Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry


# Supporting Information

# Asymmetric Autocatalysis Triggered by Oxygen Isotopically Chiral Glycerin

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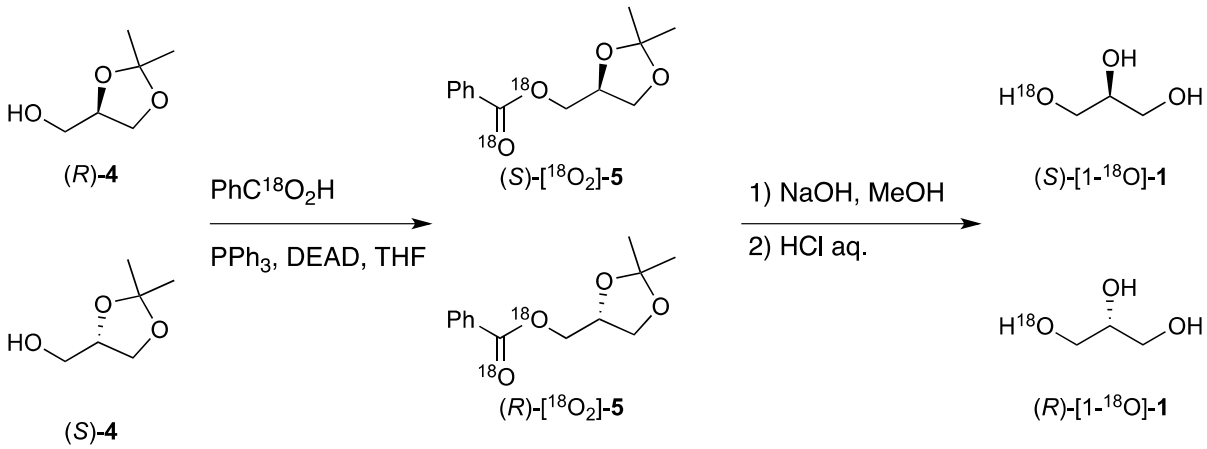
## 1. General

All reactions were performed under an argon atmosphere unless otherwise noted. NMR spectra were recorded on a BRUKER AV600 spectrometer and reported using residual solvent packs as references. Multiplicities are classified by the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad signal. Infrared (IR) data were recorded on a Horiba FT-720 FT-IR spectrometer. Optical rotations were measured using a Jasco P-1030 digital polarimeter using 10 cm cells. High-resolution mass spectra were recorded using a ESI-TOF mass spectrometers (Bruker Daltonics microTOF focus).

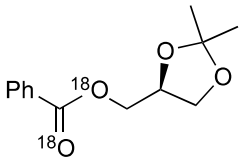
## 2. Synthesis of [$^{18}$O]-substituted glycerin (Scheme 2a)




### (*S*)-(–)-2,2-Dimethyl-1,3-dioxolane-4-methylene-[$^{18}O_2$]-benzoate 5

In a dried flask were placed (*R*)-(–)-2,2-dimethyl-1,3-dioxolane-4-methanol **4** (0.562 mL, 4.5

mmol), [$^{18}O_2$]-benzoicacid[1] (0.564 g, 4.5 mmol), triphenylphosphine (1.19 g, 4.5 mmol), and THF (16 mL). To this solution, a toluene solution of DEAD (2.2 M, 2.1 mL, 4.54 mmol) was added slowly. After stirring of additional 20 min, the reaction was quenched by water and extracted with EtOAc 3 times. The combined organic layers were dried over $MgSO_4$ and the volatiles were removed under reduced pressures. The obtained crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 10/1) to give the (*S*)-[1-$^{18}$O]-**5** in quant yield (1.08 g) with >99.5% ee (determined by HPLC, CHIRALPAK OB-H, 4.6 x 250 mm, eluent: 10% IPA in Hexane, 1.0 mL/min, detector: UV, 254 nm, temp: rt, retention time: 18.3 min).




(*S*)-[$^{18}O_2$]-**5**

Yellow oil.

$[\alpha]_D^{24}$ –16.8 (c 0.634, Cyclohexane)

$^1$H-NMR (600 MHz, $C_6D_6$) $\delta$ 1.25 (3H, s), 1.37 (3H, s), 3.49-3.51 (1H, dd, *J* = 6, 8.4 Hz), 3.64-3.66 (1H, dd, *J* = 6.6, 8.4 Hz), 4.03-4.07 (1H, quintet, *J* = 5.4 Hz), 4.13-4.16 (1H, dd, *J* = 5.4, 11.4 Hz), 4.19-4.22 (1H, dd, *J* = 4.8, 11.4 Hz), 7.02-7.04 (2H, m), 7.08-7.11 (1H, m), 8.14-8.16 (2H, m).

$^{13}$C-NMR (150 MHz, $C_6D_6$) $\delta$ 25.9, 27.3, 65.7, 66.7, 74.4, 110.1, 128.7, 128.9, 130.4, 133.4, 166.5.

FT-IR (neat.) $cm^{-1}$ 710, 843, 933, 974, 1026, 1159, 1176, 1217, 1271, 1315, 1371, 1452, 1603, 1693, 2885, 2937, 2987, 3064.

HRMS: Calcd. for $C_{13}H_{16}O_2{}^{18}O_2Na^+$[M+Na]$^+$: 263.1026, Found: 263.0999.

**(*R*)-(–)-2,2-Dimethyl-1,3-dioxolane-4-methylene-[$^{18}O_2$]-benzoate 5**

Obtained by same procedure with (*R*)-**4** in quant yield, >99.5% ee (determined by HPLC, CHIRALPAK OB-H, 4.6 x 250 mm, eluent: 10% IPA in Hexane, 1.0 mL/min, detector: UV, 254 nm, temp: rt, retention time: 12.5 min).

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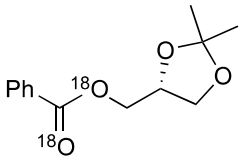
[1] [$^{18}O_2$]-benzoic acid was synthesized according to the reported procedure. D. C. Kapeller, F. Hammerschmidt, *J. Org. Chem.* **2009,** *74,* 2380–2388.




(*R*)-[$^{18}O_2$]-**5**

Yellow oil.

[ $\alpha$ ]$_D^{24}$ +17.99 (c 0.553, Cyclohexane)

$^1$H-NMR (600 MHz, $C_6D_6$) $\delta$1.25 (3H, s), 1.37 (3H, s), 3.49-3.51 (1H, dd, *J* = 6.6, 8.4 Hz), 3.64-3.66 (1H, dd, *J* = 6.6, 8.4 Hz), 4.03-4.07 (1H, quintet, *J* = 5.4 Hz), 4.13-4.16 (1H, dd, *J* = 5.4, 11.4 Hz), 4.19-4.22 (1H, dd, *J* = 4.8, 12.0 Hz), 7.02-7.04 (2H, m), 7.08-7.11 (1H, m), 8.14-8.16 (2H, m).

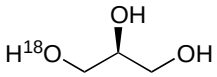
$^{13}$C-NMR (150 MHz, $C_6D_6$) $\delta$ 25.9, 27.3, 65.7, 66.7, 74.4, 110.1, 128.7, 128.9, 130.4, 133.4, 166.5.

FT-IR: (neat.) cm$^{-1}$ 710, 843, 933, 974, 1026, 1068, 1092, 1159, 1176, 1265, 1315, 1371, 1452, 1491, 1583, 1603, 1694, 1780, 2885, 2937, 2987, 3064.

HRMS: Calcd. for $C_{13}H_{16}O_2{}^{18}O_2Na^+$ $[M+Na]^+$: 263.1026, Found: 263.0988.

**(*S*)-[1-$^{18}$O]-Glycerin 1**

To this solution of (*S*)-(-)-2,2-dimethyl-1,3-dioxolane-4-methylene-[$^{18}O_2$]-benzoate **5** (1.08 g, 4.5 mmol) in MeOH (20 mL) was added NaOH aq. (0.4 M , 1.8 mL). After 1 h stirring, the compounds were extracted with $Et_2O$ and volatiles were removed under reduced pressures at 0 °C. The obtained crude products were dissolved in 1M HCl (4.2 mL). After 2 h stirring, HCl was removed under reduced pressures at 60 °C. The crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 1/1 then $CHCl_3$/MeOH = 10/1) followed by kugelrohr distillation to give (*S*)-[1-$^{18}$O]-**1** in 57% yield (241 mg).




(*S*)-[1-$^{18}$O]-**1**

Colorless oil

[ $\alpha$ ]$_D^{25}$ below the detection level

$^1$H-NMR (600 MHz, DMSO-$d_6$) $\delta$3.27-3.30 (2H, m), 3.34-3.37 (2H, m), 3.41-3.43 (1H, m), 4.38-4.40 (2H, br), 4.46-4.47 (1H, br)

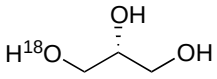
$^{13}$C-NMR (150 MHz, DMSO-$d_6$) $\delta$ 63.06, 63.08, 72.5

FT-IR (neat.) 856, 920, 980, 1039, 1111, 1225, 1331, 1415, 1651, 2883, 2939, 3361

HRMS: Calcd. for $C_3H_8O_2{}^{18}ONa^+$[M+Na]$^+$: 117.0408, Found: 117.0420

**(*R*)-[1-$^{18}$O]-Glycerin 1**

Same procedure was applied to (*R*)-(+)-2,2-dimethyl-1,3-dioxolane-4-methylene-[$^{18}O_2$]-benzoate **5** (1.08 g, 4.5 mmol). (*R*)-[1-$^{18}$O]-glycerin **1** was obtained in 64 % yield (271 mg) in 2 steps.



(*R*)-[1-$^{18}$O]-**1**

Colorless oil

[ $\alpha$ ]$_D^{26}$ below the detection level

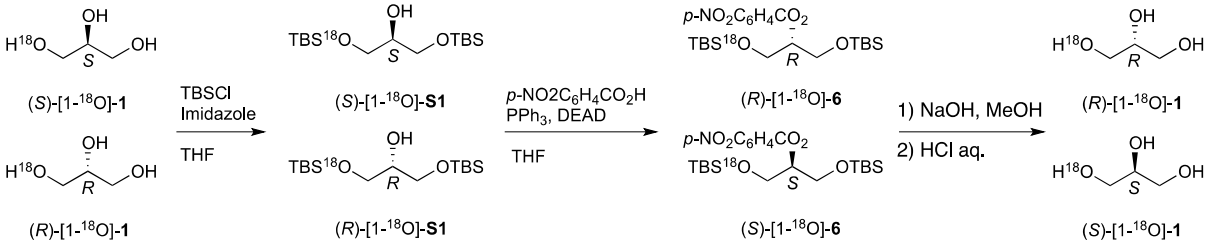
$^1$H-NMR (600 MHz, DMSO-d$_6$) $\delta$ 3.26-3.30 (2H, m), 3.34-3.37 (2H, m), 3.40-3.44 (1H, m), 4.40 (3H, br).

$^{13}$C-NMR (150 MHz, DMSO-d$_6$) $\delta$ 63.07, 63.08, 72.5.

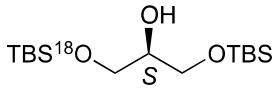
FT-IR (neat.) cm$^{-1}$ 854, 920, 980, 1039, 1109, 1415, 1649, 2885, 2941, 3363.

HRMS: Calcd. for $C_3H_8O_2{}^{18}ONa^+$[M+Na]$^+$: 117.0408, Found: 117.0419.

## 3. Stereo inversion of [$^{18}$O]-glycerin (Scheme 2b)




**(*S*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy-2-propan-1-ol S1**



(*S*)-[1-$^{18}$O]-**S1**

To the solution of (*S*)-[1-$^{18}$O]-glycerin **1**(200 mg, 2.1 mmol), imidazole (290 mg, 4.2 mmol) in THF (10 mL), *tert*-butyldimethylsilyl chloride (633 mg, 4.2 mmol) in THF (5 mL) was

added slowly at 0 °C. After 12 h stirring, the reaction was quenched by water and extracted 3 times with EtOAc. The combined organic layers were dried over $Na_2SO_4$ and the volatiles were removed under reduced pressures. The obtained crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 10/1) to give (*S*)-[1-$^{18}$O]-**S1** in 79% yield (535 mg).

Colorless oil

$[\alpha]_D^{24}$ below the detection level

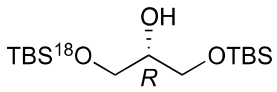
$^1$H-NMR (600 MHz, $CDCl_3$) $\delta$0.07 (12H, s), 0.90 (18H, s), 2.45 (1H, d, $J$ = 5.4 Hz), 3.63-3.65 (5H, m).

$^{13}$C-NMR (150 MHz, $CDCl_3$) $\delta$ -5.19, -5.21, 18.5, 26.1, 63.63, 63.65, 72.1.

FT-IR (neat.) cm$^{-1}$ 565, 669, 777, 839, 937, 1009, 1061, 1097, 1255, 1396, 1468, 2862, 2941, 3581, 3732.

HRMS: Calcd. for $C_{15}H_{36}O_2{}^{18}OSi_2Na^+$[M+Na]$^+$: 345.2137, Found: 345.2116.

**(*R*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy-2-propanol S1**




(*R*)-[1-$^{18}$O]-**S1**

Same procedure was applied to (*R*)-[1-$^{18}$O]-glycerin **1** (200 mg, 2.1 mmol). Yield 92% (623 mg).

Colorless oil

$[\alpha]_D^{24}$ below the detection level

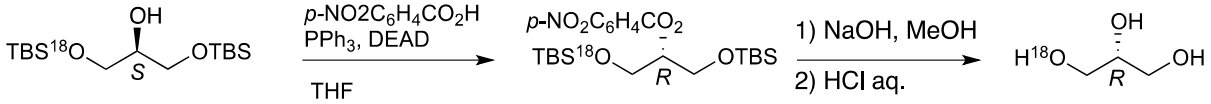
$^1$H-NMR (600 MHz, $CDCl_3$) $\delta$0.07 (12H, s), 0.90 (18H, s), 2.45 (1H, d, $J$ = 5.4 Hz), 3.63-3.65 (5H, m).

$^{13}$C-NMR (150 MHz, $CDCl_3$) $\delta$ -5.19, -5.21, 18.5, 26.1, 63.63, 63.65, 72.1

FT-IR (neat.) 575, 667, 777, 837, 937, 1005, 1066, 1111, 1255, 1333, 1362, 1389, 1406, 1541, 2857, 2929, 2954, 3587 (cm$^{-1}$)

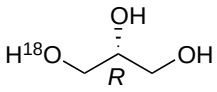
HRMS: Calcd. for $C_{15}H_{36}O_2{}^{18}OSi_2Na^+$[M+Na]$^+$: 345.2137, Found: 345.2138

**(*R*)-[1-$^{18}$O]-Glycerin 1 by stereoinversion**




(*S*)-[1-$^{18}$O]-**S1** (*R*)-[1-$^{18}$O]-**6** (*R*)-[1-$^{18}$O]-**1**

To the solution of *p*-nitrobenzoic acid (284 mg, 1.7 mmol) and triphenylphosphine (446 mg, 1.7 mmol) in THF (10 mL) was added (*S*)-1,3-di(*tert*-butyldimethylsilyloxy)-2-propan-1-[$^{18}$O]-ol **S1** (535 mg, 1.7 mmol)in THF (6 mL). To this mixture, diethyl azodicarboxylate (DEAD) in toluene (2.2 M, 3.7 mL, 1.7 mmol) was added slowly at 0 °C. After 2 h stirring, the reaction was quenched by water and extracted 3 times with EtOAc. The combined organic layers were dried over $Na_2SO_4$ and the volatiles were removed under reduced pressures. From the obtained crude (*R*)-[$^{18}$O]-**6**, high polar compounds were removed by silica gel column chromatography (eluent: hexane/EtOAc = 50/1). To the (*R*)-[$^{18}$O]-**6** (690 mg, 1.5 mmol) was added NaOH (60 mg, 1.5 mmol) in MeOH (20 mL). After 12 h stirring, extracted with, the reaction was quenched by water and extracted 3 times with EtOAc. The combined organic layers were dried over $Na_2SO_4$ and the volatiles were removed under reduced pressures. The obtained crude products were dissolved in MeOH (13 mL) and 1M HCl (1.5 mL) was added. After 2.5 h stirring, HCl was removed under reduced pressures at 60 °C. The crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 1/1 then $CHCl_3$/MeOH = 10/1) followed by kugelrohr distillation to give the stereoinverted alcohol (*R*)-[$^{18}$O]-**1** in 58% yield (94 mg) from (*S*)-[1-$^{18}$O]-**S1**.

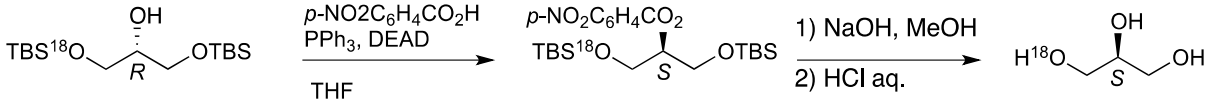



(*R*)-[1-$^{18}$O]-**1**

Colorless Oil

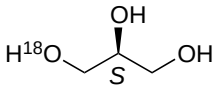
$[\alpha]_D^{23}$ below the detection level

**(*S*)-[1-$^{18}$O]-Glycerin 1 by stereoinversion**




(*R*)-[1-$^{18}$O]-**S1** (*S*)-[1-$^{18}$O]-**6** (*S*)-[1-$^{18}$O]-**1**

Same procedure was applied to (*R*)-1,3-di(*tert*-butyldimethylsilyloxy)-2-propan-1-[$^{18}$O]-ol **S1** (535 mg, 1.7 mmol.) Yield 60% (94 mg).




(*S*)-[1-$^{18}$O]-**1**

Colorless oil

[ $\alpha$ ]$_D^{23}$ below the detection level

Stereoinversion was confirmed by $^{18}$O-substitution shift in $^{13}$C-NMR of (*S*)-MTPA esters **7** synthesized from chiral glycerin **1** before and after inversion.

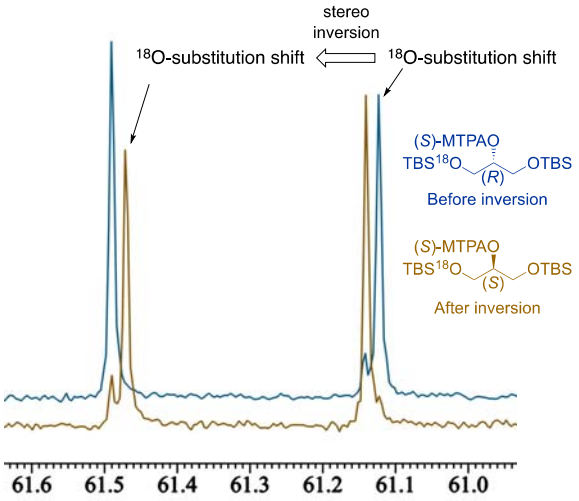
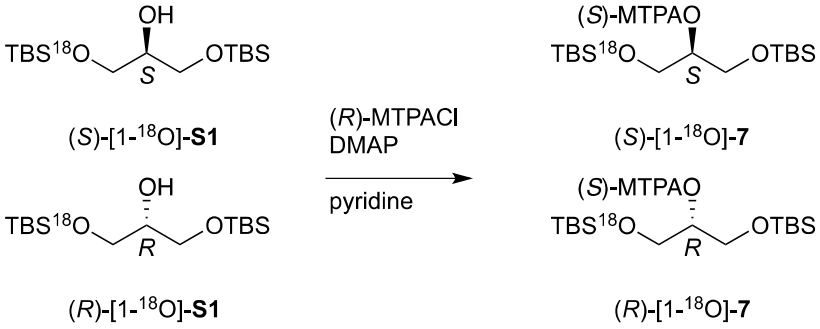



**Fig. S1** $^{18}$O-isotope shift in $^{13}$C-NMR spectrum of (*S*)-MTPA ester of protected glycerin 7 synthesized from chiral glycerin before or after stereoinversion.

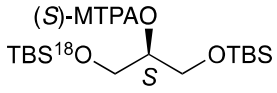
## 4. Synthesis of MTPA esters (Figure 1)




**(*S*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxypropan-2-yl-(*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate 7**

(*S*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy-2-propan-1-ol **S1**

(94.5 mg, 0.29 mmol) and 4-dimethylaminopyridine (DMAP, 3.5 mg, 0.029 mmol) were dissolved in pyridine (0.5 mL). To this solution, (*R*)-MTPACl (100 mg, 0.396 mmol) was added and stirred for 12 h. the reaction was quenched by water and extracted 5 times with $Et_2O$. The combined organic layers were dried over $Na_2SO_4$ and the volatiles were removed under reduced pressures. The crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 10/1) to give the title compound in 93% yieeld (147 mg).




(*S*)-[1-$^{18}$O]-**7**

Colorless oil

$[\alpha]_D^{24}$ -25.8 (c 0.383, Cyclohexane)

$^1$H-NMR (600 MHz, $CDCl_3$) $\delta$ -0.011 (3H, s), -0.006 (3H, s), 0.05 (3H, s) 0.06 (3H, s), 0.85 (9H, s), 0.88 (9H, s), 3.57 (3H, s), 3.71 (2H, d, $J$ = 5.4 Hz), 3.79 (1H, dd, $J$ = 6.0, 10.8 Hz), 3.87 (1H, dd, $J$ = 4.2, 10.8 Hz), 5.12-5.15 (1H, m), 7.36-7.39 (3H, m), 7.57-7.59 (2H, m).

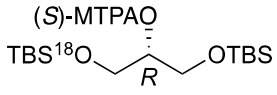
$^{13}$C-NMR (150 MHz, $C_6D_6$) $\delta$ -5.50, -5.40, -5.36, -5.33, 18.37, 18.42, 25.94, 25.98, 55.6, 61.1, 61.5, 77.8, 84.9 (q, $J_{C-F}$ = 27.5 Hz), 123.5 (q, $J_{C-F}$ = 286.7 Hz), 127.7, 128.5, 129.7, 132.6, 166.4.

FT-IR (neat.) cm$^{-1}$ 449, 503, 553, 669, 717, 777, 839, 922, 1018, 1117, 1176, 1257, 1365, 1394, 1464, 1753, 2862, 2945, 3064, 3737.

HRMS: Calcd. for $C_{25}H_{43}F_3O_4{}^{18}OSi_2Na^+$[M+Na]$^+$: 561.2536, Found: 561.2542.

**(*R*)-1-*tert*-Butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxypropan-2-yl-(*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate 7**

Same procedure was applied to (*R*)-**S1** (97.4 mg, 0.30 mmol). Yield 95% (153 mg).




(*R*)-[1-$^{18}$O]-**7**

Colorless Oil

$[\alpha]_D^{24}$ -25.7 (c 0.548, Cyclohexane)

$^{1}$H-NMR (600 MHz, $CDCl_3$) $\delta$ −0.02 (3H, s), −0.01 (3H, s), 0.05 (3H, s), 0.06 (3H, s), 0.85 (9H, s), 0.88 (9H, s), 3.57 (3H, s), 3.72 (2H, d, $J$ = 5.4 Hz), 3.79 (1H, dd, $J$ = 6.0, 10.8 Hz), 3.87 (1H, dd, $J$ = 4.2, 11.4 Hz), 5.12-5.15 (1H, m), 7.36-7.39 (3H, m), 7.57-7.59 (2H, m).

$^{13}$C-NMR (150 MHz, $C_6D_6$) $\delta$ -5.50, -5.41, -5.35, -5.33, 18.37, 18.43, 25.9, 26.0, 55.6, 61.1, 61.5, 77.8, 84.9 (q, $J_{C-F}$ = 27.5 Hz), 123.5 (q, $J_{C-F}$ = 286.8 Hz), 127.7, 128.5, 129.7, 132.6, 166.4.

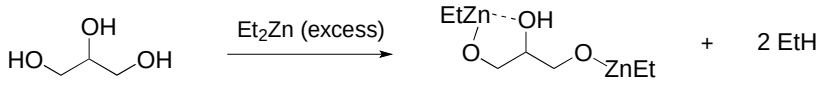
FT-IR (neat.) cm$^{-1}$ 467, 486, 669, 717, 777, 839, 920, 1018, 1115, 1176, 1257, 1365, 1394, 1464, 1753, 2862, 2945, 3737.

HRMS: Calcd. for $C_{25}H_{43}F_3O_4{}^{18}OSi_2Na^+$[M+Na]$^+$: 561.2536, Found: 561.2553.

## 5. Typical procedure of asymmetric autocatalysis with [$^{18}$O]-labeled glycerin (Table 1, entry 1)

*i*-$Pr_2Zn$ (1.0 M in toluene, 0.2 mL, 0.2 mmol) was added to (*S*)-[$^{18}$O]-glycerin **1** (4.7 mg, 0.05 mmol) at 0 °C. After stirring for 15 min, 2-*tert*-butylethynylpyrimidine-5-carbaldehyde **2** (4.7 mg, 0.025 mmol) in toluene (0.15 mL) was added slowly over 1 h. After stirring of 12 h, 0.4 mL of toluene was added to the mixture followed by slow addition of *i*-$Pr_2Zn$ (1.0 M in toluene, 0.2 mL, 0.2 mmol) and aldehyde **2** (18.8 mg, 0.1 mmol) in toluene (0.5 mL) over 1 h. After 2 h stirring, toluene (3.6 mL), *i*-$Pr_2Zn$ (1.0 M in toluene, 0.8 mL, 0.8 mmol) and aldehyde **2** (75.3 mg, 0.4 mmol) in toluene (3.0 mL) were added in the same way. After 2 h, the reaction was quenched with a mixture of sat. $NH_4Cl$ aq. and 30% $NH_3$ aq.(2/1, *v*/*v*, 10 mL) and extracted with EtOAc. The combined organic layer was dried over anhydrous $Na_2SO_4$ and the volatiles were removed under reduced pressures. The crude products were purified by silica gel column chromatography (eluent: hexane/EtOAc = 2/1) to give the (*R*)-alkanol **3** in 96% yield (114.6 mg) with 97% ee. The *ee* value was determined by HPLC analysis on a chiral stationary phase (Daicel Chiralpak IB : 4.6 250 mm, 254 nm UV detector, RT, 5 % 2-propanol in hexane, 1.0 mL min$^{-1}$, retention time : 10.9 min for (*S*)-**3** and 15.5 min for (*R*)-**3**).

## 6. Reaction of diisopropylzinc with glycerin




0.430 mmol 0.835 mmol

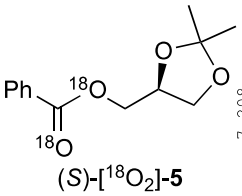
The reaction was performed using reaction vessel with 24 mL volume under atmospheric

pressure (1009 x $10^2$ Pa) at room temperature (299.7 K). A 1.0 mol/L toluene solution of $Et_2Zn$ (3.6 mL, 3.6 mmol) was added dropwise to toluene (2.5 mL) solution of glycerin (39.6 mg, 0.430 mmol). The reaction readily proceeded to observe the generation of ethane (15.7 mL). The molar amount of 15.7 mL of generating ethane gas is 0.636 mmol at 294.9 K under 1009 x $10^2$ Pa. In addition, ethane should be dissolved in the solvent. Based on the literature values,[2] the solubility of ethane in toluene is approximated to be 0.140 mol/L at 299.7 K. Considering the partial pressure of ethane in this reaction vessel (air: 24 mL, ethane 15.7 mL), the molar amount of ethane dissolved in 6.1 mL of toluene is 0.199 mmol. Therefore, total molar amount of generated ethane is calculated to be 0.835 mmol (1.9 equiv).

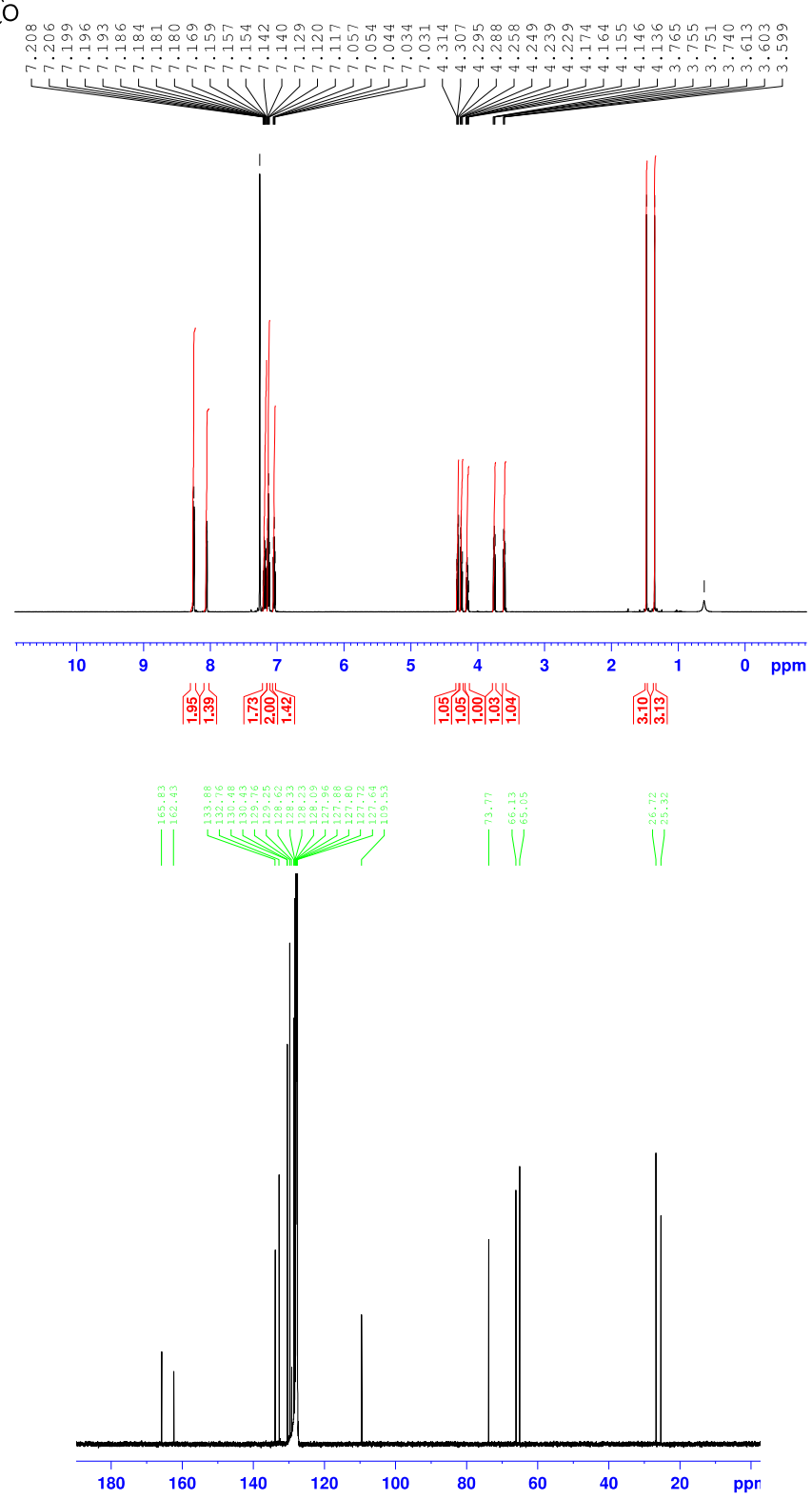
[2] J. A. Waters, G. A. Mortimer, H. E. Clements, *J. Chem. Eng. Data*, 1970, **15**, 174–176.

## 7. NMR Spectrum

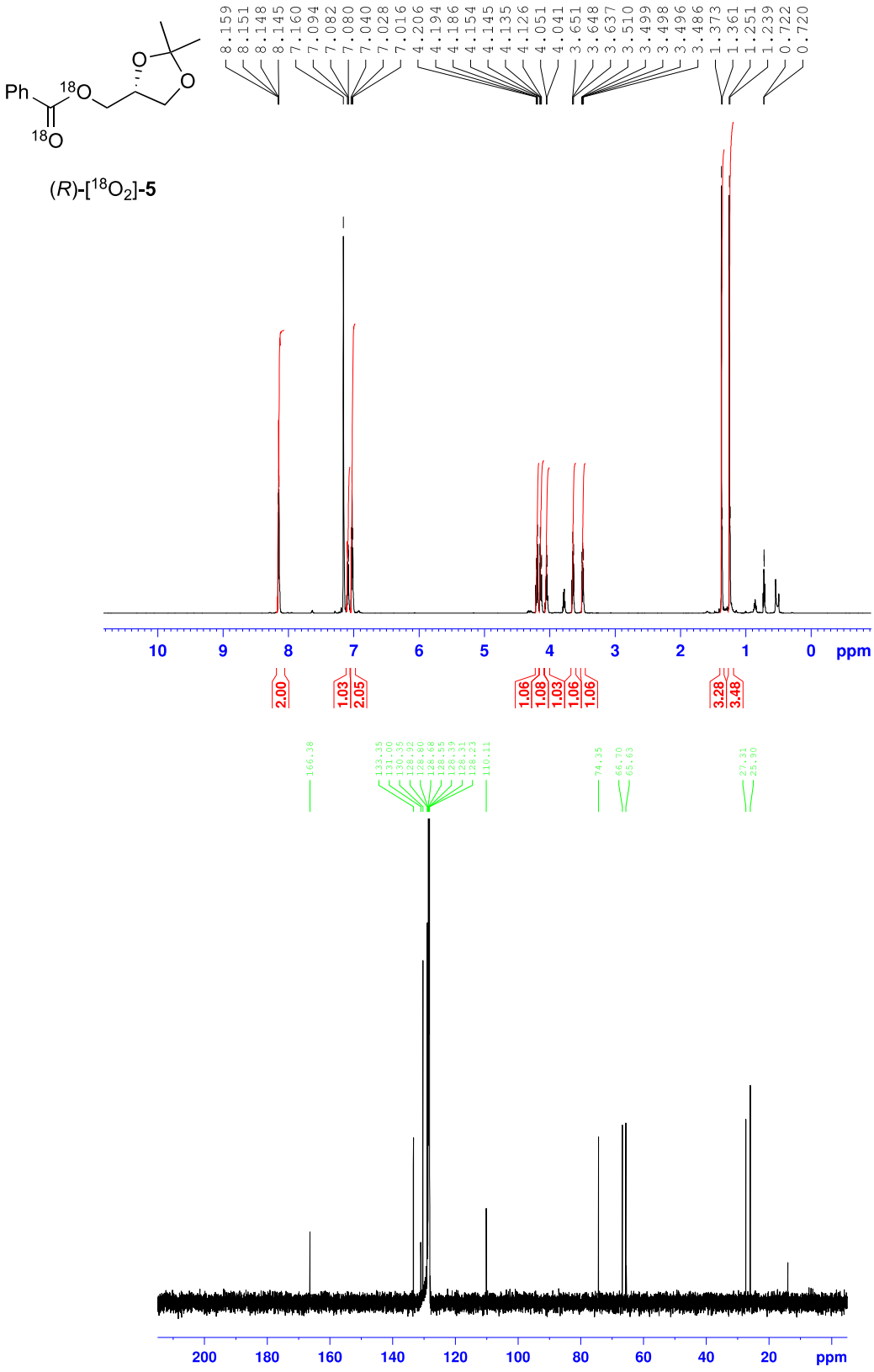
$^{1}$H- and $^{13}$C-NMR of (*S*) -2,2-dimethyl-1,3-dioxolane-4-methylenebenzoate **5** in $C_6D_6$



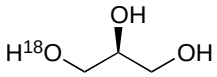

(*S*)-[$^{18}O_2$]-**5**



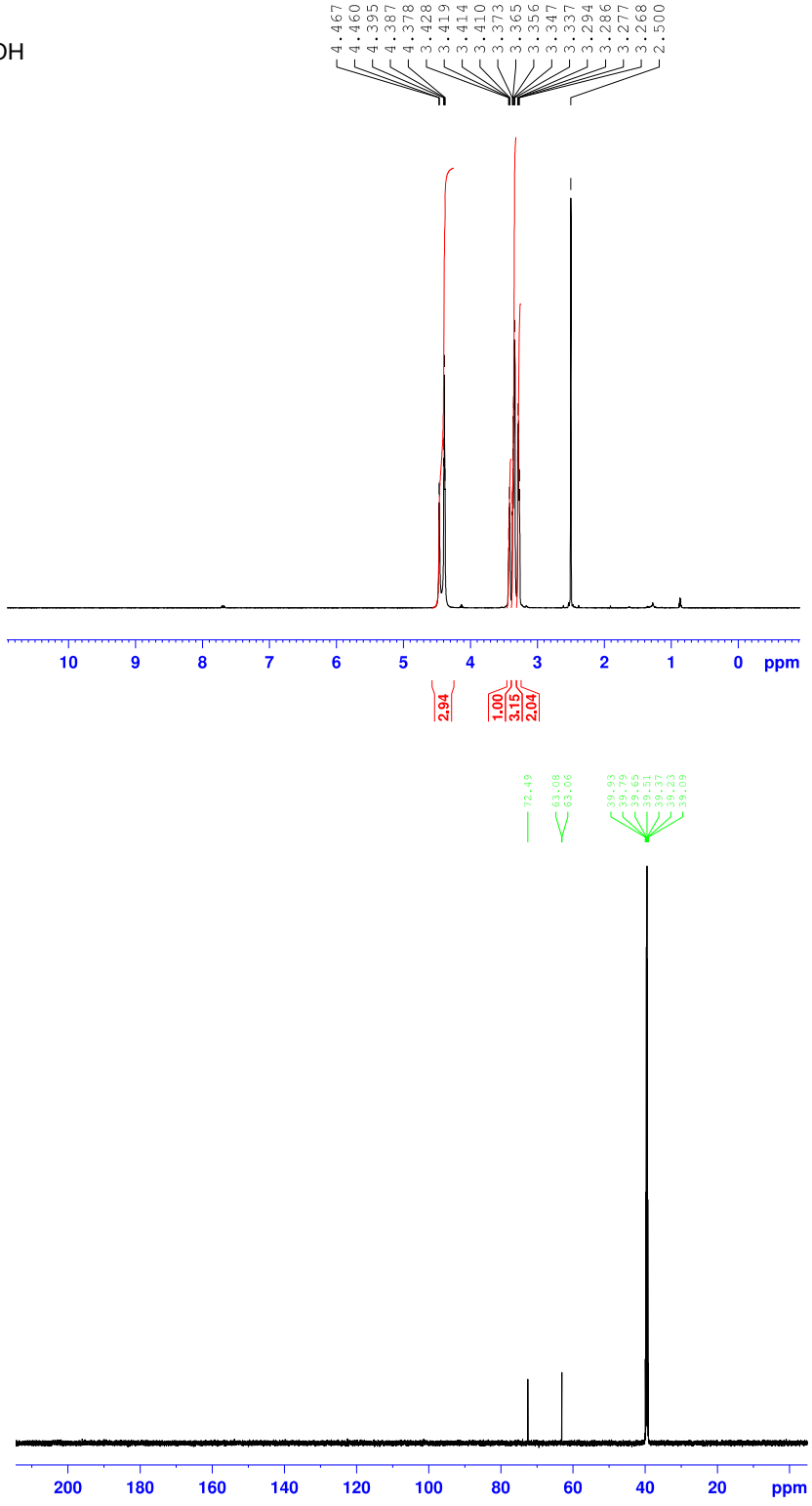
$^{1}$H- and $^{13}$C-NMR of (*R*)-2,2-dimethyl-1,3-dioxolane-4-methylenebenzoate **5** in $C_6D_6$



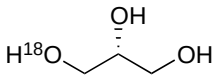
$^{1}$H- and $^{13}$C-NMR of (*S*)- [1-$^{18}$O]-glycerin **1** in $d_6$-DMSO



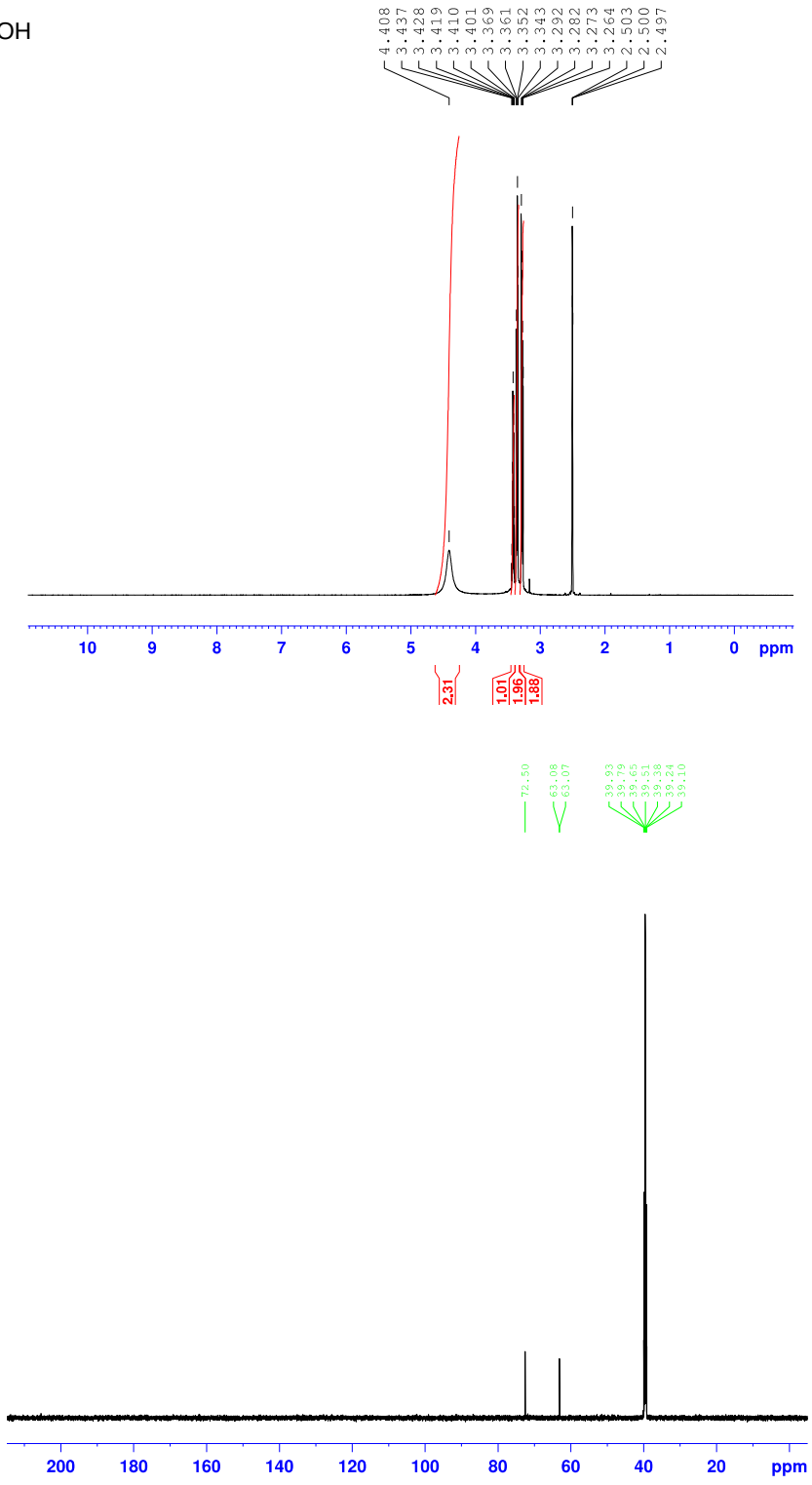

(*S*)-[1-$^{18}$O]-**1**



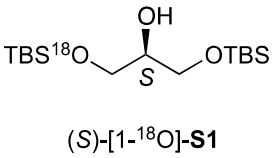
$^{1}$H- and $^{13}$C-NMR of (*R*)- [1-$^{18}$O]-glycerin **1** in $d_6$-DMSO



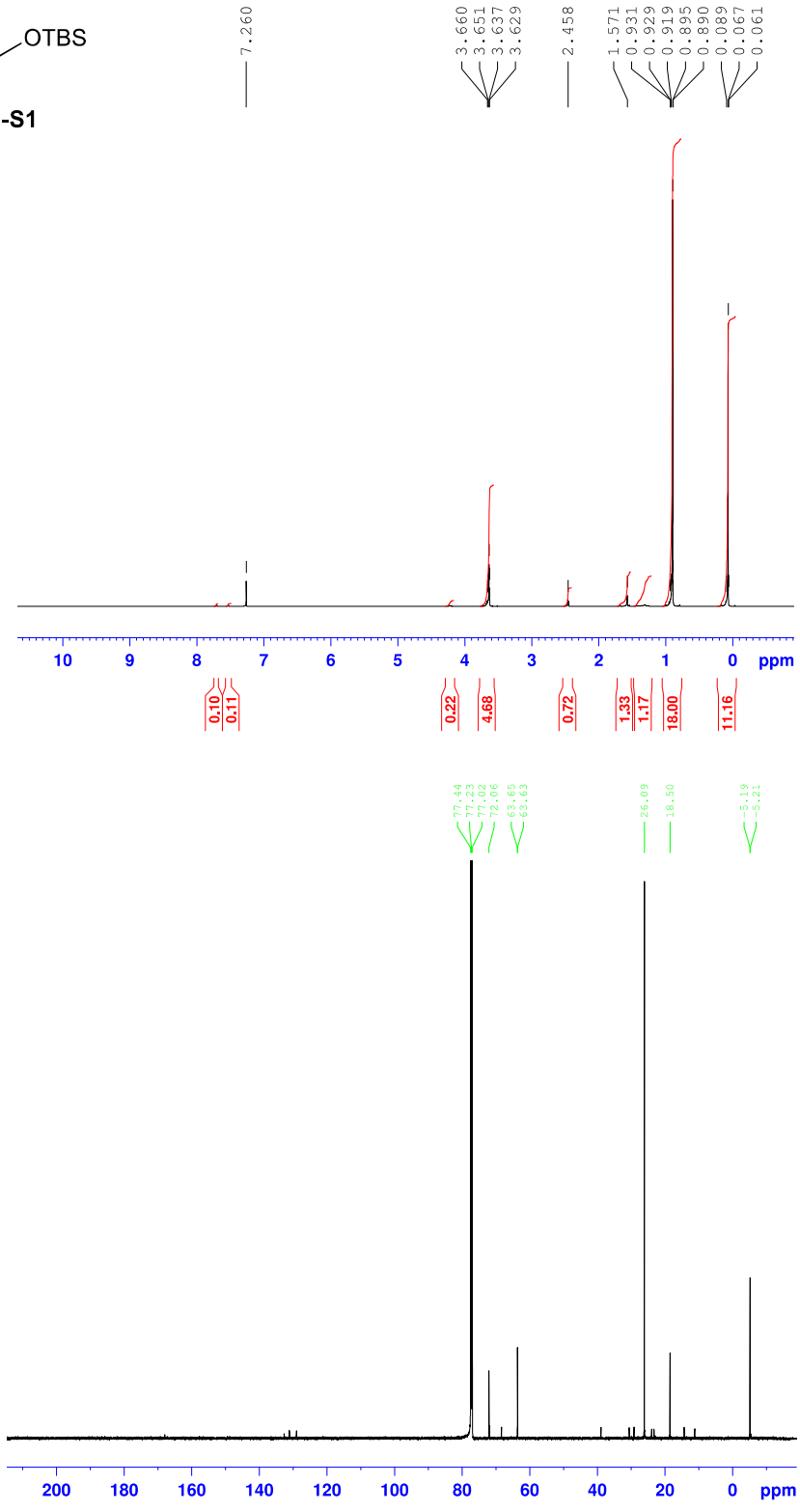

(*R*)-[1-$^{18}$O]-**1**



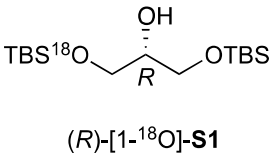
$^{1}$H- and $^{13}$C-NMR of (*S*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy-2-propanol **S1** in $CDCl_3$



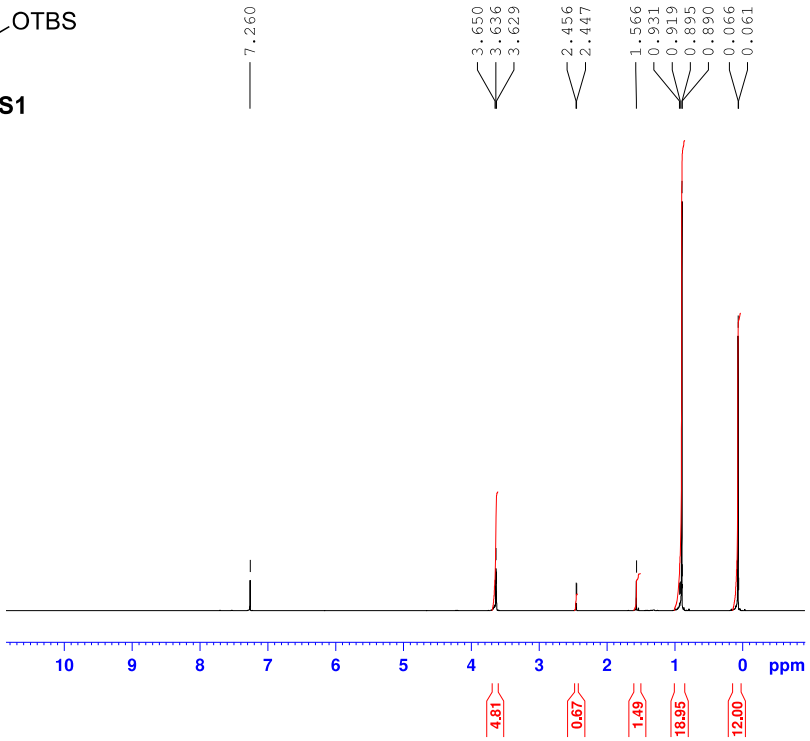

(*S*)-[1-$^{18}$O]-**S1**

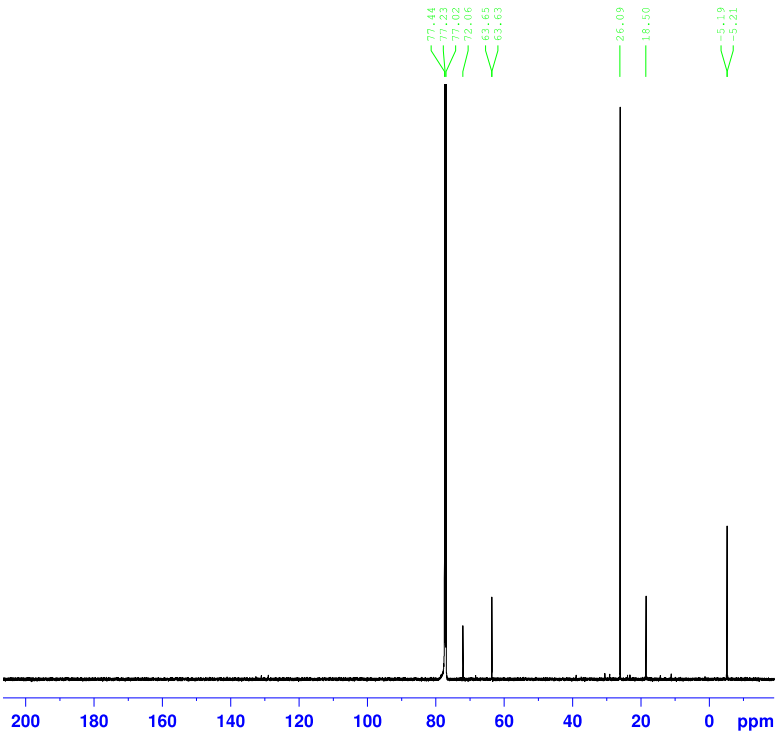


$^{1}$H- and $^{13}$C-NMR of (*R*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy-2-propanol **S1** in $CDCl_3$

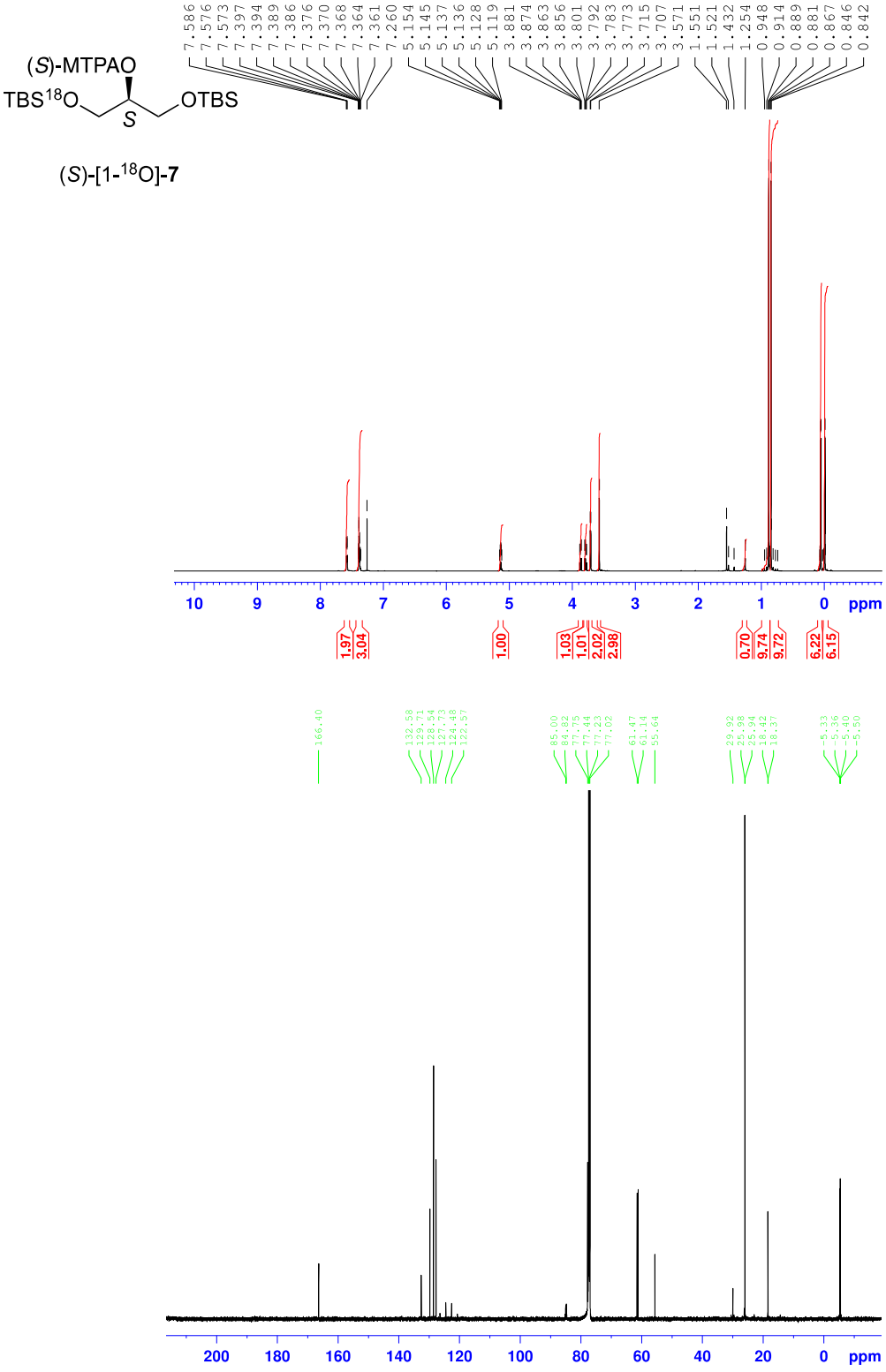



(*R*)-[1-$^{18}$O]-**S1**



$^{1}$H- and $^{13}$C-NMR of (*S*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy propan-2-yl-(*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate **7** in $CDCl_3$



$^{1}$H- and $^{13}$C-NMR of (*R*)-1-*tert*-butyldimethylsilyl-[$^{18}$O]-oxy-3-*tert*-butyldimethylsilyloxy propan-2-yl-(*S*)-3,3,3-trifluoro-2-methoxy-2-phenylpropanoate **7** in $CDCl_3$