

Supporting Information

Assembly of Polysubstituted Chiral Cyclopropylamines *via* Highly Enantioselective Cu-Catalyzed Three-component Cyclopropene Alkenylation

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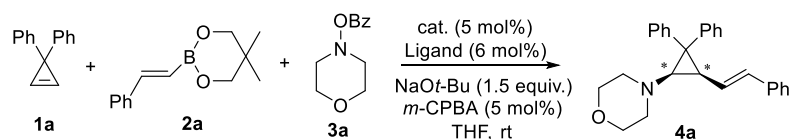
1. General Information

Unless otherwise noted, all reactions were carried out in anhydrous solvents distilled under a N₂ atmosphere. Tetrahydrofuran and dioxane were distilled over sodium with benzophenone as indicator. Palladium salts, ligands, CsCO₃, NH₂OH·HCl, *tert*-Butyldimethylsilyl chloride and substratebromobenzenes were purchased from commercial sources and used as received. *O*-(*tert*-butyldimethylsilyl) oxime were synthesized according to literature. ¹H NMR and ¹³C NMR spectra were recorded on a Bruker 400 or 600 MHz spectrometer at 25°C. Chemical shifts (δ) are expressed in parts per million (ppm) relative to internal standard [0 ppm (TMS) for ¹H NMR and 77.0 ppm (CDCl₃) for ¹³C NMR]. High resolution mass spectra were recorded on a Bruker microTOF spectrometer. NMR were processed with MestReNova software. Enantiomeric excesses (ee) were determined by an Agilent 1260 I or II Series or Shimadzu HPLC on chiral stationary phases, with chiral columns from Daicel Corp. Flash chromatography was performed on silica gel 60 (particle size 300-400 mesh ASTM, purchased from Taizhou, China). Cyclopropenes,¹ alkenyl boronates,² and hydroxyamine benzoates³ were synthesized according to the procedures of literature reports.

2. Experimental details

2.1 Reaction optimization

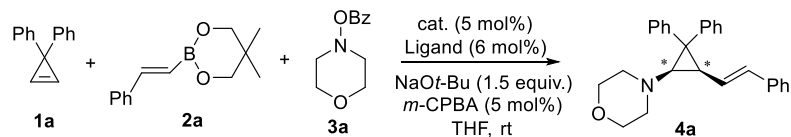
Table S1. Optimization of the racemic three-component cyclopropene vinylamination reaction (I).^a



Entry	Catalyst	Ligand	Yield/% ^b
1	CuCl	dppbz	80
2	TcCu	dppbz	nr.
3	CuOAc	dppbz	nr.
4	CuCN	dppbz	8
5	CuOTf	dppbz	trace
6	CuI	dppbz	8
7	CuCl	Xantphos	17
8	CuCl	(±)-BINAP	47
9	CuCl	Dppe	34
10	CuCl	Dppp	trace
11	CuCl	Dppf	7
12 ^c	CuCl	Tri(4-fluorophenyl)phosphine	31
13 ^c	CuCl	Tri(4-chlorophenyl)phosphine	80
14 ^c	CuCl	Tri(<i>tert</i> -butyl)phosphine	69
15 ^c	CuCl	Tri(<i>o</i> -tolyl)phosphine	74

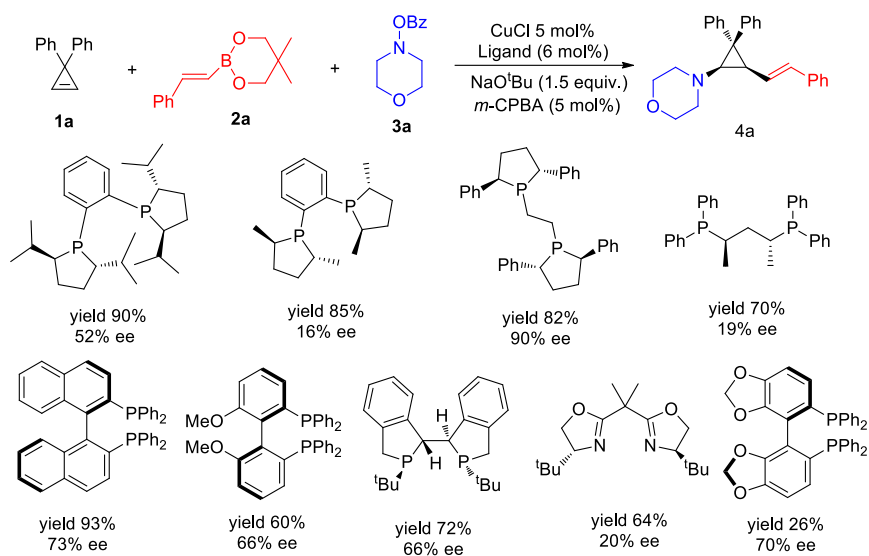
^a Conditions: cyclopropene (0.20 mmol, 1.0 equiv.), boronic ester **2** (0.24 mmol, 1.2 equiv.), **3** (0.24 mmol, 1.2 equiv.), Cu catalyst (0.010 mmol, 5 mol%), **L** (0.012 mmol, 6 mol%), NaOt-Bu (0.30 mmol, 1.5 equiv.), *m*-CPBA (0.010 mmol, 5 mol%), solvent (anhydrous, aged, 2 mL). ^b Isolated yields. ^c 12 mol% ligand was used.

Table S2. Optimization of the racemic three-component cyclopropene vinylamination reaction (II).^a



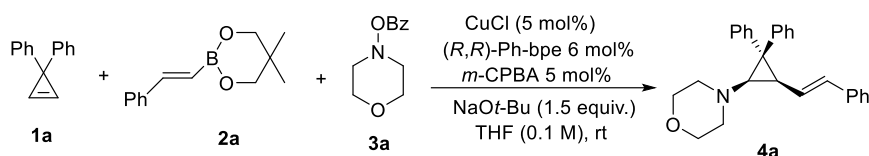
Entry	L	2a/eq	3a/eq	Yield ^b /%
1	Dppbz	1.2	1.2	80
2	Dppbz	1.5	1.5	83
3	Dppbz	2.0	2.0	91
4 ^c	Tris(4-chlorophenyl)phosphine ^c	2.0	2.0	83

^a Conditions: cyclopropene (0.20 mmol, 1.0 equiv.), boronic ester **2** (0.24 mmol, 1.2 equiv.), **3** (0.24 mmol, 1.2 equiv.), Cu catalyst (0.010 mmol, 5 mol%), **L** (0.012 mmol, 6 mol%), NaOt-Bu (0.30 mmol, 1.5 equiv.), *m*-CPBA (0.010 mmol, 5 mol%), solvent (anhydrous, aged, 2 mL). ^b Isolated yields. ^c 12 mol% ligand was used.



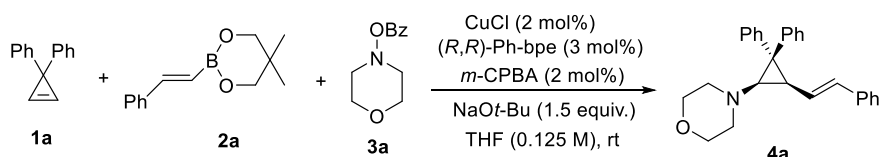
Scheme S1. Ligand effects on the enantioselective reaction.

2.2 General procedure for Cu-catalyzed cyclopropene alkenylation



In a nitrogen filled glovebox, CuCl (1.0 mg, 0.01 mmol, 0.05 equiv.), (*R,R*)-Ph-bpe (6.3 mg, 0.012 mmol, 0.06 equiv.) were dissolved in anhydrous THF (2 mL). The mixture stirred at room temperature for ca. 2 min before *m*-CPBA (2 mg, 0.01 mmol, 0.05 equiv), NaOt-Bu (28.8 mg, 0.3 mmol, 1.5 equiv), and boronic ester (65 mg, 0.30 mmol, 1.5 equiv.) were sequentially added. The mixture was stirred for about 5 min, then cyclopropene (0.2 mmol, 38 μ L) and morpholino benzoate (62.3 mg, 0.3 mmol, 1.5 equiv) were sequentially added. The resulting mixture was stirred at room temperature and monitored by TLC. After complete conversion, the solvent was removed *in vacuo* and residue was subjected to flash chromatography (eluent: petroleum/EtOAc = 50/1) to afford the title compound **4a**.

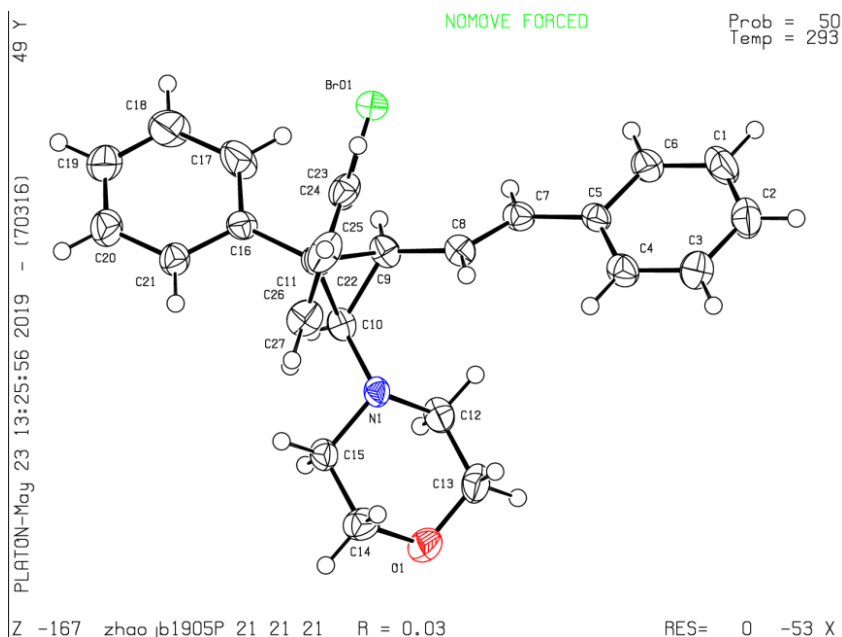
2.3 Procedure for 1 mmol scale reaction.



In a N₂ filled glovebox, CuCl (2.0 mg, 0.02 mmol, 0.02 equiv.) and (*R,R*)-Ph-BPE (15.2 mg, 0.03 mmol, 0.03 equiv.) were dissolved in anhydrous THF (8 mL). The mixture was stirred at room temperature for ca. 2 min before *m*-CPBA (2.0 mg, 0.02 mmol, 0.02 equiv), NaOt-Bu (144 mg, 1.5 mmol, 1.5 equiv.) and boronic ester (259.2 mg, 1.20 mmol, 1.2 equiv.) were successively added. The mixture was stirred for about 5 min at room temperature, then cyclopropene (190 μ L, 1 mmol, added dropwise) and morpholino benzoate (248.6 mg, 1.2 mmol, 1.2 equiv) were sequentially added. The resulting mixture was stirred at room temperature and monitored by TLC. After complete conversion, the solvent was removed *in vacuo* and residue was subjected to flash chromatography (eluent: petroleum/EtOAc = 50/1) to afford the title compound **4a** (305.8 mg, 80%).

3. Determination of structure and absolute configuration.

3.1 Single crystal X-ray diffraction study of **4t** (CCDC# 1970687).



Bond precision:	C-C = 0.0051 Å	Wavelength=1.54178
Cell:	a=9.6932 (5)	b=10.7179 (6)
	alpha=90	beta=90
		gamma=90
Temperature:	293 K	
	Calculated	Reported
Volume	2269.2 (2)	2269.2 (2)
Space group	P 21 21 21	P 21 21 21
Hall group	P 2ac 2ab	P 2ac 2ab
Moiety formula	C27 H26 Br N O	C27 H26 Br N O
Sum formula	C27 H26 Br N O	C27 H26 Br N O
Mr	460.39	460.40
Dx, g cm ⁻³	1.348	1.348
Z	4	4
Mu (mm ⁻¹)	2.595	2.595
F000	952.0	952.0
F000'	951.45	
h, k, lmax	11, 13, 26	11, 13, 26
Nref	4267 [2439]	4191
Tmin, Tmax		
Tmin'		
Correction method=	Not given	
Data completeness=	1.72/0.98	Theta (max)= 69.693
R(reflections)=	0.0282 (3921)	wR2(reflections)= 0.0640 (4191)
S =	1.072	Npar= 271

Figure S1. X-ray single crystal of **4t** and diffraction data.

3.2. NOESY and H-H COSY spectra of selected compounds **4t-4v**.

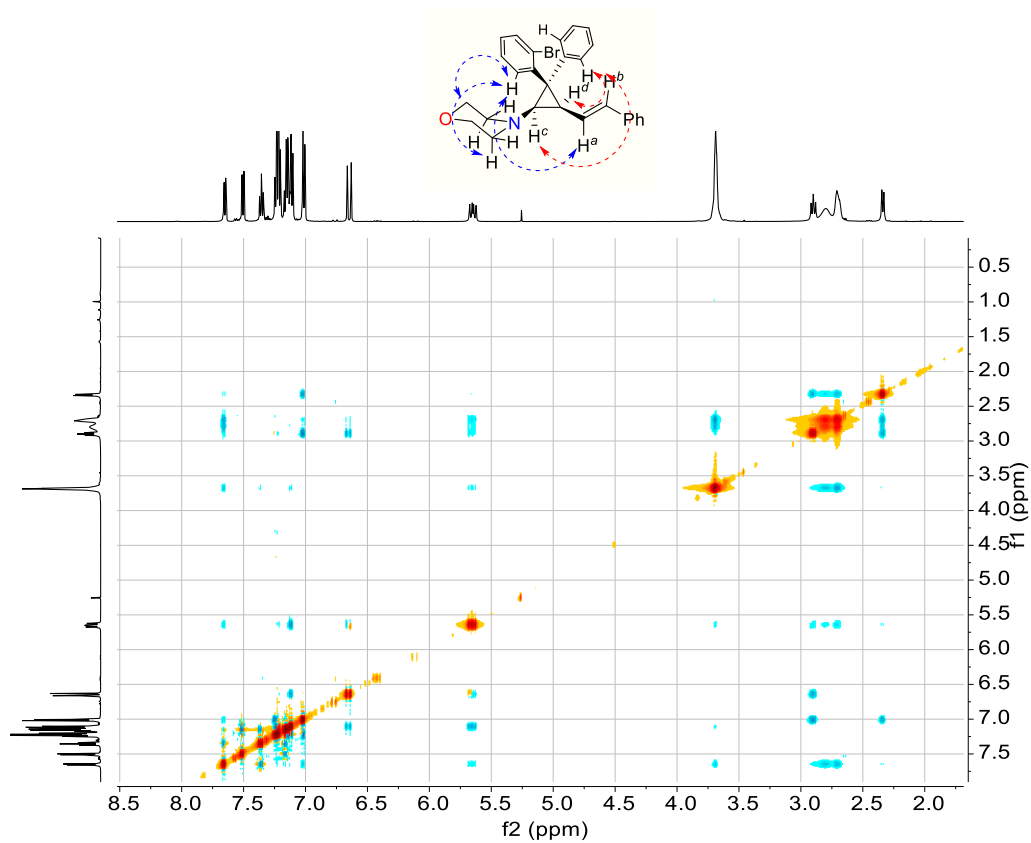


Figure S2. NOESY spectrum of **4t**.

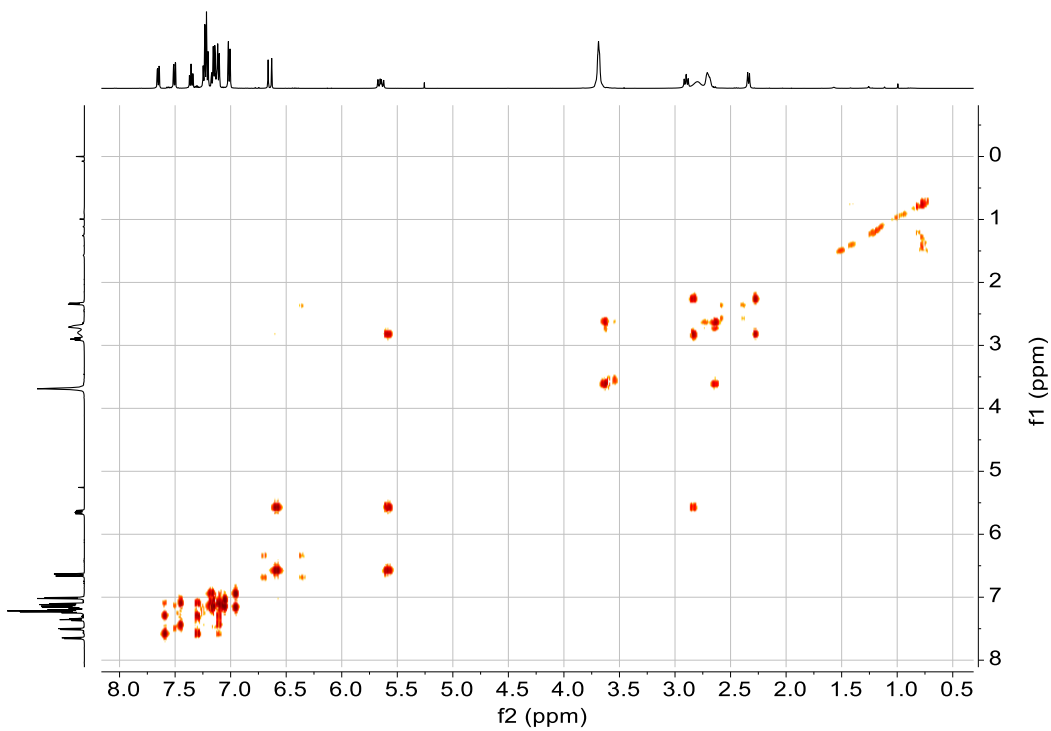


Figure S3. H-H COSY spectrum of **4t**.

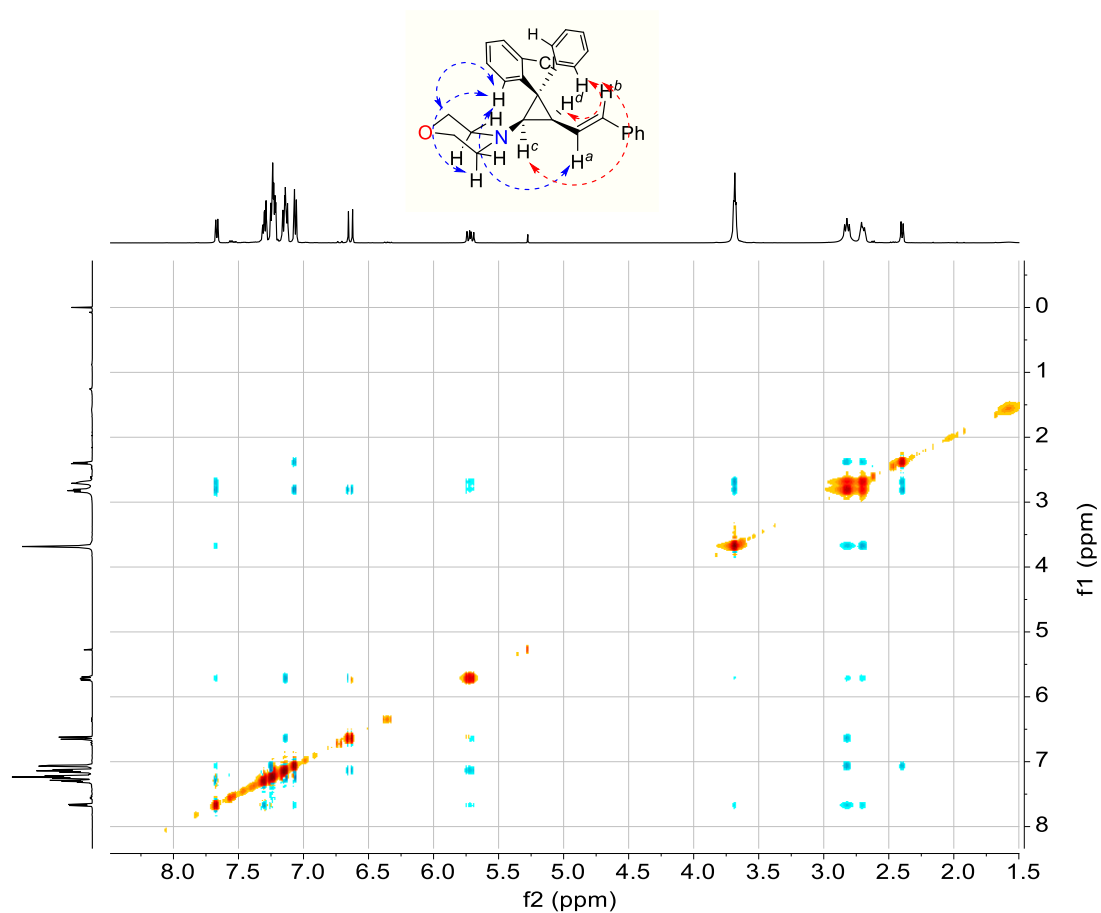


Figure S4. NOESY spectrum of **4u**.

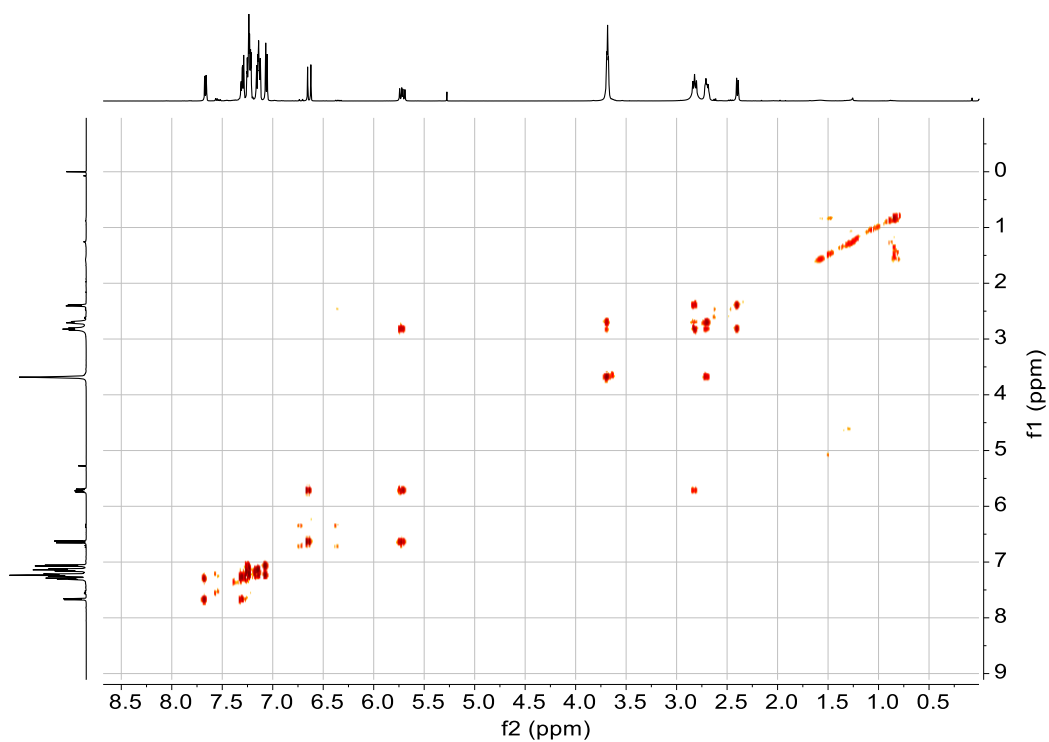


Figure S5. H-H COSY spectrum of **4u**.

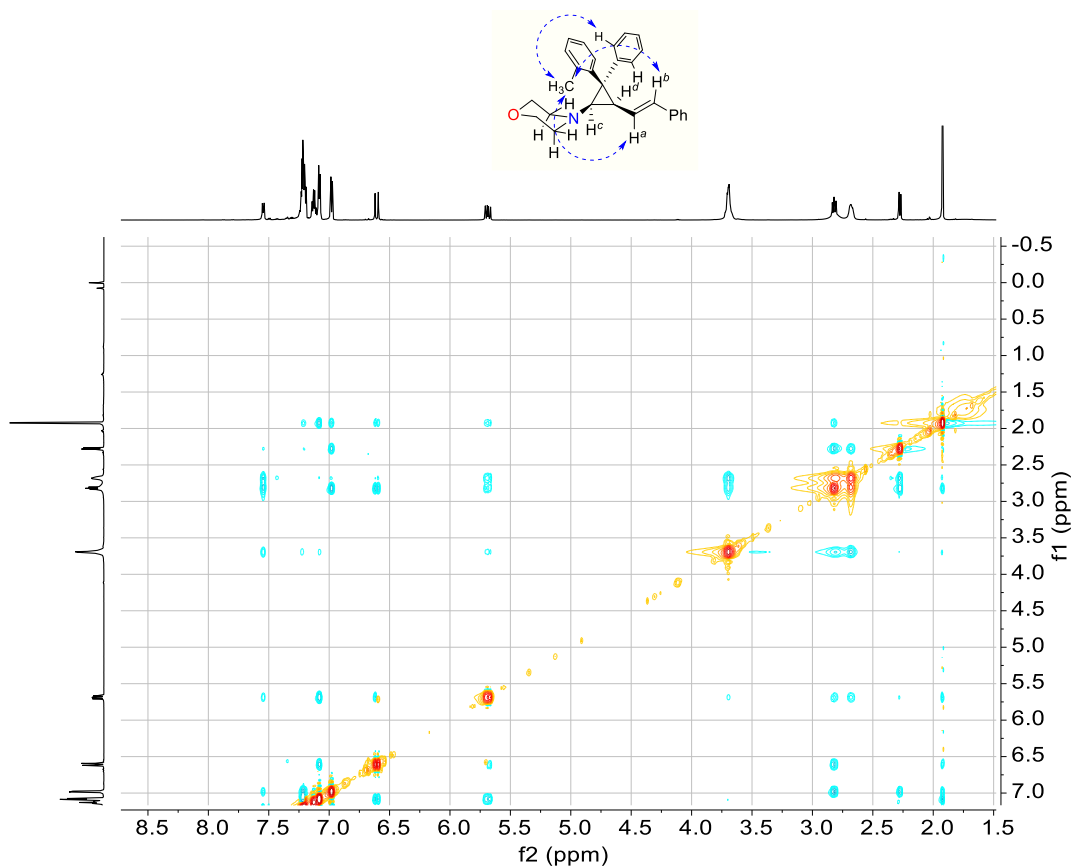


Figure S6. NOESY spectrum of 4v.

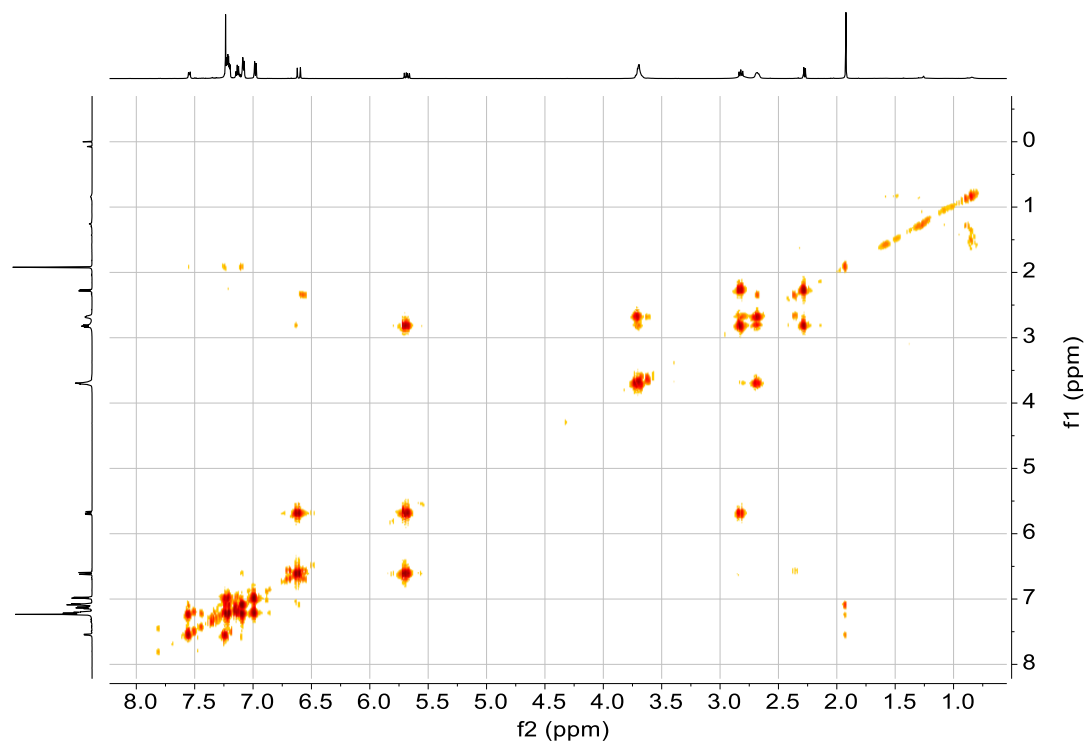
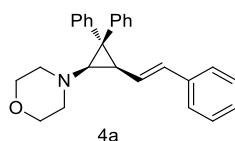


Figure S7. H-H COSY spectrum of 4v.

4. Characterization of all new compounds.



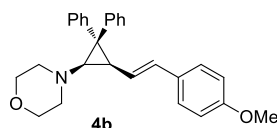
4-((1R, 3R)-2, 2-diphenyl-3-((E)-styryl)cyclopropyl)morpholine (4a): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4a** (62.3 mg, 82% yield, 90% ee) as a colorless oil.

$[\alpha]_D^{19} = 269.3$ ($c = 1.0$, CHCl_3) for 90% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.48-7.44 (m, 2H), 7.30-7.22 (m, 10H), 7.21-7.12 (m, 3H), 6.62 (d, $J = 15.6$ Hz, 1H), 6.14 (dd, $J = 15.6, 10.2$ Hz, 1H), 3.71-3.59 (m, 4H), 2.92-2.72 (m, 2H), 2.72-2.63 (m, 2H), 2.61 (d, $J = 7.8$ Hz, 1H), 2.49 (dd, $J = 10.2, 7.8$ Hz, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.0, 139.3, 137.8, 131.2, 130.2, 128.6, 128.5, 128.30, 128.29, 127.9, 126.8, 126.17, 126.15, 125.8, 66.7, 57.1, 54.3, 42.2, 34.5.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{28}\text{NO}$ ($[\text{M}+\text{H}]^+$), 382.2165, found 382.2135.



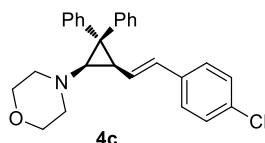
4-((1R, 3R)-3-((E)-4-methoxystyryl)-2, 2-diphenylcyclopropyl)morpholine (4b): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-(4-methoxystyryl)-1,3,2-dioxaborinane (0.30 mmol, 74.1 mg) and morpholino benzoate (0.30 mmol, 63.2 mg) afforded product **4b** (53.5 mg, 65% yield, 93% ee) as a yellow oil.

$[\alpha]_D^{19} = 171.9$ ($c = 1.0$, CHCl_3) for 93% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.47-7.43 (m, 2H), 7.28-7.22 (m, 6H), 7.22-7.14 (m, 4H), 6.85-6.81 (m, 2H), 6.57 (d, $J = 16.2$ Hz, 1H), 5.98 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.79 (s, 3H), 3.70-3.61 (m, 4H), 2.88-2.74 (m, 2H), 2.73-2.64 (m, 2H), 2.59 (d, $J = 7.8$ Hz, 1H), 2.47 (dd, $J = 10.2, 7.8$ Hz, 1H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 158.7, 147.1, 139.5, 131.3, 130.8, 129.6, 128.47, 128.35, 127.9, 126.9, 126.1, 126.0, 114.0, 66.8, 57.0, 55.3, 54.3, 41.2, 34.6;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{28}\text{H}_{30}\text{NO}_2$ ($[\text{M}+\text{H}]^+$), 412.2271, found 412.2270.



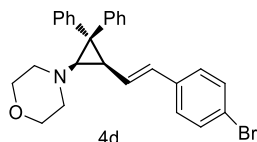
4-((1R, 3R)-3-((E)-4-chlorostyryl)-2, 2-diphenylcyclopropyl)morpholine (4c): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-2-(4-chlorostyryl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 75.1 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4c** (65.6 mg, 79% yield, 98% ee) as a colorless oil.

$[\alpha]_D^{19} = 273.1$ ($c = 1.0$, CHCl_3) for 98% ee.

¹H NMR (600 MHz, CDCl₃) δ 7.44 (d, *J* = 7.2 Hz, 2H), 7.28-7.20 (m., 8H), 7.20 – 7.12 (m, 4H), 6.57 (d, *J* = 16.2 Hz, 1H), 6.11 (dd, *J* = 15.6., 10.2 Hz, 1H), 3.72 – 3.58 (m, 4H), 2.80 (s, 2H), 2.69 – 2.63 (m, 2H), 2.62(d, *J*=7.8Hz, 1H), 2.48 (dd, *J* = 10.2, 8.4 Hz, 1H).

¹³C NMR (150 MHz, CDCl₃) δ 146.8, 139.2, 136.3, 132.3, 131.2, 129.1, 128.9, 128.7, 128.5, 128.3, 128.0, 126.9, 126.24,126.21, 66.6, 57.2, 54.3, 42.4, 34.4.

HRMS (ESI-TOF) (*m/z*): Calcd for C₂₇H₂₇ClNO ([M+H]⁺), 416.1776, found 416.1770.



4-((1R, 3R)-3-((E)-4-bromostyryl)-2, 2-diphenylcyclopropyl)morpholine (4d): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (E)-2-(4-bromostyryl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 88.5 mg) and morpholino benzoate (0.30 mmol, 63.3 mg) afforded product **4d** (59.7 mg, 65% yield, 91% ee) as a white solid.

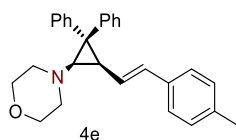
m.p. 70-71 °C.

[α]_D¹⁹ = 269.3 (c = 1.0, CHCl₃) for 91% ee.

¹H NMR (600 MHz, CDCl₃) δ 7.43 (d, *J* = 7.8 Hz, 2H), 7.38 (d, *J* = 8.4 Hz, 2H), 7.29 – 7.21 (m, 6H), 7.12-7.21 (m, 2H), 7.11 (d, *J* = 8.4 Hz, 2H), 6.55 (d, *J* = 15.6 Hz, 1H), 6.13 (dd, *J* = 16.2, 10.2 Hz, 1H), 3.74 – 3.57 (m, 4H), 2.80 (s, 2H), 2.73 – 2.58 (m, 3H), 2.48 (dd, *J* = 9.6, 8.4 Hz, 1H).

¹³C NMR (150 MHz, CDCl₃) δ 146.7, 139.2, 136.7, 131.7, 131.2, 129.3, 129.0, 128.5, 128.3, 128.0, 127.3, 126.25, 126.21, 120.4, 66.6, 57.2, 54.3, 42.4, 34.4.

HRMS (ESI-TOF) (*m/z*): Calcd for C₂₇H₂₇BrNO ([M+H]⁺), 460.1271, found 460.1263.



4-((1R, 3R)-3-((E)-4-methylstyryl)-2, 2-diphenylcyclopropyl)morpholine (4e): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (E)-5,5-dimethyl-2-(4-methylstyryl)-1,3,2-dioxaborinane (0.30 mmol, 69.0 mg) and morpholino benzoate (0.30 mmol, 62.9 mg) afforded product **4e** (53.0 mg, 67% yield, 98% ee) as a white solid.

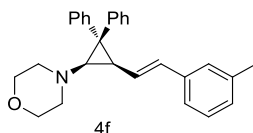
m.p. 56-57 °C

[α]_D¹⁹ = 273.6 (c = 1.0, CHCl₃) for 98% ee.

¹H NMR (600 MHz, CDCl₃) δ 7.45 (d, *J* = 8.4 Hz, 2H), 7.28 – 7.21 (m, 6H), 7.21 – 7.10 (m, 4H), 7.08 (d, *J* = 7.8 Hz, 2H), 6.59 (d, *J* = 15.6 Hz, 1H), 6.08 (dd, *J* = 15.6, 10.2 Hz, 1H), 3.68-3.60(m, 4H), 2.79 (s, 2H), 2.69-2.65 (m, 2H), 2.60 (d, *J* = 7.8 Hz, 1H), 2.47 (dd, *J* = 10.2, 7.8 Hz, 1H), 2.31 (s, 3H).

¹³C NMR (150 MHz, CDCl₃) δ 147.0, 139.4, 136.6, 135.1, 131.3, 130.0, 129.2, 128.4, 128.3, 127.9, 127.2, 126.12, 126.09, 125.7, 66.7, 57.0, 54.3, 42.1, 34.5, 21.1.

HRMS (ESI-TOF) (*m/z*): Calcd for C₂₈H₃₀NO ([M+H]⁺), 396.2322, found 396.2329.



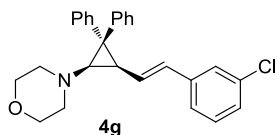
4-((1R, 3R)-3-((E)-3-methylstyryl)-2, 2-diphenylcyclopropyl)morpholine (4f): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (E)-5,5-dimethyl-2-(3-methylstyryl)-1,3,2-dioxaborinane (0.30 mmol, 70 mg) and morpholino benzoate (0.30 mmol, 63 mg) afforded product **4f** (46.1 mg, 58% yield, 90% ee) as a colorless oil.

$[\alpha]_D^{19} = 199.7$ ($c = 1.0$, CHCl_3) for 90% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.48-7.43 (m, 2H), 7.30-7.22 (m, 6H), 7.21-7.14 (m, 3H), 7.10-7.05 (m, 2H), 7.02-6.97 (m, 1H), 6.60 (d, $J = 16.2$ Hz, 1H), 6.11 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.71-3.61 (m, 4H), 2.87-2.76 (m, 2H), 2.71-2.65 (m, 2H), 2.61 (d, $J = 7.8$ Hz, 1H), 2.48 (dd, $J = 10.2, 7.8$ Hz, 1H), 2.32 (s, 3H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.1, 139.4, 138.2, 137.8, 131.3, 130.3, 128.5, 128.3, 128.1, 128.0, 127.6, 126.7, 126.18, 126.14, 125.5, 122.9, 66.7, 57.1, 54.3, 42.2, 34.6, 21.4;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{28}\text{H}_{30}\text{NO}$ ($[\text{M}+\text{H}]^+$), 396.2322, found 396.2325.



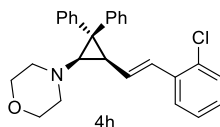
4-((1R, 3R)-3-((E)-3-chlorostyryl)-2, 2-diphenylcyclopropyl)morpholine (4g): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (E)-5,5-dimethyl-2-(3-chlorostyryl)-1,3,2-dioxaborinane (0.30 mmol, 74 mg) and morpholino benzoate (0.30 mmol, 63.4 mg) afforded product **4g** (74.3 mg, 89% yield, 97% ee) as a colorless oil.

$[\alpha]_D^{19} = 276.1$ ($c = 0.5$, CHCl_3) for 97% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.47-7.43 (m, 2H), 7.30-7.10 (m, 12H), 6.56 (d, $J = 16.2$ Hz, 1H), 6.15 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.73-3.60 (m, 4H), 2.93-2.72 (m, 2H), 2.70-2.60 (m, 3H), 2.48 (dd, $J = 10.2, 7.8$ Hz, 1H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 146.8, 139.7, 139.2, 134.5, 131.1, 130.1, 129.8, 128.5, 128.3, 128.0, 126.7, 126.3, 126.2, 125.8, 123.9, 66.7, 57.3, 54.3, 42.6, 34.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{27}\text{ClNO}$ ($[\text{M}+\text{H}]^+$), 416.1776, found 416.1771.



4-((1R, 3R)-3-((E)-2-chlorostyryl)-2, 2-diphenylcyclopropyl)morpholine (4h): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (E)-2-(2-chlorostyryl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 75.8 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4h** (42.3 mg, 51% yield, 93% ee) as a white solid.

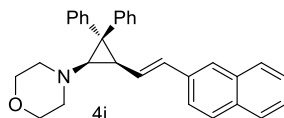
m.p. 63-64 °C

$[\alpha]_D^{12} = 229.7$ ($c = 1.0$, CHCl_3) for 93% ee.

¹H NMR (600 MHz, CDCl₃) δ 7.48 – 7.44 (m, 2H), 7.32 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.30-7.23(m, 6H), 7.22 – 7.08 (m, 5H), 7.02 (d, *J* = 16.2 Hz, 1H), 6.13 (dd, *J* = 16.2 10.2 Hz, 1H), 3.70 – 3.62 (m, 4H), 2.82 (s, 2H), 2.72 – 2.66 (m, 2H), 2.64 (d, *J* = 7.8 Hz, 1H), 2.58 (dd, *J* = 10.2, 8.4 Hz, 1H).

¹³C NMR (150 MHz, CDCl₃) δ 146.7, 139.2, 135.7, 132.2, 131.24, 131.22, 129.6, 128.5, 128.3, 128.0, 127.8, 126.8, 126.4, 126.24, 126.22, 126.1, 66.7, 57.3, 54.3, 42.6, 34.4.

HRMS (ESI-TOF) (*m/z*): Calcd for C₂₇H₂₇ClNO ([M+H]⁺), 416.1776, found 416.1785.



4-((1*R*, 3*R*)-3-((*E*)-2-(naphthalen-2-yl)vinyl)-2, 2-diphenylcyclopropyl)morpholine (4i**):**

following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-(2-(naphthalen-2-yl)vinyl)-1,3,2-dioxaborinane (0.30 mmol, 80.1 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4i** (60.3 mg, 70% yield, 96% ee) as a white solid.

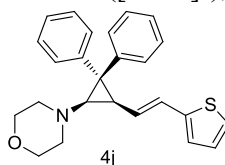
m.p. 76-77 °C.

[α]_D¹⁹ = 186.4 (c = 1.0, CHCl₃) for 96% ee.

¹H NMR (600 MHz, CDCl₃) δ 7.78 – 7.73 (m, 2H), 7.71 (d, *J* = 9.0 Hz, 1H), 7.61 (s, 1H), 7.48 (d, *J* = 7.2 Hz, 2H), 7.46 – 7.36 (m, 3H), 7.29 – 7.23 (m, 6H), 7.22 – 7.14 (m, 2H), 6.78 (d, *J* = 15.6 Hz, 1H), 6.26 (dd, *J* = 16.2, 10.2 Hz, 1H), 3.72 – 3.61 (m, 4H), 2.81 (s, 2H), 2.74 – 2.67 (m, 2H), 2.64 (d, *J* = 7.8 Hz, 1H), 2.54 (dd, *J* = 10.2, 7.8 Hz, 1H).

¹³C NMR (150 MHz, CDCl₃) δ 147.0, 139.3, 135.3, 133.7, 132.6, 131.3, 130.4, 128.9, 128.5, 128.3, 128.2, 128.0, 127.8, 127.6, 126.22, 126.20, 126.17, 125.5, 125.1, 123.4, 66.7, 57.2, 54.3, 42.4, 34.6.

HRMS (ESI-TOF) (*m/z*): Calcd for C₃₁H₃₀NO ([M+H]⁺), 432.2322, found 432.2330.



4-((1*R*,3*R*)-2,2-Diphenyl-3-((*E*)-2-(thiophen-2-yl)vinyl)cyclopropyl)morpholine (4j**):**

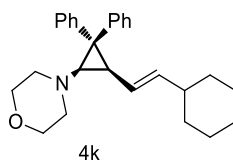
following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-(2-(thiophen-2-yl)vinyl)-1,3,2-dioxaborinane (0.30 mmol, 66.7 mg) and morpholino benzoate (0.30 mmol, 62.0 mg) afforded product **4j** (49.6 mg, 65% yield, 95% ee) as a yellow oil.

[α]_D¹² = 540.1 (c = 1.0, CHCl₃) for 95% ee..

¹H NMR (600 MHz, CDCl₃) δ 7.44 (d, *J* = 7.2 Hz, 2H), 7.29 – 7.21 (m, 6H), 7.21-7.13 (m, 2H), 7.06 (d, *J* = 4.8 Hz, 1H), 6.92 (dd, *J* = 5.4, 3.6 Hz, 1H), 6.85 (d, *J* = 3.6 Hz, 1H), 6.74 (d, *J* = 15.6 Hz, 1H), 6.00 (dd, *J* = 15.6, 10.2 Hz, 1H), 3.73 – 3.58 (m, 4H), 2.78 (s, 2H), 2.72 – 2.64 (m, 2H), 2.62 (d, *J* = 7.8 Hz, 1H), 2.42 (dd, *J* = 10.2, 7.8 Hz, 1H).

¹³C NMR (150 MHz, CDCl₃) δ 146.9, 143.4, 139.2, 131.2, 128.6, 128.4, 128.3, 128.0, 127.4, 126.29, 126.27, 123.9, 123.4, 123.3, 66.8, 57.0, 54.3, 42.4, 34.5.

HRMS (ESI-TOF) (*m/z*): Calcd for C₂₅H₂₆NOS ([M+H]⁺), 388.1730, found 388.1724.



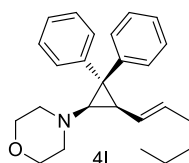
4-((1R, 3R)-3-((E)-2-cyclohexylvinyl)-2,2-diphenylcyclopropyl)morpholine (4k): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-2-(2-cyclohexylvinyl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 66.9 mg) and morpholino benzoate (0.30 mmol, 62.9 mg) afforded product **4k** (48.8 mg, 63% yield, 96% ee) as a colorless oil.

$[\alpha]_D^{12} = 60.3$ ($c = 1.0$, CHCl_3) for 96% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.33 (d, $J = 7.8$ Hz, 2H), 7.20-7.00 (m, , 8H), 5.55 (dd, $J = 15.6$, 6.6 Hz, 1H), 5.18 (dd, $J = 15.6$, 10.2 Hz, 1H), 3.64-3.52 (m, 4H), 2.66 (s, 2H), 2.62 – 2.55 (m, 2H), 2.35 (d, $J = 7.8$ Hz, 1H), 2.22 (t, $J = 9.6$ Hz, 1H), 1.91 – 1.84 (m, 1H), 1.66 – 1.50 (m, 6H), 1.22 – 1.12 (m, 2H), 1.10 – 1.02 (m, 1H), 0.96 (dt, $J = 16.2$, 8.6 Hz, 2H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.3, 139.6, 137.7, 131.3, 128.35, 128.34, 127.6, 125.89, 125.83, 124.7, 66.7, 56.4, 54.2, 40.7, 40.4, 33.8, 33.12, 33.09, 26.2, 26.0.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{34}\text{NO}$ ($[\text{M}+\text{H}]^+$), 388.2635, found 388.2630.



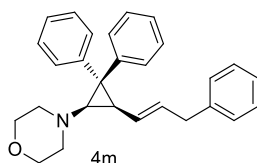
4-((1R, 3R)-3-((E)-hex-1-en-1-yl)-2,2-diphenylcyclopropyl)morpholine (4l): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-2-(hex-1-en-1-yl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 59 mg) and morpholino benzoate (0.30 mmol, 62.6 mg) afforded product **4l** (58.2 mg, 80% yield, 96% ee) as a colorless oil.

$[\alpha]_D^{12} = 128.4$ ($c = 1.0$, CHCl_3) for 96% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.42 (d, $J = 7.6$ Hz, 2H), 7.26-7.16 (m, 6H), 7.16-7.10 (m, 2H), 5.72 – 5.62 (m, 1H), 5.31 (dd, $J = 15.6$, 10.2 Hz, 1H), 3.72-3.60 (m, 4H), 2.74 (s, 2H), 2.70 – 2.61 (m, 2H), 2.42 (d, $J = 7.8$ Hz, 1H), 2.32 (t, $J = 7.2$, 1H), 2.02 (q, $J = 6.6$ Hz, 2H), 1.39 – 1.22 (m, 4H), 0.87 (t, $J = 7.2$ Hz, 3H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.3, 139.7, 131.9, 131.2, 128.43, 128.36, 127.6, 126.9, 125.9, 125.8, 66.7, 56.4, 54.2, 40.4, 33.7, 32.3, 31.6, 22.0, 13.8.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{25}\text{H}_{32}\text{NO}$ ($[\text{M}+\text{H}]^+$), 362.2478, found 362.2466.



4-((1R, 3R)-2,2-diphenyl-3-((E)-3-phenylprop-1-en-1-yl)cyclopropyl)morpholine (4m):

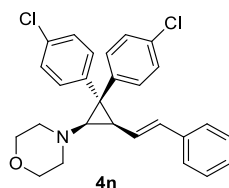
following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-(3-phenylprop-1-en-1-yl)-1,3,2-dioxaborinane (0.30 mmol, 69.2mg) and morpholino benzoate (0.30 mmol, 62.9 mg) afforded product **4m** (55.6 mg, 70% yield, 94% ee) as a yellow oil.

$[\alpha]_D^{12} = 40.1$ ($c = 1.0$, CHCl_3) for 94% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.33 (d, $J = 7.8$ Hz, 2H), 7.25-7.00 (m, 15H), 5.80 – 5.70 (m, 1H), 5.32 (dd, $J = 15.6, 10.2$ Hz, 1H), 3.60-3.54 (m, 4H), 3.26 (d, $J = 6.6$ Hz, 2H), 2.65 (s, 2H), 2.60 – 2.53 (m, 2H), 2.36 (d, $J = 7.8$ Hz, 1H), 2.30 – 2.24 (m, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.1, 130.8, 139.6, 131.2, 130.3, 128.6, 128.45, 128.44, 128.38, 128.32, 127.7, 126.0, 125.9, 66.7, 56.6, 54.2, 40.8, 39.4, 33.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{28}\text{H}_{30}\text{NO}$ ($[\text{M}+\text{H}]^+$), 396.2322, found 396.2307.



4-((1R,3R)-2-bis(4-chlorophenyl)-3-((*E*)-styryl)cyclopropyl)morpholine (4n**):** following the general procedure (II), the reaction of 3,3-di(4-chlorophenyl) cyclopropene (0.2 mmol, 52.3 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65 mg) and morpholino benzoate (0.30 mmol, 62.1 mg) afforded product **4n** (60.0 mg, 66% yield, 95% ee) as a white solid.

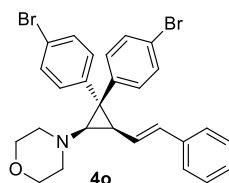
m.p. 63-64 °C

$[\alpha]_D^{19} = 109.5$ ($c = 1.0$, CHCl_3) for 95% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.40-7.33 (m, 2H), 7.33-7.18 (m, 9H), 7.16-7.10 (m, 2H), 6.64 (d, $J = 16.2$ Hz, 1H), 6.05 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.73-3.57 (m, 4H), 2.84-2.70 (m, 2H), 2.70-2.60 (m, 2H), 2.56 (d, $J = 7.8$ Hz, 1H), 2.46 (dd, $J = 10.2, 7.8$ Hz, 1H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 144.8, 137.46, 137.41, 132.4, 132.3, 132.2, 131.1, 129.6, 128.7, 128.6, 128.2, 127.1, 126.9, 125.8, 66.6, 57.0, 54.2, 40.8, 34.6;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{26}\text{Cl}_2\text{NO}$ ($[\text{M}+\text{H}]^+$), 450.1386, found 450.1388.



4-((1R,3R)-2-bis(4-bromophenyl)-3-((*E*)-styryl)cyclopropyl)morpholine (4o**):** following the general procedure (II), the reaction of 3,3-di(4-bromophenyl) cyclopropene (0.20 mmol, 70.3 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.3 mg) and morpholino benzoate (0.30 mmol, 62.1 mg) afforded product **4o** (99.2 mg, 92% yield, 97% ee) as a colorless oil.

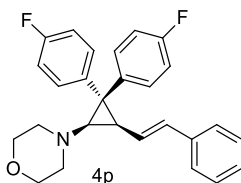
$[\alpha]_D^{17} = 215.2$ ($c = 1.0$, CHCl_3) for 97% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.44-7.36 (m, 4H), 7.34-7.17 (m, 7H), 7.10-7.04 (m, 2H), 6.64 (d, $J = 16.2$ Hz, 1H), 6.04 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.72-3.60 (m, broad, 4H), 2.80-2.70 (m, 2H), 2.70-2.62 (m, 2H), 2.55 (d, $J = 7.8$ Hz, 1H), 2.46 (dd, $J = 10.2, 7.8$ Hz, 1H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 145.3, 137.9, 137.4, 132.8, 131.7, 131.21, 131.16, 130.0, 128.6,

127.1, 126.8, 125.8, 120.5, 120.3, 66.6, 57.0, 54.2, 40.9, 34.6;

HRMS (ESI-TOF) (m/z): Calcd for $C_{27}H_{26}Br_2NO$ ($[M+H]^+$), 538.0376, found 538.0373.



4-((1R, 3R)-2, 2-bis(4-fluorophenyl)-3-((E)-styryl)cyclopropyl)morpholine (4p): following the general procedure (II), the reaction of 4,4'-(cycloprop-2-ene-1,1-diyl)bis(fluorobenzene) (0.2 mmol, 45.6 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.2 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4p** (65.1 mg, 76% yield, 96% ee) as a colorless oil.

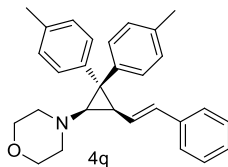
$[\alpha]_D^{19} = 292.6$ ($c = 1.0$, $CHCl_3$) for 96% ee.

1H NMR (600 MHz, $CDCl_3$) δ 7.41 – 7.37 (m, 2H), 7.32 – 7.24 (m, 4H), 7.22 – 7.15 (m, 3H), 7.01-6.91 (m, 4H), 6.63 (d, $J = 16.2$ Hz, 1H), 6.06 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.73-3.58 (m, 4H), 2.85-2.72 (m, 2H), 2.71 – 2.62 (m, 2H), 2.55 (d, $J = 8.4$ Hz, 1H), 2.45 (dd, $J = 10.2, 8.4$ Hz, 1H).

^{13}C NMR (150 MHz, $CDCl_3$) δ 162.1 (d, $J = 13.1$ Hz, 1C), 160.4 (d, $J = 13.1$ Hz, 1C), 142.54 (d, $J = 3.2$ Hz, 1C), 137.6, 135.0 (d, $J = 3.2$ Hz, 1C), 132.5 (d, $J = 7.7$ Hz, 1C), 130.86, 129.8 (d, $J = 7.7$ Hz, 1C), 128.6, 127.4, 127.0, 125.8, 115.4 (d, $J = 21.3$ Hz, 1C), 114.9 (d, $J = 21.3$ Hz, 1C), 66.7, 57.0, 54.3, 40.7, 34.4.

^{19}F NMR (470 MHz, $CDCl_3$) δ -116.3 (s), -116.4 (s).

HRMS (ESI-TOF) (m/z): Calcd for $C_{27}H_{26}F_2NO$ ($[M+H]^+$), 418.1977, found 418.1967.



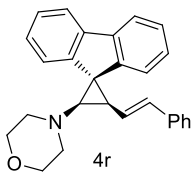
4-((1R, 3R)-3-((E)-styryl)-2,2-di-*p*-tolylcyclopropyl)morpholine (4q): following the general procedure (II), the reaction of 4,4'-(cycloprop-2-ene-1,1-diyl)bis(methylbenzene) (0.20 mmol, 44.2 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.9 mg) and morpholino benzoate (0.30 mmol, 62.4 mg) afforded product **4q** (42.5 mg, 52% yield, 97% ee) as a colorless oil.

$[\alpha]_D^{17} = 332.5$ ($c = 1.0$, $CHCl_3$) for 97% ee.

1H NMR (600 MHz, $CDCl_3$) δ 7.33 (d, $J = 8.4$ Hz, 2H), 7.27 (d, $J = 16.2$ Hz, 4H), 7.20 – 7.15 (m, 1H), 7.14 – 7.10 (m, 2H), 7.08 – 7.00 (m, 4H), 6.60 (d, $J = 16.2$ Hz, 1H), 6.15 (dd, $J = 16.0, 10.2$ Hz, 1H), 3.68 – 3.58 (m, 4H), 2.85-2.72 (m, 2H), 2.70 – 2.60 (m, 2H), 2.56 (d, $J = 7.8$ Hz, 1H), 2.43 (dd, $J = 10.2, 7.8$ Hz, 1H), 2.28 (d, $J = 7.8$ Hz, 6H).

^{13}C NMR (150 MHz, $CDCl_3$) δ 144.4, 138.0, 136.4, 135.6, 135.5, 131.0, 129.9, 129.1, 128.7, 128.6, 128.5, 128.1, 125.8, 66.7, 57.1, 54.3, 41.6, 34.5, 21.0, 20.9.

HRMS (ESI-TOF) (m/z): Calcd for $C_{29}H_{31}NO$ ($[M+H]^+$), 410.2478, found 410.2480.



4-((2R,3R)-2-((E)-styryl)spiro[cyclopropane-1,9'-fluoren]-3-yl)morpholine (4r):

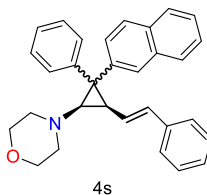
following the general procedure (II), the reaction of spiro[cycloprop[2]ene-1,9'-fluorene (0.20 mmol, 38.1 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.9 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4r** (28.5 mg, 38% yield, 86% ee) as a yellow oil.

$[\alpha]_D^{17} = 224.2$ ($c = 1.0$, CHCl_3) for 86% ee.

^1H NMR (600 MHz, CDCl_3) δ 7.88 (d, $J = 7.8$ Hz, 1H), 7.75 (dd, $J = 19.2, 7.2$ Hz, 2H), 7.34 – 7.15 (m, 8H), 7.11 (t, $J = 7.2$ Hz, 1H), 6.98 (d, $J = 7.2$ Hz, 1H), 6.77 (dd, $J = 15.6, 9.6$ Hz, 1H), 6.47 (d, $J = 15.9$ Hz, 1H), 3.64 (m, 4H), 3.04 (d, $J = 7.2$ Hz, 1H), 2.90 – 2.80 (m, 1H), 2.75 (dd, $J = 10.2, 7.2$ Hz, 1H), 2.60 – 2.05 (m, 3H).

^{13}C NMR (150 MHz, CDCl_3) δ 146.9, 141.3, 141.2, 139.3, 137.5, 133.9, 128.5, 127.1, 127.0, 126.5, 126.22, 126.17, 125.9, 125.1, 123.6, 119.9, 119.6, 118.5, 66.9, 57.3, 53.0, 41.3, 39.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{26}\text{NO}$ ($[\text{M}+\text{H}]^+$), 380.2009; found 380.2010.



4-((1R,2S,3R)-2-(naphthalen-2-yl)-2-phenyl-3-((E)-styryl)cyclopropyl)morpholine (4s):

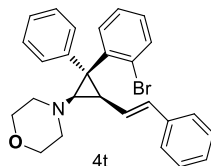
following the general procedure (II), the reaction of 2-(1-phenylcycloprop-2-en-1-yl)naphthalene (0.2 mmol, 48.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.2 mg) and 1,4-dioxo-8-azaspiro[4.5]decan-8-yl benzoate (0.30 mmol, 63.3mg) afforded product **4s** (53.5 mg, 62% yield, 1.7:1 dr.; major isomer: 96% ee; minor isomer: 91% ee) as a colorless oil.

$[\alpha]_D^{17} = 186.4$ ($c = 1.0$, CHCl_3) for a mixture of diastereomers with 1.7:1 dr.

^1H NMR (600 MHz, CDCl_3) δ (the signals of both isomers were assigned together due to their inseparability and signal overlap) 7.99 (s, 0.5H), 7.85 – 7.67 (m, 3.5H), 7.60-7.50 (m, 1.5H), 7.46 – 7.35 (m, 2.5H), 7.33 – 7.21 (m, 7H), 7.21 – 7.13 (m, 2H), 7.01 – 6.92 (m, 1H), 6.68 (dd, $J = 15.6, 3.6$ Hz, 1H), 6.30-6.10 (m, 1H), 3.87 – 3.57 (m, 4H), 2.86 (s, 2H), 2.76 – 2.67 (m, 3H), 2.65-2.50 (m, 1H).

^{13}C NMR (150 MHz, CDCl_3) δ (the signals of both isomers were assigned together due to their inseparability) 146.7, 144.3, 139.3, 137.83, 137.80, 136.8, 133.4, 133.3, 132.0, 131.2, 130.4, 130.3, 130.0, 128.6, 128.5, 128.34, 128.30, 128.25, 128.1, 128.0, 127.9, 127.6, 127.5, 127.4, 127.31, 127.27, 126.84, 126.81, 126.5, 126.2, 126.1, 125.84, 125.82, 125.76, 125.67, 125.74, 66.74, 66.69, 57.2, 57.0, 54.4, 54.3, 42.4, 42.3, 34.8, 34.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{31}\text{H}_{30}\text{NO}$ ($[\text{M}+\text{H}]^+$), 432.2322, found 432.2332.



4-((1R, 2S, 3R)-2-(2-bromophenyl)-2-phenyl-3-((E)-styryl)cyclopropyl)morpholine (4t):

following the general procedure (II), the reaction of 1-bromo-2-(1-phenylcycloprop-2-en-1-yl)benzene (0.2 mmol, 54.3 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.8 mg) and morpholino benzoate (0.30 mmol, 62.1 mg) afforded product **4t** (73.5mg, 80% yield, 98% ee) as a white solid.

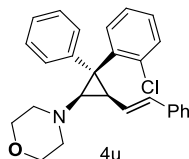
m.p. 68-69 °C

$[\alpha]_D^{13} = 740.3$ ($c = 1.0$, CHCl_3) for 98% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.57 (d, $J = 7.2$ Hz, 1H), 7.43 (d, $J = 7.8$ Hz, 1H), 7.28 (t, $J = 7.8$ Hz, 1H), 7.15 (dd, $J = 16.2, 7.8$ Hz, 4H), 7.10-7.02 (m, 5H), 6.94 (d, $J = 7.2$ Hz, 2H), 6.57 (d, $J = 16.2$ Hz, 1H), 5.57 (dd, $J = 16.2, 10.2$ Hz, 3.61 (s, 4H), 2.84-2.80 (m, 1H), 2.79-2.68 (m, 2H), 2.68-2.55 (m, 2H), 2.26 (d, $J = 7.8$ Hz, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 144.4, 138.2, 137.8, 134.2, 132.7, 131.9, 128.43, 128.38, 128.34, 128.1, 126.7, 126.6, 126.1, 126.0, 125.8, 125.6, 66.7, 60.7, 55.0, 41.4, 34.5.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{27}\text{BrNO}$ ($[\text{M}+\text{H}]^+$), 460.1271, found 460.1263.



4-((1R, 2S, 3R)-2-(2-chlorophenyl)-2-phenyl-3-((E)-styryl)cyclopropyl)morpholine (4u):

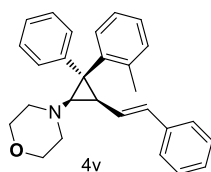
following the general procedure (II), the reaction of 1-chloro-2-(1-phenylcycloprop-2-en-1-yl)benzene (0.2 mmol, 45.3 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65 mg) and morpholino benzoate (0.30 mmol, 62.3 mg) afforded product **4u** (53.2 mg, 64% yield, 95% ee) as a colorless oil.

$[\alpha]_D^{12} = 227.7$ ($c = 1.0$, CHCl_3) for 95% ee

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.68 – 7.65 (m, 1H), 7.30 (dd, $J = 7.2, 4.8$ Hz, 2H), 7.26 – 7.18 (m, 5H), 7.14 (dd, $J = 10.6, 7.8$ Hz, 4H), 7.06 (d, $J = 7.8$ Hz, 2H), 6.64 (d, $J = 16.2$ Hz, 1H), 5.72 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.68 (s, 4H), 2.88 – 2.77 (m, 3H), 2.75-2.65 (m, 2H), 2.40 (d, $J = 8.4$ Hz, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 144.4, 137.9, 137.4, 136.8, 132.4, 131.5, 130.6, 128.5, 128.2, 128.1, 126.8, 126.4, 126.3, 126.0, 125.8, 125.7, 66.7, 59.7, 55.0, 40.1, 34.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{27}\text{ClNO}$ ($[\text{M}+\text{H}]^+$), 416.1776 found 416.1771.



4-((1R, 2S, 3R)-2-phenyl-3-((E)-styryl)-2-(o-tolyl)cyclopropyl)morpholine (4v): following the general procedure (II), the reaction of 1-methyl-2-(1-phenylcycloprop-2-en-1-yl)benzene

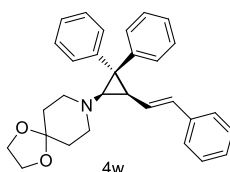
(0.2 mmol, 41.2 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.7 mg) and morpholino benzoate (0.30 mmol, 62.1 mg) afforded product **4v** (45.9 mg, 58% yield, 90% ee) as a colorless oil.

$[\alpha]_D^{12} = 375.9$ ($c = 1.0$, CHCl_3) for 90% ee.

¹H NMR (600 MHz, CDCl_3) δ 7.47 (d, $J = 6.6$ Hz, 1H), 7.13 (dd, $J = 12.6, 7.2$ Hz, 6H), 7.05 (dd, $J = 12.6, 6.6$ Hz, 2H), 7.00 (d, $J = 7.2$ Hz, 2H), 6.90 (d, $J = 7.8$ Hz, 2H), 6.53 (d, $J = 16.2$ Hz, 1H), 5.61 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.70-3.53 (m, 4H), 2.74 (m, 3H), 2.62-2.58 (m, 2H), 2.20 (d, $J = 7.2$ Hz, 1H), 1.84 (s, 3H).

¹³C NMR (150 MHz, CDCl_3) δ 145.3, 140.0, 137.7, 136.8, 131.1, 130.9, 130.8, 128.5, 128.2, 127.3, 126.9, 126.8, 125.8, 125.6, 125.5, 125.0, 66.7, 61.0, 55.1, 40.0, 34.0, 20.7.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{28}\text{H}_{30}\text{NO}$ ($[\text{M}+\text{H}]^+$), 396.2322, found 396.2325.



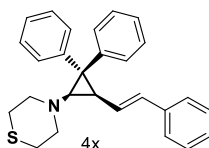
8-((1*R*, 3*R*)-2,2-diphenyl-3-((*E*)-styryl)cyclopropyl)-1,4-dioxo-8-azaspiro[4.5]decane (4w**):** following the general procedure (II), the reaction of 3,3-diphenylcyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.2 mg) and 1,4-dioxo-8-azaspiro[4.5]decan-8-yl benzoate (0.30 mmol, 89 mg) afforded product **4w** (59.4 mg, 68% yield, 97% ee) as a colorless oil.

$[\alpha]_D^{17} = 194.9$ ($c = 1.0$, CHCl_3) for 97% ee.

¹H NMR (600 MHz, CDCl_3) δ 7.50-7.44 (m, 2H), 7.31-7.20 (m, 10H), 7.20-7.12 (m, 3H), 6.62 (d, $J = 16.2$ Hz, 1H), 6.14 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.93 (s, 4H), 3.03-2.79 (m, broad, 2H), 2.79-2.68 (m, broad, 2H), 2.65 (d, $J = 7.8$ Hz, 1H), 2.50 (dd, $J = 10.2, 7.8$ Hz, 1H), 1.75-1.65 (m, 4H);

¹³C NMR (150 MHz, CDCl_3) δ 147.1, 139.5, 137.9, 131.1, 130.1, 128.5, 128.43, 128.40, 127.8, 126.7, 126.1, 126.0, 125.8, 107.2, 64.2, 56.7, 51.9, 42.3, 35.0, 34.8;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{30}\text{H}_{32}\text{NO}_2$ ($[\text{M}+\text{H}]^+$), 438.2428, found 438.2430.



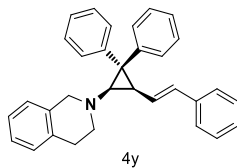
4-((1*R*, 3*R*)-2,2-diphenyl-3-((*E*)-styryl)cyclopropyl)thiomorpholine (4x**):** following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.5 mg) and thiomorpholino benzoate (0.30 mmol, 67.0 mg) afforded product **4x** (67.6 mg, 85% yield, 99% ee) as a colorless oil.

$[\alpha]_D^{19} = 231.8$ ($c = 1.0$, CHCl_3) for 99% ee.

¹H NMR (600 MHz, CDCl_3) δ 7.47-7.40 (m, 2H), 7.31-7.22 (m, 10H), 7.21-7.13 (m, 3H), 6.62 (d, $J = 16.2$ Hz, 1H), 6.09 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.13-3.00 (m, 2H), 3.00-2.87 (m, 2H), 2.70 (d, $J = 7.8$ Hz, 1H), 2.68-2.57 (m, 4H), 2.51 (dd, $J = 10.2, 7.8$ Hz, 1H);

¹³C NMR (150 MHz, CDCl_3) δ 146.9, 139.3, 137.8, 131.2, 130.3, 128.6, 128.5, 128.4, 128.0, 127.9, 126.8, 126.2, 126.1, 125.8, 57.5, 55.9, 42.2, 34.8, 27.6;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{27}\text{H}_{28}\text{NS}$ ($[\text{M}+\text{H}]^+$), 398.1937, found 398.1940.



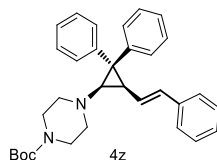
2-((1R, 3R)-2, 2-diphenyl-3-((E)-styryl)cyclopropyl)-1,2,3,4-tetrahydroisoquinoline (4y): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.9 mg) and 3,4-dihydroisoquinolin-2(1*H*)-yl benzoate (0.30 mmol, 75.3 mg) afforded product **4y** (58.7 mg, 68% yield, 94% ee) as a yellow oil

$[\alpha]_D^{19} = 57.8$ ($c = 1.0$, CHCl_3) for 94% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.83-7.47 (m, 2H), 7.35-7.19 (m, 10H), 7.19-7.05 (m, 6H), 7.01-6.95 (m, 1H), 6.67 (d, $J = 15.6$ Hz, 1H), 6.17 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.94-3.80 (m, 2H), 3.35-3.16 (m, 1H), 2.98-2.87 (m, 2H), 2.87-2.80 (m, 1H), 2.78 (d, $J = 7.8$ Hz, 1H), 2.58 (dd, $J = 10.2, 7.8$ Hz, 1H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 147.1, 139.4, 137.9, 135.0, 134.5, 131.2, 130.3, 128.6, 128.5, 128.5, 128.4, 127.9, 126.7, 126.6, 126.1, 126.0, 125.9, 125.6, 56.9, 56.2, 52.0, 42.3, 35.0, 28.8.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{31}\text{H}_{30}\text{N}$ ($[\text{M}+\text{H}]^+$), 428.2373, found 428.2378.



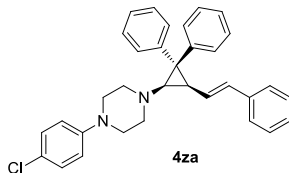
tert-Butyl 4-((1R,3R)-2,2-diphenyl-3-((E)-styryl)cyclopropyl)piperazine-1-carboxylate (4z): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.20 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.3 mmol, 65.2 mg) and *tert*-butyl 4-(benzoyloxy)piperazine-1-carboxylate (0.3 mmol, 90.8 mg) afforded product **4z** (76.6 mg, 80% yield, 90% ee) as a yellow oil.

$[\alpha]_D^{17} = 124.2$ ($c = 1.0$, CHCl_3) for 90% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.49-7.20 (m, 2H), 7.33-7.21 (m, 10H), 7.21-7.13 (m, 3H), 6.63 (dd, $J = 16.2$ Hz, 1H), 6.13 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.54-3.27 (m, broad, 4H), 2.85-2.65 (m, broad, 2H), 2.65-2.57 (m, 3H), 2.50 (dd, $J = 10.2, 7.8$ Hz, 1H), 1.44 (s, 9 H);

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 154.9, 146.9, 139.2, 137.8, 131.2, 130.3, 128.6, 128.5, 128.3, 128.2, 127.9, 126.8, 126.18, 126.15, 125.8, 79.5, 56.7, 53.5, 42.3, 34.7, 29.7, 28.4;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{32}\text{H}_{37}\text{N}_2\text{O}_2$ ($[\text{M}+\text{H}]^+$), 481.2850, found 481.2856.



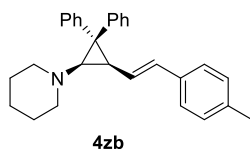
1-(4-Chlorophenyl)-4-((1R, 3R)-2,2-diphenyl-3-((E)-styryl)cyclopropyl)piperazine (4za): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.8 mg) and 4-(4-chlorophenyl)piperazine-1-yl benzoate (0.30 mmol, 94.8 mg) afforded product **4za** (81.3 mg, 83% yield, 97% ee) as a colorless oil.

$[\alpha]_D^{12} = 225.3$ ($c = 1.0$, CHCl_3) for 97% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.47 (d, $J = 7.2$ Hz, 2H), 7.33 – 7.22 (m, 10H), 7.22 – 7.12 (m, 5H), 6.78 (d, $J = 9.0$ Hz, 2H), 6.64 (d, $J = 15.6$ Hz, 1H), 6.15 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.15 – 3.03 (m, 4H), 2.95 (s, 2H), 2.85–2.78 (m, 2H), 2.66 (d, $J = 7.8$ Hz, 1H), 2.52 (dd, $J = 10.2, 7.8$ Hz, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 149.9, 146.9, 139.3, 137.8, 131.2, 130.2, 128.8, 128.6, 128.5, 128.27, 128.25, 127.9, 126.8, 126.19, 125.16, 124.8, 124.3, 116.9, 56.6, 53.5, 48.7, 42.3, 34.7.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{33}\text{H}_{32}\text{ClN}_2$ ($[\text{M}+\text{H}]^+$), 491.2249, found 491.2219.



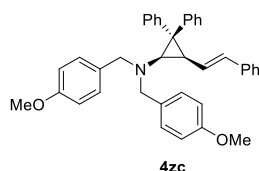
1-((1R,3R)-3-((E)-4-methylstyryl)-2,2-diphenylcyclopropyl)piperidine (4zb): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-(4-methylstyryl)-1,3,2-dioxaborinane (0.30 mmol, 69 mg) and piperidin-1-yl benzoate (0.30 mmol, 61.6 mg) afforded product **4zc** (69.2 mg, 88% yield, 98% ee) as a colorless oil.

$[\alpha]_D^{25} = 123.4$ ($c = 1.0$, CHCl_3) for 98% ee.

$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.52–7.44 (m, 2H), 7.30–7.18 (m, 6 H), 7.18–7.10 (m, 4 H), 7.10–7.02 (m, 2H), 5.57 (d, $J = 16.0$ Hz, 1H), 6.07 (dd, $J = 16.0, 9.6$ Hz, 1H), 2.80–2.64 (m, 2H), 2.64–2.54 (m, 2H), 2.54–2.43 (m, 2H), 2.30 (s, 3H), 1.60–1.48 (m, 4H), 1.48–1.38 (m, 2H);

$^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 147.5, 140.0, 136.3, 135.4, 131.3, 129.7, 129.2, 128.6, 128.4, 127.8, 127.7, 125.9, 125.83, 125.75, 58.1, 55.3, 41.9, 34.8, 25.7, 24.5, 21.1;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{29}\text{H}_{32}\text{N}^+$ ($[\text{M}+\text{H}]^+$), 394.2529, found 394.2527.



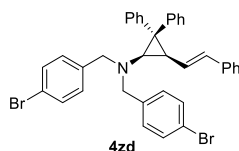
(1R, 3R)-N,N-bis(4-methoxybenzyl)-2, 2-diphenyl-3-((E)-styryl)cyclopropanamine (4zc): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.4 mg) and *O*-benzoyl-*N,N*-bis(4-methoxybenzyl)hydroxylamine (0.30 mmol, 113.3 mg) afforded product **4zc** (82.8 mg, 75% yield, 90% ee) as a colorless oil.

$[\alpha]_D^{13} = 47.3$ ($c = 1.0$, CHCl_3) for 90% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.48 – 7.43 (m, 2H), 7.22 (d, $J = 7.2$ Hz, 2H), 7.20 – 7.15 (m, 6H), 7.15 – 7.10 (m, 3H), 7.10–7.06 (m, 1H), 7.04 – 6.98 (m, 5H), 6.74 (d, $J = 8.4$ Hz, 4H), 6.64 (d, $J = 15.6$ Hz, 1H), 6.22 (dd, $J = 16.4, 10.2$ Hz, 1H), 3.87 (d, $J = 14.4$ Hz, 2H), 3.68 (s, 6H), 3.49 (d, $J = 15.6$ Hz, 2H), 2.73 (d, $J = 7.8$ Hz, 1H), 2.54 (dd, $J = 10.2, 7.8$ Hz, 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 158.6, 147.3, 139.1, 137.9, 131.7, 130.7, 129.8, 129.3, 128.9, 128.5, 128.4, 128.1, 128.0, 126.7, 126.2, 126.0, 125.9, 113.4, 55.1, 54.3, 53.8, 43.5, 36.4 .

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{39}\text{H}_{38}\text{NO}_2$ ($[\text{M}+\text{H}]^+$), 552.2897, found 552.2871.



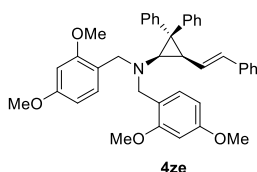
(1R,3R)-N,N-bis(4-bromobenzyl)-2,2-diphenyl-3-((E)-styryl)cyclopropan-1-amine (4zd): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65 mg) and *O*-benzoyl-*N,N*-bis(4-bromobenzyl)hydroxylamine (0.30 mmol, 142.6 mg) afforded product **4zd** (66.8 mg, 51% yield, 95% ee) as a colorless oil.

$[\alpha]_D^{26} = 123.4$ ($c = 1.0$, CHCl_3) for 95% ee.

$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.60-7.52 (m, 2H), 7.50-7.40 (m, 4H), 7.40-7.24 (m, 12H), 7.22-7.15 (m, 1H), 7.08-6.97 (m, 4H), 6.81 (d, $J = 16.0$ Hz, 1H), 6.34 (dd, $J = 16.0, 10.0$ Hz, 1H), 4.04 (s, 1H), 4.00 (s, 1H), 3.64 (s, 1H), 3.60 (s, 1H), 2.91 (d, $J = 7.6$ Hz, 1H), 2.68 (dd, $J = 10.0, 7.6$ Hz, 1H);

$^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 147.5, 140.0, 136.3, 135.4, 131.3, 129.7, 129.2, 128.6, 128.4, 127.8, 127.7, 125.9, 125.83, 125.75, 58.1, 55.3, 41.9, 34.8, 25.7, 24.5, 21.1;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{37}\text{H}_{32}\text{Br}_2\text{N}^+$ ($[\text{M}+\text{H}]^+$), 648.0896, found 648.0899.



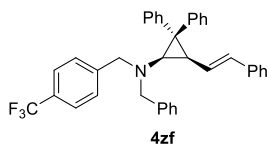
(1R, 3R)-N, N-bis(2, 4-dimethoxybenzyl)-2, 2-diphenyl-3-((E)-styryl)cyclopropanamine (4ze): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 65.1 mg) and *O*-benzoyl-*N,N*-bis(2,4-dimethoxybenzyl)hydroxylamine (0.30 mmol, 133.1 mg) afforded product **4ze** (77.1 mg, 63% yield, 92% ee) as a colorless oil.

$[\alpha]_D^{13} = 17.9$ ($c = 1.0$, CHCl_3) for 92% ee.

$^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.49 (d, $J = 7.2$ Hz, 2H), 7.26-7.02 (m, 14H), 7.04 (d, $J = 8.4$ Hz, 2H), 6.59 (d, $J = 16.2$ Hz, 1H), 6.40 – 6.33 (m, 4H), 6.20 (dd, $J = 16.2, 10.2$ Hz, 1H), 3.88 (d, $J = 13.8$ Hz, 2H), 3.83 – 3.73 (m, 8H), 3.61 (s, 6H), 2.94 (d, $J = 7.8$ Hz, 1H), 2.54 (t, $J = 9.6$ Hz 1H).

$^{13}\text{C NMR}$ (150 MHz, CDCl_3) δ 159.5, 158.6, 147.6, 139.2, 138.2, 132.0, 131.2, 129.8, 129.1, 128.4, 128.2, 127.8, 126.4, 126.0, 125.9, 125.7, 118.4, 103.6, 97.7, 55.9, 55.2, 54.8, 49.6, 43.1, 37.4.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{41}\text{H}_{42}\text{NO}_4$ ($[\text{M}+\text{H}]^+$), 612.3108, found 612.3094.



(1R,3R)-N-benzyl-2,2-diphenyl-3-((E)-styryl)-N-(4-(trifluoromethyl)benzyl)cyclopropan-1-amine (4zf): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2

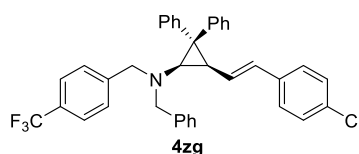
mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 69.0 mg) and *O*-benzoyl-*N*-benzyl-*N*-(4-(trifluoromethyl)benzyl)hydroxylamine (0.30 mmol, 115.6 mg) afforded product **4zf** (53.9 mg, 48 % yield, 92 % ee) as a colorless oil.

$[\alpha]_D^{26} = 36.6$ ($c = 1.0$, CHCl_3) for 92% ee.

$^1\text{H NMR}$ (400 MHz, C_6D_6) δ 7.62-7.52 (m, 2H), 7.37-7.25 (m, 4H), 7.25-6.92 (m, 19H), 6.64 (d, $J = 16.0$ Hz, 1H), 6.28 (dd, $J = 16.0, 10.0$ Hz, 1H), 4.01 (d, $J = 14.4$ Hz, 1H), 3.93 (d, $J = 14.4$ Hz, 1H), 3.61 (d, $J = 14.4$ Hz, 1H), 3.52 (d, $J = 14.4$ Hz, 1H), 2.92 (d, $J = 8.0$ Hz, 1H), 2.56 (dd, $J = 10.0, 8.0$ Hz, 1H);

$^{13}\text{C NMR}$ (101 MHz, CDCl_3) δ 147.1, 141.5, 138.9, 137.7, 136.1, 131.7, 130.4, 129.8, 129.6, 129.2 (q, $^2J_{\text{C-F}} = 32.3$ Hz, 1C), 128.8, 128.6, 128.5, 128.2, 128.0, 127.2, 126.9, 126.5, 126.2, 125.9, 125.0 (q, $^3J_{\text{C-F}} = 4.0$ Hz, 1C), 124.3 (q, $^1J_{\text{C-F}} = 272.7$ Hz, 1C), 55.7, 55.3, 53.9, 43.7, 36.5;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{38}\text{H}_{33}\text{F}_3\text{N}$ ($[\text{M}+\text{H}]^+$), 560.2560, found 560.2558.



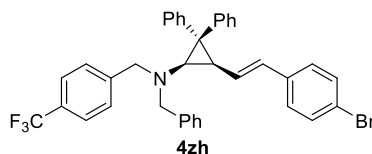
(1*R*,3*R*)-*N*-benzyl-3-((*E*)-4-chlorostyryl)-2,2-diphenyl-*N*-(4-(trifluoromethyl)benzyl)cyclopropan-1-amine (4zg**)**: following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-2-(4-chlorostyryl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 75.2 mg) and *O*-benzoyl-*N*-benzyl-*N*-(4-(trifluoromethyl)benzyl)hydroxylamine (0.30 mmol, 115.6 mg) afforded product **4zg** (47.5 mg, 40% yield, 99 % ee) as a colorless oil.

$[\alpha]_D^{13} = 33.0$ ($c = 1.0$, CHCl_3) for 99% ee.

$^1\text{H NMR}$ (400 MHz, C_6D_6) δ 7.65-7.52 (m, 4H), 7.40-7.15 (m, 19H), 6.77 (d, $J = 16.0$ Hz, 1H), 6.35 (dd, $J = 16.0, 10.0$ Hz, 1H), 4.25-4.00 (m, 2H), 3.81 (d, $J = 14.4$ Hz, 1H), 3.68 (d, $J = 14.4$ Hz, 1H), 3.00 (d, $J = 7.6$ Hz, 1H), 2.71 (dd, $J = 9.6, 7.6$ Hz, 1H);

$^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 146.9, 141.4, 138.8, 136.2, 136.1, 132.5, 131.6, 130.6, 129.7, 129.6, 129.5, 128.9 (q, $^2J_{\text{C-F}} = 36.4$ Hz, 1C), 128.7, 128.6, 128.1, 128.0, 127.3, 127.1, 126.5, 126.3, 125.0 (q, $^3J_{\text{C-F}} = 4$ Hz, 1C), 124.3 (q, $^1J_{\text{C-F}} = 272.7$ Hz, 1C), 55.9, 55.5, 54.1, 43.9, 36.4;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{38}\text{H}_{32}\text{ClF}_3\text{N}$ ($[\text{M}+\text{H}]^+$), 594.2170; found, 594.2172.



(1*R*,3*R*)-*N*-benzyl-3-((*E*)-4-bromostyryl)-2,2-diphenyl-*N*-(4-(trifluoromethyl)benzyl)cyclopropan-1-amine (4zh**)**: following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-2-(4-bromostyryl)-5,5-dimethyl-1,3,2-dioxaborinane (0.30 mmol, 88.5 mg) and *O*-benzoyl-*N*-benzyl-*N*-(4-(trifluoromethyl)benzyl)hydroxylamine (0.30 mmol, 115.6 mg) afforded product **4zh** (56.1 mg, 44% yield, 98% ee) as a colorless oil.

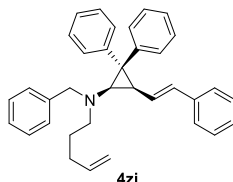
$[\alpha]_D^{27} = 22.2$ ($c = 1.0$, CHCl_3) for 98% ee.

$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.58-7.45 (m, 4H), 7.43-7.34 (m, 2H), 7.34-7.17 (m, 13H), 7.17-7.08 (m, 5H), 6.68 (d, $J = 16.0$ Hz, 1H), 6.30 (dd, $J = 16.0, 10.4$ Hz, 1H), 4.06 (d, $J = 14.4$ Hz,

1H), 4.00 (d, $J = 14.4$ Hz, 1H), 3.74 (d, $J = 14.4$ Hz, 1H), 3.60 (d, $J = 14.4$ Hz, 1H), 2.92 (d, $J = 8.0$ Hz, 1H), 2.64 (dd, $J = 10.4, 7.6$ Hz, 1H);

^{13}C NMR (100 MHz, CDCl_3) δ 146.9, 141.4, 138.8, 136.6, 136.1, 131.7, 131.6, 129.8, 129.7, 129.5, 129.4, 129.1, 128.6, 128.2, 128.0, 127.4, 127.3, 126.5, 126.3, 125.0 (q, $^3J_{\text{C-F}} = 4$ Hz, 1C), 124.3 (q, $^1J_{\text{C-F}} = 272.7$ Hz, 1C), 120.6, 55.9, 55.5, 54.1, 43.9, 36.4;

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{38}\text{H}_{32}\text{BrF}_3\text{N}([\text{M}+\text{H}]^+)$, 638.1665; found, 638.1666.



(1R, 3R)-N-benzyl-N-(pent-4-en-1-yl)-2,2-diphenyl-3-((E)-styryl)cyclopropanamine (4zi): following the general procedure (II), the reaction of 3,3-diphenyl cyclopropene (0.2 mmol, 38.4 mg), (*E*)-5,5-dimethyl-2-styryl-1,3,2-dioxaborinane (0.30 mmol, 64.8 mg) and *O*-benzoyl-*N*-benzyl-*N*-(pent-4-en-1-yl)hydroxylamine (0.30 mmol, 88.5 mg) afforded product **4zi** (77.7 mg, 82.7% yield, 91% ee) as a yellow oil.

$[\alpha]_{\text{D}}^{25} = 344.8$ ($c = 1.0$, CHCl_3) for 91% ee.

^1H NMR (600 MHz, CDCl_3) δ 7.51 (d, $J = 7.2$ Hz, 2H), 7.30 – 7.20 (m, 12H), 7.20-7.16 (m, 2H), 7.16-7.10 (m, 2H), 6.65 (d, $J = 15.6$ Hz, 1H), 6.27 (dd, $J = 16.2, 10.2$ Hz, 1H), 5.71-5.62 (m, 1H), 4.97 – 4.77 (m, 2H), 4.05 (d, $J = 14.4$ Hz, 1H), 3.84 (d, $J = 13.8$ Hz, 1H), 2.97 (d, $J = 7.8$ Hz, 1H), 2.79 – 2.69 (m, 1H), 2.67-2.60 (m, 1H), 2.55 (dd, $J = 10.4, 7.8$ Hz, 1H), 1.87 (q, $J = 7.2$ Hz, 2H), 1.61 – 1.41 (m, 2H).

^{13}C NMR (150 MHz, CDCl_3) δ 147.4, 139.3, 138.5, 138.1, 137.9, 131.6, 129.9, 129.06, 129.04, 128.5, 128.4, 128.2, 128.0, 127.9, 126.8, 126.7, 126.2, 126.0, 125.8, 114.4, 57.3, 55.5, 53.1, 43.1, 36.2, 31.6, 24.6.

HRMS (ESI-TOF) (m/z): Calcd for $\text{C}_{35}\text{H}_{36}\text{N}([\text{M}+\text{H}]^+)$, 470.2842, found 470.2835.

5. DFT calculation details

To explore the detailed reaction mechanism of catalyzed by copper, theoretical calculations were performed by Gaussian 16 suite package⁴ with density functional theory (DFT). The geometry optimizations of the starting materials, transition states and intermediates of **4t**, **4u** and **4v** were calculated by the M06 functional⁵ and the basis sets of 6-31G(d,p)⁶ for non-metal atoms and SDD⁷ for Cu atom in the gas phase. Harmonic vibrational frequency calculations were carried out to confirm the rationality of all the minima geometries (no imaginary frequency) and transition states structures (only one imaginary frequency) at the same levels of optimizations. The intrinsic reaction coordinate (IRC) calculations were performed to ensure that the located transition states connect to the starting complexes and the products. M06 functional with 6-311G(d,p)⁸ basis set (SDD for Cu) were used to calculate the single point energies to obtain more accurate energy data under the tetrahydrofuran (THF) solvent with SMD⁹ solvation model. The corresponding single point energies based on Gibbs correction were displayed in Table S3 and used in the discussion below. To simplify calculation, truncated ligands without the corresponding phenyls (from Ph-BPE) were used.

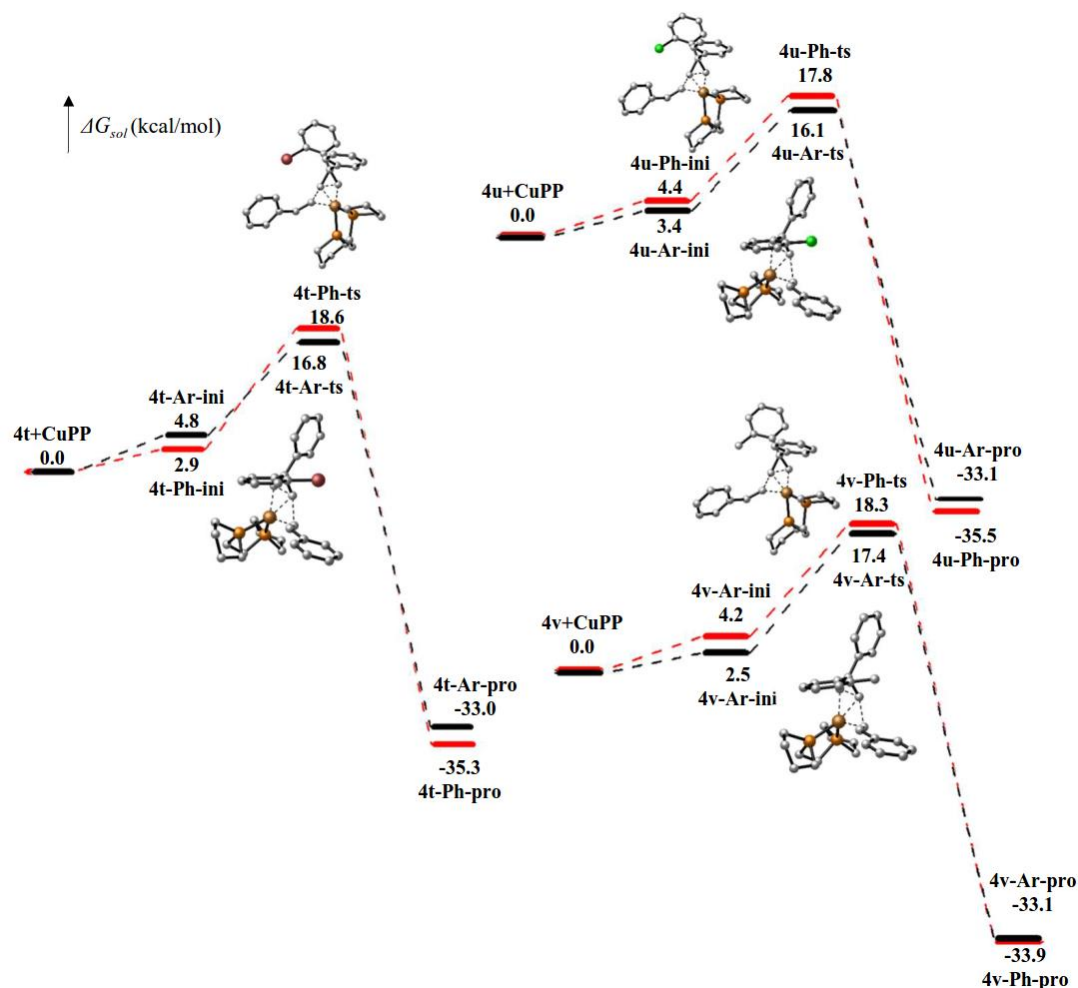


Figure S8. Calculated free energy profiles of the two diastereomeric carbocupration pathways of **4t-4v**. The paths represented by the black lines are favored due to lower reaction barriers.

Table S3. The calculated energies and Gibbs correction in gas phase ($E_{\text{electron-gas}}$, $G_{\text{correction}}$), the single point energies calculated in solvent THF ($E_{\text{electron-solvent}}$) of all the compounds and imaginary frequencies of transition states (IF).

Geometry	$E_{\text{electron-gas}}$	$G_{\text{correction}}$	$E_{\text{electron-solvent}}$	IF
CuPP	-1581.66949	0.348936	-1581.90137	
4t-ini	-3148.926681	0.165057	-3151.84473	
4t-Si-ini	-4730.630002	0.543343	-4733.767873	
4t-Si-ts	-4730.612564	0.544531	-4733.749831	-274.36
4t-Si-pro	-4730.693383	0.546291	-4733.830976	
4t-Re-ini	-4730.625494	0.536129	-4733.763643	
4t-Re-ts	-4730.611166	0.544327	-4733.746723	-276.34
4t-Re-pro	-4730.698684	0.546861	-4733.83515	
4u-ini	-1037.843729	0.166179	-1038.018508	
4u-Si-ini	-2619.546191	0.543637	-2619.943048	
4u-Si-ts	-2619.528988	0.546014	-2619.925176	-275.58
4u-Si-pro	-2619.610425	0.548521	-2620.005996	
4u-Re-ini	-2619.54255	0.539871	-2619.937701	
4u-Re-ts	-2619.527244	0.545137	-2619.921593	-280.18
4u-Re-pro	-2619.615532	0.548312	-2620.009696	
4v-ini	-617.5639726	0.202522	-617.7186969	
4v-Si-ini	-2199.269321	0.579	-2199.643645	
4v-Si-ts	-2199.251593	0.584385	-2199.625223	-275.58
4v-Si-pro	-2199.329989	0.584485	-2199.705763	
4v-Re-ini	-2199.263819	0.576547	-2199.638521	
4v-Re-ts	-2199.245733	0.581409	-2199.620831	-291.41
4v-Re-pro	-2199.334367	0.586377	-2199.709011	

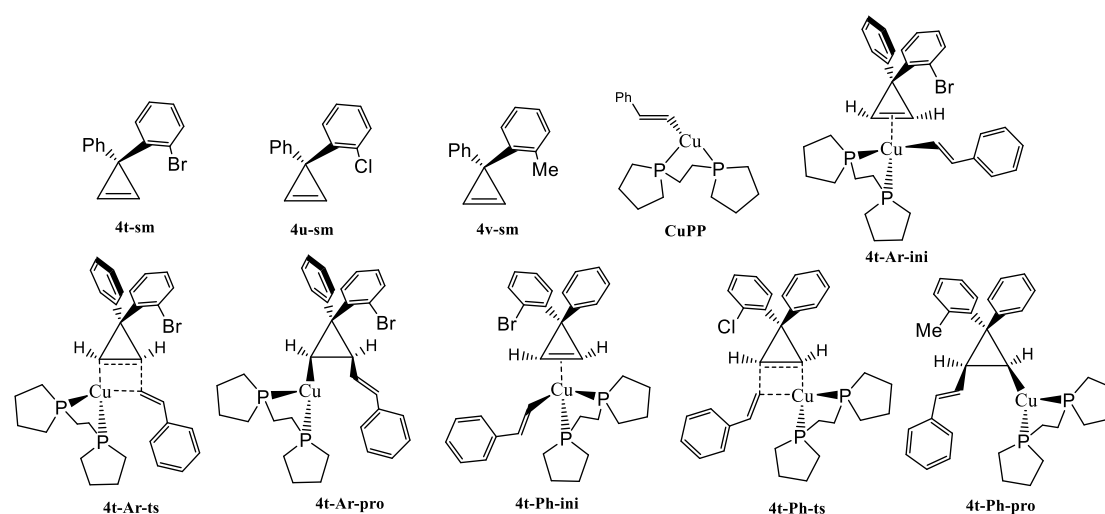


Figure S9. The structures of all the starting materials, transition states and productions for the reaction of **4t**. Respective species for **4u** and **4v** were named analogously whose structures were omitted for clarity.

We performed potential energy surfaces (PESs) scanning of **4t-Ar-ts** and **4t-Ph-ts** by rotating the *ortho*-Br phenyl and the non-substituted phenyl groups. The *ortho*-Br phenyl and non-substituted phenyl were respectively twisted for 360° and 180°, with 30° per step and the corresponding energies of these data points are summarized in Table S4. Some irrational structures are omitted¹⁰. It can be concluded that the initial geometries of **4t-Ar-ts** and **4t-Ph-ts** are the energy minimum on the PESs. The structures with 180° torsions of the bromophenyl group may be competitive with initial ones. Hence, we performed optimized calculations of **4t-Ar-ts** and **4t-Ph-ts** with 180° torsions of bromophenyl under the same level of theory. The corresponding coordinates are listed in Table S7. The energies of the twisted structures, [**4t-Ar-ts**]' and [**4t-Ph-ts**]' are 0.6 and 0.7 kcal/mol higher than initial ones, respectively, indicating that the originally obtained geometries of **4t-Ar-ts** and **4t-Ph-ts** are indeed the most probable ones.

Table S4. The single point energies of twisted **4t-Ar-ts** and **4t-Ph-ts**.^{a,b}

4t-Ar-ts												
$\begin{matrix} \text{Br} \\ \text{non} \end{matrix}$	0	30	60	90	120	150	180	210	240	270	300	330
0	0				145.9	15.1	12.5	221.4				108.0
30	6.8	38		220.3	113.8	15.1	15.5	246.8				108.3
60	39.9		232.3	128	111.9	16.9	19.0	242.3				110.4
90	32.2	96.4	87.4	121.7	118.7	17.5	15.5	220.7				110.4
120	5.2	24.9	70.4	178.1	182.8	22.4	14.3	218.5				110.3
150	1.7	18.5	133.1			20.5	14.1	218.9				110.6

4t-Ph-ts												
$\begin{matrix} \text{Br} \\ \text{non} \end{matrix}$	0	30	60	90	120	150	180	210	240	270	300	330
0	0.0	31.1	104.7	49.7	14.7	5.2	0.6	10.3	28.2	14.4	20.8	11.7
30	7.4	10.6	23.5	30.1	55.3	45.9	11.1	14.7	28.8	18.9	30.2	21.7
60	55.1	53.3	60.7	119.7	335.9	222.9	59.3	60.9	75.3	71.9	103.6	87.8
90	74.6	73.5	99.0	394.5		127.6	75.3	81.4	102.0	149.3		105.1
120	84.4	90.8	258.3		230.5	92.8	85.4	96.3	152.3		147.5	100.8
150	18.4	55.6		234.3	43.6	20.7	19.2	35.0	115.2	63.5	43.6	30.6

^a “Br” stands for 2-bromophenyl and “non” represents non-substituted phenyl. ^b Unit of the energies: kcal/mol.

Table S5. The geometrical coordinates of all the starting materials, transition states and productions.

CuPP			
Cu	0.52920200	-0.93787000	-0.69705900
C	-1.36069700	-0.93645900	-0.82802600
H	-1.80696000	-0.36794500	-1.65897600
C	-2.24194600	-1.41641700	0.07330100
H	-1.87468000	-2.00700000	0.92060600

C	-3.70418300	-1.25388900	0.07329800
C	-4.47808800	-1.99098700	0.97953600
C	-4.37523800	-0.37186900	-0.78634300
C	-5.86178600	-1.86977500	1.01846200
H	-3.97262200	-2.67618500	1.66048200
C	-5.75669200	-0.24808600	-0.75076200
H	-3.79766300	0.22872300	-1.48788100
C	-6.51070500	-0.99721000	0.15071000
H	-6.43673100	-2.45918700	1.73037000
H	-6.25256700	0.44446900	-1.42868800
H	-7.59348900	-0.89643400	0.17877600
C	1.90268900	1.56213500	0.95919300
H	1.38137300	0.90620900	1.67258900
H	2.19102100	2.46643900	1.51341600
C	3.13005600	0.85678200	0.38529900
H	3.96034800	0.80726400	1.10506500
H	3.50453700	1.39185000	-0.50048700
C	4.16855700	-1.43433100	-1.12192800
C	3.15390800	-1.86563600	1.35747900
C	4.79994400	-2.56655300	-0.30632300
H	4.85878100	-0.58506700	-1.21322500
H	3.88191400	-1.73960400	-2.13194300
C	4.62871000	-2.21417800	1.16836000
H	2.53495900	-2.77094900	1.37159600
H	2.93551100	-1.30373800	2.27333500
H	4.27327700	-3.50870300	-0.51480000
H	5.85025000	-2.72022900	-0.57988000
H	4.94372800	-3.03054200	1.82895800
H	5.25614700	-1.34361300	1.41311000
P	2.68495300	-0.86839100	-0.14105900
C	-0.85247600	2.36250600	0.57069300
C	1.11056800	3.82624100	-0.57354800
C	-1.08157600	3.87273900	0.49113500
H	-0.68619200	2.04431600	1.60876600
H	-1.69173100	1.77028300	0.18987200
C	0.28922200	4.54066600	0.49570100
H	0.80975100	4.16089600	-1.57462400
H	2.19328500	3.98639400	-0.49035300
H	-1.59594000	4.12011300	-0.44919400
H	-1.72333700	4.22940200	1.30600400
H	0.22647600	5.62230100	0.31811100
H	0.75778500	4.40602200	1.48297000
P	0.69933400	1.99430200	-0.42338600

4t-ini

C	0.35249600	-0.21454600	2.43680700
C	0.54138900	-1.48676800	2.32199800
C	0.38186300	-0.73250500	1.03019300
C	1.59404800	-0.48543100	0.17366300
C	2.81371800	-0.13356400	0.76009200
C	1.54350400	-0.61649700	-1.21673700
C	3.94540100	0.08070100	-0.01643100
H	2.87614100	-0.02875400	1.84187200
C	2.67625100	-0.40424200	-1.99516400
H	0.60497000	-0.88564300	-1.69793400
C	3.88309900	-0.05461500	-1.40004300
H	4.88230700	0.35697600	0.46300100
H	2.61192100	-0.51210400	-3.07586600
H	4.76854000	0.11281200	-2.00894100
C	-0.92422300	-0.85995900	0.29764500
C	-1.47166300	-2.12243200	0.05936100
C	-1.63892600	0.24333000	-0.17335500
C	-2.67802100	-2.28245800	-0.61126900
H	-0.92540600	-2.99441600	0.41756600
C	-2.84924500	0.10622000	-0.84351700
C	-3.36965400	-1.16360900	-1.06340400
H	-3.07783500	-3.27925600	-0.78095200
H	-3.37527700	0.99298900	-1.18675200
H	-4.31621500	-1.27371500	-1.58694900
Br	-0.96758100	2.00106100	0.09359300
H	0.74670000	-2.45497000	2.75473300
H	0.26927500	0.68719300	3.02543500

4t-Ar-ini

Cu	0.62443900	-0.78241300	-0.07550300
C	0.98453700	1.01902900	-0.73836500
H	1.06902500	1.21709700	-1.81808900
C	0.89212700	2.10755800	0.04852600
H	0.77780300	1.96856100	1.13114200
C	0.84374300	3.52447100	-0.33960600
C	0.75689400	4.50039200	0.66289600
C	0.84861800	3.96019500	-1.67252000
C	0.69393500	5.85406600	0.35535500
H	0.73642300	4.17544500	1.70458800
C	0.78925600	5.31096600	-1.98325700
H	0.88948400	3.22146200	-2.47171800
C	0.71350100	6.26815700	-0.97252400

H	0.62878800	6.58927800	1.15547400
H	0.79426400	5.62347100	-3.02599500
H	0.66342000	7.32615100	-1.22036300
C	-0.91409200	-1.38320700	-1.18964100
C	-0.78500300	-2.25936900	-0.15639200
C	-2.01117800	-1.36632500	-0.16078800
C	-3.31829200	-1.99059300	-0.54428800
C	-4.52768000	-1.55380400	0.00560900
C	-3.35501400	-3.04309700	-1.46729200
C	-5.73164600	-2.14773900	-0.35498200
H	-4.52615400	-0.73485400	0.72236100
C	-4.55833000	-3.63635300	-1.82788800
H	-2.42779200	-3.40351700	-1.90922200
C	-5.75435500	-3.19209700	-1.27306400
H	-6.65928900	-1.78826500	0.08537100
H	-4.56066500	-4.45182300	-2.54830000
H	-6.69677900	-3.65594000	-1.55503400
C	-2.07062400	-0.22313900	0.81126200
C	-1.87978100	-0.46154000	2.17567900
C	-2.28725700	1.10035300	0.41863800
C	-1.87175900	0.57239500	3.10572400
H	-1.72751400	-1.49348400	2.49477200
C	-2.26168800	2.15014700	1.33038400
C	-2.04957700	1.88556700	2.67818000
H	-1.72987600	0.35442800	4.16316500
H	-2.39218100	3.16932500	0.97514900
H	-2.02986700	2.70716300	3.39067100
Br	-2.60922300	1.52842700	-1.39846500
H	-0.60761100	-3.31523200	0.01938100
H	-0.88099800	-1.31100700	-2.27165600
C	3.92860900	-0.87591500	0.13620800
H	3.69159700	0.19748100	0.12869300
H	5.00852200	-0.98046800	-0.04087000
C	3.52562300	-1.50314600	1.46625600
H	4.17408500	-1.17603000	2.29202000
H	3.60567400	-2.59996600	1.41482900
C	1.36147700	-2.32106900	3.23304900
C	1.92475000	0.32181500	3.05613700
C	1.17817300	-1.49304600	4.50868900
H	2.20784800	-3.01361900	3.33396400
H	0.47791300	-2.91439000	2.97445300
C	2.14261800	-0.31260600	4.42701900
H	0.98143300	0.88526500	3.03710900
H	2.72295300	0.99872400	2.72926200

H	0.14839500	-1.10804700	4.54945000
H	1.33137400	-2.09734000	5.41059300
H	1.98459400	0.40627500	5.24026300
H	3.17782200	-0.67591600	4.51803800
P	1.75531400	-1.10022600	1.87250500
C	3.45979700	-0.56494600	-2.69757300
C	4.19281100	-2.99071200	-1.75491700
C	4.36089200	-1.40685800	-3.60246500
H	3.99701100	0.30615000	-2.29919200
H	2.57190900	-0.18597700	-3.21347700
C	5.18472600	-2.32051000	-2.70201500
H	3.64967600	-3.79201300	-2.27221400
H	4.65849900	-3.43620300	-0.86657700
H	3.74149500	-2.02684500	-4.26756200
H	4.98858400	-0.78001400	-4.24766600
H	5.76993200	-3.05093100	-3.27564800
H	5.90376400	-1.71650200	-2.12787200
P	2.95572700	-1.66091300	-1.25888000

4t-Ar-ts

Cu	-1.39180700	0.32708300	-0.06857600
C	-0.08135600	-0.53217700	-1.32319300
H	-0.06937000	-0.33370300	-2.40104600
C	0.62230200	-1.58513900	-0.86211800
H	0.63295700	-1.77670500	0.21707300
C	1.39636000	-2.56566400	-1.62566300
C	1.85394900	-3.71932800	-0.97323500
C	1.71573300	-2.40805800	-2.98195700
C	2.58571100	-4.68810900	-1.64881000
H	1.62382300	-3.84444700	0.08686000
C	2.44578200	-3.37415400	-3.65787500
H	1.39859400	-1.50455100	-3.50073100
C	2.88286700	-4.52189200	-2.99765500
H	2.92794500	-5.57563300	-1.11993600
H	2.68614400	-3.22919000	-4.70940500
H	3.45798400	-5.27570800	-3.53063900
C	0.14342500	1.48517100	-0.60410300
C	-0.44658600	2.04392400	0.55574200
C	1.03403200	1.77271300	0.57536600
C	1.91782300	2.98258600	0.46611000
C	1.62454100	4.00795600	-0.44098200
C	3.01839300	3.15658500	1.31235800
C	2.41619200	5.14730600	-0.51887500
H	0.75795900	3.92019000	-1.09338500

C	3.80412600	4.30049100	1.24377000
H	3.26510900	2.38086600	2.03472700
C	3.51258400	5.30120700	0.32308000
H	2.16965500	5.92316100	-1.24116200
H	4.65345700	4.40735200	1.91546900
H	4.13028300	6.19457100	0.26551600
C	1.59826500	0.61825700	1.34500600
C	1.02057000	0.22171100	2.55164200
C	2.69228400	-0.12513000	0.88645100
C	1.49547100	-0.87351300	3.26661500
H	0.16810600	0.80037100	2.90706200
C	3.17392500	-1.22958500	1.58035300
C	2.56947500	-1.60916400	2.77374100
H	1.03052900	-1.15135000	4.21164000
H	4.00895500	-1.79309300	1.17178700
H	2.94639300	-2.47161700	3.31906900
Br	3.56749100	0.32414400	-0.73715100
H	-0.89213600	3.03124600	0.64942800
H	0.28847700	1.84168400	-1.62229600
C	-4.60354700	-0.53386000	-0.14085500
H	-4.48759100	-1.37155300	-0.84515400
H	-5.66817700	-0.25864400	-0.14400000
C	-4.14038900	-0.95150100	1.25089600
H	-4.68942400	-1.83502500	1.60819100
H	-4.32073300	-0.14355300	1.97567500
C	-1.99234700	-1.73728100	3.05221900
C	-2.20165600	-3.03860700	0.67941600
C	-1.39624000	-3.14343700	2.98705900
H	-2.94647100	-1.74098000	3.59788500
H	-1.32702200	-1.01032400	3.52852900
C	-2.19210500	-3.90976900	1.93437500
H	-1.26759700	-3.14094400	0.11062800
H	-3.02439200	-3.26170200	-0.01093000
H	-0.34247000	-3.07614100	2.67049600
H	-1.40921100	-3.63706800	3.96649600
H	-1.77188800	-4.90371100	1.73840500
H	-3.22043200	-4.06067800	2.29789200
P	-2.30827100	-1.27514200	1.27154500
C	-4.34940500	1.07015200	-2.52369900
C	-4.45052400	2.35275100	-0.13891800
C	-5.00195800	2.45441400	-2.51640600
H	-5.10414200	0.28389400	-2.66191700
H	-3.60240600	0.95383900	-3.31430300
C	-5.57436100	2.67662100	-1.11984500

H	-3.72513000	3.17481700	-0.08472100
H	-4.79108600	2.15624900	0.88505000
H	-4.24109100	3.22237700	-2.71856900
H	-5.76372300	2.54723100	-3.29983400
H	-5.95813600	3.69561200	-0.98662900
H	-6.42183400	1.99280600	-0.95978400
P	-3.56917700	0.85959200	-0.83051300

4t-Ar-pro

Cu	0.81300700	-1.63981200	-0.16467900
C	-0.49751200	1.03953200	-1.46733500
H	-0.54645200	1.74976000	-2.29825100
C	0.26825000	1.36914100	-0.41194800
H	0.25982300	0.71512900	0.46615600
C	1.07787100	2.57875800	-0.28086900
C	1.39640200	3.05544800	1.00005700
C	1.58059500	3.28571600	-1.38440800
C	2.17637900	4.19226900	1.17384000
H	0.99107800	2.53051200	1.86606900
C	2.35641600	4.42428200	-1.21113600
H	1.36563200	2.92670000	-2.39017500
C	2.66242500	4.88344000	0.06808900
H	2.39955100	4.54521900	2.17876400
H	2.73372000	4.95482700	-2.08320700
H	3.27526600	5.77198600	0.20046800
C	-1.32596900	-0.16722000	-1.63178000
C	-0.95969400	-1.50432800	-0.98493200
C	-2.17464300	-0.75693500	-0.50748300
C	-3.52155500	-1.31945000	-0.88034400
C	-3.97899600	-2.45714900	-0.20571400
C	-4.33333600	-0.77133300	-1.87429600
C	-5.20485200	-3.03109400	-0.51532500
H	-3.34976500	-2.89626200	0.56867300
C	-5.56056000	-1.34707400	-2.19175700
H	-4.00422400	0.12339900	-2.39848400
C	-6.00246100	-2.47707400	-1.51393400
H	-5.53825500	-3.91781400	0.02044100
H	-6.17733500	-0.90280000	-2.97062400
H	-6.96252700	-2.92524200	-1.76090700
C	-2.16999000	-0.12054100	0.85181200
C	-1.67141400	-0.83994500	1.94476000
C	-2.66733300	1.15838000	1.12309200
C	-1.64897400	-0.31311600	3.23064600
H	-1.26894200	-1.83310100	1.74470100

C	-2.62625600	1.71621900	2.39788400
C	-2.11309000	0.97958800	3.45745400
H	-1.26645900	-0.91075500	4.05718400
H	-3.00455700	2.72347900	2.55055800
H	-2.08969100	1.41230100	4.45500300
Br	-3.42668500	2.23297500	-0.24717400
H	-1.25675700	-2.33553500	-1.63444300
H	-1.82052900	-0.20402400	-2.60401200
C	3.80692600	-0.27099700	-0.33911100
H	3.31936900	0.68702200	-0.09538500
H	4.79473700	-0.03057500	-0.75705700
C	3.92948600	-1.14749900	0.90495100
H	4.56387700	-0.68254400	1.67343400
H	4.38997400	-2.11440700	0.64978300
C	2.59776800	-2.76377100	2.94442600
C	2.01800900	-0.11414000	2.80870400
C	2.16034500	-2.08786200	4.24475200
H	3.67758600	-2.96687400	2.95586200
H	2.07951100	-3.70791200	2.75451000
C	2.56688200	-0.62144200	4.14089600
H	0.94323200	0.10145600	2.88567100
H	2.51107100	0.79184500	2.43333600
H	1.06567100	-2.15248500	4.34051500
H	2.58961900	-2.58311500	5.12378000
H	2.19632700	-0.02734500	4.98515400
H	3.66505300	-0.54659300	4.15245600
P	2.24036400	-1.51619800	1.60038300
C	2.68334500	0.15978800	-2.98471400
C	4.02786600	-2.14179100	-2.50324900
C	3.48890500	-0.41974400	-4.14964300
H	3.12914400	1.09113300	-2.60788600
H	1.64229800	0.37835800	-3.24546900
C	4.64242800	-1.21999000	-3.55447500
H	3.52599200	-2.99306500	-2.97984700
H	4.75501800	-2.54928200	-1.79004200
H	2.85137800	-1.09511700	-4.73852400
H	3.83580800	0.36525400	-4.83233500
H	5.19745300	-1.77903700	-4.31849100
H	5.35823200	-0.53309000	-3.07824800
P	2.73456000	-1.11589500	-1.61677100

4t-Ph-ini

Cu	-0.44416900	-0.42319700	-0.15361500
C	-1.60183200	0.82649100	0.79410700

H	-1.84094200	0.64960700	1.85699300
C	-2.21150400	1.88812600	0.23443300
H	-2.01430100	2.10700300	-0.82489700
C	-3.18031200	2.81371400	0.84139200
C	-3.87513100	3.71207500	0.02051500
C	-3.45879900	2.84076000	2.21557000
C	-4.81521700	4.59324000	0.54128500
H	-3.66579400	3.70958700	-1.05010600
C	-4.39554300	3.71982800	2.73935200
H	-2.92090500	2.16510400	2.87913100
C	-5.08250900	4.60148300	1.90626400
H	-5.34049700	5.27817700	-0.12180600
H	-4.59004800	3.72323800	3.81044600
H	-5.81504600	5.29096200	2.32004100
C	0.95795300	0.62050000	-1.10780400
C	1.14793700	-0.70020300	-1.38769800
C	2.20997200	-0.01578200	-0.56650200
C	2.36707400	-0.36394900	0.89066900
C	1.74236300	0.37085900	1.90020800
C	3.14710600	-1.46789900	1.24785000
C	1.87556900	-0.00578400	3.23437800
H	1.13724000	1.23361100	1.62881100
C	3.28925400	-1.84107700	2.57996200
H	3.65107600	-2.03584100	0.46478500
C	2.64886900	-1.11074000	3.57930800
H	1.38196500	0.57821100	4.00891200
H	3.90214100	-2.70205700	2.84048600
H	2.75903500	-1.39870600	4.62282000
C	3.50536600	0.30921000	-1.25953900
C	4.10379600	-0.63240000	-2.10250100
C	4.17208700	1.52691800	-1.09599200
C	5.30915500	-0.38165100	-2.74589500
H	3.59837700	-1.58643200	-2.24997800
C	5.37739300	1.79815900	-1.73378000
C	5.94968900	0.83848100	-2.55962900
H	5.74744500	-1.13820900	-3.39236400
H	5.85694400	2.76149200	-1.58205900
H	6.89231300	1.05014500	-3.05842500
Br	3.43182000	2.88954200	-0.00117600
C	-2.61279300	-2.88759900	0.38205000
H	-3.25325700	-2.13443000	0.86625400
H	-2.86834300	-3.86097300	0.82619600
C	-2.83825900	-2.89218200	-1.12512300
H	-3.87086200	-3.19080700	-1.35839400

H	-2.18226700	-3.63513400	-1.60485100
C	-2.93885300	-1.68906400	-3.71010000
C	-4.07247200	-0.35685200	-1.64524200
C	-4.17034100	-0.84148900	-4.03610200
H	-3.18167600	-2.75986600	-3.75642200
H	-2.10954500	-1.50935900	-4.40135300
C	-5.01498000	-0.77571600	-2.76895800
H	-3.87389700	0.72270500	-1.67079400
H	-4.44874000	-0.57237500	-0.63787300
H	-3.85533500	0.17639900	-4.30934500
H	-4.72631400	-1.24322500	-4.89239900
H	-5.86315200	-0.08718600	-2.87064900
H	-5.43713800	-1.77089700	-2.56078000
P	-2.45239600	-1.24583400	-1.94106700
C	-0.89217700	-2.51490100	2.68775100
C	0.05315300	-4.01720200	0.63647200
C	-0.01191500	-3.71315900	3.06030900
H	-1.93034500	-2.65316200	3.01864600
H	-0.52301900	-1.57554900	3.11406900
C	-0.14553800	-4.75931800	1.95649900
H	1.11165700	-3.76335400	0.48561200
H	-0.28768400	-4.57020000	-0.24714500
H	1.03492100	-3.38023000	3.11286400
H	-0.27382600	-4.11486600	4.04631900
H	0.57217700	-5.57990900	2.07890900
H	-1.15036800	-5.20777500	1.98630800
P	-0.87508200	-2.41924900	0.82682700
H	0.70757500	1.57135700	-1.56494100
H	1.11847800	-1.38930100	-2.22449600

4t-Ph-ts

Cu	-1.06200800	-0.47325100	-0.68077000
C	-0.22701800	0.96543600	0.43965600
H	0.24529400	0.59177600	1.35658400
C	-0.37145700	2.29756400	0.31476500
H	-0.80645700	2.69851900	-0.60919700
C	0.00599600	3.32262600	1.29235100
C	-0.51369000	4.61863500	1.16940900
C	0.88654200	3.06846700	2.35512000
C	-0.18789400	5.61675600	2.07904600
H	-1.19202600	4.83372200	0.34276100
C	1.21341400	4.06449600	3.26398200
H	1.33053300	2.07800800	2.45216300

C	0.67643100	5.34424100	3.13484300
H	-0.60891200	6.61353300	1.96216800
H	1.90349200	3.84518700	4.07656800
H	0.93792900	6.12391000	3.84669600
C	0.77901400	0.01863700	-1.22989300
C	0.49041000	-1.23518000	-1.81355100
C	1.64063100	-1.14099100	-0.84469500
C	1.55091900	-1.85274000	0.48146000
C	2.15489100	-1.34220900	1.63437700
C	0.89649600	-3.08342800	0.56118800
C	2.08556500	-2.03476400	2.83985600
H	2.68133100	-0.38973300	1.58136700
C	0.84460400	-3.78962600	1.75941000
H	0.42098600	-3.47030000	-0.34014200
C	1.43309300	-3.26312100	2.90668800
H	2.55330800	-1.61754100	3.72939100
H	0.34492000	-4.75735500	1.79834400
H	1.38858600	-3.81039000	3.84641500
C	3.03911800	-1.14491200	-1.40621300
C	3.45164900	-2.28196500	-2.11215700
C	3.97366700	-0.11427900	-1.27084300
C	4.71953500	-2.38876800	-2.66432200
H	2.73474800	-3.09587600	-2.21999100
C	5.24859200	-0.20024400	-1.82497100
C	5.62306900	-1.33959800	-2.52335800
H	5.00258400	-3.28795000	-3.20648300
H	5.94025200	0.62864700	-1.70008900
H	6.61956000	-1.40483300	-2.95355800
Br	3.57322500	1.48459900	-0.31062500
C	-3.91711700	-0.60072200	0.75782100
H	-3.70157300	0.39569300	1.17371700
H	-4.70389100	-1.05019900	1.37999800
C	-4.35393600	-0.48702600	-0.69876400
H	-5.30034100	0.06406200	-0.79616200
H	-4.52253000	-1.48772300	-1.12524800
C	-3.75222700	0.11784300	-3.45666700
C	-3.53689100	2.10828100	-1.63499400
C	-4.12141500	1.52600600	-3.93069700
H	-4.64578200	-0.51692000	-3.38451600
H	-3.04412200	-0.38409600	-4.12236400
C	-4.60142800	2.30538800	-2.71013400
H	-2.65550600	2.72743500	-1.84694400
H	-3.86322800	2.35401600	-0.61677300
H	-3.23039800	2.02142200	-4.34298500

H	-4.87020300	1.50050300	-4.73153200
H	-4.76747800	3.36606800	-2.93585200
H	-5.56514200	1.89731500	-2.36941900
P	-3.02514400	0.31544100	-1.73800600
C	-1.95522500	-1.47991600	2.70827900
C	-2.97124800	-3.30593000	0.98592100
C	-2.30166600	-2.85431000	3.29734300
H	-2.56342600	-0.67734500	3.14540200
H	-0.90224900	-1.21951100	2.86503600
C	-3.39422200	-3.49080100	2.44145800
H	-2.15048200	-3.98644700	0.72479200
H	-3.77770400	-3.46741300	0.26053000
H	-1.40447900	-3.48782300	3.25870800
H	-2.59636600	-2.77924700	4.35081000
H	-3.54698000	-4.54761400	2.69450000
H	-4.35353200	-2.98195700	2.61907300
P	-2.32603900	-1.56338800	0.88098100
H	1.08843200	0.97597400	-1.63288700
H	0.53474300	-1.47609800	-2.87157900

4t-Ph-pro

Cu	-0.76509200	0.55802500	1.43447400
C	0.28825300	-1.26382200	-0.62549700
H	-0.07454400	-0.29495700	-0.97974700
C	-0.30848000	-2.37990100	-1.07573100
H	0.03685000	-3.34897100	-0.70523300
C	-1.48739000	-2.40344000	-1.93812600
C	-2.23162600	-3.58587900	-2.05483900
C	-1.96493600	-1.26670600	-2.61302000
C	-3.41684100	-3.62781400	-2.77974100
H	-1.87507000	-4.48042000	-1.54414500
C	-3.15134100	-1.30648800	-3.33306900
H	-1.38985400	-0.34091900	-2.58273800
C	-3.89131300	-2.48521700	-3.41628700
H	-3.97571600	-4.55928800	-2.84437800
H	-3.49759100	-0.40909800	-3.84457300
H	-4.81949100	-2.51379900	-3.98200900
C	1.31988100	-1.18411700	0.40558800
C	1.03490600	-0.20179100	1.56122900
C	2.15457300	0.05953700	0.58681100
C	2.04890600	1.23262400	-0.35211600
C	1.79988800	2.50484200	0.17400800
C	2.24358600	1.11355100	-1.73053900
C	1.76825000	3.62730500	-0.64519100

H	1.62083400	2.59728700	1.24507600
C	2.19363100	2.23369000	-2.55872000
H	2.43825300	0.13000700	-2.15400500
C	1.96392000	3.49524600	-2.01932500
H	1.58979300	4.61094300	-0.21174500
H	2.34596000	2.11824900	-3.63004000
H	1.93469400	4.37173900	-2.66416000
C	3.56340900	-0.14630000	1.07448200
C	3.96038000	0.51547500	2.24390700
C	4.53873000	-0.92077300	0.43797000
C	5.24699200	0.41835300	2.75308800
H	3.21147100	1.11466400	2.76021600
C	5.83280500	-1.04000700	0.93807600
C	6.19056300	-0.36604400	2.09741600
H	5.51201700	0.94978900	3.66423500
H	6.55157700	-1.66195200	0.41115900
H	7.20215100	-0.45912500	2.48535400
Br	4.16589300	-1.89061500	-1.16039100
H	1.40273500	-0.61593200	2.50546500
H	1.81740000	-2.12803400	0.64026200
C	-3.61134600	1.27232700	-0.13590600
H	-3.50786700	0.44374000	-0.85550000
H	-4.31421600	1.99233600	-0.57871700
C	-4.12070800	0.74712200	1.20200100
H	-5.06765900	0.20167700	1.08027100
H	-4.31589600	1.57856200	1.89622600
C	-3.74013600	-0.89880800	3.56199200
C	-3.13489400	-1.95786500	1.13556600
C	-3.95948000	-2.40515600	3.39354000
H	-4.69937600	-0.36576800	3.61547100
H	-3.16964400	-0.64970100	4.46122000
C	-4.24222600	-2.65985600	1.91681200
H	-2.19728100	-2.52920900	1.16395400
H	-3.36735200	-1.79273000	0.07482100
H	-3.04479900	-2.94293700	3.68180600
H	-4.76360700	-2.76984100	4.04409100
H	-4.28986600	-3.73011900	1.68147200
H	-5.22088600	-2.23152600	1.65163200
P	-2.83987100	-0.34096900	2.01533100
C	-1.56523000	2.51006900	-1.75412800
C	-2.31652400	3.77198400	0.52317500
C	-1.66877000	4.03916000	-1.81733700
H	-2.31964500	2.02618800	-2.39086800
H	-0.57576300	2.15599900	-2.06910100

C	-2.68081500	4.49506700	-0.77121800
H	-1.41606100	4.21003500	0.97416000
H	-3.10684700	3.78595000	1.28327200
H	-0.68501500	4.46726700	-1.57695100
H	-1.93047800	4.38266500	-2.82528900
H	-2.67889500	5.58510400	-0.64571900
H	-3.69730600	4.21375500	-1.08482900
P	-1.90821500	2.02490000	0.02162100

4u-ini

C	-0.22884600	2.30399200	0.82232800
C	-0.30592600	2.58214000	-0.43619900
C	-0.20947600	1.11971800	-0.09744100
C	-1.43695100	0.25796400	-0.21983400
C	-2.68978900	0.75661300	0.15161200
C	-1.36757100	-1.04577600	-0.71838200
C	-3.83417800	-0.02116400	0.03078900
H	-2.76823000	1.77043500	0.54011200
C	-2.51309400	-1.82497100	-0.84163400
H	-0.40453000	-1.45873900	-1.01296300
C	-3.75235700	-1.31786400	-0.46791700
H	-4.79682700	0.38845700	0.32988100
H	-2.43284900	-2.83723300	-1.23226900
H	-4.64773400	-1.92783000	-0.56284300
C	1.10467000	0.42972400	-0.33162600
C	1.75568500	0.55272700	-1.56090000
C	1.72944100	-0.35082600	0.64349700
C	2.97506200	-0.06569000	-1.80864100
H	1.28074900	1.15629400	-2.33363200
C	2.95094100	-0.97604000	0.41949600
C	3.57447400	-0.83170600	-0.81406800
H	3.45700300	0.04991900	-2.77636000
H	3.40155900	-1.56768600	1.21191200
H	4.53006500	-1.31829800	-0.99350600
H	-0.42985500	3.28957600	-1.24303100
H	-0.22782500	2.59111900	1.86343000
Cl	0.97211700	-0.56171000	2.21075200

4u-Ar-ini

Cu	0.36402000	-0.76445800	-0.07062400
C	1.01947000	0.91720800	-0.81523800
H	1.17172100	1.02144200	-1.90065200
C	1.07286800	2.06236100	-0.10918900

H	0.90030900	2.02547300	0.97409500
C	1.26622500	3.43471400	-0.60083600
C	1.26967000	4.49448100	0.31653000
C	1.42049700	3.75007000	-1.95848300
C	1.43356100	5.81153300	-0.09628000
H	1.13565900	4.26656700	1.37535100
C	1.58717600	5.06297900	-2.37396200
H	1.39872400	2.94825300	-2.69505000
C	1.59696600	6.10365700	-1.44643400
H	1.43310700	6.61383000	0.63944300
H	1.70449400	5.28069700	-3.43406100
H	1.72484400	7.13243600	-1.77584900
C	-1.18024300	-1.19641500	-1.25326400
C	-1.24740300	-2.01812000	-0.17077600
C	-2.32016300	-0.95380500	-0.30248400
C	-3.68272500	-1.39744900	-0.74011600
C	-4.84089000	-0.75474000	-0.29160800
C	-3.82659100	-2.48497600	-1.61064800
C	-6.09875300	-1.18243600	-0.70058400
H	-4.75519700	0.09434500	0.38383600
C	-5.08361500	-2.91228200	-2.01947200
H	-2.94141800	-3.00478100	-1.97286200
C	-6.22774300	-2.26318600	-1.56631300
H	-6.98449000	-0.66409500	-0.33942600
H	-5.16902600	-3.75885600	-2.69767000
H	-7.21215600	-2.59702000	-1.88616700
C	-2.25692800	0.24440300	0.60012900
C	-2.15602500	0.07633500	1.98397700
C	-2.26180500	1.55575500	0.11559500
C	-2.03059300	1.16036100	2.84634000
H	-2.16755900	-0.94235800	2.37386000
C	-2.11475800	2.65244400	0.95839700
C	-1.99609200	2.45250300	2.32848400
H	-1.96247500	0.99828700	3.92100700
H	-2.07829600	3.65108200	0.53027300
H	-1.88196600	3.30957500	2.98832300
H	-1.24379800	-3.07613200	0.06933800
H	-1.07095400	-1.19366000	-2.33265000
C	3.60255900	-1.32554000	0.33067300
H	3.52599800	-0.23157300	0.25348600
H	4.66292100	-1.59445300	0.22178200
C	3.04702900	-1.80719700	1.66648300
H	3.69586600	-1.52897200	2.50972300
H	2.96564800	-2.90508500	1.67684900

C	0.70337300	-2.18954700	3.35122700
C	1.66077100	0.32700500	3.06045700
C	0.58485400	-1.26522300	4.56684700
H	1.43125500	-2.99060900	3.53744100
H	-0.24540300	-2.66264500	3.07635800
C	1.71621500	-0.24458400	4.47455400
H	0.81350800	1.01907400	2.95556500
H	2.56576400	0.85813400	2.74252600
H	-0.37713500	-0.73313100	4.52868600
H	0.60368300	-1.82741100	5.50792000
H	1.62787900	0.53923000	5.23678600
H	2.68058600	-0.74790900	4.64356000
P	1.33870500	-1.12694200	1.95006700
C	3.32763800	-1.12281100	-2.53806600
C	3.64527100	-3.56775500	-1.42786600
C	4.13387400	-2.14125600	-3.34557600
H	3.97065100	-0.31872100	-2.15565900
H	2.53317800	-0.64791000	-3.12246200
C	4.76916800	-3.10865700	-2.35315400
H	3.01486200	-4.31279200	-1.93000300
H	3.99752500	-4.01965400	-0.49185200
H	3.46042700	-2.70347500	-4.00944600
H	4.87749100	-1.65377100	-3.98788500
H	5.26524900	-3.95043200	-2.85349700
H	5.54255400	-2.58213900	-1.77340300
P	2.59547000	-2.04489200	-1.07552100
Cl	-2.43413900	1.85982100	-1.59610400

4u-Ar-ts

Cu	1.20209200	0.26895600	0.08520100
C	-0.12032700	-0.51446400	1.37665300
H	-0.09020000	-0.32196100	2.45512600
C	-0.90593700	-1.51457900	0.93055000
H	-0.95537200	-1.70159700	-0.14843700
C	-1.72736400	-2.44184000	1.71089100
C	-2.25929200	-3.57199800	1.07381100
C	-2.02128700	-2.25399900	3.06900600
C	-3.03693700	-4.49147600	1.76676300
H	-2.05009400	-3.71818400	0.01200800
C	-2.79753700	-3.17080600	3.76215900
H	-1.64704800	-1.36537500	3.57524900
C	-3.30734400	-4.29715900	3.11759300
H	-3.43608300	-5.36228900	1.25016300
H	-3.01717300	-3.00296800	4.81481400

H	-3.91822400	-5.01213000	3.66412700
C	-0.24031900	1.51757700	0.67151400
C	0.34456700	2.04615300	-0.50385800
C	-1.14970100	1.86536100	-0.47752900
C	-1.95508900	3.12447400	-0.32843200
C	-1.54602000	4.13740200	0.54787000
C	-3.09321100	3.35911300	-1.10786400
C	-2.25942500	5.32457600	0.65888600
H	-0.64854400	4.00148000	1.14811000
C	-3.80167800	4.55013700	-1.00580000
H	-3.43018500	2.59496000	-1.80568000
C	-3.39308700	5.53932000	-0.11783900
H	-1.92171800	6.08994600	1.35500800
H	-4.68236100	4.70349700	-1.62620500
H	-3.94944400	6.47024600	-0.03522800
C	-1.79850000	0.75332000	-1.24314400
C	-1.27144100	0.33375400	-2.46495000
C	-2.92010200	0.06559400	-0.76360100
C	-1.81957000	-0.73069800	-3.17358300
H	-0.39627500	0.86673700	-2.83594700
C	-3.47542100	-1.00938200	-1.44961600
C	-2.91868000	-1.41233100	-2.65821000
H	-1.39219900	-1.02739800	-4.13043600
H	-4.32762700	-1.52989700	-1.01988200
H	-3.35188100	-2.25141600	-3.19812900
H	0.84876000	3.00351600	-0.61019900
H	-0.33067200	1.87705800	1.69487700
C	4.36202700	-0.77507300	0.06864800
H	4.21832100	-1.59625900	0.78710500
H	5.44062200	-0.56369200	0.03628700
C	3.83343600	-1.17989700	-1.30318100
H	4.31720800	-2.09922500	-1.66448700
H	4.04152300	-0.39285100	-2.04336200
C	1.59347200	-1.85142400	-3.03490600
C	1.78580600	-3.13811200	-0.65328000
C	0.91231300	-3.21639600	-2.93754200
H	2.53074700	-1.92090900	-3.60487200
H	0.96231900	-1.08982600	-3.50265400
C	1.68616400	-4.02028700	-1.89652400
H	0.86365800	-3.17480000	-0.05779000
H	2.61205400	-3.40540900	0.01683000
H	-0.12669300	-3.07944500	-2.59585100
H	0.86903000	-3.72004700	-3.91096900
H	1.20905900	-4.98306700	-1.67666400

H	2.69239000	-4.24074800	-2.28544800
P	1.98522300	-1.39102900	-1.26907300
C	4.29850700	0.88136200	2.42530300
C	4.36781600	2.11249900	0.01276500
C	5.03695200	2.22042000	2.35902200
H	5.00651200	0.05074700	2.55039800
H	3.58083000	0.83018200	3.24915900
C	5.55507900	2.38235500	0.93325400
H	3.69122500	2.97620800	-0.02093200
H	4.64524800	1.88112200	-1.02287200
H	4.33698900	3.03916800	2.58088700
H	5.83957000	2.27748300	3.10412600
H	5.99358600	3.37324300	0.76216000
H	6.35075700	1.64499500	0.74727900
P	3.43397200	0.68527000	0.77114700
Cl	-3.66320200	0.52497500	0.75302400

4u-Ar-pro

Cu	0.44968700	-0.55247200	1.45825400
C	-0.54917700	-1.14305000	-1.57721000
H	-0.49367000	-1.78529200	-2.46136600
C	0.22492100	-0.04312000	-1.55752100
H	0.12036000	0.65614400	-0.72195500
C	1.17926600	0.36090600	-2.58820400
C	1.53062300	1.71487700	-2.70231100
C	1.79375400	-0.54897600	-3.46285600
C	2.45069400	2.14466900	-3.65070600
H	1.04052600	2.43591800	-2.04663800
C	2.71027800	-0.11921600	-4.41359900
H	1.55587400	-1.60912300	-3.38317500
C	3.04785100	1.22878700	-4.51184100
H	2.69728800	3.20212700	-3.72316600
H	3.17303500	-0.84483700	-5.07971700
H	3.77074000	1.56115700	-5.25316500
C	-1.50336300	-1.58601500	-0.54598200
C	-1.28804400	-1.29159800	0.94090400
C	-2.42487400	-0.63223300	0.21027200
C	-3.81726800	-1.11550400	0.52066600
C	-4.40344200	-0.71976600	1.72828100
C	-4.54925800	-1.94859900	-0.32601600
C	-5.67684300	-1.14547200	2.08192000
H	-3.83760600	-0.07205700	2.39819300
C	-5.82443300	-2.38219200	0.02725600
H	-4.11899600	-2.25275000	-1.27806500

C	-6.39402200	-1.98268700	1.23045400
H	-6.11084900	-0.82762900	3.02799500
H	-6.37772200	-3.03166100	-0.64839000
H	-7.39113200	-2.32043700	1.50474300
C	-2.37652500	0.83979500	-0.07414400
C	-1.95418100	1.72906700	0.92058600
C	-2.76476800	1.40676300	-1.29264200
C	-1.89486300	3.10172600	0.70921900
H	-1.64031900	1.29850100	1.87171500
C	-2.68406600	2.77478000	-1.53673100
C	-2.24430900	3.62685000	-0.53192700
H	-1.57370800	3.76341700	1.51276700
H	-2.97533500	3.15819200	-2.51102600
H	-2.18958200	4.69707800	-0.71759200
H	-1.66110800	-2.12130300	1.55204800
H	-1.98293400	-2.53270000	-0.80051100
C	3.58657500	-0.41797100	0.44528300
H	3.21198300	0.06116000	-0.47393600
H	4.60241200	-0.77737700	0.22833700
C	3.58417800	0.57009200	1.60911700
H	4.25583400	1.42124100	1.42581300
H	3.93189100	0.07859600	2.53083200
C	2.03703400	2.17268600	3.50272200
C	1.77426400	2.68789000	0.84914600
C	1.66210700	3.60357600	3.11345200
H	3.08474500	2.12022600	3.82974900
H	1.41328700	1.76735100	4.30444400
C	2.23900600	3.85086900	1.72348600
H	0.73087000	2.82825900	0.53448200
H	2.37476500	2.53662600	-0.05713000
H	0.56606800	3.69587500	3.07118500
H	2.01740600	4.33119800	3.85275400
H	1.92770300	4.81840800	1.31115000
H	3.33803500	3.86538400	1.78335000
P	1.85147100	1.17407000	1.93427600
C	2.56929100	-2.86206500	-0.75273500
C	3.61547900	-2.97648000	1.74284900
C	3.32311700	-4.14206400	-0.38371800
H	3.11486800	-2.27279300	-1.50317000
H	1.56689700	-3.05105000	-1.15172800
C	4.35843600	-3.77492400	0.67407100
H	3.02213900	-3.64233900	2.38177300
H	4.27354700	-2.39470500	2.40007600
H	2.62082200	-4.87332300	0.04210700

H	3.77688800	-4.61285800	-1.26410000
H	4.85585600	-4.65927700	1.09211200
H	5.14335000	-3.15233000	0.21871900
P	2.44160700	-1.84900400	0.81526400
Cl	-3.37035100	0.39966300	-2.59183700

4u-Ph-ini

Cu	-0.20491600	-0.28475500	-0.16677400
C	-1.51220300	0.78096500	0.81109300
H	-1.73758300	0.53840400	1.86389100
C	-2.24255100	1.77951300	0.28065000
H	-2.06720300	2.05691200	-0.76879500
C	-3.32314400	2.55672600	0.90691400
C	-4.12564100	3.38078200	0.10656400
C	-3.60566400	2.50992200	2.27971500
C	-5.17299600	4.11844200	0.64538800
H	-3.91504300	3.43497000	-0.96246500
C	-4.64940300	3.24589300	2.82150700
H	-2.98596900	1.89188700	2.92792700
C	-5.44254700	4.05404600	2.00842600
H	-5.78053600	4.74815400	-0.00200300
H	-4.84507000	3.19499800	3.89118800
H	-6.25895400	4.63153100	2.43643900
C	1.04629500	0.96288600	-1.08098800
C	1.40603600	-0.31070700	-1.40998300
C	2.37138700	0.47448300	-0.56096100
C	2.57349000	0.09336200	0.88181700
C	1.87226700	0.71319000	1.91751800
C	3.47587500	-0.92707700	1.19657500
C	2.05368100	0.30498800	3.23673700
H	1.17098000	1.51013100	1.67778400
C	3.66455800	-1.33189100	2.51349100
H	4.03723100	-1.40344500	0.39167200
C	2.94910400	-0.71705200	3.53944700
H	1.50001300	0.79906700	4.03292400
H	4.37214600	-2.12692700	2.74163200
H	3.09560700	-1.02954500	4.57140700
C	3.61052200	0.99797900	-1.23394900
C	4.32265500	0.19783800	-2.13209700
C	4.11204900	2.28102400	-0.99436100
C	5.48067100	0.64551500	-2.75587100
H	3.94671000	-0.80381400	-2.33865400
C	5.26707600	2.74967100	-1.61017000
C	5.95519400	1.92589200	-2.49244400

H	6.01149200	-0.00462900	-3.44710900
H	5.61336500	3.75717200	-1.39552000
H	6.85868400	2.29015700	-2.97524100
C	-2.05307000	-3.01757900	0.28528900
H	-2.78727600	-2.36882900	0.78723300
H	-2.18373000	-4.02889500	0.69780800
C	-2.27226400	-3.00276900	-1.22281600
H	-3.25789500	-3.42303300	-1.47148600
H	-1.52554500	-3.63957300	-1.72202600
C	-2.54528800	-1.73348100	-3.76215100
C	-3.81362500	-0.62334000	-1.64416100
C	-3.87364500	-1.03147300	-4.05114600
H	-2.65667100	-2.82368300	-3.84449200
H	-1.75082500	-1.43089000	-4.45141400
C	-4.70824900	-1.11356600	-2.77820400
H	-3.75022600	0.47281500	-1.62695400
H	-4.15122700	-0.92184200	-0.64420600
H	-3.68738700	0.02617200	-4.28919600
H	-4.38477500	-1.46776700	-4.91842800
H	-5.63474300	-0.53033800	-2.85098700
H	-5.00436300	-2.15947700	-2.60407600
P	-2.09924300	-1.29478200	-1.98138300
C	-0.42842400	-2.46896100	2.62185000
C	0.73304000	-3.80864300	0.57036100
C	0.57764800	-3.56298100	2.99695900
H	-1.44928500	-2.73011000	2.93167200
H	-0.17800100	-1.49955100	3.06686600
C	0.59663500	-4.59514300	1.87222900
H	1.75428300	-3.41949600	0.45338100
H	0.48737100	-4.38258000	-0.33124400
H	1.57622400	-3.11093300	3.08429400
H	0.34024700	-4.01303900	3.96818800
H	1.40585900	-5.32506700	1.99827000
H	-0.34651000	-5.16256600	1.86973300
P	-0.39269000	-2.34308400	0.76258900
H	0.67488100	1.88966500	-1.50392100
H	1.46316100	-0.96510600	-2.27265200
Cl	3.26796100	3.36378100	0.09220900

4u-Ph-ts

Cu	-0.75634800	-0.55890400	-0.69571900
C	-0.20198000	1.04236900	0.37695700
H	0.31615500	0.78881000	1.31008000
C	-0.59537800	2.31847300	0.21235200

H	-1.08419300	2.60468500	-0.72713600
C	-0.44821200	3.41847400	1.17009000
C	-1.21380200	4.58120400	1.00702800
C	0.43784500	3.36460900	2.25667800
C	-1.11772400	5.64029900	1.90086200
H	-1.90120100	4.64036300	0.16208000
C	0.53580400	4.42188500	3.14953600
H	1.06707900	2.48449100	2.38614200
C	-0.24318200	5.56534200	2.98046900
H	-1.72706700	6.52989200	1.75319300
H	1.23471700	4.35979500	3.98154500
H	-0.16133600	6.39382200	3.68041200
C	0.96844000	0.23687700	-1.26743600
C	0.90730900	-1.06922200	-1.80461400
C	2.02159800	-0.73700000	-0.84714300
C	2.06011900	-1.39150200	0.50977600
C	2.55751200	-0.72124900	1.63130600
C	1.64127600	-2.71524600	0.65474800
C	2.61643500	-1.35369300	2.86967300
H	2.89621900	0.30920200	1.52706200
C	1.71847600	-3.35809700	1.88700900
H	1.24408700	-3.22618700	-0.22248000
C	2.20061300	-2.67643700	3.00169900
H	2.99810000	-0.81403000	3.73408600
H	1.40298300	-4.39724800	1.97810400
H	2.25653500	-3.17526300	3.96741100
C	3.39770000	-0.51601700	-1.41952500
C	4.00935100	-1.58116900	-2.09147700
C	4.12981500	0.67092300	-1.32550500
C	5.27457900	-1.47251400	-2.65007000
H	3.45239600	-2.51499100	-2.16756800
C	5.39755200	0.80341100	-1.88641200
C	5.97114300	-0.27157100	-2.55073400
H	5.71637600	-2.32210500	-3.16528400
H	5.92320900	1.74999400	-1.79201600
H	6.96164600	-0.16853500	-2.98724200
C	-3.53231300	-1.11700100	0.78967400
H	-3.48452900	-0.08217500	1.16258700
H	-4.22561600	-1.66640900	1.44192400
C	-3.99642000	-1.13933700	-0.66271500
H	-5.02414100	-0.76233900	-0.76535200
H	-3.99560500	-2.17068100	-1.04745400
C	-3.53473900	-0.55293100	-3.45118400
C	-3.65074000	1.51610900	-1.71018200

C	-4.15653700	0.74705900	-3.96887000
H	-4.29828800	-1.33482500	-3.34055900
H	-2.75529500	-0.94452700	-4.11116600
C	-4.74927400	1.47803800	-2.76809100
H	-2.89491800	2.26967200	-1.96714500
H	-3.99921500	1.74560600	-0.69541100
H	-3.37454500	1.37575200	-4.41891900
H	-4.90077500	0.55653900	-4.75147000
H	-5.10440200	2.48258700	-3.02949600
H	-5.62001500	0.92012300	-2.39145000
P	-2.83552000	-0.16349800	-1.75358400
C	-1.42824700	-1.56178100	2.73765200
C	-2.14100000	-3.60976900	1.11871300
C	-1.56840000	-2.93781600	3.40417800
H	-2.13719400	-0.82815800	3.14266700
H	-0.42012200	-1.14960600	2.86162300
C	-2.53530500	-3.78824600	2.58305800
H	-1.21530600	-4.15389300	0.89039200
H	-2.90448000	-3.94264800	0.40536100
H	-0.58328100	-3.42376600	3.40934300
H	-1.88663600	-2.84967800	4.44969600
H	-2.51214700	-4.84161000	2.88989100
H	-3.56703900	-3.43826200	2.73687000
P	-1.79969000	-1.79095100	0.92365000
H	1.10027500	1.22053800	-1.70310800
H	0.99567400	-1.33770800	-2.85314700
Cl	3.48707300	2.07240400	-0.47848200

4u-Ph-pro

Cu	0.41284600	0.25692000	-1.45432300
C	-0.34556700	-1.29009100	0.93830300
H	-0.06218000	-0.24638900	1.10073300
C	0.38155200	-2.25294800	1.52894200
H	0.12108400	-3.29904700	1.34664600
C	1.59402100	-2.01741200	2.30898200
C	2.47176400	-3.08221500	2.55678500
C	1.96898700	-0.74515800	2.77395900
C	3.68592000	-2.88482300	3.20398600
H	2.19611000	-4.07832700	2.21039600
C	3.18419400	-0.54620800	3.41546600
H	1.28998100	0.09766200	2.64241800
C	4.05631800	-1.61276100	3.62897900
H	4.34917400	-3.73060600	3.37403400
H	3.44875000	0.45155800	3.76367000

H	5.00647000	-1.45445700	4.13350100
C	-1.42919200	-1.48058800	-0.02266200
C	-1.29984400	-0.68551400	-1.33977300
C	-2.39336400	-0.36779000	-0.35363900
C	-2.36681400	0.95007100	0.37463500
C	-2.45609900	1.04474900	1.76569100
C	-2.30674000	2.13446200	-0.36766600
C	-2.48863400	2.28742200	2.39654000
H	-2.50225200	0.13163300	2.35618900
C	-2.35582800	3.37583900	0.25559800
H	-2.21219600	2.06295700	-1.45114400
C	-2.44650900	3.45711900	1.64459500
H	-2.55766000	2.33892800	3.48136200
H	-2.32312800	4.28569500	-0.34288800
H	-2.48150700	4.42776800	2.13599300
C	-3.79447100	-0.78547200	-0.70827600
C	-4.31025100	-0.42014400	-1.95809200
C	-4.65685400	-1.49170600	0.13685000
C	-5.60385400	-0.73587700	-2.34815700
H	-3.65080600	0.12289600	-2.63384500
C	-5.95463500	-1.82809700	-0.23742100
C	-6.43121200	-1.44606200	-1.48391300
H	-5.96486600	-0.43278000	-3.32824100
H	-6.57894800	-2.38629900	0.45532700
H	-7.44547400	-1.70697200	-1.77656900
C	3.23548300	1.48039100	-0.19619500
H	3.24346100	0.77714300	0.65255700
H	3.88189100	2.32414300	0.08428500
C	3.73821800	0.78830600	-1.45846200
H	4.73964500	0.36090000	-1.30524600
H	3.81902900	1.50661200	-2.28842700
C	3.42396400	-1.25182600	-3.49782000
C	3.03749000	-1.94890600	-0.90157600
C	3.80296300	-2.68259100	-3.10498300
H	4.32063600	-0.64760600	-3.69283600
H	2.79231900	-1.20851300	-4.38961000
C	4.17508800	-2.66313400	-1.62617900
H	2.16292000	-2.60251000	-0.78158800
H	3.29878100	-1.59001200	0.10314300
H	2.93611800	-3.34362200	-3.24832800
H	4.61070600	-3.07263300	-3.73608000
H	4.34224100	-3.67083600	-1.22645900
H	5.11557900	-2.10720700	-1.49210800
P	2.54010600	-0.53361300	-2.00881800

C	1.14499100	2.77090200	1.31903100
C	1.67332100	3.71258900	-1.16682700
C	1.09313500	4.29250800	1.13443300
H	1.97142600	2.47079500	1.97908900
H	0.21143100	2.37960500	1.74196600
C	2.01241100	4.66635400	-0.02377100
H	0.71712700	3.98635100	-1.63238800
H	2.42887500	3.67644300	-1.96084400
H	0.06223900	4.58006400	0.88291500
H	1.35612700	4.81872800	2.05986200
H	1.89515200	5.71667100	-0.31873600
H	3.06359600	4.53608400	0.27430500
P	1.46171000	2.03948700	-0.37503400
H	-1.84114800	-2.49176600	-0.06703100
H	-1.66547500	-1.28561400	-2.17913000
Cl	-4.13733600	-2.01085700	1.73423900

4v-ini

C	-0.14062100	2.38046400	0.77163900
C	-0.14458200	2.53344300	-0.51042900
C	-0.08949200	1.10843300	-0.02946000
C	-1.33315300	0.26956600	-0.15349300
C	-2.54577900	0.70447000	0.38722300
C	-1.31066100	-0.95500100	-0.82811300
C	-3.70065000	-0.05846800	0.26256200
H	-2.58301300	1.65923700	0.91057400
C	-2.46587200	-1.71820700	-0.95809300
H	-0.37321800	-1.31276100	-1.25140800
C	-3.66636200	-1.27482700	-0.41250300
H	-4.63216100	0.29781600	0.69768100
H	-2.42610300	-2.66691100	-1.48937300
H	-4.56890500	-1.87360200	-0.51140400
C	1.21733100	0.36641100	-0.10732700
C	2.06382400	0.56330800	-1.19695000
C	1.60505900	-0.51787200	0.91602600
C	3.28477700	-0.09559200	-1.29492700
H	1.75471400	1.25486500	-1.98080400
C	2.83424700	-1.16869000	0.80816800
C	3.67128000	-0.96736800	-0.28456600
H	3.92921200	0.07292700	-2.15485100
H	3.14000000	-1.84656200	1.60488400
H	4.62470300	-1.48794800	-0.34212000
H	-0.19505900	3.16536900	-1.38487400
H	-0.17309500	2.79204700	1.77030000

C	0.72693500	-0.76459400	2.10717800
H	0.39800400	0.17364200	2.57135600
H	-0.18526900	-1.30940300	1.83093800
H	1.25251200	-1.35157300	2.86749100

4v-Ar-ini

Cu	0.06993500	-0.66078000	-0.07381700
C	1.27599300	0.70925200	-0.76354500
H	1.97230300	0.46039700	-1.57992600
C	1.32442200	1.99197700	-0.35864800
H	0.61535700	2.33942600	0.40542600
C	2.18942000	3.05898600	-0.88378800
C	1.82492600	4.39800200	-0.69177400
C	3.37997200	2.79918600	-1.57692800
C	2.60167400	5.43703900	-1.18981800
H	0.90393800	4.61347400	-0.14802900
C	4.15869400	3.83432000	-2.07505100
H	3.69792700	1.76503900	-1.71207900
C	3.77366600	5.16052200	-1.88721100
H	2.29132600	6.46845800	-1.03293900
H	5.08072000	3.60742600	-2.60745700
H	4.38707600	5.97065000	-2.27537100
C	-1.39047100	-0.85660300	-1.39886800
C	-1.68167100	-1.65373300	-0.33080100
C	-2.57238900	-0.44944800	-0.55420600
C	-3.92974800	-0.70646200	-1.14081800
C	-5.02770500	0.10394800	-0.83085700
C	-4.13119300	-1.77690200	-2.02238300
C	-6.27959300	-0.14626100	-1.38206000
H	-4.89746200	0.94216200	-0.14898400
C	-5.38210900	-2.02730100	-2.57201800
H	-3.29575700	-2.42530600	-2.28014400
C	-6.46480600	-1.21288900	-2.25483000
H	-7.11652100	0.49971900	-1.12497800
H	-5.51127000	-2.86565900	-3.25356900
H	-7.44442100	-1.40837900	-2.68489800
C	-2.46500600	0.72070100	0.38380000
C	-2.65791000	0.51137600	1.75114000
C	-2.21674300	2.02200800	-0.08700900
C	-2.58977400	1.56106100	2.66194300
H	-2.87063500	-0.50238500	2.09442000
C	-2.13345000	3.06353400	0.84118000
C	-2.31476500	2.84537100	2.20266800
H	-2.76633100	1.38114100	3.72122500

H	-1.93124000	4.07106600	0.47725700
H	-2.25558500	3.67842800	2.89982800
H	-1.85301800	-2.70223300	-0.11025100
H	-1.20104300	-0.90268100	-2.46626000
C	3.14644200	-1.73281300	0.75109800
H	3.26231600	-0.66300200	0.52324200
H	4.15398700	-2.16862200	0.81562800
C	2.38613800	-1.92114600	2.05847100
H	2.98317000	-1.60997700	2.92815900
H	2.14060600	-2.98371300	2.20918100
C	-0.10947300	-1.74129700	3.52341700
C	1.19116700	0.57122400	2.97129300
C	-0.19377100	-0.63719800	4.58220200
H	0.48234700	-2.59218400	3.88673800
H	-1.09132200	-2.12402300	3.22531400
C	1.06014000	0.22419400	4.45168600
H	0.45054600	1.32876600	2.67668900
H	2.17755500	0.94103400	2.66907400
H	-1.07291400	-0.00962000	4.38010100
H	-0.31425800	-1.05085600	5.59049900
H	1.00871100	1.12193100	5.07965500
H	1.93905900	-0.34902800	4.78526400
P	0.77605300	-0.98827900	2.05898900
C	3.29493800	-1.97250800	-2.11184400
C	2.96402200	-4.21658300	-0.64111900
C	3.95060200	-3.24498400	-2.64960700
H	4.05345600	-1.27131000	-1.73606500
H	2.70876100	-1.44198500	-2.86939900
C	4.25590300	-4.13473800	-1.45023000
H	2.25987100	-4.91413800	-1.11239800
H	3.11047900	-4.55516000	0.39245700
H	3.24976000	-3.77010500	-3.31551600
H	4.84541100	-3.02134400	-3.24340900
H	4.62107200	-5.12559900	-1.74966200
H	5.05033200	-3.67177200	-0.84538600
P	2.20002700	-2.49665500	-0.67411000
C	-2.01204700	2.29723300	-1.54510000
H	-2.79370800	1.83614600	-2.16139100
H	-2.00753800	3.37455900	-1.74302500
H	-1.04534700	1.89148300	-1.87381200

4v-Ar-ts

Cu	1.12669600	0.24126100	0.09804500
C	-0.20630500	-0.48917300	1.41114600

H	-0.15273400	-0.28813300	2.48790400
C	-1.04471900	-1.45655800	0.98688900
H	-1.12038400	-1.65024200	-0.08880300
C	-1.90549400	-2.32652200	1.79093900
C	-2.52314100	-3.42309700	1.17190600
C	-2.16290100	-2.11146900	3.15286200
C	-3.34804700	-4.28365700	1.88527900
H	-2.34441100	-3.58850300	0.10769900
C	-2.98659600	-2.96988200	3.86648700
H	-1.71786200	-1.24945600	3.64842600
C	-3.58176700	-4.06347500	3.23926400
H	-3.81338100	-5.12893800	1.38186400
H	-3.17449000	-2.78168400	4.92189000
H	-4.22894100	-4.73289000	3.80144400
C	-0.27773200	1.52900200	0.69404900
C	0.31624400	2.04620800	-0.48020900
C	-1.18299100	1.89709900	-0.45751400
C	-1.95654200	3.17462300	-0.28845500
C	-1.52226900	4.16908200	0.59799700
C	-3.09766200	3.44282300	-1.05467400
C	-2.21372500	5.36643100	0.73407700
H	-0.61964300	4.01065900	1.18482000
C	-3.78545800	4.64421900	-0.92639200
H	-3.44825400	2.69554100	-1.76434700
C	-3.35214600	5.61218100	-0.02670200
H	-1.85509800	6.11595600	1.43697100
H	-4.66769300	4.82343500	-1.53778100
H	-3.89174300	6.55094400	0.07585100
C	-1.86525500	0.80812900	-1.23263700
C	-1.34402600	0.40644900	-2.46092100
C	-3.00960900	0.16166200	-0.72359300
C	-1.92254200	-0.62819900	-3.19114000
H	-0.45546900	0.92128900	-2.82638700
C	-3.57214800	-0.88228500	-1.46111200
C	-3.03863600	-1.28389200	-2.68169300
H	-1.50671200	-0.91932100	-4.15535000
H	-4.43988800	-1.40064400	-1.05278100
H	-3.49897000	-2.09988700	-3.23556500
H	0.84724800	2.98988100	-0.57986000
H	-0.34624900	1.89748700	1.71672200
C	4.24164600	-0.91975400	0.05732000
H	4.07034500	-1.73118400	0.78077300
H	5.32755200	-0.75115500	0.01642800
C	3.68762600	-1.30823400	-1.30887400

H	4.13179100	-2.24752900	-1.66977700
H	3.92321500	-0.53313700	-2.05342300
C	1.41783500	-1.87495500	-3.03415800
C	1.56309300	-3.18501400	-0.66163600
C	0.68501400	-3.21333400	-2.94493900
H	2.35050200	-1.97564300	-3.60708100
H	0.81372100	-1.08616600	-3.49189600
C	1.42918900	-4.05378100	-1.91109400
H	0.63912200	-3.18912800	-0.06778600
H	2.37706900	-3.48911900	0.00791000
H	-0.34783400	-3.03778400	-2.60212900
H	0.62148000	-3.70789400	-3.92191100
H	0.91698300	-4.99984100	-1.69770000
H	2.42635400	-4.30869000	-2.30249500
P	1.83206600	-1.44343700	-1.26702400
C	4.26941600	0.75778100	2.40088800
C	4.35283500	1.96568900	-0.02288600
C	5.05036100	2.07131900	2.31526800
H	4.95161100	-0.09461600	2.52303100
H	3.56131400	0.73597900	3.23431400
C	5.55820100	2.20362400	0.88277000
H	3.70570900	2.85156400	-0.05932000
H	4.61168400	1.71446400	-1.05870200
H	4.37975800	2.91445200	2.53682100
H	5.86229600	2.10868000	3.05151800
H	6.02793500	3.17765600	0.69819900
H	6.32659000	1.43821300	0.69532400
P	3.37738000	0.57963000	0.75917000
C	-3.62329700	0.55493300	0.58729100
H	-4.18585000	1.49425000	0.50442300
H	-4.30771700	-0.22252100	0.94428200
H	-2.85553700	0.70637000	1.35617100

4v-Ar-pro

Cu	0.00343200	1.03111600	1.12551700
C	-0.54121700	-2.08493700	0.11979200
H	-0.39390300	-3.16306100	0.23506500
C	0.21381700	-1.43605000	-0.78362900
H	0.05857500	-0.35984600	-0.91131100
C	1.26430300	-2.00171300	-1.62493900
C	1.94947400	-1.15088600	-2.50568500
C	1.66073200	-3.34794200	-1.58407800
C	3.00284700	-1.60992000	-3.28783800
H	1.62799900	-0.11024300	-2.57600800

C	2.70882900	-3.80909900	-2.36713100
H	1.14593200	-4.04196800	-0.92140100
C	3.39380400	-2.94301700	-3.21837400
H	3.51598600	-0.92471300	-3.95976600
H	2.99780500	-4.85682100	-2.31261400
H	4.21754000	-3.30817400	-3.82716400
C	-1.57518100	-1.51472900	1.00056900
C	-1.51860100	-0.08665500	1.53373300
C	-2.59616400	-0.46661000	0.54890200
C	-3.99814900	-0.59122000	1.08373500
C	-4.76057600	0.57493300	1.22370800
C	-4.57960500	-1.80271700	1.46370300
C	-6.05072900	0.53437100	1.73427100
H	-4.32134100	1.52670500	0.92557200
C	-5.87359700	-1.84788600	1.97784800
H	-4.01606600	-2.72726500	1.34790600
C	-6.61465700	-0.68089400	2.11659500
H	-6.62030800	1.45601600	1.83721900
H	-6.30425500	-2.80513400	2.26542200
H	-7.62536600	-0.71591200	2.51724200
C	-2.55030000	0.06958400	-0.85677600
C	-2.19888300	1.40363600	-1.07980300
C	-2.88440200	-0.73391600	-1.96445200
C	-2.12728400	1.93931600	-2.36232600
H	-1.96186200	2.02247700	-0.21282000
C	-2.78539100	-0.19112600	-3.24780000
C	-2.40355100	1.12860000	-3.45754900
H	-1.86150600	2.98710700	-2.50442500
H	-3.02020200	-0.82628300	-4.10166200
H	-2.33962000	1.52384300	-4.46922300
H	-1.91634800	-0.04004900	2.55285200
H	-1.99018800	-2.26017000	1.68035900
C	3.54765100	0.63198000	0.49490500
H	3.19579400	0.26952100	-0.48493300
H	4.63097400	0.44688700	0.52553800
C	3.25342300	2.11983200	0.65976200
H	3.87521000	2.73714900	-0.00615700
H	3.46327400	2.44890600	1.68887300
C	1.31036800	4.31611800	0.62093900
C	1.44765400	2.67284700	-1.53945600
C	0.80497100	4.88618300	-0.70477700
H	2.30167900	4.72238700	0.86624900
H	0.64172400	4.51845100	1.46236500
C	1.57495700	4.17236400	-1.81142200

H	0.48966100	2.28327500	-1.90958000
H	2.24810500	2.07379000	-1.99166100
H	-0.26931700	4.66995000	-0.81087000
H	0.91953700	5.97563300	-0.74819200
H	1.20495400	4.43374400	-2.81019400
H	2.63233300	4.47520900	-1.76952000
P	1.47106500	2.48603100	0.31520500
C	3.25819900	-2.10831500	1.26727300
C	3.99525300	-0.30544800	3.14093200
C	4.23416200	-2.59634700	2.33890300
H	3.74927300	-2.02733700	0.28668900
H	2.39919500	-2.77443100	1.13667600
C	5.02500700	-1.38489200	2.81826300
H	3.51403400	-0.50954200	4.10587800
H	4.41852800	0.70550700	3.20010300
H	3.67300500	-3.01426500	3.18783600
H	4.88306500	-3.39668100	1.96218300
H	5.66318900	-1.61889100	3.68025300
H	5.69214800	-1.04165200	2.01298600
P	2.67755300	-0.39903500	1.80046200
C	-3.33500600	-2.15201400	-1.79564100
H	-4.24850800	-2.21099400	-1.19045700
H	-3.53815600	-2.61725300	-2.76587600
H	-2.57430100	-2.75376000	-1.28137200

4v-Ph-ini

Cu	-0.16112900	-0.19906600	-0.13362900
C	-1.53362900	0.82972300	0.79367800
H	-1.70594200	0.66527800	1.87124100
C	-2.36094000	1.71446300	0.20573400
H	-2.23840100	1.91080400	-0.86943300
C	-3.48243400	2.45803300	0.80009800
C	-4.36250400	3.15474700	-0.03878000
C	-3.72850900	2.50220800	2.18002800
C	-5.44765500	3.85781400	0.47081100
H	-4.18246400	3.13616600	-1.11459800
C	-4.80990300	3.20390200	2.69259900
H	-3.05121700	1.98243600	2.85626000
C	-5.67890100	3.88569800	1.84211700
H	-6.11509500	4.38798800	-0.20609400
H	-4.97629200	3.22530500	3.76821800
H	-6.52487600	4.43665500	2.24706000
C	1.01311100	1.07814600	-1.11381700
C	1.45329700	-0.18522400	-1.37544300

C	2.38435600	0.71163500	-0.60002200
C	2.64358200	0.42442600	0.85563400
C	1.85507100	0.95612400	1.87883300
C	3.71330300	-0.40849300	1.20047900
C	2.11786700	0.64646900	3.21154100
H	1.02499800	1.61227100	1.62016400
C	3.98216200	-0.71398400	2.53022300
H	4.34543000	-0.80983300	0.40767000
C	3.18228900	-0.18725700	3.54279400
H	1.49454700	1.07415800	3.99486500
H	4.82114800	-1.36111600	2.77871300
H	3.39311000	-0.42020100	4.58447900
C	3.56621700	1.29205500	-1.33197400
C	4.23155400	0.53331700	-2.29549900
C	4.01649300	2.59591000	-1.05248100
C	5.33132700	1.03530800	-2.98281300
H	3.87669600	-0.47537900	-2.50698900
C	5.11681000	3.08904900	-1.75438300
C	5.77582400	2.32285700	-2.70975000
H	5.83568100	0.42333100	-3.72738500
H	5.45974000	4.10190200	-1.54414000
H	6.63137000	2.73413500	-3.24098600
C	-1.68140100	-3.12406000	0.42005100
H	-2.49611600	-2.57071400	0.91191100
H	-1.67563800	-4.13688000	0.84945700
C	-1.89844000	-3.16333500	-1.08790400
H	-2.82391100	-3.70679900	-1.32882700
H	-1.07747400	-3.71124600	-1.57599100
C	-2.32789900	-1.97878100	-3.64853800
C	-3.71375800	-0.98983200	-1.54417800
C	-3.73115400	-1.44488600	-3.94295900
H	-2.30830900	-3.07566600	-3.71270700
H	-1.57665400	-1.59473000	-4.34559900
C	-4.54695300	-1.60326600	-2.66501900
H	-3.77879400	0.10629400	-1.54938400
H	-4.01205600	-1.30702300	-0.53749500
H	-3.67263400	-0.37695400	-4.19991900
H	-4.18894500	-1.95404300	-4.80022200
H	-5.53635000	-1.13559400	-2.74372300
H	-4.71602200	-2.67368000	-2.47135600
P	-1.93372500	-1.46067200	-1.87707700
C	-0.13358500	-2.31522000	2.74069400
C	1.19161200	-3.52375400	0.70465800
C	1.05228700	-3.20707200	3.12230900

H	-1.08861500	-2.74948200	3.06611800
H	-0.05563600	-1.30852900	3.16613600
C	1.20554200	-4.26962400	2.03717200
H	2.14330800	-2.99881600	0.54046100
H	1.00612800	-4.16172100	-0.16799000
H	1.96417300	-2.59223300	3.15359100
H	0.92262500	-3.64598700	4.11872500
H	2.11970400	-4.86187800	2.16707300
H	0.35982300	-4.97301800	2.08249200
P	-0.12603900	-2.22564200	0.87911900
H	0.57471300	1.94109300	-1.60396000
H	1.53745400	-0.87812100	-2.20551600
C	3.33758100	3.45261800	-0.02616800
H	2.25189500	3.49047500	-0.17988200
H	3.49142100	3.06295200	0.98867200
H	3.72093800	4.47774600	-0.05481000

4v-Ph-ts

Cu	-0.70792700	-0.51399600	-0.68644300
C	-0.12693800	1.06529400	0.41046300
H	0.38718500	0.76552600	1.33255900
C	-0.46845200	2.36165800	0.28628500
H	-0.94182600	2.69418000	-0.64669800
C	-0.27000800	3.43308400	1.26650800
C	-0.92145600	4.66065600	1.08269000
C	0.55791500	3.29475500	2.39162600
C	-0.76996300	5.70282300	1.98839300
H	-1.56276500	4.78632200	0.20960300
C	0.71090700	4.33482900	3.29660900
H	1.09594500	2.35954500	2.54621000
C	0.04653800	5.54507500	3.10381200
H	-1.29034500	6.64402000	1.82187400
H	1.36201600	4.20514100	4.15907900
H	0.17123500	6.35915200	3.81418900
C	0.98725400	0.32728300	-1.28471500
C	0.94712800	-0.97138900	-1.84029500
C	2.08701600	-0.61826200	-0.91863900
C	2.17706300	-1.29452300	0.42566000
C	2.73704400	-0.65301300	1.53448200
C	1.74541500	-2.61385400	0.57219300
C	2.82952400	-1.29878300	2.76347500
H	3.10865000	0.36634500	1.43267700
C	1.86285900	-3.27471600	1.79168500
H	1.31348800	-3.10824100	-0.29788400

C	2.39346100	-2.61486100	2.89716600
H	3.25720700	-0.77722000	3.61743300
H	1.54343700	-4.31318000	1.87837600
H	2.47756100	-3.12677100	3.85387400
C	3.44088800	-0.33680400	-1.52111400
C	4.08932100	-1.40327000	-2.15300600
C	4.07902800	0.91385900	-1.45906200
C	5.34126200	-1.25534700	-2.73168300
H	3.58169700	-2.36800600	-2.18231700
C	5.34167100	1.04630000	-2.04822500
C	5.97212100	-0.01588400	-2.68038400
H	5.82314400	-2.10068400	-3.21818100
H	5.83853000	2.01569700	-1.99957700
H	6.95515300	0.12127700	-3.12587500
C	-3.46251700	-1.21476700	0.80076000
H	-3.44811700	-0.20397100	1.23703000
H	-4.13197300	-1.82686800	1.42156400
C	-3.93705200	-1.16232500	-0.64752400
H	-4.97419500	-0.80455100	-0.72028300
H	-3.91480700	-2.16855200	-1.09326600
C	-3.54112200	-0.37121400	-3.39478500
C	-3.63648100	1.56681200	-1.50665000
C	-4.16619700	0.96294600	-3.81064900
H	-4.30682800	-1.15558500	-3.32272200
H	-2.77614000	-0.72000300	-4.09444700
C	-4.74583300	1.60422000	-2.55349800
H	-2.88737500	2.34359600	-1.70746300
H	-3.97763300	1.71314300	-0.47437600
H	-3.38787800	1.62225100	-4.22174700
H	-4.91854100	0.83014200	-4.59744800
H	-5.10467300	2.62454300	-2.73725700
H	-5.61203200	1.01897200	-2.20913900
P	-2.80939200	-0.09739300	-1.68847000
C	-1.33312900	-1.69819000	2.71189700
C	-1.97730400	-3.67275200	0.97465100
C	-1.38240600	-3.12145700	3.28468700
H	-2.08558300	-1.04260100	3.16916000
H	-0.35244900	-1.23152100	2.85977500
C	-2.33292100	-3.95846200	2.43189300
H	-1.03811900	-4.16742000	0.69441400
H	-2.74344000	-3.98784900	0.25610200
H	-0.37493900	-3.55695000	3.22669500
H	-1.67142800	-3.12105200	4.34237100
H	-2.26130700	-5.02713300	2.67061100

H	-3.37386400	-3.66065000	2.62804300
P	-1.70676600	-1.83368600	0.88783300
H	1.06668600	1.31389900	-1.72781200
H	1.00898900	-1.21140300	-2.89758400
C	3.47178000	2.12653500	-0.80681700
H	2.96882500	2.76824900	-1.54431600
H	2.72154900	1.88322400	-0.04838400
H	4.24870400	2.73952000	-0.33577300

4v-Ph-pro

Cu	0.24788800	0.03632600	-1.41181800
C	-0.34959600	-1.26492400	1.16728500
H	-0.08492400	-0.20423100	1.15634000
C	0.43191300	-2.10706500	1.86487000
H	0.20832100	-3.17726100	1.85209400
C	1.66261300	-1.70950600	2.54512000
C	2.60996000	-2.68453100	2.88824400
C	1.98177900	-0.36840700	2.82085900
C	3.83602200	-2.33911900	3.44450900
H	2.37872800	-3.73109200	2.68960600
C	3.20864200	-0.02247600	3.37113800
H	1.24923700	0.41288900	2.61459500
C	4.14918800	-1.00412200	3.68043800
H	4.55363200	-3.11885300	3.69195800
H	3.42869800	1.02496100	3.57409600
H	5.10819800	-0.73067200	4.11394000
C	-1.46344100	-1.60960800	0.28889400
C	-1.40551100	-0.96758400	-1.11580900
C	-2.48868200	-0.58417100	-0.14452200
C	-2.49094900	0.80879700	0.42693400
C	-2.40294600	1.07953500	1.79519500
C	-2.63667000	1.89101300	-0.44885800
C	-2.47444600	2.38718500	2.27547500
H	-2.26482900	0.25565700	2.49395200
C	-2.71828100	3.19470100	0.02391400
H	-2.68117900	1.68772900	-1.51865300
C	-2.64077400	3.44913900	1.39320100
H	-2.40555800	2.57253900	3.34578300
H	-2.84413200	4.01903400	-0.67692200
H	-2.70592600	4.46933300	1.76684200
C	-3.88290100	-1.09997200	-0.40764500
C	-4.38184400	-1.01960000	-1.71111400
C	-4.71055400	-1.62722300	0.60236900
C	-5.66273600	-1.44897400	-2.03414000

H	-3.73264700	-0.61428000	-2.48641600
C	-5.99049200	-2.07104200	0.25965700
C	-6.47307700	-1.98422500	-1.04005500
H	-6.02170100	-1.37328000	-3.05847800
H	-6.62185900	-2.49324400	1.04173400
H	-7.47538400	-2.33698900	-1.27402500
C	3.06430700	1.55244900	-0.48796000
H	3.16665300	0.97297400	0.44397700
H	3.66882800	2.46231400	-0.36427500
C	3.53835700	0.72480800	-1.67740600
H	4.56809500	0.36927100	-1.52856500
H	3.53722000	1.33067000	-2.59620600
C	3.24331800	-1.58885400	-3.40300100
C	3.00003500	-1.94032400	-0.72112500
C	3.70669700	-2.93548100	-2.83994200
H	4.10103500	-0.97932500	-3.71911000
H	2.57452300	-1.69430600	-4.26187000
C	4.13900400	-2.69913200	-1.39666500
H	2.16339300	-2.60709500	-0.47248400
H	3.28613300	-1.43777200	0.21276200
H	2.86737700	-3.64565100	-2.85154400
H	4.50516100	-3.37378700	-3.45083900
H	4.37013100	-3.63519700	-0.87363800
H	5.05696000	-2.09188100	-1.38352600
P	2.38703200	-0.71274400	-1.98393300
C	0.99121300	2.90711100	0.98764200
C	1.29832300	3.54451200	-1.62880500
C	0.81090600	4.38285100	0.61307100
H	1.87945000	2.75322300	1.61683300
H	0.12080300	2.51266100	1.52545000
C	1.63246500	4.66024700	-0.64159300
H	0.29955400	3.69249200	-2.06047400
H	2.00797000	3.45133200	-2.45965500
H	-0.25161500	4.56188600	0.39496000
H	1.08417500	5.04482100	1.44350600
H	1.42225400	5.65272600	-1.05953000
H	2.70564700	4.63858500	-0.39924300
P	1.24992700	1.98058100	-0.61784500
H	-1.82923300	-2.63750800	0.36824100
H	-1.76330700	-1.67919000	-1.86611300
C	-4.27732700	-1.70991700	2.03657300
H	-3.24119300	-2.05241700	2.14119800
H	-4.33531400	-0.72683000	2.52263700
H	-4.92357700	-2.39180100	2.59997900

Table S6. The coordinates of [4t-Ar-ts]' and [4t-Ph-ts]', which have the bromophenyl group being rotated by 180° from 4t-Ar-ts and 4t-Ph-ts, respectively.

	[4t-Ar-ts]'		
Cu	-0.60384900	0.66959300	-0.67515200
C	-1.16386200	-1.27792600	-0.80326200
H	-1.66272500	-1.59713000	-1.72875500
C	-1.32614400	-2.05319700	0.28699500
H	-0.82218100	-1.76134100	1.21133900
C	-2.13220100	-3.26862100	0.42078800
C	-2.32563100	-3.80788100	1.70098200
C	-2.72882000	-3.92821000	-0.66408500
C	-3.09024200	-4.95097700	1.89576200
H	-1.86110500	-3.30766900	2.55274300
C	-3.49168900	-5.07058600	-0.47156000
H	-2.57977100	-3.54174700	-1.67128200
C	-3.68004600	-5.58868000	0.80884600
H	-3.22493200	-5.34761800	2.90013300
H	-3.94079100	-5.56803700	-1.32906100
H	-4.27758900	-6.48549200	0.95537400
C	0.64227300	-0.61034100	-1.62719800
C	1.20662900	0.68927200	-1.59288000
C	1.98717800	-0.42281900	-0.96017600
C	3.15840500	-0.98128200	-1.71943000
C	3.16870000	-0.95863000	-3.12056500
C	4.27561300	-1.51657900	-1.06844300
C	4.24248900	-1.46631700	-3.84031200
H	2.32492200	-0.52741700	-3.65576600
C	5.35501700	-2.01690100	-1.78849500
H	4.30564200	-1.53981300	0.01898400
C	5.34408900	-1.99977500	-3.17838100
H	4.22017400	-1.43904500	-4.92801600
H	6.21163800	-2.42320800	-1.25446500
H	6.18756100	-2.39323900	-3.74115000
C	2.10177300	-0.52355700	0.53048600
C	1.74141300	-1.71731100	1.16490200
C	2.62093600	0.49007200	1.33882400
C	1.83297500	-1.87827700	2.54234900
H	1.37415600	-2.52943400	0.54000600
C	2.73093700	0.34614500	2.71934000
C	2.32375900	-0.83749900	3.32570100
H	1.52925500	-2.81789800	2.99973100
H	3.14464100	1.16141600	3.30927700

H	2.40759200	-0.94603500	4.40505100
Br	3.26808200	2.10760600	0.58276700
H	1.53945600	1.29544700	-2.43047000
H	0.45376300	-1.29117500	-2.45666500
C	-3.47189500	1.82260400	0.12132100
H	-3.73852000	0.79364700	0.40850900
H	-4.41039300	2.37637300	-0.02653100
C	-2.60162400	2.46761400	1.19368600
H	-3.14670800	2.57988500	2.14138000
H	-2.30071100	3.47881200	0.87961500
C	-0.07702300	2.67516500	2.56840500
C	-1.50563800	0.40309300	2.88080300
C	-0.12621100	2.08475700	3.98363900
H	-0.57063500	3.65489900	2.52625700
H	0.94598800	2.80727400	2.19768400
C	-1.41764000	1.28322000	4.12341800
H	-0.76679200	-0.41023000	2.93665700
H	-2.48802700	-0.05409800	2.70597100
H	0.72437300	1.40111000	4.11689000
H	-0.03644000	2.86504400	4.74898600
H	-1.43341200	0.69159900	5.04748300
H	-2.28052100	1.96481900	4.16907400
P	-1.02204700	1.50142400	1.45572000
C	-3.76323300	0.80373700	-2.57322100
C	-2.87536000	3.34552800	-2.25385400
C	-4.17915000	1.81566400	-3.64402500
H	-4.62159000	0.50422700	-1.95698300
H	-3.32837100	-0.10823700	-2.99376100
C	-4.20681500	3.19156900	-2.98516300
H	-2.06525300	3.57177100	-2.95790600
H	-2.87339500	4.13428300	-1.49186500
H	-3.43480400	1.82199400	-4.45355700
H	-5.14139700	1.55195400	-4.09889100
H	-4.37295900	3.99540300	-3.71308700
H	-5.03783900	3.23602200	-2.26501900
P	-2.52710600	1.68257800	-1.47749000

[4t-Ph-ts]'

Cu	-0.72495800	-0.74245500	-0.46140300
C	-1.00500800	1.19480800	-0.02370700
H	-0.61133300	1.44122500	0.96903300
C	-1.78784100	2.11139400	-0.62273800
H	-2.15892900	1.91192500	-1.63651900

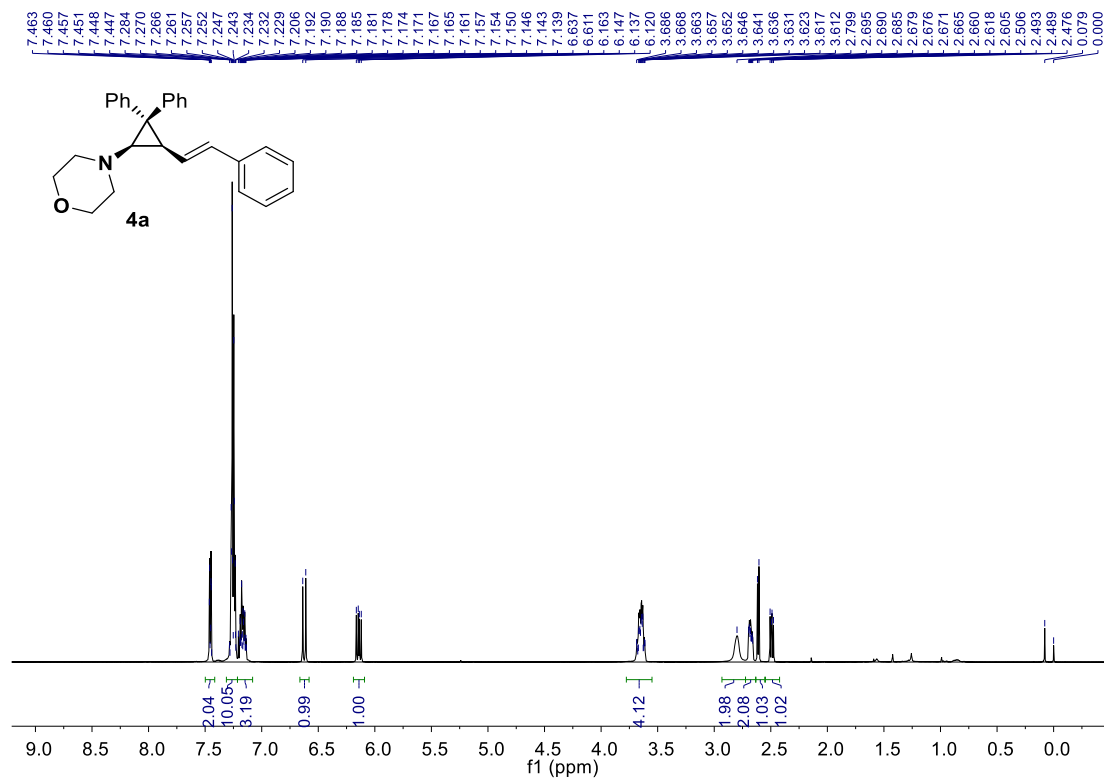
C	-2.21286300	3.40406100	-0.07520400
C	-3.14917100	4.17460500	-0.77845200
C	-1.71922100	3.92107900	1.13332700
C	-3.58343500	5.40379000	-0.29760600
H	-3.53959800	3.79078500	-1.72140000
C	-2.15141700	5.14789400	1.61435200
H	-0.97847500	3.35288600	1.69623200
C	-3.08762500	5.89806300	0.90420700
H	-4.31156300	5.97952900	-0.86574200
H	-1.75061100	5.52835100	2.55205600
H	-3.42266400	6.86058100	1.28392300
C	0.64909100	0.47488500	-1.21788400
C	1.18969100	-0.83036600	-1.23183000
C	1.90757600	0.22088800	-0.43883400
C	1.91634900	0.18024300	1.06747000
C	1.92007400	1.36246500	1.81267000
C	1.93134500	-1.03795300	1.74653600
C	1.91587800	1.33041100	3.20379200
H	1.91362800	2.31981300	1.28971500
C	1.95405300	-1.07528300	3.13797800
H	1.92536800	-1.95405500	1.15766100
C	1.93775000	0.10828100	3.87198900
H	1.90631800	2.26112900	3.76761700
H	1.99154100	-2.03447200	3.65394400
H	1.94894500	0.07837700	4.95992100
C	3.12897400	0.88714700	-1.01447400
C	3.07774400	2.23494900	-1.39008400
C	4.35186900	0.23234400	-1.18370100
C	4.18333500	2.89607400	-1.90987700
H	2.13604400	2.76900300	-1.26305500
C	5.46928100	0.87628000	-1.70366300
C	5.38470000	2.21430600	-2.06838400
H	4.10578600	3.94399800	-2.18984500
H	6.39767900	0.32353300	-1.82061800
H	6.25796400	2.71810100	-2.47570200
Br	4.54241700	-1.59889400	-0.71322300
C	-3.34090900	-1.87641100	0.98744700
H	-3.76293700	-0.86168300	0.92065400
H	-3.90071200	-2.41054000	1.76804800
C	-3.44459400	-2.58455200	-0.35902200
H	-4.49181800	-2.73870100	-0.65649600
H	-2.97807200	-3.58006000	-0.30468900
C	-2.66142600	-2.82344900	-3.12987500
C	-3.88138100	-0.53920800	-2.33970700

C	-3.57290400	-2.14221100	-4.15386700
H	-3.10881300	-3.76035100	-2.77119000
H	-1.67220300	-3.06243600	-3.53080100
C	-4.63376900	-1.37021000	-3.37501800
H	-3.41073500	0.33362600	-2.81064700
H	-4.50231600	-0.16353100	-1.51710100
H	-2.98570400	-1.43425300	-4.75669900
H	-4.01078800	-2.86659400	-4.85112300
H	-5.25710800	-0.74837800	-4.02947700
H	-5.30816500	-2.07991300	-2.87216500
P	-2.52560200	-1.63968200	-1.68118400
C	-1.69803200	-0.66096300	3.04310900
C	-1.23101200	-3.24547000	2.38428000
C	-1.43572400	-1.62393800	4.20908500
H	-2.70546300	-0.22656100	3.08262100
H	-0.98145500	0.16873800	3.02924400
C	-1.82425400	-3.03569900	3.77580200
H	-0.14429600	-3.39162900	2.43709700
H	-1.65291600	-4.09995200	1.84175400
H	-0.36211600	-1.60563300	4.44272000
H	-1.96630000	-1.31267400	5.11675200
H	-1.47459400	-3.79200600	4.48988600
H	-2.91998300	-3.12628100	3.73212600
P	-1.55361600	-1.65628600	1.47035900
H	0.47585700	1.21598200	-1.99102000
H	1.55522900	-1.38540600	-2.08956900

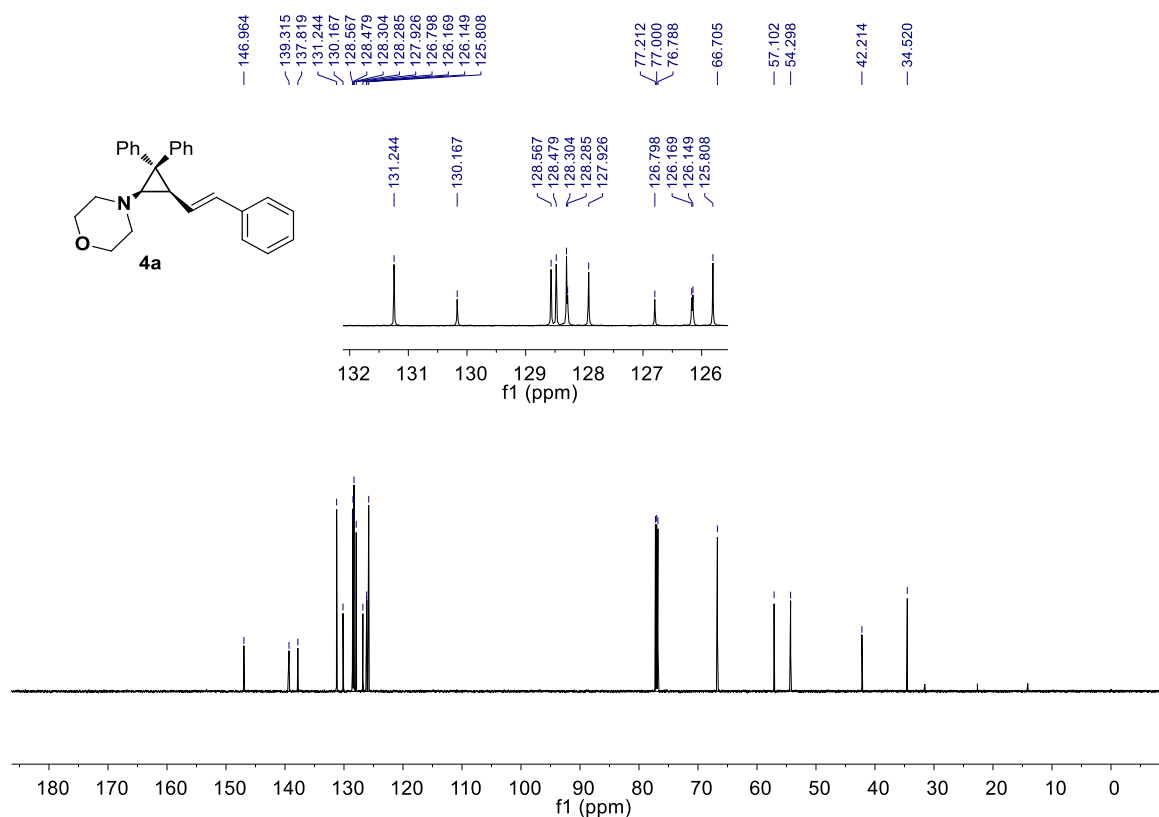
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6. Copies of NMR spectra and chromatograph of products.



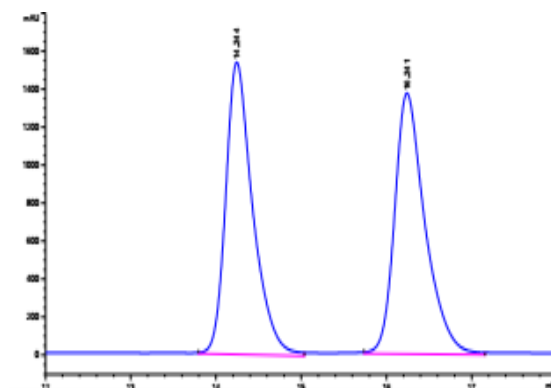
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4a.



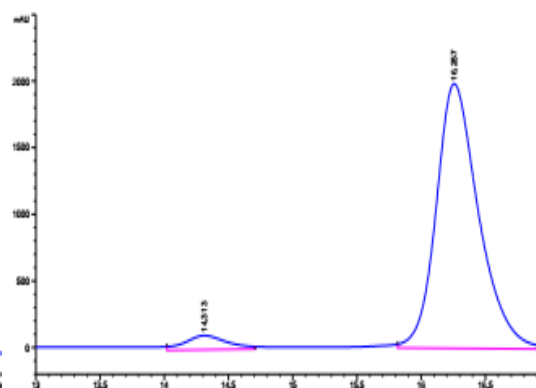
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4a.

HPLC conditions: CHIRALCEL AD-H, 95/5 hexanes/*i*-PrOH, 0.4 mL/min, 250 nm, t_R (major) = 16.2 min, t_R (minor) = 14.3 min.

Racemate:



Chiral sample:



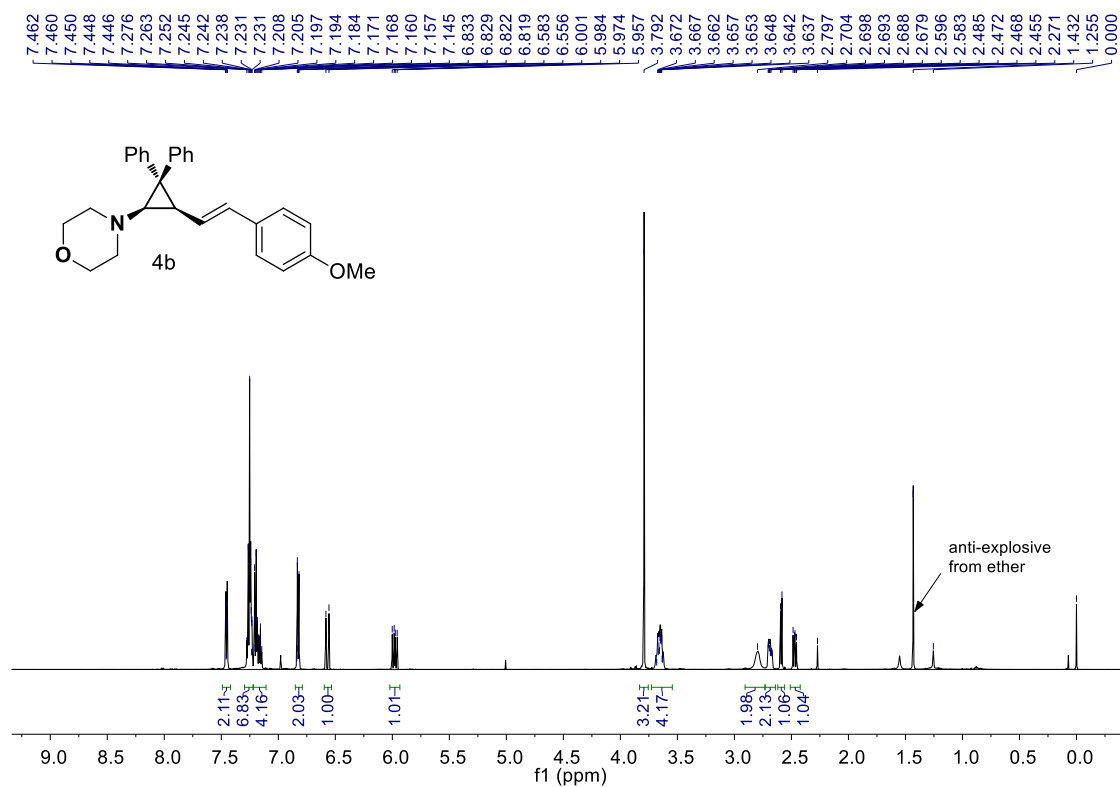
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	14.244	MM R	0.3681	3.39500e4	1537.14600	49.9214
2	16.241	MM R	0.4137	3.40568e4	1372.18555	50.0786

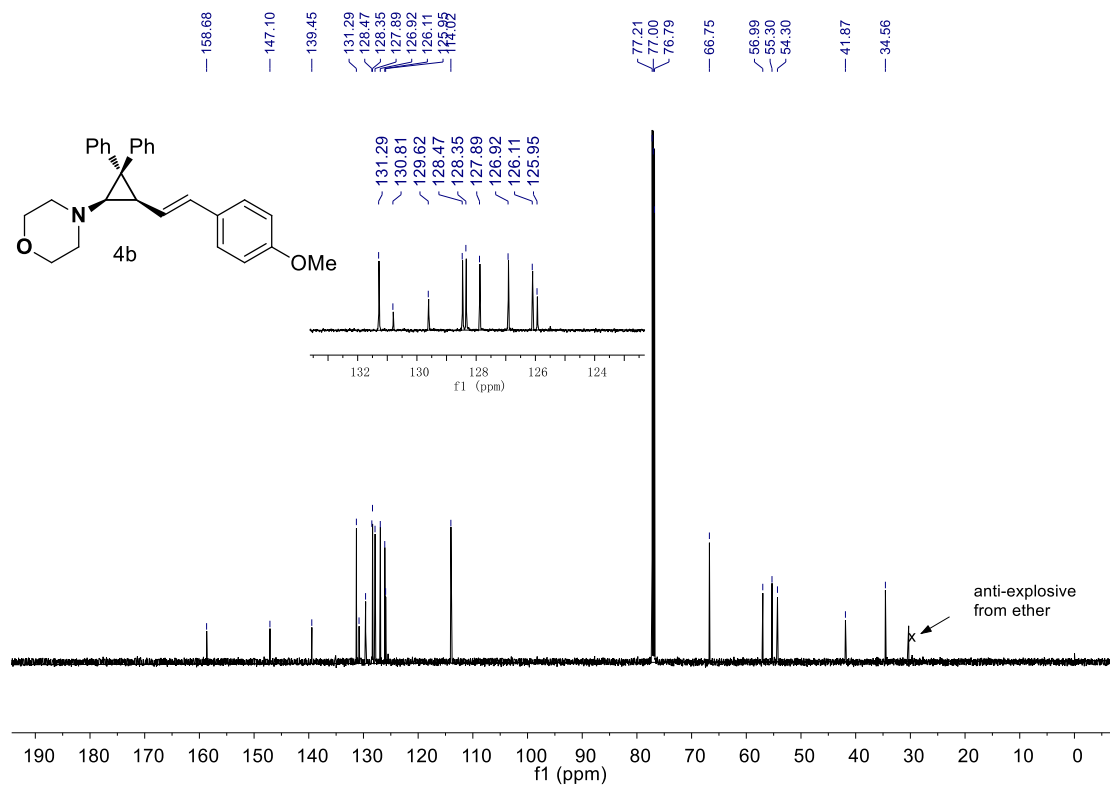
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	14.313	MM R	0.3817	2460.76392	107.44676	5.1214
2	16.257	MM R	0.3824	4.55884e4	1986.76709	94.8786

HPLC chromatograph for compound 4a.



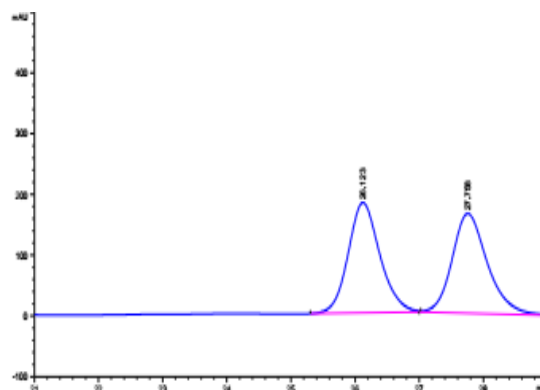
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4b.



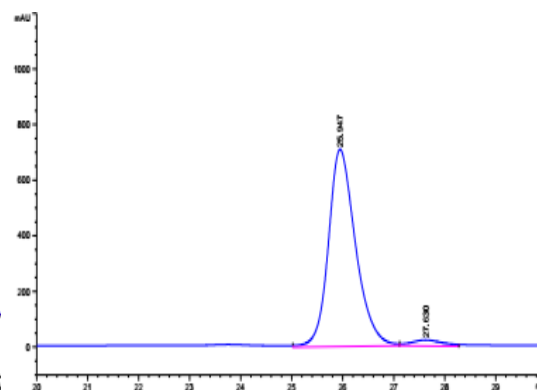
^{13}C NMR (150 MHz, CDCl_3) spectrum for compound 4b.

HPLC Conditions: CHIRALCEL OD-H column, 97/3 hexanes/*i*-PrOH, 0.4 mL/min; t_R (major) = 25.9 min, t_R (minor) = 27.6 min.

Racemate:



Chiral sample:



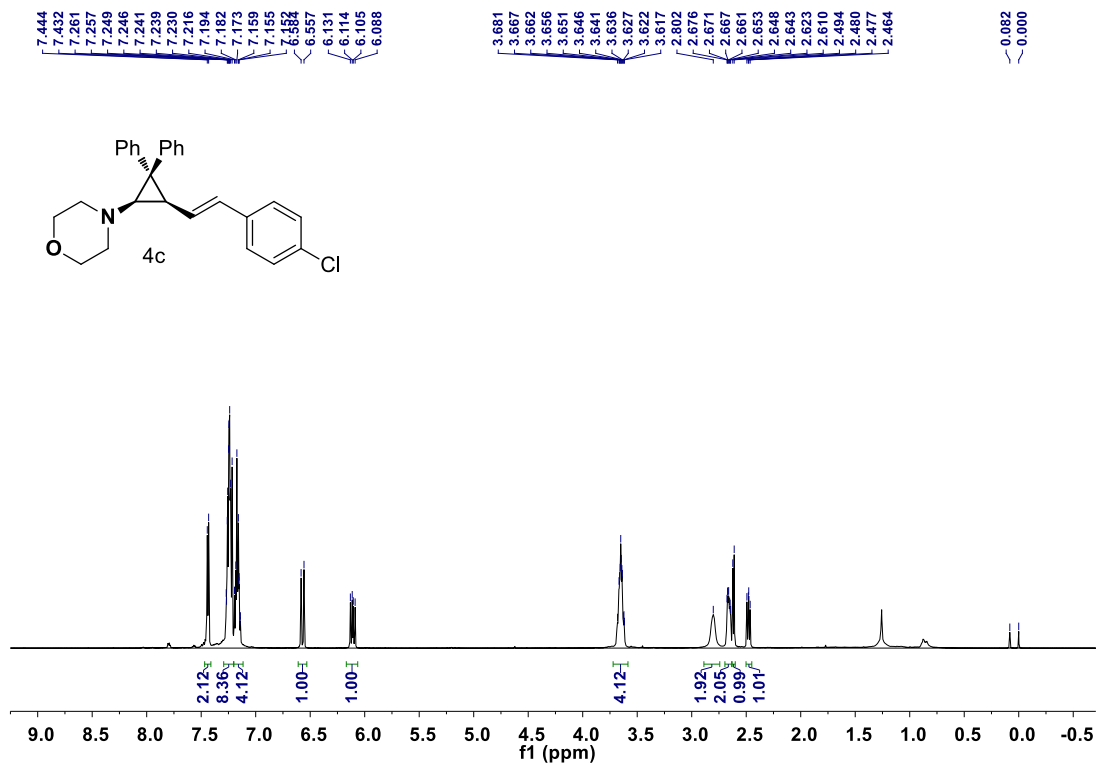
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	26.123	MM R	0.5737	181.49986	181.49986	49.9332
2	27.758	MM R	0.6181	6264.77979	164.16418	50.0668

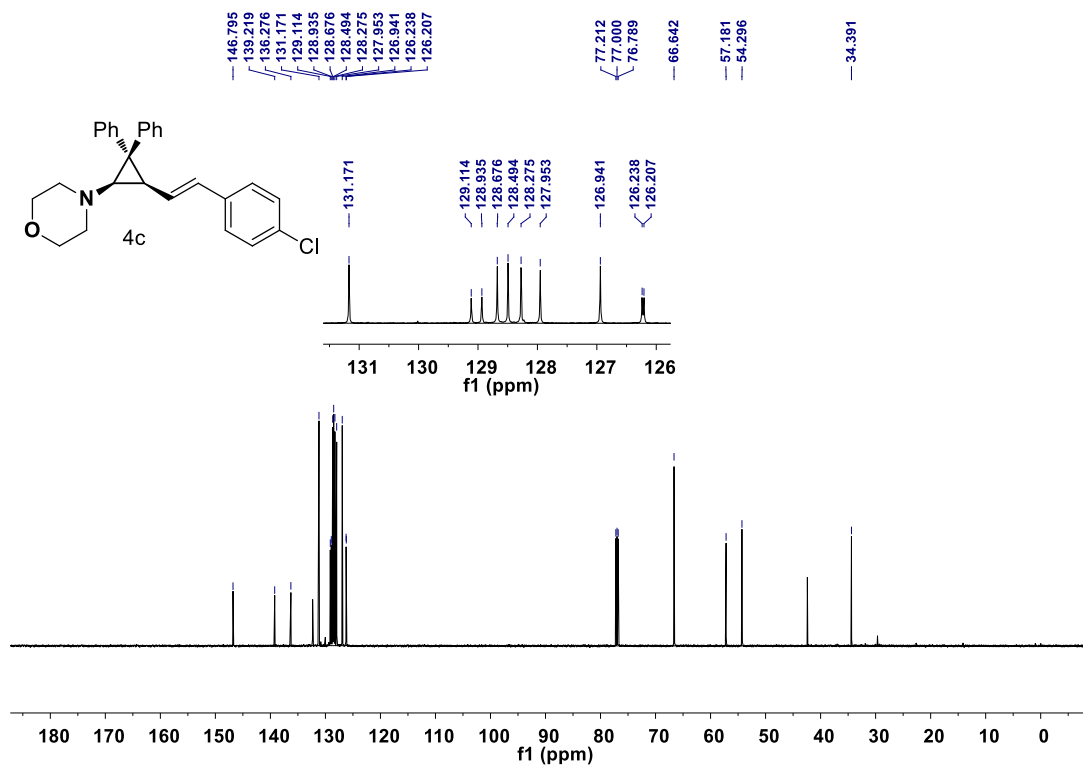
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	25.947	MM R	0.6166	2.62541e4	709.69208	96.5046
2	27.630	MM R	0.7235	950.992908	21.90622	3.4954

HPLC chromatograph for compound 4b.



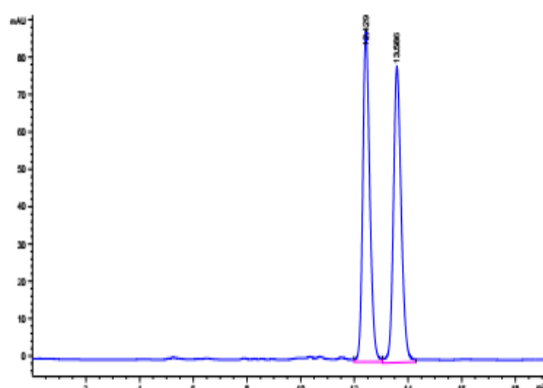
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4c.



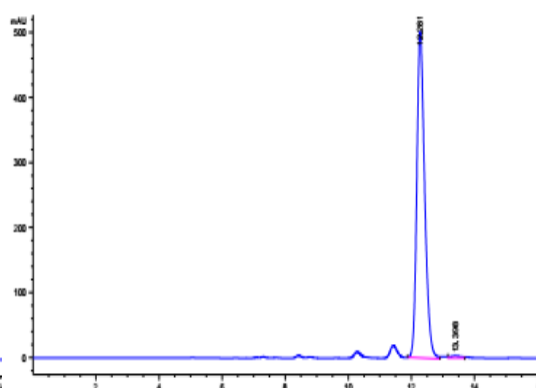
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4c.

HPLC Conditions: CHIRALCEL AD-H column, 97/3 hexanes/*i*-PrOH, 0.6 mL/min; t_R (major) = 12.3 min, t_R (minor) = 13.4 min.

Racemate:



Chiral sample:



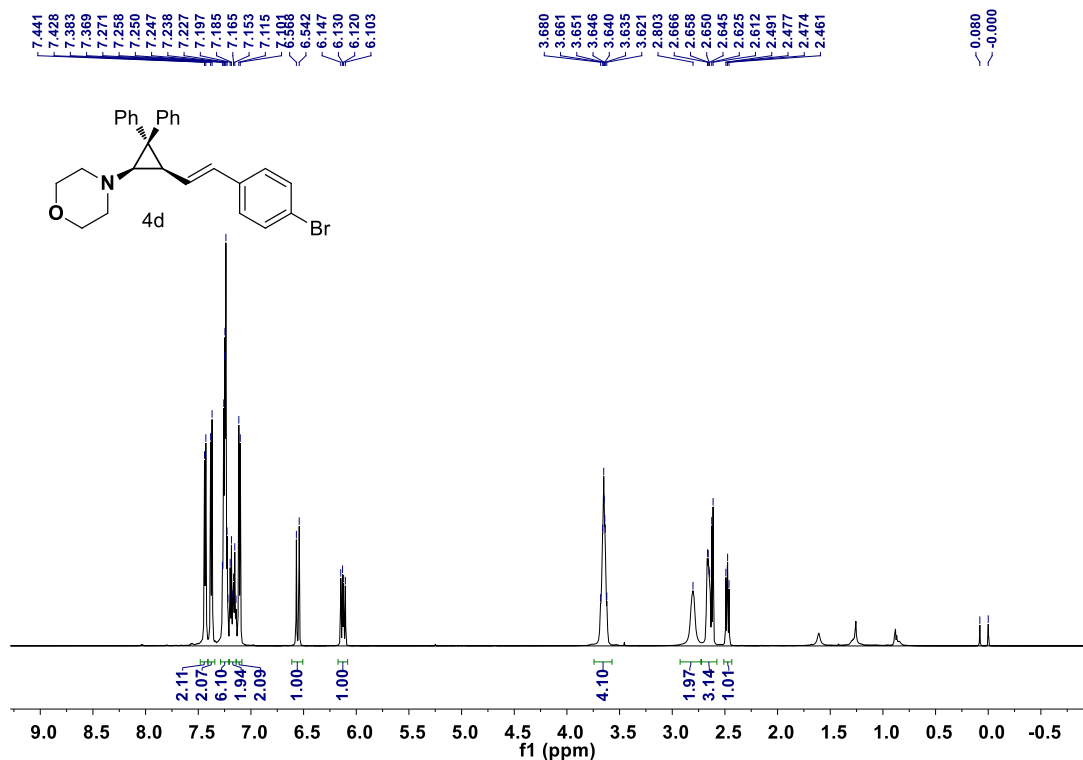
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.429	MM R	0.3038	1612.13782	88.44658	50.1221
2	13.586	MM R	0.3379	1604.28357	79.13845	49.8779

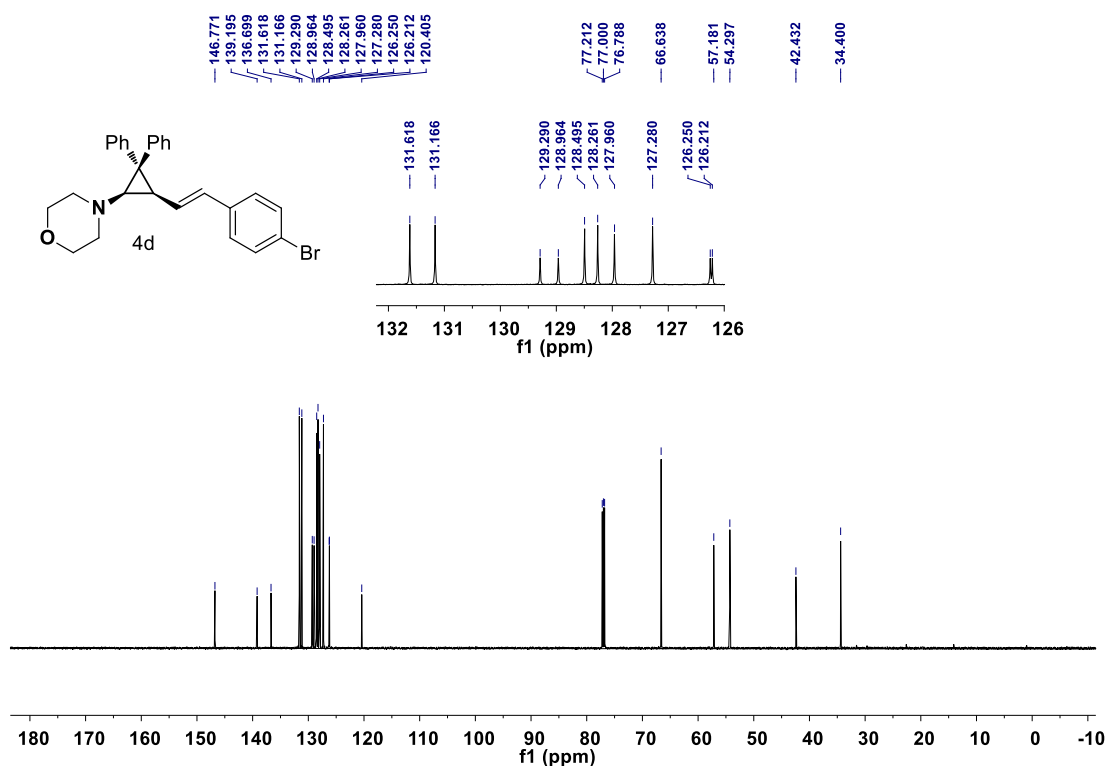
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.281	MM R	0.2879 8	8680.60352	502.60693	99.0691
2	13.398	MM R	0.3853	81.56821	3.52813	0.9309

HPLC chromatograph for compound 4c.



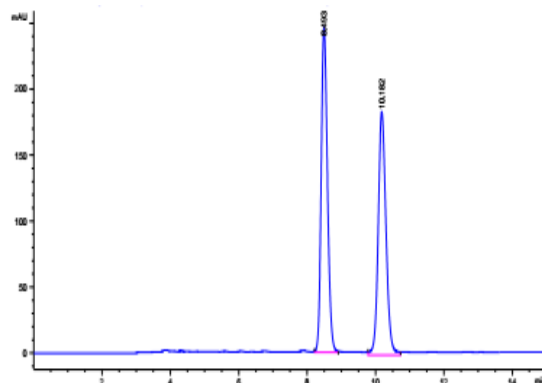
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4d.



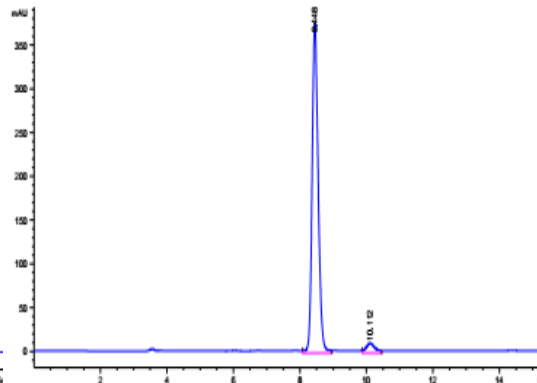
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4d.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; *t_R* (major) = 8.4 min, *t_R* (minor) = 10.1 min.

Racemate:



Chiral sample:



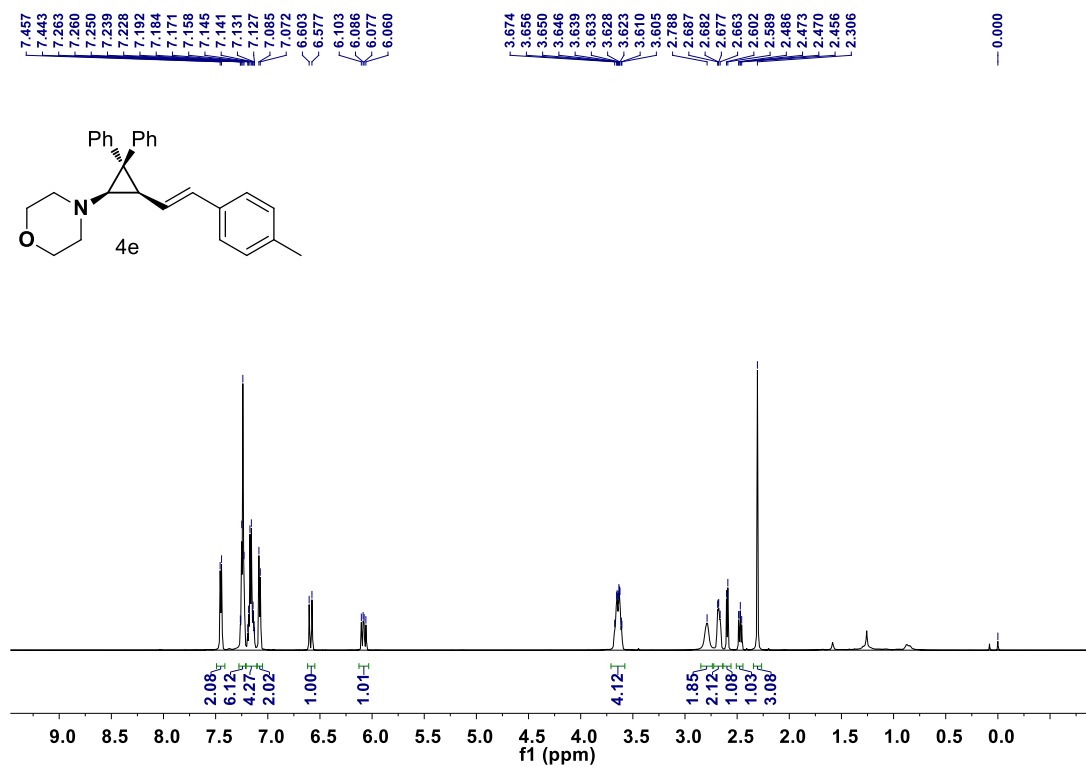
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.582	MM R	0.1932	3975.77441	343.04459	49.9702
2	9.260	MM R	0.2068	3980.50977	320.81049	50.0298

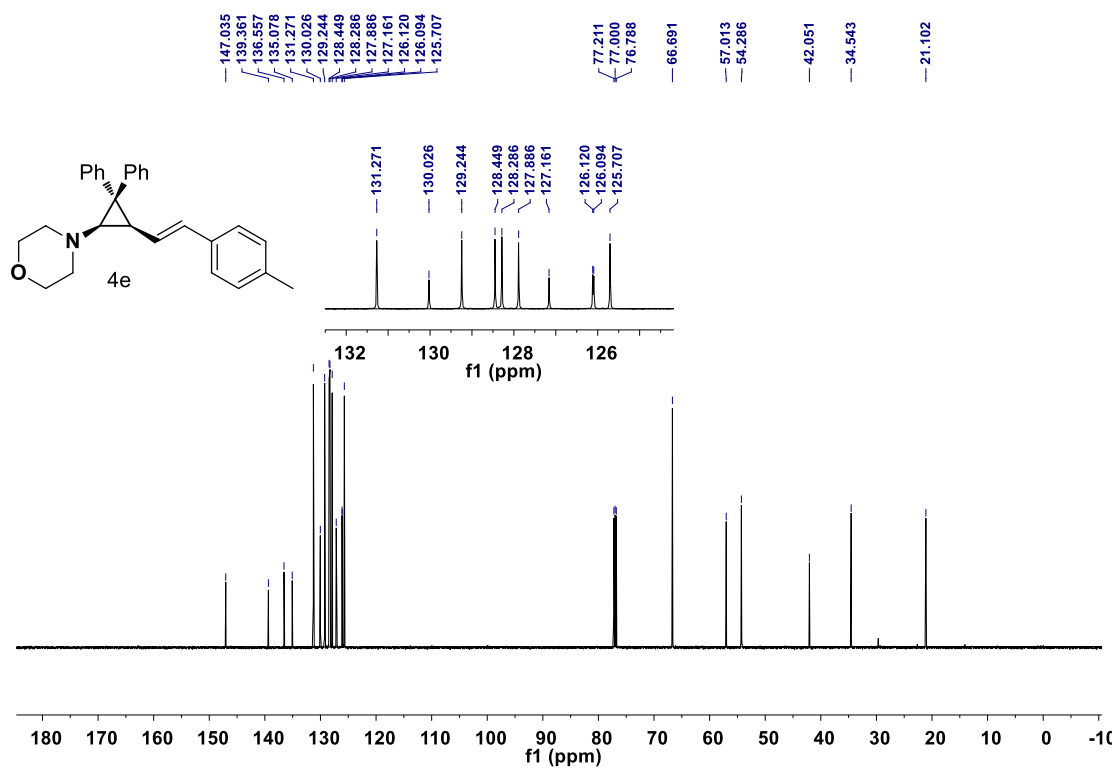
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.448	MM R	0.2115	4778.61182	376.63974	95.6211
2	10.112	MM R	0.3198	218.83397	11.40621	4.3789

HPLC chromatograph for compound 4d.



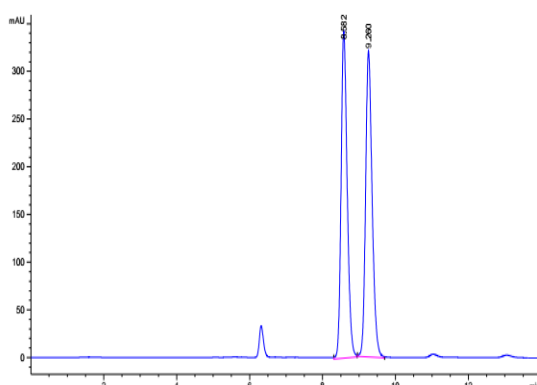
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4e.



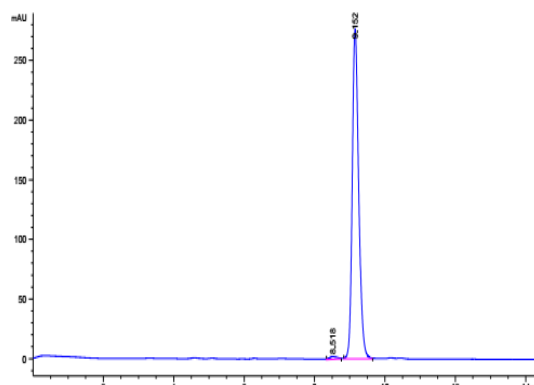
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4e.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.6 mL/min; t_R (major) = 9.2 min, t_R (minor) = 8.5 min.

Racemate:



Chiral sample:



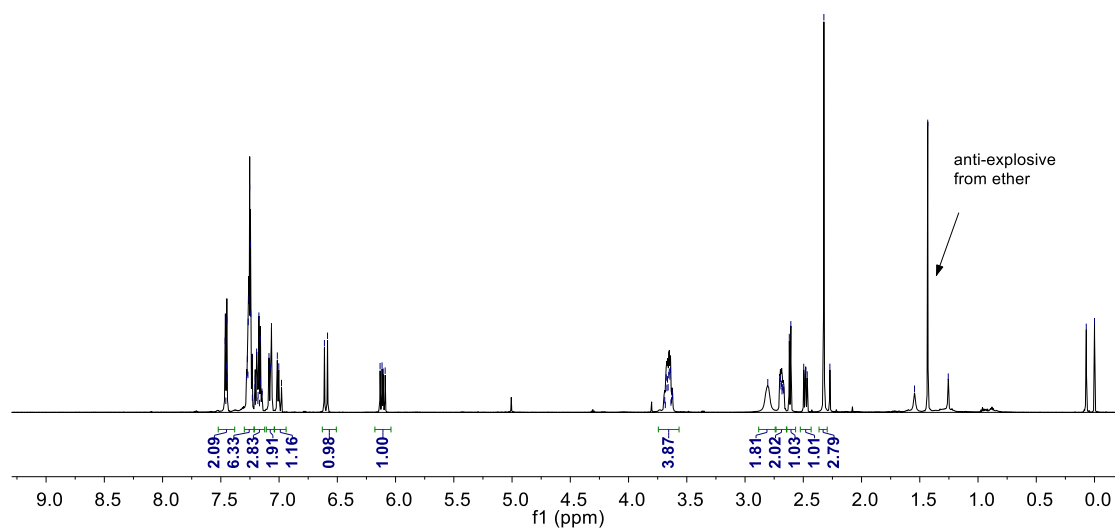
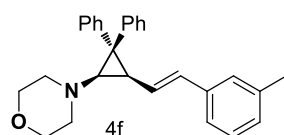
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.582	MM R	0.1932	3975.77441	343.04459	49.9702
2	9.260	MM R	0.2068	3980.50977	320.81049	50.0298

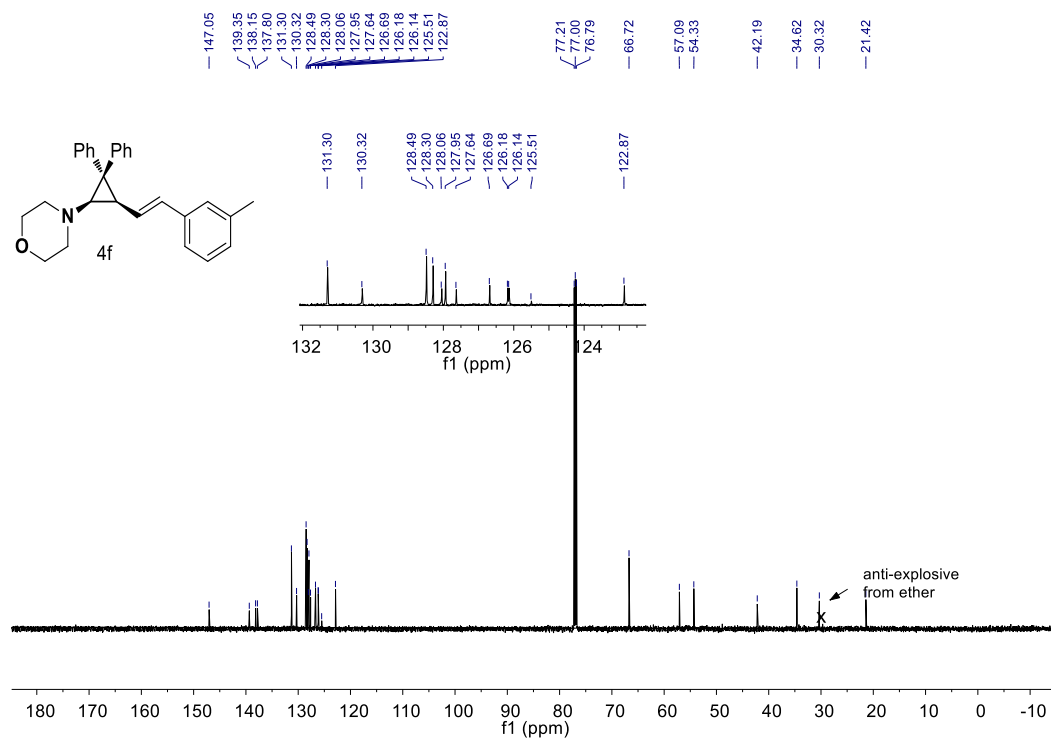
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.518	MM R	0.2506	34.81854	2.31534	0.9834
2	9.152	MM R	0.2117	3505.90698	276.04465	99.0166

HPLC chromatograph for compound 4e.



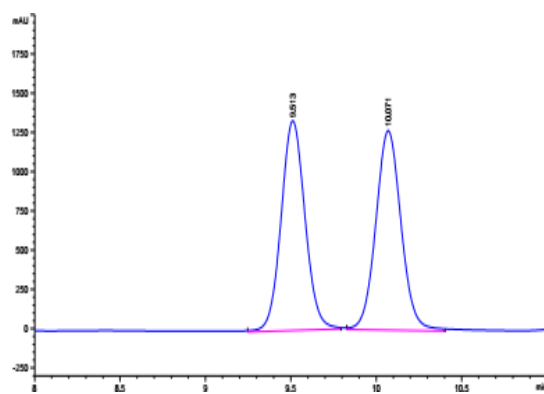
1H NMR (600 MHz, $CDCl_3$) spectrum for compound 4f.



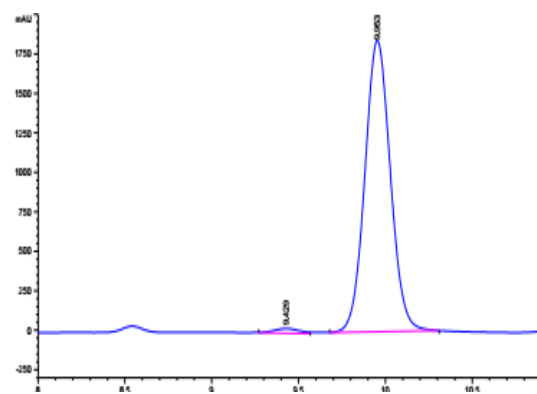
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4f.

HPLC conditions: CHIRALCEL IA column, 98/2 hexanes/*i*-PrOH, 0.7 mL/min, *t*_R (major) = 10.0 min, *t*_R (minor) = 9.4 min.

Racemate:



Chiral sample:



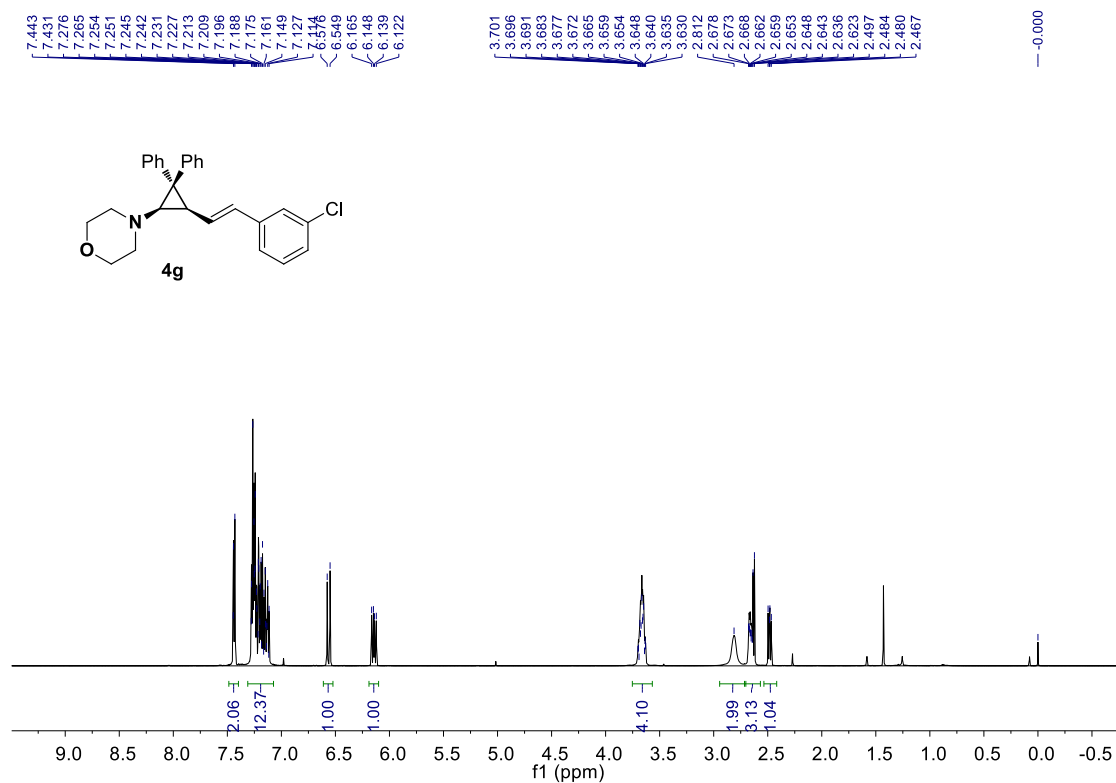
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.513	MM R	0.1618	1.29931e4	1335.14722	49.8141
2	10.171	MM R	0.1716	1.30901e4	1271.03967	50.0786

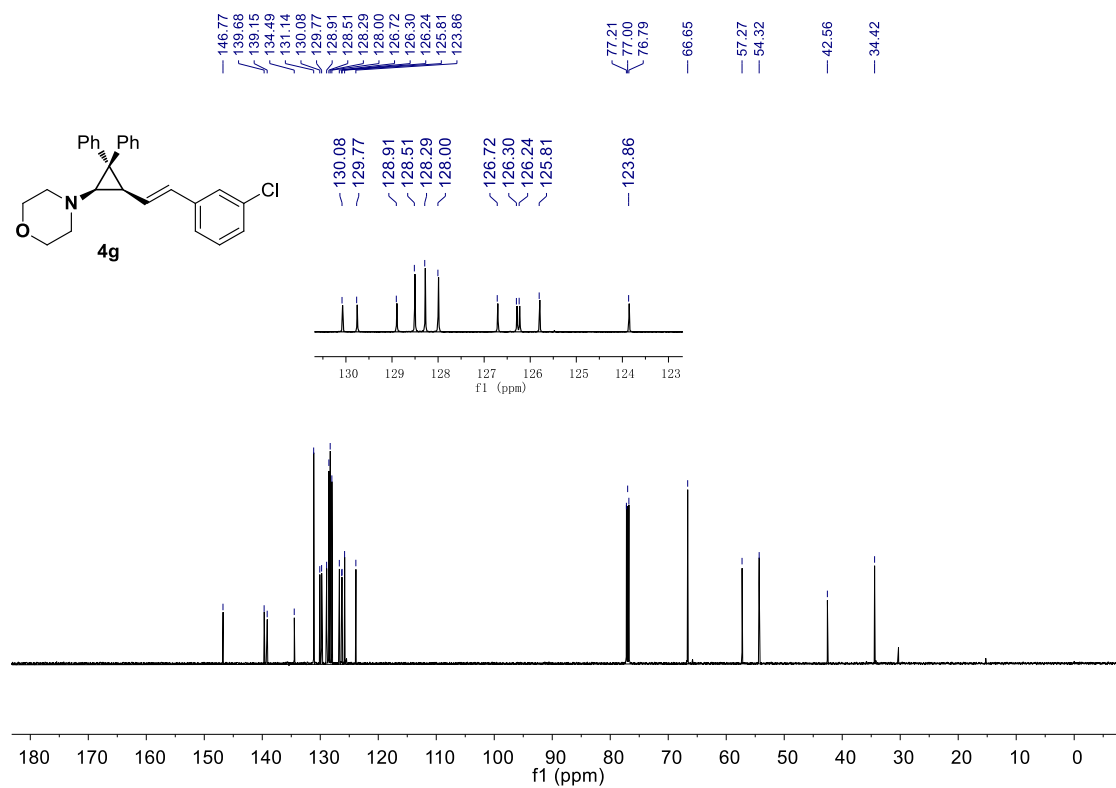
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.429	MM R	0.1697	306.25800	30.07751	5.1214
2	9.953	MM R	0.1701	1.88328e4	1845.03418	94.8786

HPLC chromatograph for compound 4f.



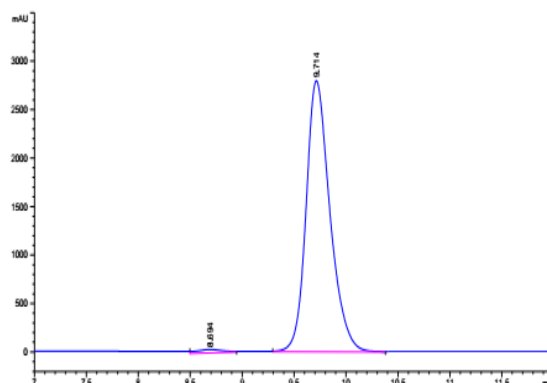
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4g.



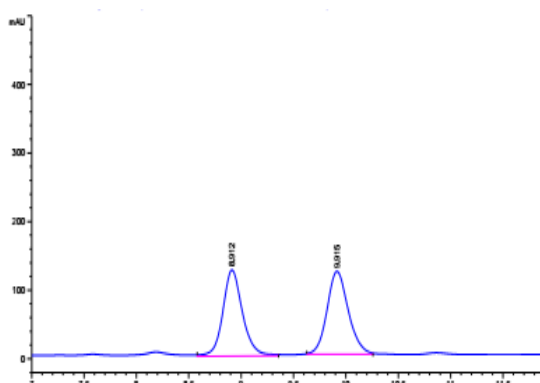
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4g.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 9.7 min, t_R (minor) = 8.7 min.

Racemate:



Chiral sample:



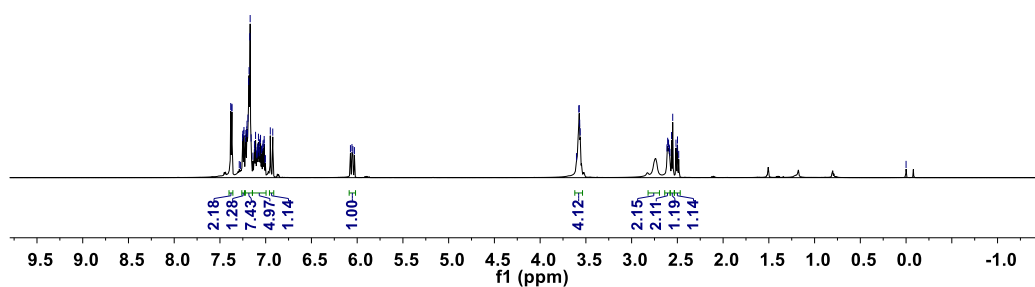
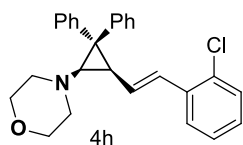
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.912	MM R	0.2184	1644.69714	125.50198	49.2228
2	9.915	MM R	0.2344	1696.63623	120.64114	50.7772

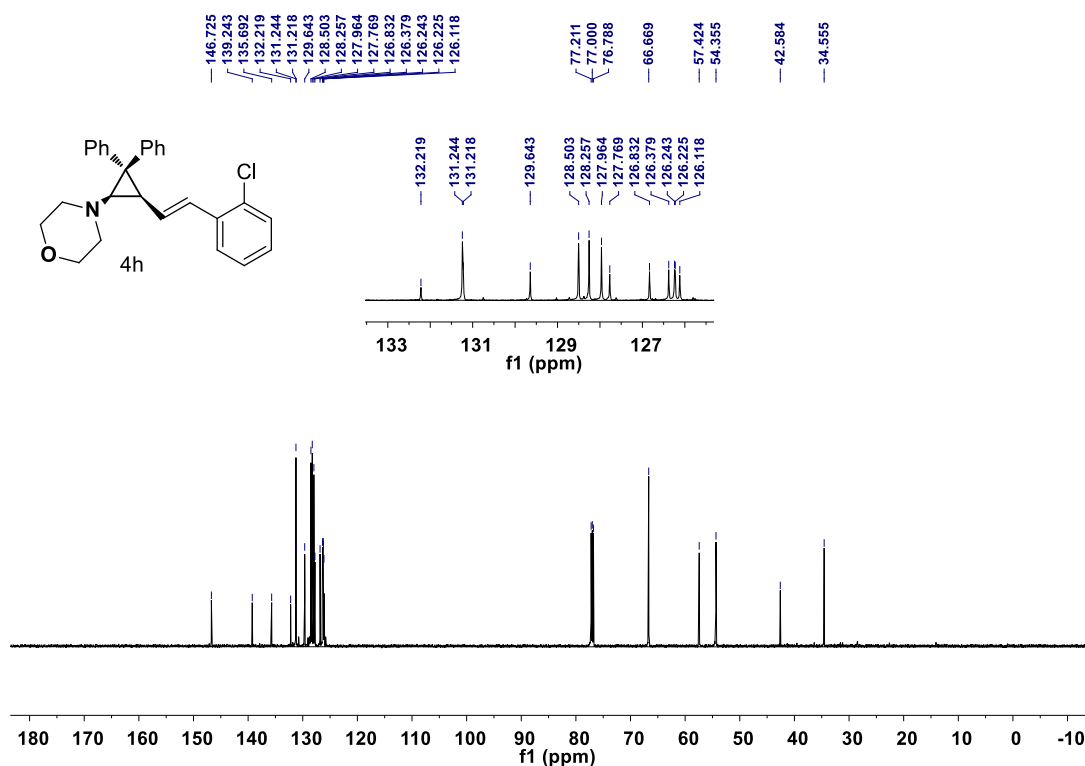
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.694	MM R	0.2912	633.22302	36.24260	1.3947
2	9.714	MM R	0.2667	4.47679e4	2797.74609	98.6053

HPLC chromatograph for compound 4g.



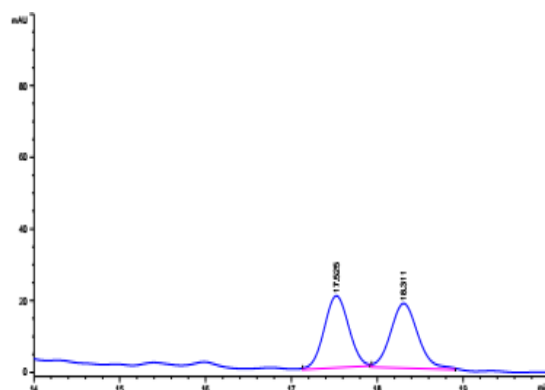
^1H NMR (600 MHz, CDCl_3) spectrum for compound 4h.



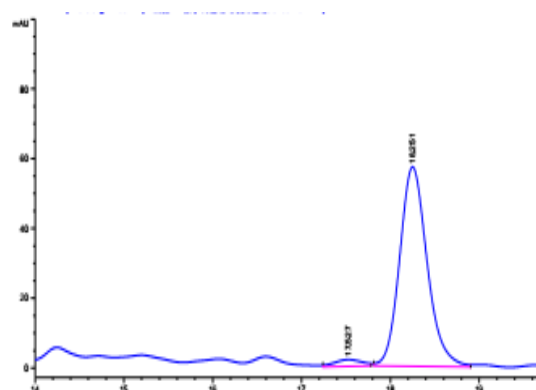
^{13}C NMR (150 MHz, CDCl_3) spectrum for compound 4h.

HPLC Conditions: CHIRALCEL IC column, 99/1 hexanes/*i*-PrOH, 0.4 mL/min; t_R (major) = 18.3 min, t_R (minor) = 17.5 min.

Racemate:



Chiral sample:



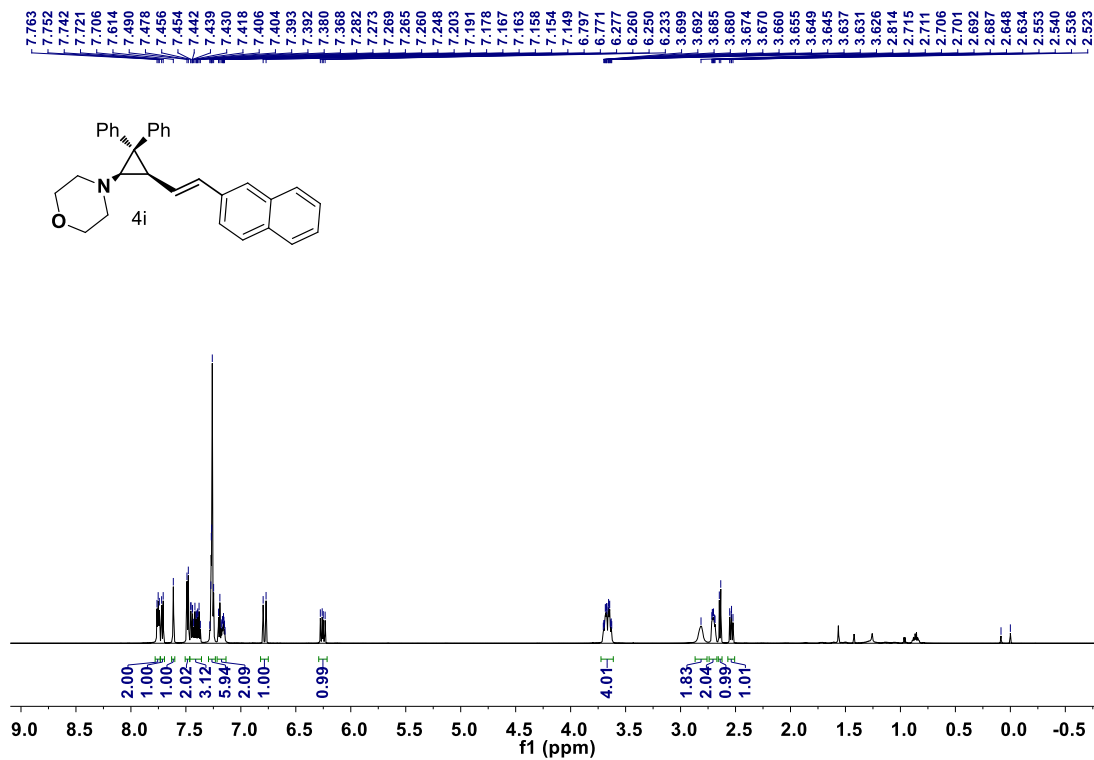
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	17.525	MM R	0.3310	398.63031	20.06940	49.9363
2	18.311	MM R	0.3691	399.64743	18.04430	50.0637

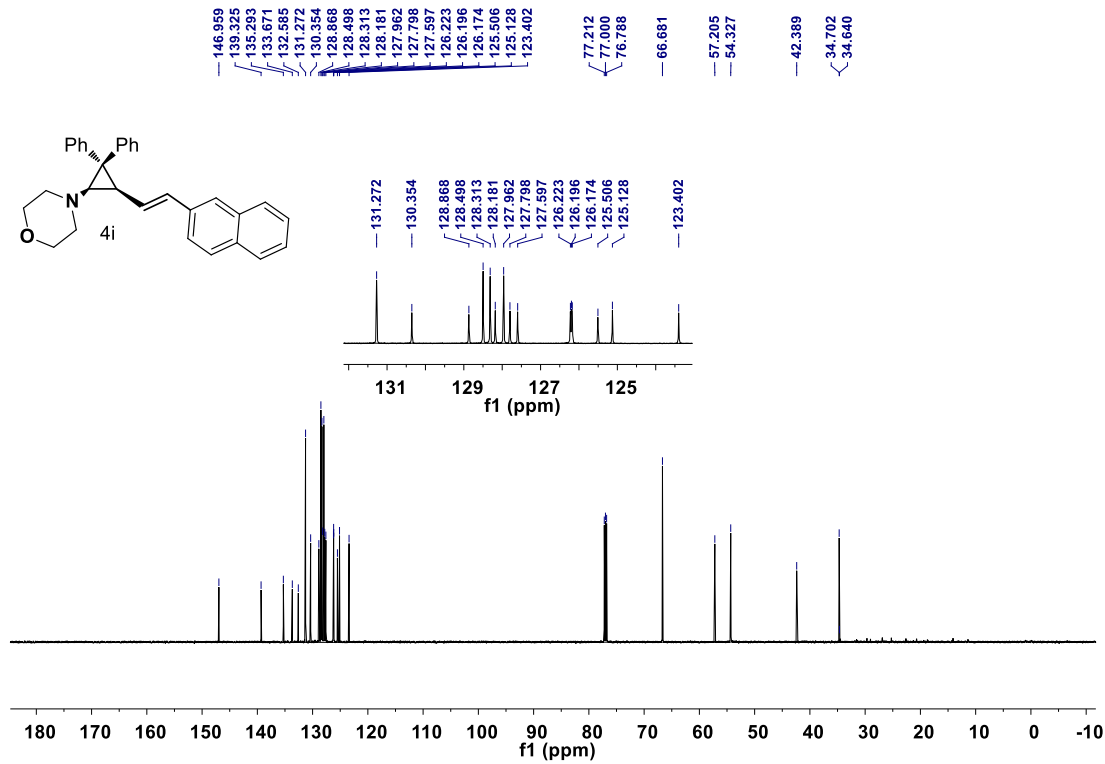
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	17.527	MM R	0.3596	41.92551	1.94316	3.2962
2	18.251	MM R	0.3588	1230.02783	57.13962	96.7038

HPLC chromatograph for compound 4h.



^1H NMR (600 MHz, CDCl_3) spectrum for compound 4i.

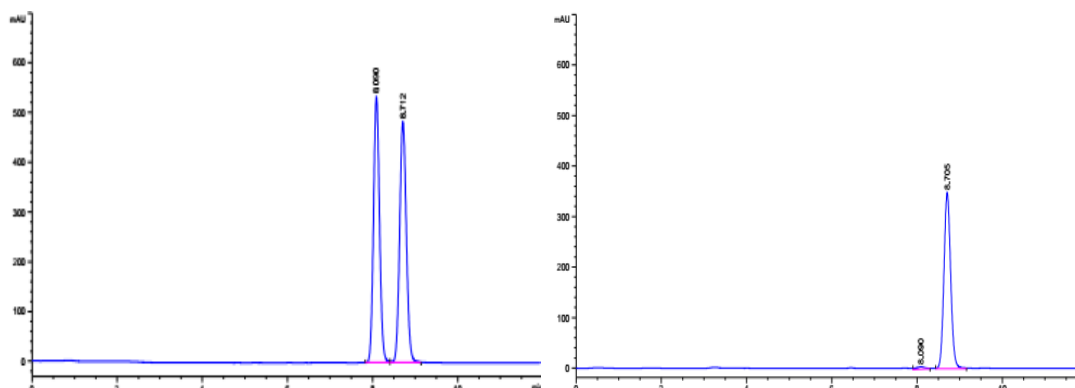


^{13}C NMR (150 MHz, CDCl_3) spectrum for compound 4i.

HPLC Conditions: CHIRALCEL IC column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 8.7 min, t_R (minor) = 8.1 min.

Racemate:

Chiral sample:



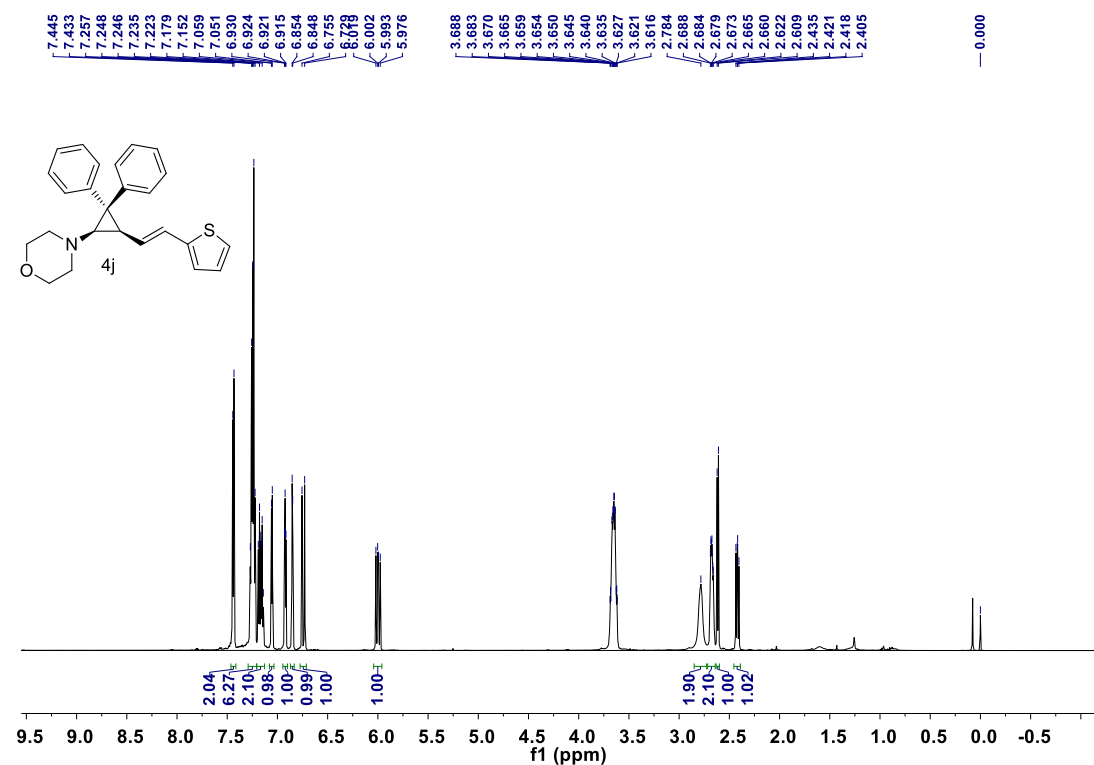
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.090	MM R	0.1639	5243.91357	533.32489	49.8954
2	8.712	MM R	0.1814	5265.90039	483.91769	50.1046

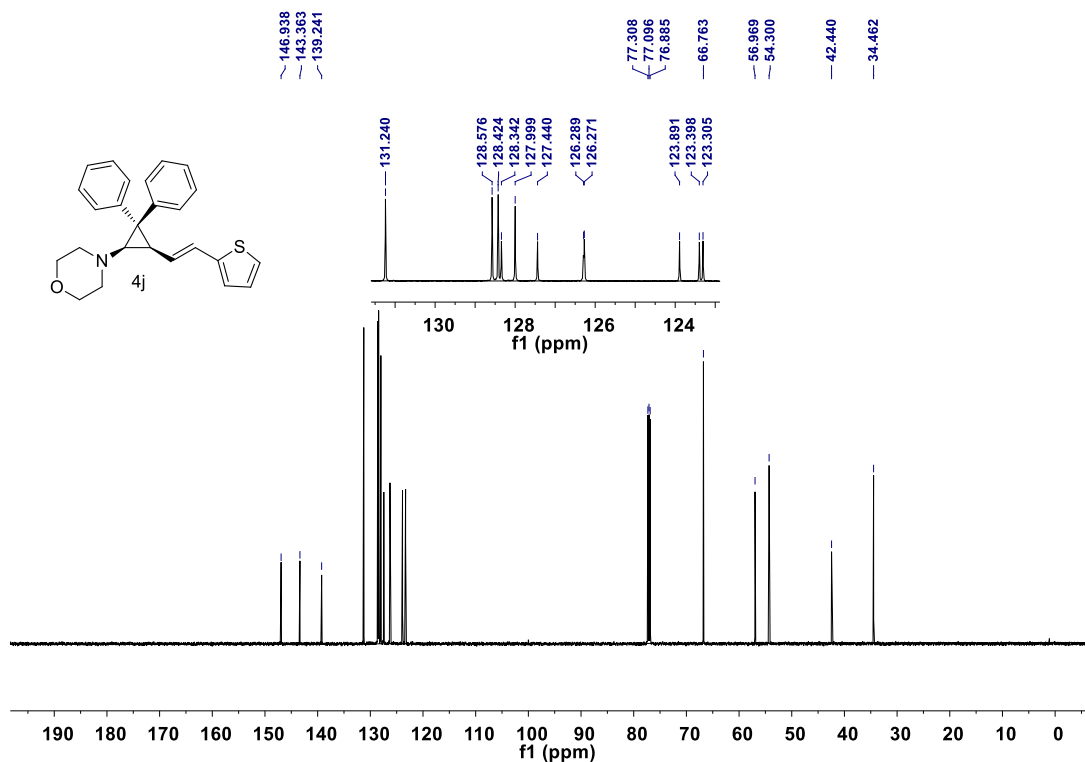
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	8.090	MM R	0.2447	69.57803	4.73834	1.7752
2	8.705	MM R	0.1840	3849.79248	348.68872	98.2248

HPLC chromatograph for compound 4i.



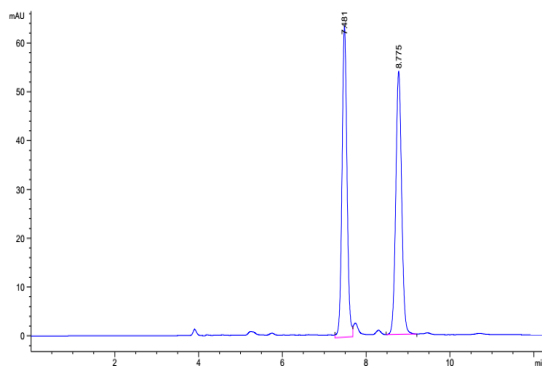
^1H NMR (600 MHz, CDCl_3) spectrum for compound 4j.



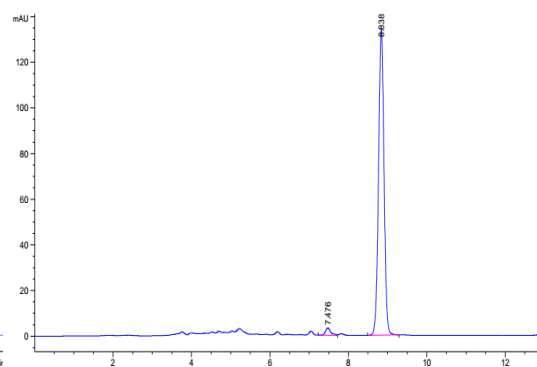
^{13}C NMR (150 MHz, CDCl_3) spectrum for compound **4j**.

HPLC Conditions: CHIRALCEL IA column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 8.8 min, t_R (minor) = 7.5 min.

Racemate:



Chiral sample:



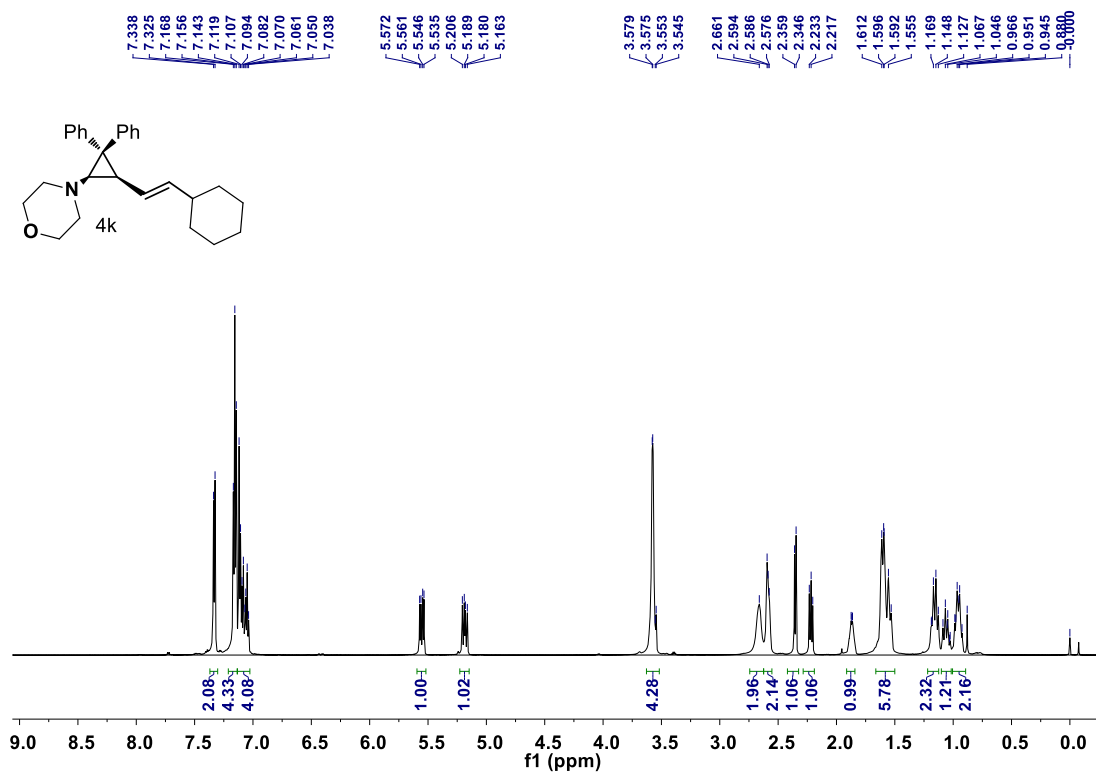
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.418	MM R	0.1381	527.54755	63.65674	50.3250
2	8.775	MM R	0.1488	520.73370	53.84904	49.6750

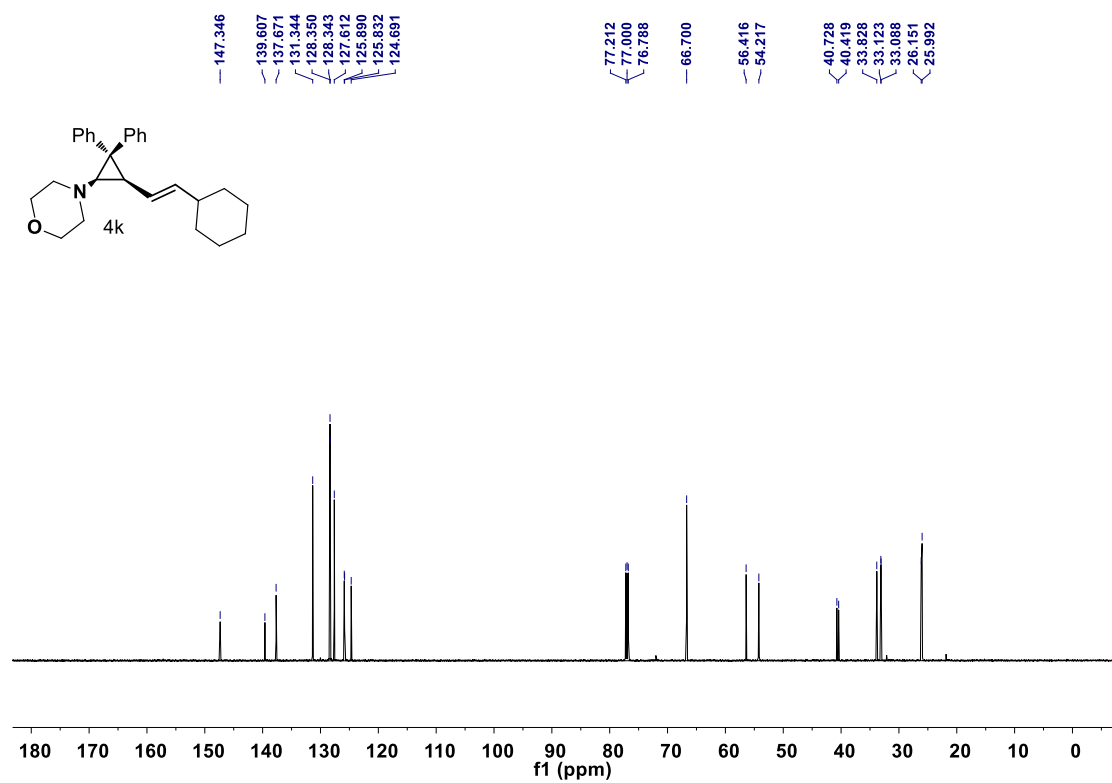
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.476	MM R	0.1396	3.22048	3.22048	2.2802
2	8.838	MM R	0.1498	134.08609	134.08609	97.7198

HPLC chromatograph for compound **4j.**



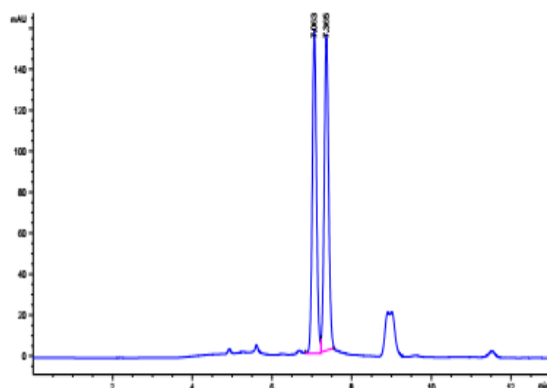
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4k.



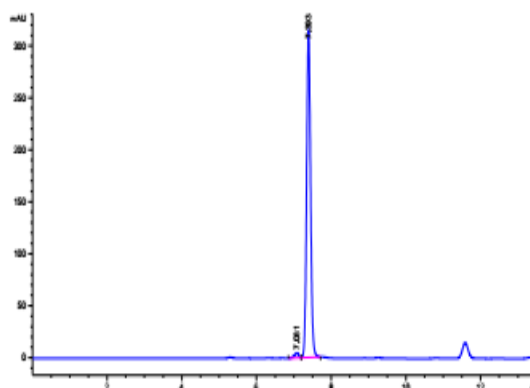
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4k.

HPLC Conditions: CHIRALCEL IA column, 97/3 hexanes/*i*-PrOH, 0.6 mL/min; t_R (major) = 7.4 min, t_R (minor) = 7.1 min.

Racemate:



Chiral sample:



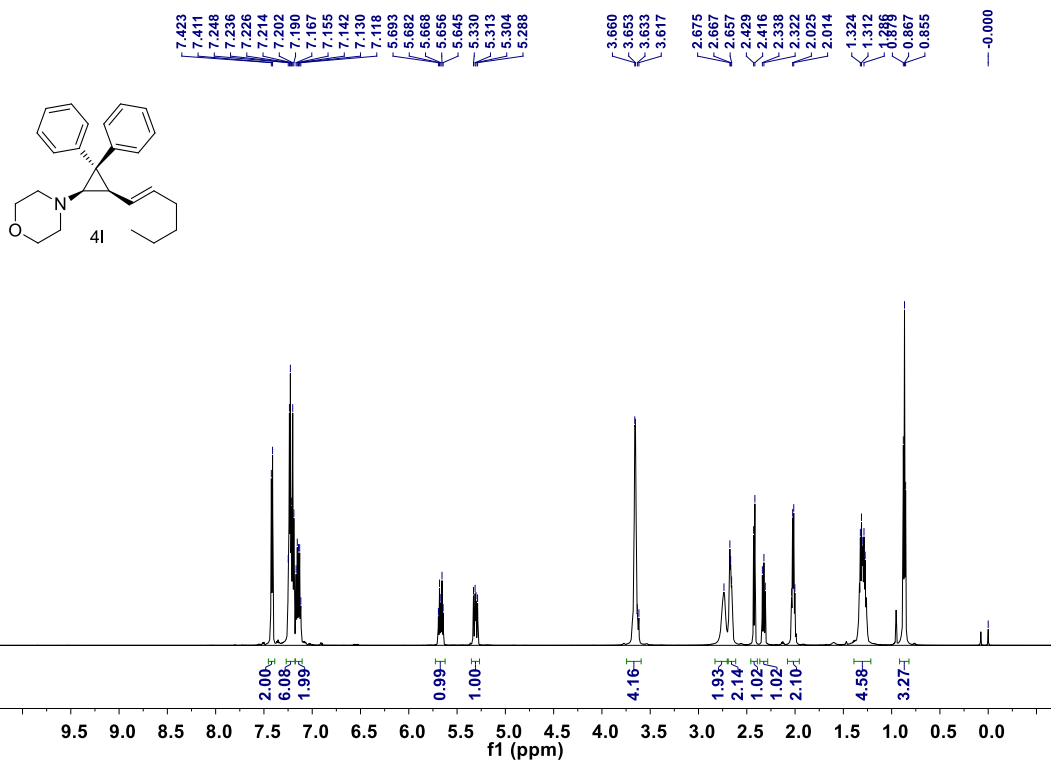
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.063	MM R	0.1213	1152.23206	158.31845	49.6055
2	7.365	MM R	0.1275	1170.55823	153.07063	50.3945

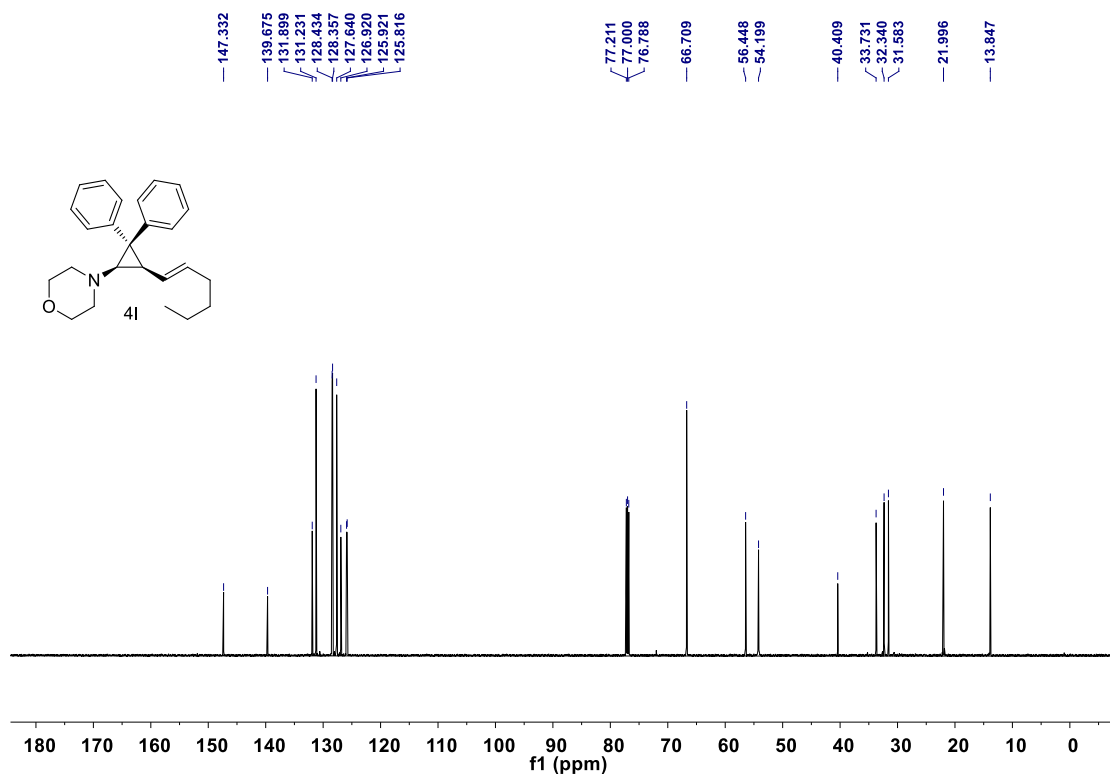
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.081	MM R	0.1184	38.27110	4.77997	1.6274
2	7.393	MM R	0.1137	2313.35474	314.74539	98.3726

HPLC chromatograph for compound 4k.



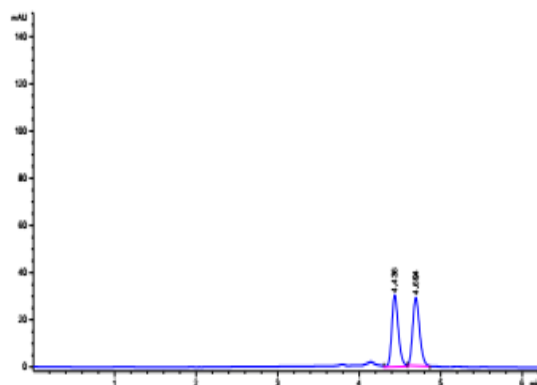
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4l.



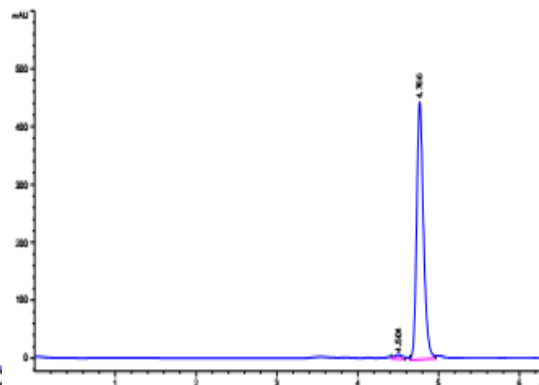
^{13}C NMR (150 MHz, CDCl_3) spectrum for compound 4l.

HPLC Conditions: CHIRALCEL AD-H column, 96/4 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 4.8 min, t_R (minor) = 4.5 min.

Racemate:



Chiral sample:



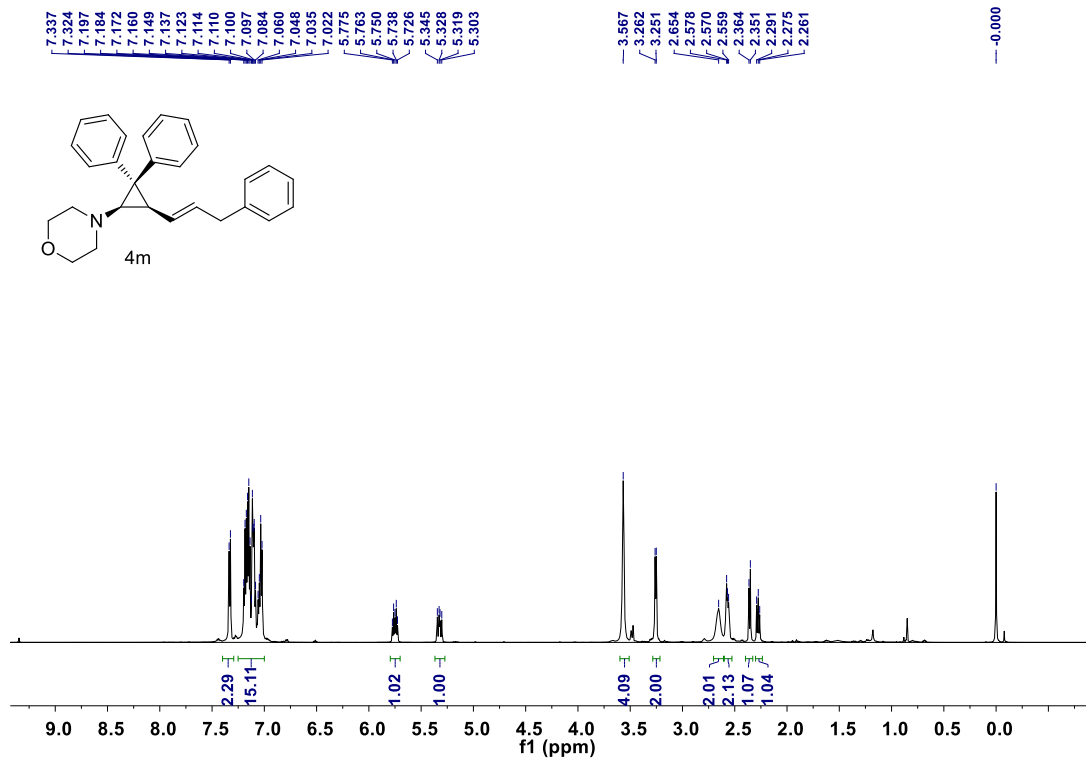
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	4.436	MM R	0.0929	169.67908	30.44222	49.7702
2	4.694	MM R	0.0988	171.24626	28.88927	50.2298

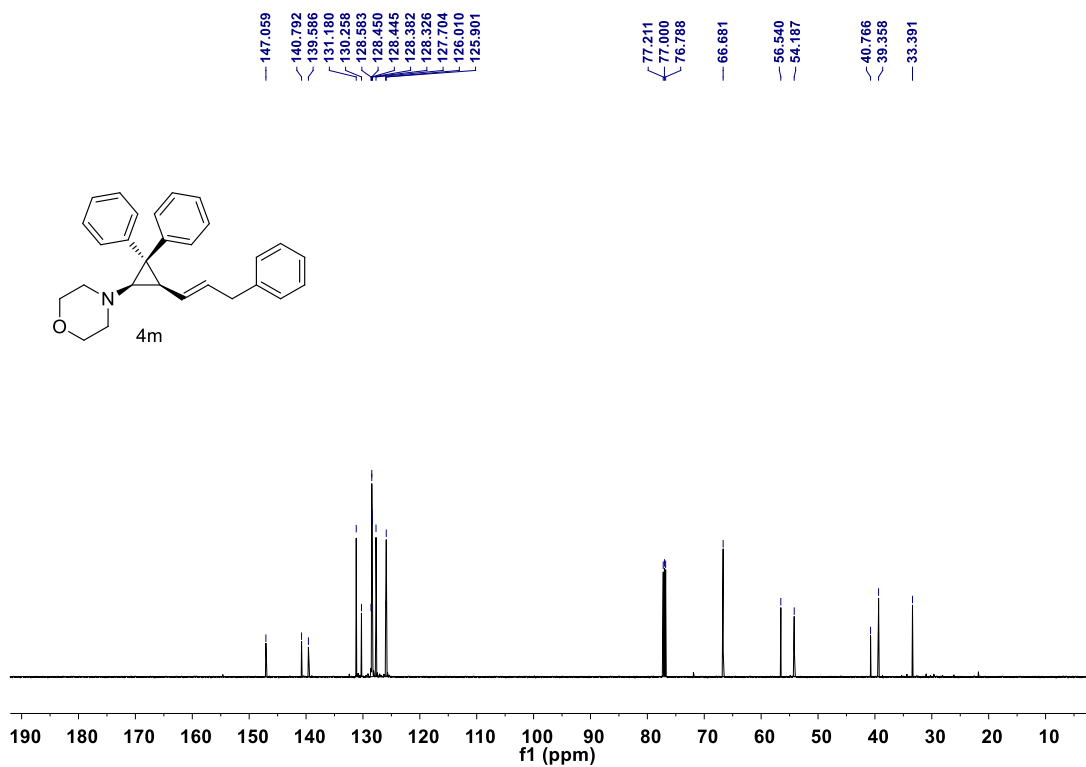
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	4.504	MM R	0.1108	48.53121	7.29815	1.8270
2	4.766	MM R	0.0977	2607.73828	444.86124	98.1730

HPLC chromatograph for compound 4l.



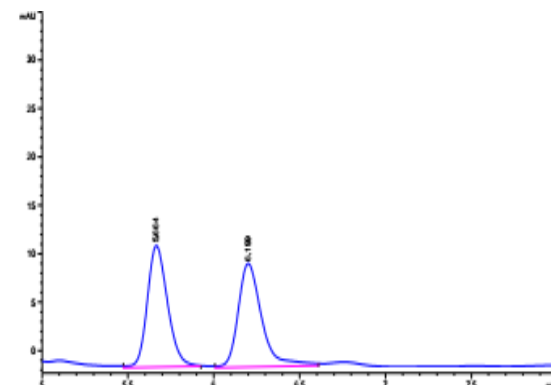
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4m.



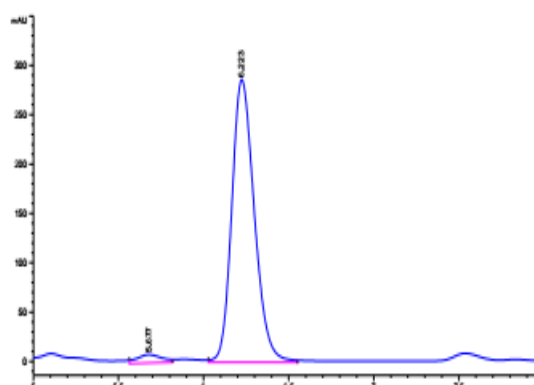
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4m.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 6.2 min, t_R (minor) = 5.7 min.

Racemate:



Chiral sample:



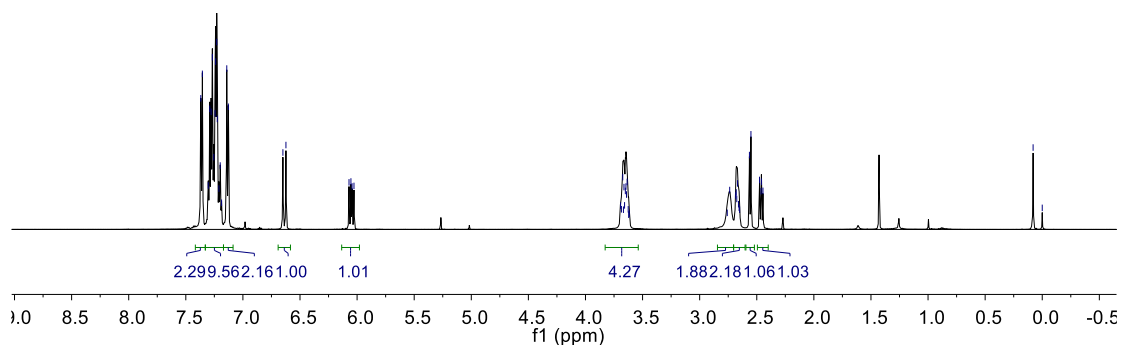
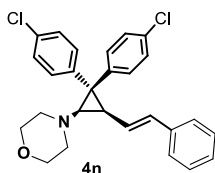
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	5.664	MM R	0.1369	103.06401	12.54835	50.2815
2	6.199	MM R	0.1588	101.90999	10.69304	49.7185

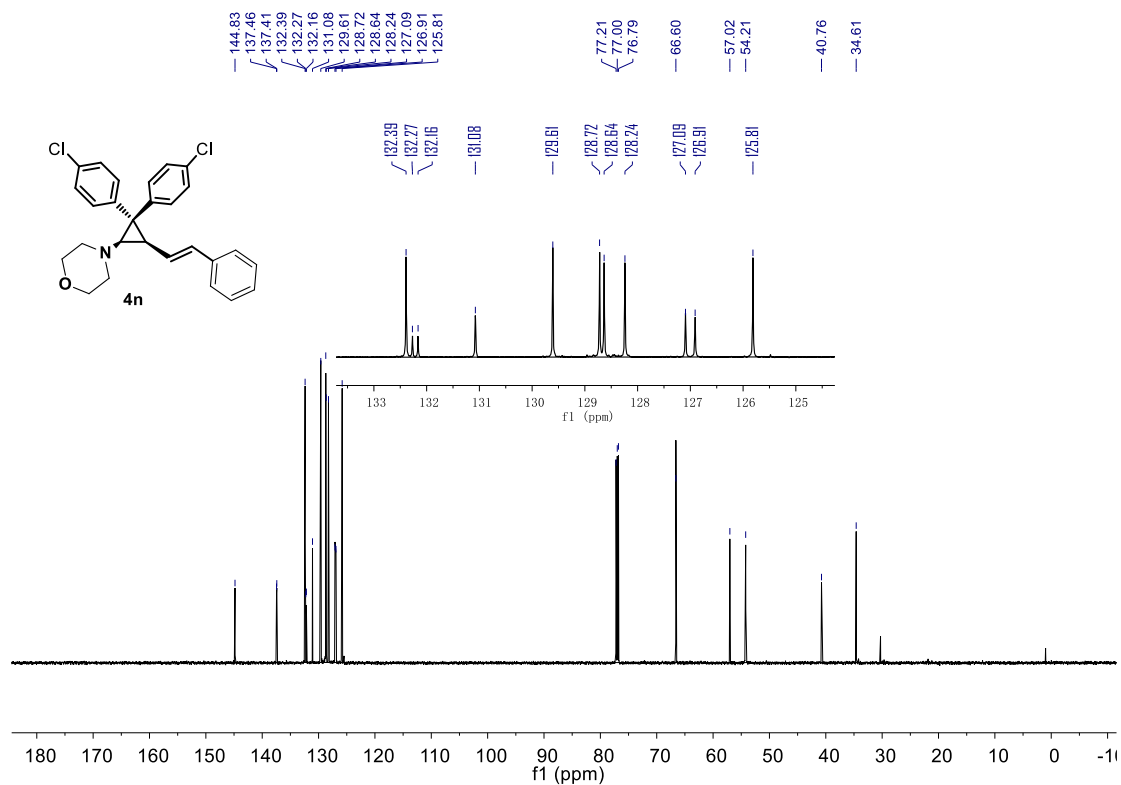
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	5.677	MM R	0.1677	85.06754	8.45541	3.1206
2	6.223	MM R	0.1531	2640.91992	286.55582	96.8794

HPLC chromatograph for compound 4m.



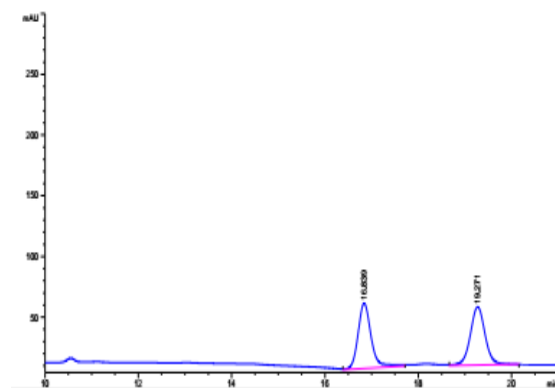
1H NMR (600 MHz, $CDCl_3$) spectrum for compound 4n.



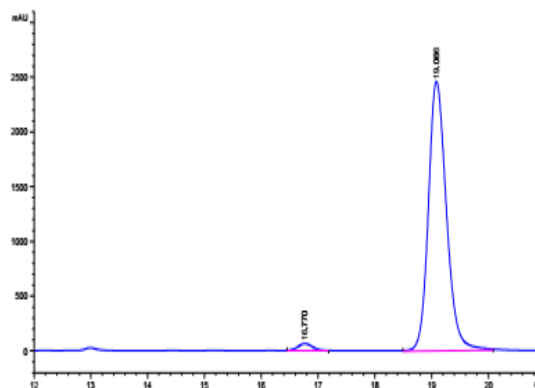
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4n.

HPLC Conditions: CHIRALCEL IA-H column, 95/5 hexanes/*i*-PrOH, 0.5 mL/min; *t_R* (major) = 19.1 min, *t_R* (minor) = 16.8 min.

Racemate:



Chiral sample:



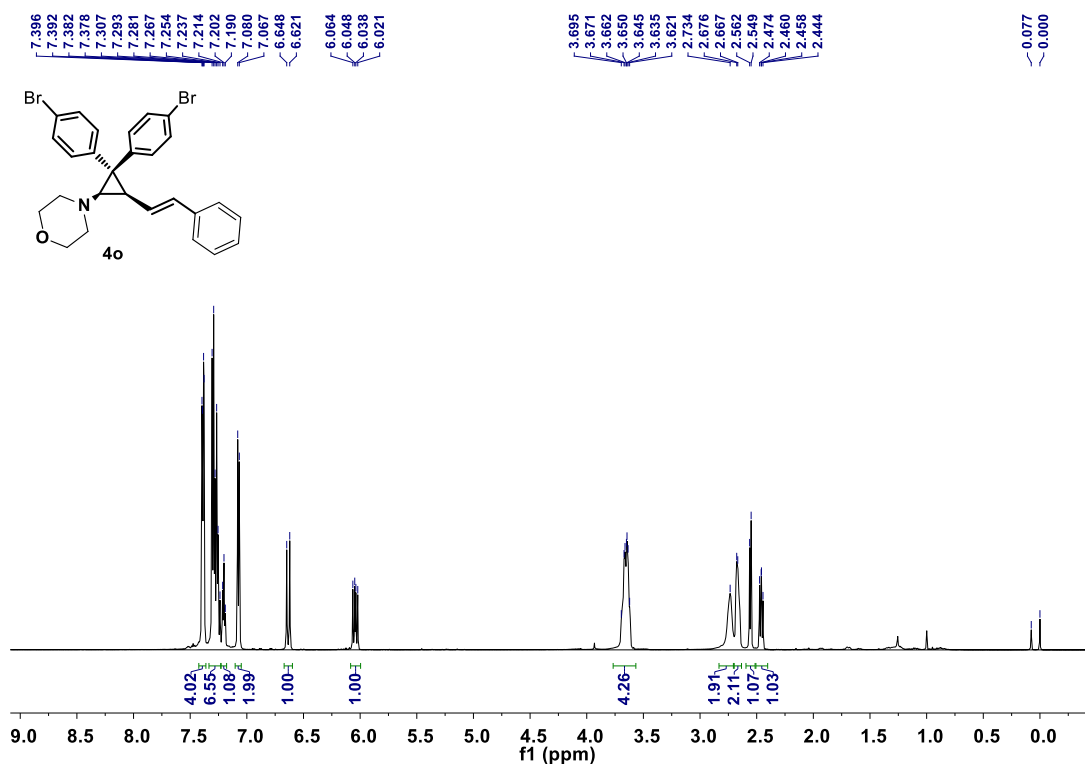
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	16.839	MM R	0.3126	1050.83105	53.66994	49.9367
2	19.271	MM R	0.3474	1053.49658	47.94884	50.0633

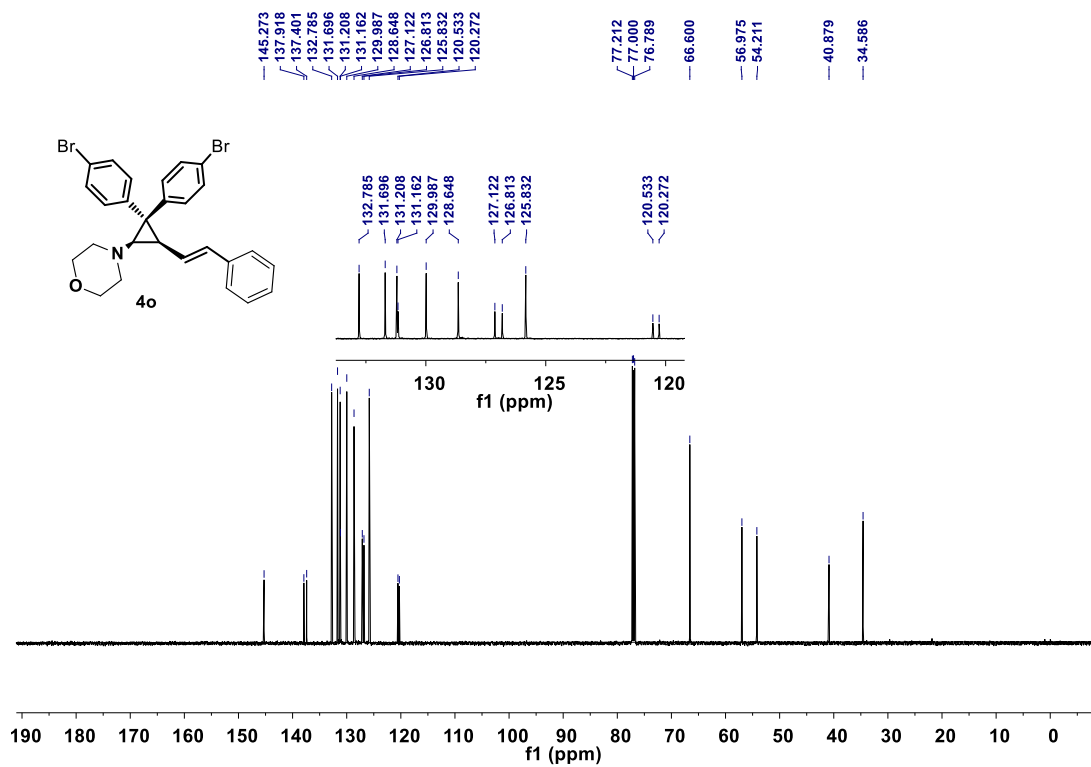
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	16.770	MM R	0.3122	1249.31238	66.69720	2.2474
2	19.086	MM R	0.3678	5.43397e4	2462.63647	97.7526

HPLC chromatograph for compound 4n.



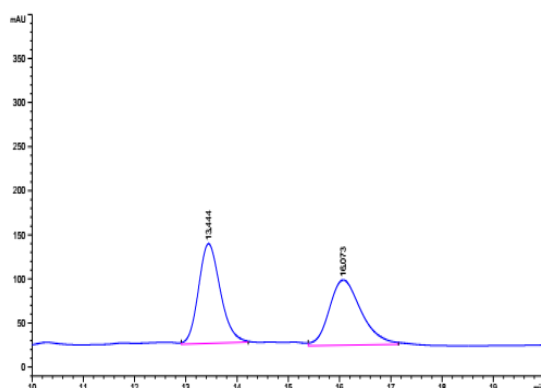
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4o.



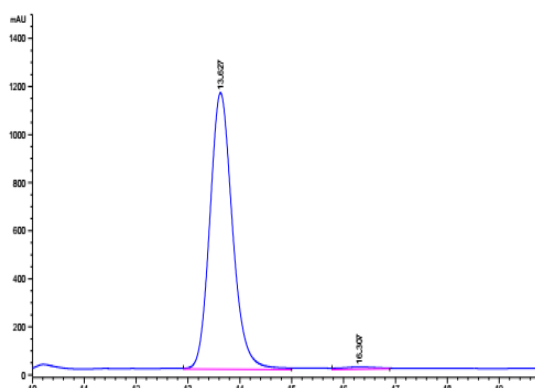
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4o.

HPLC Conditions: CHIRALCEL OD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 13.6 min, t_R (minor) = 16.3 min.

Racemate:



Chiral sample:



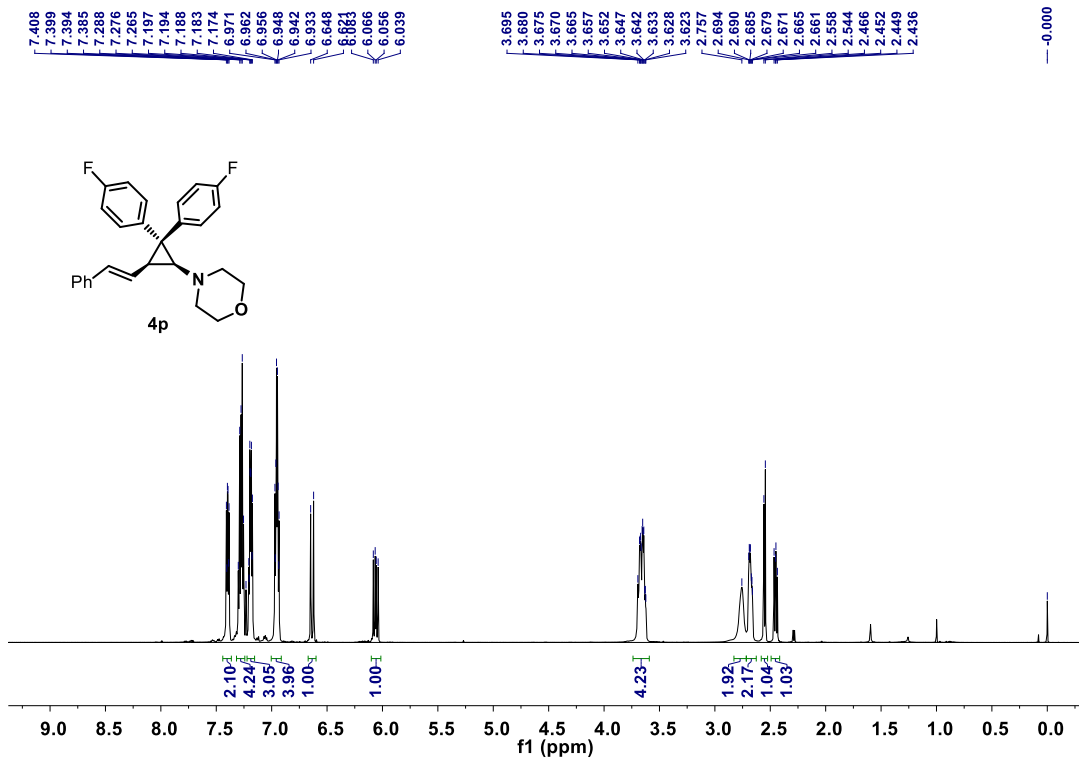
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	13.444	MM R	0.4916	3333.04590	113.00127	50.8959
2	16.073	MM R	0.7227	3215.70996	74.16123	49.1041

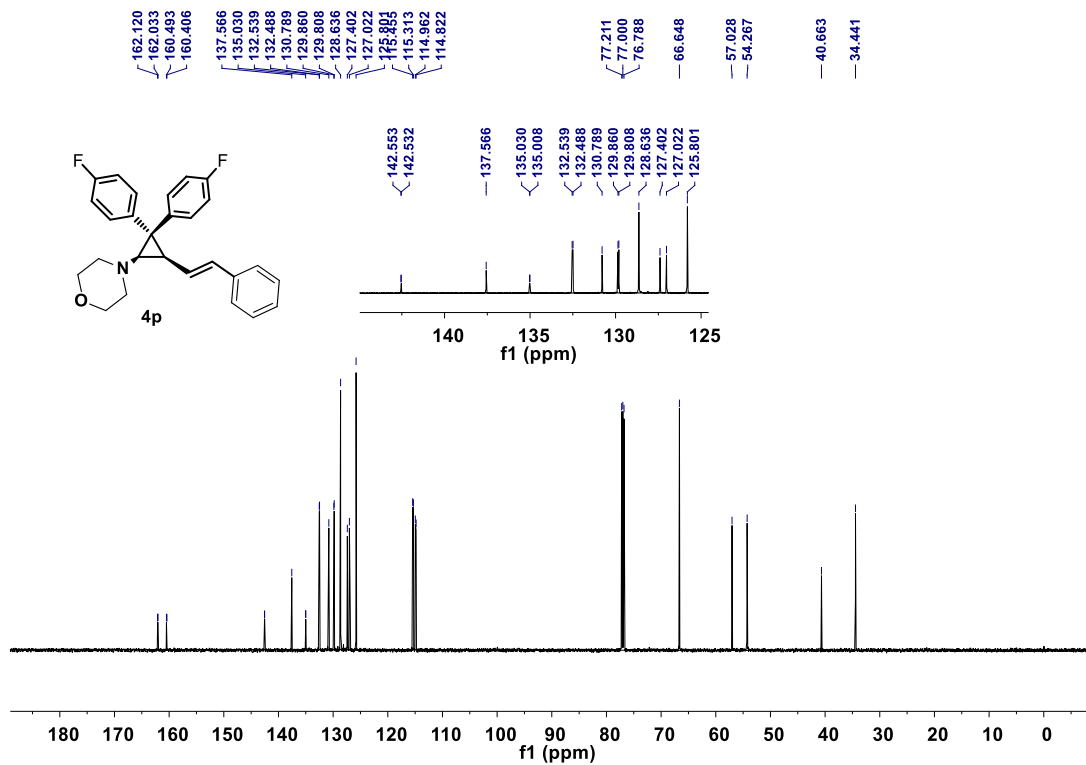
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	13.627	MM R	0.5053	3.48889e4	1150.79797	98.7873
2	16.307	MM R	0.7972	1797.38049	8.95439	1.2127

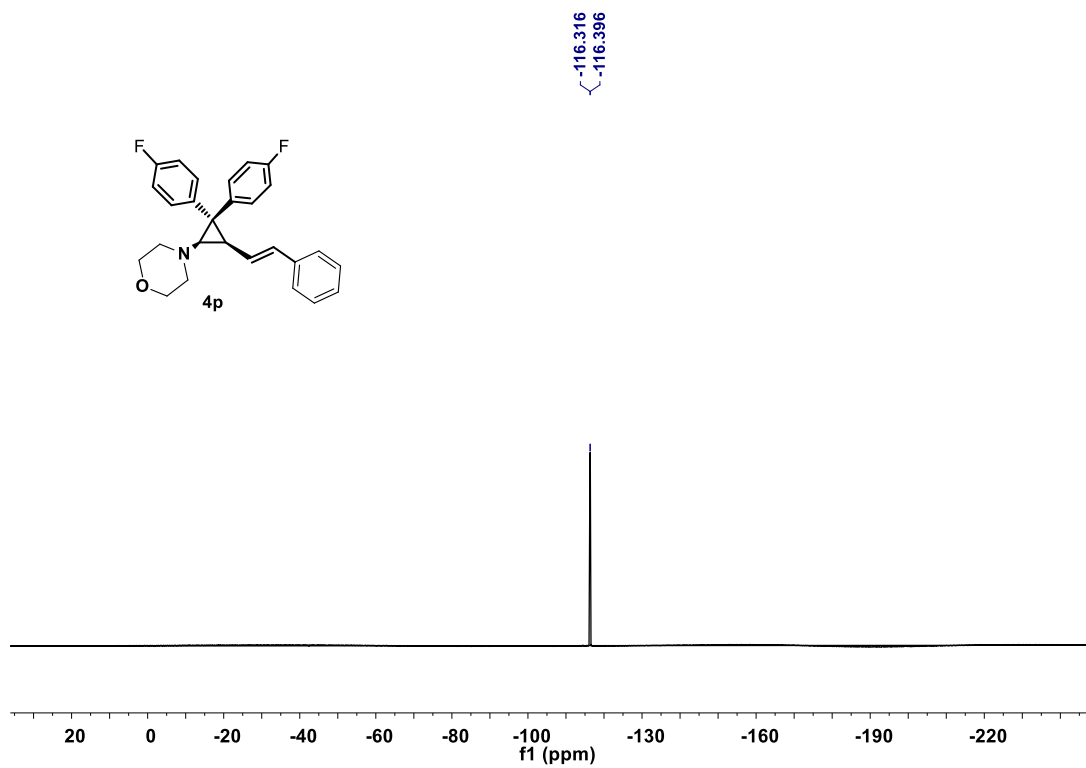
HPLC chromatograph for compound 4o.



1H NMR (600 MHz, $CDCl_3$) spectrum for compound 4p.

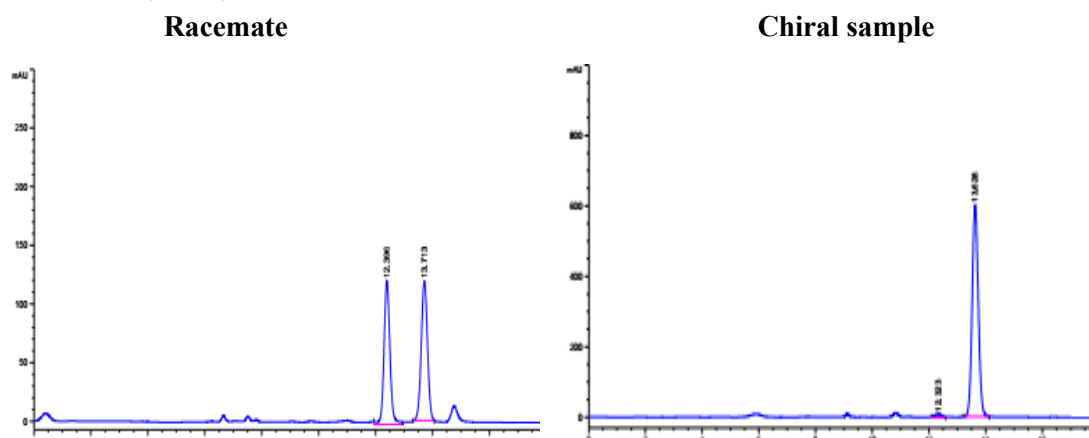


¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4p.



³⁵F NMR (470 MHz, CDCl₃) spectrum for compound 4p.

HPLC Conditions: CHIRALCEL IA column, 99/1 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 13.6 min, t_R (minor) = 12.3 min.



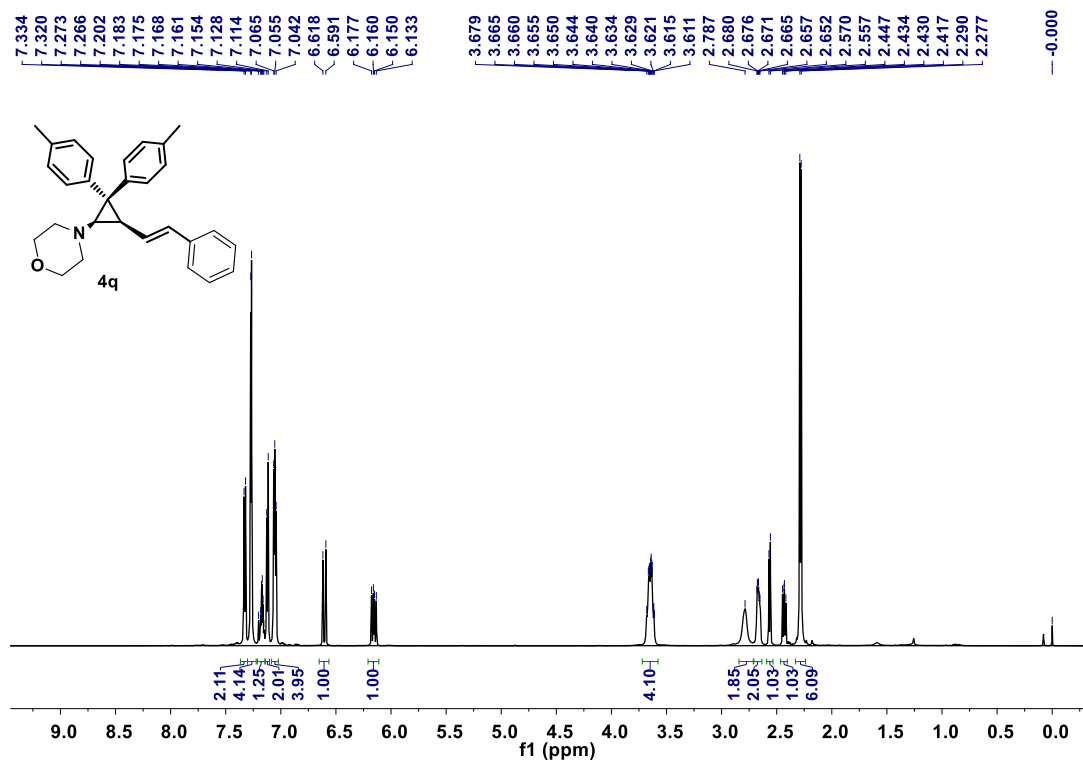
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.396	MM R	0.2423	1779.93347	122.41216	49.7561
2	13.713	MM R	0.2518	1797.38049	118.96817	50.2439

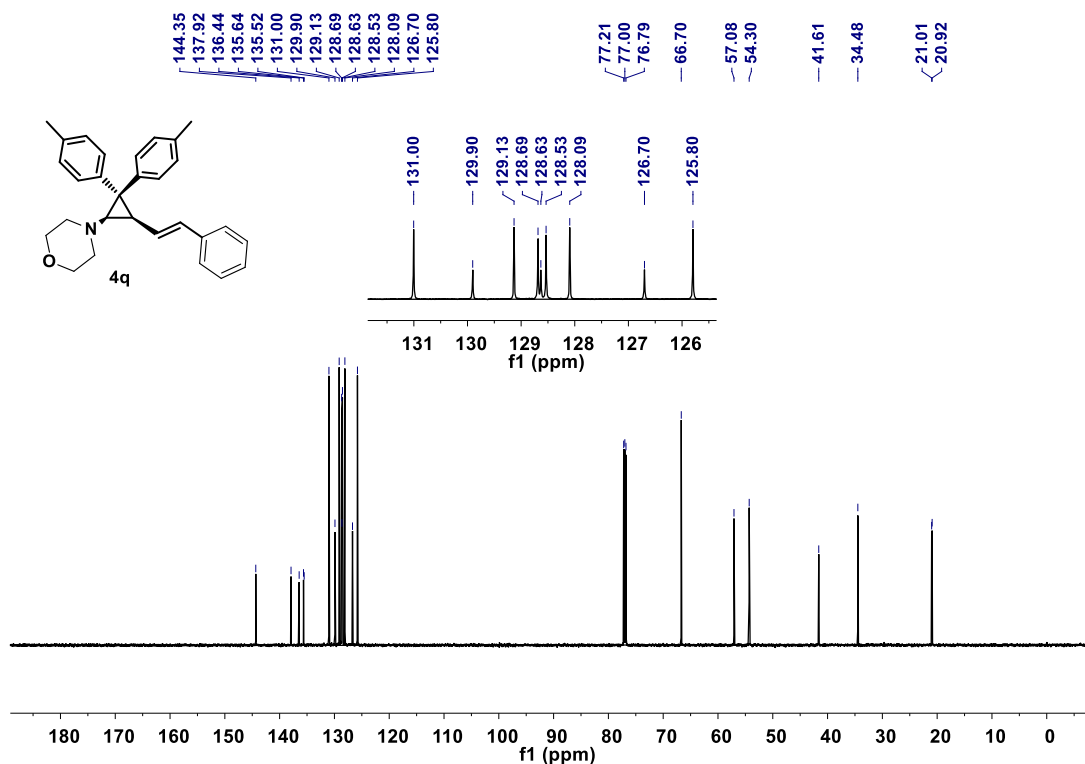
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.323	MM R	0.2580	161.13666	10.40926	1.7565
2	13.628	MM R	0.2503	9012.66113	600.23120	98.2435

HPLC chromatograph for compound 4p.

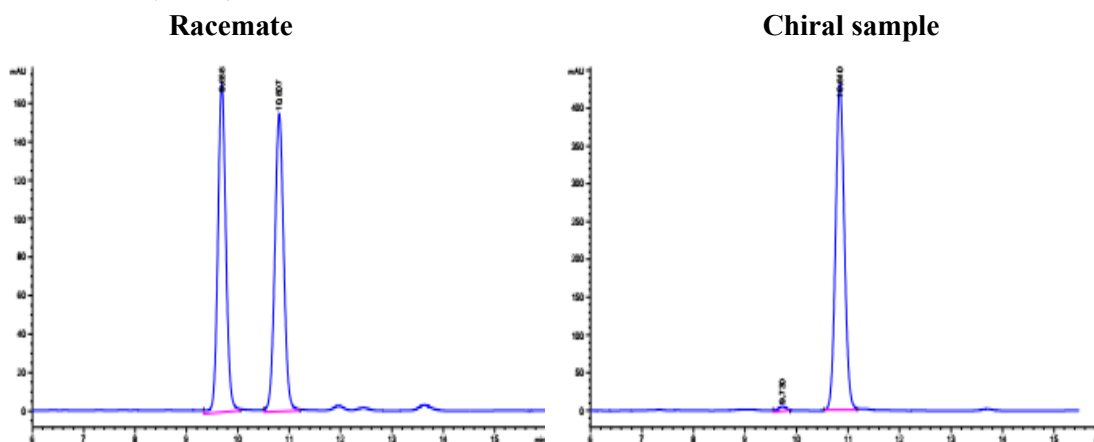


¹H NMR (600 MHz, CDCl₃) spectrum for compound 4q.



¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4q.

HPLC Conditions: CHIRALCEL IA column, 99/1 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 10.8 min, t_R (minor) = 9.7 min.



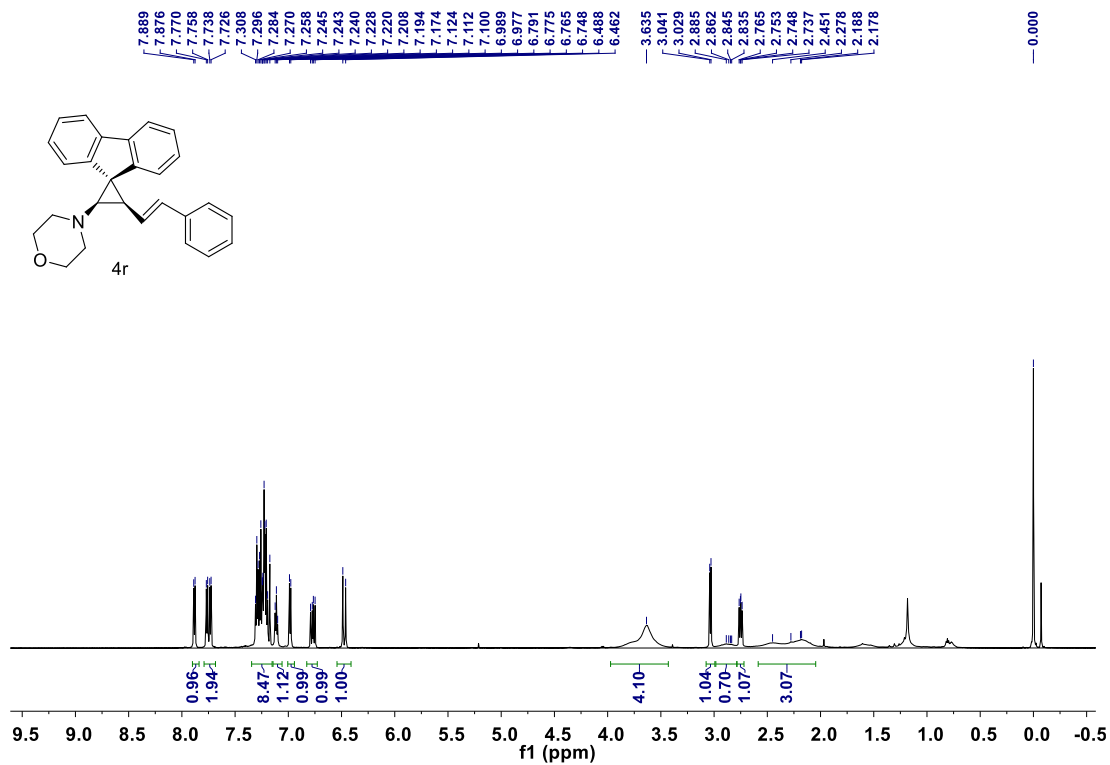
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.688	MM R	0.1798	1844.67175	170.99278	49.7647
2	10.807	MM R	0.2004	1862.11267	154.85078	50.2353

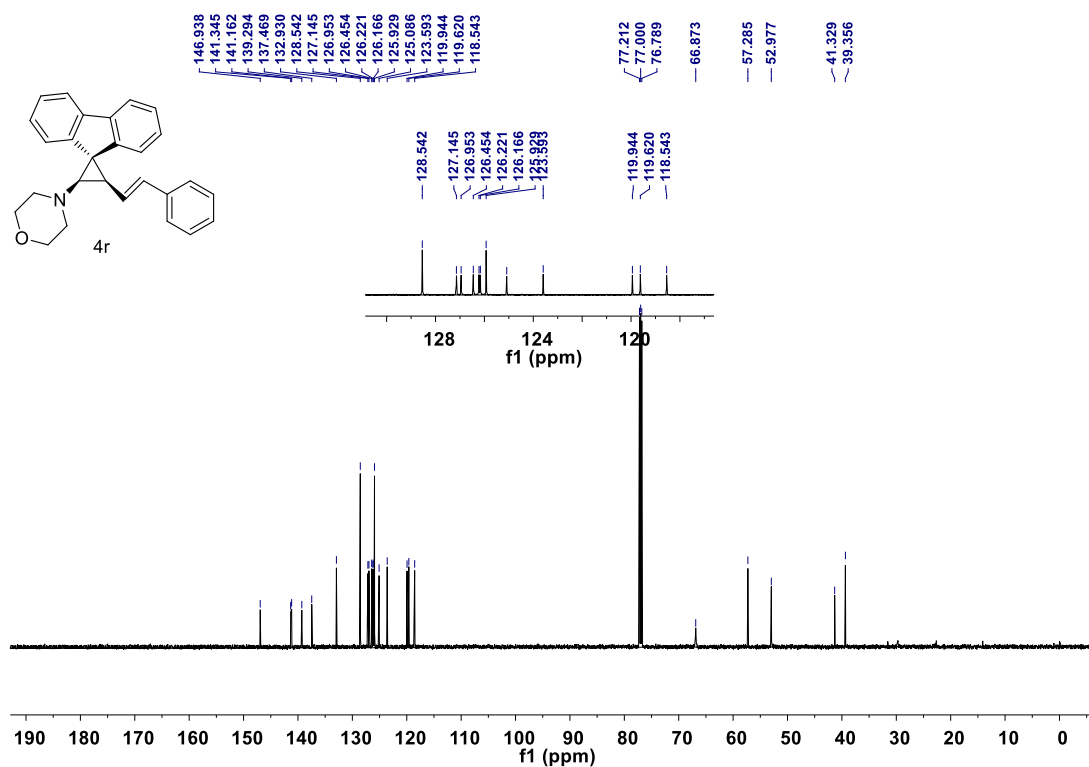
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.730	MM R	0.1869	67.55637	6.02589	1.3029
2	10.840	MM R	0.1971	5117.45605	432.73932	98.6971

HPLC chromatograph for compound 4q.

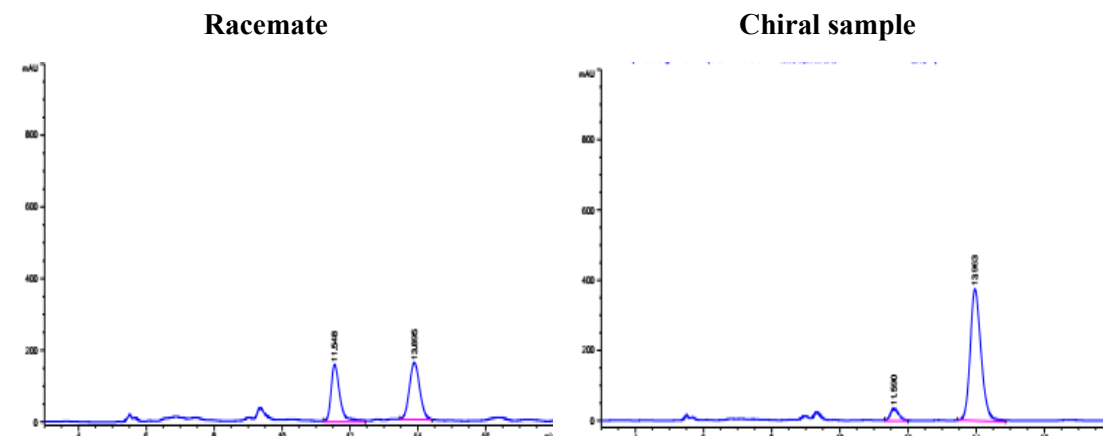


¹H NMR (600 MHz, CDCl₃) spectrum for compound 4r.



¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4r.

HPLC Conditions: CHIRALCEL AD column, 90/10 hexanes/*i*-PrOH, 0.6 mL/min; t_R (major) = 13.9 min, t_R (minor) = 11.6 min.



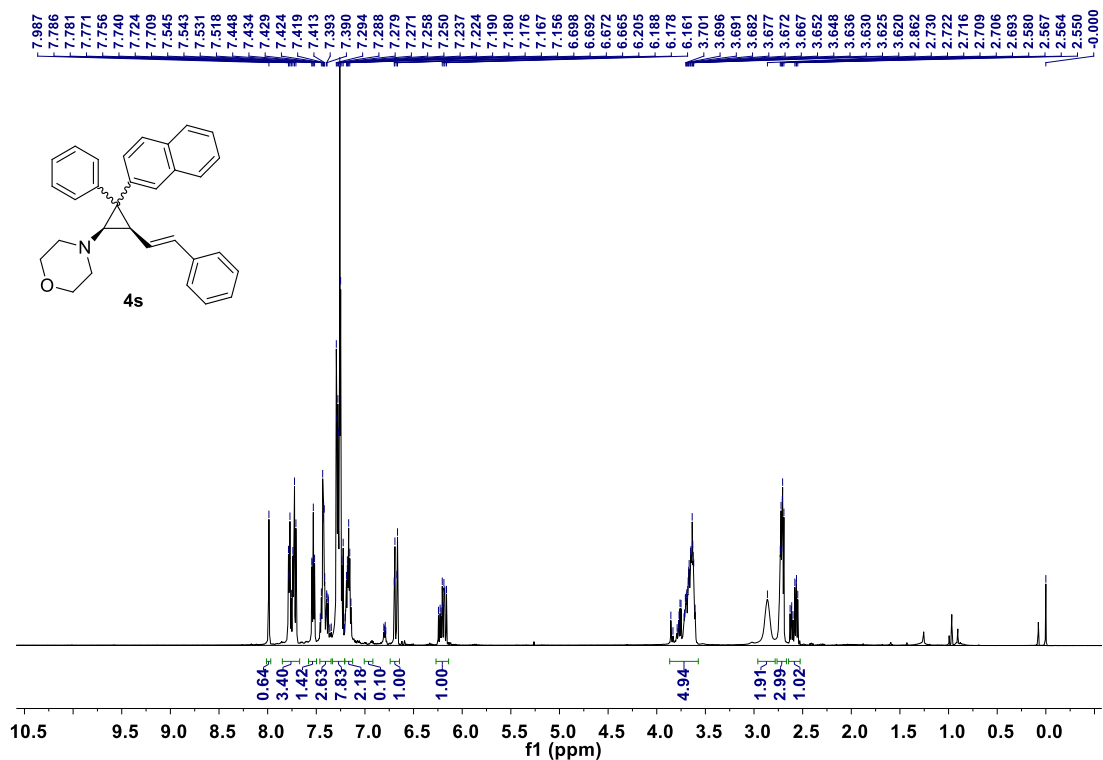
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	11.548	MM R	0.3059	2940.49561	160.22668	46.6153
2	13.895	MM R	0.3534	3367.50708	158.79982	53.3847

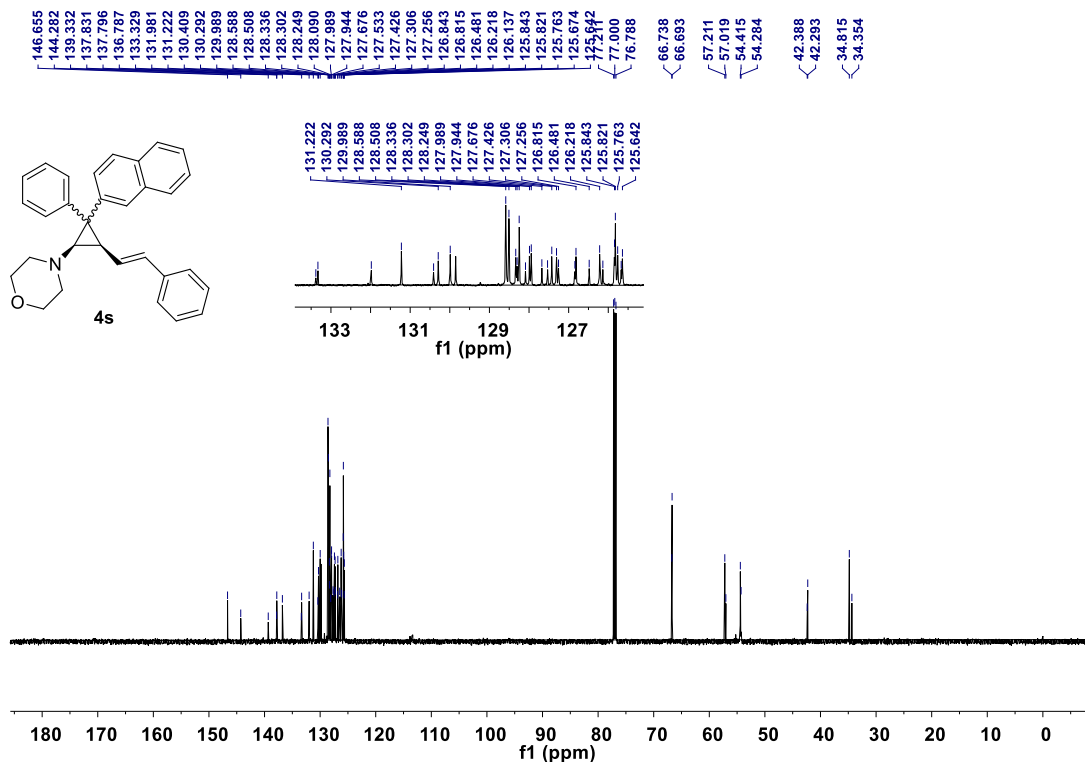
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	11.590	MM R	0.2982	628.72272	35.13592	7.0017
2	13.963	MM R	0.3719	8350.79102	374.27652	92.9983

HPLC chromatograph for compound 4r.



1H NMR (600 MHz, $CDCl_3$) spectrum for compound 4s.

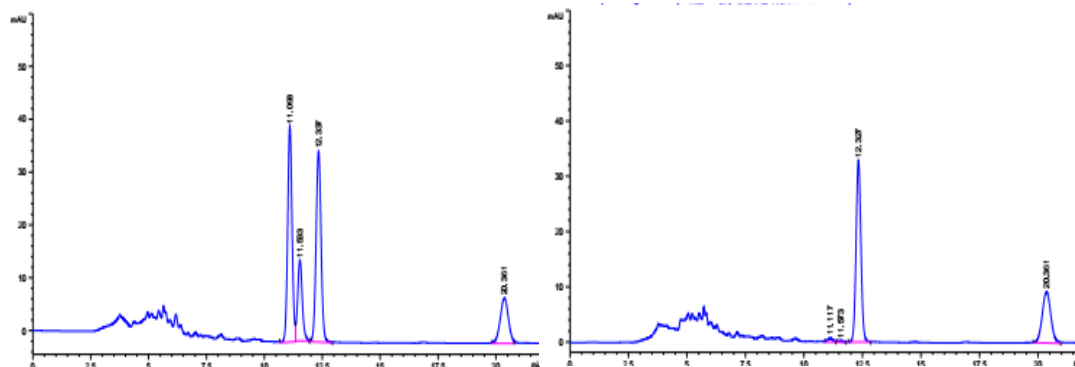


¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4s.

HPLC Conditions: CHIRALCEL IA column, 99/1 hexanes/*i*-PrOH, 0.8 mL/min; *t_R* (major) = 12.3, 20.4 min, *t_R* (minor) = 11.1, 11.6 min.

Racemate:

Chiral sample:



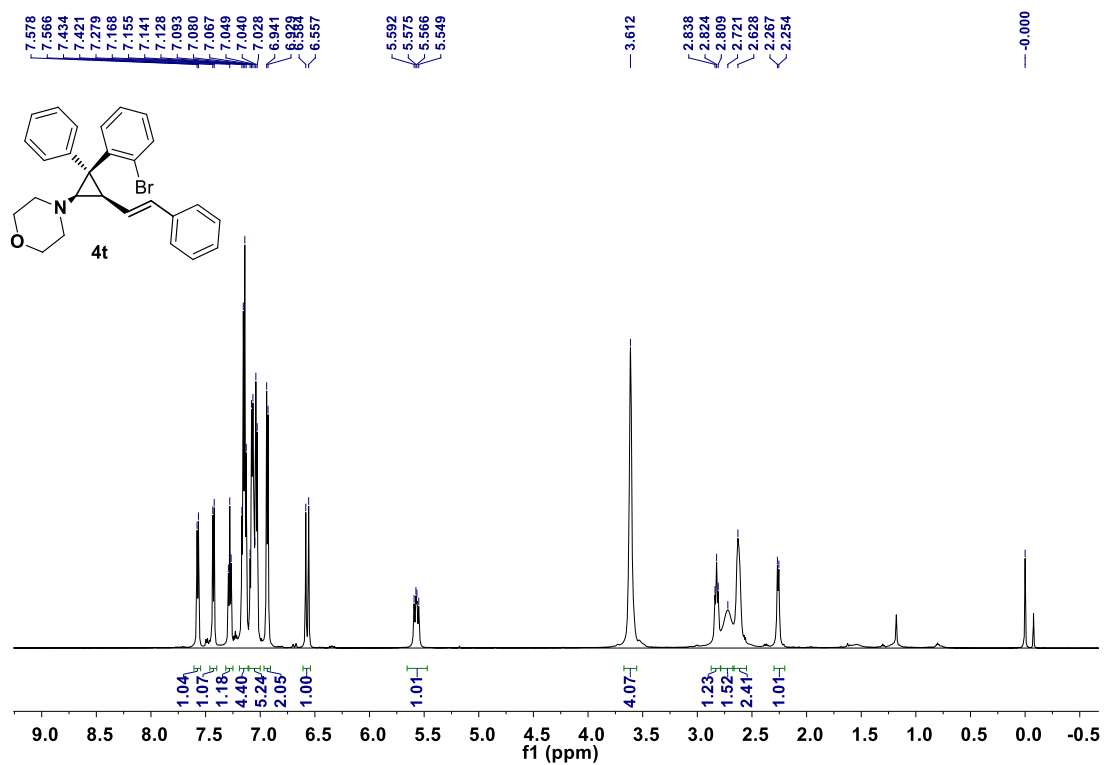
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	11.098	MM R	0.2198	540.20190	40.96717	35.9351
2	11.533	MM R	0.2306	212.11006	15.32844	14.1099
3	12.337	MM R	0.2484	538.5626	36.13845	35.8261
4	20.361	MM R	0.4108	212.39522	8.61811	14.1289

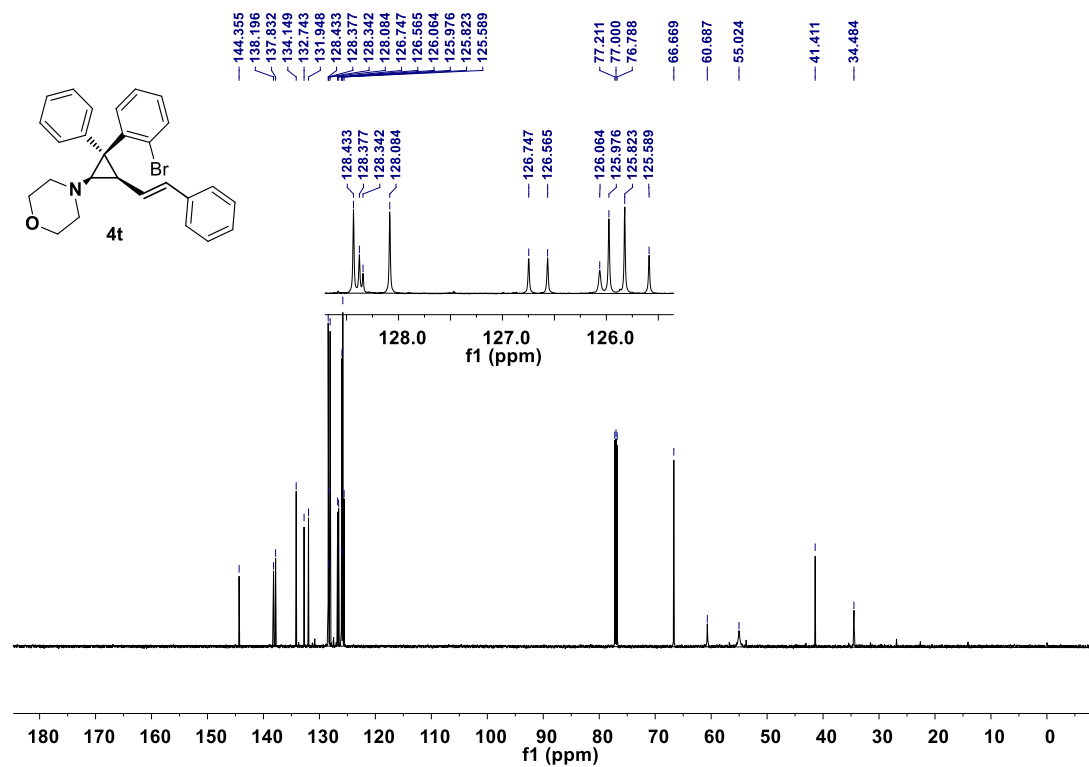
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	11.117	MM R	0.2419	10.22579	7.04544e-1	1.4115
2	11.573	MM R	0.2569	5.18444	3.36375e-1	0.7156
3	12.327	MM R	0.2393	472.97668	32.94346	65.2856
4	20.361	MM R	0.4235	236.08577	9.29155	32.5873

HPLC chromatograph for compound 4s.



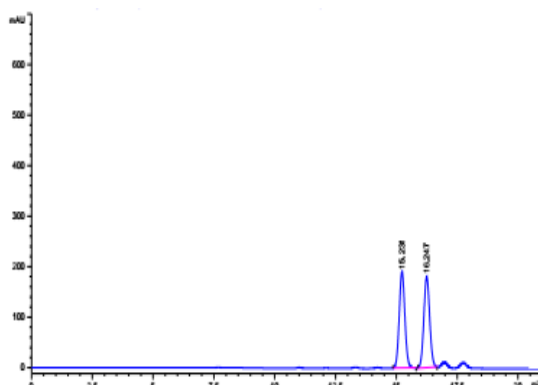
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4t.



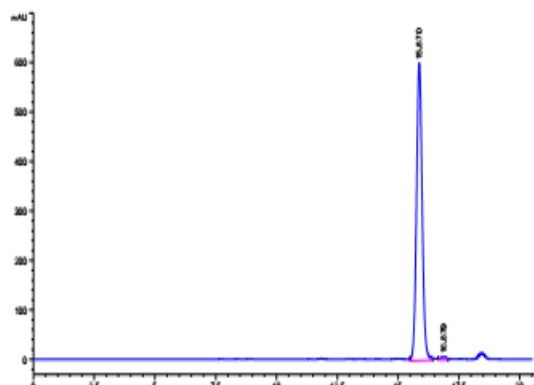
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4t.

HPLC Conditions: CHIRALCEL IA column, 98/2 hexanes/*i*-PrOH, 0.4 mL/min; t_R (major) = 15.9 min, t_R (minor) = 16.9 min.

Racemate:



Chiral sample:



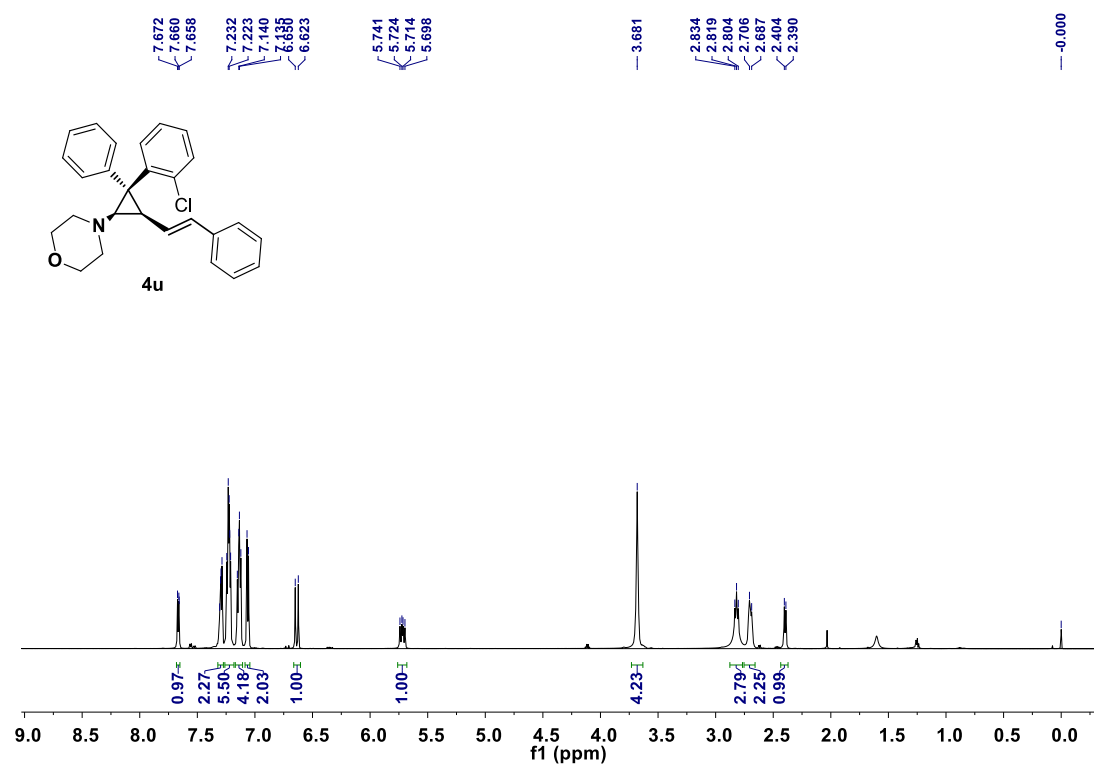
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	15.231	MM R	0.2680	3058.31714	190.17407	50.3303
2	16.247	MM R	0.2795	3018.16992	179.97801	49.6697

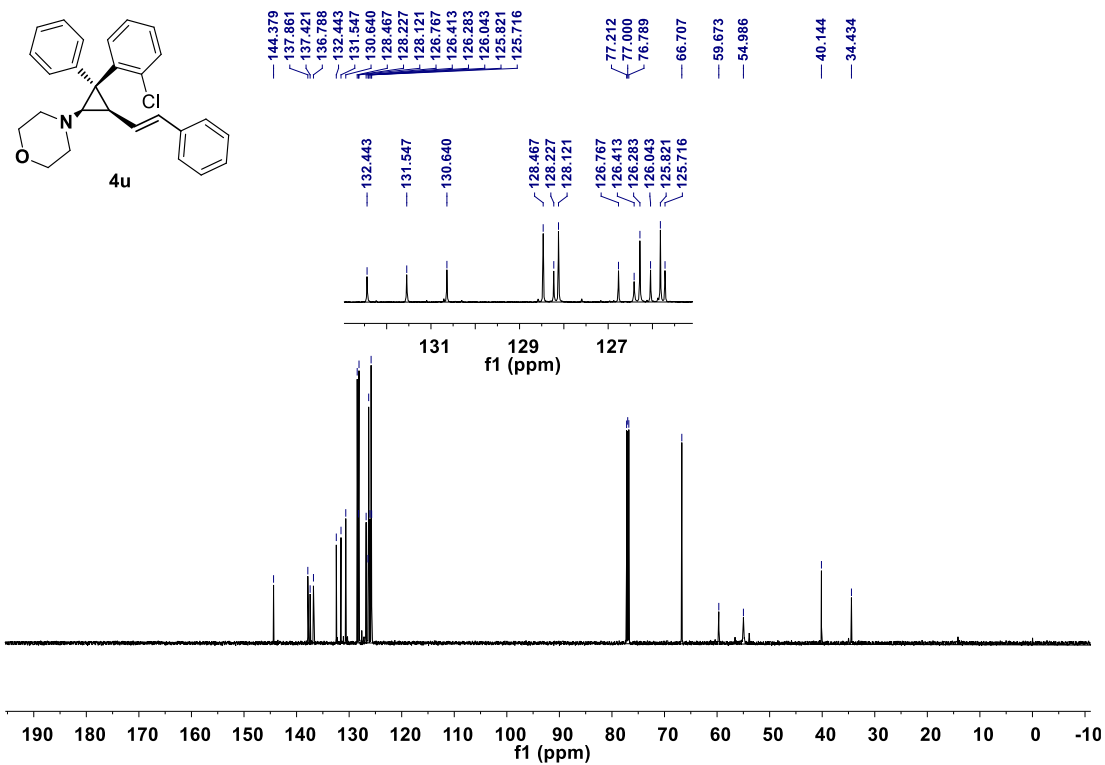
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	15.870	MM R	0.2695	9725.69238	601.51691	99.1298
2	16.879	MM R	0.2981	85.37263	4.77350	0.8702

HPLC chromatograph for compound 4t.



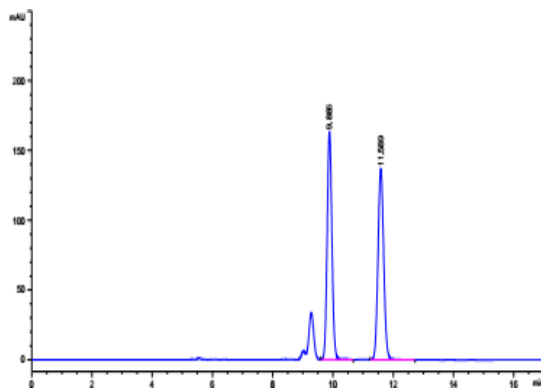
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4u.



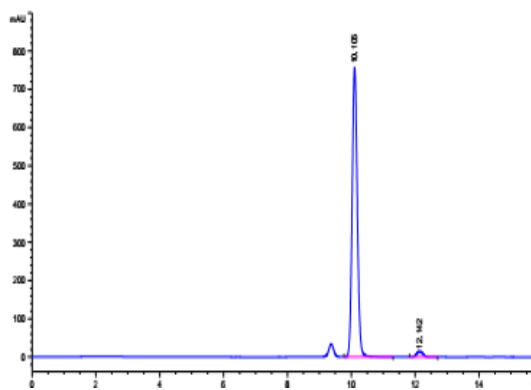
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4u.

HPLC Conditions: CHIRALCEL IC column, 96/4 hexanes/*i*-PrOH, 0.6 mL/min; *t_R* (major) = 10.1 min, *t_R* (minor) = 12.1 min.

Racemate:



Chiral sample:



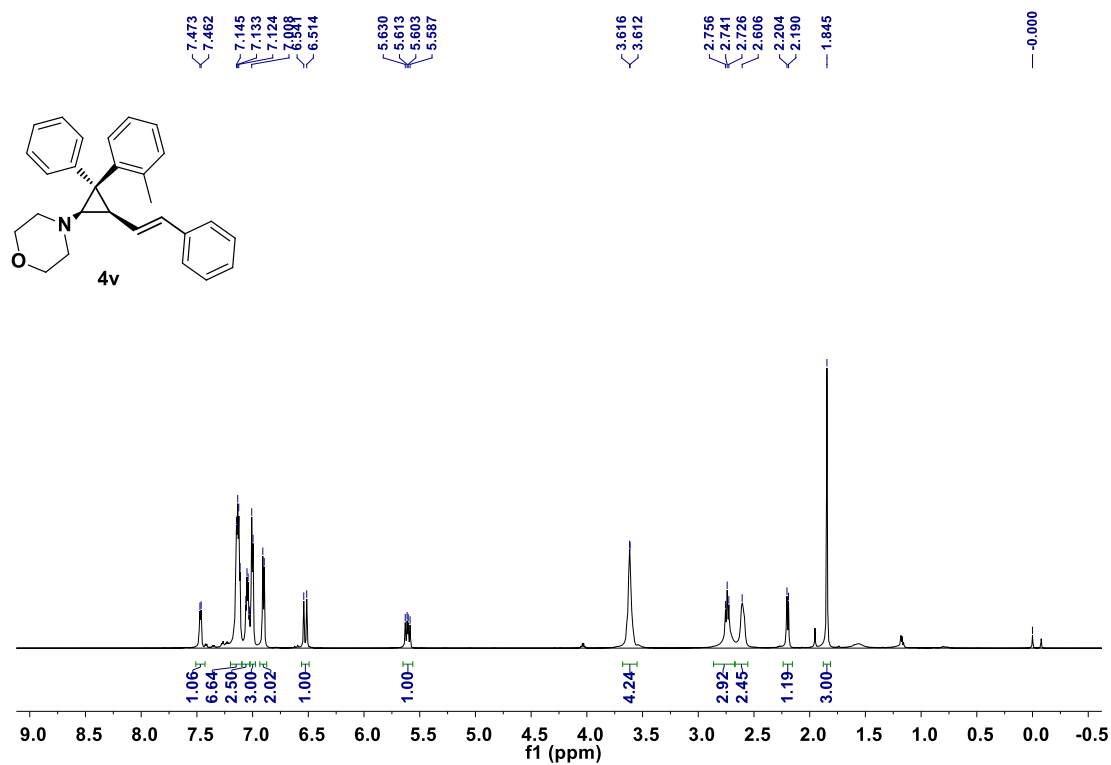
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.886	MM R	0.1700	1791.94263	163.33707	49.9785
2	11.589	MM R	0.2037	1793.48621	137.04314	50.0215

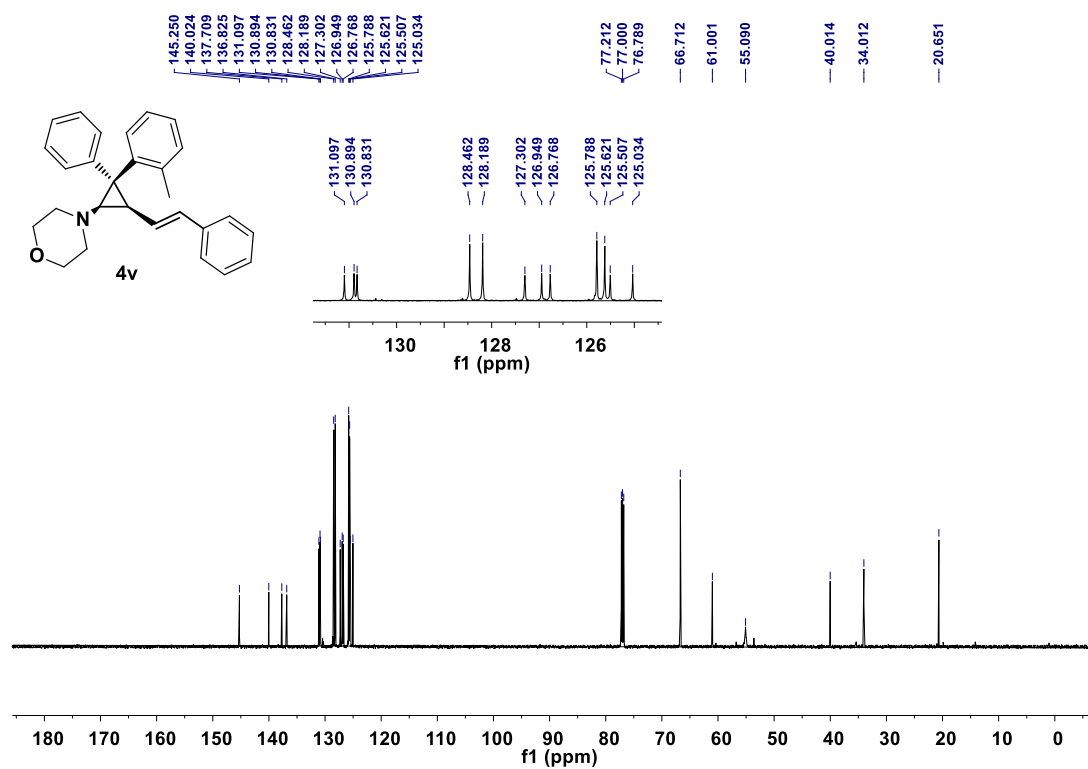
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	10.105	MM R	0.1730	8455.79688	758.98486	97.6711
2	12.142	MM R	0.2119	201.62250	14.80193	2.3289

HPLC chromatograph for compound 4u.



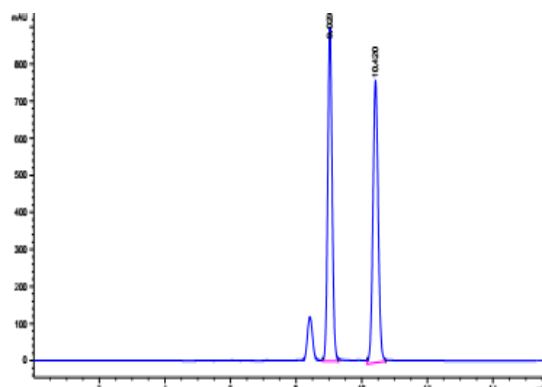
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4v.



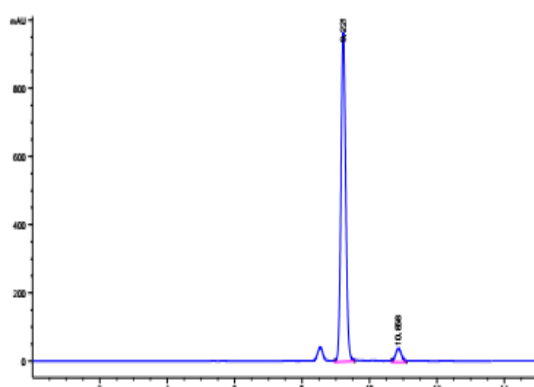
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4v.

HPLC Conditions: CHIRALCEL IC column, 96/4 hexanes/*i*-PrOH, 0.6 mL/min; t_R (major) = 9.2 min, t_R (minor) = 10.9 min.

Racemate:



Chiral sample:



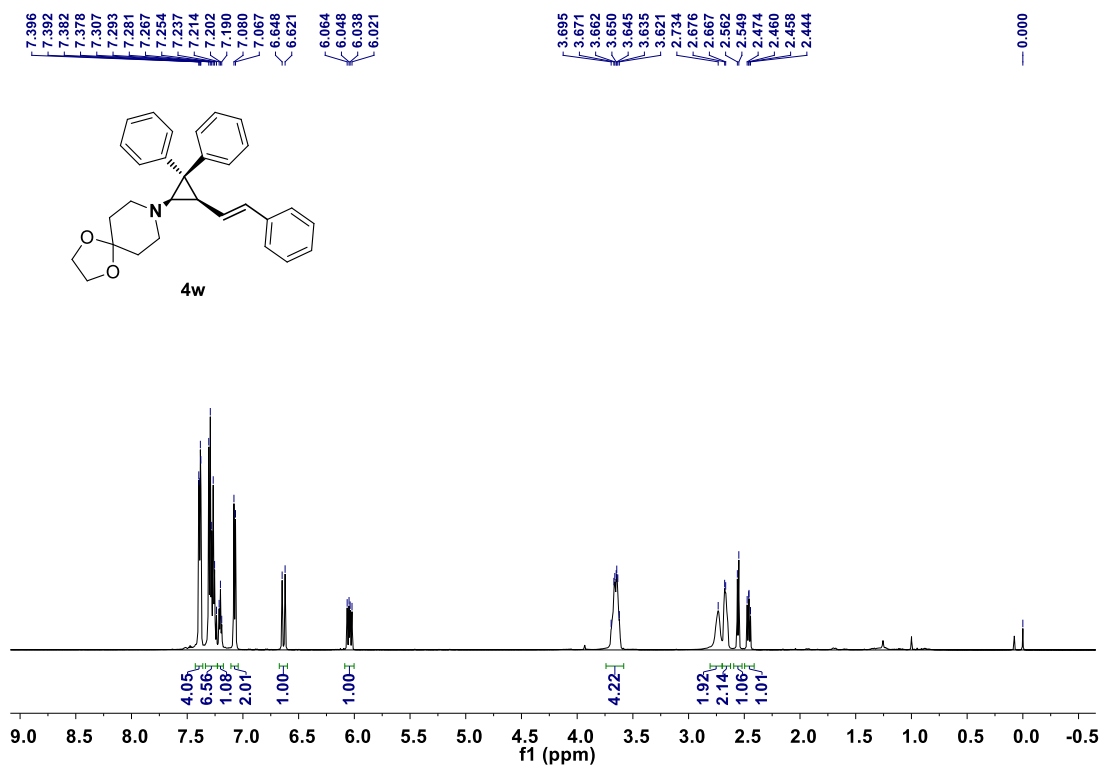
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.029	MM R	0.1562	8407.25195	897.14618	49.8720
2	10.420	MM R	0.1853	8450.40918	760.22675	50.1208

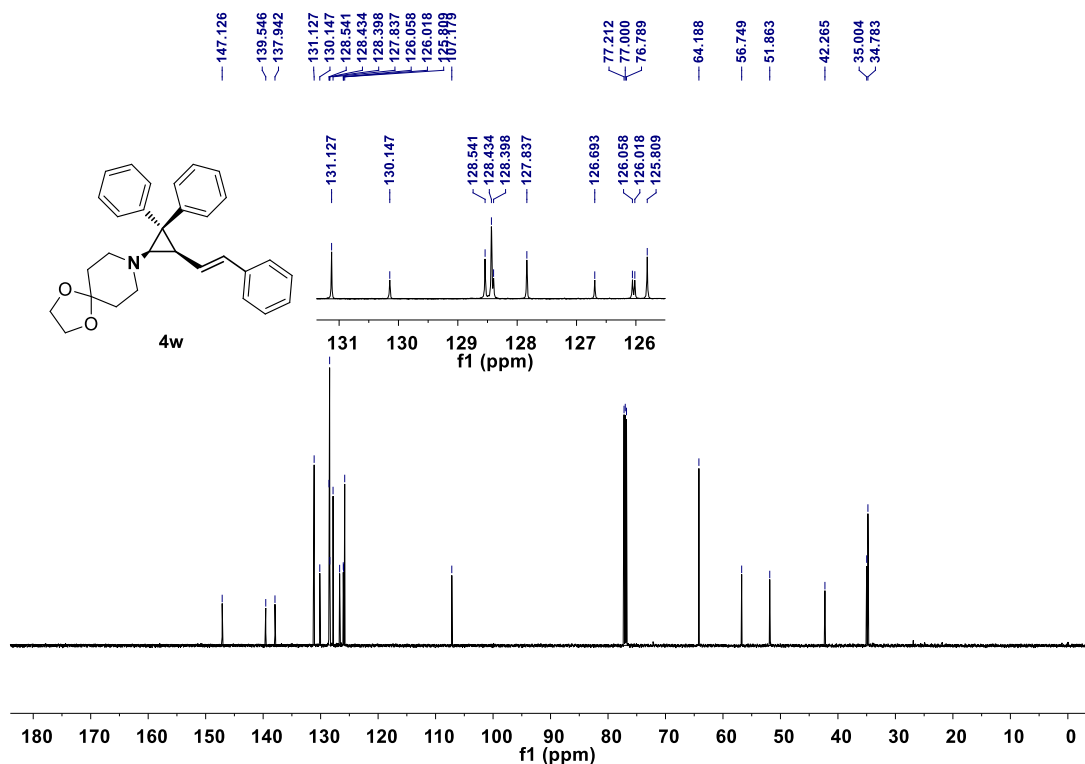
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.221	MM R	0.1638	9490.77344	965.53564	94.9880
2	10.858	MM R	0.2102	500.77646	39.71390	5.0120

HPLC chromatograph for compound 4v.



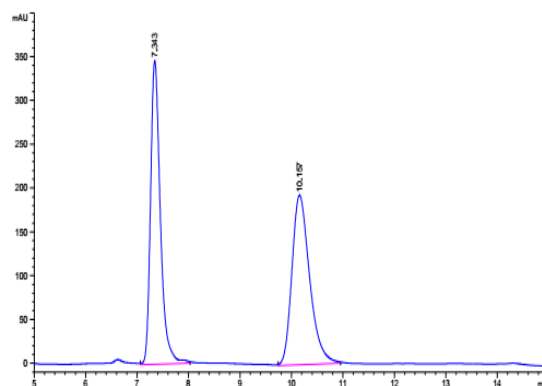
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4w.



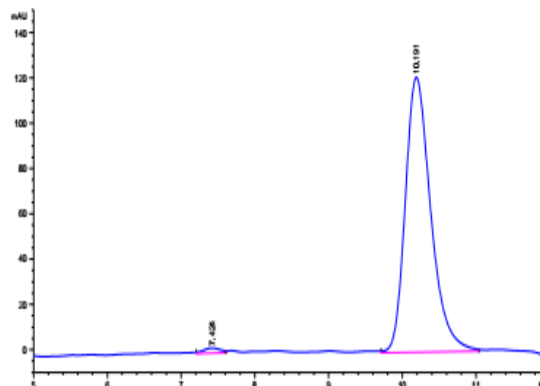
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4w.

HPLC Conditions: CHIRALCEL OD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 10.2 min, t_R (minor) = 7.4 min.

Racemate:



Chiral sample:



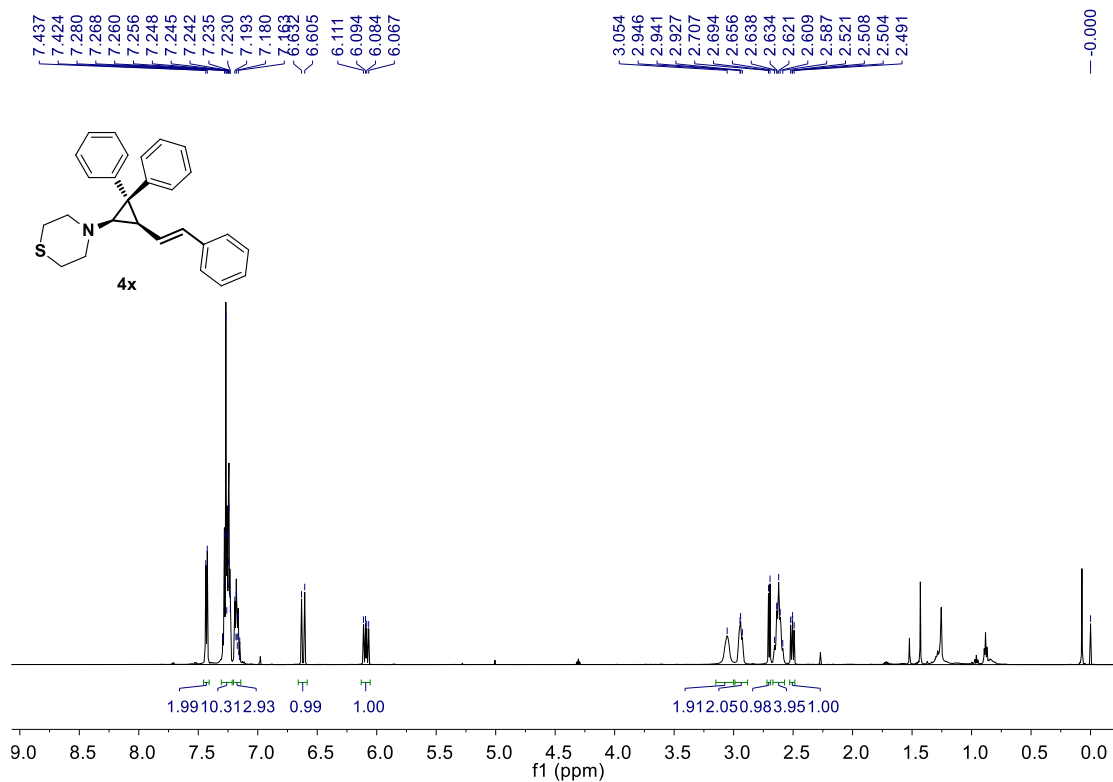
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.343	MM R	0.2203	4587.25879	346.96991	49.7501
2	10.157	MM R	0.3989	4633.33643	193.58546	50.2499

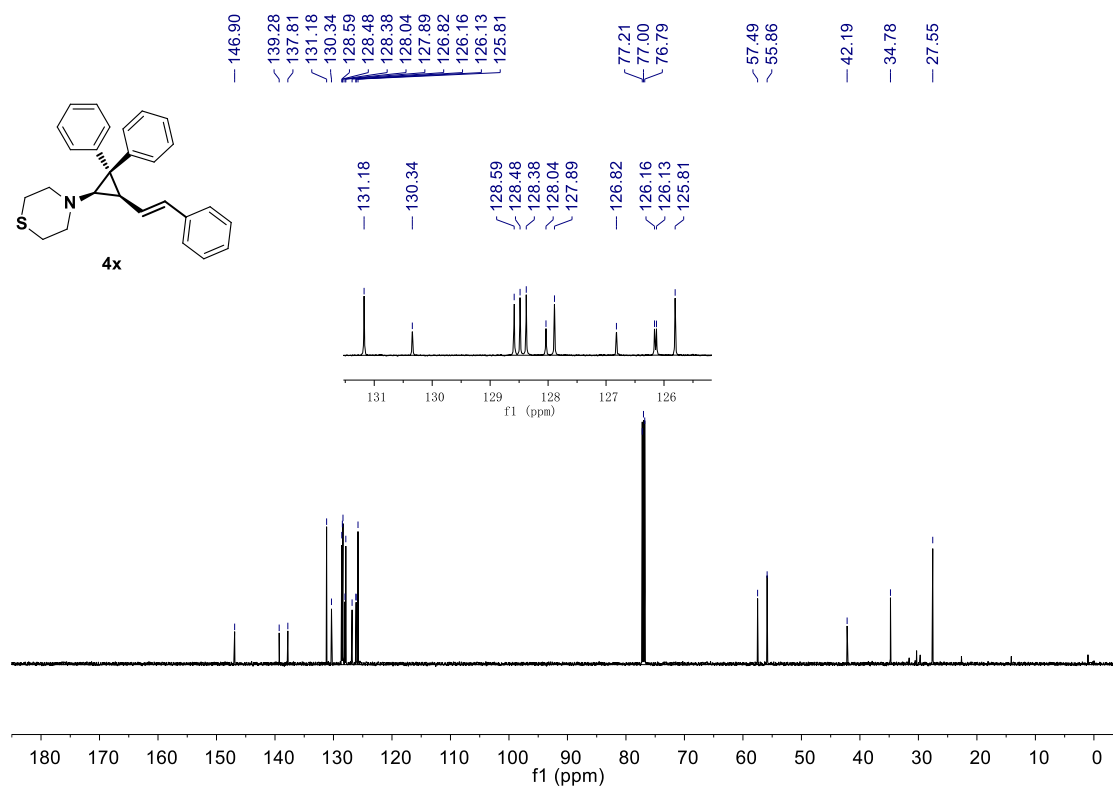
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	7.424	MM R	0.2717	37.44458	2.29654	1.2666
2	10.191	MM R	0.4007	2918.97290	121.42398	98.7334

HPLC chromatograph for compound 4w.



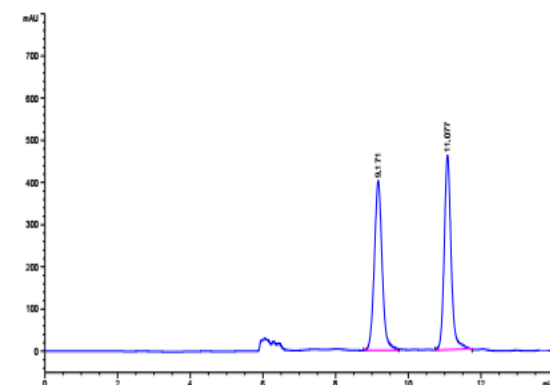
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4x.



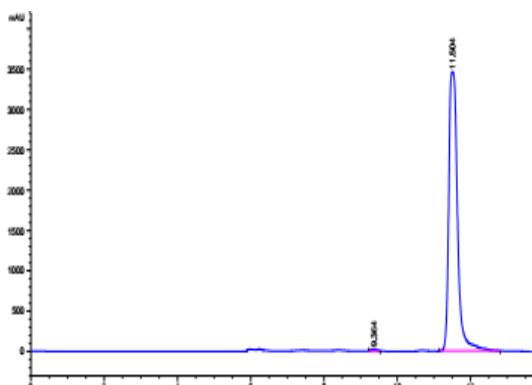
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4x.

HPLC Conditions: CHIRALCEL IA-H column, 95/5 hexanes/*i*-PrOH, 0.5 mL/min; t_R (major) = 11.5 min, t_R (minor) = 9.3 min.

Racemate:



Chiral sample:



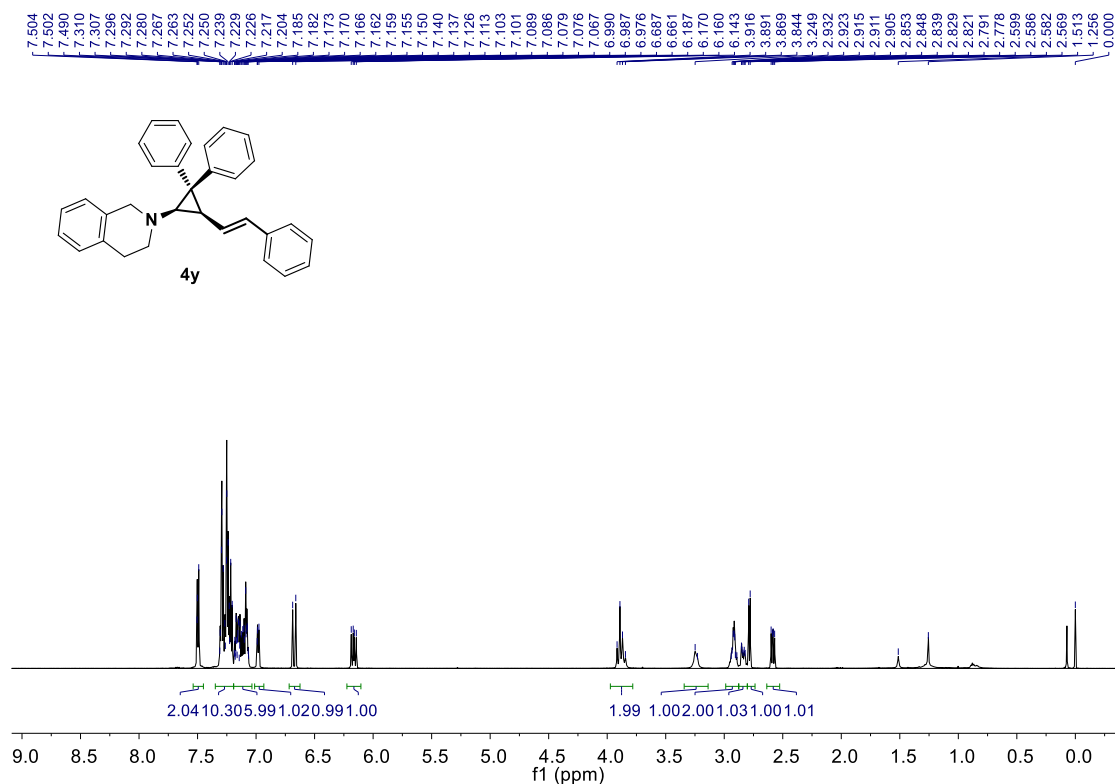
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.171	MM R	0.2473	5958.70215	401.55231	49.6764
2	11.077	MM R	0.2185	6036.33447	460.43890	50.3236

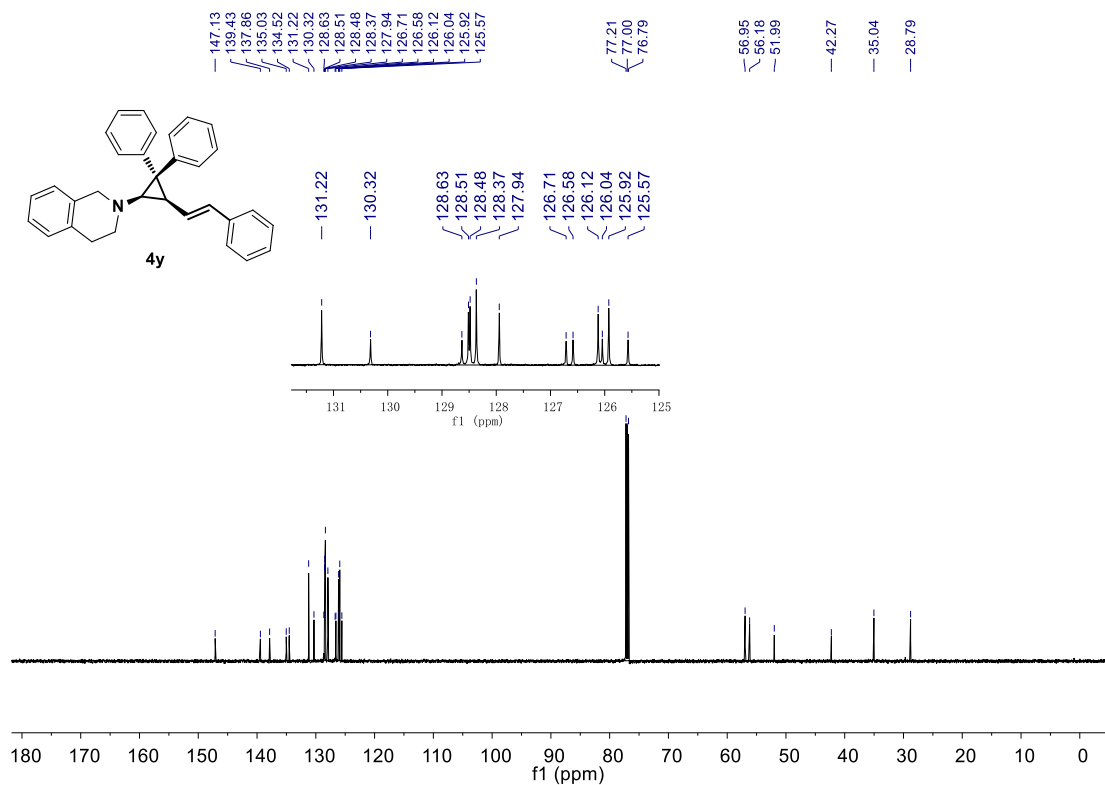
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.346	MM R	0.1767	28.14752	28.14752	0.5201
2	11.504	MM R	0.2729	5.70655e4	3456.61133	99.4799

HPLC chromatograph for compound 4x.



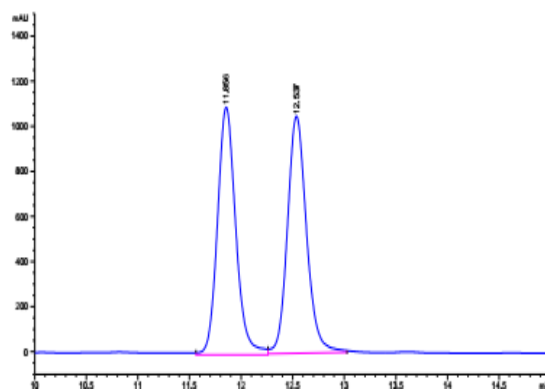
^1H NMR (600 MHz, CDCl_3) spectrum for compound 4y.



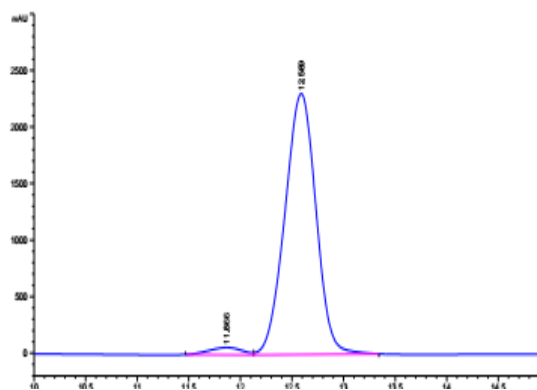
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4y.

HPLC Conditions: CHIRALCEL AD-H column, 98/2 hexanes/*i*-PrOH, 0.4 mL/min; *t_R* (major) = 12.6 min, *t_R* (minor) = 11.9 min.

Racemate:



Chiral sample:



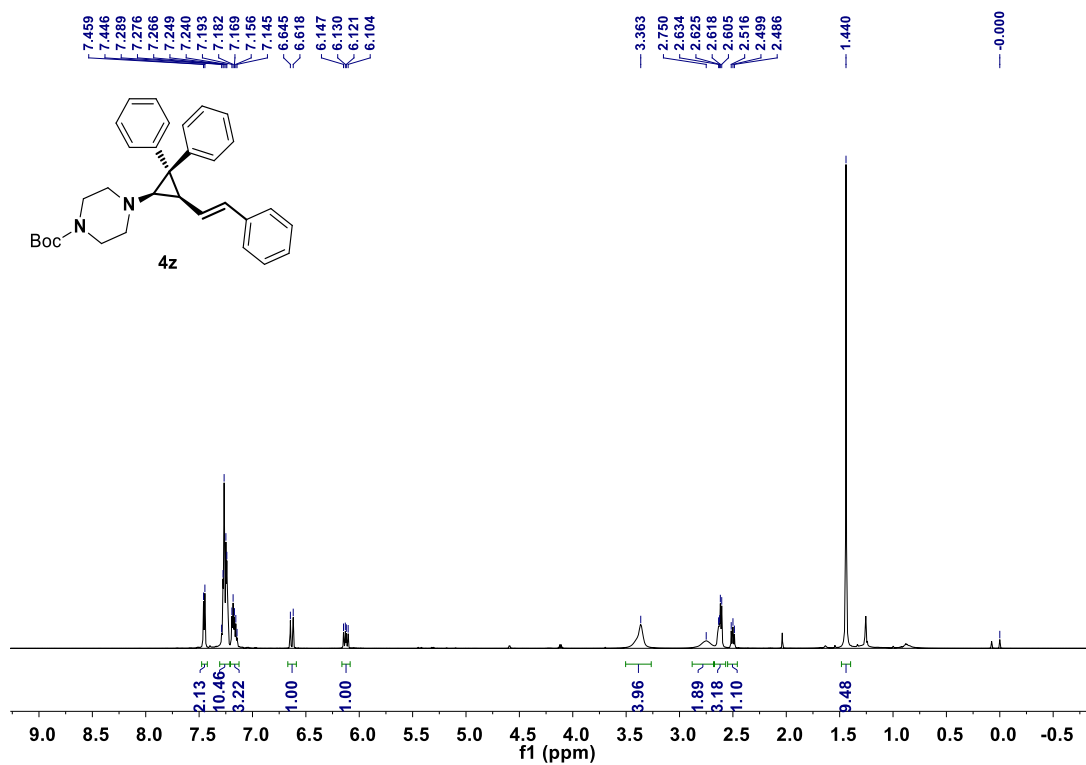
Racemate:

Peak	PetTime	Type	Width (min)	Area (mAu*S)	Hight (mAu)	Area%
1	11.856	MM R	0.2056	1.35476e4	1098.26343	49.6764
2	12.537	MM R	0.1957	1.35435e4	1052.28235	50.3236

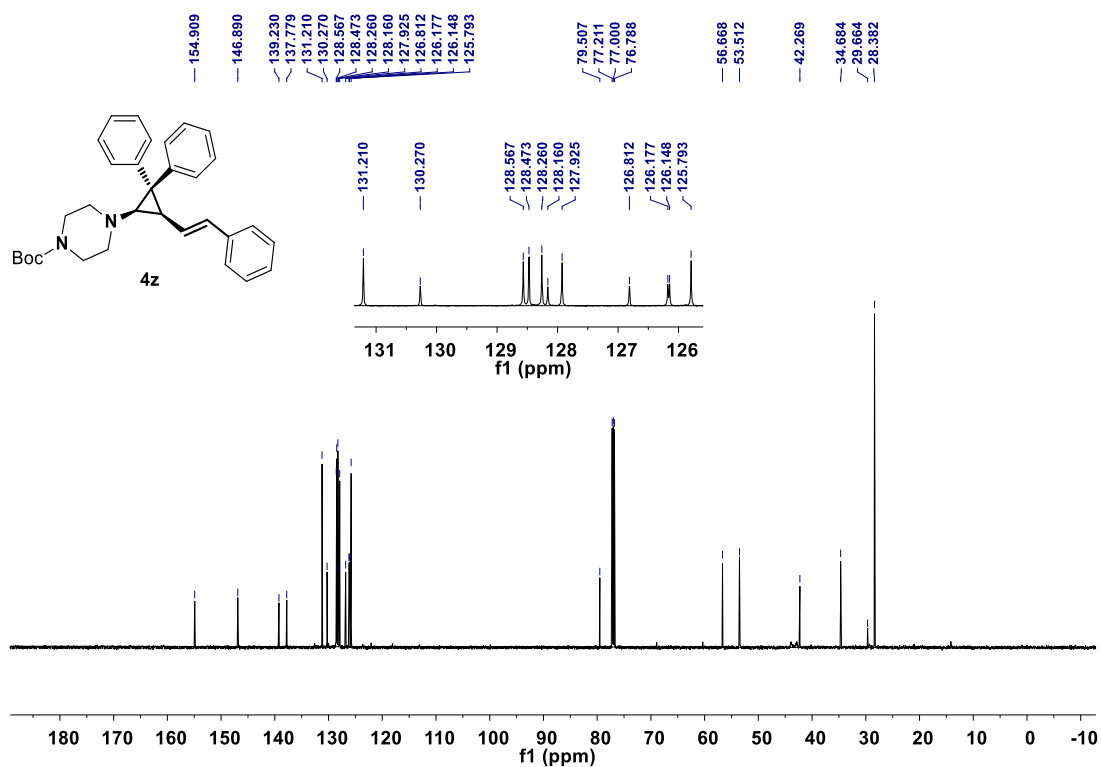
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	11.866	MM R	0.3709	1436.27441	64.54604	2.8845
2	12.589	MM R	0.3299	4.83562e4	2306.66138	97.1155

HPLC chromatograph for compound 4y.



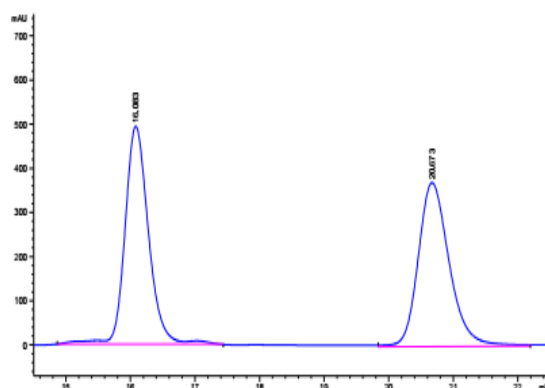
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4z.



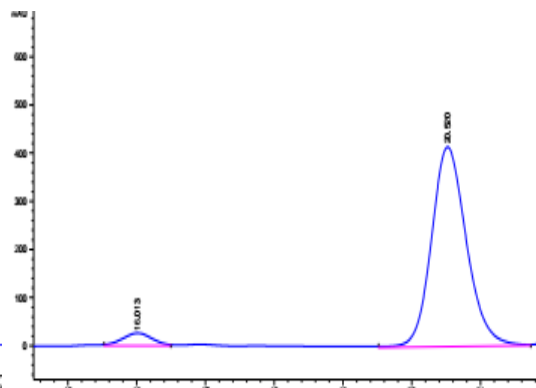
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4z.

HPLC Conditions: CHIRALCEL IC column, 95/5 hexanes/*i*-PrOH, 0.4 mL/min; t_R (major) = 20.5 min, t_R (minor) = 16.0 min.

Racemate:



Chiral sample:



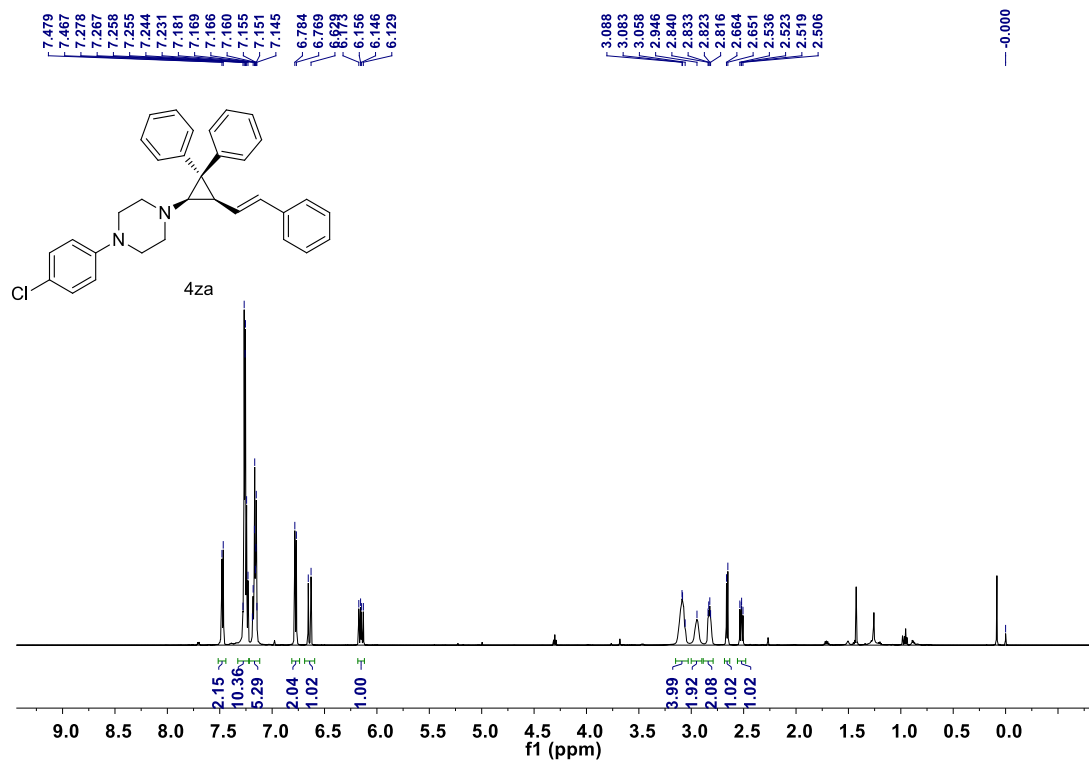
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	16.083	MM R	0.4250	1.25888e4	493.72021	50.3411
2	20.673	MM R	0.5576	1.24182e4	371.20801	49.6589

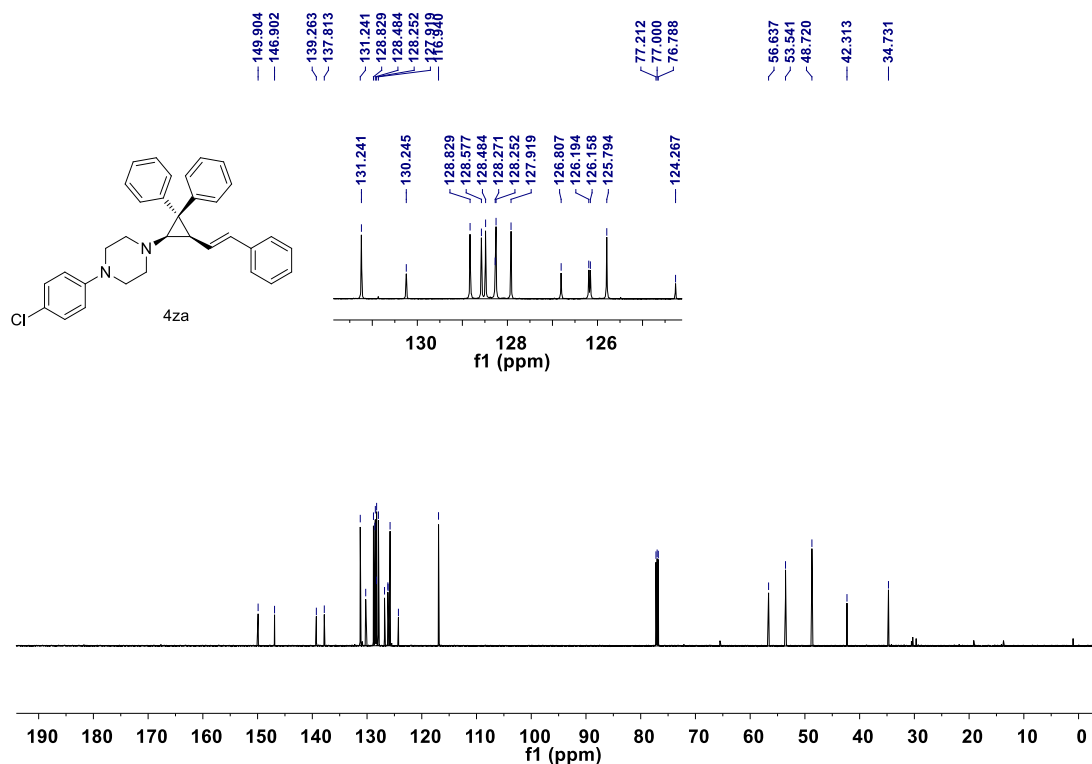
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	16.013	MM R	0.4986	779.11151	26.04366	5.0349
2	20.520	MM R	0.5906	1.46952e4	414.70084	94.9651

HPLC chromatograph for compound 4z.



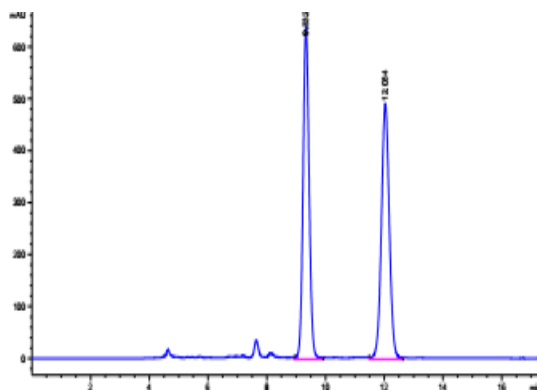
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4za.



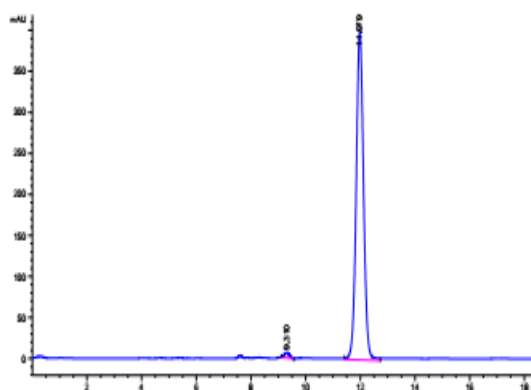
^{13}C NMR (150 MHz, CDCl_3) spectrum for compound 4za.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 12.0 min, t_R (minor) = 9.3 min.

Racemate:



Chiral sample:



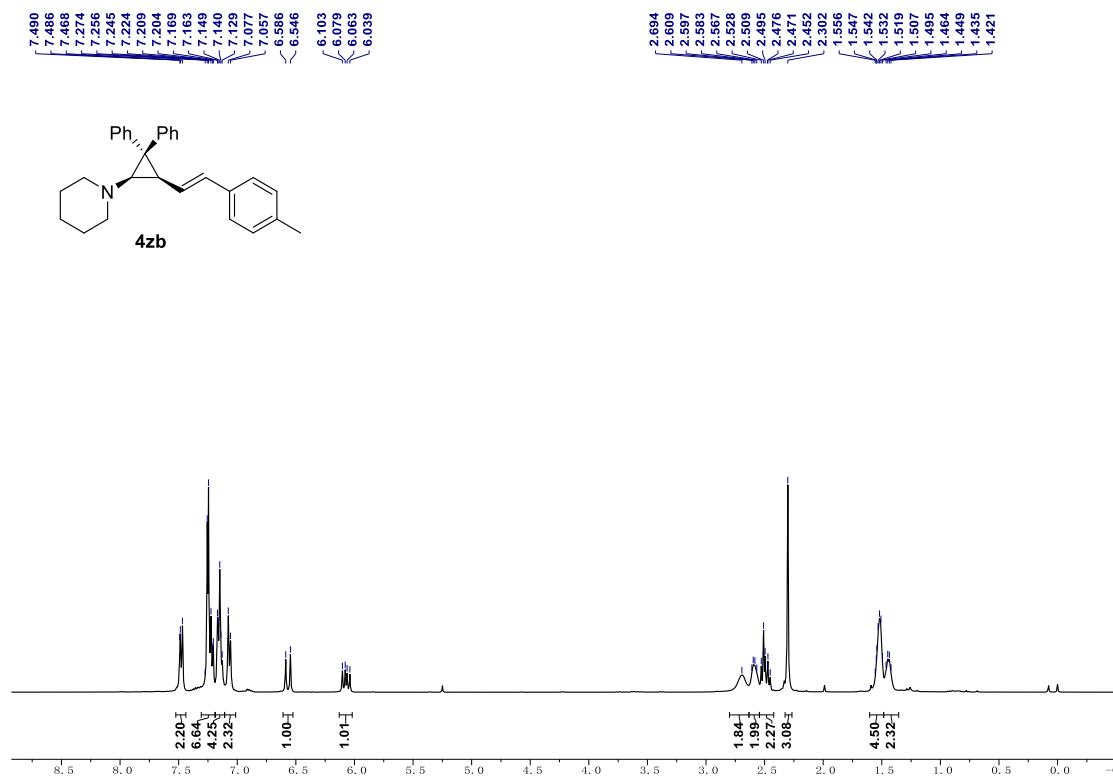
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.332	MM R	0.2390	9167.00879	639.29041	49.9445
2	12.034	MM R	0.3114	9187.36914	491.67279	50.0555

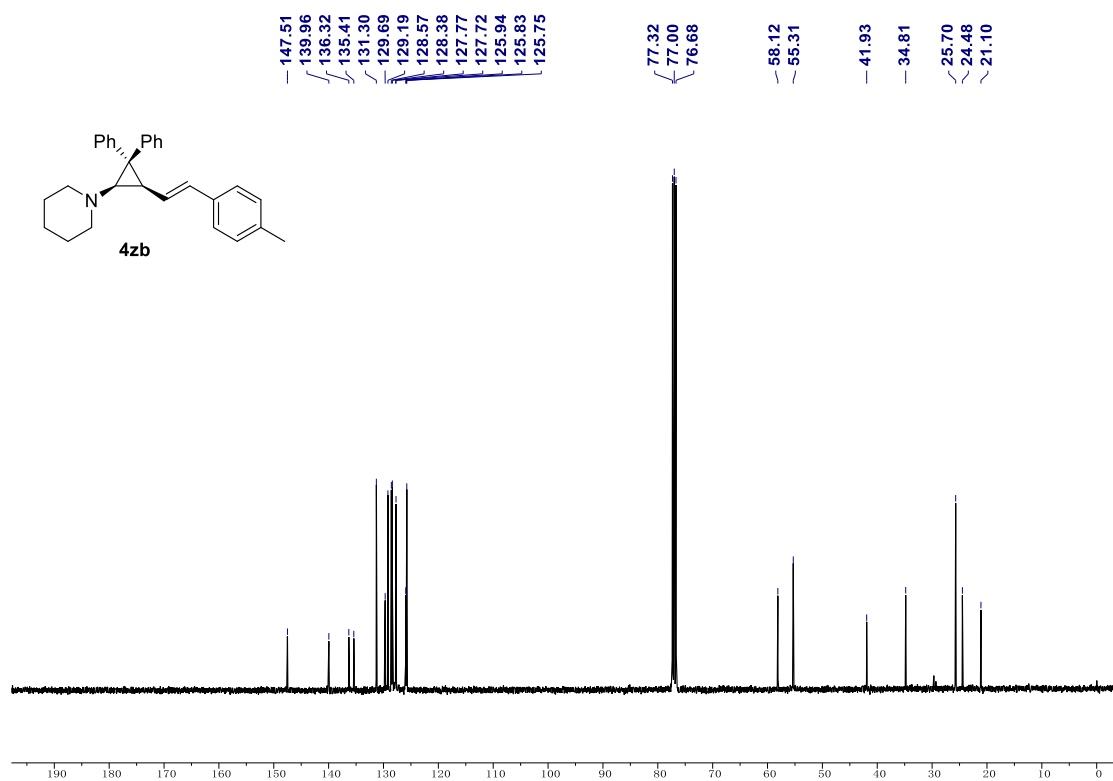
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	9.310	MM R	0.2240	88.37115	6.57592	1.1712
2	11.979	MM R	0.3103	7456.73145	400.53366	98.8288

HPLC chromatograph for compound 4za.



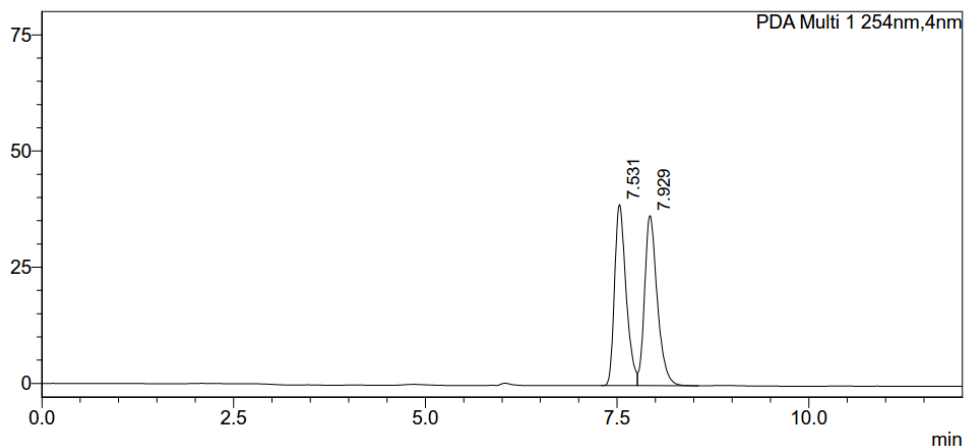
^1H NMR (400 MHz, CDCl_3) spectrum for compound **4zb**.



^{13}C NMR (100 MHz, CDCl_3) spectrum for compound **4zb**.

HPLC Conditions: CHIRALCEL OD-3 column, 99/1 hexanes/*i*-PrOH, 0.5 mL/min; t_R (major) = 7.5 min, t_R (minor) = 97.9 min.

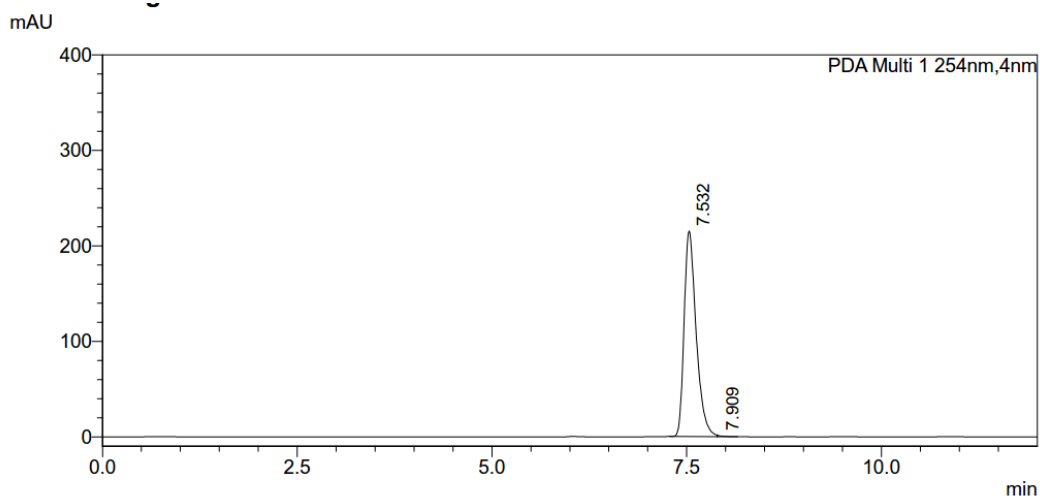
Racemic sample:



<Peak Table>

PDA Ch1 254nm					
Peak#	Ret. Time	Area	Area%	Height	Height%
1	7.531	408822	49.151	38989	51.567
2	7.929	422952	50.849	36619	48.433
Total		831774	100.000	75608	100.000

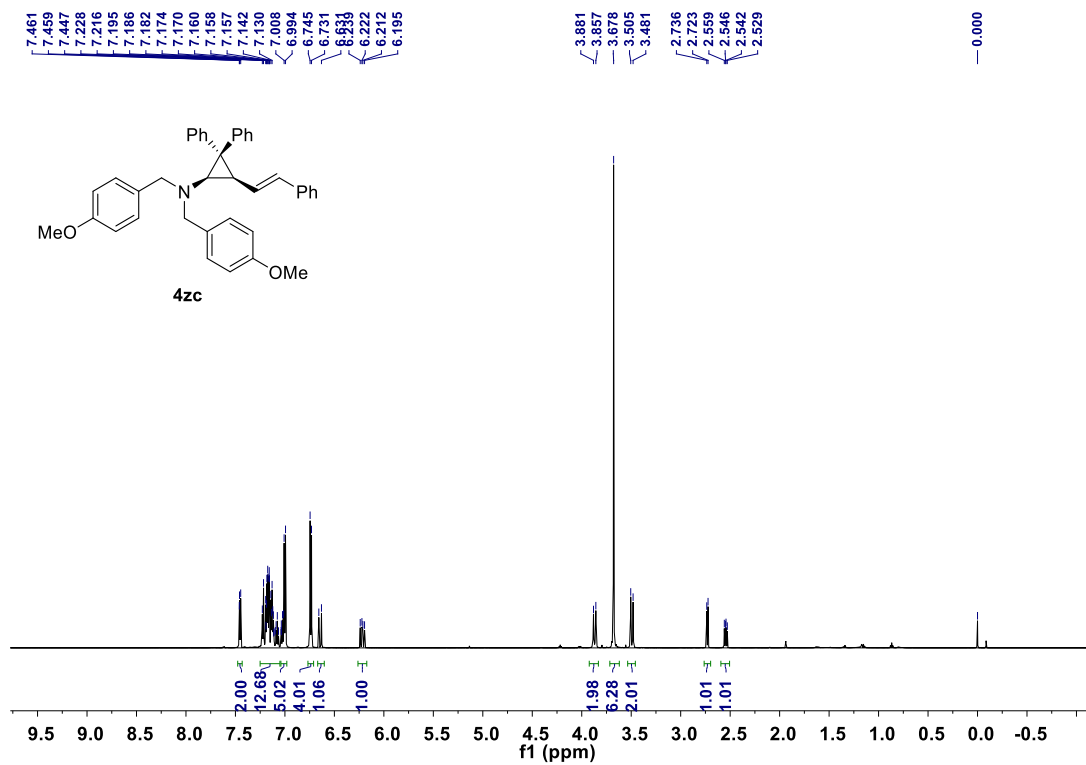
Chiral sample:



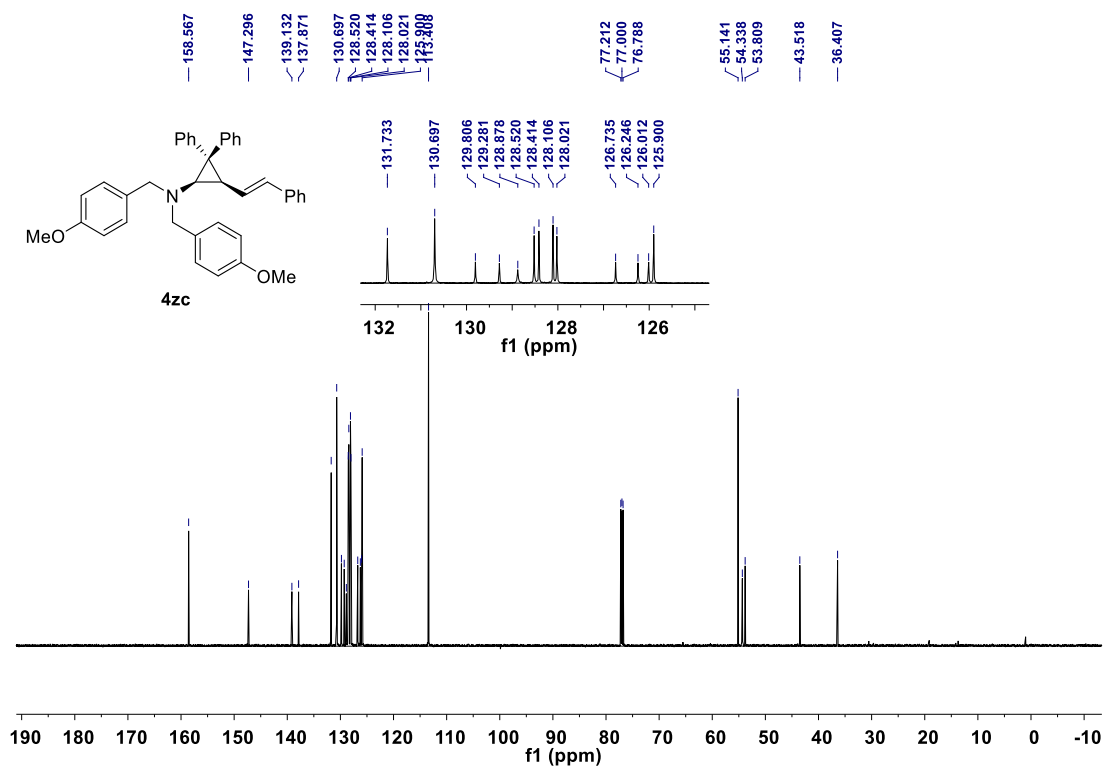
<Peak Table>

PDA Ch1 254nm					
Peak#	Ret. Time	Area	Area%	Height	Height%
1	7.532	2315626	99.789	215426	99.423
2	7.909	4892	0.211	1251	0.577
Total		2320519	100.000	216677	100.000

HPLC chromatograph for compound 4zb.



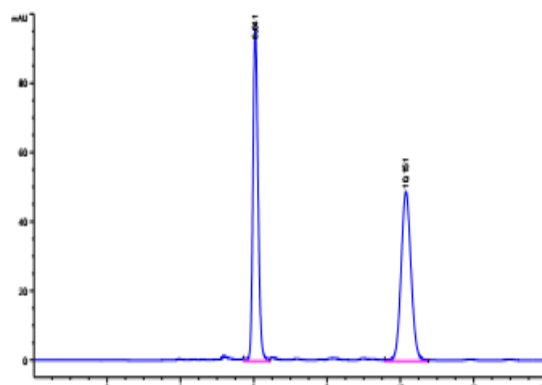
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4zc.



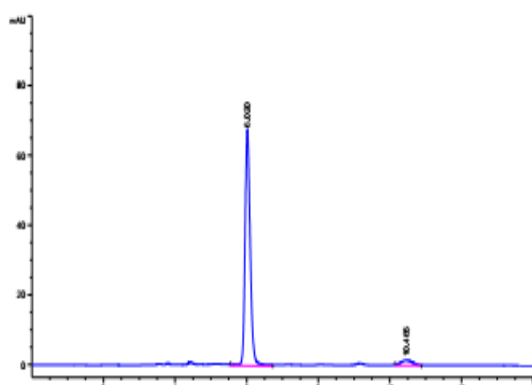
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4zc.

HPLC Conditions: CHIRALCEL AD-H column, 95/5 hexanes/*i*-PrOH, 0.8 mL/min; t_R (major) = 6.0 min, t_R (minor) = 10.5 min.

Racemate:



Chiral sample:



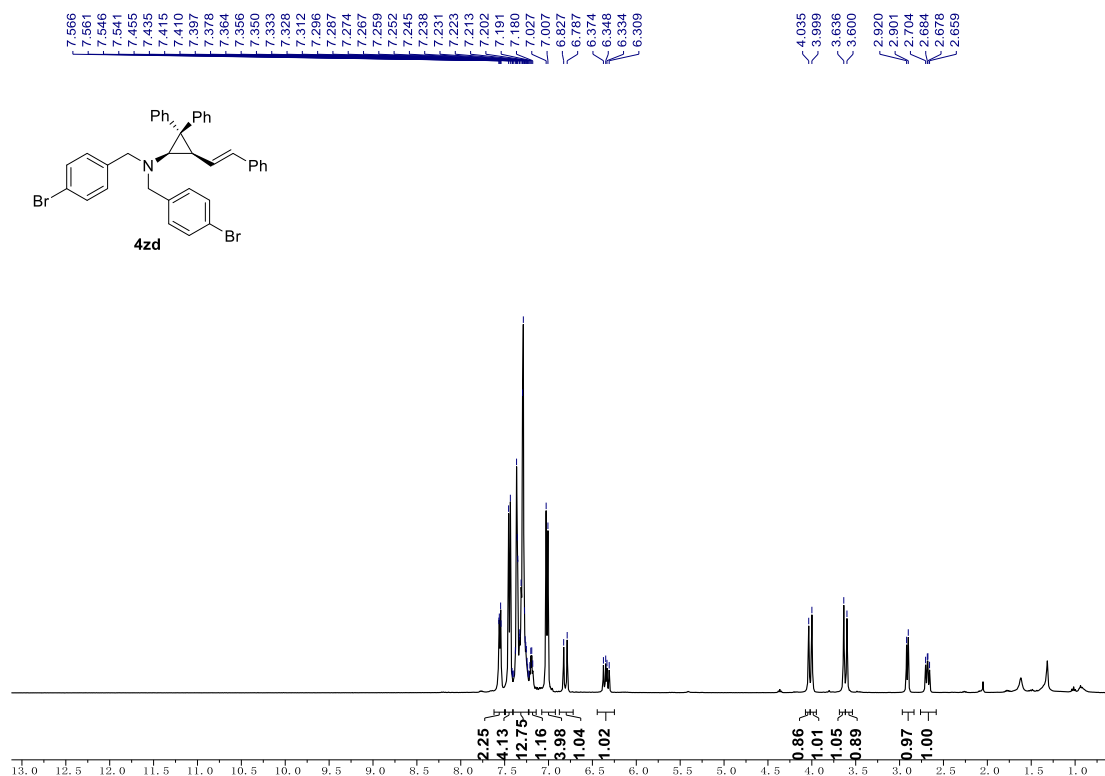
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	6.041	MM R	0.1618	933.92987	96.20237	50.0592
2	10.151	MM R	0.3168	931.72052	49.01715	49.9408

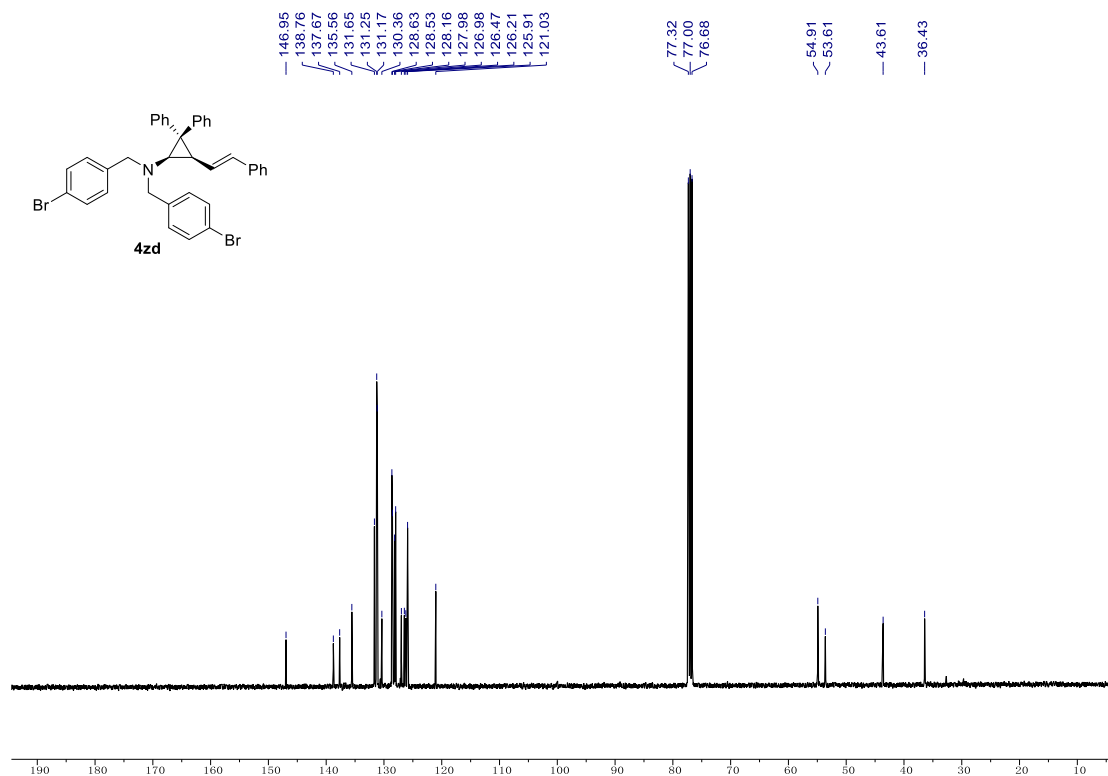
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	6.020	MM R	0.1683	685.04425	67.8361	94.9071
2	10.465	MM R	0.4001	36.76100	1.53145	5.0929

HPLC chromatograph for compound 4zc.



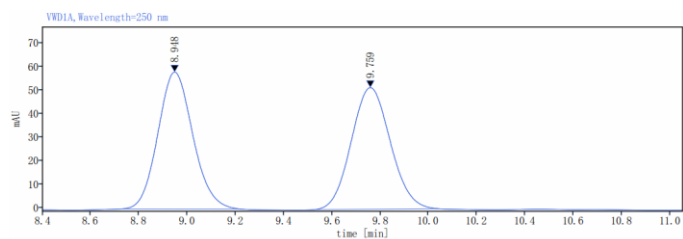
¹H NMR (400 MHz, CDCl₃) spectrum for compound 4zd.



^{13}C NMR (100 MHz, CDCl_3) spectrum for compound 4zd.

HPLC Conditions: CHIRALCEL AD-H column, 98/2 hexanes/*i*-PrOH, 0.5 mL/min; t_R (major) = 9.1 min, t_R (minor) = 10.1 min.

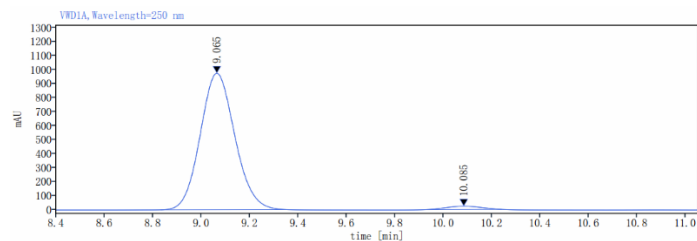
Racemic sample:



Signal: VWD1A, Wavelength=250 nm

Peak	Type	Width(min)	Area	Hight(mAu)	Area%
8.948	MM m	0.50	587.67	58.25	50.21
9.759	MM m	0.51	582.87	51.75	49.79

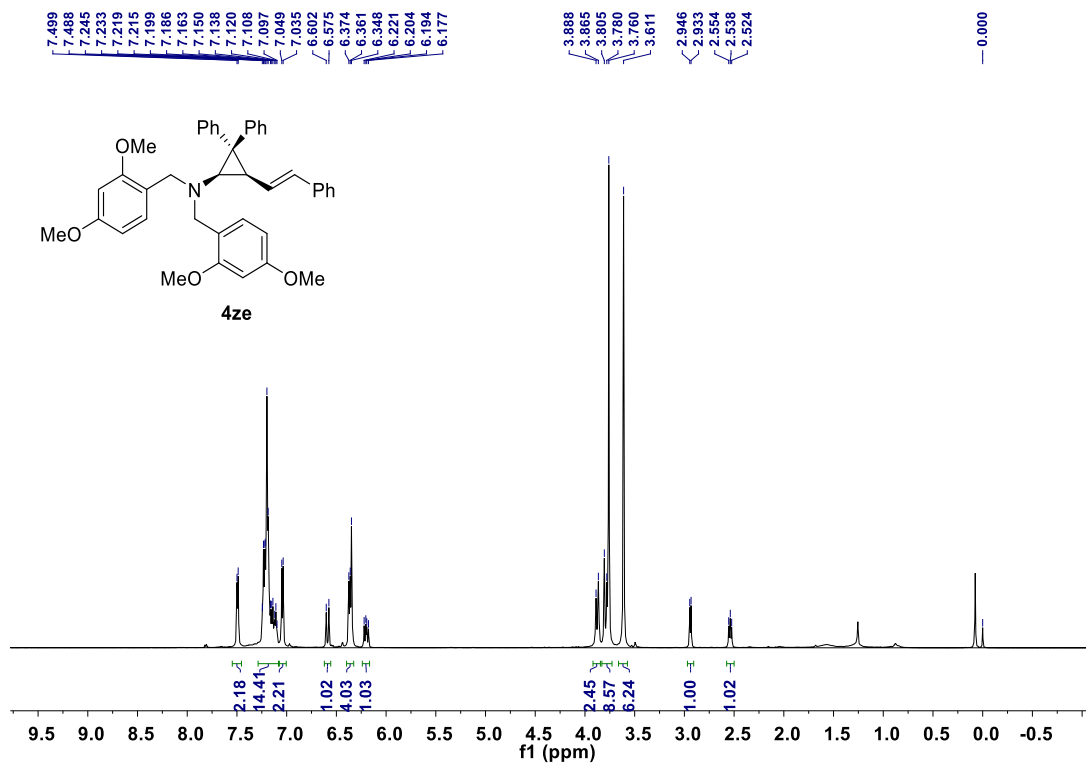
Chiral sample:



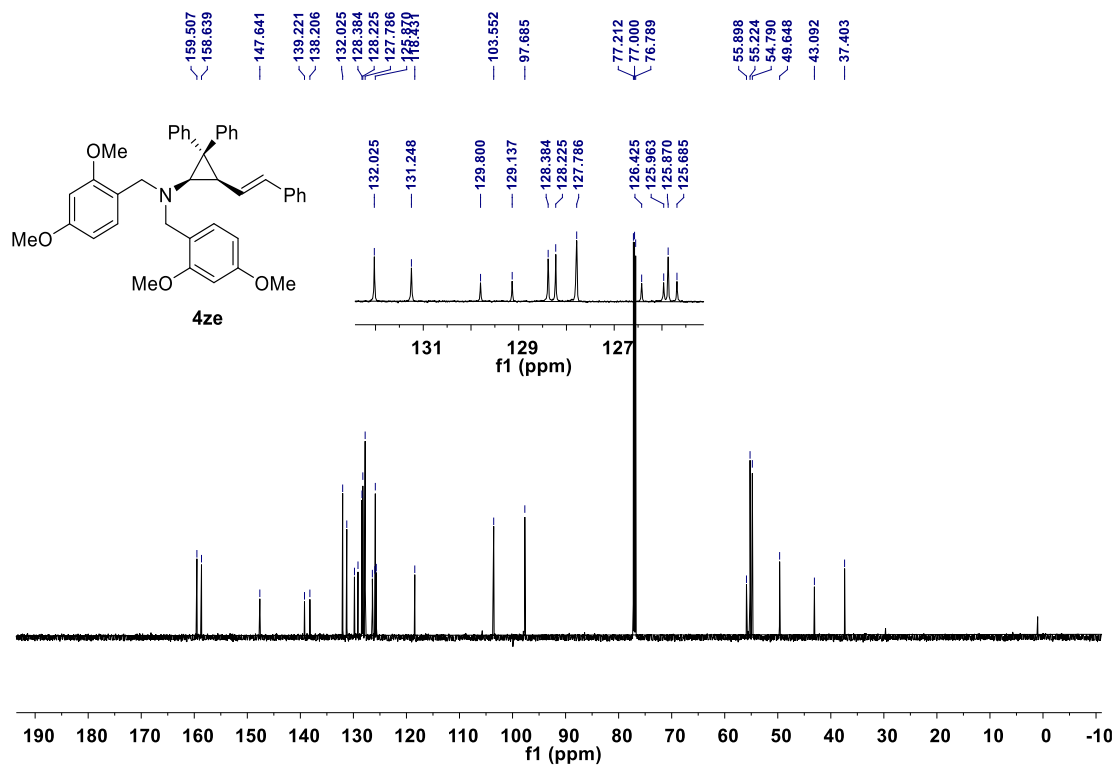
Signal: VWD1A, Wavelength=250 nm

Peak	Type	Width(min)	Area	Hight(mAu)	Area%
9.065	MM m	0.52	9675.41	975.07	97.66
10.085	MM m	0.32	231.60	23.07	2.34

HPLC chromatograph for compound 4zd.



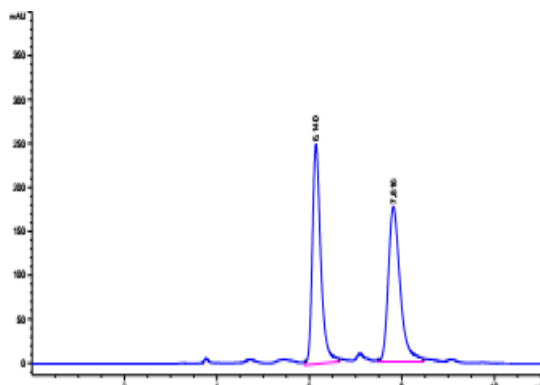
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4ze.



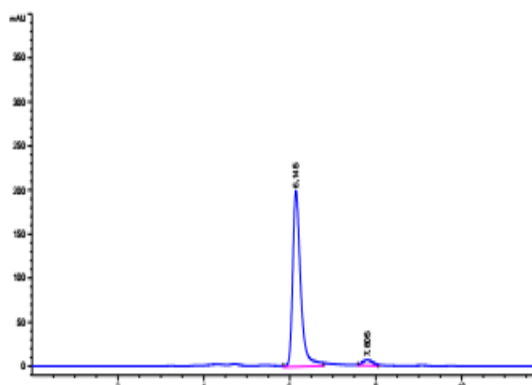
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4ze.

HPLC Conditions: CHIRALCEL AD-H column, 97/3 hexanes/*i*-PrOH, 1.0 mL/min; t_R (major) = 6.1 min, t_R (minor) = 7.8 min.

Racemate:



Chiral sample:



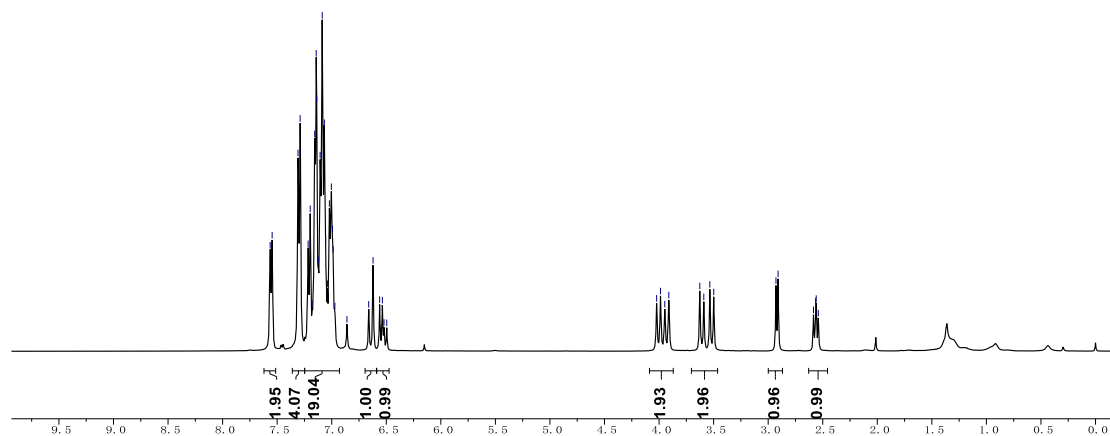
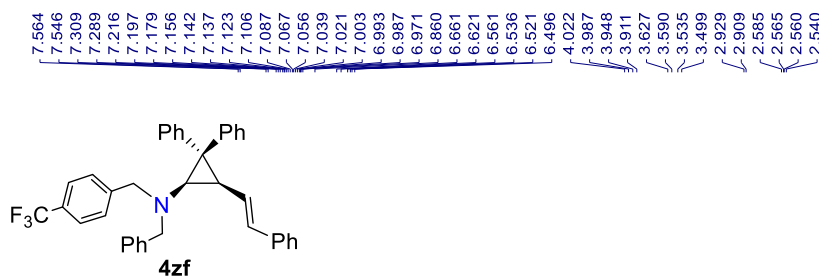
Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	6.140	MM R	0.2102	3151.17676	249.86369	50.0691
2	7.816	MM R	0.2967	3142.47363	176.50948	49.9309

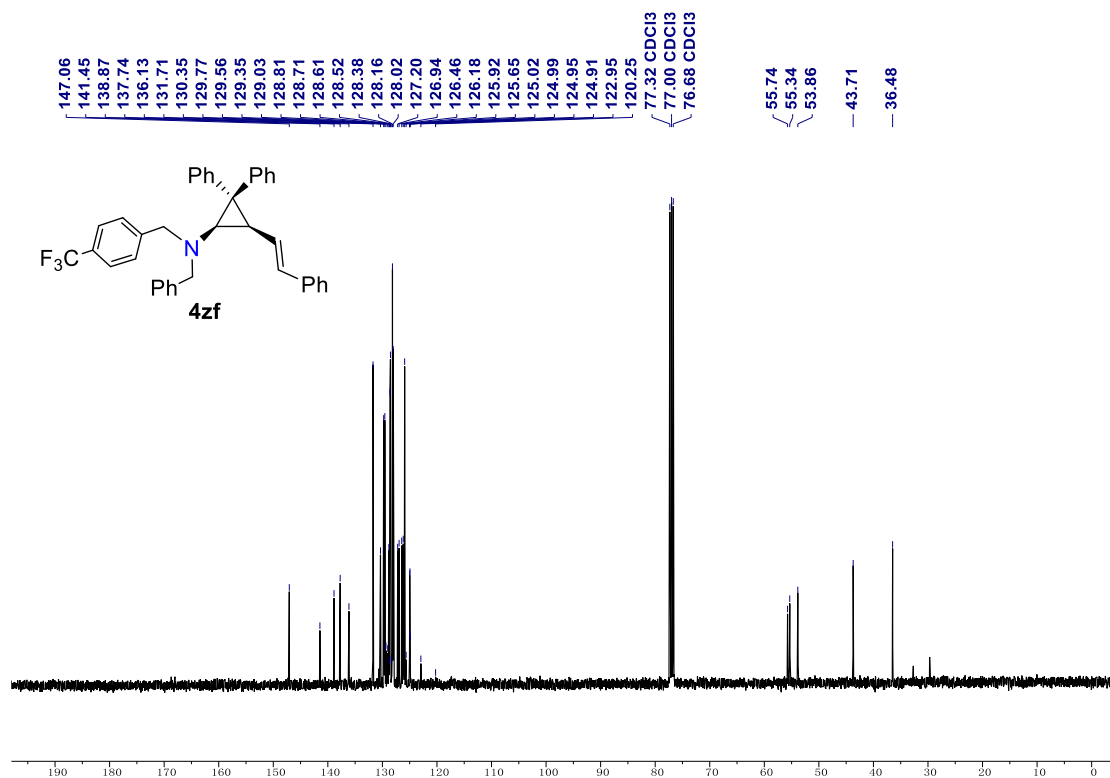
Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	6.145	MM R	0.2135	2558.53540	199.71696	96.0520
2	7.805	MM R	0.2726	105.16268	6.42934	3.9480

HPLC chromatograph for compound 4ze.



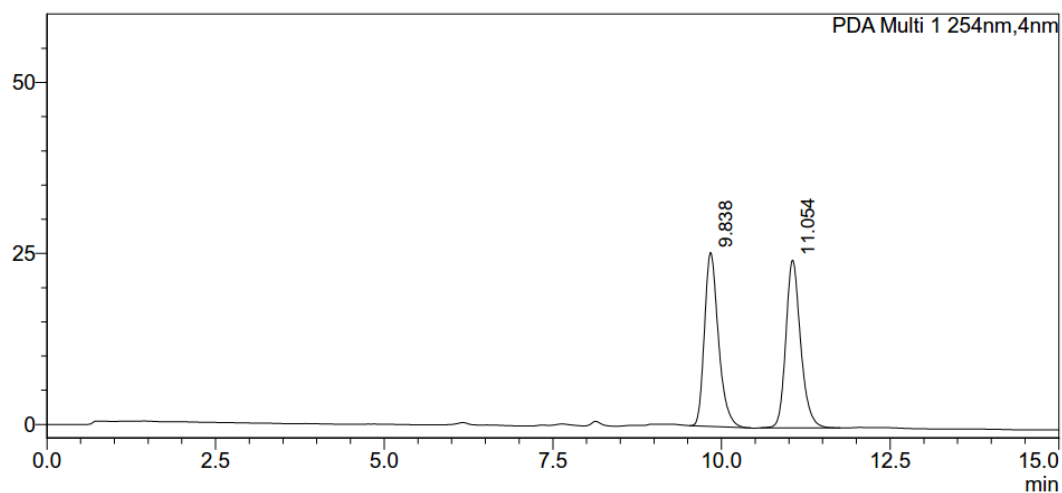
^1H NMR (400 MHz, C_6D_6) of compound 4zf.



¹³C NMR (101 MHz, CDCl₃) spectrum for compound 4zf.

HPLC conditions: Chiralpak AD-3 column (hexanes: 2-propanol = 99:1, 0.5 mL/min, 254 nm); t(major)= 10.2 min, t(minor) = 11.2 min.

Racemic sample:

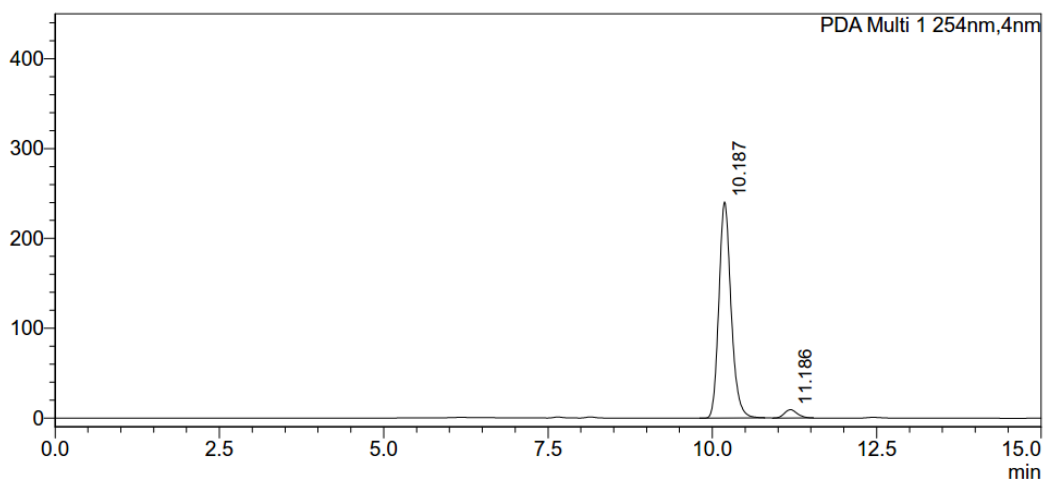


<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%	Height	Height%
1	9.838	367001	49.455	25435	50.898
2	11.054	375094	50.545	24538	49.102
Total		742094	100.000	49972	100.000

Chiral sample:

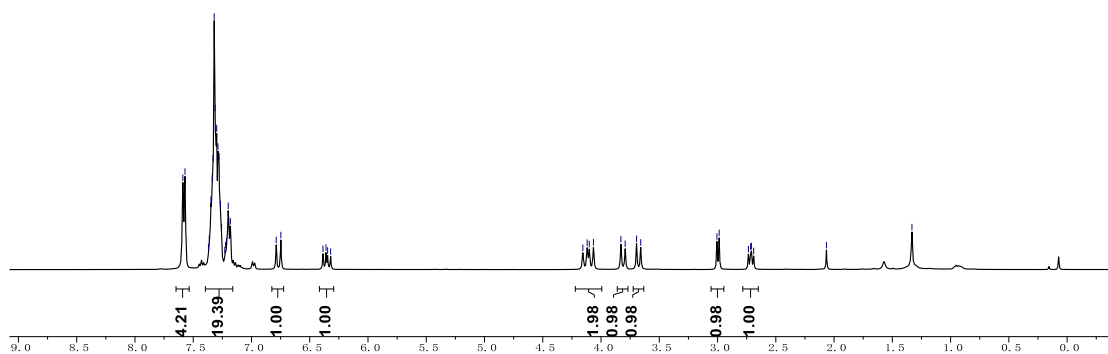
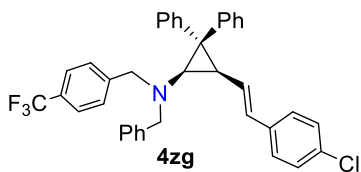


<Peak Table>

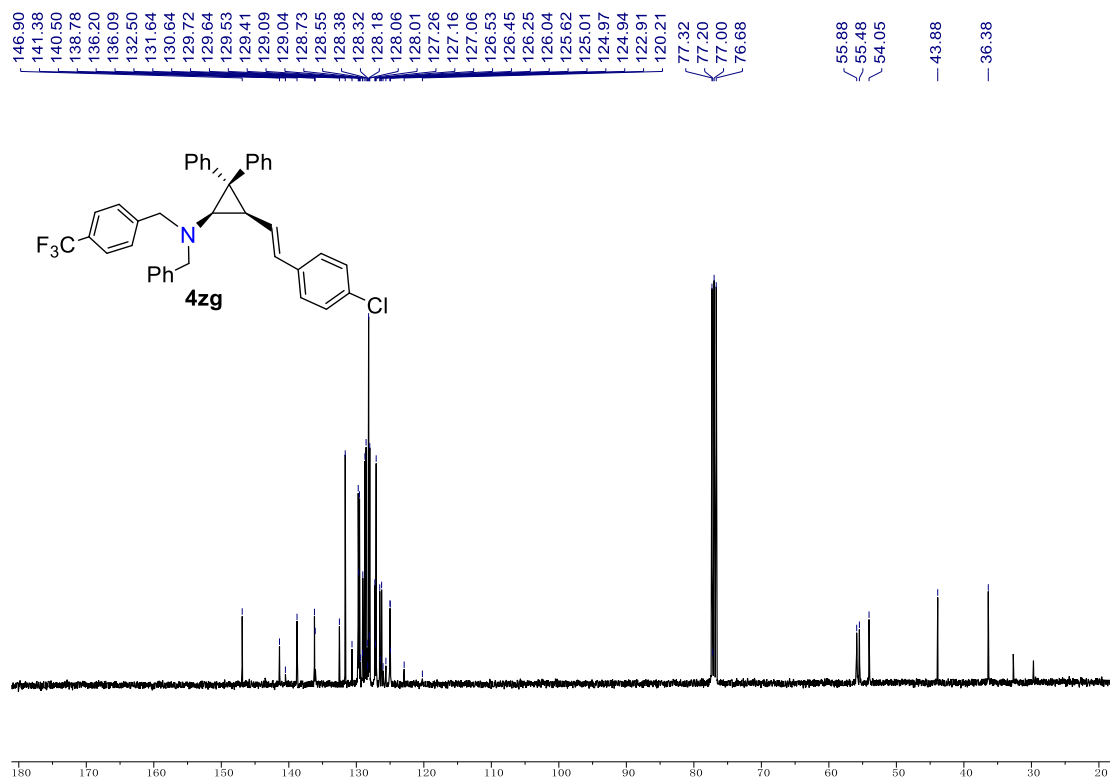
PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%	Height	Height%
1	10.187	3108236	96.097	240869	96.305
2	11.186	126253	3.903	9242	3.695
Total		3234489	100.000	250111	100.000

HPLC chromatograph for compound 4zf.



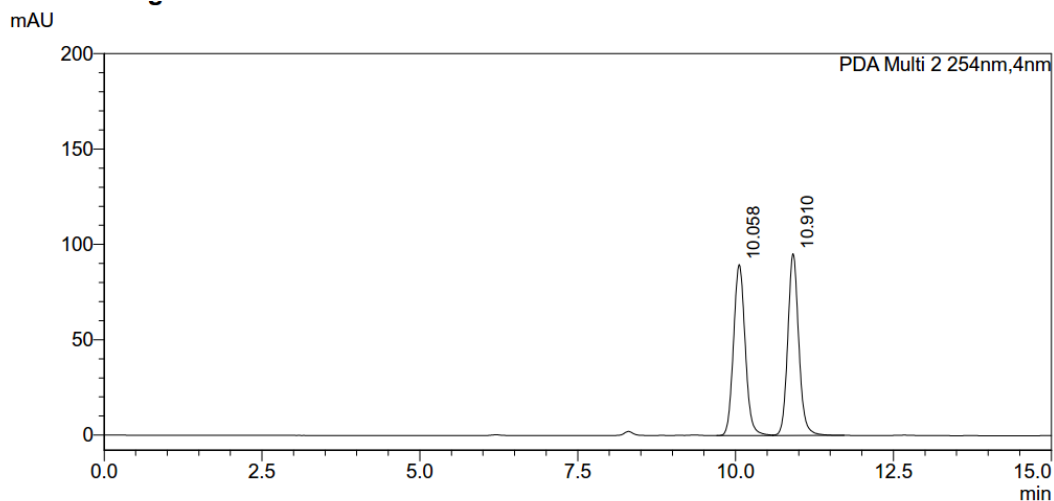
¹H NMR (400 MHz, C₆D₆) of compound 4zg.



¹³C NMR (101 MHz, CDCl₃) spectrum for compound 4zg.

HPLC conditions: Chiralpak IA column (hexanes: 2-propanol = 99:1, 0.5 mL/min, 254 nm); t(major)= 10.0 min; t(minor)= 10.8 min

Racemic sample:

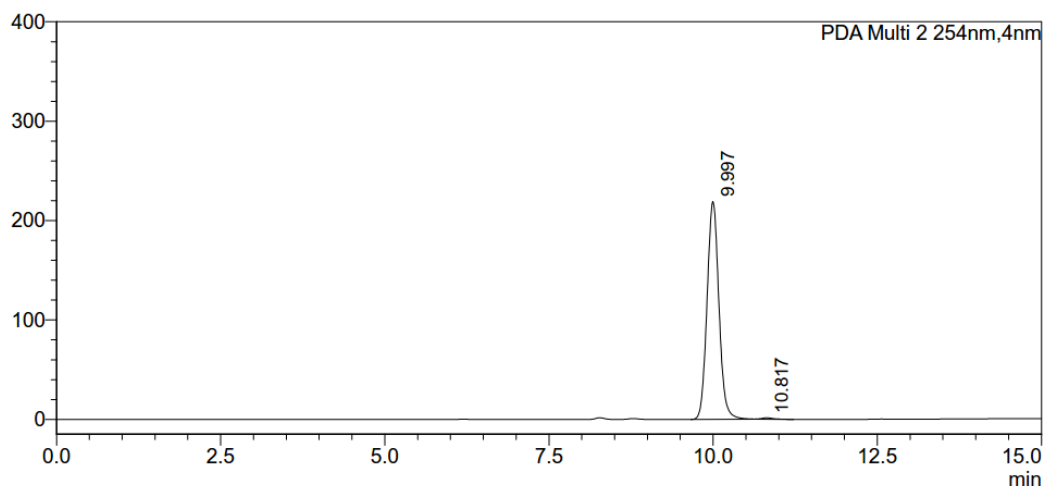


<Peak Table>

PDA Ch2 254nm

Peak#	Ret. Time	Area	Area%	Height	Height%
1	10.058	1157621	50.019	89683	48.465
2	10.910	1156745	49.981	95364	51.535
Total		2314366	100.000	185048	100.000

Chiral sample:

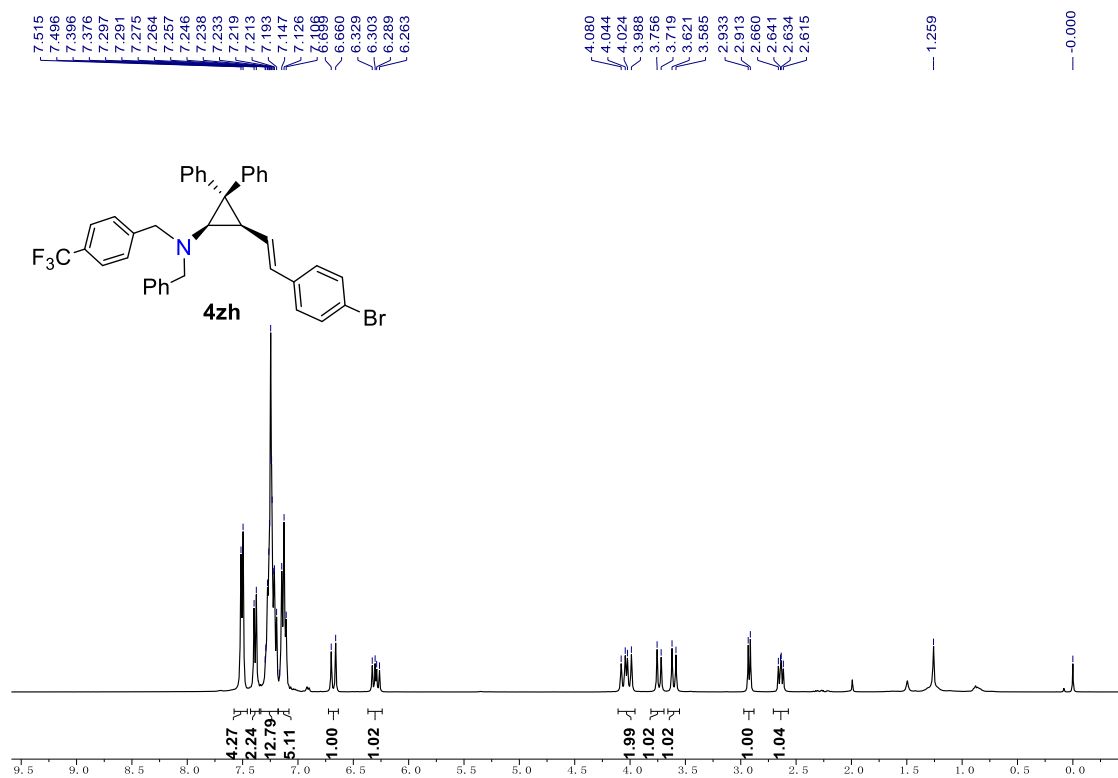


<Peak Table>

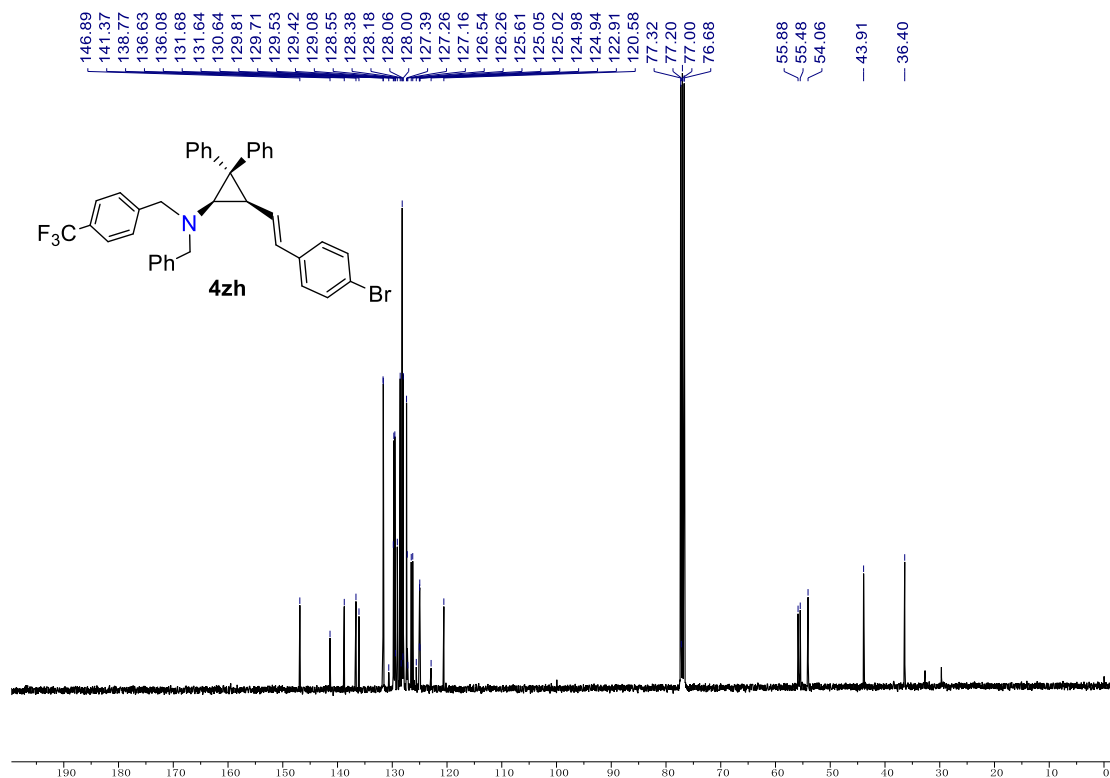
PDA Ch2 254nm

Peak#	Ret. Time	Area	Area%	Height	Height%
1	9.997	2754990	99.380	219098	99.349
2	10.817	17193	0.620	1437	0.651
Total		2772182	100.000	220534	100.000

HPLC chromatograph for compound 4zg.



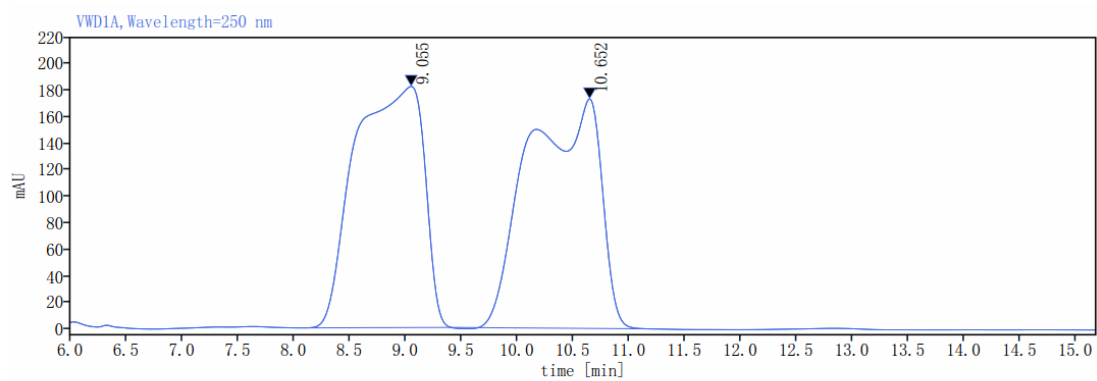
¹H NMR (400 MHz, CDCl₃) of compound 4zh.



¹³C NMR (101 MHz, CDCl₃) spectrum for compound 4zh.

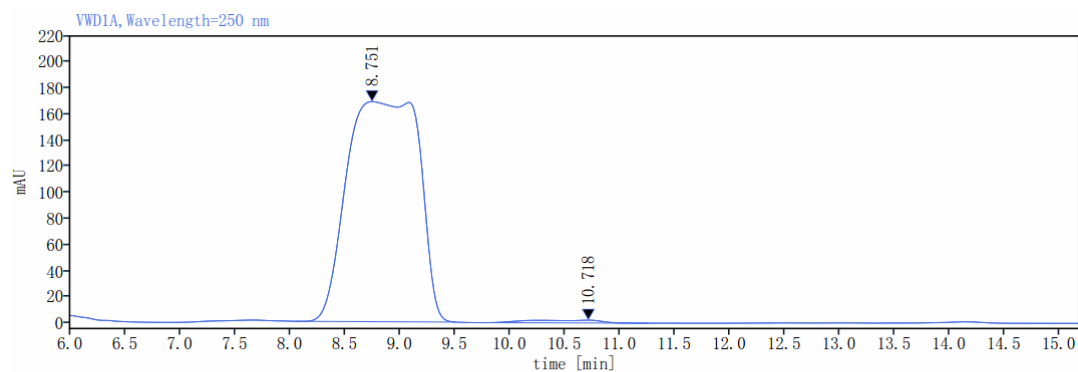
HPLC conditions: Chiralpak IA column (hexanes: 2-propanol = 98:2, 0.5 mL/min, 254 nm); t(major)= 10.7 min; t(minor)= 8.8 min

Racemic sample:



Peak	Type	Width(min)	Area	Hight (mAu)	Area%
9.055	MM m	1.31	7825.22	181.71	50.17
10.652	MM m	1.76	7773.70	172.91	49.83

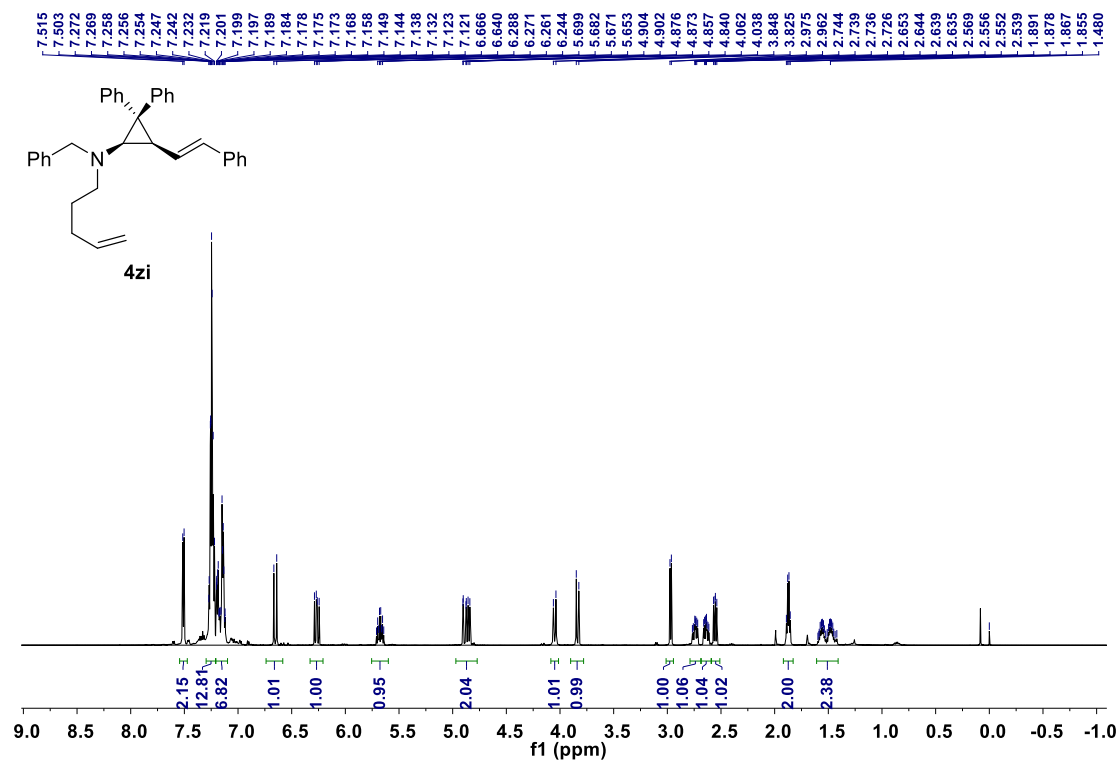
Chiral sample:



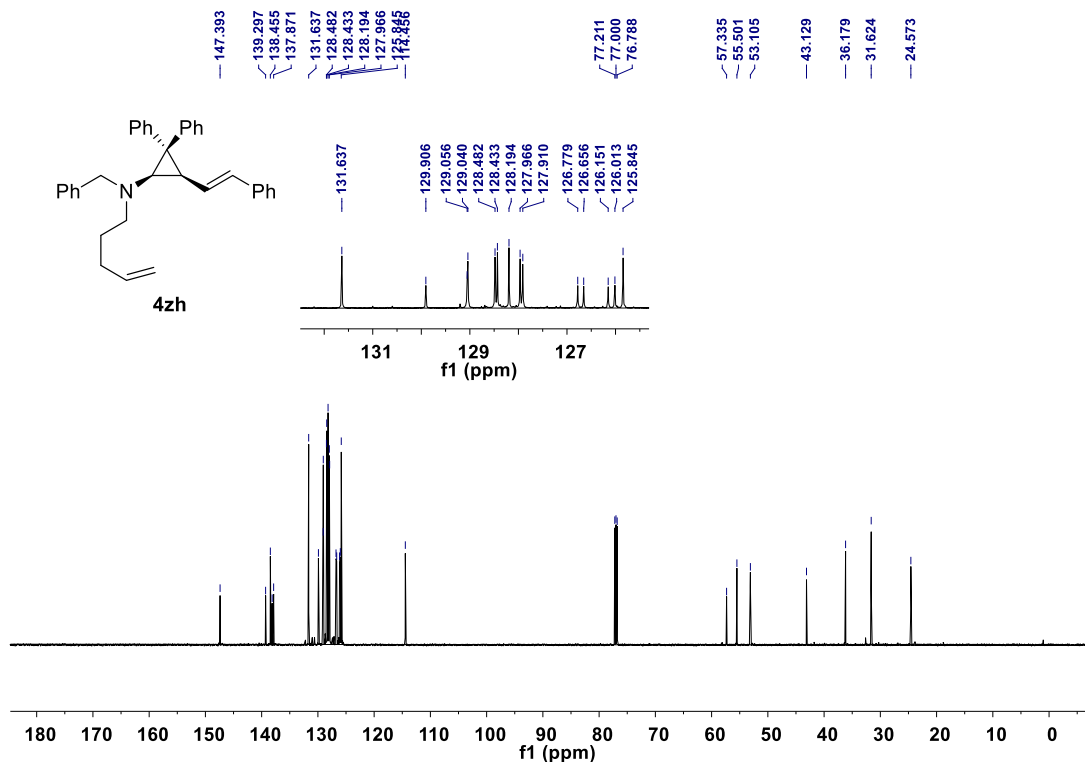
Signal: VWD1A, Wavelength=250 nm

Peak	Type	Width (min)	Area	Hight (mAu)	Area%
8.751	MM m	1.45	7750.52	168.54	98.78
10.718	MM m	1.44	95.83	2.14	1.22

HPLC chromatograph for compound 4zh.



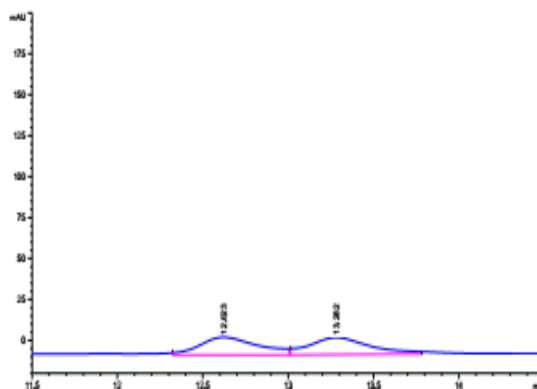
¹H NMR (600 MHz, CDCl₃) spectrum for compound 4zi.



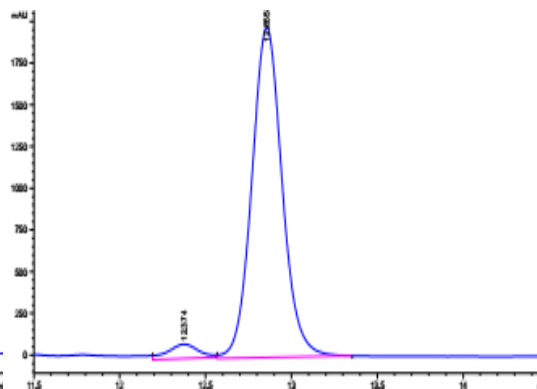
¹³C NMR (150 MHz, CDCl₃) spectrum for compound 4zi.

HPLC Conditions: CHIRALCEL IA column, 100% hexanes, 0.4 mL/min; t_R (major) = 12.9 min, t_R (minor) = 12.4 min.

Racemate:



Chiral sample:



Racemate:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.623	MM R	0.3956	254.28462	10.71288	49.7631
2	13.282	MM R	0.4115	256.70541	10.39593	50.2369

Chiral sample:

Peak	PetTime	Type	Width(min)	Area(mAu*S)	Hight(mAu)	Area%
1	12.374	MM R	0.2051	1052.33154	85.50887	4.1452
2	12.855	MM R	0.2047	2.43343e4	1980.92590	95.8548

HPLC chromatograph for compound 4zi.