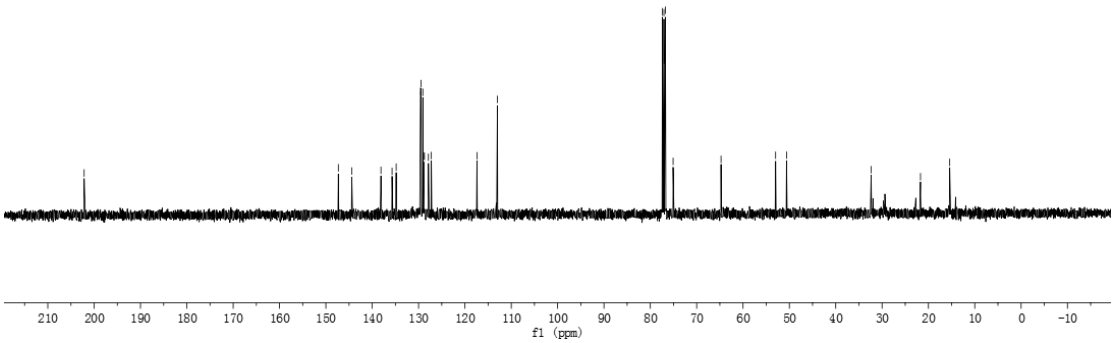
75.08
64.74
52.97
50.61
32.35
21.71
15.41


HN
Ph
OEt
O

6k


210
200
190
180
170
160
150
140
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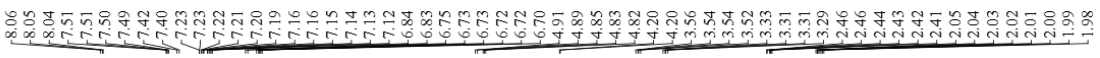
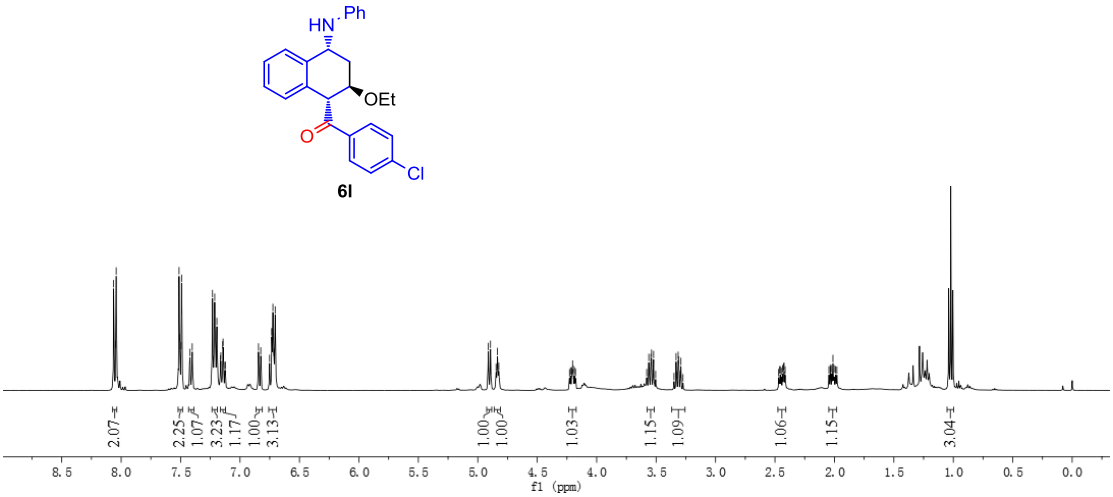
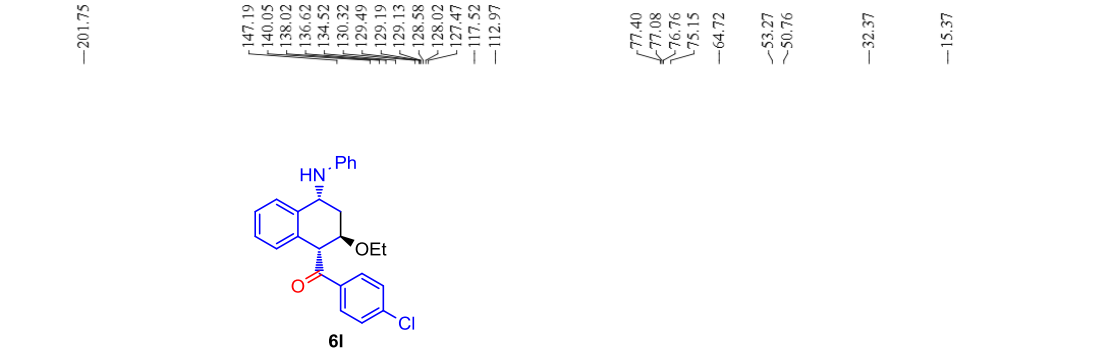
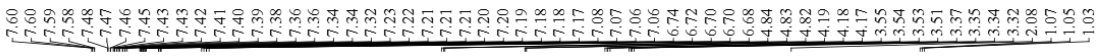
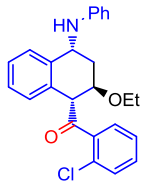
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


8.06
8.05
8.04
7.51
7.51
7.50
7.49
7.42
7.40
7.23
7.23
7.22
7.21
7.20
7.19
7.16
7.16
7.15
7.14
7.13
7.12
6.84
6.83
6.75
6.73
6.73
6.72
6.72
6.70
4.91
4.89
4.85
4.83
4.82
4.20
4.20
3.56
3.54
3.54
3.52
3.33
3.31
3.31
3.29
2.46
2.46
2.44
2.43
2.42
2.41
2.05
2.04
2.03
2.02
2.01
2.00
1.99
1.98

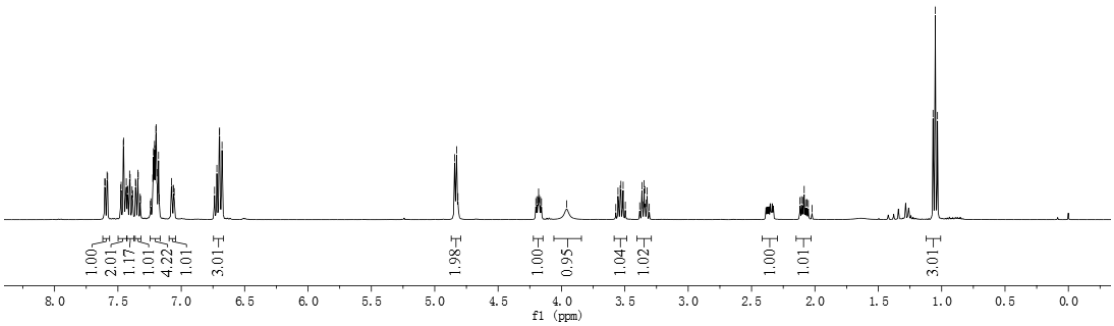

HN
Ph
OEt
O
Cl
6l
2.07
2.25
1.07
3.23
1.17
1.00
3.13
1.00
1.00
1.03
1.15
1.09
1.06
1.15
3.04
f1 (ppm)

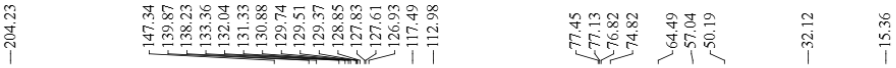

201.75
147.19
140.05
138.02
136.62
134.52
130.32
129.49
129.19
129.13
128.58
128.02
127.47
117.52
112.97
77.40
77.08
76.76
75.15
64.72
53.27
50.76
32.37
15.37
HN
Ph
OEt
O
Cl
6l
f1 (ppm)

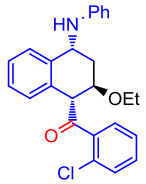



HN
Ph
OEt
O
Cl

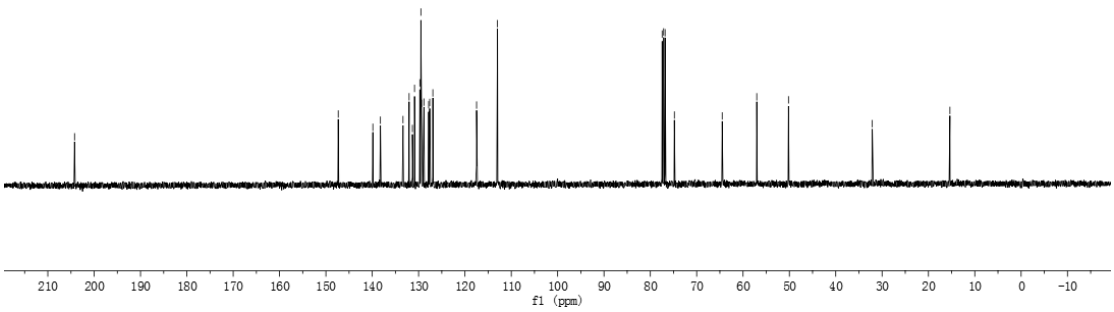
6m

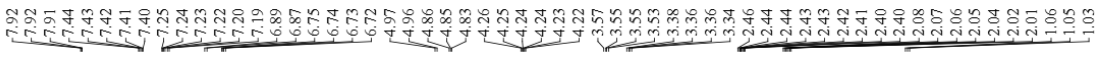

1.00
2.01
1.17
1.01
4.22
1.01
3.01
1.98
1.00
0.95
1.04
1.02
1.00
1.01
3.01
f1 (ppm)

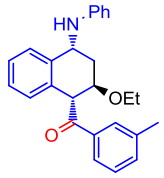



HN
Ph
OEt
O
Cl

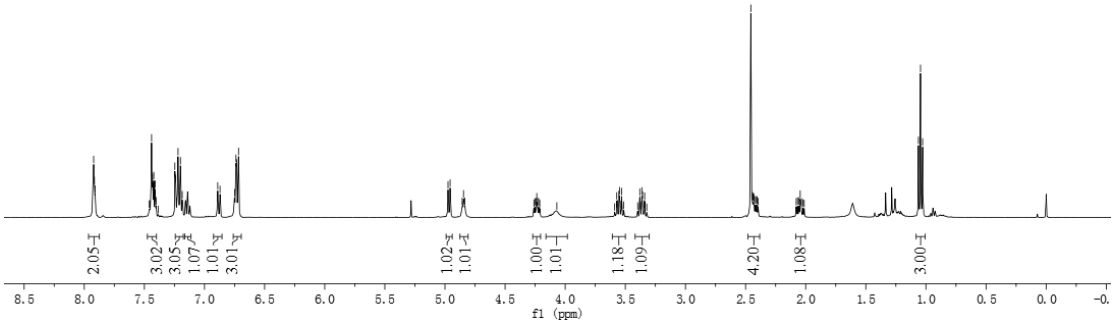
6m


f1 (ppm)

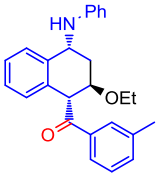

7.92
7.92
7.91
7.44
7.43
7.42
7.41
7.40
7.25
7.24
7.23
7.22
7.20
7.19
6.89
6.87
6.75
6.74
6.73
6.72
4.97
4.96
4.86
4.85
4.83
4.26
4.25
4.24
4.24
4.23
4.22
3.57
3.55
3.55
3.53
3.38
3.36
3.36
3.34
2.46
2.44
2.44
2.43
2.43
2.42
2.41
2.40
2.40
2.08
2.07
2.06
2.05
2.04
2.02
2.01
1.06
1.05
1.03


HN
Ph
OEt
O

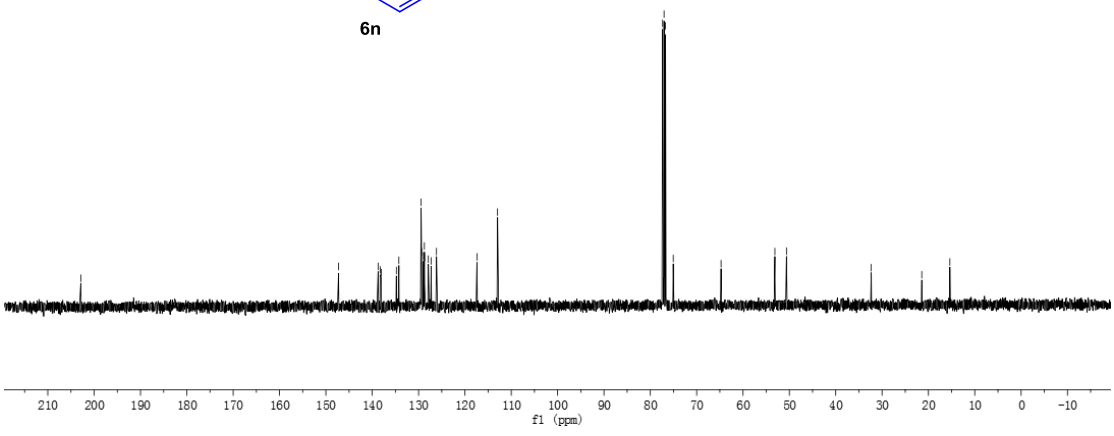
6n


2.05
3.02
3.05
1.07
1.01
3.01
1.02
1.01
1.00
1.01
1.18
1.09
4.20
1.08
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

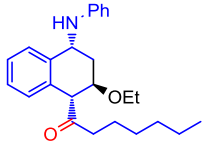

202.87
147.27
129.46
129.35
128.94
128.75
128.71
117.40
112.96
77.35
77.04
76.72
75.05
64.74
53.13
50.62
32.33
21.43
15.37


HN
Ph
OEt
O

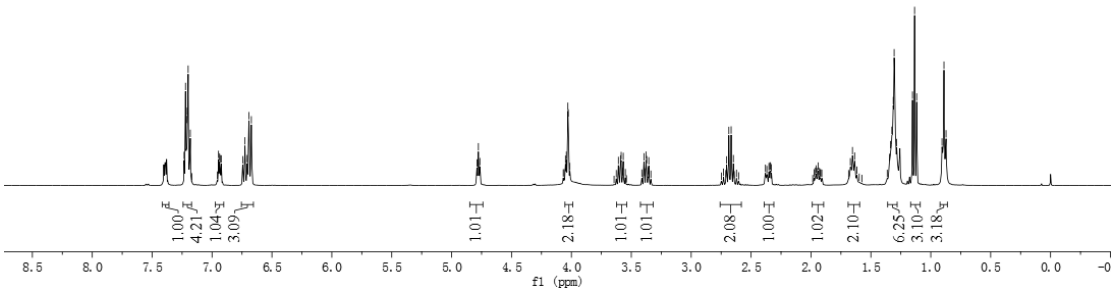
6n

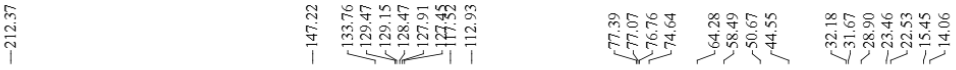

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

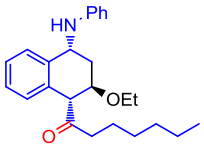

7.23
7.22
7.21
7.21
7.20
7.18
6.95
6.94
6.93
6.92
6.74
6.73
6.71
6.69
6.67
4.79
4.78
4.76
4.05
4.04
4.03
4.03
4.01
3.61
3.59
3.58
3.57
3.39
3.38
3.37
3.35
2.70
2.69
2.67
2.65
2.38
2.37
2.35
2.34
2.34
2.33
1.96
1.94
1.67
1.65
1.64
1.34
1.34
1.32
1.31
1.31
1.28
1.15
1.14
1.12
0.91
0.89
0.87


HN
Ph
OEt
O

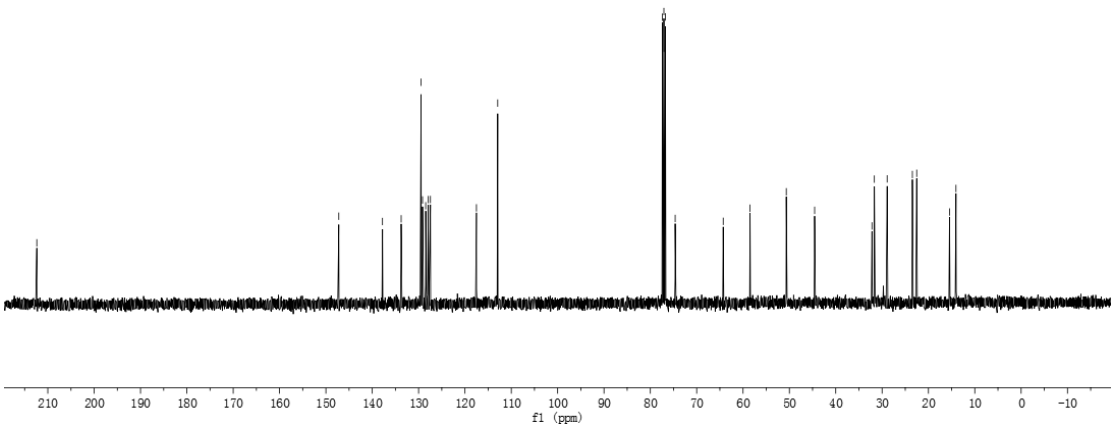
6o

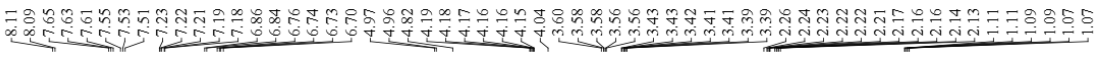

1.00
4.21
1.04
3.09
1.01
2.18
1.01
1.01
2.08
1.00
1.02
2.10
6.25
3.10
3.18
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

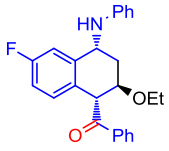

212.37
147.22
133.76
129.47
129.15
128.47
127.91
112.93
77.39
77.07
76.76
74.64
64.28
58.49
50.67
44.55
32.18
31.67
28.90
23.46
22.53
15.45
14.06


HN
Ph
OEt
O

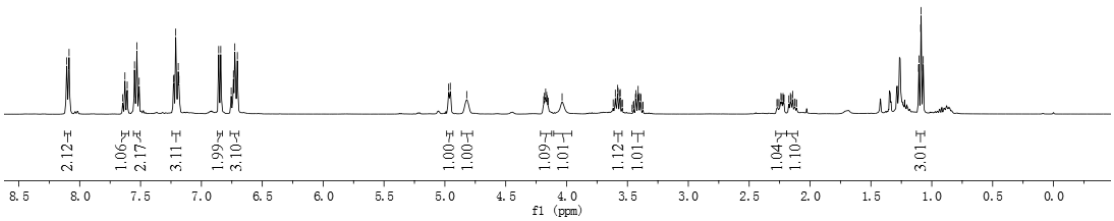
6o


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

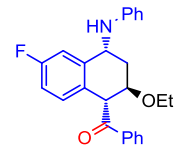

8.11
8.09
7.65
7.63
7.61
7.55
7.53
7.51
7.23
7.22
7.21
7.19
7.18
6.86
6.84
6.76
6.74
6.73
6.70
4.97
4.96
4.82
4.19
4.18
4.17
4.16
4.16
4.15
4.04
3.60
3.58
3.58
3.56
3.56
3.43
3.43
3.42
3.41
3.41
3.39
3.39
2.26
2.24
2.23
2.22
2.22
2.21
2.17
2.16
2.16
2.14
2.13
1.11
1.11
1.09
1.09
1.07
1.07


HN
Ph
F
OEt
O
Ph

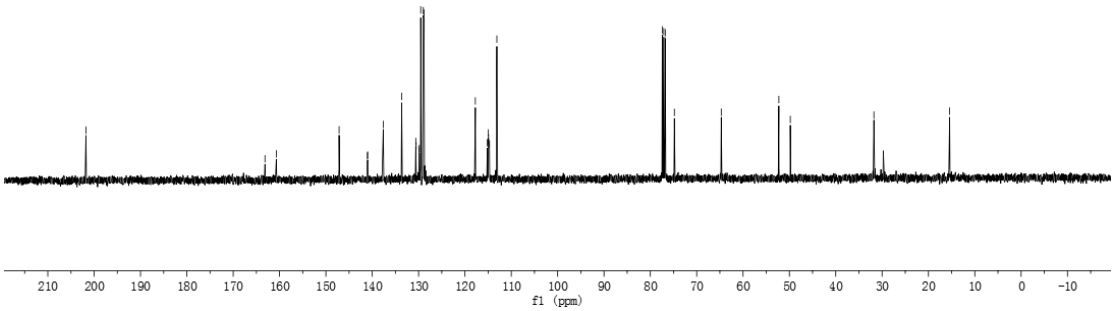
6p

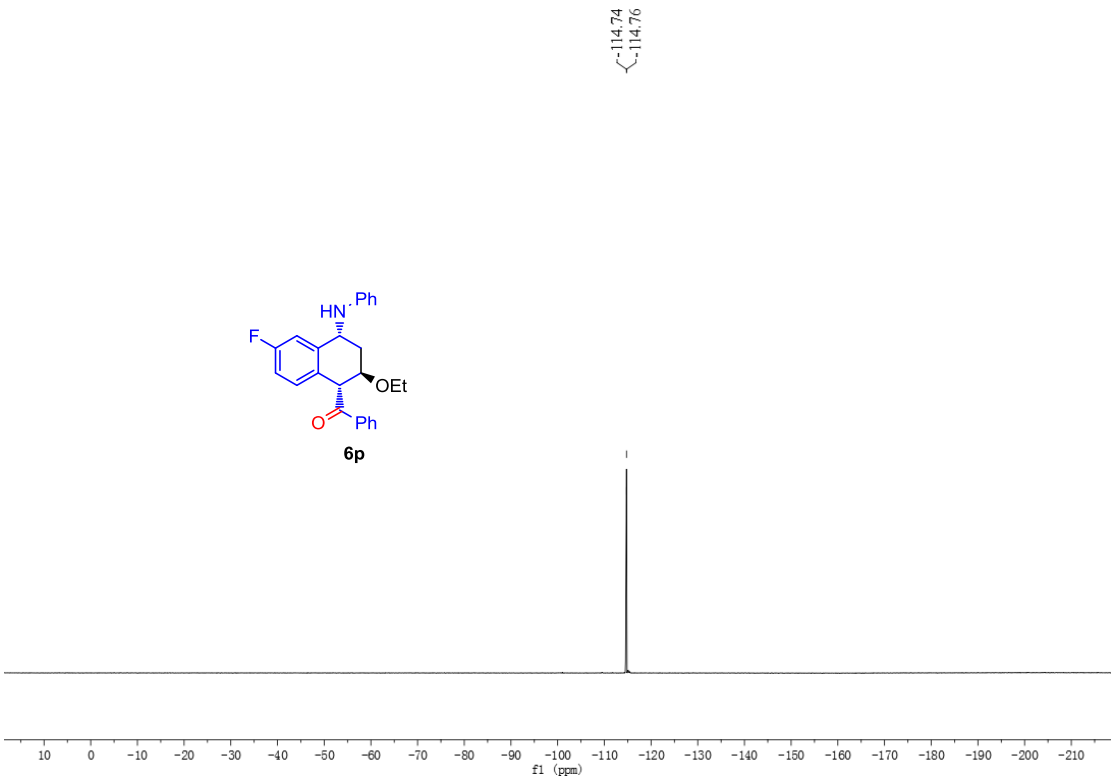

2.12
1.06
2.17
3.11
1.99
3.10
1.00
1.00
1.09
1.01
1.12
1.01
1.04
1.10
3.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

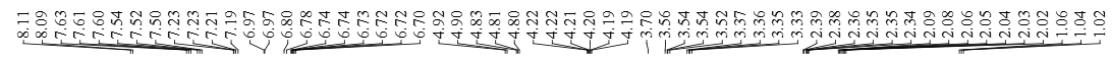

201.77
163.14
160.70
147.15
137.62
133.65
130.61
130.53
129.54
128.99
115.17
114.95
114.92
114.70
113.11
77.42
77.10
76.78
74.82
64.70
52.27
49.80
31.76
15.43


HN
Ph
F
OEt
O
Ph

6p


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-114.74
-114.76
HN
Ph
F
OEt
O
Ph
6p
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


8.11
8.09
7.63
7.61
7.60
7.54
7.52
7.50
7.23
7.23
7.21
7.19
6.97
6.97
6.80
6.78
6.74
6.74
6.73
6.72
6.72
6.70
4.92
4.90
4.83
4.81
4.80
4.22
4.22
4.21
4.20
4.19
4.19
3.70
3.56
3.54
3.54
3.52
3.37
3.36
3.35
3.33
2.39
2.38
2.36
2.35
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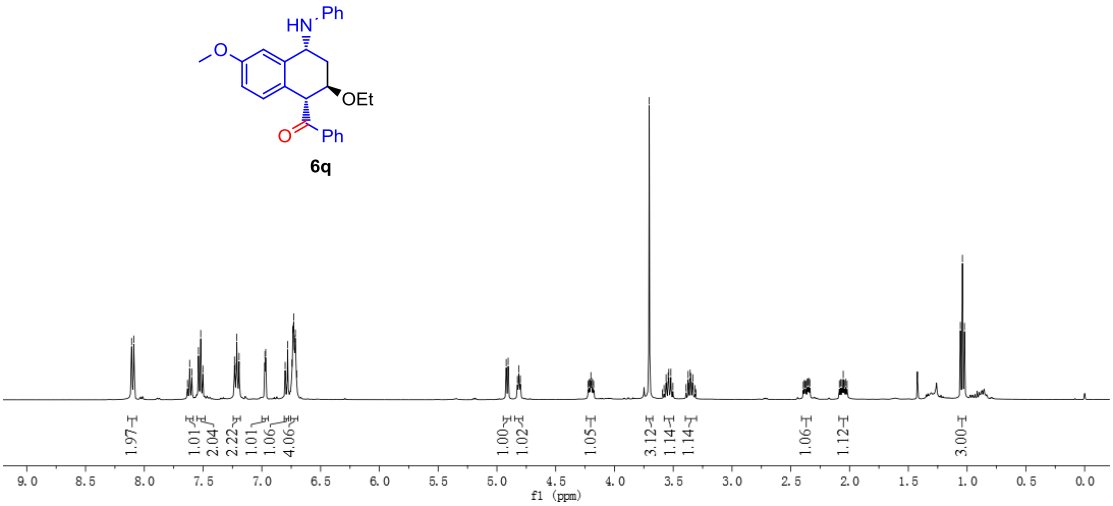
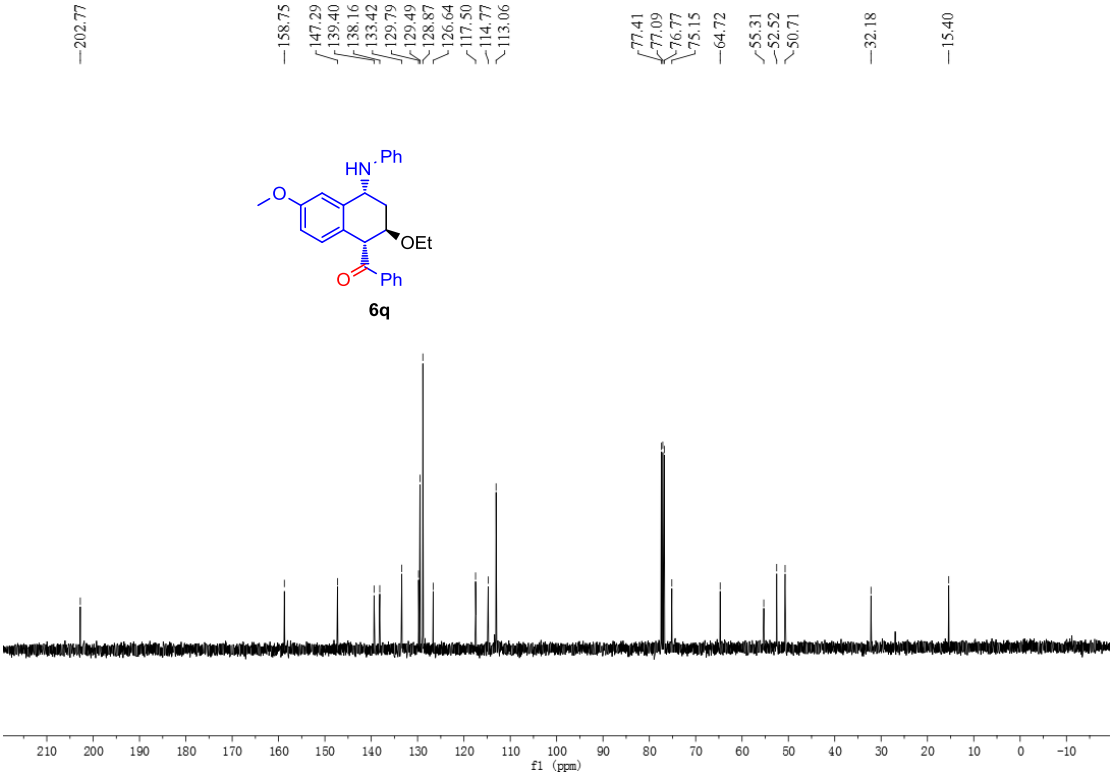
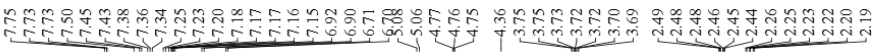
2.04
2.03
2.02
1.06
1.04
1.02


HN
Ph
O
OEt
O
Ph
6q
1.97
1.01
2.04
2.22
1.01
1.06
4.06
1.00
1.02
1.05
3.12
1.14
1.14
1.06
1.12
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


202.77
158.75
147.29
139.40
138.16
133.42
129.79
129.49
128.87
126.64
117.50
114.77
113.06
77.41
77.09
76.77
75.15
64.72
55.31
52.52
50.71
32.18
15.40
HN
Ph
O
OEt
O
Ph
6q
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.75
7.73
7.73
7.50
7.45
7.43
7.38
7.36
7.34
7.25
7.23
7.20
7.18
7.17
7.17
7.16
7.15
6.92
6.90
6.71
6.70
5.08
5.06
4.77
4.76
4.75
4.36
3.75
3.75
3.73
3.72
3.72
3.70
3.69
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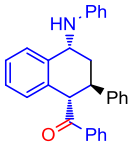
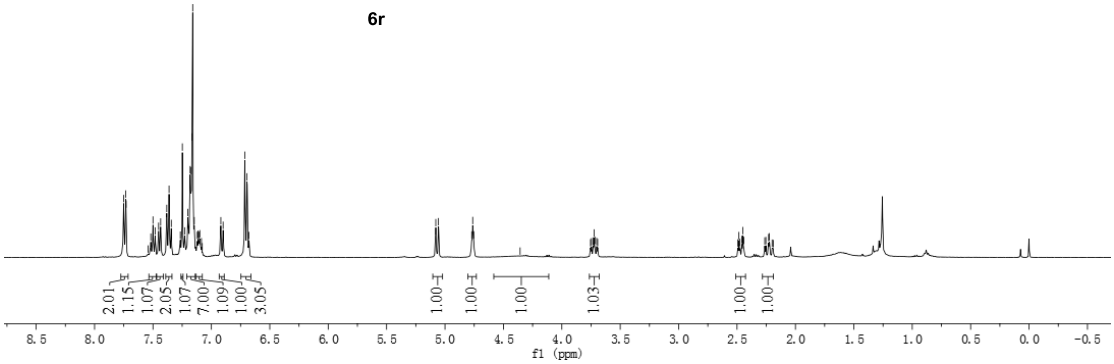
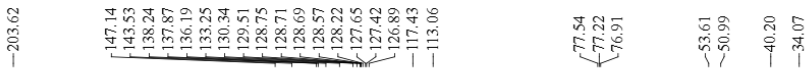
2.26
2.25
2.23
2.22
2.20
2.19


HN
Ph
Ph
O
Ph

6r


2.01
1.15
1.07
2.05
1.07
7.00
1.09
1.00
3.05
1.00
1.00
1.00
1.03
1.00
1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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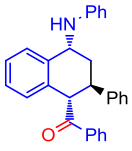
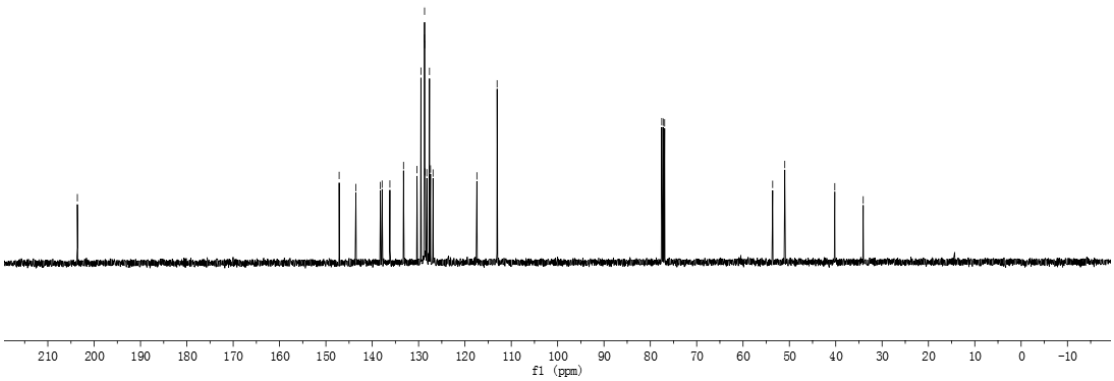
143.53
138.24
137.87
136.19
133.25
130.34
129.51
128.75
128.71
128.69
128.57
128.22
127.65
127.42
126.89
117.43
113.06
77.54
77.22
76.91
53.61
50.99
40.20
34.07


HN
Ph
Ph
O
Ph

6r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200
190
180
170
160
150
140
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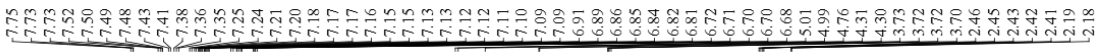
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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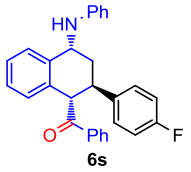
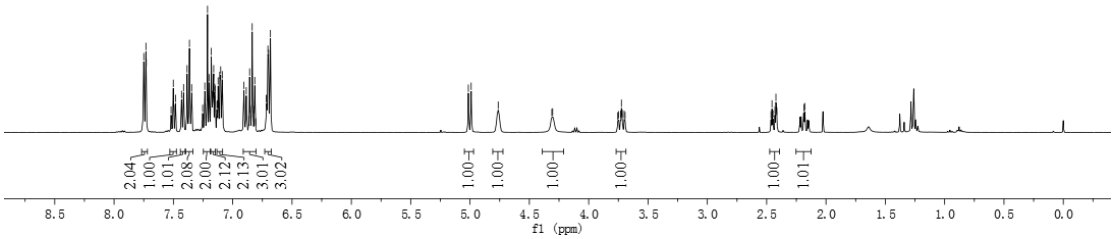
7.73
7.73
7.52
7.50
7.49
7.48
7.43
7.41
7.38
7.36
7.35
7.25
7.24
7.21
7.20
7.18
7.17
7.17
7.16
7.15
7.15
7.13
7.13
7.12
7.12
7.11
7.10
7.09
7.09
6.91
6.89
6.86
6.85
6.84
6.82
6.81
6.72
6.71
6.70
6.70
6.68
5.01
4.99
4.76
4.31
4.30
3.73
3.72
3.72
3.70
2.46
2.45
2.43
2.42
2.41
2.19
2.18


HN
Ph
O
Ph
F

6s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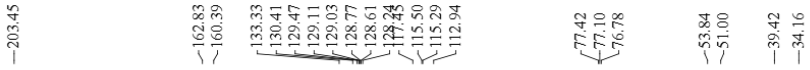
1.00
1.01
2.08
2.00
2.12
2.13
3.01
3.02
1.00
1.00
1.00
1.00
1.00
1.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


203.45
162.83
160.39
133.33
130.41
129.47
129.11
129.03
128.77
128.61
115.50
115.29
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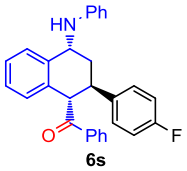
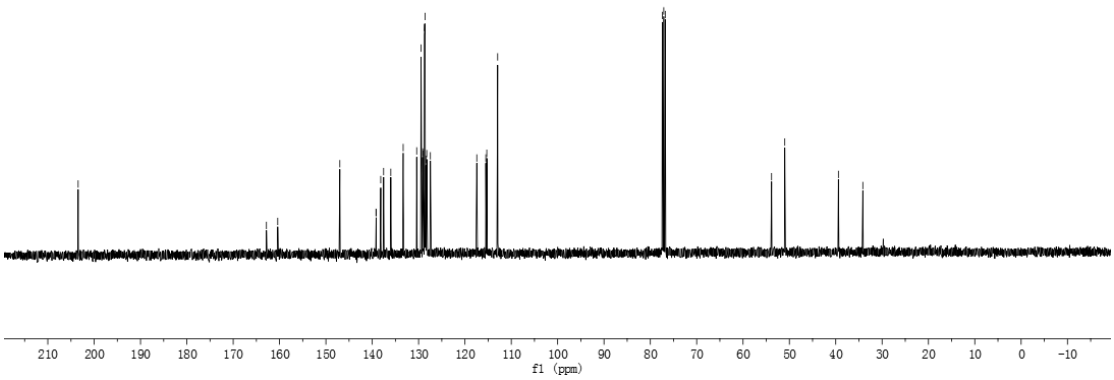
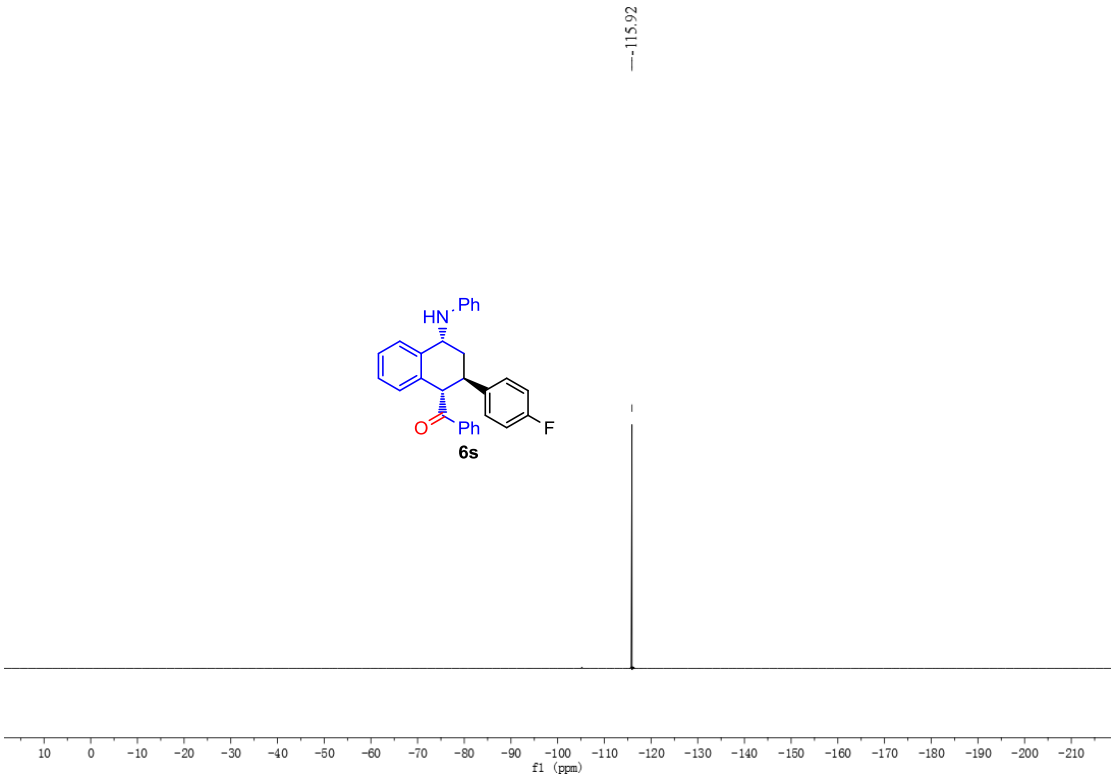
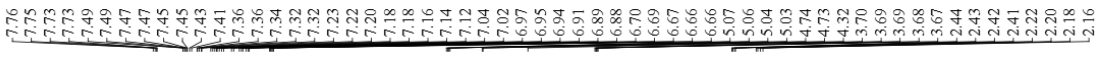
77.10
76.78
53.84
51.00
39.42
34.16

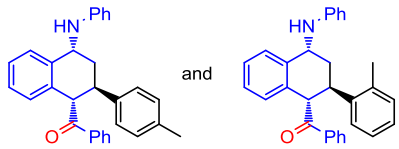

HN
Ph
O
Ph
F

6s

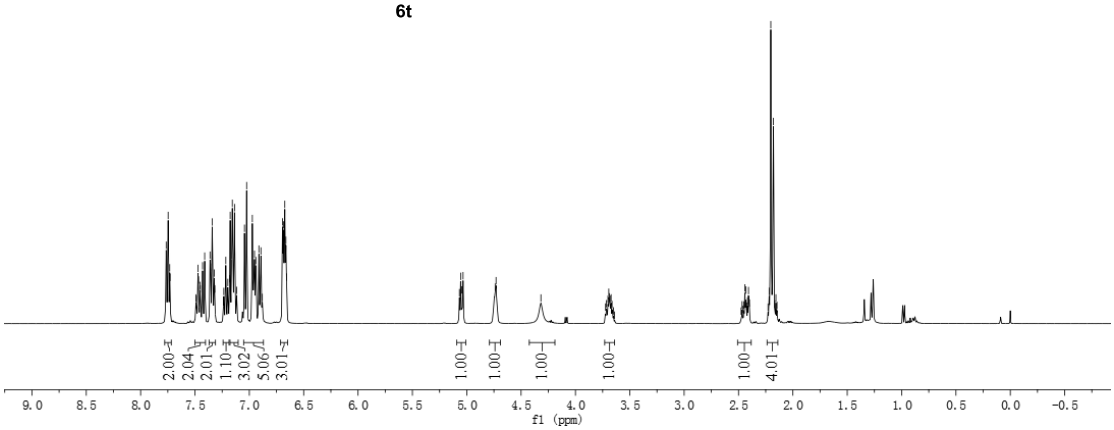

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

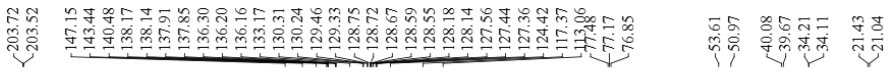

-115.92
HN
Ph
O
Ph
F
6s
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

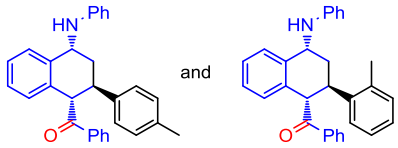




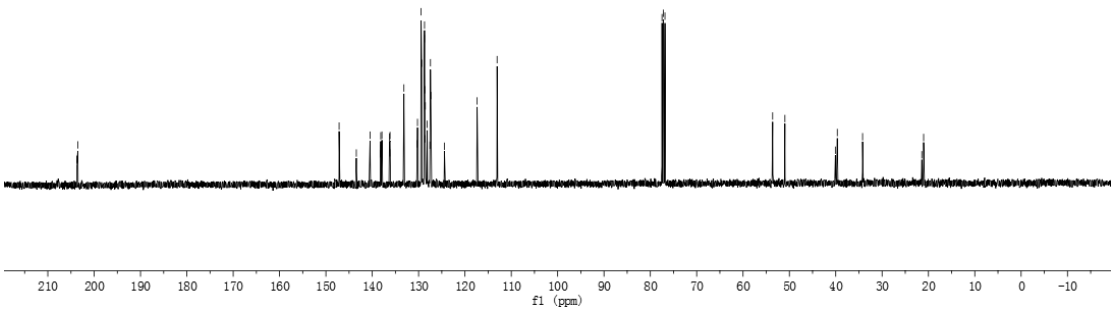
6t

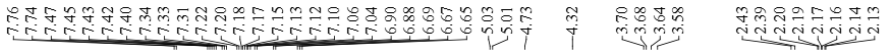


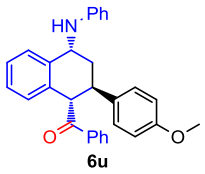




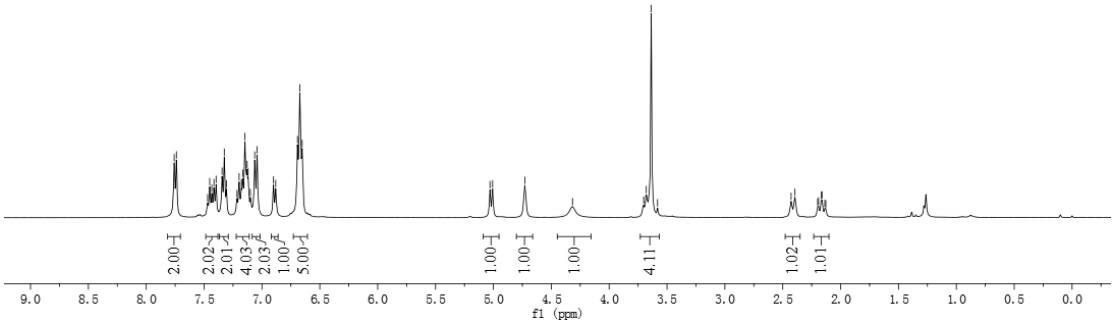
6t




7.76
7.74
7.47
7.45
7.43
7.42
7.40
7.34
7.33
7.31
7.22
7.20
7.18
7.17
7.15
7.13
7.12
7.10
7.06
7.04
6.90
6.88
6.69
6.67
6.65
5.03
5.01
4.73
4.32
3.70
3.68
3.64
3.58
2.43
2.39
2.20
2.19
2.17
2.16
2.14
2.13


HN
Ph
O
Ph
O

6u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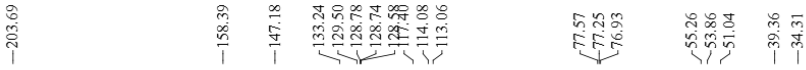
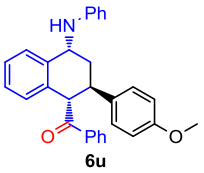
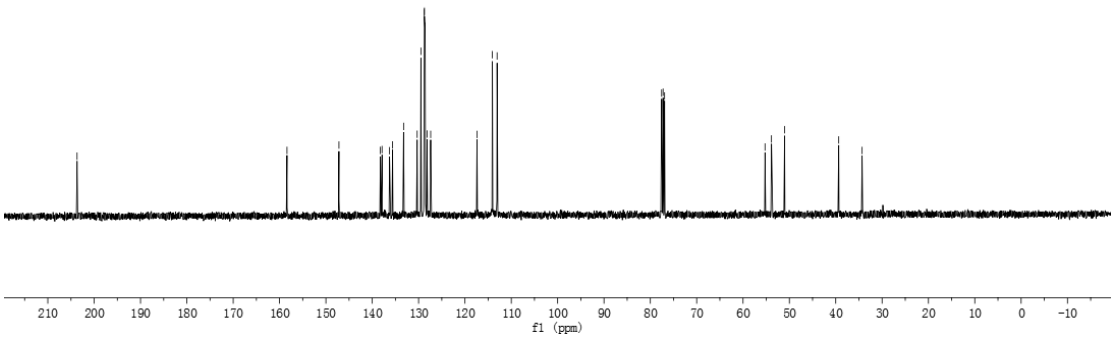
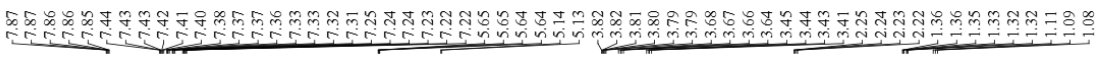
2.02
2.01
4.03
2.03
1.00
5.00
1.00
1.00
1.00
4.11
1.02
1.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

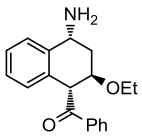

203.69
158.39
147.18
133.24
129.50
128.78
128.74
128.58
117.40
114.08
113.06
77.57
77.25
76.93
55.26
53.86
51.04
39.36
34.31


HN
Ph
O
Ph
O

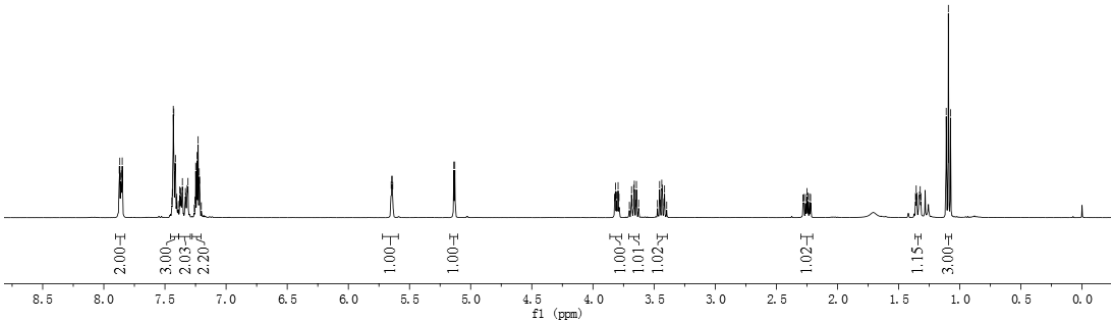
6u


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.87
7.87
7.86
7.86
7.85
7.44
7.43
7.43
7.42
7.41
7.40
7.38
7.37
7.37
7.36
7.33
7.33
7.32
7.31
7.25
7.24
7.24
7.23
7.22
7.22
5.65
5.65
5.64
5.64
5.14
5.13
3.82
3.82
3.81
3.80
3.79
3.79
3.68
3.67
3.66
3.64
3.45
3.44
3.43
3.41
2.25
2.24
2.23
2.22
1.36
1.36
1.35
1.33
1.32
1.32
1.11
1.09
1.08


NH2
OEt
O
Ph

7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3.00
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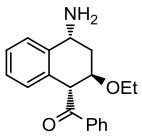
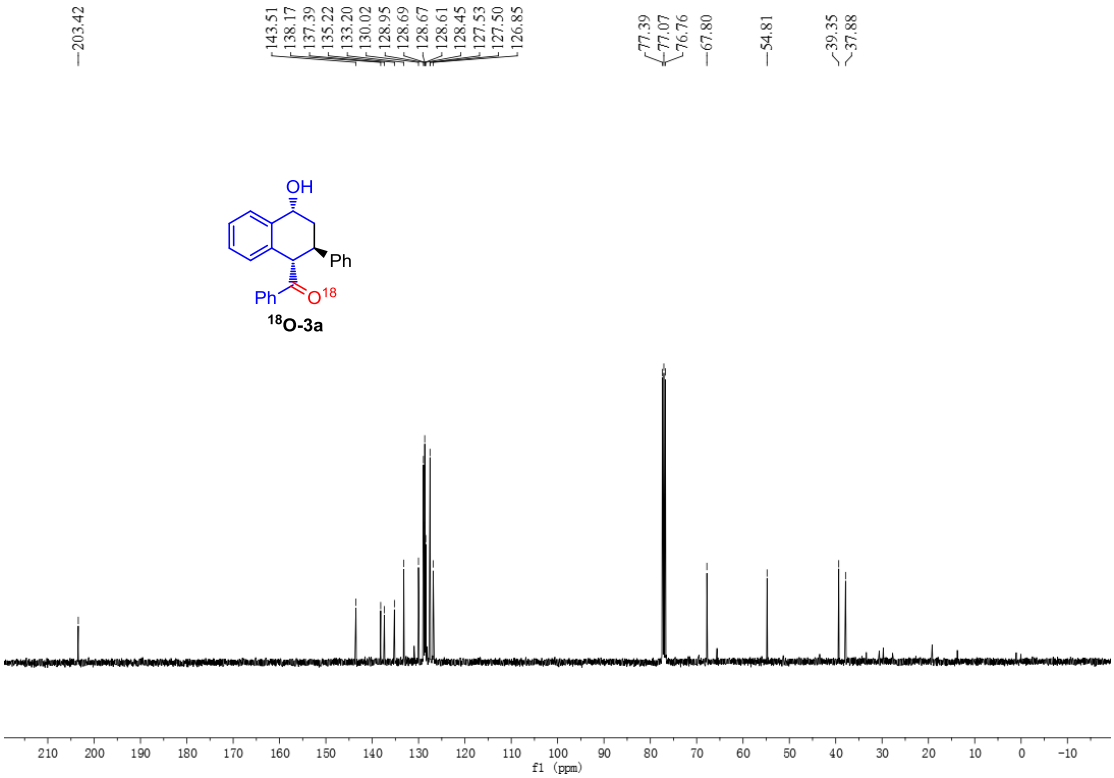
1.00
1.00
1.01
1.02
1.02
1.15
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


173.85
140.70
136.23
134.47
130.60
128.64
126.62
126.38
126.34
125.54
122.89
77.34
77.02
76.70
73.67
63.94
62.12
47.29
34.41
15.26


NH2
OEt
O
Ph

7

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)


203.42
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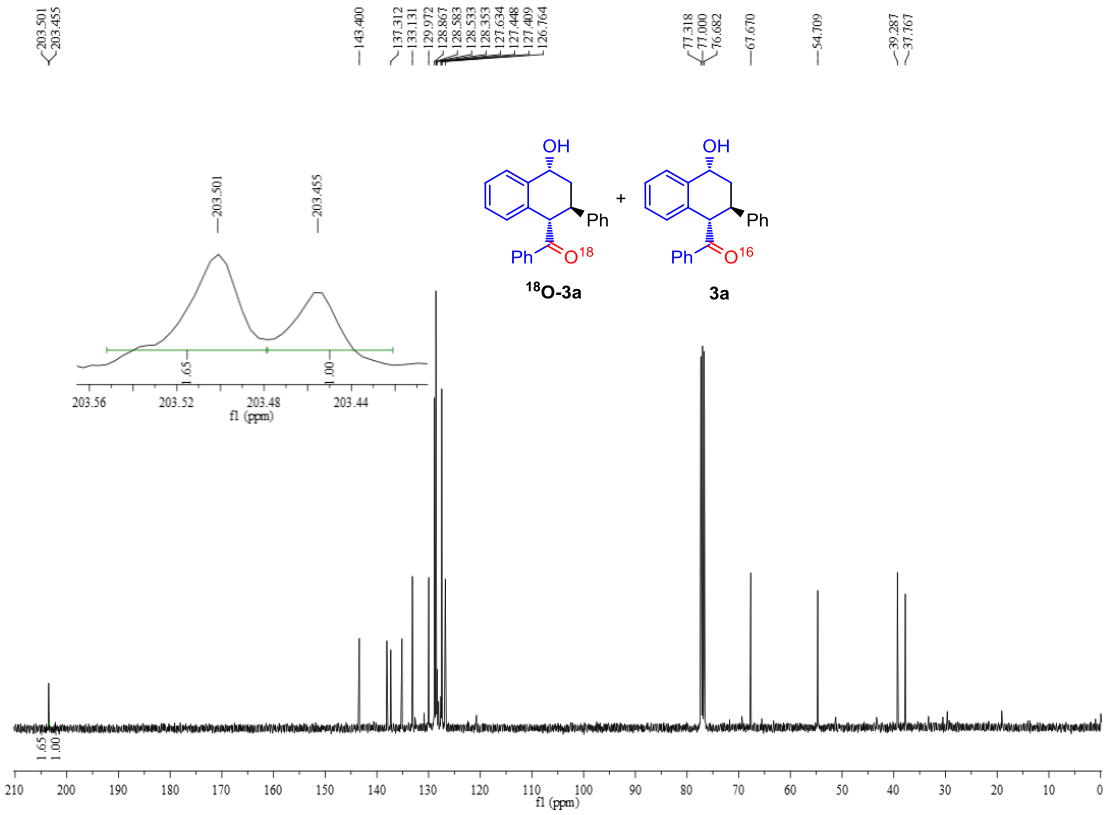
135.22
133.20
130.02
128.95
128.69
128.67
128.61
128.45
127.53
127.50
126.85
77.39
77.07
76.76
67.80
54.81
39.35
37.88
OH
Ph
Ph
O18
18O-3a
f1 (ppm)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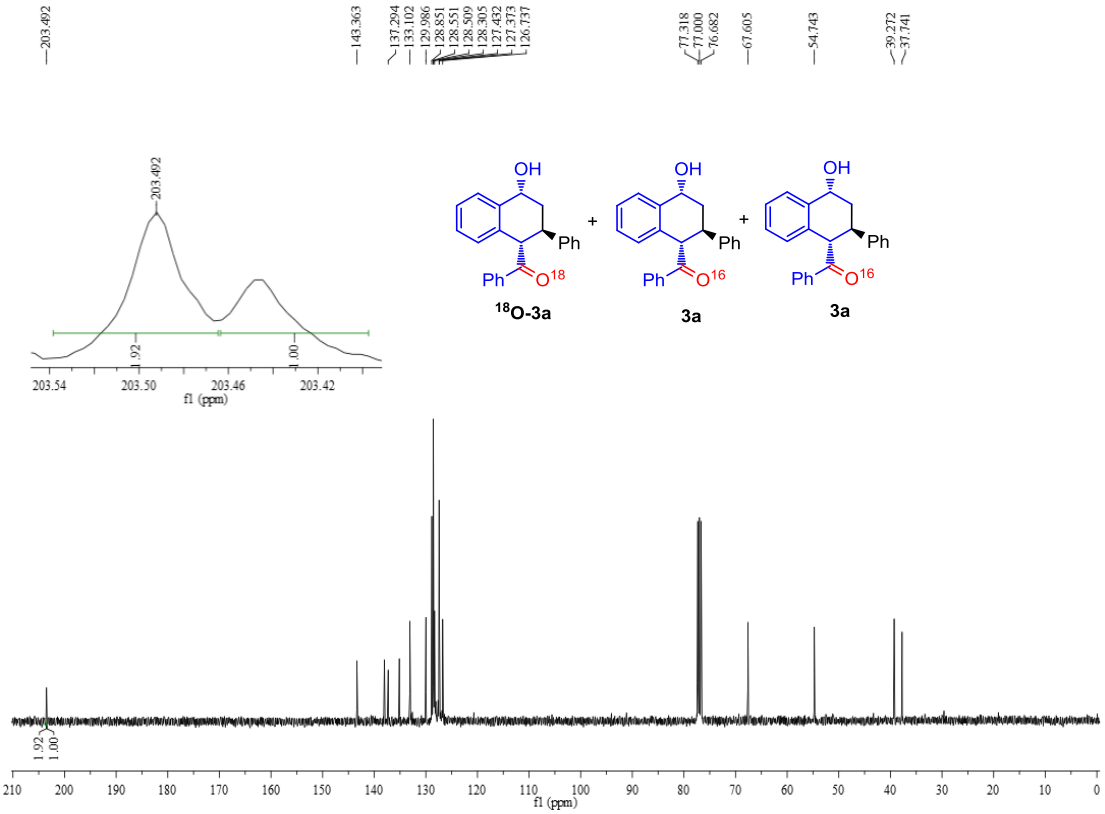
137.312
133.131
129.972
128.867
128.583
128.533
128.353
127.634
127.448
127.409
126.764
77.318
77.000
76.682
67.670
54.709
39.287
37.767
203.501
203.455
1.65
1.00
203.56
203.52
203.48
203.44
f1 (ppm)
OH
Ph
Ph
O18
18O-3a
+
OH
Ph
Ph
O16
3a
1.65
1.00
f1 (ppm)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128.851
128.551
128.509
128.305
127.432
127.373
126.737
77.318
77.000
76.682
67.605
54.743
39.272
37.741
203.492
1.92
1.00
203.54
203.50
203.46
203.42
f1 (ppm)
OH
Ph
Ph
O18
18O-3a
OH
Ph
Ph
O16
3a
OH
Ph
Ph
O16
3a
1.92
1.00
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)