Palladium(0)-Catalyzed Asymmetric C(sp^3)–H Arylation Using a Chiral Binol-Derived Phosphate and an Achiral Ligand

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General Information

Techniques: All reactions involving air-sensitive material were carried out in pre-dried glassware under an argon atmosphere by using Schlenk techniques employing double-line argon-vacuum lines and working in an argon-filled glove box. Analytical thin layer chromatography (TLC) was performed using pre-coated *Merck silica gel 60 F254* plates (0.25 mm). Visualization of the developed chromatogram was performed by UV absorbance (254 nm) or TLC stains ($KMnO_4$ and Phosphomolybdic acid). Flash chromatography was performed using *Silicycle SiliaFlash P60* (230-400 mesh) with the indicated solvent system, using gradients of increasing polarity in most cases.

Chemicals

Anhydrous solvents were obtained by distillation over calcium hydride (DIPEA, xylenes, and *t*-AmOH) or by distillation over sodium (mesitylene, cumene). Anhydrous THF, 2-Me THF, DME, DMF, DMSO, PhCl, $PhCF_3$, *m*-xylene were purchased from Acros Organics. The solvents were degassed by three cycles of freeze-pump-thaw and storing in single-necked flasks equipped with a J-Young PTFE valve when necessary. $Pd(PCy_3)_2$, $Pd(OAc)_2$, $Pd_2(dba)_3$ were purchased from Strem. All other chemical reagents were purchased from Sigma-Aldrich, Acros Organics, Fisher, and Fluorochem and used as received without further purification unless otherwise stated. (*R*)-(-)-VAPOL hydrogenphosphate and (*R*)-TRIP were purchased from Sigma-Aldrich. All other chiral phosphoric acids were prepared in accordance with literature procedures.[1]

Instrumentation:

GCMS analyses were performed with a Shimadzu QP2010SB GCMS apparatus on a Rtx®-5ms-Low-Bleed column lined with a mass (EI) detection system.

HPLC analyses were performed using a Shimadzu Prominence system with SIL-20A auto sample, CTO-20AC column oven, LC-20AD pump system, $DGU\text{-}20A_3$ degasser and SPD-M20A Diode Array or UV/VIS detector. The following chiral columns from Daicel Chemical Industries were used: OD-H (chiralcel), OJ-H (chiralcel) or IA (chiralpak) in 4.6 x 250 mm size.

Melting points were obtained on a Gallenkamp melting point apparatus and are uncorrected.

Infrared spectra were taken on a Bruker ALPHA FT-IR spectrometer and are reported in reciprocal centimeters (cm^{-1}).

Nuclear magnetic resonance spectra were recorded on a Bruker Advance 400 (400 MHz) in deuterated chloroform (residual peaks ^{1}H δ 7.26 ppm, ^{13}C δ 77.16 ppm) unless otherwise noted. ^{19}F NMR spectra were referenced to external $CFCl_3$. Data are reported in parts per million (ppm) as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintuplet, sept = septuplet, m = multiplet and bs = broad signal), coupling constant in Hz and integration.

High resolution mass spectra were recorded by Dr. H. Nadig (Department of Chemistry, University of Basel) on a Bruker maXis 4G QTOF ESI mass spectrometer.

X-ray crystallographic analysis was performed by Dr. M. Neuburger of the University of Basel.

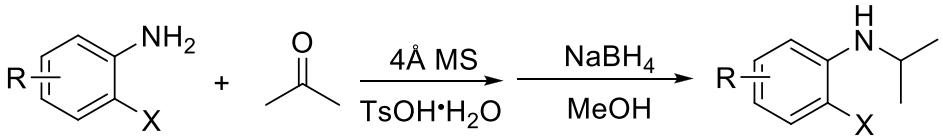
Optical rotations were measured on a Perkin Elmer 341 Polarimeter in a 1 mL micro cuvette (cell length 100mm) with Na_D-Line (λ = 589 nm) at 20 °C. The concentration (*c*) is given in g/100 mL.

Circular dichroism (CD) measurements were performed on a Chirascan CD Spectrometer in *n*-heptane at room temperature in 1cm quartz glass cuvettes after the Xray diffraction.

General procedures for substrates synthesis

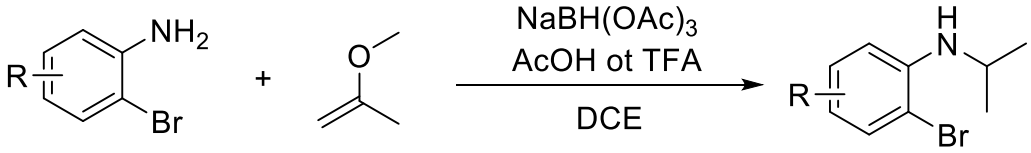
Preparation of *N*-alkyl-*o*-haloarylamine derivatives

General procedure A[2]



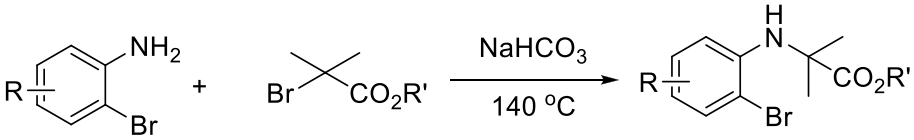
Molecular sieves (4 Å, 2.0 g/mmol), $TsOH \cdot H_2O$ (0.2 eq.) were added to a solution of *o*-haloarylamine (1.0 eq.) in dry acetone (5 mL/mmol) and the resulting mixture was vigorously stirred at 50 ^{o}C for 12-48 h . It was filtered and the filtrate was evaporated to afford the crude imine. $NaBH_4$ (3.0 eq.) was added at 0 ^{o}C to a solution of this oil in methanol. The reaction mixture was stirred overnight, during which time the ice bath warmed up to ambient temperature. Then 1.0 M aq. NaOH solution was added and stirred for 10 min. The resulting mixture was extracted with CH_2Cl_2 and the combined organic layers were dried over anhydrous Na_2SO_4. After removal of solvents, the crude product was purified by flash column chromatography using EtOAc–pentane mixture as an eluent.

General procedure B[3]



To a stirred solution of *o*-haloarylamine (1.0 eq.) in DCE (2-3 mL/mmol) under argon was added sequentially 2-methoxypropene (1.5 eq.), AcOH or TFA (1.0 eq.), $NaBH(OAc)_3$ (1.5 eq.). After stirring at r.t. for required time, the reaction mixture was quenched with aq. 1 N NaOH solution and extracted with CH_2Cl_2. The combined organic layers extracts were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure after filtration. If necessary, the crude product was purified by flash column chromatography using EtOAc–pentane mixture as an eluent.

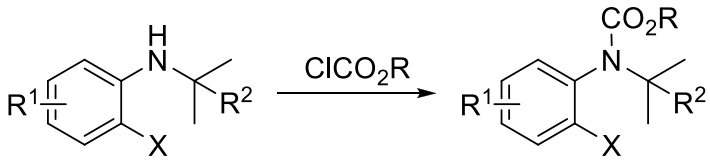
General procedure C[4]



A mixture of *o*-bromoarylamine (1.0 eq.), sodium bicarbonate (1.5 eq.) and 2-bromo-2-methylpropanoate (1.68 eq.) was heated at 140 ^{o}C for 48 h. The reaction mixture was cooled down to room temperature and was directly purified by flash column chromatography on silica gel using EtOAc–pentane mixture as an eluent.

Preparation of *N*-alkyl-*o*-haloarylcarbamate derivatives[5]

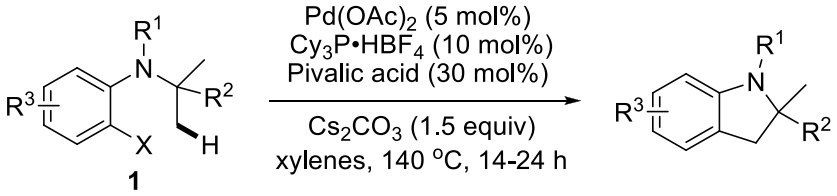
General procedure D



A mixture of *N*-alkyl-*o*-bromoarylamine in chloroformate (2-3 mL/mmol) was heated under reflux overnight. The mixture was poured into water and extracted with chloroform. The organic extracts were, dried over Na_2SO_4, and concentrated under reduced pressure after filtration. The crude material was purified by flash column chromatography using EtOAc–pentane mixture as an eluent.

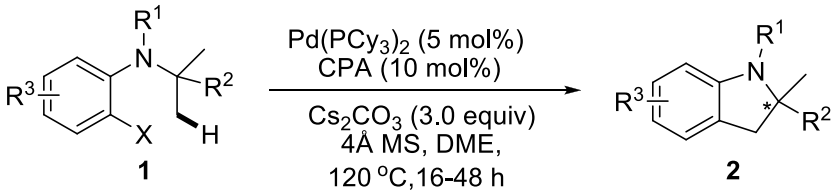
Palladium catalysed racemic and asymmetric synthesis of indolines

General procedure E: Representative procedure for the racemic synthesis of indolines



In the glovebox, **1** (0.2 mmol, 1.0 eq.), $Pd(OAc)_2$ (0.05 eq.), pivalic acid (0.3 eq.), cesium carbonate (1.5 eq.) and $PCy_3 \cdot BF_4$ (0.1 eq.) were successfully weighted and placed into a reaction tube. The tube was sealed with a rubber septum, taken out of the glovebox and degassed dry xylenes (2 mL/0.2 mmol **1**) were added under argon. The rubber septum was replaced with a Teflon screw cap and the reaction tube was sealed. The reaction mixture was heated at 140 ^{o}C in a preheated oil bath or a metal block with vigorous stirring for 14-16 h. The reaction mixture was cooled down to room temperature and was directly purified by flash column chromatography on silica gel using EtOAc–pentane mixture as an eluent to afford the desired racemic indoline.

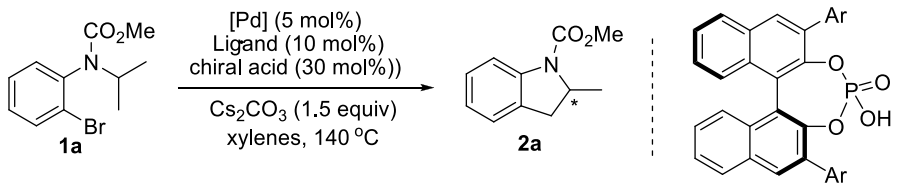
General procedure F: Representative procedure for the asymmetric C(sp^3)–H arylation



In the glovebox, **1** (0.2 mmol, 1.0 eq.), $Pd(PCy_3)_2$ (0.05 eq.), chiral phosphoric acid (0.1 eq.), 4Å MS (50 mg/0.2 mmol **1**) and cesium carbonate (3.0 eq.) were successively weighed into a 25 mL J-Young tube equipped with a magnetic stir bar. The J-Young tube was sealed and taken out of the glovebox and dry DME (2 mL/0.2 mmol **1**) was added under argon. The reaction mixture was degassed by three freeze-pump-thaw cycles and was heated at 120° C. After required time, the reaction mixture was cooled to room temperature and diluted with ethyl acetate followed by filtration through a pad of celite. The filtrate was evaporated under reduced pressure. The crude residue was purified by flash column chromatography on silica gel using EtOAc–pentane mixture as an eluent to afford the desired enantioenriched indoline **2**.

Full optimization studies

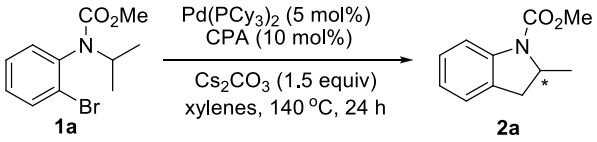
Table S1 Initial exploration of the enantioselective synthesis of indoline **2a**

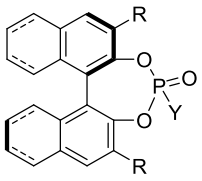


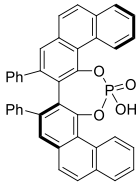
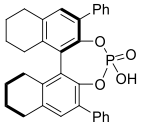
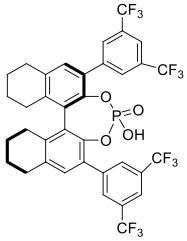
Entry	Ar	[Pd]	Ligand	Time (h)	Yield of **2a** (%)[a]	e.r. of **2a**[b]
1	H	$Pd(OAc)_2$	$PCy_3.HBF_4$	12	94	50:50
2	Ph	$Pd(OAc)_2$	$PCy_3.HBF_4$	12	86	50:50
3	1-naphthyl	$Pd(OAc)_2$	$PCy_3.HBF_4$	12	52	50:50
4	2-naphthyl	$Pd(OAc)_2$	$PCy_3.HBF_4$	12	76	50:50
5	3,5-$(CF_3)_2$-C_6H_3	$Pd(OAc)_2$	$PCy_3.HBF_4$	12	86	54:46
6	2-naphthyl	$Pd(OAc)_2$	-	12	trace	-
7	2-naphthyl	$Pd(OAc)_2$	PCy_3	12	68	50:50
8	3,5-$(CF_3)_2$-C_6H_3	$Pd(PCy_3)_2$	-	12	31	82:18
9	3,5-$(CF_3)_2$-C_6H_3	$Pd(PCy_3)_2$	-	24	50	80:20

[a] Isolated yield.
[b] Determined by HPLC using a chiral phase.
[c] 10 mol% of chiral phosphoric acid was used.

Table S2 Screening of chiral phosphoric acids (CPAs)





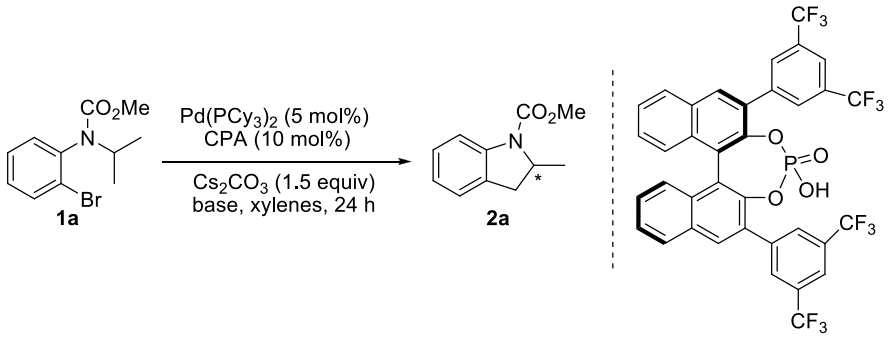
Entry	Chiral phosphoric acid		Yield of **2a** (%)[a]	e.r. of **2a**[b]
	R	Y		
1	Me	OH	80	52:48
2	Ph	OH	65	50:50
3	4-biphenyl	OH	52	53:47
4	1-naphthyl	OH	71	53:47
5	2-naphthyl	OH	68	54:46
6	9-phenanthryl	OH	71	52:48
7	3',5'-bis(trifluoromethyl)biphenyl -4-yl	OH	50	58:52
8	4-nitrophenyl	OH	34	54:46
9	4-chlorophenyl	OH	47	54:46
10	2,4,6-triisopropylphenyl	OH	21	56:14
11	perfluorophenyl	OH	31	50:50
12	3,5-bis(methyl)phenyl	OH	39	57:43
13	3,5-bis(*tert*-butyl)phenyl	OH	63	55:45
14	3,5-bis(isopropyl)phenyl	OH	45	56:44
15	3,5-bis(nitro)phenyl	OH	50	57:43
16	**3,5-bis(trifluoromethyl)phenyl**	**OH**	**50**	**80:20**
17[c]	3,5-bis(trifluoromethyl)phenyl	OH	55	88:12
18[c]	3,5-bis(trifluoromethyl)phenyl	NHTf	15	55:45
19[c]	3,5-bis(trifluoromethyl)phenyl	NH_2	50	84:16
20			79	50:50
21			52	50:50
22			63	50:50

[a] Isolated yield.

[b] Determined by HPLC using a chiral phase.

[c] These reactions were run at 120 °C in the presence of 3.0 eq. Cs_2CO_3 for 24 h.

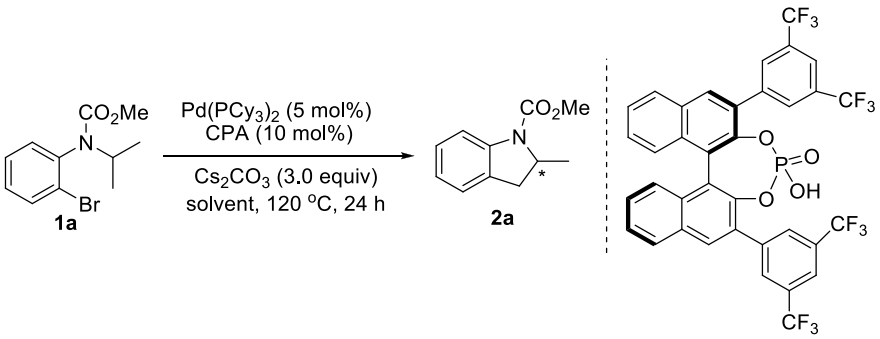
Table S3 Screening of bases



Entry	Base	Temp.(°C)	Time (h)	Yield of **2a** (%)[a]	e.r. of **2a**[b]
1	Li_2CO_3	140	24	0	-
2	Na_2CO_3	140	24	0	-
3	K_2CO_3	140	24	26	50.5:49.5
4	Rb_2CO_3	140	24	73	50:50
5	CsOH	140	24	29	79:21
6	CsOPiv	140	24	63	50:50
7	KOAc	140	24	16	50:50
8	Cs_2CO_3	120	40	24	87:13
9[c]	**Cs_2CO_3**	**120**	**40**	**73**	**83:17**

[a]Isolated yield.
[b] Determined by HPLC using a chiral phase.
[c] 3.0 eq. Cs_2CO_3 was used.

Table S4 Screening of solvents

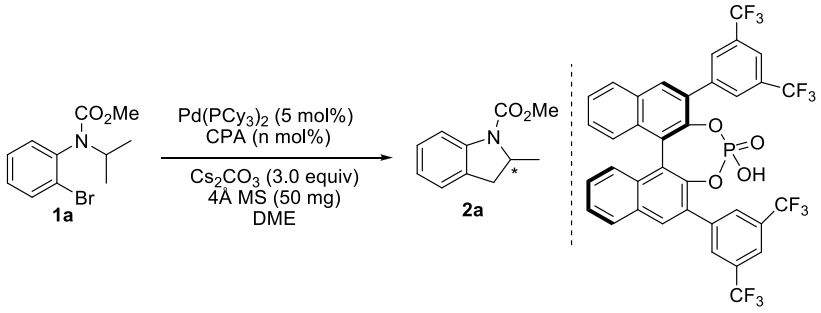


Entry	Solvent	Yield of **2a** (%)[a]	e.r. of **2a**[b]
1	xylenes	56	84:16
2	toluene	64	88:12
3	*m*-xylene	55	91:9
4	cumene	49	87:13
5	mesitylene	58	94:6
6	CF_3Ph	80	90:10
7	PhCl	26	90:10
8	DME	84	93:7
9	THF	55	94:6
10	2-Me THF	34	95:5
11	PhOMe	60	89:11
12	$(n\text{-Bu})_2O$	82	62:38
13	1,4-dioxane	-	-
14	DMF	44	74:26
15	DMSO	25	50:50
16	*t*-AmOH	42	51:49
17	HFIP	-	-
18[c]	THF	71	96:4
19[c]	**DME**	**86**	**96:4**

[a] Isolated yield.

[b] Determined by HPLC using a chiral phase.
[c] 4Å MS (50 mg) was added as the additive.

Table S5 Study of other reaction parameters (concentration, CPA and [Pd] loading)

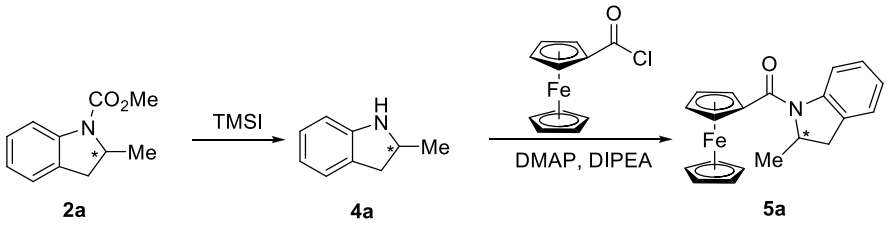


Entry	Concentration (M)	Temp. (^{o}C)	Time (h)	n	Yield of **2a** (%)[a]	e.r. of **2a**[b]
1	0.1	120	16	5	73	95:5
2	0.1	120	16	20	84	97.5:2.5
3	0.1	120	16	30	84	97:3
4	0.1	120	16	10	80	97:3
5[c]	0.1	120	24	10	43	85:15
6	0.1	100	24	10	44	97:3
7	0.2	120	16	10	74	97:3
8	0.05	120	16	10	87	93:7

[a] Isolated yield.
[b] Determined by HPLC using a chiral phase.
[c] 2.5 mol% $Pd(PCy_3)_2$ was used.

Cleavage of the carbamate group and determination of absolute configuration

Trisubstituted indoline

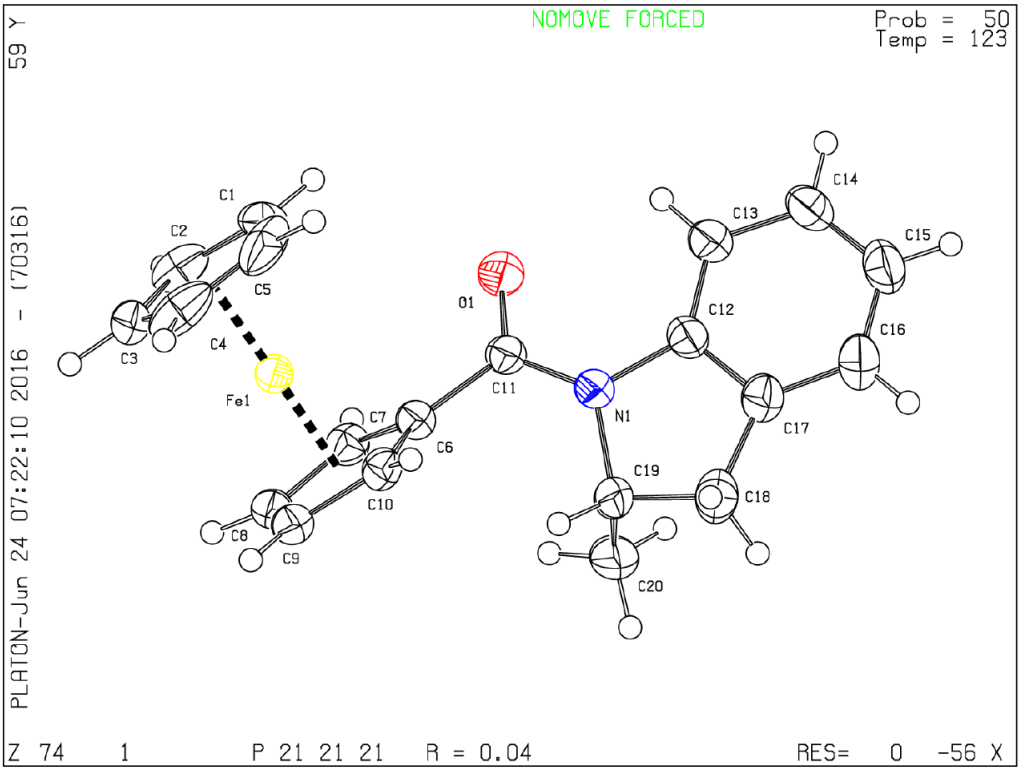


2a **4a** **5a**

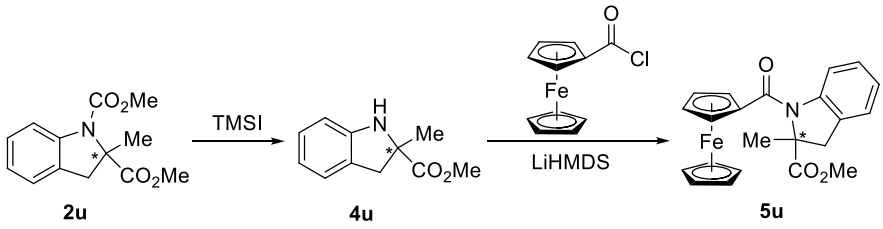
Deprotection Step Employing TMSI.[6] Under argon, TMSI (602 μL, 4.24 mmol, 10 eq.) was added to a solution of **2a** (81 mg, 93.5:6.5 e.r., 0.424 mmol, 1.0 eq.) in $CHCl_3$ (10 mL) at room temperature. After this time, the solvent was removed under reduced pressure and ammonia hydroxide (10 mL, 28% NH_3 in H_2O) was added. Once the phases were separated, the aqueous layer was extracted with CH_2Cl_2 and the combined organic layers were dried over Na_2SO_4. After removing the solvent under reduced pressure, the crude amine **4a** was obtained as a colorless viscous oil, which was directly used in the next step.

Amidation Step Employing DMAP/DIPEA.[7] A round-bottom flask equipped with a magnetic stir bar was charged with crude **4a**. DCM (4 mL) was added and the mixture was cooled to 0 ^{o}C. DMAP (5.2 mg, 0.0424 mmol, 0.10 eq.) was added, followed by DIPEA (210 μL, 1.27 mmol, 3.0 eq.) to give a clear solution. Ferrocene carboxylic acid chloride[8] (0.466 mmol, 116 mg, 1.1 eq.) in DCM (1 mL) was added last. The reaction was warmed to room temperature and stirred for 1 hour. The mixture was concentrated under reduced pressure to give the crude product, which was purified by flash column chromatography (silica gel, pentane/EtOAc 4:1 as the eluent) affording 121.3 mg of desired amide **5a** (0.35 mmol, 93:7 e.r., 83%, two steps) as an orange solid.

Suitable crystals for X-ray diffraction analysis were obtained from dichloromethane and pentane as solvent and anti-solvent, respectively.



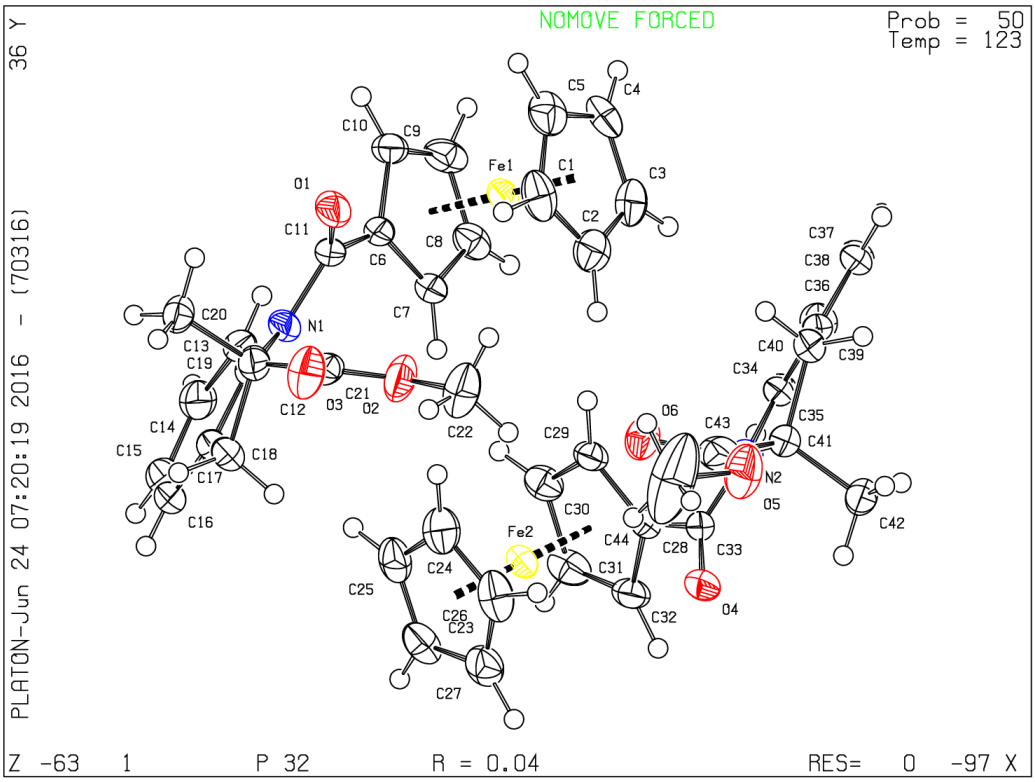
Tetrasubstituted indoline



Deprotection Step Employing TMSI.[6] Under argon, TMSI (542 μL, 3.8 mmol, 10 eq.) was added to a solution of **2u** (94 mg, 0.38 mmol, 90:10 e.r., 1.0 eq.) in $CHCl_3$ (10 mL) at room temperature. The reaction mixture was refluxed for 20 h, then MeOH (10 mL) was added and the reaction was refluxed 3 h more. After this time, the solvent was removed under reduced pressure and ammonia hydroxide (10 mL, 28% NH_3 in H_2O) was added. Once the phases were separated, the aqueous layer was extracted with CH_2Cl_2 and the combined organic layers were dried over Na_2SO_4. After removing the solvent under reduced pressure, the crude amine (71 mg) was obtained as a slight yellow viscous oil, which was directly used in the next step.

Amidation Step Employing LiHMDS.[9] To a solution of the crude amine **4u** in dry THF (5 mL) was added LiHMDS (0.45 mmol, 450 μL, 1.0 M in THF, 1.2 eq.) dropwise at -78 °C under argon. The mixture was stirred for 10 min at -78 °C, then for 20 min at -10 °C. At this time, ferrocene carboxylic acid chloride (0.45 mmol, 112 mg, 1.2 eq.) was added in one portion and the mixture was stirred at -10 °C for 3 h. The reaction was quenched with saturated solution of NH_4Cl and extracted three times with ethyl acetate. The organic layers were combined and washed with water, brine, dried (Na_2SO_4), and finally concentrated under reduced pressure. The crude product was purified by flash column chromatography (silica gel, pentane/EtOAc 10:1 as the eluent) affording 122 mg of desired amide **5u** (0.3 mmol, 90:10 e.r., 80%, two steps) as an orange solid.

Suitable crystals for X-ray diffraction analysis were obtained from diethyl ether and pentane as solvent and anti-solvent, respectively.



Circular dichroism spectrum

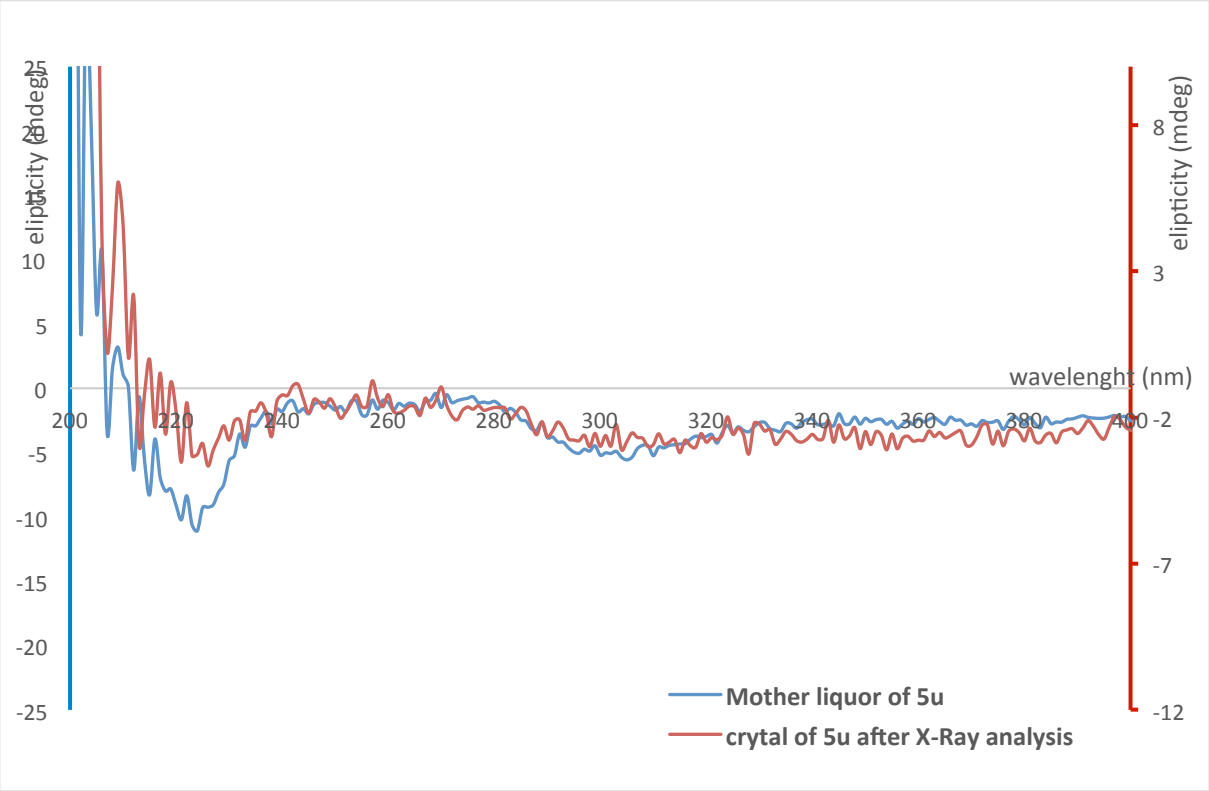
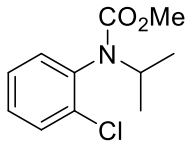


Figure S1

To avoid assigning the absolute configuration to the minor enantiomer, the circular dichroism spectrum of the solution prepared from the same single crystal of **5u**, which was analyzed by Xray diffraction, was measured. It showed the same Cotton effect as the corresponding mother liquor, thereby showing that the major enantiomer was indeed analyzed by Xray diffraction.

methyl (2-chlorophenyl)(isopropyl)carbamate (1aCl):

Obtained according to the ***General procedure A and General procedure D***, as a slight yellow oil (65% yield over two steps).



Chemical Formula: $C_{11}H_{14}ClNO_2$
Molecular Weight: 227,6880 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.46-7.42 (m, 1H), 7.28-7.22 (m, 2H), 7.14-7.20 (m, 1H), 4.63-4.42 (m, 1H), 3.60 (s, 3H), 1.28 (d, *J* = 6.8 Hz, 3H), 1.02 (d, *J* = 6.8 Hz, 3H)

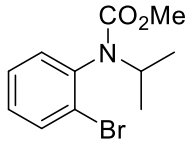
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.5, 136.8, 135.0, 130.9, 130.3, 128.8, 127.2, 52.9, 50.4, 22.5, 19.7

IR (neat)**:** ν (cm^{-1}) 2977, 2953, 1700, 1480, 1440, 1319, 1095, 756

HRMS (ESI): Calcd for $C_{11}H_{14}ClNNaO_2$ $[M+Na]^+$: 250.0605, found 250.0605

methyl (2-bromophenyl)(isopropyl)carbamate (1aBr):

Obtained according to the ***General procedure A and General procedure D***, as a white solid (83% yield over two steps).



Chemical Formula: $C_{11}H_{14}BrNO_2$
Molecular Weight: 272,1420 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.63 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.31 (td, *J* = 7.9, 1.5 Hz, 1H), 7.22-7.13 (m, 2H), 4.58-4.42 (m, 1H), 3.61 (s, 3H), 1.31 (d, *J* = 6.8 Hz, 3H), 1.02 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.3, 138.5, 133.5, 130.8, 129.0, 127.9, 126.0, 52.9, 50.4, 22.6, 19.7

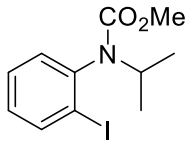
IR (neat)**:** ν (cm^{-1}) 2977, 2951, 1693, 1323, 1096, 763

HRMS (ESI): Calcd for $C_{11}H_{14}BrNNaO_2$ $[M+Na]^+$: 294.0100, found 294.0103

Mp: 49-51 °C

methyl (2-iodophenyl)(isopropyl)carbamate (1aI):

Obtained according to the ***General procedure A and General procedure D***, as a slight yellow solid (55% yield over two steps).



Chemical Formula: $C_{11}H_{14}INO_2$
Molecular Weight: 319,1425 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.90 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.36 (td, *J* = 7.8, 1.3 Hz, 1H), 7.19 (d, *J* = 7.8 Hz, 1H), 7.02 (td, *J* = 7.8, 1.6 Hz, 1H), 4.55-4.41 (m, 1H), 3.64 (s, 3H), 1.35 (d, *J* = 6.7 Hz, 3H), 1.03 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.1, 142.1, 139.9, 129.8, 129.1, 128.9, 103.5, 52.9, 50.5, 22.9, 19.9

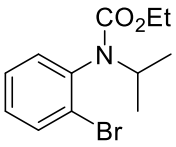
IR (neat)**:** ν (cm^{-1}) 2974, 2948, 1694, 1439, 1334, 1323, 1091, 761

HRMS (ESI): Calcd for $C_{11}H_{14}INNaO_2$ $[M+Na]^+$: 341.9961, found 341.9965

Mp: 72-75 °C

ethyl (2-bromophenyl)(isopropyl)carbamate (1b):

Obtained according to the ***General procedure A and General procedure D***, as a colorless viscous oil (81% yield over two steps).



Chemical Formula: $C_{12}H_{16}BrNO_2$
Molecular Weight: 286,1690 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.63 (dd, *J* = 7.9, 1.4 Hz, 1H), 7.31 (ddd, *J* = 7.9, 7.4, 1.4 Hz, 1H), 7.23-7.15 (m, 2H), 4.61-4.46 (m, 1H), 4.23-3.95 (m, 2H), 1.31 (d, *J* = 6.7 Hz, 3H), 1.16-1.09 (m, 2H), 1.03 (d, *J* = 6.7 Hz, 3H)

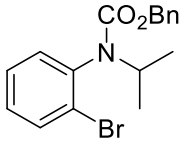
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.7, 138.5, 133.3, 130.7, 128.8, 127.8, 125.9, 61.4, 50.0, 22.6, 19.6, 14.6

IR (neat)**:** ν (cm^{-1}) 2977, 2934, 1698, 1443, 1309, 1086, 752

HRMS (ESI): Calcd for $C_{12}H_{16}CBrNNaO_2$ $[M+Na]^+$: 308.0257, found 308.0260

benzyl (2-bromophenyl)(isopropyl)carbamate (1c):

Obtained according to the ***General procedure A and General procedure D***, as a white solid (45% yield over two steps).



Chemical Formula: $C_{17}H_{18}BrNO_2$
Molecular Weight: 348,2400 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.64 (d, *J* = 7.8 Hz, 1H), 7.49-7.10 (m, 8H), 5.32-5.01 (m, 2H), 4.63-4.40 (m, 1H), 1.33 (d, *J* = 6.7 Hz, 3H), 1.05 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.7, 138.4, 136.8, 133.5, 130.9, 129.0, 128.3, 127.9, 127.7, 127.4, 126.0, 67.1, 50.5, 22.6, 19.7

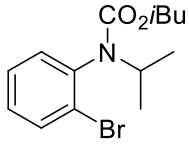
IR (neat)**:** ν (cm^{-1}) 2980, 1691, 1404, 1307, 1085, 688

HRMS (ESI): Calcd for $C_{17}H_{18}BrNNaO_2$ $[M+Na]^+$: 370.0413, found 370.0416

Mp: 56-58 °C

isobutyl (2-bromophenyl)(isopropyl)carbamate (1d):

Obtained according to the ***General procedure A and General procedure D***, as a colorless viscous oil (77% yield over two steps).



Chemical Formula: $C_{14}H_{20}BrNO_2$
Molecular Weight: 314,2230 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.63 (d, *J* = 7.9 Hz, 1H), 7.33-7.28 (m, 1H), 7.25-7.13 (m, 2H), 4.63-4.28 (m, 1H), 4.11-3.70 (m, 2H), 1.80-1.64 (m, 1H), 1.31 (d, *J* = 6.7 Hz, 3H), 1.05 (d, *J* = 6.7 Hz, 3H), 0.71 (s, 6H)

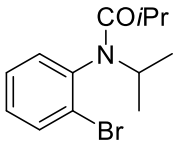
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.0, 138.7, 133.4, 131.0, 128.9, 127.8, 126.2, 71.7, 50.0, 28.0, 22.7, 19.8, 19.1

IR (neat)**:** ν (cm^{-1}) 2960, 2874, 1697, 1314, 1087, 763

HRMS (ESI): Calcd for $C_{14}H_{20}BrNNaO_2$ $[M+Na]^+$: 336.0570, found 336.0575

***N*-(2-bromophenyl)-*N*-isopropylisobutyramide (1e):**

Obtained according to the ***General procedure A and General procedure D***, as a white solid (81% yield over two steps). Spectroscopic data are consistent with those previously reported. [10]



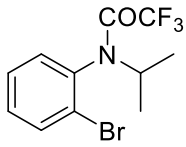
Chemical Formula: $C_{13}H_{18}BrNO$
Molecular Weight: 284,1970 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.71-7.67 (m, 1H), 7.40-7.35 (m, 1H), 7.26-7.21 (m, 2H), 4.85 (sept, *J* = 6.7 Hz, 1H), 2.10 (sept, *J* = 6.7 Hz, 1H), 1.23 (d, *J* = 6.5 Hz, 3H), 1.12 (d, *J* = 6.5 Hz, 3H), 0.96 (d, *J* = 6.7 Hz, 3H), 0.90 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 177.0, 139.2, 134.0, 131.3, 129.6, 128.3, 126.7, 47.9, 32.9, 22.3, 20.1, 19.4, 19.3

***N*-(2-bromophenyl)-2,2,2-trifluoro-*N*-isopropylacetamide (1f):**

N-isopropyl-2-bromoaniline (Obtained according to the ***General procedure A***) was mixed with TFAA (5 equiv.) and NEt_3 (1.5 equiv.), the mixture was stirred overnight at ambient temperature. Then the crude was concentrated under reduce pressure and purified by flash column chromatography with a mixture of pentane / AcOEt to give **1f** as a white solid (84% yield over two steps).



Chemical Formula: $C_{11}H_{11}BrF_3NO$
Molecular Weight: 310,1142 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.68 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.37 (td, *J* = 7.7, 1.6 Hz, 1H), 7.29 (td, *J* = 7.7, 1.6 Hz, 1H), 7.24 (dd, *J* = 7.7, 0.9 Hz, 1H), 4.59 (sept, *J* = 6.7 Hz, 1H), 1.34 (d, *J* = 6.7 Hz, 3H), 1.12 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 156.6 (q, *J* = 35.4 Hz), 136.1, 133.9, 131.7, 130.8, 128.0, 125.8, 116.0 (q, *J* = 289.0 Hz), 52.7, 21.1, 18.8

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -69.13 (s)

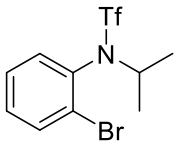
IR (neat)**:** ν (cm^{-1}) 2985, 1682, 1473, 1187, 1146, 1110, 736, 700, 552

HRMS (ESI): Calcd for $C_{11}H_{11}BrF_3NNaO$ $[M+Na]^+$: 331.9868, found 331.9868

Mp: 40-42 °C

***N*-(2-bromophenyl)-1,1,1-trifluoro-*N*-isopropylmethanesulfonamide (1g):**

Obtained according to the describe procedure of the Cramer group, as a white solid (44% yield over two steps). Spectroscopic data are consistent with those previously reported.[11]



Chemical Formula: $C_{10}H_{11}BrF_3NO_2S$
Molecular Weight: 346,1622 g.mol^{-1}

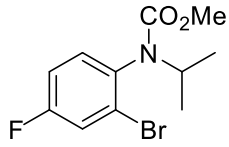
^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.74 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.38 (ddd, *J* = 8.2, 6.9, 1.5 Hz, 1H), 7.33-7.27 (m, 2H), 4.55 (hept, *J* = 6.7 Hz, 1H), 1.32 (d, *J* = 6.7 Hz, 3H), 1.31 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 134.8, 133.4, 133.3, 131.1, 128.1, 128.0, 120. (q, *J* = 323.8 Hz), 56.6, 22.2, 22.1

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -74.86 (s)

methyl (2-bromo-4-fluorophenyl)(isopropyl)carbamate (1h):

Obtained according to the ***General procedure B and General procedure D***, as a colorless viscous oil (82% yield over two steps).



Chemical Formula: $C_{11}H_{13}BrFNO_2$
Molecular Weight: 290,1324 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): 7.38 (dd, *J* = 8.0, 2.9 Hz, 1H), 7.16 (dd, *J* = 8.7, 5.6 Hz, 1H), 7.03 (ddd, *J* = 8.7, 7.7, 2.9 Hz, 1H), 4.59-4.40 (m, 1H), 3.62 (s, 3H), 1.29 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 161.3 (d, *J* = 251.5 Hz), 155.3, 134.8, 131.5 (d, *J* = 5.7 Hz), 126.5 (d, *J* = 10.0 Hz), 120.8 (d, *J* = 25.2 Hz), 115.0 (d, *J* = 21.9 Hz), 53.0, 50.4, 22.6, 19.8

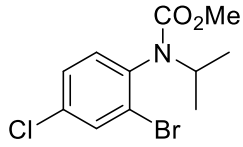
^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) 112.22 (m).

IR (neat)**:** ν (cm^{-1}) 2980, 2957, 1696, 1442, 1314, 1257, 1094, 587

HRMS (ESI): Calcd for $C_{11}H_{13}BrFNNaO_2$ $[M+Na]^+$: 312.0006, found 312.0007

methyl (2-bromo-4-chlorophenyl)(isopropyl)carbamate (1i):

Obtained according to the ***General procedure A and General procedure D***, as a white solid (54% yield over two steps).



Chemical Formula: $C_{11}H_{13}BrClNO_2$
Molecular Weight: 306,5840 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.64 (d, *J* = 2.4 Hz, 1H), 7.30 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.12 (d, *J* = 8.4 Hz, 1H), 4.57-4.44 (m, 1H), 3.62 (s, 3H), 1.29 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.1, 137.3, 134.0, 133.3, 131.4, 128.2, 126.7, 53.0, 50.5, 22.6, 19.8

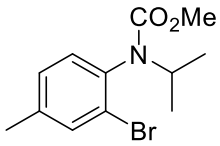
IR (neat)**:** ν (cm^{-1}) 3058, 2981, 2948, 1693, 1440, 1322, 1094, 766, 514

HRMS (ESI): Calcd for $C_{11}H_{13}BrClNNaO_2$ $[M+Na]^+$: 327.9710, found 327.9709

Mp: 43-45 °C

methyl (2-bromo-4-methylphenyl)(isopropyl)carbamate (1j):

Obtained according to the ***General procedure A and General procedure D***, as a colorless oil (57% yield over two steps).



Chemical Formula: $C_{12}H_{16}BrNO_2$
Molecular Weight: 286,1690 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.44 (s, 1H), 7.12-7.02 (m, 2H), 4.58-4.42 (m, 1H), 3.60 (s, 3H), 2.33 (s, 3H), 1.28 (d, *J* = 6.8 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H)

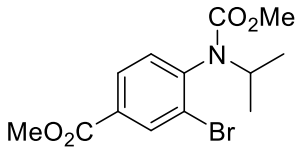
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.4, 139.2, 135.6, 133.9, 130.3, 128.6, 125.5, 52.8, 50.2, 22.6, 20.8, 19.7

IR (neat)**:** ν (cm^{-1}) 2978, 2949, 1696, 1440, 1318, 1094, 766

HRMS (ESI): Calcd for $C_{12}H_{16}BrNNaO_2$ $[M+Na]^+$: 308.0257, found 308.0258

methyl 3-bromo-4-(isopropyl(methoxycarbonyl)amino)benzoate (1k):

Obtained according to the ***General procedure B and General procedure D***, as a colorless oil (93% yield over two steps).



Chemical Formula: $C_{13}H_{16}BrNO_4$
Molecular Weight: 330,1780 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.30 (d, *J* = 2.0 Hz, 1H), 7.98 (dd, *J* = 8.2, 2.0 Hz, 1H), 7.26 (d, *J* = 8.2 Hz, 1H), 4.43-4.58 (m, 1H), 3.92 (s, 3H), 3.62 (s, 3H), 1.32 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H)

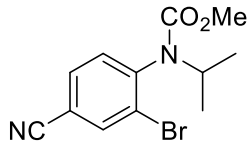
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 165.4, 154.8, 142.9, 134.7, 130.8, 130.6, 129.2, 126.2, 53.0, 52.6, 50.7, 22.7, 19.8

IR (neat)**:** ν (cm^{-1}) 2977, 2952, 1716, 1439, 1279, 1098, 764, 732

HRMS (ESI): Calcd for $C_{13}H_{16}BrNNaO_4$ $[M+Na]^+$: 352.0155, found 352.0153

methyl (2-bromo-4-cyanophenyl)(isopropyl)carbamate (1l):

Obtained according to the ***General procedure A and General procedure D***, as a white solid (18% yield over two steps).



Chemical Formula: $C_{12}H_{13}BrN_2O_2$
Molecular Weight: 297,1520 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.93 (d, *J* = 1.9 Hz, 1H), 7.63 (dd, *J* = 8.1, 1.9 Hz, 1H), 7.30 (d, *J* = 8.1 Hz, 1H), 4.58-4.42 (m, 1H), 3.63 (s, 3H), 1.32 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.5, 143.5, 136.9, 131.7, 131.4, 127.0, 117.0, 113.0, 53.1, 50.9, 22.7, 19.8

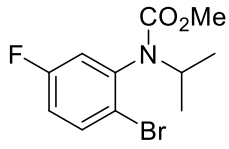
IR (neat)**:** ν (cm^{-1}) 2981, 2951, 2228, 1695, 1443, 1331, 1306, 1096, 764

HRMS (ESI): Calcd for $C_{12}H_{13}BrN_2NaO_2$ $[M+Na]^+$: 319.0053, found 319.0053

Mp: 125-127 °C

methyl (2-bromo-5-fluorophenyl)(isopropyl)carbamate (1m):

Obtained according to the ***General procedure B and General procedure D***, as a white solid (76% yield over two steps).



Chemical Formula: $C_{11}H_{13}BrFNO_2$
Molecular Weight: 290,1324 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.62-7.56 (m, 1H), 6.98-6.91 (m, 2H), 4.58-4.42 (m, 1H), 3.65 (s, 3H), 1.32 (d, *J* = 6.8 Hz, 3H), 1.05 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 161.7 (d, *J* = 248.7 Hz), 155.0, 139.9, 134.1 (d, *J* = 8.6 Hz), 120.6 (d, *J* = 3.9 Hz), 118.3 (d, *J* = 22.0 Hz), 116.3 (d, *J* = 22.1 Hz), 53.0, 50.6, 22.7, 19.7

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -113.33 to -113.41 (m)

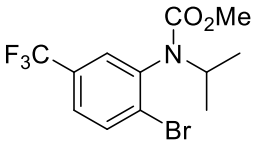
IR (neat)**:** ν (cm^{-1}) 2976, 1699, 1441, 1332, 1318, 1096, 819, 764, 598

HRMS (ESI): Calcd for $C_{12}H_{16}BrNNaO_2$ $[M+Na]^+$: 312.0006, found 312.0008

Mp: 58-61 °C

methyl (2-bromo-5-(trifluoromethyl)phenyl)(isopropyl)carbamate (1n):

Obtained according to the ***General procedure B and General procedure D***, as a white solid (50% yield over two steps).



Chemical Formula: $C_{12}H_{13}BrF_3NO_2$
Molecular Weight: 340,1402 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.77 (d, *J* = 8.3 Hz, 1H), 7.46-7.41 (m, 2H), 4.59-4.45 (m, 1H), 3.64 (s, 3H), 1.33 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.9, 139.5, 134.2, 130.7 (q, *J* = 33.3 Hz), 130.4, 127.6, 125.7, 123.5 (q, *J* = 272.5 Hz), 53.1, 50.7, 22.7, 19.8

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -62.69 (s).

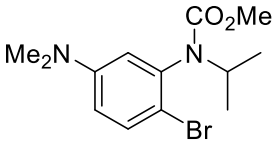
IR (neat)**:** ν (cm^{-1}) 2982, 2954, 1700, 1442, 1319, 1114, 1077, 846

HRMS (ESI): Calcd for $C_{12}H_{13}BrF_3NNaO_2$ $[M+Na]^+$: 361.9974, found 361.9978

Mp: 89-92 °C

methyl (2-bromo-5-(dimethylamino)phenyl)(isopropyl)carbamate (1o):

methyl (2-bromo-5-nitrophenyl)(isopropyl)carbamate [Obtained according to the ***General procedure B and General procedure D***, as a white solid (32% yield over two steps)] (1.0 g, 3.2 mmol) was dissolved in MeCN (70 mL), ZnBr (3.6 g, 16.0 mmol, 5 eq.) and a 37 % aqueous formaldehyde solution (12 mL) was added. After the addition of 10 % Pd/C (341 mg, 0.32 mmol, 10 mol%), the solution was purged with hydrogen and stirred under a hydrogen atmosphere (1 bar) for 24 h. The catalyst was filtered off and the filtrate was concentrated under reduced pressure. The residue was purified by flash column chromatography using an EtOAc-pentane mixture to give **1o** as a white solid (520 mg, 1.65 mmol, 52 %).



Chemical Formula: $C_{13}H_{19}BrN_2O_2$
Molecular Weight: 315,2110 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.40 (d, *J* = 8.8 Hz, 1H), 6.56-6.47 (m, 2H), 4.57-4.45 (m, 1H), 3.64 (s, 3H), 2.94 (s, 6H), 1.33 (d, *J* = 6.7 Hz, 3H), 1.05 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.6, 150.2, 138.6, 133.2, 114.5, 112.9, 111.4, 52.9, 50.3, 40.5, 22.9, 19.7

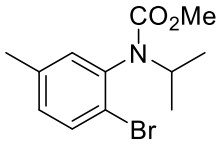
IR (neat)**:** ν (cm^{-1}) 2978, 2923, 1705, 1690, 1440, 1317, 1098

HRMS (ESI): Calcd for $C_{12}H_{16}BrNNaO_2$ $[M+Na]^+$: 337.0522, found 337.0524

Mp: 66-69 °C

methyl (2-bromo-5-methylphenyl)(isopropyl)carbamate (1p):

Obtained according to the ***General procedure A and General procedure D***, as white solid (52% yield over two steps).



Chemical Formula: $C_{12}H_{16}BrNO_2$
Molecular Weight: 286,1690 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.44 (s, 1H), 7.11-7.02 (m, 2H), 4.58-4.44 (m, 1H), 3.60 (s, 2H), 2.33 (s, 3H), 1.28 (d, *J* = 6.8 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.4, 139.2, 135.6, 133.9, 130.3, 128.6, 125.5, 52.8, 50.2, 22.6, 20.8, 19.7

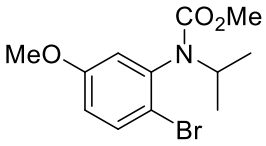
IR (neat)**:** ν (cm^{-1}) 2975, 2955, 1697, 1441, 1320, 1095, 822, 768

HRMS (ESI): Calcd for $C_{12}H_{16}BrNNaO_2$ $[M+Na]^+$: 308.0257, found 308.0257

Mp: 46-48 °C

methyl (2-bromo-5-methoxyphenyl)(isopropyl)carbamate (1q):

Obtained according to the ***General procedure A and General procedure D***, as a white solid (83% yield over two steps).



Chemical Formula: $C_{12}H_{16}BrNO_3$
Molecular Weight: 302,1680 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.52-7.46 (m, 1H), 6.78-6.72 (m, 2H), 4.59-4.41 (m, 1H), 3.79 (s, 3H), 3.63 (s, 3H), 1.32 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 159.2, 155.3, 139.2, 133.5, 116.4, 116.4, 114.3, 55.7, 52.9, 50.4, 22.7, 19.7

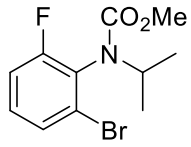
IR (neat)**:** ν (cm^{-1}) 2983, 2953, 1697, 1445, 1320, 1308, 1218, 1097

HRMS (ESI): Calcd for $C_{12}H_{16}BrNNaO_3$ $[M+Na]^+$: 324.0206, found 324.0205

Mp: 55-57 °C

methyl (2-bromo-6-fluorophenyl)(isopropyl)carbamate (1r):

Obtained according to the ***General procedure B and General procedure D***, as a white solid (23% yield over two steps).



Chemical Formula: $C_{11}H_{13}BrFNO_2$
Molecular Weight: 290,1324 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.41 (d, *J* = 7.9 Hz, 1H), 7.20-7.05 (m, 2H), 4.37-4.15 (m, 1H), 3.60 (s, 3H), 1.32 (dd, *J* = 6.7, 1.8 Hz, 3H), 1.15 (d, *J* = 6.7 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 160.0 (d, *J* = 251.4 Hz), 155.0, 129.6 (d, *J* = 8.8 Hz), 128.7 (d, *J* = 3.5 Hz), 127.0, 115.6 (d, *J* = 22.0 Hz), 53.0, 51.9, 21.4, 20.2

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -112.56 to -112.71 (m)

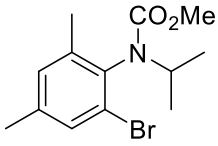
IR (neat)**:** ν (cm^{-1}) 2977, 2951, 1707, 1440, 1089, 866, 768

HRMS (ESI): Calcd for $C_{12}H_{13}BrN_2NaO_2$ $[M+Na]^+$: 312.0006, found 312.0007

Mp: 48-49 °C

methyl (2-bromo-4,6-dimethylphenyl)(isopropyl)carbamate (1s):

Obtained according to the ***General procedure B and General procedure D***, as a colorless viscous oil (39% yield over two steps).



Chemical Formula: $C_{13}H_{18}BrNO_2$
Molecular Weight: 300,1960 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.28-7.26 (m, 1H), 6.99-6.98 (m, 1H), 4.10 (hept, *J* = 6.7 Hz, 1H), 3.60 (s, 3H), 2.29 (s, 3H), 2.23 (s, 3H), 1.32 (d, *J* = 6.7 Hz, 3H), 1.16 (d, *J* = 6.7 Hz, 4H)

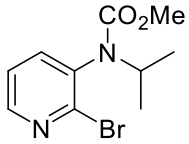
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.6, 139.0, 138.7, 136.6, 131.3, 130.7, 125.6, 52.8, 51.6, 22.0, 20.9, 20.8, 19.7

IR (neat)**:** ν (cm^{-1}) 2972, 2950, 1706, 1439, 1339, 1316, 1087

HRMS (ESI): Calcd for $C_{13}H_{18}BrNNaO_2$ $[M+Na]^+$: 322.0413, found 322,0416

methyl (2-bromopyridin-3-yl)(isopropyl)carbamate (1t):

Obtained according to the ***General procedure B and General procedure D***, as a colorless viscous oil (64% yield over two steps).



Chemical Formula: $C_{10}H_{13}BrN_2O_2$
Molecular Weight: 273,1300 g.mol^{-1}

Mixture or rotameres:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 8.25 (dd, *J* = 4.7, 1.8 Hz, 2/3 H), 8.22 (dd, *J* = 4.7, 1.8 Hz, 1/3 H), 7.48-7.41 (m, 2H), 7.22 (dd, *J* = 7.8, 4.7 H, dd, *J* = 7.8, 4.7 Hz superimposed, 1H), 4.55-4.35 (m, 2H), 3.53 (s, 4H), 1.21 (d, *J* = 6.8 Hz, 1H), 1.18 (d, *J* = 6.7 Hz, 2H), 0.97 (d, *J* = 6.8 Hz, 3H, d, *J* = 6.8 Hz superimposed, 3H)

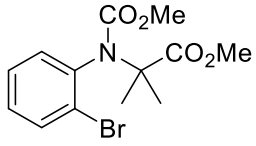
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.8, 152.3, 148.3, 148.0, 145.8, 139.2, 138.5, 136.0, 133.6, 122.9, 122.7, 52.8, 50.4, 50.3, 22.5, 22.3, 19.7

IR (neat)**:** ν (cm^{-1}) 2978, 2951, 1703, 1401, 1316, 1097, 1077, 768

HRMS (ESI): Calcd for $C_{10}H_{13}BrN_2NaO_2$ $[M+Na]^+$: 295.0053, found 295.0052

methyl 2-((2-bromophenyl)(methoxycarbonyl)amino)-2-methylpropanoate (1u):

Obtained according to the ***General procedure C and General procedure D***, as a white solid (40% yield over two steps).



Chemical Formula: $C_{13}H_{16}BrNO_4$
Molecular Weight: 330,1780 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.65-7.58 (m, 1H), 7.56-7.51 (m, 1H), 7.35-7.29 (m, 1H), 7.21-7.14 (m, 1H), 3.78 (s, 3H), 3.56 (s, 3H), 1.77 (s, 3H), 1.14 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.5, 155.2, 138.9, 133.2, 132.1, 129.5, 127.9, 126.0, 62.9, 53.2, 52.7, 26.0, 24.9

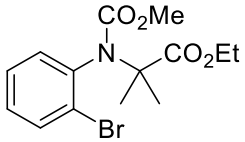
IR (neat)**:** ν (cm^{-1}) 2960, 2930, 1733, 1703, 1337, 1267, 1151, 1088, 756

HRMS (ESI): Calcd for $C_{13}H_{16}BrNNaO_4$ $[M+Na]^+$: 352.0155, found 352,0160

Mp: 71-73 °C

ethyl 2-((2-bromophenyl)(methoxycarbonyl)amino)-2-methylpropanoate (1v):

Obtained according to the ***General procedure C and General procedure D***, as a colorless oil (19% yield over two steps).



Chemical Formula: $C_{14}H_{18}BrNO_4$
Molecular Weight: 344,2050 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.59 (dd, *J* = 8.9, 1.4 Hz, 1H), 7.52 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.29 (td, *J* = 7.7, 1.4 Hz, 1H), 7.18-7.12 (m, 1H), 4.22 (q, *J* = 7.2 Hz, 2H), 3.53 (s, 3H), 1.75 (s, 3H), 1.28 (t, *J* = 7.1 Hz, 3H), 1.12 (s, 3H)

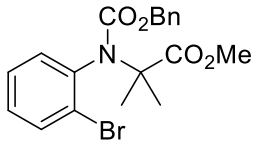
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 174.7, 155.1, 138.9, 133.1, 131.9, 129.3, 127.8, 125.9, 62.8, 61.3, 53.0, 25.9, 24.7, 14.2

IR (neat)**:** ν (cm^{-1}) 2982, 2956, 1735, 1711, 1337, 1147, 1092, 729

HRMS (ESI): Calcd for $C_{14}H_{18}BrNNaO_4$ $[M+Na]^+$: 366.0311, found 366.0312

methyl 2-(((benzyloxy)carbonyl)(2-bromophenyl)amino)-2-methylpropanoate (1w):

Obtained according to the ***General procedure C and General procedure D***, as a colorless oil (26% yield over two steps).



Chemical Formula: $C_{19}H_{20}BrNO_4$
Molecular Weight: 406,2760 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.64 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.56 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.39-7.29 (m, 2H), 7.25-7.16 (m, 5H), 7.13-7.08 (m, 2H), 5.06 (s, 2H), 3.77 (s, 3H), 1.82 (s, 3H), 1.17 (s, 3H)

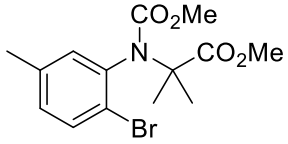
^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.5, 154.6, 138.9, 136.7, 133.3, 132.1, 129.5, 128.3, 127.9, 127.7, 127.2, 126.1, 67.2, 63.0, 52.7, 26.0, 24.9

IR (neat)**:** ν (cm^{-1}) 2993, 2950, 1740, 1707, 1295

HRMS (ESI): Calcd for $C_{19}H_{20}BrNNaO_4$ $[M+Na]^+$: 428.0468, found 428.0474

methyl 2-((2-bromo-5-methylphenyl)(methoxycarbonyl)amino)-2-methylpropanoate (1x):

Obtained according to the ***General procedure C and General procedure D***, as a white solid (25% yield over two steps).



Chemical Formula: $C_{14}H_{18}BrNO_4$
Molecular Weight: 344,2050 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.47 (d, *J* = 8.2 Hz, 1H), 7.33 (s, 1H), 6.99 (dd, *J* = 8.2, 1.4 Hz, 1H), 3.79 (s, 3H), 3.58 (s, 3H), 2.31 (s, 3H), 1.77 (s, 3H), 1.15 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.6, 155.3, 138.4, 138.1, 132.8, 132.5, 130.4, 122.4, 62.9, 53.2, 52.7, 26.1, 24.9, 20.9

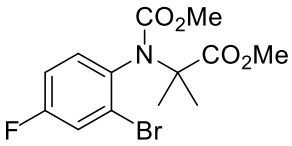
IR (neat)**:** ν (cm^{-1}) 2994, 2954, 1742, 1707, 1333, 1142, 1096

HRMS (ESI): Calcd for $C_{14}H_{18}BrNNaO_4$ $[M+Na]^+$: 366.0311, found 366.0318

Mp: 98-99 °C

methyl 2-((2-bromo-4-fluorophenyl)(methoxycarbonyl)amino)-2-methylpropanoate (1y):

Obtained according to the ***General procedure C and General procedure D***, as a white solid (36% yield over two steps).



Chemical Formula: $C_{13}H_{15}BrFNO_4$
Molecular Weight: 348,1684 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.54 (dd, *J* = 8.8, 5.7 Hz, 1H), 7.35 (dd, *J* = 7.5, 2.0 Hz, 1H), 7.06-7.00 (m, 1H), 3.79 (s, 3H), 3.58 (s, 3H), 1.78 (s, 3H), 1.13 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.4, 161.5 (d, *J* = 252.3 Hz), 155.3, 135.3 (d, *J* = 3.5 Hz), 132.8 (d, *J* = 8.9 Hz), 126.4 (d, *J* = 10.1 Hz), 120.3 (d, *J* = 25.2 Hz), 115.1 (d, *J* = 21.9 Hz), 63.0, 53.2, 52.7, 26.1, 24.9

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -111.33 (s)

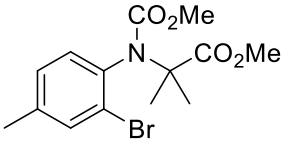
IR (neat)**:** ν (cm^{-1}) 2996, 2954, 1736, 1703, 1335, 1094

HRMS (ESI): Calcd for $C_{13}H_{15}BrFNNaO_4$ $[M+Na]^+$: 370.0061, found 370.0061

Mp: 86-87 °C

methyl 2-((2-bromo-4-methylphenyl)(methoxycarbonyl)amino)-2-methylpropanoate (1y):

Obtained according to the ***General procedure C and General procedure D***, as a white solid (36% yield over two steps).



Chemical Formula: $C_{14}H_{18}BrNO_4$
Molecular Weight: 344,2050 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.54 (dd, *J* = 8.8, 5.7 Hz, 1H), 7.35 (dd, *J* = 7.5, 2.0 Hz, 1H), 7.06-7.00 (m, 1H), 3.79 (s, 3H), 3.58 (s, 3H), 1.78 (s, 3H), 1.13 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.4, 161.5 (d, *J* = 252.3 Hz), 155.3, 135.3 (d, *J* = 3.5 Hz), 132.8 (d, *J* = 8.9 Hz), 126.4 (d, *J* = 10.1 Hz), 120.3 (d, *J* = 25.2 Hz), 115.1 (d, *J* = 21.9 Hz), 63.0, 53.2, 52.7, 26.1, 24.9

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -111.33 (s).

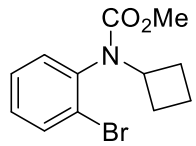
IR (neat)**:** ν (cm^{-1}) 2996, 2954, 1740, 1708, 1336, 1094

HRMS (ESI): Calcd for $C_{14}H_{18}BrNNaO_4$ $[M+Na]^+$: 366.0311, found 366.0313

Mp: 105-107 °C

methyl (2-bromophenyl)(cyclobutyl)carbamate (1aa):

Obtained according to the ***General procedure B and General procedure D***, as a white solid (66% yield over two steps). Spectroscopic data are consistent with those previously reported.[12]



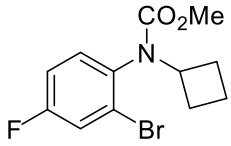
Chemical Formula: $C_{12}H_{14}BrNO_2$
Molecular Weight: 284,1530 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.65 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.35 (td, *J* = 7.6, 1.6 Hz, 1H), 7.20 (td, *J* = 7.9, 1.6 Hz, 1H), 7.16 (d, *J* = 7.6 Hz, 1H), 4.83-4.71 (m, 1H), 3.61 (s, 3H), 2.24-2.09 (m, 2H), 1.90 (quint, *J* = 10.0 Hz, 1H), 1.84-1.70 (m, 1H), 1.65-1.44 (m, 2H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.4, 138.2, 133.4, 131.6, 129.2, 128.1, 125.9, 53.0, 52.6, 29.5, 28.5, 15.2

methyl (2-bromo-4-fluorophenyl)(cyclobutyl)carbamate (1ab):

Obtained according to the ***General procedure B and General procedure D***, as a pale viscous oil (62% yield over two steps).



Chemical Formula: $C_{12}H_{13}BrFNO_2$
Molecular Weight: 302,1434 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.35 (dd, *J* = 7.8, 2.9 Hz, 1H), 7.16-7.07 (m, 1H), 7.03 (ddd, *J* = 8.7, 7.8, 2.9 Hz, 1H), 4.81-4.66 (m, 1H), 3.57 (s, 3H), 2.21-2.05 (m, 2H), 1.84 (quint, *J* = 10.0 Hz, 1H), 1.78-1.66 (m, 1H), 1.61-1.43 (m, 2H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 161.3 (d, *J* = 251.7 Hz), 155.2, 134.4, 132.2 (d, *J* = 8.1 Hz), 126.2 (d, *J* = 9.6 Hz), 120.5 (d, *J* = 25.3 Hz), 115.0 (d, *J* = 22.0 Hz), 52.9, 52.4, 29.3, 28.4, 15.0

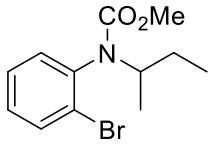
^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -111.87 to -111.95 (m)

IR (neat)**:** ν (cm^{-1}) 2979, 2950, 1706, 1489, 1441, 1321, 1294, 878

HRMS (ESI): Calcd for $C_{12}H_{13}BrFNNaO_2$ $[M+Na]^+$: 324.0006, found 324.0006

methyl (2-bromophenyl)(sec-butyl)carbamate (1ac):

Obtained according to the ***General procedure A and General procedure D***, as a colorless oil (77% yield over two steps). Spectroscopic data are consistent with those previously reported.[13]



Chemical Formula: $C_{12}H_{16}BrNO_2$
Molecular Weight: 286,1690 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.63 (dd, *J* = 7.9, 3.7 Hz, 1H), 7.35-7.28 (m, 1H), 7.23-7.12 (m, 2H), 4.44-4.02 (m, 1H), 3.63 (s, 3H), 1.86-1.71 (m, 1H), 1.61-1.47 (m, 1H), 1.34 (d, *J* = 6.7 Hz, 1H), 1.04-0.96 (m, 4H), 0.89 (t, *J* = 7.4 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.6, 155.1, 139.5, 138.3, 133.4, 130.4, 128.8, 128.7, 127.9, 126.1, 125.6, 57.4, 55.8, 52.8, 52.7, 29.7, 26.8, 19.2, 16.7, 11.6, 11.1

methyl (*S*)-2-methylindoline-1-carboxylate (2a):

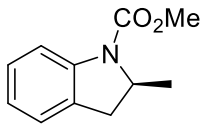
Small scale synthesis:

1aCl as the substrate: The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 140 °C/26 h) and purified by chromatography to give a slight yellow oil (12.8 mg, 34% yield).

1aBr as the substrate: The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/24 h) and purified by chromatography to give a slight yellow oil (32.7 mg, 86% yield).

1aI as the substrate: The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/20 h) and purified by chromatography to give a slight yellow oil (25.8 mg, 68% yield).

Gram scale synthesis: In the glovebox, carbamate **1a** (5.0 mmol, 1.36 g, 1.0 eq.), $Pd(PCy_3)_2$ (0.25 mmol, 167 mg, 0.05 eq.), chiral phosphoric acid (0.5 mmol, 385 mg, 0.1 eq.), 4Å MS (1.25 g) and cesium carbonate (15 mmol, 4.9 g, 3.0 eq.) were successfully weighed into a 100 mL J-Young tube equipped with a magnetic stir bar. The J-Young tube was sealed and taken out of the glovebox and dry DME (40 mL) was added under argon. The reaction mixture was degassed by three freeze-pump-thaw cycles and was heated at 120 °C for 24 h. The reaction mixture was cooled to room temperature and filtered through a pad of celite, washed with ethyl acetate. The filtrate was evaporated under reduced pressure. The crude residue was purified by flash column chromatography (silica gel, pentane/EtOAc 30:1 as the eluent) affording 825 mg (4.32 mmol, 86%) of a slight yellow oil. Spectroscopic data are consistent with those previously reported.[14]



Chemical Formula: $C_{11}H_{13}NO_2$
Molecular Weight: 191,2300 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.80 (bs, 1H), 7.22-7.12 (m, 2H), 6.96 (td, *J* = 7.4, 1.0 Hz, 1H), 4.62-4.48 (m, 1H), 3.85 (s, 3H), 3.36 (dd, *J* = 15.9, 9.6 Hz, 1H), 2.63 (dd, *J* = 15.9, 2.1 Hz, 1H), 1.30 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.7, 141.5, 130.1, 127.5, 125.1, 122.8, 115.4, 55.4, 52.5, 35.9, 21.2

IR (neat)**:** ν (cm^{-1}) 2953, 2926, 1703, 1485, 1389, 753

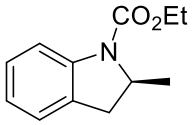
HRMS (ESI): Calcd for $C_{11}H_{13}NNaO_2$ $[M+Na]^+$: 214.0844, found 214,0837

$[\alpha]_D^{20}$ = +40.8° (c = 1.46, $CHCl_3$); lit. +48.3 (c = 0.8, CH_2Cl_2).[14]

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 243 nm, t_r(minor) = 9.6 min, t_r(major) = 10.6 min, 96:4 e.r.

ethyl (*S*)-2-methylindoline-1-carboxylate (2b):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/16 h) and purified by chromatography to give a colorless oil (34.1 mg, 83% yield).



Chemical Formula: $C_{12}H_{15}NO_2$
Molecular Weight: 205,2570 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.81 (bs, 1H), 7.23-7.12 (m, 2H), 6.96 (td, *J* = 7.4, 1.0 Hz, 1H), 4.64-4.47 (m, 1H), 4.30 (q, *J* = 7.0 Hz, 2H), 3.37 (dd, *J* = 15.9, 9.6 Hz, 2H), 2.63 (dd, *J* = 15.9, 2.0 Hz, 1H), 1.37 (t, *J* = 7.0 Hz, 3H), 1.30 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.3, 141.6, 130.2, 127.5, 125.1, 122.7, 115.5, 61.4, 55.4, 35.9, 21.2, 14.8

IR (neat)**:** ν (cm^{-1}) 2978, 2929, 1698, 1484, 1280, 1053, 748

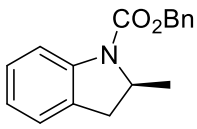
HRMS (ESI): Calcd for $C_{12}H_{15}NNaO_2$ $[M+Na]^+$: 228.1000, found 228,0995

$[\alpha]_D^{20}$ = +40.1° (c = 0.85, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 243 nm, t_r(minor) = 8.3 min, t_r(major) = 9.4 min, 94:6 e.r.

benzyl (*S*)-2-methylindoline-1-carboxylate (2c):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/24 h) and purified by chromatography to give a colorless oil (40.1 mg, 75% yield).



Chemical Formula: $C_{17}H_{17}NO_2$
Molecular Weight: 267,3280 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.89 (bs, 1H), 7.51-7.31 (m, 5H), 7.24-7.13 (m, 2H), 6.98 (t, *J* = 7.4 Hz, 1H), 5.31 (s, 2H), 4.69-4.51 (m, 1H), 3.38 (dd, *J* = 15.9, 9.6 Hz, 1H), 2.65 (dd, *J* = 15.9, 2.1 Hz, 1H), 1.32 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.0, 141.6, 136.5, 130.1, 128.7, 128.3, 128.2, 127.6, 125.2, 122.9, 115.6, 67.1, 55.5, 36.0, 21.4

IR (neat)**:** ν (cm^{-1}) 3033, 2958, 1701, 1484, 1403, 1282, 753

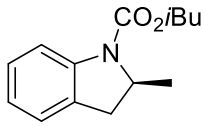
HRMS (ESI): Calcd for $C_{17}H_{17}NNaO_2$ $[M+Na]^+$: 290.1157, found 290,1152

$[\alpha]_D^{20}$ = +25.7° (c = 1.10, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 243 nm, t_r(major) = 17.9 min, t_r(minor) = 21.7 min, 92:8 e.r.

isobutyl (*S*)-2-methylindoline-1-carboxylate (2d):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/16 h) and purified by chromatography to give a colorless oil (41.3 mg, 89% yield).



Chemical Formula: $C_{14}H_{19}NO_2$
Molecular Weight: 233,3110 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.82 (bs, 1H), 7.22-7.12 (m, 2H), 6.96 (td, *J* = 7.4, 1.0 Hz, 1H), 4.66-4.43 (m, 1H), 4.03 (d, *J* = 6.2 Hz, 2H), 3.38 (dd, *J* = 15.9, 9.6 Hz, 1H), 2.64 (dd, *J* = 15.9, 1.8 Hz, 1H), 2.13-1.95 (m, 1H), 1.32 (d, *J* = 6.4 Hz, 3H), 1.01 (d, *J* = 6.7 Hz, 6H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.4, 141.7, 130.1, 127.6, 125.1, 122.7, 115.5, 71.7, 55.4, 36.0, 28.1, 21.4, 19.4

IR (neat)**:** ν (cm^{-1}) 2960, 2927, 1701, 1485, 1407, 1281, 751

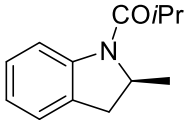
HRMS (ESI): Calcd for $C_{14}H_{19}NNaO_2$ $[M+Na]^+$: 256.1313, found 256,1304

$[\alpha]_D^{20}$ = +32.1° (c = 1.20, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99.5:0.5 (*n*-heptane/*i*-PrOH), 0.5 ml.min^{-1}, 243 nm, t_r(minor) = 13.8 min, t_r(major) = 15.2 min, 94.5:5.5 e.r.

(*S*)-2-methyl-1-(2-methylindolin-1-yl)propan-1-one (2e):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/16 h) and purified by chromatography to give a colorless oil (33.3 mg, 82% yield). Spectroscopic data are consistent with those previously reported.[10]



Chemical Formula: $C_{13}H_{17}NO$
Molecular Weight: 203,2850 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 8.22 (d, *J* = 5.0 Hz, 1H), 7.23-7.17 (m, 3H), 7.02 (td, *J* = 7.4, 0.9 Hz, 1H), 4.63-4.41 (m, 1H), 3.47-3.32 (m, 1H), 2.91-2.76 (m, 1H), 2.67 (d, *J* = 15.3 Hz, 1H), 1.35-1.15 (m, 9H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 175.8, 141.9, 130.5, 127.6, 125.0, 123.8, 118.3, 55.4, 36.5, 32.9, 22.5, 20.6, 19.5

IR (neat)**:** ν (cm^{-1}) 2966, 2929, 1651, 1479, 1404, 1270, 759

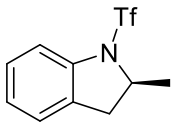
HRMS (ESI): Calcd for $C_{13}H_{17}NNaO$ $[M+Na]^+$: 226.1208, found 226,1202

$[\alpha]_D^{20}$ = +21.1° (c = 1.30, $CHCl_3$); lit. +27.5 (c = 1.0, CH_2Cl_2).[10]

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 254 nm, t_r(minor) = 8.8 min, t_r(major) = 12.0 min, 81.5:18.5 e.r.

(*S*)-2-methyl-1-((trifluoromethyl)sulfonyl)indoline (2g):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 100 °C/24 h) and purified by chromatography to give a colorless oil (34 mg, 64% yield). Spectroscopic data are consistent with those previously reported.[11]



Chemical Formula: $C_{10}H_{10}F_3NO_2S$
Molecular Weight: 265,2502 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.46 (d, *J* = 8.1 Hz, 1H), 7.27-7.19 (m, 2H), 7.17-7.11 (m, 1H), 4.81-4.64 (m, 1H), 3.52 (dd, *J* = 15.9, 9.2 Hz, 1H), 2.73 (dd, *J* = 15.9, 1.8 Hz, 1H), 1.44 (d, *J* = 6.5 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 138.6, 130.8, 128.2, 126.0, 125.7, 120.3 (q, *J* = 325.6 Hz), 115.8, 61.0, 36.4, 22.9

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -73.97 (bs)

IR (neat)**:** ν (cm^{-1}) 2926, 2857, 1395, 1223, 1189, 1145, 610

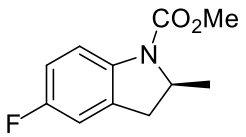
HRMS (ESI): Calcd for $C_{10}H_{10}F_3NNaO_2S$ $[M+Na]^+$: 288.0282, found 288,0277

$[\alpha]_D^{20}$ = +16.1° (c = 1.35, $CHCl_3$); lit. +25.3 (c = 1.0, $CHCl_3$).[11]

HPLC separation: Chiralcel OJ-H; 99.5:0.5 (*n*-heptane/*i*-PrOH), 0.5 $ml.min^{-1}$, 229 nm, t_r(major) = 11.4 min, t_r(minor) = 12.0 min, 74:26 e.r.

methyl (*S*)-5-fluoro-2-methylindoline-1-carboxylate (2h):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a colorless oil (35.3 mg, 84% yield).



Chemical Formula: $C_{11}H_{12}FNO_2$
Molecular Weight: 209,2204 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.75 (bs, 1H), 6.90-6.81 (m, 2H), 4.62-4.48 (s, 1H), 3.83 (s, 3H), 3.35 (ddd, *J* = 16.2, 9.6, 1.1 Hz, 1H), 2.60 (dd, *J* = 16.2, 1.8 Hz, 1H), 1.29 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 159.1 (d, *J* = 240.5 Hz), 153.6, 137.4, 132.0, 116.1 (d, *J* = 8.2 Hz), 113.8 (d, *J* = 22.9 Hz), 112.4 (d, *J* = 24.0 Hz), 55.8, 52.6, 36.0, 21.3

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -121.21 (s)

IR (neat)**:** ν (cm^{-1}) 2955, 2855, 1702, 1486, 1389

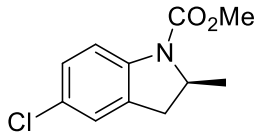
HRMS (ESI): Calcd for $C_{11}H_{12}FNNaO_2$ $[M+Na]^+$: 232.0750, found 232,0741

$[\alpha]_D^{20}$ = +47.3° (c = 1.50, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 240 nm, t_r(major) = 11.0 min, t_r(minor) = 12.4 min, 97.5:2.5 e.r.

methyl (*S*)-5-chloro-2-methylindoline-1-carboxylate (2i):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/32 h) and purified by chromatography to give a colorless oil (22.3 mg, 49% yield).



Chemical Formula: $C_{11}H_{12}ClNO_2$
Molecular Weight: 225,6720 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.73 (bs, 1H), 7.16-7.09 (m, 2H), 4.65-4.47 (m, 1H), 3.84 (s, 3H), 3.34 (dd, *J* = 16.2, 9.6 Hz, 1H), 2.61 (dd, *J* = 16.2, 2.0 Hz, 1H), 1.28 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.6, 140.3, 132.1, 127.7, 127.5, 125.3, 116.3, 55.8, 52.7, 35.8, 21.2

IR (neat)**:** ν (cm^{-1}) 2955, 2927, 1704, 1480, 1383, 763

HRMS (ESI): Calcd for $C_{11}H_{14}ClNNaO_2$ $[M+Na]^+$: 248.0454, found 248,0447

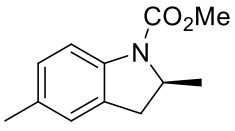
$[\alpha]_D^{20}$ = +39.4° (c = 0.95, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 249 nm, t_r(minor) = 11.0 min, t_r(major) = 13.4 min, 92:8 e.r.

methyl (*S*)-2,5-dimethylindoline-1-carboxylate (2j):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/32 h) and purified by chromatography to give a colorless oil (21.1 mg, 51% yield).

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.70 (bs, 1H), 7.02-



Chemical Formula: $C_{12}H_{15}NO_2$
Molecular Weight: 205,2570 $g.mol^{-1}$

6.92 (m, *J* = 9.5 Hz, 2H), 4.59-4.46 (m, 1H), 3.83 (s, 3H), 3.33 (dd, *J* = 15.9, 9.5 Hz, 1H), 2.59 (dd, *J* = 15.9, 1.8 Hz, 1H), 2.30 (s, 3H), 1.28 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.8, 139.3, 132.4, 130.1, 128.0, 125.9, 115.2, 55.5, 52.5, 36.0, 29.8, 21.0

IR (neat)**:** ν (cm^{-1}) 2921, 2853, 1705, 1493, 1386, 1282, 762

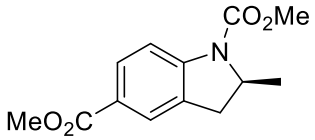
HRMS (ESI): Calcd for $C_{12}H_{15}NNaO_2$ $[M+Na]^+$: 228.0995, found 228,0991

$[\alpha]_D^{20}$ = +25.8° (c = 1.10, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 245 nm, t_r(minor) = 14.8 min, t_r(major) = 19.1 min, 91:9 e.r.

dimethyl (*S*)-2-methylindoline-1,5-dicarboxylate (2k):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/36 h) and purified by chromatography to give a slight viscous yellow oil (40.1 mg, 80% yield).



Chemical Formula: $C_{13}H_{15}NO_4$
Molecular Weight: 249,2660 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.89 (d, *J* = 8.1 Hz, 1H), 7.81 (s, 1H), 7.76 (bs, 1H), 4.68-4.46 (m, 1H), 3.87 (s, 3H), 3.85 (s, 3H), 3.36 (ddd, *J* = 16.1, 9.6, 0.5 Hz, 1H), 2.66 (dd, *J* = 16.1, 1.7 Hz, 1H), 1.29 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 167.0, 153.6, 145.6, 130.3, 126.6, 124.6, 114.7, 56.2, 52.8, 52.0, 35.5, 21.3

IR (neat)**:** ν (cm^{-1}) 2953, 2854, 1707, 1384, 1267, 769

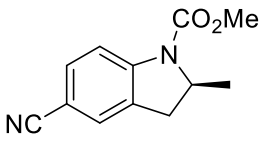
HRMS (ESI): Calcd for $C_{13}H_{15}NNaO_4$ $[M+Na]^+$: 272.0893, found 272,0894

$[\alpha]_D^{20}$ = +48.7° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 275 nm, t_r(minor) = 31.2 min, t_r(major) = 45.6 min, 94:6 e.r.

methyl (*S*)-5-cyano-2-methylindoline-1-carboxylate (2l):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 140 °C/48 h) and purified by chromatography to give a white solid (26 mg, 60% yield).



Chemical Formula: $C_{12}H_{12}N_2O_2$
Molecular Weight: 216,2400 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.82 (bs, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.41 (s, 1H), 4.69-4.44 (m, 1H), 3.87 (s,

3H), 3.37 (dd, *J* = 16.3, 9.7 Hz, 1H), 2.68 (dd, *J* = 16.3, 2.0 Hz, 1H), 1.31 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.4, 132.9, 131.3, 128.7, 119.6, 115.7, 105.7, 56.2, 53.1, 35.5, 21.3

IR (neat)**:** ν (cm^{-1}) 2923, 2852, 2221, 1710, 1383, 1277, 758

HRMS (ESI): Calcd for $C_{12}H_{12}N_2NaO_2$ $[M+Na]^+$: 239.0791, found 239,0789

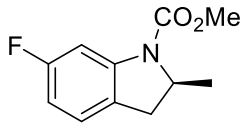
Mp: 88-90 °C

$[\alpha]_D^{20}$ = +58.6° (c = 1.12, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 269 nm, t_r(minor) = 25.4 min, t_r(major) = 30.2 min, 97:3 e.r.

methyl (*S*)-6-fluoro-2-methylindoline-1-carboxylate (2m):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a colorless oil (40.2 mg, 96% yield).



Chemical Formula: $C_{11}H_{12}FNO_2$
Molecular Weight: 209,2204 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.53 (bs, 1H), 7.07-7.02 (m, 1H), 6.64 (tdd, *J* = 9.0, 8.2, 1.7 Hz, 1H), 4.64-4.50 (m, 1H), 3.84 (s, 3H), 3.30 (dd, *J* = 15.7, 9.6 Hz, 1H), 2.59 (d, *J* = 15.7 Hz, 1H), 1.29 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 162.7 (d, *J* = 241.4 Hz), 153.4, 142.7, 125.4 (d, *J* = 9.5 Hz), 109.0 (d, *J* = 22.8 Hz), 103.6 (d, *J* = 28.9 Hz), 56.4, 52.6, 35.2, 21.1

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) δ -112.64 (s)

IR (neat)**:** ν (cm^{-1}) 2954, 2860, 1707, 1494, 1444, 1388, 1295

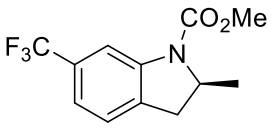
HRMS (ESI): Calcd for $C_{11}H1_2FNNaO_2$ $[M+Na]^+$: 232.0744, found 232,0743

$[\alpha]_D^{20}$ = +31.1° (c = 1.17, $CHCl_3$)

HPLC separation: Chiralcel OD-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 241 nm, t_r(major) = 6.20 min, t_r(minor) = 6.80 min, 98:2 e.r.

methyl (*S*)-2-methyl-6-(trifluoromethyl)indoline-1-carboxylate (2n):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a white solid (47.6 mg, 92% yield).



Chemical Formula: $C_{12}H_{12}F_3NO_2$
Molecular Weight: 259,2282 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 8.09 (bs, 1H), 7.23 (bs, 2H), 4.68-4.52 (m, 1H), 3.87 (s, 3H), 3.40 (dd, *J* = 16.7, 9.7 Hz, 1H), 2.69 (d, *J* = 16.7 Hz, 1H), 1.31 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.6, 130.2 (q, *J* = 31.3 Hz), 125.3, 124.4 (q, *J* = 272.2 Hz), 119.9 (q, *J* = 4.0 Hz), 112.4 (q, *J* = 4.0 Hz), 55.9, 52.9, 35.9, 21.2

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -62.17 (s)

IR (neat)**:** ν (cm^{-1}) 2959, 2922, 1706, 1290, 819

HRMS (ESI): Calcd for $C_{12}H_{12}F_3NNaO_2$ $[M+Na]^+$: 282.0712, found 282,0711

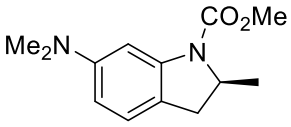
Mp: 62-64 °C

$[\alpha]_D^{20}$ = + 32.5° (c = 1.38, $CHCl_3$)

HPLC separation: Chiralcel OD-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 246 nm, t_r(major) = 5.5 min, t_r(minor) = 6.0 min, 97.5:2.5 e.r.

methyl (*S*)-6-(dimethylamino)-2-methylindoline-1-carboxylate (2o):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a colorless oil (35.3 mg, 75% yield).



Chemical Formula: $C_{13}H_{18}N_2O_2$
Molecular Weight: 234,2990 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.40 (bs, 1H), 7.00 (d, *J* = 8.2 Hz, 1H), 6.38 (dd, *J* = 8.2, 2.4 Hz, 1H), 4.61-4.44 (m, 1H), 3.83 (s, 3H), 3.27 (ddd, *J* = 15.2, 9.4, 0.8 Hz, 1H), 2.94 (s, 6H), 2.53 (dd, *J* = 15.2, 1.9 Hz, 1H), 1.28 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.8, 151.0, 125.2, 107.6, 100.9, 56.2, 52.4, 41.3, 35.2, 21.4

IR (neat)**:** ν (cm^{-1}) 2854, 2796, 1704, 1508, 1387, 1055, 763

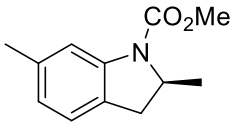
HRMS (ESI): Calcd for $C_{13}H_{18}N_2NaO_2$ $[M+H]^+$: 235.1441, found 235.1440

$[\alpha]_D^{20}$ = - 2.9° (c = 1.31, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 312 nm, t_r(minor) = 15.2 min, t_r(major) = 19.1 min, 94.5:5.5 e.r.

methyl (*S*)-2,6-dimethylindoline-1-carboxylate (2p):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/20 h) and purified by chromatography to give a white solid (38.7 mg, 94% yield).



Chemical Formula: $C_{12}H_{15}NO_2$
Molecular Weight: 205,2570 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.68 (bs, 1H), 7.03 (d, *J* = 7.5 Hz, 2H), 6.79 (dd, *J* = 7.5, 0.6 Hz, 2H), 4.60-4.48 (m, 1H), 3.84 (s, 3H), 3.31 (dd, *J* = 15.7, 9.5 Hz, 1H), 2.58 (dd, *J* = 15.8, 1.2 Hz, 1H), 2.34 (s, 3H), 1.28 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.8, 141.6, 137.5, 127.2, 124.8, 123.5, 116.2, 55.8, 52.5, 35.7, 21.8, 21.3

IR (neat)**:** ν (cm^{-1}) 2925, 2855, 1698, 1373, 1277, 1134, 803, 759

HRMS (ESI): Calcd for $C_{12}H_{15}NNaO_2$ $[M+Na]^+$: 228.0995, found 228,0993

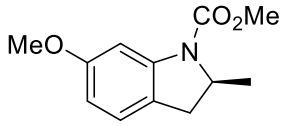
Mp: 84-86 °C

$[\alpha]_D^{20}$ = +33.8° (c = 1.16, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 224 nm, t_r(minor) = 8.3 min, t_r(major) = 10.3 min, 96:4 e.r.

methyl (*S*)-6-methoxy-2-methylindoline-1-carboxylate (2q):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/20 h) and purified by chromatography to give a colorless oil (36.7 mg, 83% yield).



Chemical Formula: $C_{12}H_{15}NO_3$
Molecular Weight: 221,2560 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.50 (bs, 1H), 7.02 (d, *J* = 8.2 Hz, 1H), 6.52 (dd, *J* = 8.2, 2.4 Hz, 1H), 4.46-4.62 (m, 1H), 3.84 (s, 3H), 3.80 (s, 3H), 3.28 (ddd, *J* = 15.5, 9.5, 1.1 Hz, 1H), 2.55 (dd, *J* = 15.5, 2.1 Hz, 1H), 1.28 (d, *J* = 6.3 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 159.7, 153.7, 142.6, 125.3, 121.8, 109.0, 101.4, 56.4, 55.6, 52.6, 35.3, 21.3

IR (neat)**:** ν (cm^{-1}) 2953, 2857, 1704, 1386, 1296, 764

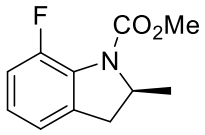
HRMS (ESI): Calcd for $C_{12}H_{15}NNaO_3$ $[M+Na]^+$: 244.0944, found 244,0945

$[\alpha]_D^{20}$ = +22.5° (c = 1.30, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 244 nm, t_r(minor) = 11.6 min, t_r(major) = 13.0 min, 96:4 e.r.

methyl (*S*)-7-fluoro-2-methylindoline-1-carboxylate (2r):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a slight yellow oil (33.1 mg, 79% yield).



Chemical Formula: $C_{11}H_{12}FNO_2$
Molecular Weight: 209,2204 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.02-6.90 (m, 3H), 4.67 (dqd, *J* = 8.5, 6.6, 1.4 Hz, 1H), 3.82 (s, 3H), 3.42 (dd, *J* = 15.8, 8.5 Hz, 1H), 2.52 (d, *J* = 15.8 Hz, 1H), 1.26 (d, *J* = 6.6 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 154.1, 151.9 (d, *J* = 252.1 Hz), 135.6 (d, *J* = 2.8 Hz), 127.9 (d, *J* = 9.9 Hz), 125.1 (d, *J* = 7.0 Hz), 120.8 (d, *J* = 3.3 Hz), 116.0 (d, *J* = 21.2 Hz), 57.9, 53.1, 36.7 (d, *J* = 1.7 Hz), 21.2

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -117.60 to -117.71 (m)

IR (neat)**:** ν (cm^{-1}) 2955, 2926, 1704, 1484, 1381, 762

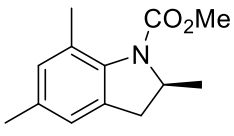
HRMS (ESI): Calcd for $C_{11}H_{12}FNNaO_2$ $[M+Na]^+$: 232.0744, found 232,0744

$[\alpha]_D^{20}$ = +64.5° (c = 1.14, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 242 nm, t_r(minor) = 14.6 min, t_r(major) = 15.5 min, 95.5:4.5 e.r.

methyl (*S*)-2,5,7-trimethylindoline-1-carboxylate (2s):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/18 h) and purified by chromatography to give a slight yellow oil (41.1 mg, 94% yield).



Chemical Formula: $C_{13}H_{17}NO_2$
Molecular Weight: 219,2840 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 6.85 (s, 2H), 4.70 (dqd, *J* = 7.6, 6.6, 0.9 Hz, 1H), 3.78 (s, 3H), 3.35 (dd, *J* = 15.5, 8.4 Hz, 1H), 2.38 (d, *J* = 15.5 Hz, 1H), 2.28 (s, 3H), 2.25 (s, 3H), 1.21 (d, *J* = 6.6 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 155.0, 137.6, 134.2, 133.2, 130.6, 127.9, 123.2, 58.1, 52.6, 36.7, 21.2, 21.0, 20.1

IR (neat)**:** ν (cm^{-1}) 2953, 2922, 1710, 1439, 1366, 1262

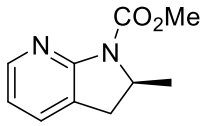
HRMS (ESI): Calcd for $C_{13}H_{17}NNaO_2$ $[M+Na]^+$: 242,1151, found 242,1155

$[\alpha]_D^{20}$ = +12.0° (c = 1.18, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 243 nm, t_r(minor) = 11.3 min, t_r(major) = 17.1 min, 84:16 e.r.

methyl (*S*)-2-methyl-2,3-dihydro-1*H*-pyrrolo[2,3-b]pyridine-1-carboxylate (2t):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 ^{o}C/24 h) and purified by chromatography to give a slight yellow oil (25.8 mg, 67% yield).



Chemical Formula: $C_{10}H_{12}N_2O_2$
Molecular Weight: 192,2180 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 8.11 (dd, *J* = 5.0, 1.4 Hz, 1H), 7.98 (bs, 1H), 7.06 (dd, *J* = 7.9, 5.0 Hz, 1H), 4.64-4.47 (m, 1H), 3.85 (s, 3H), 3.48 (ddd, *J* = 17.0, 9.8, 0.8 Hz, 1H), 2.77 (dd, *J* = 17.0, 2.7 Hz, 1H), 1.34 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.9, 152.6, 143.6, 136.3, 122.1, 121.7, 54.1, 52.8, 38.2, 21.6

IR (neat)**:** ν (cm^{-1}) 2957, 2928, 1706, 1445, 1293, 764

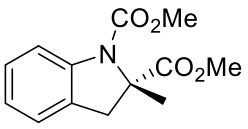
HRMS (ESI): Calcd for $C_{10}H_{13}N_2O_2$ $[M+H]^+$: 193.0977, found 193.0972

$[\alpha]_D^{20}$ = +9.9° (c = 0.80, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 242 nm, t_r(major) = 20.0 min, t_r(minor) = 22.5 min, 94:6 e.r.

dimethyl (*S*)-2-methylindoline-1,2-dicarboxylate (2u):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/20 h) and purified by chromatography to give a colorless oil (41.5 mg, 83% yield).



Chemical Formula: $C_{13}H_{15}NO_4$
Molecular Weight: 249,2660 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.93 (bs, 1H), 7.17-7.27 (m, 1H), 7.18-7.08 (m, 2H), 6.99 (t, *J* = 7.4 Hz, 1H), 3.99-3.67 (m, 6H), 3.46 (d, *J* = 16.1 Hz, 1H), 3.04 (d, *J* = 16.1 Hz, 1H), 1.69 (d, *J* = 1.8 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.8, 152.9, 142.1, 128.1, 123.2, 115.2, 67.7, 52.7, 42.9, 23.7

IR (neat)**:** ν (cm^{-1}) 2952, 2855, 1745, 1703, 1486, 1370, 764

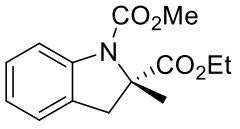
HRMS (ESI): Calcd for $C_{13}H_{15}NNaO_4$ $[M+Na]^+$: 272.0893, found 272,0891

$[\alpha]_D^{20}$ = -10.0° (c = 0.90, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 241 nm, t_r(major) = 22.4 min, t_r(minor) = 26.9 min, 92:8 e.r.

2-ethyl 1-methyl (*S*)-2-methylindoline-1,2-dicarboxylate (2v):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/24 h) and purified by chromatography to give a colorless oil (37.6 mg, 71% yield).



Chemical Formula: $C_{14}H_{17}NO_4$
Molecular Weight: 263,2930 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.93 (bs, 1H), 7.28-7.17 (m, 1H), 7.12 (d, *J* = 7.3 Hz, 1H), 7.00 (t, *J* = 7.3 Hz, 1H), 4.34-4.09 (m, 2H), 3.77 (s, 3H), 3.45 (d, *J* = 16.1 Hz, 1H), 3.03 (d, *J* = 16.1 Hz, 1H), 1.68 (s, 3H), 1.24 (t, *J* = 7.1 Hz, 7H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.3, 142.3, 128.1, 127.3, 124.6, 123.2, 115.3, 67.8, 61.6, 52.5, 43.0, 23.5, 14.3

IR (neat)**:** ν (cm^{-1}) 2982, 2855, 1738, 1704, 1371, 1240, 754

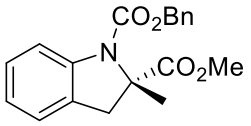
HRMS (ESI): Calcd for $C_{14}H_{17}NNaO_4$ $[M+Na]^+$: 286.1050, found 286,1051

$[\alpha]_D^{20}$ = -13.7° (c = 1.15, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 241 nm, t_r(major) = 23.9 min, t_r(minor) = 27.4 min, 85:15 e.r.

1-benzyl 2-methyl (*S*)-2-methylindoline-1,2-dicarboxylate (2w):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/17 h) and purified by chromatography to give a colorless oil (30 mg, 46% yield).



Chemical Formula: $C_{19}H_{19}NO_4$
Molecular Weight: 325,3640 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.98 (d, *J* = 6.6 Hz, 1H), 7.47-6.95 (m, 8H), 5.40-5.30 (m, *J* = 11.1 Hz, 2H), 3.46 (d, *J* = 16.2 Hz, 1H), 3.42 (s, 3H), 3.04 (d, *J* = 16.2 Hz, 1H), 1.70 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.6, 152.2, 142.2, 140.9, 135.8, 128.7, 128.4, 128.1, 127.1, 124.5, 123.3, 115.4, 67.7, 67.4, 52.5, 43.0, 23.7

IR (neat)**:** ν (cm^{-1}) 3033, 2949, 1744, 1703, 1397, 753

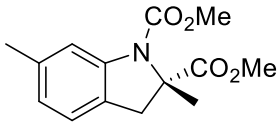
HRMS (ESI): Calcd for $C_{19}H_{19}NNaO_4$ $[M+Na]^+$: 348.1206, found 348,1208

$[\alpha]_D^{20}$ = -22.6° (c = 1.36, $CHCl_3$)

HPLC separation: Chiralpak IA; 97:3 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 242 nm, t_r(major) = 18.9 min, t_r(minor) = 31.7 min, 80:20 e.r.

dimethyl (*S*)-2,6-dimethylindoline-1,2-dicarboxylate (2x):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/20 h) and purified by chromatography to give a pale viscous oil (26.5 mg, 50% yield).



Chemical Formula: $C_{14}H_{17}NO_4$
Molecular Weight: 263,2930 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.78 (bs, 1H), 6.99 (d, *J* = 7.5 Hz, 1H), 6.81 (d, *J* = 7.5 Hz, 1H), 3.93-3.68 (m, 6H), 3.41 (d, *J* = 15.9 Hz, 1H), 2.99 (d, *J* = 15.9 Hz, 1H), 2.35 (s, 3H), 1.68 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.9, 153.0, 142.3, 138.2, 124.6, 124.2, 123.9, 116.0, 68.0, 52.7, 42.6, 23.6, 21.8

IR (neat)**:** ν (cm^{-1}) 2954, 2860, 1745, 1701, 1369, 1070, 752

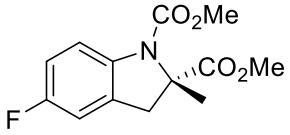
HRMS (ESI): Calcd for $C_{14}H_{17}NNaO_4$ $[M+Na]^+$: 286.1050, found 286,1049

$[\alpha]_D^{20}$ = -10.0° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 243 nm, t_r(major) = 15.3 min, t_r(minor) = 16.3 min, 94:6 e.r.

dimethyl (*S*)-5-fluoro-2-methylindoline-1,2-dicarboxylate (2y):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/17 h) and purified by chromatography to give a colorless oil (41.2 mg, 77% yield).



Chemical Formula: $C_{13}H_{14}FNO_4$
Molecular Weight: 267,2564 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.86 (bs, 1H), 6.99-6.76 (m, 2H), 3.90-3.67 (m, 6H), 3.43 (d, *J* = 16.4 Hz, 1H), 3.01 (d, *J* = 16.4 Hz, 1H), 1.68 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.5, 159.2 (d, *J* = 241.1 Hz), 153.0, 138.3, 128.8, 115.9, 114.4 (d, *J* = 22.5 Hz), 112.0, 68.1, 52.8, 42.7, 23.7

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -120.55 (s)

IR (neat)**:** ν (cm^{-1}) 2954, 2854, 1745, 1707, 1487, 1372, 1257, 764

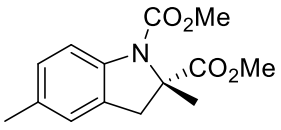
HRMS (ESI): Calcd for $C_{13}H_{14}FNNaO_4$ $[M+Na]^+$: 290.0799, found 290,0800

$[\alpha]_D^{20}$ = -5.9° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 238 nm, t_r(major) = 22.5 min, t_r(minor) = 25.3 min, 93.5:6.5 e.r.

dimethyl (*S*)-2,5-dimethylindoline-1,2-dicarboxylate (2z):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/22 h) and purified by chromatography to give a pale viscous oil (31.1 mg, 59% yield).



Chemical Formula: $C_{14}H_{17}NO_4$
Molecular Weight: 263,2930 g.mol^{-1}

Mixture of two rotameres, description of the major:

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.79 (bs, 1H), 7.07-6.96 (m, 1H), 6.93 (s, 1H), 3.90-3.67 (m, 6H), 3.42 (d, *J* = 16.2 Hz, 1H), 3.00 (d, *J* = 16.2 Hz, 1H), 2.29 (s, 3H), 1.68 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.9, 152.9, 139.9,

132.8, 128.6, 127.2, 125.2, 115.0, 67.7, 52.7, 42.9, 23.6, 20.9

IR (neat)**:** ν (cm^{-1}) 2953, 2857, 1745, 1705, 1493, 1361, 1073, 763

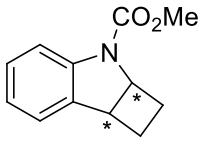
HRMS (ESI): Calcd for $C_{14}H_{17}NNaO_4$ $[M+Na]^+$: 286.1050, found 286,1052

$[\alpha]_D^{20}$ = -3.4° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 97:3 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 243 nm, t_r(major) = 23.3 min, t_r(minor) = 33.9 min, 93:7 e.r.

methyl 2,2a-dihydro-1*H*-cyclobuta[b]indole-3(7b*H*)-carboxylate (2aa):

The title compound was prepared according to the ***General procedure F*** (0.5 mmol scale, 140 °C/48 h) and purified by chromatography to give a slight yellow oil (18 mg, 18% yield).



Chemical Formula: $C_{12}H_{13}NO_2$
Molecular Weight: 203,2410 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.93 (d, *J* = 7.1 Hz, 1H), 7.23 (t, *J* = 7.3 Hz, 1H), 7.14 (d, *J* = 7.4 Hz, 1H), 7.00 (td, *J* = 7.4, 1.0 Hz, 1H), 4.99-4.75 (m, 1H), 4.00-3.73 (m, 4H), 2.70-2.46 (m, 2H), 2.32-2.15 (m, 1H), 2.07-1.95 (m, 1H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.2, 143.8, 135.8, 128.0, 124.7, 123.1, 115.4, 58.5, 52.5, 41.1, 29.4, 26.8

IR (neat)**:** ν (cm^{-1}) 2947, 2853, 1702, 1386, 1062, 747

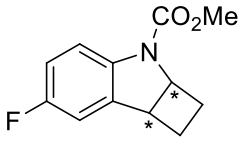
HRMS (ESI): Calcd for $C_{12}H_{13}NNaO_2$ $[M+Na]^+$: 226.0838, found 226,0838

$[\alpha]_D^{20}$ = -39.2° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 $ml.min^{-1}$, 245 nm, t_r(minor) = 9.1 min, t_r(major) = 10.1 min, 97:3 e.r.

methyl 6-fluoro-2,2a-dihydro-1*H*-cyclobuta[b]indole-3(7b*H*)-carboxylate (2ab):

The title compound was prepared according to the ***General procedure F*** (0.5 mmol scale, 140 °C/48 h) and purified by chromatography to give a white solid (25 mg, 23% yield).



Chemical Formula: $C_{12}H_{12}FNO_2$
Molecular Weight: 221,2314 $g.mol^{-1}$

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.85 (dd, *J* = 7.4, 4.1 Hz, 1H), 6.90 (t, *J* = 8.6 Hz, 1H), 6.84 (dd, *J* = 8.1, 2.3 Hz, 1H), 5.01-4.77 (m, 1H), 3.96-3.69 (m, 4H), 2.67-2.43 (m, 2H), 2.32-2.15 (m, 1H), 2.07-1.94 (m, 1H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 159.3 (d, *J* = 240.9 Hz), 153.2, 139.8, 137.6, 116.1, 114.2 (d, *J* = 22.7 Hz), 111.9 (d, *J* = 24.0 Hz), 58.9, 52.6, 41.1, 29.4, 26.7

^{19}F NMR (376 MHz, $CDCl_3$): δ (ppm) -120.88 (s)

IR (neat)**:** ν (cm^{-1}) 2994, 2951, 2920, 2851, 1705, 1248, 1071, 853, 751

HRMS (ESI): Calcd for $C_{12}H_{12}FNNaO_2$ $[M+Na]^+$: 244.0744, found 244,0745

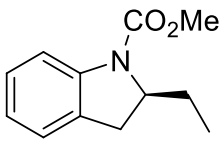
Mp: 57-60 °C

$[\alpha]_D^{20}$ = -29.4° (c = 0.50, $CHCl_3$)

HPLC separation: Chiralpak IA; 99.5:0.5 (*n*-heptane/*i*-PrOH), 0.5 $ml.min^{-1}$, 242 nm, t_r(minor) = 17.8 min, t_r(major) = 20.4 min, 97:3 e.r.

(*S*)-methyl 2-ethylindoline-1-carboxylate (2ac):

The title compound was prepared according to the ***General procedure F*** (0.2 mmol scale, 120 °C/24 h) and purified by chromatography to give a colorless oil (12.6 mg, 31% yield). NMR spectroscopic data are consistent with those previously reported.[14] **2ac** was assigned a (*S*) absolute configuration by comparison of HPLC data with those previously reported.[13]



Chemical Formula: $C_{12}H_{15}NO_2$
Molecular Weight: 205,2570 $g.mol^{-1}$

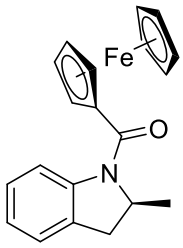
^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.72 (bs, 1H), 7.19-7.13 (m, 2H), 6.95 (td, *J* = 7.4, 1.0 Hz, 1H), 4.39 (m, 1H), 3.84 (s, 3H), 3.28 (dd, *J* = 16.1, 9.7 Hz, 1H), 2.76 (dd, *J* = 16.1, 2.2 Hz, 1H), 1.78 (m, 1H), 1.67-1.49 (m, 1H), 0.88 (t, *J* = 7.5 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 153.9, 142.0, 130.5, 127.4, 124.9, 122.8, 115.4, 60.7, 52.5, 32.9, 27.4, 9.1

$[\alpha]_D^{20}$ = +26.3° (c = 0.96, $CHCl_3$)

HPLC separation: Chiralpak AD-H; 99:1 (*n*-heptane/*i*-PrOH), 0.5 $ml.min^{-1}$, 243 nm, t_r(minor) = 20.6 min, t_r(major) = 26.4 min, 73:27 e.r.

(S)-2-methylindoline-1-Ferrocenoyl (5a):



Chemical Formula: $C_{20}H_{19}FeNO$
Molecular Weight: 345,2230 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.78 (bs, 1H), 7.21 (d, *J* = 7.4 Hz, 1H), 7.14 (t, *J* = 6.9 Hz, 1H), 7.01 (t, *J* = 7.4 Hz, 1H), 4.97-4.86 (m, 1H), 4.83-4.71 (m, *J* = 10.2 Hz, 2H), 4.41-4.35 (m, 2H), 4.26 (s, 4H), 3.39 (dd, *J* = 15.5, 8.6 Hz, 1H), 2.64 (d, *J* = 15.5 Hz, 1H), 1.29 (d, *J* = 6.4 Hz, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 168.6, 142.5, 131.0, 127.2, 125.3, 123.7, 118.0, 79.4, 72.8, 71.0, 70.4, 70.2, 70.0, 69.7, 56.6, 36.7, 21.7

IR (neat)**:** ν (cm^{-1}) 2958, 2920, 1632, 1385, 756, 480

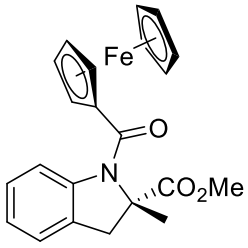
HRMS (ESI): Calcd for $C_{20}H_{19}FeNNaO$ $[M+H]^+$: 346.0894, found 346.0889

Mp: 130-133 °C

$[\alpha]_D^{20}$ = +13.9° (c = 1.09, $CHCl_3$)

HPLC separation: Chiralcel OJ-H; 97:3 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 272 nm, t_r(minor) = 15.1 min, t_r(major) = 17.1 min, 93:7 e.r.

methyl (S)-2-methylindoline-2-carboxylate-1-ferrocenoyl (5u):



Chemical Formula: $C_{22}H_{21}FeNO_3$
Molecular Weight: 403,2590 g.mol^{-1}

^{1}H NMR (400 MHz, $CDCl_3$): δ (ppm) 7.15-7.10 (m, 1H), 6.94-6.85 (m, 2H), 6.61-6.55 (m, 1H), 4.81 (dt, *J* = 2.5, 1.3 Hz, 1H), 4.63 (dt, *J* = 2.5, 1.2 Hz, 1H), 4.41 (td, *J* = 2.5, 1.3 Hz, 1H), 4.31 (td, *J* = 2.5, 1.3 Hz, 1H), 4.26 (s, 4H), 3.81 (s, 3H), 3.45 (d, *J* = 15.6 Hz, 1H), 2.93 (d, *J* = 15.6 Hz, 1H), 1.73 (s, 3H)

^{13}C NMR (101 MHz, $CDCl_3$): δ (ppm) 173.5, 169.2, 142.2, 129.7, 126.7, 125.3, 123.0, 115.6, 79.2, 72.2, 70.6, 70.3, 70.2, 69.8, 69.3, 52.8, 41.9, 21.7

IR (neat)**:** ν (cm^{-1}) 2924, 2853, 1740, 1318, 747, 482

HRMS (ESI): Calcd for $C_{22}H_{21}FeNNaO_3$ $[M+Na]^+$: 426.0763, found 426,0761

Mp: 61-63 °C

$[\alpha]_D^{20}$ = -163° (c = 1.00, $CHCl_3$)

HPLC separation: Chiralpak IA; 99:1 (*n*-heptane/*i*-PrOH), 1.0 ml.min^{-1}, 210 nm, t_r(major) = 16.1 min, t_r(minor) = 20.6 min, 90:10 e.r

Computational details (Figure 1)

DFT-D3 calculations were performed with Gaussian 09 D.01, with the hybrid PBE0 functional,[15] and the D3(bj) correction.[16] The Pd atom was represented by the relativistic effective core potential (RECP) from the Stuttgart group and the associated basis set augmented by a f polarization function (α = 1.472).[17] The remaining atoms (C, H, N, O) were represented by a SVP basis set.[18] The solvent (mesitylene) influence was taken into consideration through single point calculations on the gas-phase optimized geometry within the SMD model.[19] For the SCRF calculations, the atoms were treated with a Def2-svp basis sets.[20]

Cartesian coordinates of optimized κ^2-complex

```
150
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C          1.42865       -2.75023        1.54535
C          1.94846       -5.03260        3.15432
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C          1.00245        5.36538       -0.35243
C         -1.40491        5.38221       -0.83996
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C         -2.99656        2.20750       -0.17021
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C	3.29554	3.56098	0.13905
C	4.45384	2.93401	0.59718
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C	-5.31124	-2.10665	-0.14170
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F	-4.23280	-2.03219	-4.40255
F	-2.28475	-1.44293	-3.70822
F	-3.01541	-3.43495	-3.32258

References

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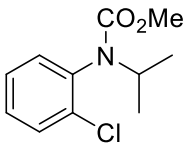
NMR Spectra and chromatograms

^{1}H NMR, $CDCl_3$, 400 MHz



1aCl

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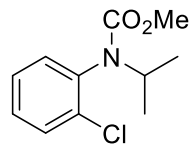

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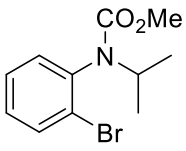

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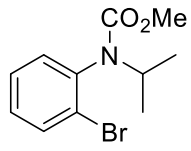

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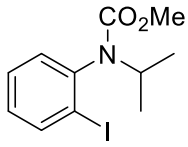

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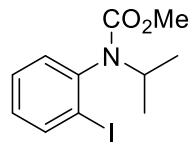

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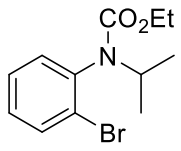

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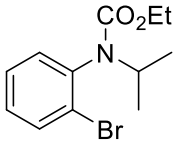

1b

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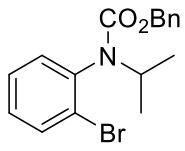

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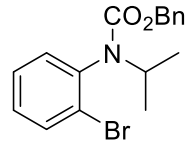

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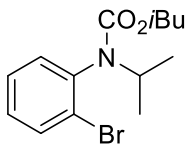

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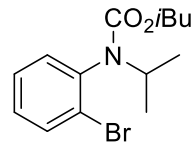

1d

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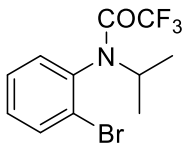

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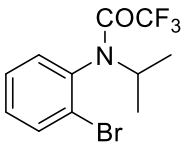

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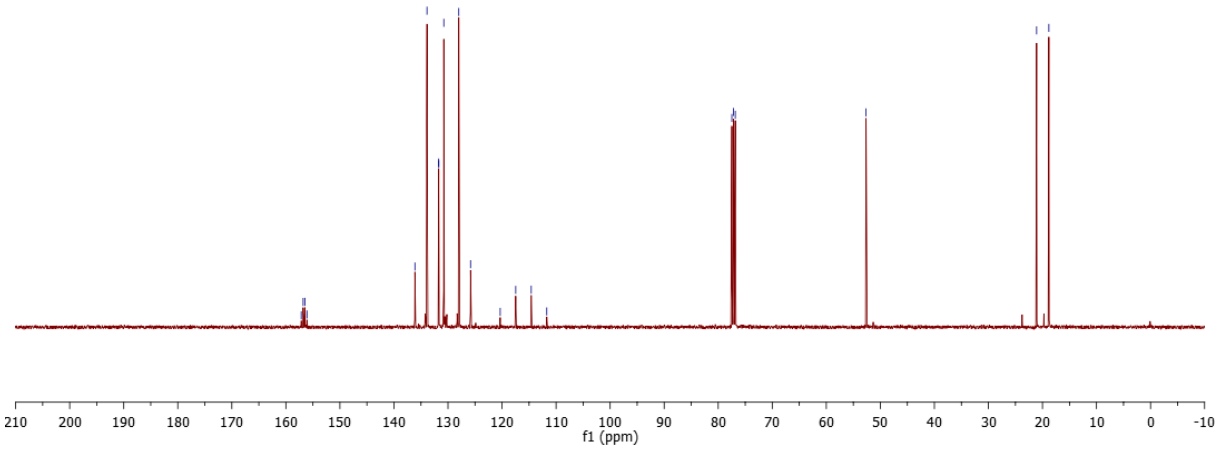

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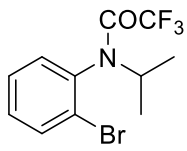

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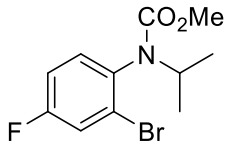

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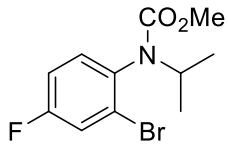

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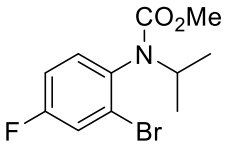

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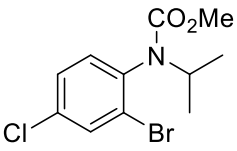

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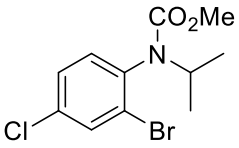

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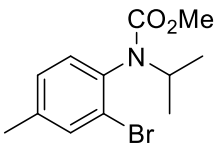

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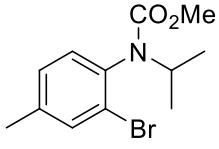

1j

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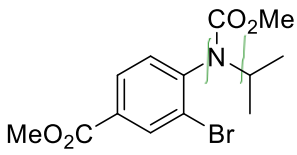

1k

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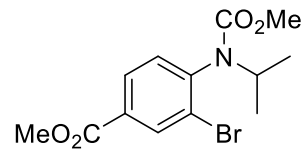

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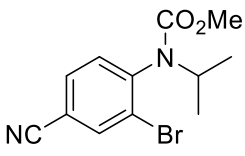

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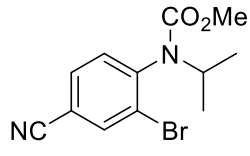

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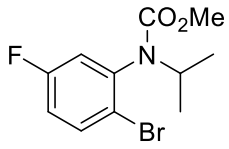

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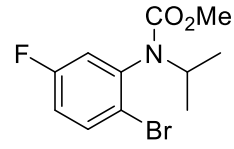

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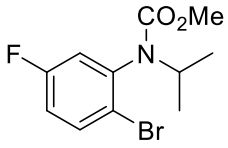

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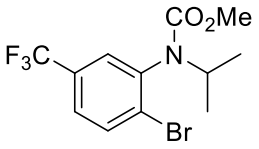

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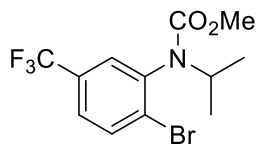

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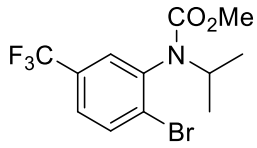

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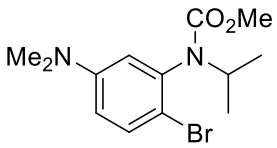

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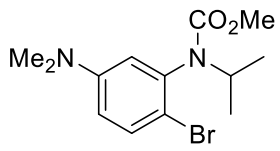

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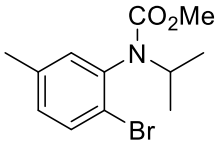

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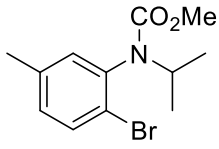

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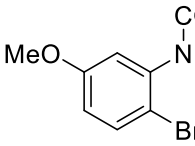

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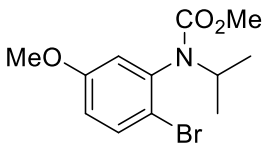

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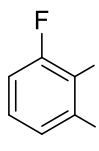

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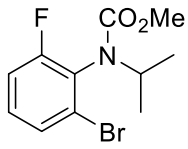

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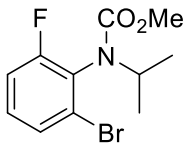

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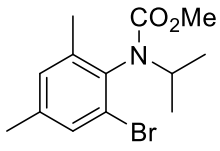

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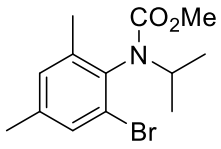
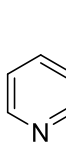


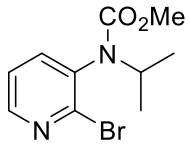
1s

^{1}H NMR, $CDCl_3$, 400 MHz



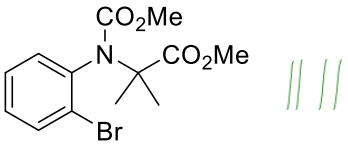
1t

^{13}C NMR, $CDCl_3$, 101 MHz



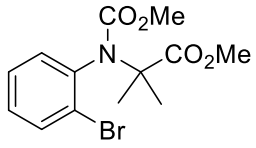
1s

^{1}H NMR, $CDCl_3$, 400 MHz



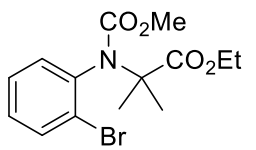
1u

^{13}C NMR, $CDCl_3$, 101 MHz



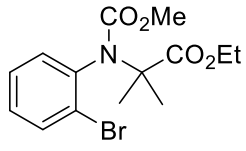
1u

^{1}H NMR, $CDCl_3$, 400 MHz



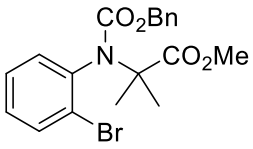
1v

^{13}C NMR, $CDCl_3$, 101 MHz



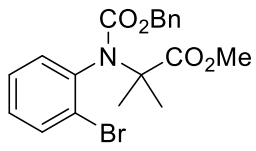
1v

^{1}H NMR, $CDCl_3$, 400 MHz



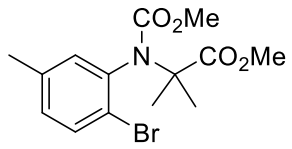
1w

^{13}C NMR, $CDCl_3$, 101 MHz



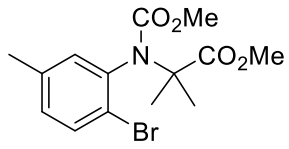
1w

^{1}H NMR, $CDCl_3$, 400 MHz



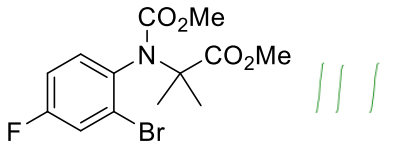
1x

^{13}C NMR, $CDCl_3$, 101 MHz



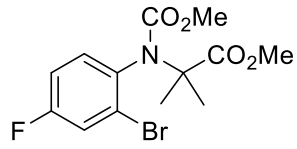
1x

^{1}H NMR, $CDCl_3$, 400 MHz



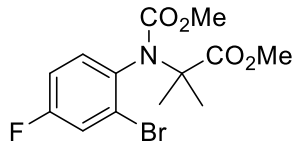
1y

^{13}C NMR, $CDCl_3$, 101 MHz



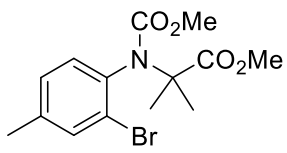
1y

^{19}F NMR, $CDCl_3$, 376 MHz



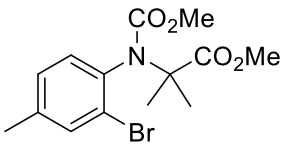
1y

^{1}H NMR, $CDCl_3$, 400 MHz



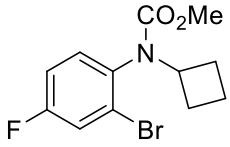
1z

^{13}C NMR, $CDCl_3$, 101 MHz



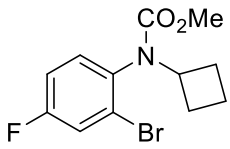
1z

^{1}H NMR, $CDCl_3$, 400 MHz



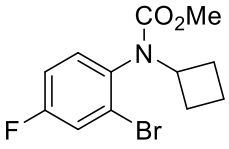
1ab

^{13}C NMR, $CDCl_3$, 101 MHz



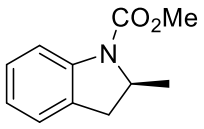
1ab

^{19}F NMR, $CDCl_3$, 376 MHz



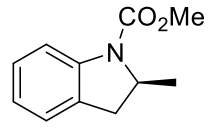
1ab

^{1}H NMR, $CDCl_3$, 400 MHz

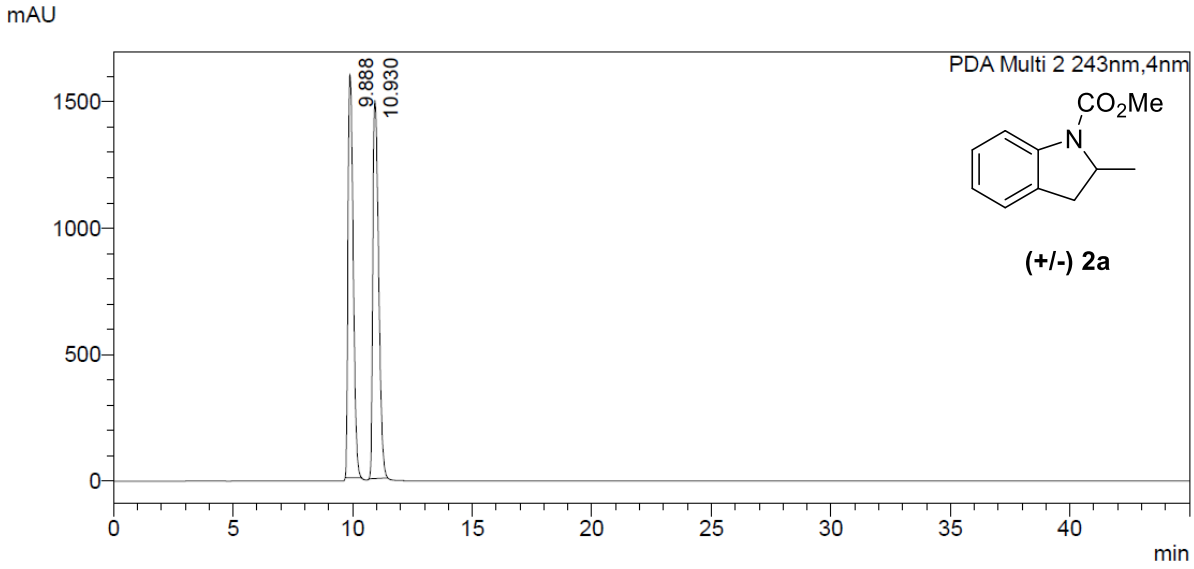


2a

^{13}C NMR, $CDCl_3$, 101 MHz



2a

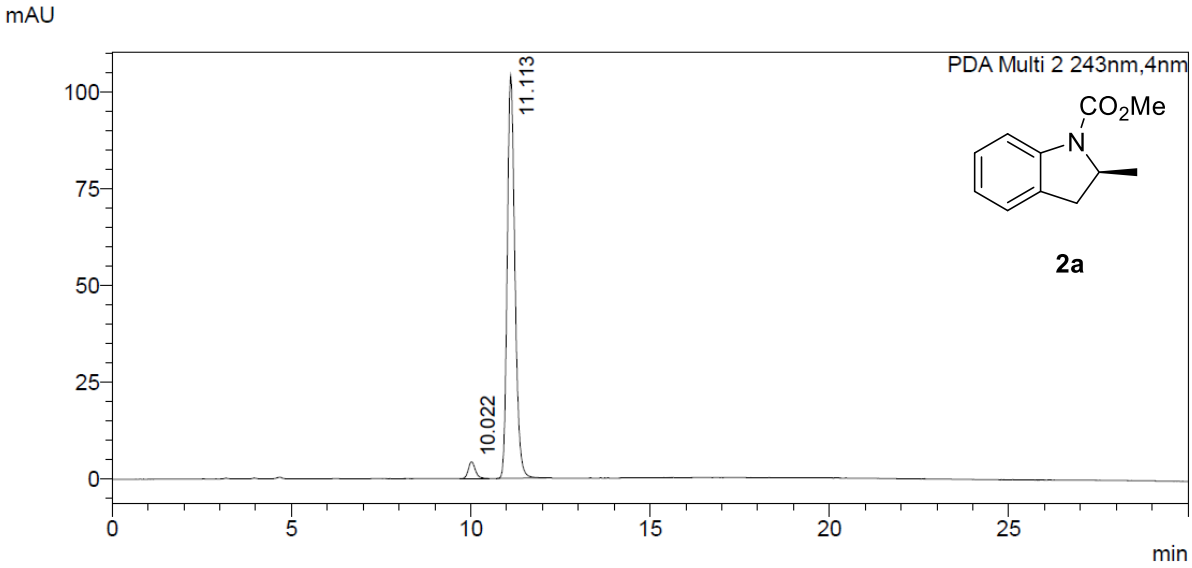


<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	9.888	24265404	1591847	49.017
2	10.930	25238882	1495620	50.983
Total		49504286	3087467	100.000

Small scale (0.2 mmol)

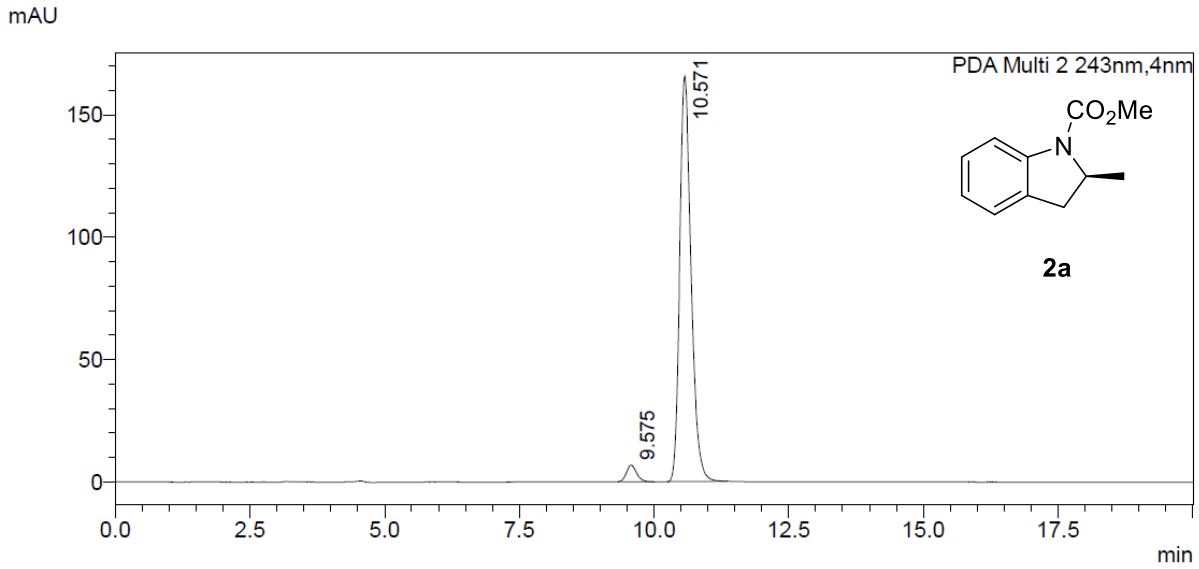


<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	10.022	58166	4319	3.619
2	11.113	1548946	103968	96.381
Total		1607112	108287	100.000

Gram scale (5 mmol)

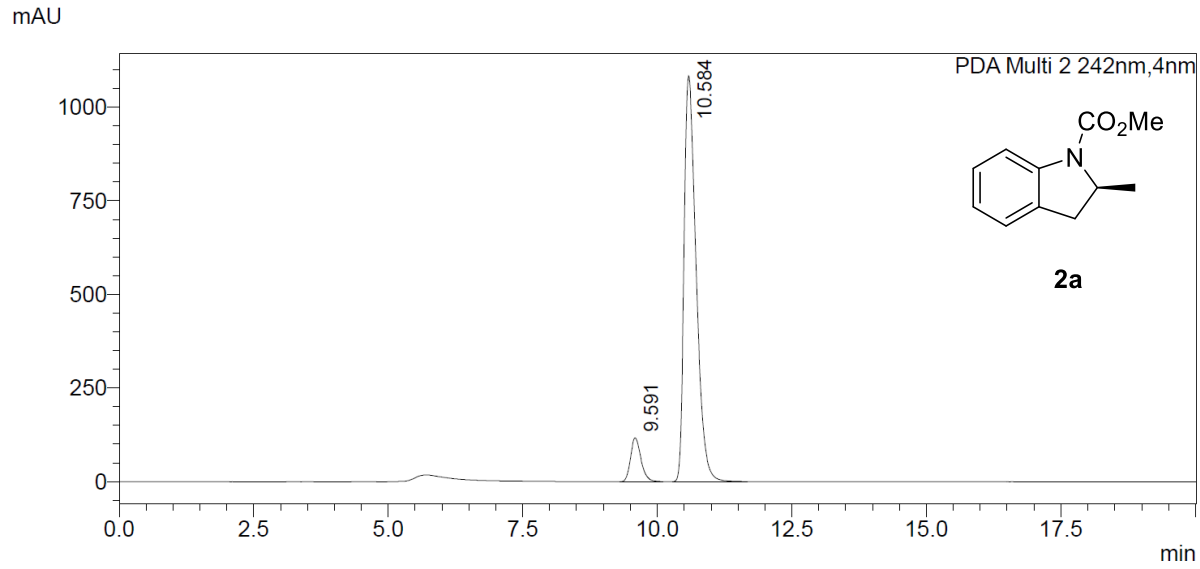


<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	9.575	88777	6793	3.521
2	10.571	2432462	165708	96.479
Total		2521239	172501	100.000

Methyl 2-chlorophenyl(isopropyl)carbamate as the substrate

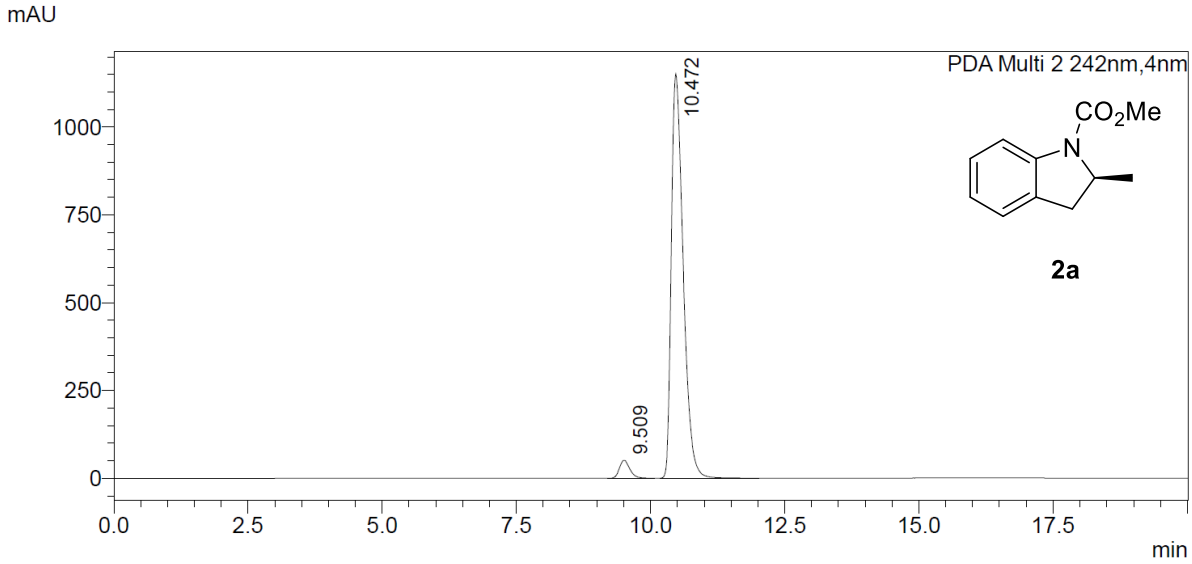


<Peak Table>

PDA Ch2 242nm

Peak#	Ret. Time	Area	Height	Area%
1	9.591	1570580	117053	8.529
2	10.584	16844490	1083280	91.471
Total		18415070	1200333	100.000

Methyl 2-iodophenyl(isopropyl)carbamate as the substrate

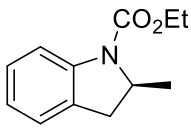


<Peak Table>

PDA Ch2 242nm

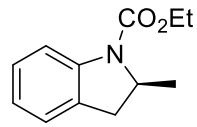
Peak#	Ret. Time	Area	Height	Area%
1	9.509	684830	51133	3.722
2	10.472	17716701	1150815	96.278
Total		18401531	1201947	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

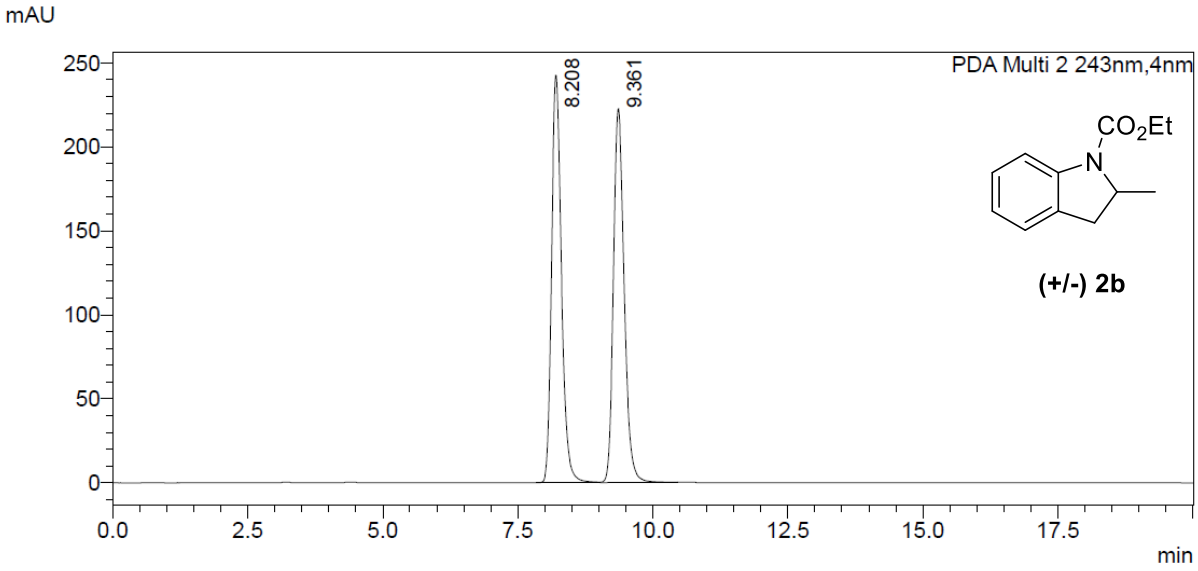


2b

^{13}C NMR, $CDCl_3$, 101 MHz



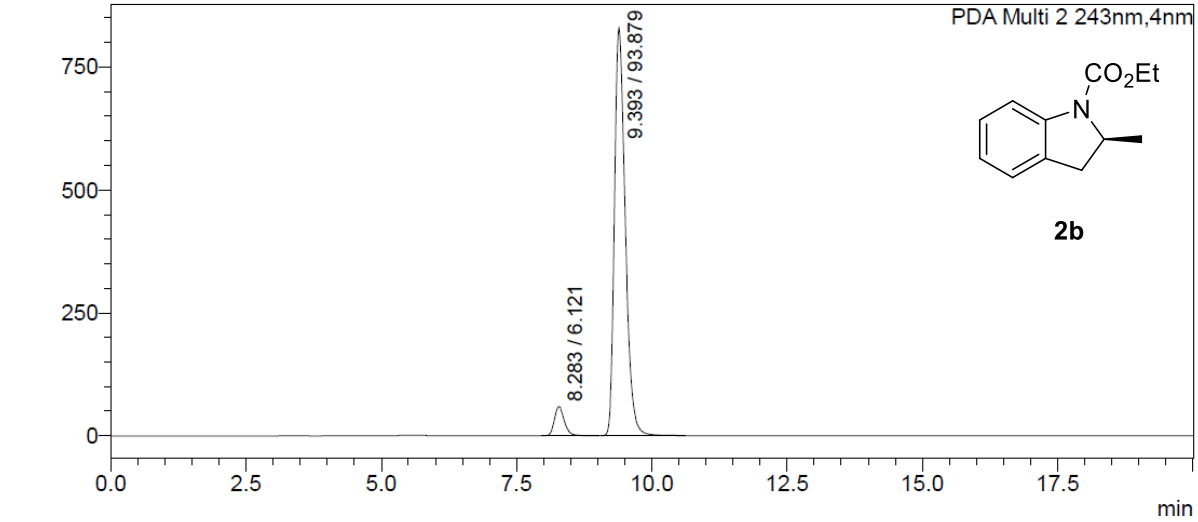
2b



<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	8.208	3075134	242442	49.975
2	9.361	3078236	222441	50.025
Total		6153370	464883	100.000

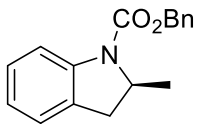


<Peak Table>

PDA Ch2 243nm

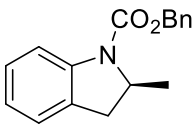
Peak#	Ret. Time	Area	Height	Area%
1	8.283	753891	59486	6.121
2	9.393	11561909	829587	93.879
Total		12315801	889073	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

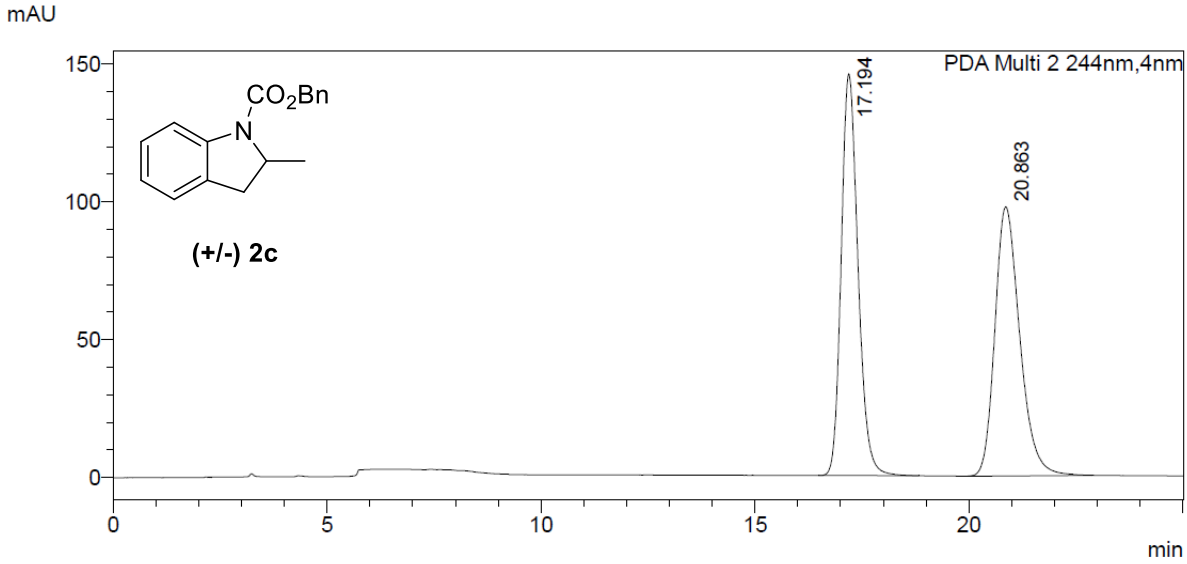


2c

^{13}C NMR, $CDCl_3$, 101 MHz



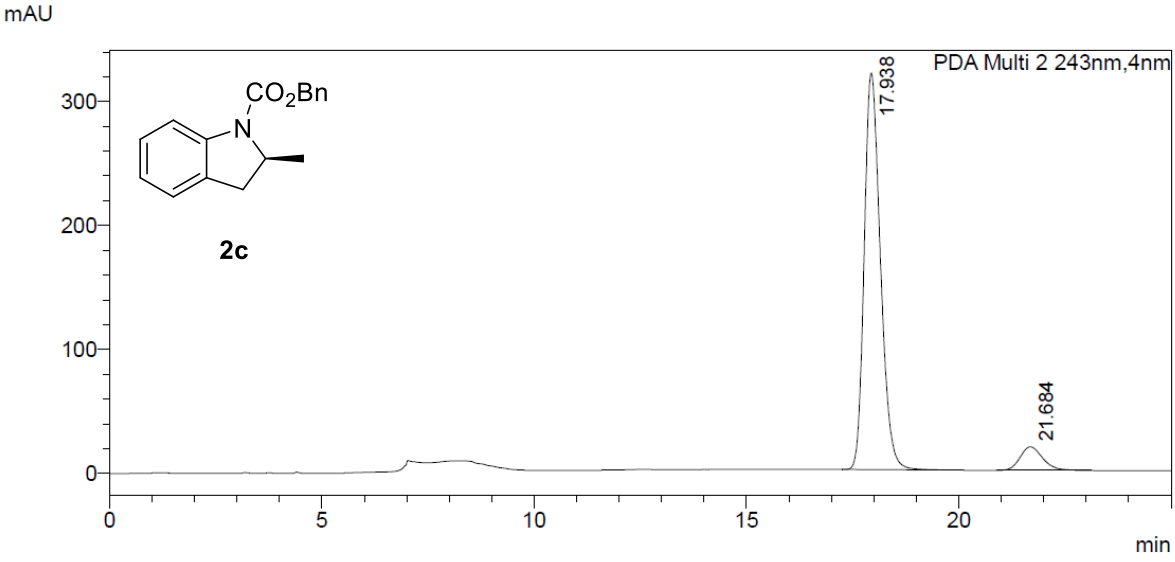
2c



<Peak Table>

PDA Ch2 244nm

Peak#	Ret. Time	Area	Height	Area%
1	17.194	3972368	145545	50.154
2	20.863	3947941	97514	49.846
Total		7920309	243059	100.000

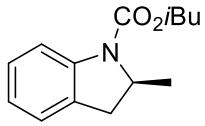


<Peak Table>

PDA Ch2 243nm

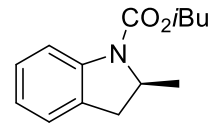
Peak#	Ret. Time	Area	Height	Area%
1	17.938	8483025	319782	92.342
2	21.684	703458	19002	7.658
Total		9186483	338784	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

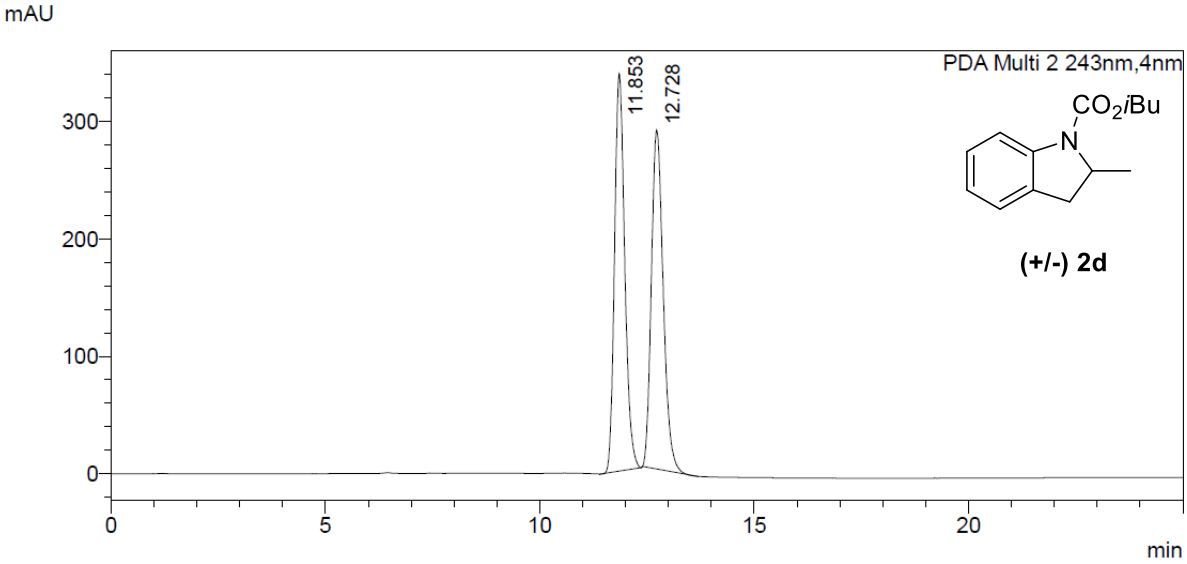


2d

^{13}C NMR, $CDCl_3$, 101 MHz



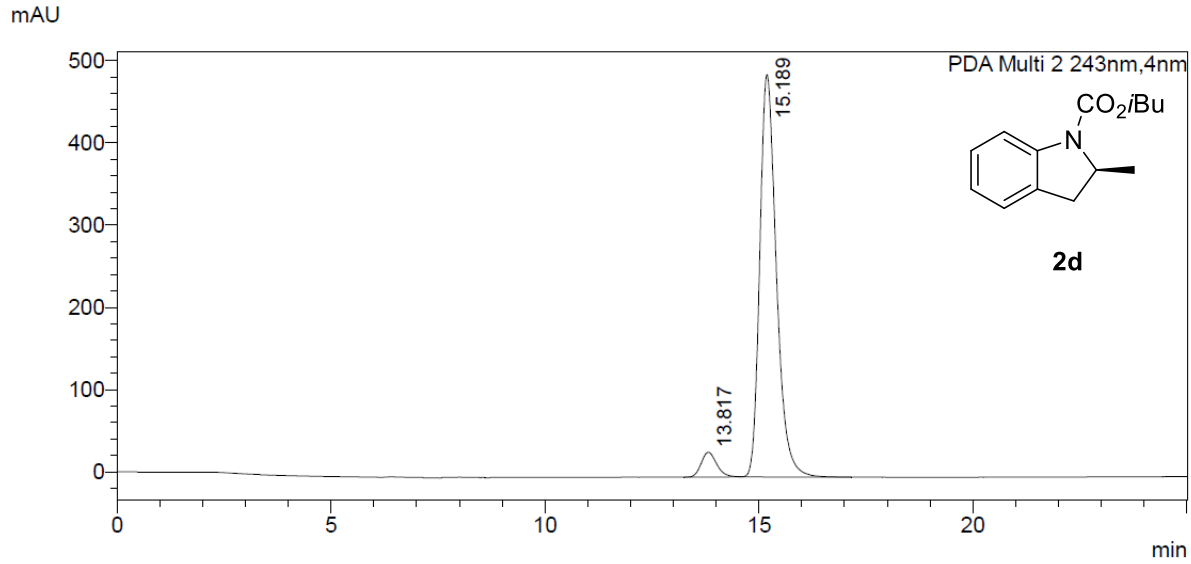
2d



<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	11.853	5603938	338509	50.240
2	12.728	5550466	288814	49.760
Total		11154404	627323	100.000

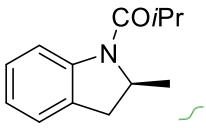


<Peak Table>

PDA Ch2 243nm

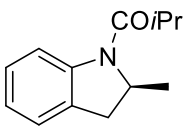
Peak#	Ret. Time	Area	Height	Area%
1	13.817	757360	30144	5.428
2	15.189	13195955	488695	94.572
Total		13953315	518839	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

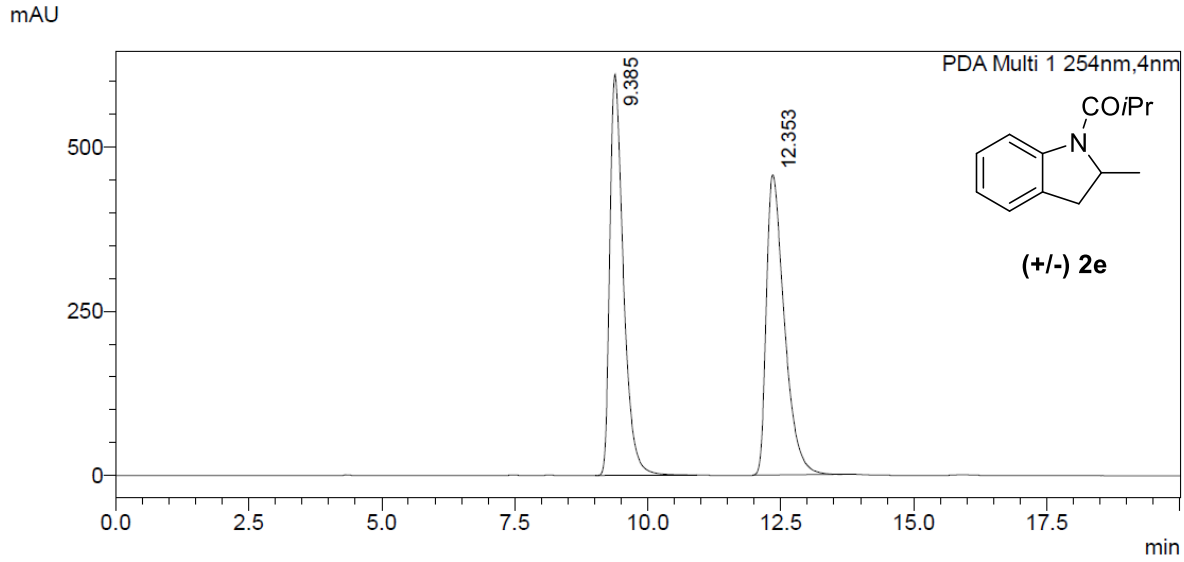


2e

^{13}C NMR, $CDCl_3$, 101 MHz



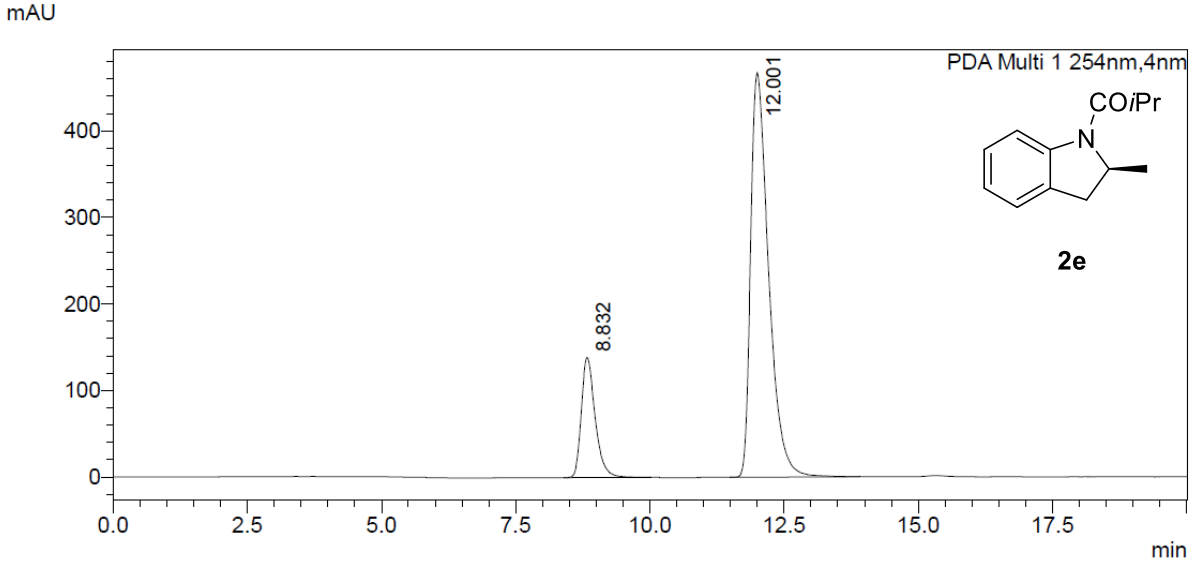
2e



<Peak Table>

PDA Ch1 254nm

Peak#	Ret. Time	Area	Height	Area%
1	9.385	10875515	611160	50.149
2	12.353	10810916	457455	49.851
Total		21686431	1068615	100.000

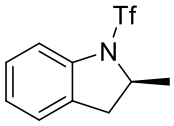


<Peak Table>

PDA Ch1 254nm

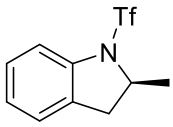
Peak#	Ret. Time	Area	Height	Area%
1	8.832	2492245	138925	18.590
2	12.001	10914480	467498	81.410
Total		13406724	606422	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



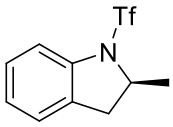
2g

^{13}C NMR, $CDCl_3$, 101 MHz

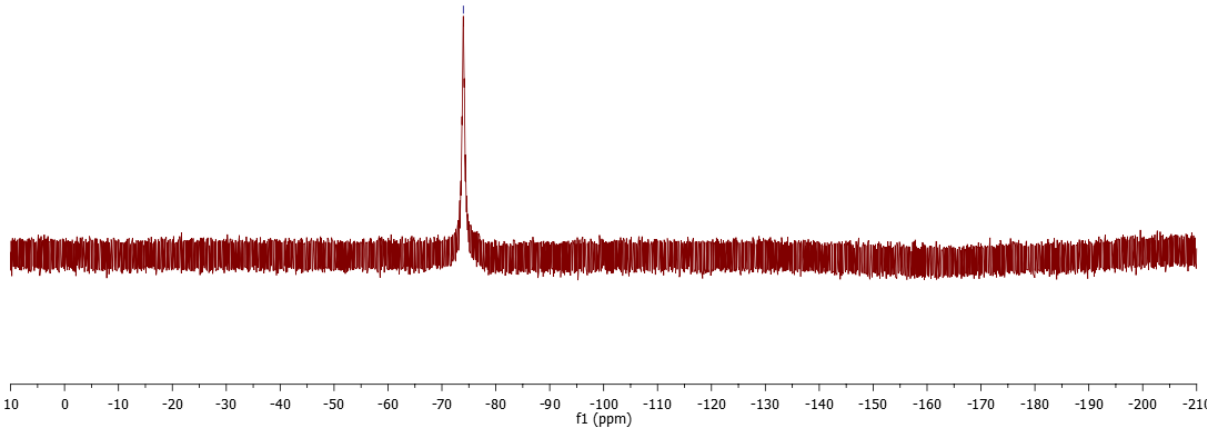


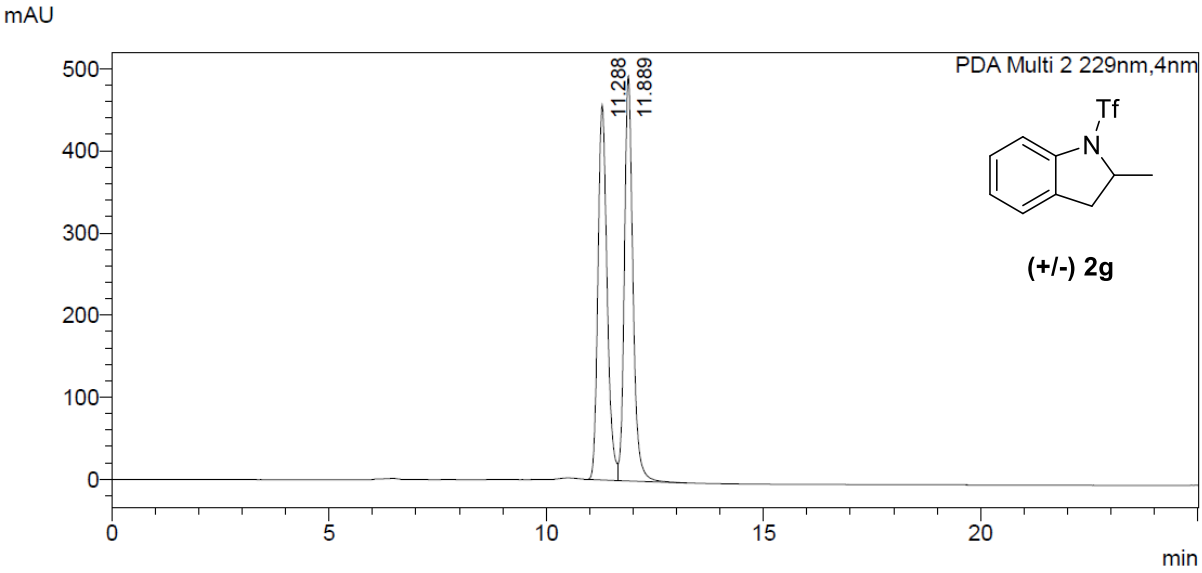
2g

^{19}F NMR, $CDCl_3$, 376 MHz



2g

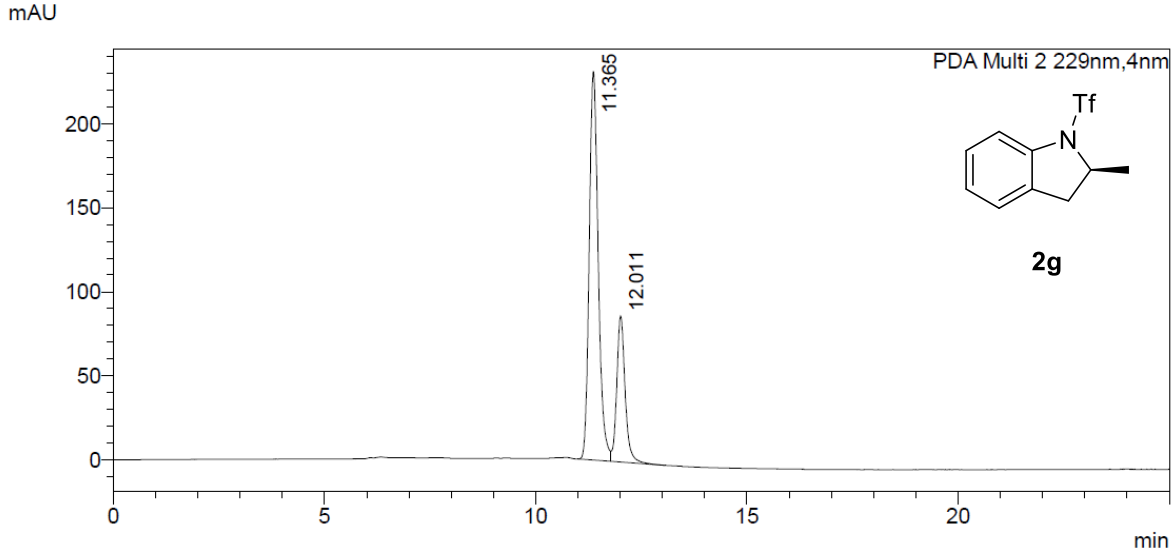




<Peak Table>

PDA Ch2 229nm

Peak#	Ret. Time	Area	Height	Area%
1	11.288	6695079	456641	49.706
2	11.889	6774408	493005	50.294
Total		13469487	949646	100.000

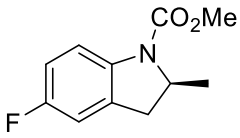


<Peak Table>

PDA Ch2 229nm

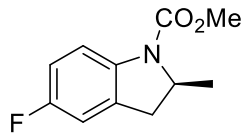
Peak#	Ret. Time	Area	Height	Area%
1	11.365	3432550	231122	74.065
2	12.011	1201934	86878	25.935
Total		4634483	318000	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



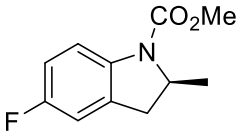
2h

^{13}C NMR, $CDCl_3$, 101 MHz

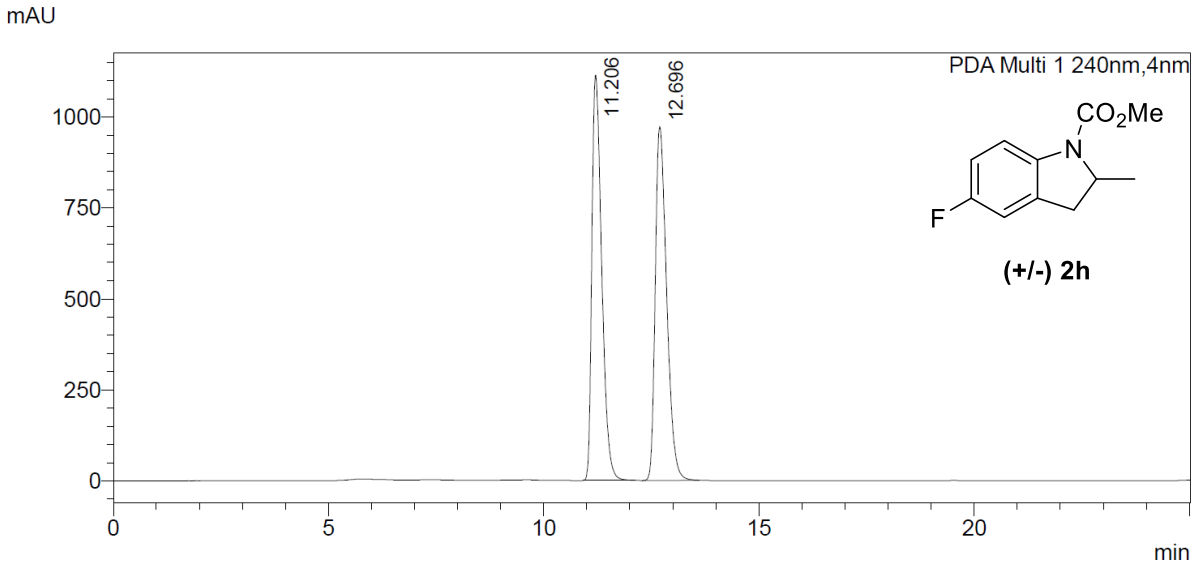


2h

^{19}F NMR, $CDCl_3$, 376 MHz



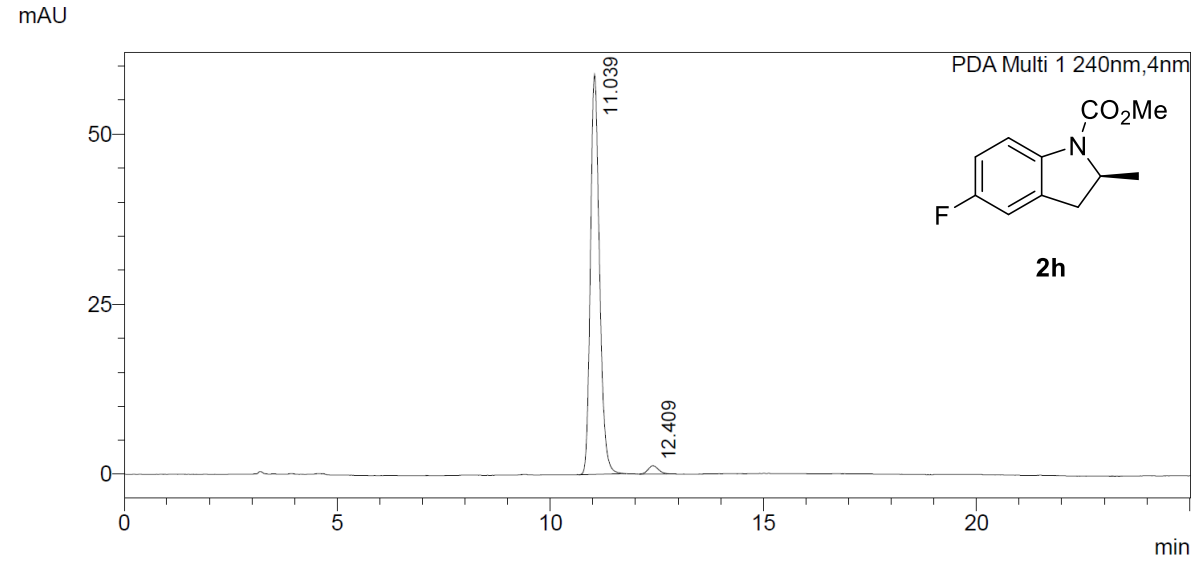
2h



<Peak Table>

PDA Ch1 240nm

Peak#	Ret. Time	Area	Height	Area%
1	11.206	17693224	1113742	49.793
2	12.696	17840493	972153	50.207
Total		35533718	2085895	100.000

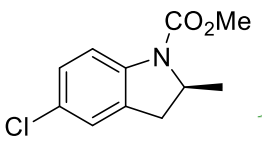


<Peak Table>

PDA Ch1 240nm

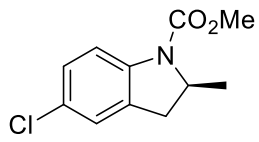
Peak#	Ret. Time	Area	Height	Area%
1	11.039	870376	58780	97.663
2	12.409	20832	1218	2.337
Total		891207	59998	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

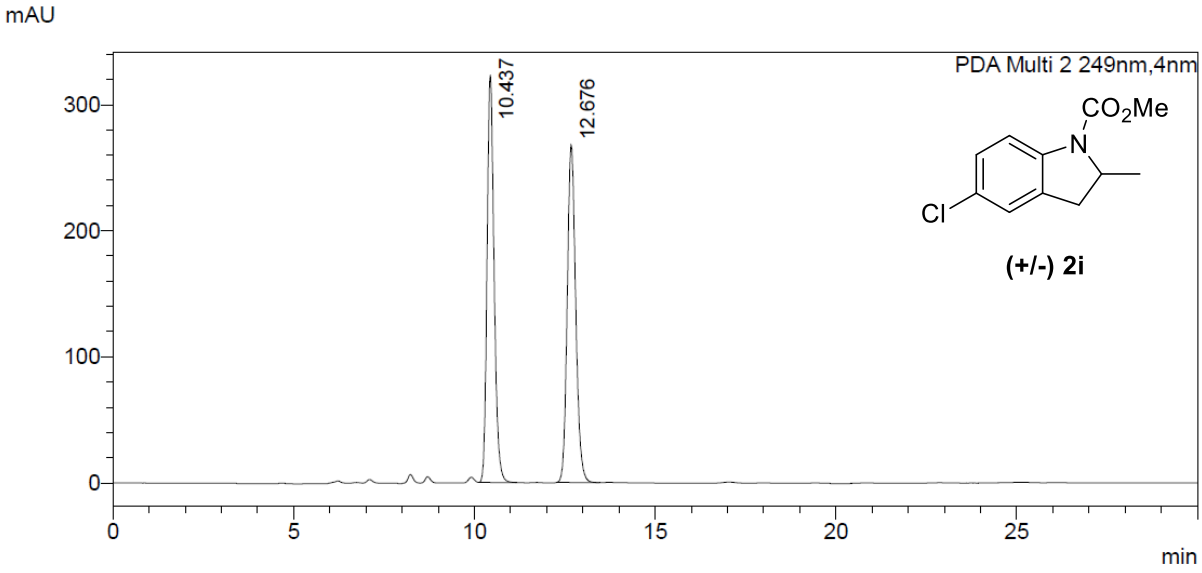


2i

^{13}C NMR, $CDCl_3$, 101 MHz



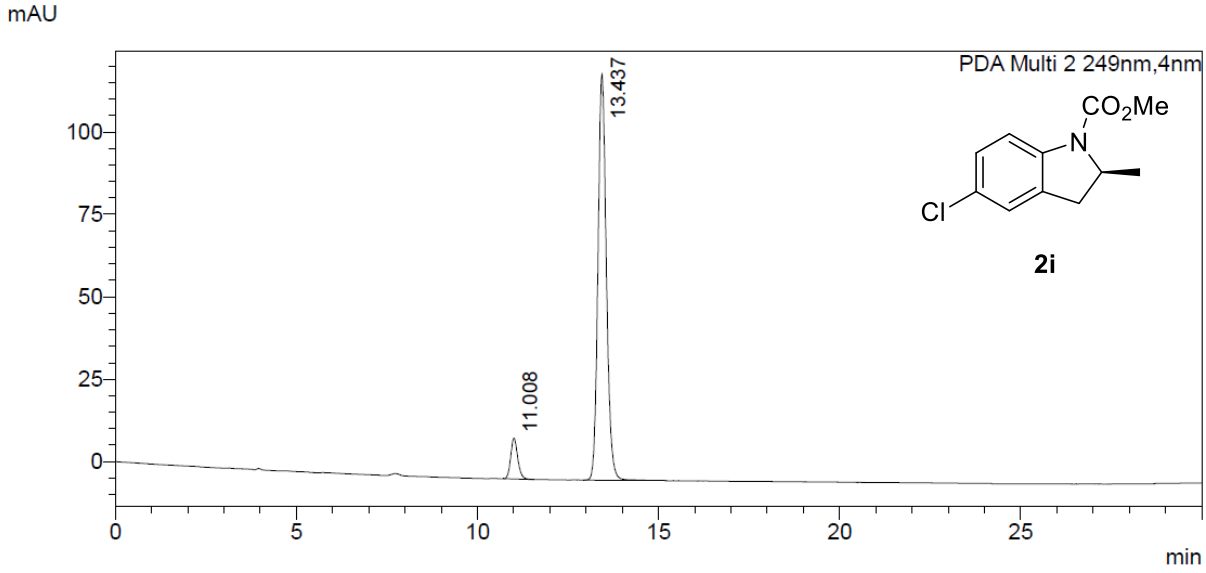
2i



<Peak Table>

PDA Ch2 249nm

Peak#	Ret. Time	Area	Height	Area%
1	10.437	4360101	322560	49.957
2	12.676	4367691	267644	50.043
Total		8727791	590203	100.000

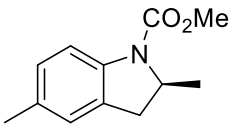


<Peak Table>

PDA Ch2 249nm

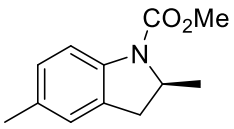
Peak#	Ret. Time	Area	Height	Area%
1	11.008	167659	12415	7.762
2	13.437	1992355	123055	92.238
Total		2160014	135470	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

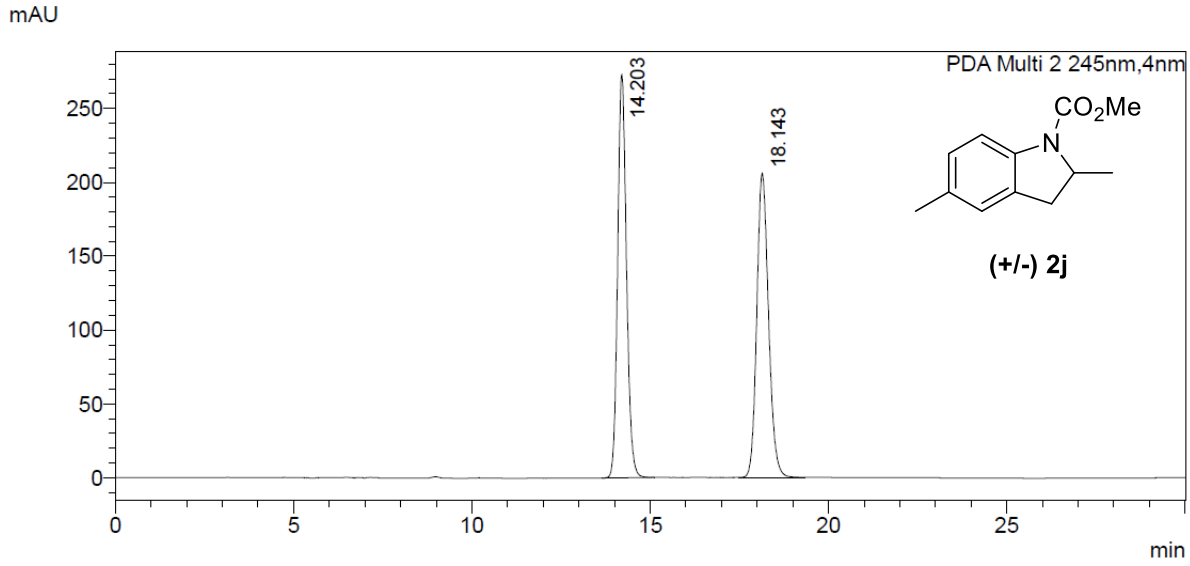


2j

^{13}C NMR, $CDCl_3$, 101 MHz



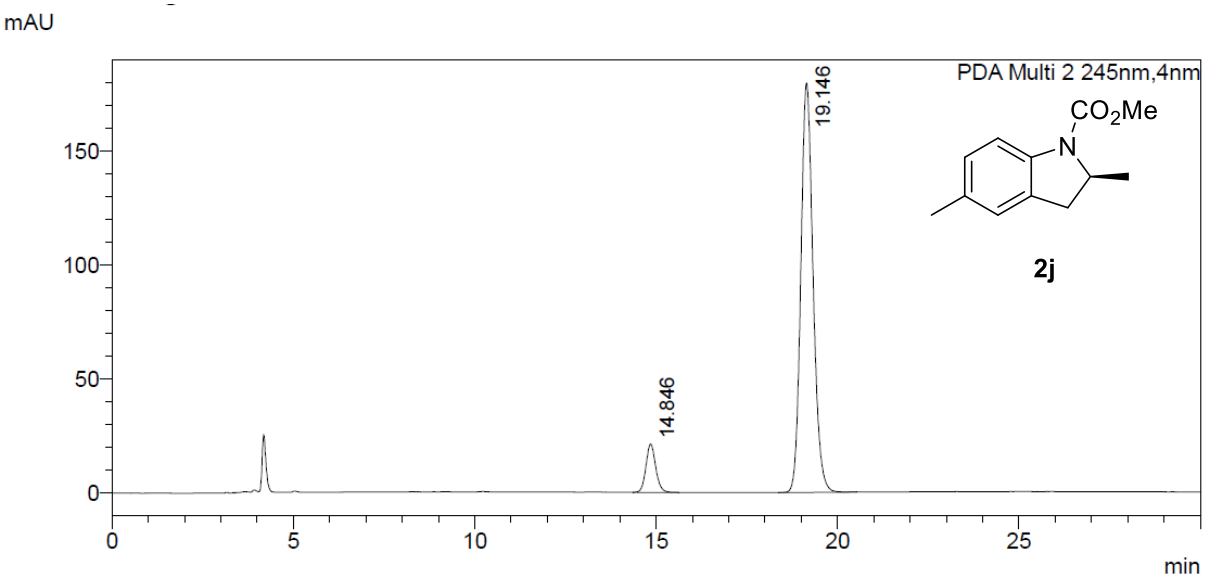
2j



<Peak Table>

PDA Ch2 245nm

Peak#	Ret. Time	Area	Height	Area%
1	14.203	4700330	273014	49.947
2	18.143	4710359	205910	50.053
Total		9410688	478924	100.000

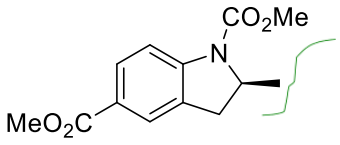


<Peak Table>

PDA Ch2 245nm

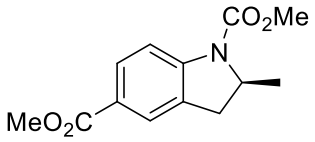
Peak#	Ret. Time	Area	Height	Area%
1	14.846	398759	21230	8.631
2	19.146	4221449	179579	91.369
Total		4620207	200809	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

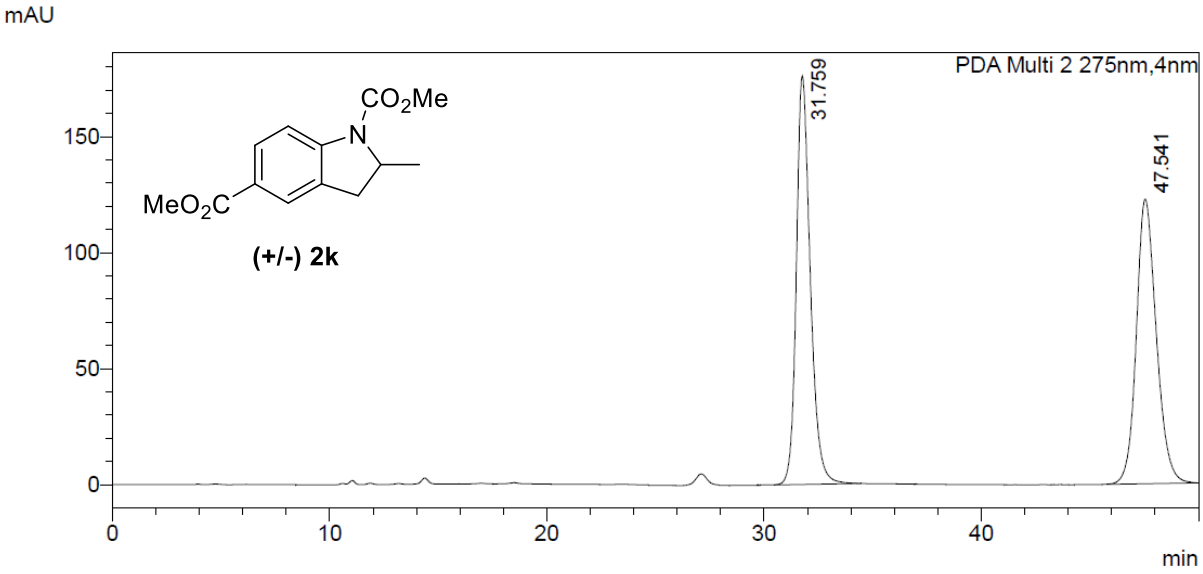


2k

^{13}C NMR, $CDCl_3$, 101 MHz



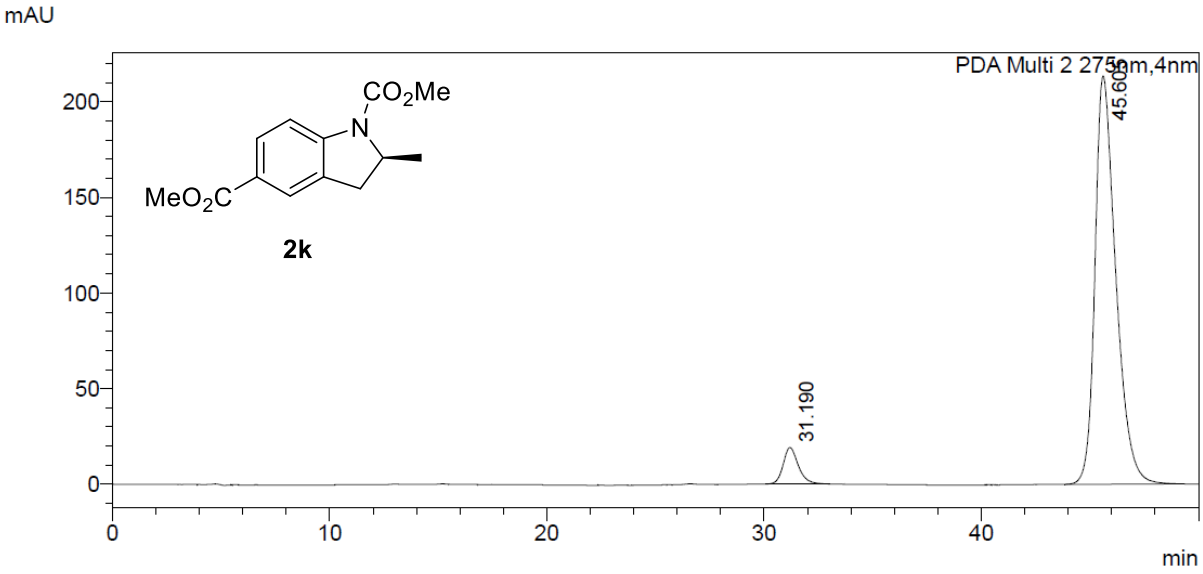
2k



<Peak Table>

PDA Ch2 275nm

Peak#	Ret. Time	Area	Height	Area%
1	31.759	7867113	176070	50.102
2	47.541	7835040	122622	49.898
Total		15702153	298692	100.000

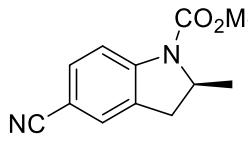


<Peak Table>

PDA Ch2 275nm

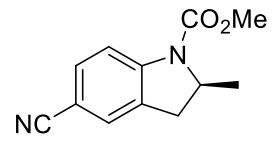
Peak#	Ret. Time	Area	Height	Area%
1	31.190	933992	19138	6.164
2	45.605	14218564	213398	93.836
Total		15152557	232536	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

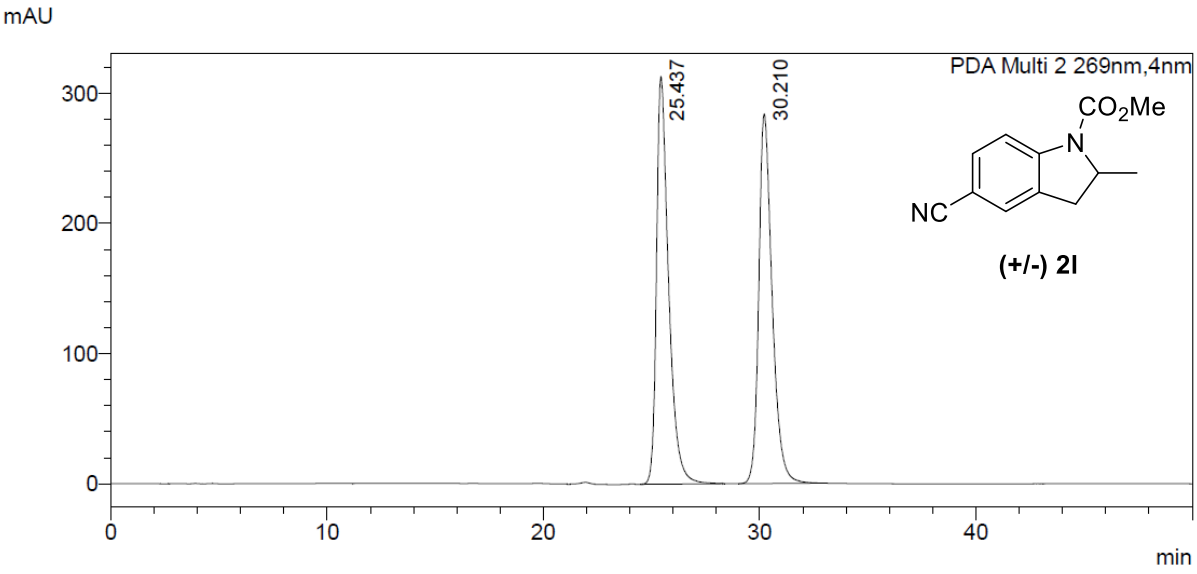


2l

^{13}C NMR, $CDCl_3$, 101 MHz



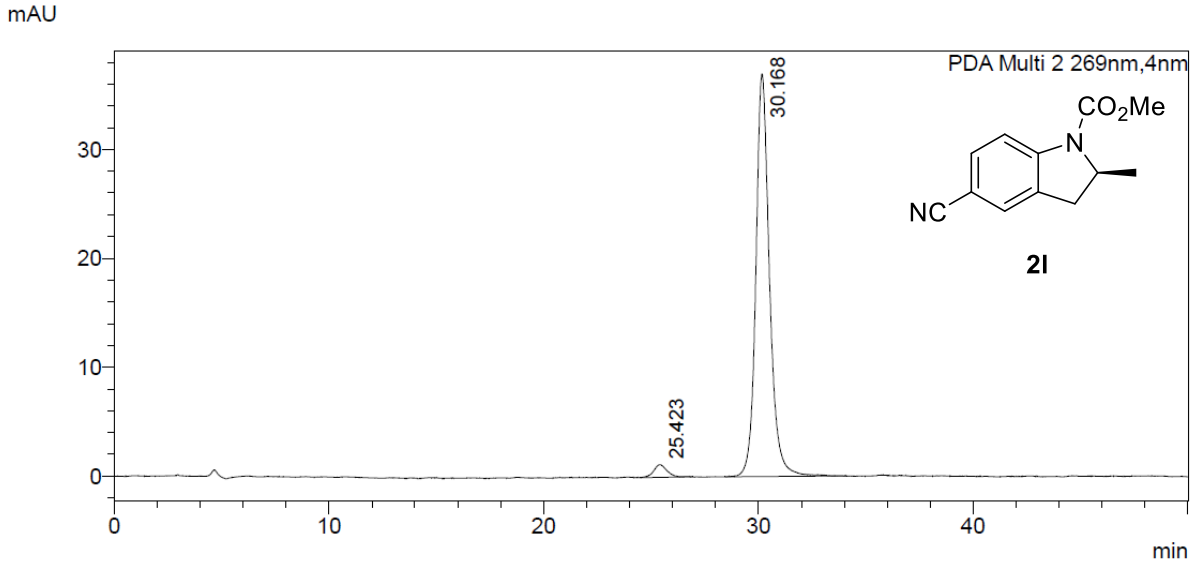
2l



<Peak Table>

PDA Ch2 269nm

Peak#	Ret. Time	Area	Height	Area%
1	25.437	12195863	313214	50.009
2	30.210	12191331	284154	49.991
Total		24387194	597368	100.000

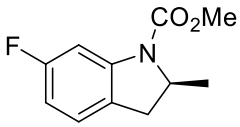


<Peak Table>

PDA Ch2 269nm

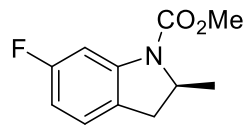
Peak#	Ret. Time	Area	Height	Area%
1	25.423	51142	1175	3.035
2	30.168	1634066	36960	96.965
Total		1685208	38135	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



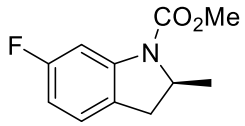
2m

^{13}C NMR, $CDCl_3$, 101 MHz

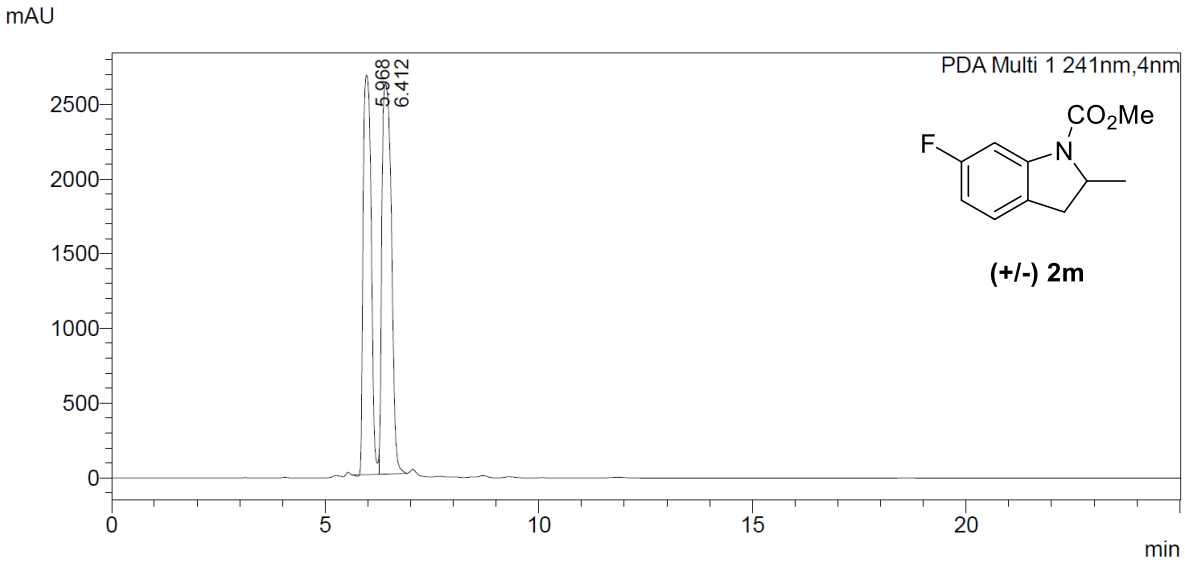


2m

^{19}F NMR, $CDCl_3$, 376 MHz



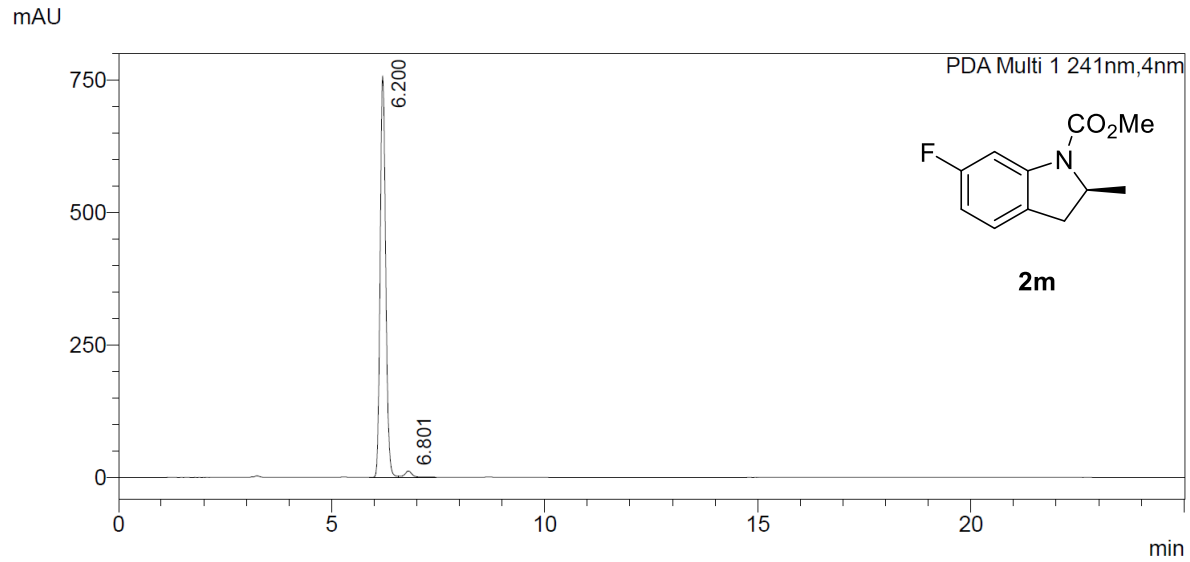
2m



<Peak Table>

PDA Ch1 241nm

Peak#	Ret. Time	Area	Height	Area%
1	5.968	34934094	2672998	46.494
2	6.412	40203252	2614261	53.506
Total		75137346	5287258	100.000

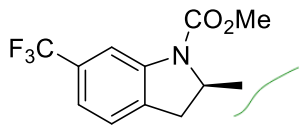


<Peak Table>

PDA Ch1 241nm

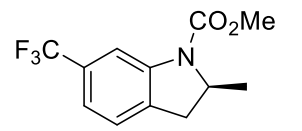
Peak#	Ret. Time	Area	Height	Area%
1	6.200	6856929	758418	97.945
2	6.801	143845	11676	2.055
Total		7000775	770094	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



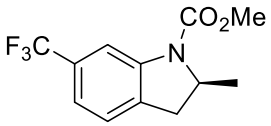
2n

^{13}C NMR, $CDCl_3$, 101 MHz

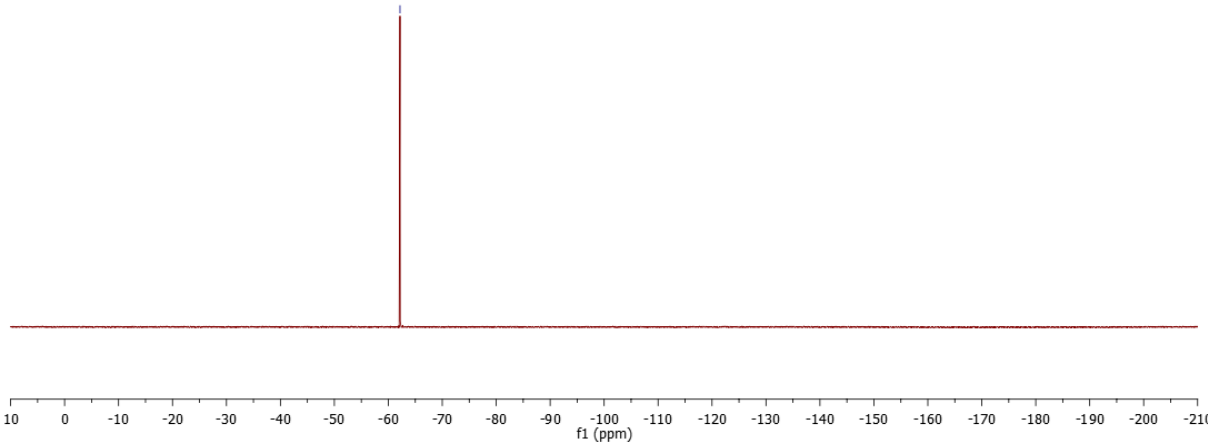


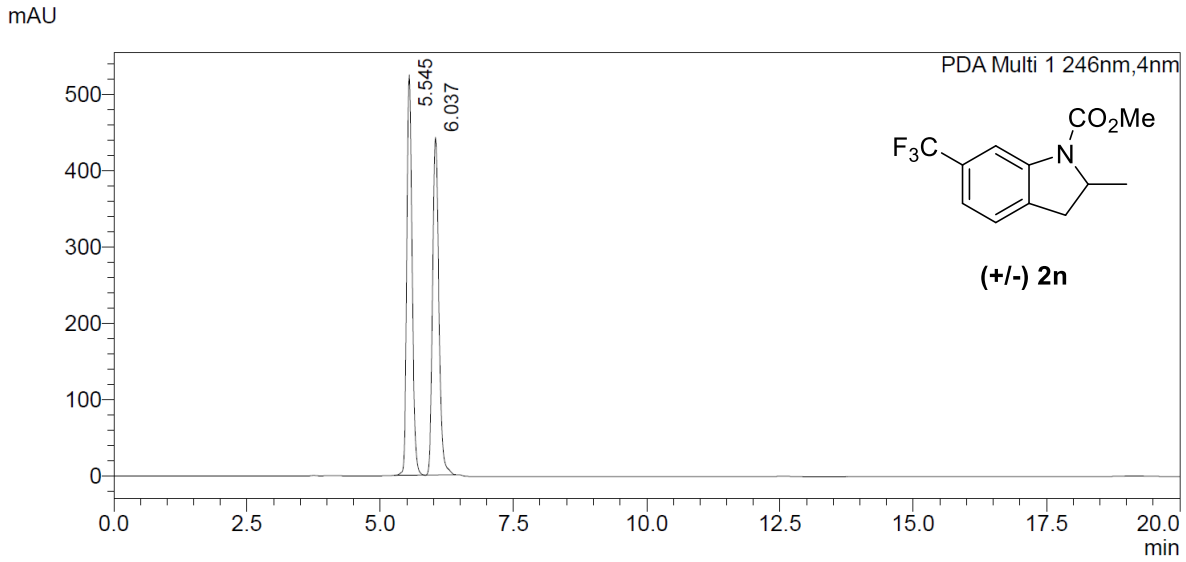
2n

^{19}F NMR, $CDCl_3$, 376 MHz



2n

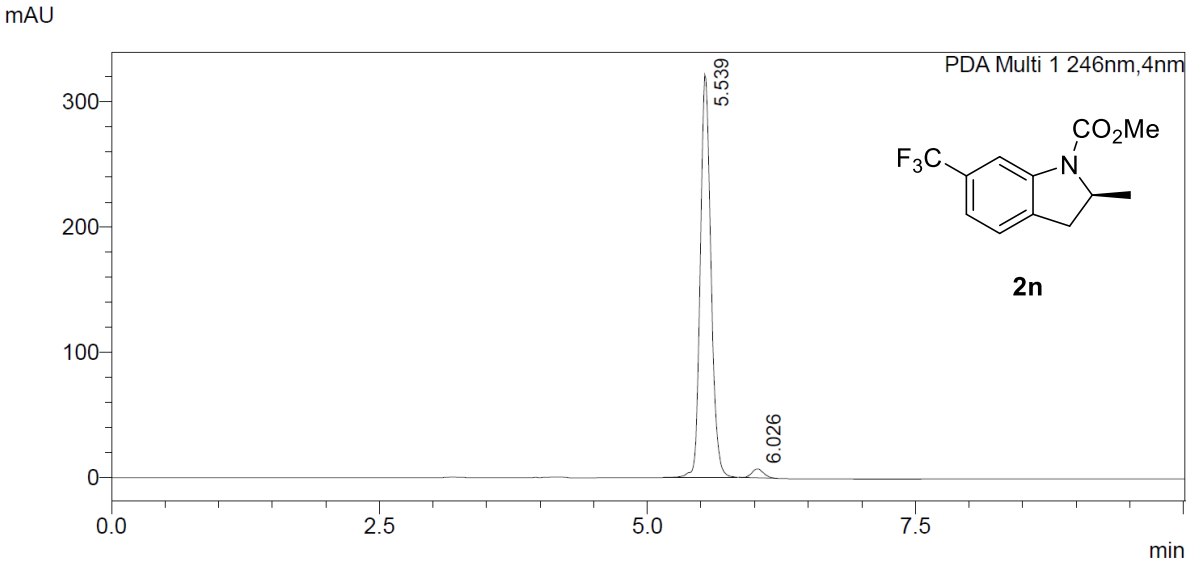




<Peak Table>

PDA Ch1 246nm

Peak#	Ret. Time	Area	Height	Area%
1	5.545	3614807	524285	49.928
2	6.037	3625271	442363	50.072
Total		7240077	966648	100.000

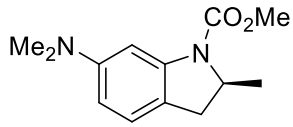


<Peak Table>

PDA Ch1 246nm

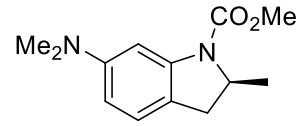
Peak#	Ret. Time	Area	Height	Area%
1	5.539	2218612	321543	97.663
2	6.026	53090	7055	2.337
Total		2271702	328597	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

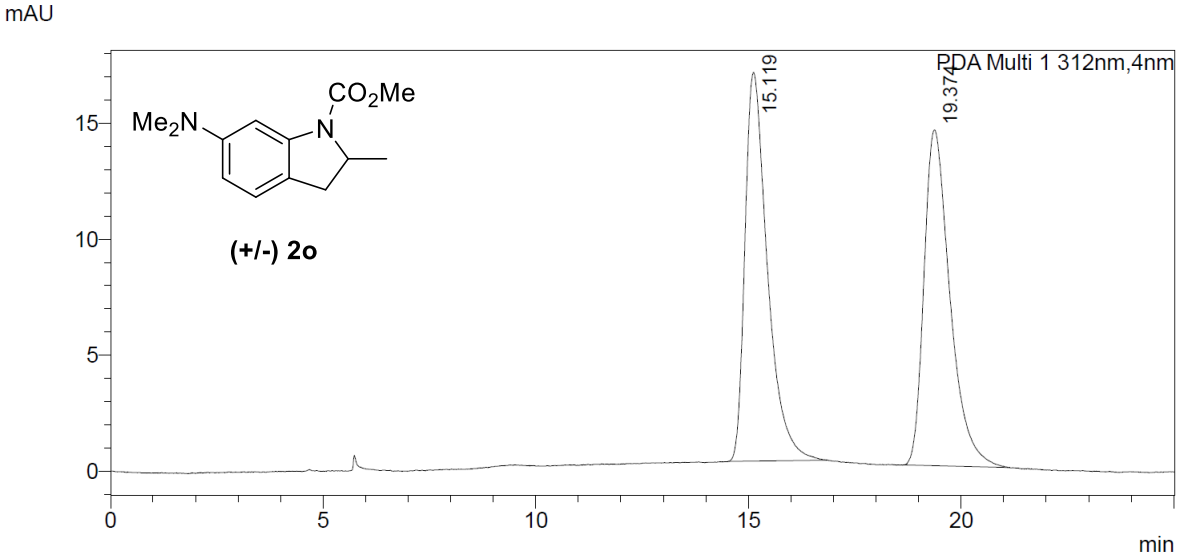


2o

^{13}C NMR, $CDCl_3$, 101 MHz



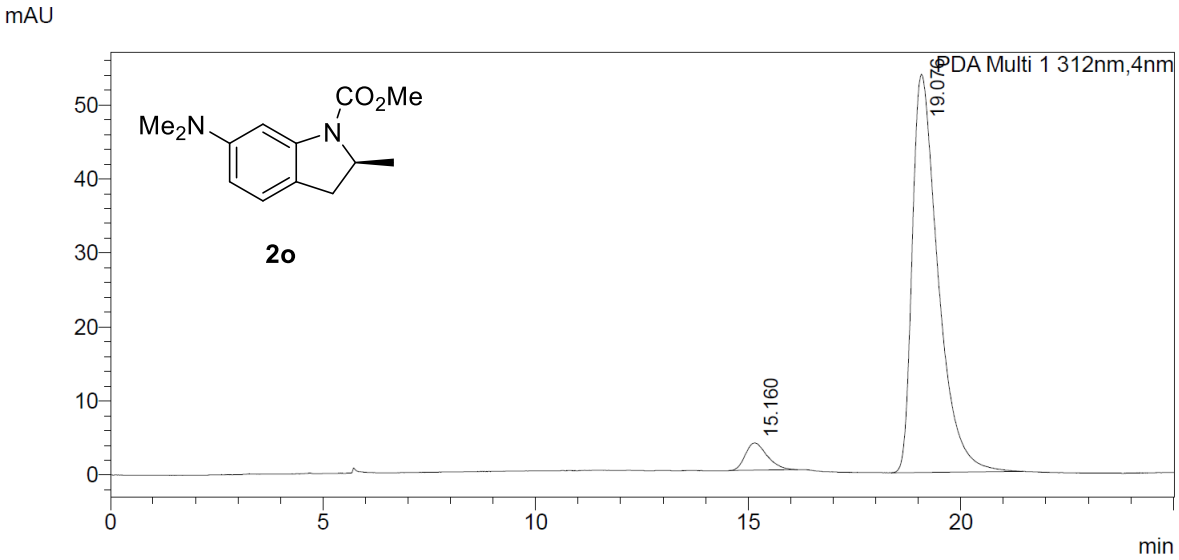
2o



<Peak Table>

PDA Ch1 312nm

Peak#	Ret. Time	Area	Height	Area%
1	15.119	616790	16762	50.014
2	19.374	616441	14482	49.986
Total		1233231	31244	100.000

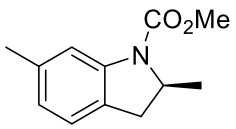


<Peak Table>

PDA Ch1 312nm

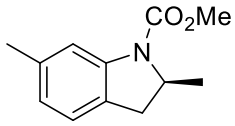
Peak#	Ret. Time	Area	Height	Area%
1	15.160	131325	3690	5.467
2	19.076	2270769	53789	94.533
Total		2402095	57480	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

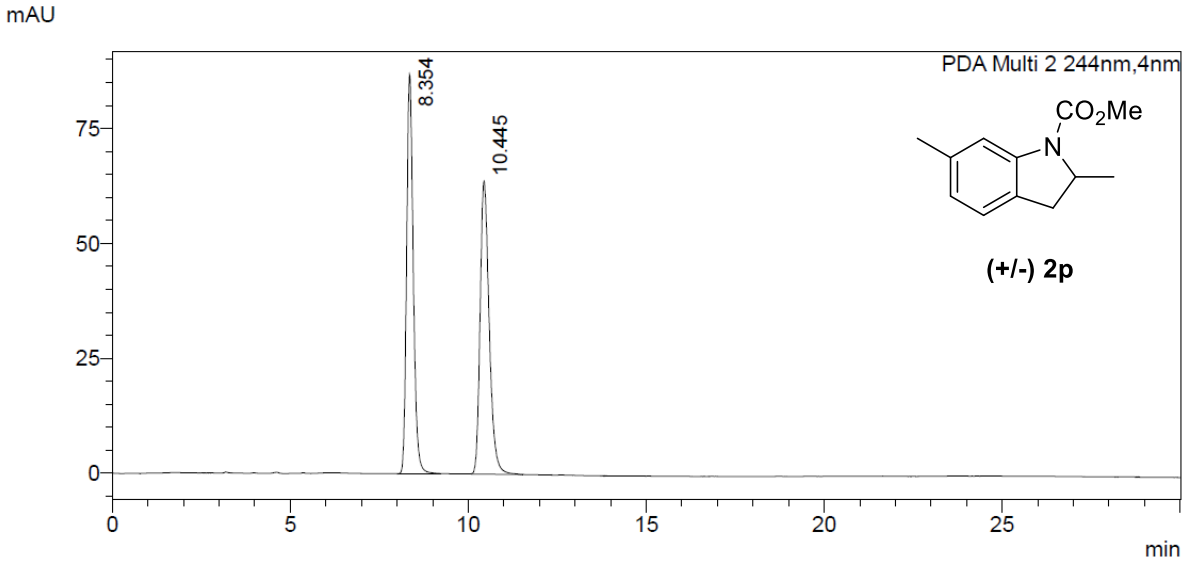


2p

^{13}C NMR, $CDCl_3$, 101 MHz



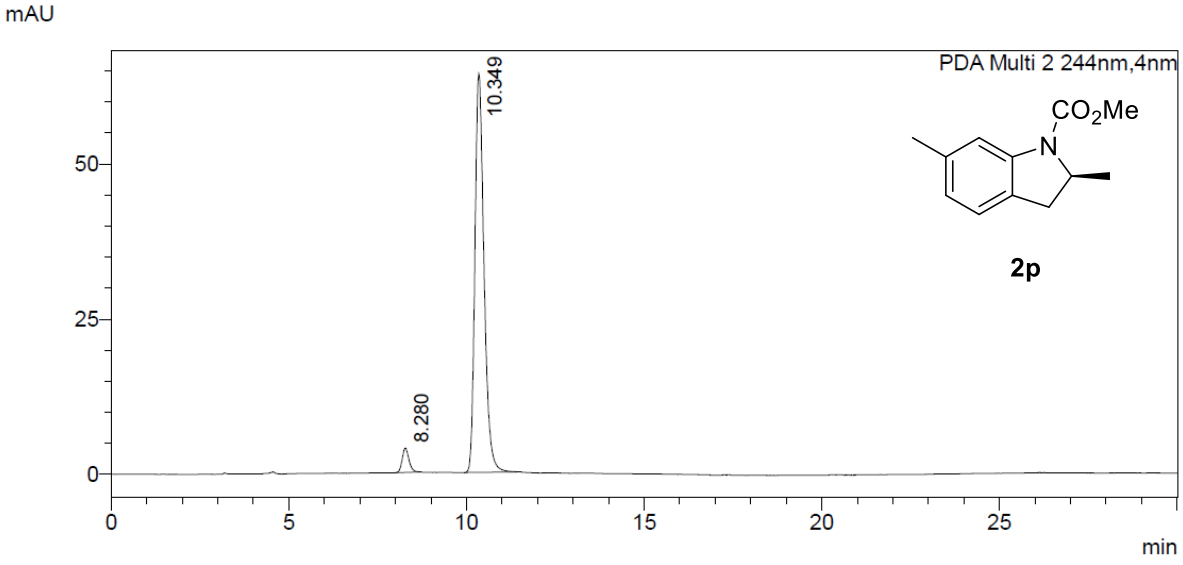
2p



<Peak Table>

PDA Ch2 244nm

Peak#	Ret. Time	Area	Height	Area%
1	8.354	1133948	86846	50.063
2	10.445	1131106	63778	49.937
Total		2265054	150624	100.000

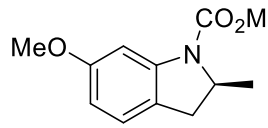


<Peak Table>

PDA Ch2 244nm

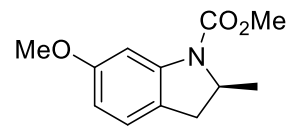
Peak#	Ret. Time	Area	Height	Area%
1	8.280	51873	3920	4.331
2	10.349	1145831	64250	95.669
Total		1197703	68170	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

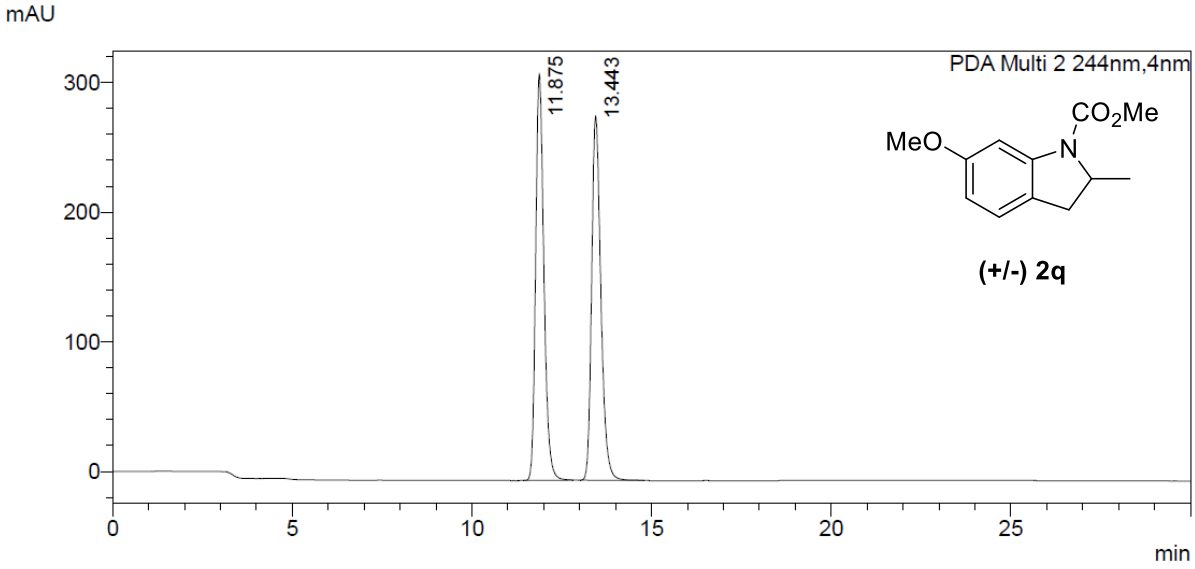


2q

^{13}C NMR, $CDCl_3$, 101 MHz



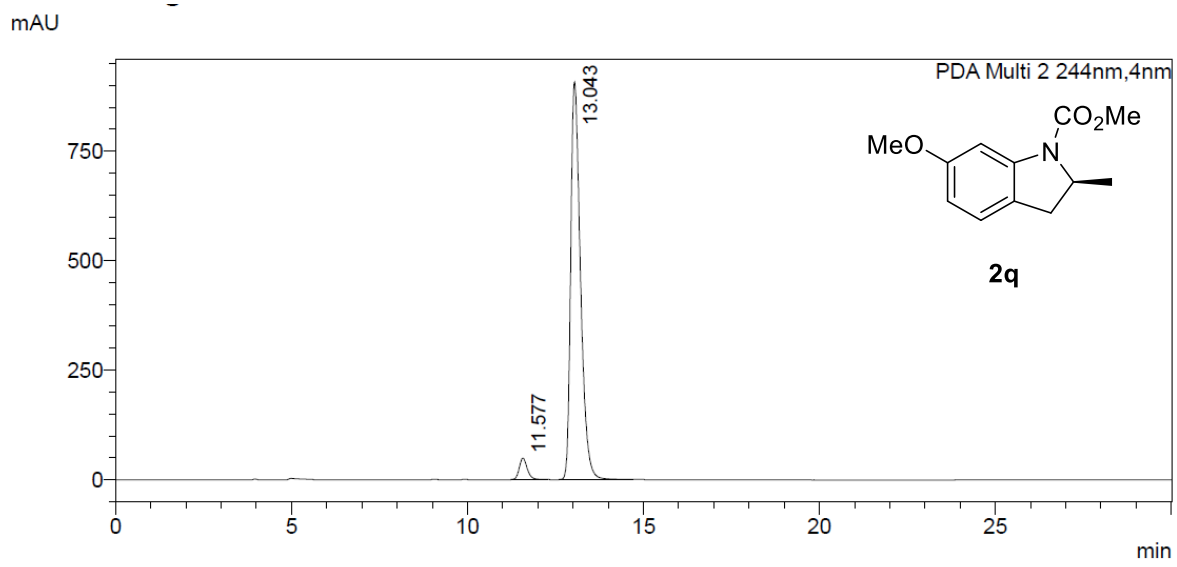
2q



<Peak Table>

PDA Ch2 244nm

Peak#	Ret. Time	Area	Height	Area%
1	11.875	5010149	313411	49.973
2	13.443	5015631	280866	50.027
Total		10025781	594277	100.000

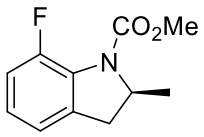


<Peak Table>

PDA Ch2 244nm

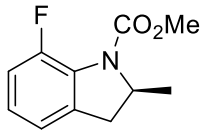
Peak#	Ret. Time	Area	Height	Conc.	Area%
1	11.577	771295	49148	4.210	4.210
2	13.043	17547455	907407	95.790	95.790
Total		18318750	956555		100.000

^{1}H NMR, $CDCl_3$, 400 MHz



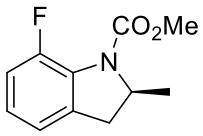
2r

^{13}C NMR, $CDCl_3$, 101 MHz

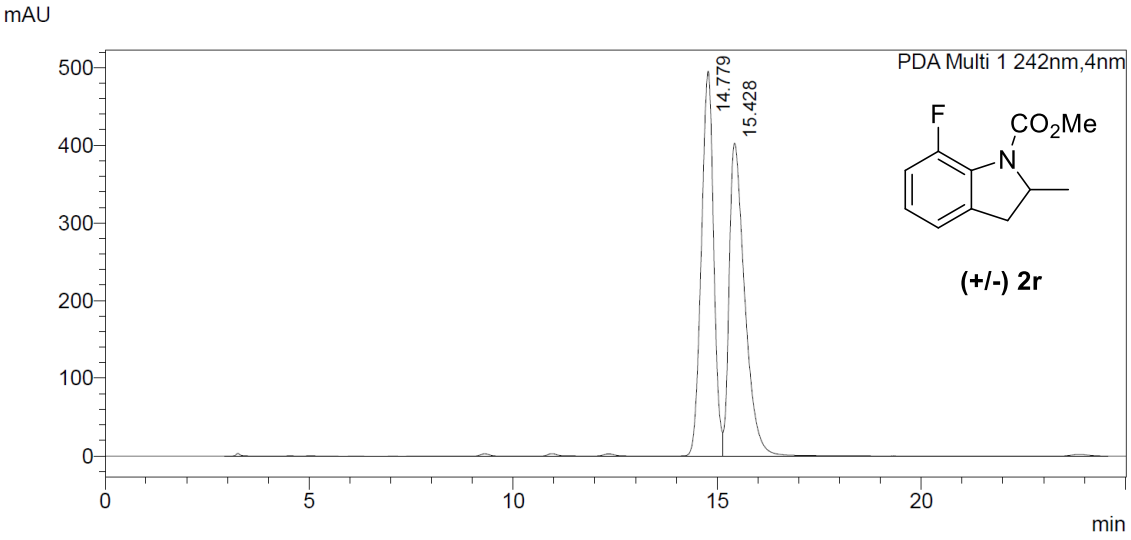


2r

^{19}F NMR, $CDCl_3$, 376 MHz



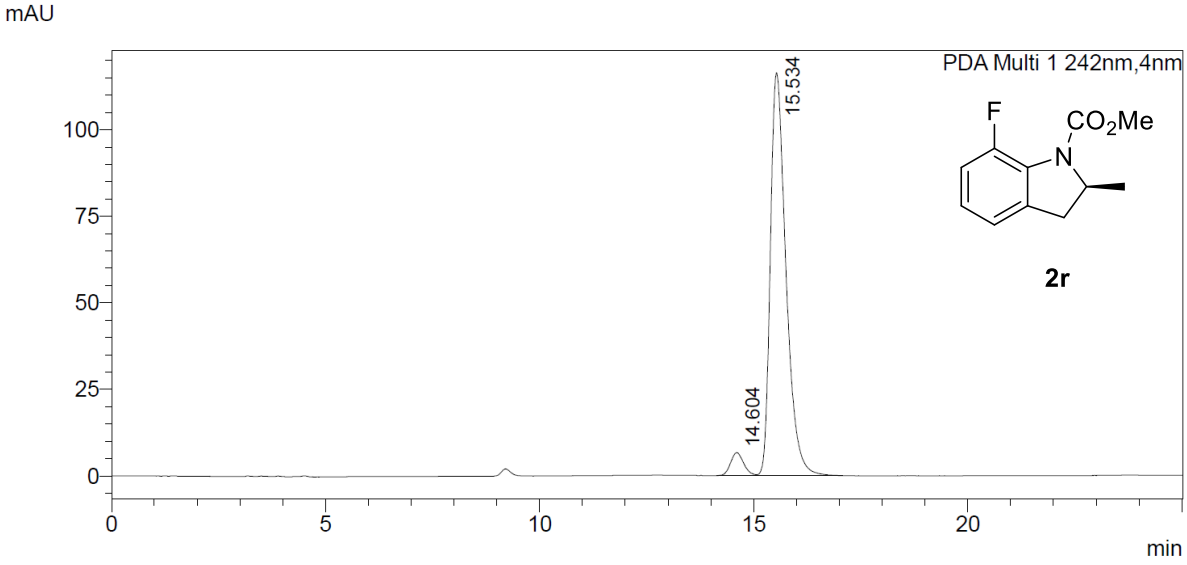
2r



<Peak Table>

PDA Ch1 242nm

Peak#	Ret. Time	Area	Height	Area%
1	14.779	10551527	495275	49.491
2	15.428	10768496	402795	50.509
Total		21320023	898070	100.000

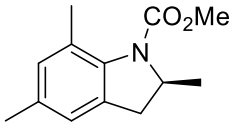


<Peak Table>

PDA Ch1 242nm

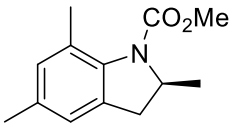
Peak#	Ret. Time	Area	Height	Area%
1	14.604	140604	6620	4.549
2	15.534	2950336	116399	95.451
Total		3090940	123020	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

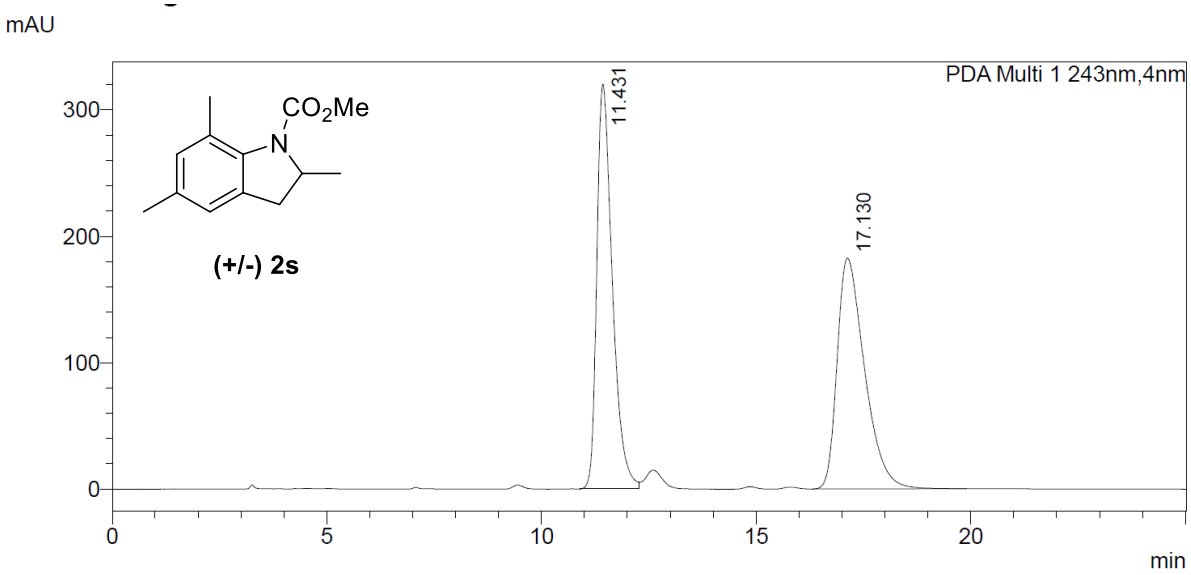


2s

^{13}C NMR, $CDCl_3$, 101 MHz



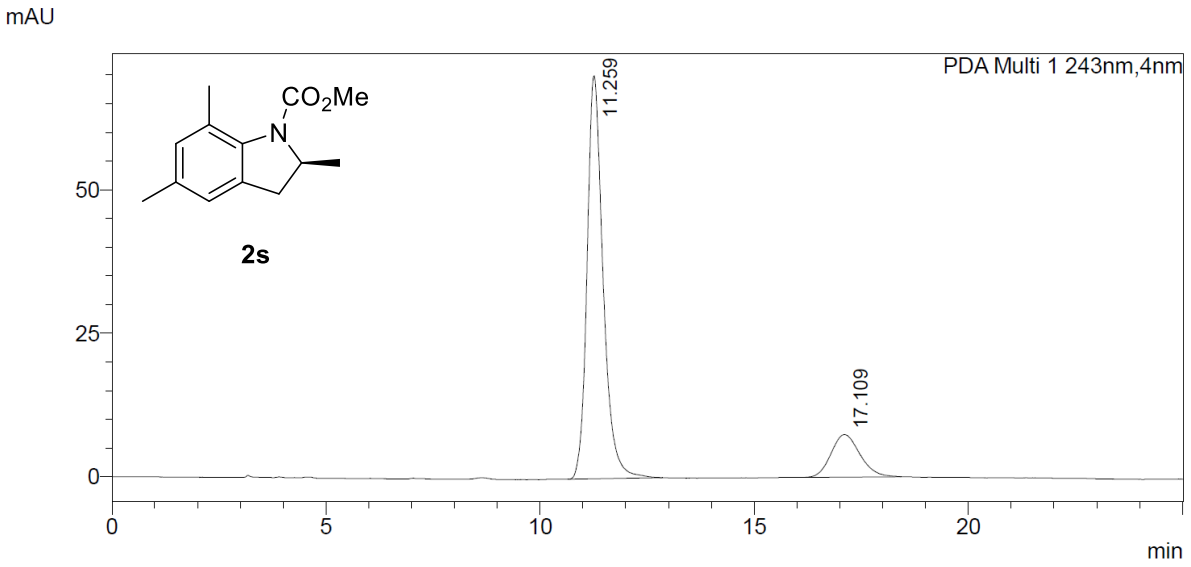
2s



<Peak Table>

PDA Ch1 243nm

Peak#	Ret. Time	Area	Height	Area%
1	11.431	8043518	320070	49.788
2	17.130	8112132	182525	50.212
Total		16155651	502596	100.000

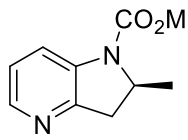


<Peak Table>

PDA Ch1 243nm

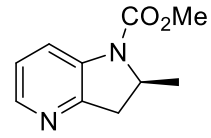
Peak#	Ret. Time	Area	Height	Area%
1	11.259	1829198	70201	84.073
2	17.109	346518	7402	15.927
Total		2175716	77602	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

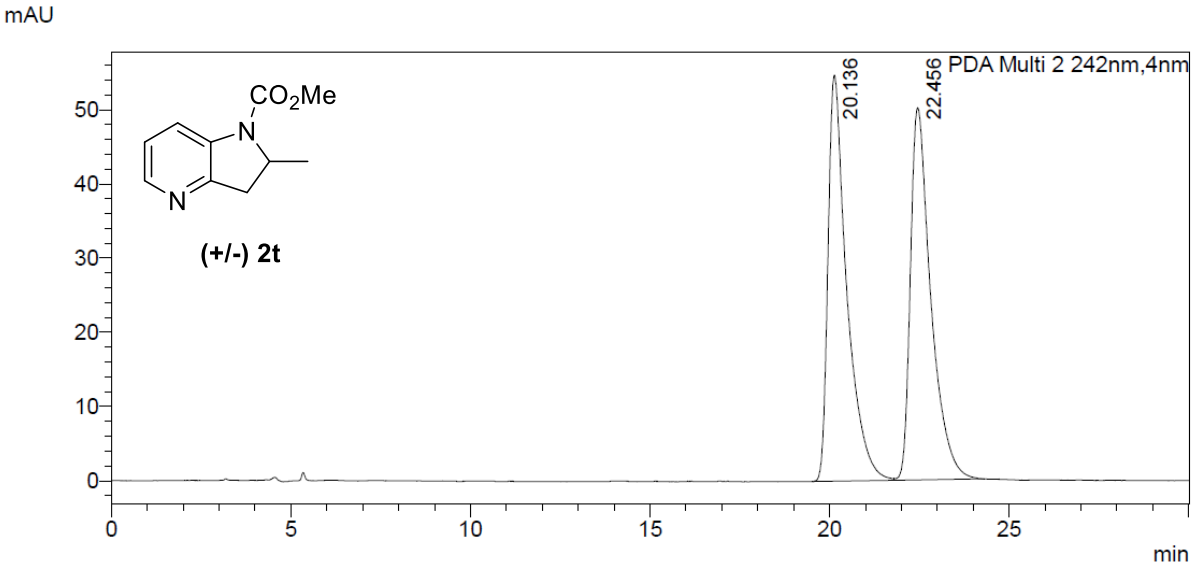


2t

^{13}C NMR, $CDCl_3$, 101 MHz



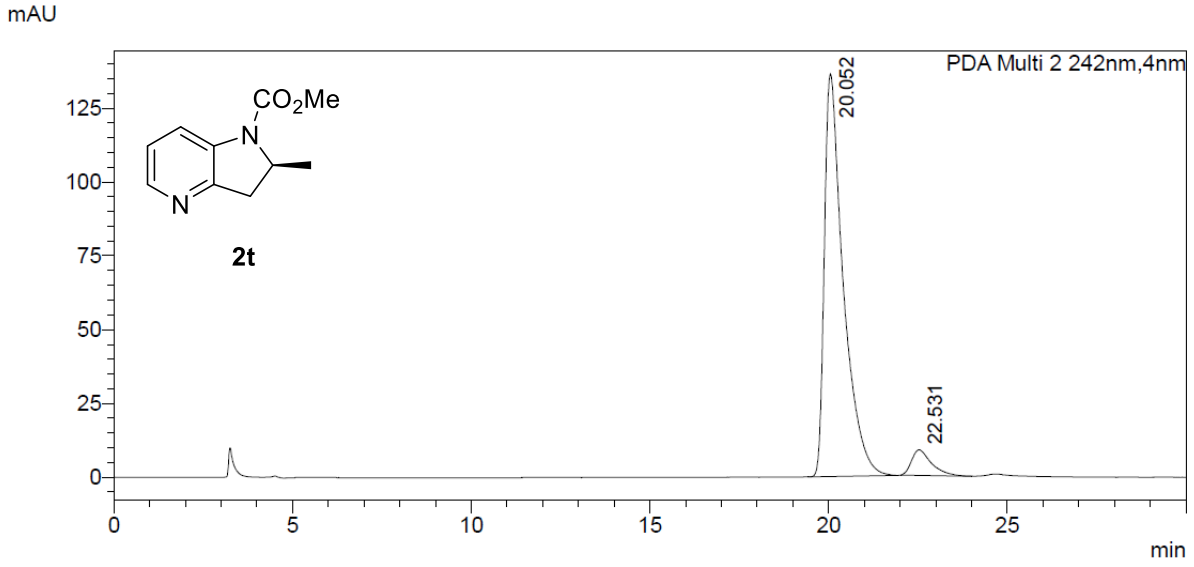
2t



<Peak Table>

PDA Ch2 242nm

Peak#	Ret. Time	Area	Height	Area%
1	20.136	1989381	54691	50.087
2	22.456	1982484	50165	49.913
Total		3971865	104856	100.000

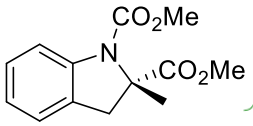


<Peak Table>

PDA Ch2 242nm

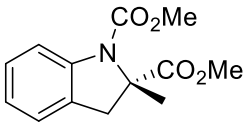
Peak#	Ret. Time	Area	Height	Area%
1	20.052	5008295	136294	93.767
2	22.531	332899	8621	6.233
Total		5341194	144915	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

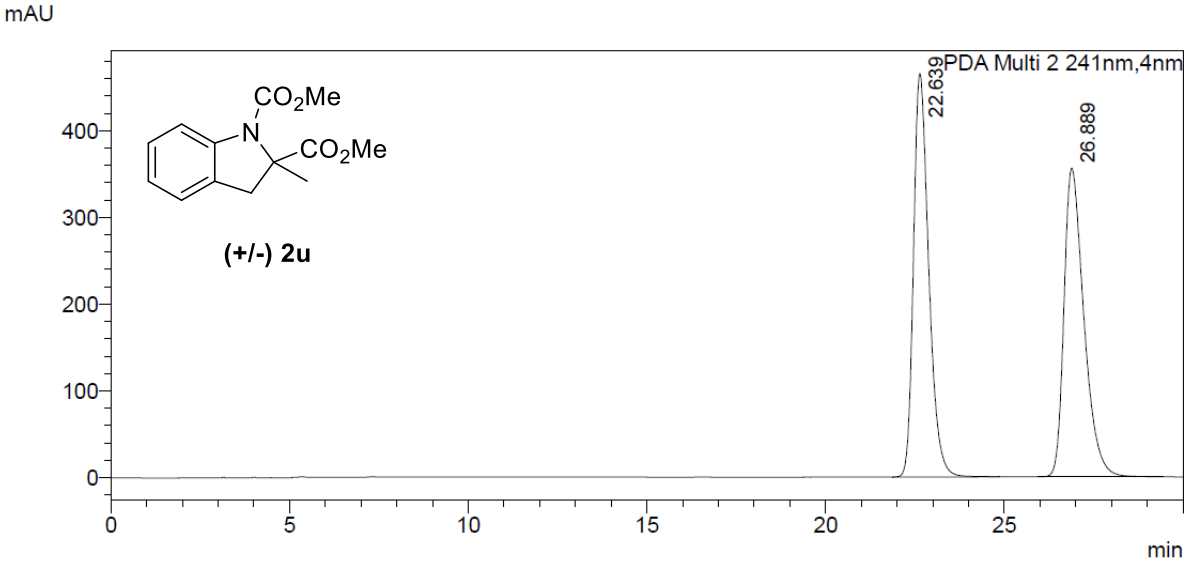


2u

^{13}C NMR, $CDCl_3$, 101 MHz



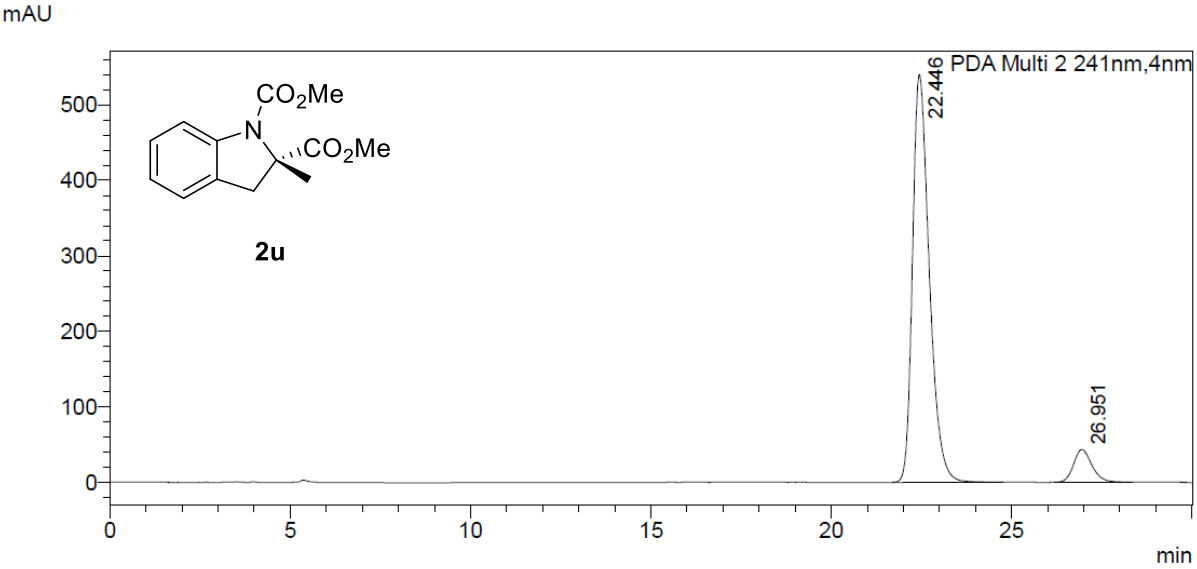
2u



<Peak Table>

PDA Ch2 241nm

Peak#	Ret. Time	Area	Height	Area%
1	22.639	13795045	464981	49.980
2	26.889	13806168	355961	50.020
Total		27601213	820942	100.000

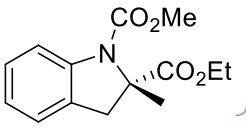


<Peak Table>

PDA Ch2 241nm

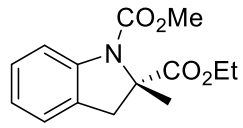
Peak#	Ret. Time	Area	Height	Area%
1	22.446	17440591	540449	91.902
2	26.951	1536726	43398	8.098
Total		18977317	583847	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

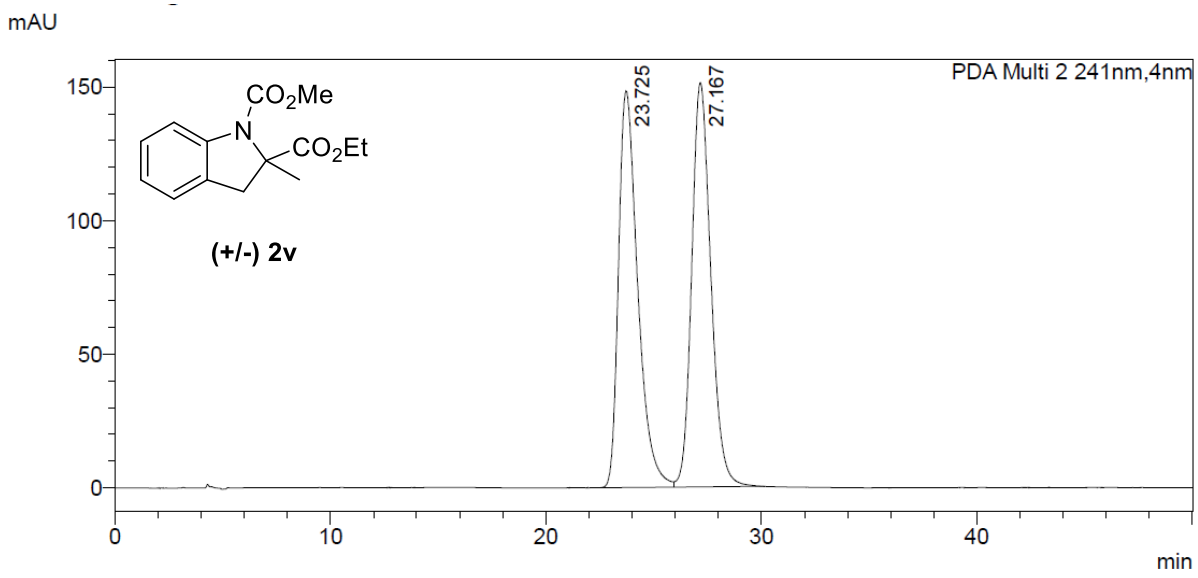


2v

^{13}C NMR, $CDCl_3$, 101 MHz



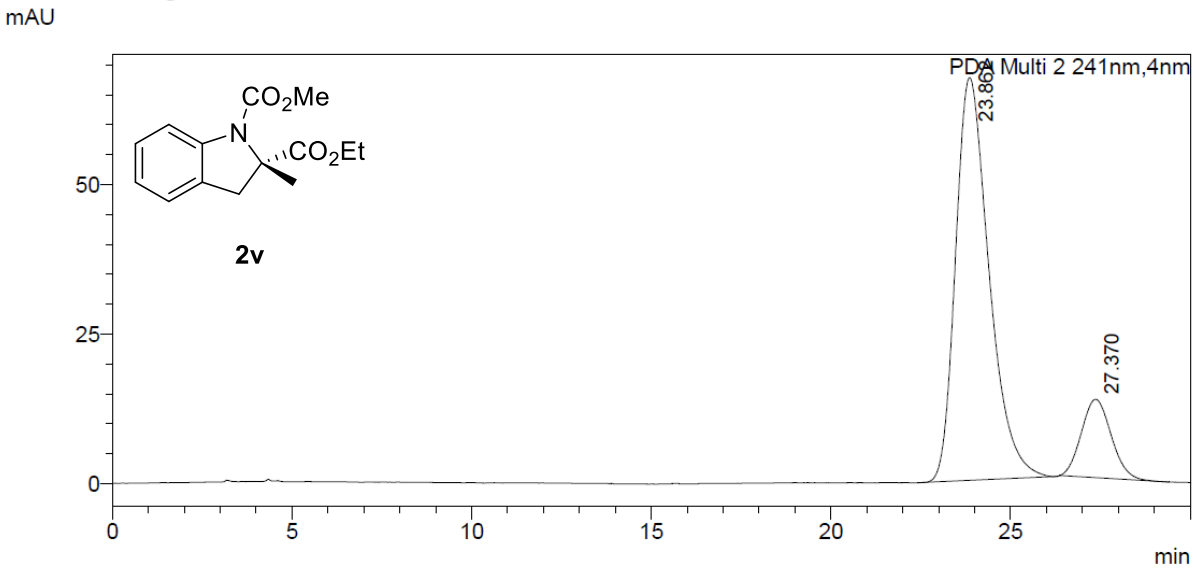
2v



<Peak Table>

PDA Ch2 241nm

Peak#	Ret. Time	Area	Height	Area%
1	23.725	9192792	148374	49.636
2	27.167	9327585	151262	50.364
Total		18520377	299636	100.000

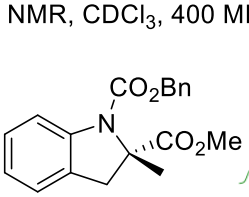


<Peak Table>

PDA Ch2 241nm

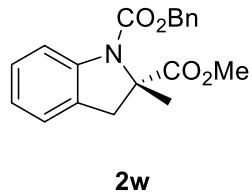
Peak#	Ret. Time	Area	Height	Area%
1	23.862	4366582	67415	85.165
2	27.370	760595	13115	14.835
Total		5127177	80529	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

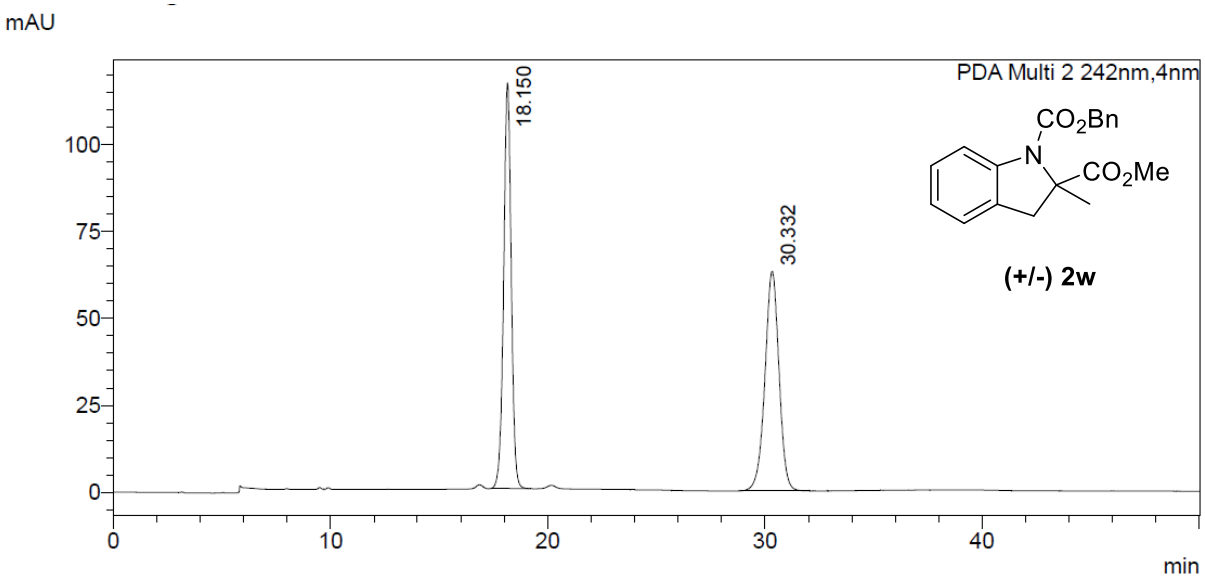


2w

^{13}C NMR, $CDCl_3$, 101 MHz



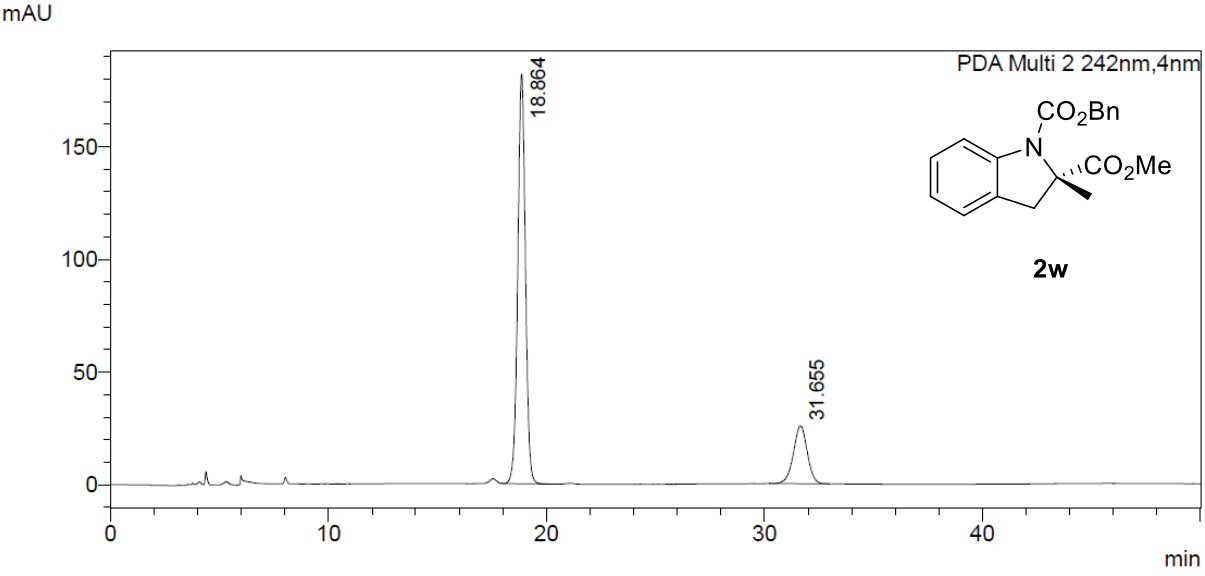
2w



<Peak Table>

PDA Ch2 242nm

Peak#	Ret. Time	Area	Height	Area%
1	18.150	2834687	116518	49.882
2	30.332	2848120	63117	50.118
Total		5682807	179635	100.000

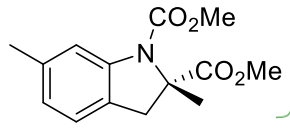


<Peak Table>

PDA Ch2 242nm

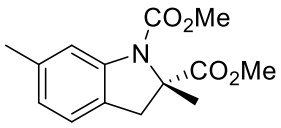
Peak#	Ret. Time	Area	Height	Area%
1	18.864	4455643	181857	79.605
2	31.655	1141547	25683	20.395
Total		5597190	207539	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

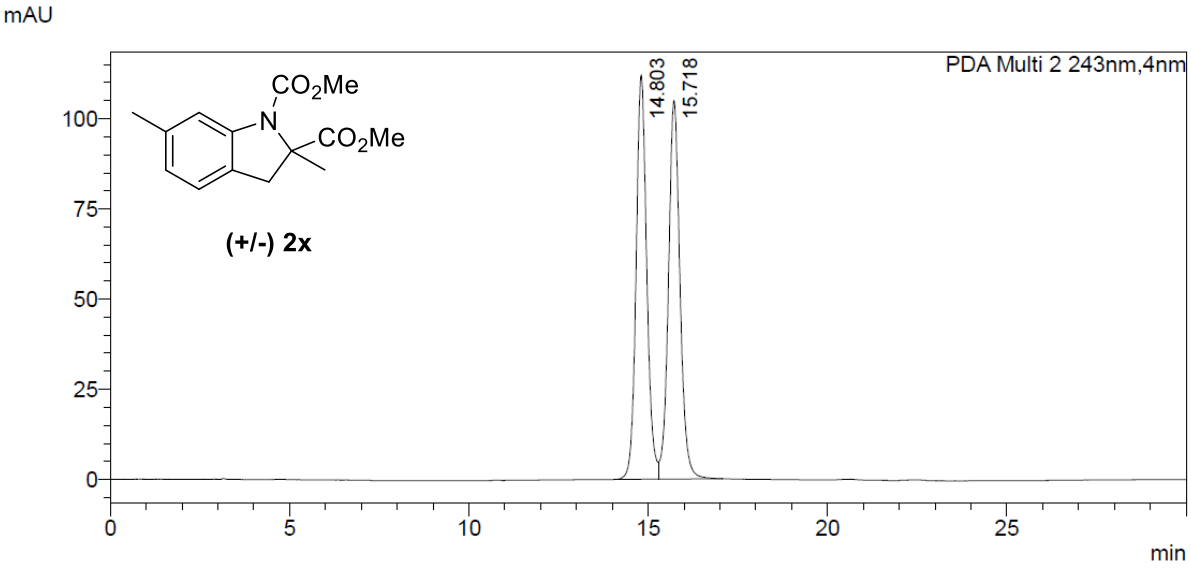


2x

^{13}C NMR, $CDCl_3$, 101 MHz



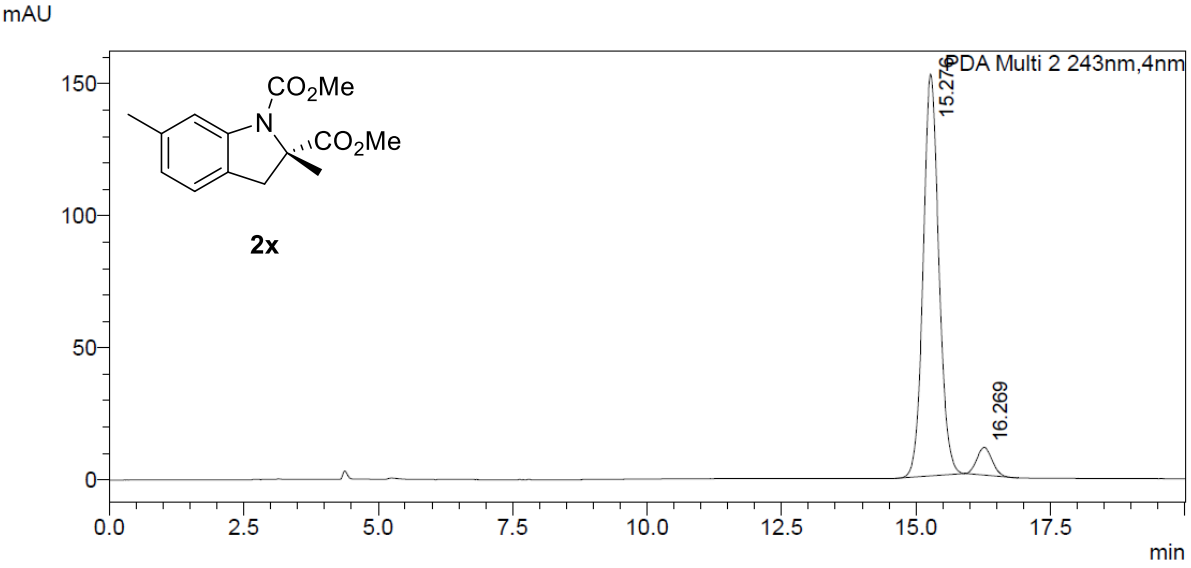
2x



<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	14.803	2318719	112054	49.623
2	15.718	2353956	104882	50.377
Total		4672675	216936	100.000

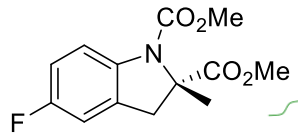


<Peak Table>

PDA Ch2 243nm

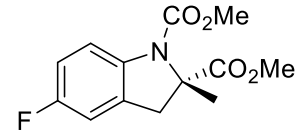
Peak#	Ret. Time	Area	Height	Area%
1	15.276	3087051	152101	93.724
2	16.269	206704	10486	6.276
Total		3293755	162588	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



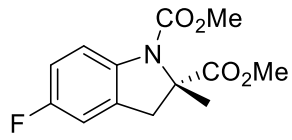
2y

^{13}C NMR, $CDCl_3$, 101 MHz

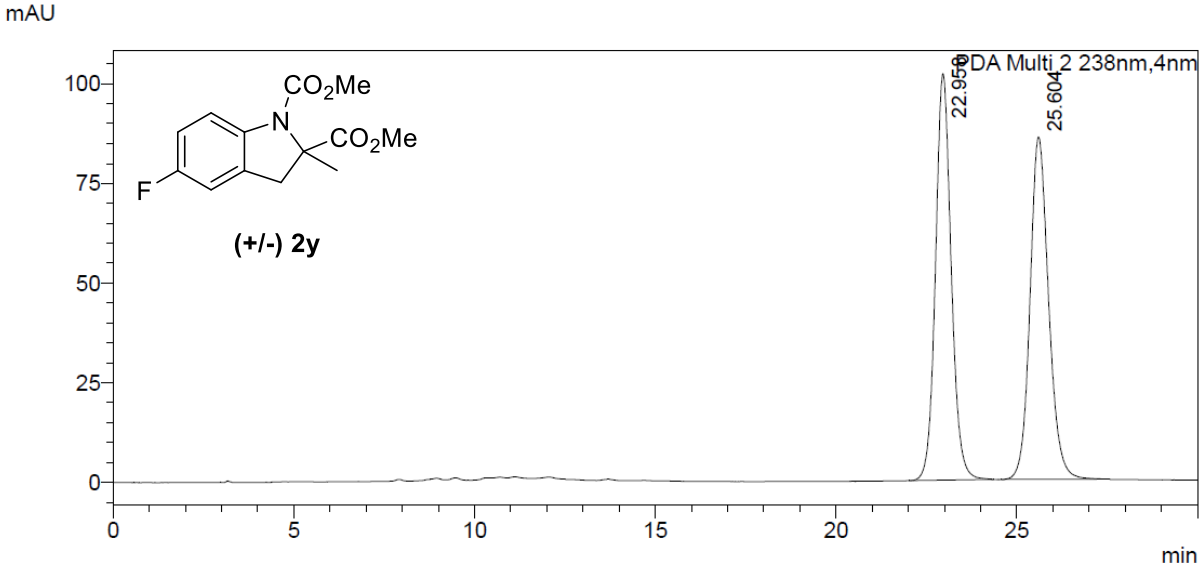


2y

^{19}F NMR, $CDCl_3$, 376 MHz



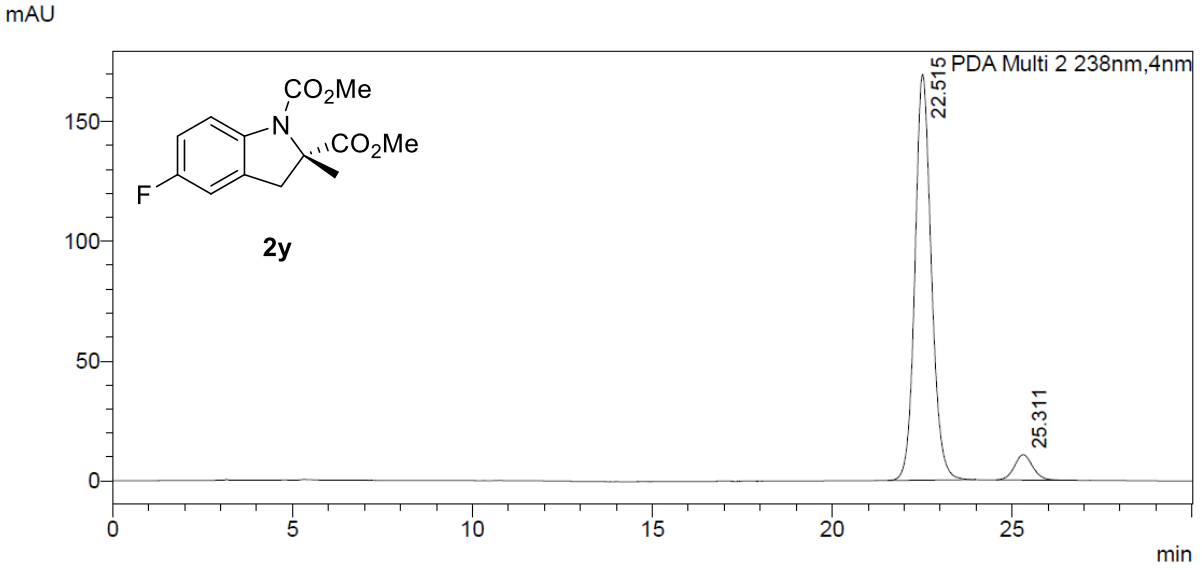
2y



<Peak Table>

PDA Ch2 238nm

Peak#	Ret. Time	Area	Height	Area%
1	22.958	3087898	101883	50.068
2	25.604	3079454	85857	49.932
Total		6167351	187739	100.000

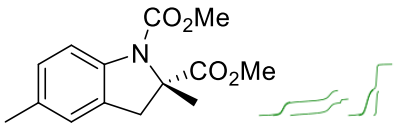


<Peak Table>

PDA Ch2 238nm

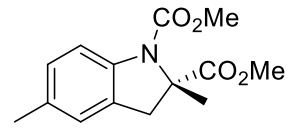
Peak#	Ret. Time	Area	Height	Area%
1	22.515	5370517	169261	93.505
2	25.311	373022	10558	6.495
Total		5743539	179820	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

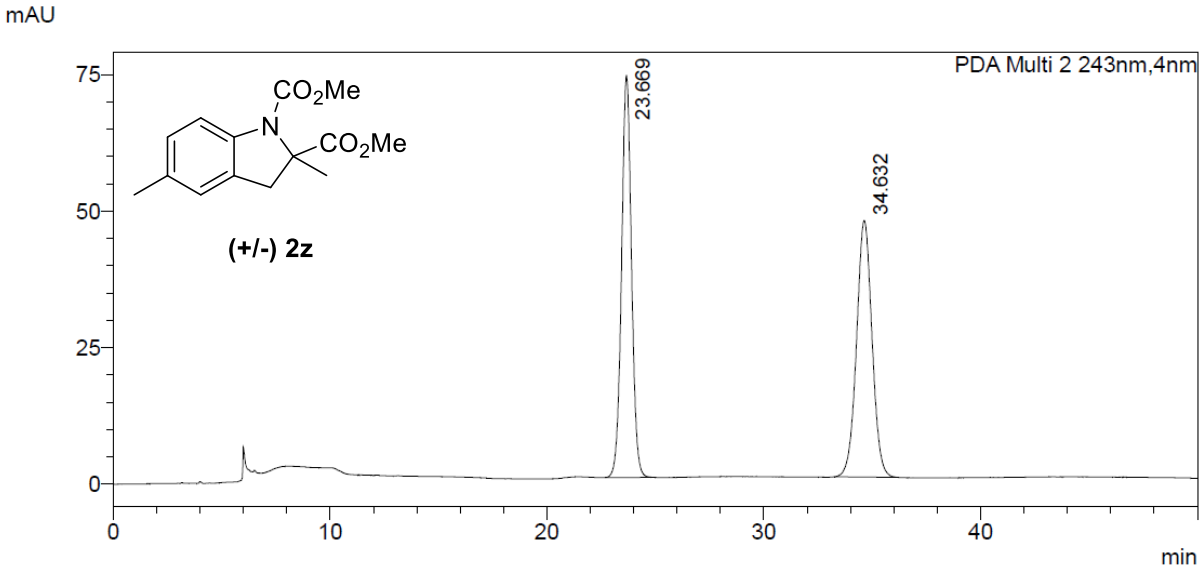


2z

^{13}C NMR, $CDCl_3$, 101 MHz



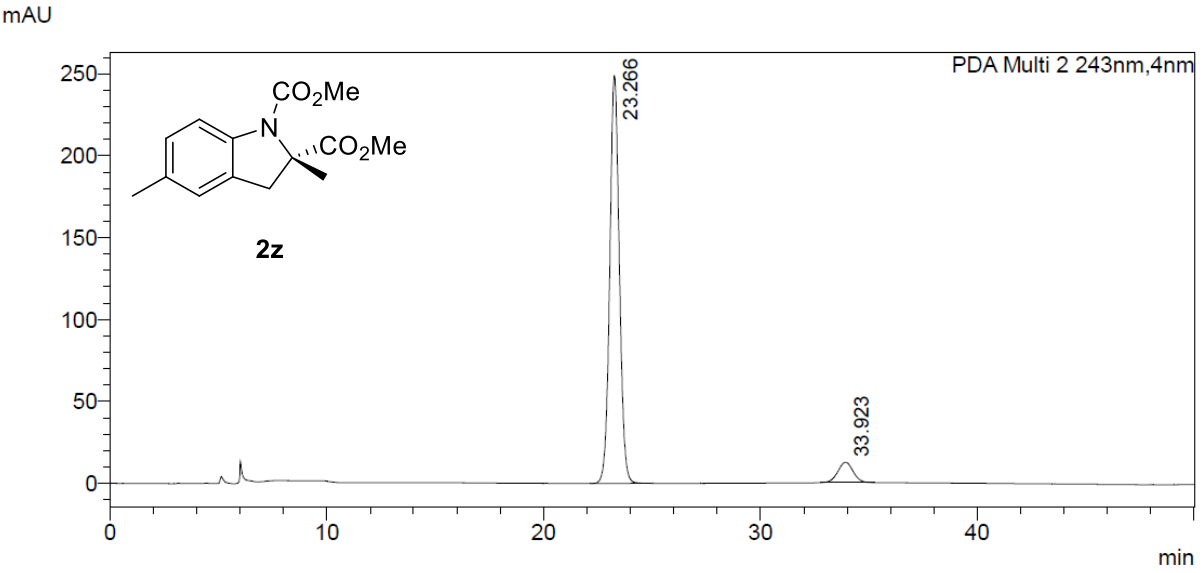
2z



<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height	Area%
1	23.669	2345104	73597	50.090
2	34.632	2336675	46991	49.910
Total		4681779	120588	100.000

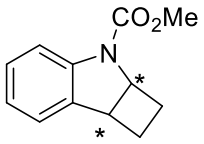


<Peak Table>

PDA Ch2 243nm

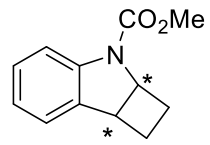
Peak#	Ret. Time	Area	Height	Area%
1	23.266	7666168	248757	92.588
2	33.923	613704	12505	7.412
Total		8279872	261262	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

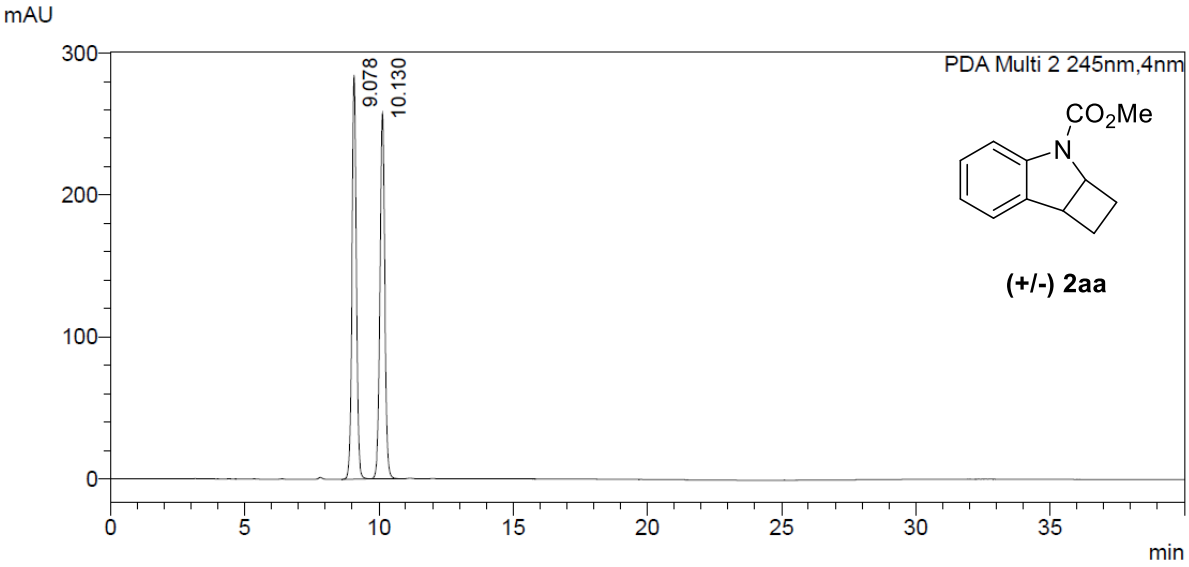


2aa

^{13}C NMR, $CDCl_3$, 101 MHz



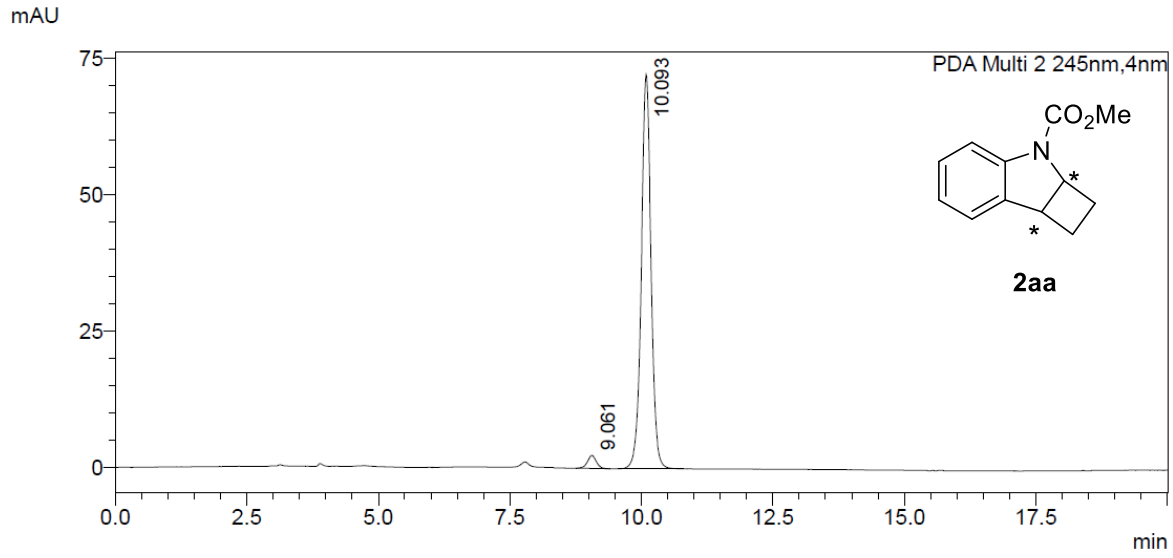
2aa



<Peak Table>

PDA Ch2 245nm

Peak#	Ret. Time	Area	Height	Area%
1	9.078	3237008	284756	49.930
2	10.130	3246137	257569	50.070
Total		6483145	542325	100.000

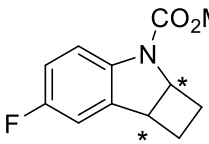


<Peak Table>

PDA Ch2 245nm

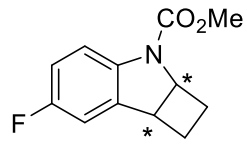
Peak#	Ret. Time	Area	Height	Area%
1	9.061	27525	2365	2.878
2	10.093	928984	72297	97.122
Total		956509	74661	100.000

^{1}H NMR, $CDCl_3$, 400 MHz



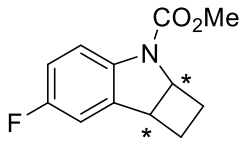
2ab

^{13}C NMR, $CDCl_3$, 101 MHz

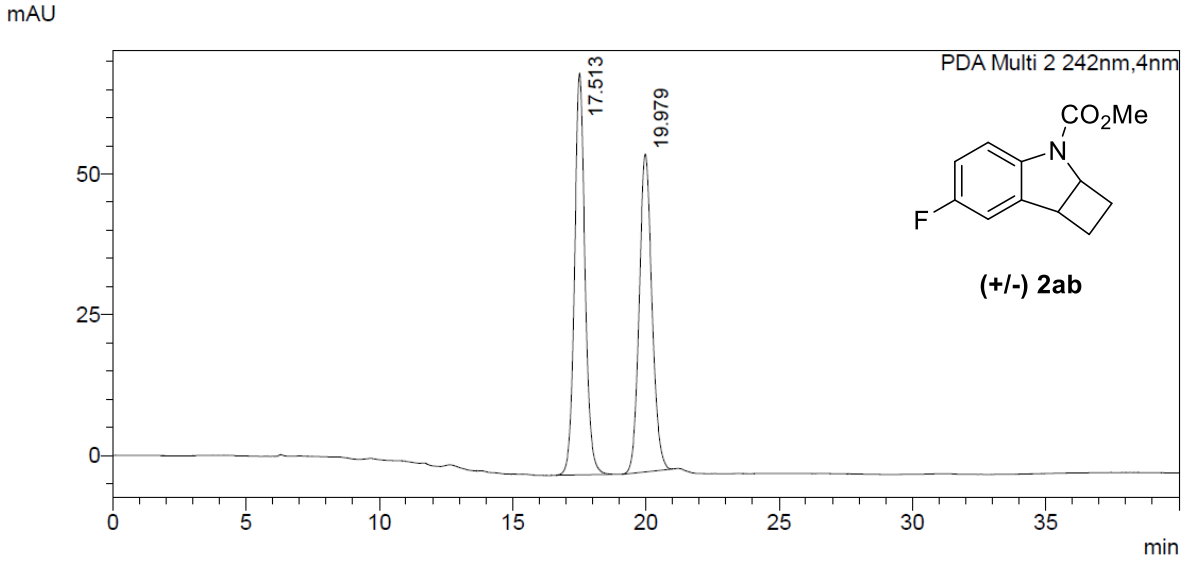


2ab

^{19}F NMR, $CDCl_3$, 376 MHz



2ab

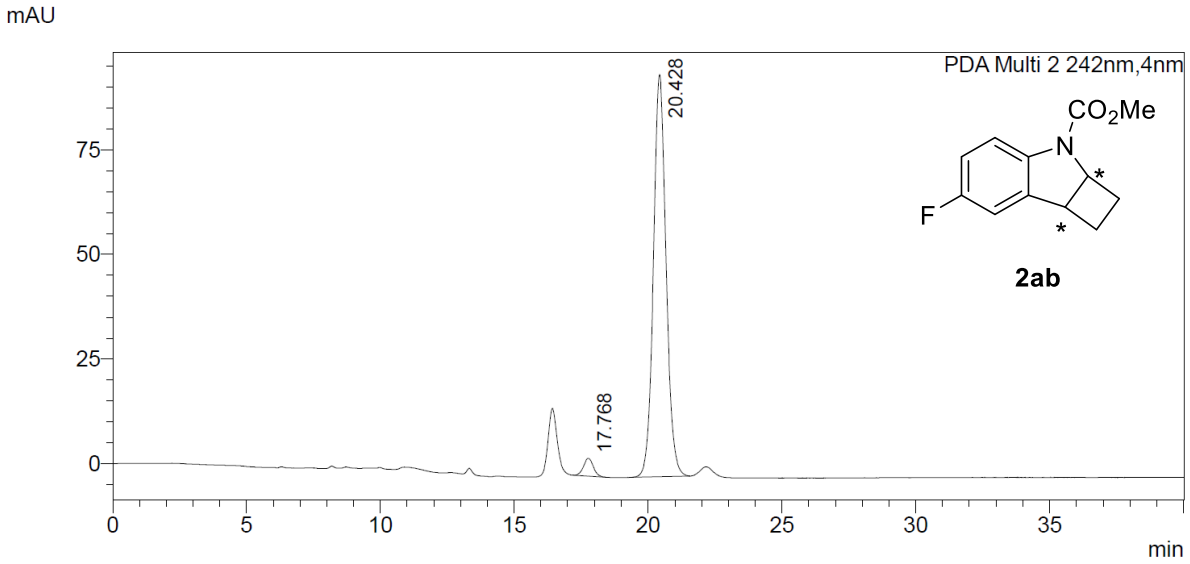


<Peak Table>

PDA Ch2 242nm

Peak#	Ret. Time	Area	Height	Area%
1	17.513	1951867	71317	50.961
2	19.979	1878217	56480	49.039
Total		3830085	127797	100.000

After a first column chromatography (EA:pentane = 1:90)

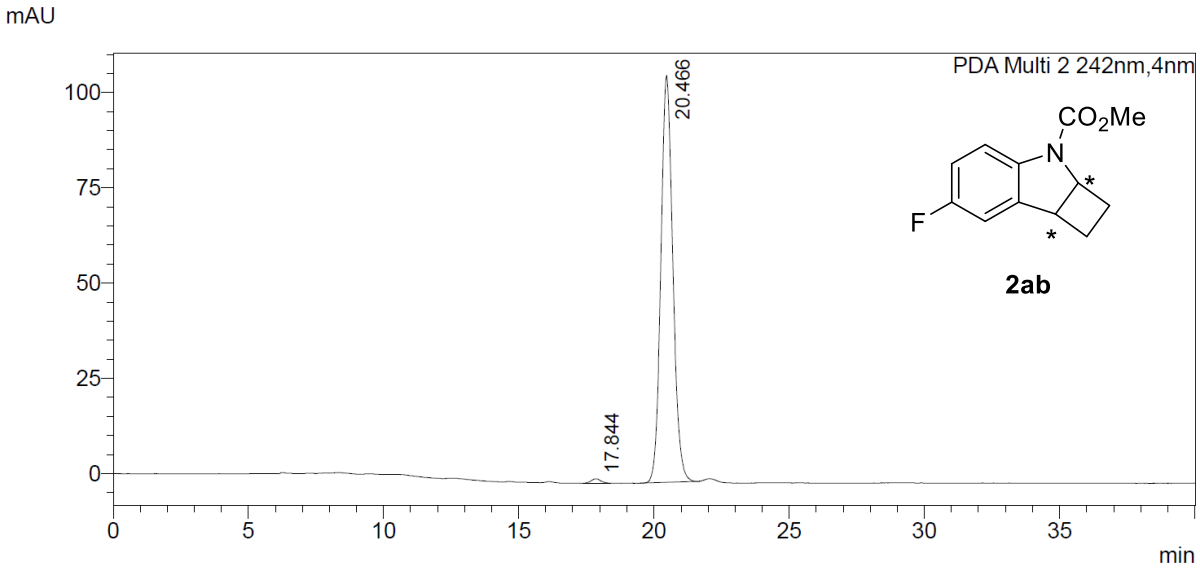


<Peak Table>

PDA Ch2 242nm

Peak#	Ret. Time	Area	Height	Area%
1	17.768	109127	4288	3.344
2	20.428	3153935	96029	96.656
Total		3263063	100317	100.000

After two Pre-TLC (Et_2O:pentane = 1:50 and DCM:pentane = 1:9)

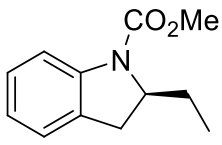


<Peak Table>

PDA Ch2 242nm

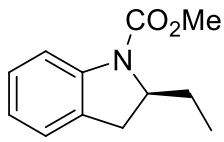
Peak#	Ret. Time	Area	Height	Area%
1	17.844	27446	1145	0.826
2	20.466	3293650	106748	99.174
Total		3321096	107893	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

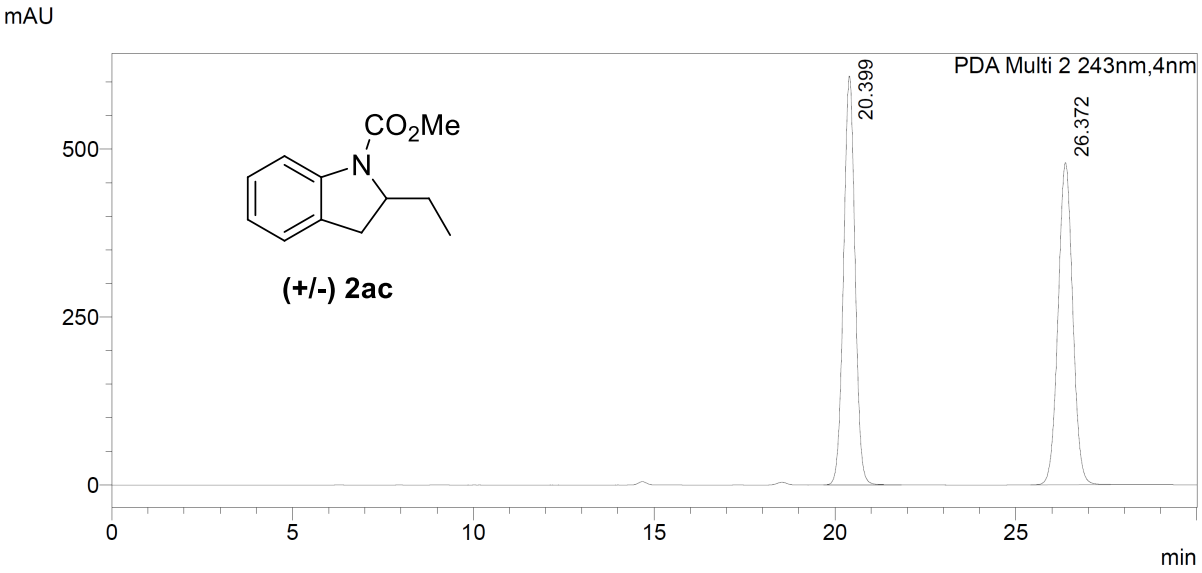


2ac

^{13}C NMR, $CDCl_3$, 101 MHz



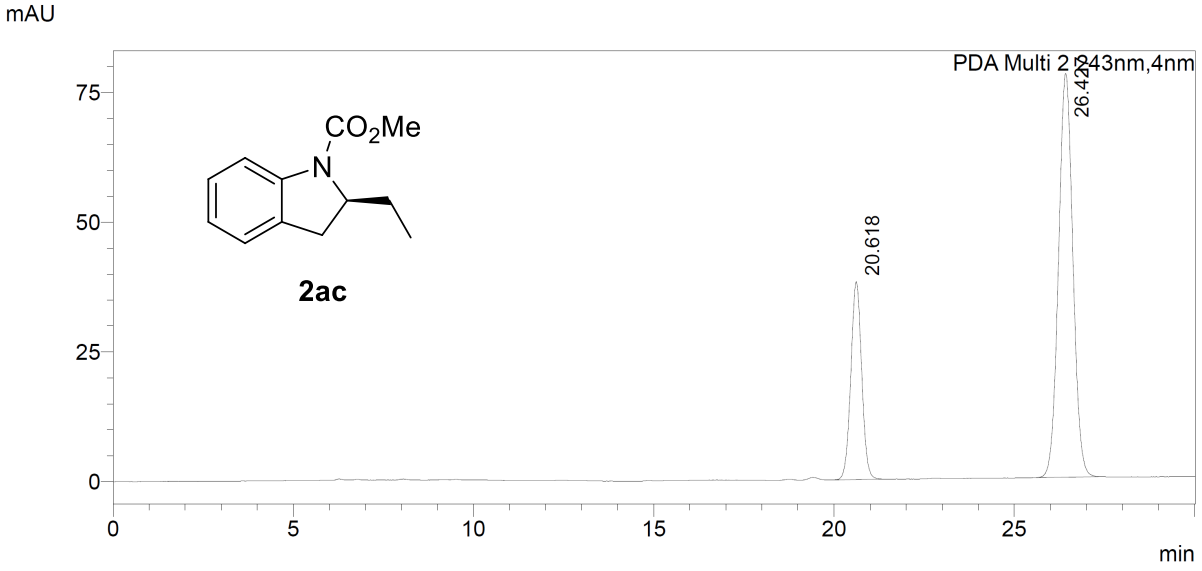
2ac



<Peak Table>

PDA Ch2 243nm

Peak#	Ret. Time	Area	Height%	Area%
1	20.399	13408720	55.939	49.819
2	26.372	13505979	44.061	50.181
Total		26914699	100.000	100.000

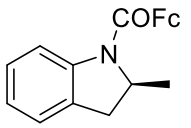


<Peak Table>

PDA Ch2 243nm

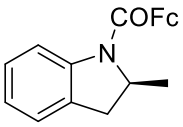
Peak#	Ret. Time	Area	Height	Area%
1	20.618	799763	38119	27.013
2	26.427	2160943	77798	72.987
Total		2960705	115917	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

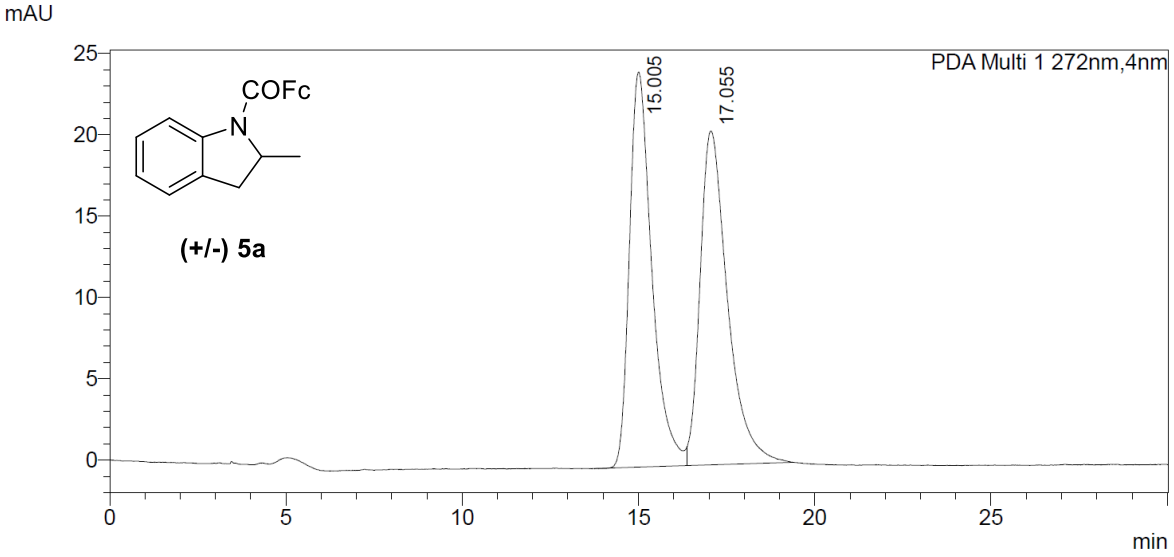


5a

^{13}C NMR, $CDCl_3$, 101 MHz



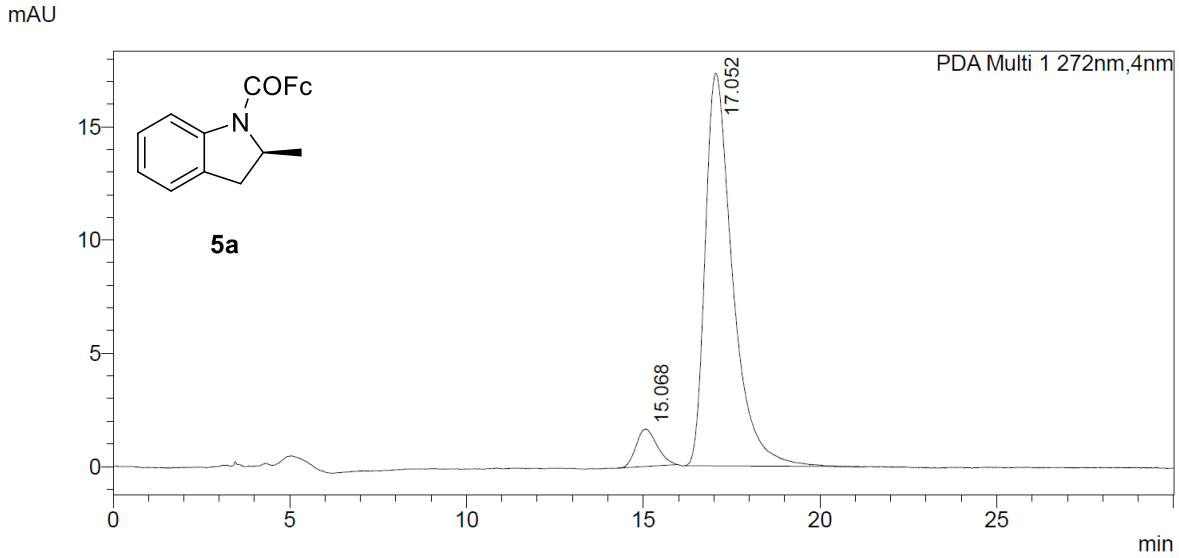
5a



<Peak Table>

PDA Ch1 272nm

Peak#	Ret. Time	Area	Height	Area%
1	15.005	1079571	24285	49.315
2	17.055	1109556	20528	50.685
Total		2189126	44813	100.000

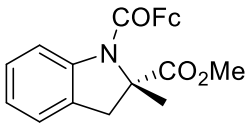


<Peak Table>

PDA Ch1 272nm

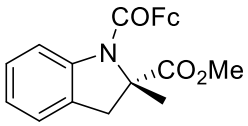
Peak#	Ret. Time	Area	Height	Area%
1	15.068	68103	1660	6.793
2	17.052	934391	17339	93.207
Total		1002495	18999	100.000

^{1}H NMR, $CDCl_3$, 400 MHz

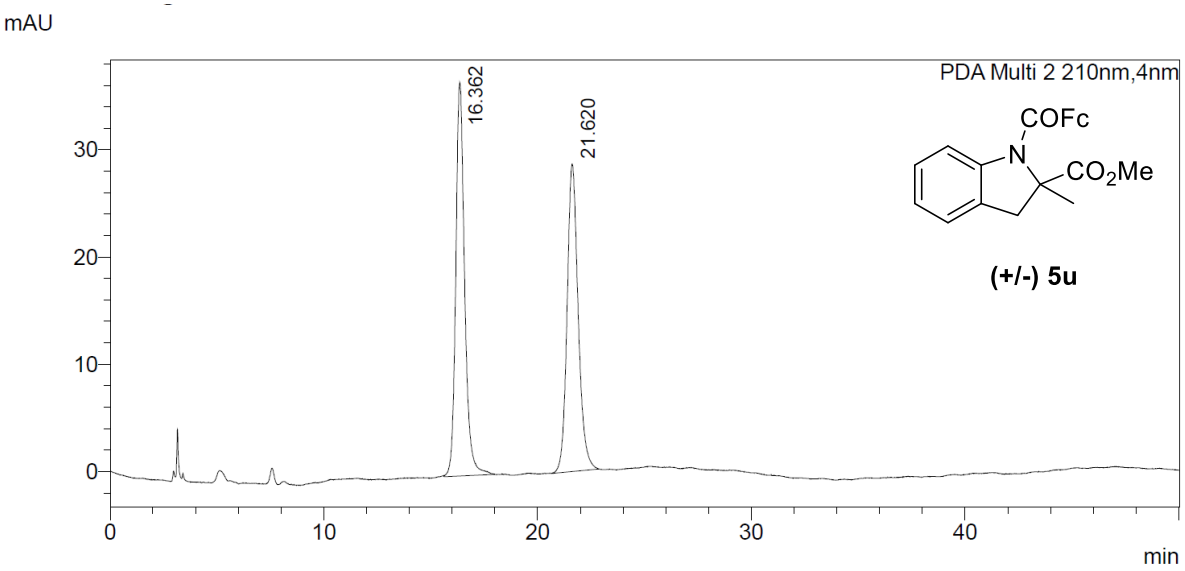


5u

^{13}C NMR, $CDCl_3$, 101 MHz



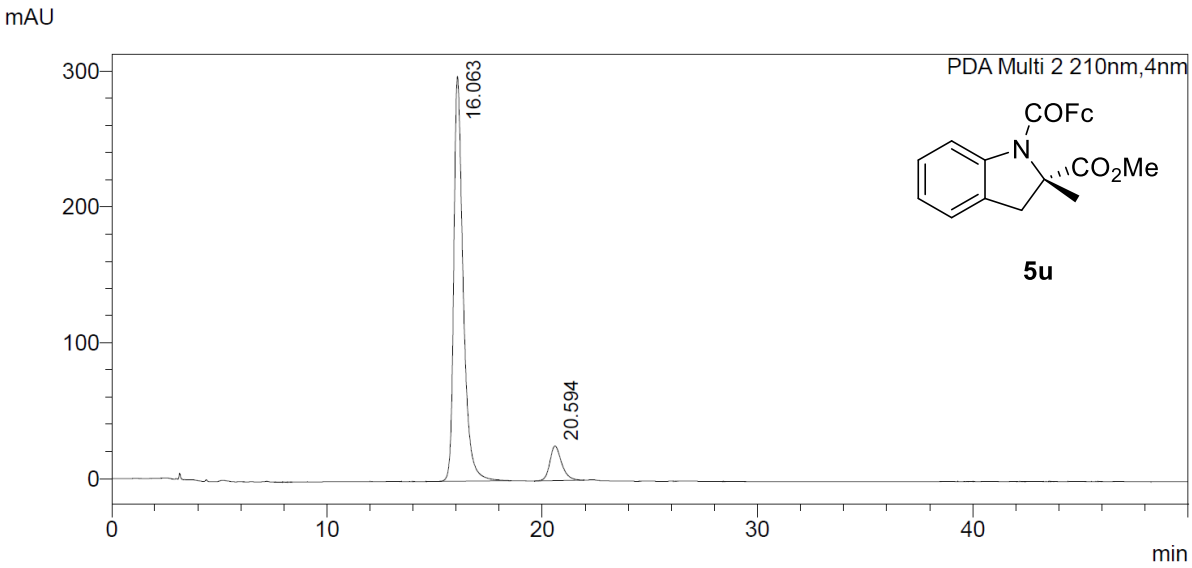
5u



<Peak Table>

PDA Ch2 210nm

Peak#	Ret. Time	Area	Height	Area%
1	16.362	1055774	36701	50.551
2	21.620	1032763	28656	49.449
Total		2088537	65357	100.000



<Peak Table>

PDA Ch2 210nm

Peak#	Ret. Time	Area	Height	Area%
1	16.063	9039482	297723	90.238
2	20.594	977888	25561	9.762
Total		10017370	323283	100.000