SUPPORTING INFORMATION

Efficient Synthesis of Tetrahydrofurans with Chiral Tertiary Allylic Alcohols Catalyzed by Ni/P-Chiral Ligand DI-BIDIME

Yu Mu,[‡a] Tao Zhang,[‡a] Yaping Cheng,[a] Wenzhen Fu,[b] Zuting Wei,[a] Wanjun Chen[a] and Guodu Liu*[ab]

a. Key Laboratory of Fine Organic Synthesis of Inner Mongolia, College of Chemistry and Chemical Engineering, Inner Mongolia University, 235 Daxue West Rd, Hohhot 010021, China. Email: guoduliu@imu.edu.cn

b. State Key Laboratory of Bio-organic and Natural Products Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, 345 Ling Ling Rd, Shanghai 200032, China.

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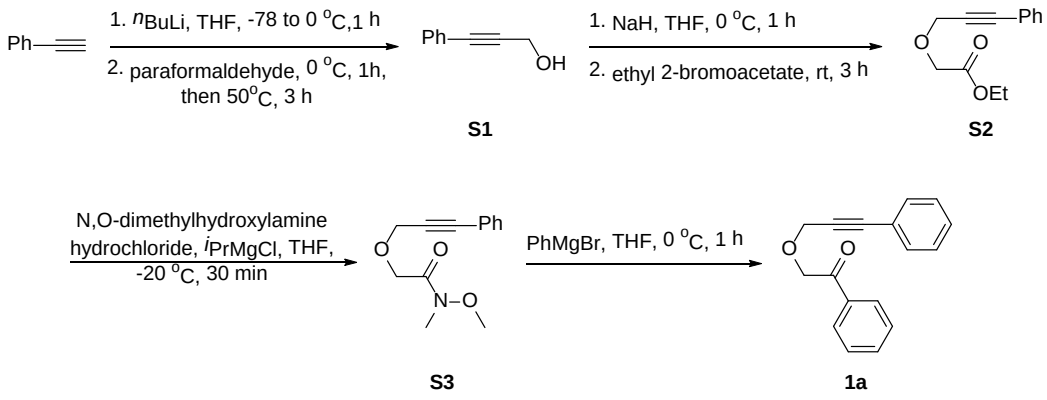
1. General Information and Materials

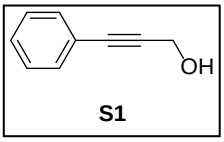
All reactions and manipulations were performed in a nitrogen-filled glove box or using standard Schlenk techniques, unless otherwise noted. All anhydrous solvents were purchased from J & K Chemicals or Alfa Chemicals Inc, or used after standard purification procedures. $Ni(cod)_2$ was purchased from Strem chemicals. Commercialized reagents were used without further purifications. All air sensitive ligands were stored in a nitrogen-filled glove box before use. Chiral ligand intermediates were prepared according to our reported procedures. cod = 1,5-cyclooctadiene.

^{1}H, and ^{13}C NMR data were recorded on a BrukerDRX500, DRX400, NMR Spectrometer with $CDCl_3$, or CD_3OD as the solvent. ^{1}H chemical shifts were referenced to $CDCl_3$ at 7.26 ppm. ^{13}C chemical shifts were referenced to $CDCl_3$ at 77.16 ppm and obtained with ^{1}H decoupling. ^{31}P shifts were referenced to 85% H_3PO_4 in D_2O at 0.0 ppm as external standard and obtained with ^{1}H decoupling. Multiplicities are abbreviated as follows: singlet (s), doublet (d), triplet (t), quartet (q), doublet-doublet (dd), quintet (quint), septet (sept), multiplet (m), and broad (br). MS was measured on Agilent 5973N (EI), Agilent 1100 Series LC/MSD (ESI) mass spectrometers. Column chromatography was performed with silica gel (200-300 mesh). X-Ray crystallographic analysis data were collected using a Bruker Smart-APEX instrument (CCD detector) or a Bruker Kappa APEX-II instrument (CCD detector). HPLC analyses and purifications were performed on a Thermo Fisher LC system with UV/VIS detector using chiralcel columns.

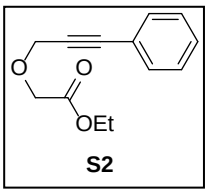
2. Substrates Synthesis

Scheme 1. General procedure for substrate 1a



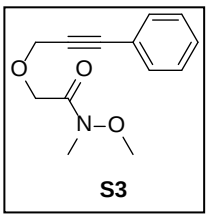


Phenylprop-2-yn-1-ol (S1). To a solution of phenylacetylene (22.0 mL, 200 mmol, 1.00 equiv) in THF (150 mL) at -78 °C was added dropwise *n*BuLi (84.0 mL, 210 mmol, 1.05 equiv, 2.5 M) in hexanes over 1 h under nitrogen. The resulting mixture was warmed to 0 °C and paraformaldehyde (7.87 g, 240 mmol, 1.20 equiv) was added. After stirred at rt for 1 h, the mixture was heated to 50 °C and stirred for 3 h, then cooled to rt, quenched with saturated NH_4Cl solution (500 mL), extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 20/1) to provide compound **S1** as light yellow oil (**S1**, 20.6 g, 78% yield). **S1**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47-7.40 (m, 2H), 7.34-7.27 (m, 3H), 4.50 (s, 2H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[1,5] **S1** was prepared according to literature procedure.[5]



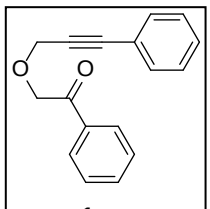
Ethyl 2-((3-phenylprop-2-yn-1-yl)oxy)acetate (S2). To a solution of NaH (4.32 g, 108.2 mmol, 1.20 equiv, 60% content) in THF (150 mL) at 0 °C was added 3-phenylprop-2-yn-1-ol (**S1**, 12.5 g, 94.6 mmol, 1.05 equiv) under nitrogen. Until no gas was generated, the mixture was allowed to warm up to rt and stirred for 1 h. Then ethyl 2-bromoacetate (10.0 mL, 90.2 mmol, 1.00 equiv) was added at rt under nitrogen. After stirred at rt for 3 h, the reaction was quenched with saturated NH_4Cl solution, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 15/1) to afford compound **S2** as light yellow oil (**S2**, 14.7 g, 75%). **S2**: ^{1}H NMR (500 MHz, CDCl3) δ 7.45 (dd, J = 7.5, 2.0 Hz, 2H), 7.33 (t, J = 5.9 Hz, 3H), 4.54 (s, 2H), 4.24 (dd, J = 13.3,

6.2 Hz, 4H), 1.30 (t, J = 7.2 Hz, 3H).The ^{1}H NMR spectra is in agreement with these reported in the literature.[2,5] **S2** was prepared according to literature procedure.[5]



S3

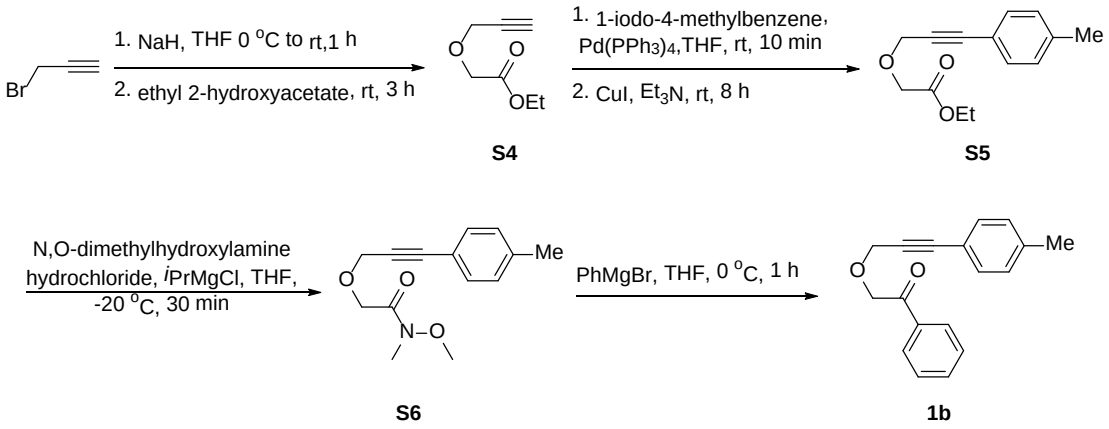
Methoxy-N-methyl-2-((3-phenylprop-2-yn-1-yl)oxy)acetamide (S3). To a solution of ethyl 2-((3-phenylprop-2-yn-1-yl)oxy)acetate (**S2**, 8.7 g, 40.0 mmol, 1.00 equiv) and N,O- dimethylhydroxylamine hydrochloride (6.5 g, 60.0 mmol, 1.50 equiv) in THF (150 mL) at -20 ^{o}C was added dropwise *i*PrMgCl (90.0 mL, 180 mmol, 3.00 equiv, 2.0 M) in THF over 30 min under nitrogen. The mixture was stirred at -20 ^{o}C for 30 min, then quenched with saturated NH_4Cl solution, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 5/1 to 3/1) to afford **S3** as white solid (**S3**, 6.16 g, 66% yield). **S3**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (dd, J = 7.4, 2.3 Hz, 2H), 7.35 – 7.29 (m, 3H), 4.57 (s, 2H), 4.46 (s, 2H), 3.71 (s, 3H), 3.21 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[2,5] **S3** was prepared according to literature procedure.[5]

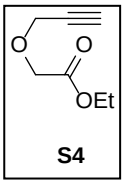


1a

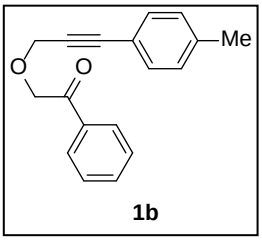
Phenyl-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1a). To a solution of N-methoxy-N-methyl-2-((3-phenylprop-2-yn-1-yl)oxy)acetamide (**S3**, 500 mg, 2.14 mmol, 1.00 equiv) in THF (10 mL) at 0 ^{o}C under nitrogen was added PhMgBr (3.2 mL, 3.21 mml, 1.5 equiv, 1.0 M) in THF. After stirred at 0 ^{o}C for 1 h, the reaction was quenched with 2 M HCl, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 20/1) to afford compound **1a** as white solid (498 mg, 93% yield). **1a**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (m, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.44 (dd, *J* = 7.5, 1.8 Hz, 2H), 7.35 – 7.27 (m, 3H), 4.94 (s, 2H), 4.60 (s, 2H). ^{1}H NMR spectra is in agreement with these reported in the literature.[3,5] **1a** was prepared according to literature procedure.[5]

Scheme 2. Synthetic Procedures for Substrate 1b



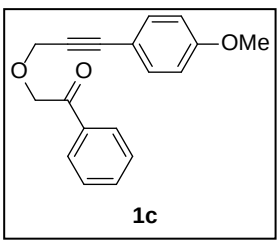


Ethyl 2-(prop-2-yn-1-yloxy)acetate (S4). To a solution of NaH (693 mg, 17.4 mmol, 1.00 equiv, 60% content) in THF (60 mL) at 0 °C was added dropwise ethyl 2-hydroxyacetate (1.64 mL, 17.4 mmol, 1.00 equiv) under nitrogen. Until no gas was generated, the mixture was allowed to warm up to rt and stirred for 1 h. Then 3-bromoprop-1-yne (1.80 mL, 20.9 mmol, 1.20 equiv) was added. After stirred at rt for 3 h, the reaction was quenched with saturated NH_4Cl solution, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 50/1) to afford colorless oil (**S4**, 1.98 g, 80%). **S4**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (dd, J = 7.4, 2.3 Hz, 2H), 7.35 – 7.29 (m, 3H), 4.57 (s, 2H), 4.46 (s, 2H), 3.71 (s, 3H), 3.21 (s, 3H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[4,5] **S4**, **S5**, **S6** and **1b** was prepared according to literature procedure.[5]



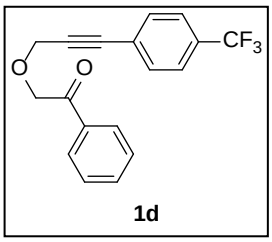
phenyl-2-((3-(p-tolyl)prop-2-yn-1-yl)oxy)ethan-1-one (1b): white solid, 95% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.4 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 7.9 Hz, 2H), 4.94 (s, 2H), 4.59 (s, 2H), 2.35 (s, 3H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

Preparation of **1c**-**1s** were carried out according to a procedure similar to that for the synthesis of **1b** from corresponding aryl iodides.

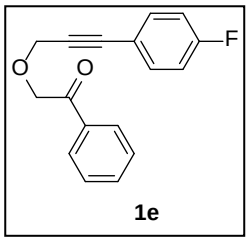


2-((3-(4-methoxyphenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1c): white solid, 79% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 8.3, 1.1 Hz, 2H), 7.62 – 7.55 (m, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.41 – 7.34 (m, 2H), 6.88 – 6.78 (m, 2H), 4.93 (s, 2H), 4.59 (s, 2H), 3.81 (s, 3H). The ^{1}H NMR spectra is in agreement with these reported in the

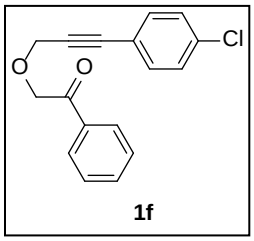
literature.[5]



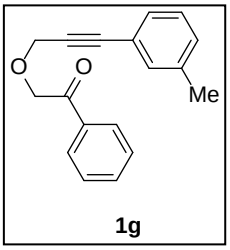
1-phenyl-2-((3-(4-(trifluoromethyl)phenyl)prop-2-yn-1-yl)oxy)ethan-1-one (1d):white solid, 74% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.6 Hz, 2H), 7.60 (t, *J* = 7.5 Hz, 1H), 7.59 – 7.51 (m, 4H), 7.49 (t, *J* = 7.7 Hz, 2H), 4.94 (s, 2H), 4.62 (s, 2H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



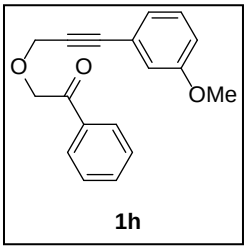
2-((3-(4-fluorophenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1e): white solid, 93% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 – 7.91 (m, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.7 Hz, 2H), 7.45 – 7.38 (m, 2H), 7.04 – 6.94 (m, 2H), 4.93 (s, 2H), 4.59 (s, 2H). ^{13}C NMR (126 MHz, CDCl3) δ 195.7, 163.7, 161.7, 134.9, 133.8, 133.7, 133.7, 128.8, 127.9, 118.4, 115.7, 115.5, 86.3, 83.9, 71.8, 59.2. HRMS (ESI) calculated for [M+Na, $C_{17}H_{13}NaFO_2$]$^+$:291.0792; found: 291.0792.



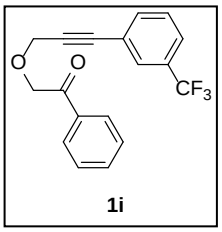
2-((3-(4-chlorophenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1f): white solid, 76% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 8.3, 1.2 Hz, 2H), 7.64 – 7.56 (m, 1H), 7.48 (t, *J* = 7.8 Hz, 2H), 7.40 – 7.32 (m, 2H), 7.32 – 7.27 (m, 2H), 4.92 (s, 2H), 4.59 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.6, 134.8, 134.8, 133.7, 133.0, 128.8, 128.7, 127.9, 120.8, 86.2, 85.2, 71.9, 59.2. HRMS (ESI) calculated for [M+Na, $C_{17}H_{13}NaClO_2$]$^+$: 307.0496; found: 307.0499.



1-phenyl-2-((3-(m-tolyl)prop-2-yn-1-yl)oxy)ethan-1-one (1g): light yellow oil, 84% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 – 7.92 (m, 2H), 7.62 – 7.54 (m, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.24 (d, *J* = 9.6 Hz, 2H), 7.19 (t, *J* = 7.5 Hz, 1H), 7.13 (d, *J* = 7.5 Hz, 1H), 4.93 (s, 2H), 4.59 (s, 2H), 2.31 (s, 3H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

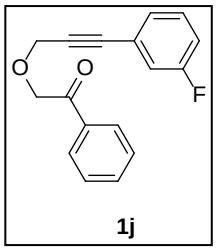


2-((3-(3-methoxyphenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1h): colorless oil, 76% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 – 7.88 (m, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 2H), 7.21 (t, *J* = 8.0 Hz, 1H), 7.03 (d, *J* = 7.6 Hz, 1H), 6.97 (d, *J* = 2.3 Hz, 1H), 6.88 (dd, *J* = 8.3, 2.5 Hz, 1H), 4.94 (s, 2H), 4.60 (s, 2H), 3.78 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.7, 159.3, 134.9, 133.6, 129.4, 128.8, 127.9, 124.3, 123.3, 116.7, 115.2, 87.3, 84.0, 71.8, 59.2, 55.3; HRMS (ESI) calculated for [M+Na, $C_{18}H_{16}NaO_3$]$^+$: 303.0992; found: 303.1008.



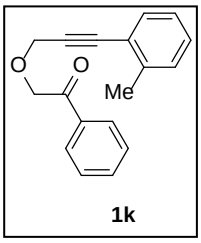
1i

1-phenyl-2-((3-(3-(trifluoromethyl)phenyl)prop-2-yn-1-yl)oxy)ethan-1-one (1i): colorless oil, 86% yield; ^{1}H NMR (500 MHz, cdcl$_3$) δ 7.99 – 7.93 (m, 2H), 7.68 (s, 1H), 7.63 – 7.56 (m, 3H), 7.51 – 7.46 (m, 2H), 7.44 (t, *J* = 7.8 Hz, 1H), 4.94 (s, 2H), 4.61 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.6, 134.9, 134.8, 133.7, 131.1, 130.8, 128.9, 128.8, 128.6 (q, J = 3.8 Hz), 127.9, 125.2 (q, J = 3.7 Hz), 123.3, 85.9, 85.8, 72.0, 59.1. HRMS (ESI) calculated for [M+Na, $C_{18}H_{13}NaF_3O_2$]$^+$: 341.0760; found: 341.0761.



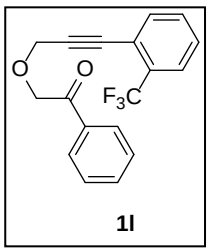
1j

2-((3-(3-fluorophenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1j):light yellow oil, 78% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (dd, *J* = 8.3, 1.1 Hz, 2H), 7.64 – 7.54 (m, 1H), 7.47 (t, *J* = 7.8 Hz, 2H), 7.27 (td, *J* = 7.8, 5.8 Hz, 1H), 7.21 (dt, *J* = 7.7, 1.1 Hz, 1H), 7.12 (ddd, *J* = 9.4, 2.4, 1.4 Hz, 1H), 7.03 (tdd, *J* = 8.5, 2.6, 1.0 Hz, 1H), 4.93 (s, 2H), 4.59 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.6, 163.3, 161.3, 134.8, 133.7, 129.9, 128.8, 127.9, 127.7, 124.2, 118.7, 118.5, 116.1, 115.9, 86.1, 85.2, 71.9, 59.1.; HRMS (ESI) calculated for [M+Na, $C_{17}H_{13}NaFO_2$]$^+$: 291.0792; found: 291.0796.



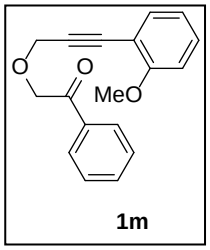
1k

1-phenyl-2-((3-(o-tolyl)prop-2-yn-1-yl)oxy)ethan-1-one (1k): light yellow oil, 83% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (m, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.40 (d, *J* = 7.7 Hz, 1H), 7.24 – 7.17 (m, 2H), 7.13 (t, *J* = 7.3 Hz, 1H), 4.96 (s, 2H), 4.65 (s, 2H), 2.42 (s, 3H). The ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

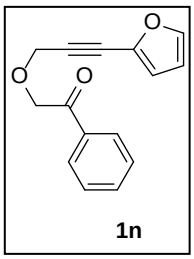


1l

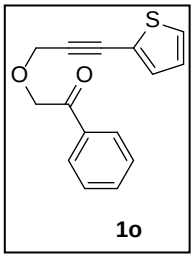
1-phenyl-2-((3-(2-(trifluoromethyl)phenyl)prop-2-yn-1-yl)oxy)ethan-1-one (1l): colorless oil, 81% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 – 7.91 (m, 2H), 7.65 (d, *J* = 7.8 Hz, 1H), 7.59 (t, *J* = 7.3 Hz, 2H), 7.52 – 7.45 (m, 3H), 7.42 (t, *J* = 7.7 Hz, 1H), 4.98 (s, 2H), 4.65 (s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 195.6, 134.8, 134.1, 133.7, 131.8, 131.5, 129.6, 128.8, 128.4, 127.9, 125.85 (q, J = 5.1 Hz), 124.9, 122.2, 120.6, 90.0, 83.4, 71.6, 59.0.; HRMS (ESI) calculated for [M+Na, $C_{18}H_{13}NaF_3O_2$]$^+$: 341.0760; found: 341.0758.



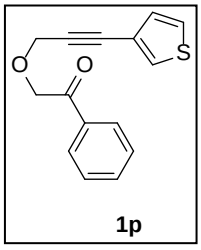
2-((3-(2-methoxyphenyl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1m): white solid, 70% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 8.3, 1.2 Hz, 2H), 7.63 – 7.54 (m, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.40 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.30 (td, *J* = 8.4, 1.7 Hz, 1H), 6.90 (td, *J* = 7.5, 0.8 Hz, 1H), 6.87 (d, *J* = 8.4 Hz, 1H), 4.98 (s, 2H), 4.66 (s, 2H), 3.84 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.9 , 160.2, 135.0, 133.7, 133.5, 130.1, 128.7, 128.0, 120.4, 111.5, 110.6, 88.2, 84.0, 71.6, 59.4, 55.7.; HRMS (ESI) calculated for [M+Na, $C_{18}H_{16}NaO_3$]$^+$: 303.0992; found: 303.1009.



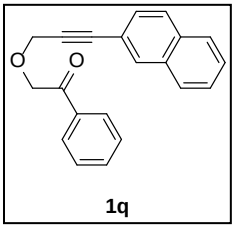
2-((3-(furan-2-yl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1n):light yellow oil, 82% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 – 7.88 (m, 2H), 7.59 (tt, 1H), 7.52 – 7.43 (m, 2H), 7.38 (dd, *J* = 1.8, 0.6 Hz, 1H), 6.61 (d, *J* = 3.4 Hz, 1H), 6.38 (dd, *J* = 3.4, 1.9 Hz, 1H), 4.92 (s, 2H), 4.62 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.5, 143.9, 136.2, 134.8, 133.7, 128.8, 127.9, 116.1, 110.9, 88.8, 77.7, 71.7, 59.1. HRMS (ESI) calculated for [M+Na, $C_{15}H_{12}NaO_3$]$^+$: 263.0679; found: 263.0685.



1-phenyl-2-((3-(thiophen-2-yl)prop-2-yn-1-yl)oxy)ethan-1-one (1o):light yellow oil, 77% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 – 7.89 (m, 2H), 7.62 – 7.53 (m, 1H), 7.47 (t, *J* = 7.8 Hz, 2H), 7.24 (ddd, 2H), 6.97 (dd, *J* = 5.1, 3.7 Hz, 1H), 4.92 (s, 2H), 4.61 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.7, 134.8, 133.7, 132.7, 128.8, 127.9, 127.7, 127.0, 122.2, 88.2 , 80.7, 71.8, 59.3. HRMS (ESI) calculated for [M+Na, $C_{15}H_{12}NaSO_2$]$^+$:279.0450; found: 279.0470.

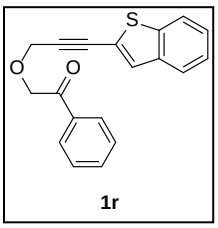


1-phenyl-2-((3-(thiophen-3-yl)prop-2-yn-1-yl)oxy)ethan-1-one (1p):light yellow oil, 71% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.95 (dd, *J* = 8.3, 1.2 Hz, 2H), 7.65 – 7.54 (m, 1H), 7.52 – 7.42 (m, 3H), 7.25 (dd, *J* = 5.0, 3.0 Hz, 1H), 7.10 (dd, *J* = 5.0, 1.1 Hz, 1H), 4.92 (s, 2H), 4.58 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.8, 134.8, 133.7, 129.9, 129.5, 128.8, 127.9, 125.4, 121.4, 83.9, 82.5, 71.8, 59.3. HRMS (ESI) calculated for [M+Na, $C_{15}H_{12}NaSO_2$]$^+$: 279.0450; found: 279.0449.



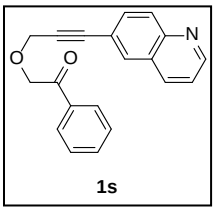
1q

2-((3-(naphthalen-2-yl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1q): white solid, 95% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 7.4, 6.2 Hz, 3H), 7.79 (ddd, *J* = 13.1, 7.1, 3.6 Hz, 3H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.53 – 7.41 (m, 5H), 4.97 (s, 2H), 4.65 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.8, 134.9, 133.6, 133.0, 133.9, 131.9, 128.8, 128.4, 128.0, 127.9, 127.8 , 127.8, 126.9, 126.6, 119.6, 87.7, 84.5, 71.9, 59.4. HRMS (ESI) calculated for [M+Na, $C_{21}H_{16}NaO_2$]$^{+}$: 323.1043; found: 323.1053.



1r

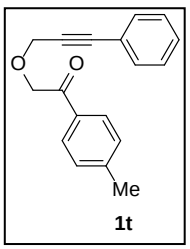
2-((3-(benzo[b]thiophen-2-yl)prop-2-yn-1-yl)oxy)-1-phenylethan-1-one (1r):white solid, 73% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 – 7.92 (m, 2H), 7.78 – 7.70 (m, 2H), 7.62 – 7.55 (m, 1H), 7.51 – 7.42 (m, 3H), 7.39 – 7.32 (m, 2H), 4.94 (s, 2H), 4.64 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.6, 140.3, 138.9, 134.8, 133.7, 129.6, 128.8, 128.0, 125.7, 124.8, 123.9, 122.1, 122.0, 90.1, 80.9, 71.9, 59.3. HRMS (ESI) calculated for [M+Na, $C_{19}H_{14}NaSO_2$]$^{+}$: 329.0607; found: 329.0608.



1s

1-phenyl-2-((3-(quinolin-6-yl)prop-2-yn-1-yl)oxy)ethan-1-one (1s): white solid, 86% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.91 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.10 (d, *J* = 8.3 Hz, 1H), 8.04 (d, *J* = 8.7 Hz, 1H), 7.98 (dd, *J* = 8.3, 1.1 Hz, 2H), 7.93 (d, *J* = 1.5 Hz, 1H), 7.71 (dd, *J* = 8.7, 1.8 Hz, 1H), 7.63 – 7.56 (m, 1H), 7.48 (dd, *J* = 10.8, 4.7 Hz, 2H), 7.41 (q, *J* = 8.3, 4.2 Hz, 1H), 4.97 (s, 2H), 4.66 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.7, 151.2, 147.9, 135.8, 134.9, 133.7, 132.1, 131.6, 129.7, 128.8, 127.9, 121.8, 120.6, 86.9, 85.5, 71.9, 59.3. HRMS (ESI) calculated for [M+Na, $C_{20}H_{15}NaNO_2$]$^{+}$: 324.0995; found: 324.1047.

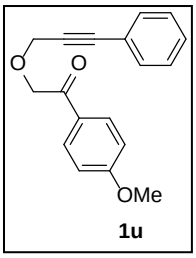
Preparation of **1t-1am** were carried out according to a procedure similar to that for the synthesis of **1a** from corresponding magnesium reagents.



1t

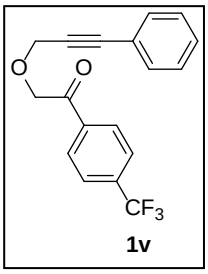
2-((3-phenylprop-2-yn-1-yl)oxy)-1-(p-tolyl)ethan-1-one (1t): white solid, 95% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (dd, *J* = 6.9, 5.5 Hz, 2H), 7.48 – 7.41 (m, 2H), 7.37 (dd, *J* = 14.6, 7.5 Hz, 2H), 7.33 – 7.27 (m, 3H), 4.93 (s, 2H),

4.60 (s, 2H), 2.40 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



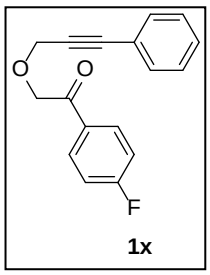
1u

1-(4-methoxyphenyl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1u): white solid, 85% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.99 – 7.91 (m, 2H), 7.44 (dd, *J* = 7.4, 2.0 Hz, 2H), 7.36 – 7.27 (m, 3H), 6.99 – 6.89 (m, 2H), 4.88 (s, 2H), 4.59 (s, 2H), 3.86 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



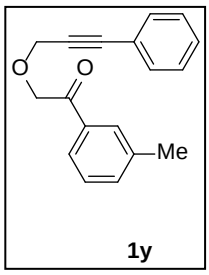
1v

2-((3-phenylprop-2-yn-1-yl)oxy)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (1v): white solid, 64% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.23 (s, 1H), 8.16 (d, *J* = 7.8 Hz, 1H), 7.84 (d, *J* = 7.8 Hz, 1H), 7.62 (t, *J* = 7.8 Hz, 1H), 7.43 (dd, *J* = 7.6, 1.7 Hz, 2H), 7.38 – 7.28 (m, 3H), 4.92 (s, 2H), 4.60 (s, 2H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



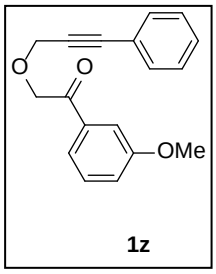
1x

1-(4-fluorophenyl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1x): white solid, 53% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 – 7.96 (m, 2H), 7.43 (dd, *J* = 7.6, 1.8 Hz, 2H), 7.38 – 7.27 (m, 3H), 7.18 – 7.11 (m, 2H), 4.88 (s, 2H), 4.59 (s, 2H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



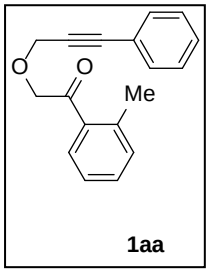
1y

2-((3-phenylprop-2-yn-1-yl)oxy)-1-(m-tolyl)ethan-1-one (1y): colorless oil, 73% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.2 Hz, 2H), 7.51 – 7.38 (m, 2H), 7.37 – 7.28 (m, 3H), 7.26 (d, *J* = 8.0 Hz, 2H), 4.91 (s, 2H), 4.59 (s, 2H), 2.41 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

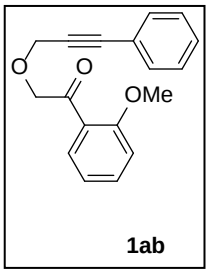


1z

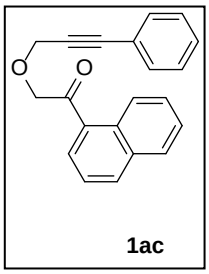
1-(3-methoxyphenyl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1z): white solid, 77% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.7 Hz, 1H), 7.50 – 7.48 (m, 1H), 7.44 (dd, *J* = 7.5, 1.9 Hz, 2H), 7.38 (t, *J* = 7.9 Hz, 1H), 7.35 – 7.28 (m, 3H), 7.13 (dd, *J* = 8.2, 2.6 Hz, 1H), 4.92 (s, 2H), 4.60 (s, 2H), 3.85 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.6, 160.0, 136.2, 131.8, 129.8, 128.6, 128.3, 122.4, 120.4, 120.2, 112.2, 87.4, 84.1, 71.8, 59.3, 55.5.; HRMS (ESI) calculated for [M+Na, $C_{18}H_{16}NaO_3$]$^+$: 303.0992; found:303.1012.



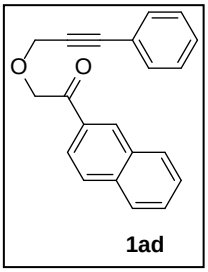
3-((3-phenylprop-2-yn-1-yl)oxy)-1-(o-tolyl)ethan-1-one (1aa): colorless oil, 94% yield; ^{1}H NMR (500 MHz, cdcl$_3$) δ 7.61 (d, *J* = 7.7 Hz, 1H), 7.44 (dd, *J* = 7.5, 1.8 Hz, 2H), 7.39 (t, *J* = 7.5 Hz, 1H), 7.31 (t, *J* = 6.0 Hz, 3H), 7.26 (d, *J* = 8.1 Hz, 2H), 4.79 (s, 2H), 4.58 (s, 2H), 2.52 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



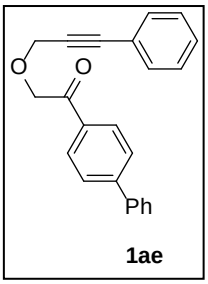
(2-methoxyphenyl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1ab): white solid, 87% yield; ^{1}H NMR (500 MHz, CDCl$_3$) δ 7.91 (dd, *J* = 7.7, 0.8 Hz, 1H), 7.53 – 7.48 (m, 1H), 7.44 (dd, *J* = 6.9, 1.7 Hz, 2H), 7.38 – 7.27 (m, 3H), 7.04 (t, *J* = 7.5 Hz, 1H), 6.98 (d, *J* = 8.4 Hz, 1H), 4.87 (d, *J* = 0.7 Hz, 2H), 4.59 (s, 2H), 3.92 (s, 3H). ^{13}C NMR (126 MHz, CDCl$_3$) δ 197.2, 159.2, 134.4, 131.8, 130.8, 128.5, 128.3, 125.3, 122.6, 121.0, 111.5, 86.8, 84.8, 75.6, 59.1, 55.6; HRMS (ESI) calculated for [M+Na, $C_{18}H_{16}NaO_3$]$^{+}$:303.0992; found:303.1035.



1-(naphthalen-1-yl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1ac): light yellow oil, 87% yield ;^{1}H NMR (500 MHz, CDCl$_3$) δ 8.64 (d, *J* = 8.4 Hz, 1H), 8.01 (d, *J* = 8.2 Hz, 1H), 7.92 – 7.81 (m, 2H), 7.61 – 7.51 (m, 2H), 7.49 (dd, *J* = 8.0, 7.4 Hz, 1H), 7.43 (dd, *J* = 7.6, 1.8 Hz, 2H), 7.34 – 7.26 (m, 3H), 4.93 (s, 2H), 4.63 (s, 2H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

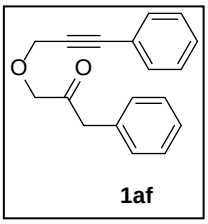


1-(naphthalen-2-yl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1ad): light yellow oil, 90% yield; ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.48 (s, 1H), 8.01 (dd, *J* = 8.6, 1.7 Hz, 1H), 7.94 (d, *J* = 8.1 Hz, 1H), 7.88 (dd, *J* = 15.2, 8.4 Hz, 2H), 7.57 (dddd, *J* = 28.0, 8.1, 6.9, 1.2 Hz, 2H), 7.46 – 7.42 (m, 2H), 7.34 – 7.26 (m, 3H), 5.06 (s, 2H), 4.64 (s, 2H). ^{13}C NMR (126 MHz, CDCl$_3$) δ 195.9, 136.0, 132.6, 132.3, 131.9, 129.8, 128.8, 128.7, 128.5, 128.0, 127.9, 127.0, 125.9, 123.7, 122.5, 87.5, 84.3, 72.1, 59.5. HRMS (ESI) calculated for [M+Na, $C_{21}H_{16}NaO_2$]$^{+}$: 323.1045; found: 323.1065.



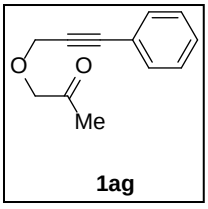
1ae

1-([1,1'-biphenyl]-4-yl)-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1ae): white solid, 86% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.4 Hz, 2H), 7.69 (d, *J* = 8.4 Hz, 2H), 7.62 (dd, *J* = 5.2, 3.4 Hz, 2H), 7.50 – 7.37 (m, 5H), 7.35 – 7.27 (m, 3H), 4.96 (s, 2H), 4.62 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 195.4, 146.3, 139.8, 133.6, 131.8, 129.0, 128.7, 128.4, 127.4, 127.3, 122.4, 87.4, 84.2, 71.9, 59.3. HRMS (ESI) calculated for [M+Na, $C_{23}H_{18}NaO_2]^+$: 349.1199; found: 349.1197.



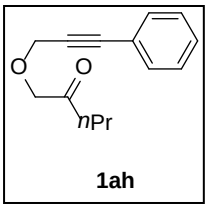
1af

1-phenyl-3-((3-phenylprop-2-yn-1-yl)oxy)propan-2-one (1af): white solid, 84% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 (dd, *J* = 7.6, 1.8 Hz, 2H), 7.32 (dt, *J* = 7.5, 5.3 Hz, 5H), 7.27 – 7.20 (m, 3H), 4.46 (s, 2H), 4.28 (s, 2H), 3.81 (s, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 205.6, 133.4, 131.8, 129.5, 128.8, 128.7, 128.4, 127.2, 122.2, 87.4, 83.9, 73.7, 59.3, 46.4. HRMS (ESI) calculated for [M+Na, $C_{18}H_{16}NaO_2]^+$: 287.1043; found: 287.1057.



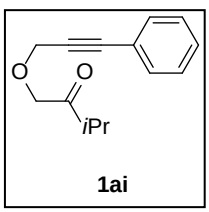
1ag

1-((3-phenylprop-2-yn-1-yl)oxy)propan-2-one (1ag): colorless oil, 90% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.40 (m, 2H), 7.36 – 7.28 (m, 3H), 4.49 (s, 2H), 4.23 (s, 2H), 2.20 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



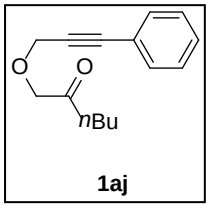
1ah

1-((3-phenylprop-2-yn-1-yl)oxy)pentan-2-one (1ah): colorless oil, 78% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.5, 2.1 Hz, 2H), 7.37 – 7.28 (m, 3H), 4.49 (s, 2H), 4.22 (s, 2H), 2.47 (t, *J* = 7.3 Hz, 2H), 1.72 – 1.56 (m, 2H), 0.94 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 208.2, 131.8, 128.7, 128.3, 122.3, 87.3, 84.0, 74.3, 59.2, 41.0, 16.8, 13.7. HRMS (ESI) calculated for [M+Na, $C_{14}H_{16}NaO_2]^+$: 239.1043; found: 239.1044.

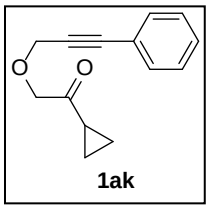


1ai

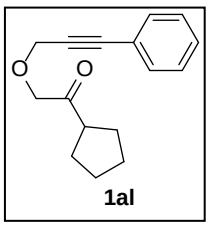
1-methyl-1-((3-phenylprop-2-yn-1-yl)oxy)butan-2-one (1ai): colorless oil, 95% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.5, 2.1 Hz, 2H), 7.38 – 7.28 (m, 3H), 4.49 (s, 2H), 4.32 (s, 2H), 2.81 (hept, *J* = 6.9 Hz, 1H), 1.13 (d, *J* = 7.0 Hz, 6H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



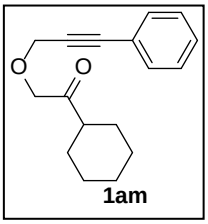
1-((3-phenylprop-2-yn-1-yl)oxy)hexan-2-one (1aj): colorless oil, 68% yield; ^{1}H NMR (500 MHz, cdcl$_3$) δ 7.47 – 7.40 (m, 2H), 7.35 – 7.28 (m, 3H), 4.49 (s, 2H), 4.23 (s, 2H), 2.48 (t, *J* = 7.5 Hz, 2H), 1.63 – 1.54 (m, 2H), 1.38 – 1.28 (m, 2H), 0.90 (t, *J* = 7.4 Hz, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



1-cyclopropyl-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1ak): colorless oil, 79% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (dd, *J* = 7.5, 2.1 Hz, 2H), 7.36 – 7.27 (m, 3H), 4.51 (s, 2H), 4.38 (s, 2H), 2.20 – 2.10 (m, 1H), 1.15 – 1.08 (m, 2H), 0.95 (dq, *J* = 7.3, 3.6 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 208.0, 131.8, 128.7, 128.3, 122.3, 87.2, 84.1, 74.6, 59.2, 17.1, 11.5. HRMS (ESI) calculated for [M+Na, $C_{14}H_{14}NaO_2$]$^{+}$: 237.0886; found: 237.0909.

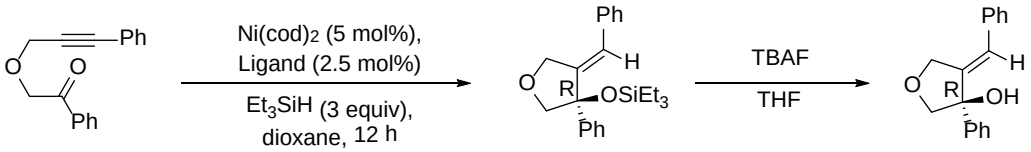


1-cyclopentyl-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1al): colorless oil, 84% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 – 7.40 (m, 2H), 7.38 – 7.28 (m, 3H), 4.50 (s, 2H), 4.32 (s, 2H), 3.07 – 2.95 (m, 1H), 1.88 – 1.73 (m, 4H), 1.73 – 1.63 (m, 2H), 1.63 – 1.54 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 210.1, 131.8, 128.6, 128.4, 122.4, 87.2, 84.1, 73.5, 59.1, 47.5, 28.9, 26.1. HRMS (ESI) calculated for [M+Na, $C_{16}H_{18}NaO_2$]$^{+}$: 265.1199; found: 265.1214.



1-cyclohexyl-2-((3-phenylprop-2-yn-1-yl)oxy)ethan-1-one (1am): colorless oil , 88% yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 – 7.40 (m, 2H), 7.38 – 7.28 (m, 3H), 4.49 (s, 2H), 4.31 (s, 2H), 2.53 (tt, *J* = 11.5, 3.4 Hz, 1H), 1.91 – 1.73 (m, 4H), 1.46 – 1.14 (m, 6H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 210.6, 131.8, 128.6, 128.3, 122.4, 87.2, 84.1, 72.8, 59.1, 47.1, 28.2, 25.8, 25.6. HRMS (ESI) calculated for [M+Na, $C_{17}H_{20}NaO_2$]$^{+}$:279.1356; found: 279.1365.

3. General Procedure of Nickel-Catalyzed Intramolecular Reductive Coupling of O-Alkynones

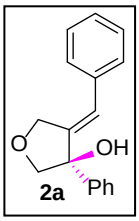


1a **1a'** **2a**

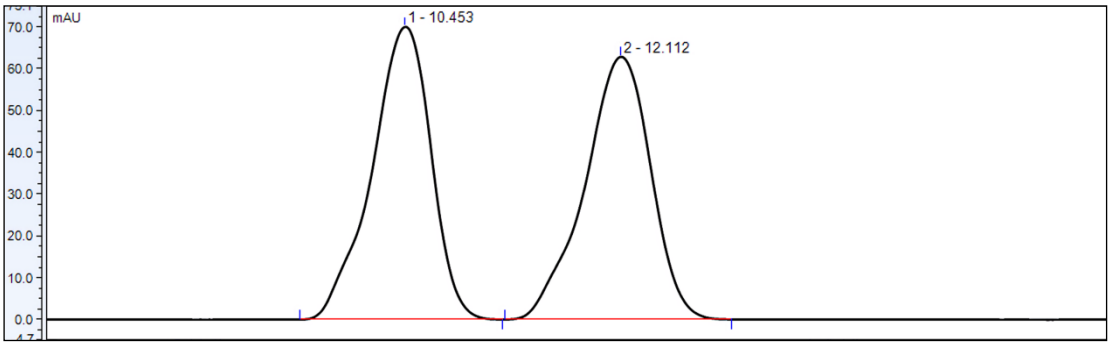
General procedure for asymmetric synthesis: $Ni(cod)_2$ (0.0075 mmol, 5 mol %), **(*S*,*S*)-DI-BIDIME** (**L13**, 0.00375 mmol, 2.5 mol %), and dioxane (0.4 mL) were added to a 4 mL screw-cap vial equipped with a magnetic stirring bar in the glove box. Substrate **1a** (0.15 mmol, 1.0 equiv.) was added to the solution in one portion, stirred for 5 mins, followed by the addition of triethylsilane (Et_3SiH, 0.072 mL, 0.45 mmol, 3.0 equiv.). The vial was closed with a screw-cap, and the resulting mixture was stirred at 0 ^oC for 12 h. Quenched with saturated sodium bicarbonate ($NaHCO_3$), extracted with ethyl acetate (EtOAc), washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 40/1) to afford **1a'.** After **1a'** was desilylated with TBAF in THF, the reaction was quenched with saturated NH_4Cl solution, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum.The residue was purified by column chromatography (eluent: PE/EA 4/1) to afford **2a**.

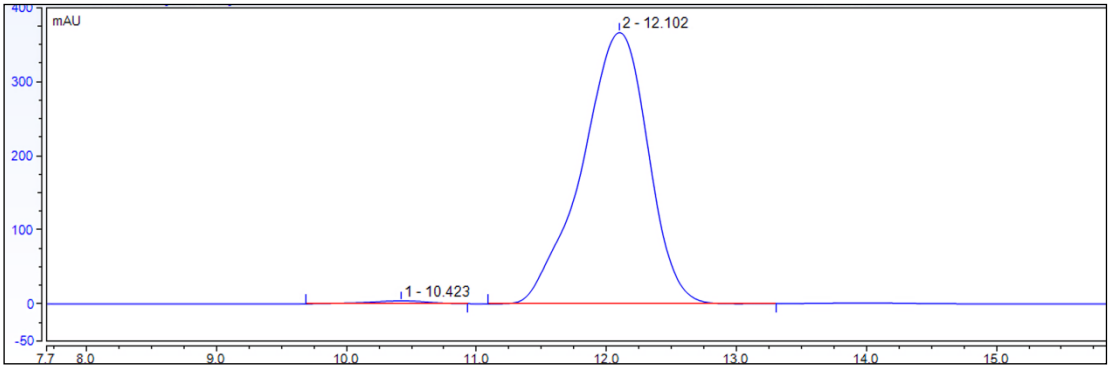
General procedure for preparing racemic product: $Ni(cod)_2$ (0.0075 mmol, 5 mol %), PPh_3 (0.0075 mmol, 5 mol %), and dioxane (0.4 mL) were added to a 4 mL screw-cap vial equipped with a magnetic stirring bar in the glove box. Substrate **1a** (0.15 mmol, 1.0 equiv.) was added to the solution in one portion, stirred for 5 mins, followed by the addition of triethylsilane (Et_3SiH, 0.072 mL, 0.45 mmol, 3.0 equiv.). The vial was closed with a screw-cap, and the resulting mixture was stirred at rt for 12 h. Quenched with saturated sodium bicarbonate ($NaHCO_3$), extracted with ethyl acetate (EtOAc), washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The residue was purified by column chromatography (eluent: PE/EA 40/1) to afford racemic **1a'.** After racemic **1a'** was desilylated with TBAF in THF, the reaction was quenched with saturated NH_4Cl solution, extracted with EtOAc, washed with brine, dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum.The residue was purified by column chromatography (eluent: PE/EA 4/1) to afford racemic **2a**.

4. Physical Data of Products

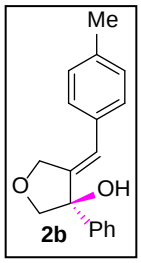


2a: white solid, 99% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 10.42 min (*S*), 12.10 min (*R*). $[\alpha]_D^{25}$ = +4.4 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58 (d, *J* = 7.4 Hz, 2H), 7.40 – 7.31 (m, 5H), 7.27 – 7.24 (m, 1H), 7.13 (d, *J* = 7.5 Hz, 2H), 6.30 (t, *J* = 2.5 Hz, 1H), 4.97 (ddd, *J* = 113.1, 14.5, 2.5 Hz, 2H), 4.04 (dd, *J* = 58.6, 9.6 Hz, 2H), 2.41 (s, 1H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]



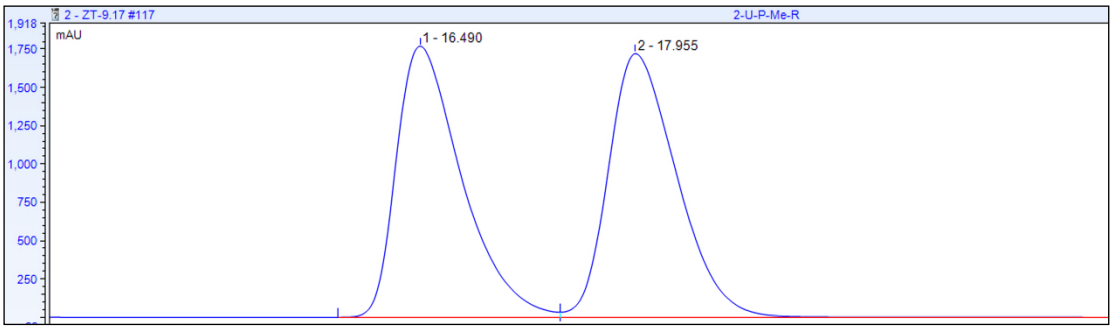


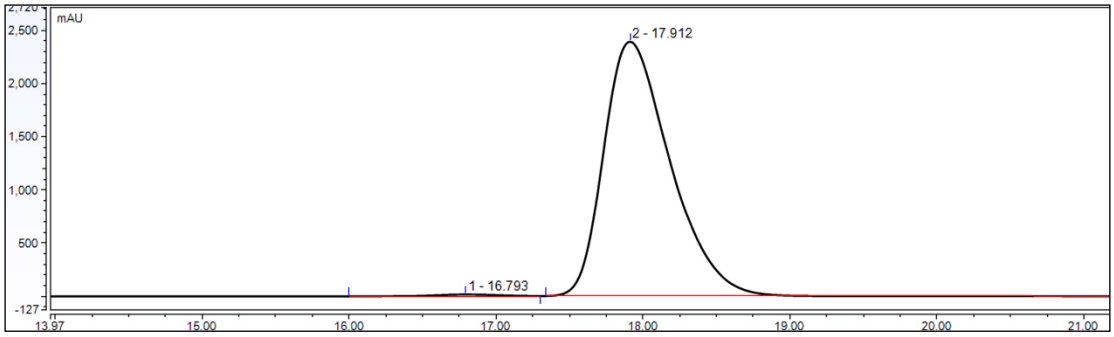
	min	min				%
1	10.423	0.483	BMB*	1.95	0.85	0.94
2	12.102	0.533	BMB*	n.a.	0.87	99.06



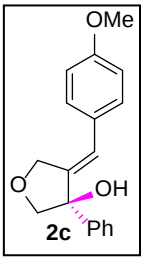
2b: white solid, 93% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 95/5, 254 nm, 16.80 min (*S*), 17.91 min (*R*). $[\alpha]_D^{25}$ = +15.2 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 – 7.51 (m, 2H), 7.38 (dd, *J* = 10.4, 4.7 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.08 (dd, *J* = 64.7, 8.0 Hz, 4H), 6.25 (t, *J*

= 2.4 Hz, 1H), 4.94 (ddd, *J* = 114.7, 14.4, 2.4 Hz, 2H), 4.02 (dd, *J* = 61.4, 9.6 Hz, 2H), 2.46 (s, 1H), 2.34 (s, 3H).[1]H NMR spectra is in agreement with these reported in the literature.[5]



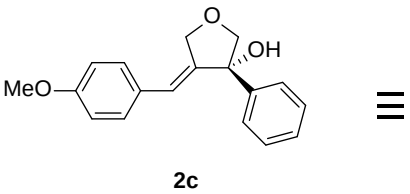


	min	min				%
1	16.793	0.490	BM	1.36	n.a.	0.68
2	17.912	0.483	BMB*	n.a.	1.43	99.32



2c: white solid, 90% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 15/85, 254 nm, 7.48 min (*S*), 9.34 min (*R*). $[\alpha]_D^{25}$ = +25.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 – 7.52 (m, 2H), 7.38 (t, *J* = 7.5 Hz, 2H), 7.31 (t, *J* = 7.3 Hz, 1H), 6.97 (dd, *J* = 75.4, 8.7 Hz, 4H), 6.23 (t, *J* = 2.5 Hz, 1H), 4.94 (ddd, *J* = 92.7, 14.3, 2.4 Hz, 2H), 4.03 (dd, *J* = 51.6, 9.5 Hz, 2H), 3.81 (s, 3H), 2.41 (s, 1H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

Crystalization from n-Pentane/DCM (9:1) gave crystals suitable for X-ray crystallographic analysis, which revealed its absolute configuration for the chiral tertiary alcohol **2c** as shown in **Figure 1**.



2c

≡

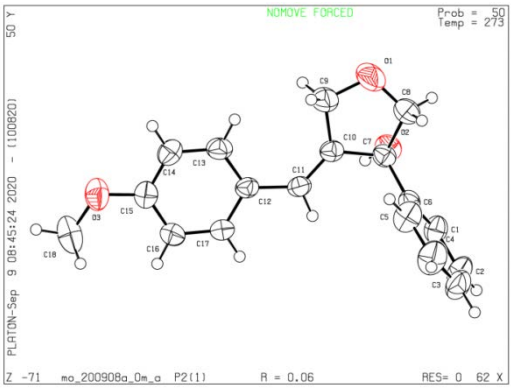
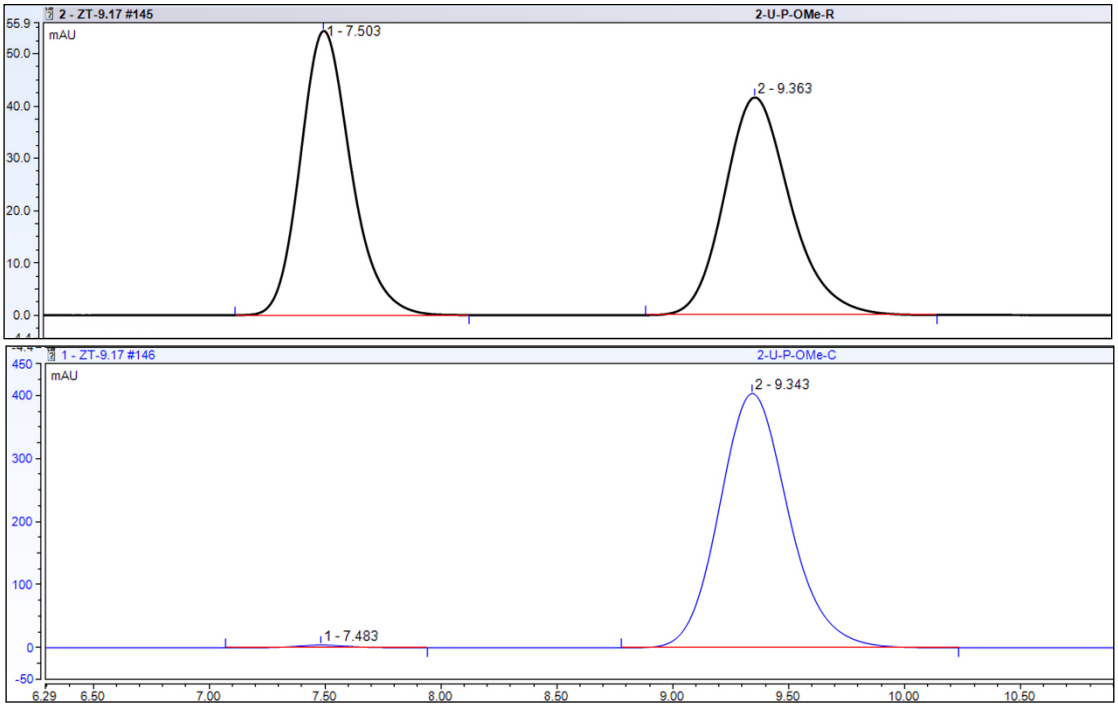
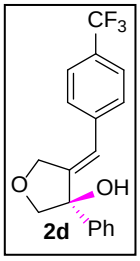


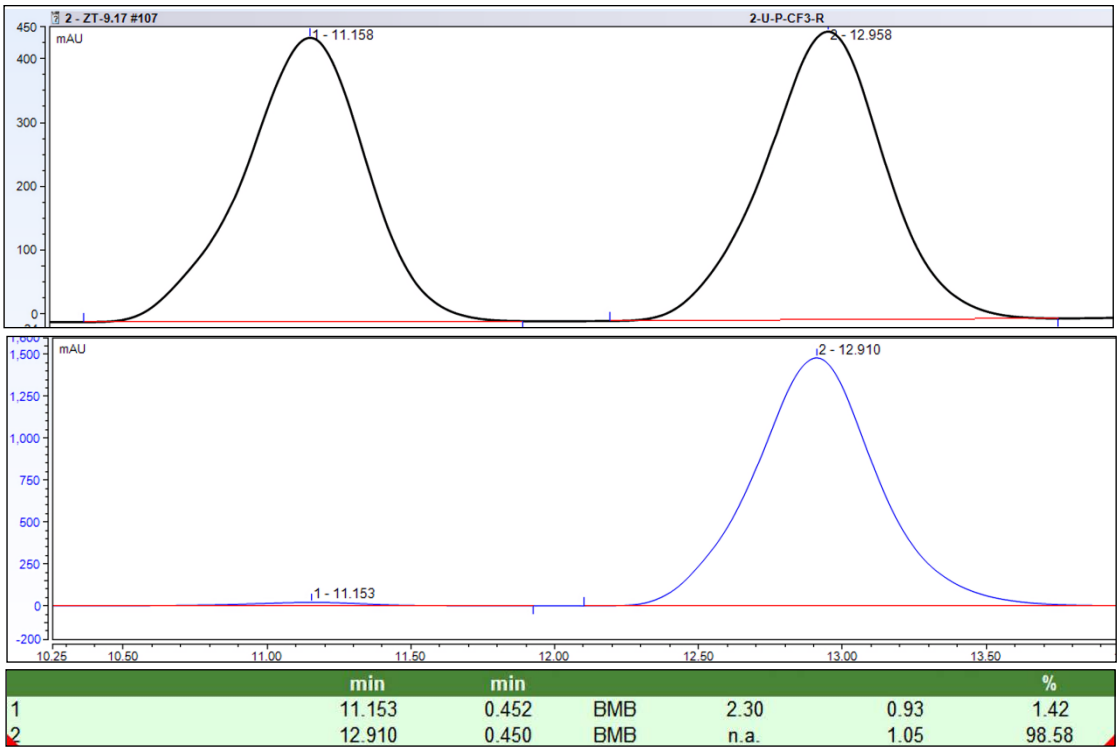
Figure 1. X-ray derived ORTEP representation of **2c**. (CCDC Number: 2040946 contains the supplementary crystallographic data of **2c**. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre)



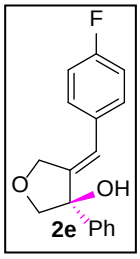
	min	min				%
1	7.483	0.241	BMB	3.93	1.11	0.76
2	9.343	0.317	BMB	n.a.	1.14	99.24



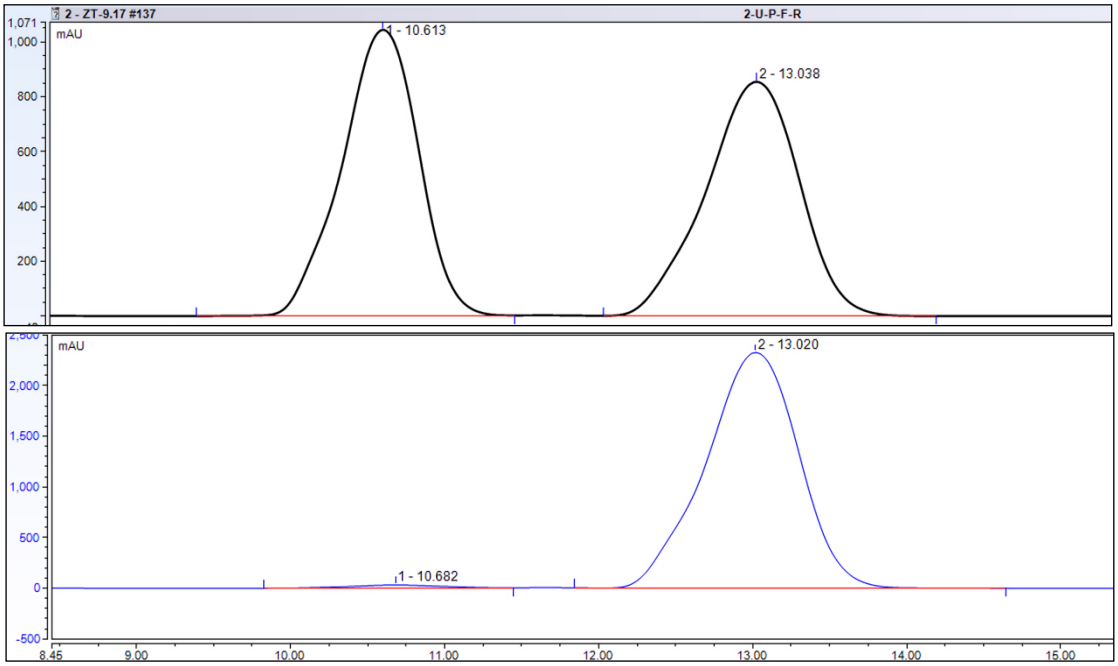
2d: white solid, 70% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 11.16 min (*S*), 12.91 min (*R*). $[\alpha]_D^{25}$ = +8.6 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.57 (ddd, *J* = 8.3, 7.1, 5.3 Hz, 4H), 7.43 – 7.37 (m, 2H), 7.36 – 7.30 (m, 1H), 7.22 (d, *J* = 8.2 Hz, 2H), 6.34 (t, *J* = 2.5 Hz, 1H), 4.95 (ddd, *J* = 105.5, 14.7, 2.5 Hz, 2H), 4.06 (dd, *J* = 40.7, 9.6 Hz, 2H), 2.52 (s, 1H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]



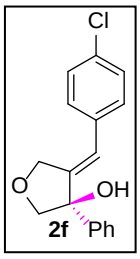
	min	min				%
1	11.153	0.452	BMB	2.30	0.93	1.42
2	12.910	0.450	BMB	n.a.	1.05	98.58



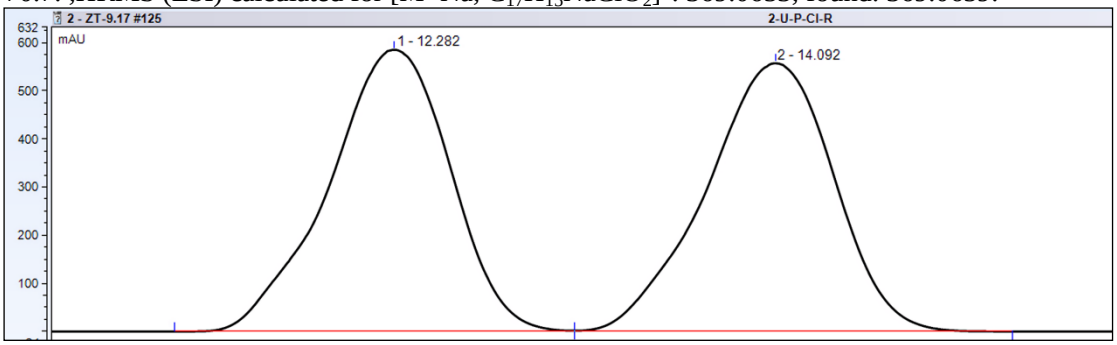
2e: colorless oil, 79% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 10.68 min (*S*), 13.02 min (*R*). $[\alpha]_D^{25}$ = +4.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (dt, *J* = 3.1, 1.8 Hz, 2H), 7.43 – 7.35 (m, 2H), 7.34 – 7.28 (m, 1H), 7.13 – 6.97 (m, 4H), 6.25 (t, *J* = 2.6 Hz, 1H), 4.91 (ddd, *J* = 108.9, 14.4, 2.5 Hz, 2H), 4.03 (dd, *J* = 52.3, 9.6 Hz, 2H), 2.57 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.0, 161.0, 147.0, 147.0, 141.5, 132.5, 130.0 (d, J = 8.1 Hz), 128.2, 127.6, 126.3, 123.7, 115.7, 115.6, 82.9, 81.2, 70.6. HRMS (ESI) calculated for [M+Na, $C_{17}H_{15}NaFO_2]^+$:239.0948; found: 239.0949.

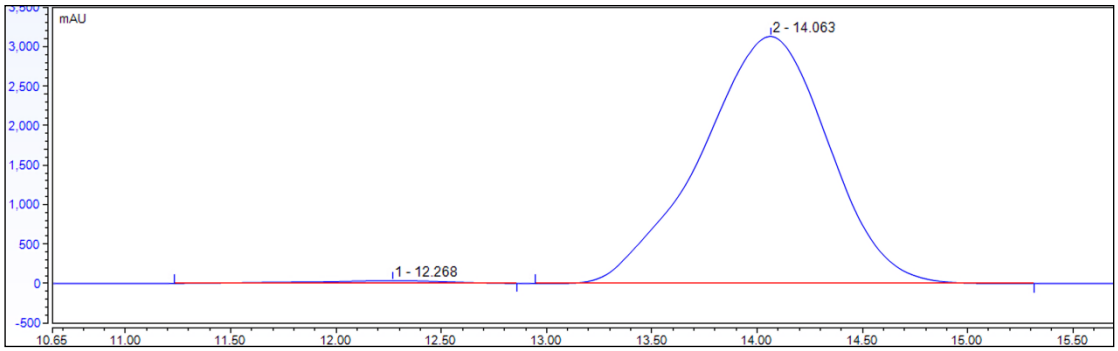


	min	min				%
1	10.682	0.629	BMB*	2.16	0.95	1.19
2	13.020	0.649	BMB*	n.a.	0.93	98.81

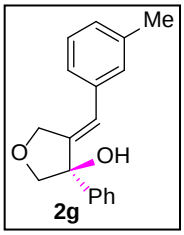


2f: colorless oil, 83% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 12.27 min (*S*), 14.06 min (*R*). $[\alpha]_D^{25}$ = +20 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.51 (m, 2H), 7.42 – 7.36 (m, 2H), 7.35 – 7.29 (m, 3H), 7.05 (t, *J* = 5.5 Hz, 2H), 6.25 (t, *J* = 2.6 Hz, 1H), 4.92 (ddd, *J* = 109.3, 14.5, 2.5 Hz, 2H), 4.04 (dd, *J* = 48.4, 9.6 Hz, 2H), 2.41 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 148.1, 141.3, 134.8, 133.4, 129.7, 128.8, 128.3, 127.6, 126.2, 123.7, 83.0, 81.1, 70.7. ;HRMS (ESI) calculated for $[M+Na, C_{17}H_{15}NaClO_2]^+$: 369.0653; found: 369.0659.

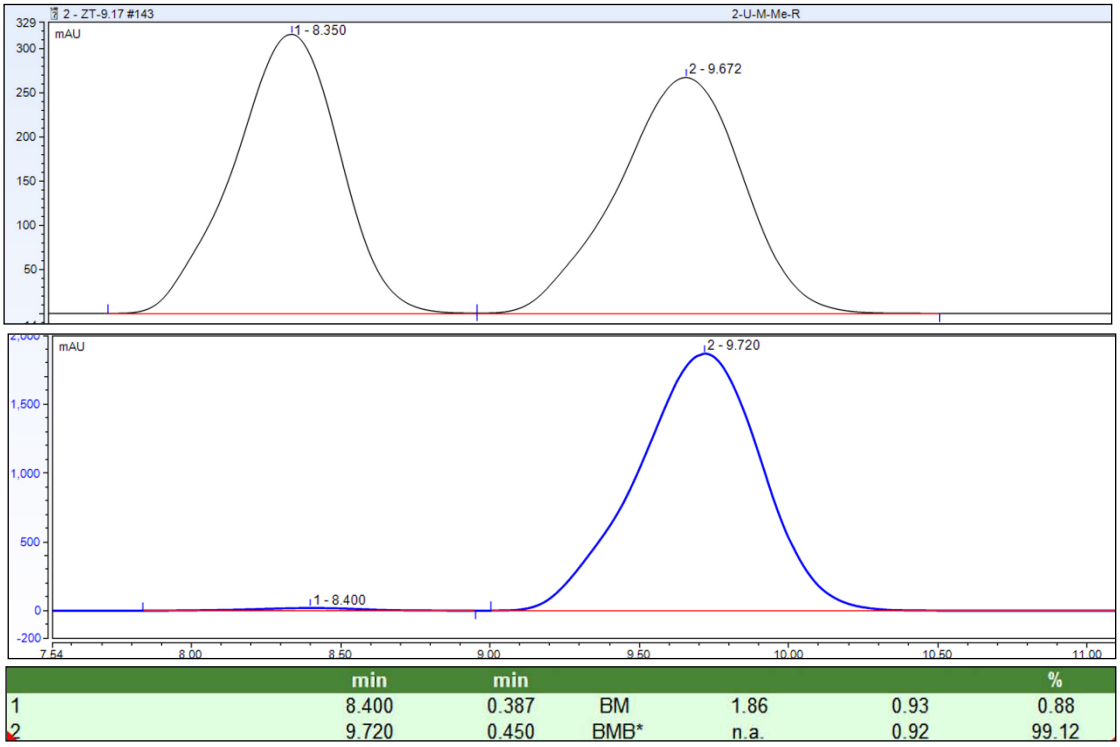




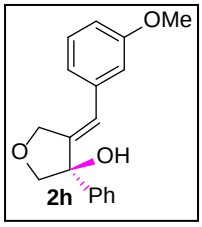
	min	min				%
1	12.268	0.693	BMB*	1.58	0.78	1.14
2	14.063	0.647	BMB*	n.a.	0.92	98.86



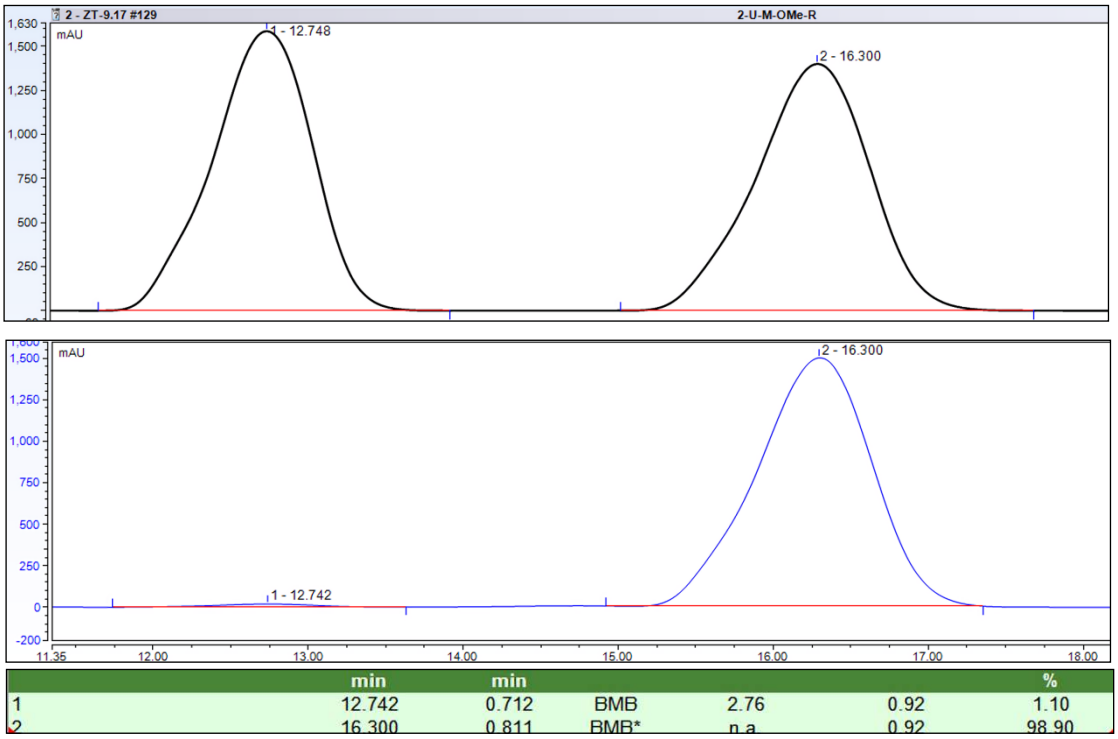
2g: white solid, 84% yield, > 99/1 er with **L2** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 8.40 min (*S*), 9.72 min (*R*). $[\alpha]_D^{25}$ = +4.7 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (dt, *J* = 3.0, 1.8 Hz, 2H), 7.41 – 7.34 (m, 2H), 7.33 – 7.26 (m, 1H), 7.23 (dd, *J* = 10.8, 4.8 Hz, 1H), 7.06 (d, *J* = 7.5 Hz, 1H), 6.92 (d, *J* = 7.4 Hz, 2H), 6.25 (t, *J* = 2.6 Hz, 1H), 4.94 (ddd, *J* = 112.5, 14.5, 2.5 Hz, 2H), 4.02 (dd, *J* = 59.7, 9.6 Hz, 2H), 2.58 (s, 1H), 2.32 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]



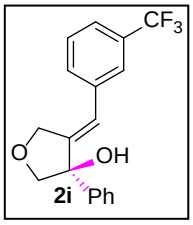
	min	min				%
1	8.400	0.387	BM	1.86	0.93	0.88
2	9.720	0.450	BMB*	n.a.	0.92	99.12



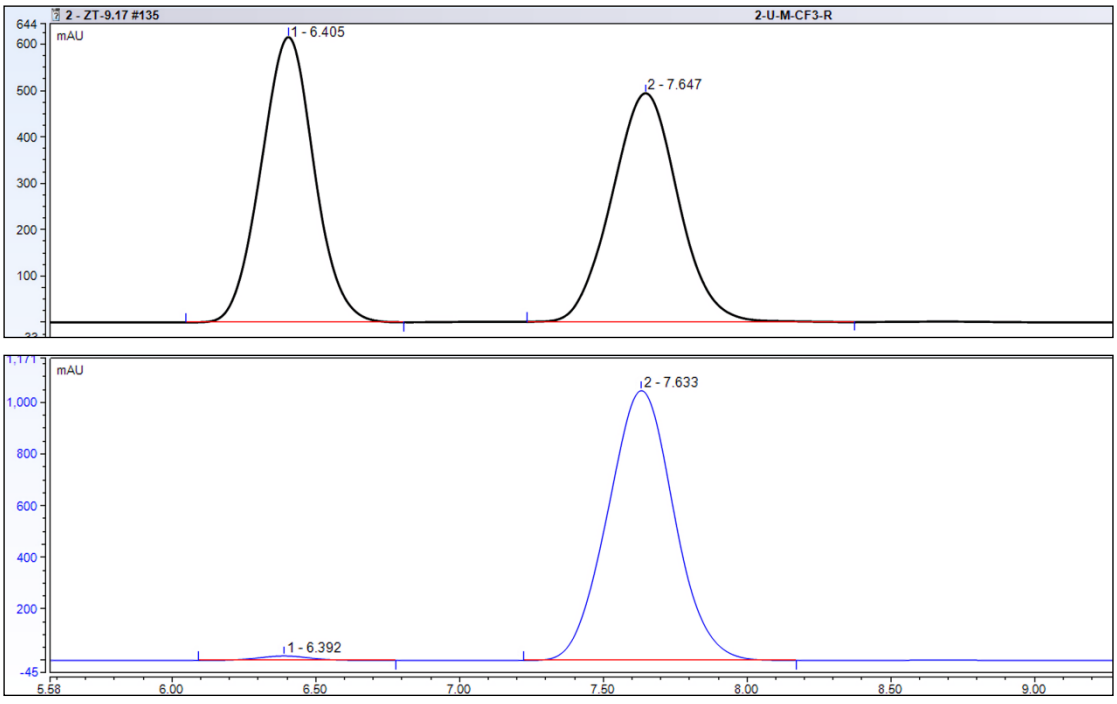
2h: colorless oil, 71% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 12.74 min (*S*), 16.30 min (*R*). $[\alpha]_D^{25}$ = +5.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 – 7.52 (m, 2H), 7.41 – 7.35 (m, 2H), 7.34 – 7.29 (m, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 6.81 (dd, *J* = 8.2, 2.3 Hz, 1H), 6.72 (d, *J* = 7.7 Hz, 1H), 6.66 – 6.62 (m, 1H), 6.26 (t, *J* = 2.6 Hz, 1H), 4.95 (ddd, *J* = 112.2, 14.5, 2.5 Hz, 2H), 4.03 (dd, *J* = 57.1, 9.6 Hz, 2H), 3.78 (s, 3H), 2.49 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.7, 147.8, 141.6, 137.7, 129.6, 128.2, 127.5, 126.3, 124.8, 120.8, 114.0, 113.2, 83.0, 81.2, 70.8, 55.2. HRMS (ESI) calculated for [M+Na, $C_{18}H_{18}NaO_3$]$^+$: 305.1148; found: 305.1150.



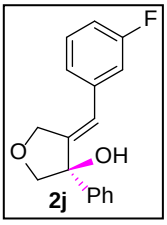
	min	min				%
1	12.742	0.712	BMB	2.76	0.92	1.10
2	16.300	0.811	BMB*	n.a.	0.92	98.90



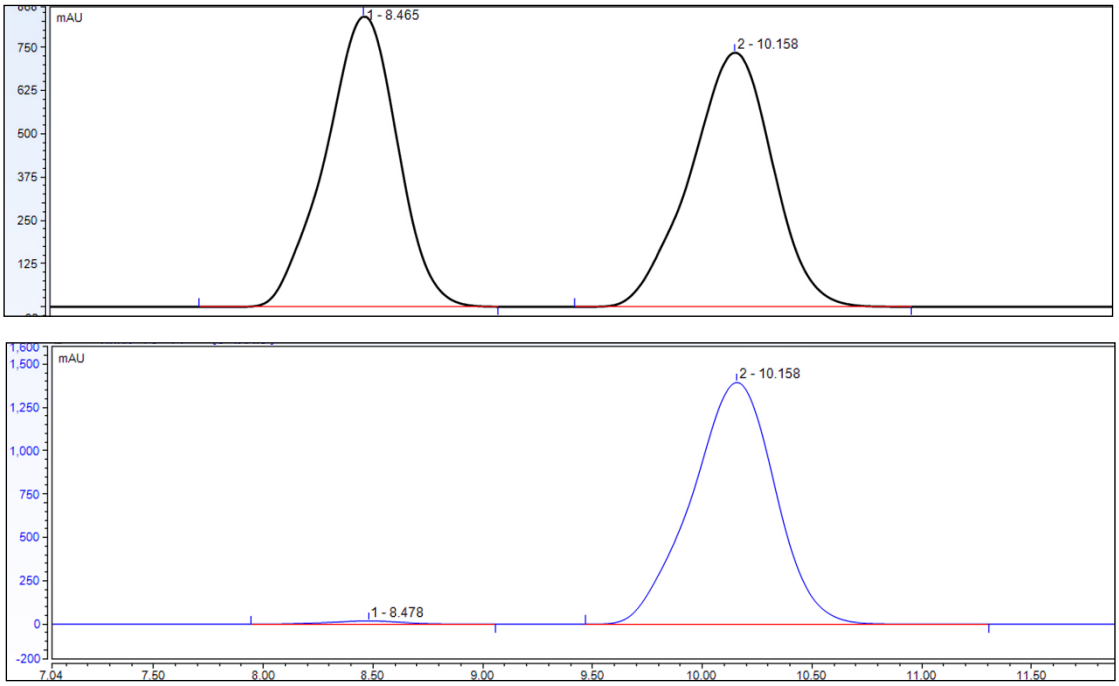
2i: colorless oil, 58% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 6.39min (*S*), 7.63 min (*R*). $[\alpha]_D^{25}$ = +12.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58 (dd, *J* = 5.3, 3.4 Hz, 2H), 7.49 (dt, *J* = 15.3, 7.7 Hz, 2H), 7.43 – 7.36 (m, 3H), 7.36 – 7.29 (m, 2H), 6.33 (t, *J* = 2.6 Hz, 1H), 4.96 (ddd, *J* = 104.8, 14.6, 2.6 Hz, 2H), 4.06 (dd, *J* = 40.8, 9.6 Hz, 2H), 2.38 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 149.6, 141.2, 137.0, 131.2, 129.2, 128.4, 127.7, 126.2, 125.1, 124.1, 123.5, 82.9, 81.1, 70.5. HRMS (ESI) calculated for [M+Na, $C_{18}H_{15}NaF_3O_2$]$^+$: 343.0916; found: 343.0920



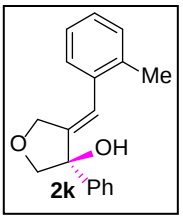
	min	min				%
1	6.392	0.198	BMB	3.28	1.03	1.34
2	7.633	0.249	BMB	n.a.	1.03	98.66



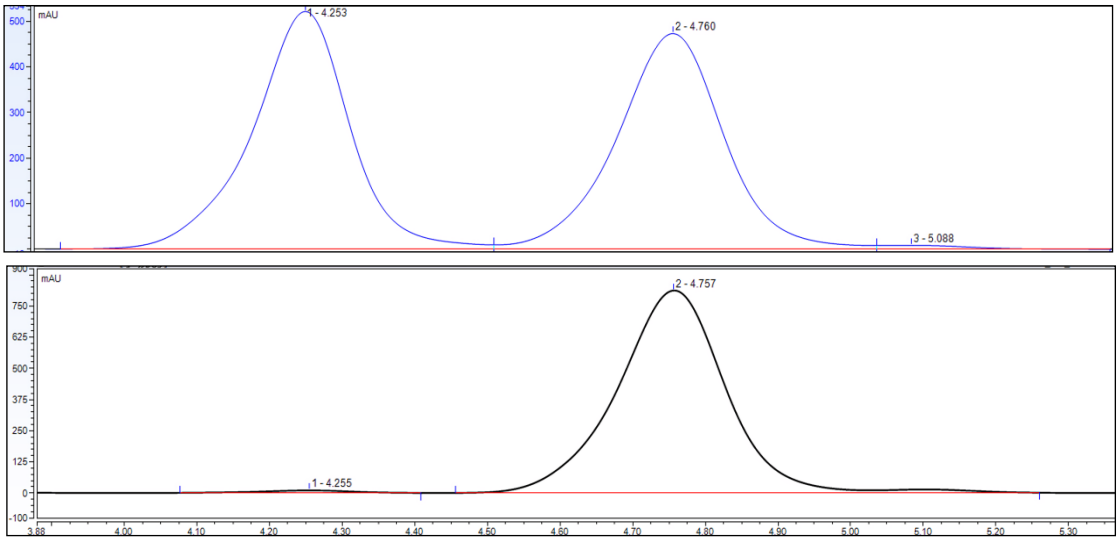
2j: colorless oil, 83% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 8.48 min (*S*), 10.16 min (*R*). $[\alpha]_D^{25}$ = +5.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58 – 7.50 (m, 2H), 7.42 – 7.34 (m, 2H), 7.33 – 7.23 (m, 2H), 6.93 (td, *J* = 8.4, 2.4 Hz, 1H), 6.87 (d, *J* = 7.8 Hz, 1H), 6.82 – 6.75 (m, 1H), 6.25 (t, *J* = 2.6 Hz, 1H), 4.90 (ddd, *J* = 105.6, 14.6, 2.5 Hz, 2H), 4.02 (dd, *J* = 48.3, 9.6 Hz, 2H), 2.82 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.9, 161.9, 148.82, 141.4, 138.5, 138.5, 128.3, 127.6, 126.3, 124.1, 124.1, 123.8, 123.8, 114.7 (dd, J = 67.4, 21.6 Hz), 82.9, 81.0, 70.6. HRMS (ESI) calculated for [M+Na, $C_{17}H_{15}NaFO_2$]$^+$:239.0948; found: 239.0948.



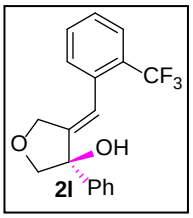
	min	min				%
1	8.478	0.349	BMB	2.62	0.93	1.14
2	10.158	0.407	BMB	n.a.	0.94	98.86



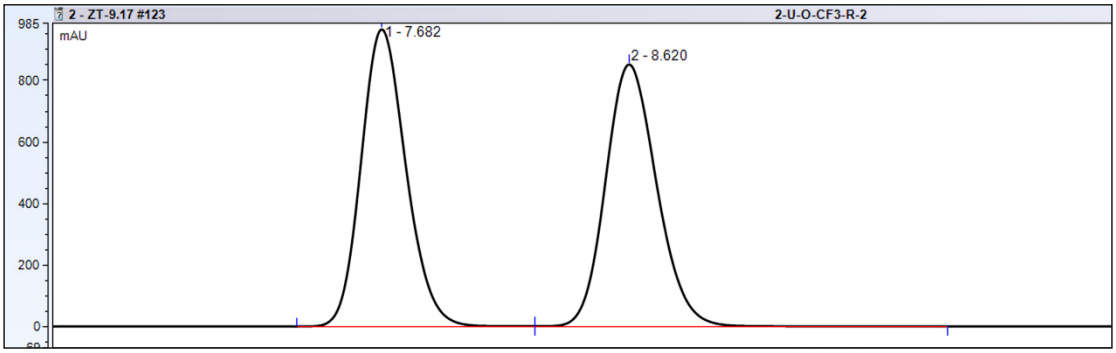
2k: white solid, 97% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 15/85, 254 nm, 4.26 min (*S*), 4.76 min (*R*). $[\alpha]_D^{25}$ = -28.7 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (dt, *J* = 3.0, 1.7 Hz, 2H), 7.43 – 7.34 (m, 2H), 7.34 – 7.27 (m, 1H), 7.21 – 7.10 (m, 3H), 7.08 – 7.01 (m, 1H), 6.45 (t, *J* = 2.5 Hz, 1H), 4.82 (ddd, *J* = 131.2, 14.3, 2.5 Hz, 2H), 4.04 (dd, *J* = 63.5, 9.6 Hz, 2H), 2.57 (s, 1H), 2.17 (s, 3H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

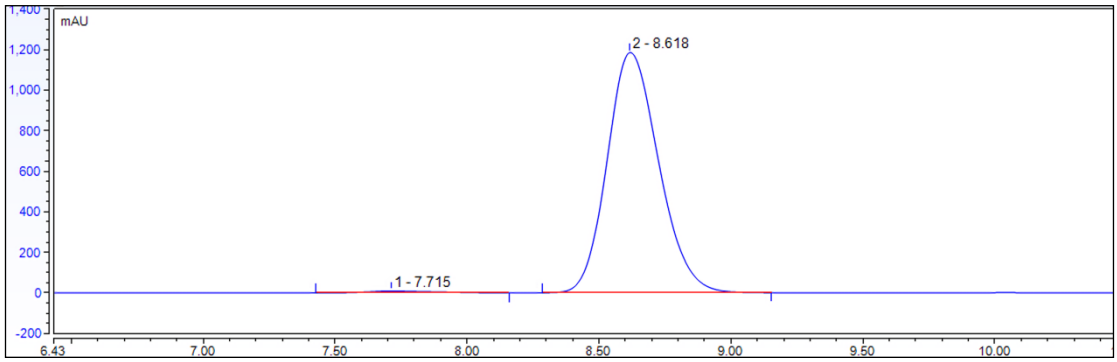


	min	min				%
1	4.255	0.130	BMB*	2.09	0.90	0.98
2	4.757	0.153	BMB*	n.a.	0.96	99.02

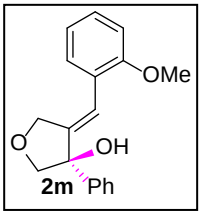


2l: colorless oil, 56% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 7.72 min (*S*), 8.62 min (*R*). $[\alpha]_D^{25}$ = -8.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.8 Hz, 1H), 7.61 – 7.56 (m, 2H), 7.53 (t, *J* = 7.6 Hz, 1H), 7.45 – 7.31 (m, 4H), 7.25 (d, *J* = 8.1 Hz, 1H), 6.58 (dd, *J* = 4.6, 2.3 Hz, 1H), 4.75 (ddd, *J* = 138.7, 14.5, 2.5 Hz, 2H), 4.06 (dd, *J* = 55.5, 9.7 Hz, 2H), 2.39 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.6, 140.8, 135.1, 131.8, 129.3, 128.2, 127.7, 126.2, 126.1 (q, J = 5.7 Hz)., 121.2, 82.4, 81.3, 70.0. HRMS (ESI) calculated for [M+Na, $C_{18}H_{15}NaF_3O_2]^+$: 343.0916; found: 343.0915.

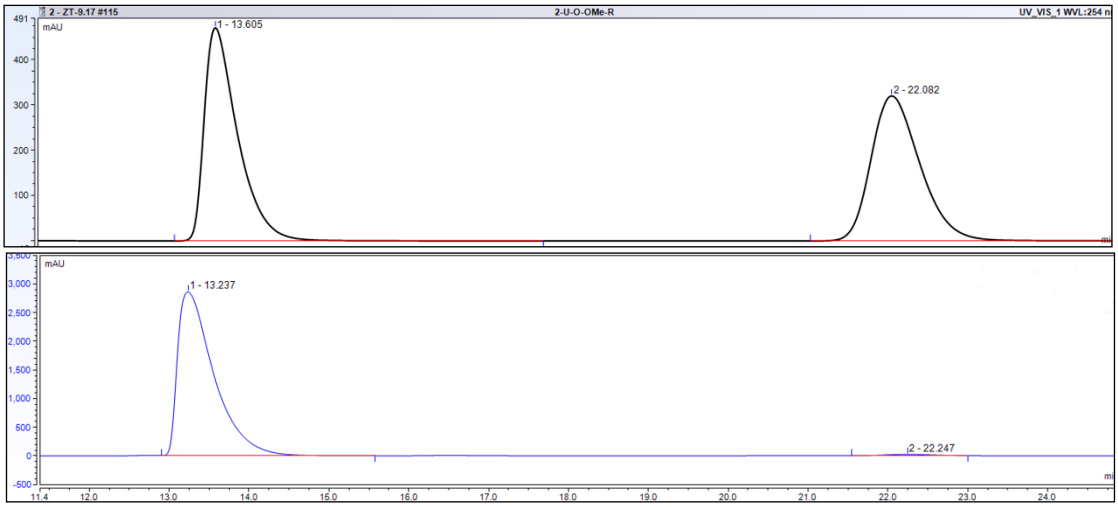




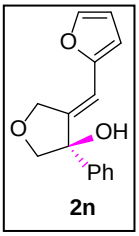
	min	min				%
1	7.715	0.268	BMB	2.23	1.44	0.91
2	8.618	0.210	BMB	n.a.	1.18	99.09



2m: white solid, 17% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 13.24 min (*R*), 22.25 min (*S*). $[\alpha]_D^{25}$ = -8.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 – 7.54 (m, 2H), 7.41 – 7.32 (m, 2H), 7.32 – 7.26 (m, 1H), 7.25 – 7.19 (m, 1H), 7.03 (dd, *J* = 7.6, 1.6 Hz, 1H), 6.93 (td, *J* = 7.5, 0.7 Hz, 1H), 6.83 (dd, *J* = 8.2, 0.7 Hz, 1H), 6.67 (t, *J* = 2.5 Hz, 1H), 4.86 (ddd, *J* = 84.2, 14.3, 2.6 Hz, 2H), 4.02 (dd, *J* = 62.3, 9.5 Hz, 2H), 3.73 (s, 3H), 2.66 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.9, 147.2, 142.2, 129.0, 128.4, 128.1, 127.4, 126.4, 125.4, 120.4, 119.5, 110.7, 82.8, 81.4, 70.9, 55.4. HRMS (ESI) calculated for [M+Na, $C_{18}H_{18}NaO_3$]$^+$: 305.1148; found: 305.1149.

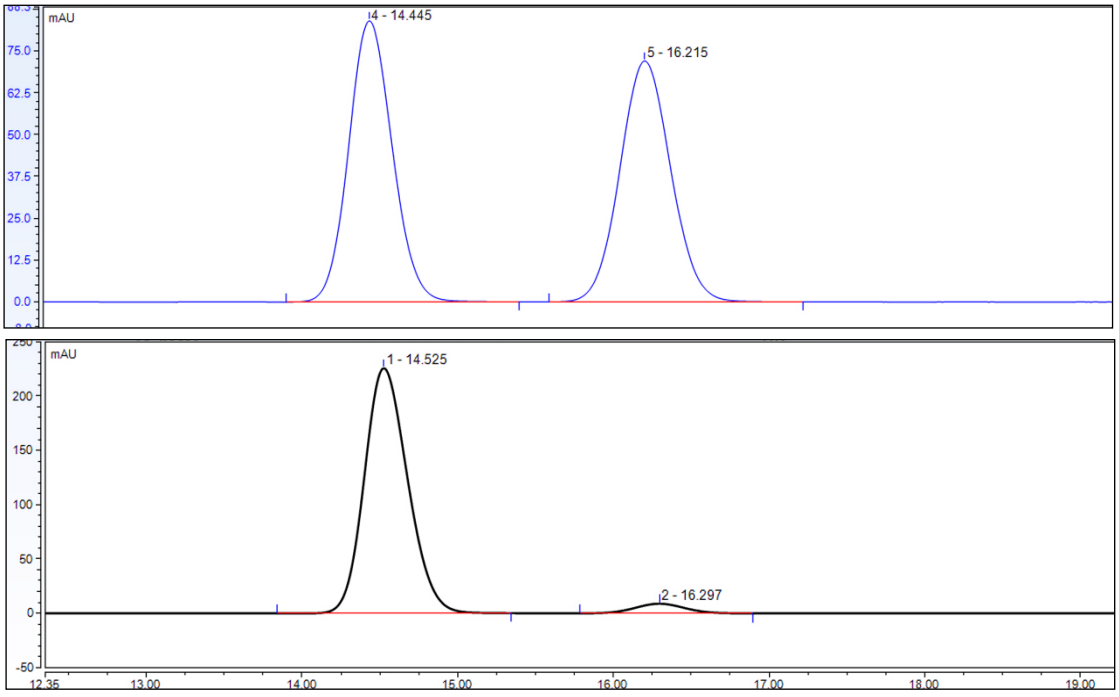


	min	min				%
1	13.237	0.468	BMB	9.82	2.41	98.97
2	22.247	0.615	BMB*	n.a.	1.09	1.03

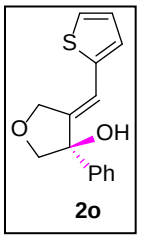


2n

2n: colorless oil, 47% yield, 96:4 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OJ-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 80/20, 254 nm, 14.53 min (*R*), 16.30 min (*S*). $[\alpha]_D^{25}$ = +12.4 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.55 (dq, *J* = 2.6, 1.8 Hz, 2H), 7.43 (d, *J* = 1.6 Hz, 1H), 7.41 – 7.34 (m, 2H), 7.33 – 7.28 (m, 1H), 6.39 (dd, *J* = 3.3, 1.8 Hz, 1H), 6.18 (d, *J* = 3.3 Hz, 1H), 6.09 (t, *J* = 2.6 Hz, 1H), 5.00 (ddd, *J* = 141.1, 15.7, 2.5 Hz, 2H), 4.03 (dd, *J* = 61.8, 9.6 Hz, 2H), 2.44 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 152.2, 145.3, 143.0, 141.1, 128.2, 127.5, 126.3, 112.3, 111.6, 110.2, 82.6, 81.5, 71.5. HRMS (ESI) calculated for [M+Na, $C_{15}H_{14}NaO_3$]$^+$: 265.0835; found: 265.0836.

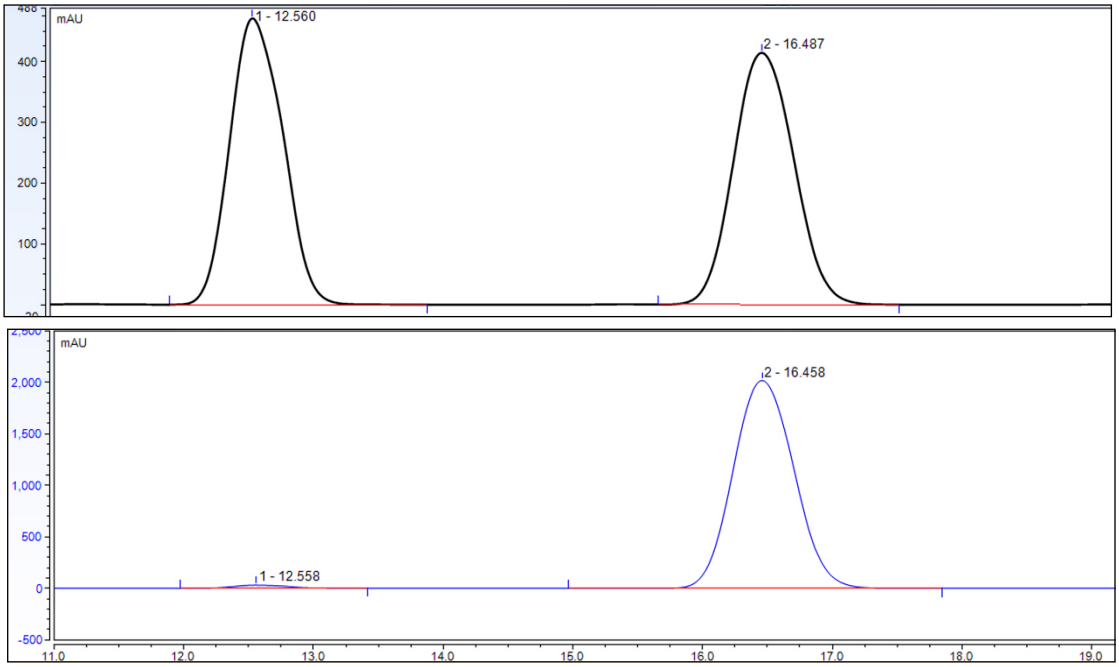


	min	min				%
1	14.525	0.301	BMB*	3.22	1.17	95.68
2	16.297	0.349	BMB*	n.a.	1.03	4.32

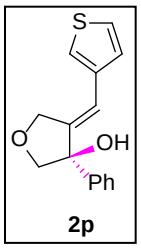


2o

2o: light yellow oil, 58% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 12.56 min (*S*), 16.46 min (*R*). $[\alpha]_D^{25}$ = +6.0 (*c* = 1.0, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (dt, *J* = 3.1, 1.8 Hz, 2H), 7.41 – 7.36 (m, 2H), 7.36 – 7.29 (m, 2H), 7.02 (dd, *J* = 5.1, 3.6 Hz, 1H), 6.88 (d, *J* = 3.5 Hz, 1H), 6.47 (t, *J* = 2.6 Hz, 1H), 4.91 (ddd, *J* = 126.2, 15.0, 2.5 Hz, 2H), 4.05 (dd, *J* = 58.3, 9.6 Hz, 2H), 2.44 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.3, 141.2, 140.2, 128.2, 127.6, 126.7, 126.4, 117.6, 82.9, 81.8, 71.1. HRMS (ESI) calculated for [M+Na, $C_{15}H_{14}NaSO_2$]$^+$: 281.0607; found: 281.0608.

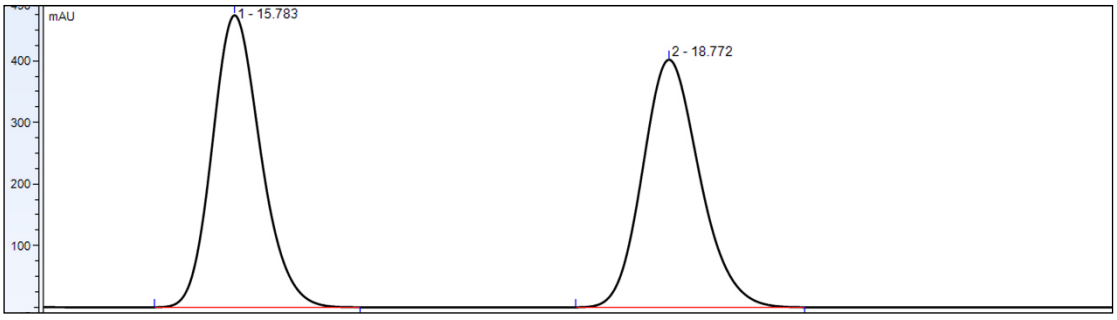


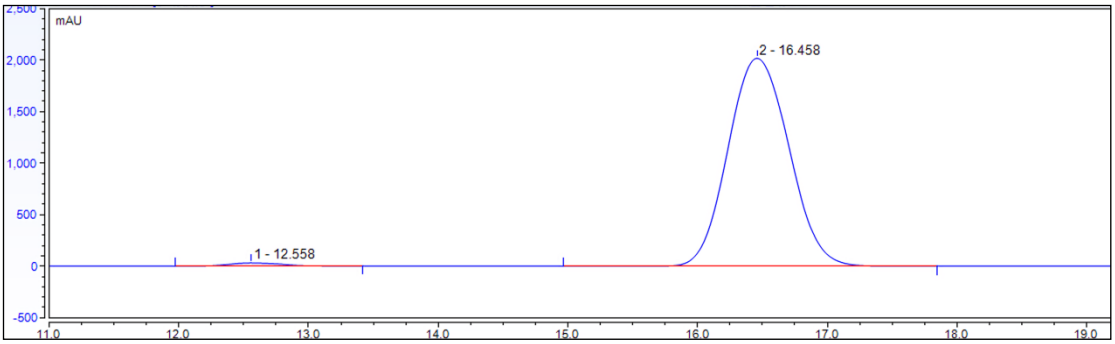
	min	min				%
1	12.558	0.457	BMB*	4.71	1.19	1.34
2	16.458	0.519	BMB*	n.a.	1.08	98.66



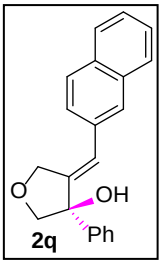
2p

2p: white solid, 60% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 15.71 min (*S*), 18.66 min (*R*). $[\alpha]_D^{25}$=+5.4 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (dt, *J* = 3.1, 1.9 Hz, 2H), 7.41 – 7.34 (m, 2H), 7.34 – 7.27 (m, 2H), 7.02 (d, *J* = 2.3 Hz, 1H), 6.95 (dd, *J* = 5.0, 1.2 Hz, 1H), 6.30 (t, *J* = 2.6 Hz, 1H), 4.91 (ddd, *J* = 115.3, 14.4, 2.6 Hz, 2H), 4.03 (dd, *J* = 60.3, 9.6 Hz, 2H), 2.51 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 146.1, 141.4, 138.0, 128.2, 127.6, 127.5, 126.4, 126.1, 123.8, 118.5, 82.8, 81.6, 71.1. HRMS (ESI) calculated for [M+Na, $C_{15}H_{14}NaSO_2$]$^+$: 281.0607; found: 281.0605.

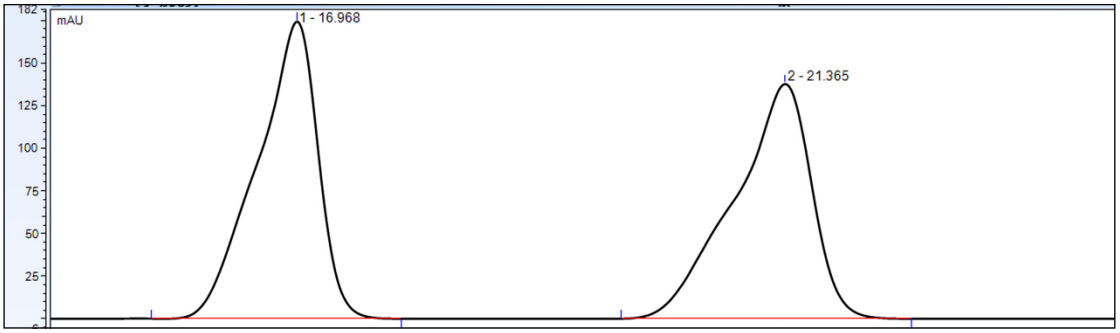


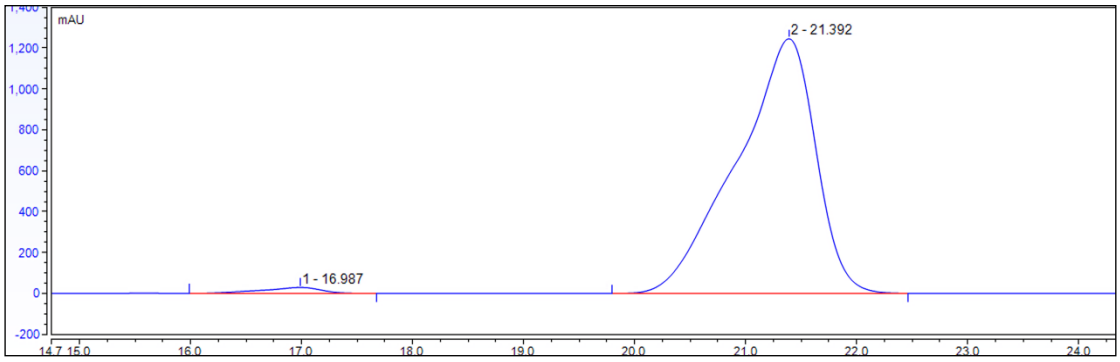


	min	min				%
1	12.558	0.457	BMB*	4.71	1.19	1.34
2	16.458	0.519	BMB*	n.a.	1.08	98.66

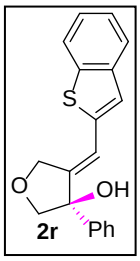


2q: colorless oil, 95% yield, 98:2 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 16.99 min (*S*), 21.39 min (*R*). $[\alpha]_D^{25}$ = +43.4 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 – 7.70 (m, 3H), 7.65 – 7.56 (m, 2H), 7.53 (s, 1H), 7.48 – 7.42 (m, 2H), 7.42 – 7.36 (m, 2H), 7.35 – 7.29 (m, 1H), 7.23 (dd, *J* = 8.6, 1.7 Hz, 1H), 6.44 (t, *J* = 2.6 Hz, 1H), 5.05 (ddd, *J* = 111.5, 14.4, 2.5 Hz, 2H), 4.06 (dd, *J* = 53.8, 9.6 Hz, 2H), 2.66 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 147.8, 141.7, 133.9, 133.4, 132.5, 128.3, 128.1, 127.8, 127.6, 126.5, 126.4, 126.4, 126.0, 125.0, 83.1, 81.2, 70.9. HRMS (ESI) calculated for [M+Na, $C_{21}H_{18}NaO_2$]$^+$: 325.1199; found: 325.1212.

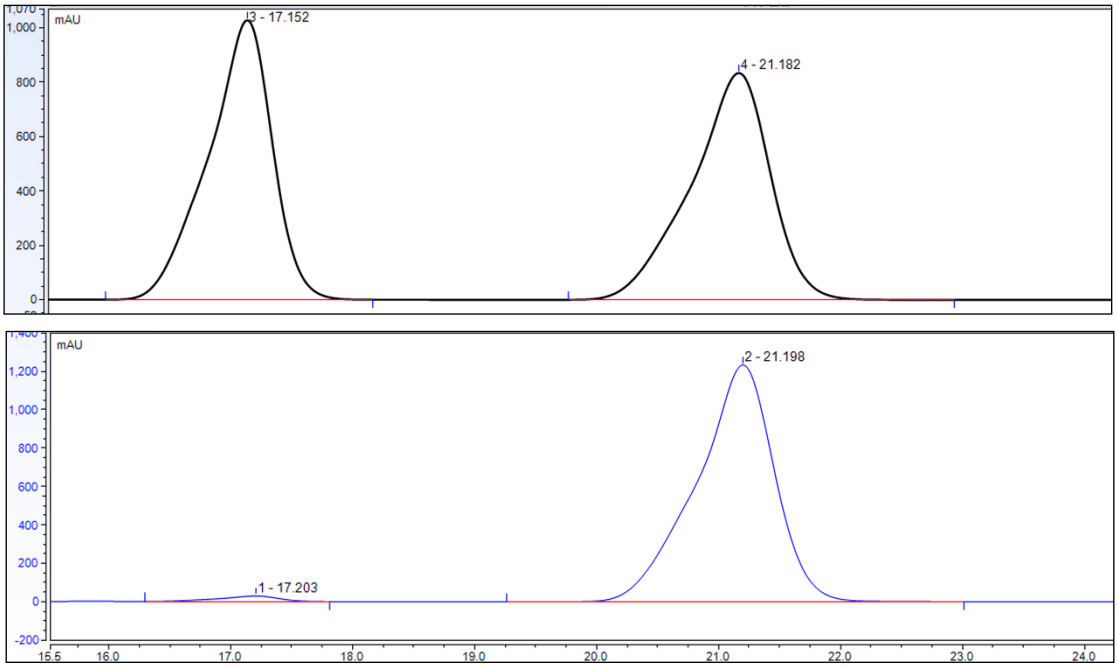




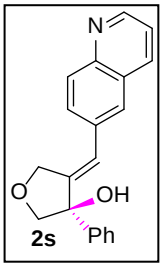
	min	min				%
1	16.987	0.584	BMB*	3.86	0.77	1.79
2	21.392	0.762	BMB*	n.a.	0.75	98.21



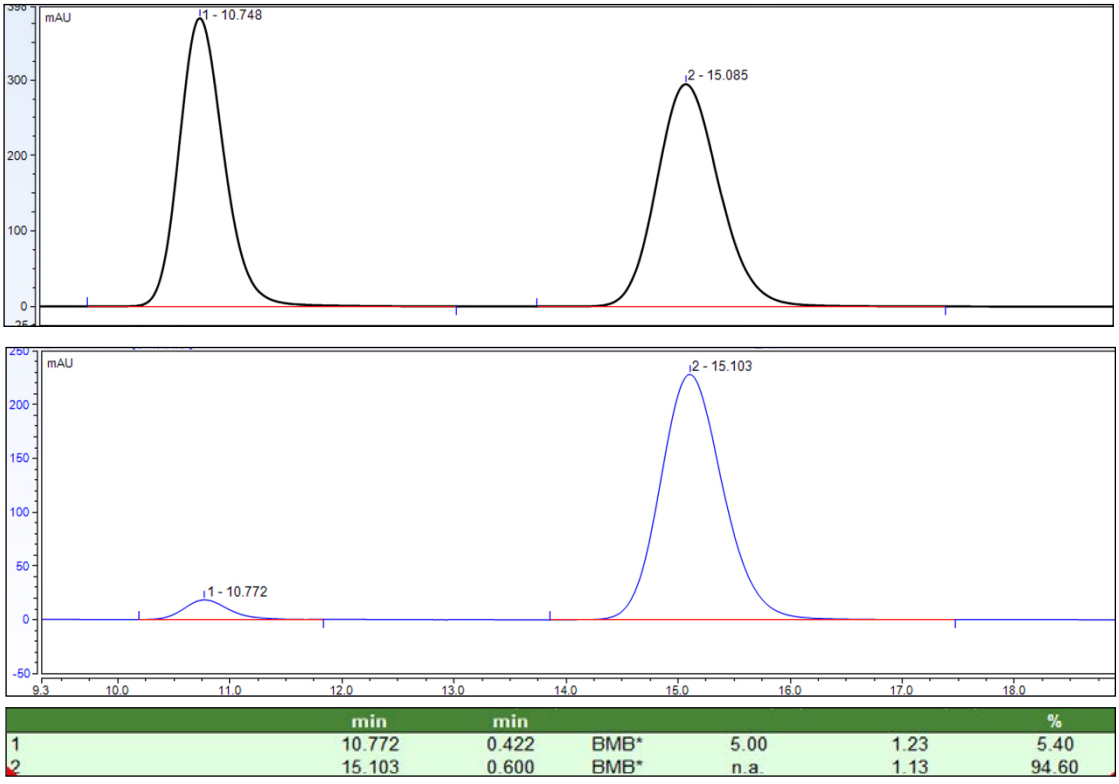
2r: white solid, 30% yield, 98:2 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 17.20 min (*S*), 21.20 min (*R*). $[\alpha]_D^{25}$ = +3.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.76 (dd, *J* = 42.0, 7.3 Hz, 2H), 7.64 – 7.52 (m, 2H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.38 – 7.27 (m, 3H), 7.09 (s, 1H), 6.54 (t, *J* = 2.5 Hz, 1H), 5.03 (ddd, *J* = 133.1, 15.1, 2.5 Hz, 2H), 4.08 (dd, *J* = 51.7, 9.6 Hz, 2H), 2.43 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 148.0, 141.0, 140.4, 140.0, 139.6, 128.3, 127.7, 126.3, 124.7, 124.4, 123.8, 122.7, 118.2, 82.9, 81.6, 70.8. HRMS (ESI) calculated for [M+Na, $C_{19}H_{16}NaSO_2$]$^+$: 331.0763; found: 331.0766.



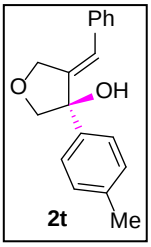
	min	min				%
1	17.203	0.524	BMB*	3.98	0.80	1.81
2	21.198	0.660	BMB*	n.a.	0.83	98.19



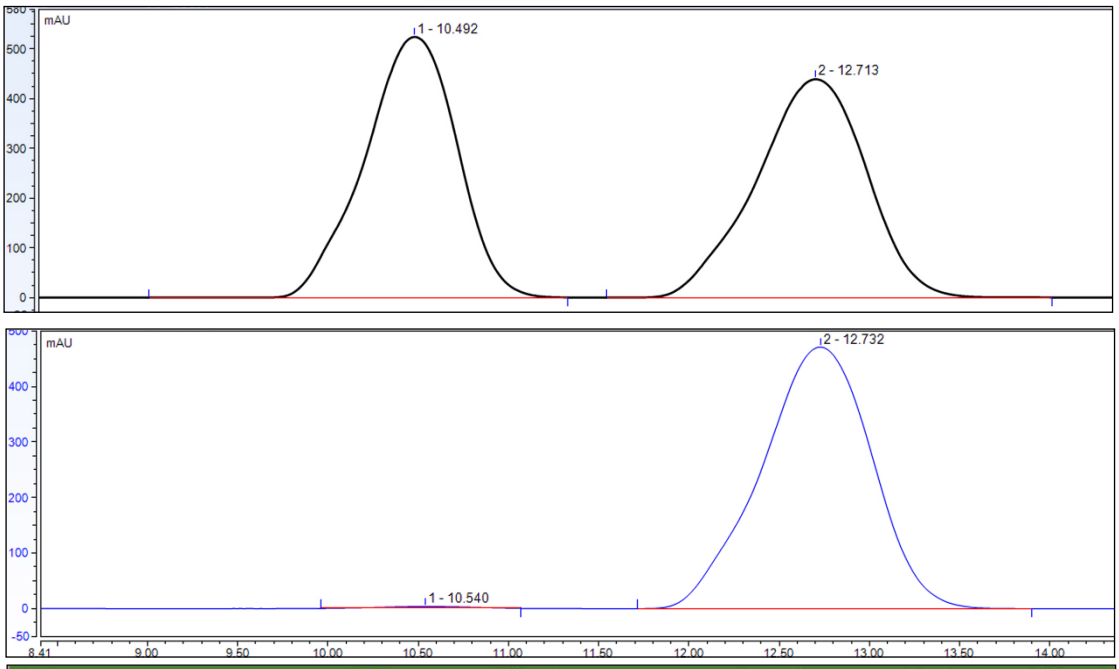
2s: white solid, 31% yield, 95:5 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 70/30, 254 nm, 10.77 min (*S*), 15.10 min (*R*). $[\alpha]_D^{25}$ = +10.2 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.88 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.10 (d, *J* = 7.5 Hz, 1H), 8.06 (d, *J* = 8.7 Hz, 1H), 7.68 – 7.58 (m, 2H), 7.51 (s, 1H), 7.49 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.45 – 7.37 (m, 3H), 7.34 (ddd, *J* = 7.3, 3.8, 1.2 Hz, 1H), 6.46 (t, *J* = 2.6 Hz, 1H), 5.06 (ddd, *J* = 101.5, 14.5, 2.5 Hz, 2H), 4.09 (dd, *J* = 45.7, 9.6 Hz, 2H), 2.75 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.7, 149.1, 147.4, 141.5, 136.1, 134.7, 129.8, 129.7, 128.3, 128.2, 127.6, 127.3, 126.3, 124.1, 121.6, 83.0, 81.2, 70.8. HRMS (ESI) calculated for [M+Na, $C_{20}H_{17}NaNO_2]^+$: 326.1151; found: 326.1153.



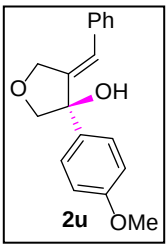
	min	min				%
1	10.772	0.422	BMB*	5.00	1.23	5.40
2	15.103	0.600	BMB*	n.a.	1.13	94.60



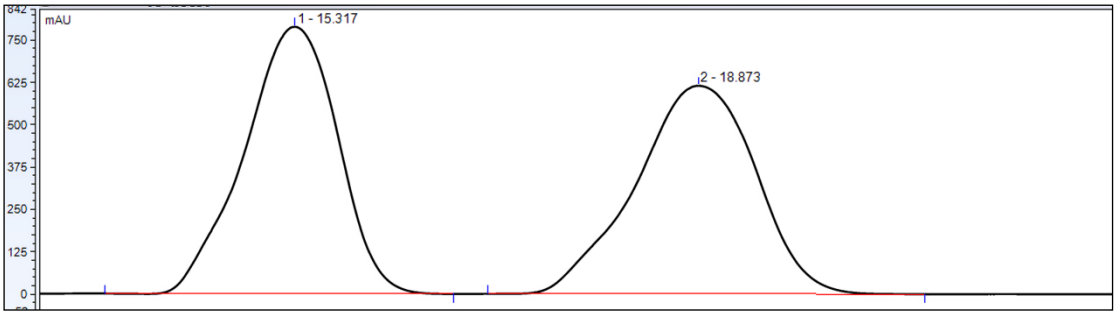
2t: light yellow oil, 98% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 10.54 min (*S*), 12.73 min (*R*). $[\alpha]_D^{25}$=+24.5 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.2 Hz, 2H), 7.33 (t, *J* = 7.6 Hz, 2H), 7.24 (t, *J* = 7.4 Hz, 1H), 7.15 (dd, *J* = 33.4, 7.7 Hz, 4H), 6.29 (t, *J* = 2.5 Hz, 1H), 4.94 (ddd, *J* = 113.1, 14.5, 2.5 Hz, 2H), 4.00 (dd, *J* = 60.3, 9.5 Hz, 2H), 2.52 (s, 1H), 2.36 (s, 3H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

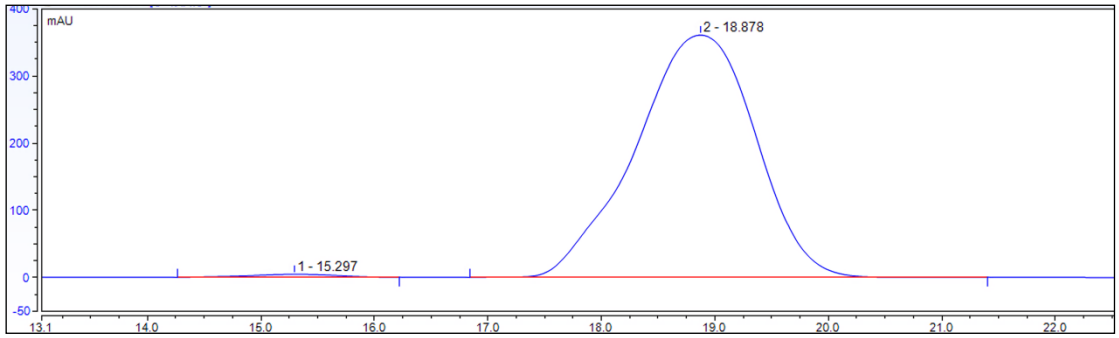


	min	min				%
1	10.540	0.572	BMB*	2.09	0.96	0.58
2	12.732	0.665	BMB	n.a.	0.93	99.42

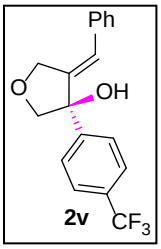


2u: white solid, 91% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 15.30 min (*S*), 18.88 min (*R*). $[\alpha]_D^{25}$ = -2.6 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.42 (m, 2H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.24 (dd, *J* = 8.4, 6.3 Hz, 1H), 7.11 (d, *J* = 7.5 Hz, 2H), 6.96 – 6.84 (m, 2H), 6.30 (t, *J* = 2.5 Hz, 1H), 4.92 (ddd, *J* = 89.4, 14.5, 2.4 Hz, 2H), 3.99 (dd, *J* = 50.1, 9.5 Hz, 2H), 3.81 (s, 3H), 2.59 (s, 1H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

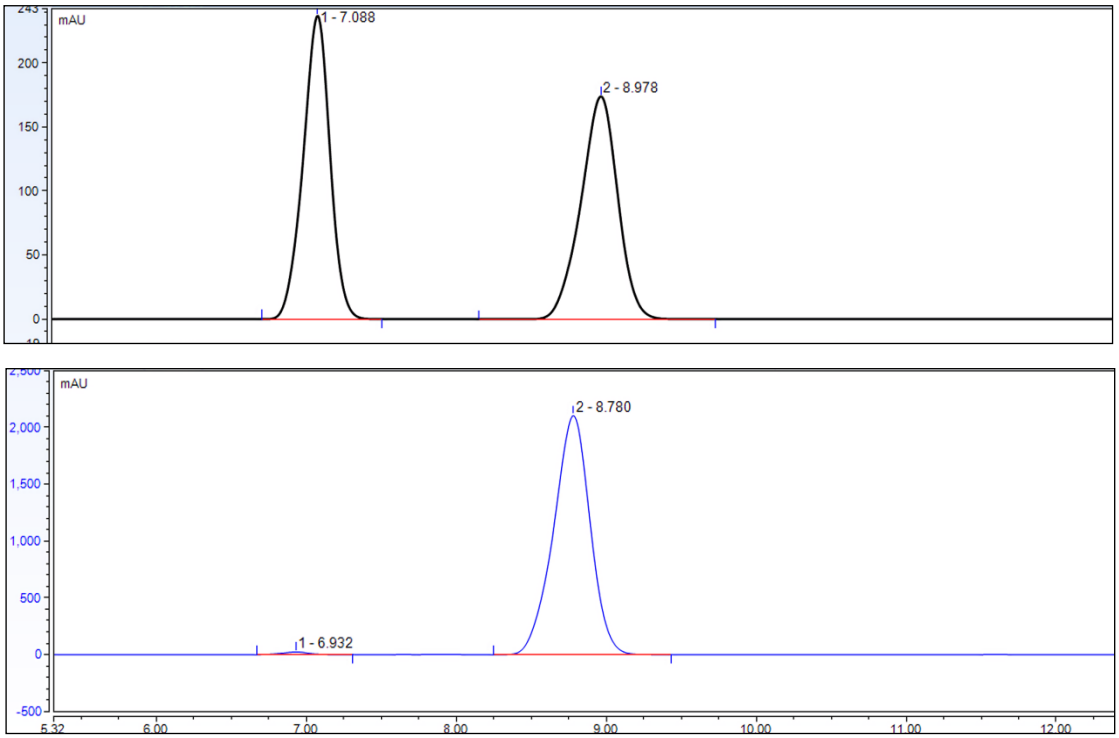




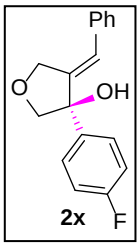
	min	min				%
1	15.297	0.853	BMB*	2.12	0.91	0.93
2	18.878	1.141	BMB*	n.a.	0.91	99.07



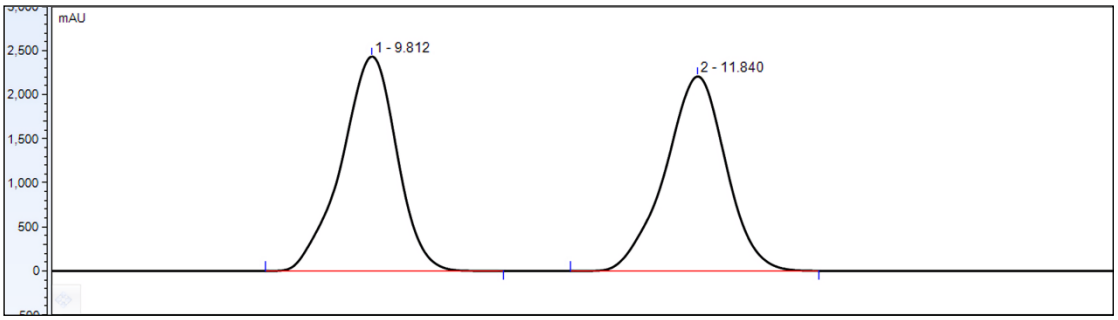
2v: white solid, 99% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 6.93 min (*S*), 8.78 min (*R*). $[\alpha]_D^{25}$ = +5.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.71 (d, *J* = 7.9 Hz, 1H), 7.58 (d, *J* = 7.8 Hz, 1H), 7.49 (t, *J* = 7.8 Hz, 1H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.30 – 7.22 (m, 1H), 7.12 (d, *J* = 7.4 Hz, 2H), 6.27 (t, *J* = 2.6 Hz, 1H), 4.97 (ddd, *J* = 105.3, 14.5, 2.5 Hz, 2H), 4.03 (dd, *J* = 70.1, 9.7 Hz, 2H), 2.65 (s, 1H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

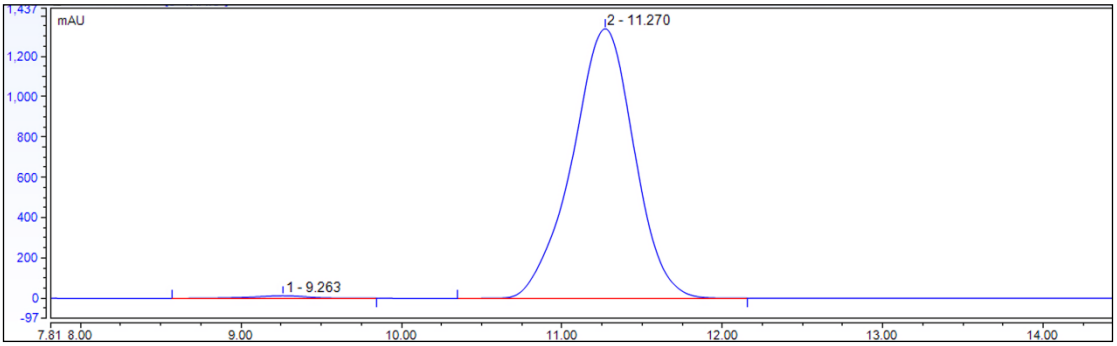


	min	min				%
1	6.932	0.186	BMB*	4.90	0.94	0.78
2	8.780	0.259	BMB*	n.a.	0.93	99.22

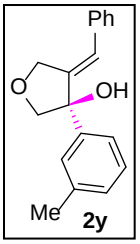


2x: white solid, 99% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 9.26 min (*S*), 11.27 min (*R*). $[\alpha]_D^{25}$ = +4.6 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.48 (m, 2H), 7.34 (t, *J* = 7.6 Hz, 2H), 7.25 (dd, *J* = 9.5, 5.1 Hz, 1H), 7.11 (d, *J* = 7.6 Hz, 2H), 7.08 – 7.00 (m, 2H), 6.28 (t, *J* = 2.5 Hz, 1H), 4.93 (ddd, *J* = 111.0, 14.5, 2.4 Hz, 2H), 3.99 (dd, *J* = 68.2, 9.6 Hz, 2H), 2.61 (s, 1H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

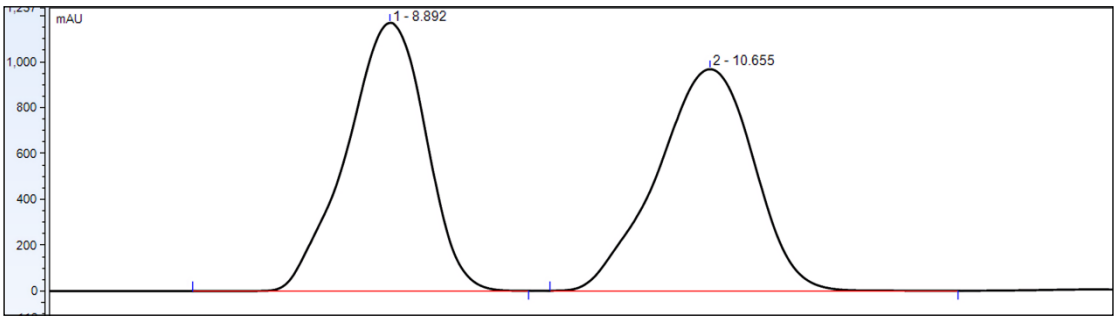


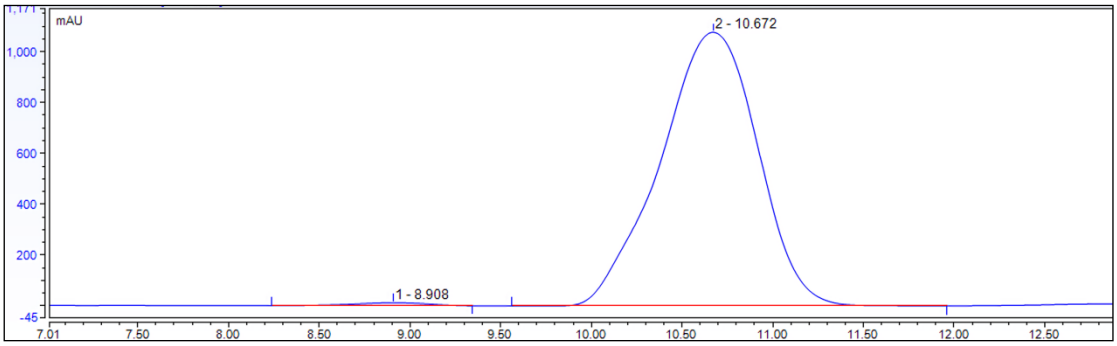


	min	min				%
1	9.263	0.360	BMB	3.08	0.89	0.86
2	11.270	0.409	BMB*	n.a.	0.94	99.14

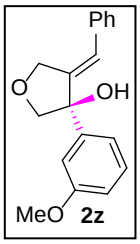


2y: light yellow oil, 96% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 8.91 min (*S*), 10.67 min (*R*). $[\alpha]_D^{25}$ = +7.1 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 (s, 1H), 7.34 (dd, *J* = 10.6, 4.5 Hz, 3H), 7.29 – 7.21 (m, 2H), 7.12 (d, *J* = 7.6 Hz, 3H), 6.30 (t, *J* = 2.5 Hz, 1H), 4.95 (ddd, *J* = 109.5, 14.5, 2.5 Hz, 2H), 4.02 (dd, *J* = 52.8, 9.5 Hz, 2H), 2.53 (s, 1H), 2.37 (s, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

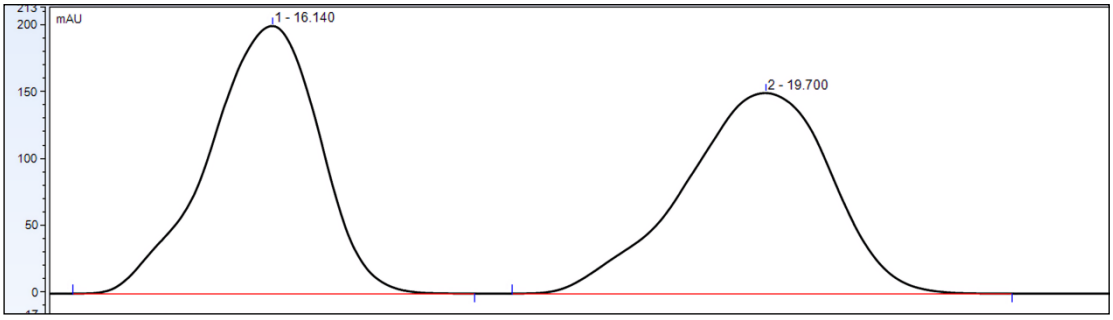


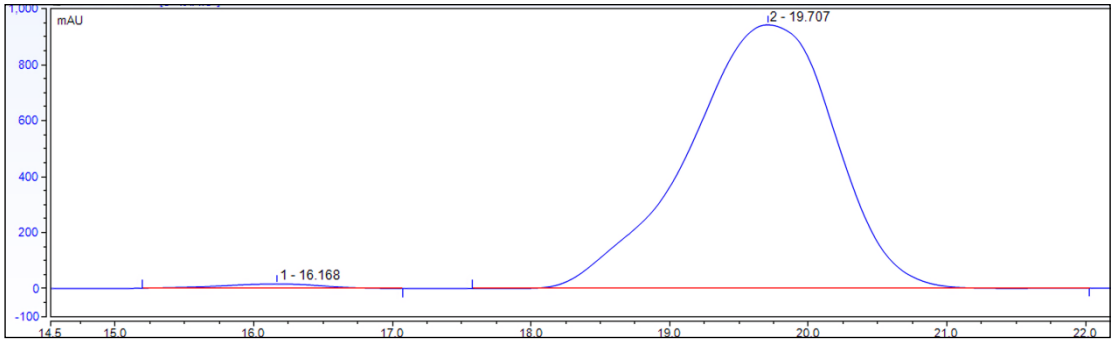


	min	min				%
1	8.908	0.460	BMB*	2.00	0.87	0.86
2	10.672	0.579	BMB*	n.a.	0.92	99.14

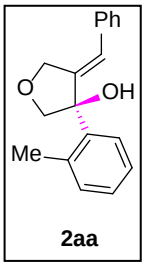


2z: colorless oil, 93% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 16.17 min (*S*), 19.71 min (*R*). $[\alpha]_D^{25}$ = +12.7 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (t, *J* = 7.6 Hz, 2H), 7.28 (t, *J* = 8.0 Hz, 1H), 7.24 (dd, *J* = 8.0, 6.8 Hz, 1H), 7.20 – 7.16 (m, 1H), 7.11 (t, *J* = 7.6 Hz, 3H), 6.89 – 6.79 (m, 1H), 6.31 (t, *J* = 2.5 Hz, 1H), 4.94 (ddd, *J* = 109.4, 14.5, 2.5 Hz, 2H), 4.02 (dd, *J* = 54.4, 9.5 Hz, 2H), 3.82 (s, 3H), 2.60 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.6, 147.2, 143.4, 136.3, 129.3, 128.7, 128.4, 127.6, 124.9, 118.8, 112.8, 112.4, 82.9, 81.2, 70.8, 55.3. HRMS (ESI) calculated for [M+Na, $C_{18}H_{18}NaO_3$]$^+$: 305.1148; found: 305.1149.



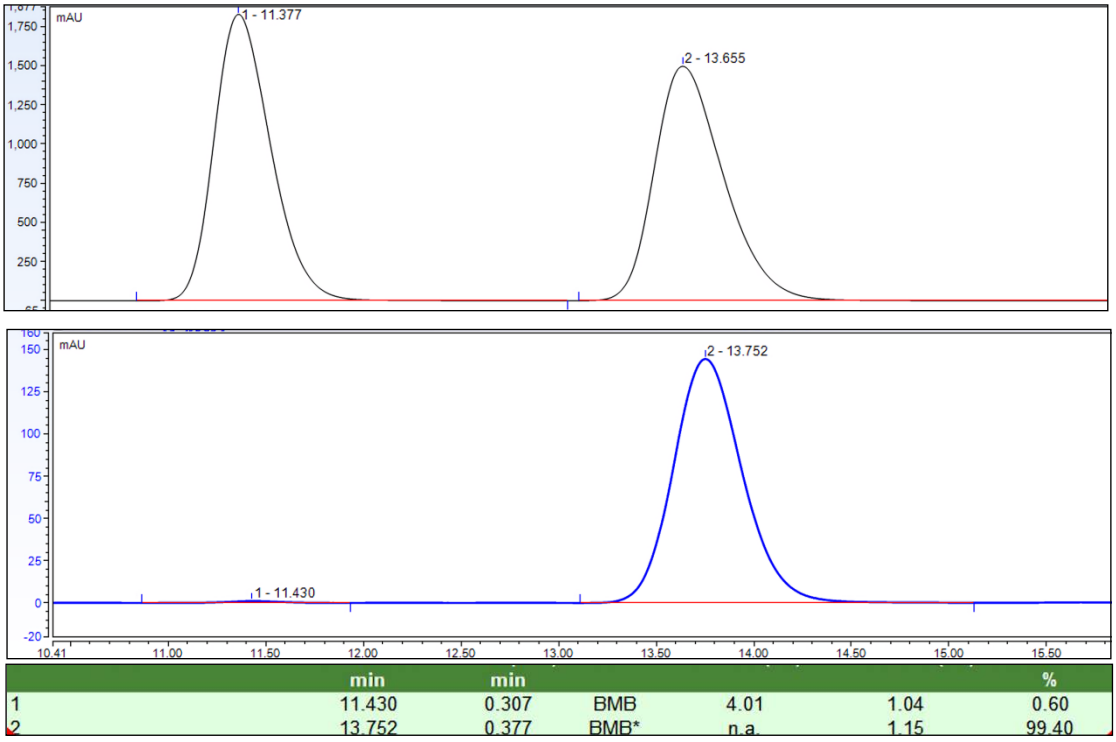


	min	min				%
1	16.168	0.796	BMB*	2.17	0.89	1.14
2	19.707	1.129	BMB*	n.a.	0.87	98.86

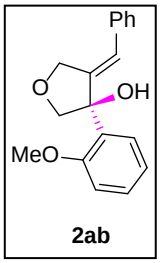


2aa

2aa: white solid, 98% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 11.43 min (*S*), 13.75 min (*R*). $[\alpha]_D^{25}$ = +29.3 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.86 – 7.80 (m, 1H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.28 – 7.22 (m, 3H), 7.21 – 7.17 (m, 1H), 7.13 (d, *J* = 7.5 Hz, 2H), 6.31 (t, *J* = 2.4 Hz, 1H), 4.98 (ddd, *J* = 84.3, 14.4, 2.4 Hz, 2H), 4.08 (dd, *J* = 61.6, 9.7 Hz, 2H), 2.39 (d, *J* = 9.9 Hz, 1H), 2.35 (s, 3H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

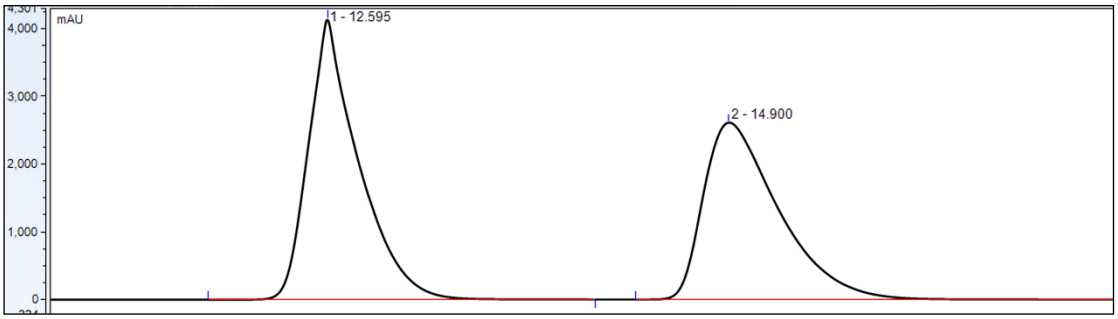


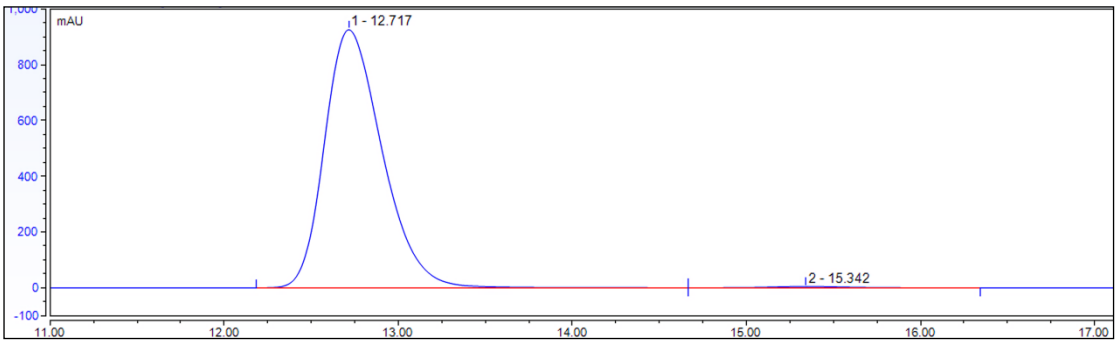
		min	min				%
1	11.430	0.307	BMB	4.01	1.04	0.60
2	13.752	0.377	BMB*	n.a.	1.15	99.40



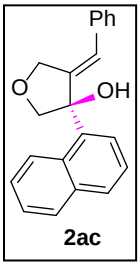
2ab

2ab: white solid, 99% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 12.72 min (*R*), 15.34 min (*S*). $[\alpha]_D^{25}$ = +30.2 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.30 (td, *J* = 8.0, 1.7 Hz, 1H), 7.24 (dd, *J* = 8.7, 6.1 Hz, 1H), 7.18 (d, *J* = 7.4 Hz, 2H), 6.98 (td, *J* = 7.6, 0.8 Hz, 1H), 6.93 (d, *J* = 8.2 Hz, 1H), 6.45 (t, *J* = 2.4 Hz, 1H), 4.90 (ddd, *J* = 48.4, 14.1, 2.4 Hz, 2H), 4.10 (dd, *J* = 159.6, 8.9 Hz, 2H), 3.85 (s, 3H), 3.77 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.4, 146.0, 136.9, 130.9, 129.1, 128.6, 128.4, 128.1, 127.2, 123.1, 120.9, 111.4, 81.9, 78.8, 70.6, 55.5. HRMS (ESI) calculated for [M+Na, $C_{18}H_{18}NaO_3]^+$: 305.1148; found: 305.1150.

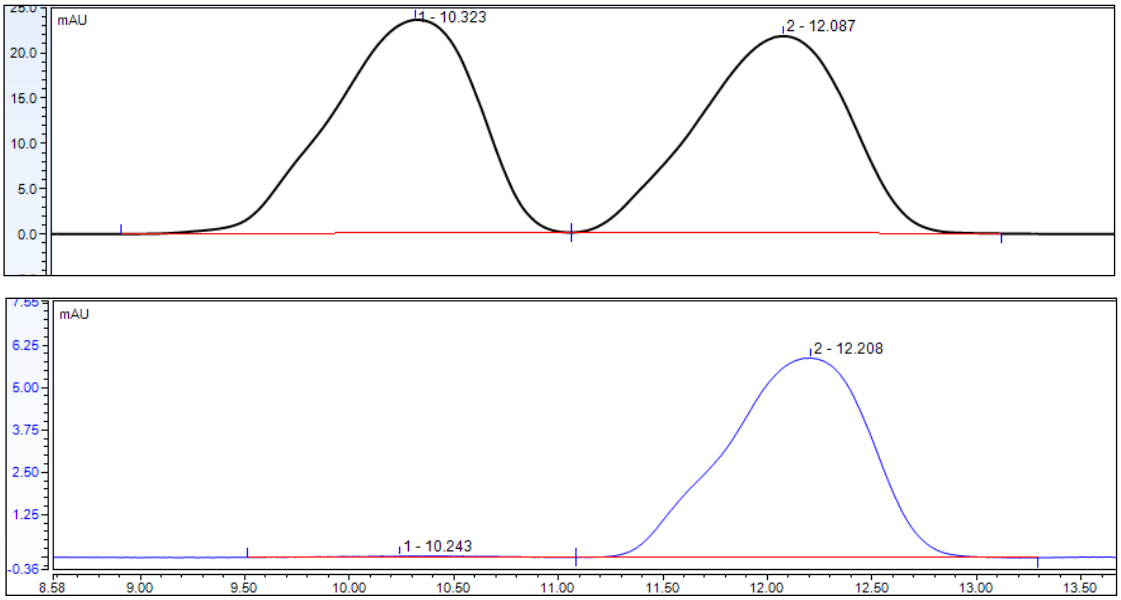




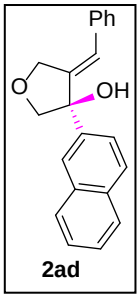
	min	min				%
1	12.717	0.354	BM	3.84	1.30	99.30
2	15.342	0.453	MB	n.a.	1.06	0.70



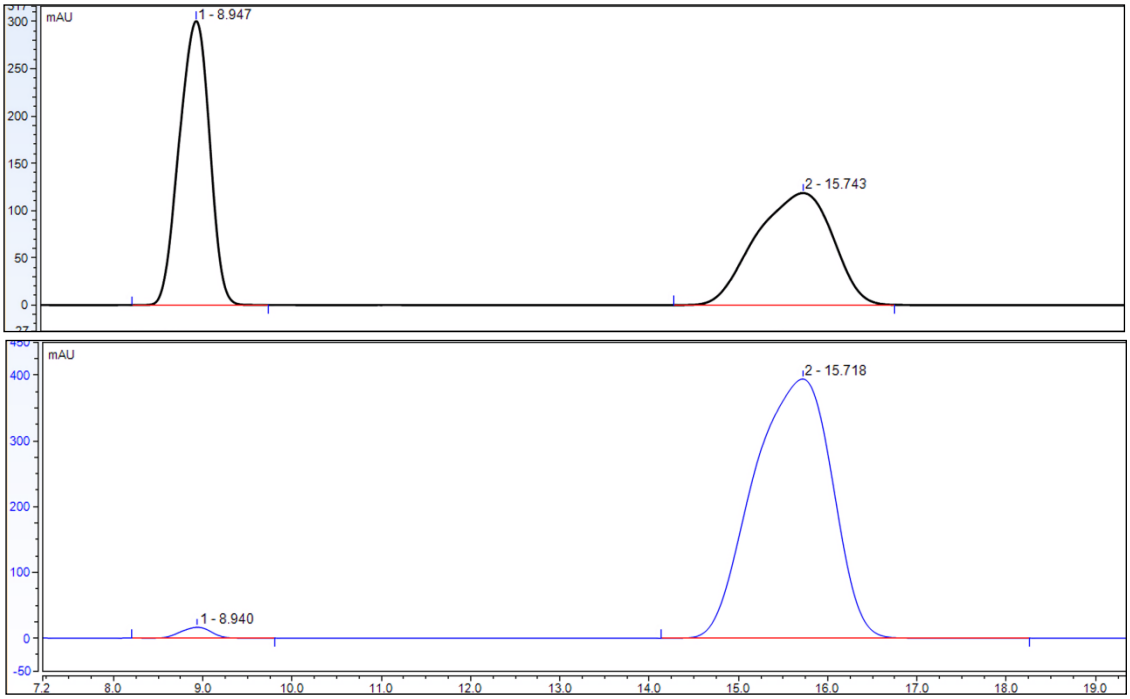
2ac: yellow solid, 99% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 85/15, 254 nm, 10.24 min (*S*), 12.21 min (*R*). $[\alpha]_D^{25}$ = -9.8 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.09 (dd, *J* = 6.8, 2.7 Hz, 1H), 7.93 (dd, *J* = 7.3, 1.1 Hz, 1H), 7.90 – 7.86 (m, 1H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.50 – 7.41 (m, 3H), 7.38 – 7.31 (m, 2H), 7.28 – 7.24 (m, 1H), 7.13 (d, *J* = 7.3 Hz, 2H), 6.35 (t, *J* = 2.5 Hz, 1H), 5.10 (ddd, *J* = 33.1, 14.5, 2.5 Hz, 2H), 4.32 (dd, *J* = 177.5, 9.5 Hz, 2H), 2.58 (s, 1H). HRMS (ESI) calculated for [M+Na, $C_{21}H_{18}NaO_2$]$^+$: 323.1043; found: 323.1072.^{1}H NMR spectra is in agreement with these reported in the literature.[5]



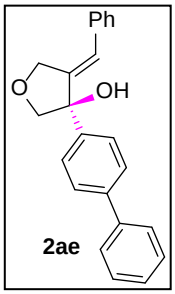
	min	min				%
1	10.243	0.456	BMB*	1.90	1.13	0.55
2	12.208	0.765	BMB*	n.a.	0.85	99.45



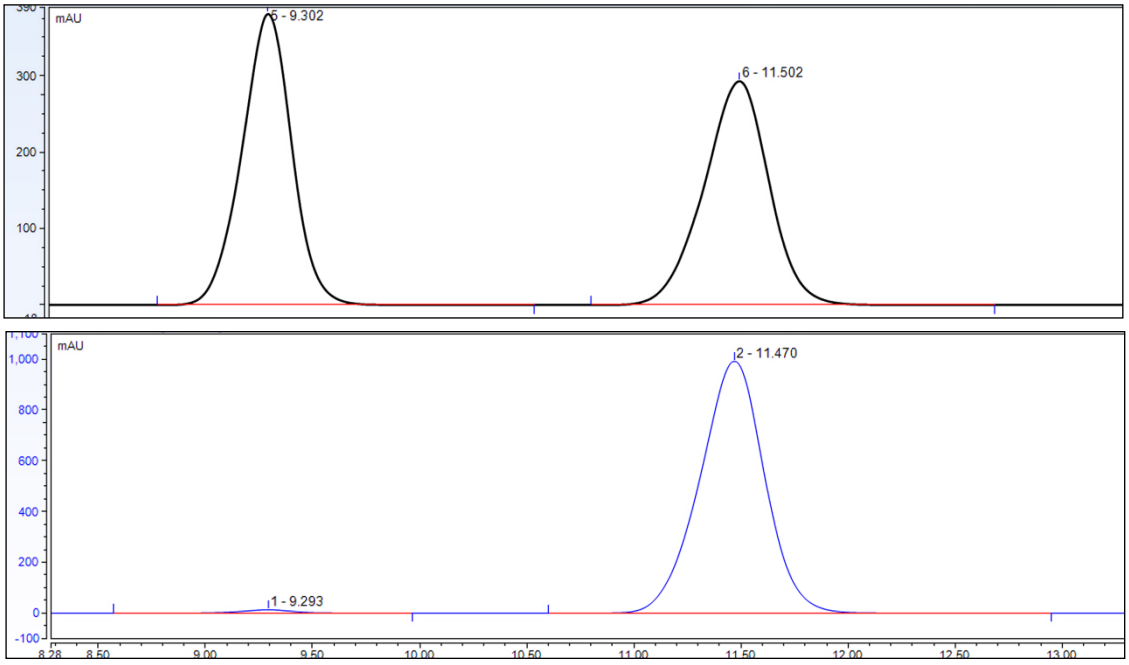
2ad: white solid, 80% yield, 98:2 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 8.94 min (*S*), 15.72 min (*R*). $[\alpha]_D^{25}$ = +85.9 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.18 (d, *J* = 1.3 Hz, 1H), 7.92 – 7.78 (m, 3H), 7.55 – 7.45 (m, 3H), 7.33 (dd, *J* = 10.5, 4.7 Hz, 2H), 7.24 (t, *J* = 7.4 Hz, 1H), 7.10 (d, *J* = 7.3 Hz, 2H), 6.29 (t, *J* = 2.6 Hz, 1H), 5.01 (ddd, *J* = 107.9, 14.5, 2.5 Hz, 2H), 4.12 (dd, *J* = 32.2, 9.7 Hz, 2H), 2.67 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 147.4, 138.9, 136.3, 133.0, 132.7, 128.7, 128.4, 128.0, 127.6, 127.6, 126.3, 126.2, 125.2, 124.5, 83.3, 81.0, 70.9. HRMS (ESI) calculated for [M+Na, $C_{21}H_{18}NaO_2$]$^+$: 325.1199; found: 325.1201.



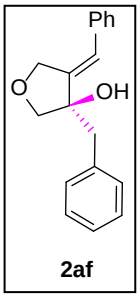
	min	min				%
1	8.940	0.383	BMB*	5.68	0.94	1.59
2	15.718	1.026	BMB*	n.a.	0.85	98.41



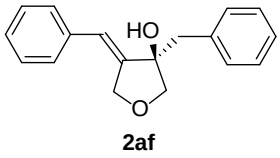
2ae: white solid, 98% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 80/20, 254 nm, 9.29 min (*S*), 11.47 min (*R*). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 – 7.57 (m, 6H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 3H), 7.26 (t, *J* = 7.4 Hz, 1H), 7.15 (d, *J* = 7.4 Hz, 2H), 6.36 (t, *J* = 2.5 Hz, 1H), 4.99 (ddd, *J* = 108.2, 14.5, 2.5 Hz, 2H), 4.07 (dd, *J* = 51.0, 9.6 Hz, 2H), 2.47 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 147.3, 140.7, 140.6, 140.4, 136.3, 128.8, 128.7, 128.4, 127.6, 127.4, 127.1, 127.0, 126.8, 124.9, 83.0, 81.2, 70.9. HRMS (ESI) calculated for [M+Na, $C_{23}H_{20}NaO_2]^+$: 351.1356; found: 351.1353.



	min	min				%
1	9.293	0.248	BMB*	4.51	0.96	1.02
2	11.470	0.322	BMB*	n.a.	0.95	98.98



2af: white solid, 68% yield, 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 16.47 min (*R*), 19.22 min (*S*). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.6 Hz, 2H), 7.33 – 7.23 (m, 6H), 7.13 (d, *J* = 7.4 Hz, 2H), 6.37 (t, *J* = 2.5 Hz, 1H), 4.76 (ddd, *J* = 57.2, 14.4, 2.5 Hz, 2H), 3.73 (dd, *J* = 184.6, 9.1 Hz, 2H), 3.06 (q, *J* = 13.7 Hz, 2H), 2.04 (s, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.0, 136.5, 136.4, 130.5, 128.6, 128.3, 127.3, 126.9, 122.4, 80.2, 70.4, 44.4. HRMS (ESI) calculated for [M+Na, $C_{18}H_{18}NaO_2$]$^{+}$: 289.1199; found: 289.1199. Crystalization from n-Pentane/DCM (9:1) gave crystals suitable for X-ray crystallographic analysis, which revealed its absolute configuration for the chiral tertiary alcohol **2af** as shown in **Figure 2**.



≡

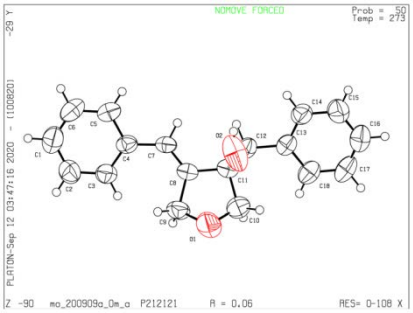
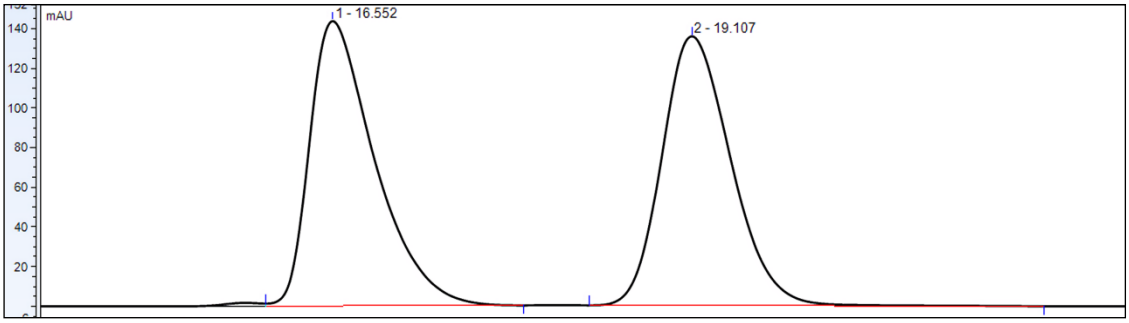
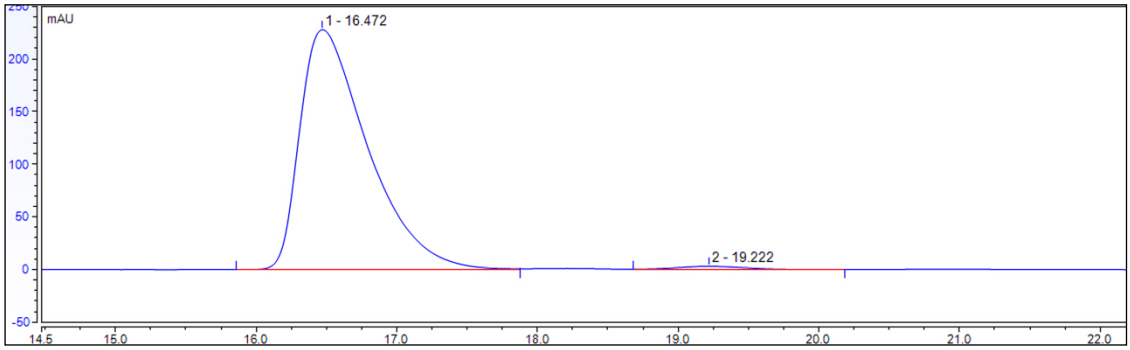
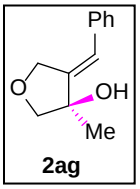


Figure 2. X-ray derived ORTEP representation of **2af**. (CCDC Number: 2040947 contains the supplementary crystallographic data of **2af**. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre)



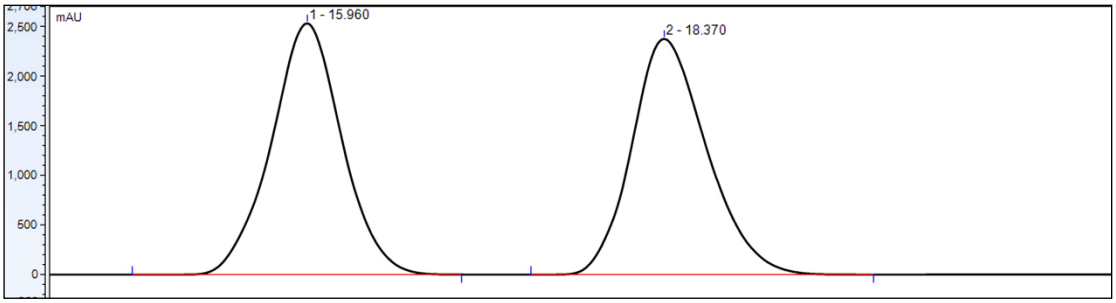


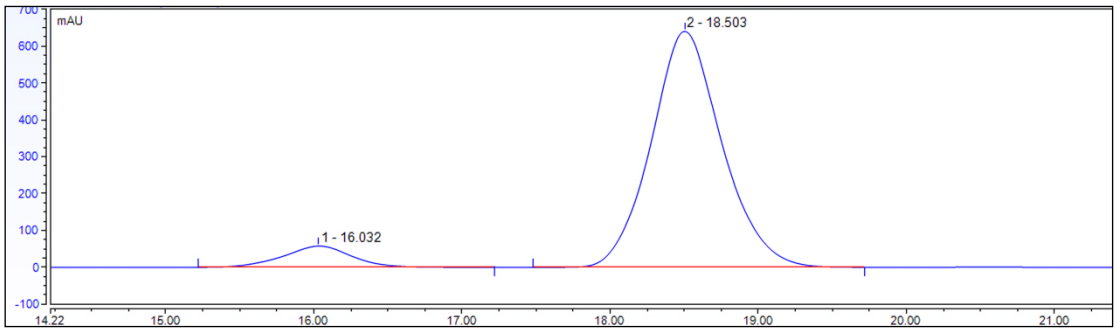
	min	min				%
1	16.472	0.508	BM	3.17	1.84	98.80
2	19.222	0.517	BMB*	n.a.	1.09	1.20



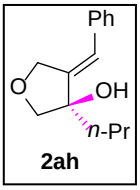
2ag

2ag: colorless oil, 60% yield, 92:8 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 95/5, 254 nm, 16.03 min (*S*), 18.50 min (*R*). $[\alpha]_D^{25}$=+49.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.6 Hz, 2H), 7.27 (d, *J* = 6.1 Hz, 1H), 7.17 (d, *J* = 7.4 Hz, 2H), 6.56 (t, *J* = 2.5 Hz, 1H), 4.77 (ddd, *J* = 78.6, 14.5, 2.5 Hz, 2H), 3.76 (dd, *J* = 64.4, 9.2 Hz, 2H), 2.10 (s, 1H), 1.52 (s, 3H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

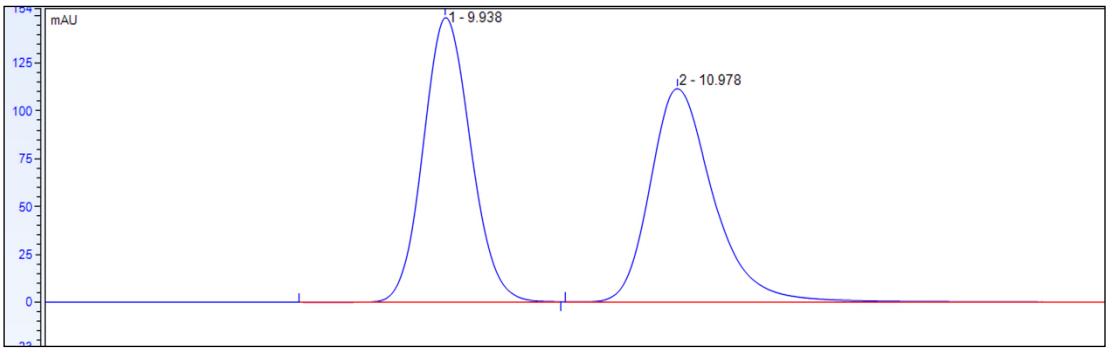


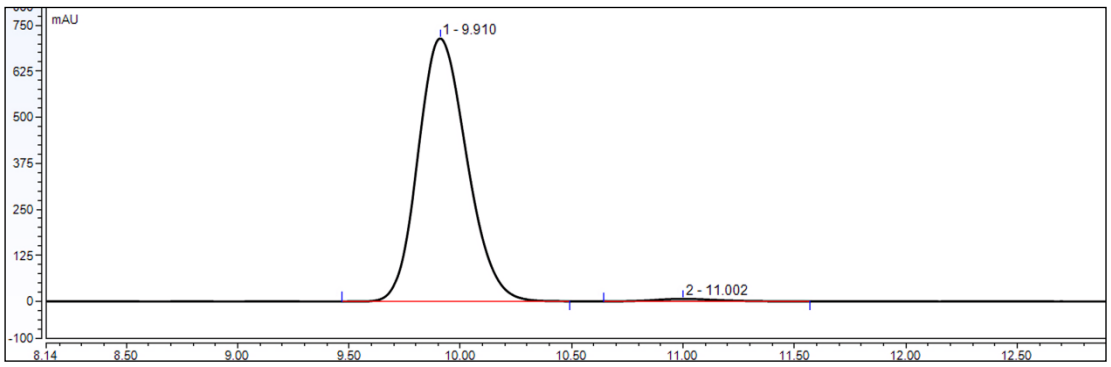


		min	min				%
1		16.032	0.480	BMB	2.97	0.97	7.95
2		18.503	0.500	BMB*	n.a.	1.11	92.05

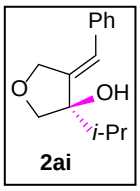


2ah: colorless oil, 83% yield, 99:1 er with **L13** (2 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 9.91 min (*R*), 11.00 min (*S*). $[\alpha]_D^{25}$ = +43.1 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.7 Hz, 2H), 7.25 (t, *J* = 7.4 Hz, 1H), 7.16 (d, *J* = 7.4 Hz, 2H), 6.51 (t, *J* = 2.5 Hz, 1H), 4.74 (ddd, *J* = 87.1, 14.4, 2.5 Hz, 2H), 3.78 (dd, *J* = 21.7, 9.2 Hz, 2H), 1.97 (s, 1H), 1.86 (ddd, *J* = 13.6, 12.2, 4.5 Hz, 1H), 1.76 – 1.65 (m, 1H), 1.61 – 1.50 (m, 1H), 1.44 – 1.31 (m, 1H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.9, 136.5, 128.6, 128.3, 127.3, 121.7, 80.5, 70.3, 40.3, 17.6, 14.6. HRMS (ESI) calculated for [M+Na, $C_{14}H_{18}NaO_2$]$^+$:241.1199; found: 241.1199.



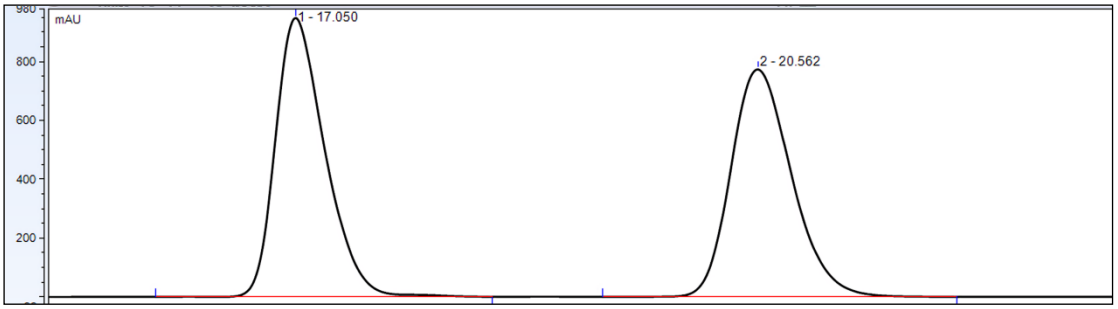


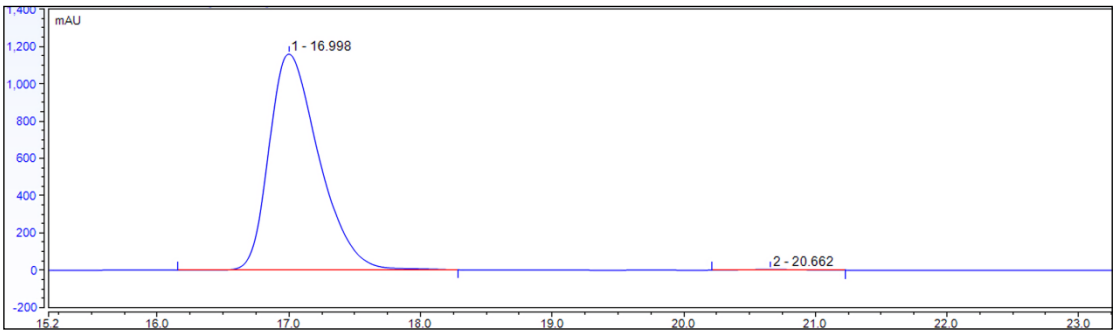
	min	min				%
1	9.910	0.237	BMB*	2.37	1.16	98.80
2	11.002	0.307	BMB*	n.a.	1.24	1.20



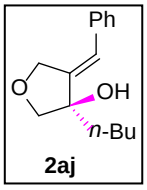
2ai

2ai: light yellow oil, 40% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 17.00 min (*R*), 20.66 min (*S*). $[\alpha]_D^{25}$ = +58.0 (*c* = 1.0, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 (dd, *J* = 10.6, 4.7 Hz, 2H), 7.27 (s, 1H), 7.17 (d, *J* = 7.3 Hz, 2H), 4.72 (ddd, *J* = 89.9, 14.4, 2.5 Hz, 2H), 3.84 (dd, *J* = 163.4, 9.4 Hz, 2H), 2.12 (hept, *J* = 6.9 Hz, 1H), 1.85 (s, 1H), 1.04 (dd, *J* = 48.0, 6.9 Hz, 6H).^{1}H NMR spectra is in agreement with these reported in the literature.[5]

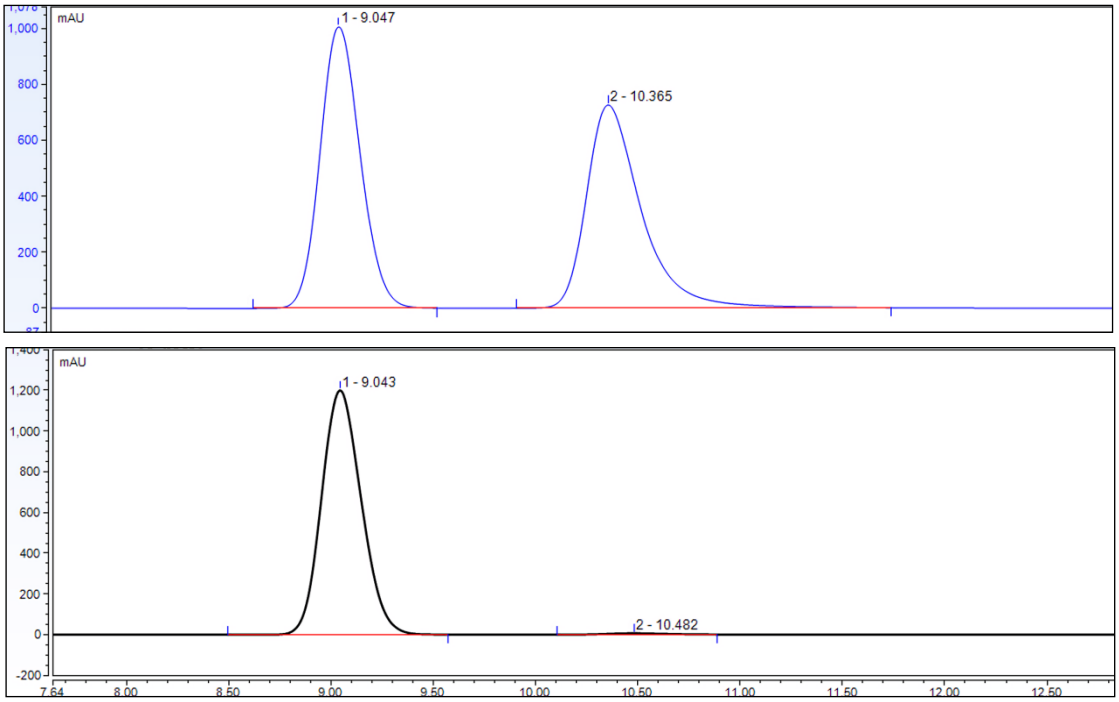




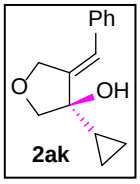
	min	min				%
1	16.998	0.403	BMB*	4.97	1.41	99.67
2	20.662	0.466	BMB*	n.a.	1.10	0.33



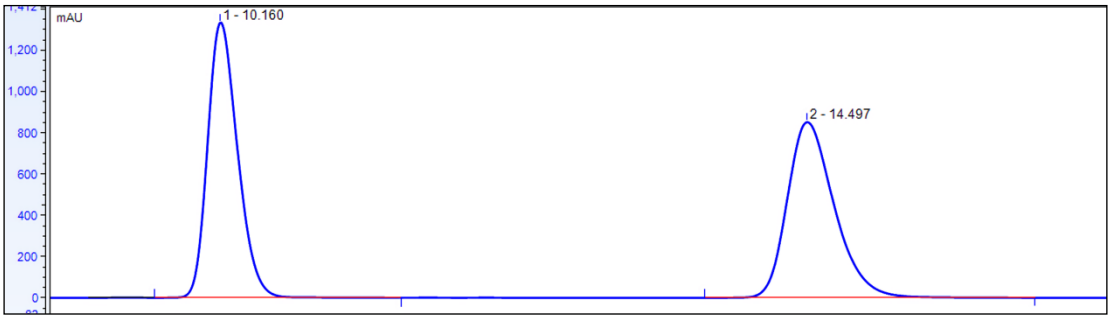
2aj: colorless oil, 98% yield, > 99:1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 9.04 min (*R*), 10.48 min (*S*). $[\alpha]_D^{25}$ = +47.1 (*c* = 1.0, CH_2Cl_2);^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.7 Hz, 2H), 7.26 (d, *J* = 6.2 Hz, 1H), 7.17 (d, *J* = 7.4 Hz, 2H), 6.51 (t, *J* = 2.5 Hz, 1H), 4.75 (ddd, *J* = 87.4, 14.4, 2.5 Hz, 2H), 3.79 (dd, *J* = 21.7, 9.2 Hz, 2H), 1.90 (s, 1H), 1.89 – 1.84 (m, 1H), 1.78 – 1.68 (m, 1H), 1.57 – 1.48 (m, 1H), 1.35 (tt, *J* = 10.0, 6.2 Hz, 3H), 0.93 (t, *J* = 7.2 Hz, 3H). ^{1}H NMR spectra is in agreement with these reported in the literature.[5]

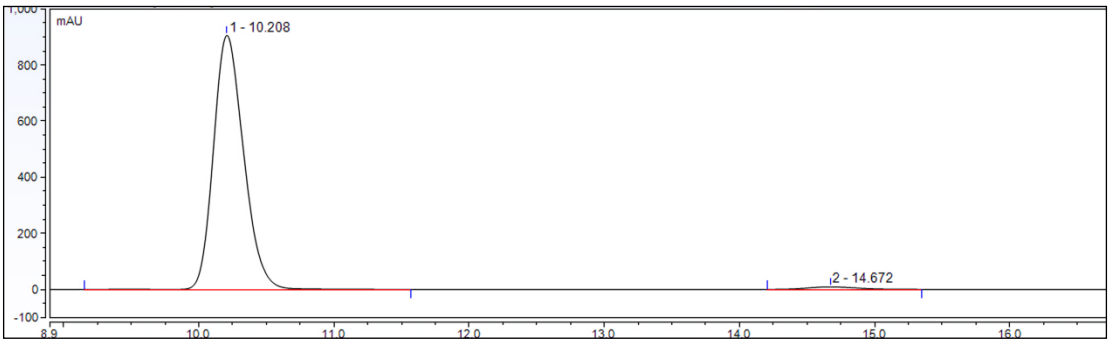


	min	min				%
1	9.043	0.212	BMB*	3.22	1.14	99.20
2	10.482	0.316	BMB*	n.a.	1.16	0.80

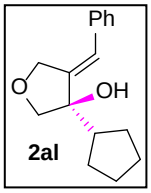


2ak: white solid, 44% yield, 98:2 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 10.21 min (*R*), 14.67 min (*S*). $[\alpha]_D^{25}$ = +48.0 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.7 Hz, 2H), 7.27 – 7.24 (m, 1H), 7.17 (d, *J* = 7.3 Hz, 2H), 6.65 (t, *J* = 2.6 Hz, 1H), 4.78 (ddd, *J* = 82.3, 14.5, 2.6 Hz, 2H), 3.80 – 3.72 (m, 2H), 1.74 (s, 1H), 1.12 (tt, *J* = 8.3, 5.4 Hz, 1H), 0.64 – 0.41 (m, 4H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.4, 136.5, 128.6, 128.4, 127.3, 122.4, 78.9, 77.9, 70.6, 16.8, 0.6, 0.5. HRMS (ESI) calculated for [M+Na, $C_{14}H_{16}NaO_2$]$^+$: 239.1043; found: 239.1044.

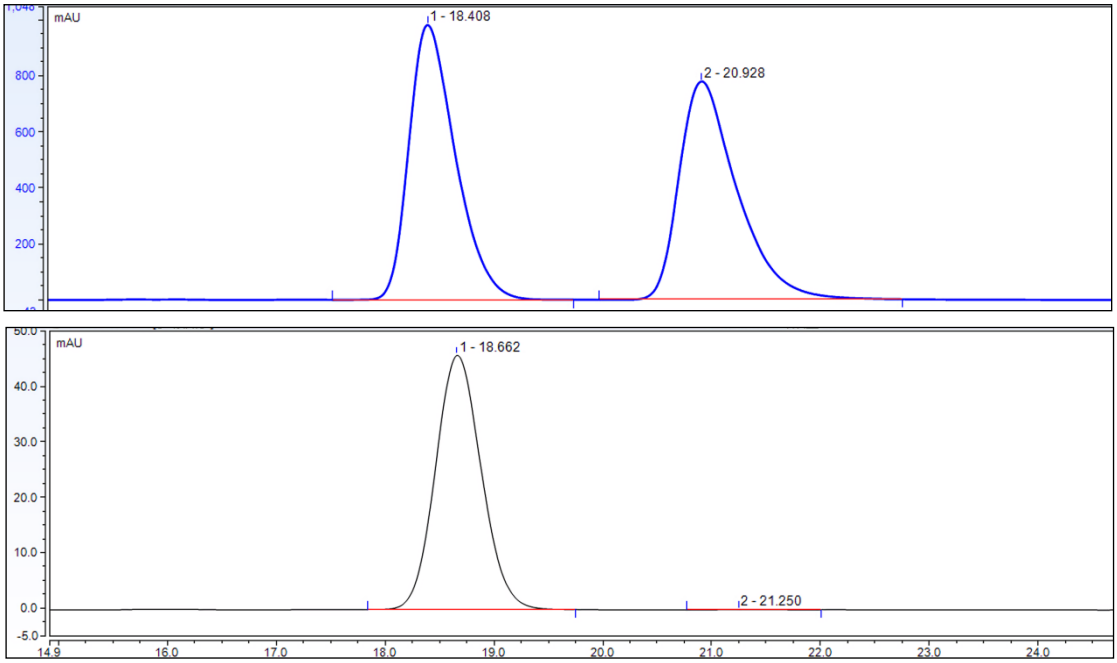




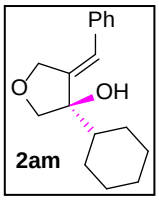
	min	min				%
1	10.208	0.240	BMB*	8.27	1.21	98.39
2	14.672	0.398	BMB*	n.a.	1.16	1.61



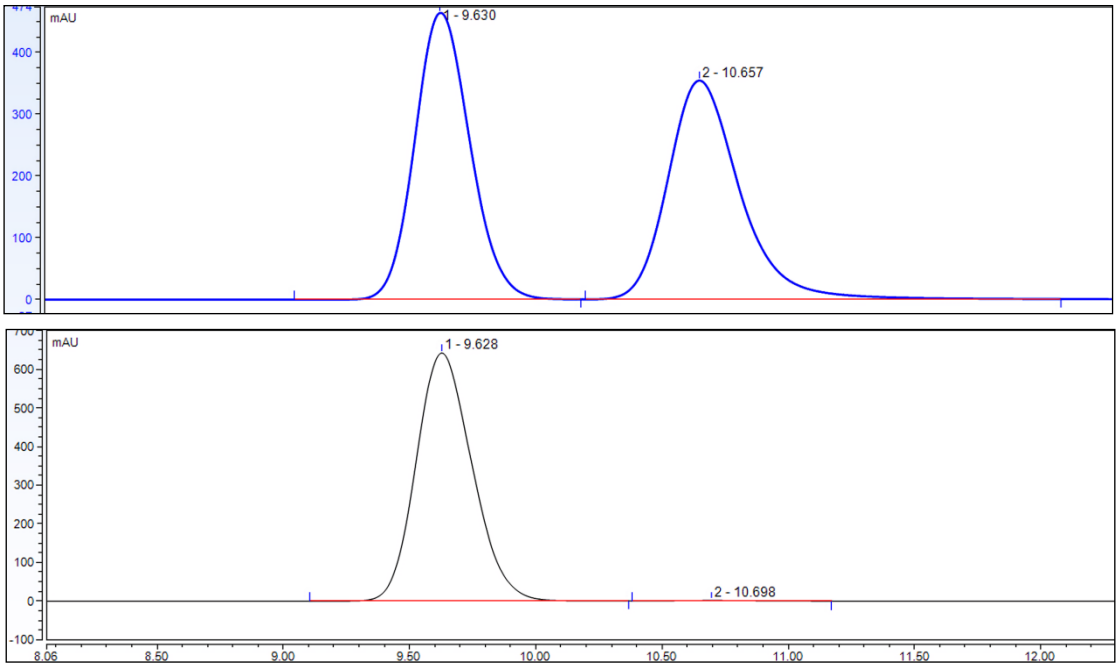
2al: white solid, 75% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 18.66 min (*R*), 21.25 min (*S*). $[\alpha]_D^{25}$ = +54.4 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.7 Hz, 2H), 7.27 – 7.24 (m, 1H), 7.16 (d, *J* = 7.4 Hz, 2H), 6.54 (t, *J* = 2.5 Hz, 1H), 4.74 (ddd, *J* = 66.2, 14.4, 2.5 Hz, 2H), 3.82 (dd, *J* = 110.4, 9.2 Hz, 2H), 2.38 (p, *J* = 8.8 Hz, 1H), 1.92 (s, 1H), 1.91 – 1.82 (m, 1H), 1.72 – 1.41 (m, 7H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.9, 136.6, 128.6, 128.4, 127.2, 122.1, 82.2, 76.2, 70.6, 46.8, 27.6, 27.6, 26.0, 25.8. HRMS (ESI) calculated for [M+Na, $C_{16}H_{20}NaO_2]^+$:267.1356; found: 267.1356.



	min	min				%
1	18.662	0.456	BMB	3.82	1.10	99.86
2	21.250	0.342	BMB*	n.a.	1.21	0.14

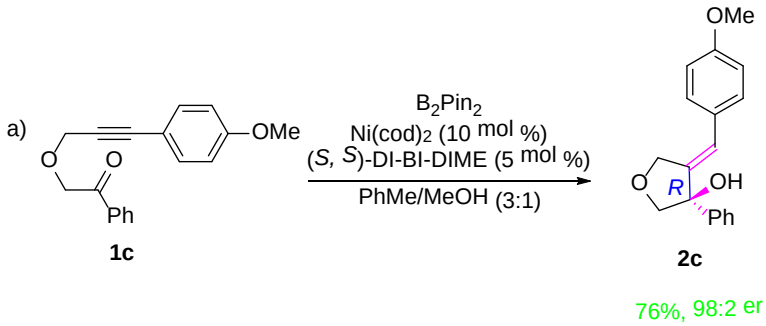


2am: white solid, 80% yield, > 99/1 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark OD-H, 25 °C, flow rate: 1 mL/min, hexanes/isopropanol: 90/10, 254 nm, 9.63 min (*R*), 10.70 min (*S*). $[\alpha]_D^{25}$ = +70.8 (*c* = 1.0, CH_2Cl_2); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (t, *J* = 7.7 Hz, 2H), 7.25 (t, *J* = 7.4 Hz, 1H), 7.17 (d, *J* = 7.4 Hz, 2H), 6.49 (t, *J* = 2.5 Hz, 1H), 4.70 (ddd, *J* = 91.9, 14.3, 2.5 Hz, 2H), 3.83 (dd, *J* = 178.8, 9.4 Hz, 2H), 2.10 (d, *J* = 12.9 Hz, 1H), 1.88 (s, 1H), 1.82 (d, *J* = 13.4 Hz, 1H), 1.79 – 1.65 (m, 4H), 1.33 – 1.20 (m, 2H), 1.18 – 1.07 (m, 2H), 1.03 (ddd, *J* = 24.9, 12.6, 3.6 Hz, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.7, 136.5, 128.6, 128.3, 127.3, 122.3, 82.9, 75.4, 70.8, 45.7, 27.8, 27.4, 26.6, 26.5, 26.4. HRMS (ESI) calculated for [M+Na, $C_{17}H_{22}NaO_2$]$^+$: 281.1512; found: 281.1526.

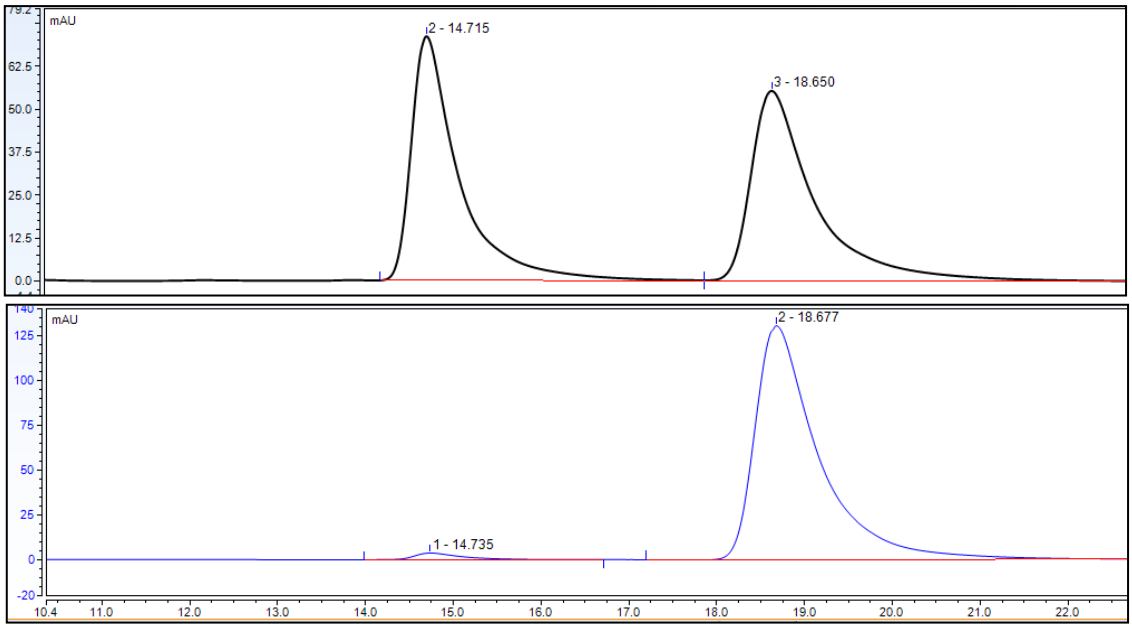


	min	min				%
1	9.628	0.241	BMB*	2.27	1.16	99.70
2	10.698	0.316	BMB*	n.a.	1.18	0.30

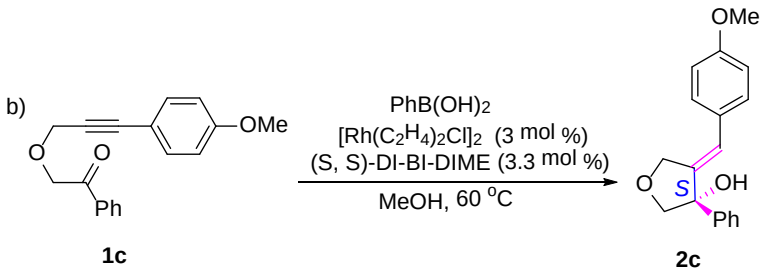
5. Discovered New Asymmetric Cyclization Reactions with (*S,S*)-DI-BIDIME and *O*-Alkynone 1c



General Procedure: $Ni(cod)_2$ (0.0075 mmol, 10 mol %), **(*S,S*)-DI-BIDIME** (**L13**, 0.00375 mmol, 5 mol %), toluene (0.3 mL) were added to a 4 mL screw-cap vial equipped with a magnetic stirring bar in the glove box and stirrs for 10min. followed by the addition of B_2Pin_2 (0.375 mmol, 2.5 equiv.) and the mixture was stirred for 30 min. Substrate **1c** (0.1 mmol, 1.0 equiv.) and methanol (0.1 mL) was added to the solution in one portion. The vial was closed with a screw-cap, and the resulting mixture was stirred at rt for 24 h. The mixture was filtered through a Celite pad and concentrated. The residue was purified by column chromatography (eluent: PE/EA 4/1) to afford **2c**. **2c**: white solid, 76% yield, 98:2 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 0.5 mL/min, hexanes/isopropanol: 15/85, 254 nm, 14.74 min (*S*), 18.68 min (*R*). ^{1}H NMR spectra is in agreement with mentioned above.



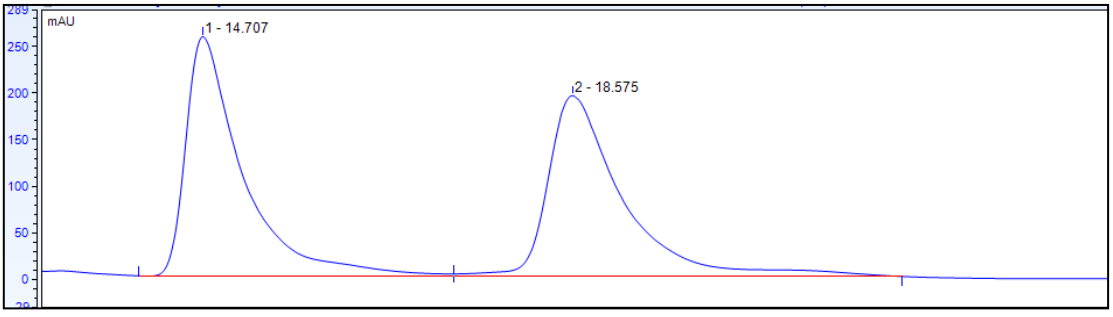
	min	min				%
1	14.735	0.523	BMB	3.82	1.87	2.09
2	18.677	0.693	BMB*	n.a.	2.00	97.91

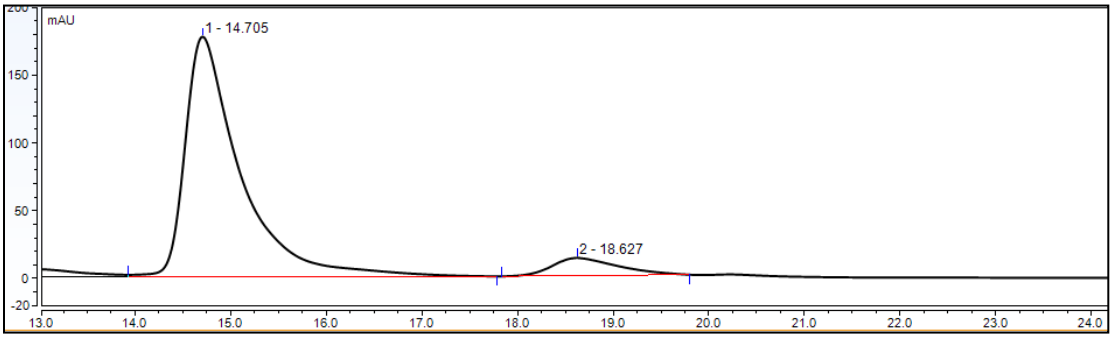


1c **2c**

64%, 92:8 er

General Procedure: $[Rh(C_2H_4)_2Cl]_2$ (0.03 mmol, 3 mol%), phenylboric acid (0.2 mmol, 2 equiv), **(*S*,*S*)-DI-BIDIME** (**L13**, 0.015 mmol, 1.5 mol %), and degassed methanol (0.5 mL) were added to a 4 mL screw-cap vial equipped with a magnetic stirring bar in the glove box. Substrate **1c** (0.1 mmol, 1.0 equiv.) was added to the solution in one portion. The vial was closed with a screw-cap, and the resulting mixture was stirred at 60 °C until the raw materials are completely consumed. The solvent was removed in vacuo. The residue was purified by column chromatography (eluent: PE/EA 4/1) to afford **2c**. **2c**: white solid, 64% yield, 92:8 er with **L13** (2.5 mol %). Enantiomeric ratio was determined by chiral HPLC. Chiralpark AD-H, 25 °C, flow rate: 0.5 mL/min, hexanes/isopropanol: 15/85, 254 nm, 14.71 min (*S*), 18.57 min (*R*). ^{1}H NMR spectra is in agreement with mentioned above.





	min	min				%
1	14.705	0.537	MB	3.66	2.11	91.93
2	18.627	0.728	BMB	n.a.	1.38	8.07

6. References

[1] A. D. Worthy, C. L. Joe, T. E. Lightburn, K. L. Tan, *J. Am. Chem. Soc.* **2010**, *132*, 14757-14759.

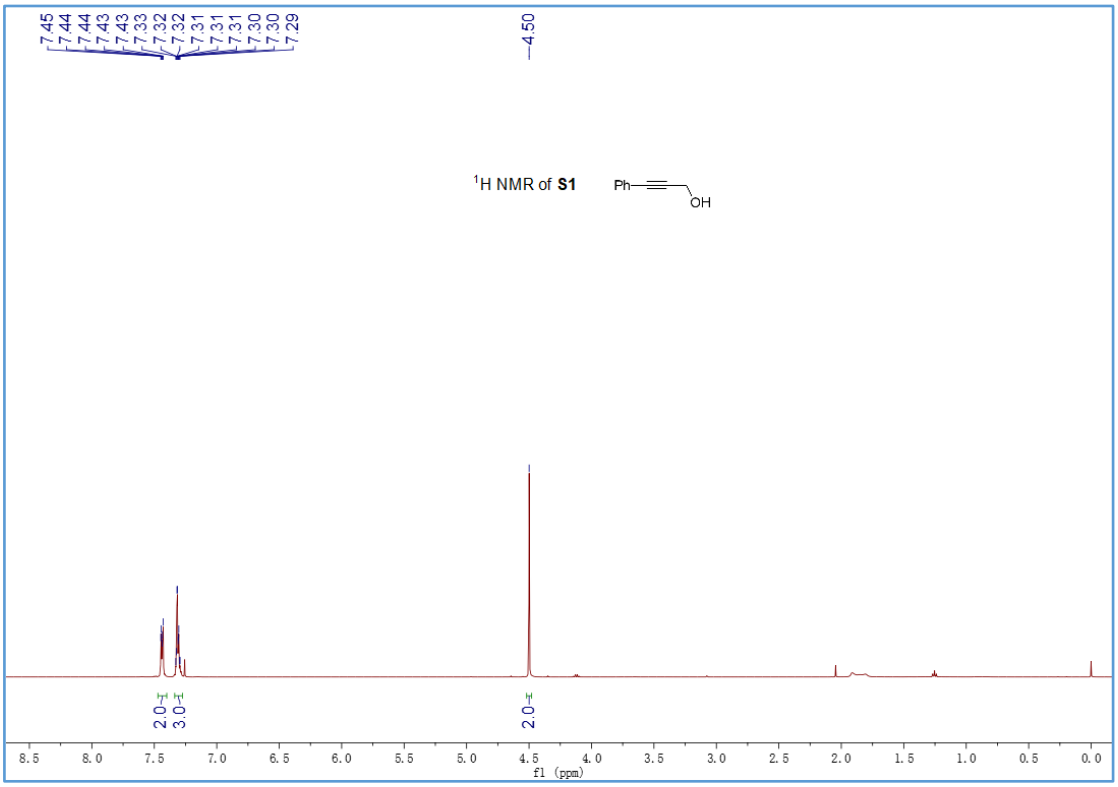
[2] P. Wessig, G. Müller, R. Herre, A. Kühn, Helv. *Chim. Acta.* **2006**, *89*, 2694-2719.

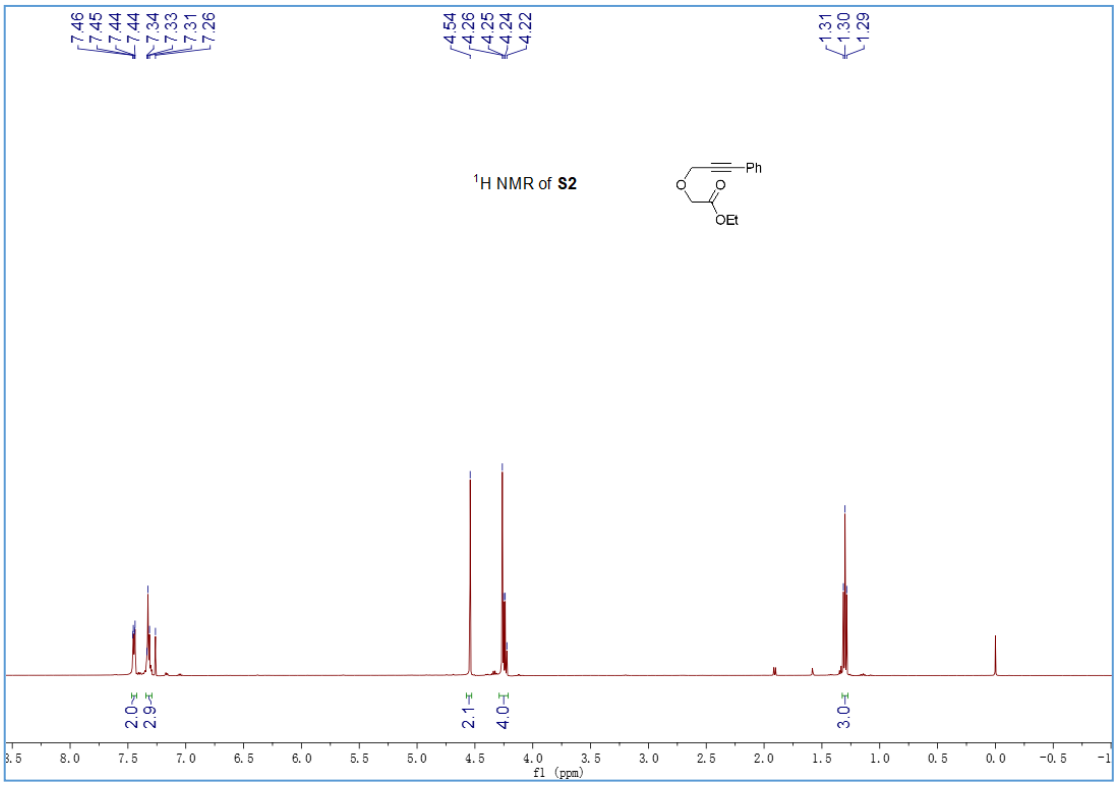
[3] L. Zhao, X. Lu, *Angew. Chem. Int. Ed.* **2002**, *41*, 4343-4345.

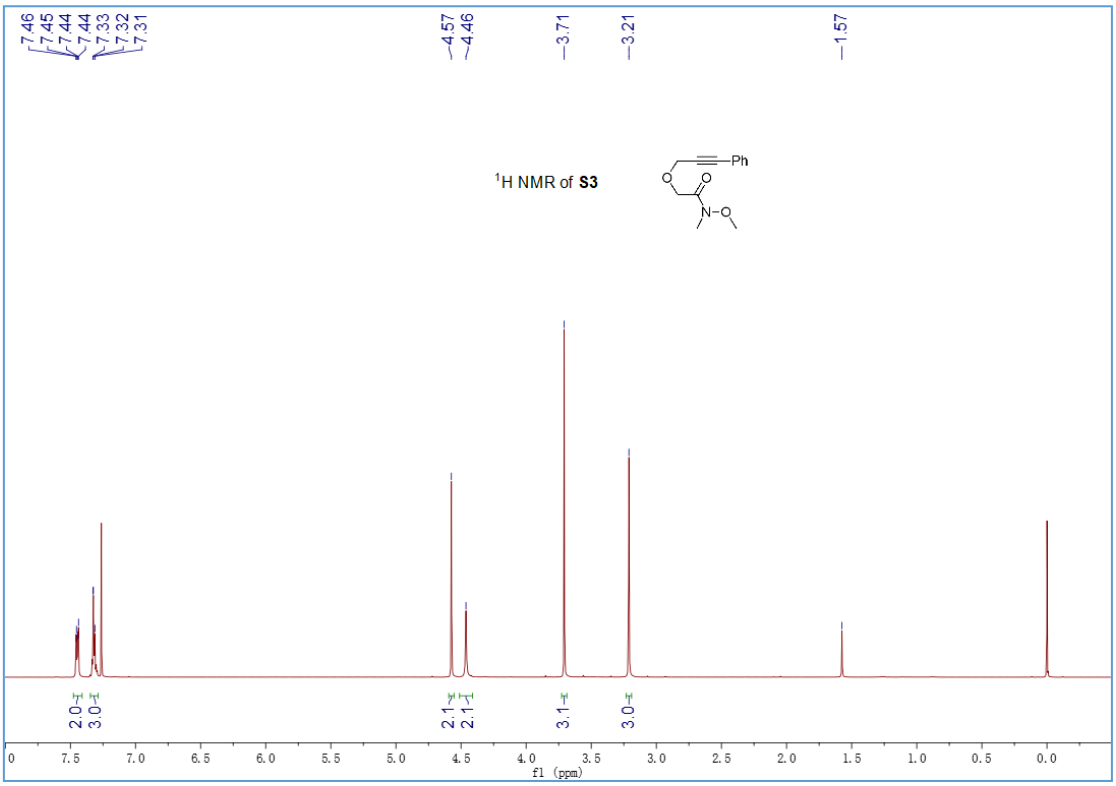
[4] M. Starck, P. Kadjane, E. Bois, B. Darbouret, A. Incamps, R. Ziessel, L. J. Charbonnière, *Chem. Eur. J.* **2011**, *17*, 9164-9179.

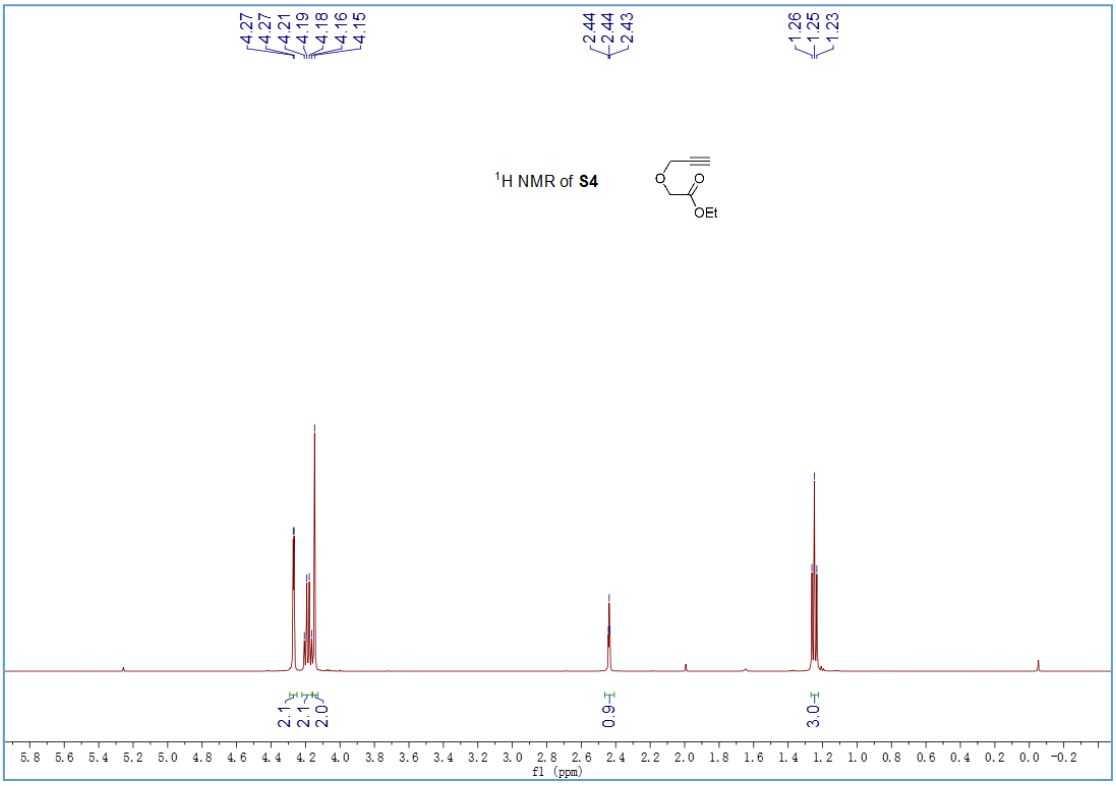
[5] W. Fu, M. Nie, A. Wang, Z. Cao, W. Tang, *Angew. Chem. Int. Ed.* **2015**, *54*, 2520-2524.

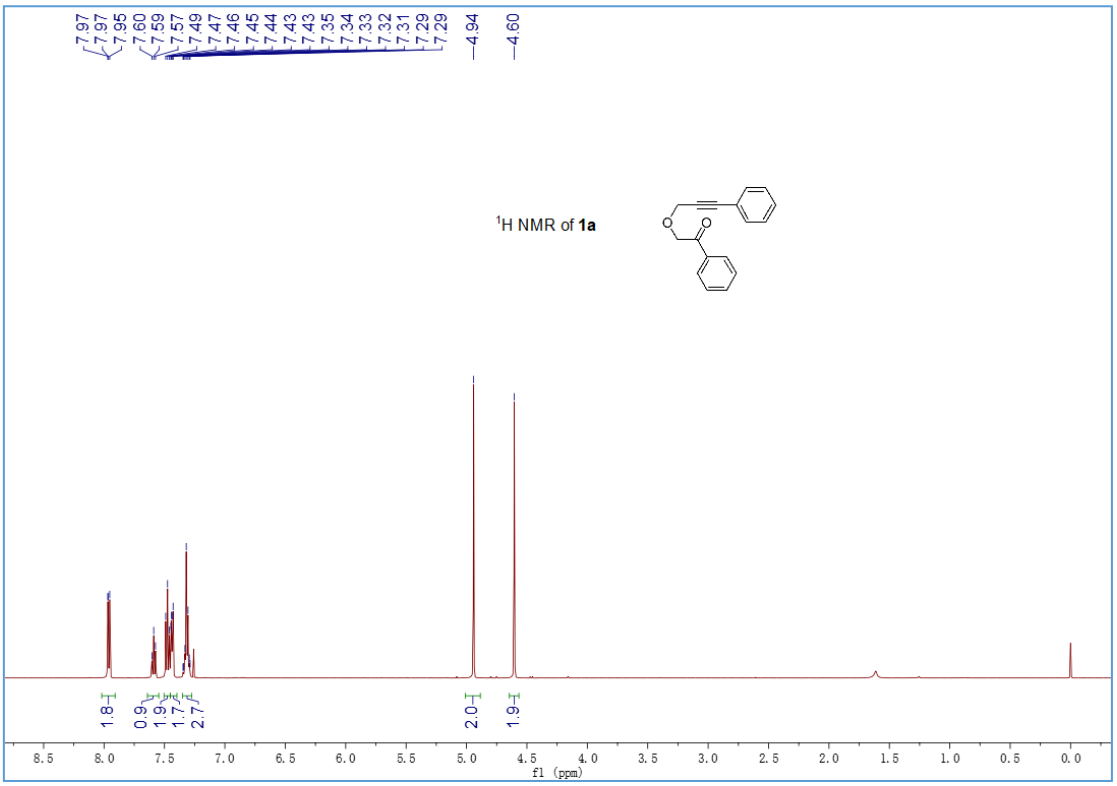
7. NMR Spectra

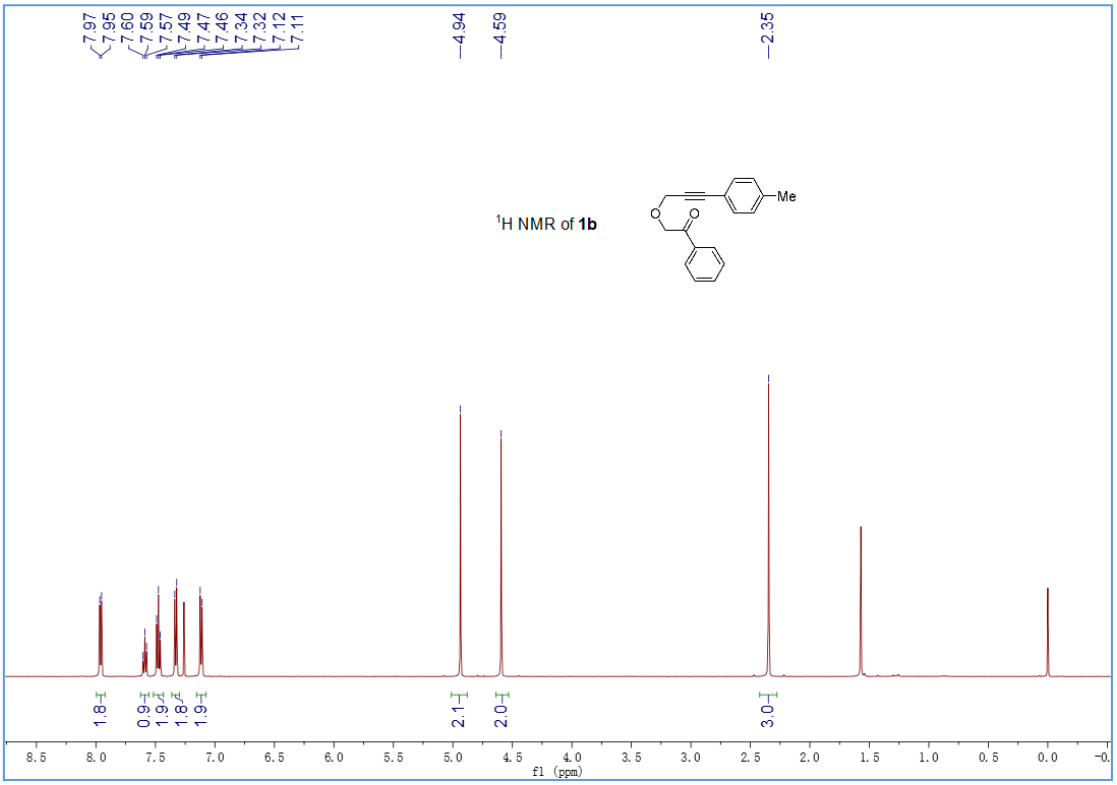


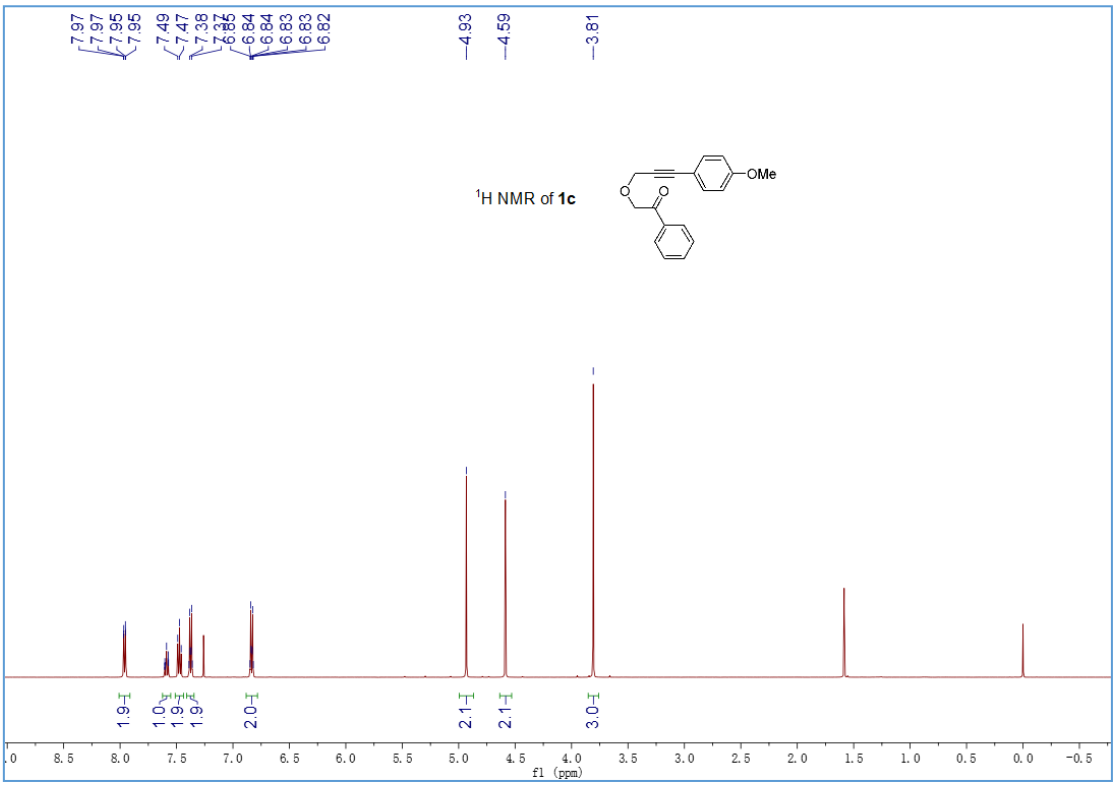


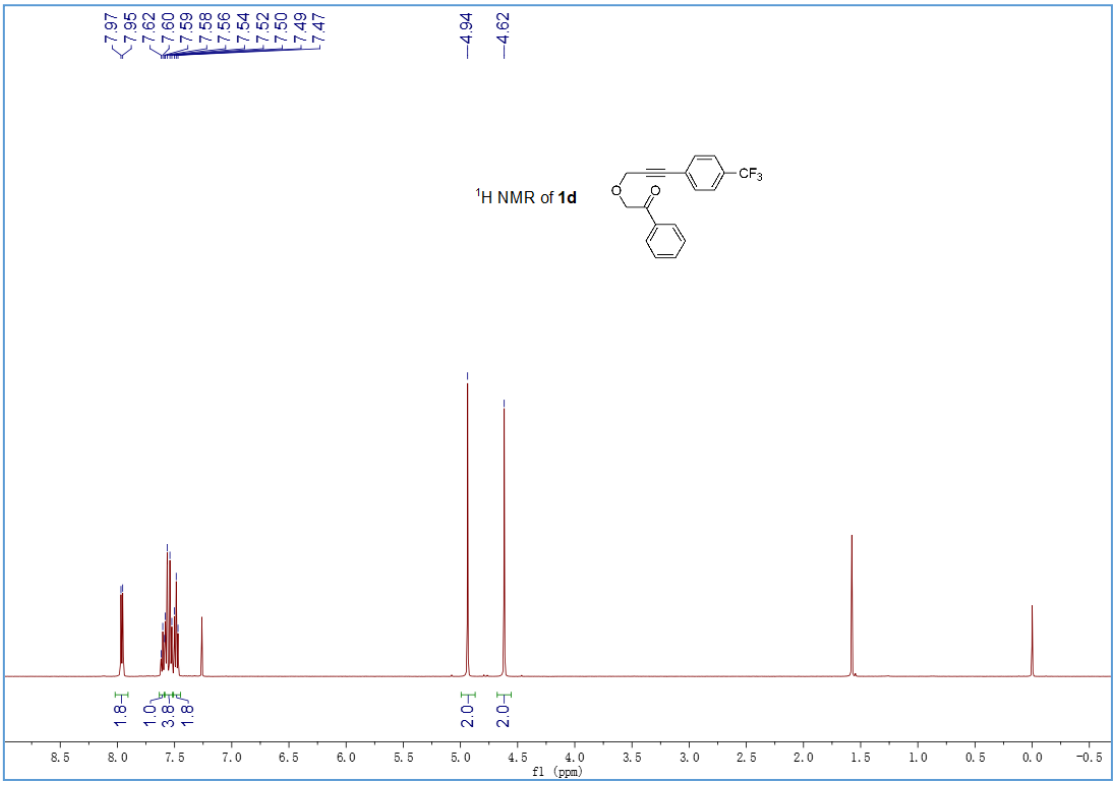

7.46
7.45
7.44
7.44
7.33
7.32
7.31
4.57
4.46
3.71
3.21
1.57
^{1}H NMR of **S3**
Ph
O
O
N–O
2.0
3.0
2.1
2.1
3.1
3.0
f1 (ppm)

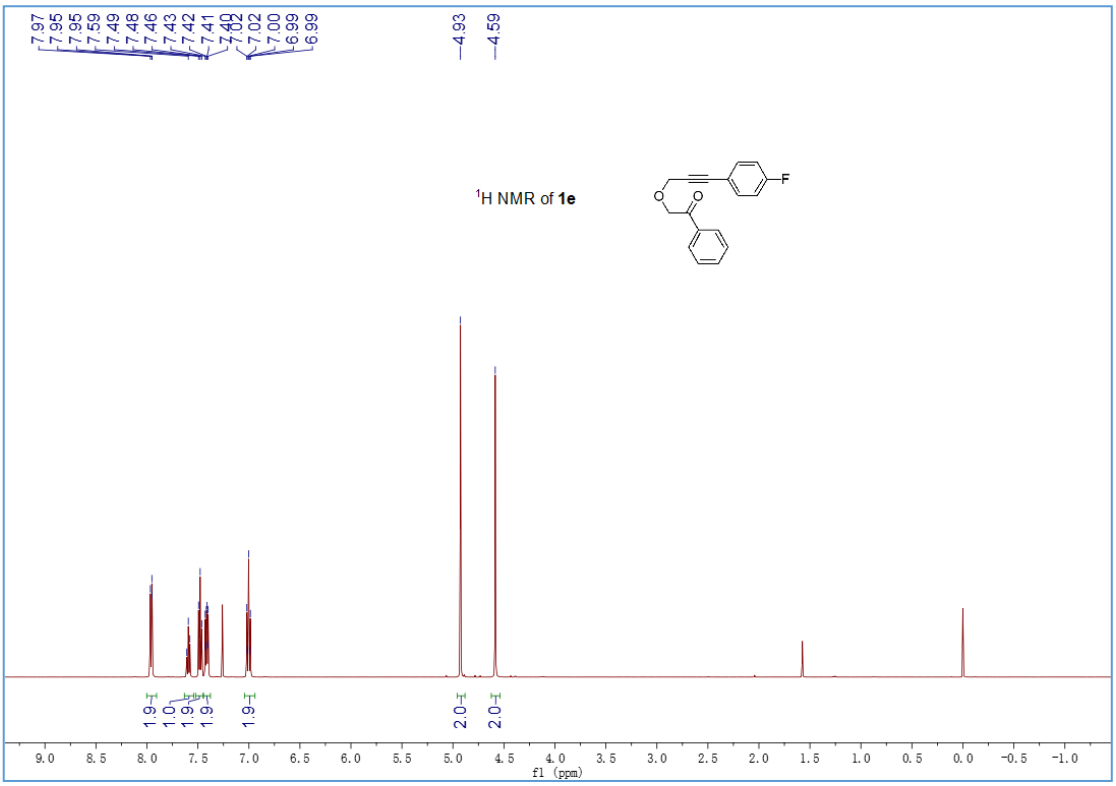

4.27
4.27
4.21
4.19
4.18
4.16
4.15
2.44
2.44
2.43
1.26
1.25
1.23
^{1}H NMR of **S4**
O
O
OEt
2.1
2.1
2.0
0.9
3.0
f1 (ppm)

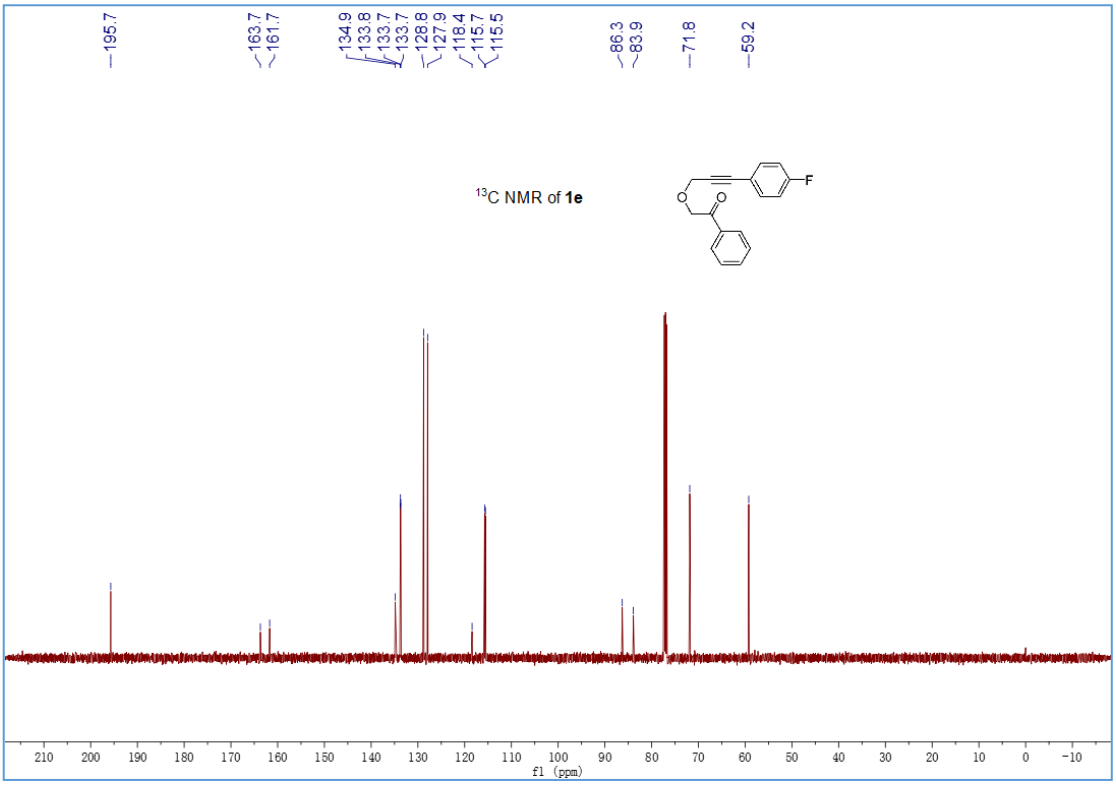

7.97
7.97
7.95
7.60
7.59
7.57
7.49
7.47
7.46
7.45
7.44
7.43
7.43
7.35
7.34
7.33
7.32
7.31
7.29
7.29
4.94
4.60
1H NMR of 1a
1.8
0.9
1.9
1.7
2.7
2.0
1.9
f1 (ppm)

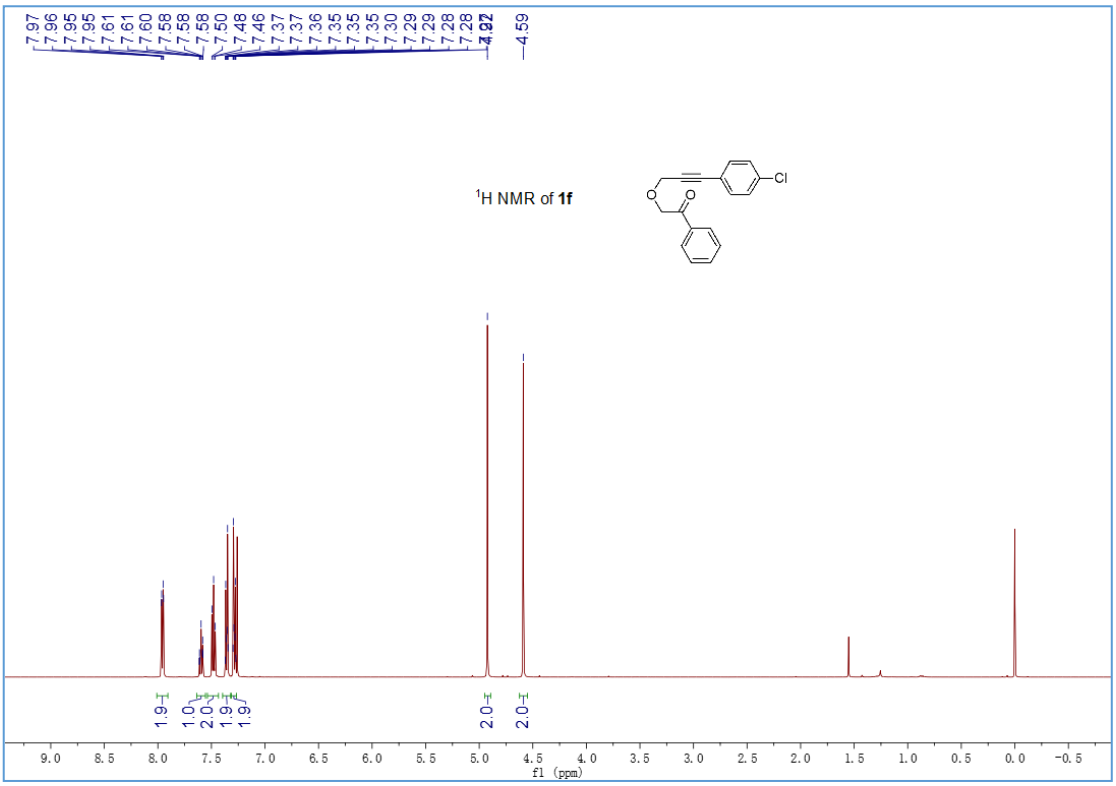

7.97
7.95
7.60
7.59
7.57
7.49
7.47
7.46
7.34
7.32
7.12
7.11
4.94
4.59
2.35
Me
1H NMR of 1b
1.8
0.9
1.9
1.8
1.9
2.1
2.0
3.0
f1 (ppm)

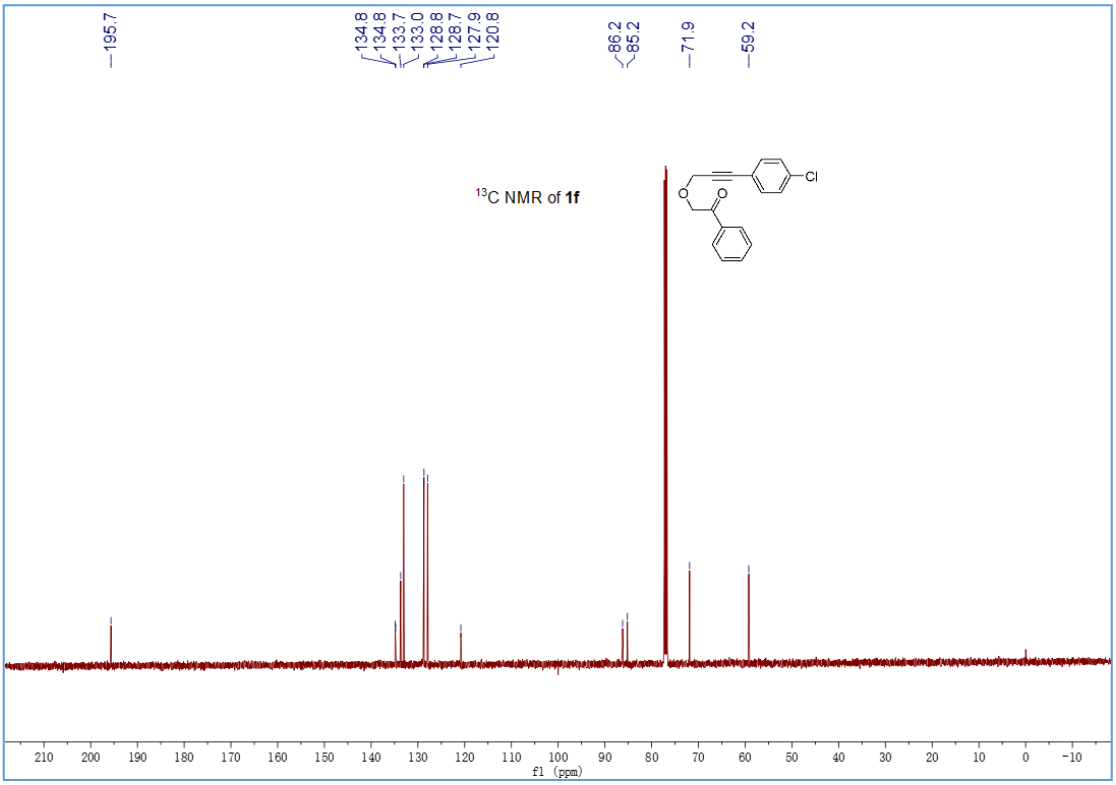

7.97
7.97
7.95
7.95
7.49
7.47
7.38
7.37
6.85
6.84
6.84
6.83
6.83
6.82
4.93
4.59
3.81
^{1}H NMR of **1c**
OMe
1.9
1.0
1.9
1.9
2.0
2.1
2.1
3.0
f1 (ppm)

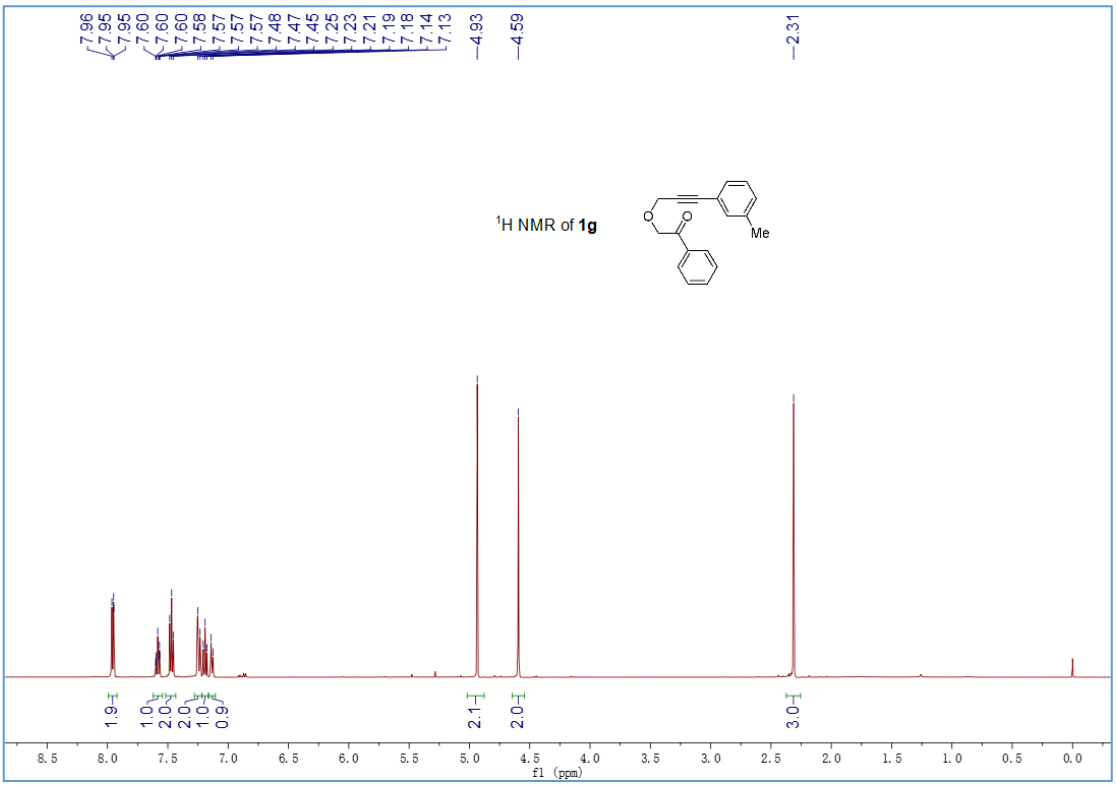

7.97
7.95
7.62
7.60
7.59
7.58
7.56
7.54
7.52
7.50
7.49
7.47
4.94
4.62
^{1}H NMR of **1d**
CF_3
1.8
1.0
3.8
1.8
2.0
2.0
f1 (ppm)


7.97
7.95
7.95
7.59
7.49
7.48
7.46
7.43
7.42
7.41
7.40
7.02
7.00
6.99
6.99
4.93
4.59
^{1}H NMR of **1e**
F
O
O
1.9
1.0
1.9
1.9
1.9
2.0
2.0
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)


195.7
163.7
161.7
134.9
133.8
133.7
133.7
128.8
127.9
118.4
115.7
115.5
86.3
83.9
71.8
59.2
^{13}C NMR of **1e**
F
O
O
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)


7.97
7.96
7.95
7.95
7.61
7.61
7.60
7.58
7.58
7.58
7.50
7.48
7.46
7.37
7.37
7.36
7.35
7.35
7.35
7.30
7.29
7.29
7.28
7.28
4.59
^{1}H NMR of **1f**
Cl
O
O
1.9
1.0
2.0
1.9
1.9
2.0
2.0
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)


195.7
134.8
134.8
133.7
133.0
128.8
128.7
127.9
120.8
86.2
85.2
71.9
59.2
^{13}C NMR of **1f**
Cl
O
O
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)


7.96
7.95
7.95
7.60
7.60
7.60
7.58
7.57
7.57
7.57
7.48
7.47
7.45
7.25
7.23
7.21
7.19
7.18
7.14
7.13
4.93
4.59
2.31
1H NMR of 1g
Me
1.9
1.0
2.0
2.0
1.0
0.9
2.1
2.0
3.0
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
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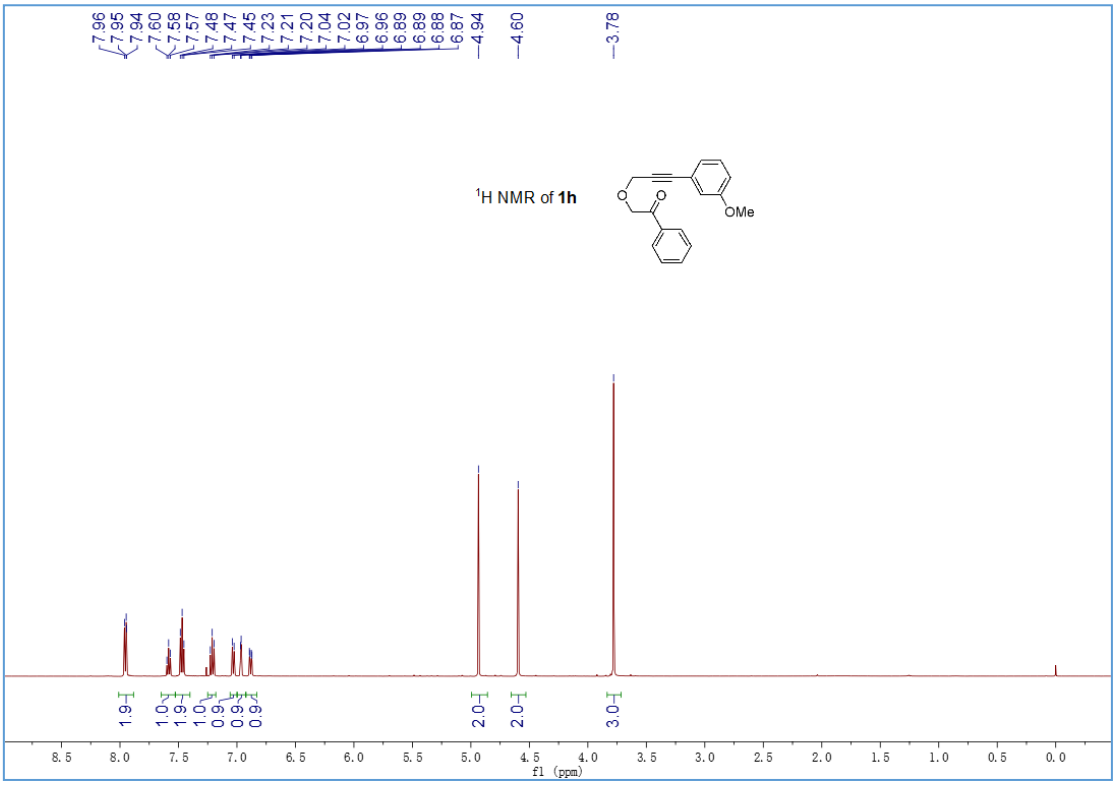
1.0
0.5
0.0
f1 (ppm)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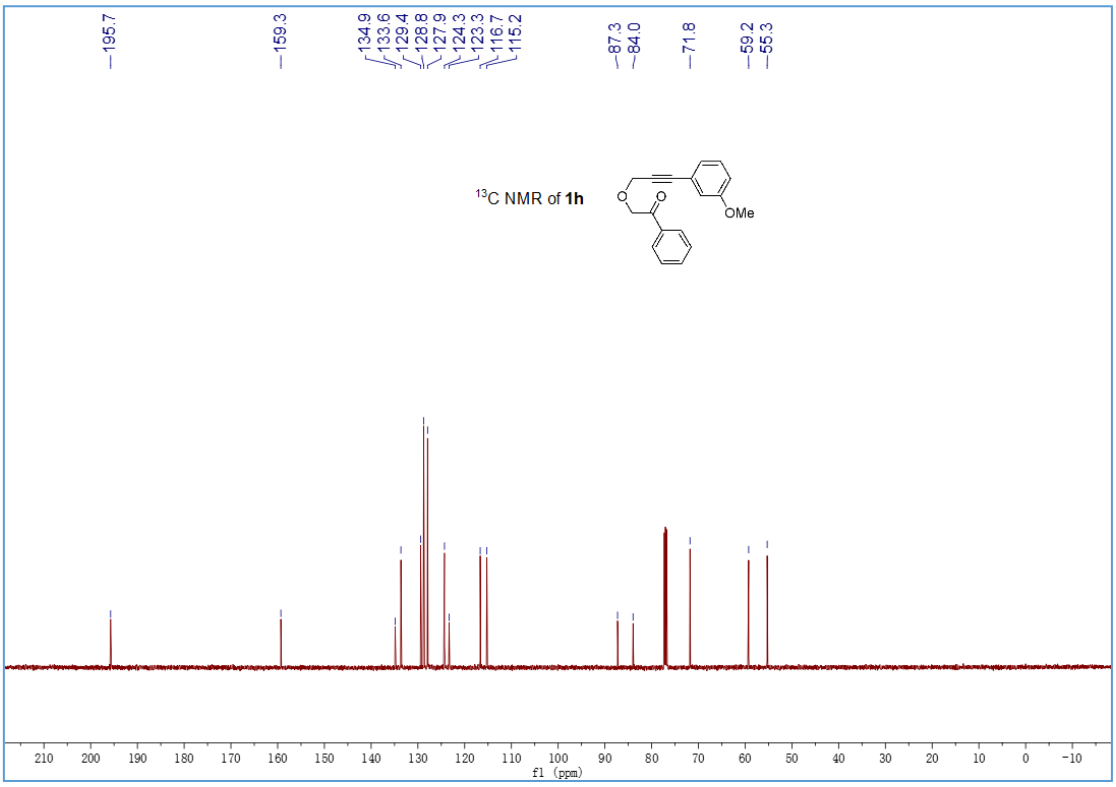
7.95
7.94
7.60
7.58
7.57
7.48
7.47
7.45
7.23
7.21
7.20
7.04
7.02
6.97
6.96
6.89
6.89
6.88
6.87
4.94
4.60
3.78
1H NMR of 1h
OMe
1.9
1.0
1.9
1.0
0.9
0.9
0.9
2.0
2.0
3.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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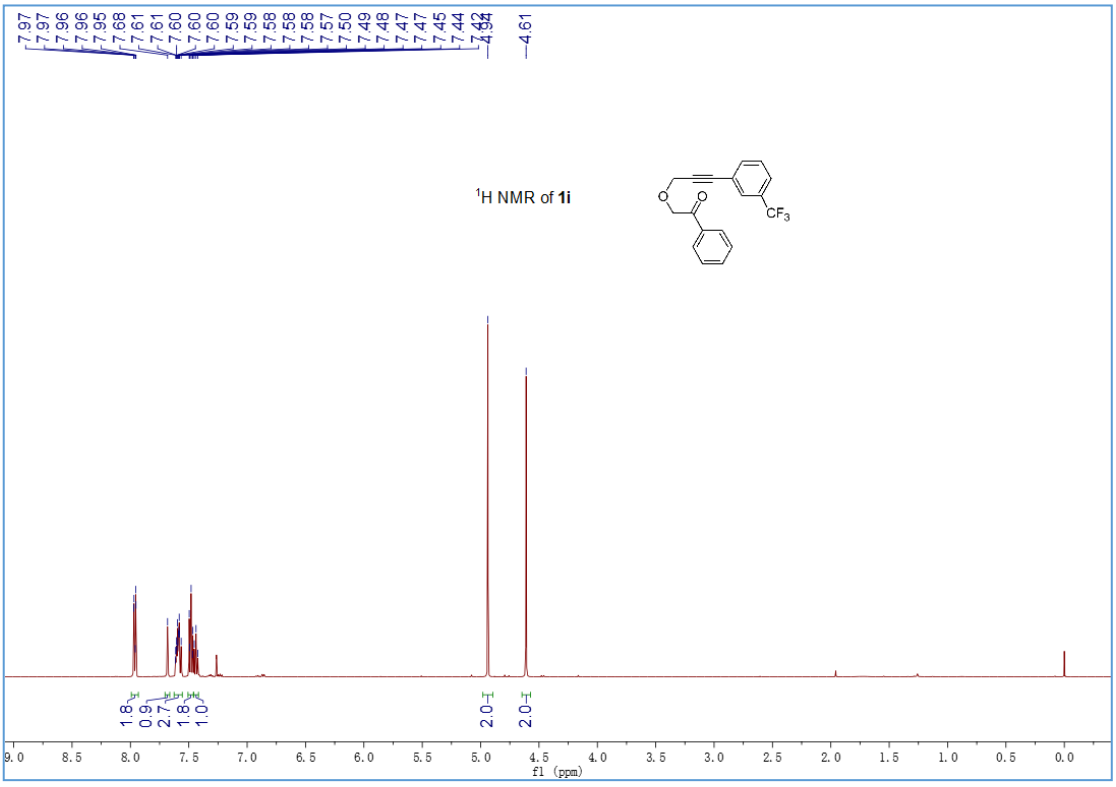
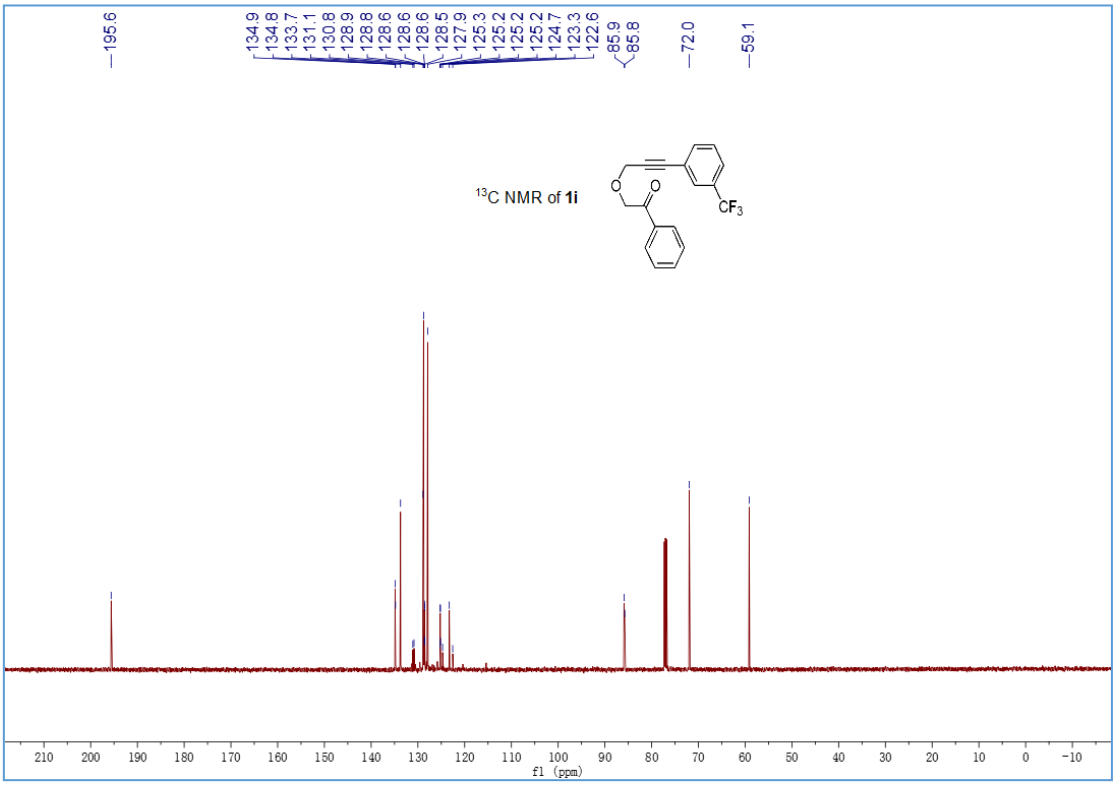
159.3
134.9
133.6
129.4
128.8
127.9
124.3
123.3
116.7
115.2
87.3
84.0
71.8
59.2
55.3
^{13}C NMR of **1h**
OMe
f1 (ppm)


7.97
7.97
7.96
7.96
7.95
7.68
7.61
7.61
7.60
7.60
7.60
7.59
7.59
7.58
7.58
7.58
7.57
7.50
7.49
7.48
7.47
7.47
7.45
7.44
7.42
4.61
^{1}H NMR of **1i**
CF_3
1.8
0.9
2.7
1.8
1.0
2.0
2.0
f1 (ppm)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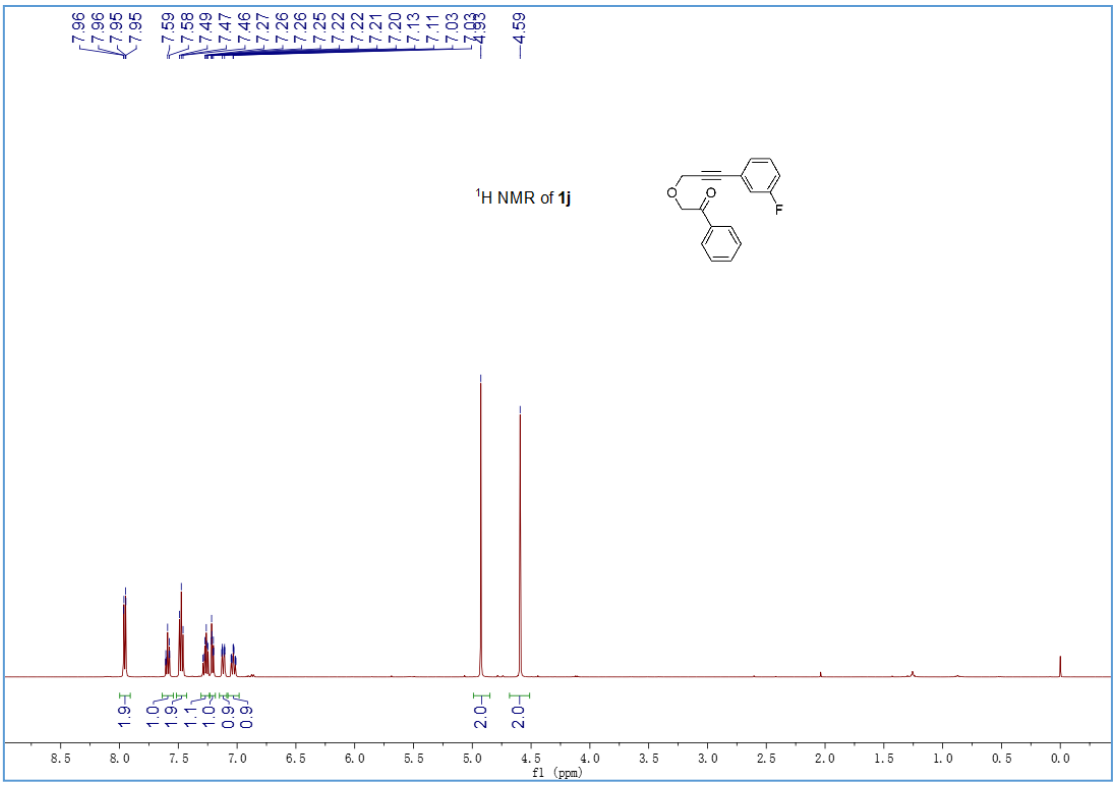
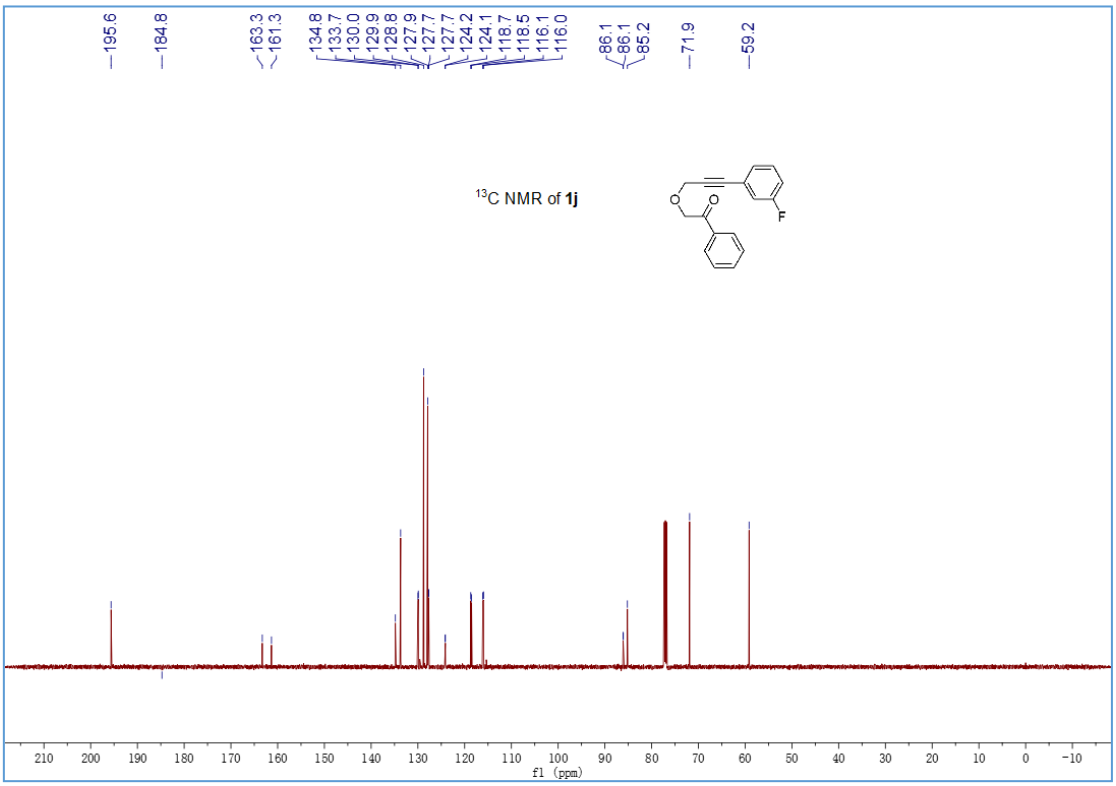
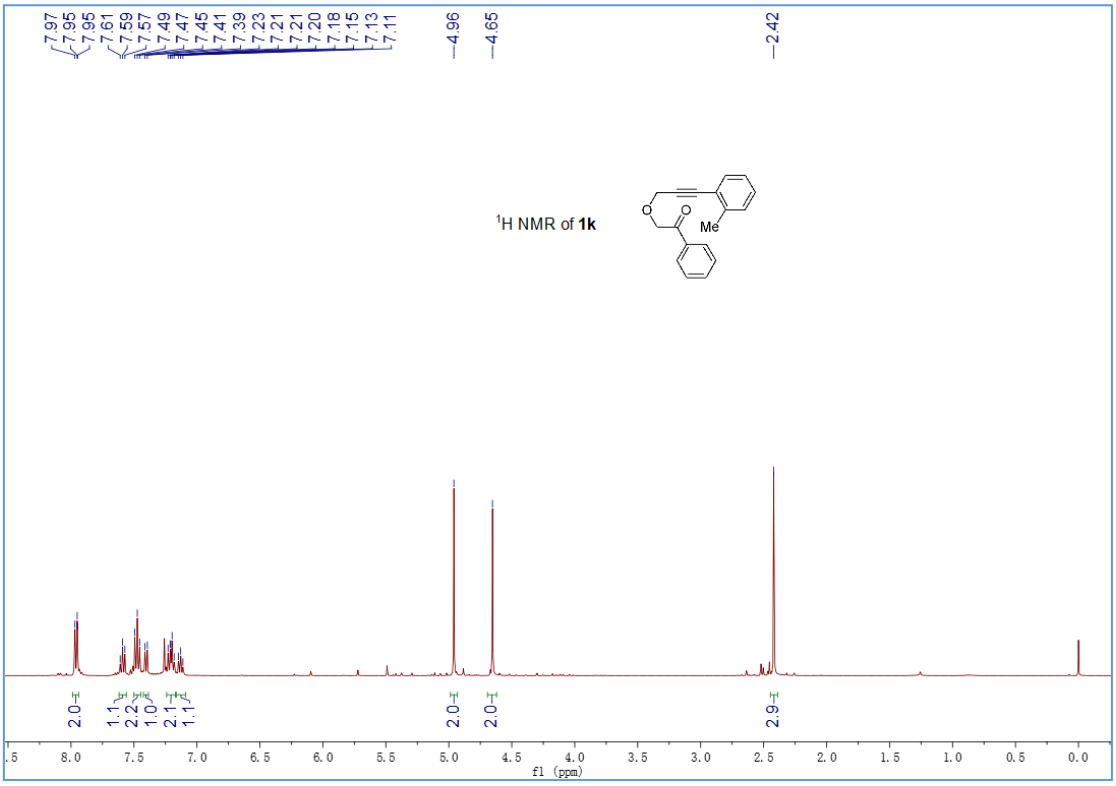
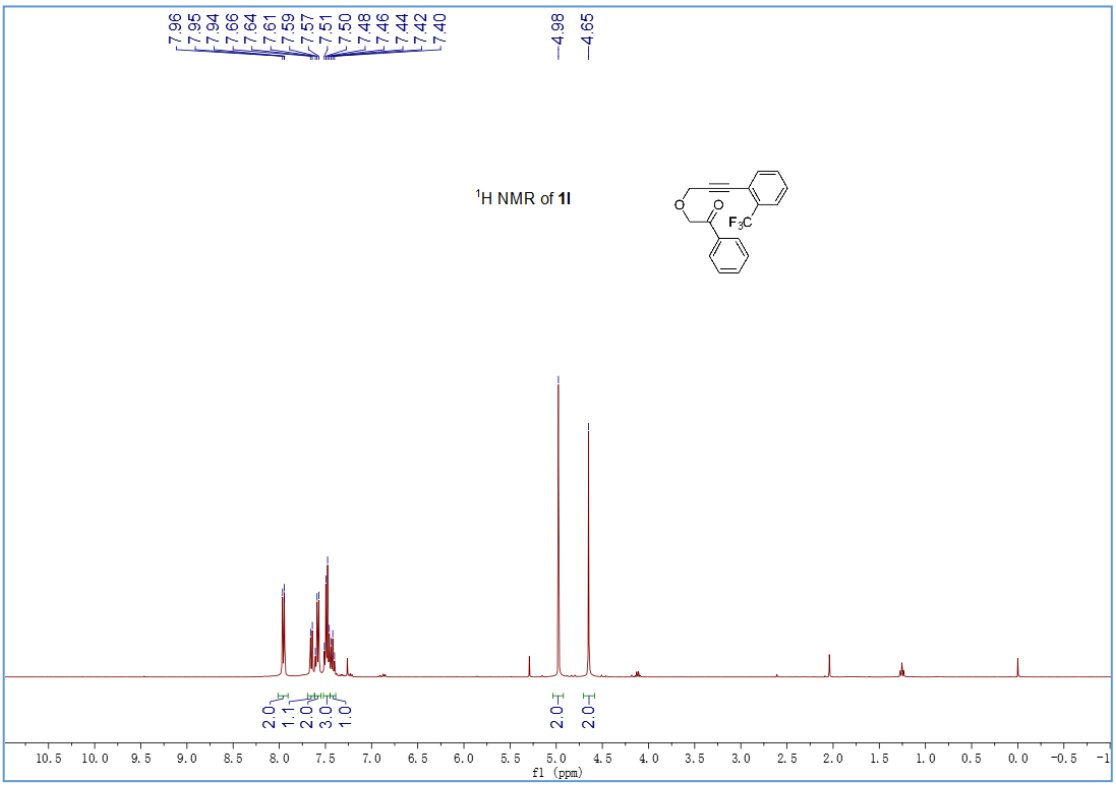
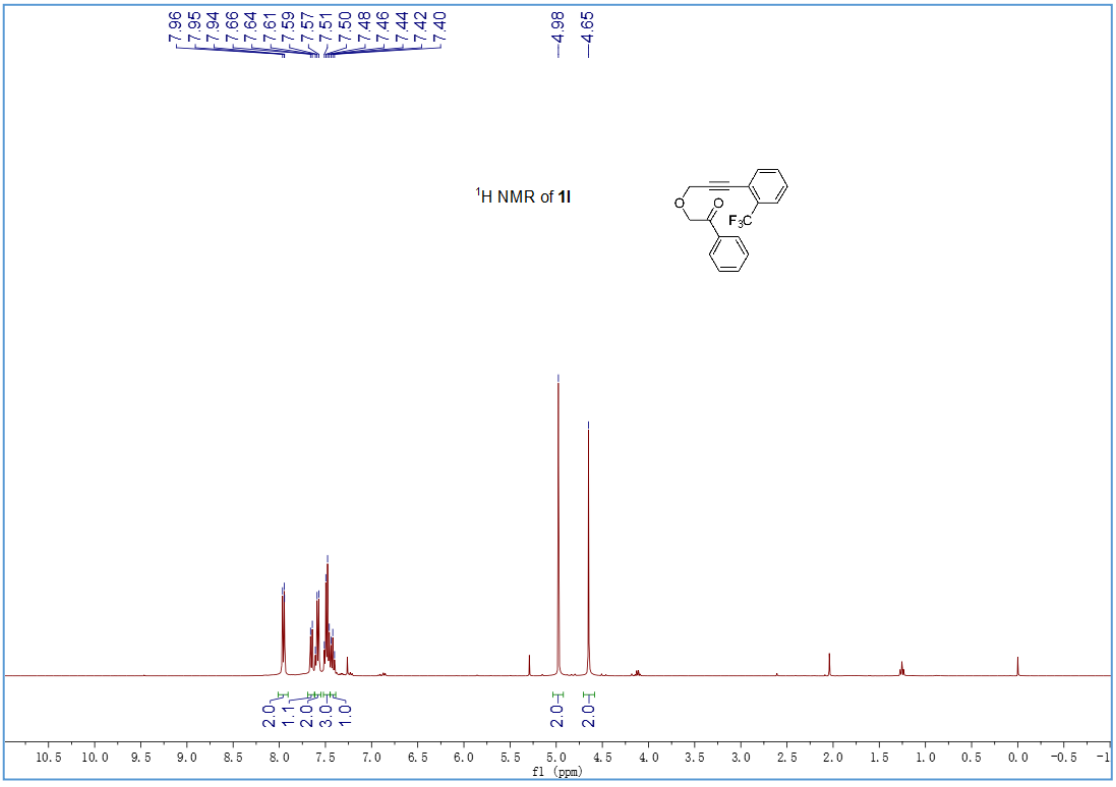
134.9
134.8
133.7
131.1
130.8
128.9
128.8
128.6
128.6
128.6
128.5
127.9
125.3
125.2
125.2
125.2
124.7
123.3
122.6
85.9
85.8
72.0
59.1
^{13}C NMR of **1i**
CF_3
f1 (ppm)

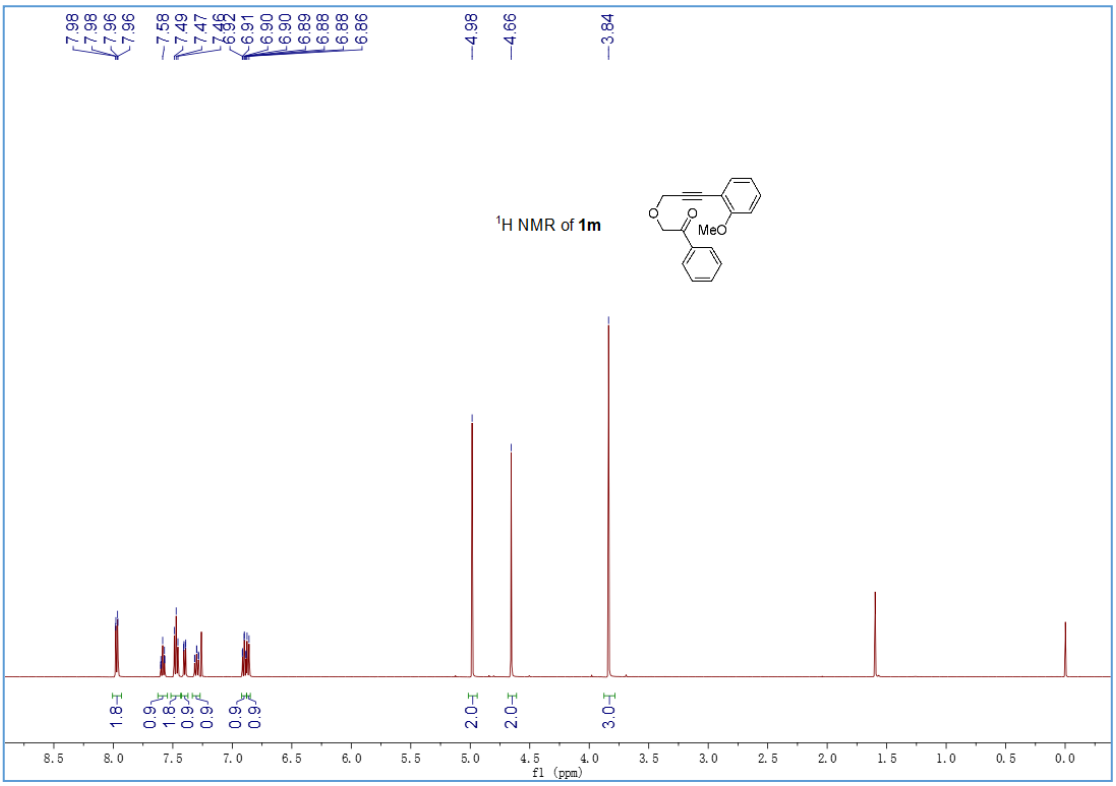

7.96
7.96
7.95
7.95
7.59
7.58
7.49
7.47
7.46
7.27
7.26
7.26
7.25
7.22
7.22
7.21
7.20
7.13
7.11
7.03
4.93
4.59
^{1}H NMR of **1j**
F
1.9
1.0
1.9
1.1
1.0
0.9
0.9
2.0
2.0
f1 (ppm)

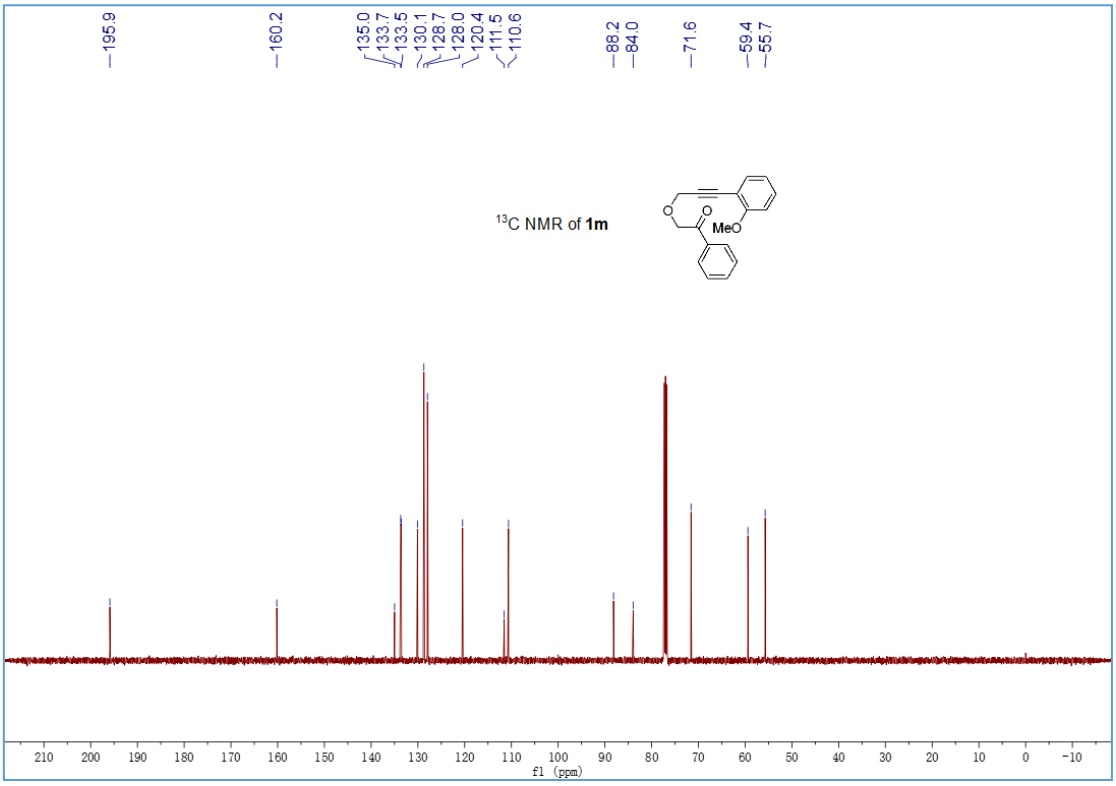

195.6
184.8
163.3
161.3
134.8
133.7
130.0
129.9
128.8
127.9
127.7
127.7
124.2
124.1
118.7
118.5
116.1
116.0
86.1
86.1
85.2
71.9
59.2
13C NMR of 1j
O
O
F
f1 (ppm)

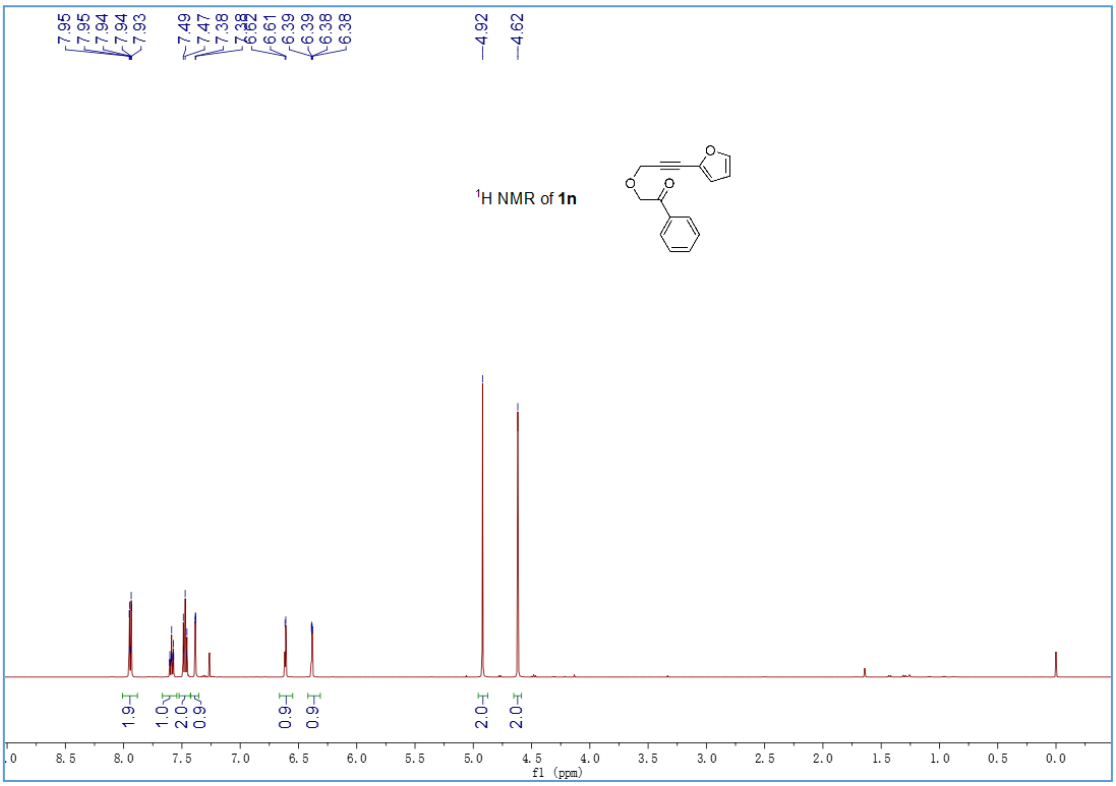

7.97
7.95
7.95
7.61
7.59
7.57
7.49
7.47
7.45
7.41
7.39
7.23
7.21
7.21
7.20
7.18
7.15
7.13
7.11
4.96
4.65
2.42
1H NMR of 1k
O
O
Me
2.0
1.1
2.2
1.0
2.1
1.1
2.0
2.0
2.9
f1 (ppm)

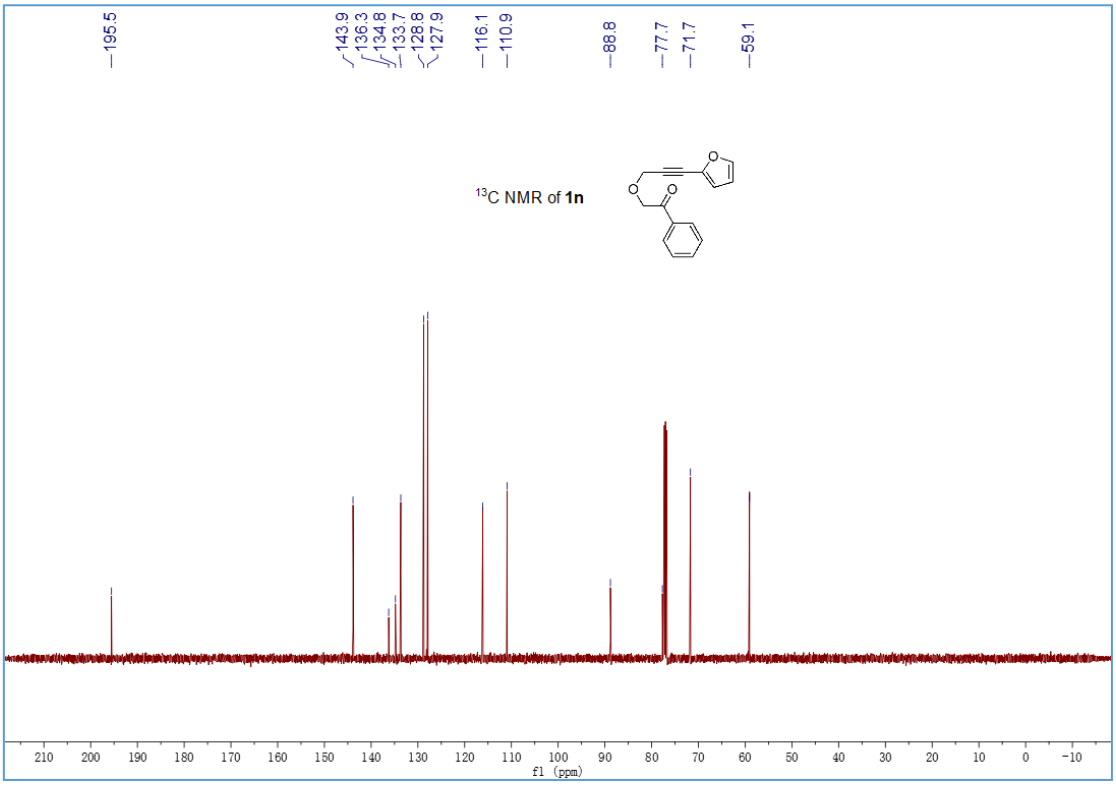

7.96
7.95
7.94
7.66
7.64
7.61
7.59
7.57
7.51
7.50
7.48
7.46
7.44
7.42
7.40
4.98
4.65
^{1}H NMR of **1l**
F3C
2.0
1.1
2.0
3.0
1.0
2.0
2.0
f1 (ppm)


7.96
7.95
7.94
7.66
7.64
7.61
7.59
7.57
7.51
7.50
7.48
7.46
7.44
7.42
7.40
4.98
4.65
^{1}H NMR of **1l**
F3C
2.0
1.1
2.0
3.0
1.0
2.0
2.0
f1 (ppm)


7.98
7.98
7.96
7.96
7.58
7.49
7.47
6.91
6.90
6.90
6.89
6.88
6.88
6.86
4.98
4.66
3.84
^{1}H NMR of **1m**
MeO
1.8
0.9
1.8
0.9
0.9
0.9
0.9
2.0
2.0
3.0
f1 (ppm)


195.9
160.2
135.0
133.7
133.5
130.1
128.7
128.0
120.4
111.5
110.6
88.2
84.0
71.6
59.4
55.7
^{13}C NMR of **1m**
MeO
f1 (ppm)


7.95
7.95
7.94
7.94
7.93
7.49
7.47
7.38
6.61
6.39
6.39
6.38
6.38
4.92
4.62
^{1}H NMR of **1n**
1.9
1.0
2.0
0.9
0.9
0.9
2.0
2.0
f1 (ppm)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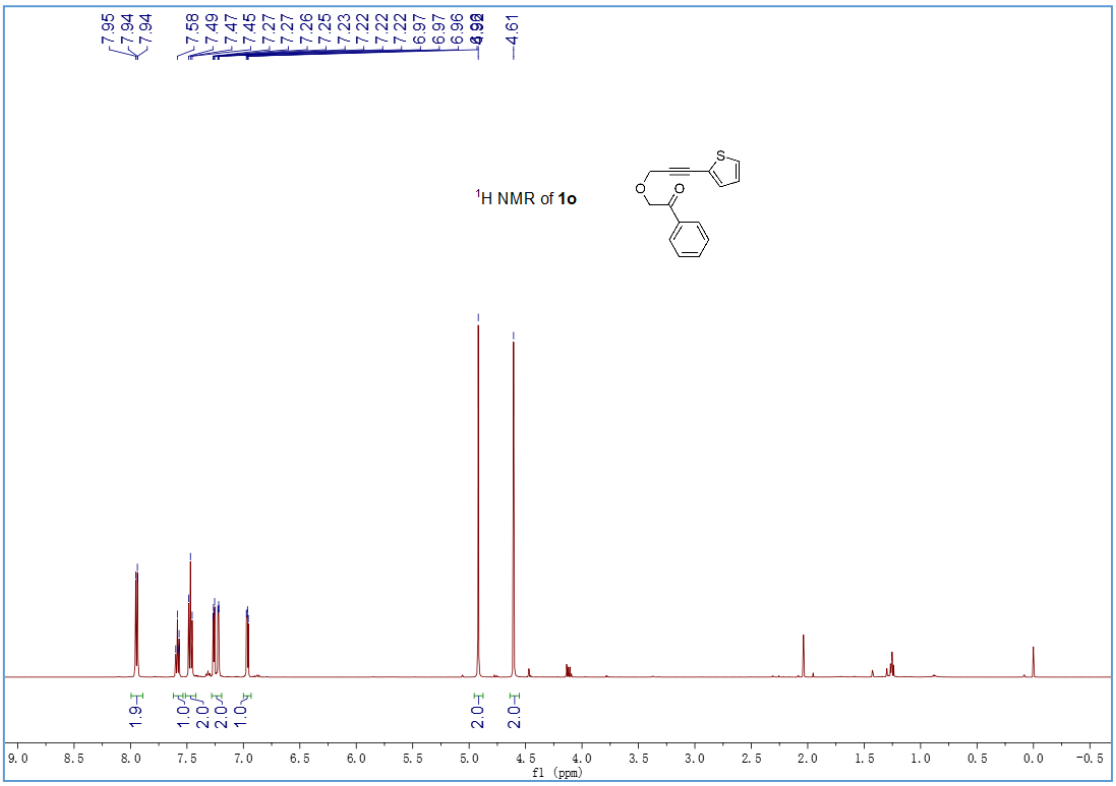
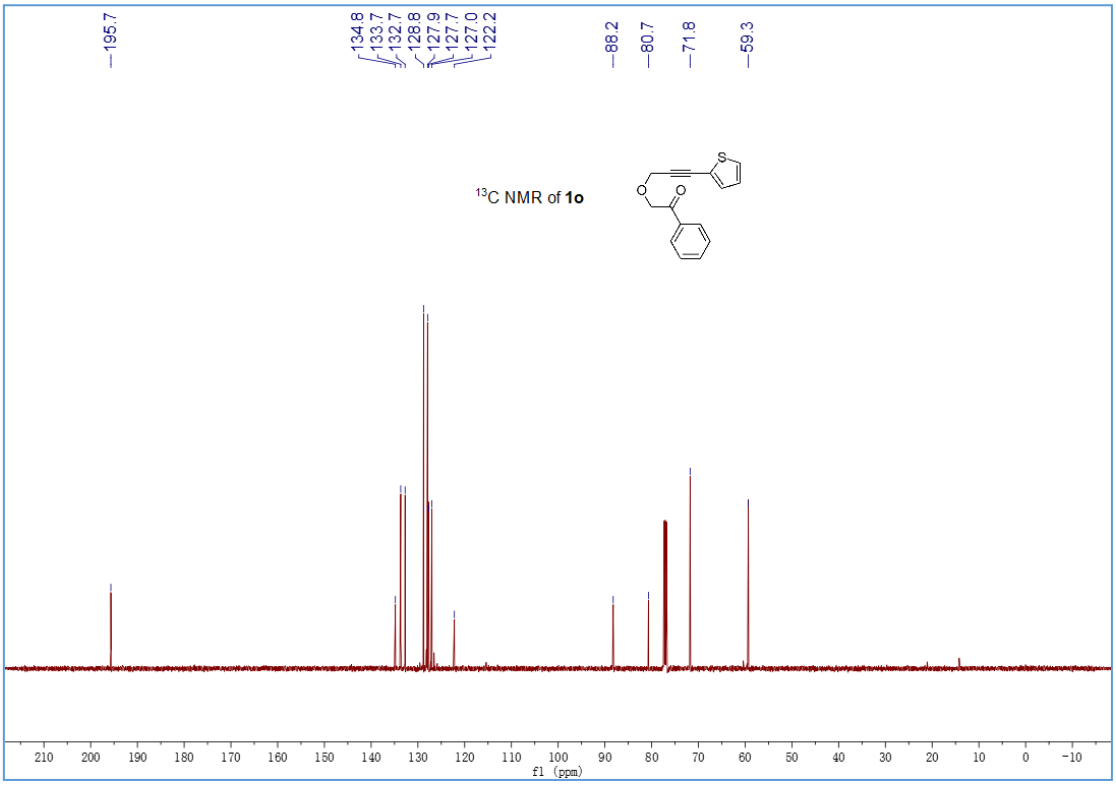
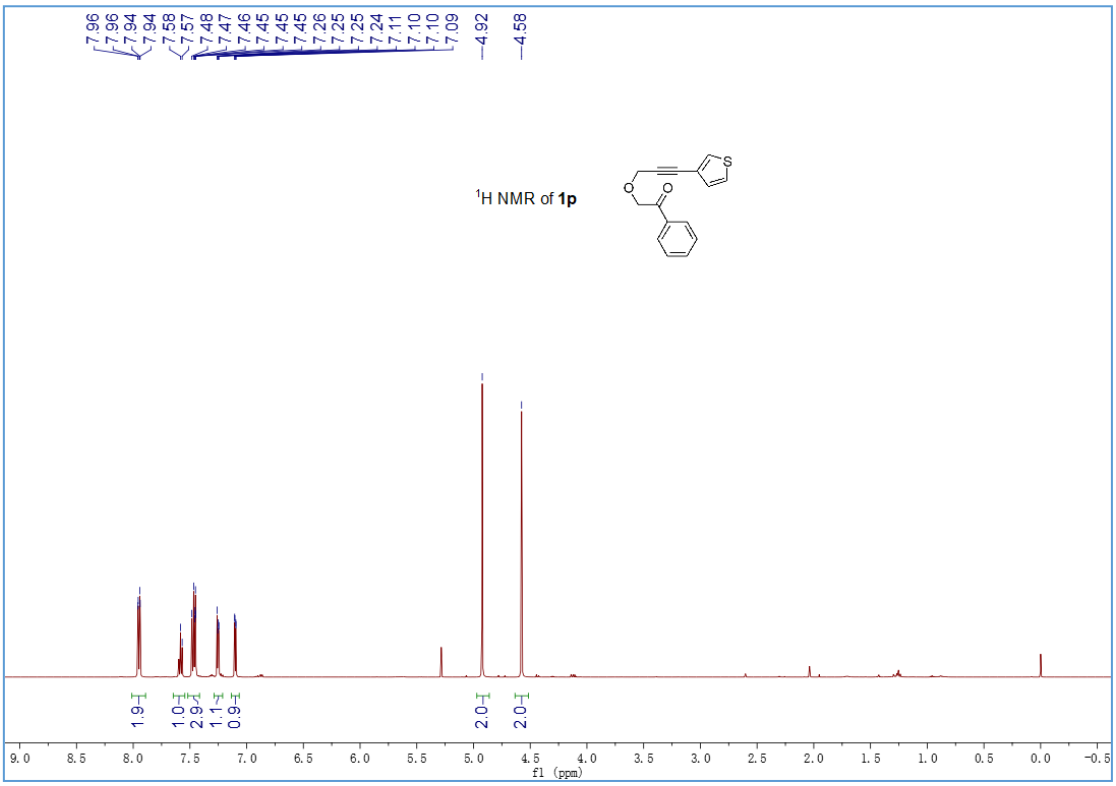
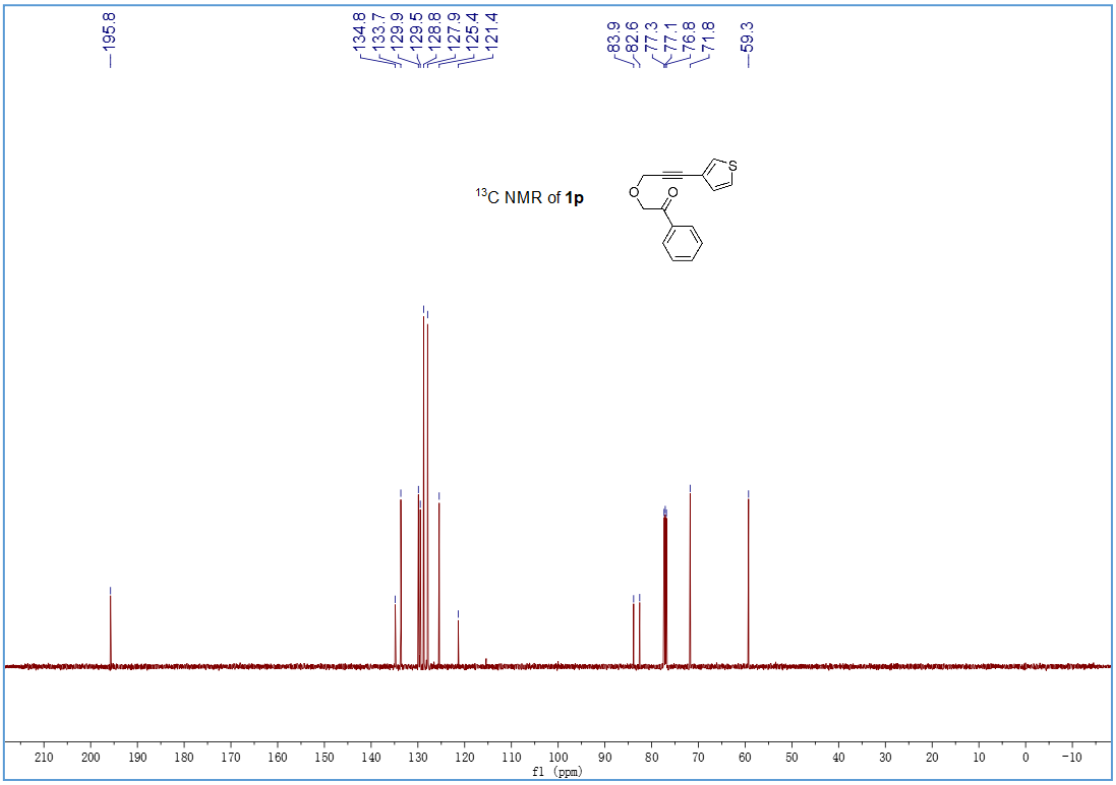
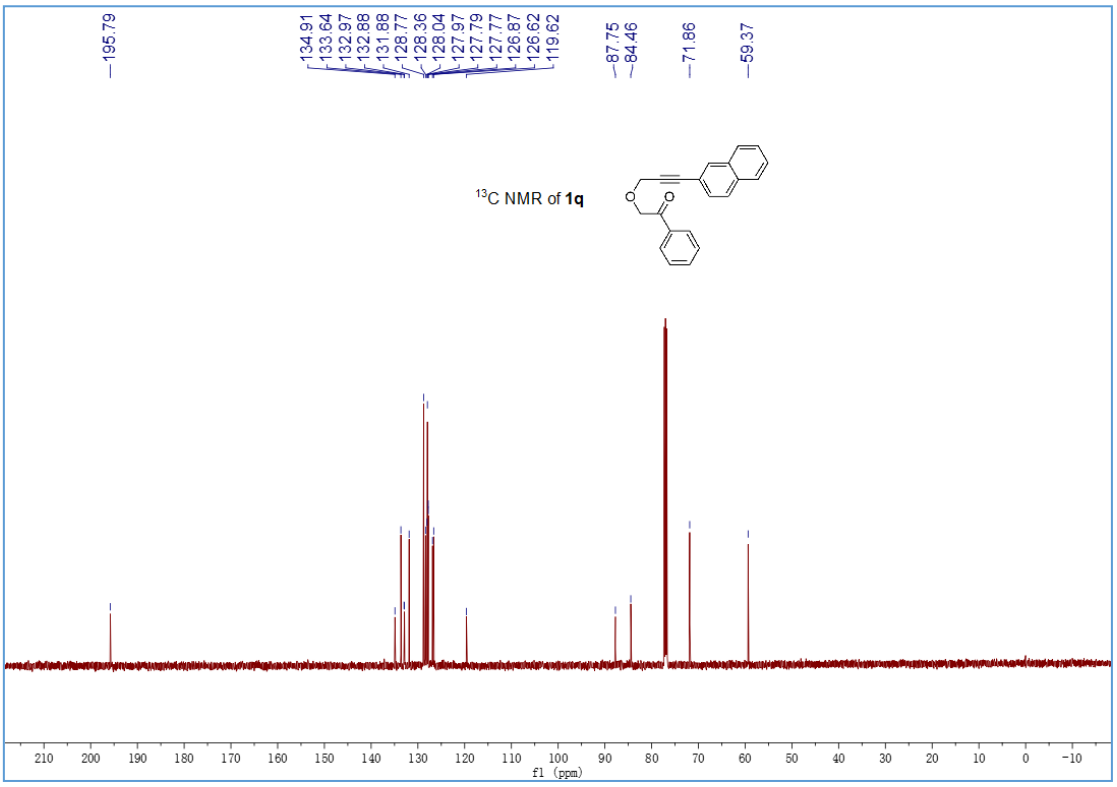
143.9
136.3
134.8
133.7
128.8
127.9
116.1
110.9
88.8
77.7
71.7
59.1
^{13}C NMR of **1n**
f1 (ppm)

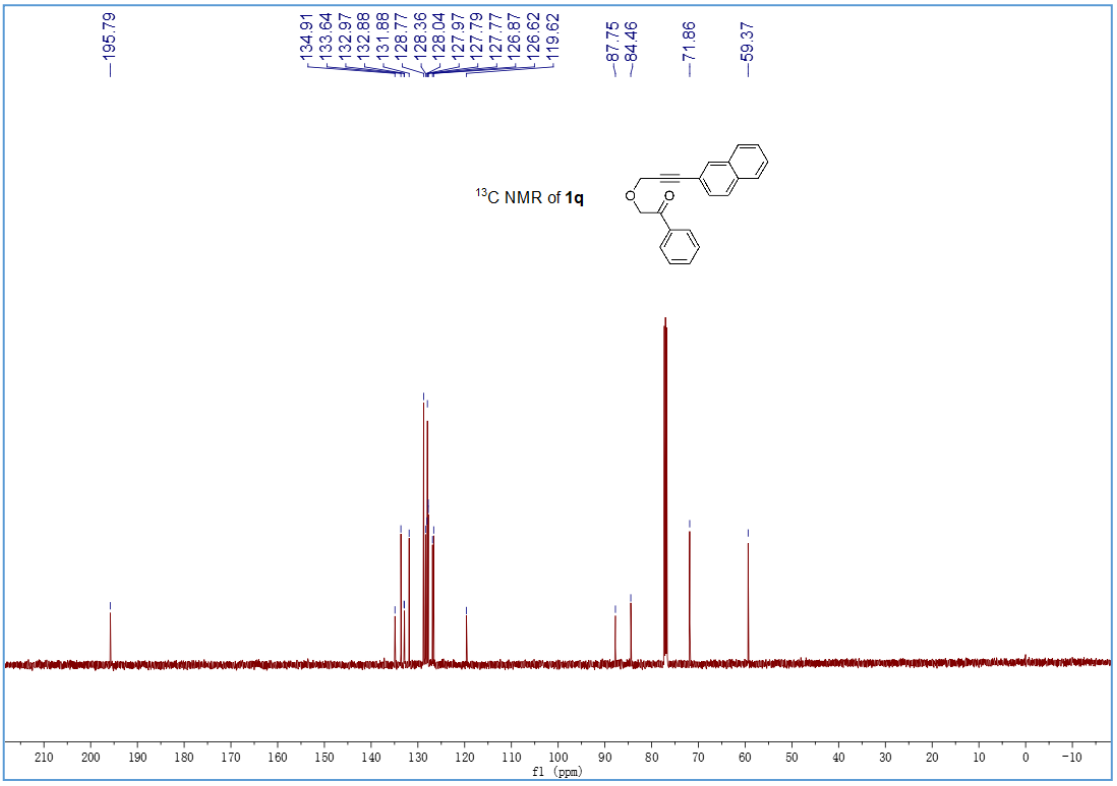

7.95
7.94
7.94
7.58
7.49
7.47
7.45
7.27
7.27
7.26
7.25
7.23
7.22
7.22
7.22
6.97
6.96
4.61
^{1}H NMR of **1o**
1.9
1.0
2.0
2.0
1.0
2.0
2.0
f1 (ppm)

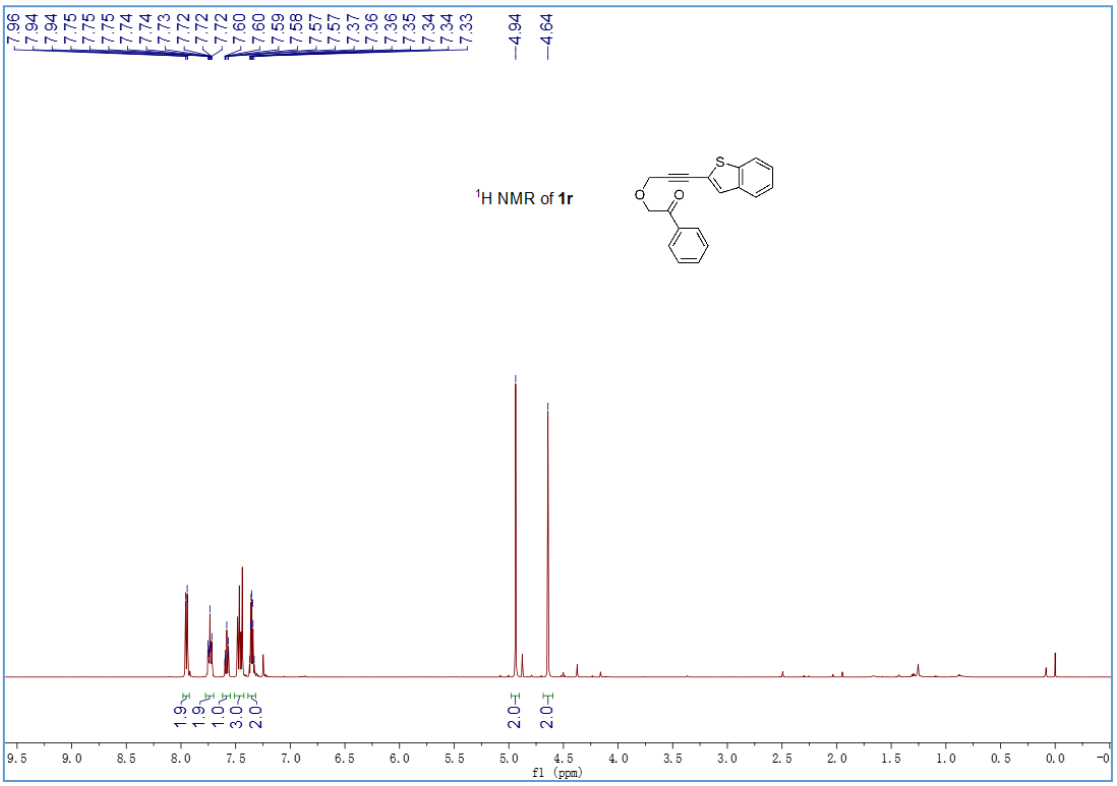

195.7
134.8
133.7
132.7
128.8
127.9
127.7
127.0
122.2
88.2
80.7
71.8
59.3
^{13}C NMR of **1o**
f1 (ppm)

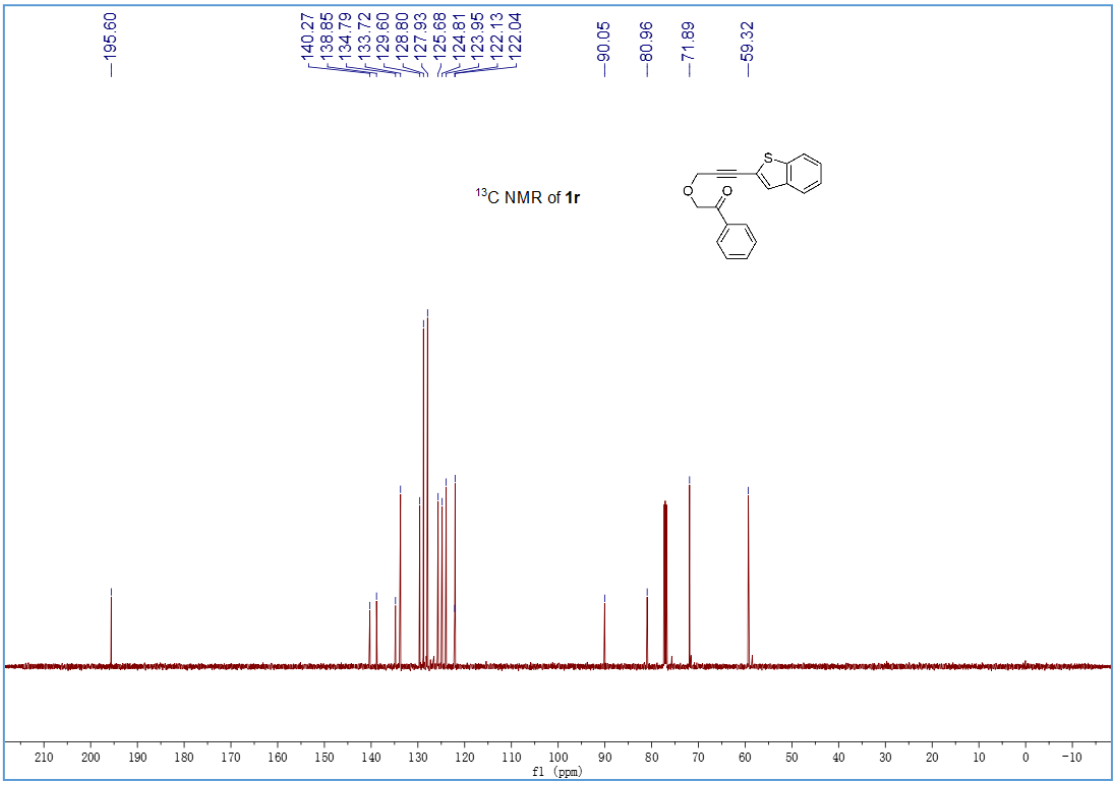

7.96
7.96
7.94
7.94
7.58
7.57
7.48
7.47
7.46
7.45
7.45
7.45
7.26
7.25
7.25
7.24
7.11
7.10
7.10
7.09
4.92
4.58
^{1}H NMR of **1p**
S
O
O
1.9
1.0
2.9
1.1
0.9
2.0
2.0
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

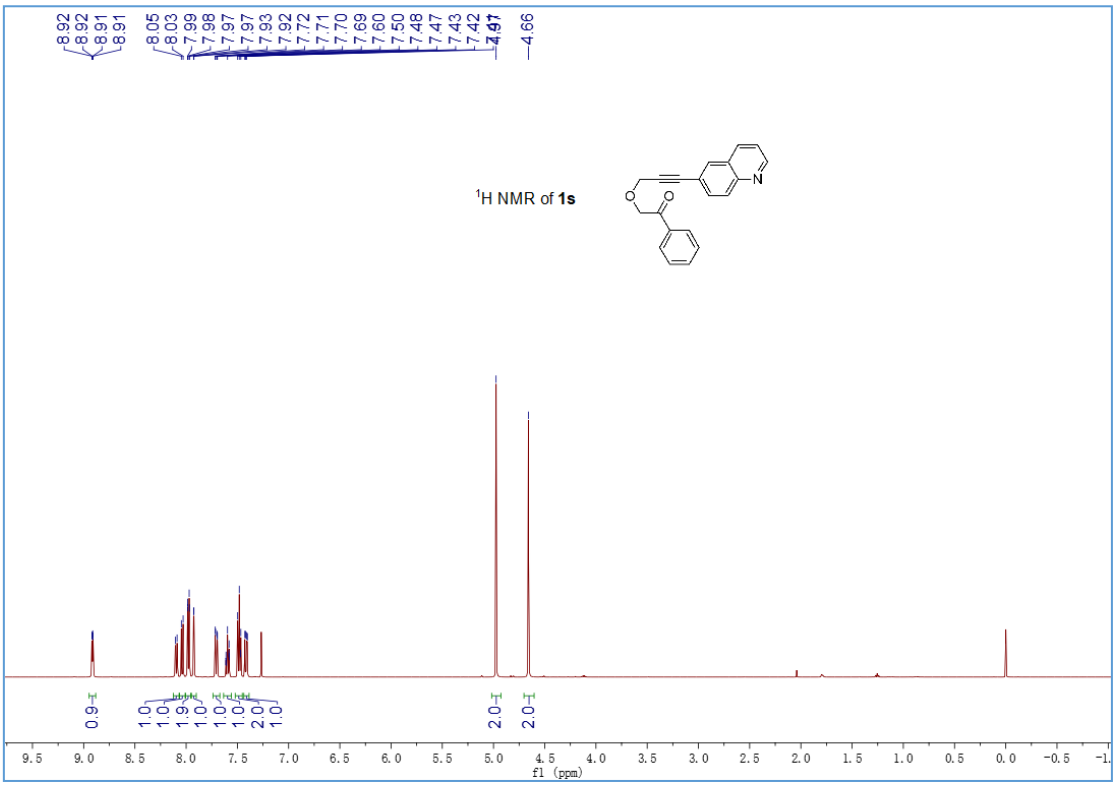

195.8
134.8
133.7
129.9
129.5
128.8
127.9
125.4
121.4
83.9
82.6
77.3
77.1
76.8
71.8
59.3
^{13}C NMR of **1p**
S
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

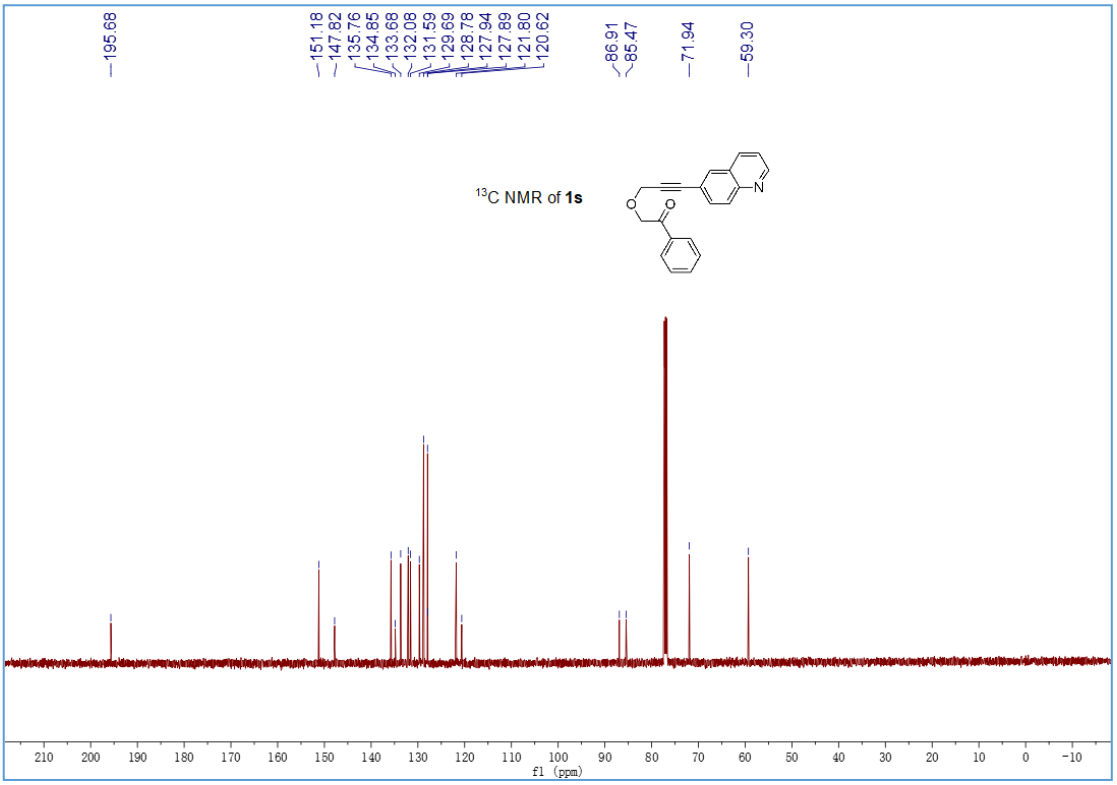

195.79
134.91
133.64
132.97
132.88
131.88
128.77
128.36
128.04
127.97
127.79
127.77
126.87
126.62
119.62
87.75
84.46
71.86
59.37
^{13}C NMR of **1q**
f1 (ppm)

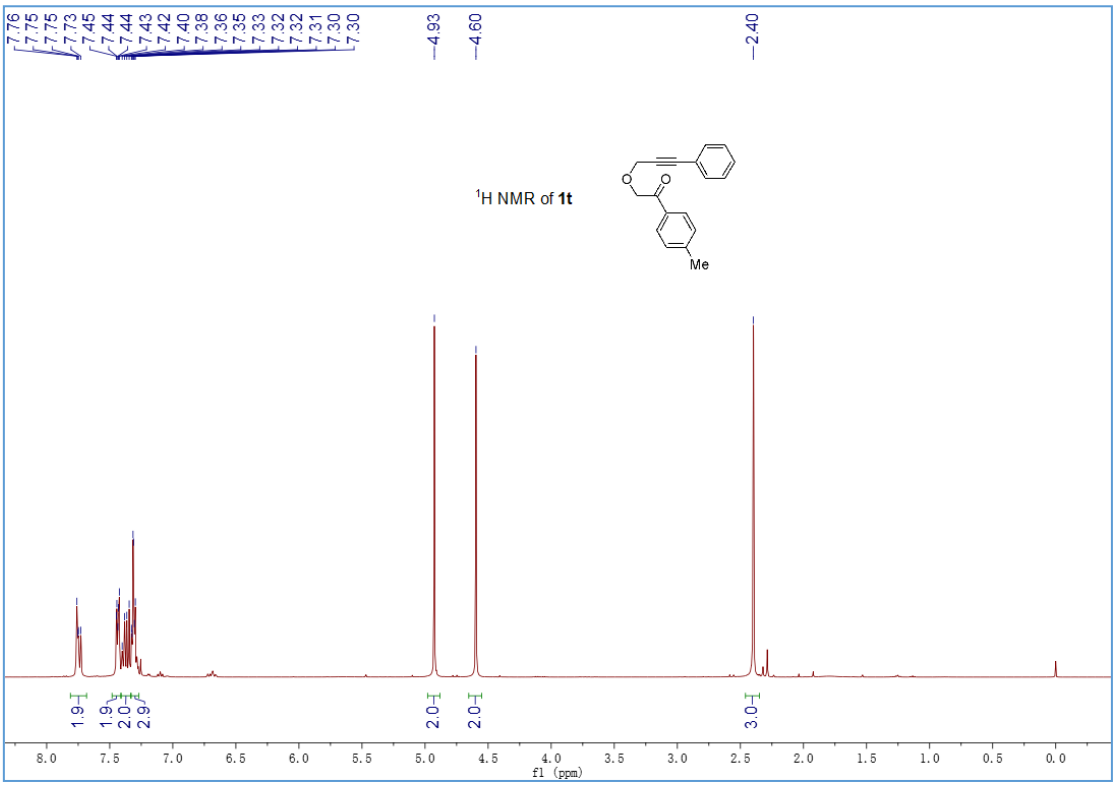

195.79
134.91
133.64
132.97
132.88
131.88
128.77
128.36
128.04
127.97
127.79
127.77
126.87
126.62
119.62
87.75
84.46
71.86
59.37
^{13}C NMR of **1q**
f1 (ppm)

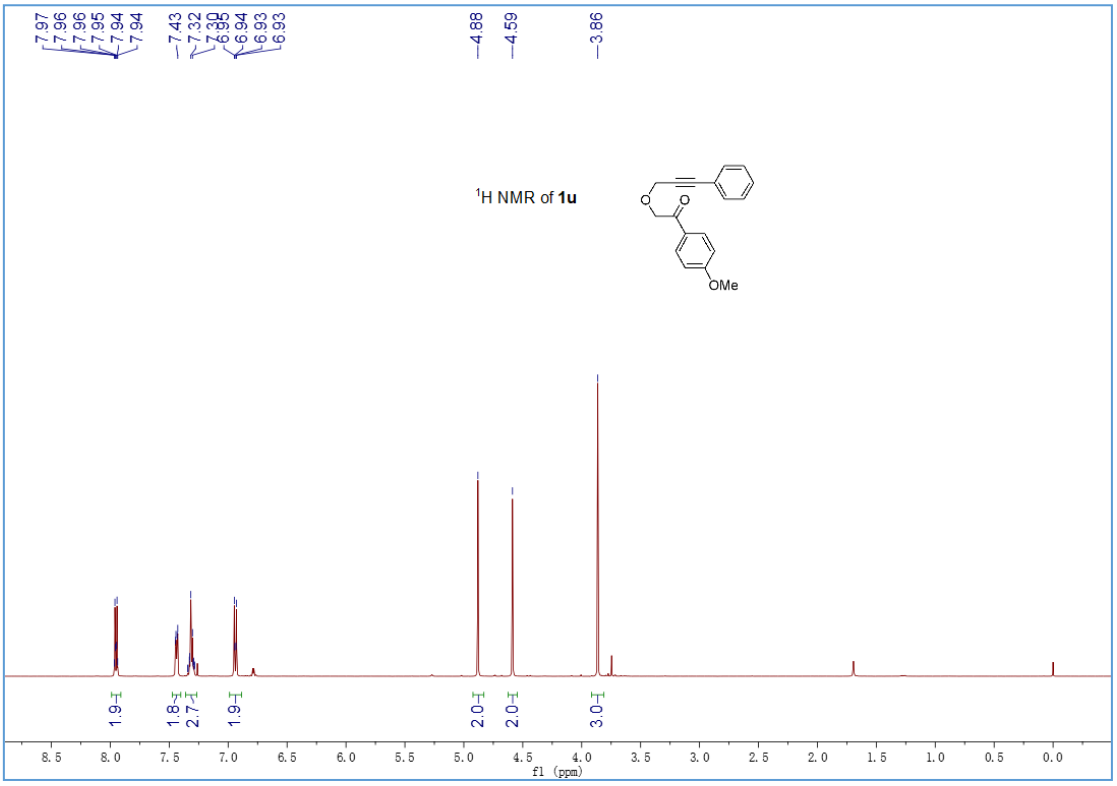

7.96
7.94
7.94
7.75
7.75
7.75
7.74
7.74
7.73
7.72
7.72
7.72
7.60
7.60
7.59
7.58
7.57
7.57
7.37
7.36
7.36
7.35
7.34
7.34
7.33
4.94
4.64
^{1}H NMR of **1r**
S
O
O
1.9
1.9
1.0
3.0
2.0
2.0
2.0
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

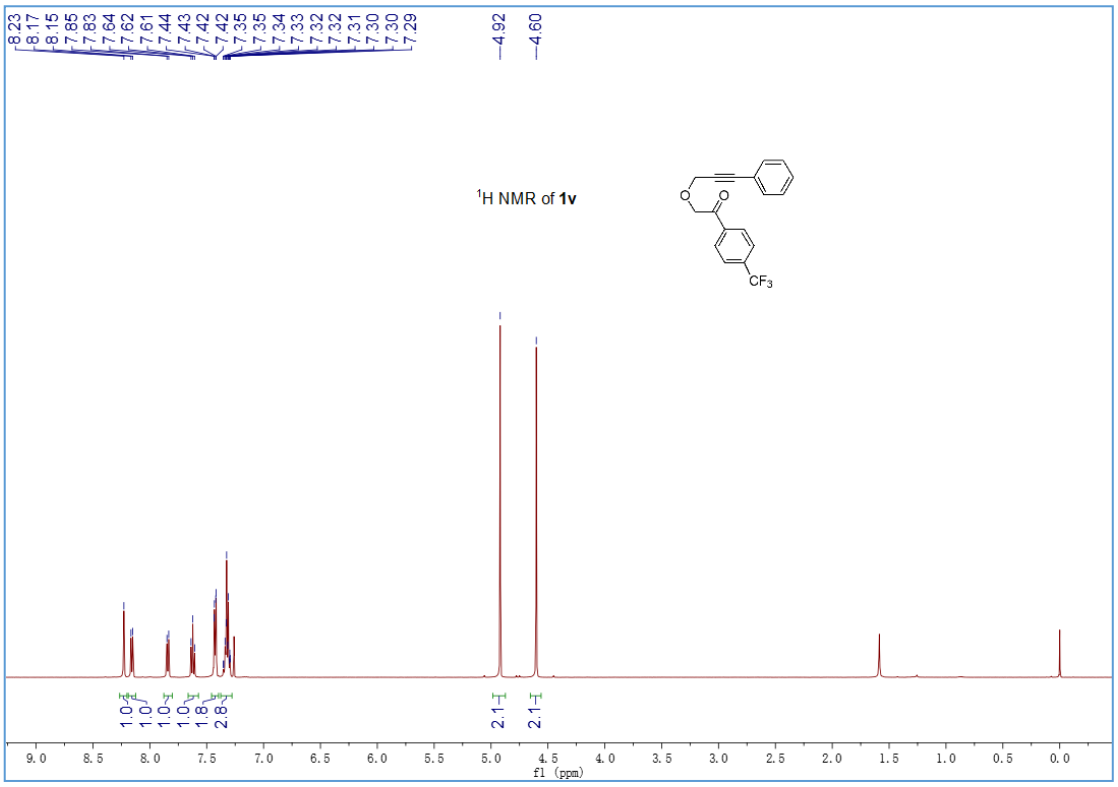

195.60
140.27
138.85
134.79
133.72
129.60
128.80
127.93
125.68
124.81
123.95
122.13
122.04
90.05
80.96
71.89
59.32
^{13}C NMR of **1r**
S
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

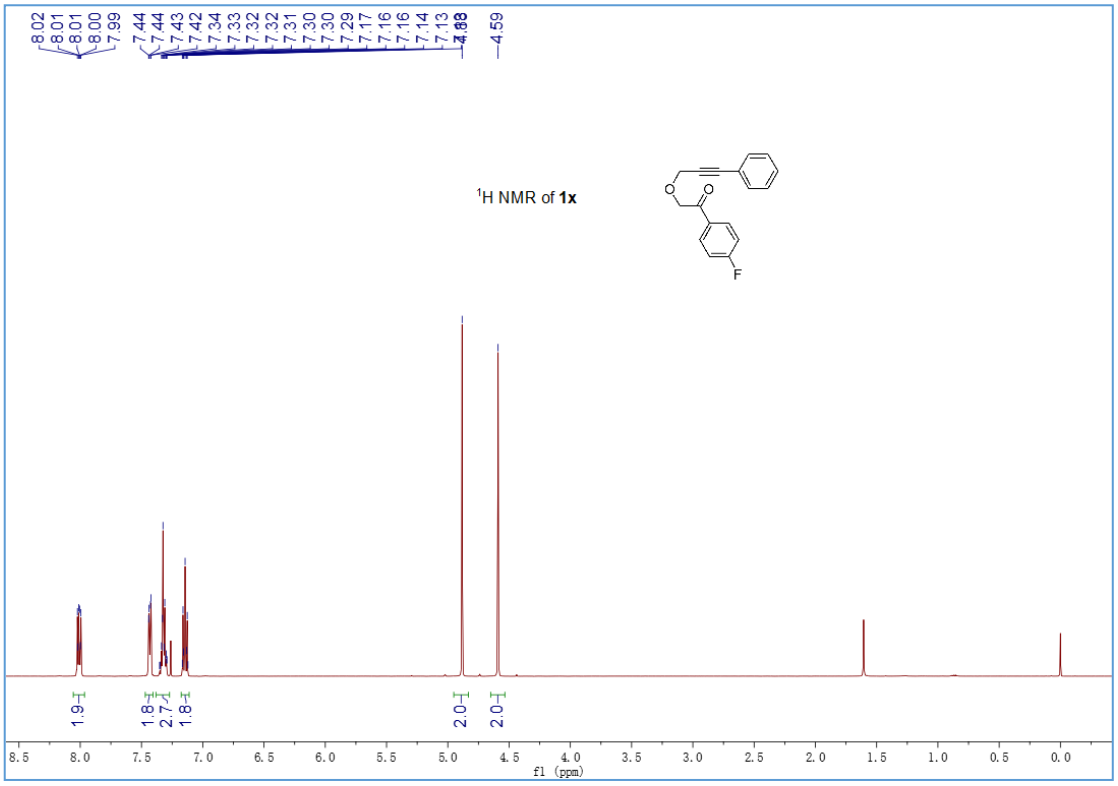

8.92
8.92
8.91
8.91
8.05
8.03
7.99
7.98
7.97
7.97
7.93
7.92
7.72
7.71
7.70
7.69
7.60
7.50
7.48
7.47
7.43
7.42
4.66
^{1}H NMR of **1s**
0.9
1.0
1.0
1.9
1.0
1.0
1.0
2.0
1.0
2.0
2.0
f1 (ppm)

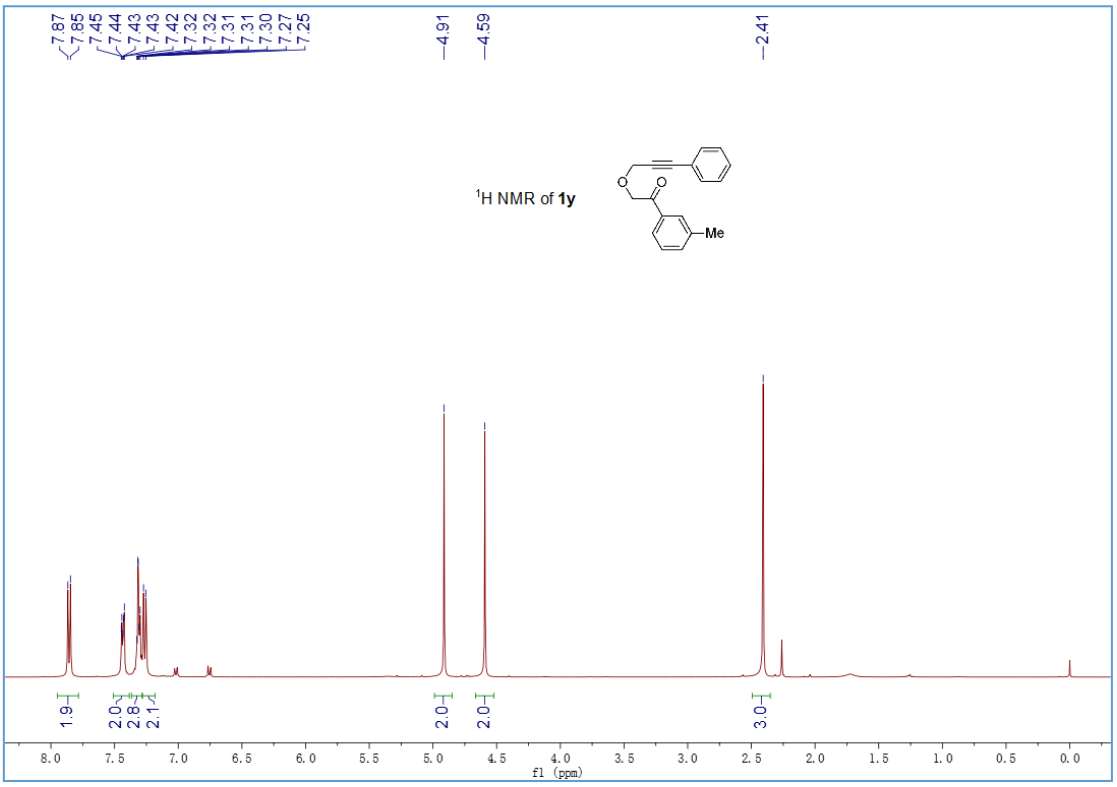

195.68
151.18
147.82
135.76
134.85
133.68
132.08
131.59
129.69
128.78
127.94
127.89
121.80
120.62
86.91
85.47
71.94
59.30
^{13}C NMR of **1s**
f1 (ppm)

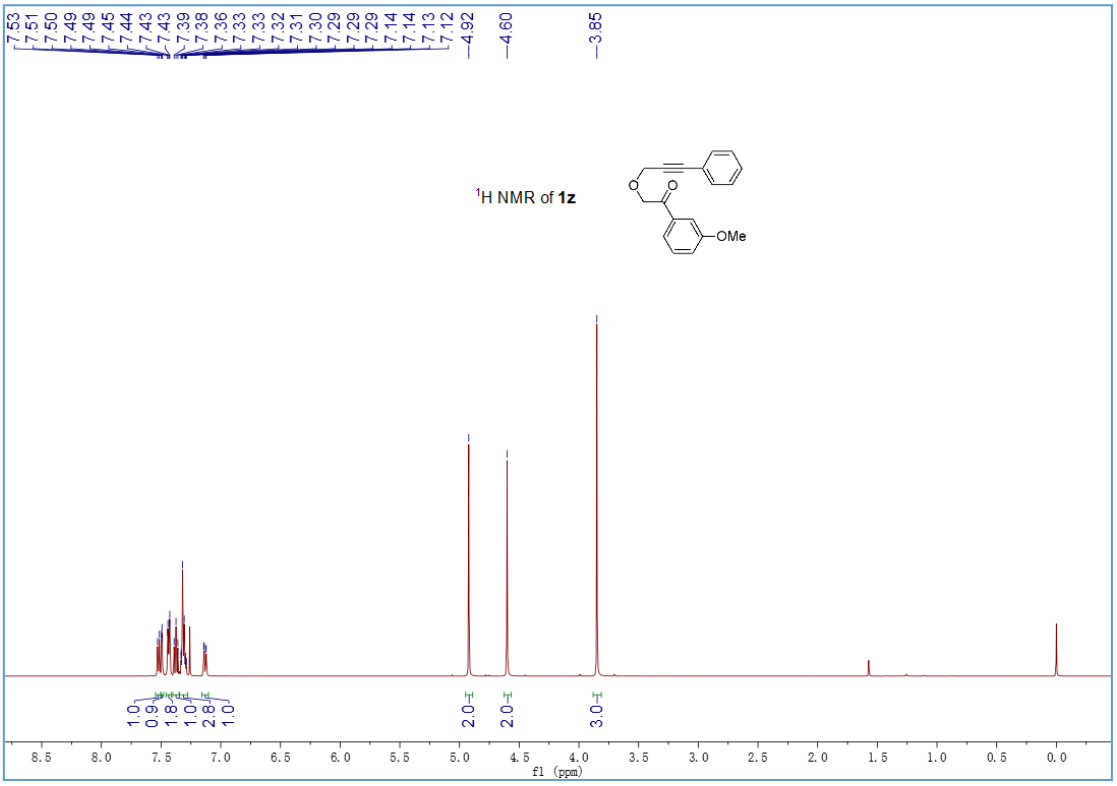

7.76
7.75
7.75
7.73
7.45
7.44
7.44
7.43
7.42
7.40
7.38
7.36
7.35
7.33
7.32
7.32
7.31
7.30
7.30
4.93
4.60
2.40
1H NMR of 1t
Me
1.9
1.9
2.0
2.9
2.0
2.0
3.0
f1 (ppm)

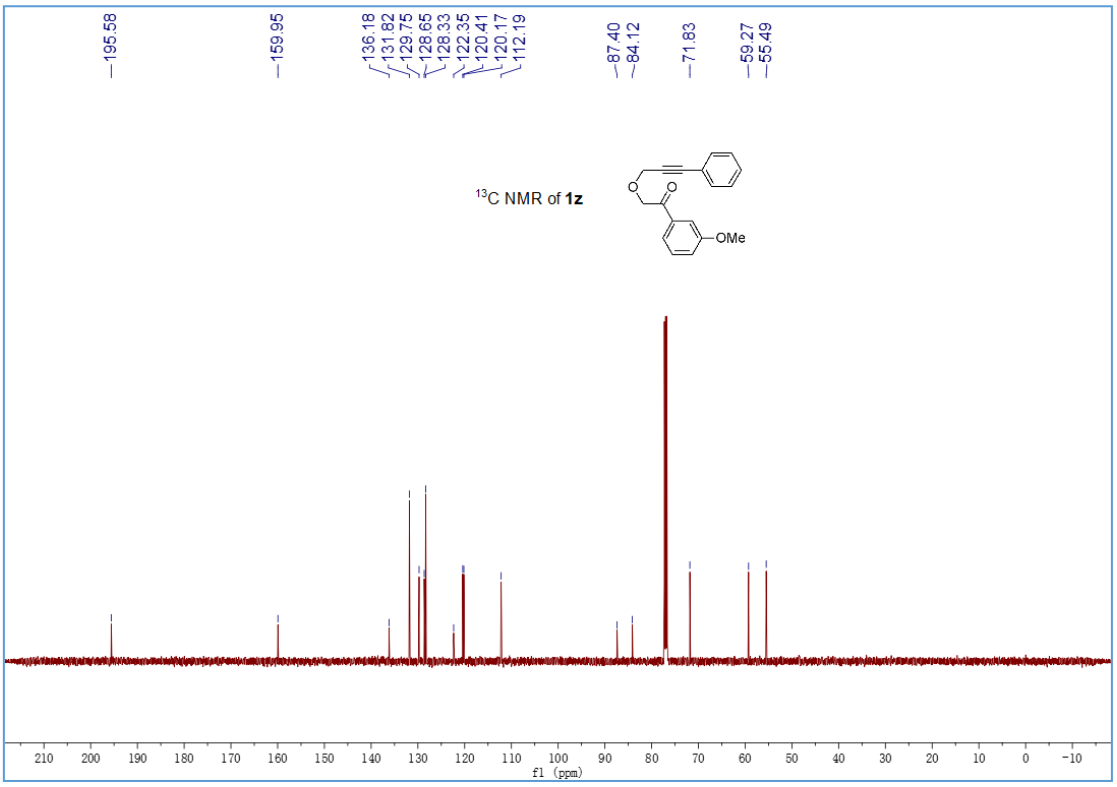

7.97
7.96
7.96
7.95
7.94
7.94
7.43
7.32
7.30
6.94
6.93
6.93
4.88
4.59
3.86
1H NMR of 1u
OMe
1.9
1.8
2.7
1.9
2.0
2.0
3.0
f1 (ppm)


8.23
8.17
8.15
7.85
7.83
7.64
7.62
7.61
7.44
7.43
7.42
7.42
7.35
7.35
7.34
7.33
7.32
7.32
7.31
7.30
7.30
7.29
4.92
4.60
^{1}H NMR of **1v**
CF_3
1.0
1.0
1.0
1.8
2.8
2.1
2.1
f1 (ppm)


8.02
8.01
8.01
8.00
7.99
7.44
7.44
7.43
7.42
7.34
7.33
7.32
7.32
7.31
7.30
7.30
7.29
7.17
7.16
7.16
7.14
7.13
4.59
^{1}H NMR of **1x**
F
1.9
1.8
2.7
1.8
2.0
2.0
f1 (ppm)


7.87
7.85
7.45
7.44
7.43
7.43
7.42
7.32
7.32
7.31
7.31
7.30
7.27
7.25
4.91
4.59
2.41
^{1}H NMR of **1y**
Me
1.9
2.0
2.8
2.1
2.0
2.0
3.0
f1 (ppm)


7.53
7.51
7.50
7.49
7.49
7.45
7.44
7.43
7.43
7.39
7.38
7.36
7.33
7.33
7.32
7.31
7.30
7.29
7.29
7.29
7.14
7.13
7.12
4.92
4.60
3.85
^{1}H NMR of **1z**
OMe
1.0
0.9
1.8
1.0
2.8
1.0
2.0
2.0
3.0
f1 (ppm)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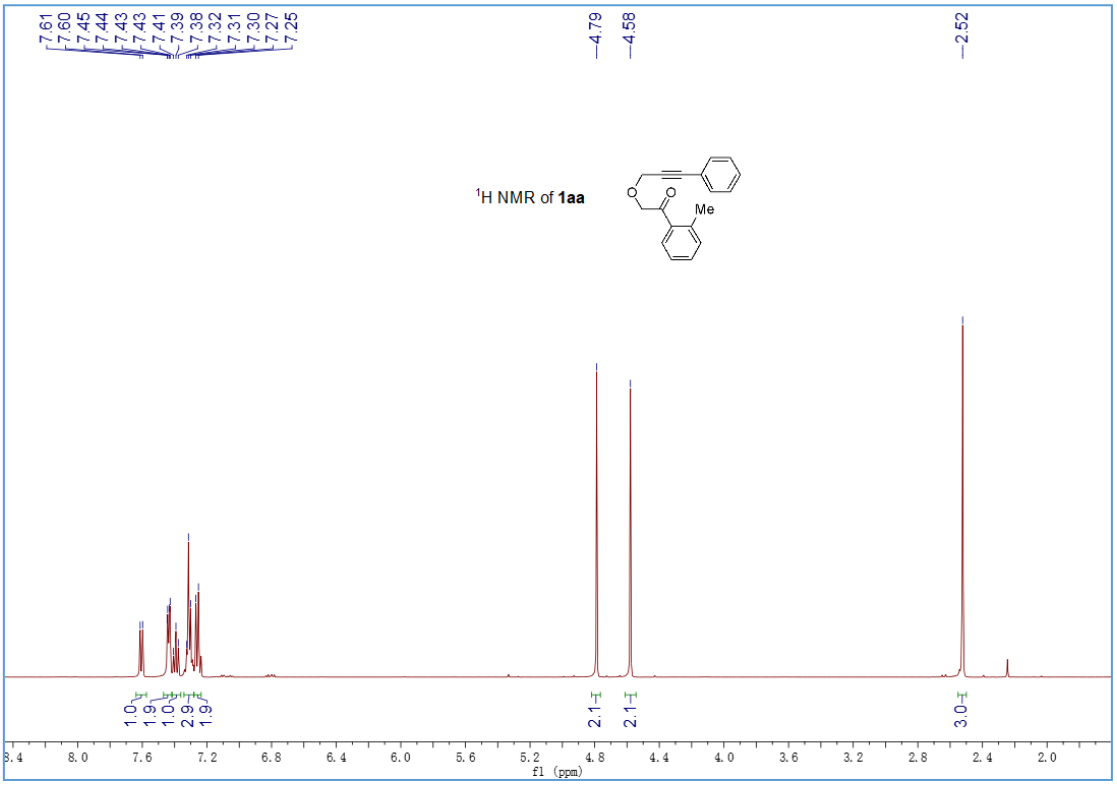
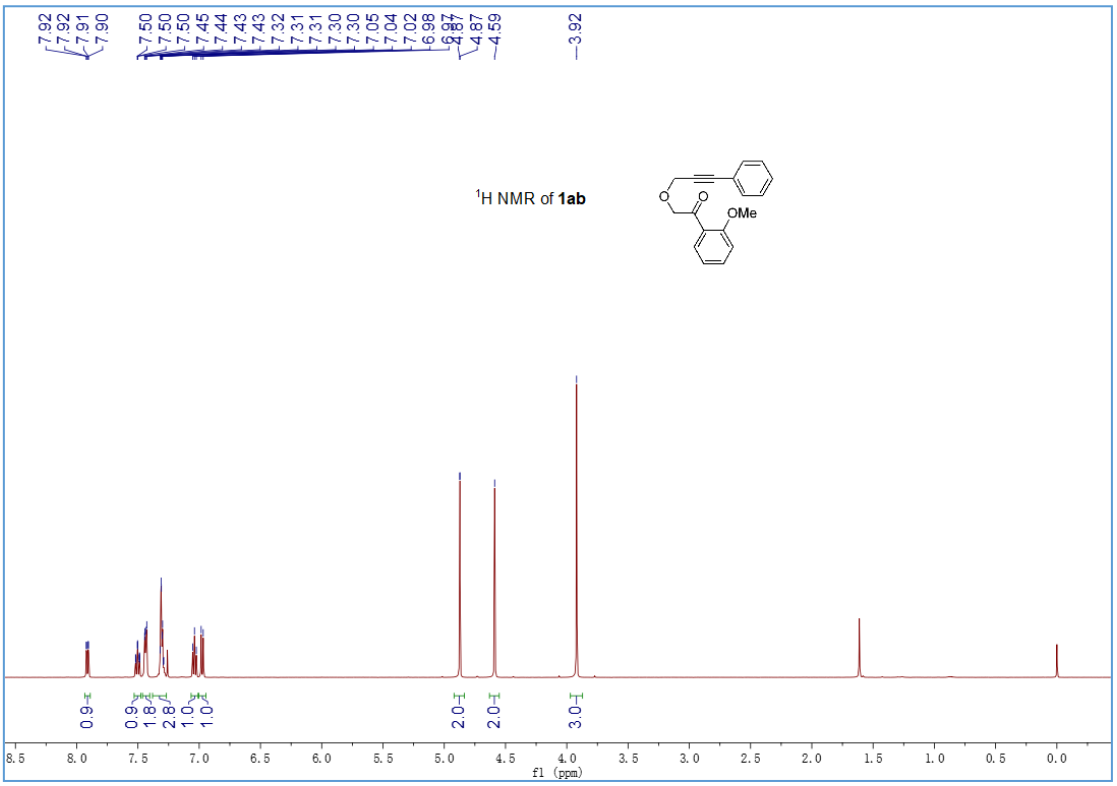
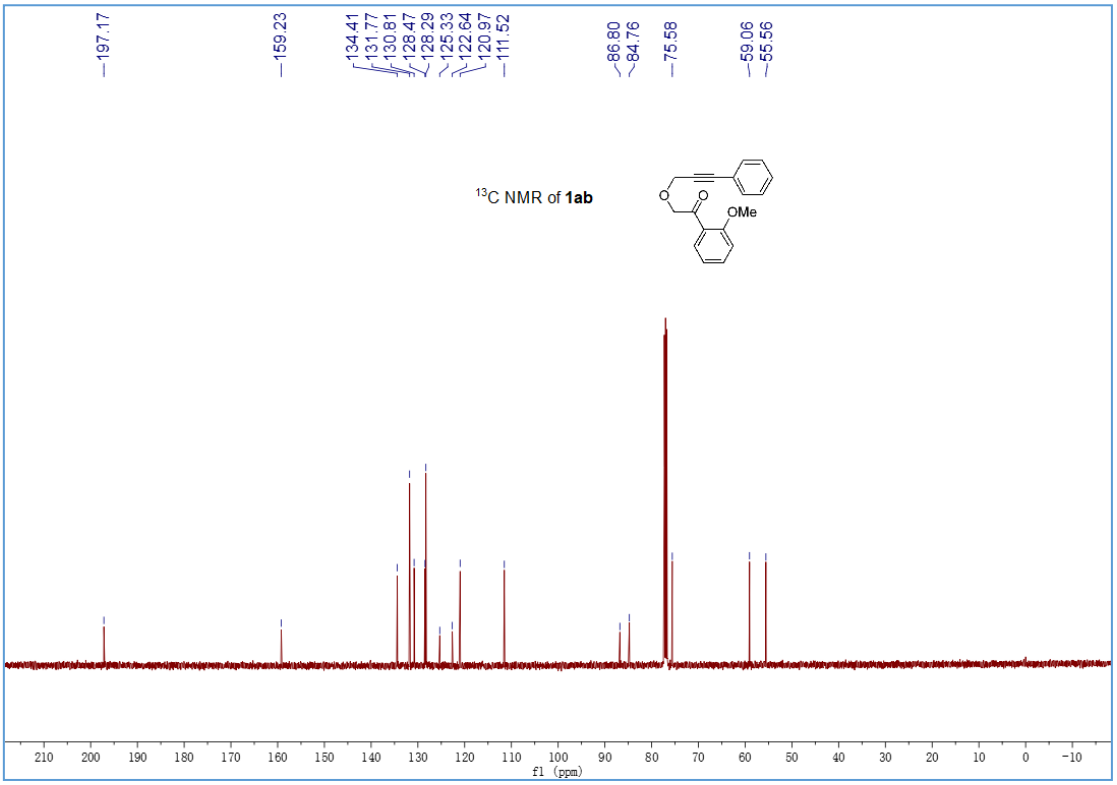
159.95
136.18
131.82
129.75
128.65
128.33
122.35
120.41
120.17
112.19
87.40
84.12
71.83
59.27
55.49
^{13}C NMR of **1z**
OMe
f1 (ppm)


7.61
7.60
7.45
7.44
7.43
7.43
7.41
7.39
7.38
7.32
7.31
7.30
7.27
7.25
4.79
4.58
2.52
^{1}H NMR of **1aa**
Me
1.0
1.9
1.0
2.9
1.9
2.1
2.1
3.0
f1 (ppm)


7.92
7.92
7.91
7.90
7.50
7.50
7.50
7.45
7.44
7.43
7.43
7.32
7.31
7.31
7.30
7.30
7.05
7.04
7.02
6.98
6.97
4.87
4.87
4.59
3.92
^{1}H NMR of **1ab**
OMe
0.9
0.9
1.8
2.8
1.0
1.0
2.0
2.0
3.0
f1 (ppm)


197.17
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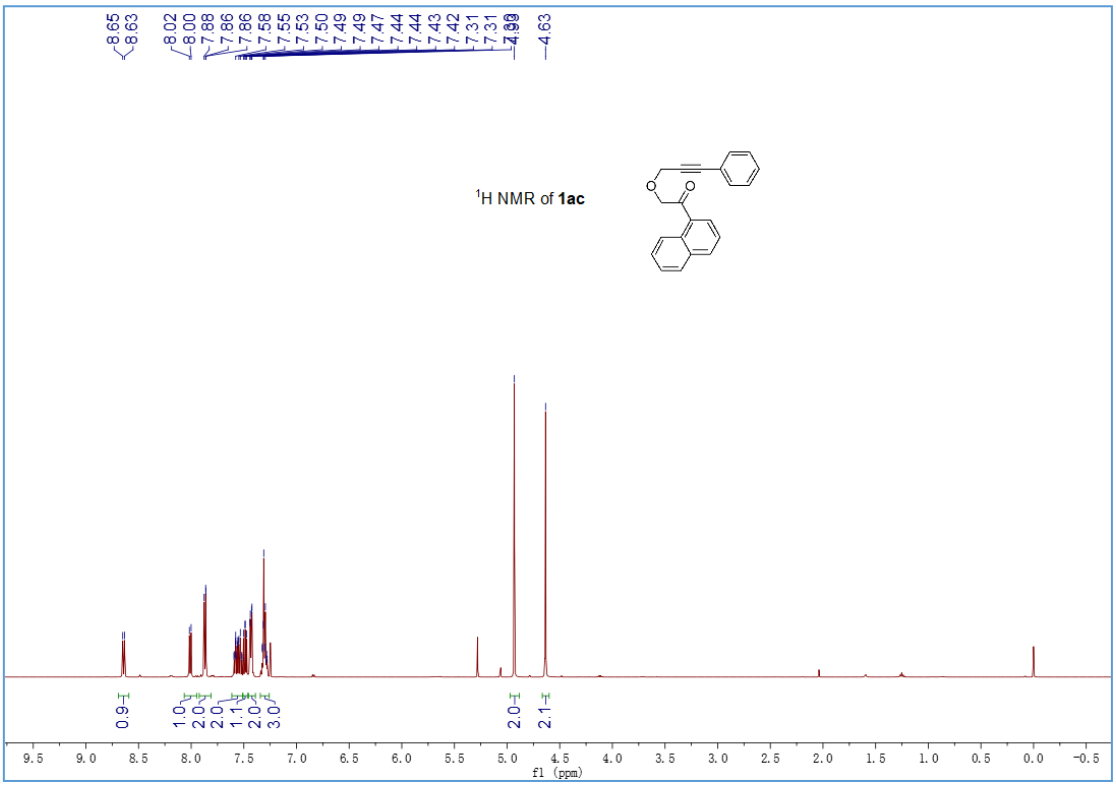
131.77
130.81
128.47
128.29
125.33
122.64
120.97
111.52
86.80
84.76
75.58
59.06
55.56
^{13}C NMR of **1ab**
OMe
f1 (ppm)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8.63
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7.86
7.86
7.58
7.55
7.53
7.50
7.49
7.49
7.47
7.44
7.44
7.43
7.42
7.31
7.31
4.63
^{1}H NMR of **1ac**
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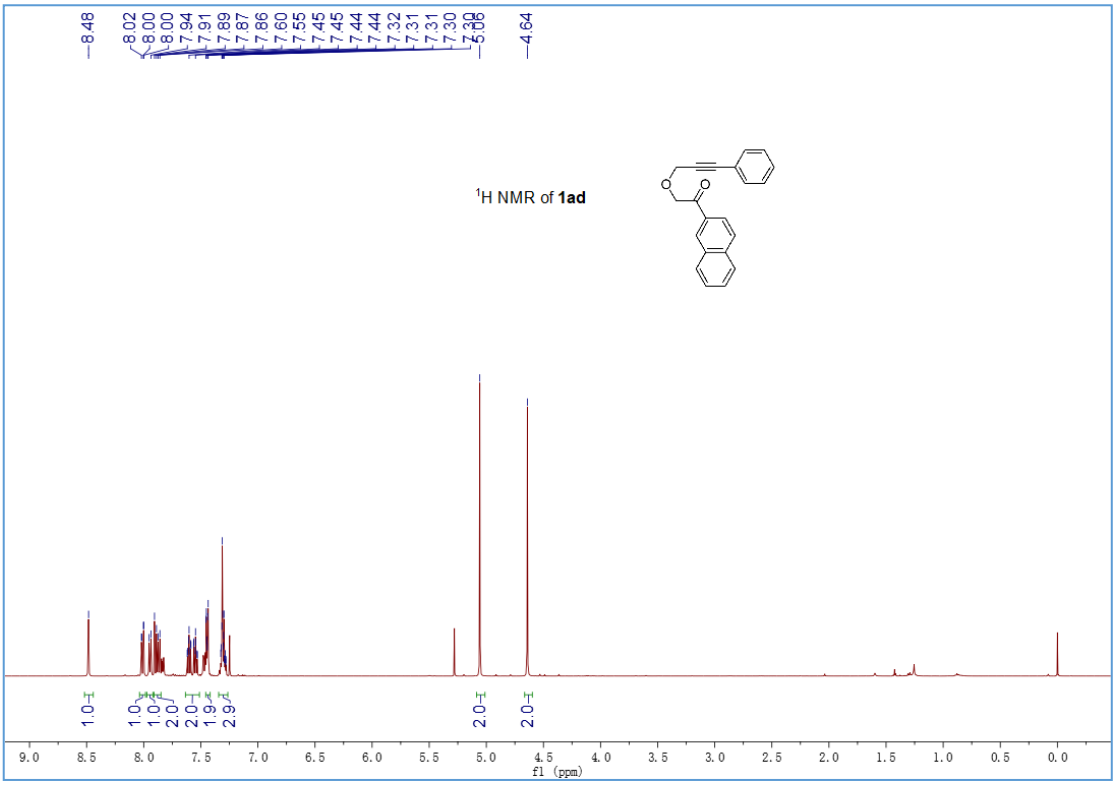
2.0
2.0
1.1
2.0
3.0
2.0
2.1
f1 (ppm)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8.00
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7.89
7.87
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7.60
7.55
7.45
7.45
7.44
7.44
7.32
7.31
7.31
7.30
5.06
4.64
^{1}H NMR of **1ad**
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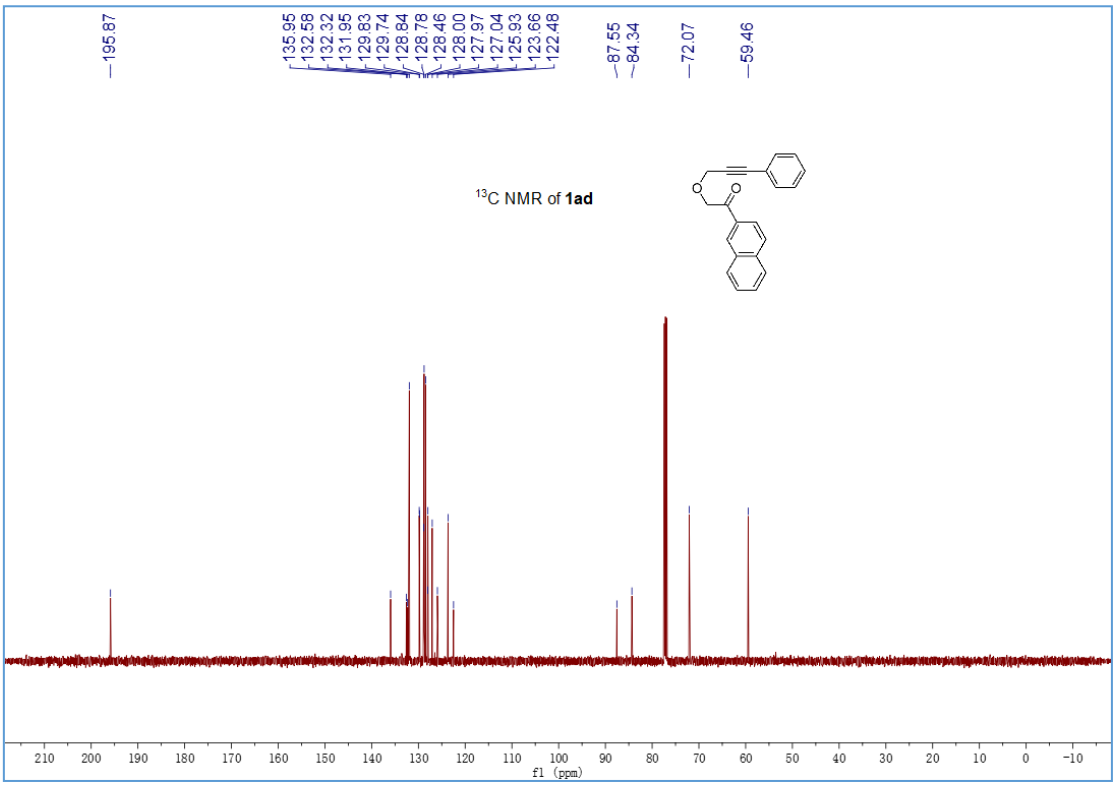
1.0
1.0
2.0
2.0
1.9
2.9
2.0
2.0
f1 (ppm)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128.84
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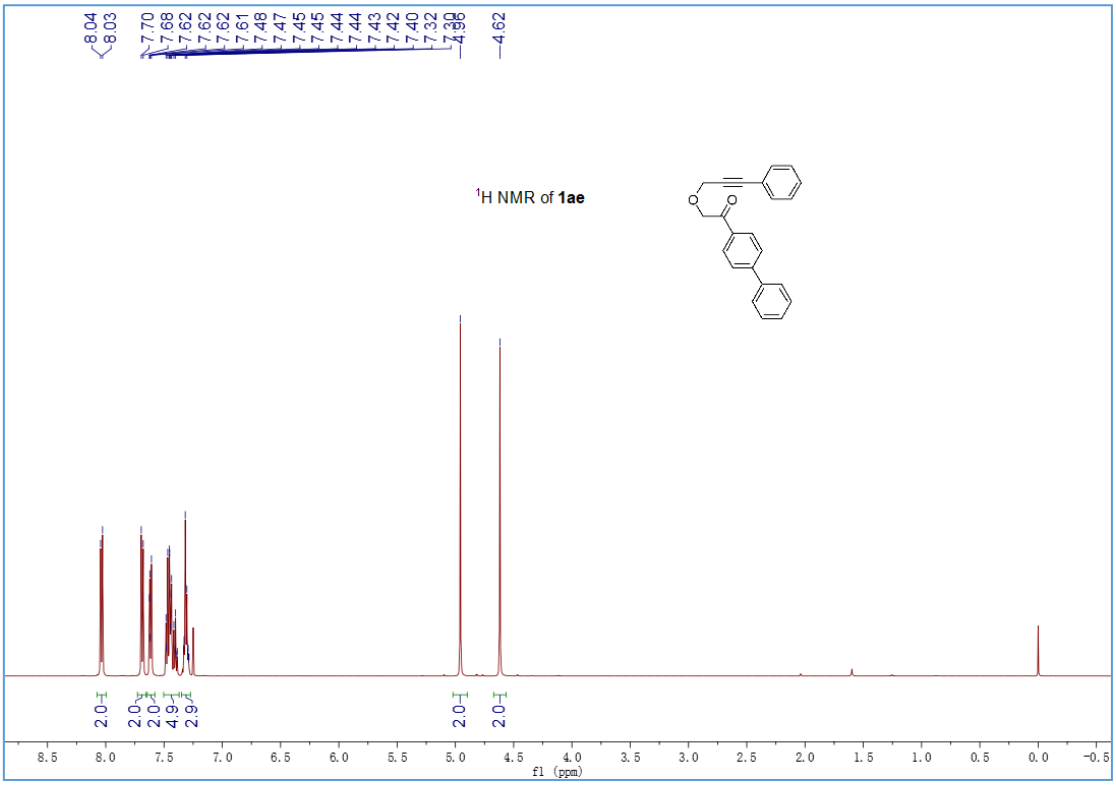
128.46
128.00
127.97
127.04
125.93
123.66
122.48
87.55
84.34
72.07
59.46
^{13}C NMR of **1ad**
f1 (ppm)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8.03
7.70
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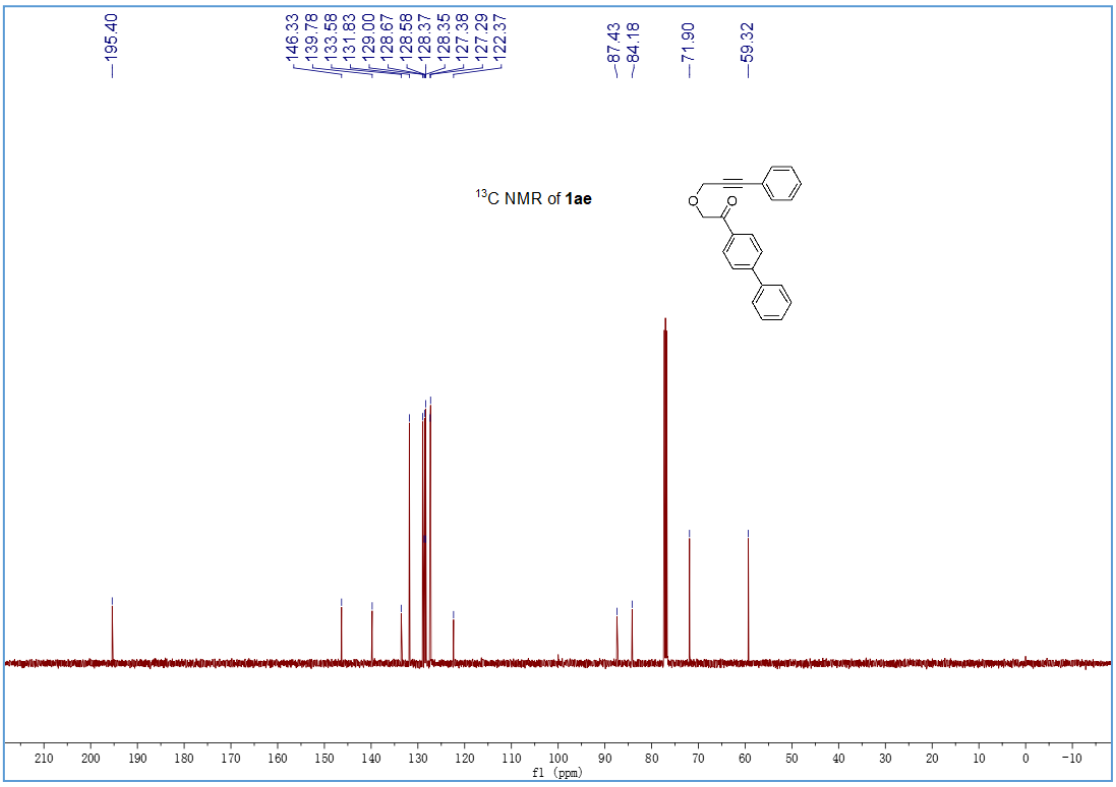
7.62
7.62
7.61
7.48
7.47
7.45
7.45
7.44
7.44
7.43
7.42
7.40
7.32
4.62
^{1}H NMR of **1ae**
2.0
2.0
2.0
4.9
2.9
2.0
2.0
f1 (ppm)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128.58
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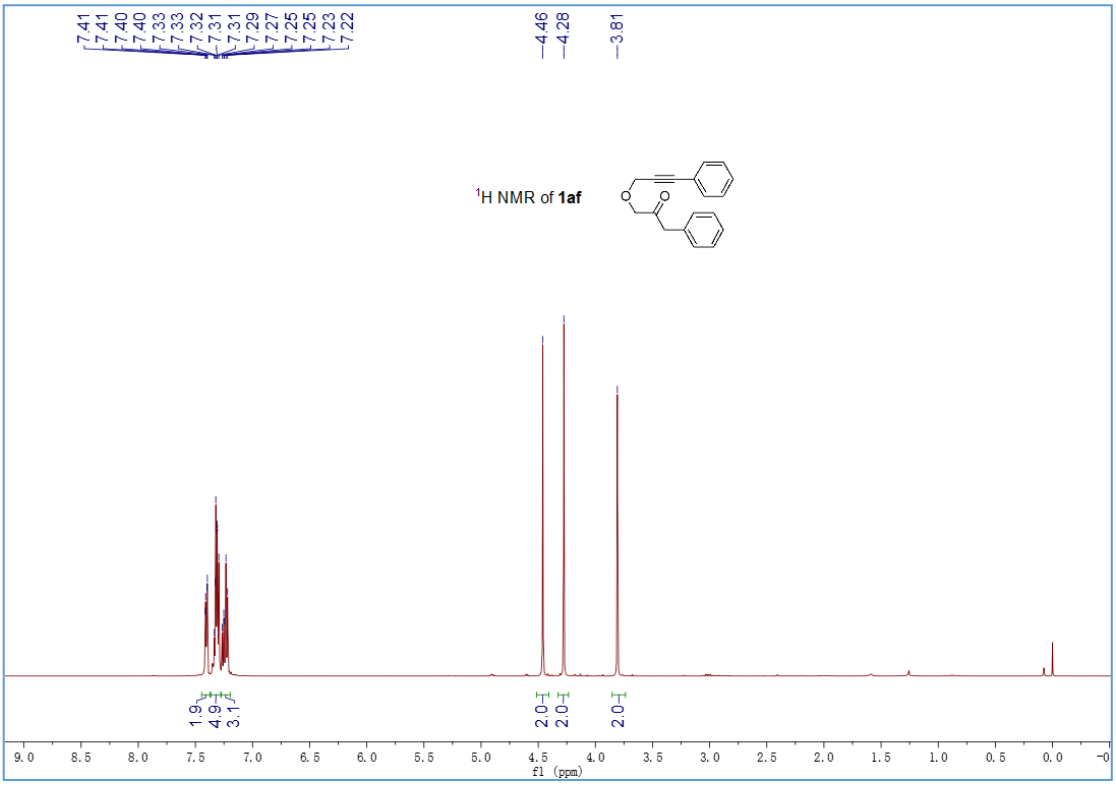
127.38
127.29
122.37
87.43
84.18
71.90
59.32
13C NMR of 1ae
f1 (ppm)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7.32
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7.31
7.29
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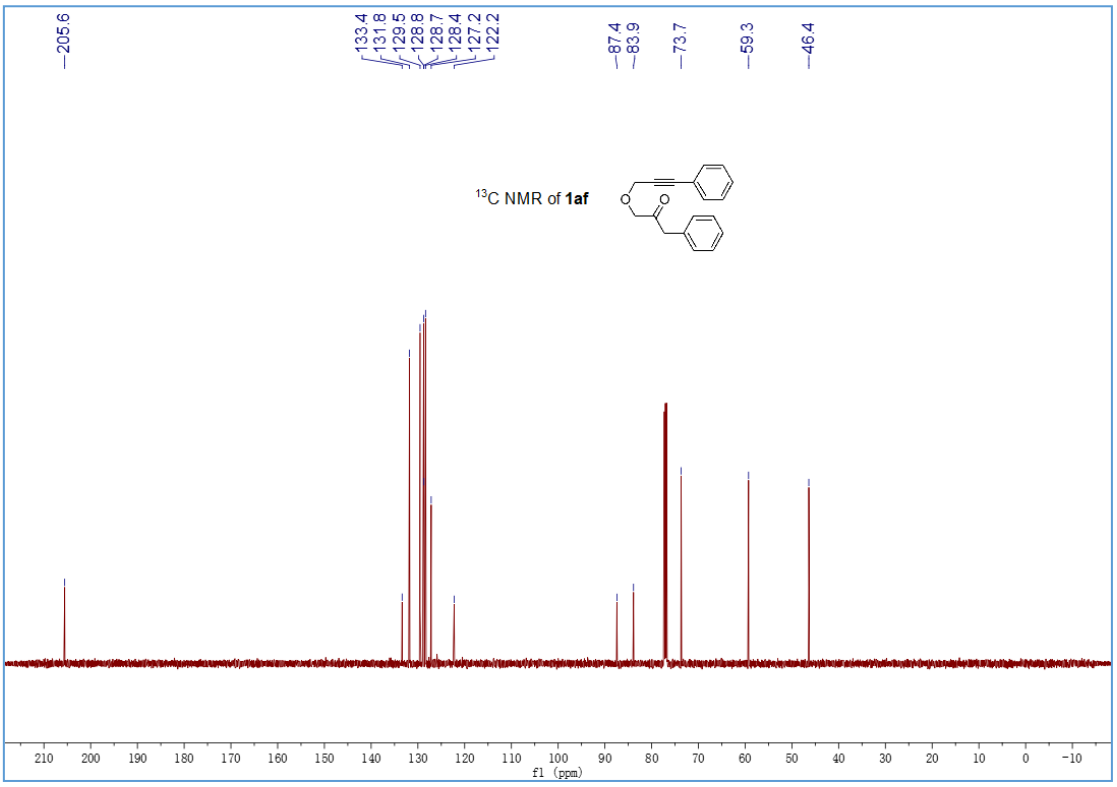
7.25
7.25
7.23
7.22
4.46
4.28
3.81
1H NMR of 1af
1.9
4.9
3.1
2.0
2.0
2.0
f1 (ppm)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133.4
131.8
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128.7
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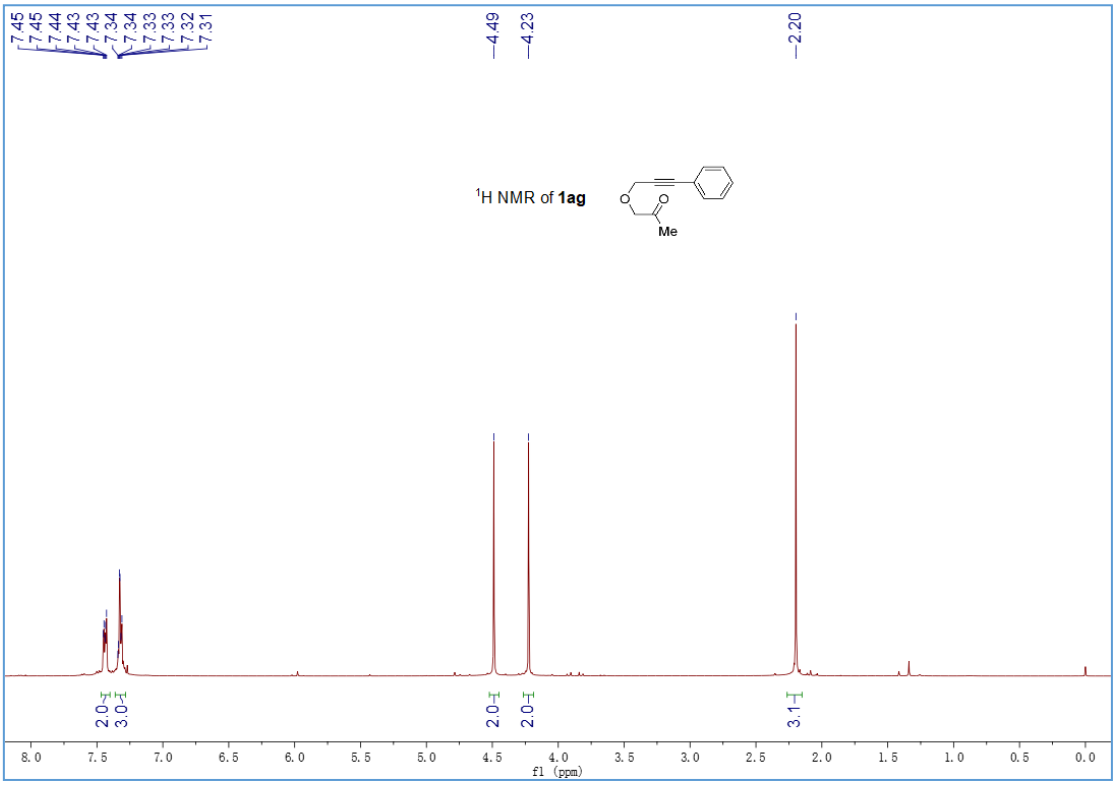
127.2
122.2
87.4
83.9
73.7
59.3
46.4
^{13}C NMR of **1af**
f1 (ppm)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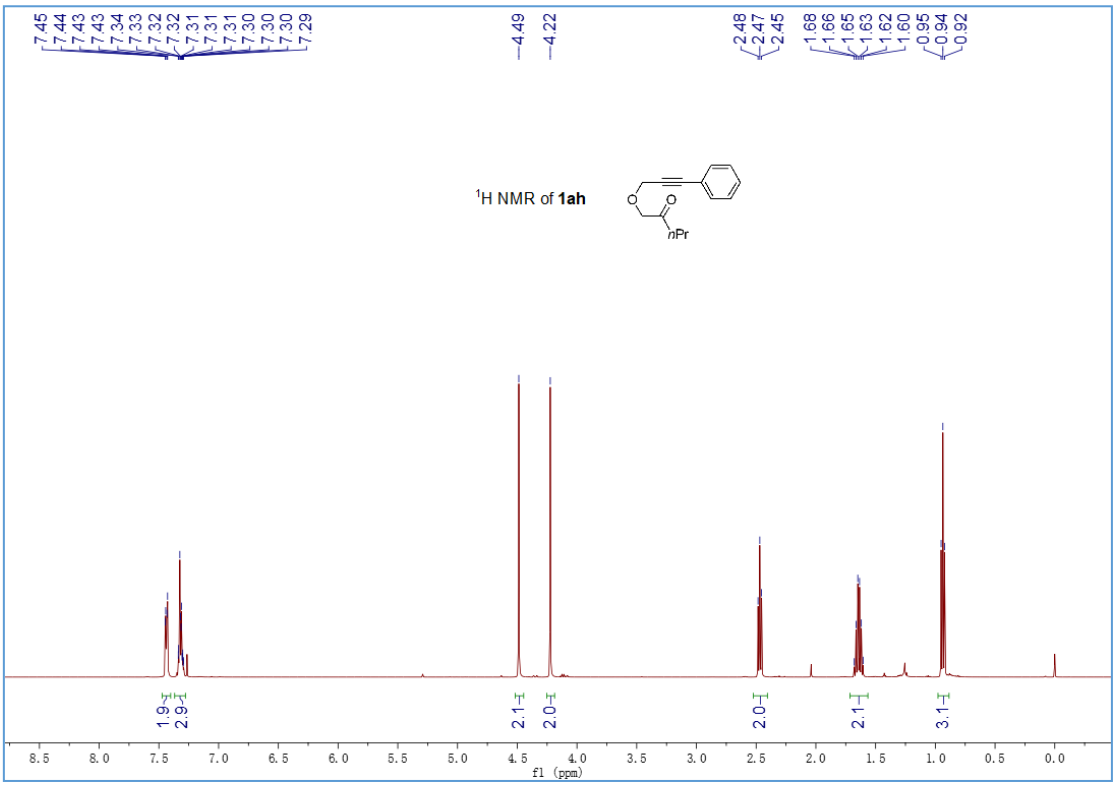
7.43
7.43
7.34
7.34
7.33
7.33
7.32
7.31
4.49
4.23
2.20
^{1}H NMR of **1ag**
Me
2.0
3.0
2.0
2.0
3.1
f1 (ppm)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7.32
7.31
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7.31
7.30
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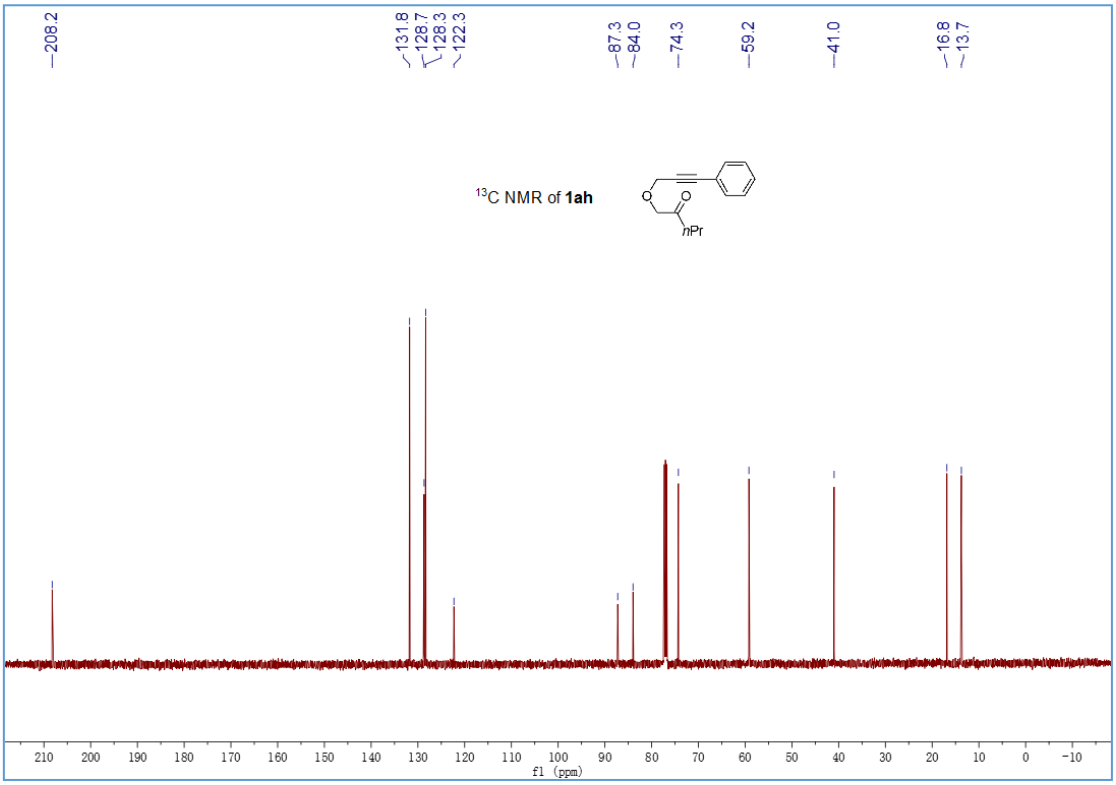
7.30
7.29
4.49
4.22
2.48
2.47
2.45
1.68
1.66
1.65
1.63
1.62
1.60
0.95
0.94
0.92
1H NMR of 1ah
nPr
1.9
2.9
2.1
2.0
2.0
2.1
3.1
f1 (ppm)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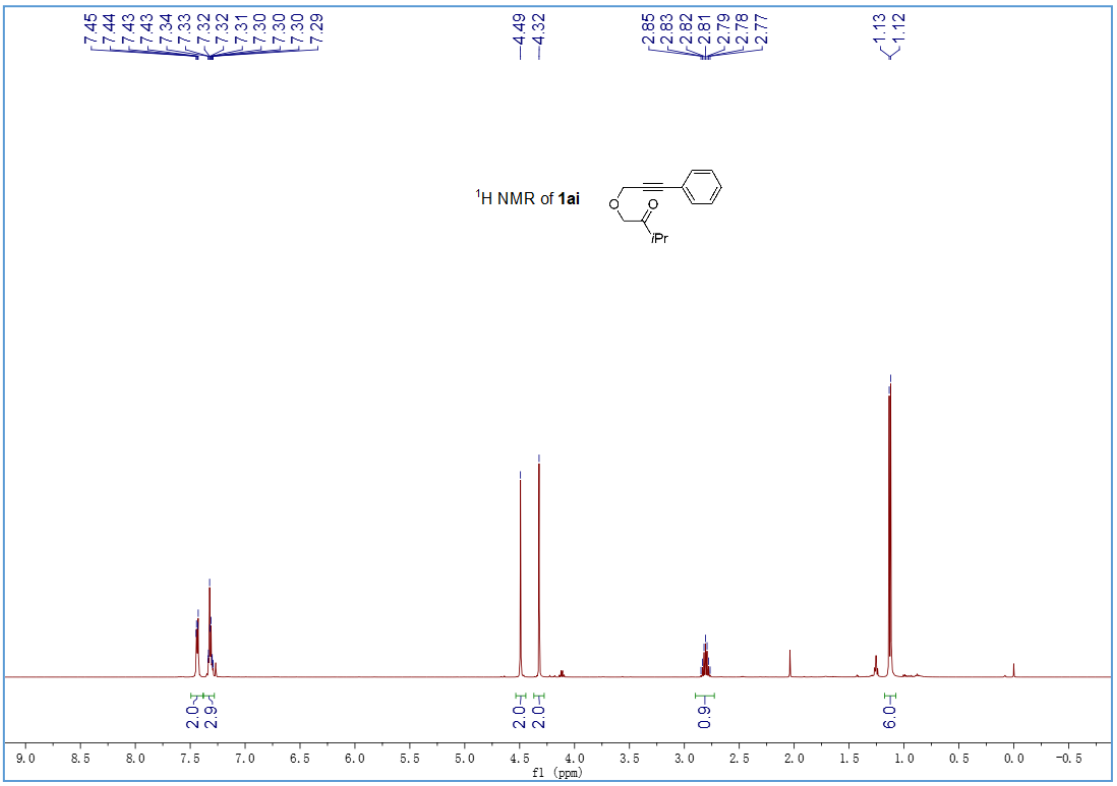
131.8
128.7
128.3
122.3
87.3
84.0
74.3
59.2
41.0
16.8
13.7
13C NMR of 1ah
nPr
f1 (ppm)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7.43
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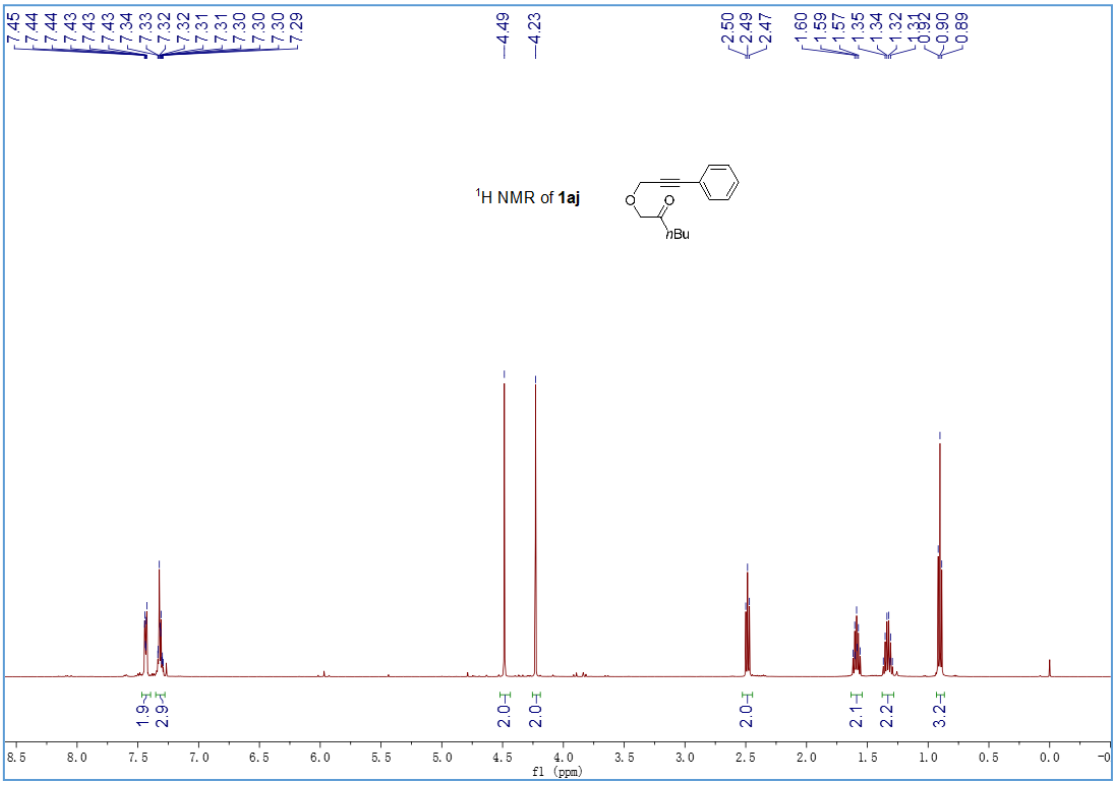
7.32
7.32
7.31
7.30
7.30
7.30
7.29
4.49
4.32
2.85
2.83
2.82
2.81
2.79
2.78
2.77
1.13
1.12
1H NMR of 1ai
iPr
2.0
2.9
2.0
2.0
0.9
6.0
f1 (ppm)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7.33
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7.31
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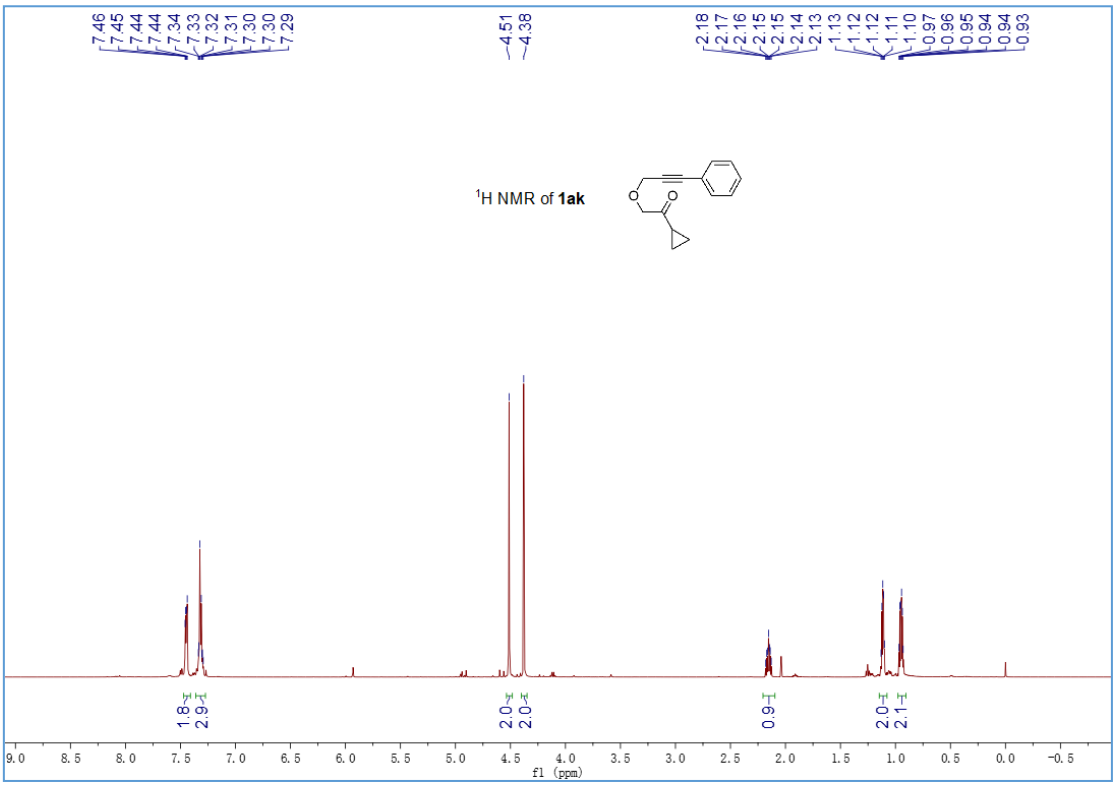
7.30
7.30
7.29
4.49
4.23
2.50
2.49
2.47
1.60
1.59
1.57
1.35
1.34
1.32
0.92
0.91
0.90
0.89
1H NMR of 1aj
nBu
1.9
2.9
2.0
2.0
2.0
2.1
2.2
3.2
f1 (ppm)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7.44
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7.32
7.31
7.30
7.30
7.29
4.51
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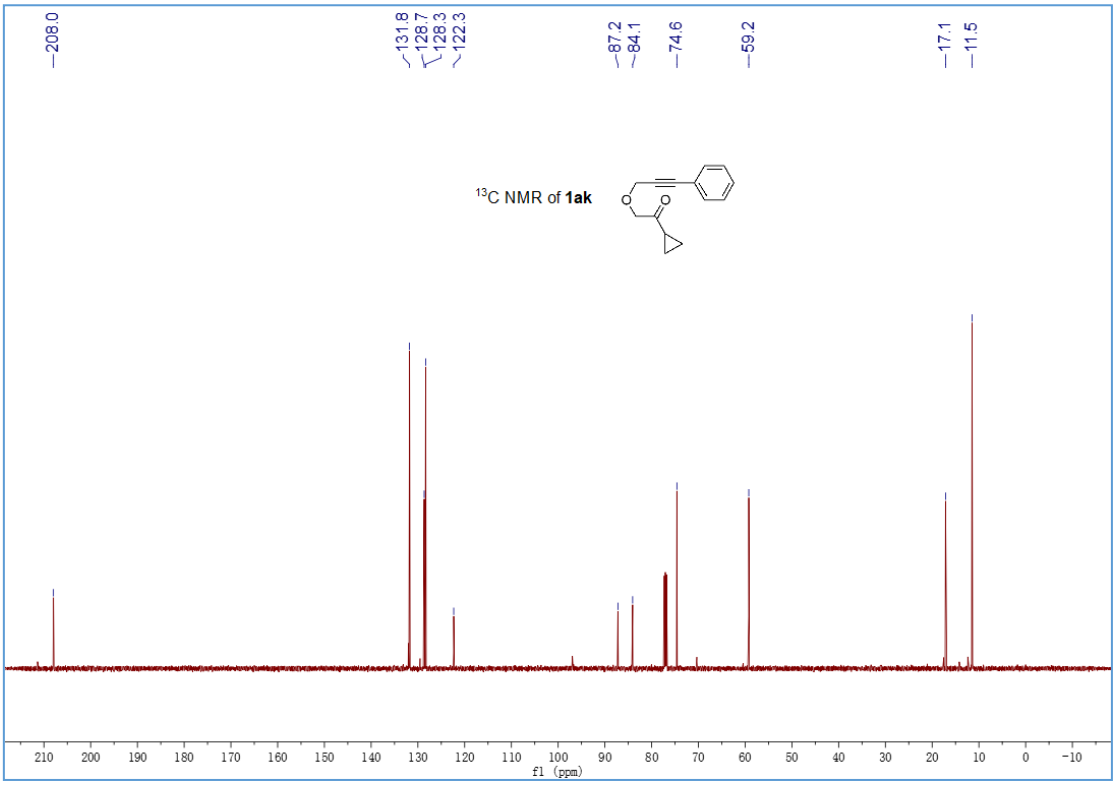
2.18
2.17
2.16
2.15
2.15
2.14
2.13
1.13
1.12
1.12
1.11
1.10
0.97
0.96
0.95
0.94
0.94
0.93
^{1}H NMR of **1ak**
1.8
2.9
2.0
2.0
0.9
2.0
2.1
f1 (ppm)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74.6
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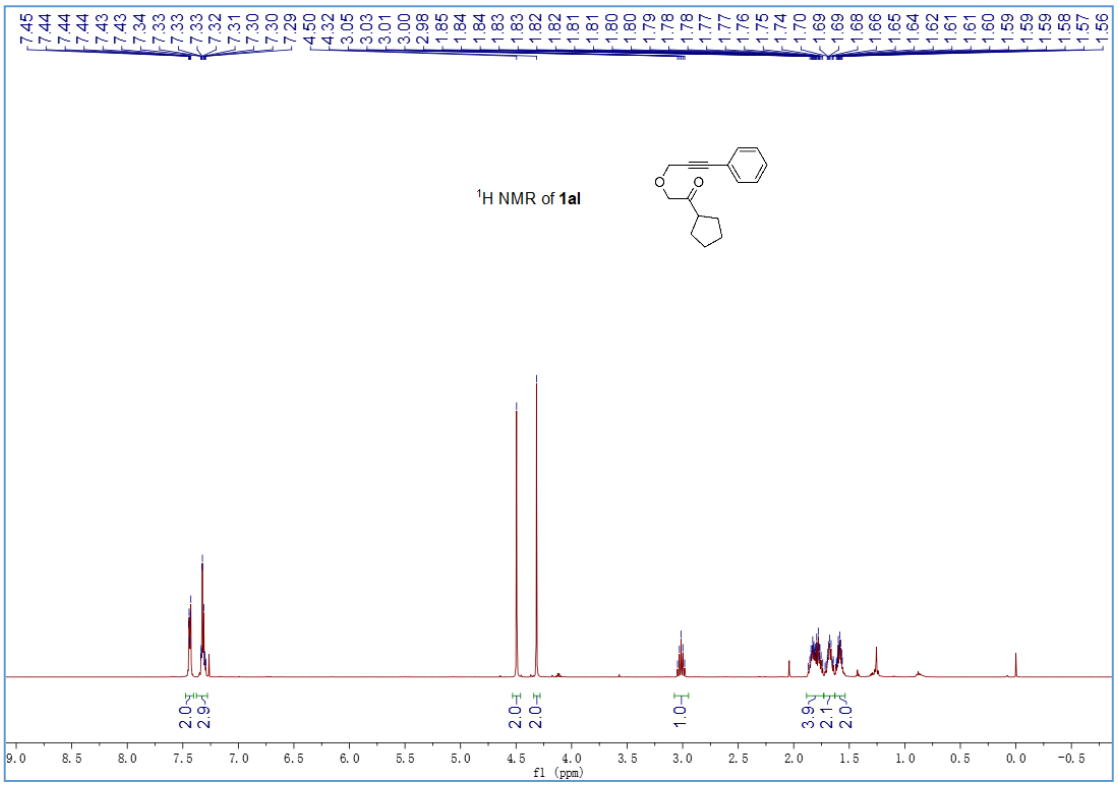
17.1
11.5
^{13}C NMR of **1ak**
f1 (ppm)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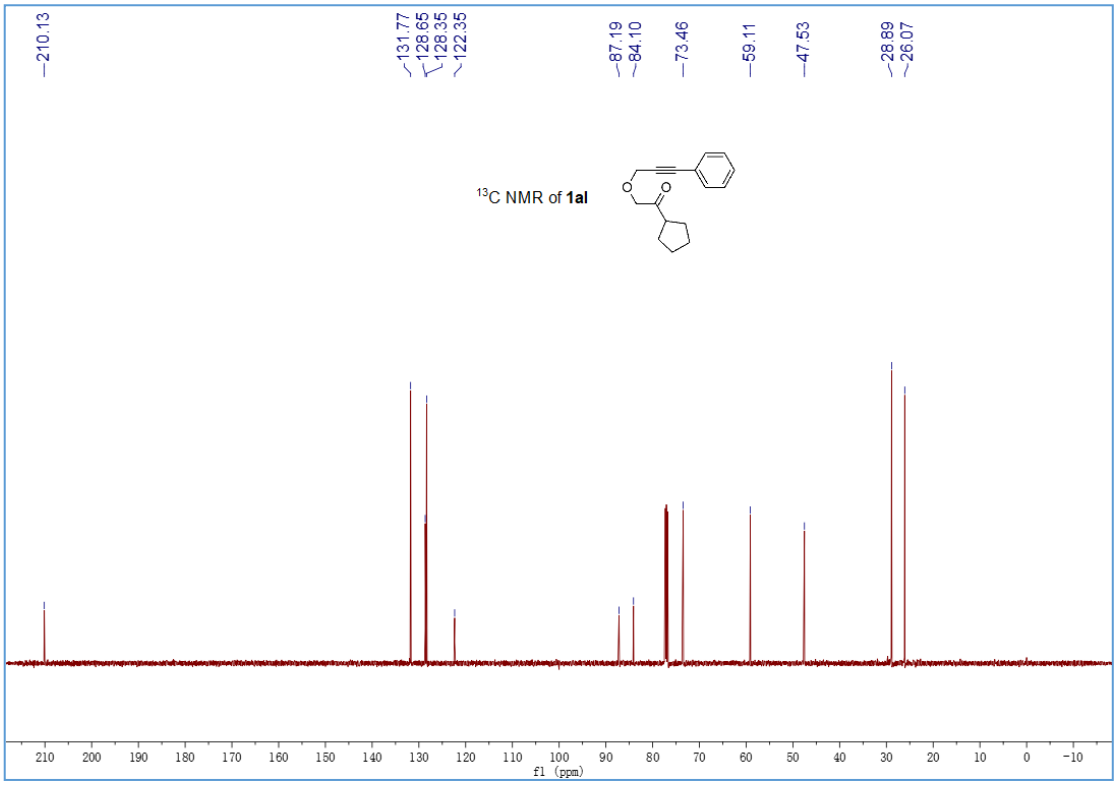
^{1}H NMR of **1al**
2.0 2.9 2.0 2.0 1.0 3.9 2.1 2.0
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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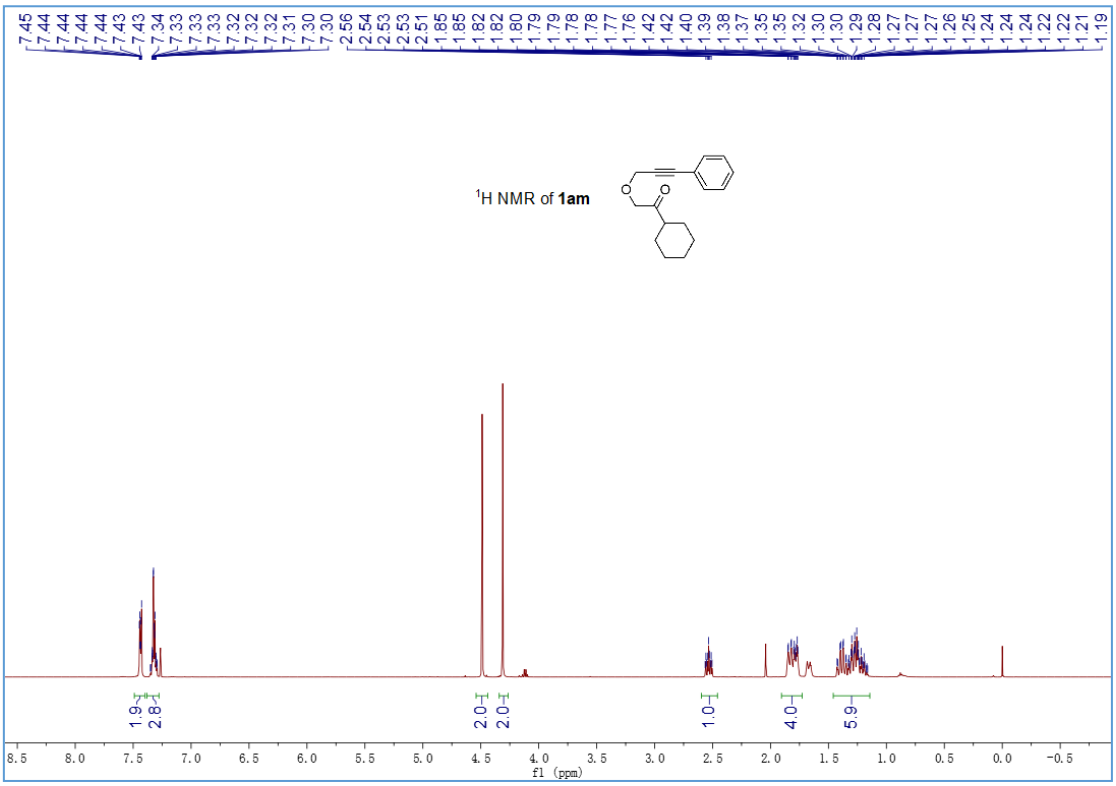
131.77 128.65 128.35 122.35
87.19 84.10 73.46 59.11 47.53 28.89 26.07
^{13}C NMR of **1al**
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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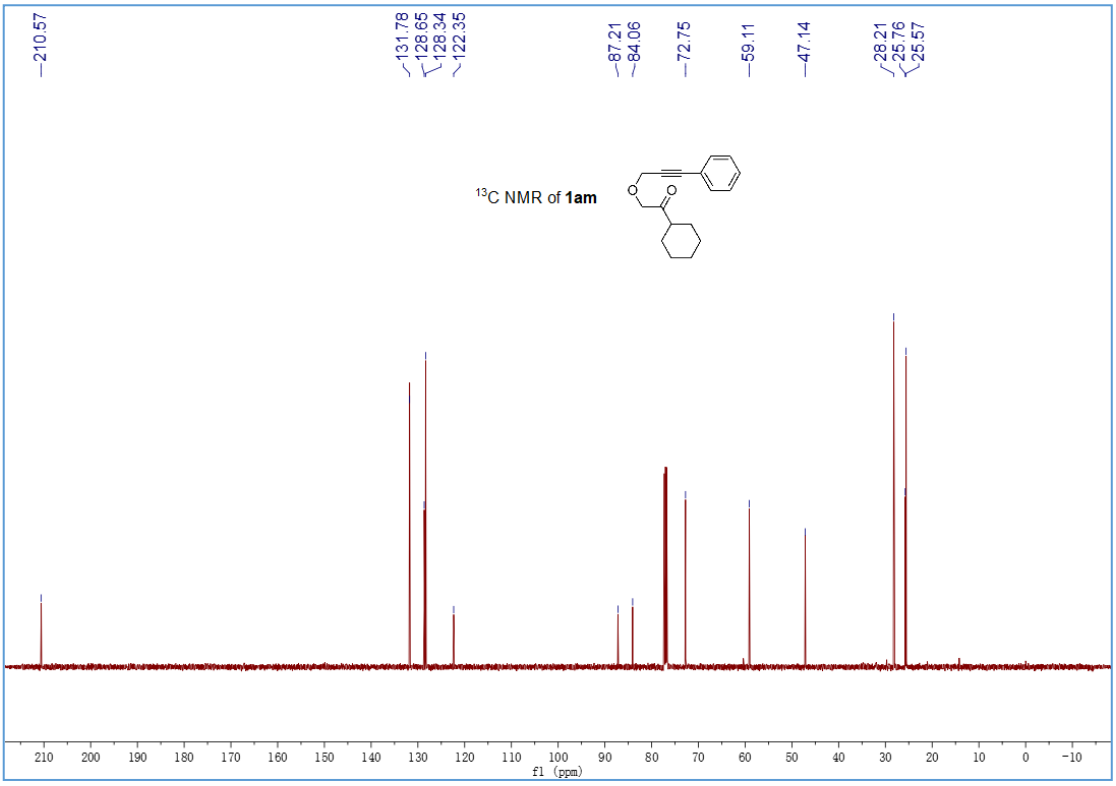
^{1}H NMR of **1am**
1.9 2.8 2.0 2.0 1.0 4.0 5.9
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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87.21 84.06 72.75 59.11 47.14 28.21 25.76 25.57
^{13}C NMR of **1am**
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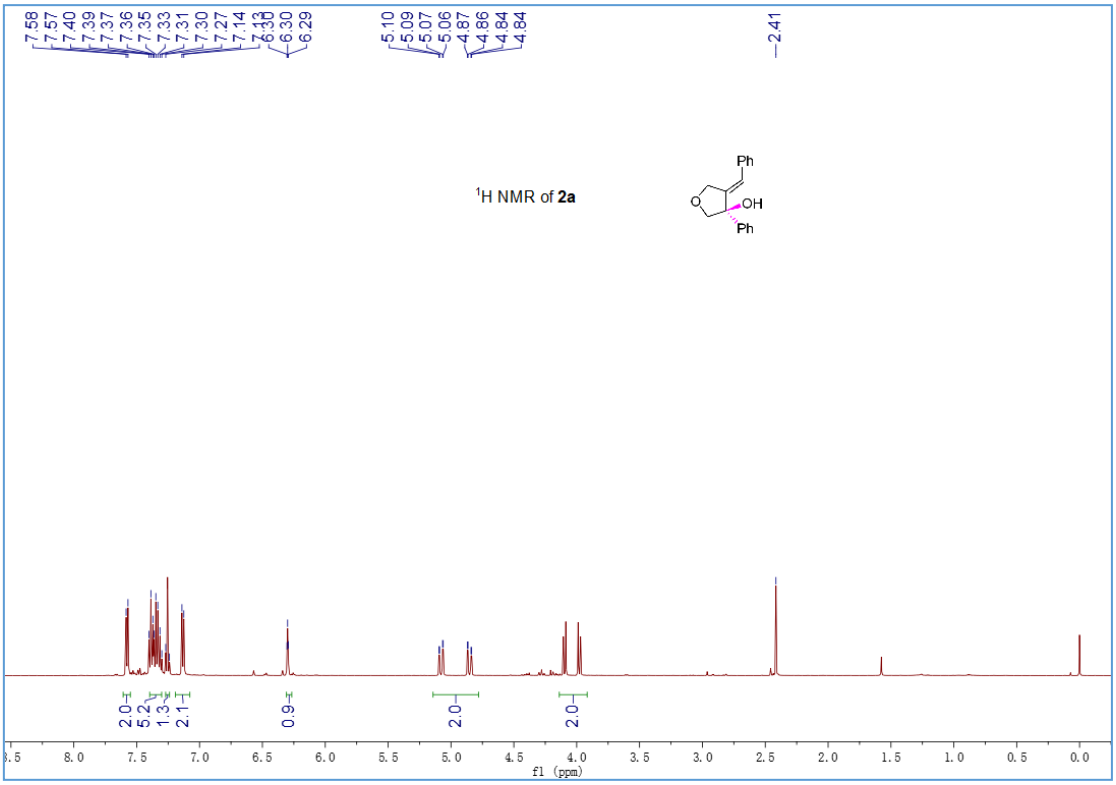
f1 (ppm)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6.29
5.10
5.09
5.07
5.06
4.87
4.86
4.84
4.84
2.41
1H NMR of 2a
Ph
OH
Ph
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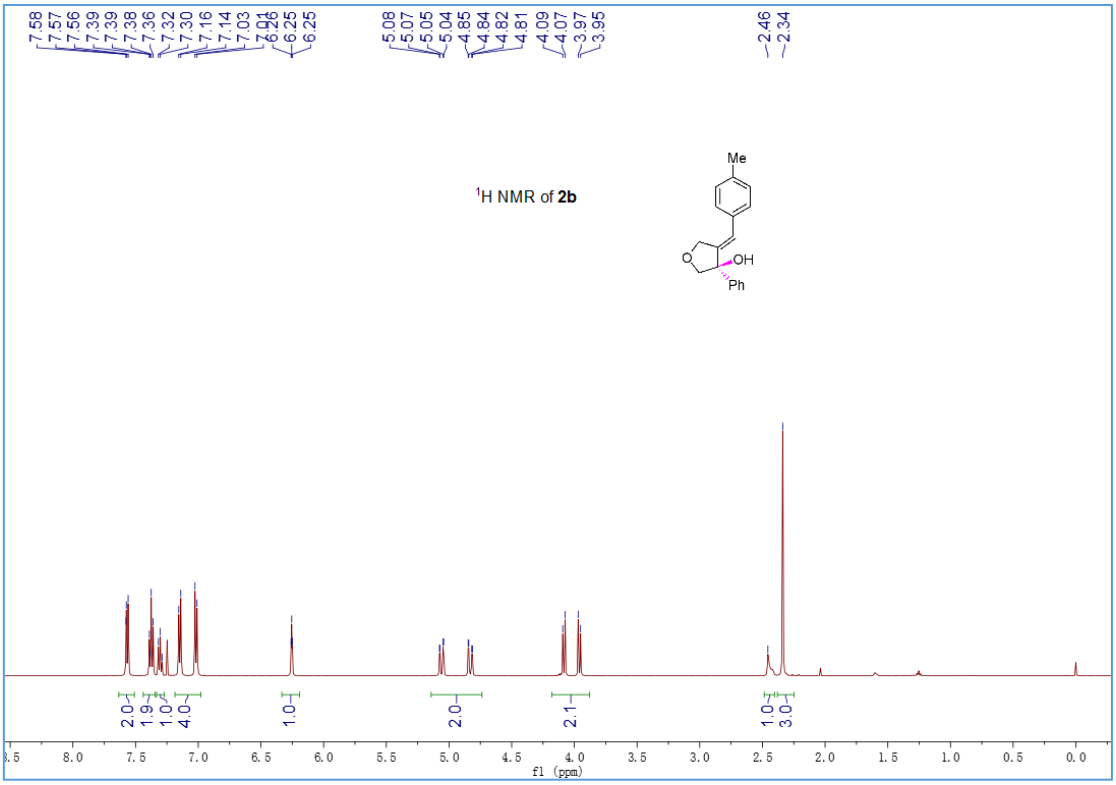
2.0
f1 (ppm)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5.08
5.07
5.05
5.04
4.85
4.84
4.82
4.81
4.09
4.07
3.97
3.95
2.46
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1H NMR of 2b
Me
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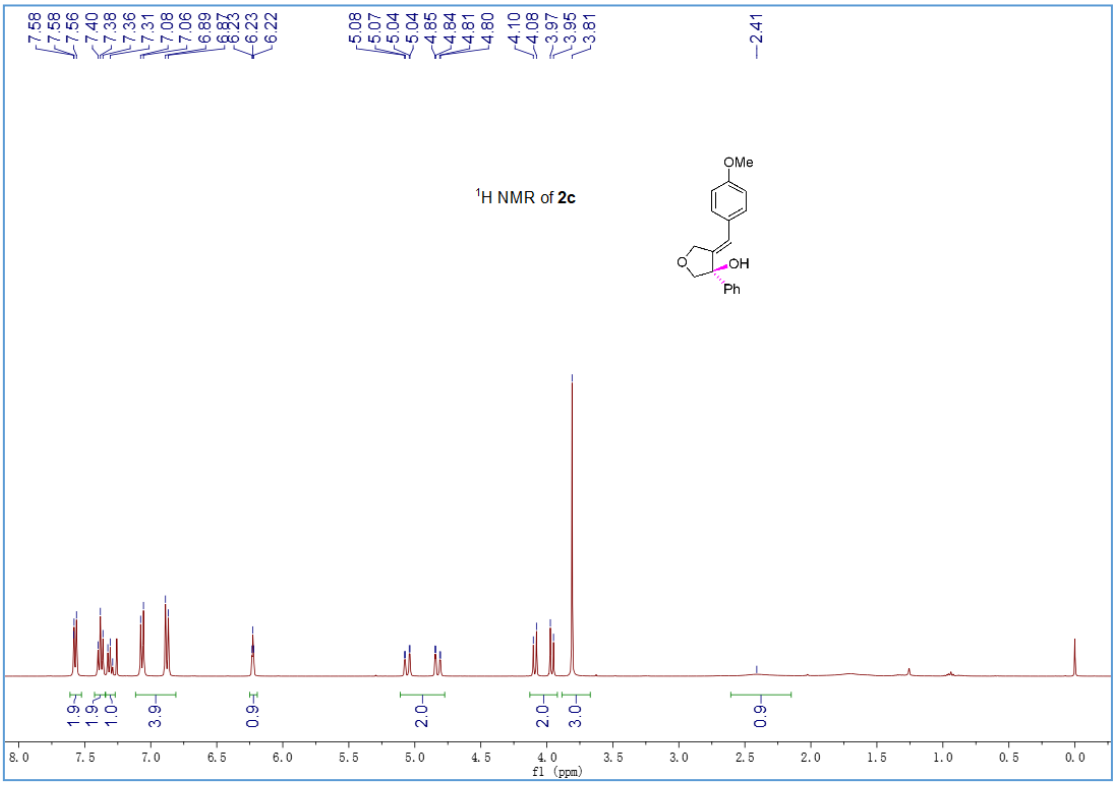
f1 (ppm)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5.07
5.04
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4.84
4.81
4.80
4.10
4.08
3.97
3.95
3.81
2.41
1H NMR of 2c
OMe
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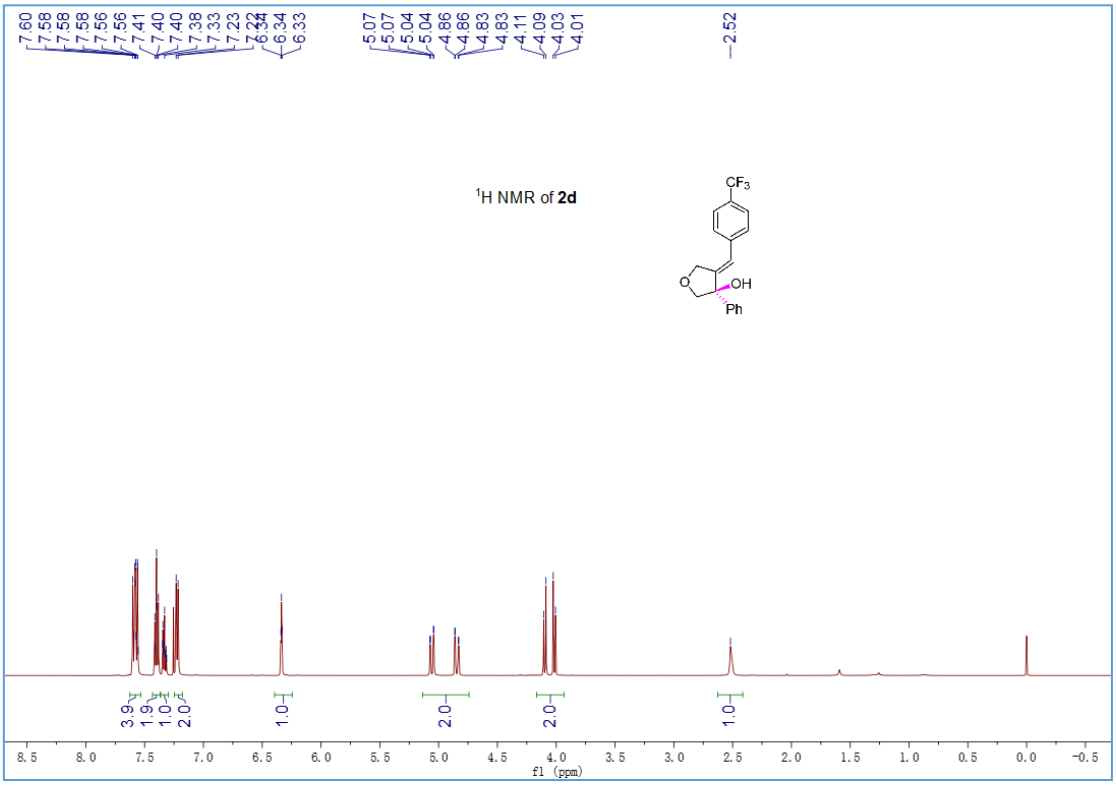
f1 (ppm)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6.33
5.07
5.07
5.04
5.04
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4.86
4.83
4.83
4.11
4.09
4.03
4.01
2.52
1H NMR of 2d
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Ph
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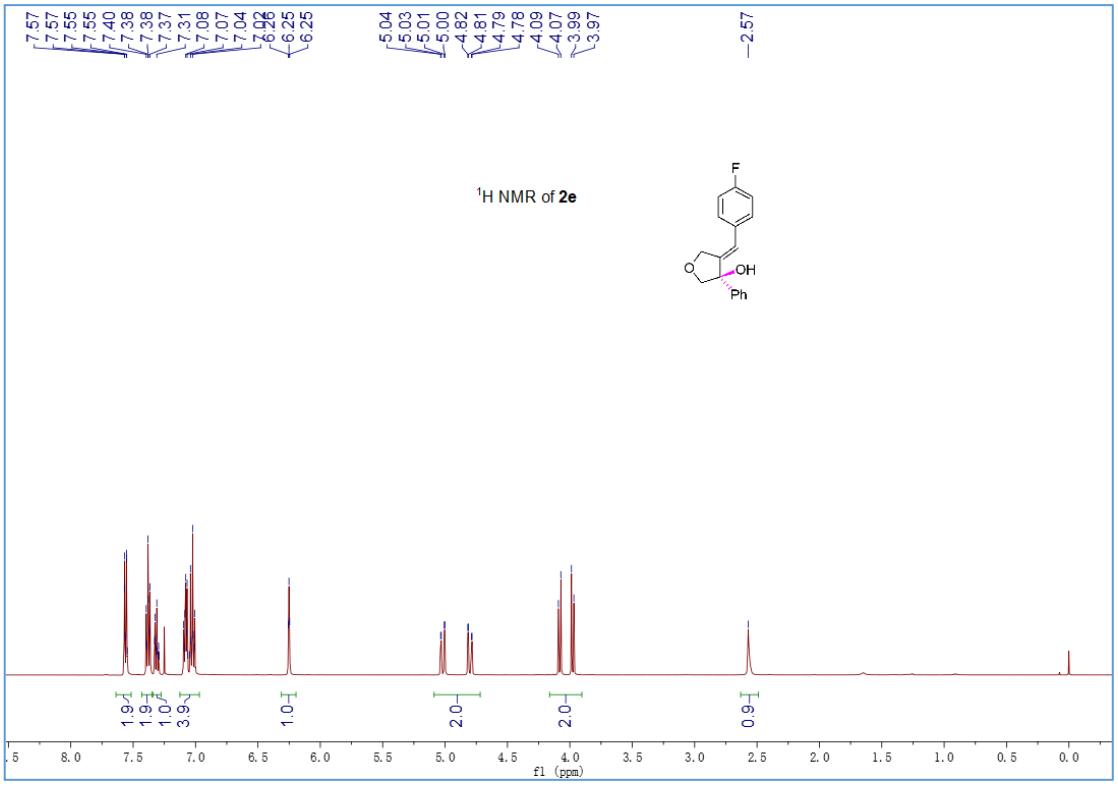
f1 (ppm)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7.04
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6.25
5.04
5.03
5.01
5.00
4.82
4.81
4.79
4.78
4.09
4.07
3.99
3.97
2.57
1H NMR of 2e
F
OH
Ph
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1.0
3.9
1.0
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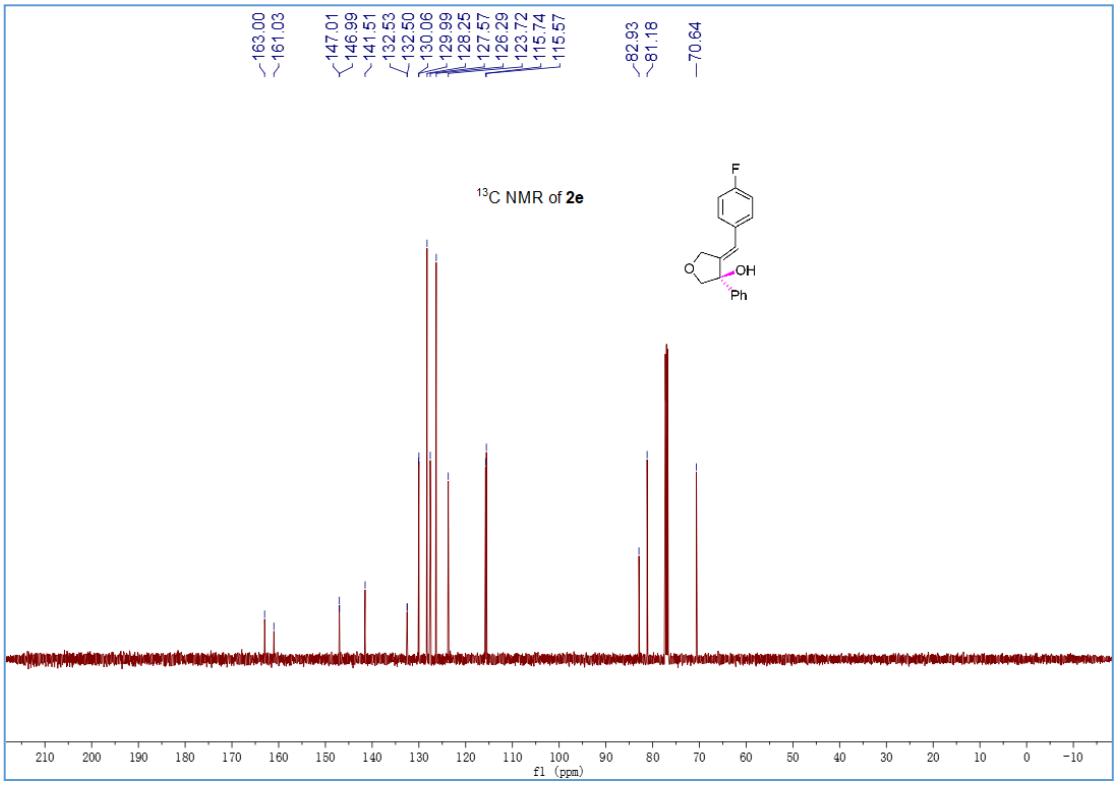
0.9
f1 (ppm)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115.57
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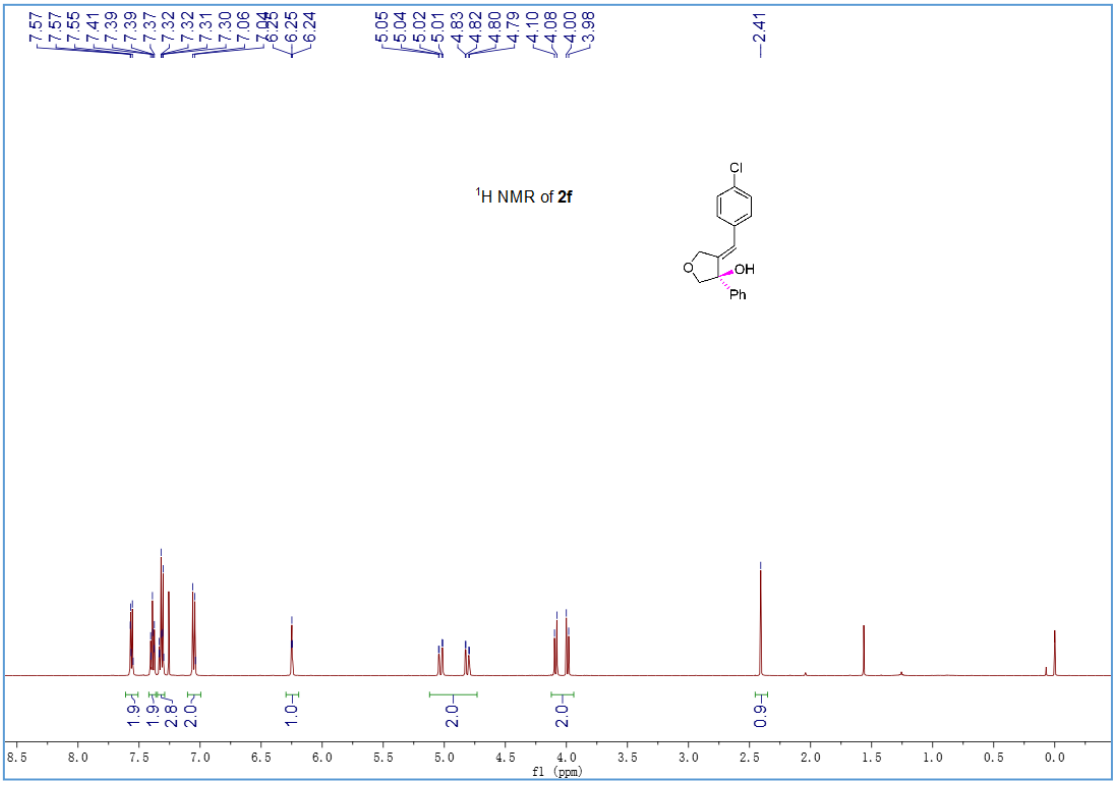
13C NMR of 2e
F
OH
Ph
f1 (ppm)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7.06
7.04
6.25
6.24
5.05
5.04
5.02
5.01
4.83
4.82
4.80
4.79
4.10
4.08
4.00
3.98
2.41
1H NMR of 2f
Cl
OH
Ph
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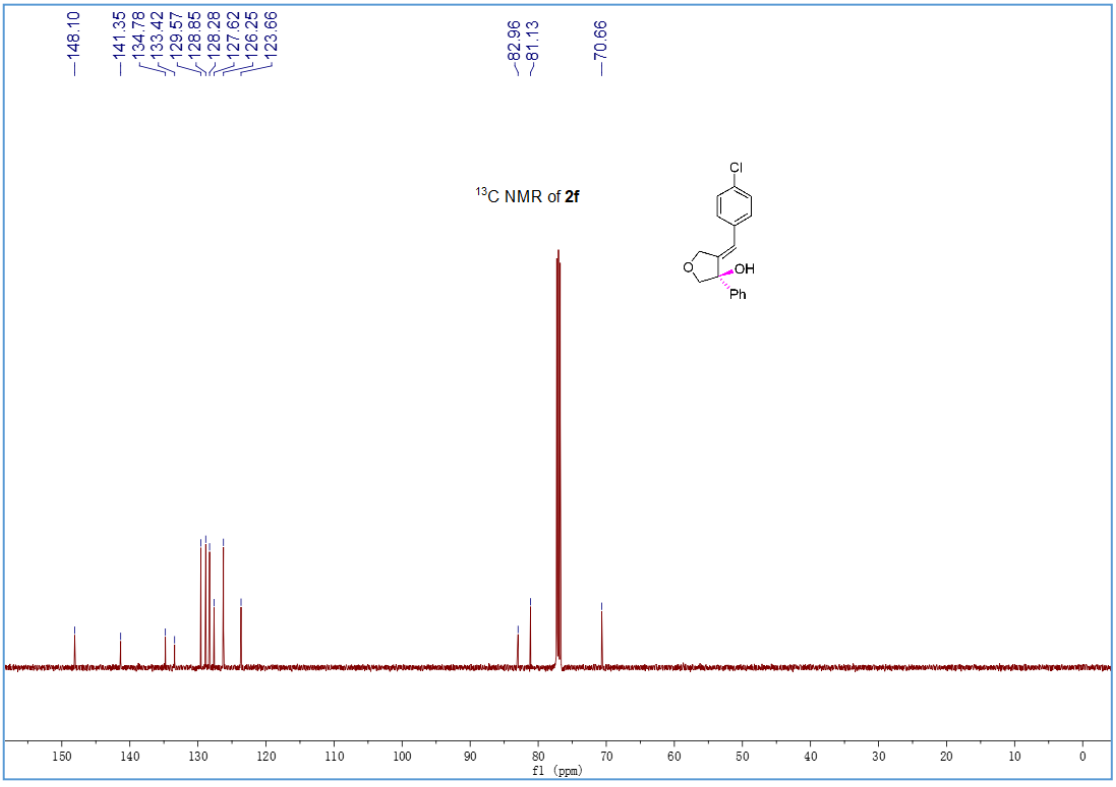
f1 (ppm)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81.13
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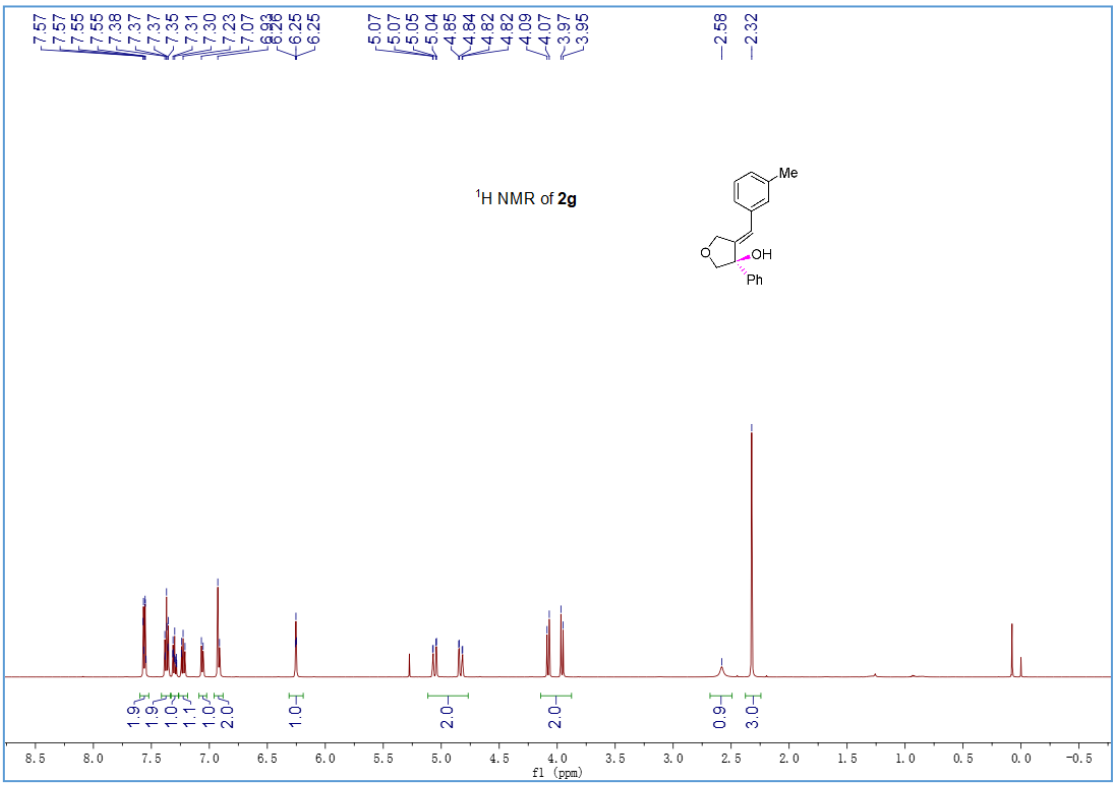
13C NMR of 2f
Cl
OH
Ph
f1 (ppm)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6.25
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5.07
5.05
5.04
4.85
4.84
4.82
4.82
4.09
4.07
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1H NMR of 2g
Me
OH
Ph
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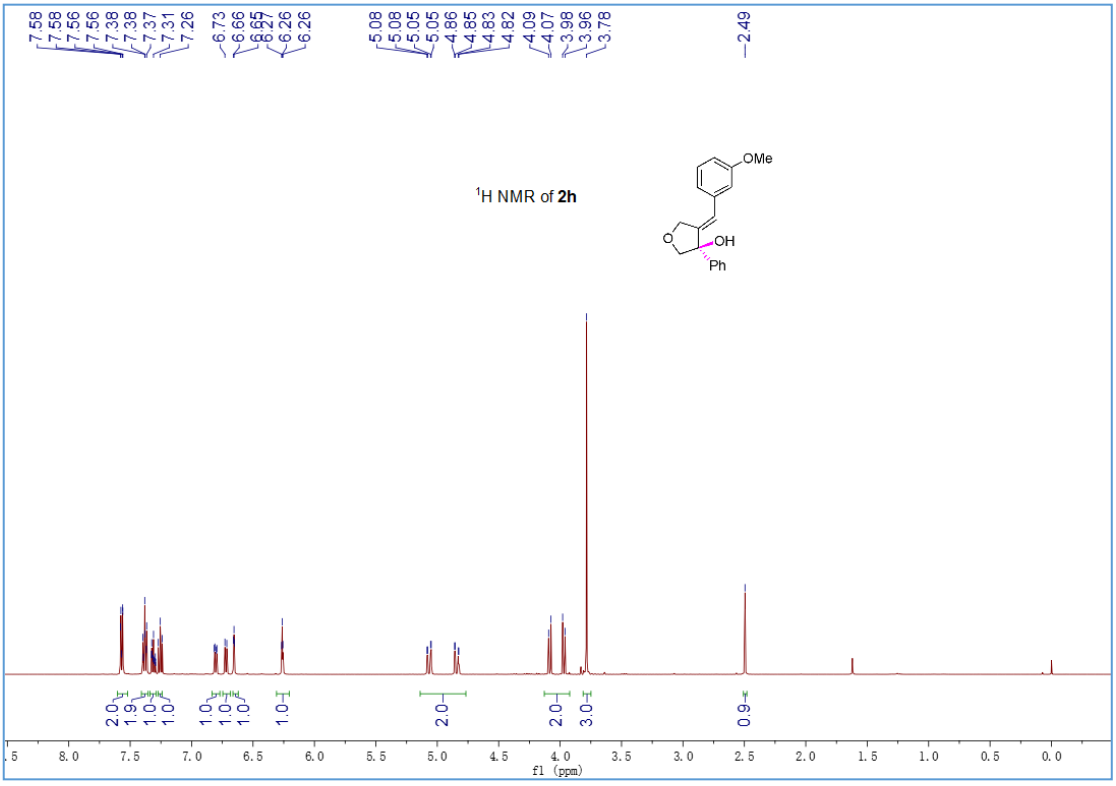
f1 (ppm)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4.09
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1H NMR of 2h
OMe
OH
Ph
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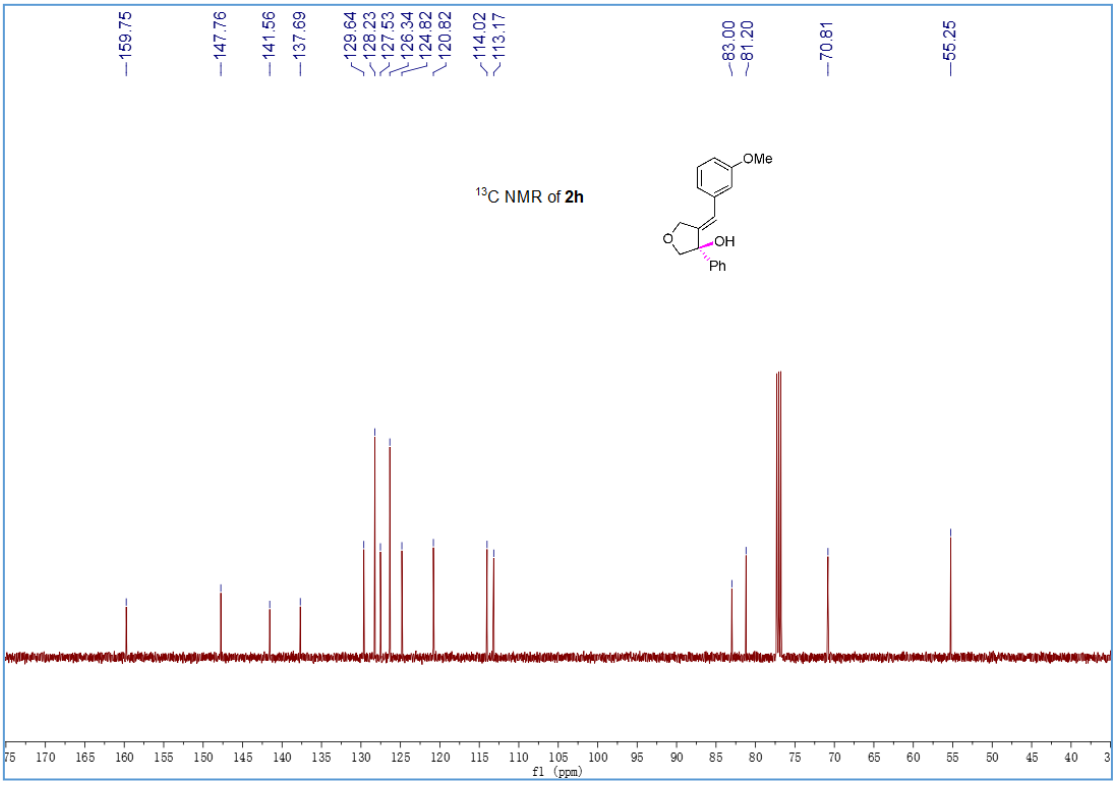
f1 (ppm)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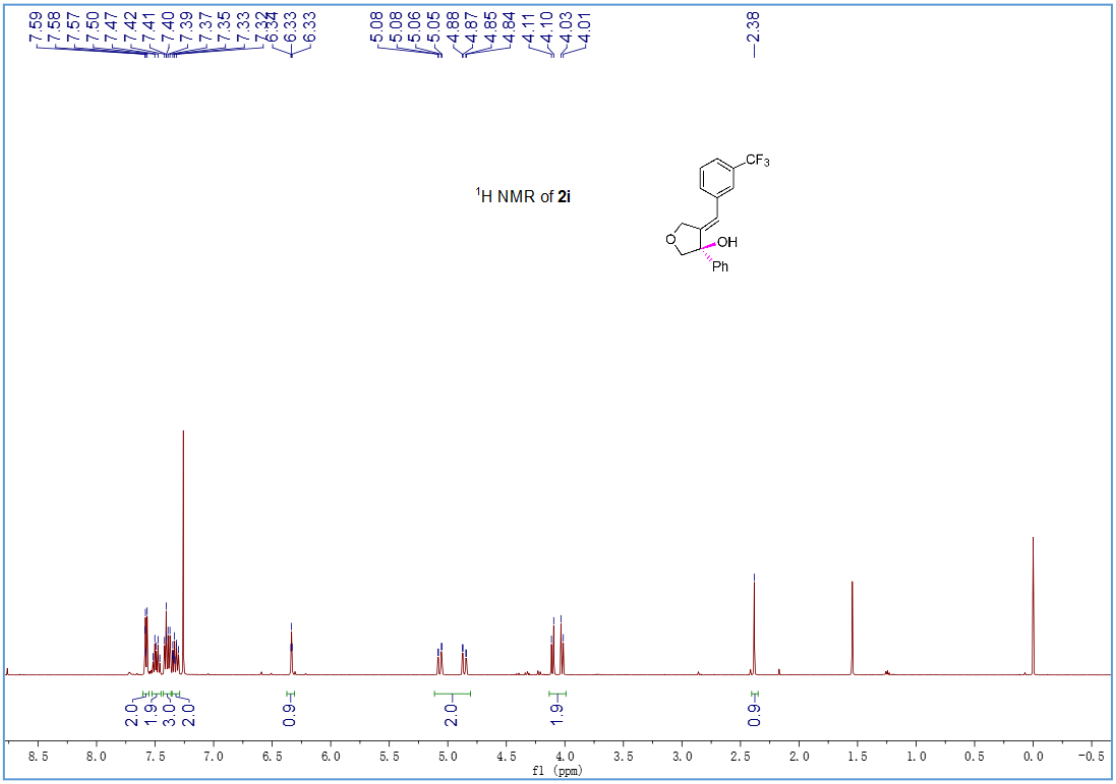
128.23
127.53
126.34
124.82
120.82
114.02
113.17
83.00
81.20
70.81
55.25
13C NMR of 2h
OMe
OH
Ph
f1 (ppm)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7.40
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7.35
7.33
6.34
6.33
6.33
5.08
5.08
5.06
5.05
4.88
4.87
4.85
4.84
4.11
4.10
4.03
4.01
2.38
1H NMR of 2i
CF3
OH
Ph
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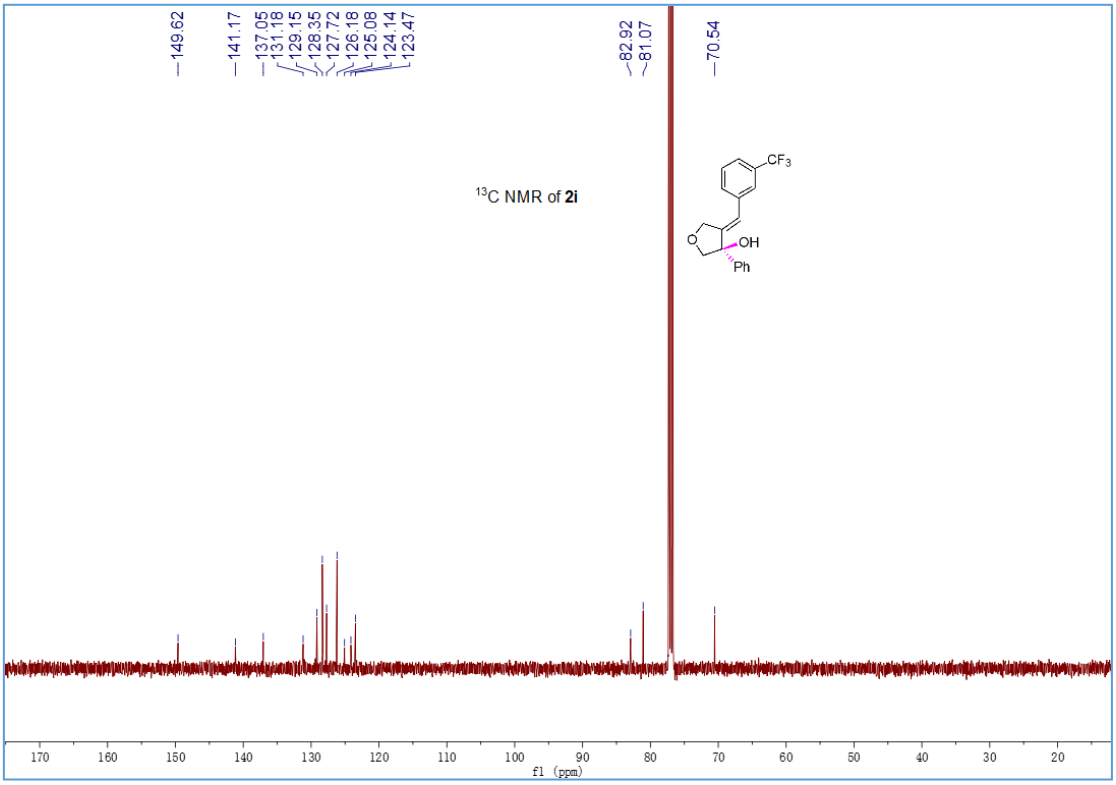
1.9
3.0
2.0
0.9
2.0
1.9
0.9
f1 (ppm)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137.05
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127.72
126.18
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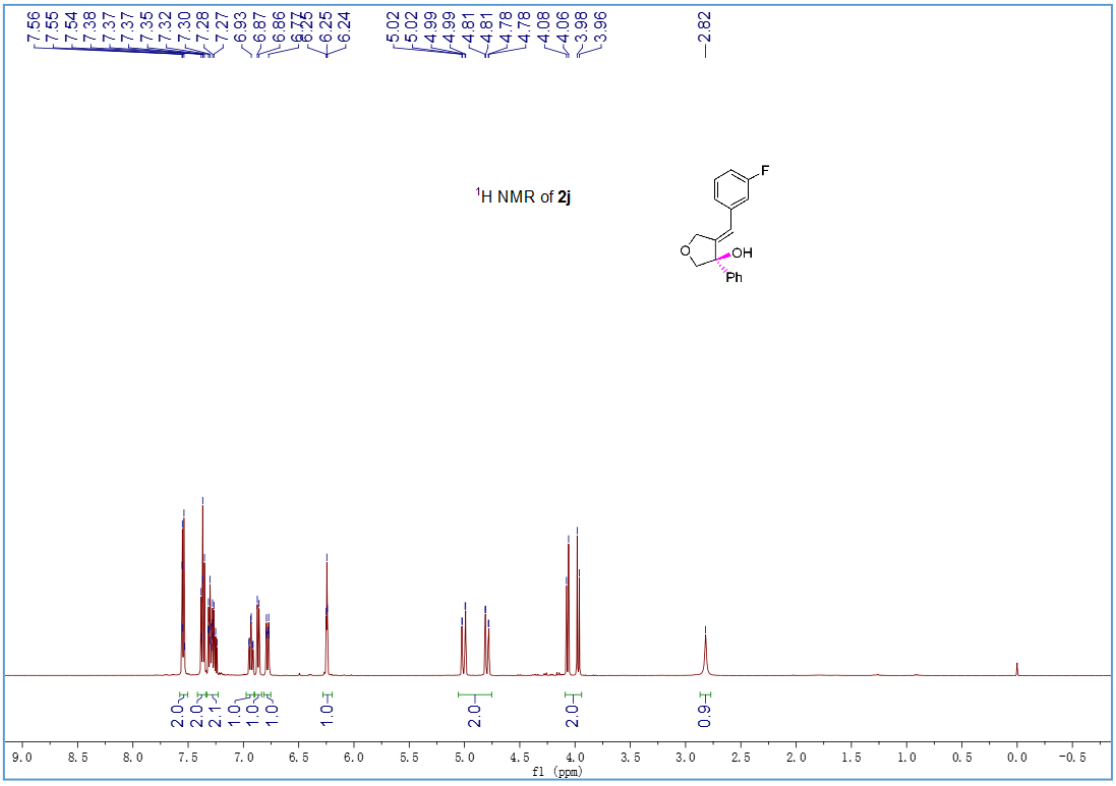
123.47
82.92
81.07
70.54
13C NMR of 2i
CF3
OH
Ph
f1 (ppm)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7.32
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7.27
6.93
6.87
6.86
6.25
6.24
5.02
5.02
4.99
4.99
4.81
4.81
4.78
4.08
4.06
3.98
3.96
2.82
1H NMR of 2j
F
OH
Ph
2.0
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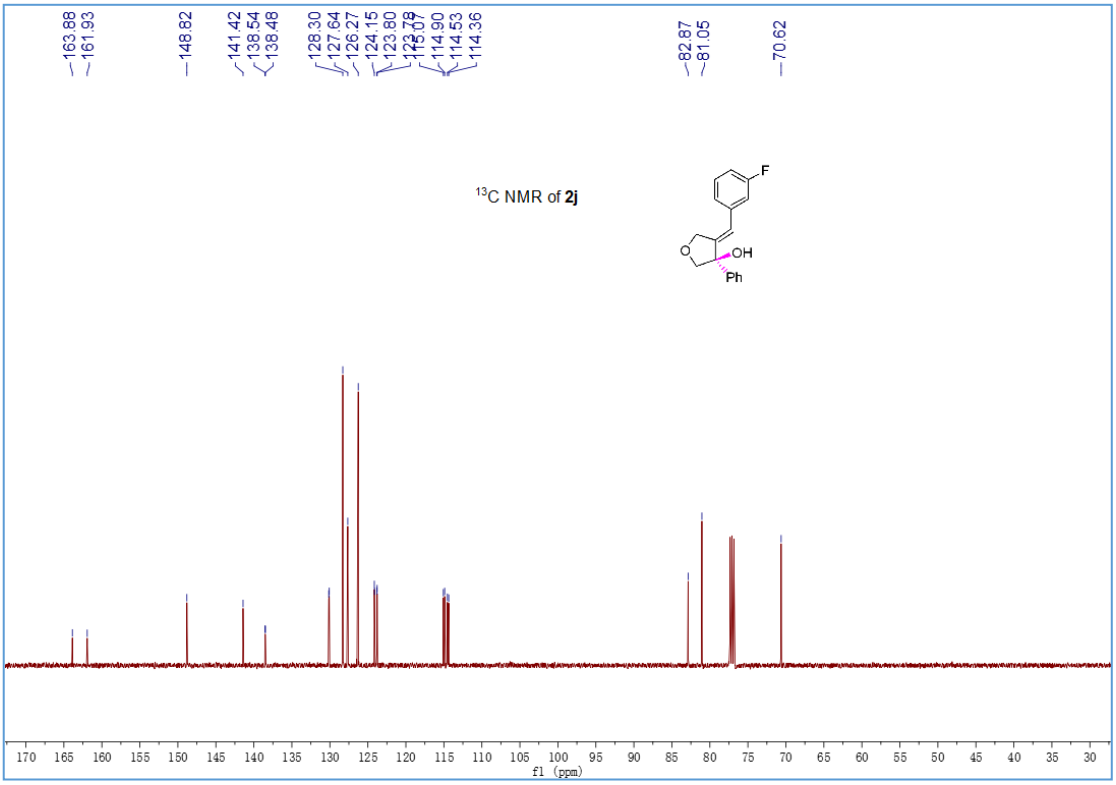
2.1
1.0
1.0
1.0
1.0
2.0
2.0
0.9
f1 (ppm)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127.64
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124.15
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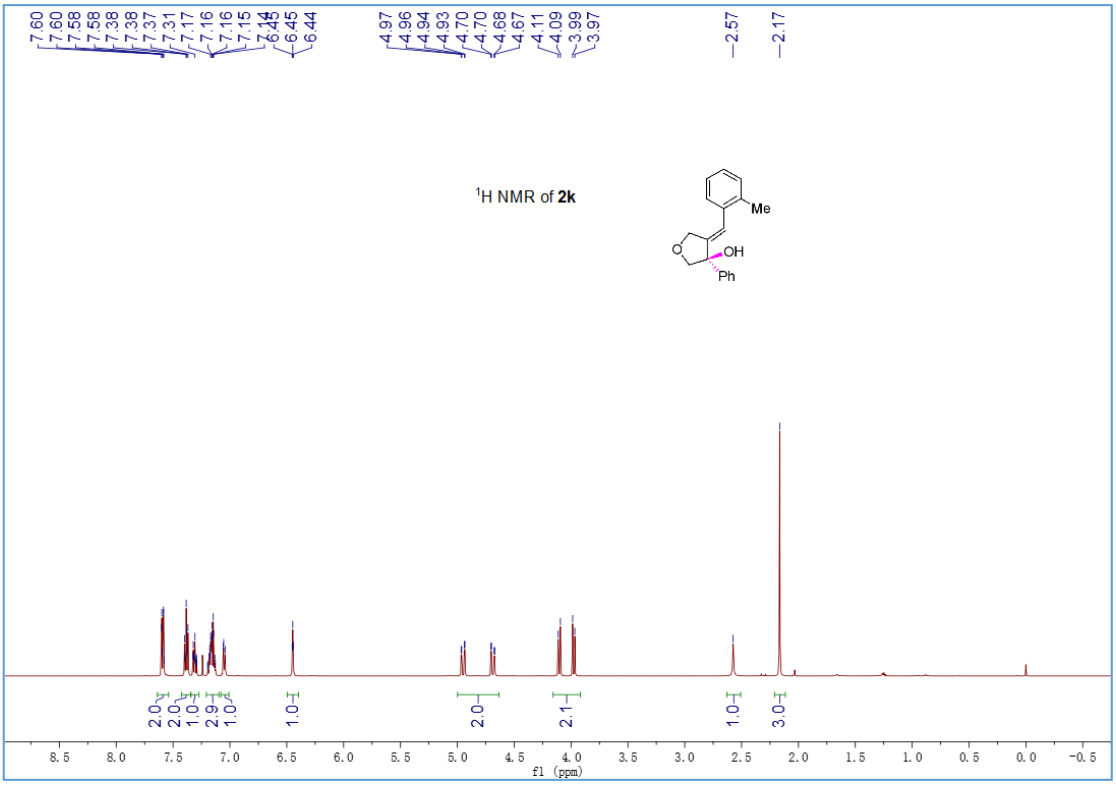
114.53
114.36
82.87
81.05
70.62
13C NMR of 2j
F
OH
Ph
f1 (ppm)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7.58
7.38
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7.16
7.15
6.45
6.44
4.97
4.96
4.94
4.93
4.70
4.68
4.67
4.11
4.09
3.99
3.97
2.57
2.17
1H NMR of 2k
Me
OH
Ph
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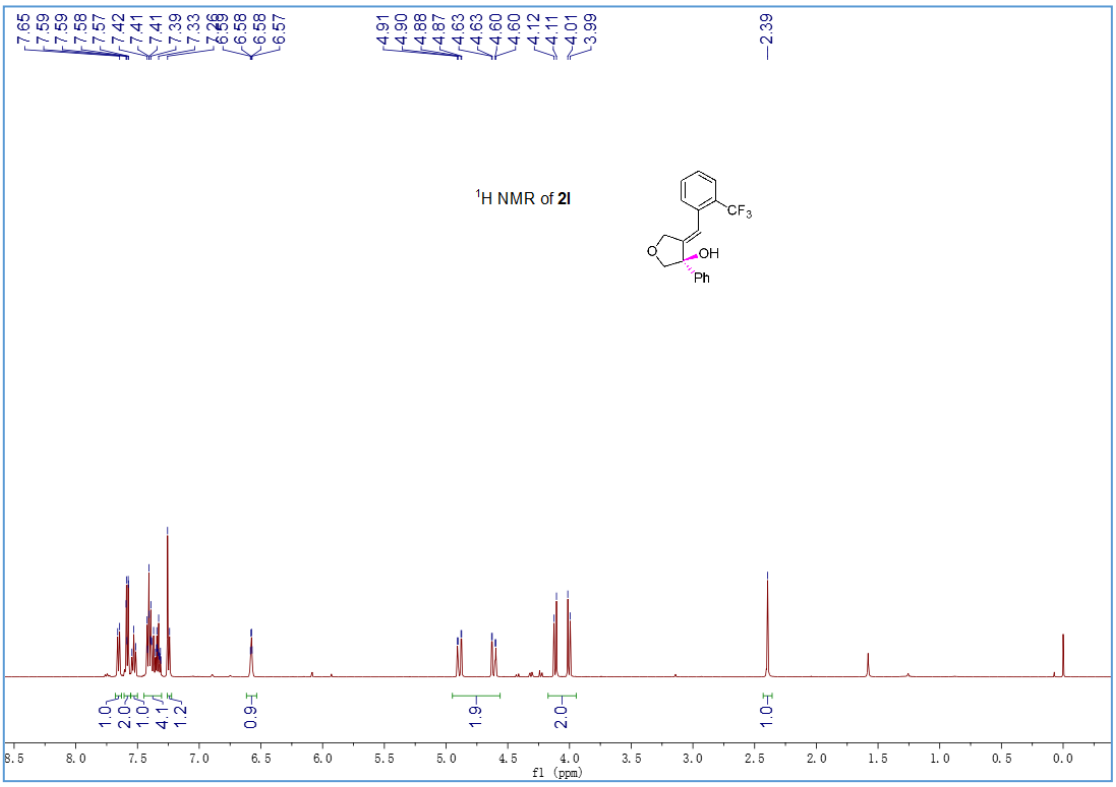
1.0
2.9
1.0
1.0
2.0
2.1
1.0
3.0
f1 (ppm)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7.41
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6.58
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6.57
4.91
4.90
4.88
4.87
4.63
4.63
4.60
4.60
4.12
4.11
4.01
3.99
2.39
1H NMR of 2l
CF3
OH
Ph
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2.0
1.0
4.1
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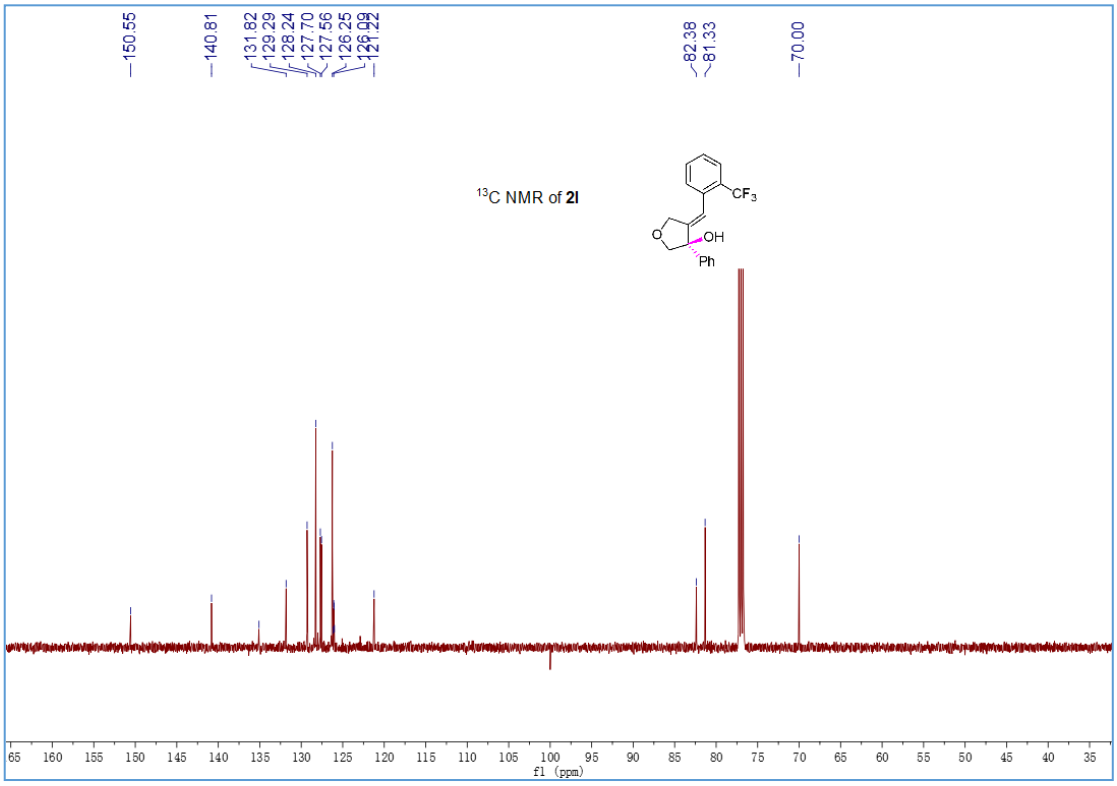
0.9
1.9
2.0
1.0
f1 (ppm)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126.25
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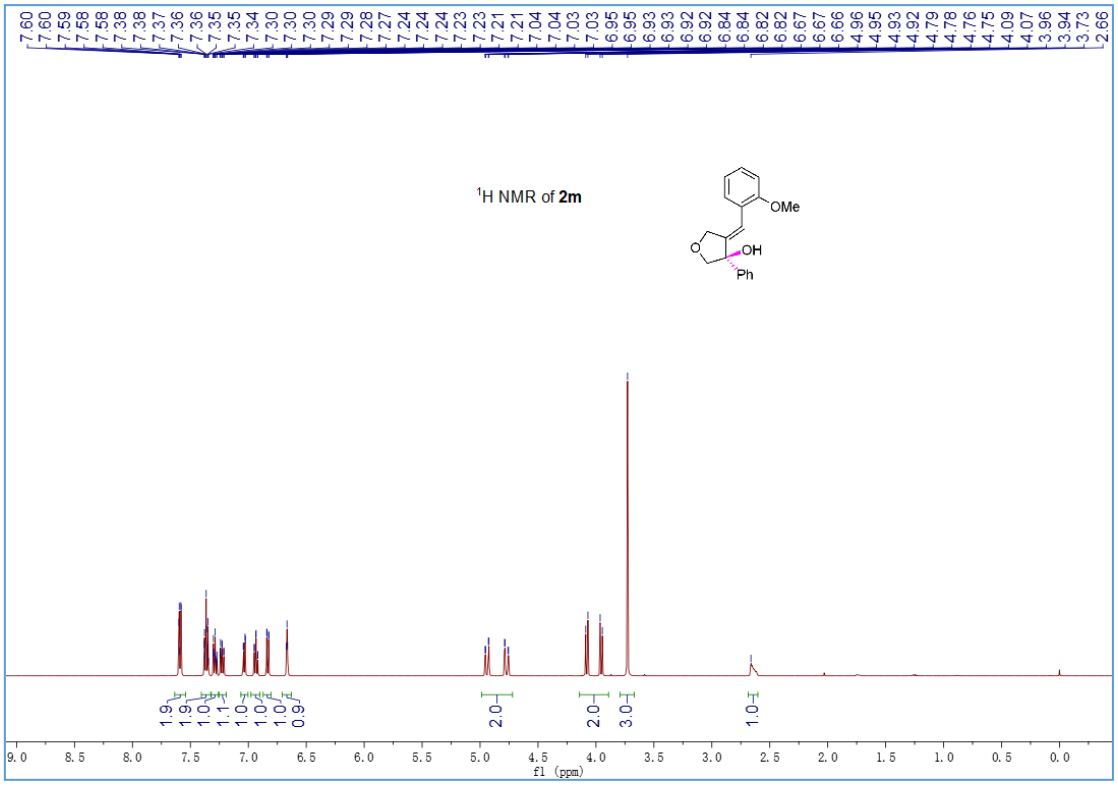
70.00
13C NMR of 2l
CF3
OH
Ph
f1 (ppm)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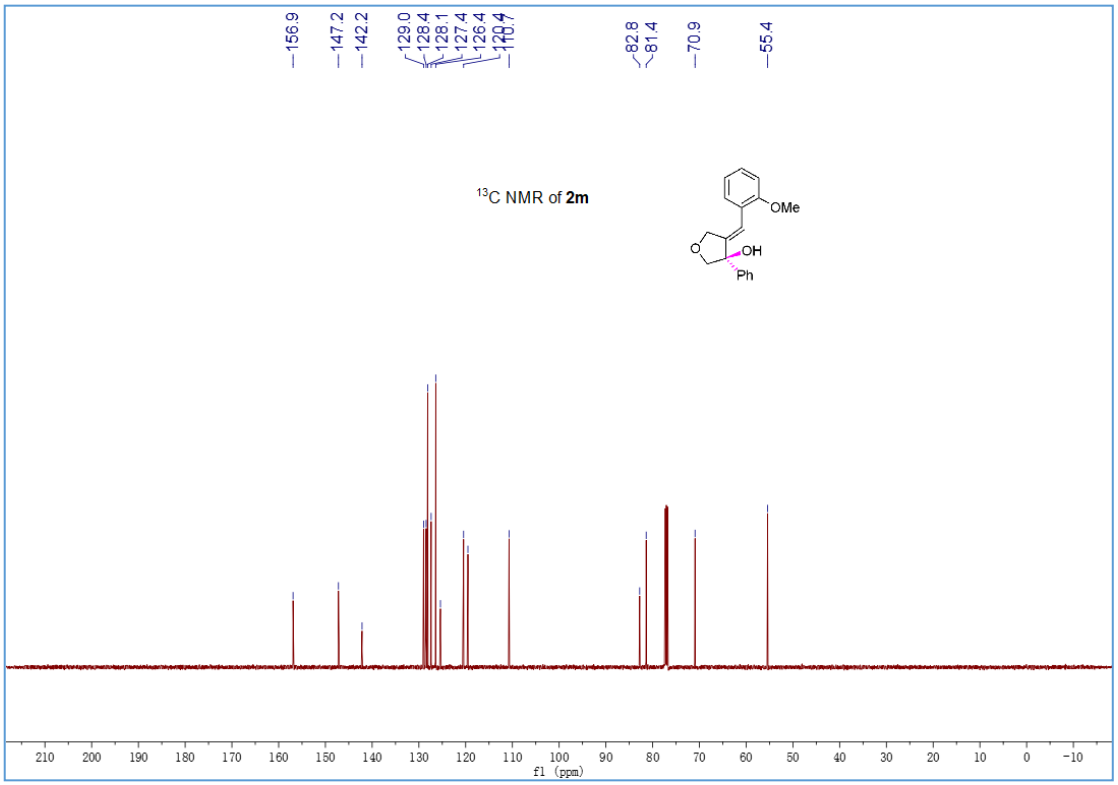
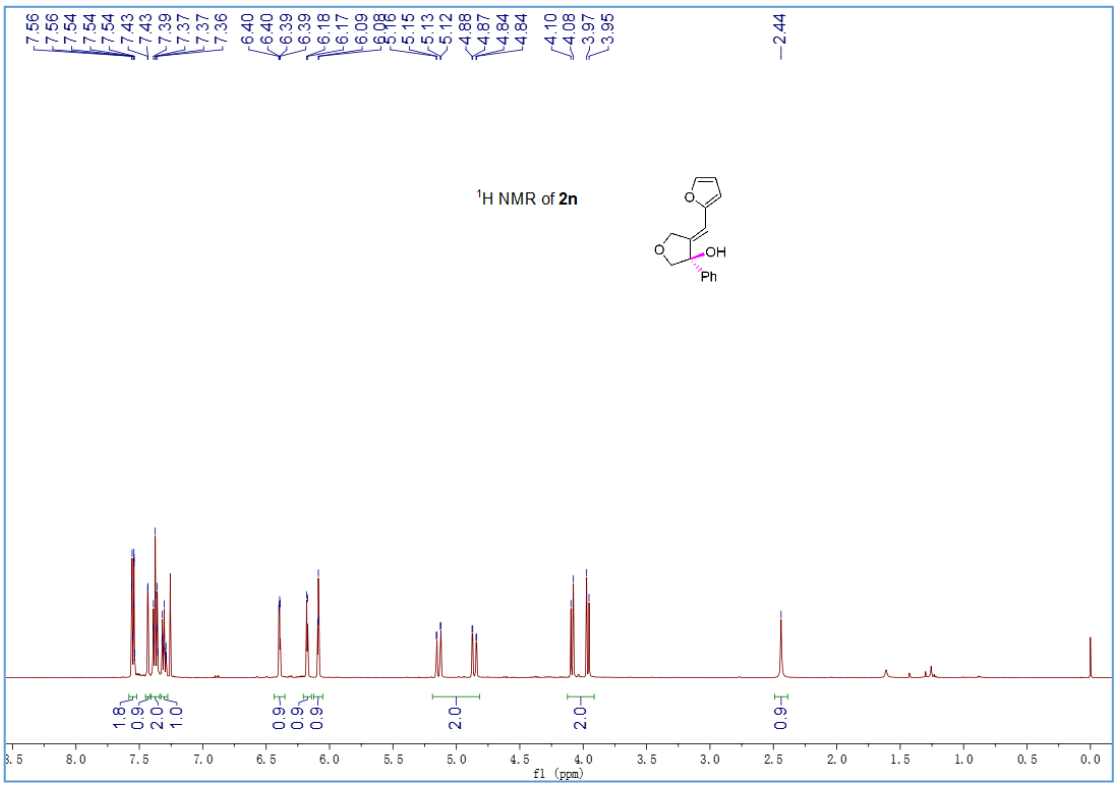
1H NMR of 2m
OMe
OH
Ph
1.9 1.9 1.0 1.1 1.0 1.0 1.0 0.9 2.0 2.0 3.0 1.0
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


156.9 147.2 142.2 129.0 128.4 128.1 127.4 126.4 120.4 110.7 82.8 81.4 70.9 55.4
13C NMR of 2m
OMe
OH
Ph
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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7.39
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7.37
7.36
6.40
6.40
6.39
6.39
6.18
6.17
6.09
6.08
5.16
5.15
5.13
5.12
4.88
4.87
4.84
4.84
4.10
4.08
3.97
3.95
2.44
1H NMR of 2n
O
O
OH
Ph
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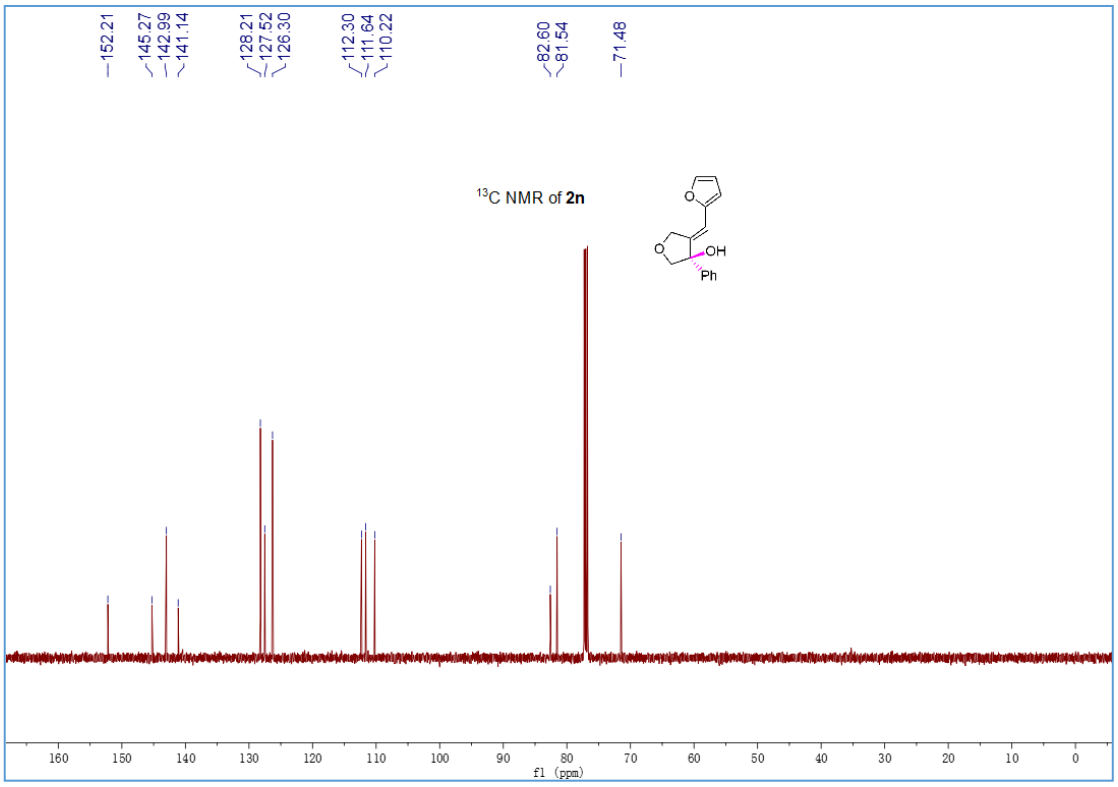
0.9
2.0
1.0
0.9
0.9
0.9
2.0
2.0
0.9
f1 (ppm)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145.27
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127.52
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112.30
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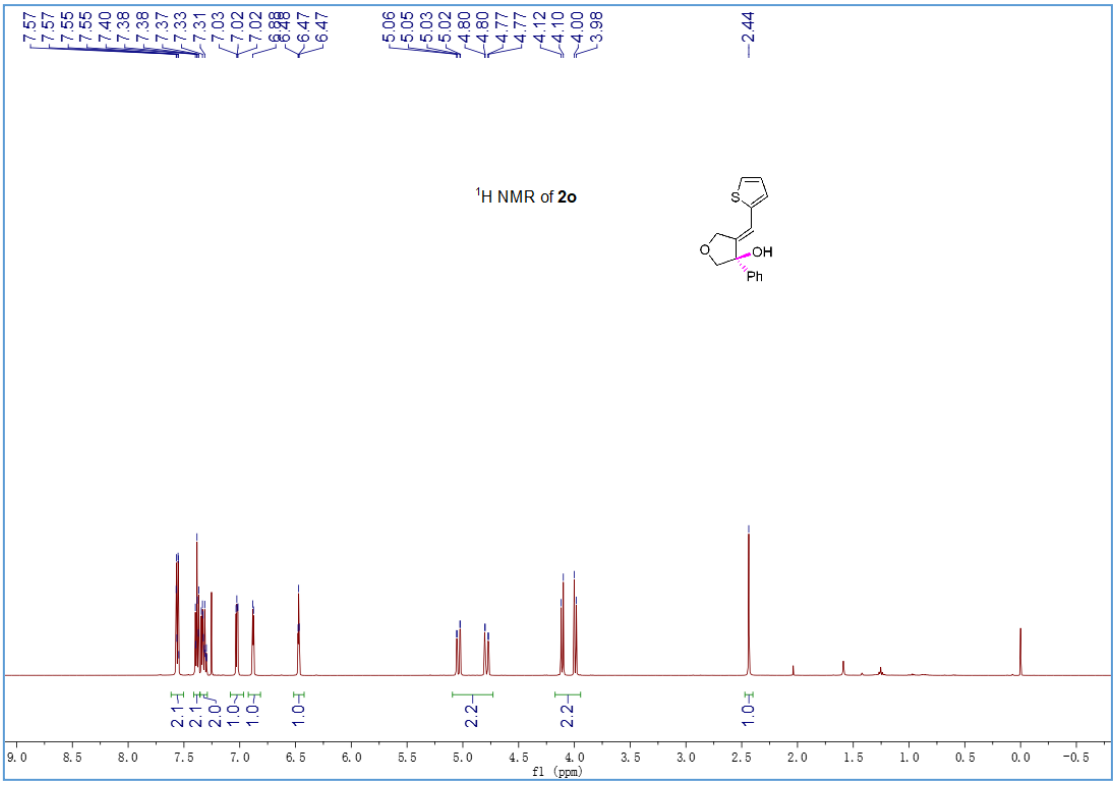
110.22
82.60
81.54
71.48
13C NMR of 2n
O
O
OH
Ph
f1 (ppm)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7.38
7.37
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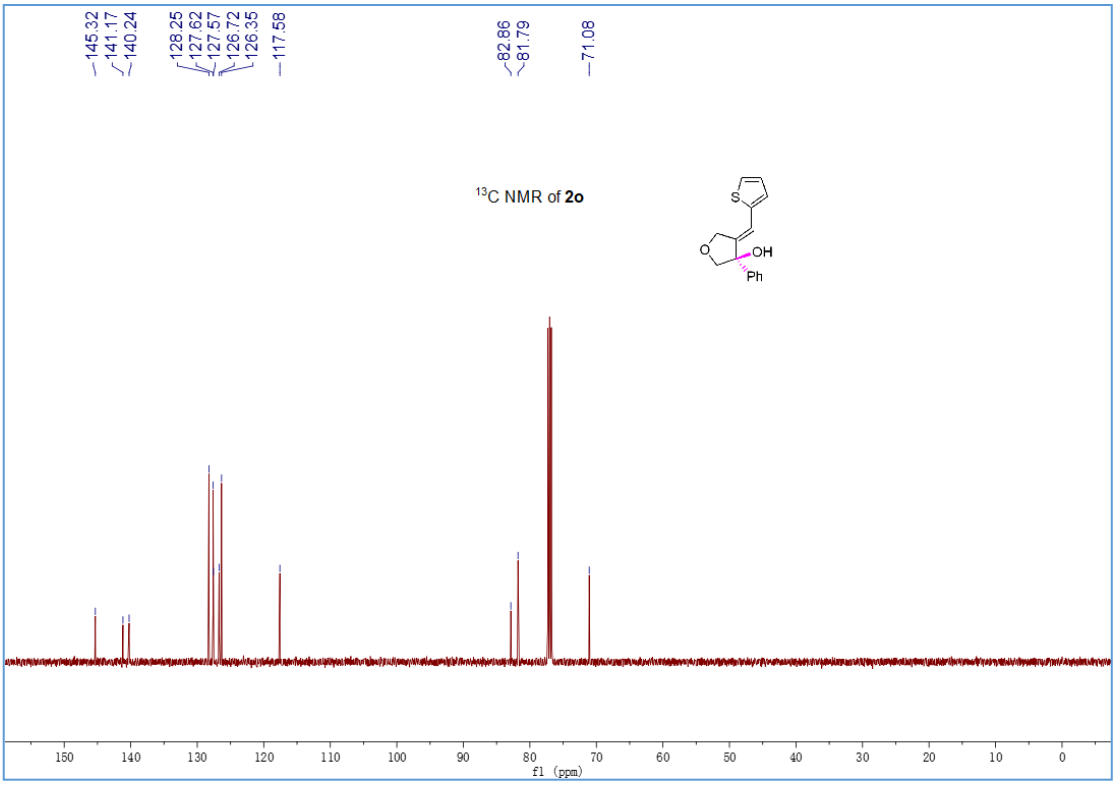
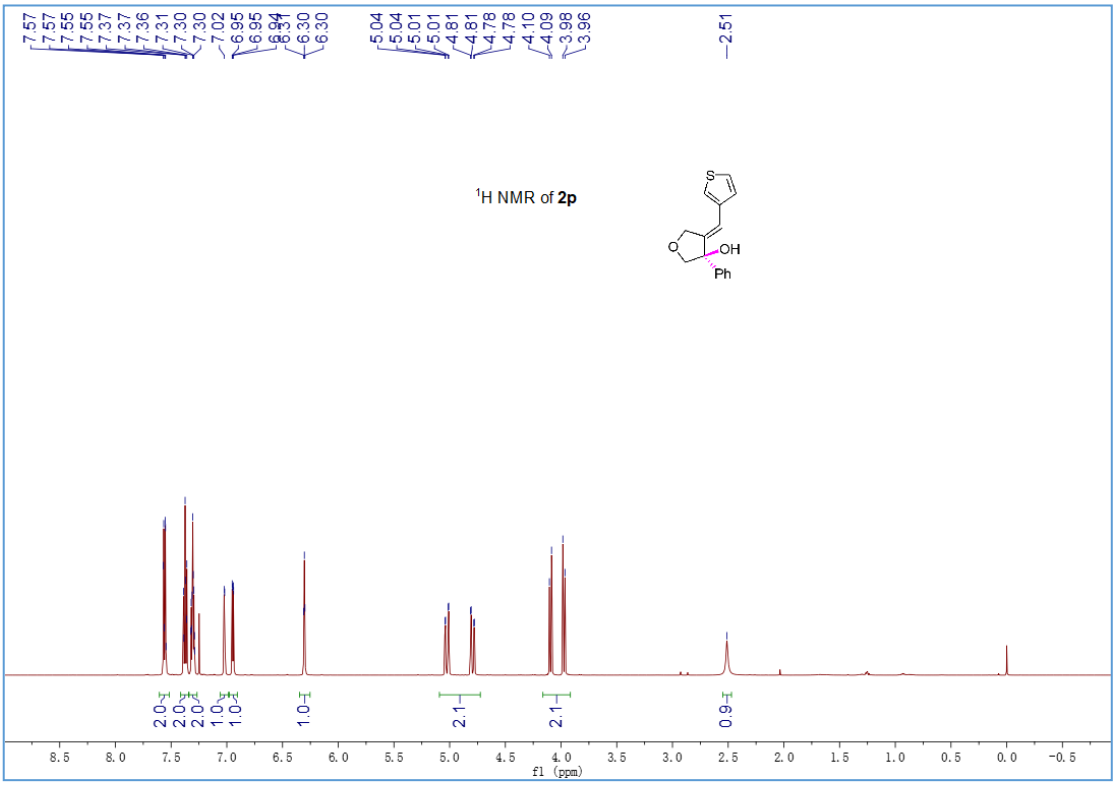
7.31
7.03
7.02
7.02
6.47
6.47
5.06
5.05
5.03
5.02
4.80
4.80
4.77
4.77
4.12
4.10
4.00
3.98
2.44
1H NMR of 2o
S
O
OH
Ph
2.1
2.1
2.0
1.0
1.0
1.0
2.2
2.2
1.0
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


145.32
141.17
140.24
128.25
127.62
127.57
126.72
126.35
117.58
82.86
81.79
71.08
13C NMR of 2o
S
O
OH
Ph
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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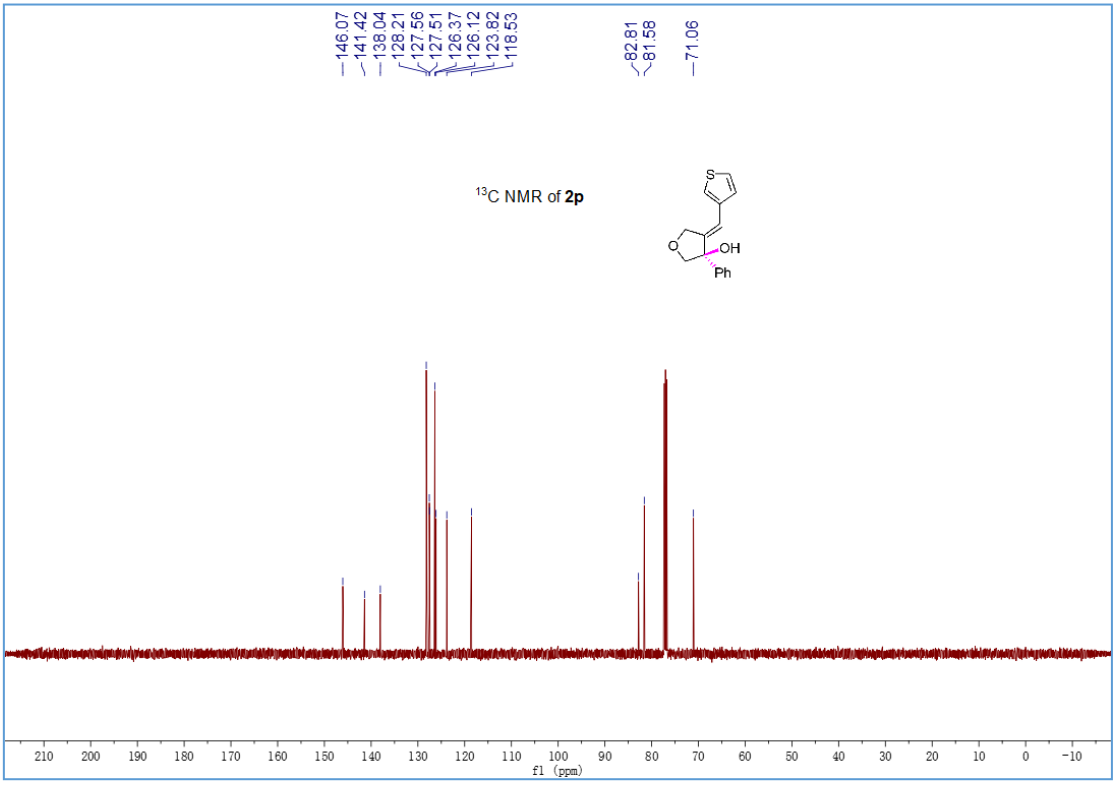
7.55
7.55
7.37
7.37
7.36
7.31
7.30
7.30
7.02
6.95
6.95
6.94
6.31
6.30
6.30
5.04
5.04
5.01
5.01
4.81
4.81
4.78
4.78
4.10
4.09
3.98
3.96
2.51
1H NMR of 2p
S
O
OH
Ph
2.0
2.0
2.0
1.0
1.0
1.0
2.1
2.1
0.9
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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141.42
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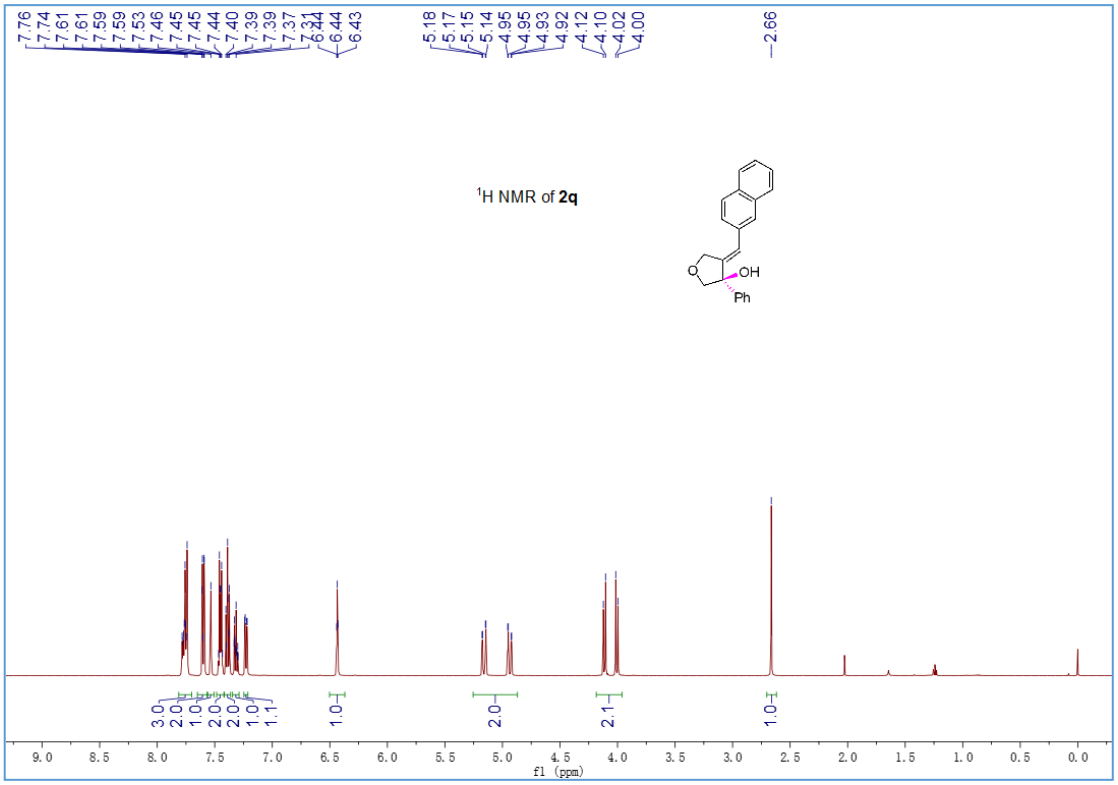
128.21
127.56
127.51
126.37
126.12
123.82
118.53
82.81
81.58
71.06
13C NMR of 2p
S
O
OH
Ph
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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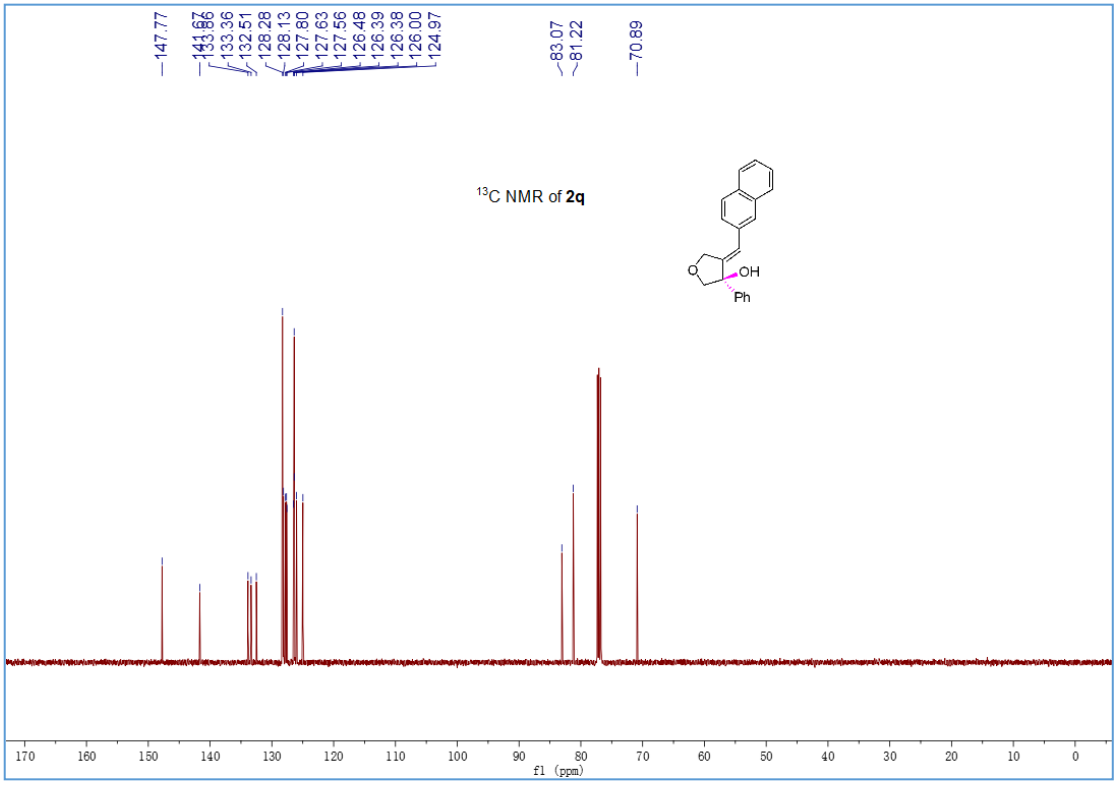
7.39
7.39
7.37
7.31
6.44
6.43
5.18
5.17
5.15
5.14
4.95
4.95
4.93
4.92
4.12
4.10
4.02
4.00
2.66
1H NMR of 2q
OH
Ph
3.0
2.0
1.0
2.0
2.0
1.0
1.1
1.0
2.0
2.1
1.0
f1 (ppm)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141.67
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132.51
128.28
128.13
127.80
127.63
127.56
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126.38
126.00
124.97
83.07
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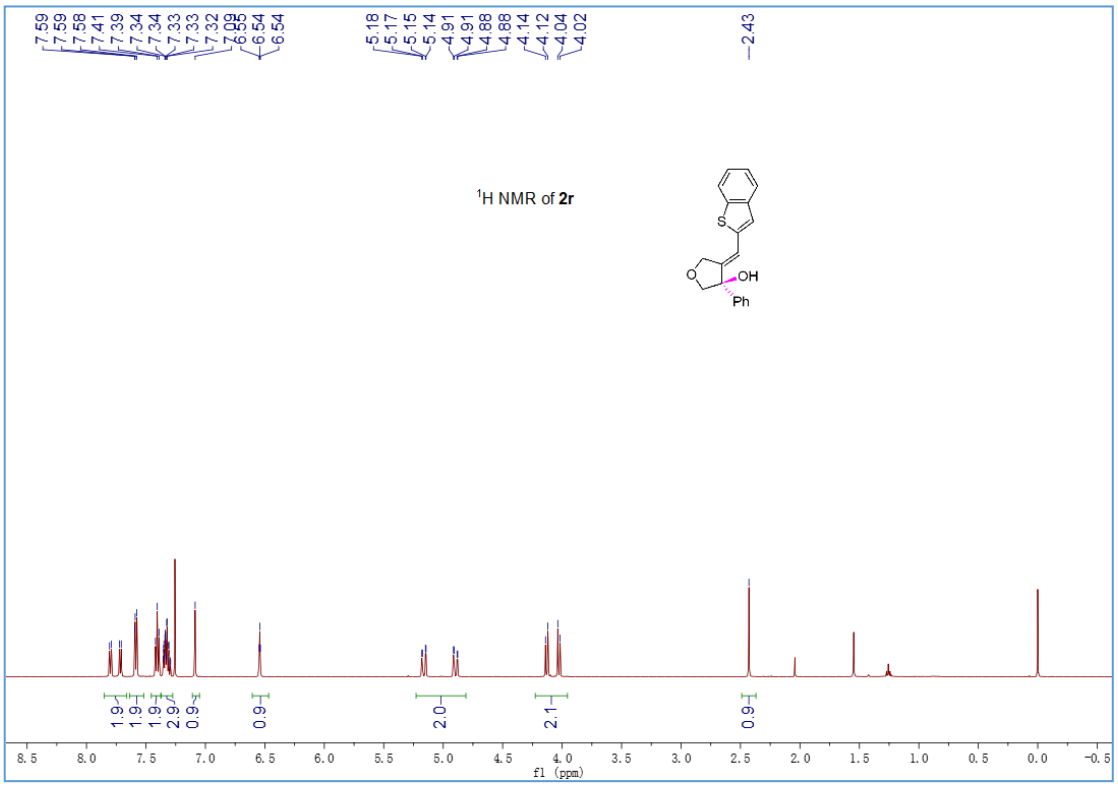
70.89
13C NMR of 2q
OH
Ph
f1 (ppm)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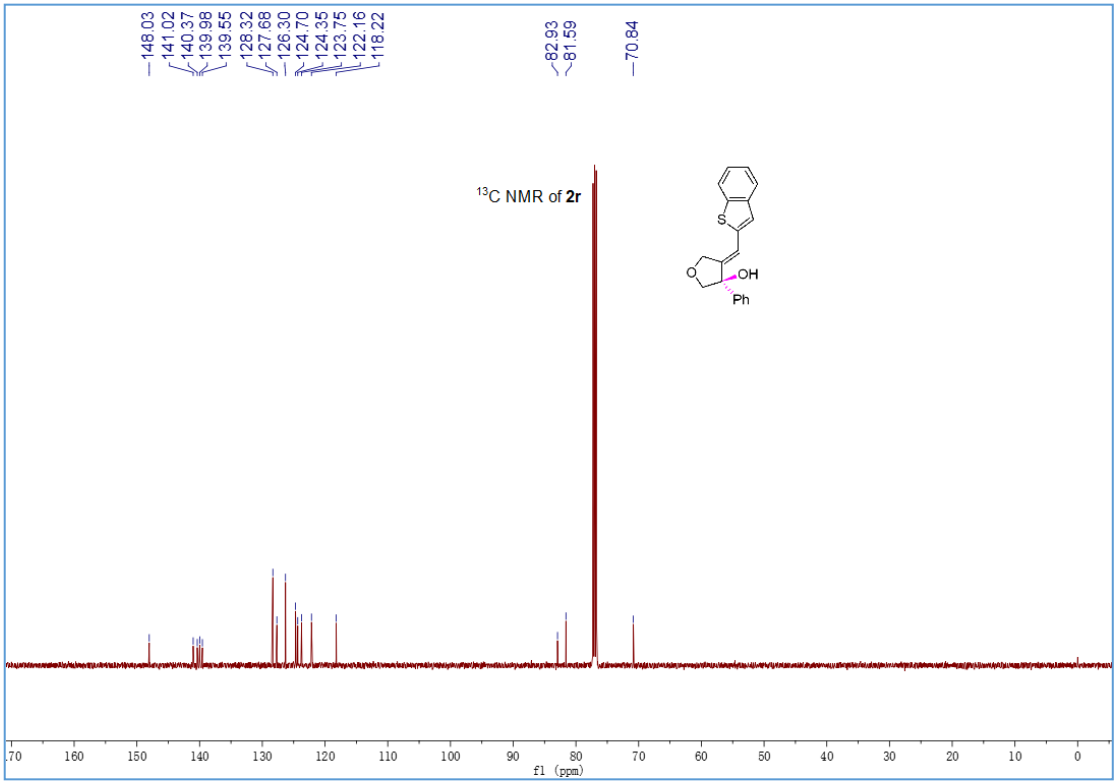
7.34
7.33
7.33
7.32
7.09
6.55
6.54
6.54
5.18
5.17
5.15
5.14
4.91
4.91
4.88
4.88
4.14
4.12
4.04
4.02
2.43
^{1}H NMR of **2r**
S
O
OH
Ph
1.9
1.9
1.9
2.9
0.9
0.9
2.0
2.1
0.9
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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141.02
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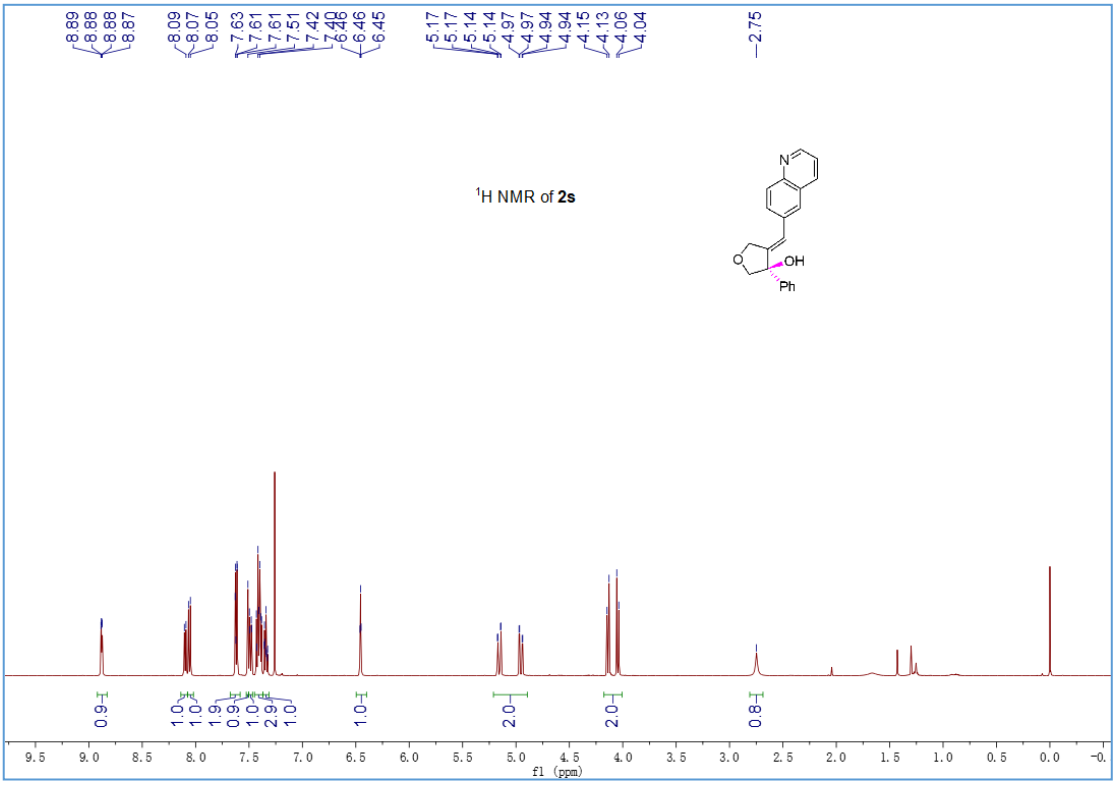
128.32
127.68
126.30
124.70
124.35
123.75
122.16
118.22
82.93
81.59
70.84
^{13}C NMR of **2r**
S
O
OH
Ph
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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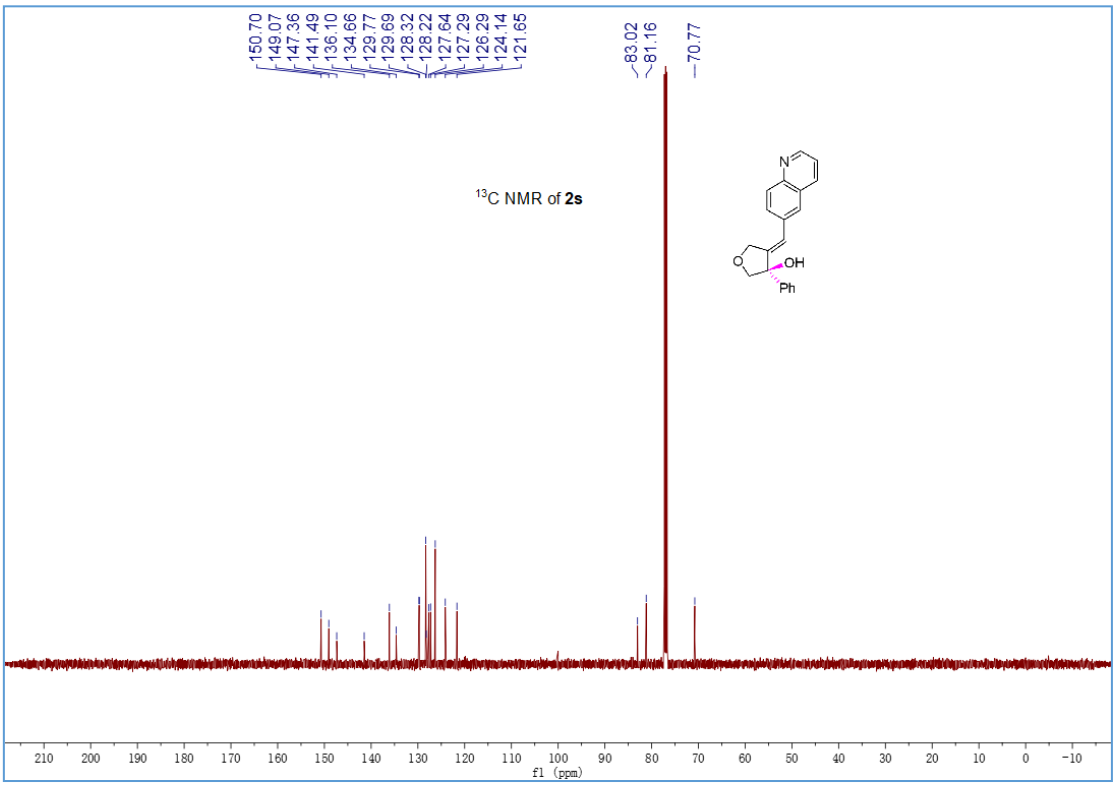
8.88
8.87
8.09
8.07
8.05
7.63
7.61
7.61
7.51
7.42
7.40
6.46
6.45
5.17
5.17
5.14
5.14
4.97
4.97
4.94
4.94
4.15
4.13
4.06
4.04
2.75
^{1}H NMR of **2s**
N
O
OH
Ph
0.9
1.0
1.0
1.9
0.9
1.0
2.9
1.0
1.0
2.0
2.0
0.8
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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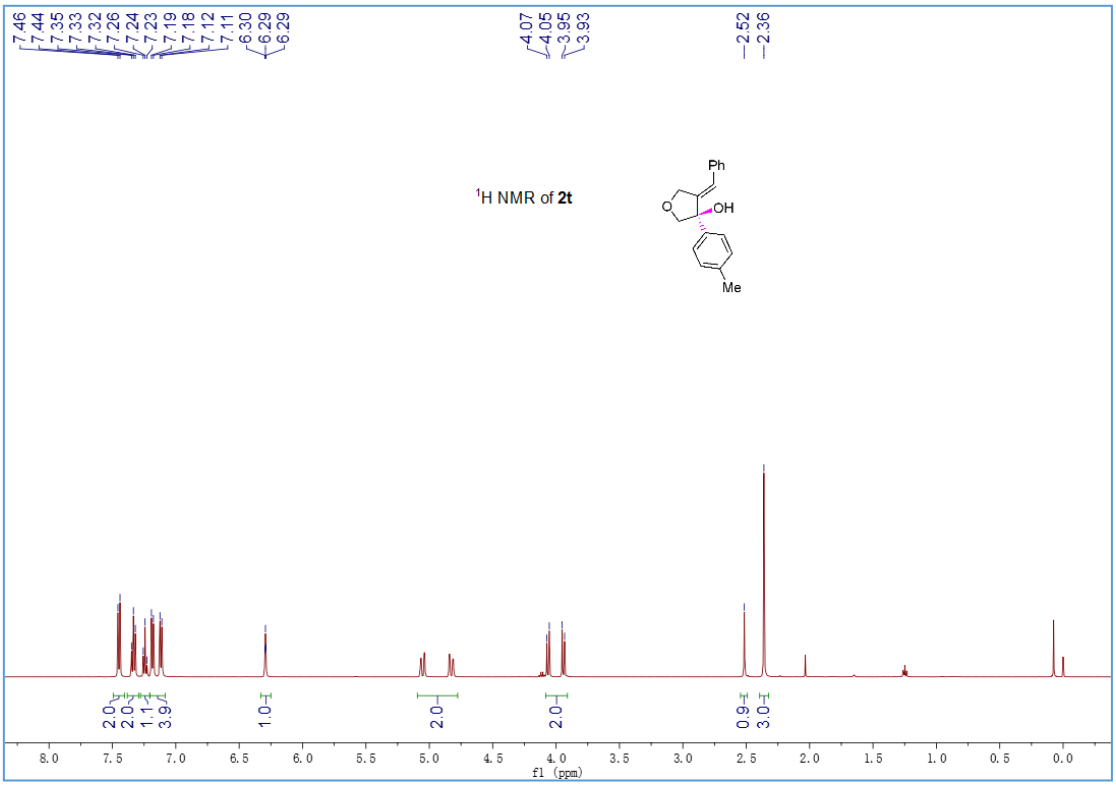
129.69
128.32
128.22
127.64
127.29
126.29
124.14
121.65
83.02
81.16
70.77
^{13}C NMR of **2s**
N
O
OH
Ph
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.19
7.18
7.12
7.11
6.30
6.29
6.29
4.07
4.05
3.95
3.93
2.52
2.36
^{1}H NMR of **2t**
Ph
OH
Me
2.0
2.0
1.1
3.9
1.0
2.0
2.0
0.9
3.0
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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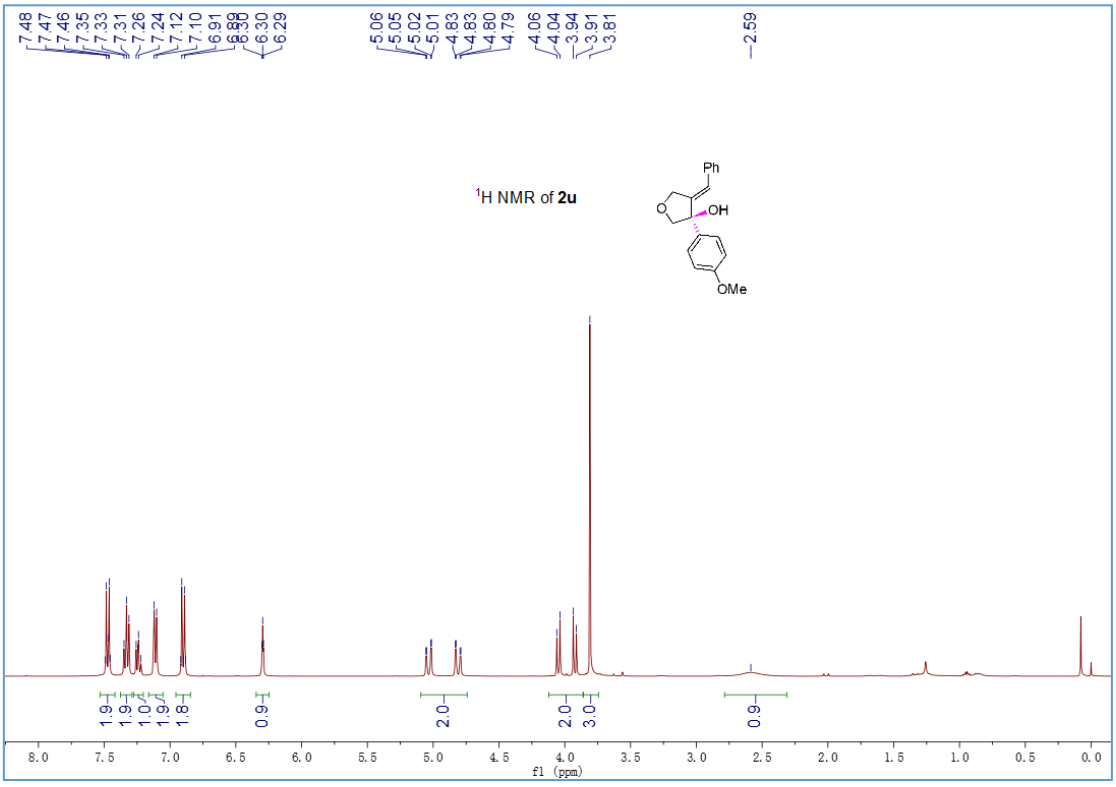
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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7.47
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7.33
7.31
7.26
7.24
7.12
7.10
6.91
6.30
6.29
5.06
5.05
5.02
5.01
4.83
4.83
4.80
4.79
4.06
4.04
3.94
3.91
3.81
2.59
^{1}H NMR of **2u**
Ph
OH
OMe
1.9
1.9
1.0
1.9
1.8
0.9
2.0
2.0
3.0
0.9
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
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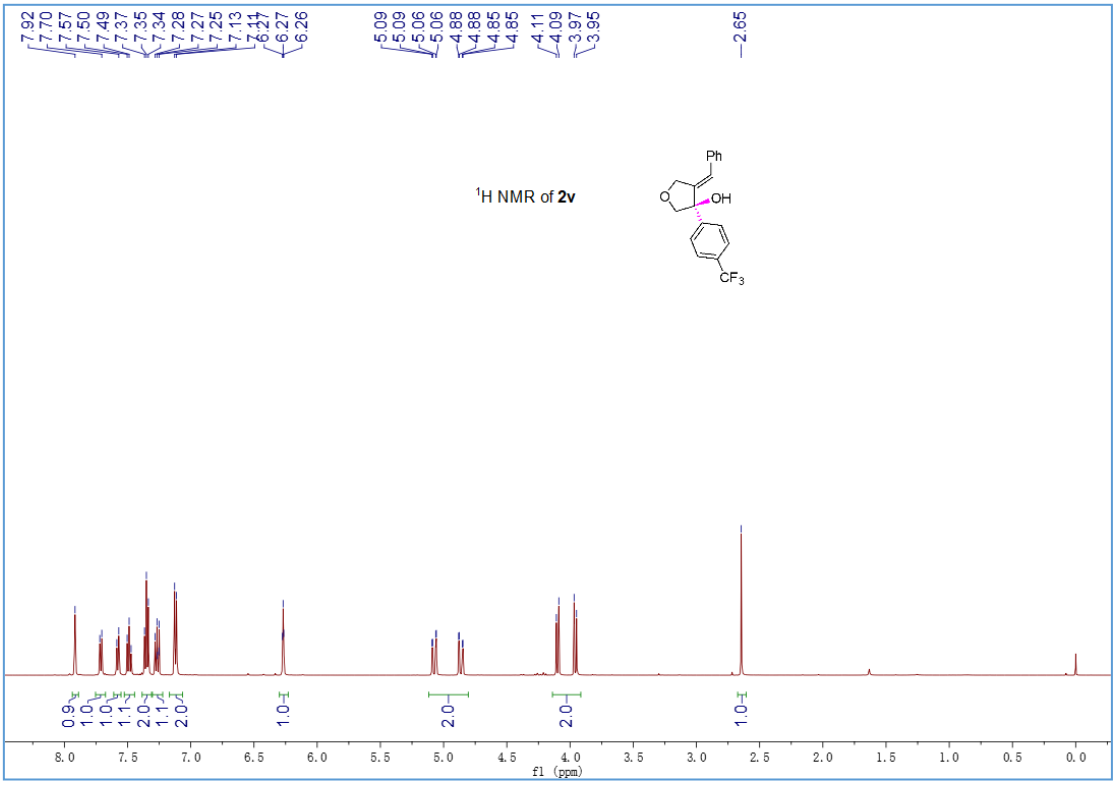
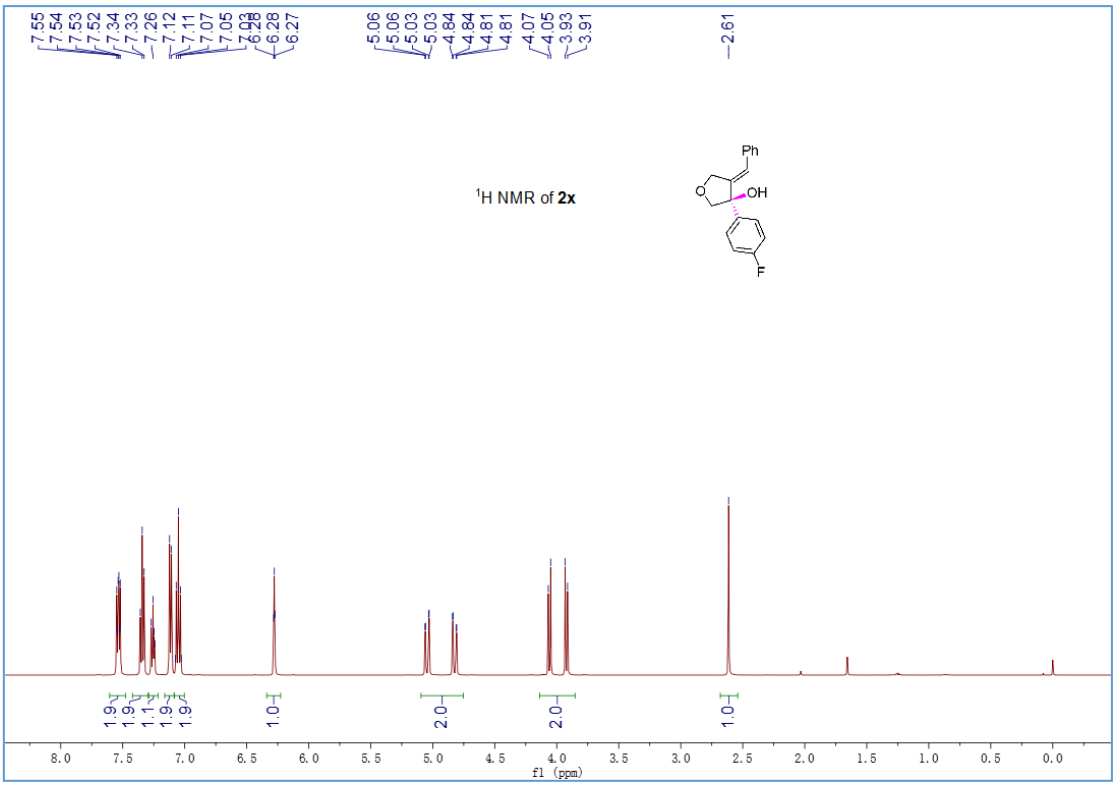
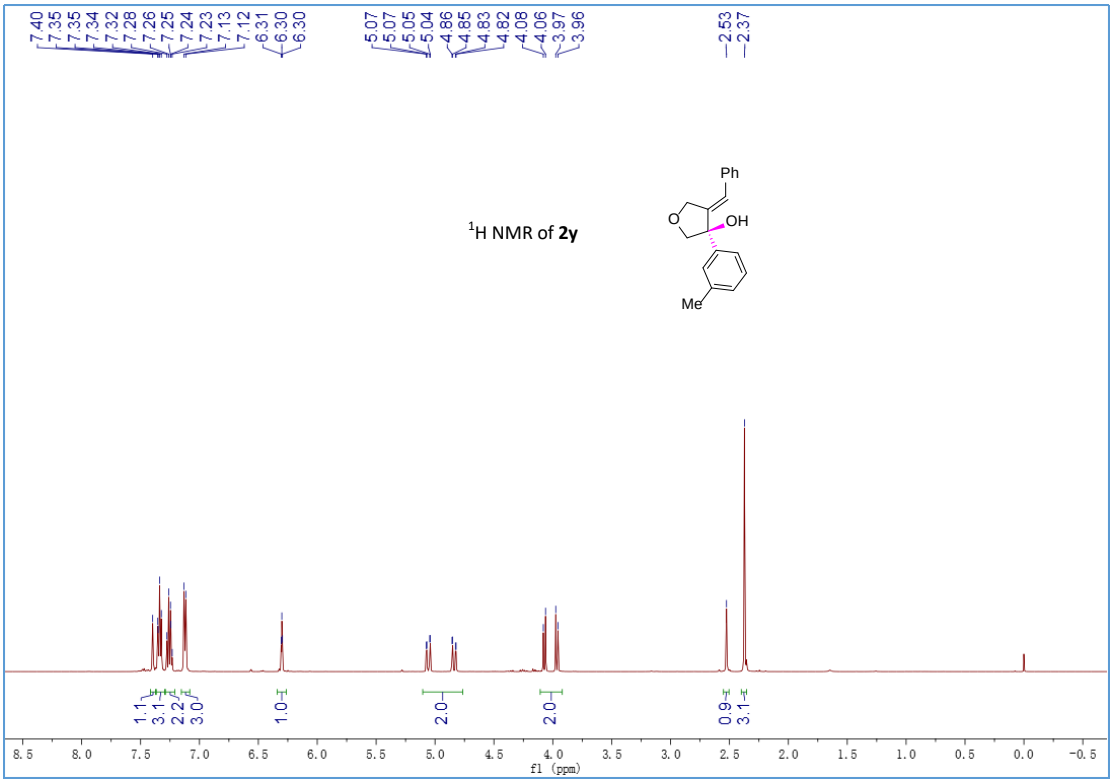
0.5
0.0
f1 (ppm)



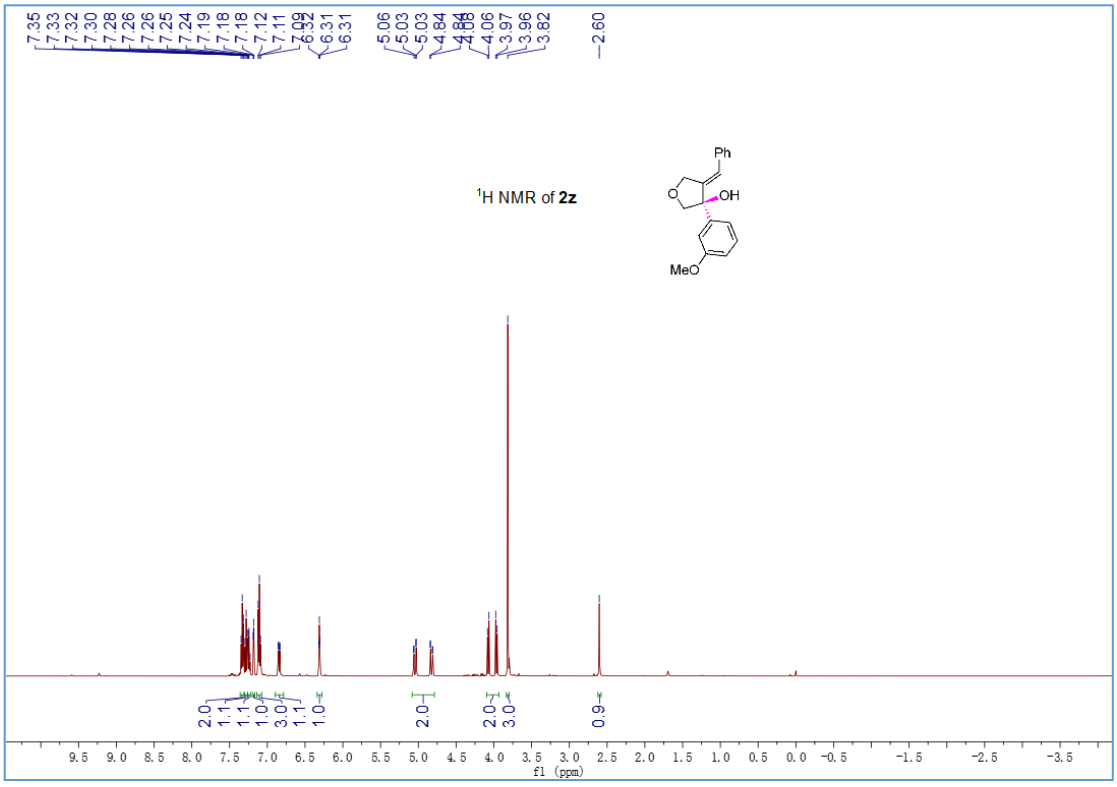
^{1}H NMR of **2v**



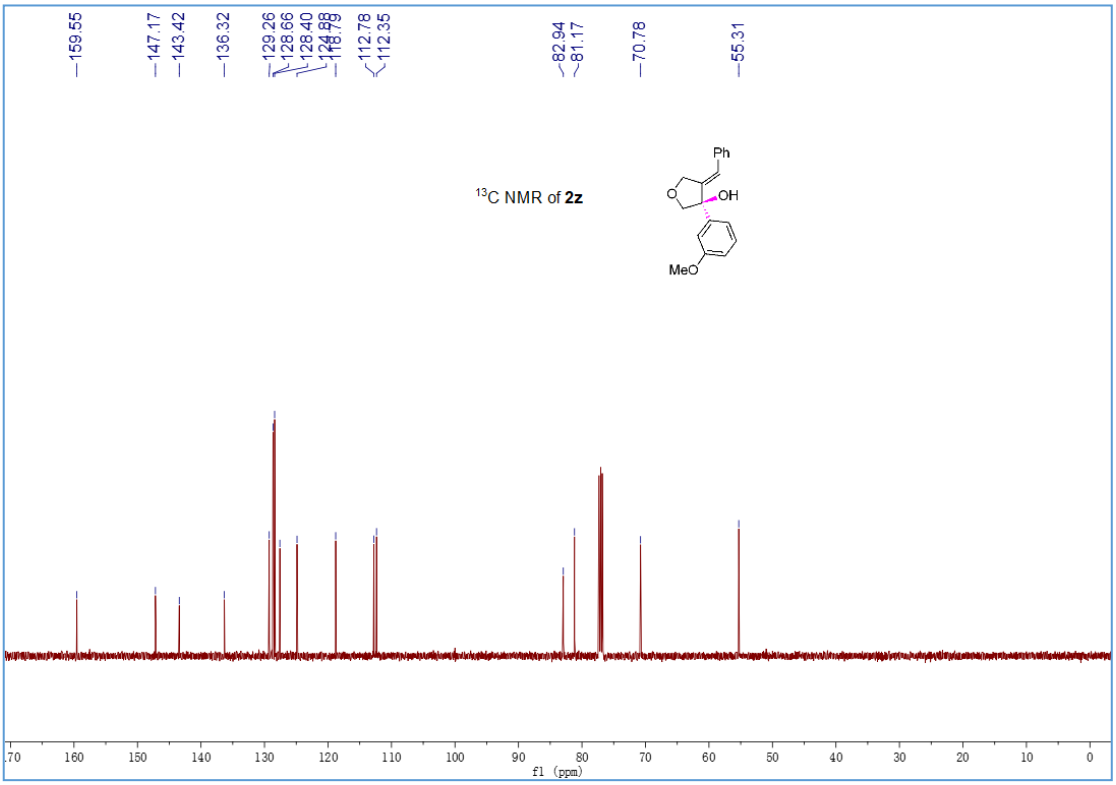
^{1}H NMR of **2x**



^{1}H NMR of **2y**



^{1}H NMR of **2z**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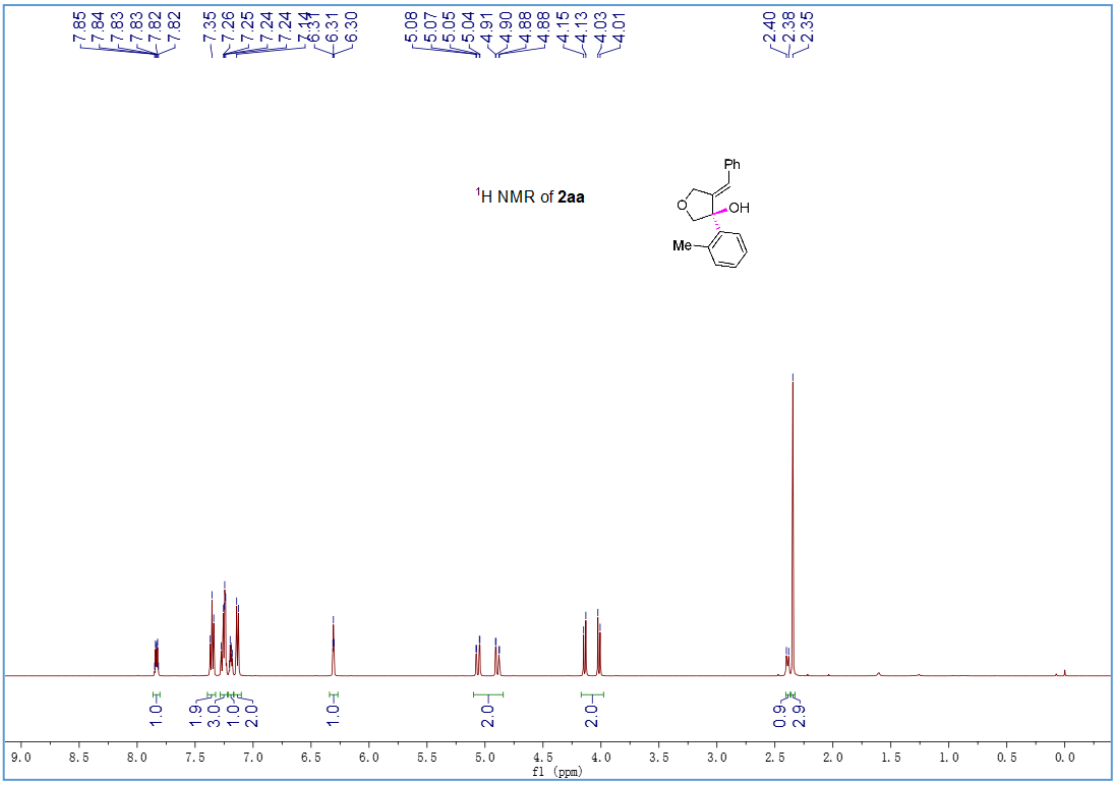
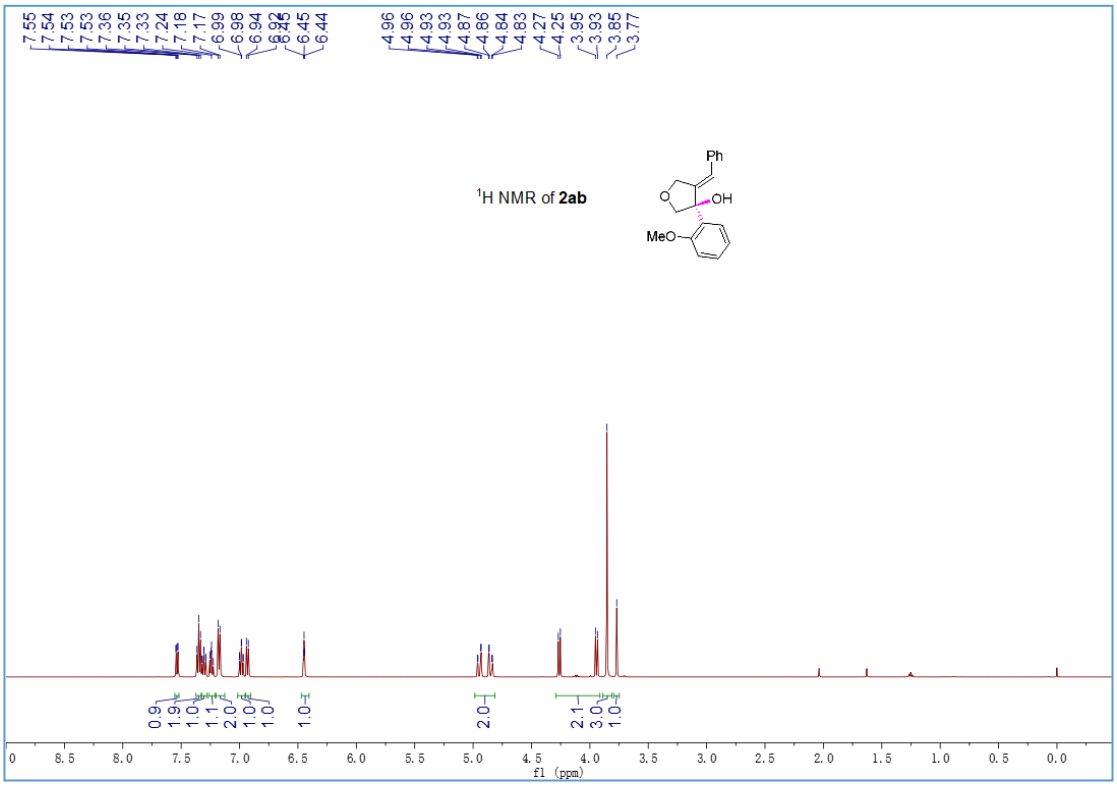
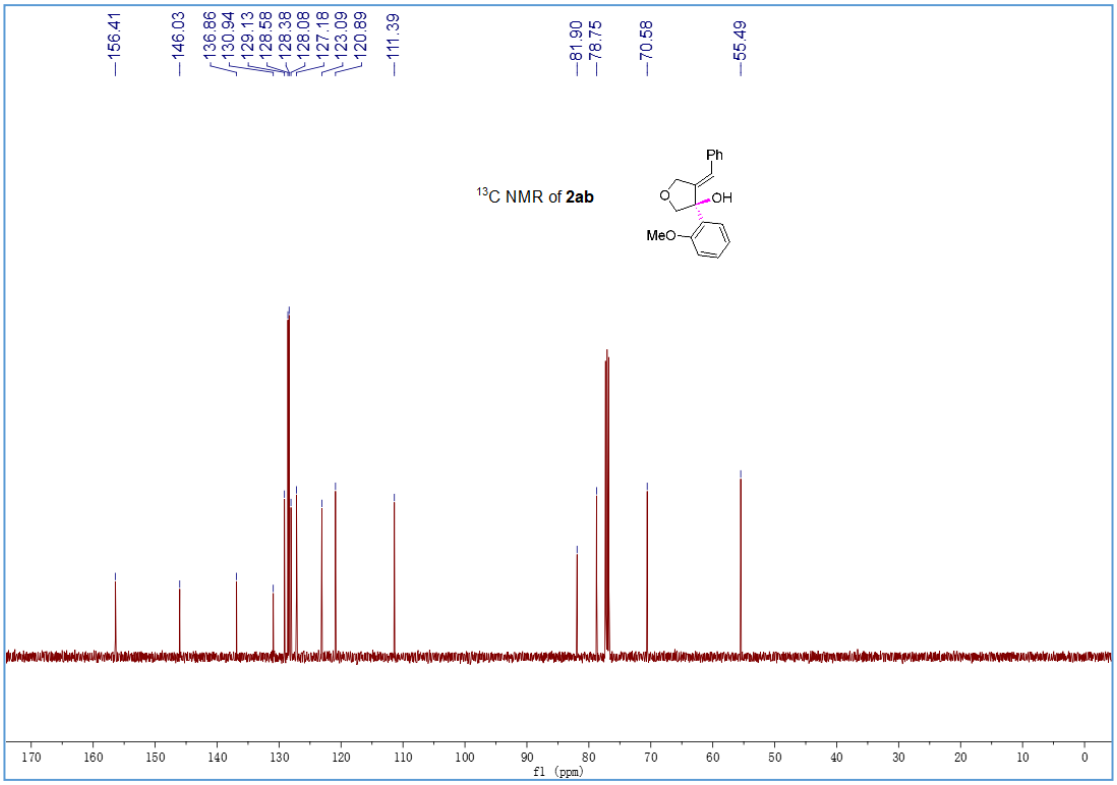
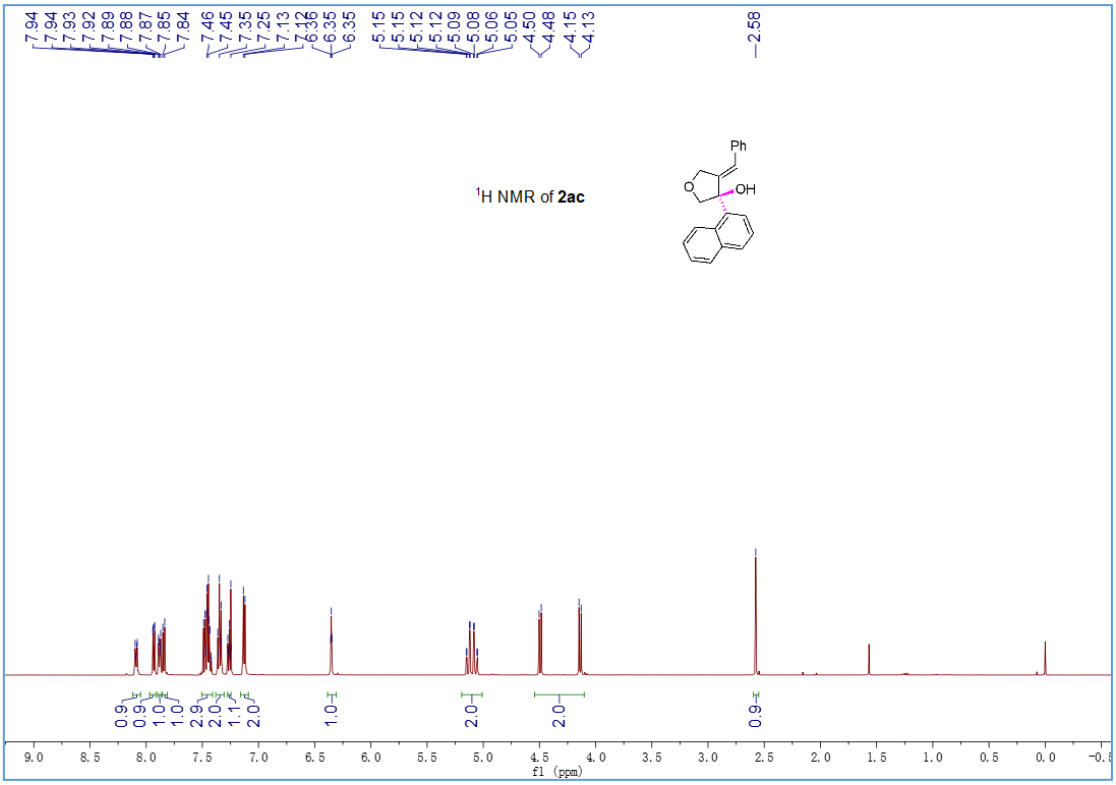
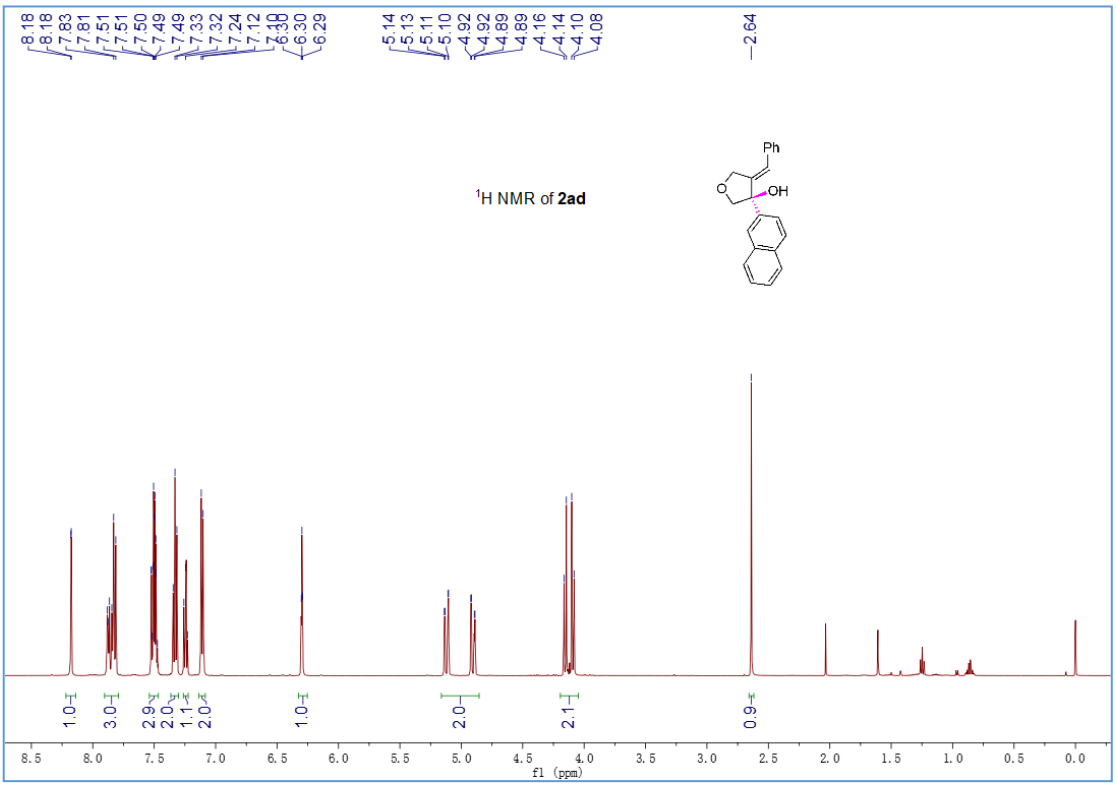
136.32
129.26
128.66
128.40
112.78
112.35
82.94
81.17
70.78
55.31
13C NMR of 2z
Ph
OH
MeO
f1 (ppm)

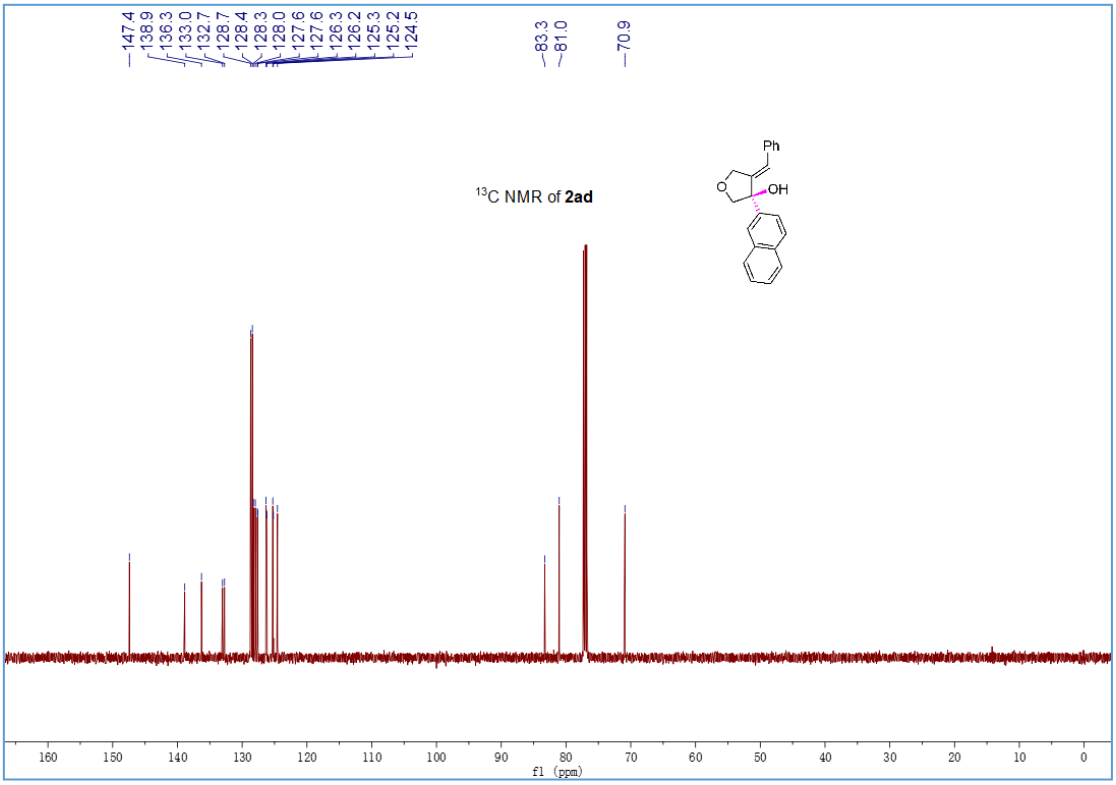

7.85
7.84
7.83
7.82
7.35
7.26
7.25
7.24
6.31
6.30
5.08
5.07
5.05
5.04
4.91
4.90
4.88
4.15
4.13
4.03
4.01
2.40
2.38
2.35
1H NMR of 2aa
Ph
OH
Me
1.0
1.9
3.0
1.0
2.0
1.0
2.0
2.0
0.9
2.9
f1 (ppm)

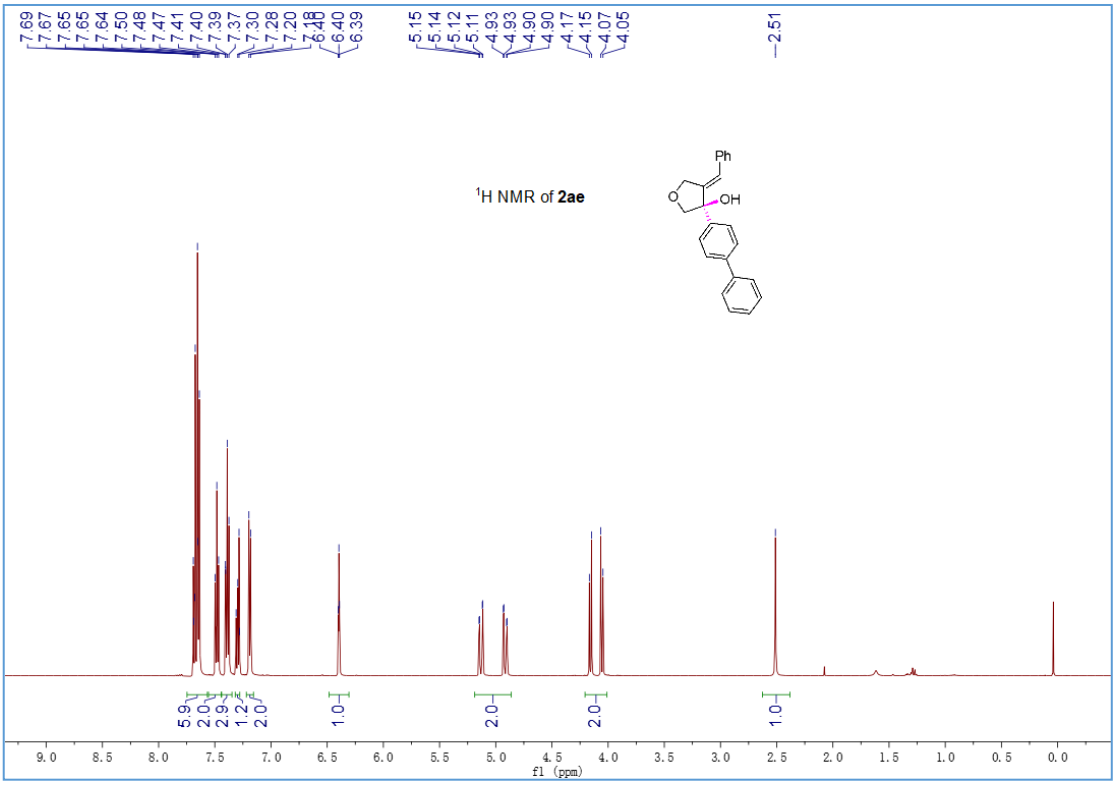

7.55
7.54
7.53
7.53
7.36
7.35
7.33
7.24
7.18
7.17
6.99
6.98
6.94
6.45
6.44
4.96
4.96
4.93
4.93
4.87
4.86
4.84
4.83
4.27
4.25
3.95
3.93
3.85
3.77
^{1}H NMR of **2ab**
Ph
OH
MeO
0.9
1.9
1.0
1.1
2.0
1.0
1.0
1.0
2.0
2.1
3.0
1.0
f1 (ppm)

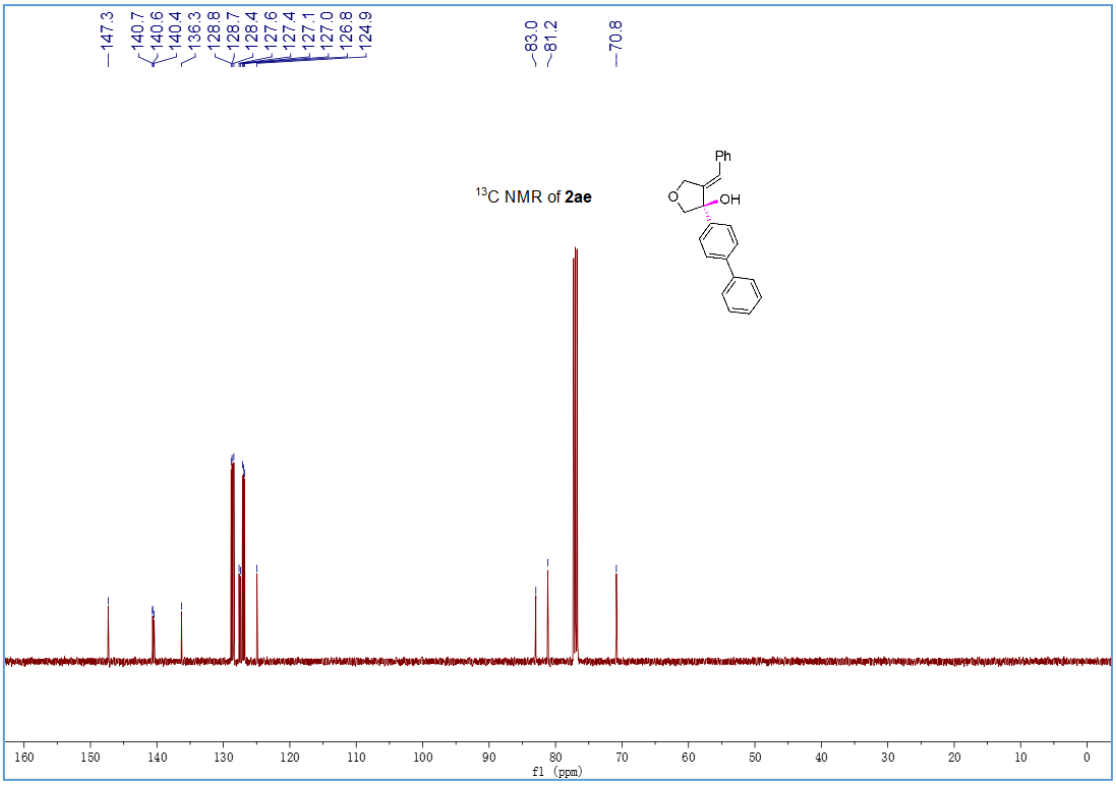

156.41
146.03
136.86
130.94
129.13
128.58
128.38
128.08
127.18
123.09
120.89
111.39
81.90
78.75
70.58
55.49
^{13}C NMR of **2ab**
Ph
OH
MeO
f1 (ppm)

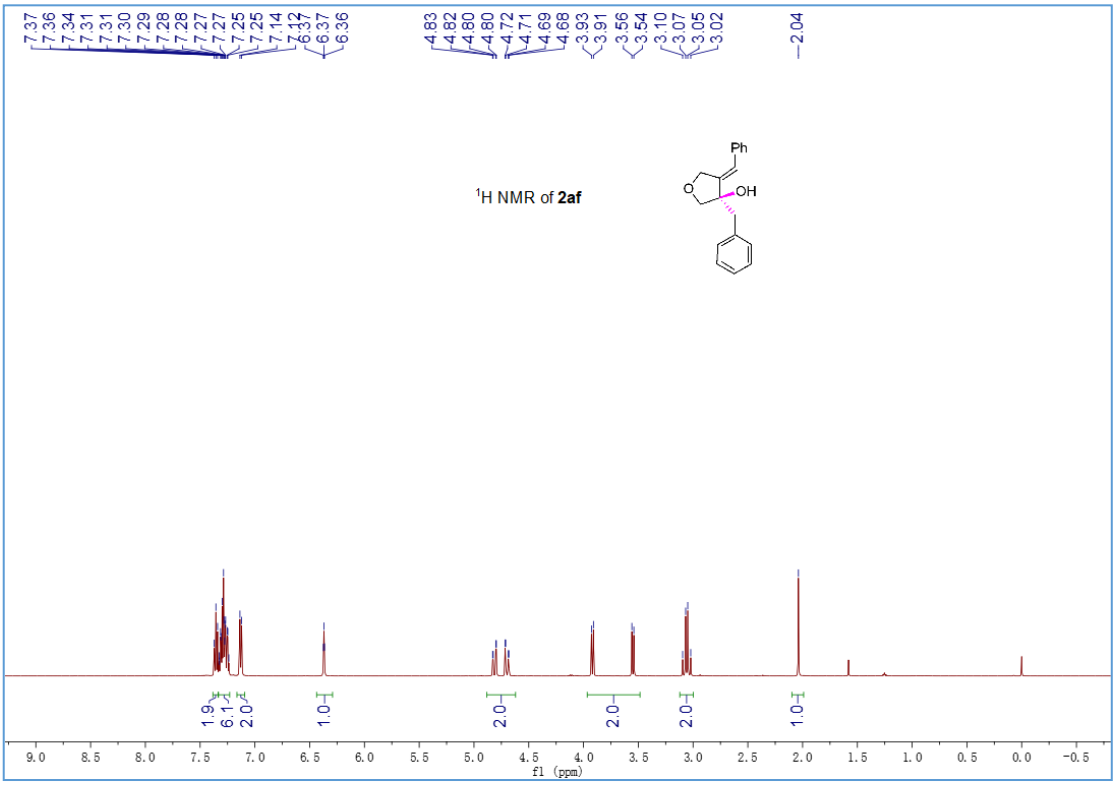

7.94
7.94
7.93
7.92
7.89
7.88
7.87
7.85
7.84
7.46
7.45
7.35
7.25
7.13
7.12
6.36
6.35
6.35
5.15
5.15
5.12
5.12
5.09
5.08
5.06
5.05
4.50
4.48
4.15
4.13
2.58
^{1}H NMR of **2ac**
Ph
OH
0.9
0.9
1.0
1.0
2.9
2.0
1.1
2.0
1.0
2.0
2.0
0.9
f1 (ppm)

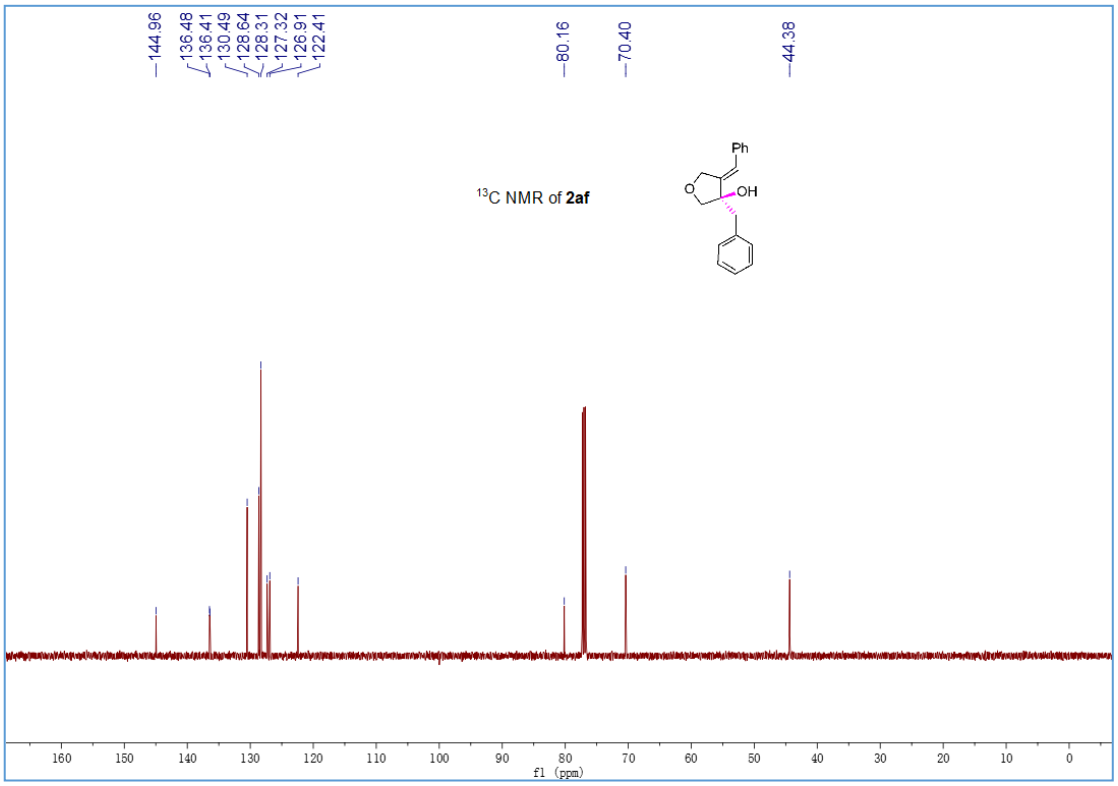

8.18
8.18
7.83
7.81
7.51
7.51
7.50
7.49
7.49
7.33
7.32
7.24
7.12
6.30
6.29
5.14
5.13
5.11
5.10
4.92
4.92
4.89
4.16
4.14
4.10
4.08
2.64
^{1}H NMR of **2ad**
Ph
OH
1.0
3.0
2.9
2.0
1.1
2.0
1.0
2.0
2.1
0.9
f1 (ppm)

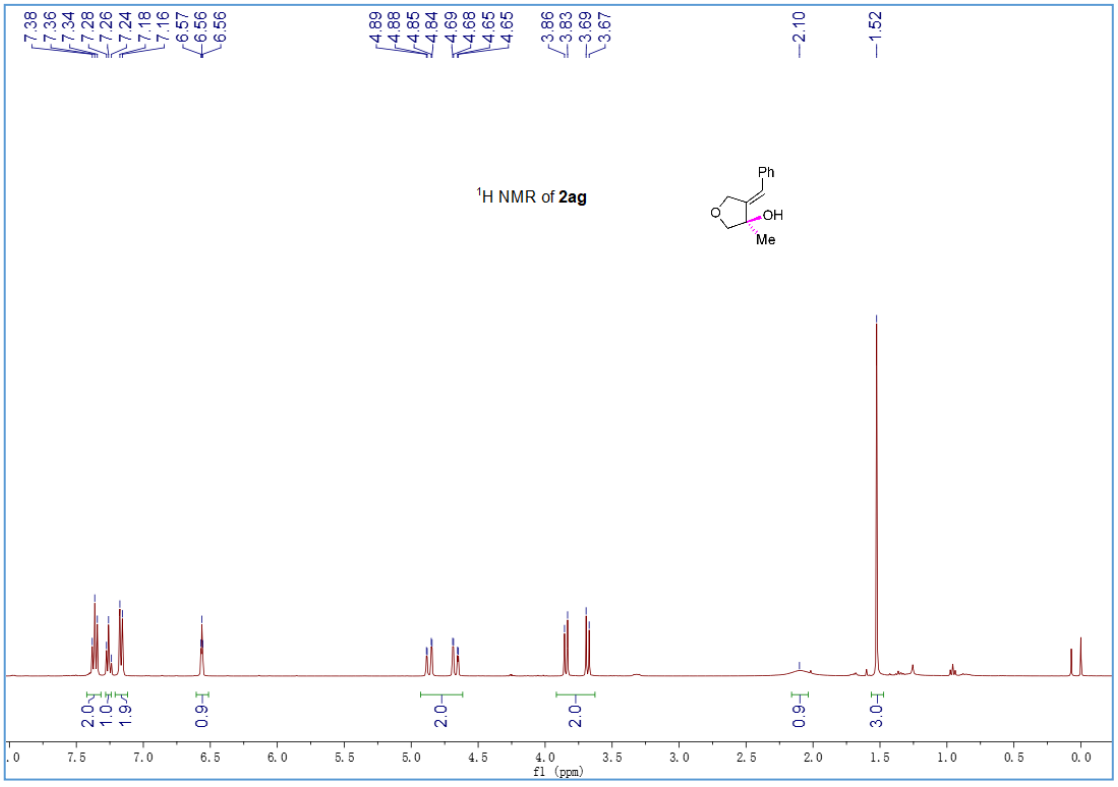

147.4
138.9
136.3
133.0
132.7
128.7
128.4
128.3
128.0
127.6
127.6
126.3
126.2
125.3
125.2
124.5
83.3
81.0
70.9
^{13}C NMR of **2ad**
Ph
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

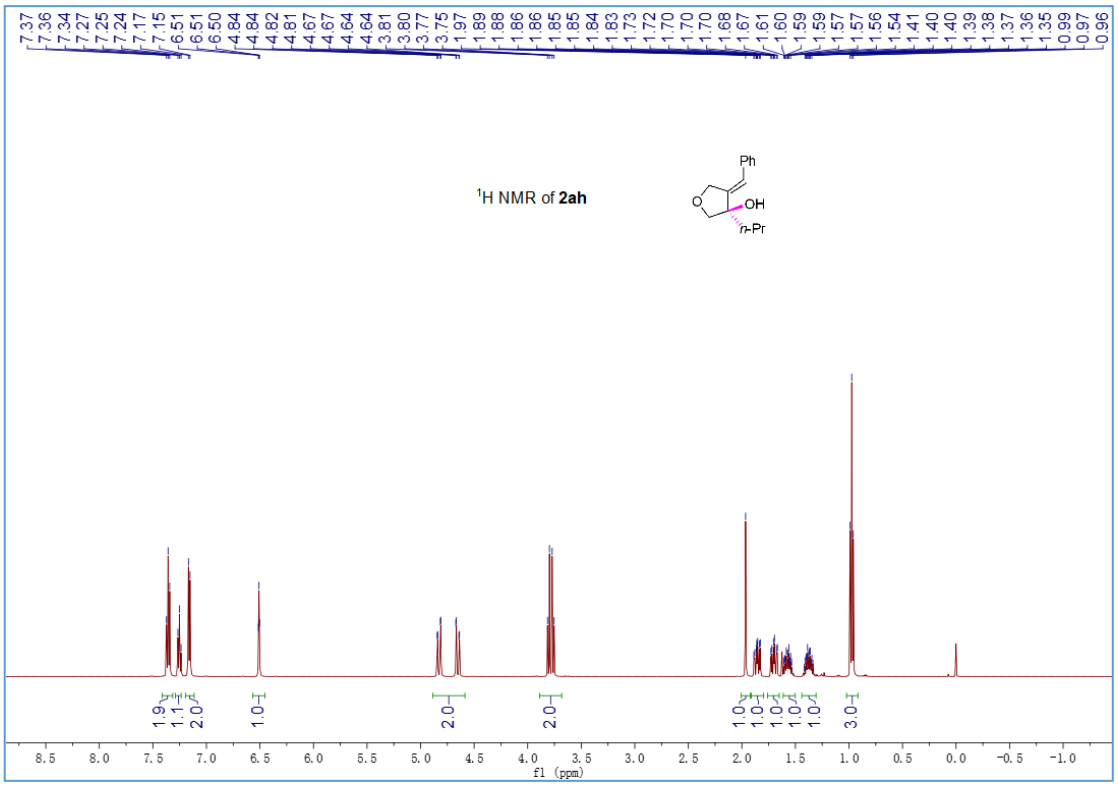

7.69
7.67
7.65
7.65
7.64
7.50
7.48
7.47
7.41
7.40
7.39
7.37
7.30
7.28
7.20
7.18
6.48
6.40
6.39
5.15
5.14
5.12
5.11
4.93
4.93
4.90
4.90
4.17
4.15
4.07
4.05
2.51
^{1}H NMR of **2ae**
Ph
OH
5.9
2.0
2.9
1.2
2.0
1.0
2.0
2.0
1.0
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

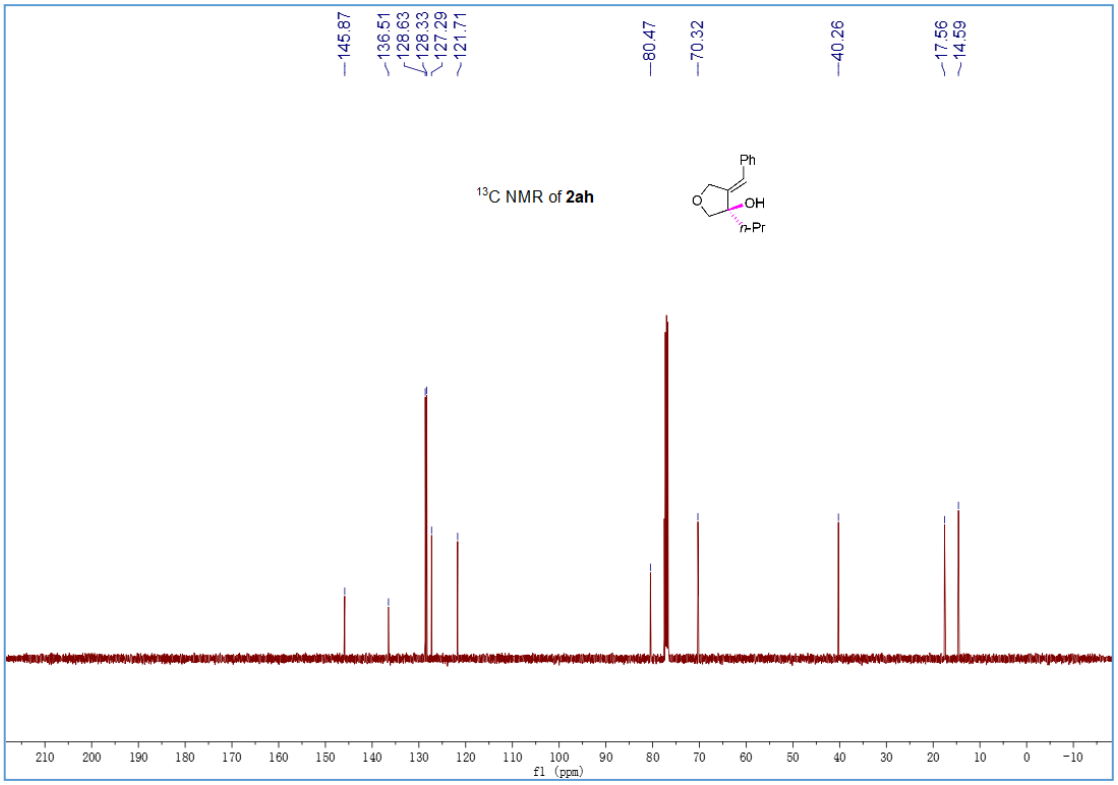

147.3
140.7
140.6
140.4
136.3
128.8
128.7
128.4
127.6
127.4
127.1
127.0
126.8
124.9
83.0
81.2
70.8
^{13}C NMR of **2ae**
Ph
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

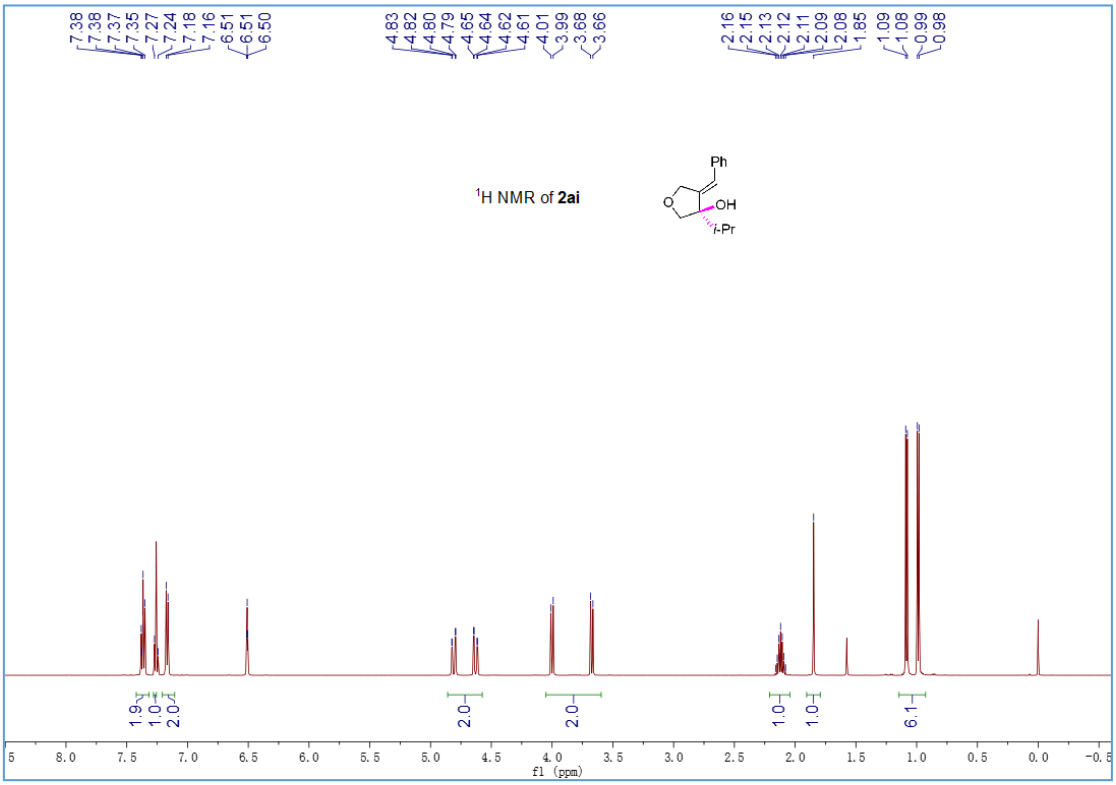

7.37
7.36
7.34
7.31
7.31
7.30
7.29
7.28
7.28
7.27
7.27
7.25
7.25
7.14
6.37
6.37
6.36
4.83
4.82
4.80
4.80
4.72
4.71
4.69
4.68
3.93
3.91
3.56
3.54
3.10
3.07
3.05
3.02
2.04
^{1}H NMR of **2af**
Ph
OH
1.9
6.1
2.0
1.0
2.0
2.0
2.0
1.0
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

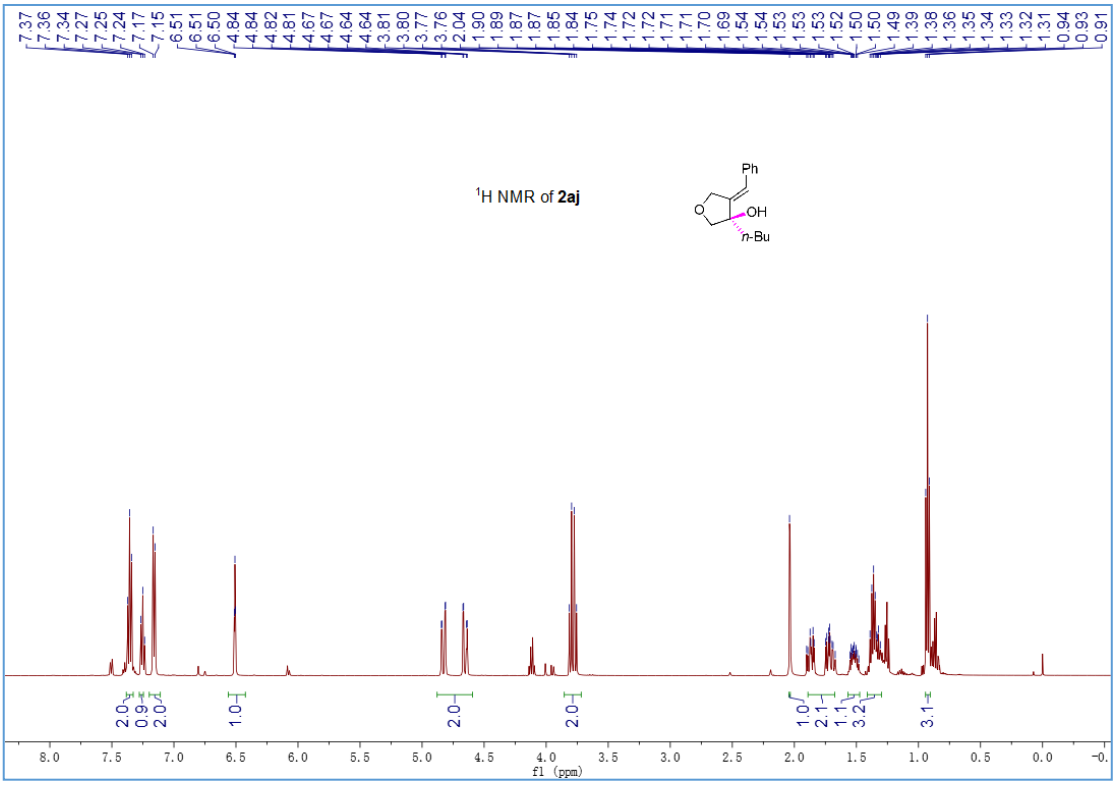

144.96
136.48
136.41
130.49
128.64
128.31
127.32
126.91
122.41
80.16
70.40
44.38
13C NMR of 2af
Ph
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

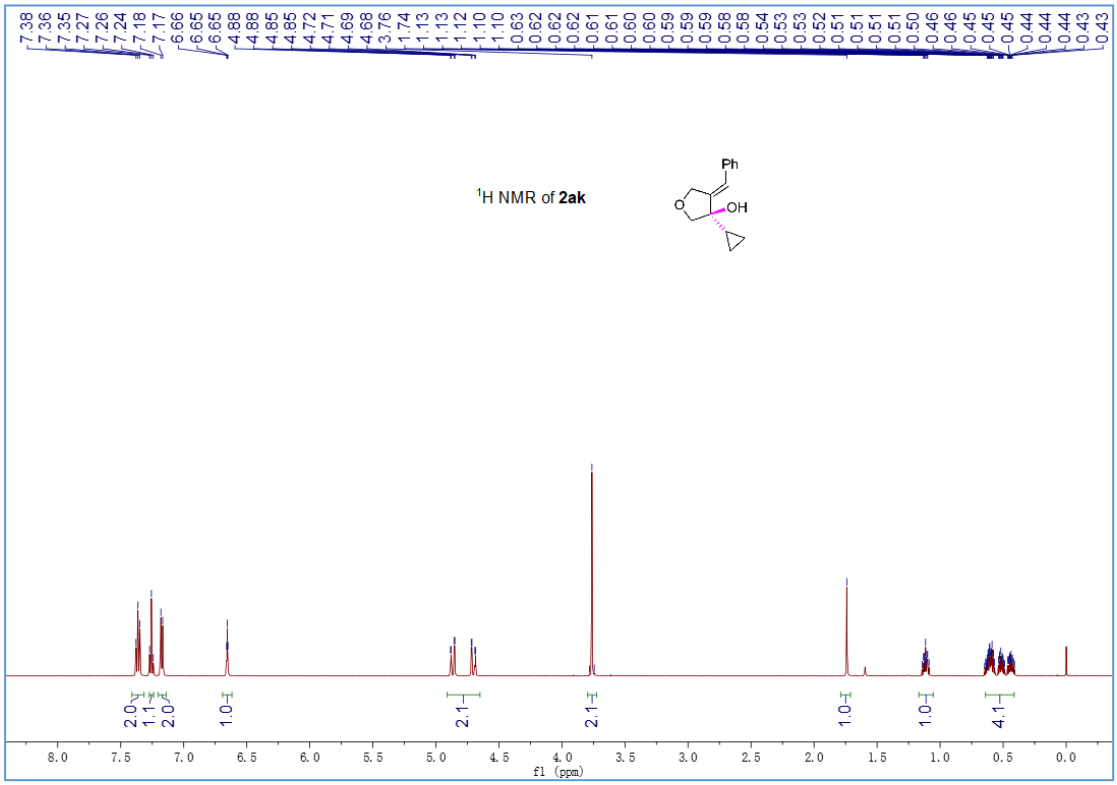

7.38
7.36
7.34
7.28
7.26
7.24
7.18
7.16
6.57
6.56
6.56
4.89
4.88
4.85
4.84
4.69
4.68
4.65
4.65
3.86
3.83
3.69
3.67
2.10
1.52
1H NMR of 2ag
Ph
OH
Me
2.0
1.0
1.9
0.9
2.0
2.0
0.9
3.0
f1 (ppm)

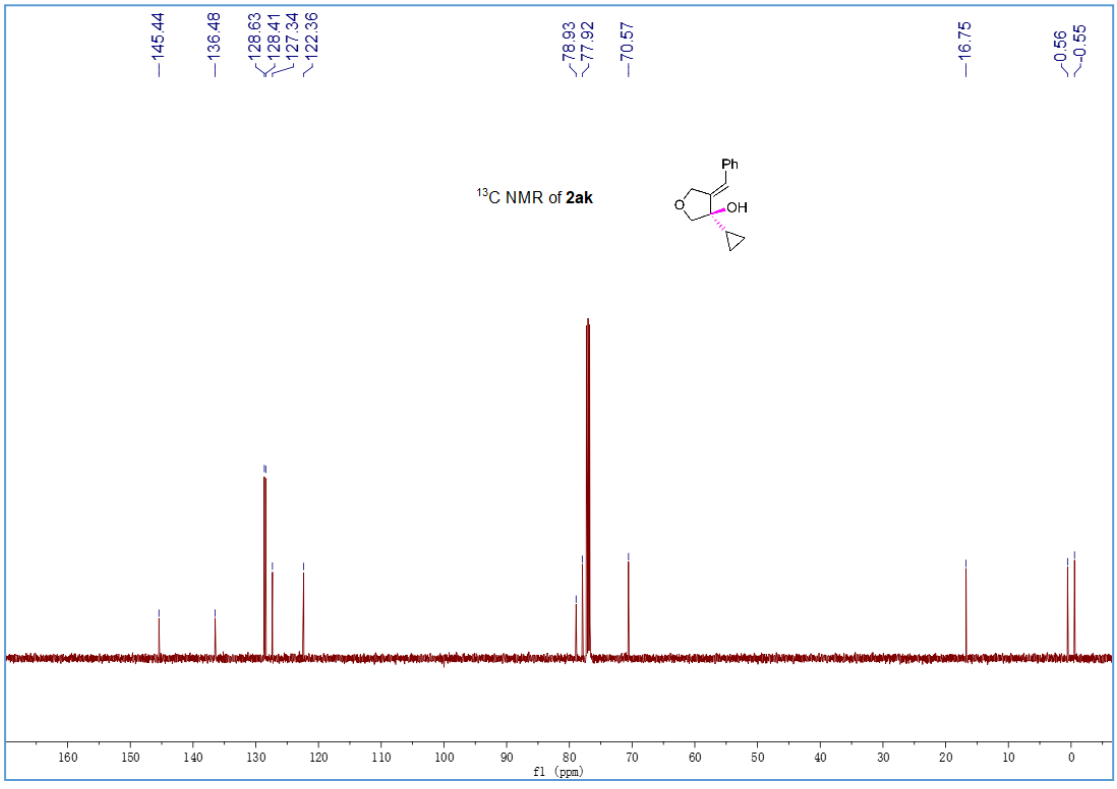

7.37
7.36
7.34
7.27
7.25
7.24
7.17
7.15
6.51
6.50
4.84
4.84
4.82
4.81
4.67
4.64
4.64
3.81
3.80
3.77
3.75
1.97
1.89
1.88
1.86
1.86
1.85
1.85
1.84
1.83
1.73
1.72
1.70
1.70
1.70
1.68
1.67
1.61
1.60
1.59
1.59
1.57
1.57
1.56
1.54
1.41
1.40
1.40
1.39
1.38
1.37
1.36
1.35
0.99
0.97
0.96
^{1}H NMR of **2ah**
Ph
OH
n-Pr
1.9
1.1
2.0
1.0
2.0
2.0
1.0
1.0
1.0
1.0
3.0
f1 (ppm)

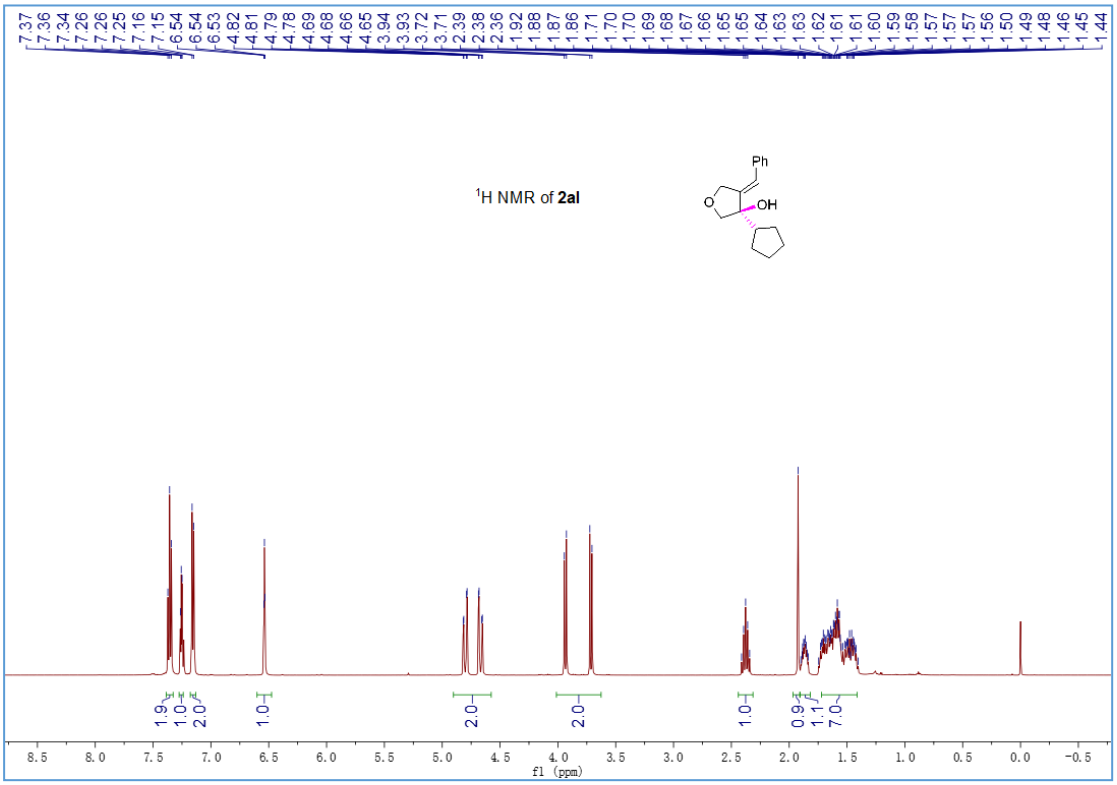

145.87
136.51
128.63
128.33
127.29
121.71
80.47
70.32
40.26
17.56
14.59
^{13}C NMR of **2ah**
Ph
OH
n-Pr
f1 (ppm)

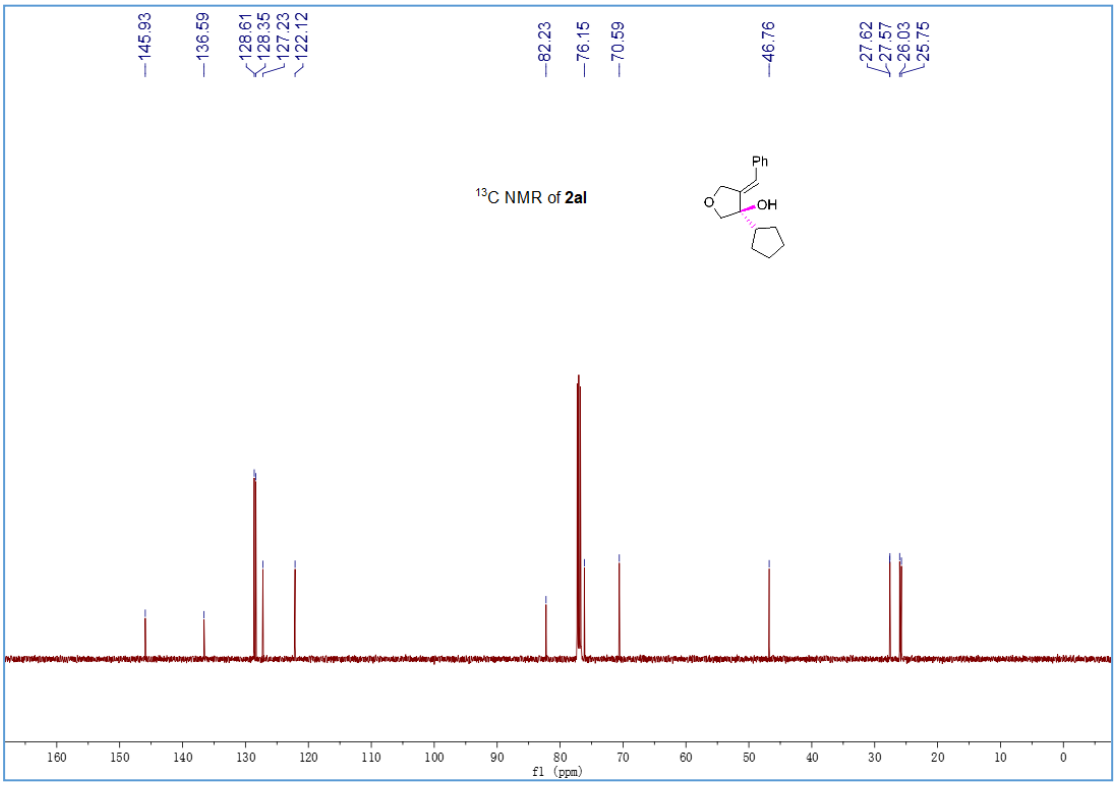

7.38
7.38
7.37
7.35
7.27
7.24
7.18
7.16
6.51
6.50
4.83
4.82
4.80
4.79
4.65
4.64
4.62
4.61
4.01
3.99
3.68
3.66
2.16
2.15
2.13
2.12
2.11
2.09
2.08
1.85
1.09
1.08
0.99
0.98
1H NMR of 2ai
Ph
OH
i-Pr
1.9
1.0
2.0
2.0
2.0
1.0
1.0
6.1
f1 (ppm)

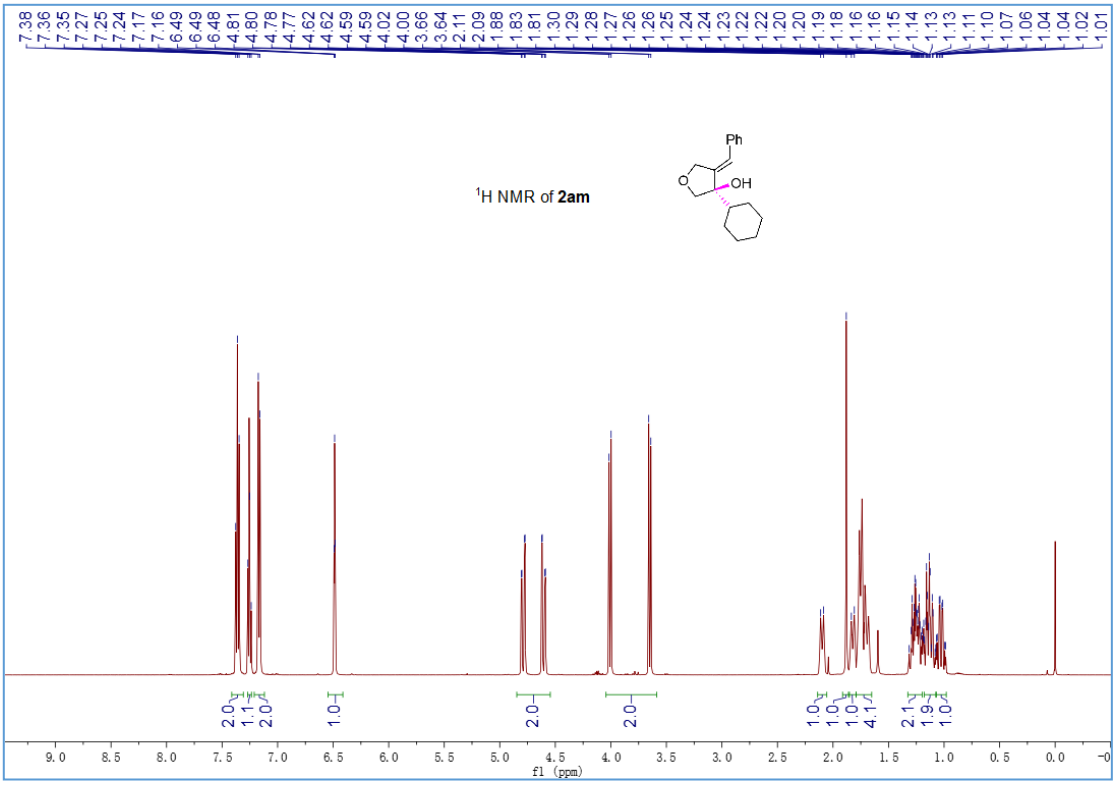

7.37
7.36
7.34
7.27
7.25
7.24
7.17
7.15
6.51
6.50
4.84
4.84
4.82
4.81
4.67
4.64
4.64
3.81
3.80
3.77
3.76
2.04
1.90
1.89
1.87
1.87
1.85
1.84
1.75
1.74
1.72
1.72
1.71
1.71
1.70
1.69
1.54
1.54
1.53
1.53
1.53
1.52
1.50
1.50
1.49
1.39
1.38
1.36
1.35
1.34
1.33
1.32
1.31
0.94
0.93
0.91
1H NMR of 2aj
Ph
OH
n-Bu
2.0
0.9
2.0
1.0
2.0
2.0
1.0
2.1
1.1
3.2
3.1
f1 (ppm)

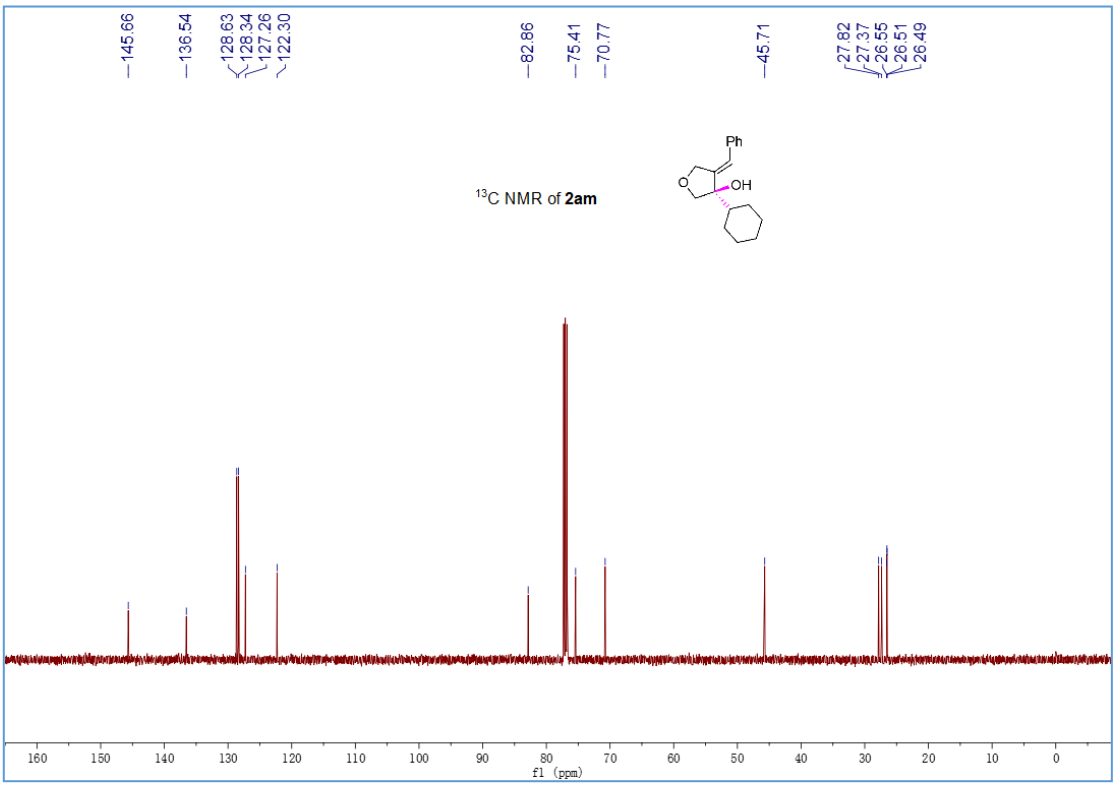

7.38 7.36 7.35 7.27 7.26 7.24 7.18 7.17 6.66 6.65 6.65 4.88 4.88 4.85 4.85 4.72 4.71 4.69 4.68 3.76 1.74 1.13 1.13 1.12 1.10 1.10 0.63 0.62 0.62 0.62 0.61 0.61 0.60 0.60 0.59 0.59 0.59 0.58 0.58 0.54 0.53 0.52 0.51 0.51 0.51 0.50 0.46 0.46 0.45 0.45 0.45 0.44 0.44 0.44 0.43 0.43
^{1}H NMR of **2ak**
Ph
O
OH
2.0 1.1 2.0 1.0 2.1 2.1 1.0 1.0 4.1
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)


145.44 136.48 128.63 128.41 127.34 122.36 78.93 77.92 70.57 16.75 0.56 -0.55
^{13}C NMR of **2ak**
Ph
O
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.37
7.36
7.34
7.26
7.26
7.25
7.16
7.15
6.54
6.54
6.53
4.82
4.81
4.79
4.78
4.69
4.68
4.66
4.65
3.94
3.93
3.72
3.71
2.39
2.38
2.36
1.92
1.88
1.87
1.86
1.71
1.70
1.70
1.69
1.68
1.67
1.66
1.65
1.65
1.64
1.63
1.63
1.62
1.61
1.61
1.60
1.59
1.58
1.57
1.57
1.57
1.56
1.50
1.49
1.48
1.46
1.45
1.44
1H NMR of 2al
Ph
O
OH
1.9
1.0
2.0
1.0
2.0
2.0
1.0
0.9
1.1
7.0
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)


145.93
136.59
128.61
128.35
127.23
122.12
82.23
76.15
70.59
46.76
27.62
27.57
26.03
25.75
13C NMR of 2al
Ph
O
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.38 7.36 7.35 7.27 7.25 7.24 7.17 7.16 6.49 6.48 4.81 4.80 4.78 4.77 4.62 4.59 4.59 4.02 4.00 3.66 3.64 2.11 2.09 1.88 1.83 1.81 1.30 1.29 1.28 1.27 1.26 1.26 1.25 1.24 1.24 1.23 1.22 1.22 1.20 1.20 1.19 1.18 1.16 1.16 1.15 1.14 1.13 1.13 1.11 1.10 1.07 1.06 1.04 1.04 1.02 1.01
Ph
OH
1H NMR of 2am
2.0 1.1 2.0 1.0 2.0 2.0 1.0 1.0 1.0 4.1 2.1 1.9 1.0
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)


145.66 136.54 128.63 128.34 127.26 122.30 82.86 75.41 70.77 45.71 27.82 27.37 26.55 26.51 26.49
Ph
OH
13C NMR of 2am
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)